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Smart Meter Data Analysis for Residential Energy Consumption: A Human-Centered Study of the N-Ergy-View App

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Contents

1. Introduction

The energy sector has experienced a number of crises in the last couple of years. The International Energy Agency (IEA) releases an outlook on the energy sector every year, which showcases various forecasts and trends [1, 2] within the energy sector regarding energy demand or production, for instance. They also deal with the investment in renewable energy sources such as solar or wind power and also analyse CO2 emissions and the resulting air pollution. According to the IEA's World Energy Outlook Analysis, the Covid-19 pandemic and the recent Russian invasion of Ukraine has influenced the demand in and prices of energy in various ways.

The European Union has also made various attempts to address challenges in its energy sector and has introduced various laws and packages to deal with current issues such as green energy or regulations within the European energy market. The EU Directive 2019/944 of the European Parliament, for example, introduced common rules for the internal market for electricity that have to be devised into law by the individual member states [3]. This directive is part of the Clean Energy Package, which contains many other directives and regulations, which deal with Europe's energy policy framework. This package was established in order to move the EU member states towards using clean energy and reaching their commitments to reduce greenhouse gas emissions, which have been set out in the Paris Agreement of 2015 [4]. Directive 2019/944 establishes new market rules within the energy sector, promoting a more liberalized market and greater consumer involvement. One key aspect of this directive is the right of consumers to access their own energy data through smart metering systems, as outlined in Article 20 [3]. Additionally, the directive enforces the installation of smart metering devices in households, further enabling active consumer participation in smart energy systems [5]. This directive thereby could potentially enable various interesting projects and services with interesting business models and solutions aimed at solving specific issues within the energy sector.

In this thesis, the European internal energy market and the resulting business use cases will therefore be examined. This will include an overview of which regulations enable green and innovative data driven energy services and ensure that the EU can reach its climate goals. After learning that these new rules try to liberalize the internal energy market by also introducing smart meter devices to European households, this thesis will further discover what these Internet of Things (IoT) devices do and how they can contribute to the energy system and the stakeholders of the internal energy market. Furthermore, the vast amount of smart meters being introduced worldwide also means that there is a need for an infrastructure or framework, which would be able to manage all of these devices and to integrate as well as aggregate the collected data. Using big data management, frameworks and energy data spaces can bring more control over energy data

as well as the energy system itself. Moreover, they enable data-driven energy services for the energy ecosystem. By applying big data analytics, machine learning or AI to energy data gained this way, more knowledge and insights can be achieved. Forecasts and pattern recognition can help the grid by better responding to higher energy demand or the dynamically pricing of tariffs.

Consequentially, there are many different use cases that will be discussed in this thesis that have the potential to change the energy market and system. Most use cases can already be found in scientific literature. However, in many cases there are no clear conclusions on how private households directly benefit from these innovations. To address this gap, a closer examination (or focus) on human centered apsects and Human-Computer Interaction (HCI) literature was conducted, particularly focusing on how energy monitoring dashboards and apps for households influence consumer behavior. Additionally, an in-depth investigation of energy use cases in the practical field was carried out. With the implementation of EU Directive 2019/944, households are entitled to access their energy consumption data, which could be leveraged for more advanced dashboard and visualization applications. While some utility companies may already provide basic visualizations, they often lack deeper analytical insights. Integrating Machine Learning (ML), Artificial Intelligence (AI) and Data Analytics into these tools could potentially enhance consumer engagement, enabling more effective energy savings and cost reductions. Since there is currently no literature about energy monitoring apps that use ML/AI and to further explore this potential, a pilot study will analyze companies that currently use—or could benefit from—smart energy data. As part of this study, participants will categorize these companies and identify use cases that combine energy monitoring with AI/ML-driven analytics. Furthermore, presentations and accompanying Q&A sessions with companies from the energy sector were analyzed to gather practical insights into current use cases and industry challenges. These insights should also help to further understand the issues within the sector as well see how energy data can be used for various use cases. This research will help understand the direction in which a potential application could go.

Furthermore, the University of Vienna is a partner of the European Distributed Data Infrastructure for Energy (EDDIE) project, an EU-funded project that implements a decentralized, distributed and open-source Data Space framework for energy related data [6]. Consequently, as a project partner for EDDIE, University of Vienna must implement a demonstrator that uses this framework. Therefore, the University of Vienna decided to implement *N-Ergy-View*, an energy monitoring and analysis application for households. This application predicts future energy consumption, compares fixed and dynamic energy prices by calculating the costs for the next day based on predictions, and calculates the household's carbon footprint using consumption data. These analytics aim to help households save both energy and money, as well as raise awareness about the environmental impact of their consumption. Additionally, through price comparisons and clear visualizations of the insights, users are empowered to better understand their household consumption patterns and make more informed decisions. An exploratory human-centered design approach was adopted for the implementation and requirements

development of the application, as detailed throughout this thesis. Insights gained during this research process have also been disseminated through a publication authored by the researcher in the context of the EDDIE project [7].

Research Questions Context

The first aim of this thesis is to examine lessons learned from the literature by analyzing practical insights from the field. This investigation addresses a identified scientific gap regarding how households can directly benefit from the vast amount of energy data and associated use cases, as well as how such data driven energy services should be optimally designed and implemented. Through thematic clustering, key themes, opportunities, and challenges were identified based on insights from company presentations at a professional exchange meeting within the EDDIE project context. Additionally, the previously mentioned categorization of use cases, which were identified through a student pilot study, played a crucial role in determining main categories within the energy sector. These findings significantly informed and influenced both the conceptual design and the overall direction of the energy service that was developed for this thesis.

Afterwards, the thesis discusses the app's overall approach and objectives, with a particular focus on the themes that emerged from the thematic analysis through interviews with the target user group and a human-centered design approach. These themes include visualizations and graphical representation of insights, as well as user experience, behavior change, and data privacy, which were used for the user requirement engineering of the app and therefore influenced the design and technical implementation.

This leads to the first central research question:

- **How can data-driven-energy-services for households be designed and implemented to ensure both technical functionality and meaningful user engagement?**

In this context, the thesis also explores the following sub-questions:

- What are the key user requirements and design principles for such a service?
- What can be learned from the development process and the technical challenges encountered?

To conclude the thesis and evaluate *N-Ergy-View*, a pre- and post-survey was conducted, during which a short demo presentation of the app was shown. The pre-survey presented only the concept of the app, while the post-survey included a live demonstration and an explanatory video. This approach aimed to observe any noticeable shifts in user perception from concept to actual implementation, assessing whether the identified requirements and design goals were effectively realized.

These findings directly address the final and concluding research question:

- **What insights can be gained about user adoption of data-driven-energy-services that incorporate data analytics?**

2. State of the Art

The **State of the Art** chapter focuses on the approaches and decisions involved in gathering foundational information from existing literature, covering key topics such as the European energy market, energy data use cases, human-computer interaction (HCI) in energy monitoring, and behavioral economics. What is more is that, a gap in the literature will be identified, particularly regarding the lack of research on the benefits of energy use cases for households, the integration of AI/ML in monitoring applications, and the practical challenges of working with energy data. These insights are highly valuable overall for the research of this thesis and for the design decisions of *N-Ergy-View*.

2.1. Selection and Scope of Literature

This section will deal with the general exploration and search approach of the **State of the Art** chapter and will explain why certain topics were chosen for this chapter and research. The first focus is initially laid on the European Energy Sector. Therefore, in-depth research has been conducted on other European projects and undertakings related to energy and how these affect Europe. Other projects from the EU and reports regarding energy and environmental impact, such as those from the International Energy Agency (IEA), have been found via web search. Due to the European Directive 2019/944 [3], which has enabled the installation of smart metering devices in households and provides access to personal energy data, as well as the purpose of the EDDIE project to facilitate the distribution of energy data among member states, a particular emphasis has been placed on smart metering. This includes examining the technical, societal, and economic benefits and drawbacks of smart meters. Various libraries, such as IEEE Xplore, ACM Digital Library, and Google Scholar [8, 9, 10], were searched using keywords such as *smart metering*, *smart meter benefits*, *smart meter privacy*, and *smart grid* to understand the technical, societal, and economic aspects of smart meters within the energy system.

Since smart meters gather a large amount of data, a central next step is to examine how systems manage this data volume. Consequently, a search for various frameworks, big data management strategies, and data space concepts has been conducted. To further understand what kinds of use cases with energy data are possible, a literature review was performed, particularly in the areas of energy data analytics, artificial intelligence, and machine learning. Much of the research found under the terms *energy data* and *smart meter data* focuses on *data-driven services* and *smart meter data analytics*. A closer look was taken at the benefits these use cases and studies offer. Most concluded that there are positive effects for smart grids, automatic building systems such as Heating, Ventilation, and Air Conditioning (HVAC), anomaly detection in the grid, and load management.

However, no scientific papers or research were found that explore how households would benefit or profit from these data analytics or data-driven services.

Consequently, for the input of *N-Ergy-View* and as a possible solution to the scientific gap in data-driven services where households can benefit from data analytics, a review and focus have been placed on literature regarding energy monitoring applications, their visualizations, and dashboard design. This review examines how these feedback systems help consumers better assess their energy consumption and potentially change their consumption behavior. By searching for keywords such as *energy monitoring*, *energy consumption monitoring*, and *energy monitoring in households*, a better assessment of the types of studies on monitoring applications has been conducted.

Furthermore, in regard to Human-Computer Interaction (HCI) and the human-centered design approach of *N-Ergy-View*'s dashboard, insights have been gained by searching for keywords such as *energy data visualizations* and *energy monitoring visualizations*. These insights will later be beneficial for the design of *N-Ergy-View*, as the evaluation survey of *N-Ergy-View* will address the visualization and overall design of the application.

Lastly, with the demonstrator, certain benefits and behavioral changes are aimed for, such as energy or cost savings, as well as making more informed decisions based on the information provided by the dashboard. As a result, by examining scientific literature regarding behavior change of users in energy systems and design decisions in this area, more insights into goal settings and intervention strategies for the user experience have been gained.

The following sections will provide a detailed review and summary of all the previously mentioned topics.

2.2. The European Energy Market

The European Energy sector is an important topic for the EU's member states, including its citizens, and it is currently undergoing various changes. The Russian invasion of Ukraine and climate change, for instance, present critical challenges at this point in time for the European Union. Russia's invasion of Ukraine caused the global energy market to fall into complete disarray, and as an answer, the European Commission introduced the "REPowerEU Plan" in order to save energy, further increase the production of clean energy and diversify Europe's energy supplies. This is because the European Union remains dependent on Russian fossil fuels [11]. This new strategy also goes hand in hand with the European Green Deal, as the RePowerEU strategy also requires further development and investments in renewable energy sources [12]. Furthermore, Europe's long-term strategy is to be climate-neutral by 2050, and this requires substantial strategies as well as investments into new technologies [13, 14]. One of the EU's key funding programs, which enforces the development and research of innovative as well as sustainable technologies, is called "Horizon Europe". This program helps the Union's strategy in tackling climate change, reaching the UN's Sustainable Development goals as well as strengthening Europe's economic growth and competitiveness [15].

Moreover, the European Union also introduced various legislative directives over the

years with goals of liberalizing the internal energy market, regulating the energy networks, securing energy supply and other actions in order to introduce new market rules for energy [16]. The liberalization of the internal energy market enforces some of the core principles of the EU so as to remove obstacles and barriers within the market as well as to help to harmonize the rules and policies among the member states [16]. The fourth energy package saw the establishment of directive 2019/944/EU and three other regulations to provide market rules for renewable energy sources and investments into this segment as well as other goals within the energy market [17]. The previous third energy package also initiated the plan to equip 80% of European households with smart meters by 2020 [18, 19], and a study from 2019 expects that by 2024, 77% of European electricity consumers will have a smart meter installed in their homes [20].Consequentially, while building a competitive market for the European energy consumers, the liberalization of Europe's energy market also helps the decrease of carbon dioxide emissions [21]. However, social-economic factors also show that only countries with high-income levels in the EU manged to reduce the emissions with the policy changes in the internal energy market [21]. As a result, it can be said that the process of liberalizing and changing the energy market through policies is very complex. Therefore, governments must support this process in order to develop and achieve efficient energy systems, which would consequentially benefit the consumer and the environment by promoting the production of green energy from renewable energy sources [22, 23].

2.3. Aggregating Energy Data

As mentioned in the previous chapters, the European Union sought to liberalize the internal energy market. As a consequence of these various policies, the third energy package states that European energy households should be equipped with smart meter devices [19]. Moreover, in directive 2019/944 [3], it has been established that energy consumers should also be active participants in the market and benefit from the new developments within the energy sector. One of these benefits is to better trade their self-generated electricity and also have an improved overview over their own energy consumption via smart meters, which will provide accurate near real-time data. Furthermore, articles 19 and 20 of directive 2019/944 lay out important rules for smart metering systems and deal with the roll out, deployment, operation and security of these meters. As we can see, smart meters and the data that they collect play an essential role for the innovations and advancements in the energy sector and therefore, should be examined closer.

2.3.1. Internet of Things and Smart Meters

In the energy domain, IoT is required for different processes. One of them is the collection of energy data through the above-mentioned smart meters. These meters have a broad range of benefits within the energy sector. Since our modern society needs electricity to function and energy demand has been increasing globally [24], there is the need to efficiently manage and operate energy supply and systems [25]. Smart meters are

deployed within a smart grid and are essential for the two-way information flow within the electrical system which includes electricity generation, transmission, distribution, and consumption [26]. Smart meters measure valuable information about the consumer's energy consumption, collect time stamps as well as the voltages and frequencies used. Thus, this knowledge can be shared with utility companies or system operators. These utilities need this information to gain insights into peak-periods or energy usage patterns and, as a consequence, can better maintain the system, avoid or reduce power outages and can respond faster if there is an outage [25].

The various meter models use different communication technologies such as Radio Frequency (RF) or Power Line Carrier (PLC) to ensure that the two-way information flow is stable [26]. Regarding the communication, there is also some research focusing on the various EU projects that deploy smart meters for the smart grid and discussing the various architectural styles for the communication of the meters such as communication directly through mobile networks, a PLC/Broadband over Power Lines (BPL) data concentrator or a PLC/BPL Gateway [27]. The information and data collected and forwarded by smart meters and the smart grid has many benefits for the various stakeholders in the energy market. The information flow between consumer and supplier will ensure better energy efficiency, for example. Barman et al. [28] also propose a system, which is less error prone and therefore ensures better energy conservation, easier consumption tracking and power theft detection. This paper also correlates with Corbett et al.'s [29] research where the authors explore how a modern electricity grid and the effects of smart metering would benefit the energy efficiency and the load management strategies on the demand-side in the United States of America. However, there are some privacy concerns with collecting and forwarding data which have to be pointed out. In their work, Chen et al. [30] mention that with some analysis of energy consumption data, it can be determined when someone is at home or not depending on the usage, at what time the homeowner goes to bed or other activity patterns . Of course, there are different types of defense mechanisms that would ensure data privacy, however, there is a tradeoff between privacy, Iot functionalities and costs.

While there are many technical perks of smart metering, there are also societal benefits. These benefits are usually results of the investments in smart meters and the actions taken from the consumers. As mentioned, the customers will benefit from efficient energy usage and, therefore, also better and newer services on the energy market [31]. The consumer is also better informed and gets direct feedback about the energy bill and pricing [31, 25, 26]. Moreover, depending on the demand of energy on the system, fossil fuels could be used to match this surge in demand. Consequentially, this would mean that carbon emissions are released and the system is dependent on foreign fossil fuel imports. These are externalities which are costs that have an negative impact and should be avoided. Nonetheless, now that consumers are able to see their consumption and there are better demand response systems due to smart metering, these costs can be reduced all together [31]. Lastly, another societal benefit would be the macroeconomic impact of investing into smart meters and the smart grid, as, for example, more jobs would be created by these investments.

2.3.2. Big Data and Energy

Smart meters are an devices within the smart grid which collect data. However, there are a wide range of various metering systems, standards, technologies and approaches used to gather this data within this complex cyber physical system. Furthermore, it is necessary to effectively manage and store this big energy data for further processing and to gain insights to allow for better decision making as well as to ensure interoperability between systems. Consequentially, certain technologies are needed that execute this task. In this section we will therefore have a closer look at some of the proposed solutions and some issues that arise within these big data systems.

Big Data Management, Frameworks and Data Spaces

According to Zhou's et al. [32] process model for big data driven smart energy management, there are seven steps to achieve smart energy management objectives. These consist of preparation phases such as data collection, transmission, storage, cleaning, preprocessing, integration and feature selection which are needed for data mining and knowledge discovery steps. Moving further in the process model, the knowledge and the insights should then be visualized and in this way assist the decision making stage. The final steps are the different smart energy management objectives such as efficient energy use, real-time monitoring, demand response, active energy consumers, dynamic pricing and intelligent control. Therefore, we can see that smart grid management, which includes power generation, distribution, transmission and transformation, requires big data analytics. There are also challenges within the energy big data arena. For instance, smart grids are large distributed systems within which a significant amount of data is collected and streamed; as a consequence, a scalabe and interoperable infrastructure is needed [33]. Further challenges of data integration and interoperability include how to accommodate the scope of data, data inconsistencies, query optimizations, inadequate resources, scalability, implementing support systems for updates or errors and the big data processing [34]. These challenges of interoperability can be avoided by using standardized metadata schemas, ontologies and semantic models that ensure that shared understanding can be communicated [35].

Hu et al. [33] mention that real-time decisions for system operations and real-time pricing require a large amount of data, and that processing this data will be very difficult. What is more, this processing also requires artificial intelligence and machine learning algorithms, which can find more insights from the data. However, these algorithms need suitable knowledge interpretation, so that good decisions can be made from the gained knowledge. Lastly, Hu et al. [33] also mention the security and privacy concerns which arise in cyber physical system, such as with smart meters as previously discussed [30]. As mentioned above, there are some challenges with big data, and this highlights the need for efficient ways in which to integrate and share data, if needed. Nie et al. [36] propose a hybrid hierarchy architecture, which collects different data from various sources and divides the data into particular themes and uses data warehouses as a "middle man" as storage. This allows for better mapping of relationships and faster query response times

for data integration systems. To ensure correct and secure data sharing, Karafili et al. [37] want to create certain data policy language that defines how data should be used, shared and/or accessed within data rich environments. Furthermore, these policies can create restrictions and security by ensuring that the quality of the data cannot be altered [38].

Due to the large volume, velocity, variability and variety of data that is being produced especially in smart grids there are various frameworks that deal with this issue as well. Therefore, Liu et al. [39] proposes a framework within the Chinese power grid that guarantees data quality for other data driven services. Data quality is defined as the number of features and the characteristics of the data to enable a certain purpose [40]. The Chinese electric grid system shows various characteristics of data, such as multiple types, multiple sources, multiple layers and large scale, within the power grid system. This creates "information islands" as sensors and the resulting data are not integrated as well as different performance requirements for the data processing [39]. The proposed framework must consider all these characteristics and, as a consequence, is composed of the following three major parts:

1. **Data Acquisition:** Collects real-time and historical data from IoT devices. Apache Kafka is used for data streaming, and monitoring data is obtained from scheduled tasks.

2. **Data Storage:** Can be implemented using a relational database, a NoSQL database, or a distributed file system like HDFS to accommodate different types of data.

3. **Data Computation Module:** This module of the framework processes the incoming data and all the data and also executes a data quality assessment method

Munshi et al. [41] also came up with a similar idea of a framework within smart grids that tries to tackle the issues of big data . The framework consist of five modules - data acquisition, storing, processing, querying and analytics. The analytics module further improves the efficiency of the smart grid by fulfilling two objectives which are to learn from the collected data and to respond if necessary. Furthermore, Munshi et al. [41] talk about the infrastructure layer of these big data systems and conclude that because of the nature of the framework it should be cloud based so that scalabilty, accessibility and cost-effectiveness can be provided. All these various challenges of data integration, interoperability, data sovereignty and trust within systems can be encountered within data spaces, which is a fairly new concept where the data does not need physical integration and is saved at the origin source [42]. Since the energy sector is undergoing a digitalization process, energy data spaces are also being developed in Europe, such as Gaia-X [43, 44], which includes a dedicated data space for energy-related data. An energy data space allows for the data sovereignty of the data owner and allows for innovative data-driven services [45]. These energy data spaces enable interesting use cases, for instance better communication and data exchange, as well as availability which enables predictive forecasts that are needed for better smart grid operations [45].

There are other ongoing projects that create big data frameworks or data spaces on a European level. For instance, the already mentioend project EDDIE will also tackle the issue of data availability, interoperability and sharing, and intends to create an energy data space as well [6]. This decentralised, distributed, open-source Data Space will allow energy services to access energy data from European households. In order to comply with the GDPR EU regulation, the household has to give prior consent sharing the energy data with other parties who operate in the European energy market [6]. Other projects in regards to energy spaces are for example Omega-X, Synergy, Data Cellar and Enershare, which are also EU-funded [46, 47, 48, 49]

Singh et al. [50] also believes in a consumer-centric architecture for energy data analytics. They believe that data management should be in the hands of the energy consumer, who should have control over their data even if the infrastructure is outsourced. The energy consumer should also get a better view of the data collected from multiple sources and be given the choice of algorithm that runs the data analysis, which would benefit data privacy [50]. As we can see, the topic of big data within the energy sector is nearly boundless and to make the smart grid more effective there are many variables to consider.

2.4. Use Cases with Energy Data in Literature

In this chapter, we investigate the use cases that are possible with the collected data and the benefits these new insights can provide to the smart grid, the energy consumer, and the energy ecosystem as a whole, particularly through analyzing and utilizing the data.

2.4.1. Use Cases

Amasyali et al. [51] reviewed various building energy consumption prediction studies that used data from smart meters, sensors, weather stations and building management systems. Furthermore, using also various temporal granularities, the studies used a wide variety of machine learning algorithms like support vector machines (SVM), artificial neural networks (ANN), decision trees and other algorithms. Most of these studies predicted either the overall energy consumption, cooling or heating energy consumption for Heating, Ventilation and Air Conditioning (HVAC) systems as well as lighting energy consumption. In addition, the algorithms predicted either the sub-hourly, hourly daily, monthly and yearly energy consumption. Also, the building types where the models either focused on residential or non-residential buildings such as schools or commercial buildings were analyzed. There were many features analyzed for these predictions, for example weather conditions, indoor conditions, building characteristics, time, occupancy and energy use behavior of the occupant. Amasyali et al. [51] conclude that each of these models have their strenghts and weaknesses and cannot be applied under all conditions. Lastly, for future research there should be more focus on the energy usage patterns of the consumer and thereby on studying efficient energy usage of consumers.

Pattern and consumption analysis is also needed for Non-Intrusive Load Monitoring

(NILM), which is a method which analyzes changes in voltages and currents and thereby deduces and estimates the energy consumption of different household appliances [52]. Utility companies can profit from these insights by better understanding the consumption patterns of consumers and can generate personal recommendations for their clients. However, the neural networks used for NILM are very memory-intensive and therefore, can only be applied on powerful computational hardware. In their work, Bouchur et al. [52] propose that a reduction in the size of neural network-based NILM-models can subsequently allow this method to be executed on embedded hardware. By using various compression methods such quantization, pruning, weight sharing, depthwise separable convolution, pooling and multitask learning they were not only able to reduce the model's size but also the model's accuracy. Furthermore, by combining the best-performing methods they could achieve an improved performance versus the initial model and thereby could easily include the model in the flash memory of a microcontroller unit. Other Energy consumption forecasts use a k CNN-LSTM deep learning framework. The k mean clustering detects patterns within the energy consumption while the Convolutional Neural Networks (CNN) finds features that affect the consumption. Lastly, Long Short Term Memory (LSTM) neural networks model long term dependencies in the data. Somu et al. [53] in a case study applied this framework to the building of the Kanwal Rekhi School of Information Technology and evaluated its performance to other state-of-the-art energy demand forecast models. They concluded that the framework could provide more accurate energy demand forecasting than any other model. In order to promote energy saving measures and renewable energy sources in buildings Guzhov et al. [54] use a method based on statistical, neural network and fuzzy methods, which combines the modeling and analysis of energy consumption processes in buildings. Furthermore, they developed a method, which then proposes a set of measures to energy managers which can then improve the energy efficiency of buildings as well.

Further using smart meter data analytics, Wang et al. [55] apply descriptive, predictive and prescriptive analytics on the data. They concluded that there are three main data analytics application areas namely load analysis, load forecasting and load management. Load analysis in this work deals with detecting anomalies in the data such as unusual patterns or even energy theft detection and creating load profiles for consumers according to their electricity consumption behaviors. Load Forecasting, on the other hand, uses short- and long-term forecasts that benefit the operating and planning processes of power distribution companies as well as assists electricity providers in making decisions for pricing, procurement and hedging based on the load forecast of their customers. Lastly, load management is focused on creating a better understanding of consumers' sociodemographic characteristics in order to provide personalized and superior services. Demand response program marketing as well as the demand response program implementation also fall under this application category.

For other smart meter energy data services Lee et al. [56] classified three business use case concepts under third party, demand management and integrated meter reading. Third party use cases include the settlement of power transactions using power trading platforms while there are also other supporting services such as demand response and

virtual power plants (VPP) which analyze the effect that distributed energy resources have on the system. Demand management, on the other hand, deals with loss detection such as power theft, which could minimize the profits of utility companies as well as using consumer analysis to the design the optimal tariff. Additionally, integrated meter reading can be applied to integrate other resources such as gas, heat and water into smart meter monitoring without deploying a separate infrastructure.

To conclude this section, it is clear that a broad range of use cases leverage energy data from smart metering systems. However, these are primarily geared toward the needs of grid operators, utility companies, and building management systems. Most of the reviewed approaches focus on system-level optimizations, such as load forecasting, anomaly detection, and energy theft prevention, or on enhancing energy efficiency in commercial buildings through advanced machine learning models. However, there is a notable gap in research and application when it comes to empowering individual households. There is limited investigation into how households can directly benefit from the vast amounts of energy data collected through smart meters, especially in terms of data analytics.

2.5. Bridging Energy Data Use Cases to Monitoring and Behavior Change

Energy drives our modern society and has an immediate impact on the environment, the public, and the economy. To better utilize energy resources, an efficient and stable system to control this asset is needed. Adding smart meters to the grid is one step that can be made to gain greater insights into the energy consumption of households. By using big data analytics and data integration frameworks, as well as creating data spaces, we can gain more knowledge about the energy system through data sharing and analytics. Furthermore, this allows for the creation of a controlled management system for this data. The number of use cases that can be applied to aggregated energy data, such as demand predictions, detecting patterns, machine learning, and other methods, is nearly limitless. These use cases help to further improve energy systems or aid in reducing carbon emissions by allowing for more efficient energy usage.

However, the literature review revealed a significant gap: there is a lack of research on how households specifically benefit from these energy data use cases. While the broader advantages for the energy system are well-documented, the direct benefits for individual consumers remain under-explored. This gap highlights the need for further investigation into how energy data analytics can be leveraged to provide tangible benefits to households, such as cost savings or improved energy services, especially through consensual energy consumption data sharing.

The role of the energy consumer in the energy system, as well as the socio-economic impact of new data-driven-energy-services, should be emphasized and researched. As the majority of data is generated by the consumer, they should also profit from it. These profits could be monetary or could include the energy provider offering better services, for example.

Given the lack of literature on household benefits through energy data analytics, a closer look was taken at the monitoring side of smart meter data and Human-Computer Interaction (HCI). By understanding how to effectively present energy consumption data to consumers and engage them through well-designed interfaces, we can bridge the gap between data collection and meaningful action. This focus on monitoring and HCI is crucial for driving behavior change and maximizing the benefits of smart metering for households.

2.6. Smart Meter Monitoring and its Impact

To understand how monitoring applications should be designed and their influence on behavior, a deep dive into various studies and literature has been conducted. These findings will help identify what needs to be considered in energy monitoring applications for households, as well as how users can gain insights.

Geelen et al. [57] conducted three studies in Dutch households ($N = 519$) with smart meters to see how smartphone and tablet apps would influence their energy consumption. They tracked daily electricity and gas consumption and used questionnaires ($N = 270$) to gather insights on how the households used the apps as well as how they perceived the impact on their energy consumption. They also used interviews ($N = 12$) to get more in-depth understandings of the usage of these apps and the behavior . The researchers could not find any significant reduction in the power consumption, but, in the questionnaires users reported higher awareness regarding their consumption and more changes in their behavior. During an initial learning phase people would actively check for consumption patterns and specific appliance power usage, however, after gaining some understanding of their consumption the usage shifted towards monitoring the levels instead of reducing them.

The study proposed that apps could be better and more effective if they provided more actionable and meaningful information tailored to the user's specific situation and goals. Despite some users dropping out over time for the long-term use, most users still used the monitoring functionalities. Geelen et al. [57] conclude that in spite of increasing the awareness of one's own energy consumption, this did not translate to reducing it, as users should be provided with more guidance on how to take actions to save energy. Furthermore, in order for the apps to be more effective, the designs should not only focus on monitoring but also consider encouraging energy saving.

Hargreaves et al. [58] conducted a qualitative field study with 15 households in the United Kingdom, who interacted with feedback on their domestic energy consumption through real-time displays and smart energy monitors, to make energy usage more visible. The study aimed to understand motivations for acquiring the monitors, usage patterns and behavior changes. For the study the researchers used three various monitor devices that had different types of displays and visualizations such as milometer to express the amount of electricity used for the days in either kilowatt per hour, pounds sterling or carbon dioxide emissions. Other devices, on the one hand, could also be connected to the boiler and display information like hot water usage or heat. On the other hand, one

monitoring function allowed users to set up a daily budget that resembled a fuel tank, displaying a tick or a cross if the limit was met or exceeded. Furthermore, they found that participants were motivated by financial savings, environmental concerns, a desire for information, and interest in new technology. Consequently, they observed that absolute measures of electricity consumption were less engaging for users, and metrics like money spent were preferred over kilowatt-hours or carbon emissions. Additionally, users found the fuel tank symbol engaging and considered appliance-specific monitoring valuable for identifying high-energy-consuming appliances. However, interest in the monitors dwindled over time, especially for the more complex, less aesthetically pleasing, and harder-to-integrate devices.

Additionally, the authors reported that subjects of the study exhibited various types of behavioral changes. Some participants had immediate reactions to high consumption measurements, reactively turning off appliances when high readings were noted. Others were more considerate, planning and reducing their energy use, and even changing their lifestyle. However, there were limitations to these behavioral changes, as some high-energy-consuming appliances were still used due to necessity or comfort. In other cases, household members disagreed on certain actions after analyzing potential energy savings. Hargreaves et al. [58] concluded that smart energy monitors can prompt energy-saving behaviors; however, their effectiveness is heavily influenced by the dynamics of the households and broader societal contexts.

To conclude, the reviewed literature emphasizes that while energy monitoring applications and feedback tools can raise awareness and sometimes prompt behavioral changes, their long-term impact on actual energy reduction remains limited unless users are guided more effectively. Simply providing data is not enough, as users require actionable, context-specific insights, motivational elements, and user-friendly designs to translate awareness into sustained behavioral change.

2.7. The Role of Human-Computer Interaction in Promoting Behavior Change

In the context of energy services that involve data analytics and consumption monitoring, Human-Computer Interaction (HCI) must be considered with a strong emphasis on behavior change. Understanding how users interact with such systems, what motivates them, and how design can influence their decision-making is essential. To address this, relevant literature has been reviewed to examine the role of behavioral theory in HCI and explore how changes in user behavior can be effectively evaluated.

HCI is a research field that is continuing to design technologies, that promote change in behavior in various domains. Therefore, to integrate behavioral theory into Human-Computer Interaction (HCI) research, specifically focusing on technology designed to support behavior change, Heckler et al. [59] aimed to bridge the gap between those two research fields. The authors defined various forms of behavioral theory, such as meta-models, conceptual frameworks, constructs, and empirical findings. They also identified three broad uses of behavioral theory. Firstly, to inform the design of technical

systems by making decisions about which functionalities should be implemented and how. For example, they mention that the physical activity application *UbiFit* used the goal-setting theory, the transtheoretical model, and Goffman's theory [59] of the presentation of self for its designs and functionalities. Secondly, behavioral theories, such as the default bias from behavioral economics, are used to guide evaluations of behavior change technologies by helping in designing evaluation studies and interpreting findings. Lastly, behavioral theories, such as the transtheoretical model, imply that different user groups have distinct needs. These theories can help identify these needs and ensure that certain interventions are tailored to them appropriately, as some might not work for a specific group.

Further continuing on the evaluation of behavior change within technologies, Klasnja et al. [60] propose that HCI research should be evaluated by the experience of the users of the technology and by measuring the effectiveness of the suggested behavior-change intervention strategy of the underlying system, such as self-monitoring and conditioning. Here, they specialize in technologies that try to change behavior related to health issues, such as chronic diseases, and the challenges involved in evaluating these changes. Some challenges are that behavior change is a long-term process with high relapse rates and is, therefore, difficult to measure. This is often impractical for HCI technologies and research in their early stages, as they want to understand why a certain technology works or does not in order to advance with the designs.

As a consequence, the authors suggest that by applying targeted evaluations, the outcome measures should be specifically matched to the intervention strategies employed by the technology. For example, if a technology uses self-monitoring, the evaluation should assess whether the behavior being monitored increases during the intervention and decreases after it stops. This approach allows researchers to determine if the intervention strategy is having the desired effect without requiring long-term studies. They also conclude that conducting qualitative studies, such as interviews or field studies, is essential to uncover potential problems with a system. These studies help to understand what the user experiences, perceives, and which patterns arise due to the usage. This can further reveal why a certain technology works or doesn't work and identify any unintended consequences of the design. Lastly, Klasnja et al. [60] encourage both HCI and health science researchers should collaborate for the validation of the technology, which could provide deeper insights into the effectiveness of health behavior change technologies.

Respectively to the topic of environment Froehlich et al. [61] explore the development and evaluation of technologies that provide feedback on the behavior of individuals or groups with the aim of reducing environmental impact. They deduce that most people are not aware of their everyday behavior that affects the environment such as driving the car or showering and that technology could fill this environmental literacy gap by giving information on their activities. After browsing through papers with environmental psychology background, they discuss how HCI should learn from this research field and the role it should play. They found studies that show that so called eco-feedback technology is able to change consumption behavior. They mention that there are many reasons

like education, economics, sociology, etc. why people have environmentally responsible behavior. There are many theoretical models for proenvironmental behavior, however, there is no decisive explanation yet. Furthermore, the authors say that if designers are basing the designs of eco-feedback technology on these models and how they display information, is enough to influence environmentally responsible behaviors. What is more, is that there are various strategies to motivate environmental friendly behavior. One is to present information in an easy understandable way and should attract attention. Another way to motivate people to change their behavior is by setting up goals. Goals have multiple purposes as they require attention and effort toward the relevant activities as well as having an energizing objective because high goals need more effort than low goals. They affect persistence and the behavior as people have to learn or adapt strategies and knowledge to accomplish these goals. In addition, people could compare their action with other individuals or groups which would further motivate them, if they get feedback of their performance. Also, by committing towards a goal or a promise, people also behave in a certain way as this would also increase the probability to pursue a specif behavior. A different technique, on the one hand, to influence behavior change would be to implement incentives or disincentives in order to motivate . On the other hand, rewards and penalties are motivation techniques that, consequentially, come after a certain behaviour. Additionally, for the purpose of being effective, all these motivation techniques require some form of feedback. This feedback could provide details on how to change or improve a precise behavior or help improve the performance towards a goal [61].

Schweiger et al. [5] focused on how effective consumer participation in smart energy systems should be integrated into novel business models and solutions. The authors identified motivation as the primary driving force behind consumer behavior. Motivation can be intrinsic, driven by internal satisfaction, or extrinsic, driven by external rewards. Overall, key motivational factors include reducing energy bills, environmental concerns, and improved comfort. The researchers also emphasized that energy services should be tailored to align with consumers' values, such as a desire for sustainability. Furthermore, gamification elements can engage and motivate consumers, distinguishable by either extrinsic motivation (e.g., rewards) or intrinsic motivation (e.g., meaningful gamification). Lastly, retention strategies, such as personalized reminders, should be designed to be personal, fun, and playful to keep consumers engaged over time.

From this section, we saw the crucial role Human-Computer Interaction plays in shaping user behavior, particularly through thoughtful design strategies grounded in behavioral theory. Effective behavior change technologies must look beyond mere data presentation toward personalized, goal-oriented, and engaging experiences. Techniques such as self-monitoring, goal setting, gamification, and tailored feedback have shown promise in encouraging lasting behavioral change, which are important design decisions for *N-Ergy-View* in terms of user motivation, feedback mechanisms, and promoting meaningful energy-saving behaviors.

