EMERGENCE OF DIGITAL AND X-AS-A-SERVICE PLATFORMS IN GERMAN ENERGY SECTOR

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Abstract

Business models in the energy sector in Germany experiencing a profound transformation due to the evolution of digital services. Over the recent years, various digital technologies have been adopted and are supporting this transformation. Typically a gap between technological advancement and business value capture can be observed that is often filled by startups offering innovative business models, products and services based on new technologies. State-of-the-art digital technologies facilitate companies to collect and process huge amounts of consumer data which allow them to sense consumer trends and future value proposition opportunities. In practice, such startups are aiming at the final consumers by focusing on the consumer-specific part of the energy value chain. By this, they are disintegrating the conventional energy value chain with its linear business models that dominated in the past (Business-to-Business (B2B) or Business-to-Consumer (B2C) models). In this work, we had analysed the business activities of 240 active German energy startups founded in 2014 to 2020 (April). The data is collected from multiple sources including company databases, web-scraping and professional data collection services. The underlying focus of this analysis is centered on the digital platform and X-as-a-Service (XaaS) business models. The finding reveals that most of the innovative energy startups are early adopters of digital technologies such as Artificial intelligence (AI), Blockchain, Digital-twin (DT), etc. Along with, to respond to the scalability challenges a significant number of startups have adopted or in the transition to adopting a platform-driven economy. These startups are privileged by the increasing Network Externalities (NE) among the consumers, which improves the startup's value proposition and profitability by targeting a large number of consumers. The finding also covers the geographical distribution of startups implementing multi-sided platform business models in Germany.

Introduction

Digitalisation is affecting our society more than ever. Over the last decade, it has influenced almost every sector of activity. At the same time, the digitalisation wave is fuelling innovations in the terms of new business models, digital services and products. De facto, the current wave of digitalisation is demand-driven and driven by consumers seeking sophisticated digital services or products [1]. Similar to other sectors, the energy sector is also experiencing a digital transformation. The Digital agenda (https://www.de.digital/DIGITAL/Navigation/DE/Home/home.html#) of the Federal government in Germany is promoting the digital transformation in Germany and is led by the Federal Ministry for Economic Affairs and Energy (BMWi). Therefore, the energy sector has a high priority among policymakers [2]. As a result, various services based on digital technologies have been successfully developed and are integrated into the energy sector. New technologies like Web 2.0, Artificial intelligence (AI), Blockchain, Internet of Things (IoT) and Cloud have further potential to disrupt the energy market. Typically a gap between technological advancement and business value capture can be observed that is often filled by startups offering business model innovation (BMI), innovative products and services based on new technologies.

The conventional value chain in the energy sector was primarily dominated by generation, transmission and distribution. Moreover, the consumers had the least priority in the value chain. Nowadays, energy startups are disintegrating the existing value chain by realizing a *consumer-first* approach (Figure 1). A significant number of services have been implemented using digital and XaaS platforms. Such changes are only feasible due to emerging digital platforms with strong *Network effects* or *Network externalities (NE)*. Network externality is defined as a phenomenon in which the number of users utilizing similar products or services increases the value of a network. Furthermore, positive network externalities (P-NEs) represent a strong network effect with increasing demand. On the

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contrary, the negative network externalities (N-NEs) signify the negative effect in the network and show less demand for a particular product and service in a network [3].