2.8. Visualizations in Energy Monitoring Applications

Lastly, the goal is to understand which visualizations are most effective within energy monitoring applications, the role they play, and how they should be implemented. Therefore, Al-Kababji et al. [62] used randomized controlled trials to to evaluate various energy data visualizations. They used an application based on React Native and various libraries such as D3.js, Plot Kit, and others. The application could display conventional visualizations like bar charts, line charts, and stacked area charts, as well as more novel and enhanced visualizations such as time-pie charts, heatmaps, and stacked bar charts. The authors identified three main categories for the tasks of these visualizations: providing direct feedback on the energy consumption of specific rooms, showing historical trends, and helping to set up energy-saving goals, often in combination with rewards (e.g., monetary). Participants (n=133) from multiple countries were assigned to evaluate the conventional or enhanced visualizations based on effectiveness, aesthetic appeal, and understandability.

The key findings were that conventional visualizations were deemed to be superior in terms of clarity and aesthetic appeal compared to the enhanced visualizations. However, despite being less preferred in relation to of simplicity and aesthetics, the enhanced visualizations yielded better results with regards to questions about analysis. This indicates their potential for deeper engagement and insight for the users, as they provide richer interactions and more detailed data. The researchers believe that because the participants needed more time to understand these enhanced plots, they paid more attention to the details within. All in all, Al-Kababji et al. [62] indicate that the balance between simplicity and detail in energy visualizations is important to promote energy-saving behaviors among consumers.

Also, to further understand the role of visualizations in promoting energy awareness, Suppers et al. [63] explored various methods. They closely examined the current state of research in this regard and identified four main perspective. First, there are personal characteristics that influence behavior and the type of motivation or behavior change techniques required. Users have different individual personalities and need appropriate visualization strategies. For example, people who want to minimize their consumption but do not want to spend too much time thinking about solutions need simple and fast methods to change their consumption behavior.

Second, the authors state that visualizations should deliver effective feedback mechanisms, which are crucial for raising awareness and providing actionable information. For instance, the authors provided two general types of visualizations: pragmatic and simple, or artistic. While the former conveys data in an easily understandable way, the latter keeps users more interested while also providing enough information. Other examples include ambient displays and real-time feedback systems that inform users of their energy consumption patterns.

The next perspective examines the effectiveness of the feedback provided by the visualizations. Different approaches to feedback, such as direct (e.g., real-time) and indirect (e.g., historical), can be analyzed for their impact on energy-saving behaviors.

Studies found by the authors showed that direct feedback combined with goal-setting was particularly effective. Lastly, social interactions, such as comparing consumption with others, allow users to benchmark their own consumption behavior. Social media also plays a role by promoting energy-saving competitions and sharing tips among users.

Consequently, Suppers et al. [63] recommend that for effective visualizations of domestic energy use, they should be tailored to different user types and their specific needs. Furthermore, feedback mechanisms should be implemented that provide real-time and easy-to-understand feedback, as well as clear and actionable information. Additionally, social engagement on social networks or other community-based approaches should be utilized to enhance motivation through social comparison and competition. Last but not least, visualizations should be relevant to the users' context, whether at home, in an office, or in a public space.

As we can see, visualizations play a crucial role in energy monitoring applications by influencing how users perceive and respond to their energy consumption. Existing research indicates that while conventional visualizations offer greater ease of interpretation and aesthetic appeal, enhanced visualizations provide deeper analytical insights and encourage more reflective user engagement. To effectively influence end-user behavior, visualizations must be carefully selected and designed. Tailoring visual feedback to user types, combining it with goal-setting, and fostering social interaction can increase the effectiveness of these tools. For the development of an energy-data-driven monitoring service, this implies integrating clear, interactive, and context-aware elements that empower users to make informed and motivated energy-saving decisions.

2.9. Conclusion of the State of the Art

The review of the current state of research has highlighted the complexity of the energy sector, particularly in relation to smart metering, energy data management, and user engagement. While numerous studies and projects focus on the technical and systemic benefits of smart meters and big data frameworks which range from grid stability to load forecasting and anomaly detection, there is a gap in the literature concerning the tangible benefits for individual households, for instance through data sharing. Most existing use cases are oriented toward system-level efficiency, with limited attention to the consumer and residential perspective.

Furthermore, the integration of principles from the Human-Computer Interaction (HCI) and behavioral theory into energy monitoring applications show that well-designed feedback systems and goal-setting strategies can influence user behavior and increase awareness of the users. Visualization techniques also play a crucial role in this interaction and must strike a balance between simplicity, clarity, and depth to effectively engage users and promote energy-saving actions.

In conclusion, while significant progress has been made in the development of smart metering technologies, big data infrastructures, and system-level applications, the potential benefits of energy data for individual households remain underexplored. In particular, there is a lack of research addressing how data-driven services can be designed to em-

power residential users through personalized insights, effective feedback mechanisms, and behavior-oriented features. This gap calls for approaches that integrate data analytics with Human-Computer Interaction (HCI) principles and behavioral theory to support meaningful user engagement. The identified need for user-centered, actionable, and adoptable energy services forms the basis for the research conducted in this thesis.

3. Research Methodology

The research gap identified in the **State of the Art** section, this thesis aims to close it through the research presented in this work. This thesis, together with the development of the *N-Ergy-View* application, follows a human-centered design approach that employs a structured research methodology consisting of three distinct phases: the **Exploration Phase**, the **Implementation Phase**, and the **Evaluation Phase**. Using a mixed-methodology approach, a combination of qualitative and quantitative methods is employed to investigate energy markets, energy systems, and relevant use cases. This approach is essential for understanding the complexity and potential of energy data and its application in digital solutions. Furthermore, this research supports the development and evaluation of the *N-Ergy-View Dashboard*, an energy analysis and monitoring application which tries to bridge the gap in energy data use cases and combines the knowledge from data analytics use cases, monitoring, HCI, and behavioral economics research from the previous literature chapter. These phases, along with their order and the actions taken in each, can be seen in Figure 3.1. The following sections provide a detailed discussion of each phase and the methodologies employed.

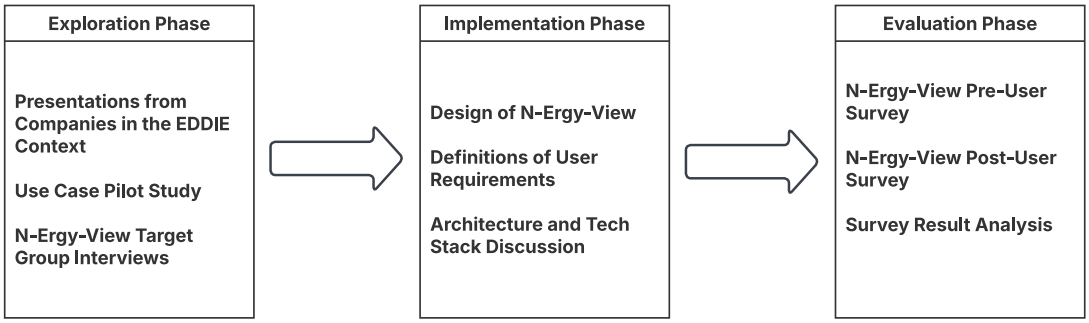

Figure 3.1.: Graphical Overview of the Phases

3.1. Exploration Phase

The **Exploration Phase** was used to further delve into the energy market and systems, building upon the **State of the Art** and addressing areas observed to be uninvestigated by scientific research in this broad and complex topic.

As smart meters gather a significant amount of data, and considering that there is a lack of scientific research on how households would benefit or profit from these data analytics or data-driven-energy-services, it is crucial for this thesis to understand what is already

available on the market. The EDDIE project also served as a valuable starting point for engaging with various services and businesses that gave presentations in this context, which the author of this thesis attended as an observer. In accordance with research ethics and data protection principles, the participating companies are anonymized in the presentation of results, and no identifiable information is disclosed. While anonymized quotations from the sessions may be used to support the analysis, full transcripts are not included in the appendix of this thesis in order to protect the anonymity of the companies and avoid disclosing any sensitive information. This qualitative data was then analyzed using thematic analysis and clustering, following the method developed by Braun and Clarke [64]. This approach helped extract key themes through multiple iterations, which are relevant to the development of *N-Ergy-View* during the **Implementation Phase** and highlighted challenges within the energy sector and energy data management. The thematic analysis using clustering techniques and iterative processes will be applied in the later research phases of this thesis as well. This approach is also described in more detail in one of the chapters during the exploratory research.

More in-depth research was conducted in the practical field of data-driven energy services. This exploration is based on a study conducted among Computer Science students at the University of Vienna. These students were assigned to collect information regarding energy services that use smart meter data. Their task involved finding these companies, writing a short description of their services, and, most importantly, categorizing these services. The aim of this study is to explore the diversity of real-world use cases that incorporate data analytics and rely on smart meter data or could use it. The findings from this exploration also contributed to shaping the concept and feature set of *N-Ergy-View*. Furthermore, depending on the service, households could benefit from these offerings, which this thesis aims to explore and address, thereby helping to close the identified research gap. The study underwent a mix of qualitative and quantitative analysis. The data required initial cleaning and underwent multiple iterations of thematic analysis to identify use case categories [64]. These categories were then used for descriptive statistics, such as percentages, to determine which categories were most commonly found. This highlights that there are use cases in the field where smart meter data is used for various purposes, providing insights into how and what type of *N-Ergy-View* should be implemented. For the qualitative analysis, the qualitative data analysis (QDA) software *Taguette* was used, and for clustering and visualization, *Lucidchart* and *Mural* were used [65, 66].

To conclude the **Exploration Phase** of this research, semi-structured interviews were conducted with a selected group of individuals who fit the study's target demographic. To ensure confidentiality and adhere to ethical research standards, all names have been anonymized in the analysis. The interviews followed a structured yet flexible approach, incorporating both closed-ended (yes/no) and open-ended questions to examine participants' awareness of energy consumption, smart meter usage, and their perspectives on an energy monitoring application. Participants were selected based on their familiarity with energy-related topics and digital tools, ensuring a diverse yet relevant set of insights. The discussions provided valuable qualitative and quantitative feedback, contributing to

the refinement of *N-Ergy-View*'s feature set, user expectations, and potential adoption barriers. The data underwent thematic analysis following the methodology of Braun and Clarke [64]. Moreover, these findings serve as a input for the **Implementation Phase** of this thesis, as a human-centered design approach is chosen for the implementation. Additionally, specific attention was given to users' willingness to share smart meter data, as well as their attitudes toward cost transparency, predictive analytics, and feedback mechanisms.

3.2. Implementation Phase

The **Implementation Phase** is primarily focused on the design, implementation, and development of *N-Ergy-View*. Building upon the insights and data collected during the **Exploration Phase**, this phase aims to gather more detailed input on user and system requirements from interviews with the target group, as well as from expert interviews and the study on use case categories. Some of these system requirements are inherently dictated by the nature and architecture of the EDDIE Framework and must be carefully considered throughout this phase and the development process, which is described in more detail in Chapter 5.3.2.

In this phase, designs and prototypes are discussed and refined, ultimately leading to the overall final architecture of the monitoring application. Presenting models, designs, and various requirements will illustrate how the original concept evolved into the first version of the demonstrator. A human-centered design approach is employed, involving user interviews and studies to ensure that the developed solutions are user-friendly and aligned with user needs gathered from the data from the previous phase. Since the goal is to enable users to gain valuable insights from the application and take informed actions (e.g., energy savings, cost reduction, energy-aware behavior), particular emphasis is placed on Human-Computer Interaction (HCI) aspects such as user-centered design, intuitive visualizations, interactive features, and feedback mechanisms.

Additionally, this phase includes reflections on design and technical decisions, such as why specific algorithms were chosen for the prediction model and why certain types of visualizations were selected—particularly in the context of data analytics, where working with time-series data presents a range of challenges and considerations. Various machine learning algorithms, including Linear Regression, Seasonal Autoregressive Integrated Moving Average (SARIMA), and LightGBM, were evaluated during this phase and revealed different limitations. As previously mentioned, some architectural decisions were influenced by the EDDIE framework. For example, the required integration of Apache Kafka shaped key aspects of the data flow and storage architecture. Additionally, the rationale for adopting a microservice architecture is discussed in this section, as various tech stacks such as Django, Rust, Flask and others are used [67, 68, 69]. These decisions are guided by a careful balance between user impact, technical feasibility, and insights gathered during the **Exploration Phase**, ensuring that the implemented solutions effectively address the identified challenges and support behavior change in energy consumption.

3.3. Evaluation Phase

In the **Implementation Phase**, we observed which requirements and inputs from the **Exploration Phase** were implemented and how. To conclude the research methodology, we will discuss the **Evaluation Phase** and the research conducted during this phase. After completing the first working version of *N-Ergy-View* and its dashboard, a pre- and post-evaluation began, utilizing anonymized surveys and a product demonstration. This evaluation was conducted with computer science students at the University of Vienna who were informed on the anonymous data collection and ethical guidelines of the survey.

The pre-survey involved providing a brief description of *N-Ergy-View's* main functionalities and goals, showcasing only the concept of what the app aims to achieve. Participants were asked questions about their user behaviors, such as the importance of energy savings to them and their awareness of the energy consumption of appliances like refrigerators. Additionally, they were asked about core functionalities and features, as well as preferences for types of units for visualizations. Most importantly, participants were asked if they would be willing to share their data with this type of application, if they would consider paying for it, and if they see the benefits and usefulness of it.

The post-survey consisted of a product presentation of *N-Ergy-View* and its core functionalities through a product video and a short demo of the data-sharing capabilities of the EDDIE Framework, which is essential to obtain the data for the functionalities of the monitoring dashboard. The survey asked the same questions regarding functionalities but also solicited input regarding the data onboarding and the adoption of the app overall.

The main idea of this pre- and post-survey approach was to determine if there is a detectable shift from the pre-survey, where participants received only a rough description, to the post-survey, where they saw a first version of the demonstrator. This approach helps assess whether there is a shift in acceptance between the concept and the actual implementation. It assists in understanding if and which core functionalities could be accepted and if the designs and input from the **Exploration Phase** were implemented correctly in regard to user acceptance and market adoption.

The survey results were evaluated both qualitatively and quantitatively. The qualitative data will undergo thematic analysis to identify patterns in the open-ended responses from participants [64]. For the quantitative data, a descriptive statistics approach is chosen to calculate means (e.g., for the scales or prices) and to examine the distribution of closed-ended responses, which are also visualized. The data analysis and the resulting statistics will be computed in Excel.

3.4. Summary

In this section, we learned about the structured research approach of this thesis, which consists of three distinct phases: the **Exploration Phase**, the **Implementation Phase**, and the **Evaluation Phase**. By applying a user-centred design and a mixed-methods approach, the collected qualitative and quantitative data could be analyzed to their

full potential, contributing to the research objectives and helping to answer the defined research questions.

The **Exploration Phase** provided valuable insights and input by examining businesses in the European energy sector through interviews and thematic analysis. This included a categorization of international energy services based on a study conducted with computer science students. Additionally, semi-structured interviews were carried out with a selected target group. These findings informed the **Implementation Phase**, in which a human-centered design approach was used to develop a first working prototype of *N-Ergy-View*, aiming for a tangible, user-friendly, and practically relevant application. In the **Evaluation Phase**, the design process, technical implementation, and user adoption were assessed to determine the app's effectiveness and relevance from a user perspective.

This structured approach directly addresses the identified research gap and contributes to answering the research questions. By investigating how data-driven-energy-services for households can be designed and implemented effectively, the study identifies critical user requirements, key design principles, and technical challenges that need to be considered to ensure functionality and meaningful engagement. Furthermore, the evaluation focuses on user acceptance by examining whether services that leverage smart meter data and advanced analytics offer enough perceived value to encourage adoption. This includes analyzing participants' willingness to share energy data, their readiness to pay for such services, and their expectations regarding usability and functionality — all of which are essential for assessing market potential and long-term viability.

4. Energy Application Use Cases in the Field

From the prior chapters, we concluded that due to the lack of research in energy-data-driven applications specifically for households, we need to examine the practical field more closely. We also learned that these types of services should consider human-centered interactions, feedback, and behavior change-related systems to enhance user engagement and better inform them on their energy consumption. As a result, this chapter will explore the practical application of energy use cases in the field to gain a better overview of the types of businesses operating in this market.

To obtain and explore insights into the European market for energy services, this chapter will focus on companies which presented their services, expressed their needs and challenges within their respective sector, in different EDDIE project meetings [6]. With these insights, we can better understand the opportunities and challenges of working within the energy sector, specifically with energy data, and what needs to be considered for data-driven-energy-apps. In addition, a study conducted among computer science students complements this analysis by gathering and thematically categorizing additional practical examples of smart meter-based services. Together, these exploratory investigations contribute to exploring the first research question of this thesis: How should data-driven-energy-services be designed, and what key aspects must be considered?

The findings presented in this chapter lay the foundation for the conceptual design and development strategy of the demonstrator which is named *N-Ergy-View*, and mark a pivotal step in understanding how such services can be effectively tailored to household users.

4.1. Real-World Use Cases in the Energy Sector: Insights and Practices

To dig deeper into the practical field of real-world energy data-driven applications, the EDDIE project [6] has been a good starting point to meet businesses that work within the energy sector and understand their specific use cases. Furthermore, these closer observations help to get a better look at the possibilities, but also the difficulties of working within the energy sector and energy data, as well as identifying reliable data sources. This can help how a service for households should be designed or which aspects have to be considered. As the EDDIE project holds regular meetings and webinars, it was a good opportunity to meet a diverse selection of companies. All of them were European companies from four different countries. In the following sections, we will introduce these companies and their use cases, highlighting their opportunities and difficulties based on their presentations. To ensure confidentiality and comply with research ethics,

all company names and potentially identifying details have been anonymized. While anonymized quotations are used to support the analysis, full transcripts or raw materials are not included in the appendix to protect participants' privacy. Furthermore, certain quotes were also anonymized to avoid disclosing sensitive information.

Next, as these businesses gave presentations in the context of the EDDIE project—which the author attended as an observer in September 2023—about their use cases and answered questions related to them, a systematic analysis was conducted using the QDA software *Taguette* [65]. This software allows the addition of codes to certain text passages in the transcriptions of these presentations. These codes are then clustered using thematic analysis by Braun and Clarke [64], which helps to extract the main themes and takeaways from these presentations and Q&A sessions. This clustering was done in a modeling tool called *Lucidchart* [70], where these themes and codes were visualized within a diagram to showcase how certain themes are related to each other and which ones are the main ones. This thematic and clustering analysis will provide a better overview to understand what is changing inside the energy market due to new technologies or regulations such as the EU Directive 2019/944 [3]. Furthermore, it will help understand the relevance and importance of energy data in relation to the use case as well deliver valueable input for the devlopment of *N-Ergy-View*.

4.1.1. Company A

Company A is a startup company that focuses on the decarbonization of the energy system with innovative digital open-source platforms and on the integration of Distributed Energy Resources (DER) such as electric vehicles. They have a cooperation with a Canadian company, which produces a home energy station for EVs. *Company A* has a main focus on home energy management, as they are dealing with these DERs and the possibilities that solar panels bring. This opens up a lot of flexibility in the way homes can be operated.

Furthermore, with IoT devices such as smart meters being installed in homes by system operators, as well as IoT devices like smart plugs and smart heat pumps being purchased, the question and difficulty lie in how these data sources can be interconnected, which they are working on. In regards to EDDIE, they proposed a Marketplace where data and the exchange between systems can be monetized, with the consent of the customer. Additionally, they are planning an energy trading application that allows customers to trade energy in real-time with the help of robot trading. A difficulty they are facing is that every country has its own way of data exchange and access, especially in regards to application programming interfaces (APIs), where they wish to have a harmonized interface for data exchange. Also, energy markets are very fragmented for trading and transactions. They predict and foresee that consumers in the future will benefit from dynamic energy tariffs, be able to select energy communities, and trade their surplus energy production. Therefore, they want an active consumer who can participate in the market and choose suppliers and flexibility service providers.

To conclude they aim to prototype net-zero houses and showcase how these various data exchanges, data layers, and data standards, such as the Common Information Model (CIM), can be effectively implemented. CIM is a data standard often used in energy

systems. Another aspect will also be ensuring data privacy, which is essential for building trust with customers.

4.1.2. Company B

Company B is a software development company that focuses on Software-as-a-Service (SaaS) for renewable energy communities. Their primary goal is to connect energy producers and consumers within these communities through their app, relying heavily on data from the Distribution System Operator (DSO). These communities are enabled by an EU directive that has been translated into Austrian law. However, setting up these communities remains complex and demanding, as grid operators are also involved.

Initially, *Company B* aimed to automate this process, but some steps still require a degree of bureaucracy. Therefore, they support users of their app in completing the setup process for a community and provide monitoring and organizing functionalities. In their presentation, *Company B* highlighted the opportunity in a large city, which consumes three terawatt-hours of energy annually and has significant potential for utilizing PV power plants on various buildings. Managing these processes, especially in multi-tenant buildings, is complicated due to legal regulations, particularly regarding ownership. *Company B* sees the opportunity to manage these processes, including tariff invoicing and payment reporting.

The local Datahub for energy-related data, supplies *Company B* with relevant data, enabling them to participate in market communication. Furthermore, *Company B* collaborates with other energy efficiency-related businesses that rely on historical meter data, providing them with access to this data. *Company B* incorporates dynamic tariffs into their service, allowing them to charge consumers different rates at any given quarter of the year. They also mentioned the potential for automated tariffs linked to factors such as weather data, which could adjust consumption tariffs throughout the day. Moreover, they introduce an interesting aspect of nudging through gamification within energy communities. As the number of members grows, there will be benchmarking among users who produce or consume energy within that residential setup. This creates a social dynamic where community members compare their energy production and consumption, fostering a sense of competition and engagement. Furthermore, by collaborating with the local Power Grid, which serves as the Transmission System Operator (TSO) in the country of operation, they incorporate into their solution the ability for users to see the overall grid health. The TSO evaluates personal smart meter data to assess energy consumption, particularly during peak hours in the grid. This evaluation helps determine the tariffs or rates applied to energy consumption. This feature helps users understand how their energy consumption behavior contributes to grid stability and potentially to blackouts. Consequently, the solution also works similarly to a social network, fostering engagement by showing each member's contribution to the community's energy goals and promoting a sense of collective responsibility.

Some of the challenges include ensuring the availability and quality of data, which is crucial for accurate billing and invoicing processes. The system relies on data from grid operators and TSOs, emphasizing the importance of timely and accurate data for billing

and monitoring purposes.

4.1.3. Company C

Company C is a company that focuses on energy optimization for commercial and public buildings. To achieve this, they require energy data that aids in the optimization process. They have observed that optimizing large buildings can be particularly slow, as it often involves installing numerous sensors to gather data. After data collection, they typically conduct a manual data inspection and analysis to determine if the optimization process has achieved the desired effects. However, due to the scale of these projects, understanding the impacts and remembering all optimization steps can be challenging.

Company C solution is a modern, web-based cloud tool designed for energy professionals to quickly identify and address specific energy consumption issues. In their presentation, *Company C* cited reports from the EU, the Intergovernmental Panel on Climate Change (IPCC), and the International Energy Agency (IEA), highlighting the significant potential for energy efficiency and savings in buildings to reduce overall energy consumption. *Company C* emphasizes that increasing the coverage of renewable energy sources can further drive the energy transition, especially with improved building energy efficiency. The rollout of smart meters has made it easier for *Company C* customers to implement their solution. Traditional Energy Management Systems (EMS) often took a long time to integrate data, but with third-party APIs, *Company C* can quickly provide customers with access to energy data. This allows for complete automation of data analysis processes, generating a ranked list of potential improvements across a building portfolio. Knowing what, when, and where to implement these improvements is crucial for energy efficiency teams. *Company C* solution also provides direct feedback and verification of the changes made, creating a feedback loop. A key focus for *Company C* is the scalability of their system and business model, as installing sensors requires significant manual effort.

By analyzing data from smart meters, *Company C* aims to eliminate energy waste and create zero-carbon emission buildings. They use sophisticated modeling and analysis techniques to recommend installations such as PV systems and heat pumps based on energy consumption patterns. Sharing data for analysis would be advantageous, especially when working on multiple building analyses, as it could streamline automation. *Company C* customers benefit from understanding potential energy savings and cost-effective solutions without needing substantial upfront investments for building improvements. *Company C* emphasizes the importance of standardized, validated data sources. Based on their experience working with municipalities from their country of operation, *Company C* has helped achieve a median electricity savings of 12-13% across the country. *Company C* notes that most energy optimization is done in older buildings due to their cost-effectiveness. However, smaller buildings can also achieve significant savings in absolute terms, and since there are more smaller buildings, this is an important step toward energy efficiency. Nevertheless, they mention that some buildings do not experience any savings due to different usage patterns.

In the Q&A session, *Company C* highlighted the importance of standardized data and the difficulties of working with different formats. With standardized data and access,

they could more easily scale their solution. They also discussed whether a data hub architecture would benefit more from a centralized or decentralized system.

4.1.4. Company D

With their CFE (Carbon-Free Energy) Suite platform, *Company D* offers diagnostic and inventory functions. On one hand, the diagnostic function helps companies understand their current situation regarding energy matching procurement and their "Scope 2 Emissions," which are indirect greenhouse gas emissions associated with the purchase of electricity, steam, heat, or cooling [71]. This tool is designed to be easy to use, requiring minimal input while providing valuable insights without adding complexity.

On the other hand, for clients looking to advance their procurement strategies, *Company D* offers solutions to onboard renewable contracts and provides more granular "Scope 2 accounting" through their inventory function. This function also supports 24/7 matching APIs to aid in renewable energy procurement decisions. This functionality allows the inventory to serve as a portfolio management tool for all energy data, contracts, and energy attribute certificates, which act as guarantees of origin. This solution not only provides a granular view of Scope 2 emissions related to electricity but also manages the associated energy data and contracts effectively.

The data collection process for their solution focuses mainly on energy consumption and production. They need high levels of granularity in this data to enable 24/7 energy matching, and *Company D* also mentioned that studies have shown this granularity would benefit the grid as well. Furthermore, they gather all the data linked to CO2 emissions, from average emission factors to marginal emissions and mixes, as well as all the information linked to contracts and energy certificates. They then provide their clients with a platform equipped with APIs and visualizations of the data, enabling better exploration. The software from *Company D*, therefore, works as a Carbon-Free Energy (CFE) portfolio management tool, as it also helps client companies with their next decisions regarding renewable energy procurement. Furthermore, as a future use case, they envision that the excess energy from renewable sources from the contracts can also be traded, which also undergoes a certification process. Clients can also integrate these results and solutions into their own software.

Additionally, *Company D* is trying to collect this data on behalf of the clients. They mentioned encountering different ways to collect this metering data, as there are various unique access point solutions such as centralized data hubs or direct links to DSOs, depending on the region they are working with. This can be very time-consuming when they are trying to onboard new customers, and they hope that there could be new solutions that remove a lot of barriers regarding data collection, as there are still processes involved that need authorization letters, as not everything is digitized yet in the various regions. They are hoping that this solution could normalize and standardize data collection, as that would free up resources within the company. This data collection, along with the management of those certificates and the mentioned inventory, brings many challenges, especially with respect to large companies.

Company D is also developing other models within their CFE Suite, which are still in

progress. They are seeking assistance from partners to further enhance these offerings. The company is also updating their software solutions to better integrate various services, reflecting their commitment to innovation and improvement in the energy sector especially in reagrds to carbon free energy.

4.1.5. Company E

Company E is a startup that created an app for saving energy and providing visualizations. The co-founders, both with backgrounds in software engineering and UX design, aim to create the dashboard with the best intuitive experience for end users in mind. They started as a hobby project in the spring of 2022 and initially had only very basic features, wanting to see if it would gain any traction. According to *Company E*, their app gained many users during the summer of 2022, when the energy crisis hit Europe, making it very difficult for people in their country of operation to consume electricity at the cheapest time of the day.

A key goal they want to achieve with their application is to accelerate the transition to sustainable energy through a user-centric app experience. The app makes users more informed regarding their energy decisions by providing a clear overview of electricity prices and notifying them when to start their various appliances. Furthermore, it features a machine learning-based 7-day forecast for long-term planning, such as charging your EV when prices are predicted to be the cheapest. Additionally, the application allows users to track their historical and live consumption, continuously calculating costs, thus helping them stay on top of their bills and energy usage.

Company E also provides further insight into the current energy mix of the grid, and by combining this with the energy consumption of a household, users can see their environmental impact in real time. Regarding their business model, they provide a freemium version with display ads and partnerships. On the other hand, they offer features that must be paid for to be used. They aim to target as many households as possible and want to be able to scale their solution across many households, helping them track their energy habits. They showcase some statistics in their presentation where they were able to lower energy consumption of a Danish household in 2022 by comparing it to 2021. They were able to show that they moved the hours of energy consumption of the household as well. This is something that, according to *Company E*, would benefit the grid. For future use cases, they do not only want to focus on electricity but also on other energy resources or even water consumption.

The energy data they obtain from their local TSO, and market prices from an European power market operator that facilitates the trading of electricity across multiple countries through day-ahead and intraday markets, enabling efficient buying and selling . It provides platforms for day-ahead and intraday markets, enabling market participants to buy and sell electricity efficiently. This follows a centralized and standardized data collection approach by these data sources, which the app includes in its visualizations. However, they would also love to enable all European citizens to be informed and try to change their behavior. This is very difficult for a small startup, as each country would need custom data integration for each system operator. Therefore, they highlight the

importance of having standardized methods of data collection across Europe, which would make it more accessible and enable them to scale their product across the continent. Their requirements for such centralized data across Europe would be to have an easy onboarding process for users in order to grant an excellent user experience but also provide enough documentation from a technical standpoint for developers.

4.1.6. Summary of the Company Descriptions

As we can see from the descriptions based on the presentations and transcripts, these companies and start-ups have interesting use cases. Moreover, *Company A*, *Company B*, and *Company E* have residential households as their main target users, which also provided valuable insights in this regard. However, what they have in common, besides working within the energy sector, is dealing with energy data for their business models. In some cases, they even combine other data sources, as in the examples of *Company D* and *Company E*. Furthermore, it seems the difficulty lies not only in the process of collecting and integrating these data sources but also in the various approaches and processes involved. In some cases, even bureaucratic and manual steps must be taken. As these companies are interested in using the EDDIE framework it seems that many of them would be interested in it's capability to act as an energy data space and provide easier access to the required consumption data [6].

To analyze the various use cases and business situations, and to understand how this can provide practical input for the development of *N-Ergy-View*, a qualitative data analysis is now presented. In this analysis, the various themes in the transcripts of the presentations and interviews have been clustered in a chart. Selected anonymized quotations used in this thesis are based on transcripts of company presentations and discussions observed during the meetings.

4.1.7. Qualitative Data Analysis of the Real-World Use Cases in the EDDIE Project

For this section, the iterative process of thematic analysis clustering by Braun and Clarke and their phases is described by using the collected qualitative data [64]. This method is a structured approach for thematic analysis to identify patterns within data from presentations and interviews and to determine the key findings and themes. Lastly, a discussion about the results is provided, exploring how this input contributes to the understanding of the energy market for energy data-driven services in Europe and how it affects the development of *N-Ergy-View*.

Process of Clustering

The first step involves familiarizing oneself with the transcripts to gain an understanding of the key topics, as well as inductively assigning codes to certain parts that are considered interesting and important within the dataset. For example, in the interview with *Company C* they stated:

> "[...] highly available energy data that we have in our country."

Consequently, this part of the transcript got the code *Availability of Energy Data in our country*.

A good starting point for the thematic clustering was the main theme that emerged: *Energy*. Therefore, any code containing the word *Energy* was clustered around that theme. This process and the resulting cluster can be found in Figure A.1. However, since the focus lies on *Energy Use Cases* and their underlying *Energy Business Models*, the aim was to understand patterns and relevance for different stakeholders. Therefore, the next step involved an additional iteration of the thematic analysis to specifically examine the *Challenges* and *Opportunities* faced by businesses and customers (see Figure A.2).

This perspective-oriented grouping resembles a simplified, deductive SWOT-style [72] approach combined with Braun and Clarke's method, which is also used by Kiamnesh et al. [73]. This clustering approach helped to highlight themes that emerged as either barriers or enablers of innovation in energy services, based on statements from the interviewed companies and their presentations. Following this deductive analysis, the next iteration process began on an inductive basis to identify new themes, which can be seen in Figure A.3. This process led to the first iteration of the entire cluster, which can be seen in Figure A.4. The focus in this figure is especially on the themes, as the codes were used to deduce them.

Through an iterative process of identifying more themes and finding overlaps, the final cluster can be seen in Figure 4.1. The results and the implications for the thesis and the development of *N-Ergy-View* will be discussed in the following section. The approach of applying thematic clustering and iterative processes will also be used in the later research phases of this thesis.

Result and Conclusion

After conducting thematic analysis using the Braun and Clarke method, and by inductively and in some parts deductively generating themes from the qualitative data, we will discuss a short description of the final iteration. As illustrated in Figure 4.1, the main theme revolves around the unique *Energy Use Cases* these companies had, and the *Challenges* and *Opportunities* they identified within the energy market, with a particular focus on energy data.

First, focusing on the *Challenges*, the themes *Issues with Energy Data*, *Regulations*, and *Scalability* were derived from the codes and previous themes in earlier iterations. For example, the main reason for the *Issues with Energy Data* theme was that all these companies offer data-driven-energy-services and require this data to operate their business models. However, each company faced unique challenges in dealing with energy data. For instance, *Company D* mentioned in their presentation:

> "[...] we need to collect production data, but it's not always accessible via data hubs or decentralized solutions [...]"

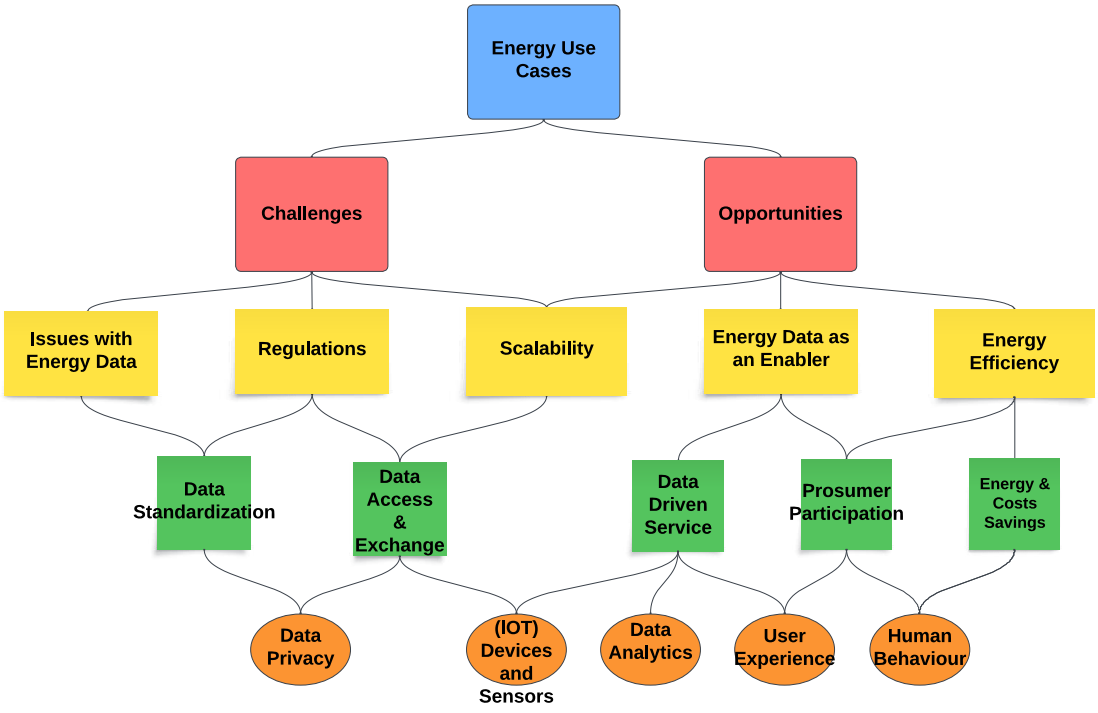

Figure 4.1.: Final Thematic Cluster

This indicates challenges in accessing energy data from data hubs. The *Regulations* theme also plays a vital role, as laws can restrict or allow access to energy data, such as the EU directive 2019/944 [3]. There are also challenges in setting up energy communities, as in *Company B's* case. They mentioned that some regulatory processes still demand paperwork. For instance, in their presentation:

> "[...] there are still pen and paper processes going on [...]"

Company B even stated:

> "[...] one of the main obstacles is the.. is the legal framework [...]"

Another theme was the desire of these companies to scale their businesses and solutions nationally or even internationally, which can be a significant challenge due to technical or legal barriers. *Company E* stated:

> "[...] we would love to have a set of standards for collecting, storing, and accessing energy data across Europe to make it easier to scale a product like ours."

Consequently, the subthemes *Data Standardization* and *Data Access & Exchange* highlight the relevance of these issues and the wishes these companies have to overcome them to succeed with their use cases.

On the other hand, the *Opportunities* theme, as the name suggests, deals with the benefits and opportunities these use cases bring. Similar to the *Challenges* theme, *Scalability* can also be an opportunity for energy use cases, as mentioned previously by *Company E*. Furthermore, energy data acts as an enabler for new business models and use cases. Therefore, the theme *Energy Data as an Enabler* should highlight this aspect.

Additionally, the use cases promote *Energy Efficiency*. For example, *Company C* focuses on building energy optimization, *Company D* aims to help large data centers achieve net-zero status by matching them 24/7 with green energy from various renewable producers, and *Company A* offers the possibility to trade excess energy production to other consumers.

Consequently, the resulting subthemes are *Data-Driven Services*, which emerge from the use of energy data, and *Prosumer Participation*, which highlights that some use cases aim to help households or businesses become more active in the energy market. This means not only consuming energy but also producing it or being flexible participants in the market.

Moreover, all these use cases and the previous emphasis on *Energy Efficiency* will ultimately lead to *Energy and Cost Savings*.

In the end, the final resulting subthemes are *Data Privacy*, *(IoT) Devices and Sensors*, *Data Analytics*, *User Experience*, and *Human Behavior*. Starting with *Data Privacy*, this is a key theme for most of the researched use cases. For instance, *Company A* mentioned regarding the energy data of their customers:

> "[...] how can we make sure these data privacy is well considered [...]"

Energy data is very sensitive, and it should be respected while processing it in various use cases. This theme is also important in terms of user consent, as users would have to share their energy data to use the applications. *Data Privacy* is also relevant for *Data Access & Exchange*.

Consequently, the theme *(IoT) Devices and Sensors* was derived due to smart meters and other internet-connected devices that collect sensor data, which is essentially the lifeblood for these *Data-Driven Services*. These meters also collect real-time data in some cases and are subject to *Data Access & Exchange* regulations such as the EU Directive [3]. With this collected and shared energy data, the *Data-Driven Services* usually perform some sort of *Data Analytics* for the customers, such as using visualizations for data exploration in *Company D's* case or AI/ML modeling for energy building optimization or predictions in *Company C's* and *Company E's* cases.

> "[...] these types of modeling and analysis techniques they are extremely important for the entire (energy) transition."

> " It's a machine learning based forecast that looks at weather data and historical data and then predicts what.. what's the price going to be seven days ahead."

From these quotes we can see that *Data Analytics* play a vital role for these use cases.

Next theme is dealing with the *User Experience* and is deduced from codes that highlight topics about how the customers interacts with the service or technical solution of these companies or even have a focus on UX. *Company E's* cofounder also stated

> " [...] And that's also why I'm very passionate about users and creating great and intuitive experiences for the end user."

But also *Company D* stated this in regards to the data access for their service:

> " [...] we also have to think about the user experience of those companies that have to provide authorization [...]"

The *User Experience* theme also goes hand in hand with the *Human Behavior* theme for these use cases. The services either require or aim to benefit the user by informing them about their behavior through the *Data Analytics* components of the service. By providing a better understanding of their consumption, such as in*Company E's* use case, the goal is to help users save energy and thereby reduce costs. Additionally, in the energy trading aspect of *Company A* or *Company D*, some behavioral questions arise. For example, to whom does the customer sell their excess energy, if at all?

> " [...] and making these behavioral changes among the consumers so we want to be able to to enable all citizens of Europe to be informed and educated about their energy consumption and habits [...]"

To conclude, we gained a good exploratory overview from the descriptions of the companies, as well as from the thematic clustering, indicating that energy data appears to be a vital theme among these energy use cases. This data can be challenging to acquire and often demands cumbersome processes due to regulations or varying data standards, formats, and data-sharing practices. Additionally, data privacy and data handling can pose significant challenges.

However, energy data enables interesting use cases for respective target groups, engaging customers in activities such as energy trading or helping them save energy. Smart meters and other devices that collect energy data are vital for these businesses, as they facilitate various data processing and analytics tasks with the provided information.

Furthermore, how users experience these applications can influence their behavior, ultimately leading to energy and cost savings. Consequently, the resulting subthemes—*Data Privacy*, *(IoT) Devices and Sensors*, *Data Analytics*, *User Experience*, and *Human Behavior*—emerged as key insights from the qualitative analysis and can be considered essential design pillars for the development of *N-Ergy View*.

These themes directly inform the design approach and are particularly relevant for addressing the first research question of this thesis: How should data-driven-energy-services be designed, and what key aspects must be considered for effective technical implementation and meaningful user engagement? Furthermore, the sub-questions concerning key user requirements and design principles are also addressed with this context.

The following research on use case categorization aims to explore existing data-driven-energy-services, with a focus on the household context, to further validate the concept of an energy monitoring app with data analytical functionalities. This exploration will also help assess the broader question of whether such applications, based on smart meter data, can be meaningfully adopted by a targeted user group.

4.2. Use Case Categorization Study

From the thematic clustering, we exploratively gained insights into what is important for energy-data-driven use cases and identified themes relevant to the development of *N-Ergy View*. Additionally, the descriptions provided by partner and external partner companies in the EDDIE project [6] offered a comprehensive overview of various practical use cases. To deepen our understanding of data-driven-energy-services and to further understand what types of use cases can be found in the practical field, a study was conducted among computer science students from the University of Vienna. The goal was to identify more business use cases that require energy data or smart meter data in particular. This practical exploration aimed to complement the academic literature and is part of the explorative phase of this thesis., which still offers limited coverage of applied ML/AI-based energy monitoring systems. The results also help inform the development and positioning of the thesis-related prototype as well help closing the literature gap on data-driven-energy-services

Data Collection

The study was conducted in the context of the courses *Foundations of Networked Systems* during the summer semester [74] and winter semester of 2024 [75], and *Cooperative Systems* during the winter semester of 2024 [76]. The students had the task of finding and analyzing at least two energy services in the field that use energy data, or more specifically, smart meter data, for their business use case. They had to specify the country of origin or operation of the company and, most importantly, categorize the business use case into various themes or categories. Finally, a short description of the identified companies had to be provided. The naming of the categories was open to the students, and no predefined category list was given; therefore, a broad variety of categories were found as they were encouraged to develop their own thematic labels based on their understanding of the services. This study supports the exploratory character of the thesis to further understand the market for energy data-driven services.

Thematic Clustering: Procedure and Insights

The data is then methodically analyzed using a combination of qualitative and quantitative analysis. All the categories identified by the students were first systematically collected into a table. From the *Foundations of Networked Systems* [74] course during the summer semester, there were $N = 38$ submissions, and in the following winter semester, there were a combined total of $N = 66$ submissions from both *Foundations of Networked Systems* [75] and *Cooperative Systems* [76]. Since the task and its requirements remained unchanged between semesters, the resulting data and analysis will be combined. This decision was made to ensure a more comprehensive and statistically robust representation of the findings.

After some manual data cleaning from the raw data, such as deleting duplicate companies, addressing typos, and standardizing the naming of the same companies and countries (e.g., USA and United States of America), the data was refined. In terms of country naming, broad definitions such as *international*,*worldwide*,*multiple European countries* and others were not included in the countries column dataset. Since there were many international students, a wide variety of different companies were found and added from various places. The full list of the data can be seen in A.2.

Metric	**Count**
Services Found	175
Countries Represented	30
Service Categories	149

Table 4.1.: Data Overview

After the first cleaning process, in total, as can be seen in Table 4.1, there were 149 categories that the students added inductively, 175 unique services were identified in the cleaned dataset, and they were counted from 30 different countries across 248 entries from the students. In Figure 4.2, the count of each country and the appearances are

counted in the country column dataset. Furthermore, EU member states are highlighted in blue to emphasize the European dimension of this thesis.

However, due to the open-ended nature of the categorization task, a second inductive thematic clustering process has been conducted to consolidate thematically and semantically similar categories. This was achieved by examining keyword-based groupings within the categories. Keywords such as *AI ML*,*Monitoring* and *Smart Home* were used to review and group the service categories into broader themes.

Due to the vagueness of some categories, the context of the services has been examined more closely. For instance, the categories *Private Sector* and *Public Sector* in the dataset were too vague. Upon closer inspection, these services were identified as energy providers and were subsequently added to the respective category.

In the end, all 149 unique categories were consolidated into 8 main category clusters through the thematic clustering process, similar to Braun and Clarke [64], using the keywords and themes that can be viewed in Table 4.2, and the resulting service category names and counts in Table 4.3. This step was essential to further clean up the structure of the dataset, give the categories clear names, identify the most frequently occurring categories, and facilitate a descriptive statistical analysis of the overall category distribution.

Category No.	**Keywords Used**
1	AI/ML, Data Analytics, etc.
2	Energy Management, Efficiency, Audits, Consulting, Optimization, etc.
3	Energy (Heat) Monitoring, Metering, Visualization, Dashboard, Control, etc.
4	Energy and/or Heat Provider, Pricings, Rates, Tariffs, Sales, etc.
5	Smart Home Solutions, Integrations, Management, etc.
6	Green Energy, Renewables, Carbon Reduction, Monitoring, etc.
7	Energy Infrastructure, Grid, Load & Demand Management, E-Mobility, Organizations, etc.
8	Other (Software Platform, IT & Telecommunication, etc.

Table 4.2.: Thematic Clustering Based on Keywords

Table 4.2 contains the keywords that were searched for the thematic clustering of the categories and further shows the process behind the clustering. **Category 1** includes all services related to artificial intelligence, machine learning, or the application of advanced analytics based on energy data. **Category 2** consists of services aimed at optimizing and managing energy consumption and efficiency, often involving consulting, audits, or energy optimization strategies. Services using keywords such as *monitoring, metering, dashboard* or *visualization* were grouped under **Category 3**, which reflects a focus on presenting and controlling energy or heat data.

Category 4 includes energy and heat providers, as well as services dealing with pricing models, tariffs, and contract management. Smart home integrations and related solutions were categorized under **Category 5**. **Category 6** captures services focusing on renewable energy, green solutions, and carbon reduction technologies. Broader infrastructure services, including grid and load management, e-mobility, and organizational or political actors in the energy sector, were grouped into **Category 7**. Finally, **Category 8** contains services that were either too general, unclear, or did not fit clearly into any of the other

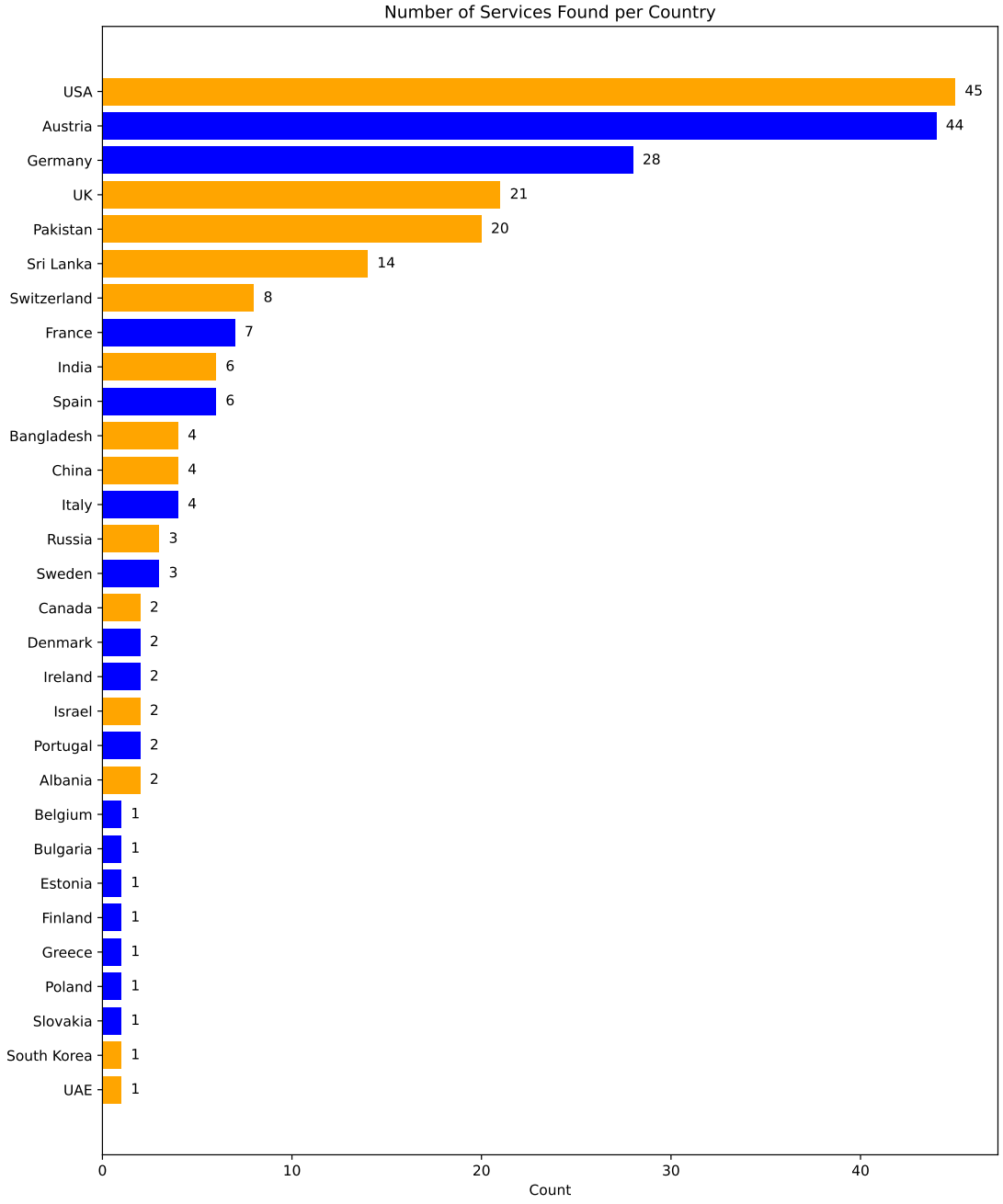

Figure 4.2.: Number of Services Found per Country (EU countries in blue)

categories—for instance, software platforms with broad or unspecified applications. The resulting service categorization names can be seen in Table 4.3, as this gives them a clearer understanding of what these types of found services from the students work with.

Conclusion

Besides the service categorization names, we can also see the distribution and percentage of categories in Table 4.3. This distribution helps us understand which types of services were more commonly found by the students. **Category 3 - Monitoring & Visualization Services** were most frequently found by the students, with 91 entries and a percentage of 36.69% overall. As the name suggests, these services deal with the visualization and monitoring of metered energy consumption. This is followed by **Category 1 - AI/ML & Data Analytics Services**, which account for 18.55% and include analytics using ML or AI on the data. Next, **Category 6 - Green & Renewable Solution Services** are ranked third overall with 12.50%. These services deal with green energy transformation and production, such as PVs, which also require or produce energy data. **Category 2 - Energy Efficiency Management & Optimization Services** deals with energy optimization of households or provides special audits on consumption, accounting for 11.29% of collected services. Ranked fifth, **Category 4 - Energy Providers & Tariff Services** are, as the name suggests, services that provide energy or handle the billing of consumption, which also requires data on energy consumption. Next, **Category 8 - Other**, which includes services that were too broad to categorize, accounts for 4.84% of the overall entries. Lastly, **Category 5 - Smart Home Solutions & Automation Services** and **Category 7 - Infrastructure, Grid Management & E-Mobility Services** are ranked last, each with 10 entries, representing 4.03% respectively. **Category 5** includes services that provide smart home solutions related to energy consumption, as well as devices such as smart thermostats. **Category 7** includes infrastructure services that are both private and public, dealing with smart grid management and e-mobility. The results of the thematic clustering and distributions are also visualized in Figure 4.3 for better oversight.

No.	Clustered Services Categories	Count	Percentage (%)
1	AI/ML & Data Analytics Services	46	18.55
2	Energy Efficiency Management & Optimization Services	28	11.29
3	Monitoring & Visualization Services	91	36.69
4	Energy Providers & Tariff Services	20	8.06
5	Smart Home Solutions & Automation Services	10	4.03
6	Green & Renewable Solution Services	31	12.50
7	Infrastructure, Grid Management & E-Mobility Services	10	4.03
8	Other	12	4.84
	Total	**248**	**100.00**

Table 4.3.: Thematic Clustering Service Categories with Percentages

To conclude, this study provided a look into the various use cases and their categories

for energy data-driven services. As previously noted, **Category 3 - Monitoring & Visualization Services** were the most frequently found and appear to be the most common energy services identified by the students. These services are essential for data exploration through visualized and displayed energy consumption. Additionally, **Category 1 - AI/ML & Data Analytics Services** were also prominently found by the students. These services utilize analytics on energy data to provide deeper insights into consumption patterns. Together, these two categories account for more than half of the services, with 55.24% of the overall data. This insight is valuable for shaping the concept and development direction of *N-Ergy View*, as it highlights that functionalities such as monitoring, data analytics, and AI are commonly integrated into similar services. By focusing on data analytics, we can provide users with better insights, and combined with visualizations and other functionalities, help users understand their energy consumption patterns. Therefore, during the development of *N-Ergy View*, a closer exploration can be made into data analytics, visualization, and thereby enhancing the user experience (UX) and consumption behavior for households, aiding in the understanding of their energy consumption.

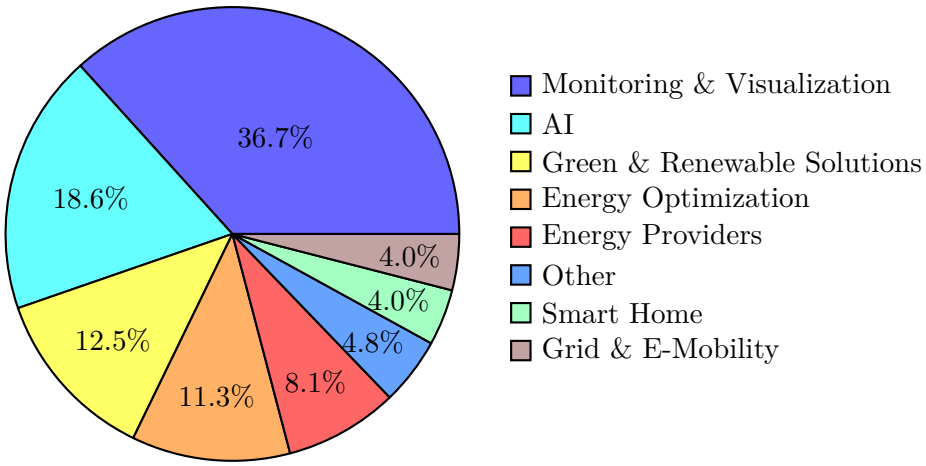

Figure 4.3.: Service Category Distribution (in %)

4.3. Conclusion of the Practical Insights Research

From the exploration into the practical world, a lot of crucial insights were gathered through real-world use cases and the study around use case categories, informing the development and focus of *N-Ergy-View*.

Using the iterative process of thematic clustering revealed several challenges that need to be addressed—such as energy data access via data hubs or smart meters and related privacy concerns. However, energy data can also act as an enabler for innovative business models, especially when the user experience is thoughtfully considered. A positive user experience can lead to desired behavior changes, and through analytics, actionable

feedback can be provided to further empower users. This research addresses the first research question, showing that data-driven-energy-services should be designed with the identified key themes and aspects in mind for designing a data-driven-energy-service: *Data Privacy*, *(IoT) Devices and Sensors*, *Data Analytics*, *User Experience*, and *Human Behavior*.

Furthermore, examining other real-world use cases, the research showed that data-driven-energy-services are increasingly built around monitoring, visualization, and data analytics functionalities, which together accounted for more than 55% of the identified use cases in the study.

This indicates that *N-Ergy-View* should be conceptualized and developed as a data analytics energy monitoring application with a focus on households. It should also consider the challenges, opportunities, and resulting themes in its development in order to close the identified literature gap.

5. N-Ergy-View: A Practical Energy Monitoring Application

The previous chapter highlighted the various challenges and opportunities that energy data-driven service companies face in the field, as well as the themes that should be considered for energy application use cases. Furthermore, it has been shown from the study in the previous chapter that monitoring applications and data analytical applications have been most commonly found in the field. Therefore, to close the literature gap, the focus for *N-Ergy View* has been placed on implementing it as a monitoring application that uses visualizations and data analytics to inform and change the energy consumption of households.

In this chapter, a short background information regarding *N-Ergy View* and its role within the EDDIE project [6] is provided, and the reasons for choosing certain features and functionalities are explained. To further understand and identify which key features are important, and to extend the **Exploration Phase** of this thesis, interviews have been conducted with the target group for the user-centric design approach to find the user requirement for the demonstrator. These insights will reveal and help understand key core functionalities and the needs of users of such data-driven monitoring applications.

After completing these interviews, the **Exploration Phase** concludes and transitions into the **Implementation Phase**, during which the core functionalities and architecture of *N-Ergy View* will be presented in detail. This phase aims to address the second research question of the thesis: What are the main user requirements for a data-driven energy service, and how should the user interface and user experience be designed and implemented for a service that both monitors energy consumption and provides advanced data analytics capabilities?

5.1. N-Ergy View in the Context of the EDDIE Project

As mentioned in the introduction of this thesis, a research and development team from the *Cooperative Systems* group is involved in the EDDIE project [6]. The goal of the project is to develop and implement a decentralized, distributed, and open-source Data Space for energy-related data. As part of this project, the team is tasked with developing demonstrators that utilize energy consumption data provided by the EDDIE Framework, sourced from various Distribution System Operators (DSOs) across European Member States. The data delivered includes both historical validated data and real-time data, made accessible through the framework's various interfaces.

N-Ergy-View is developed as one of these demonstrators and aims to integrate the

EDDIE framework to utilize energy data. Furthermore, one prerequisite and a benefit of EDDIE is that various data sources can be integrated and analyzed, combining consumption data. Therefore, one requirement of the demonstrator within the EDDIE project is to demonstrate that various data sources can be combined with the framework within an application. However, the development team at the *Cooperative Systems* research group is free to develop other key functionalities independently and can determine the processes on its own. To understand which additional functionalities or core components should be developed, design processes and requirement engineering were conducted, including interviews with the target group, which will be discussed in the following section.

5.2. Requirements Gathering & Target User-Group Interviews

To further understand the key features for the application, a user-centric design process has been chosen to explore the requirements, needs, and behaviors of the target group. The results of these interviews have played a vital role in the development of *N-Ergy-View* and its key functionalities. These results have also been published in a workshop paper by the author of this thesis [7].

Interview Process

Five interviews have been conducted with individuals from the target user group ($N = 5$). The interviewees have been young (aged between 20 and 35 years), tech-savvy (experienced with smartphones and interested in using networked technology to learn more about their energy consumption), and environmentally aware, with a keen interest in novel solutions to energy and environmental issues. The participants have been recruited through convenience sampling and have not been financially compensated for their efforts [77]. The interviews have been conducted individually in German, audio-recorded, transcribed, and subsequently analyzed qualitatively. The interviews have followed a semi-structured interview structure using an interview guide, which is in German (see Appendix A.4). The structure of the interview has allowed for flexibility in exploring the perspectives of the participants while also ensuring that key topics have been covered and encouraged the interviewees to share their opinions.

The results have been analyzed using thematic analysis by Braun and Clarke [64]. By familiarizing ourselves with the interview transcripts, codes have been applied to certain quotes or interesting passages, as well as points made by the participants, thereby identifying important functionalities or components to consider while designing and implementing *N-Ergy-View*. After applying all the codes, certain themes have been clustered iteratively, as in the previous chapters and sections. In the end, certain key themes and results have emerged, which will be discussed in the following section.

Interview Results

The interview has started by asking the participants if they consider themselves to be aware of environmental topics and have engaged in sustainable actions. In most cases,

they have answered yes, mentioning activities such as trying to recycle used products and waste, using public transport, and other sustainable engagements like changing diets by eating less meat. Consequently, the interviewees have been asked if they also think about their energy consumption. In some instances, they have answered yes, particularly in regards to rising energy costs. One participant has been very engaged, having various smart devices to track the energy usage of those devices and their household. However, some participants have mentioned that they did not have much concern about their energy consumption.

Next, the participants have been asked if they consider themselves to be tech-savvy. Some participants have also mentioned that they thought issues such as climate change could be solved by using intuitive and environmentally friendly technological solutions. Another question posed to them has been whether they are aware of the digitization of the energy market and whether they had a smart meter at home. Regarding digitization, only one participant has not been entirely sure what it would entail or mean. However, by questioning them about what they thought, they have correctly mentioned smart meters, for instance. Other participants have thought about IoT devices and sensors or the transition from a conventional electricity grid towards a smart grid where lots of hardware and software work together with more sustainable energy sources. Four out of the five interviewees have known they had a smart meter installed, while the other one has been unsure.

Further, the participants have been asked if they could think of services or had ideas for use cases that would be possible using data from smart meters. Most of them have thought of having a better overview of their energy consumption. One participant has known that smart meters are also important for energy communities, a collaborative initiative where households and organizations work together to manage, produce, and consume energy more sustainably and efficiently, which, for example, *Company B* from section 4.1 is promoting.

Subsequently, the idea of *N-Ergy-View* has been presented, and it has been explained how it could potentially help users save energy by analyzing and providing feedback regarding their consumption. Additionally, the concept of forecasts has been introduced, highlighting how they should act as a motivator to keep actual consumption below these predictions. Participants have been asked if they would use *N-Ergy View*. Three participants have stated that they definitely would, while the other two have expressed some concerns. One of these two subjects has questioned the core functionality and how it would actually help them save energy. The other participant has stated that they would not use the application due to privacy and surveillance concerns. Otherwise, some participants have appreciated the proposed prediction functionality, especially if gamification incentives could be applied.

Furthermore, the participants were asked about their opinions regarding visualizations, notifications, visual feedback, and energy-saving recommendations. Concerning the visualizations, most people preferred bar or line charts; however, some were also open to more diverse visualizations like heat maps. Additionally, regarding the user interface (UI), people expressed a desire for a user-friendly interface that could also be customized

in terms of the visual plotting of the consumption data. Usually, a "simple to use" visualization was preferred. Some feedback on the app's functionality was that it would be interesting to see which devices were consuming more energy at specific times of the day and why. Participants also suggested that this information should be displayed or notified to the user, highlighting also the need for an analysis of the household's energy consumption.

Another inquiry was whether the users wanted to display their consumption in terms of costs and which type of visual breakdown they preferred. Interestingly, all of the subjects favored showing the consumption in costs instead of kilowatt hours, which was also found by Hargreaves et al. [58]. Some mentioned that, in this case, the visualization would have more impact, as they could better track how their behavior affects their energy costs. As a follow-up question, the interviewees were asked if they were comfortable with sharing contract data regarding their energy provider to acquire their costs per kilowatt hour. Most of them found this acceptable, though some preferred a form where they could manually enter their costs per kWh.

Regarding feedback and notifications, there were mixed responses from the interviewees. Most agreed that constant notifications would be annoying and bothersome while using the application. One participant even mentioned always turning off the notifications function in the device settings. However, they appreciated having visual feedback on their energy consumption and knowing if they were on track to stay below the predictions and save energy, as well as being informed about their consumption. Some participants also suggested that it would be a great idea to add a functionality for setting energy consumption limits or energysaving goals, where *N-Ergy View* would warn them ahead of time if they were reaching the set limit of the day (e.g., at 80% of the limit reached). They felt this would help them save more energy and even plan their energy consumption more effectively.

It was also explored how participants would feel if emotional and shocking pictures based on their energy consumption were displayed. To illustrate the concept to the participants, AI-generated pictures using OpenAI's DALL-E model were presented. On one hand, a beautiful landscape with green hills, trees, and a blue river flowing through the scene was shown, as can be seen on the left side of Figure 5.1. On the other hand, if energy consumption exceeded the forecasts, the picture transformed into a more dramatic scene with droughts, dry riverbeds, dead trees, and an orange-glowing sun, as depicted on the right side of Figure 5.1. However, none of the participants liked this idea, as they feared being shamed for their behavior. Nevertheless, one participant mentioned that this approach could open up some gamification incentives, where users would be rewarded with digital flowers or trees in the UI.

Consequently, to assess the potential market adoption of this type of app, it was examined whether the individuals were willing to share their energy consumption data in order to use *N-Ergy View*. Two participants expressed willingness, while the other three were more hesitant. They were skeptical about whether *N-Ergy View* would deliver the promised service and truly help them save energy. Regarding a business and payment model, as well as the willingness to pay for the app, some participants were reluctant,

Figure 5.1.: AI Pictures presented to Participants

as the benefits would first need to be demonstrated, and the actual energy savings in terms of costs would need to be considered. For instance, one interviewee mentioned that if they had to pay a flat rate of, for example, 10 EUR, but the total energy savings amounted to only 0.40 EUR, the financial benefit would not be evident, and they would not consider the app worth the price.

Lastly, all interviewees were asked if they thought this type of application would help them save energy and benefit the environment by assisting households in reducing energy consumption. All of them agreed that *N-Ergy View* definitely has the potential to help decrease overall energy consumption. However, some also noted that it would depend on how many users adopt the application and actively follow the recommendations or change their behavior.

Thematic Analysis

From these interviews, interesting points and opinions were gathered from the participants, which can provide valuable feedback for the development of *N-Ergy View*. To better analyze this qualitative data, a thematic clustering was performed, following the method of Braun and Clarke [64], as described in the previous chapters. This process aimed to extract relevant themes for the development of the application. After familiarizing with the interview transcripts, codes had been applied to specific quotes that were deemed interesting and relevant for identifying requirements for the design and implementation of the app. The initial codes were in German, as the interviews had been conducted in that language. However, for the final iteration, the main themes and codes had been translated into English.

Using the *Mural* and *Lucidcharts* modeling tools [66] [70], the codes have been clustered, and thematic themes have been derived for the first iteration (see Appendix A.5). Sentences where participants expressed their opinions or wishes on topics such as the user interface, visualizations, or data security had been highlighted. These highlights

had received overall tags, such as *Perceive N-Ergy-View as Beneficial*. After completing this process, the Mural tool had been used to cluster all these tags and codes for the first iteration, and the final iteration had been made with *Lucidcharts*. Main themes or topics for these codes had been identified and generated, which were considered a perfect fit. For instance, codes related to visualization and the dashboard had been clustered around the *UI* topic, while thoughts about data issues had been grouped under the *Data Security* theme.

Figure 5.2.: Final Thematic Cluster from Interviews

Consequently, after identifying the initial themes, a review and refinement of the themes considered essential for the application had been conducted. Themes that had not been deemed important, such as *Economics* or *Energy Market* had been discarded

from the first iteration. As shown in Figure 5.2, the main themes assembled were *UI*, *UX*, *Data*, *Data Security*, *IoT & Sensors* and *Behavior Changes (Empowerment)* and are displayed in blue shapes.

Digging deeper into the various topics and explaining Figure 5.2, it has been found that the themes *UI* and *Data* are interconnected, as *Data* further deals with other themes like *Data Security* and *IoT & Sensors* which address issues such as *Concerns About Data Security & Processing* or *Various Experiences with Smart Meters*. The *UI* theme had been identified to deal with topics related to the dashboard, visualizations, and notifications, including sub-themes like *Customize Display & Visualizations* and *Appreciate Messages Regarding Consumption Forecasts*. Since the user interface relies heavily on data and is a key factor for user experience, these two themes had been closely connected. *Data* had been recognized as a general overarching topic, as it is the lifeblood of the application as well as the raw material it works with to provide insights for the users and drive the business model. Furthermore, it had been noted that smart meters would be needed to use the application, and there had been varying experiences with what these devices do and what they are needed for. However, the participants had been aware that sensitive data was being recorded and had expressed high concern about data security and privacy, which had been a key theme during these interviews. Consequently, some participants had even mentioned this to be a major issue for them if their data was not being handled properly.

On the other hand, *UX* and *Behavior Changes (Empowerment)* have been identified as interconnected themes. The former had focused on the users' experience and opinions while using *N-Ergy-View*, while the latter had addressed functionalities and behavioral experiences that could influence or change user behavior. The *UX*theme had also been subdivided into negative and beneficial sub-themes in regards to the perception of various use cases within the app. For instance, if the application did not provide any beneficial insights, the users would not use the app or even pay or share data with it. However, if the experience was considered to be positive while using *N-Ergy View*, this perception had changed, and the interviewees had expressed willingness to pay and share data for the provided benefits. The *Behavior Changes (Empowerment)* theme had further delved into topics such as being reassured when having good oversight over one's consumption, as well as having the ability to track the consumption of individual devices and thereby the costs of energy usage. Additionally, dealing with goal setting had been depicted, which also reflects the findings from the state of the art in regards to behavior change and goal setting and tracking for motivational purposes.

Conclusion

Choosing a human-centered design approach has allowed for an explorative research into the design and search for key functionalities that should be considered while developing *N-Ergy View*. Despite the participants being tech-savvy and environmentally conscious individuals, different approaches, wishes, and behaviors towards monitoring apps and processing sensitive data such as energy consumption had been determined from the interviews. However, there had also been positive perceptions, such as gaining a better

overview and analysis of one's consumption. Opinions about setting up feedback systems, such as notifications or goals, had also differed among participants. A variety of other opinions and input had been collected via the interviews, including possible gamification elements. It can be said that overall, most interviewees liked the concept and could see it as beneficial. The thematic clustering afterwards had allowed for the identification of the main themes, which had been found to be *Data*, *Data Security*, *IoT & Sensors*, *UI*, *UX*, and *Behavior Change (Empowerment)*. These themes and the various sub-themes derived from them had been based on the interviews and the opinions of the participants. Therefore, for the application, these mentioned themes should be considered for the user requirements and implementation of *N-Ergy View*.

5.3. Designing and Implementing N-Ergy-View

With the previous section, we concluded the **Exploration Phase** and gathered various inputs from the exploratory research for the design and implementation of the University of Vienna demonstrator for the EDDIE project. From this point on, the **Implementation Phase** will commence, focusing on the creation of *N-Ergy-View*. As mentioned previously, the focus of the application will be on energy monitoring, utilizing data analytics to inform households equipped with smart meters. It will use energy data provided via the EDDIE Framework and various other data sources to inform the users of the application. The implementation follows a human-centered design approach, ensuring that user needs, expectations, and preferences, which were collected during the **Exploration Phase**, guide both functionality and design decisions throughout the development process. This phase also aims to address the second research question, which investigates the main user requirements for a data-driven energy service and how the user interface (UI) and user experience (UX) should be designed and implemented accordingly.

On the one hand, the previous chapter highlighted the various challenges and opportunities that energy data-driven service companies face in the practical field. The results from the thematic analysis of the interviews and presentations can be viewed again in Figure 4.1. It was observed that themes such as *Data Privacy*, *IoT Devices and Sensors*, *Data Analytics*, *User Experience*, and *Human Behavior* play a crucial role and will be considered in the development of *N-Ergy View*. On the other hand, the student pilot study showed that monitoring apps and AI/ML-centric applications were most commonly found. Additionally, the interviews and the analysis with the target group revealed that themes like *Data*, *UI*, *Data Security*, *IoT & Sensors*, *UX*, and *Behavior Change (Empowerment)* are important factors for the development. Therefore, a special focus will be placed on the design of the dashboard, visualizations, and data analytics, as well as the integration of other data sources, which was a requirement and specification from the EDDIE project to demonstrate that various data sources and the data the framework delivers can be combined effectively. The dashboard should be informative for the user in order for them to have a good user experience and be able to change their behavior based on the information presented. This approach will attempt to close the identified literature gap, where households will benefit from the amount of energy they share by

receiving better information about their energy consumption, thus being able to adjust their behavior accordingly and take informed actions.

5.3.1. Deriving Functional User Requirements

In the following sections, a short discussion on some of the user requirements derived from the thematic analysis in section 5.2 is provided. This also aims to address the second research question concerning the main user requirements for a data-driven energy service and how the user interface and user experience can be effectively designed and implemented. These requirements have been identified for implementation in *N-Ergy View*. Additionally, other functionalities chosen for the use case of the demonstrator are presented. For instance, basic functionalities include account registration, authentication, and deletion, while further key functionalities were identified from thematic clusters and interviews.

In regard to the *UI* topic, it was found that users preferred displaying consumption in costs rather than kilowatt-hours for relatability. These findings are also confirmed in the literature such as Hargreaves et al. [58]. Clear visualizations of forecast values, such as using red dashed lines or bars, were also desired. Customization was deemed essential, allowing users to tailor dashboards with different visualization types like line charts, bar charts, or other visualizations such as heat maps.

The EDDIE Framework has been identified as crucial for data integration and user consent, and it is partly responsible for data handling in terms of privacy and security. Additionally, it ensures secure storage of personal information and data in the application's database. It has been integrated into *N-Ergy View*. Regarding user onboarding, it was determined that obtaining and revoking user consent should be seamless, with a straightforward registration and login process for easy access.

The *Data* theme emphasizes data handling and accurate user input functionalities. It was noted that users need to input metering points easily and select both historical data and real-time data to analyze trends. Furthermore, data processing and analysis have been identified as essential for providing insights, including a sophisticated prediction functionality and thereby identifying peak values and giving detailed information for the next day.