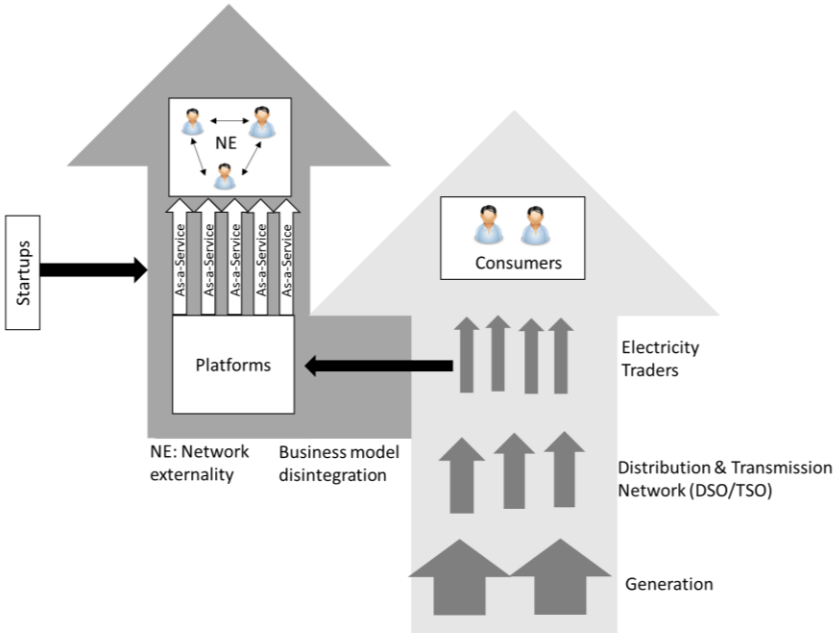

Figure 1: Value chain disintegration of the energy sector

Decentralisation and digitalisation of the energy sector have opened new opportunities for startups to innovate and reform their value proposition. Hence, the proliferation of digital platforms in the energy sector is not surprising. A Study in [4] already confirmed that 37% of German Small and medium-sized enterprises (SMEs) are using digital platforms to interact with customers. Digital platforms are also referred to as multi-side marketplace. These platforms are allowing consumers, producers and service providers to share a common marketplace. There are adequate numbers of arguments that support the development of such platforms. However, the role of emerging Information technologies (IT) is a crucial one. These technologies have the capability to build a networked community by putting a digital net among the consumers and service providers. Henceforth, the research questions are formulated as follows:

- What kind of new digital platforms or XaaS models are emerging in the energy sector?
- Which technologies are facilitating the use of digital platforms or XaaS?
- What is the role of network externalities in the XaaS business models?

In the following work, energy startup data is collected from different sources and analysed by putting digital and X-as-a-Service (XaaS) services in the first place. This case study confirms the clear inception of multi-sided digital platforms in the German energy sector. In the collected data, 23.7% have reported the use of platform driven business models. Utmost use cases for platform models are available in the energy trading and electric mobility sector.

The starting two sections of the paper provide a brief background about the digital platform in the energy sector together with data and methodology. Next section summarises the findings from the current work followed by the discussion, conclusions and future perspectives.

As-a-service and Digital platform background

Platforms are often defined as a multi-sided or collaborative space where multiple actors meet to create value by participating in various activities such as exchange of goods, transaction, knowledge sharing, resource management, etc, [5]. Moreover, there are other definitions that also exist in this context, for example, in [6] authors have defined platform as an intermediary performing the following three main tasks

- Matching supply and demand
- Meeting consumer's demand by assembling good
- Enhancing quality and innovation by managing information flow

As an intermediary, such platforms are building an eco-system comprising multiple Network candidates (NC).

In addition to above, multi-sided platforms are also offering the reproducibility and scalability of business with minimum investment. Platform models are consumer-centric, whereas traditional business models are product-centric. The new value propositions are leveraging consumer participation via digital services. Consumers themselves building a network by simultaneously participating in various digital services. The value of a network is explained by the Metcalfe's law [7]. It states that "*The strength of network (or the value of network) (S) is proportional to the square of the number* (N) *of connected users in a particular network i.e* $S \propto N^2$".

In the energy sector, a typical case of the platform is considered as balancing services, positioned between the consumers, generators and suppliers. Further, these services are disrupted by the companies or startups offering flexibility and demand-response related services. Thanks to the smart-meter technology that has leveraged electricity companies to sense and model consumer behavior based on demand-response enabled appliances. In addition to this, several platforms are offering electricity trading by aggregating consumers, prosumers and energy providers. Beyond this, few platform services are aiming at the other services by putting energy saving as a side priority. In particular, comfort-as-a-service (CaaS) model offers improved indoor comfort as well as energy saving. Indeed, the platforms driven services are quite popular in the energy sector. In a recent publication [8], authors claimed more than 200 digital platforms are active in Europe.