Additional key functionalities include entering specific energy tariffs for accurate cost calculations and receiving feedback and analysis on energy consumption. It was also found that users wanted to compare their consumption with similar households, set energy-saving goals, and incorporate gamification elements like rewards and tips. These requirements stem from the *UX* as well as the *Behavior Changes (Empowerment)* themes. Further detailed reports and analyses of consumption patterns should provide the insights needed to manage energy use of the devices and household effectively.

From the prerequisites of the EDDIE project, it was decided that, in order to compare prices, a comparison between fixed tariff prices and dynamic prices should be implemented. The dynamic tariffs are provided by Awattar [78], an Austrian company that obtains them from the European EPEX Spot Exchange [79]. This provided API will get the prices from now to 24 hours in the future. This will allow for the comparison of prices

and will be used for the analysis and prediction features. This functionality fulfills the requirements that stem from the *Data*, *UI*, *UX*, and *Behavior Changes (Empowerment)* themes.

Furthermore, since the target group consisted of environmentally conscious individuals, it has been decided to use the *Transparency Platform*-API from the European Network of Transmission System Operators for Electricity (ENTSO-E), an association of 40 Transmission System Operators (TSOs) from 36 European countries, including non-EU members [80]. This API provides energy production data and the various source types across Europe. By mapping the energy consumption of a household to the energy mix of the time of consumption, the gCOeq/kWh is calculated. This provides direct feedback on the impact of the household's consumption on the environment. With this approach, the demonstrator also proves the EDDIE requirements that energy consumption data can be used with other data sources for more meaningful information and feedback. This functionality also fulfills requirements from the *UI*,*Data*, *UX* and *Behavior Changes (Empowerment)* themes.

5.3.2. N-Ergy-View's Architecture

From the functional user requirements, there are many elements to consider, along with some other specifications to be implemented in *N-Ergy-View*. Since the app is designed for households and aims to reach as many users as possible, it was decided to implement it as a web application using a microservice architecture. The reasons for this decision include the fact that multiple data sources are used for various functionalities, and some of these sources may have stability issues. Therefore, the core of *N-Ergy-View* should remain operational even if one functionality is down due to various issues. Additionally, this approach allows project members responsible for developing the app to use their preferred technology stack for specific microservices. Furthermore, these microservices are containerized using Docker to ensure that the app can run, scale, and isolate the microservices reliably across different environments [81].

In total, there are seven containers with various services that constitute the overall *N-Ergy-View* infrastructure and architecture. Figure 5.3 illustrates the different microservices and how they communicate with each other. In the following paragraphs, the various microservices and their core functionalities are presented.

NGINX Proxy Gateway

The NGINX proxy container serves as the gateway to the app, handling both internal and external communication between the microservices and the web app [82]. As a reverse proxy, it forwards incoming requests from clients to the appropriate microservices, providing benefits such as load balancing, security, caching, routing, compression, monitoring, logging, and fault tolerance. This setup ensures efficient, secure, and scalable communication, making the NGINX proxy server a critical component in the *N-Ergy-View* architecture.

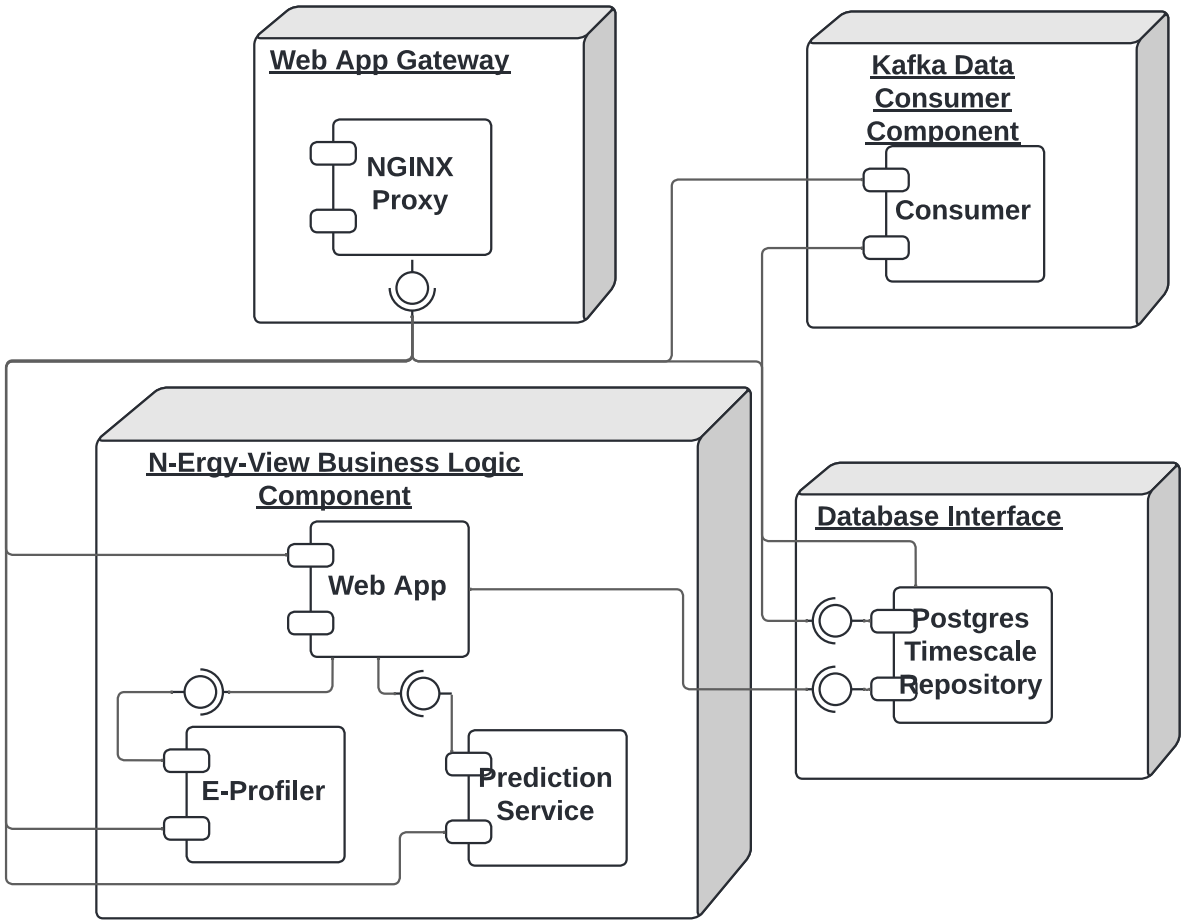

Figure 5.3.: Component Diagram of the N-Ergy-View Architecture: Overview of the Key Services and their Interactions.

Kafka Data Consumer

This component, written as a Django app, provides the energy data required for *N-Ergy-View's* core business logic [67]. The EDDIE Framework, developed and maintained by the University of Applied Sciences Upper Austria, offers regional connectors to various European Energy Data Hubs and Distribution System Operators (DSOs). It provides an Apache Kafka data stream for energy consumption data, which households consent to sharing [83]. Figure 5.4 illustrates the entire data flow and acquisition process of the app.

The sharing process is initiated by registering a user, after which the *EDDIE Connect* button—displayed during the user registration process—must be clicked to start the data sharing process. This sends a request on behalf of *N-Ergy-View* to the user's DSO. The user must then manually consent to this request on the DSO's webpage. After approving the request, the DSO sends the data via the regional connector to EDDIE, which then relays it via a Kafka stream.

Therefore, an Apache Kafka Consumer within *N-Ergy-View* is required to listen to the `validated historical consumption data` topic, which is predefined by the framework and is delivered in the Common Information Model (CIM) format, which is commonly used within the energy sector and maintained by ENTSO-E [84]. This time series data, along with unique identifiers for linking to specific users, is then stored in PostgreSQL & TimescaleDB for robust handling of time-series data. The data is used for various other functionalities, such as the prediction service, and is displayed on the frontend of the app.

N-Ergy-View Web App

The *Web App* component, written in Django, is a central part of the system architecture of *N-Ergy-View*, as it encompasses most of the business logic as well as the user-facing frontend. Serving as an interface hub, it performs multiple data operations: it sends POST requests to internal services like the *E-Profiler* to obtain information about the energy mix and calculates the gCOeq/kWh from the consumption data. It also sends requests to the *Prediction Service* to obtain energy forecasts, storing this data afterwards in the respective *Database Module*. In addition, it is responsible for handling the full user management process, which comprises user registration, where users may sign up through an assisted frontend form, as well as subsequent authentication to grant access in a secure manner. Furthermore, the frontend includes the previously mentioned EDDIE button, which is important for initiating the energy data sharing process with *N-Ergy-View*.

Another fundamental duty of the Web App is to gather external data, such as dynamic electricity prices. This is done by making API requests to the *Awattar* service, which provides 24-hour ahead electricity spot prices from the European EPEX Spot Exchange [78] [79]. Once gathered, all internal and external datasets—ranging from user-specific predictions to market prices—are processed and represented as interactive charts and graphical elements on the frontend using the Plotly library. This facilitates users' easy interpretation of their energy consumption and price tendencies in an understandable and structured fashion. By doing so, the *Web App* plays an important role in aggregating raw data to derive meaningful insights within the *N-Ergy-View* platform.

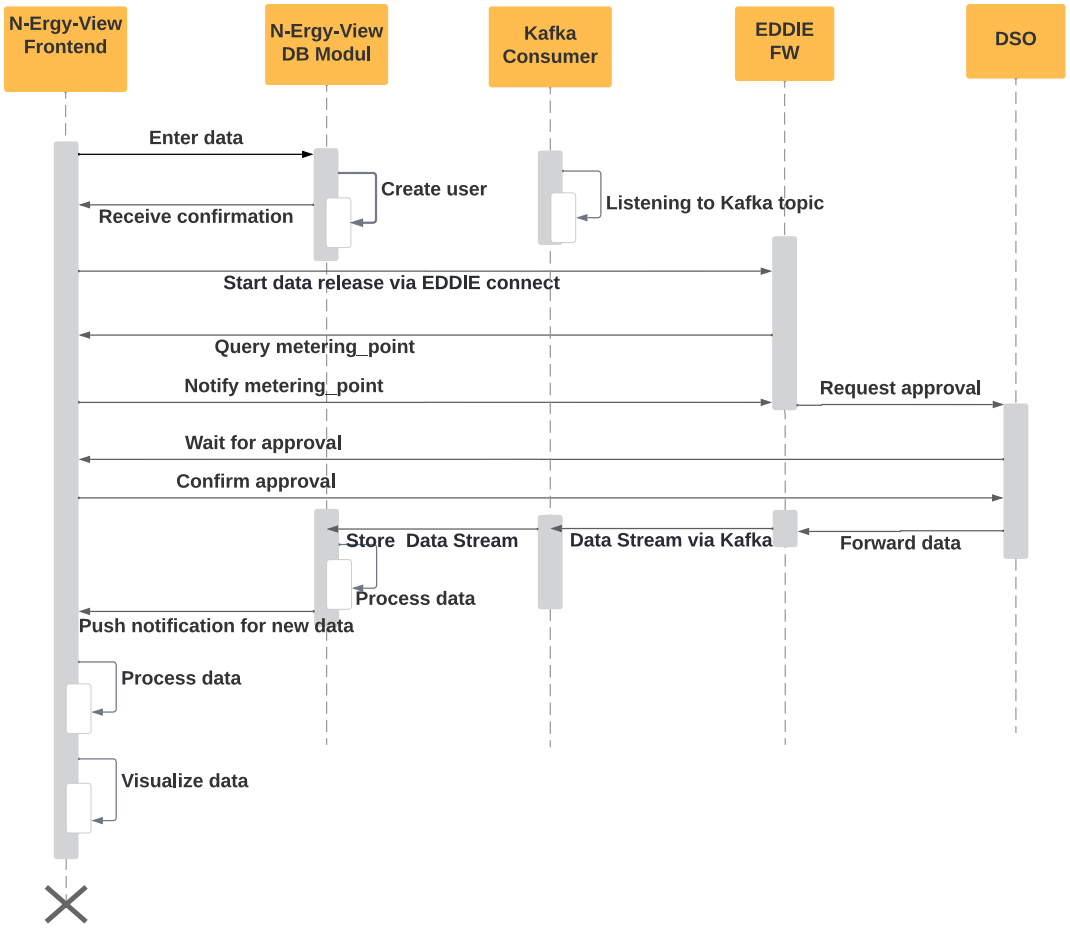

Figure 5.4.: Data Flow Between N-Ergy-View, the EDDIE Framework and DSO

Prediction Service

Further at the core of *N-Ergy-View's* business logic is the prediction service, implemented as a Flask app, which leverages historical consumption data provided by EDDIE to forecast energy usage for the upcoming day [69]. If sufficient data is available and the intervals are supported, the service provides forecasts at quarter-hourly, hourly, and total daily resolution.

While experimenting with various machine learning algorithms such as *Linear Regression* and *Seasonal Autoregressive Integrated Moving Average (SARIMA)*, the runtime of these algorithms was too slow to deliver fast analytics and results. Therefore, the prediction model is based on *LightGBM*, a gradient boosting machine learning framework optimized for performance [85] [86]. To enable accurate forecasting, the input time series is enriched with a variety of engineered features. These include temporal indicators such as the hour of the day, day of the week, and a binary flag indicating whether a timestamp falls on a weekend. In addition, the model incorporates lag features that reference past consumption values at intervals ranging from 15 minutes to a full day, allowing the system to learn from short- and long-term consumption patterns. Rolling statistics such as moving averages and standard deviations are computed over sliding time windows to capture recent trends and fluctuations. Moreover, difference features, such as the change in consumption from the previous interval or the same time on the previous day, provide information about consumption dynamics. To encode the cyclical nature of time, the hour of the day is transformed using sine and cosine functions.

Once the features are prepared, the model is trained to minimize the mean absolute error (*MAE*) between actual and predicted consumption values. After training, the model produces forecasts for 96 future quarter-hour intervals. These fine-grained forecasts are subsequently aggregated to derive hourly predictions and the total expected consumption for the day.

The service is implemented as a RESTful API that receives structured historical data and returns forecast results as a JSON object. This design ensures seamless integration with other components of the platform and enables real-time prediction delivery. Figure 5.5 illustrates the data flow and processing of how *N-Ergy-View* handles and displays the prediction in the frontend.

E-Profiler (ENTSO-E Integration)

The *E-Profiler* component serves as another microservice module within the business logic architecture of *N-Ergy-View*, written in Rust and using the Actix and Reqwest frameworks [68, 87, 88]. It focuses on the acquisition and processing of energy production data, retrieving both actual and forecasted generation data from the European ENTSO-E electricity transparency platform and converting this information into usable formats. Core functionalities include mapping production data to country-specific zones, aggregating energy generation by production type to display energy mixes, and calculating the proportional contribution of each source (e.g., wind, solar, fossil fuels) within a defined timeframe.

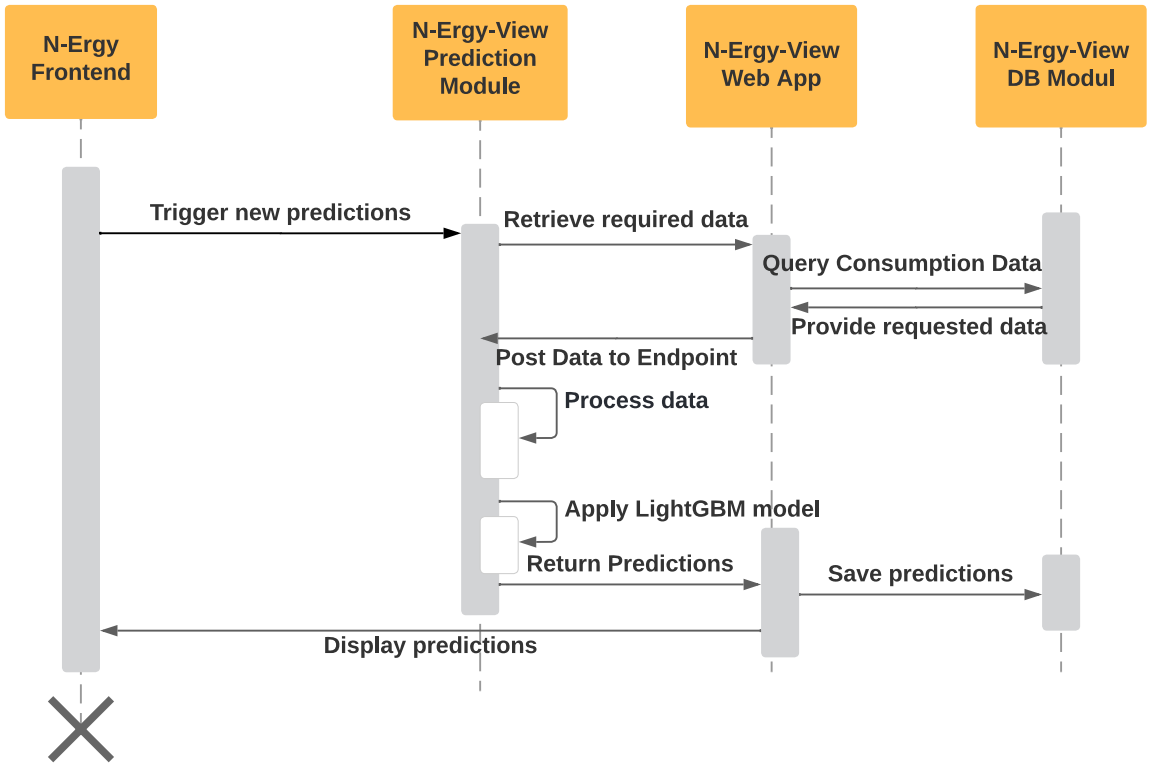

Figure 5.5.: Data Flow for the Predictions of N-Ergy-view

A central element of this service is the integrated ENTSO-E client, which enables access to publicly available electricity generation, transmission, and consumption data for the pan-European market. To further enrich the raw generation data, the *E-Profiler* estimates the associated CO_2 equivalent emissions (gCOeq/kWh) based on lifecycle emission factors published by the IPCC in its 2014 Fifth Assessment Report [89]. Since ENTSO-E uses the CIM model for production types, a mapping process is applied to align it with the emission categories defined by the IPCC.

This allows *N-Ergy-View* to quantify its environmental impact. The processed energy mix and emissions data are then made available through a REST API, enabling other modules—such as the web app frontend—to visualize this information alongside consumption data, forecasts, and electricity prices. By doing so, the *E-Profiler* plays a vital role in enriching the platform with sustainability-oriented information.

PostgreSQL & TimescaleDB Repository

The PostgreSQL & TimescaleDB repository forms the central data storage layer within the *N-Ergy-View* architecture, providing robust, scalable, and time-series optimized storage for all core services. As a relational database system enhanced with time-series extensions via TimescaleDB, it is specifically tailored to handle high-frequency energy

consumption data and temporal analytics. Several key services—including the Django-based Web App and the Kafka Data Consumer—interact directly with the database for both reading and writing operations. For example, once historical consumption data is received via the Kafka stream from the EDDIE Framework, it is stored in TimescaleDB to enable efficient time-based querying and downstream processing. Likewise, the Prediction Service is getting historical series from this repository to train and generate forecasts via POST-Requests. Additionally, the E-Profiler may store processed energy mix or emission-related metadata for reference or further analysis. The database schema is designed to link consumption records with individual user identifiers and metering point IDs, supporting personalized visualizations and analytics on the frontend. Moreover, most services store and retrieve data in the Common Information Model (CIM) format, ensuring semantic consistency and interoperability throughout the platform. By acting as the persistent backbone of the system, the PostgreSQL & TimescaleDB repository ensures data consistency, temporal resolution, and seamless interoperability across the platform's modular architecture.

Conclusion

This chapter has developed and illustrated the architecture and technical details behind *N-Ergy-View*. In summary, the architecture of *N-Ergy-View* is designed as a modular, resilient, and scalable web application based on a microservice infrastructure. Each component fulfills a specific role—ranging from user-facing interactions and consumption data acquisition to forecasting, energy mix analysis, and long-term storage. Despite being implemented using different technology stacks—including Django, Flask, Rust, PostgreSQL, and Kafka—these services interact seamlessly through well-defined interfaces and shared data formats. The integration of standardized structures such as the Common Information Model (CIM), along with the use of containerization technologies like Docker, ensures robust communication, semantic consistency, and maintainability. This architectural setup lays a solid foundation for delivering personalized, real-time energy insights while remaining adaptable to future enhancements or service extensions.

5.3.3. N-Ergy-View's Frontend Demonstration and Core Functionalities

With this chapter, we explain the frontend and the core functionalities that *N-Ergy-View* can currently present, based on a demonstration. We discuss the user registration and onboarding process for energy data sharing via the EDDIE Framework, as well as how all the various data is displayed and the functionalities and benefits they provide.

User Registration and EDDIE Onboarding

For a household to use *N-Ergy-View*, the user must create an account and have an official smart meter installed by their Distribution System Operator (DSO). When accessing the URL of *N-Ergy-View*, which is hosted by the *Cooperative Systems* research group, the

user is greeted with the app's welcome page, as shown in Figure 5.6, and can proceed to create a user account.

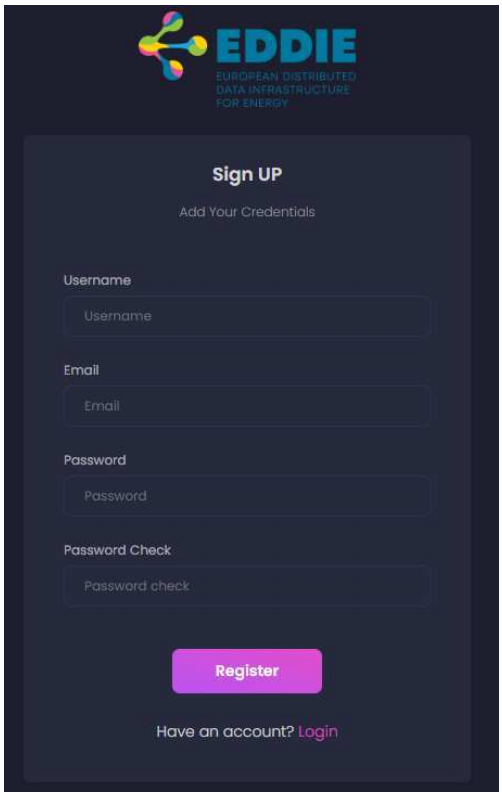

Figure 5.6.: User Regsitration for N-Ergy-View

After creating an account, the user is directed to the next screen, which includes the EDDIE Connect Button (see Figure 5.7). The button is essentially a web component written in HTML and JavaScript, provided by the EDDIE framework, and allows users to initiate a secure connection to an energy-related service or platform. A unique `connection-id` is generated dynamically using JavaScript to ensure that each session can be uniquely identified. This is used in the context for the smart meter data access and integration with energy applications.

When clicking on the button, the onboarding process is initiated, and a session in EDDIE's Consent Facade is opened. As shown in Figure 5.9, to share the user's energy data, the following information is required: the *Country* where the user's household is located, the *Permission Administrator* (which, in the case of Austria, is the user's Distribution System Operator, DSO), and the metering ID (Zählpunktnummer). The onboarding process may vary depending on the region connectors and country. By clicking the "Connect" button, a data permission request is sent to the *Permission Administrator*, requesting historical data for the past three months—preferably in quarter-hourly intervals; if that is not available, daily intervals are requested instead.

Figure 5.7.: The EDDIE Connect Button Used for Onboarding the User's Energy Data

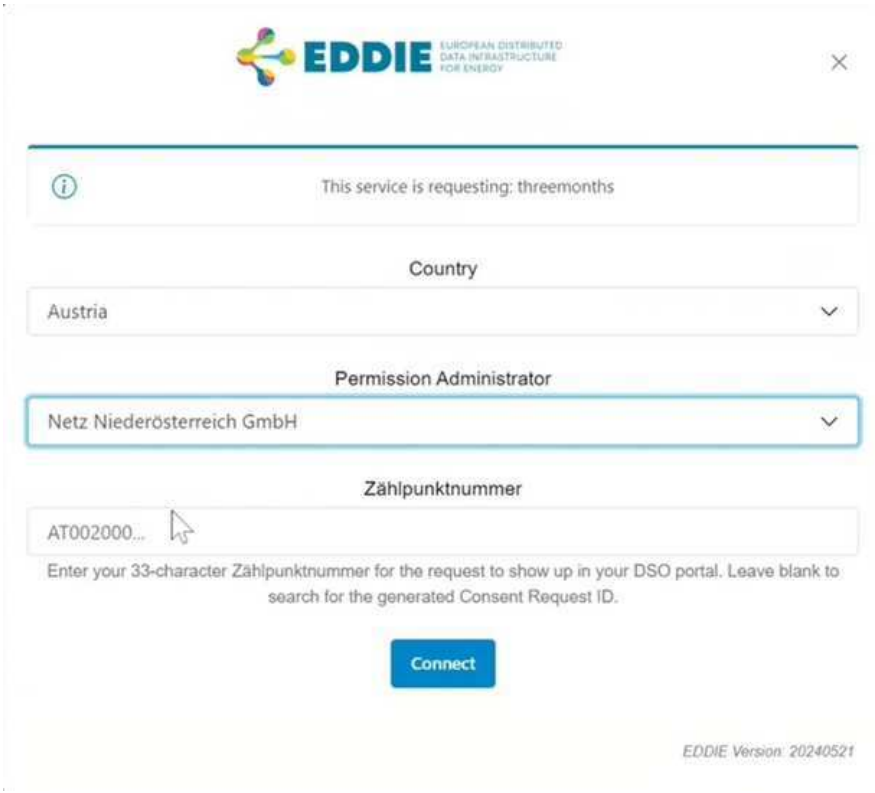

Figure 5.8.: EDDIE's Consent Facade

The DSO, in this case "Netze Niederösterreich," receives the request. The EDDIE Consent Facade provides a direct link to the DSO's webpage for a more convenient process (see Figure5.9). After the user approves the request on the DSO's or utility provider's webpage, the data flow process begins from the respective data hub. *N-Ergy-View*'s Kafka consumer then listens to the data stream, stores the incoming data in the database,

and completes the data sharing process. The detailed process, data flow, and how *N-Ergy-View* handles the data are shown in Figure 5.4 from the previous section 5.3.2.

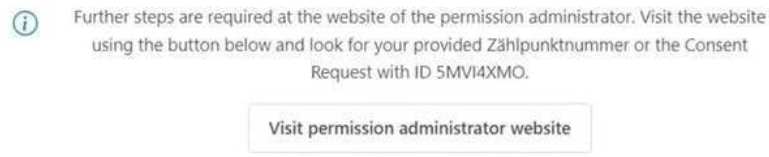

Figure 5.9.: The EDDIE redirects the user to the DSO's Webpage

Frontend Features and Core Functionalities

After consenting and sharing the user's energy data, the user is directed to the dashboard, where all the core functionalities and data analytics are visually represented. The first thing the user sees is the visualization of the shared historical data, as shown in Figure 5.11. The graph allows the user to customize and zoom into the data, providing the ability to explore it further and providing a more interactive graph. In this graph, quarter-hourly intervals are presented in kWh, if the user's smart meter provides them. Otherwise, hourly values are presented, as these are the default values sent by the smart meter. Furthermore, the shared and presented dataset can be downloaded in JSON format using the download button below the graph.

Figure 5.10.: Graphical Presentation of Historical Data in kWh

With this historical data, the *E-Profiler* microservice calculates the emissions of the household's energy consumption, as described in the previous section regarding the architecture, using energy production data from the ENTSO-E Transparency Platform API [80]. This allows the user to see the direct impact of their consumption on the environment, further enabling them to change their behavior and adopt informed actions regarding their energy usage. The line charts visualize the kgCOeq/kWh of the consumption, and their representation can also be customized—for instance, by zooming in—allowing for deeper exploration of the data. Furthermore, via the ENTSO-E interface, the various energy production types can be visualized to show the specific energy mix ratio of the

country in which the user's household is located (see Figure 5.12). Note that the current implementation of this feature is still under development. The screenshot shown in Figure 5.12 was taken from an early-stage mockup and is included for illustrative purposes to demonstrate the envisioned functionality. Due to limitations in the development timeline, a fully functional and dynamically updating version was not yet available at the time of writing. This graph will allow users to see which energy sources were used more at different times. Therefore, environmentally conscious users could adjust their energy behavior to consume energy when the mix contains more sustainable sources, further enabling the household to take informed actions and set goals for themselves in terms of sustainable energy usage.

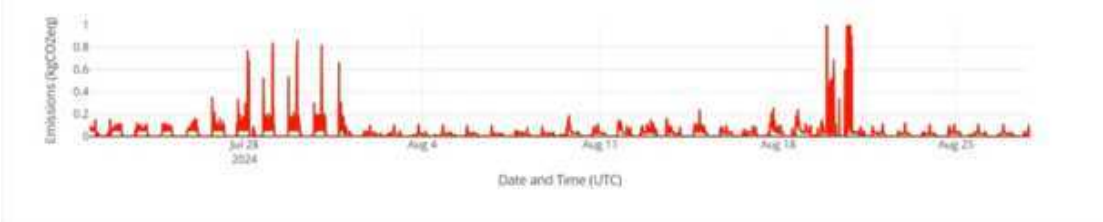

Figure 5.11.: Calculated CO emission of the Energy Consumption Data represented in kgCOeq/kWh

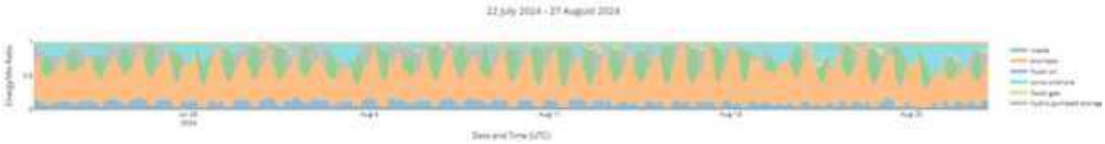

Figure 5.12.: Visualization of the Energy Mix With Various Energy Sources

The next graph shows the spot prices, which are determined by the European EPEX Spot Exchange [79] and queried via the Awattar API [78]. The prices, represented in EUR/MWh, vary throughout the day. Since these are dynamic prices, they change according to the supply and demand within the energy market. In some cases, due to high supply, even negative prices may occur, meaning that the user is paid to consume energy. As discussed in Chapter 4, "Energy Application Use Cases in the Field," some services aim to incorporate these dynamic prices into their use cases. This information on dynamic pricing could lead to interesting behavioral changes in households, as using appliances at different times of the day could impact the energy bill differently compared to a fixed tariff.

Furthermore, Figure 5.14 shows the predicted consumption for the next day in quarter-hourly intervals in kWh. If quarter-hourly values are not available from the user's smart meter, the prediction service will compute hourly values instead. The prediction service uses historical data and trains a machine learning model based on the *LightGBM* algorithm. In this case, the patterns from the historical data are well represented, highlighting the benefits of the chosen machine learning algorithm. The reason for this

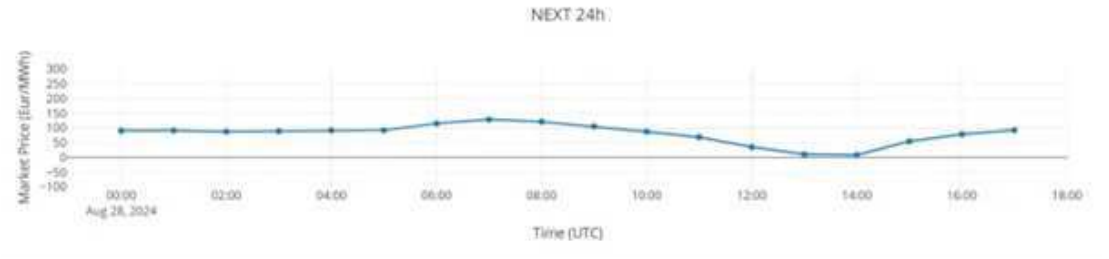

Figure 5.13.: The Dynamic Price Graph from the "awattar" API

specific pattern is that, due to an installed PV system, the household does not consume energy during certain periods of the day and feeds excess energy back into the grid. Additionally, at the top of the graph, the total predicted consumption in kWh is displayed. This allows users to see how their energy usage for the next day is expected to look. Here, gamification elements and behavioral changes through goal setting could be applied. Users could engage in energy-saving activities and observe how their consumption might change for the next day, thereby making informed decisions and trying to beat the daily prediction. Moreover, the graph displays the predicted costs for the next day using dynamic prices, which will be discussed next.

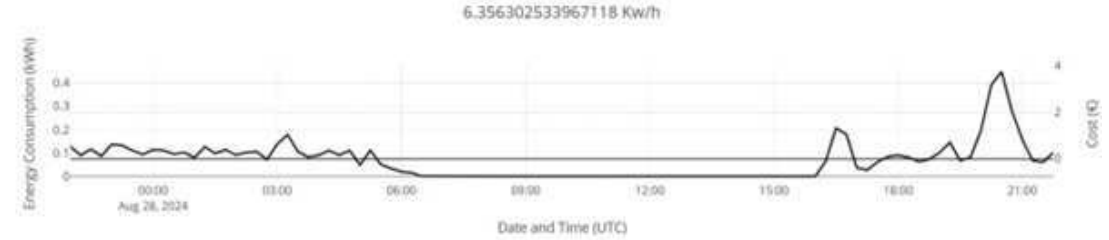

Figure 5.14.: Line chart representing the predicted quarter-hourly consumption values for the next day

The last functionality is the price comparison, where users input their current fixed tariff from their energy supplier in EUR/MWh, as shown in Figure 5.15. This is necessary and later used to compare the dynamic and fixed tariffs for the predicted next day's consumption. Furthermore, after entering the price, a report is generated that provides the user with information and insights into the cost comparisons. An example report can be found in Figure 5.16, where tomorrow's costs are highlighted. Additionally, the average EUR/MWh from the dynamic price API is calculated, and the total costs of dynamic and fixed tariffs are presented. This informs the user about the different tariffs, helping the household decide whether to switch from a dynamic to a fixed tariff or vice versa, as well as assisting them with their energy bills and potential savings. Lastly, the dynamic price is also graphically represented in blue in the prediction graph, as seen

in Figure 5.17, giving the user the ability to see what they would pay during different quarter-hour intervals. This predicted consumption pattern is particularly interesting, as the household does not consume energy during certain periods of the day, which affects the calculation of the total costs for the next day. This helps the user further understand the costs of their household and how this price comparison could impact their bill, thus also helping them change their consumption behavior, as using different appliances or devices at different times has consequences on the bill.

Figure 5.15.: Input field for entering the fixed tariff in EUR/MWh

Figure 5.16.: Example report highlighting the cost comparison between dynamic and fixed tariffs

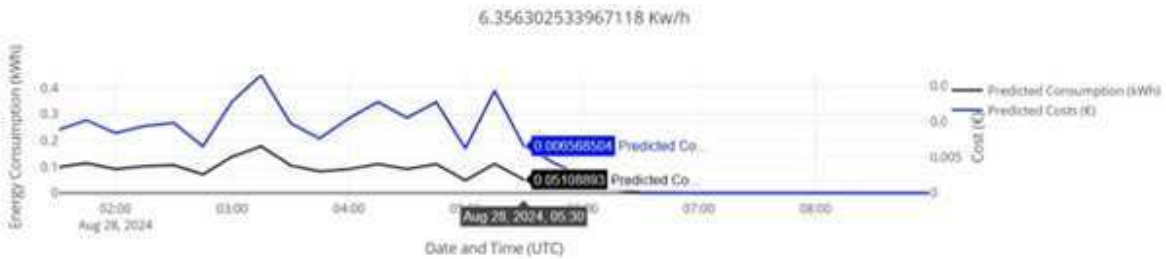

Figure 5.17.: Graphical representation of the dynamic price and predicted consumption values

5.4. Conclusion of the Implementation of N-Ergy-View

The implementation of *N-Ergy-View* has focused on integrating the findings and input of the various interview participants from the exploratory interviews as directly and effectively as possible. Through the user-centered design process from the target group interviews and the subsequent thematic analysis, several key requirements were identified and translated into concrete features. Furthermore, the energy application use cases interviews and their qualitative analysis enabled us to focus on the found themes regarding "Data Privacy," "Data Analytics," "User Experience," "Human Behavior," and "(IoT) Devices and Sensors", which emerged as key design aspects for the user requirements.

A concern expressed by users and the project partners was the topic of data security and privacy. This was addressed by integrating the EDDIE Framework, which offers a secure and transparent process for sharing energy data, fully under the control of the user. Consent is explicitly required before any data is accessed, and data sharing can be managed easily—ensuring trust in how personal information is handled.

In order to provide more analytical insights, the prediction service was also integrated to adhere to the input from the exploratory interviews. Based on historical consumption patterns and enriched data, *N-Ergy-View* forecasts the household's expected consumption for the following day using a LightGBM model. These predictions are not only fairly accurate but also open up a new motivational dynamic through a subtle form of gamification. By visualizing the predicted consumption, users are encouraged to adjust their behavior and try to stay below the forecasted values. This introduces an empowering element to energy saving—turning data into actionable goals and providing feedback if users succeed in consuming less than expected.

In terms of empowerment and adhering to the behavior change theme found in the various qualitative analyses, insights into the direct impact of the user's energy consumption would particularly appeal to sustainability- and environmentally conscious users, such as the interview participants. Seeing this direct impact could motivate users to adjust their energy consumption behavior. Furthermore, the display of the national energy mix could serve as additional detailed information for households, enabling them to shift their energy usage to periods when a higher share of sustainable energy sources is present in the mix.

Another central user input from the target group participants was the ability to view energy consumption in monetary terms, rather than only in kilowatt-hours. To accommodate this, *N-Ergy-View* allows users to input their fixed electricity tariff and automatically compares it with dynamic spot prices from the EPEX exchange [79] via the API provided by Awattar [78]. The costs and the reports are then calculated, visualized, and displayed in an intuitive way, making energy usage more tangible and relatable for users. Additionally, the app emphasizes customizable and interactive data exploration. Graphs are zoomable and support a variety of visual formats, such as bar charts, line graphs, and emissions curves. This flexibility enables users to deeply engage with their data and gain meaningful insights tailored to their needs.

In conclusion, with the input from the exploratory research, *N-Ergy-View* combines

robust architecture, user-friendly design with meaningful insights, cost transparency, and motivational elements. This design and implementation strategy directly reflects the insights gained in response to the second research question, addressing the key user requirements and how they shape an effective UI/UX for data-driven-energy-services. It empowers users to understand and reflect on their energy behavior, and actively participate in reducing their environmental footprint while still offering flexibility, control, and a positive user experience. This concludes the **Implementation Phase** of this thesis and bridges over to the final *Evaluation Phase*. In the next phase, an evaluation will be conducted to assess how these various functionalities are accepted by potential users, thereby addressing the research question of whether and how applications like *N-Ergy-View*, where households profit from insights via data sharing, would be adopted and accepted by a broader user base.

6. Evaluation of N-Ergy-View

In the previous chapter, various design and implementation decisions were described based on qualitative data from target group interviews and the findings from practical use case research. The prototype was developed to closely align with the feedback provided by participants, the identified user requirements, and the key themes derived from the analysis of energy service presentations and use case categorization. Additionally, the design principles and technical considerations identified during the research played a central role in shaping both the functional and user-oriented aspects of the application. However, an evaluation is needed to determine how and to what extent the implemented functionalities, developed through human-centered design principles, would be accepted by a broader user base—particularly among those willing to share their energy data with the application and potentially pay for such a service. This would provide evidence of user and market adoption of data-driven-energy-services, where households can benefit from the various digitization developments of energy systems and the collection of energy data.

To evaluate the app, a pre- and post-survey was carried out among computer science students at the University of Vienna. In the pre-survey, participants were introduced to the concept of *N-Ergy-View* and its intended functionalities, while the post-survey included a short demo and a more detailed explanation of the app, offering a clearer understanding of the data-sharing process and the user-facing features. In addition to gathering feedback on the perceived value of these functionalities, the survey also aimed to assess whether the prototype and the design had been implemented in line with user expectations and to identify which features had the greatest impact on participants' perceptions. This marks the beginning of the **Evaluation Phase**, concluding the structured research process of the thesis.

6.1. N-Ergy-View Survey Approach and Design

To address the research question of whether energy data-driven monitoring services such as *N-Ergy-View*, which require access to users' energy consumption data, would be accepted by a broader user base, a pre- and post-evaluation approach was developed. The survey aims to gather feedback from a larger group of participants to assess their awareness of energy consumption, especially their own, and to identify which features are most relevant to them. Additionally, it seeks to determine, if these features would help them save energy and if they find the application useful enough to assist in saving energy.

The evaluation included both closed and open-ended questions. Closed questions provided answer options such as yes/no, rankings, or selectable ranges. Open questions

invited direct feedback and encouraged participants to explain their reasoning. As part of the survey, a *No answer* option was included for certain questions to allow participants to skip items if they were unsure or preferred not to respond. This was done to respect participant autonomy and to improve data quality by encouraging honest responses. This approach enabled a deeper understanding of participant motivations and generated more detailed insights. The questions of both of the surveys can be found in the appendix A.6 and A.7.

Furthermore, the survey aims to determine whether participants would be willing to use applications like *N-Ergy-View*, share their energy data, and potentially pay for such services. The survey was conducted among students enrolled in the *Foundations of Networked Systems* [75] and *Cooperative Systems* [76] courses during the winter semester of 2024 at the University of Vienna. The participants were informed about the purpose of the survey and that their responses would remain anonymous. They were also told that the survey was optional and not mandatory for any course grading. Afterward, they received access to the survey via a QR code projected onto the classroom's whiteboard. *LimeSurvey* was chosen as the tool for conducting the survey, as it allowed the evaluation to be structured effectively and supported a wide range of question types and answer formats [90].

The pre-and post-approach made it possible to observe whether perceptions of *N-Ergy-View* changed after participants were provided with more detailed information and a firsthand impression of its features. In the pre-survey, the general concept of *N-Ergy-View* was introduced to participants via a short description on the survey platform; however, the name *N-Ergy-View* was not mentioned until the post-survey. In the post-survey, a demo video showcasing all its core functionalities was then shown. This comparison helped determine whether users' perceptions had changed between the pre-survey and post-survey phases, and whether the implemented functionalities met their expectations. It further helped to assess if there were changes in participants' willingness to share their data, pay for the application, and find it useful, thus providing insights into user and market adoption. In the next few sections, the overall approach and questionnaire structure of each survey will be discussed, along with the results.

6.2. Structure of the Pre-Survey

As mentioned, the survey contained a mix of closed and open-ended questions. By providing the students access to the *LimeSurvey* via a QR code, they were informed of the intent of the survey and its approach, as well as the fact that their answers would remain anonymous. The questions and the structure of the survey can be viewed in the appendix section A.6. The students then received a short introduction to the concept of energy monitoring apps using data analytics, explaining that its intent is to help households save energy, however for this survey the name was not used. It was described as analyzing the household's energy consumption and providing insights into energy mixes, personal carbon footprints, and computing energy consumption for the next day. Based on these predictions, the application would then perform a tariff comparison

between fixed and dynamic prices, thus also helping to save costs.

The first questions aimed to find out more about the various participants and the potential users of *N-Ergy-View* by asking them about their age, gender, and living situation (e.g., house, apartment, etc.). The next few questions were designed to assess how well participants understand the energy use of appliances and their household, and whether they are familiar with different energy units, thus showing their level of energy literacy. By asking participants to estimate how much energy their fridge and household consume, it was possible to assess their awareness of energy consumption and whether they might need more information. An open field was provided for them to enter the estimated amount and unit. Another question in this regard asked participants, on a scale, how important it is for them to save energy.

Next were the first questions concerning the core functionalities of the app. By providing a range option from 1 to 5, users could rank the features they considered to be most relevant for saving energy. This was related to features such as consumption and price predictions, information on energy mixes, information on the carbon footprint, and the overall analysis of data exploration. As a potential feature, the survey also asked how well users would receive notifications. In the thematic analysis with the target group, these were met with mixed opinions. Since notifications provide more context and user engagement, it was important to determine if they would be seen as beneficial. To confirm the findings of Hargreaves et al. [58] and the target interviews, it was also asked whether the consumption should be visualized in kWh or costs. Furthermore, the following question allowed the participants to suggest additional features they would like to have for an application such as *N-Ergy-View*. This was aimed at assessing if the core functionalities were sufficient for potential users or if there were any features missing in their opinion.

Afterward, the next few questions focused on the participants' willingness to share data and their readiness to pay for and use the application. It was explained that *N-Ergy-View* requires users to share their energy data in order to execute and compute the various functionalities. Therefore, the participants were asked if they would be willing to share their energy data with the app. A follow-up question also asked for their reasoning behind their decision. Following this, participants were asked if they would be willing to pay for *N-Ergy-View* through a monthly subscription, a one-time fee, or if they would not be willing to pay at all. Consequently, they were asked to provide a reason behind their decisions. If they indicated a willingness to pay, they were asked how much they would be willing to pay. Lastly, participants were asked if they would find apps like the one described useful for analyzing their energy consumption. All these survey questions will be analyzed statistically and qualitatively in the next subsection.

6.2.1. Results of the Pre-Survey

In total, there were $N = 54$ submitted responses for the pre-survey. Regarding the demographic data of the sample, 39 participants identified as male, 14 as female, and 1 as other (see Table 6.1). Furthermore, 19 participants were in the age range *18–24*, 34 participants were between *25–34*, and 1 participant was in the range *55–64* (see

Table 6.2). Regarding their living situation, 27 participants lived in an *Apartment/Flat*, 21 in shared accommodation with other roommates, 3 in houses, and 3 in dormitories (see Table 6.3) showing that most of the participants lived either alone or together in apartments.

Gender	**Count**	**Percentage**
Male	39	72.2%
Female	14	25.9%
Other	1	1.9%

Table 6.1.: Gender distribution - Pre-Survey

Age Group	**Count**	**Percentage**
18–24	19	35.2%
25–34	34	63.0%
55–64	1	1.9%

Table 6.2.: Age distribution - Pre-Survey

Living Situation	**Count**	**Percentage**
Apartment/Flat	27	50.0%
Shared Accommodation	21	38.9%
House	3	5.6%
Dormitory	3	5.6%
Other	0	0.0%

Table 6.3.: Living situation distribution - Pre-Survey

Regarding participants' knowledge of energy consumption, it can be observed that slightly over 90% were not aware of how much energy their fridge consumes, while only four participants stated that they knew their fridge's energy consumption (see Table 6.4).

Reviewing some of the responses for estimated fridge consumption, it became clear that many participants were uncertain. To analyze the responses, they were categorized based on the units provided—either kWh or watts (both of which are valid units for fridge consumption, depending on whether a total quantity or a rate is being described)—or whether participants gave no answer or indicated that they did not know the consumption (see Table 6.5). As a result, 16 participants gave estimates in kWh, 11 in watts, and 27 were either unsure or did not provide an answer.

Additionally, the values provided were compared to average consumption ranges for fridges to assess whether the estimates were realistic. Although energy use can vary depending on a fridge's age, size, energy efficiency rating, and features (e.g., freezer

compartments), a good estimate for the daily energy consumption of a modern fridge is approximately between 0.2 kWh and 0.9 kWh, which corresponds to an average power usage of roughly 8.33 to 37.5 watts [91, 92]. Therefore, participant estimates between 0.2 kWh and 1 kWh, or between 8 and 50 watts, were categorized as realistic. Any estimates falling outside of this range were considered unrealistic. Responses without a value or those where participants explicitly stated they did not know were also noted.

Consequently, 11 participants gave fairly realistic and accurate estimates, 20 gave unrealistic ones, and 27 either gave no answer or stated they did not know how much energy their fridge consumes. Of the four participants who had claimed to know their fridge's consumption (see Table 6.4), three provided very accurate estimates, which could suggest a relatively high level of knowledge, while one did not.

Response	**Count**	**Percentage**
Yes	4	7.4%
No	49	90.7%
No Answer	1	1.9%

Table 6.4.: Awareness of fridge energy consumption

Response	**Count**	**Percentage**
kWh	16	29.6%
Watt	11	20.4%
No Answer / Don't Know	27	50.0%

Table 6.5.: Distribution of unit types used to estimate daily fridge energy consumption.

Estimate Classification	**Count**	**Percentage**
Realistic (0.2–1 kWh or 8–50 W)	11	20.4%
Unrealistic	20	37.0%
No Evaluation / No Answer	23	42.6%

Table 6.6.: Assessment of whether the provided energy consumption estimates are realistic.

The same analysis was conducted for the questions regarding household energy consumption. First, participants were asked whether they knew how much energy their household consumes. Eleven participants said they knew, while the majority—42 participants—were unsure or did not know, and one did not provide an answer (see Table 6.7). This indicates that many people are not aware of their household's energy consumption.

Additionally, the units used in participants' estimates were categorized to analyze which units were most commonly applied. As shown in Table 6.8, 17 participants used kWh in their responses, 8 used watts, and 29 either gave no answer or stated that they did not know. In the case of energy consumption of a household, it usually makes sense to

state it in terms of kilowatt-hours (kWh) because this unit represents the actual amount of energy used over time. Electricity providers bill consumers based on how much energy they consume, not just the momentary power usage. Therefore, using kWh allows for a direct understanding of energy costs and comparisons on electricity bills.

Categorizing household energy consumption estimates is inherently challenging, as actual consumption can vary significantly depending on multiple factors. These include the number and type of appliances in use, the presence of electric water heating, the size and type of accommodation (e.g., house vs. flat), and the number of people living in the household. Since this contextual information was not collected in detail during the survey, it is not possible to make a precise assessment of whether each estimate is realistic. However, a general comparison can still be made.

For this purpose, average annual and daily consumption levels from an Austrian energy provider are used as a reference point and compared with the participants' estimates (see Table 6.9) [93]. These benchmark values serve as a rough guide for evaluating the plausibility of the reported estimates, while acknowledging that the absence of detailed household information limits the ability to draw definitive conclusions.

Furthermore, as previously mentioned, household energy consumption is typically expressed in kilowatt-hours (kWh) rather than watts. Therefore, estimates given in watts are excluded from this analysis. A range of 2 to 20 kWh per day is considered a realistic estimate for household consumption.

Response	**Count**	**Percentage**
Yes	11	20.4%
No	42	77.8%
No Answer	1	1.9%

Table 6.7.: Answers to the question: *"Do you know how much energy your household consumes?"*

Unit Used in Estimate	**Count**	**Percentage**
kWh	17	31.5%
Watt	8	14.8%
No Answer or Unknown	29	53.7%

Table 6.8.: Reported units in participants' estimates of daily energy consumption.

As shown in Table 6.10, out of the 54 participants, 12 provided realistic estimates of household energy consumption, while 10 gave unrealistic estimates or used an incorrect unit (e.g., watts instead of kilowatt-hours). Furthermore, 32 participants either did not provide an answer or stated that they did not know. An interesting finding is that of the 11 participants who claimed to know their household's energy consumption, 8 provided realistic estimates. In contrast, among the 42 participants who stated they did not know, only 2 gave estimates that could be considered realistic for an average household.

Household Size (Persons)	Annual Consumption (kWh)	Daily Average (kWh/day)
1 Person	1,500	4.1
2 Persons	2,500	6.8
3 Persons	3,500	9.6
4 Persons	4,250	11.6
5 Persons	5,000	13.7

Table 6.9.: Estimated electricity consumption by household size without electric water heating. [93]

Realistic Estimate	Count	Percentage
Realistic(2–20 kWh per day)	12	22.2%
Unrealistic	10	18.5%
No Answer or Don't Know	32	59.3%

Table 6.10.: Assessment of whether participants' energy consumption estimates were realistic.

Based on the analysis of the fridge and household energy consumption estimates, it can be concluded that many participants are still not fully aware of their energy consumption. Additionally, a lack of understanding regarding the difference between key units, such as kilowatt-hours (kWh) and watts (W), which represent different concepts, was also observed. This highlights the ongoing need for education and awareness in this area. Applications such as *N-Ergy-View* could play a valuable role in closing this information gap.

Looking at the question of whether saving energy is important to the participants, Figure 6.1 shows the responses and percentages, as well as the calculated mean, median, and mode. With a mean of 3.67, a median of 4, and option 4 being the most frequently selected—along with option 5, the highest possible rating—it can be concluded that 61.1% of participants consider energy saving to be important. Therefore, it can be inferred that users are generally interested in saving energy and may be receptive to energy data-driven monitoring services.

Next are the features that participants considered most relevant based on the mean. As described in the previous section, each feature was rated by participants on a scale from 1 (least relevant) to 5 (most relevant), with a "No Answer" option available. These ratings reflect what participants deemed most important for analyzing household energy consumption using data-driven energy monitoring apps. Table 6.11 summarizes the results, showing the ranking of features alongside the mean (rounded), median, mode, and standard deviation (rounded) for each. While most features were rated by all 54 participants, a few received one or two missing responses. All statistical comparisons were calculated based on the number of valid responses per feature (ranging between 52 and 53), and the ranking of perceived relevance remained stable despite these minor differences.

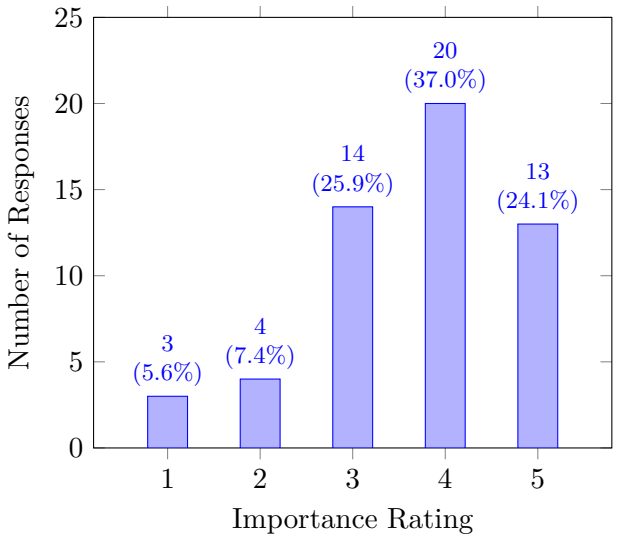

Figure 6.1.: Distribution of responses on the importance of saving energy
(1 = Lowest, 5 = Highest)
Mean = 3.67, Median = 4, Mode = 4, SD = 1.11

Feature	**1**	**2**	**3**	**4**	**5**	**Valid** n	**Mean**	**Median**	**Mode**	**SD**
Consumption Analysis	3	3	8	14	25	53	4.04	4	5	1.18
Predicted Costs	1	7	7	13	25	53	4.02	4	5	1.15
Predicted Consumption	6	6	12	17	12	53	3.43	4	4	1.28
Energy Mix Info	7	9	15	15	6	52	3.08	3	3	1.22
Carbon Footprint	9	12	12	13	6	52	2.90	3	4	1.29

Table 6.11.: Ranked relevance ratings for N-Ergy-View features, excluding "No Answer" responses. (1 = Lowest, 5 = Highest) Ordered by descending mean - Pre-Survey

The results indicate that the features *Overall Consumption Analysis* and *Predicted Costs* were considered the most relevant based on their mean. The former received a mean rating of 4.04, a median of 4, a mode of 5, and a standard deviation of 1.18. The latter followed closely with a mean of 4.02, a median of 4, a mode of 5, and a slightly lower standard deviation of 1.15, suggesting a slightly more consistent agreement among respondents. A third relevant feature, though somewhat less highly rated, was *Predicted Consumption*, with a mean of 3.43, a median of 4, a mode of 4, and a standard deviation of 1.28. The higher standard deviation indicates more varied opinions, suggesting that some participants did not find this feature as relevant. The least relevant features, based on participant ratings, were *Energy Mix Information* and *Carbon Footprint*. The energy mix feature had a mean of 3.08, a median of 3, a mode of 3, and a standard deviation of 1.22, while the carbon footprint feature showed a mean of 2.90, a median of 3, a mode of 4, and a standard deviation of 1.29. These results suggest that although

environmental insights are acknowledged, participants may not see them as immediately actionable for optimizing their household energy use. In contrast, features like *Overall Consumption Analysis* and *Predicted Costs* were rated significantly higher, indicating that users prioritize tools that offer direct, practical insights into their energy usage patterns and financial implications. This highlights a preference for features that support tangible decision-making and cost awareness over broader environmental context.

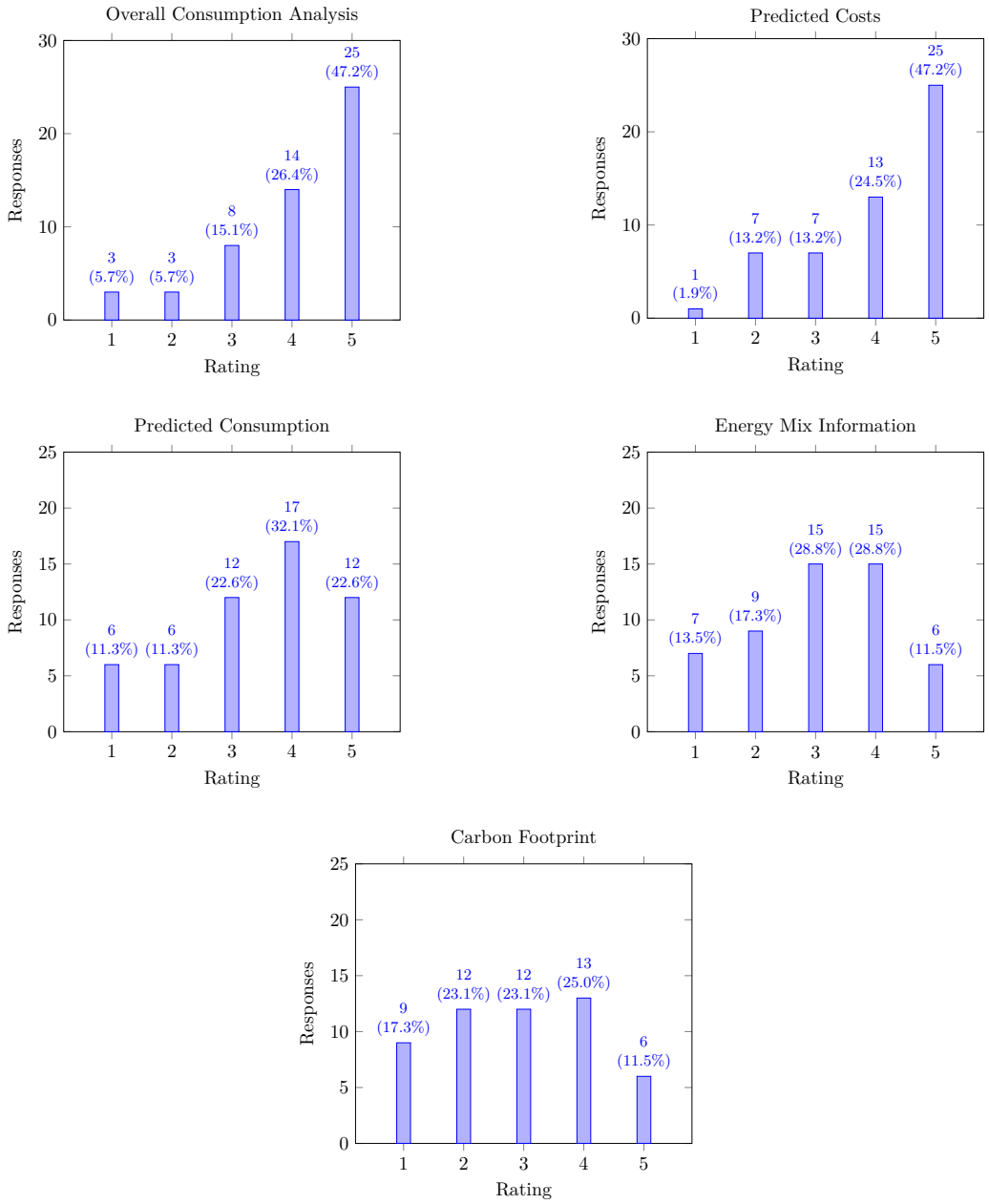

Figure 6.2.: Pre-survey distribution of ratings for five key features in *N-Ergy-View* (1 = Lowest, 5 = Highest).

Looking at the questions about receiving notifications and energy-saving tips, many participants (81.5%) stated that they would like to receive notifications, while 16.7% said they would not, and one participant gave no answer. The results can be viewed in Table 6.12. This is interesting with regard to additional features, which will be explored

later, as this could be a future feature for *N-Ergy-View* to enhance the user experience, encourage behavioral change, or provide further insights. Furthermore, the interviewees from the target group showed disinterest in receiving notifications, which contradicts the results from this survey.

Furthermore, when examining the preferred visualization units, participants were asked whether they would prefer their consumption to be visualized in kWh measurements or directly in costs. This is an important question, as this survey aims to understand what people want to see when analyzing their detailed energy consumption. Table 6.13 shows that 33.3% prefer their consumption to be visualized in actual kilowatt-hour measurements, while a majority of 66.7% would like to see their consumption interpreted in terms of costs. This indicates that users prefer to understand how much they are paying in detail regarding energy consumption, which also confirms the findings of Hargreaves et al. [58].

Response	**Count**	**Percentage**
Yes	44	81.5%
No	9	16.7%
No Answer	1	1.9%

Table 6.12.: Participant responses to the question on receiving notifications - Pre-Survey

Response	**Count**	**Percentage**
kWh	18	33.3%
Costs	36	66.7%

Table 6.13.: Participant preference for viewing energy consumption in kilowatt-hours versus monetary costs - Pre-Survey

Exploring the willingness to share data for an application such as *N-Ergy-View* is crucial, as data is the lifeblood of an energy application, especially when data analytics and personalized insights are calculated. Participants were asked if they would be willing to share their energy consumption data to enable features such as future predictions. According to Table 6.14, 77.8% said they are willing to share their data, while 14.8% said no, and 4 participants (7.4%) gave no answer. To explore the reasons further, a thematic clustering was performed using the Braun and Clarke method [64]. The thematic clusters can be seen in Figure 6.3. Regarding the reasons people were willing to share data, most stated that by sharing data, they would receive benefits such as better insights, analysis, and the ability to optimize energy consumption and costs. Additionally, many participants expressed trust in the proposed features and the security of the app. Some also wanted to support the novel idea and contribute to environmental sustainability by sharing data and receiving the proposed benefits. Others were indifferent about sharing data. On the other hand, participants who were not willing to share data primarily cited mainly privacy and security concerns. Some were unsure about the quality of the implementation or how their data would be used and stored, which made them hesitant to

share their data. These responses have significant implications for the future development of energy data-driven applications such as *N-Ergy-View*. They indicate that a majority of people are willing to share data to receive the proposed benefits and that ensuring data security is vital.

Response	Count	Percentage
Yes	42	77.8%
No	8	14.8%
No Answer	4	7.4%

Table 6.14.: Participant willingness to share energy consumption data with N-Ergy-View-Pre-Survey

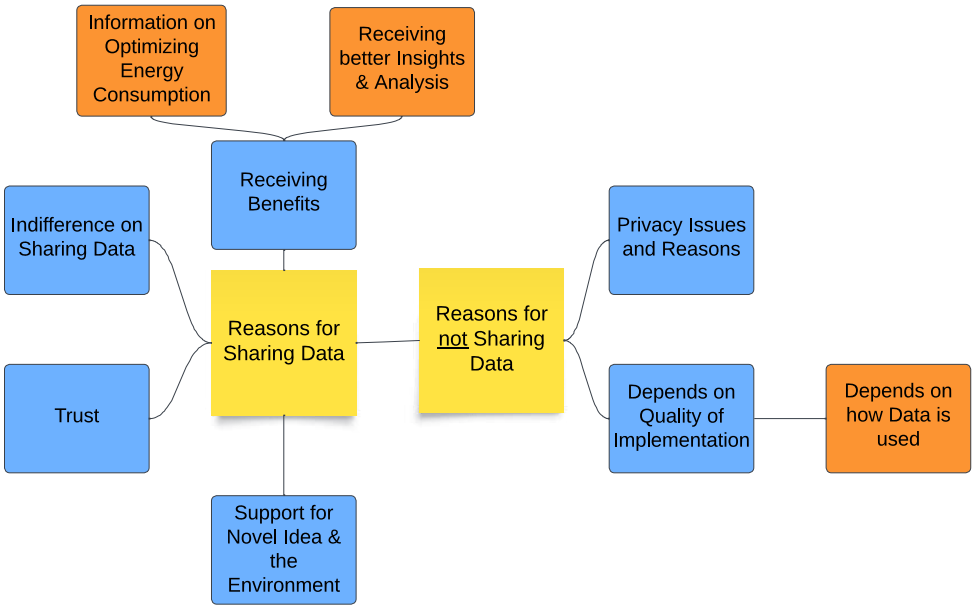

Figure 6.3.: Thematic cluster of reasons why people were willing to share data or not-Pre-Survey

For the open-ended question about extra features, the answers were grouped into themes using the Braun and Clarke method [64]. As shown in Table 6.15, 44 participants suggested new ideas, while 10 either gave no answer, said they had no ideas, or were happy with the current features. Some of these ideas are shown in the cluster in Figure 6.4. Popular suggestions included getting energy-saving tips, detailed monitoring of individual devices, real-time data access, and having the app available as a native smartphone version with clear visualizations. Other participants wanted to compare their energy use and costs with other households or see available energy tariffs on the market. Many also liked the idea of alerts—such as warnings when energy use is unusually high or when a daily energy target is almost reached, which is confirmed by the previous question

about receiving notifications. This links to features like goal setting or even gamification. Additional ideas included smart home integration and the option to use an AI chatbot. These are features that *N-Ergy-View* already offers or could add in the future.

Response	Count	Percentage
Gave idea for additional feature	44	81.5%
Blank or "nothing"/"no idea"	10	18.5%

Table 6.15.: Participant responses to the open-ended question on additional feature suggestions - Pre-Survey

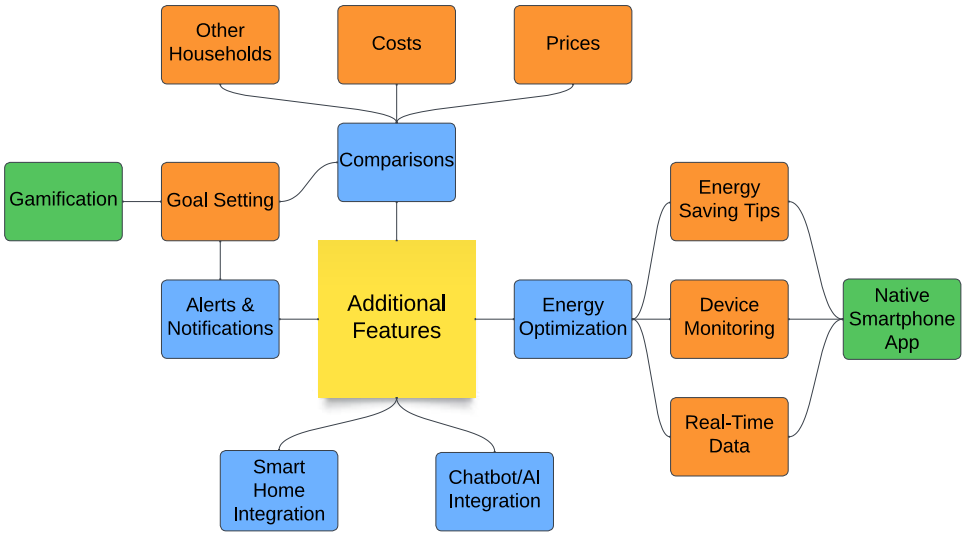

Figure 6.4.: Thematic cluster of potential additional features suggested by participants - Pre-Survey

To further assess how well the concept of data-driven energy monitoring and *N-Ergy-View* is perceived, participants were asked if they would pay for such an application. They were given options to differentiate between a one-time fee, a monthly subscription, or if they would not be willing to pay for such an app. A *No answer* option was also provided. As Table 6.16 shows, 31.5% would pay a one-time fee, while 24.1% would pay for the app on a monthly subscription basis. This means that, in total, over half (55.55%) of the participants would be willing to pay for an energy data-driven monitoring application. The prices for a one-time fee ranged from 5 to 200 Euros, with a mean of 44.35 Euros, while the prices for a monthly subscription varied between a minimum of 2 Euros and a maximum of 20 Euros, with a mean of 8.69 Euros. Figures 6.5 and 6.6 show the distribution of the price ranges given by the participants. It can be seen that for one-time payments, the most common price was 30 Euros, and for monthly subscriptions, it was 5 Euros. However, 38.9% of participants would not be willing to pay, while 3

Option	Count	%	Mean (€)	Median	Mode	Std. Dev.	Min	Max
One-time fee	17	31.5	44.35	30	30	49.58	5	200
Monthly subscription	13	24.1	8.69	5	5	6.09	2	20
Not willing to pay	21	38.9	–	–	–	–	–	–
No Answer	3	5.6	–	–	–	–	–	–

Table 6.16.: Participant responses regarding willingness to pay for an energy monitoring app, including statistical values for payment responses - Pre-Survey

participants gave no answer.

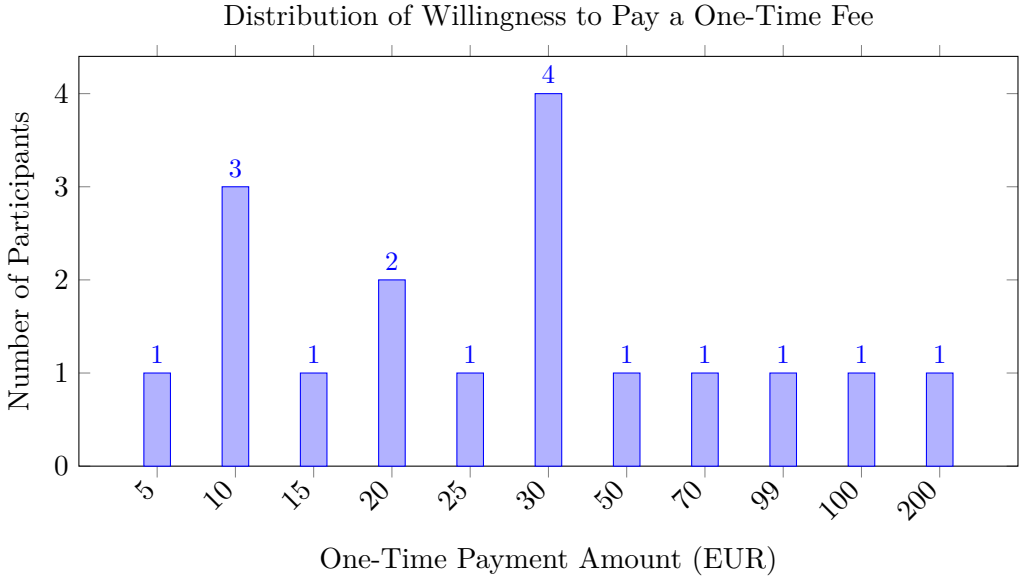

Figure 6.5.: Bar chart showing evenly spaced one-time payment frequencies for an energy app.

By further exploring the reasons why people who said they would not pay or those who did not provide an answer ($N = 24$) for the app, various opinions were gathered and clustered using the Braun and Clarke method [64]. In Figure 6.7, a thematic cluster of the various reasons is presented. One of the main reasons was *monetary reasons*, with some participants stating they could not afford to pay for another application or subscription, or they did not see the need for this type of application. Exploring further, some participants suggested that the government or other organizations should provide or even pay for this type of application. On the other hand, there were doubts about the *quality of the implementation* of the application, which were also stated in the willingness to share energy data from some participants. Some participants, in combination with *monetary reasons*, stated that with the proposed features, it did not

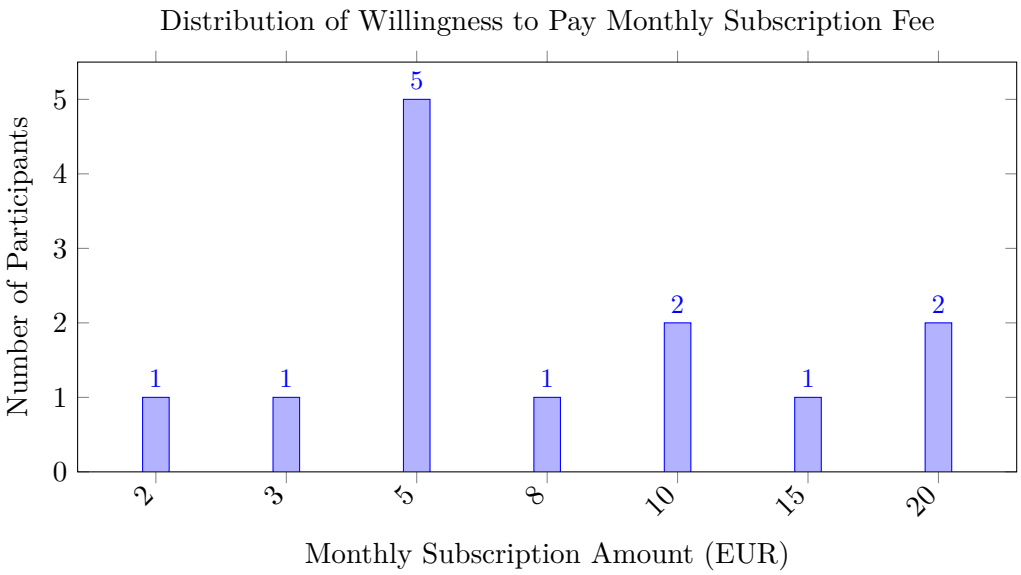

Figure 6.6.: Bar chart showing evenly spaced monthly subscription payment frequencies for an energy app - Pre-Survey

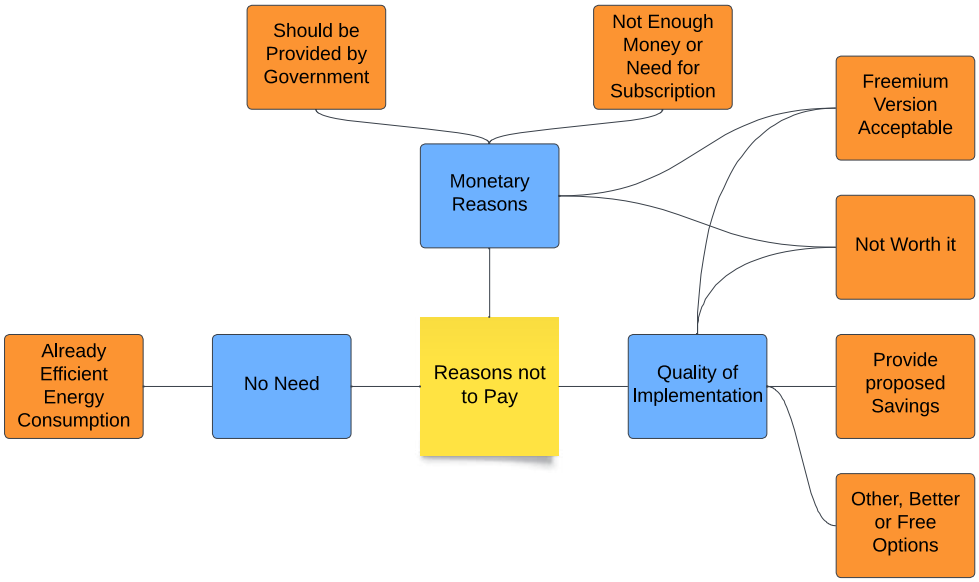

Figure 6.7.: Thematic clusters of reasons for participants' unwillingness to pay for the proposed application- Pre-Survey

seem worth it. Additionally, some people said the app would need to demonstrate that it actually provides the proposed energy savings.