Over the last few years, several XaaS models also have been emerged in the different sectors. Moreover, in a study conducted by International Data Corporation (IDC), 93% of energy utility companies have responded Energy-as-a-service (EaaS) as a most preferred business model [9]. XaaS models are considered as a special case of platform models. Though, XaaS models are new entrants in the energy sector. Various, SMEs and innovative startups are implementing XaaS models to target consumers by offering a set of services on a single platform [10]. These services are self-organizing collaborative, and independent, collectively execute a final service to internal or external stakeholders [5]. For instance, Solar-as-a-Service (SaaS) encompasses various sub-services such are financing, installation, maintenance, energy management, etc. to offer consumers solar energy as a final service outcome. Many of such models are driven by the Pay-for-Performance (PFP) or Pay-per-Use (PPU) models and users expected to choose a rental or subscription plan. Besides, XaaS models are also taking advantage of the network effect, which improves the participation of not only the consumers but also sub-service contractors, for example, platform compatible advanced software, hardware manufacturers.

Data and Methodology

The energy startup data is collected in the framework of the Innovation Systems Data - Excellence Center (ISDEC) project. The aim of the sub-project "*Data-driven assessment of energy startups in Germany*" was to analyse various activities of startups within the German energy sector. Moreover, the overreaching objective was to understand technological advancement and business model adaptation by the German energy startups. Further, nine principal business categories are covered in the study, they are: Renewable energy, Energy management, Energy storage, Electric mobility, Energy trading, Chemical and material, Utility and grid, Energy efficiency and Other [11].

In line with the project objectives, an initial list of energy startups has been collected from various public sources such as reports, membership programs, regional and federal funding programs, energy startups data platforms. A detailed data description about the data sources and collection is addressed in [11]. To develop further understanding about the selected startups, commercial databases, patent database and German commercial business register are used. In addition, data from professional data collection services [12] is also used to ameliorate our collected data.

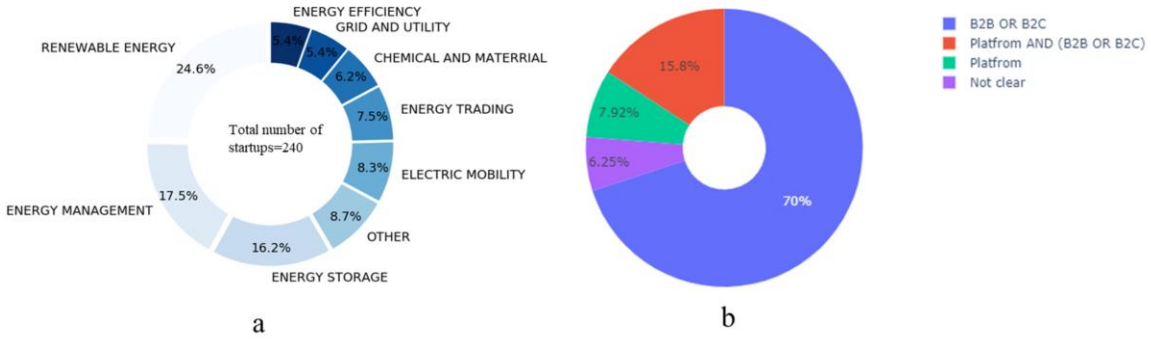

Figure 2: (a) Distribution of startups (a) over the categories, (b) over the business models

Above combination of datasets covers various information about startups such as the physical address, business text, year of incorporation and patent details. In the next step, startup websites are scaped using web-scraping techniques. Python package Scrapy and BeautifulSoup are used for web-scraping purposes. The result of web-scraping is unstructured data that allows us to dig deeper into the startup's actual business activities. With our designed data collection methodology we came up with a total of 240 energy startups in Germany founded between 2014 to April 2020, among which 53 startups are located in Bavaria, followed by Berlin (49 startups) and Baden-Württemberg region (39 startups). Figure 2a shows the distribution of energy startups over the selected categories.

Furthermore, from the web-scaped data, a set of keywords combining technology and business are extracted with the help of Natural language processing (NLTK) and automatic keyword extraction. Due to the aim of identifying the digital platforms related activities, various keywords like 'Platform', 'as-as-Service', and 'Energy cloud' etc, are taken into account. In this context, these keywords are further analysed to acknowledge the evolution of digital platforms in the German energy sector.