The last question aimed to determine if people find data-driven energy monitoring apps useful and whether they would use them to analyze their energy consumption. Table 6.17 shows the responses, with 92.6% stating that they find this type of app useful for monitoring their energy consumption. Only 5.6% said no, and one participant chose *No answer*. The responses were also thematically clustered using the Braun and Clarke method [64] to identify the different reasons. Figure 6.8 shows the thematic clusters, differentiating between reasons for finding the application useful or not.

Response	Count	Percentage
Yes	50	92.6%
No	3	5.6%
No Answer	1	1.9%

Table 6.17.: Summary of participant responses to the question on the perceived usefulness of the proposed energy monitoring app.

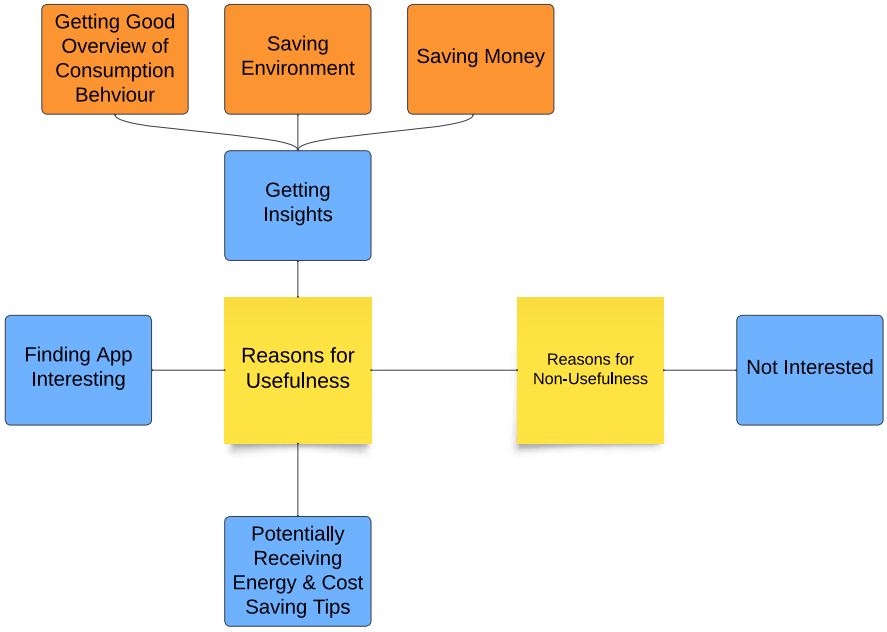

Figure 6.8.: Thematic clusters of responses explaining why participants found the application useful for analyzing energy consumption or not

Participants who found these types of apps useful most commonly stated that they appreciate gaining better insights, such as overviews of their consumption behavior and patterns through predictions. Some also mentioned that they find it very useful to save money and contribute to environmental sustainability through the insights provided. Additionally, participants liked receiving notifications about their consumption and energy-saving tips. Furthermore, some participants simply found the app and its features

interesting and considered it useful. On the other hand, the few participants who said no or the one who gave no answer plainly stated that they are not interested in this type of application and provided this as their reason.

6.2.2. Conclusion of the Pre-Survey

The pre-survey provided a wealth of interesting input, feedback, and opinions, offering valuable insights into what users expect and want from energy data-driven monitoring applications like *N-Ergy-View* and how they would be accepted.

First, it was observed that participants generally lack knowledge about their fridge's and household's energy consumption, with only a few understanding their energy usage well. There appears to be confusion regarding units and measurements, highlighting the importance of educating users through energy analytical monitoring apps about these aspects. Second, many participants in this survey demonstrated strong environmental consciousness and a desire to save energy, indicating its importance to them. When examining the features, it became clear that overall consumption analysis and cost prediction are perceived as the most relevant features for such apps. While other features were also well-received, they were deemed less relevant and important. Additionally, participants expressed a liking for receiving notifications, which was not well-received in the target group interviews. This opens up more functionality, as people could receive alerts (e.g., when reaching a consumption limit or goal) or more insights and energy-saving tips.

Regarding preferred units for visualization, it was found that people prefer to see their consumption highlighted in costs. This could indicate that users are more cost-sensitive and want to save money. Participants also suggested interesting additional features they would like to see. As the topic of notifications was discussed earlier, this functionality appears to be something users would appreciate, as it opens up more possibilities such as goal setting, behavior change, gamification, and making more informed decisions. Participants also expressed a desire for comparisons with other households, energy tariffs and prices, and overall cost comparisons. Other functionalities included optimizing energy by receiving energy-saving tips, gaining more insights, and monitoring the energy use of individual devices and appliances, as well as seeing real-time energy usage. Additionally, some potential users would like to see these features in a native smartphone app, along with smart home integration and a chatbot/AI feature.

When asked whether people would share their data to receive the proposed features, a majority were willing to share personal data regarding their energy usage. This is a significant insight, as a large majority's willingness to share data is crucial for all of *N-Ergy-View's* features or any other energy data-driven application. Consequently, when asked about their willingness to pay, more than half of the participants were willing to either pay a one-time fee or a monthly subscription, while others were not willing or gave no answer. The prices varied between one-time payments and monthly subscriptions, with some people even willing to pay up to 200 Euros for a one-time payment, while monthly subscriptions were generally less than 20 Euros, with 5 Euros being the most common amount. Further exploring the reasons why some people were not willing to

pay, it was found that monetary reasons were a significant factor, with some participants stating they did not have enough money or believed that such an app should be provided by governmental organizations. Others thought it was not worth the cost. Some were unsure about the quality of the implementation, as it is not clear if the app can provide the proposed insights and savings, or they preferred a test version or a freemium version with advertisements. Others mentioned that they were already efficient enough with their energy consumption and resulting costs. Additionally, when asked if people find data-driven energy monitoring apps useful, a large majority stated that they are useful for analyzing their consumption, as they provide better insights into their consumption and help save costs and the environment, as well as finding the concept very interesting.

In conclusion, these findings show that by presenting the concept of an app like *N-Ergy-View*, there is significant acceptance among young computer science students, who mostly live in aparmtens or sahred accomodations. Participants seem interested in getting an analysis of their energy consumption and are willing to share their consumption data and even pay for such applications. The pre-survey indicates that *N-Ergy-View* could be accepted by a broader user base and that there is a market for these types of applications.

6.3. Structure of the Post-Survey

The pre-survey provided an overall impression of the participants' views and opinions on energy consumption knowledge, data-driven energy monitoring applications, and the overall impression of the presented concept. Furthermore, the willingness to share data with the app, as well as the readiness to pay for it and its overall usefulness for energy consumption analysis, were tested.

In the post-survey, *N-Ergy-View* was presented to the same participants as before through the survey and a presentation. Before the survey began, participants were given a short introductory presentation and a product demo using a mix of a live demonstration and a video demonstration. This option was chosen as a backup to ensure that all functionalities could be presented as intended, since not all features were fully implemented at the time and some still had bugs. The video also showed the energy data sharing process and the steps users would need to take to provide *N-Ergy-View* with their data. This approach made it possible to observe if there were any changes in participants' perception of the data-driven monitoring application compared to the concept they had previously seen. As in the pre-survey, participants were informed about the anonymity of the survey and its purpose. The structure of the survey can be found in Appendix A.7.

At the start of the survey, similar to the pre-survey, participants were asked about their gender, age range, and current living situation (e.g., house, apartment, etc.) to collect demographic information. In this round, the survey also directly asked which features (the same as in the previous round) participants would find most relevant for getting a better overview of their energy consumption, using a scale option. The questions regarding notifications, the preference for visualizations in either kWh or costs, and the question about additional features remained the same to check if there were any significant shifts compared to the previous survey.

New in this survey-phase were questions regarding the data onboarding process via the EDDIE Framework. Participants were asked to rate the intuitiveness of the onboarding process on a scale, and additional feedback was also collected. Then, as in the pre-survey, participants were asked about their willingness to share data and to give reasons for their decisions. This approach made it possible to observe whether there was a shift in impressions and perceptions compared to the previous round.

Just like in the pre-survey, participants were then asked if they would be willing to pay for *N-Ergy-View*, and if so, how much they would pay and whether they preferred a subscription or a one-time fee. This was done to see if there was a shift in willingness to pay after experiencing the app more closely. Participants were also asked whether they found *N-Ergy-View* useful for analyzing energy consumption and to provide a reason for their opinion. In addition, the survey asked participants to rate, on a scale from 1 to 5, how interested they would be in using *N-Ergy-View* themselves. This helped assess both user and market adoption of the app, along with collecting their overall feedback to better understand participants' opinions. Like in the pre-survey, these results will now undergo statistical and qualitative analysis.

6.3.1. Results of the Post-Survey

To conclude the survey and evaluation, the post-survey was conducted one week after the pre-survey. Although it was conducted among the same group, there were slightly fewer responses in this round, totaling $N = 51$ completed questionnaires. As mentioned, participants were given a first look at the real implementation of *N-Ergy-View* through a presentation that included a mix of a live demo and video as a backup for features that were not correctly implemented yet or had bugs and other issues. Participants were also shown the onboarding process via the EDDIE framework, which is an important step for *N-Ergy-View* to collect the relevant data for its business logic. This process was also evaluated, as it has significant implications for the user experience of the app and could influence its adoption. The same questions regarding preferred features, receiving notifications, visualization units, additional features, willingness to share data, and willingness to pay for *N-Ergy-View* were asked again. This was done to see if there was a difference in perception between the textual concept and the actual implementation. Lastly, the overall interest and feedback were inquired from the participants to see how well *N-Ergy-View* is perceived for potential market adoption. Similar to the pre-survey, the first questions revolved around the demographic information of the participant sample (see Figures 6.18, 6.19 and 6.20. Of this sample, 37 were *male*, 12 were *female*, and 2 gave no answer. Furthermore, 31.4% were in the age range of *18-24*, 62.7% were between *25-34*, and 2% were between *35-44*. Lastly, on the demographic side, 60.8% live in an *apartment/flat*, 27.5% in a *shared accommodation (e.g., roommates)*, 5.9% in a *house*, and 3.9% in a *dormitory*. Overall, as we can see, there are some minor changes in the demographics, which are not very significant for the evaluation.

Diving straight into the feature evaluation, the results show that participants' perceptions of the relevance of different features remained largely unchanged, whether presented

Gender	Count	Percentage
Male	37	72.5%
Female	12	23.5%
Other	0	0.0%
No Answer	2	3.9%

Table 6.18.: Gender distribution - Post-Survey

Age Group	Count	Percentage
18–24	16	31.4%
25–34	32	62.7%
35–44	1	2.0%
45–54	0	0.0%
55–64	0	0.0%
65+	0	0.0%

Table 6.19.: Age distribution- Post-Survey

Living Situation	Count	Percentage
Apartment / Flat	31	60.8%
Shared accommodation (e.g., roommates)	14	27.5%
House	3	5.9%
Dormitory	2	3.9%
Other	0	0.0%

Table 6.20.: Living situation of survey participants - Post-Survey.

conceptually or through the actual implementation (see Table 6.21). *Overall Consumption Analysis* remains the highest-rated feature, closely followed by *Predicted Costs*. This suggests that users are particularly interested in tools that help them understand and manage their energy usage, especially from a financial perspective. *Predicted Consumption* holds its third place, while *Information on the Energy Mix* and the *Carbon Footprint Calculator* consistently rank lower. While there are minor fluctuations in the average ratings, these can be attributed to slight variations in the number of valid responses for each feature and in general in the sample size of this round. Despite these small changes, the overall ranking of feature relevance remains consistent, indicating a strong alignment between conceptual expectations and the reception of the functional implementation. These findings suggest that participants are primarily motivated by personal consumption awareness and cost optimization rather than environmental impact. This may imply that while sustainability is acknowledged, it is not yet a driving factor for most users in adopting data-driven energy monitoring solutions.

Feature	1	2	3	4	5	Valid n	Mean	Median	Mode	SD
Consumption Analysis	2	4	9	8	24	47	4.02	5	5	1.21
Predicted Costs	4	5	7	19	14	49	3.69	4	4	1.23
Predicted Consumption	4	10	9	13	13	49	3.43	4	4	1.31
Energy Mix Info	6	10	9	15	9	49	3.22	3	4	1.31
Carbon Footprint	4	10	13	12	8	47	3.21	3	3	1.21

Table 6.21.: Ranked relevance ratings for N-Ergy-View features, excluding "No Answer" (1 = Lowest, 5 = Highest). Ordered by descending mean - Post-Survey

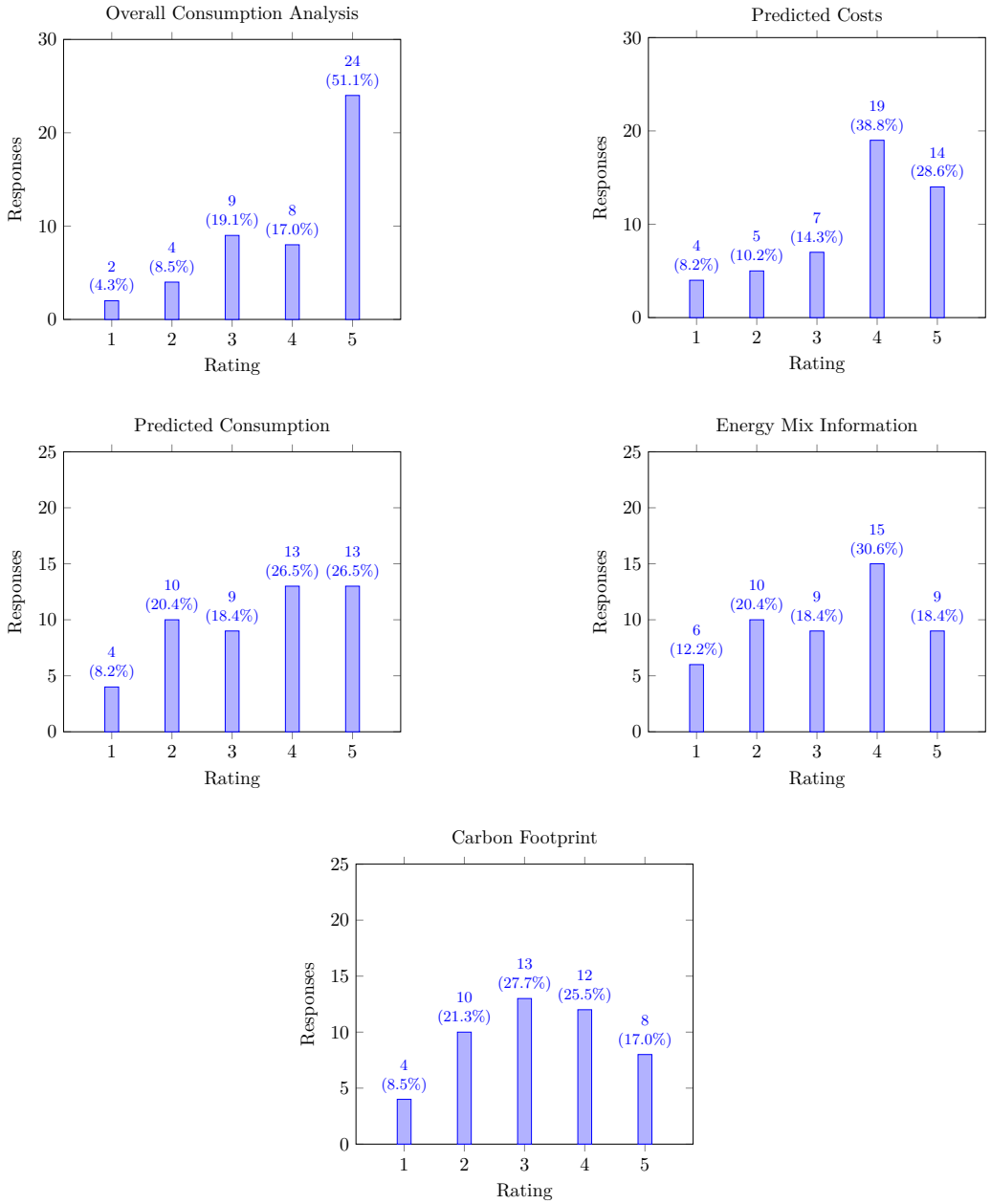

Figure 6.9.: Post-survey distribution of ratings for five key features in *N-Ergy-View* (1 = Lowest, 5 = Highest).

Looking at a potential feature to send out alerts and notifications regarding consumption behavior and energy-saving tips, participants responded overwhelmingly with *yes* (76.47%) (see Table 6.22). In general, there is a strong majority and high agreement on receiving notifications based on energy consumption behavior (e.g., alerts). There is a slight decline from 81.5% in the pre-survey to 76.5% in the post-survey, which could be due to the smaller sample size. Therefore, there is no significant change in the perception of receiving notifications. This is a feature that *N-Ergy-View* could integrate and add future functionalities such as goal settings or alerts for consumption limits.This could also enhance the user experience of the app, as receiving notifications and energy-saving tips may encourage users to change their behavior.

Response	**Count**	**Percentage**
Yes	39	76.47%
No	11	21.57%
No Answer	1	1.96%

Table 6.22.: Responses to whether participants would like to receive energy-saving tips and notifications.

In terms of preferred units for visualization, there is also no significant change (see Table 6.23). People still prefer to have costs visualized instead of kWh measurements. There is a slight variation, as in the post-survey, 60.78% of people responded with *costs* compared to 66.7% in the pre-survey. This can be attributed to the difference in sample size and has no direct impact on the fact that people prefer to have a breakdown of costs in the visualization and dashboard. This could also indicate that people are very cost-sensitive and want to get as much information on their energy bill as possible, along with insights into costs and, consequently, their behavior. This could also help improve the energy consumption behavior of potential users.

Response	**Count**	**Percentage**
kWh	20	39.22%
Costs	31	60.78%

Table 6.23.: Preferred unit for energy consumption visualization.

Further, examining the wishes for additional features, we can see in Table 6.24 that significantly fewer people provided responses compared to the pre-survey. This time, only 27 participants (52.94%) added wishes or ideas for additional features, compared to 44 (81.48%) in the pre-survey. Despite the smaller sample size ($N = 51$), this drop-off is notable. This could have various meanings, such as a perception shift where participants got a sense of what *N-Ergy-View* can deliver and felt that its implementation already met their expectations, leaving them with nothing new to add. On the other hand, it could also indicate that participants were fatigued from the survey questions and felt they had nothing else to contribute.

Looking at the responses and clustering them using thematic analysis [64], the wish

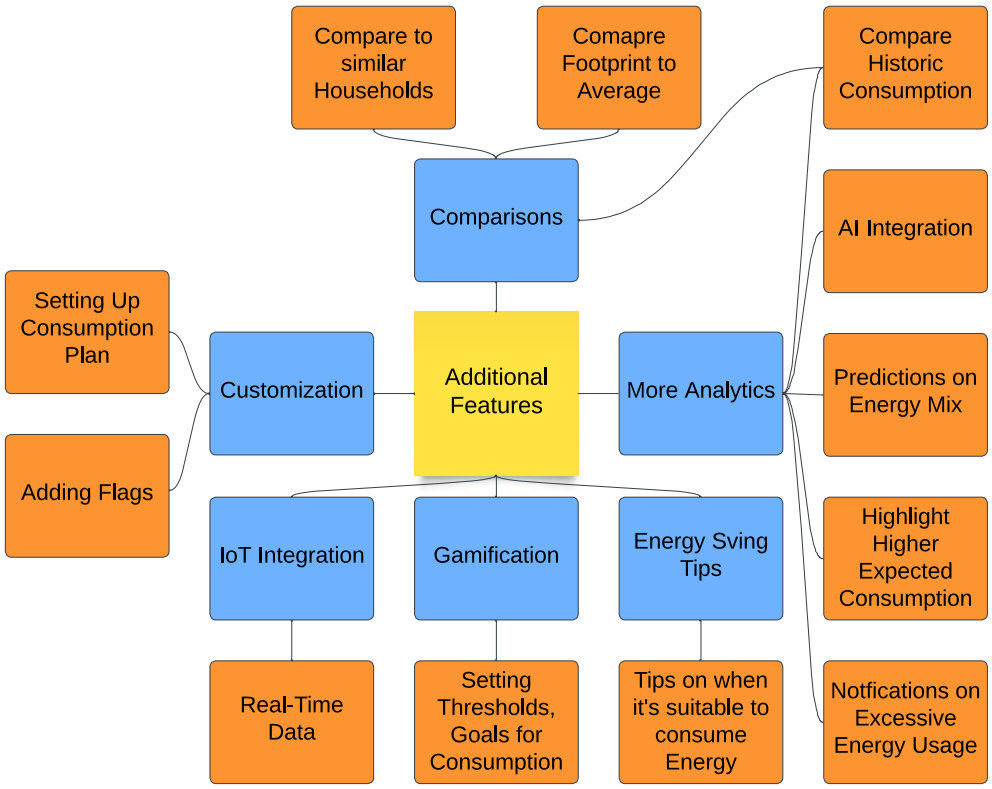

Figure 6.10.: Thematic cluster of potential additional features suggested by participants in Post-Survey.

Response	**Count**	**Percentage**
Gave idea for additional feature	27	52.94%
Blank or “nothing” / “no idea”	24	47.06%

Table 6.24.: Participant responses regarding suggestions for additional features.

to compare consumption, costs, prices, and other households remains a main feature participants want to see (see Figure 6.10. This is an interesting use case for future implementation in the app. Additionally, people expressed a desire for further insights and analytics, such as more detailed insights into their past consumption, AI integration, and more predictions regarding the energy mix (e.g., when more sustainable energy is available). Participants also wanted the app to highlight higher expected consumption due to certain events in the predictions, as well as to receive notifications about excessive energy usage. This last wish aligns with other themes, such as receiving energy-saving tips and alerts for the most suitable times to consume energy in terms of cost and sustainability. Participants also expressed interest in gamification elements, which correspond to setting up goals or thresholds. This is a feature *N-Ergy-View* aims to implement through

its prediction functionality. Furthermore, participants wanted more insights into their devices and appliances, indicating the importance and the wish for real-time data. Lastly, people desired more customization options, such as adjusting the UI, setting up flags for personal events (e.g., leaving home or going on holiday), and creating consumption plans within the app. As we can see, there is a lot of interesting feedback after participants experienced *N-Ergy-View* firsthand. Some of these ideas are already integrated in some form, while others require refinement and could be implemented in the future.

Next, the question regarding impressions and feedback on the EDDIE and data onboarding process was asked and analyzed. As shown in Table 6.25, there is a strong indication that the onboarding process is perceived as fairly intuitive, with a mean rating of 3.42, a median of 4, a mode of 4, and a standard deviation of approximately 0.95. This shows a positive trend; however, only 4 people rated it as very intuitive, and most responses fell in the 3-4 range. Therefore, it is not perceived as exceptionally smooth and could be seen as somewhat complex or not entirely self-explanatory. This may be due to the complexity of the onboarding process, which involves many entities and varies depending on the European Member State from which users request data. This suggests that future implementations should focus on explaining the steps in more detail to users who may not be knowledgeable about the energy structure and data infrastructure surrounding energy data. By providing more detailed explanations, *N-Ergy-View* could maintain a positive user experience and ensure an easy onboarding process.

Rating Category	**Count**	**Percentage**
1 (Not intuitive at all)	1	1.96%
2	9	17.65%
3	12	23.53%
4	24	47.06%
5 (Very intuitive)	4	7.84%
No Answer	1	1.96%
Mean: 3.42	**Median:** 4	**Mode:** 4 **SD:** 0.9495

Table 6.25.: Participant ratings for the intuitiveness of the onboarding process using the EDDIE Framework.

Consequently, the responses from the feedback on the process and impressions were also thematically clustered using the method developed by Braun and Clarke [64]. The clusters can be seen in Figure 6.12, where the clusters differentiate between *positive* and *negative feedback*. In terms of positive feedback, people stated that they think the onboarding process is good, straightforward, intuitive, and easy to understand, which provides a good user experience during onboarding. In terms of negative feedback, people thought that the process was too complicated and complex, as there are several steps involved, such as providing the necessary data for the metering ID, the system operator, etc., and then requiring the user to log in to the system operator's or data hub's webpage to confirm the data request. As a consequence, people felt there were too many steps and logins required for an easy onboarding process. Furthermore, people also provided tips or wishes for improving the user experience, such as the ability to select the time frame

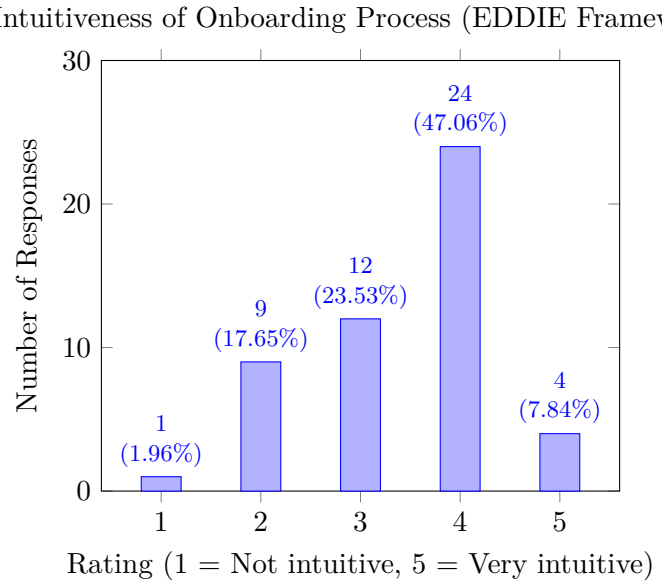

Figure 6.11.: Distribution of participant ratings on the intuitiveness of the onboarding process using the EDDIE Framework.

of the data being requested, better explanations and descriptions of what is happening or needed for the onboarding, and overall making the process easier and faster. Overall, however, it seems that the onboarding process is generally accepted by the participants, as shown in Table 6.25, Figure 6.11 and from the feedback received.

Afterward, the same question regarding the *willingness to share data* was asked again to determine if the onboarding process and the perception of *N-Ergy-View* had changed the participants' views. Table 6.26 shows that there are no significant changes in terms of willingness to share data in order to use the app. 78.4% of the participants were willing to share their energy data to use *N-Ergy-View*. There are minor variations, which could be attributed to the fact that the post-survey had a smaller participant sample size. The responses remained consistent, indicating that the onboarding process and the overall implementation had no negative impact on the willingness to share data. This suggests that people are open to the idea of sharing their energy consumption data and receiving beneficial analyses for improvements. Additionally, it could be interpreted that participants like the idea and implementation of the app and are ready to share their data.

Looking at some of the feedback, which was thematically clustered [64], there were some interesting insights, although most remained the same from the previous round. Regarding reasons to share data, the main takeaway was that people thought the implementation would provide them with benefits such as more empowerment, which was also a theme found in the thematic cluster with the target group from Section 5.2. Other benefits included reduced costs and optimized energy consumption. These benefits usually also

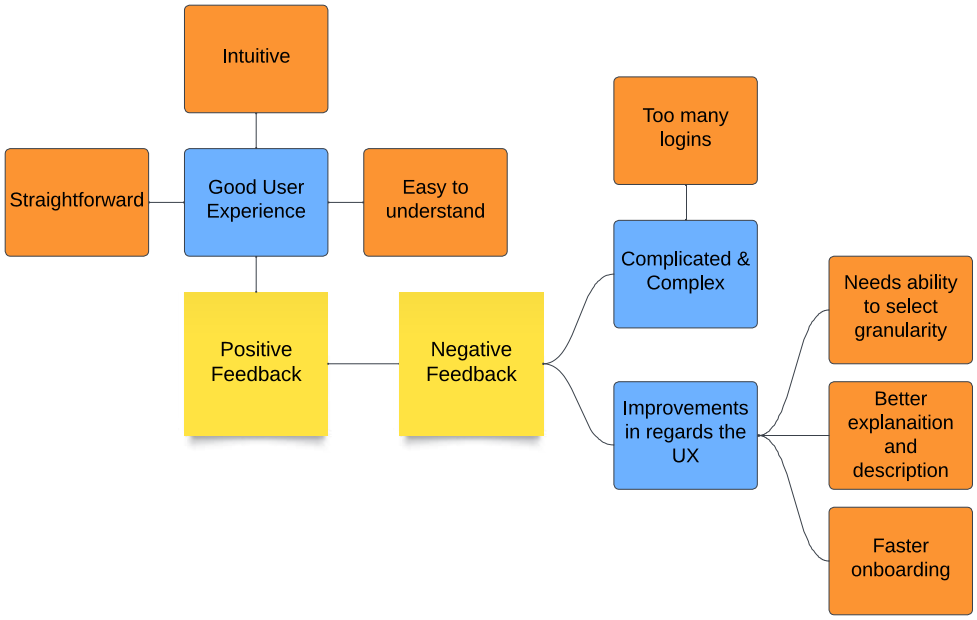

Figure 6.12.: Thematic cluster of postive and negative feedback on the data onboarding via the EDDIE Framework.

Response	Count	Percentage
Yes	40	78.43%
No	7	13.72%
No Answer	4	7.84%

Table 6.26.: Willingness to share energy consumption data with N-Ergy-View - Post-Survey

result in energy savings and sustainability goals for the users. Additional reasons, which were also found in the pre-survey, included overall trust in the application, indifference in sharing the data, and seeing it as a requirement to use the app. The reasons for not sharing data remained the same as in the pre-survey, with security and privacy concerns being the primary reasons, as participants found this data too personal to share. In conclusion, however, it seems that many people would be ready to share their energy data in order to use *N-Ergy-View* and receive the benefits it proposes.

Exploring the results in terms of *willingness to pay* in the post-survey, we can see that 33.3% of participants would pay a one-time fee for *N-Ergy-View*, 21.6% would pay a monthly subscription fee, while 35.3% would not be willing to pay for the app, and 9.8% did not provide an answer (see Table 6.27). There are some fluctuations compared to the pre-Survey, but this is likely due to the smaller sample size in the post-survey and has no significant implication on the change in willingness, as the proportions remained relatively stable. However, there are some notable changes in the amounts. In the post-survey, the

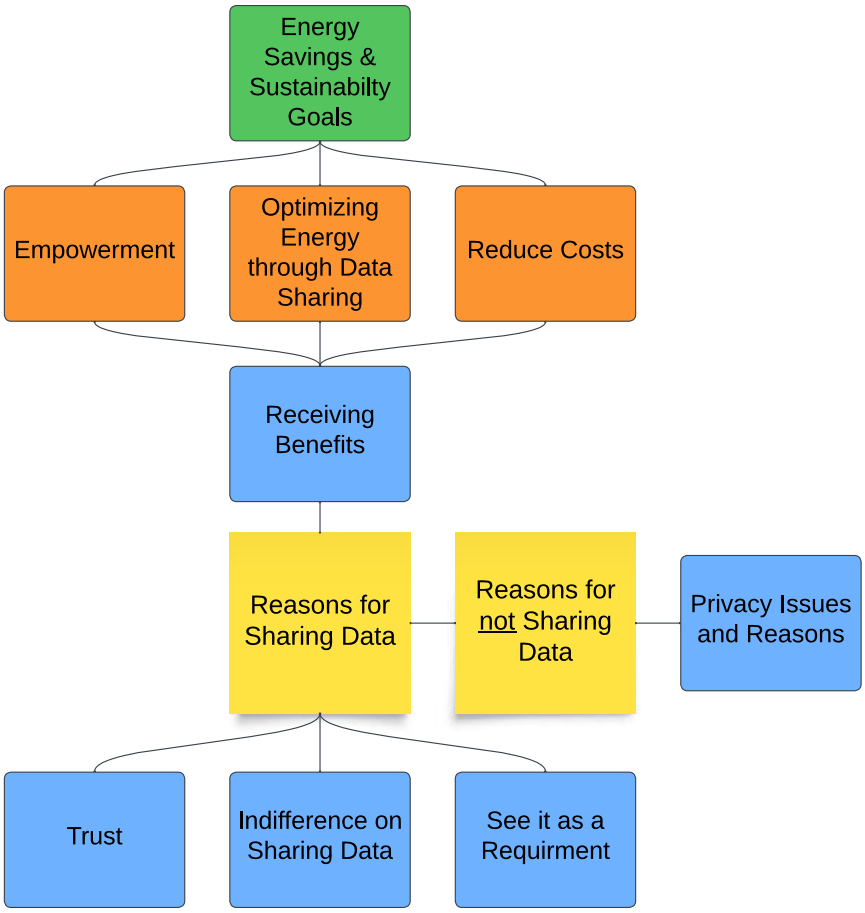

Figure 6.13.: Thematic cluster of reasons why people were willing to share data or not - Post-Survey.

mean and standard deviation for one-time payments increased significantly from 44.35 Euros to 118.25 Euros and from 49.58 to 224.04, respectively. This increase is due to some larger outliers, possibly resulting from survey fatigue, as one participant suggested an amount of 878 Euros (see Figure 6.14. Ultimately, 10 Euros was the most chosen amount for one-time fee payments. In comparison, the mean for monthly subscriptions dropped from 8.69 Euros to 6.41 Euros, with a lower standard deviation in tzhe post-survey (2.85). This suggests that responses became more concentrated around 5–10 Euros, with 5 Euros being the mode and most chosen option, while 10 Euros was the maximum amount chosen , which can be seen in Figure 6.15 (compared to 20 Euros in the pre-survey). To conclude, among the participants who indicated they were willing to pay for the app, their expectations on pricing diverged in the post-survey. These changes in pricing could have been influenced by exposure to the actual implementation, as participants gained a better understanding of the app's value proposition. While a majority of participants

showed some willingness to pay (at least over 50%), either through a one-time fee or a subscription, around one-third consistently indicated they would not be willing to pay.

Option	Count	%	Mean (€)	Median	Mode	SD	Min	Max
One-time fee	17	33.0	118.25	27.5	10	224.04	5	878
Monthly subscription	11	22.0	6.41	5	5	2.85	2	10
Not willing to pay	18	35.0	–	–	–	–	–	–
No Answer	5	10.0	–	–	–	–	–	–

Table 6.27.: Participant responses regarding willingness to pay for an energy monitoring app, including statistical values for payment responses – Post-Survey.

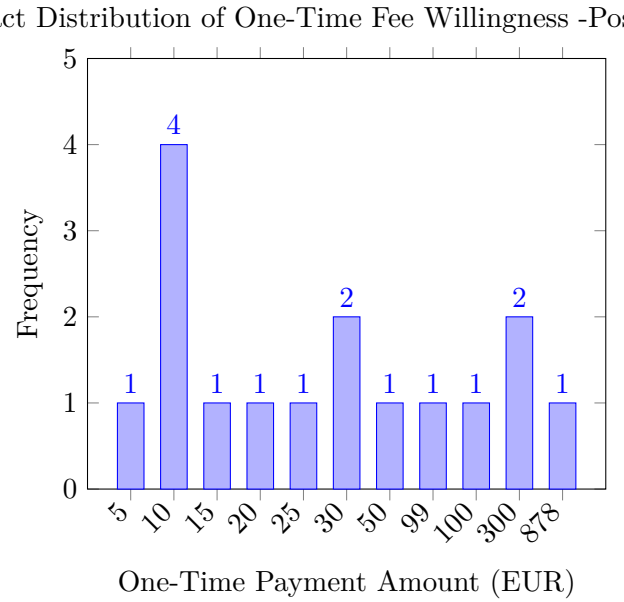

Figure 6.14.: Exact distribution of participants' stated one-time fee willingness (in Euros) - Post-Survey.