Research Findings

As noted earlier, digital technologies have enabled new business models in the German energy sector. It is notable that, German energy startups are offering various digital and X-as-a-Service (XaaS) platforms. Though, B2B and B2C business models have appeared as the largest (70%) share in our collected startup data sample. Nevertheless, 23.7% i.e 57 startups have reported the use of either platform or XaaS business models in the collected startup's profile. In few cases, the business model description is not clear from the startup's web profile. As a result, 6.25% of startups showed up with no clear business model description (Figure 2b). Our collected data reveals that out of 240 startups approximately 8.0% (19 Startups) already have implemented a completely multi-sided platform driven business model. On the other hand, 15.8% (38 Startups) are experimenting with platform or XaaS models with their traditional business-to-business and business-to-customer business models.

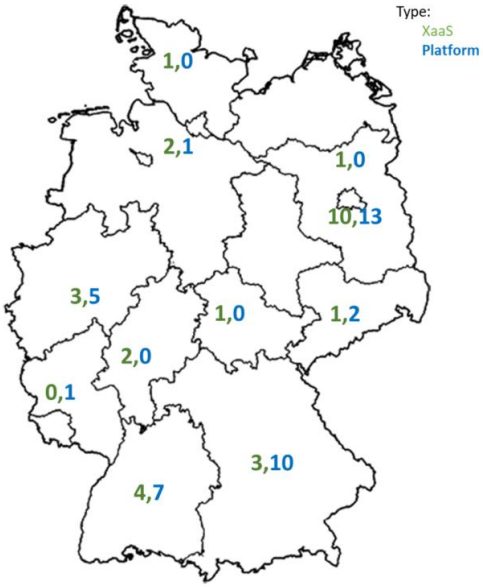

Figure 3: Geographical distribution of platform and XaaS models in Germany

Due to the strong entrepreneurial support and startup culture in Berlin, a total of 23 startups implementing either platform or XaaS belongs to Berlin followed by Bavaria (13 startups) and Baden württemberg (11 startups). The presence of these startups also signifies the activities related to digitalisation, investment, Research and Development (R&D) associated with XaaS and platform models in the particular regions. The majority of startups using platforms offering a digital marketplace to compare, trade, manage and buy energy or energy related products and services. However, a number of startups offering a specific service platform comprising various sub-services.

XaaS Business models focus

In our collected startup sample data, we have spotted a total of 10 types of XaaS service model platforms. These are listed in the following table. Moreover, startups implementing software-as-a-service, peer-to-peer, and charging-as-a-service are the most frequently appearing service platform in the dataset. Figure 4a depicts the distribution of the number of startups implementing the digital and XaaS model over the year of incorporation. Each XaaS service model

offers some core value propositions. For instance, charging-as-a-service targets potential EV users who are not willing to pay for personal charging facilities. Henceforth, the sharing of networked charging stations, charging management and increased property value are central value propositions of this particular XaaS model.

Table 1: XaaS service business models

As-a-Service business model	Central value propositions	Network candidate	Network externality
Software-as-a-Service	• Cloud-based energy management • Resource optimization • Cloud-based IT infrastructure /Software • Data analytics, visualization and reporting	• Energy service companies (ESCOs) • Utilities • ITC technology provider • Commercial and industrial sites	High [13]
Charging-as-a-Service	• Networked charging stations • Charging management • Increased property value	• EV users • EV manufacturers • Retailers, municipalities, businesses, companies with parking lots	High [14,15,16]
Peer-to-peer	• Social benefits • Direct transactions between peers • Energy trading in a network	• Prosumers/consumers • Utilities/Retailers • Households/Commercial buildings and business owners	High [17]
Flexibility-as-a-Service	• Demand-response potential • Load management • Saving based incentives	• Energy service companies • Demand response aggregator, Retailers • Industries • Households/Commercial buildings and business owner • Energy consumers in general	High [5]
Energy-as-a-Service	• Monitoring and load management services • Demand response • Design, installation, maintenance and performance management of energy services	• IT technology provider • Energy service companies • Local energy market players • Commercial and industrial buildings owners	High [9,10]
Solar-as-a-Service	• Green electricity • Co-financing for solar projects • One shop package for installation, maintenance, operation, management and billing	• Residential/Commercial building owner and users • Energy service companies • Energy retailers	Medium [Own]
Comfort-as-a-Service	• Living space management • Improved indoor environmental quality (IEQ)	• Real state owner • Facility manager • Energy service companies • Building users	Low [Own]
Battery-as-a-Service	• Battery on cloud • Quickly exchangeable battery system • Universal storage	• EV users • Charing infrastructure developer • Battery manufacturers	Medium [Own]
Micro-grid-as-a-Service	• Micro-grid deployment financing • Operation & maintenance agreements for energy infrastructure • Integrated energy system	• Utilities/Retailers • End-consumers/Prosumer	Low [Own]
Trading-as-a-Service	• Digital marketplace to connect consumers with energy producers • Price comparison	• Utilities/Retailers • Households and commercial building owners • Business owners	High [14]

It is also noticed that few XaaS service models are competing with each other to some degree. Nonetheless, their value propositions are different but they are targeting the same group of end-customers. One example of such a model is battery-as-a-service (BaaS) and charging-as-a-service. Both are targeting EV users and dealing with charging infrastructure and battery charging management. Another example of alike models could be peer-to-peer and trading-as-a-service.

Aforementioned, network candidates and network externalities are an integrated part of the platform or XaaS models. In this context, various network candidates are identified from the startup's website. The table above includes the main network candidates belonging to the mentioned XaaS models. At this stage, our analysis relies on available literature. Moreover, in few cases own assessment is also made based on company growth and investment in startups implementing a particular XaaS model. It is assumed that the financial performance of startups is also proportional to the strength of the network. In this sense, the company's databases dealing with financial activity are considered. For example, Creditreform is one of the most trusted sources not only for startups but all companies in Europe [18]. Financial activity is a key criterion for Cerditrefrom company listing. Financial growth is also linked with the change

in the number of employees in a particular company. Therefore, both together could provide an initial guess about the performance of networked business models.

Technology focus

Information and communication technologies (ICT) are playing a vital role in building a user-driven platform. The use of ICT technologies facilitates startups to test and new business model innovation. In this connection, a majority of startups have reported extensive use of data or big data-related technologies.

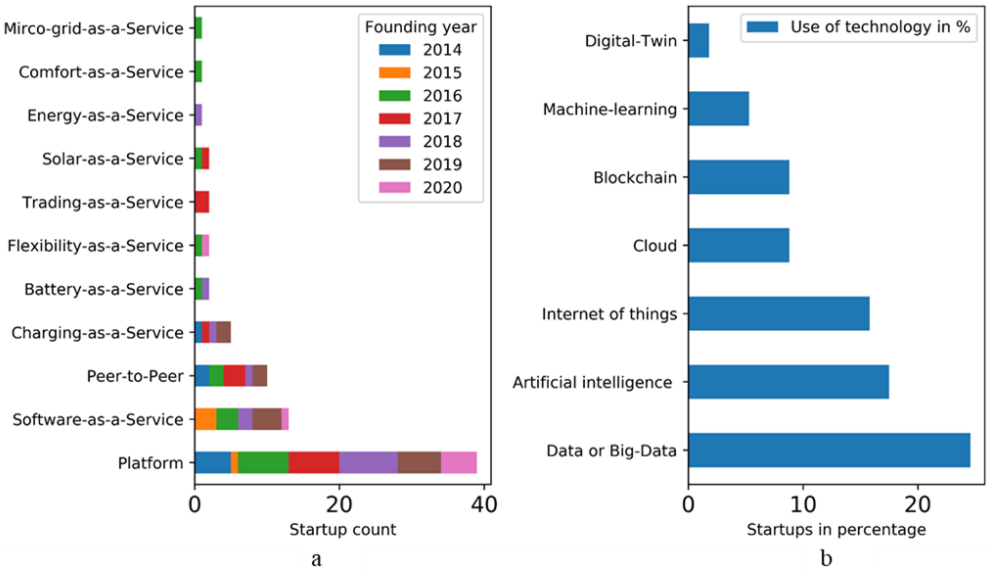

Figure 4: (a) Distribution of startups (a) Platform, XaaS business model over the year of incorporation, (b) over the digital technologies (total number of startups=57)

Indeed, data is the key attribute of platform and XaaS business models. Further, technologies like Artificial intelligence (AI), Machine learning (ML) Internet of things (IoT), etc, count on data models. For instance, startups implementing platforms related services such as customer segmentation, pricing forecast, predictive maintenance, and energy-efficient operation with the help of machine-learning in combination with data analysis, AI, and IoT. Hence, 17.5% of startups have integrated AI with their platform or XaaS value proposition followed by IoT i.e 15.8%. Blockchain or Distributed ledger technology (DTL) is another promising technology used by 8.8% of startups. It is removing the dependencies on intermediaries. Despite some limitations, it has enabled the integration of billing, Peer-to-peer trading, and supplier switching.