Examining some of the responses regarding why people said they are not willing to pay, the responses were again clustered into themes using the method developed by Braun and Clarke [64] (see Figure 6.16. There were not many additional new insights in terms of reasons for not paying for *N-Ergy-View*. The most common reason, once again, was monetary concerns—participants felt the app does not seem worth the cost, as its value is not high enough to justify payment. Furthermore, people stated that their willingness to pay would depend on the quality of the implementation, specifically whether *N-Ergy-View* delivers its proposed savings and energy usage optimization and analysis. Some interesting new feedback and subthemes emerged. For instance, one participant mentioned they would not want to pay for the app because they could implement these

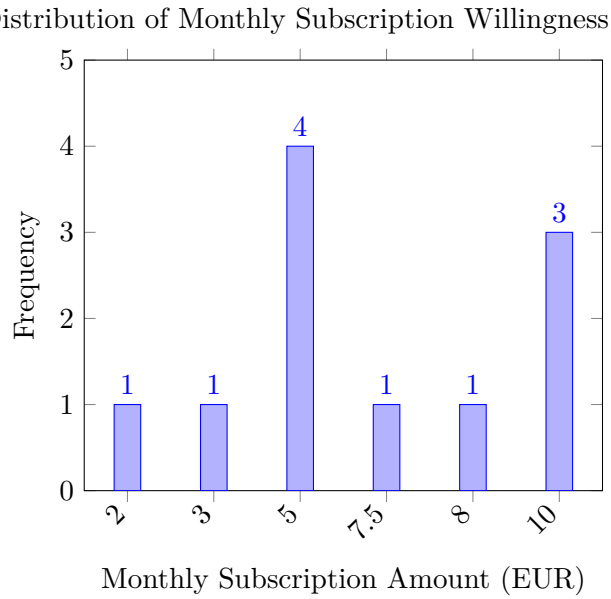

Figure 6.15.: Exact distribution of participants' stated monthly subscription willingness (in Euros) Post-Survey.

features themselves. Another interesting opinion was that the functionalities seem like basic necessities in terms of energy usage and should not require payment.

In summary, while a majority of participants expressed some willingness to pay for *N-Ergy-View*, the consistent portion of users who would not pay, in both survey rounds, highlights the need to carefully consider the pricing strategy and perceived value. The results from both rounds emphasize a clear trend of price sensitivity among users, particularly regarding features that help them reduce or monitor costs. An important aspect of the pricing strategy, therefore, is a transparent and clearly communicated value proposition. Demonstrating tangible benefits, such as proposed cost savings or actionable insights, will be essential in gaining user trust and motivating adoption, especially if any form of payment is expected.

Coming to the usefulness question in the post-survey, a high majority saw *N-Ergy-View* as useful. As shown in Table 6.28, 43 participants (84.3%) out of the 51 responses found the app useful for analyzing their energy data, while 4 (7.8%) did not, and 4 people did not provide an answer. Although the willingness to engage (answering *yes*) decreased slightly in the post-survey, the overall sentiment remains highly positive. The minor changes do not suggest a shift in participant attitudes, especially when considering the reduced sample size and possible contextual factors (e.g., survey length).

Looking at some of the feedback, which was clustered into themes [64] (see Figure 6.17), we can see some further interesting insights this post-survey. Participants who found *N-Ergy-View* useful for analyzing their consumption highlighted insights as the main aspect, such as providing lots of information, learning about energy consumption,

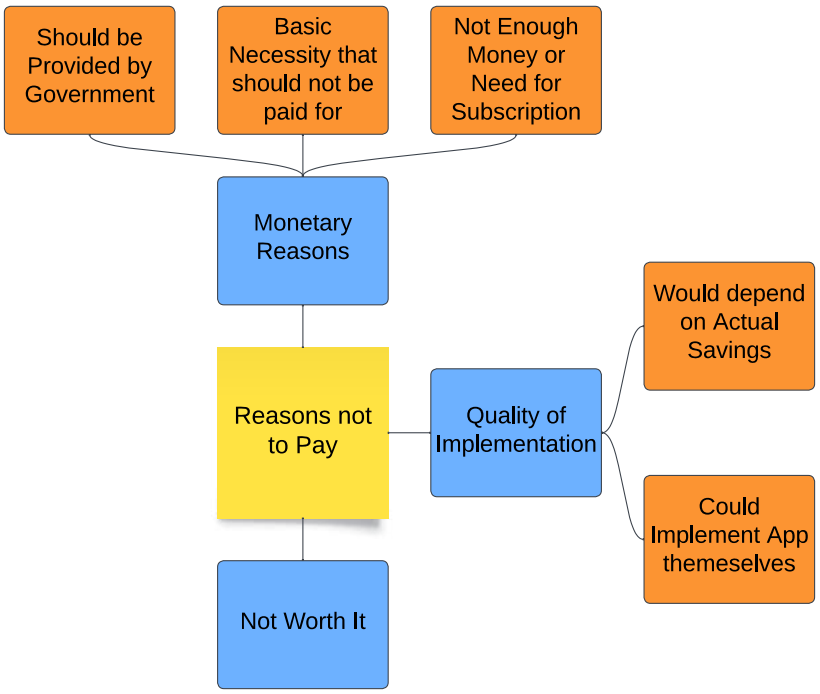

Figure 6.16.: Thematic cluster of reasons why people were willing to pay for N-Ergy-View - Post-Survey.

Response	Count	Percentage
Yes	43	84.31%
No	4	7.84%
No Answer	4	7.84%

Table 6.28.: Summary of participant responses to the question on the perceived usefulness of the proposed energy monitoring app - Post-Survey.

adopting sustainable energy usage, and helping to save money and costs. Additionally, some people said it helps raise awareness of their energy consumption and that a better overview would help change their consumption behavior. Furthermore, they liked the potential for receiving energy-saving tips and believed it would help them plan their energy consumption. On the other hand, participants who thought the app was not useful enough felt that *N-Ergy-View* had too few features to adequately analyze consumption. Additionally, some people found the information and data presented to be overwhelming. Others were simply not interested. Besides these aspects, there was nothing significant that would indicate a change from pre-survey to post in terms of the app's perceived usefulness and the feedback from the participants.

Lastly, participants were asked in this round how interested they are in using *N-Ergy-View* themselves. Table 6.29 and Figure 6.18 show the results. The mean rating

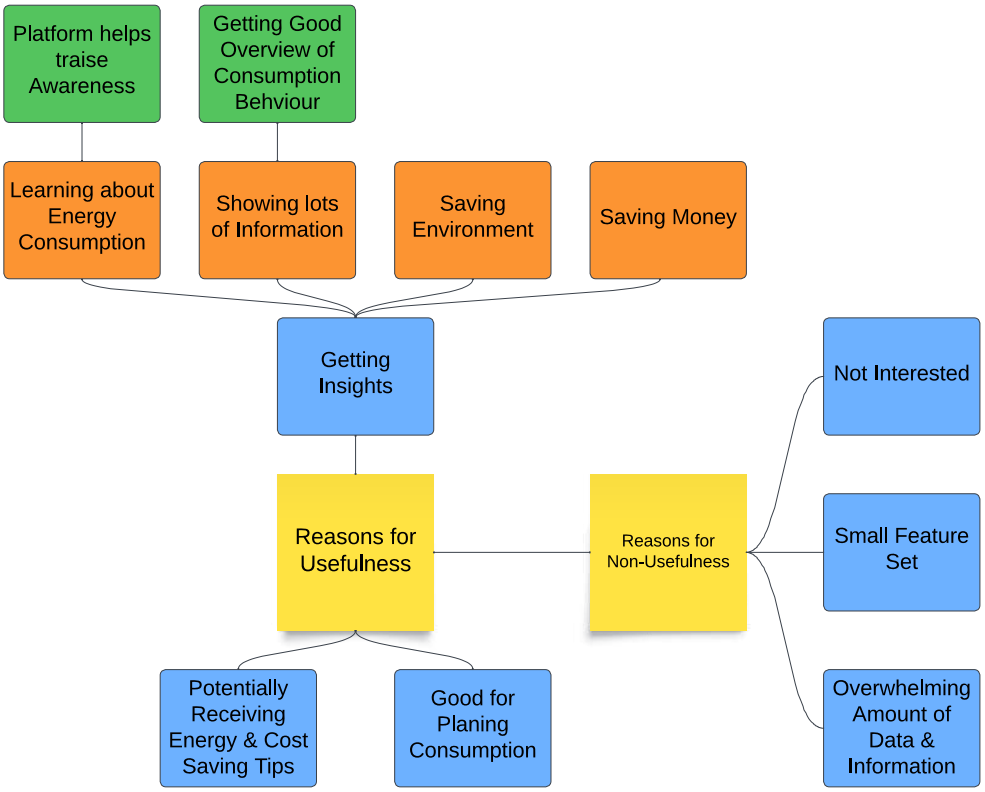

Figure 6.17.: Thematic cluster of reasons why people thought N-Ergy-View as useful for analyzing energy consumption (or not) - Post-Survey.

was approximately 3.45, with a median of 4, a mode of 4, and a standard deviation of around 1.006. This indicates that the highest response was closely followed by the third-ranked option, showing a moderate to high interest in using *N-Ergy-View*. The standard deviation of 1.006 suggests a reasonably tight distribution around moderate interest. There were 7 participants who showed high interest, indicating limited but present enthusiasm. Only a few responses showed low interest, with just 1 person (2%) selecting the lowest rating and 9 (17.65%) selecting the second-lowest rating. Despite the overall optimistic interest, these results emphasize the importance of a clear, user-focused value proposition and practical demonstrations of benefits to move users from moderate to high engagement.

Rating (1–5)	Count	Percentage	Mean	Median	Mode	SD
1	1	1.96%	3.4510	4	4	1.0063
2	9	17.65%				
3	14	27.45%				
4	20	39.22%				
5	7	13.73%				

Table 6.29.: Participant responses to "How interested are you to use N-Ergy-View yourself?" (1 = Least likely, 5 = Most likely).

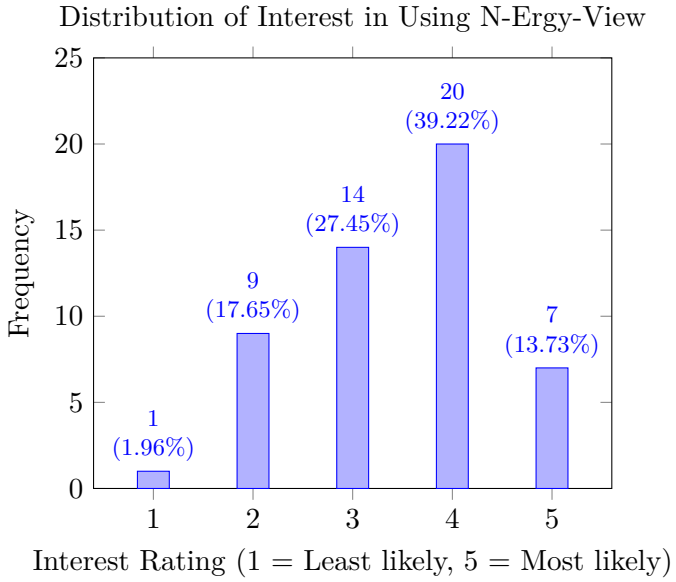

Figure 6.18.: Distribution of responses to "How interested are you to use N-Ergy-View yourself?"

Looking at some of the feedback, the input was again clustered [64] to identify the most prominent themes (see Figure 6.19. Regarding positive feedback, participants found *N-Ergy-View* to be overall very useful, as it provides good usability while being an interesting and innovative application. Participants also thought it was a very good initiative, and some expressed a desire to see it working on the market, as it provides them with valuable insights. Some of the negative feedback suggested that *N-Ergy-View* would need a broader feature set to be more interesting. This correlates with feedback from participants who do not have a smart meter and asked for a solution for those without one. Additionally, some mentioned that the onboarding process is not intuitive enough and should be improved. Others noted that for the app to gain market adoption and recognition, some advertising and strong marketing would be needed.

Overall, the feedback gathered in this round suggests that *N-Ergy-View* is perceived positively and holds strong potential for broader adoption. Participants showed moderate to high interest in using the app, and many recognized its usability, usefulness, and

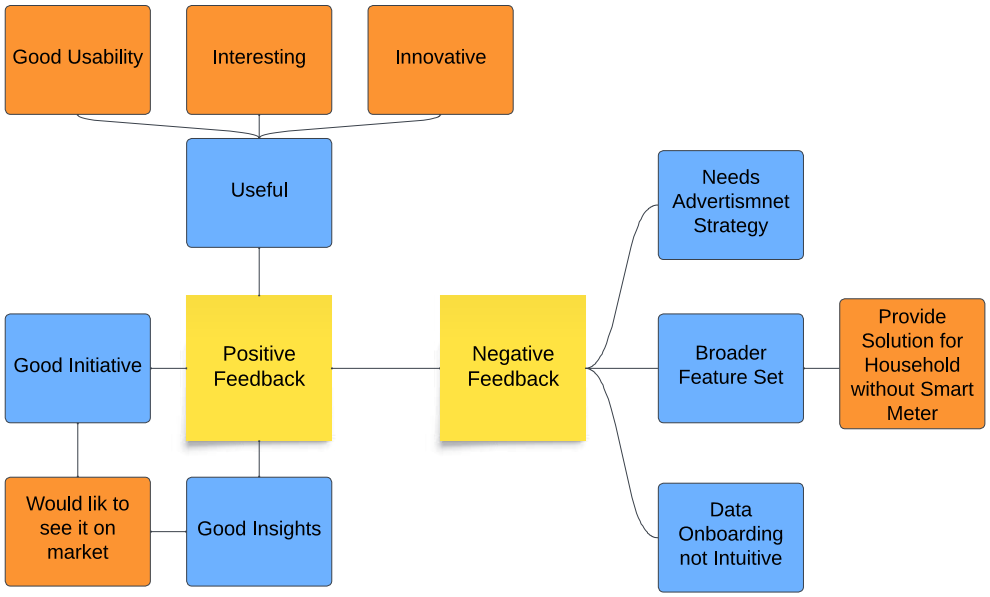

Figure 6.19.: Thematic cluster of positive and negative feedback on N-Ergy-View.

innovative character. To reach a wider user base, however, it will be important to clearly communicate the app's value proposition and demonstrate tangible benefits.

6.4. Discussion of the Surveys and Comparisons

With the analysis of the surveys, the **Evaluation Phase** of this thesis is now concluded, and with it, all the research phases as well. The pre-psot-evaluation of *N-Ergy-View* offered valuable insights into user perceptions, expectations, and potential for market adoption of energy data-driven monitoring applications. The comparative analysis between the conceptual presentation (Pre-Survey) and the implemented demo (Post-Survey) showed overall consistency in participant attitudes, with some nuanced shifts that provide meaningful direction for future development.

Across both rounds, core functionalities such as overall consumption analysis and cost predictions were rated as the most relevant features. These findings confirm that users prioritize clear, informative, and financially oriented insights when it comes to understanding and managing their energy consumption. While sustainability-oriented features like carbon footprint and energy mix were considered less relevant, they still received positive ratings, suggesting that these aspects could complement the core value proposition.

Willingness to share energy consumption data remained high and stable between both rounds (around 77–78%), indicating strong acceptance of data sharing when clear benefits are communicated. This is a crucial insight for energy applications relying on user-provided energy data. Importantly, the demo of the onboarding process via the

EDDIE Framework was perceived as moderately intuitive but with significant room for improvement. Specifically, simplifying the steps and providing clearer explanations of what is happening in the background could enhance the user experience. A smoother onboarding process, along with ensuring data privacy and security, could positively influence the user adoption of *N-Ergy-View*.

The *willingness to pay* results highlight significant price sensitivity among participants. While a majority expressed willingness to pay (over 50% in both rounds), the expected amounts varied between the rounds. A notable increase in the mean one-time fee in the post-survey was largely driven by a few outliers, while most users indicated more moderate willingness (with 10–30 Euros as typical amounts). Monthly subscriptions clustered around 5–10 Euros, indicating that lower costs are more appealing. These findings reinforce the need for a transparent and clearly communicated value proposition to justify any form of payment. Participants want to see tangible benefits in either cost savings or behavioral insights before committing financially and, therefore, using the app.

In terms of the overall usefulness of the app, it was confirmed in both rounds, with over 80% of participants affirming its utility for analyzing energy consumption. Furthermore, users showed moderate to high interest in using *N-Ergy-View* themselves. Positive feedback focused on the app's innovative design, insight generation, and potential to promote energy-saving behaviors. Negative feedback primarily pointed to the need for more features or an improved onboarding process. Additionally, a user highlighted the need to address how people without smart meters can have their energy consumption analyzed.

Taken together, these results answer the final research question and suggest that *N-Ergy-View* is well-positioned for user and market adoption, particularly among young, digitally literate, and environmentally conscious individuals living in apartments or shared accomodations. To strengthen its adoption potential, the app should clearly communicate its proposed benefits and energy savings, improve the onboarding experience, and continue enhancing its core features by integrating requested functionalities such as detailed notifications, alerts, gamification, and comparison tools. It also shows that people are willing to share their energy consumption data with the application, further indicating that users are ready to do so if the benefits are clearly communicated. This is also a significant implication for the research gap, as it shows that users or households could benefit from the vast amount of collected energy data through the installed smart meters at home. Additionally, as a majority of people were willing to pay for *N-Ergy-View*, any pricing model, such as subscriptions or one-time fees, must be backed by a clear and impactful demonstration of the app's benefits, especially regarding cost savings and offering useful, everyday insights to change energy consumption behavior. This helps users feel that the value they're getting is genuinely worth the cost. If these aspects are addressed effectively, *N-Ergy-View* could successfully appeal to a growing market and user segment interested in energy data-driven energy monitoring for households who benefit by sharing their energy data.

7. Discussion

This thesis addressed a notable gap in the current energy research landscape by focusing on household-centered energy monitoring and data analytics through the development and evaluation of the *N-Ergy-View* application. The *State of the Art* and literature review highlighted that energy is vital for modern life and plays a significant role in society, the economy, and even geopolitics, as the current energy crisis in Europe demonstrates. In the European Union, numerous projects and initiatives aim to restructure Europe's energy system and achieve sustainability goals to mitigate climate change. One such initiative, the EU Directive 2019/944 [3], mandates that households should be equipped with smart meters and become more active consumers in the energy system, thereby enabling novel use cases such as energy trading or sharing.

However, collecting and managing energy data can be very cumbersome, as the *State of the Art* chapter has shown, and there are many factors to consider, such as privacy and security [30, 33]. Consequentially, smart meters and related frameworks enable novel use cases in energy systems, as we have seen. However, there was a gap in understanding how households and residents can be empowered through these use cases and the smart meter data these users generate. Therefore, by bridging this gap with Human-Computer Interaction (HCI) and behavior change theory, we can explore how these residential use cases should be implemented and designed to provide benefits to users [59, 60]. We saw that monitoring apps can raise awareness of energy consumption, but for long-term changes, users need actionable and context-specific insights [57, 58, 61]. This highlights the need for *N-Ergy-View* to provide valuable insights by applying data analytics in its implementation. *N-Ergy-View* therefore sets out to explore how smart meter data and advanced analytics, such as ML and AI, can be harnessed to deliver tangible value to private households.

The thesis was structured into three distinct phases, applying human-centered design and a mixed-methods research methodology that included qualitative thematic clustering, as described by Braun and Clarke [64], and quantitative data analysis using descriptive statistics. These phases comprised the **Exploration**, **Implementation**, and **Evaluation** phases.

The **Exploration Phase** gathered input on how *N-Ergy-View* should be implemented and in which direction it should evolve. This phase aimed to answer the first research question: "How can data-driven-energy-services for households be designed and implemented to ensure both technical functionality and meaningful user engagement?" To this end, current practices from companies within the EDDIE project were analyzed using thematic clustering, revealing key challenges and opportunities within energy data-driven services. The main takeaways were that data privacy must be ensured, IoT devices such as smart meters are essential, data analytics are central to enabling use cases, and

a well-designed user experience is crucial to foster behavioral change. These insights directly informed the design of *N-Ergy-View*, helping to address the first research question by ensuring that the application integrates these critical aspects into its implementation, particularly with respect to functionality and user engagement.

Through a study, this research aimed to identify additional practical use cases in the field, helping to further understand business ideas involving energy data and assess the market for energy data-driven services. It was found that energy monitoring applications were the most common, followed by services applying data analytics with machine learning algorithms or artificial intelligence. This highlights that the concept of creating a combination of an energy monitoring and data analytics app is valid and indicates a market for such applications, with potential for user adoption. This also sheds light on some technical requirements that should be considered when implementing user-facing features, as the choice of algorithms and the type of insights provided will influence both the design and user perception of such apps.

By further exploring some requirements, target group interviews were conducted to determine which functionalities should be integrated and how they should be designed. Through thematic clustering, the main themes were extracted, which influenced the implementation and requirements of *N-Ergy-View*. Some functionalities were well-received, while others were not, such as showing emotional pictures depending on the household's consumption levels. Consequentially, main themes included the need for data to be clearly presented and for the resulting insights to be easily understandable, a common theme among the participants. These insights should be visualized accordingly, leading to the extraction of the UI theme. Other themes included the IoT & Sensor theme, as interviewees had varying experiences and knowledge about smart meters and data. The data security theme was also important, as some participants expressed concerns. User experience and how *N-Ergy-View* is perceived while using it was another key theme, as this can influence the adoption of the app. Additionally, behavior change and how the app could help users alter their consumption or costs was a relevant theme in terms of the requirements for *N-Ergy-View*. These insights addressed the first sub-research question: "What are the key user requirements and design principles for such a service?"

Therefore, during the **Implementation Phase**, it was essential to align the design and development of *N-Ergy-View* with the identified themes. These findings helped implement a data- and privacy-secure application through the EDDIE Framework, which handles the consent for data sharing. By developing robust analytical tools, such as carbon footprint calculators, consumption and cost predictions, and price comparison tools, users can gain valuable insights to help them change their energy consumption behavior while ensuring a good user experience. The use of predictive machine learning algorithms, such as Light Gradient Boosting Machine, demonstrates that integrating advanced data analytics for households is feasible and ensures good performance, consequently providing a positive experience for users. This further fulfilled the sub-research question, as we saw what the main user requirements for a data-driven energy service are and how the user interface and user experience should be designed and implemented for a service that both monitors energy consumption and provides advanced data analytics capabilities

such as *N-Ergy-View*.

We also learned from the development process that using energy data through the EDDIE Framework and integrating third-party data sources is possible, and that data analysis with these sources works well for visualizations, carbon footprint calculations, and predictions. Furthermore, the choice of prediction algorithm is also a technical challenge for data-analytics-based energy monitoring apps, as algorithms vary in precision and especially in runtime. Consequently, *LightGBM* was chosen, as it provides faster runtimes, delivers good predictions, and can effectively detect consumption patterns. This answers the second sub-question of the first research question: "What can be learned from the development process and the technical challenges encountered?" What we have learned is that there are different technical and user requirements to consider for a data-driven-energy-service for households, such as architecture, runtime, visualizations, and selecting the right insights and analyses for user engagement.

On top of that, to evaluate the implementation of *N-Ergy-View*, a pre-post-survey was conducted to help answer the final research question: What insights can be gained about user adoption of data-driven-energy-services that incorporate data analytics? Therefore, the focus was placed on examining how participants responded to relevant features, whether they were willing to share their consumption data with the app, whether they were willing to pay for it, and whether they found the app generally useful for analyzing energy consumption. The two surveys were designed to assess whether there was a significant shift in the perception and adoption of the app by first presenting a concept of the app and then presenting a live demo in the post-survey. The resulting shift was barely noticeable in the evaluation, which may indicate that *N-Ergy-View* is implemented in a way that aligns with how people imagine it to be and also confirms that the design and requirements identified in the previous research have been implemented correctly.

In summary, the results of both surveys showed that people found the overall consumption analysis and the predicted cost features to be the most relevant. It seems that users want to gain insights, optimize energy usage, and save energy with the help of cost predictions, which are the main features they expect in a data-driven energy monitoring app. Provided interesting insights into the participants' perception of the prototype. Furthermore, like in Hargreaves et al. [58] findings, it is also confirmed that people would prefer to have their energy consumption to be visualized or stated in costs. In combination with the predicted cost functionality, it can be said that the participants are very cost sensitive with their energy consumption and would like to have as much insights as possible.

Additionally, people were willing to share their energy data, as they saw benefits in return. The onboarding through EDDIE was accepted, which also deals with ensuring secure data sharing, which from the previous chapter is an important design feature as well as the literature says has to be considered in these systems [30, 33]. More than half of the participants were willing to pay a one-time fee or subscribe to a subscription model to use *N-Ergy-View*. However, some participants noted that the benefits and promised savings should be reflected in the pricing model. Moreover, a significant majority in both rounds found the app useful for analyzing energy consumption. In the final round, a

majority also expressed positive interest in using the app themselves if it were released on the market.

From the results, and to answer the final research question of this thesis — "What insights can be gained about user adoption of data-driven-energy-services that incorporate data analytics?" — we found that a young, environmentally conscious user base, which is not yet highly educated about energy consumption, is ready to adopt and use *N-Ergy-View* to gain insights and learn about their energy use, thereby changing their behavior. Furthermore, the majority of participants were willing to share their consumption data and to pay either a one-time fee or a monthly subscription to use the app. With this pre- and post-test approach and analysis of the surveys, the *Evaluation Phase* was concluded and the overall research.

8. Conclusion and Future Work

This thesis set out to investigate how household-centered, data-driven energy services can be designed and implemented, as well as which factors influence their user adoption. Adopting a human-centered design approach and a mixed-methods methodology, the research was structured into three distinct phases: the **Exploration Phase**, the **Implementation Phase**, and, finally, the **Evaluation Phase**.

The research also contributes to closing the identified gap in the literature by demonstrating that, with aggregated energy data and the identified use cases, it is indeed possible to develop services focused on residential users—enabling households to benefit from analyzing data obtained from smart meters. Furthermore, the results and findings provide insights into how such applications should be designed and highlight the key user requirements necessary for their successful implementation.

In the **Exploration Phase**, thematic clustering revealed the core themes for a data-driven energy service, including *Data Privacy*, *(IoT) Devices and Sensors*, *Data Analytics*, *User Experience*, and *Human Behavior*. This was the first step in addressing the first research question: *How can data-driven-energy-services for households be designed and implemented to ensure both technical functionality and meaningful user engagement?* Since this thesis set out to implement a prototype, the previously mentioned themes directly influenced the design, concept, and technical implementation.

Furthermore, through a study on use categories within energy services, this thesis revealed that monitoring applications and data analytical apps integrating machine learning or artificial intelligence were the most commonly identified services by the students. This research provided valuable input on the concept and overall direction of *N-Ergy-View*, which is intended as a data analytics monitoring app that analyzes a household's energy consumption. This also provided more insights in answering the overall research question on the design and technical functionality of a data-driven-energy-service.

Next, through the target group interviews, we identified the key design principles and user requirements. Thematic clustering revealed that *Data*, *Data Security*, *IoT Sensors*, *UI*, *UX*, and *Behavior Change (Empowerment)* were the core themes for the prototype. This answered the first sub-research question: "What are the key user requirements and design principles for such a service?" Consequently, these themes must be considered in the user requirements engineering process of *N-Ergy-View*.

Through the **Implementation Phase**, we learned from the development process that, in relation to the next sub-research question (*What can be learned from the development process and the technical challenges encountered?*), user requirements and design themes such as visualizations, the runtime of machine learning algorithms, and the relevance of insights are crucial for user engagement. Technical challenges can arise in all of these areas and must be carefully addressed.

The *Evaluation Phase* used a pre-post survey to address the final research question: *What insights can be gained about user adoption of data-driven-energy-services that incorporate data analytics?* This survey also concluded and evaluated the overall design and implementation based on the findings from the previous research questions. The results showed that the concept of an app that monitors and analyzes energy consumption—along with the overall implementation of *N-Ergy-View*—was well received. Participants indicated that they were willing to share their sensitive energy data with the app and would also be willing to pay for such a service, thereby demonstrating the potential for user adoption of an energy-data-driven application.

To conclude, this thesis demonstrates that, by using a human-centered design approach, an energy-data-driven application that monitors household energy consumption and provides data analytics can be successfully designed and implemented. Furthermore, it shows that through data sharing, households can benefit from the digitalization of the energy system.

For future research, the implementation of comparison functionalities (e.g., with other households) in *N-Ergy-View* needs to be better understood. The evaluation survey revealed that many participants lived in apartments or shared accommodations. However, comparing these households needs to be further understood. In conjunction with this functionality, further research is needed to explore how to engage users more effectively, thereby promoting behavior change. The survey revealed that people appreciate receiving notifications and alerts based on their energy consumption or for goal setting. This finding is interesting, as it contrasts with the results of the target group interviews, where most participants stated they did not want notifications. Therefore, designing and implementing a good user experience while using notifications and alerts to encourage behavior change related to energy consumption should be further investigated. Furthermore, based on participant input, there is a clear interest in more detailed, device-level monitoring, which should be explored further.

In addition, future research in the areas of Human-Computer Interaction (HCI) and behavior change should focus on how to set energy consumption goals and how households can achieve sustainability goals. Furthermore, a long-term study could assess user engagement and determine if any energy cost savings can be achieved by using the app, thereby proving its intended value proposition. Lastly, determining an appropriate pricing model for the business model of *N-Ergy-View* is another important aspect to consider for future research, especially if this or similar apps are to be developed for the market.

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A. Appendix

A.1. Iterative Process of Clustering

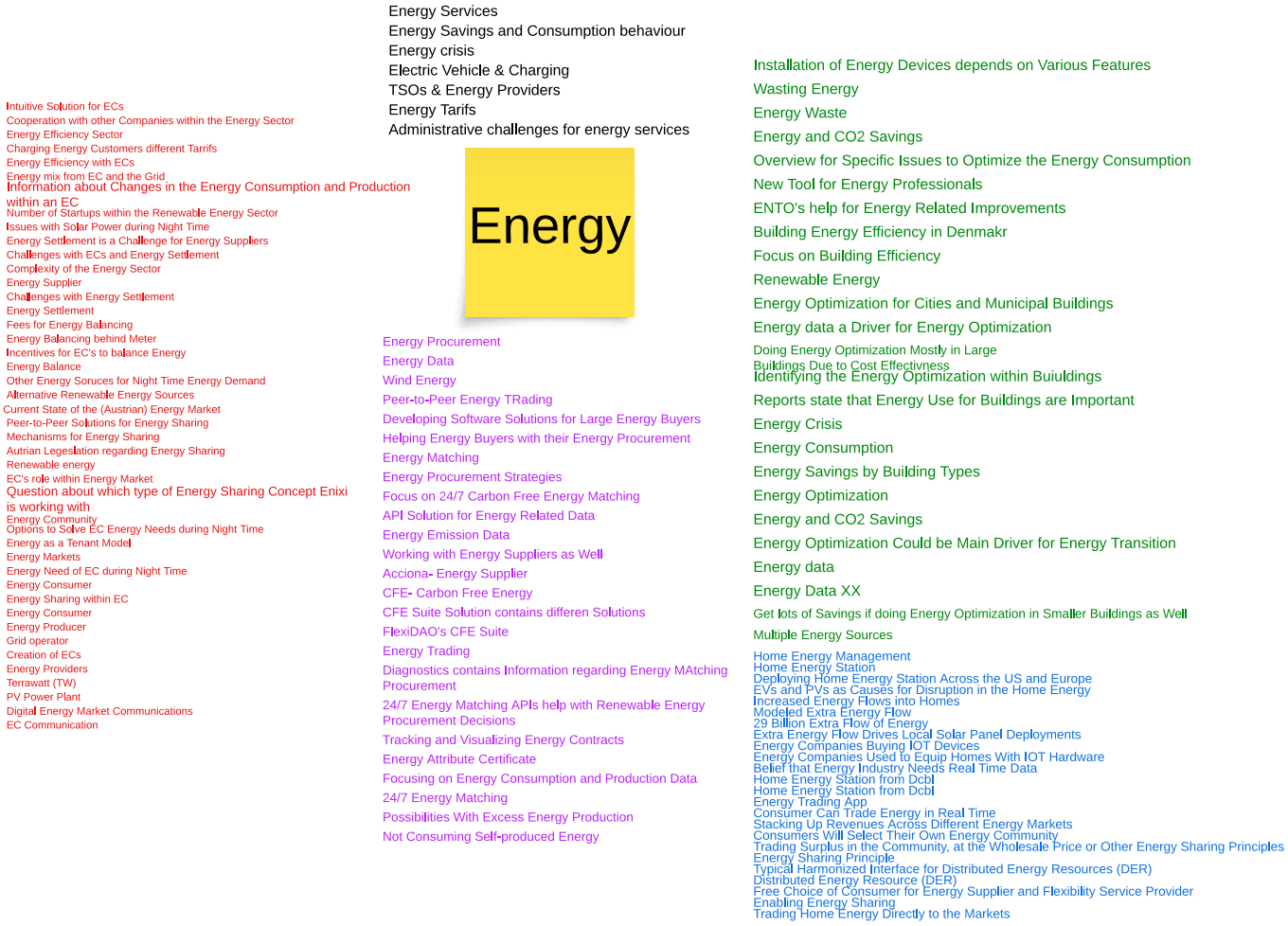

Figure A.1.: Overview of the Starting Point of the Thematic Analysis wit the theme "Energy"

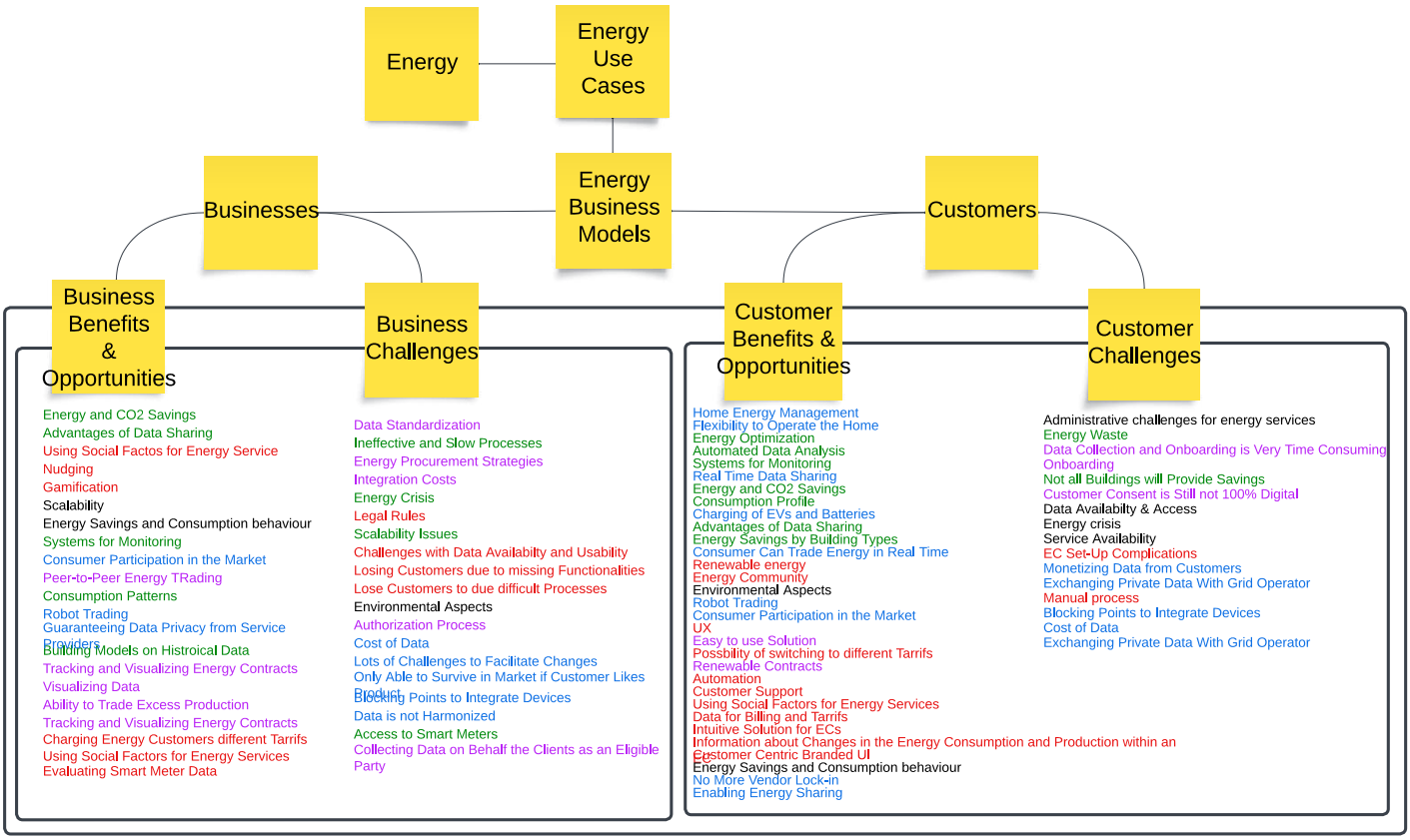

Figure A.2.: Overview of the Cluster of the Business Models Opportunites, Benefits and Challanges