Cloud technology became more popular among startups dealing with Customer relationship management (CRM). It engages customers by providing real-time data analytics and energy management software hosting. Moreover, 8.8% of startups are found with cloud implementation. Digital-Twin, often considered as an advanced layer of IoT, is another upcoming technology in the energy sector. Many energy companies are looking forward to leveraging the added value of digital-twin technology. It uses a connected data environment to automate and monitor various real-time parameters simultaneously. However, Digital-twin is considered as an *up-and-comer* in the energy sector, the major application is concentrated on monitoring, maintenance optimization, energy cost optimization in industry and buildings. Resulting, only one startup shown up in the context of startups realizing platform services.

Discussion

There is no doubt that startups are the earlier adopters of platforms and XaaS business models since it is crucial for them to gain first-mover advantages in the market competition and enhance their competitiveness by exploiting the advancements of network externality, flexibility and scalability. Therefore, it is of great significance to detect the emergence of the platforms and XaaS models from energy startup profiles systematically and comprehensively. According to our analysis results, recent platform development is supported by cloud computing, IoT, AI and big data techniques. New digital platforms and XaaS models gradually lead to pioneering business models in the energy sector, in particular as Software-as-a-Service and Peer-to-Peer. These two types of business models have high network externality and are quite mature in the other domains, which can be easily transferred to the energy sector.

The increasing trend of Charging-as-a-Service is also contributed by the rapid development of mobility. After all, while efforts to embed scalability and flexibility in the business models enable smart operations for the whole energy value chain.

From the service perspective, the higher the network externality is, the more companies are attracted since they can take advantage of customer aggregation. From the distribution perspective, the more network connections are, the better these business models are developed. Berlin, as the center of startups in Germany, has witnessed the strength of a network. The strong partnerships among startups and established enterprises contribute to the booming of the platform and XaaS based startups in Berlin. In the meantime, the impact of regulations and policies has to be considered in future research to identify the most promising opportunities for XaaS concepts and derive policy recommendations.

Conclusions and future perspectives

With the growing prevalence of digitalization, a new era of smartness is ushered in the energy sector, in particular for business models. As the pioneer of energy transition in Germany, startups are introducing more and more platform and XaaS based business models, which can largely enhance flexibility, scalability and user engagement. Targeting to analyze the status and roles of platform business models in the German energy sector, this paper establishes the workflow with web-scraping and text mining based on keyword extraction from multiple data sources. The contributions of this study are highlighted as the following points:

- In general, there is a distinguished trend that business model in the energy sector is shifting from conventional B2C and B2B to platform or X-as-a-Service (23.7%), especially for Software-as-a-Service, Peer-to-Peer and Charging-as-a-Service. The higher externality the services have, the more attractive they are to startups. However, their development quite relies on the technology transfer from other domains, which means they are still not mature yet to attract traditional energy consumers.
- Due to the strong entrepreneurial support and culture, Berlin leads both platform and X-as-a-Service business model in the German energy sector, followed by Bavaria and Baden Württemberg where are advanced in technology, economy and industry.
- Data is the key to platform and X-as-a-Service business model so that big data technologies would be the foundation of the above two business models in the near future. AI and IoT will also largely contribute to the energy transition, in particular for the business model innovations.
- In the course of the research, network externalities of various XaaS models active in the energy sector are examined.

Although the proposed approach has already brought various technical and thematic contributions, there are particular two areas that lend themselves to further exploration:

First, develop and design indicators to access the success of XaaS and digital platforms. Various factors, such as the use of the internet, data regulations, investment in digital platforms, and network strength, could collectively help design such indicators. Innovation activities behind these business models are still debatable. Whether platforms need to be innovative or innovation does not play any crucial role in the platform economy is still a question. Second, a further investigation about the future XaaS services will be definitely an interesting study. Yet, many services active in the energy sector could be combined in the form of a single value proposition.

Acknowledgment

The authors would like to acknowledge Fraunhofer society and Innovation System Data Excellence Center (ISDEC) program for the financial support to the project `Data driven assessment of energy startups in Germany'.

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