Figure A.3.: Process of Thematic Clustering and New Theme Identification

A. Appendix

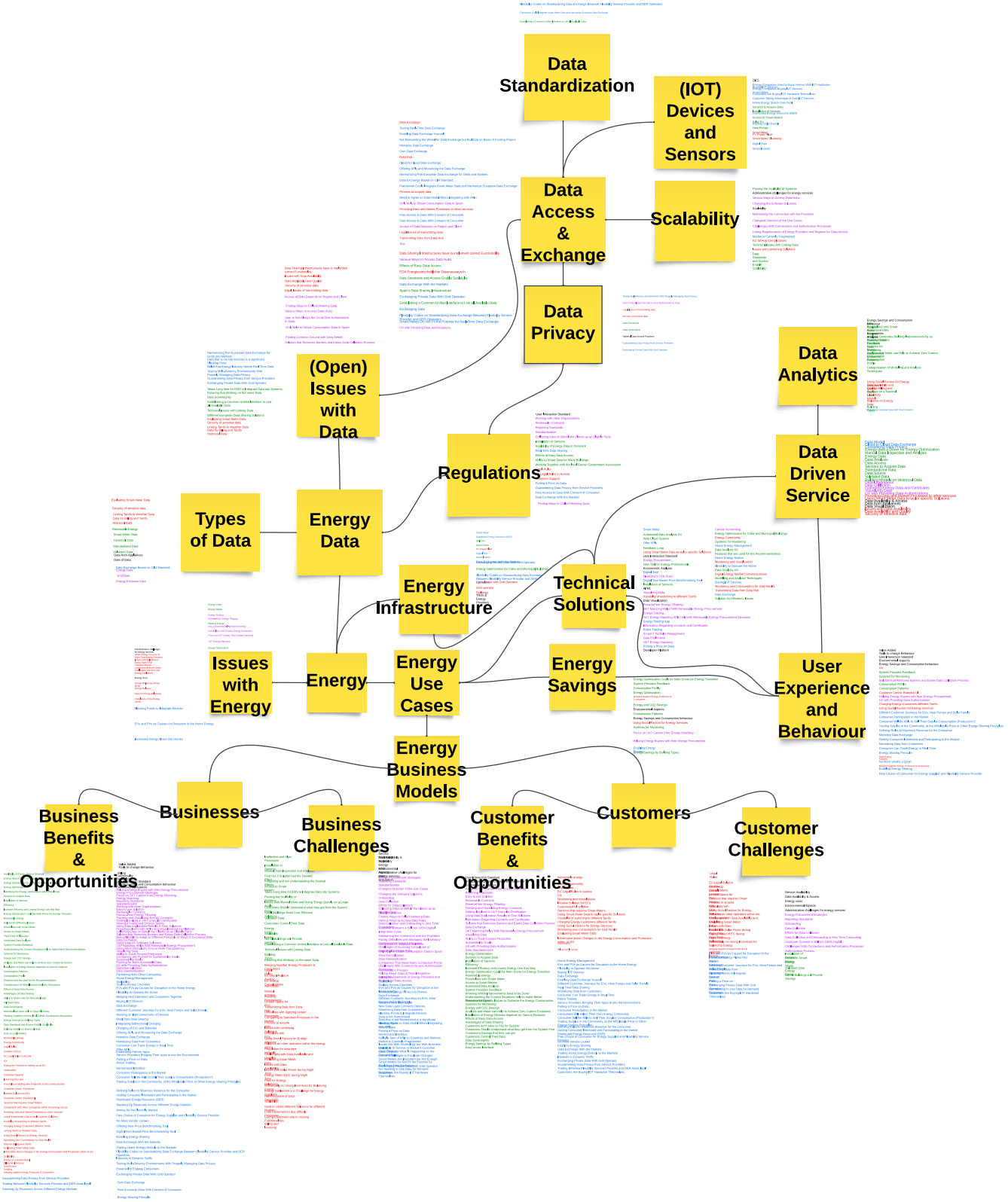

Figure A.4.: First Iteration of the Thematic Cluster using Thematic Codes

A.2 Pilot Study Data

Company	Country	Category	Comments from Authors
tado	Germany	AI based Thermostats	Intelligent that thermostats optimize energy consumption based on resident presence, weather forecasts, and user habits
Gridwatch	UK	Monitoring	Gridwatch offers real time insights into grid performance and energy consumption patterns. It utilizes advanced data analytics and machine learning algorithms to detect anomalies, predict demand, and optimize energy distribution.
Renewable AI	USA	ML/AI-based Solutions	Optimizes renewable energy production and distribution using machine learning algorithms.
Google	Worldwide	Smart Home Devices	Utilizes energy when it's least expensive, e.g., smart washing machines operating at night when energy prices are lower.
AT Smart Energy	Austria	Energy Provider	Offers real-time pricing based on energy consumption, requiring data access to allow users to optimize usage based on market prices.
Gasverbrauch App	Austria	Informational Dashboard	A Google app store app created by an individual that visualizes energy data; caution is advised due to potential data security concerns.
Wiener Netze	Austria	Monitoring & ML/AI Solutions	Access to daily and real-time consumption data, providing effective power-saving tips through accurate data.
Verbund	Austria	Optimization	Develops, operates, and optimizes electricity through hydropower.
Energi Data Service	Denmark	Monitoring	Incorporates more sustainable energy, maintains the security of supply, and guarantees equal market access to the grids.
tado	European Countries	Monitoring & Smart Management and Optimization	Provides smart management solutions for temperature control and energy optimization.

A.2 Pilot Study Data

Green Pocket	Germany	Monitoring & Cost Management	Enables monitoring and controlling of home/office temperatures, aiming to reduce energy costs through data-driven visualization.
Con Plus Ultra	Austria	Strategies for Optimized Energy Supply	Provides effective energy consumption management for individuals or companies, helping to reduce carbon footprint; identifies consumption-related production indicators.
State Grid Corporation of China (SGCC)	China	Monitoring	Largest utility company operating China's electricity grid, using advanced smart grid technologies for energy distribution and consumption, extensive use of energy data for grid management, predictive maintenance, and renewable integration.
ENN Energy Holdings Limited	China	ML/AI & Monitoring	Leading clean energy distributor focusing on natural gas and sustainable energy solutions, optimizing mixed-energy grid performance, predicting demand, maintaining supply, reducing waste, and leveraging data in customer applications.
EnergySage	USA	Energy Management	Offers energy monitoring and management solutions through its app, providing real-time monitoring, historical data, personalized insights, and energy-saving tips to help homeowners optimize energy consumption.
Wattics	Ireland	Energy Management	Provides energy monitoring and management solutions enabling users to track, analyze, and manage household energy usage with actionable insights and recommendations.

A.2 Pilot Study Data

Bidgely	USA	Energy Management	Leverages household energy data to provide personalized insights, energy-saving tips, and actionable recommendations for efficiency improvements in energy usage.
Global Energy Monitor	Global	Analysis Monitor	Tracks energy data to enhance clarity and transparency regarding global energy production, consumption, and resource extraction.
International Energy Agency	29 countries	Analysis Monitor	Provides authoritative analysis and policy recommendations to enable the affordability of energy for all and promotes the use of green energy.
Enphase Energy	USA	Green Energy Production	This company offers solu tions for optimizing solar system functions. They collect data from solar panels and other components to monitor energy production in real-time, identify issues, and optimize system performance
AutoGrid	USA	Machine Learning/AI Solutions	Provides AI-based software solu tions for energy management. They use AI and machine learn ing for real-time monitoring, optimization, and management of distributed energy resources
Siemens	Germany	Energy Management	Utilizes real-time data for grid efficiency, renewable integration, and energy management solutions
IBM	USA	AI/IoT for Energy	Leverages AI and IoT to enhance energy efficiency in industries and utilities through predictive analytics and smart grid management
Tado	Germany	Smart Home Technology	Provides smart thermostat and AC control devices that adjust home heating and air conditioning to optimize energy efficiency based on user behavior, weather forecasts, and real-time environmental data

A.2 Pilot Study Data

Sense	USA	Energy Monitoring	Offers an intelligent energy monitoring system that identifies and tracks the electricity use of individual devices in real-time, helping users optimize usage and reduce costs
Nect	Italy	Monitoring	Also for gas and water. AI/ML available in Poland, Italy, UK, Germany, and others
EDP Comercial	Portugal	Monitoring	Also monitors gas and energy contracts
Sense	USA	ML/AI	Helps with energy saving and monitoring
OhmConnect	USA	Monitoring	Notifies and controls smart home devices to avoid power use during intense grid loads
Eyedro	Canada	Monitoring	Monitors and displays energy usage and costs
Spacewell Energy (Dexma)	Spain	Monitoring	Monitors end-user devices to save energy
Thingslog	Bulgaria	Monitoring	Remote monitoring for businesses
Biz4Intellia	USA	Real-Time Monitoring	Monitoring of industrial machines using IoT sensors
GREEN.DAT.AI	Ten European Countries	ML/AI	Focuses on reducing the energy demand of AI systems, particularly in model training, inference, data storage, and retrieval. Develops energy-efficient AI algorithms with hardware acceleration, model optimization, and data compression. The consortium includes 17 partners across banking, mobility, energy, and agriculture.
WeyTec	Switzerland	Monitoring	Specializes in control room solutions for energy management, optimizing energy usage by integrating advanced monitoring and control systems. Enables real-time monitoring to identify inefficiencies and improve energy efficiency in control rooms.

A.2 Pilot Study Data

Gesellschaft für Automatisierungstechnik GmbH	Austria	Monitoring & Reporting Live Data	Offers standardized adapters to read live data from smart meters, enabling report generation for optimized electricity consumption.
Bidgely Inc.	USA	ML/AI Solutions	Analyzes meter data using ML/AI to provide accurate assessments of electricity consumption, identifying usage by specific household appliances.
Salzburg AG	Austria	Green Energy Production (Feed-in Tariffs)	Salzburg AG is an energy and infrastructure service provider based in Salzburg, Austria. Like many other energy providers, it offers the possibility for private operators to participate in the open electricity market by providing feed-in tariffs. Smart Meters come in handy to gather information about the produced energy and manage when surplussed energy is produced and can be handily fed into the system.
EnergyCAP	Ireland	Energy Management & Reporting Live Data	EnergyCAP is an energy man agement company based in Ireland. Their platform pro vides comprehensive energy analytics and management so lutions for businesses and or ganizations. They offer ser vices such as energy moni toring, analysis, and optimiza tion, helping clients to track and reduce energy consump tion, identify areas for im provement, and achieve cost savings. Their platform inte grates with various energy data sources, including smart me ters, IoT devices, and building management systems, to pro vide real-time insights and ac tionable recommendations for energy efficiency and sustain ability.

A.2 Pilot Study Data

EDP Renewals	Portugal/Spain	Green Energy Production	The analysis of current production and consumption might make it easier to operate around the globe
Austrian Power Grid	Austria	Monitoring	APG needs to use energy data, in order to measure production and consumption. With that knowledge the company is responsible for sustaining the Austrian energy network
Shepherds Flat Wind Farm	USA	Green Energy Production	-
Sempra Generation Solar	USA	Green Energy Production	-
The Shira Hydro-Electric Scheme.	UK	Green Energy Production	-
Grid4C	USA	ML/AI-based energy monitoring	Specializes in divide energy usage data from smart meters.
AutoGrid	USA	ML/AI-based energy management	Offers energy management software for supply, demand, and storage
OhmConnect	USA	Demand Response Programs (DRP)	Analyzes customer energy data for personalized peak-hour reduction incentives.
Greensource	UK	AI-powered Energy Management	Utilizes energy data to identify inefficiencies and recommend cost-saving measures through AI analysis.
Digitown	Germany	Monitoring	Provides tools to record and compare energy readings and prices.
MoritzLe	Germany	Monitoring	Offers functionalities to generate graphs from CSV files, create heatmaps, and perform statistical analyses.
GridPoint	USA	Monitoring	Analyzes data to optimize energy usage.
GreenCom Networks	Germany	ML/AI-Based Service	Optimizes grid operations using machine learning and artificial intelligence.
Dexma	Spain	Monitoring	Analyzes data to optimize energy usage and costs.
Tesla	USA	Monitoring and Controlling	Provides solutions to control and switch energy sources.
Samsung	South Korea	Monitoring and Controlling	Offers capabilities to monitor and control the state of devices.

A.2 Pilot Study Data

GREEN.DAT.AI	Multiple European Countries	ML/AI-Based Service	Focuses on reducing the energy demand of AI systems, particularly in model training, inference, data storage, and retrieval. Develops energy-efficient AI algorithms with hardware acceleration, model optimization, and data compression. The consortium includes 17 partners across banking, mobility, energy, and agriculture.
WeyTec Gesellschaft für Automatisierungstechnik GmbH	Switzerland	Monitoring	Specializes in control room solutions for energy management, optimizing energy usage by integrating advanced monitoring and control systems. Enables real-time monitoring to identify inefficiencies and improve energy efficiency in control rooms.
Bidgely Inc.	USA	ML/AI Solutions	Analyzes meter data using machine learning and artificial intelligence to provide accurate assessments of electricity consumption, identifying usage by specific household appliances.
WAGO	Germany	Monitoring/Electrical Engineering	German company specializing in the construction of electronic components and devices to achieve sustainable and interconnected energy supply.
Umweltbundesamt	Austria	Monitoring	Main authority to collect and evaluate energy data in Austria and an important institution of the Austrian Ministry of Environmental Affairs.
EnerTrack	China	Electrical Engineering	Chinese company specializing in the production and sales of photovoltaic components.
OptiEnergy	UAE	Energy Sales	Young company located in Dubai, mainly focusing on energy sales.
Fronius	Austria	Electrical Engineering	Austrian company active in photovoltaics, battery charging technology, and welding.

A.2 Pilot Study Data

Google	USA	Advertisement	Very large company dealing with data.
Amazon	USA	Advertisement	Very large company dealing with data.
SunEnergia	Finland	Monitoring	isaFinnishservicethatusesweatherdataand otherenergyinformationtostudy howbuildings andhomescangeneratesolarpower.Theyhelp clientsfigureouthowmanysolarpanelstheyneed ontheirroofstosaveenergyandmoney.(“Open energydataontheEuropeanDataPortal”)
ClirRenewables	Canada	AI/ML	uses AI technologytomonitorandanalyzedata frombothwindandsolarenergyproduction systems.Thisprovidesvaluableinsightsto operators,enablingthemtooptimizeperformance andminimizedowntimeofrenewableenergy assets.(Bolt)
IBM(Watson Iot Platform)	USA	ML/AI	Allows of real time energy data usage monitoring and analyzing
SolarEdge	Israel	Green energy & solar	Convert Solar energy into usable energy
Hark Systems	UK	ML/AI-based service	Offers AI-enhanced monitoring and management of energy and assets.
SMARTech energy	UK	Monitoring	Focuses primarily on monitoring for energy efficiency and reduction
Energy Team	Italy	ML/AI-based service	Provides both AI-based solutions and monitoring services for energy management.
Enerdata	Global	Energy Market Analysis	Provides detailed analysis, reports, and statistics on energy consumption and trends in Austria
International Energy Agency	Global	International Energy Market Analysis	Extensive data and analysis on Austria's energy policies, consumption, and transition to renewables.

A.2 Pilot Study Data

Statistics Austria	Austria	Governmental Statistical Service	Provides comprehensive annual energy balances detailing production, imports, and consumption.
APG	Austria	Data Visualization and Analysis	Offers interactive charts with historical data on Austria's energy mix and consumption by source
PakESDA	Pakistan	Data Aggregation	Provides comprehensive data for the power, oil, and gas sectors; crucial for analytics and policy making.
Grid4C	USA	ML/AI-based energy monitoring	Specializes in divide energy usage data from smart meters.
AutoGrid	USA	ML/AI-based energy management	Offers energy management software for supply, demand, and storage
GridBeyond	Austria	ML/AI based service & Smart Grids	GridBeyond offers an AI-driven energy management platform.
EnergyElephant	Austria	Monitoring	EnergyElephant provides a cloud-based energy monitoring and management services platform that helps businesses track.
Bidgely	USA	ML/AI Visualisation	AI-based energy analytics platform that disaggregates energy usage by appliance and provides insights.
Google Nest	USA	Smart Home Management	Smart home management, controlling energy consumption of devices, and automatic adjustment of heating/cooling systems.
Itron	USA	ML/AI-Based Service	Provides monitoring services and gives insights to help with better decision-making using smart meter data.
Octopus Energy	UK	Monitoring	Offers time-of-use tariffs with smart meter data, providing insights for better decision-making.
OhmConnect	USA	Monitoring	Rewards users for reducing energy during peak hours, leveraging smart meter data to track energy savings.

A.2 Pilot Study Data

Opower (Oracle)	USA	Energy Monitoring	Provides energy monitoring, data analysis, and recommendations for reducing consumption and costs.
E.ON Ono „Optimum“	Germany	Monitoring & Optimization	
Grid4C	USA	Green Energy Management	
Siemens	Switzerland	Provider of Energy Monitoring Devices	
SMA Solar Technology AG	Germany	Green Energy Management and Production	
Sonnen „SonnenFlat“	Germany	Green Energy and AI Optimization	
Viessmann	Germany	Energy Management Systems	
AELEC	Spain	Association	This is the umbrella organization of large electricity companies in Spain, aiming to represent, promote, and defend the sector's interests.
Chameleon Technologies	UK	Monitoring	In-house displays for consumption and insights.
Datadis	Spain	Data Provider	Datadis is a platform created and promoted by Spanish electricity distribution companies. The distribution companies work together to contribute to the development of an adequate energy transition and digital transformation of the electricity sector in Spain and Datadis is a piece that joins forces in this direction.
Demand Flexibility Service	UK	Demand Response System	Uses smart meter data to reduce energy consumption during peak periods by incentivizing consumers to reduce usage.
EnergyScout	USA	Data Analytics and Monitoring	Dashboard that analyzes smart meter data and helps consumers reduce their energy consumption.
Polaris Grids	India	Power Usage Control	Polaris helps efficiently manage power consumption.
Tado GmbH	Germany	Heat Control	Automatically controls household temperature in an energy-efficient manner.

A.2 Pilot Study Data

ThingsBoard	USA	Remote Monitoring and Alerting	ThingsBoard is an open-source IoT platform for data collection, processing, visualization, and device management.
Wiener Netze	Austria	Visualization	Wiener Netze provides Vienna with power and corresponding statistics.
Chai Energy	USA	Monitoring & Consumption Recommendation	App that encourages users to optimize their energy consumption through gamified challenges and rankings.
Forschung Burgenland GmbH	Austria	Monitoring	Explores advanced applications of smart meter data for real-time energy management.
Kapsch	Austria	IT & Telecommunication	Advanced Metering Infrastructure (AMI): Enables two-way communication between meters and utility providers, facilitating real-time data exchange.
Octopus Energy	UK	Renewable energy supply	Provides time-of-use tariffs and demand response programs, encouraging customers to shift energy usage to off-peak times for cost savings.
re.alto	Belgium	Software service provider	Offers APIs for accessing smart meter data, enabling the development of energy management applications.
Wiener Netze	Austria	Monitoring	Smart Meter Web Portal that provides households with detailed insights into their electricity usage.
Wiener Netze	Austria	Monitoring	Analyzes consumption data and provides insights into which devices use a lot of power.
aWATTar / tado	Austria	Data Interface (API)	Automatically lets your appliances know when it's green and cheap.
E.ON Energy Manager	Germany	Monitoring & Optimization	E.ON offers a smart energy management service which provides detailed insights into household energy use. It uses AI to predict energy needs and suggest energy-saving measures.

A.2 Pilot Study Data

EnergyHero	Switzerland	Energy Efficiency	EnergyHero analyzes household energy data using machine learning to provide personalized recommendations for reducing energy consumption and costs.
EVN	Austria	Load Forecasting, Grid Stabilization	Focuses on AI-driven demand response programs and renewable energy integration via smart meter.
Grid Singularity	Austria	Green Energy Production	Grid Singularity is a blockchain-based platform that optimizes the integration of renewable energy sources. It uses smart meter data to track household energy production (e.g., solar panels) and consumption, enabling peer-to-peer energy trading.
Honeywell Smart Meters	India	Monitoring, Predictive Maintenance	Smart meters with AI capabilities for anomaly detection and grid stabilization; supports IoT system integration for advanced analytics.
JVVNL (Mathura, Bareilly)	India	Basic Smart Metering	Focuses on prepaid systems offering remote disconnection and basic monitoring but lacks significant AI/ML integration.
KESH Energy Monitoring	Albania	Monitoring	KESH (Albanian Power Corporation) provides a monitoring tool for households to track energy consumption and identify peak usage times. This helps users understand their energy usage patterns and reduce unnecessary consumption.
Monolith AI	Global	Self-Learning Models for Smart Grids	Develops AI frameworks for predictive energy modeling, anomaly detection, and performance optimization in smart meters.

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Octopus Energy	UK	Dynamic Pricing	Octopus Energy offers dynamic pricing for households. It uses real-time smart meter data. Users can save money by consuming energy during off-peak times based on live energy market conditions.
Siemens	India	AI-Driven Analytics	Provides predictive analytics and dynamic consumption pattern recognition via ML models. Active in urban centers like Mumbai.
smartENERGY	Austria	Live Energy Monitoring	Live energy monitoring in your app, energy data update every 10 seconds from your smart meter.
Tata Power	India	Monitoring, Dynamic Pricing	Provides smart meters with real-time energy monitoring and mobile app integration for consumption analytics. AI-driven load balancing is under exploration.
Tirana AI Energy	Albania	ML/AI-Based Solutions	Tirana AI Energy leverages smart meter data and AI to forecast household energy usage, helping users plan their energy needs and integrate renewable sources.
Wien Energie	Austria	Monitoring & Renewable Integration	Wien Energie offers tools for tracking household energy use and integrating renewable energy sources like solar and wind power. It helps users achieve energy efficiency goals.
Wien Energie	Austria	Energy Efficiency, AI Integration	Offers smart meters capable of real-time tracking and energy-saving recommendations based on AI models.
Wiener Netze	Austria	Monitoring, Predictive Maintenance	Vienna's main grid operator offering smart meters with real-time consumption tracking, trend analysis, and web portals for customer energy management. Integration of IoT technologies like LoRaWAN.

A.2 Pilot Study Data

Ceylon Electricity Board (CEB)	Sri Lanka	Main Electricity Provider (Public Sector)	The primary electricity provider in Sri Lanka, offering traditional and pilot smart meter projects. While not a dedicated energy management company, it is involved in energy consumption tracking and billing.
Ceylon Electricity Board (CEB)	Sri Lanka	Public Sector	CEB is the main electricity generation company in Sri Lanka. It operates a variety of power plants, including hydropower, thermal, and renewable energy plants.
CodeGen International	Sri Lanka	Energy Management Solutions (Private Sector)	CodeGen International offers energy management solutions, including solar power energy solutions and energy monitoring systems, primarily integrated into smart homes.
DESCO	Bangladesh	ML/AI-Driven Energy Efficiency Solutions	DESCO uses smart meter data for machine learning-based load forecasting to ensure optimal energy utilization across its grid network. This minimizes grid failures and optimizes energy availability during peak hours. AI models analyze neighborhood consumption trends, enabling proactive grid management and reducing wasted energy. Historical demand data from smart meters is used to forecast loads, improving the reliability of supply for households. The integration of smart meter data enhances energy efficiency, consumer engagement, and optimal electricity distribution in Dhaka.
EnergyHub	USA	Energy Management	Provides demand-response solutions and tools for optimizing energy efficiency.

A.2 Pilot Study Data

EnergySolve	Sri Lanka	Energy Audits and Consultancy (Private Sector)	A startup in Colombo providing energy audits and consultancy services to improve power efficiency and reduce energy consumption.
Green Energy Solutions	Sri Lanka	Energy Audits and Consultancy (Private Sector)	Startups and small enterprises in Raththanapitiya offering customized energy audits and consulting services for reducing energy consumption and improving efficiency.
Hayleys Solar	Sri Lanka	Energy Monitoring Systems (Private Sector)	Hayleys Solar provides energy monitoring systems alongside solar panel installations. These often come with tools for monitoring solar power generation and usage.
JLanka Technologies	Sri Lanka	Energy Monitoring Systems (Private Sector)	JLanka Technologies provides energy monitoring systems alongside solar panel installations, offering tools for tracking solar power generation and usage.
JLanka Technologies	Sri Lanka	Private Sector (Renewable Energy Solutions)	JLanka Technologies provides real-time solar energy monitoring and smart energy systems.
Lanka Electricity Company (LECO)	Sri Lanka	Smart Meter Products (Private Sector)	A subsidiary of CEB providing electricity services. LECO has introduced smart energy meters on a pilot basis for better consumption management in alignment with CEB.
Lanka Electricity Company (LECO)	Sri Lanka	Private Sector	LECO is a subsidiary of CEB that distributes electricity in certain regions of Sri Lanka.
Schneider Electric	France	Smart Energy Solutions	Provides demand-response solutions and tools for optimizing energy efficiency.
SolarTherm	Sri Lanka	Private Sector (Renewable Energy Solutions)	SolarTherm provides solar energy solutions with systems that include energy usage monitoring, helping customers track solar production and electricity consumption.

A.2 Pilot Study Data

SOLshare	Bangladesh	Green Energy Production and Monitoring	SOLshare is a leading climate-tech company located in the heart of Bangladesh. Founded in 2014-2015, they provide cutting-edge technology and services and offer scalable solutions through their globally recognized service platform – the SOLbazaar. They track energy consumption and production, analyze data for energy sharing in the national grid, and monitor it regularly.
Sri Lanka Sustainable Energy Authority (SLSEA)	Sri Lanka	Public Sector	SLSEA promotes sustainable energy projects in Sri Lanka and facilitates the development of renewable energy sources like wind, solar, and biomass.
Tata Power	India	Electricity Monitoring	Offers smart metering solutions, electricity usage insights, and energy management services.
University of Moratuwa	Sri Lanka	Research Institute (Public Sector)	University-based research initiatives in energy management systems and IoT-based smart solutions.
Verbund	Austria	Renewable Energy	Develops tools for energy monitoring, smart grids, and sustainable energy management. One of Austria's largest electricity providers, focusing on hydroelectric power and renewable sources.
Zone24x7	Sri Lanka	Private Sector (IoT and Data Analytics)	Zone24x7 is a technology solutions provider in Sri Lanka specializing in data science, AI, IoT, and embedded systems. They assist companies in optimizing energy usage by integrating smart monitoring systems and developing customized AI solutions for real-time energy data analysis.
AWS	USA	Cloud Computing	Provides on-demand cloud computing platforms.

A.2 Pilot Study Data

EnergyHub	USA	Energy Management	Provides demand-response solutions and tools for grids and sustainable energy management.
Schneider Electric	France	Energy Monitoring	Develops tools for energy monitoring, smart grids, and sustainable energy management.
SMS-Energy	Scotland	Energy Management	Provides a grid-scale Battery Energy Storage System.
Tiko Energy Solutions	Switzerland	Energy Management	Connects users to energy networks for demand management and cost savings.
tiko Energy Solutions AG	Switzerland	Energy Management	A company that wants to help achieve an energy revolution.
Verbund	Austria	Renewable Energy	One of Austria's largest electricity providers focusing on hydroelectric power and renewable sources.
Wapda Power	Pakistan	Energy Management	Offers smart meter solutions, electricity insights, and energy management services.
Watt Analytics	Switzerland	Electricity Monitoring	Uses AI to optimize energy consumption patterns.
Zerofy	Estonia/Switzerland	Home Solutions	Cloud-based monitoring and changing of energy consumption.
Engie	France	Monitoring	Detailed monitoring of daily or monthly energy consumption, with alerts when consumption thresholds are exceeded. Provides tips on how to save energy and switch to more responsible habits.
Enphase	USA / France	Monitoring	Application for real-time monitoring of solar production, energy consumption, battery storage, and savings.
Green Pocket GmbH	Germany	Software	Provides interactive energy reports and dashboards. Enables energy-saving recommendations based on consumption patterns. Offers utilities for customer engagement through personalized energy insights. [Website](https://www.greenpocket.com/de/loesungen/branchen)

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Hello Watt	France	Monitoring/Advisory & Optimization	Daily and monthly consumption monitoring. Offers comparisons of energy suppliers, solutions for reducing bills based on user habits, and recommendations for installing solar panels or other green energy solutions.
Sense	UK	Smart Home/AI	AI-driven home energy monitoring system. Can notify users about unusual energy use (e.g., an appliance left running). Helps users reduce their energy bills by suggesting behavior changes or upgrades to more efficient devices. [Website](https://sense.com/utilities/)
TotalEnergies	France	Monitoring	Detailed monitoring of daily or monthly energy consumption, with alerts when consumption thresholds are exceeded. Provides tips on how to save energy and switch to more responsible habits.
E.ON	Germany	Fossil Fuels to Renewable Energy, AI & ML	German company involved in planning, building, operating, and managing renewable generation assets, including onshore and offshore wind farms and solar photovoltaic installations. Uses AI and Machine Learning for energy management.
E.ON Energie Österreich GmbH	Austria	Energy Supply and Services	Operates in the energy utilities sector, providing electricity and natural gas while heavily investing in renewable energy and smart grid solutions. E.ON is known for its customer-centric energy solutions.
EnergieAllianz Austria (EAA)	Austria	Solar and Wind Power, AI & ML	Produces energy through wind power plants and solar systems. Implements AI and Machine Learning for efficiency and optimization.

A.2 Pilot Study Data

Energy Informatics	Pakistan	Energy Analytics	Specializes in AI-driven energy consumption forecasting, renewable energy monitoring, and cost-optimization software for residential, commercial, and industrial users.
ENGIE	France	Mixed Energy (Fossil Fuels to Renewable)	Produces energy using a diverse mix of resources, focusing on renewable and low-carbon solutions while still operating conventional power plants. Utilizes AI and Machine Learning for optimization.
Iberdrola	Spain	Renewable Energy and Utilities	Focuses on clean energy, particularly wind, solar, and hydroelectric power generation. Iberdrola operates globally, emphasizing sustainability and innovation in renewable energy technologies.
RWE	Germany	Utilities and Renewable Energy	Operates in wind, solar, and biomass. RWE also has historical operations in fossil fuels but is transitioning towards a sustainable energy mix under its Growing Green strategy.
Sapphire Wind Power	Pakistan	Renewable Energy, AI & ML	Sapphire Group developed the Triconboston Wind Power Projects, consisting of three divisions (TBA, TBB, and TBC), each with a capacity of 49.735 MW, totaling approximately 149.2 MW. Integrates AI and Machine Learning for optimization.
United Energy Pakistan Limited	Pakistan	Oil and Gas Exploration & Production	Primarily operates in the upstream oil and gas sector. UEPL is engaged in discovering and producing hydrocarbons and does not currently prioritize AI or renewable energy.

A.2 Pilot Study Data

Zorlu Energy Power Project	Pakistan	Renewable Energy	Pakistan's renewable energy development, serving as a model for subsequent wind energy projects in the country. Utilizes Supervisory Control and Data Acquisition (SCADA) for monitoring and control.
Bidgely	United States of America	ML/AI	Provides utilities with unique behind-the-meter insights and a comprehensive solutions platform.
Discovergy GmbH	Germany	Monitoring	Offers smart electricity meters and an online portal for real-time energy consumption monitoring.
EnergoGrad	Russia	Energy consumption monitoring and analytics	Monitors and analyzes energy consumption, providing tools for savings and optimization.
Google Nest	United States of America	Smart Home Solutions	Offers thermostats and energy management devices that integrate with smart meters.
Green Moscow	Russia	Renewable energy integration	Helps households integrate renewable energy sources using smart meter data.
GreenCom Networks AG	Germany	ML/AI, energy IoT company	Focuses on integrating smart meter data with household appliances for energy optimization.
GridX	Germany	Monitoring & AI	Provides energy management solutions for optimizing energy usage in homes and businesses.
Sense	United States of America	ML/AI	Integrates software into next-generation smart meters, providing real-time insights into both home and grid energy usage.
Smart Home Moscow	Russia	Comprehensive Smart Home Solutions	Automates and optimizes energy consumption in households using smart meter data.
Tibber	Germany/Norway	Green Energy Production, Monitoring, and Optimization	Enables real-time energy consumption monitoring and offers dynamic electricity tariffs.
Voltaware	Great Britain	ML/AI, Monitoring	Uses AI to track energy use down to the appliance level for bill management and safety monitoring.

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Awattar	Austria	Homeassistant	Monitoring Dynamic Power
Hager	Worldwide	Monitoring	Monitoring, ML/AI, Smart home visualization
Low Carbon	UK	Service Provider	APP for energy tracking, reduction of carbon emissions, saving money
Octopus Energy	UK	Energy Provider	Provides energy, smart charging when energy is cheapest
Samsung (Smart Things)	Worldwide	Smart Home	Monitoring and control of energy consumption, recommendations for energy reduction
Trust Power	Germany	Smart Energy Management System	Monitoring APP with: Carbon calculator, consumption tracking, wasted energy in standby
Verdigris Technologies	USA	ML/AI	Analysis of energy consumption in commercial buildings, actionable recommendations
Fronius	Austria	Data-driven Service, Management	Makes solar inverters and provides energy management solutions, focusing on solar energy systems.
Greenely	Sweden	Monitoring	App that uses smart meter data to improve control over energy consumption.
K-Electric	Pakistan	Renewable Energy Solutions	Offers solar energy solutions for residential and commercial users.
LESCO	Pakistan	Monitoring	Provides an online portal for viewing electricity bills and consumption history.
NEPRA	Pakistan	Regulatory Authority	Oversees electricity supply, ensuring compliance and monitoring of distribution.
SMAP Energy	UK	Monitoring, ML/AI Solutions	Monitors energy consumption and engages customers via incentives for short-term adjustments.
Smart Energy Services GmbH	Austria, Germany	Energy Monitoring and Management	Monitors household energy consumption and provides dynamic pricing and optimization services.
Smart Maic	Slovakia	AI/ML-based Service	Offers advanced management services using ML and AI, providing visualization and predictive analysis.

A.2 Pilot Study Data

Tesla Energy International	International	ML/AI-based Service	Uses smart meter data for their Powerwall product to optimize energy storage.
Velux	Austria	Management Service	Known for smart climate control; could integrate smart meter data to improve energy efficiency.
Voltaware	UK	Monitoring, ML/AI Solutions	Monitors energy consumption of individual appliances using AI-based algorithms.
Chameleon Technology	UK	Energy Management - Monitoring - Visualization	Offers Smart In-Home Displays that access real-time energy data from smart meters. Involved in developing a project with Samsung for the SmartThings Energy Control App.
Copper Labs	USA	Energy Management - Usage Monitoring	Provides a mobile app connected to smart meters, allowing customers to manage energy consumption during lower time-of-use rates or optimize during peak times. Offers indoor or outdoor collectors using Wi-Fi or RF technology, and enables monitoring of renewable energy sources.
K-Electric	Pakistan	Energy Provider	Manages generation, transmission, and distribution of electricity in Karachi, offering energy consumption data access and net metering services.
LESCO	Pakistan	Energy Provider	Provides electricity and energy consumption data access to customers in Lahore.
FESCO	Pakistan	Monitoring	----------
GEPCO	Pakistan	Monitoring	Real-time monitoring of power consumption, grid health, load management, and fault detection.
GEPCO	Pakistan	Digital Meter	Every month, meter reading is noted by a meter reader.
IESCO	Pakistan	Monitoring	----------
LESCO	Pakistan	Monitoring	----------
MEPCO	Pakistan	Monitoring	----------

A.2 Pilot Study Data

SCADA	Pakistan	Monitoring	Supervisory Control and Data Acquisition (SCADA) allows utilities to remotely monitor and control electrical grids and substations.
Elmess	Poland	Metering	Intelligent electricity measurement systems.
Enel X	Italy	Management	Smart home automation and consumption insights.
Enpal	Germany	Renewables	Solar installations and virtual power plants.
Kontron	Austria	Metering	Provides metering solutions.
Octopus	UK	Tariffs	Dynamic pricing based on real-time energy data.
Sense	USA	Monitoring	Devices and apps for household energy analysis.
Tibber	Austria	AI Savings	Real-time energy monitoring and optimization.
WaterTech	Italy	Metering	Smart metering and energy management software, remote water and gas metering solutions.
Dhaka Electric Supply Company Limited (DESCO)	Bangladesh	Electric Supply	Provides reliable electricity services to residential, commercial, and industrial consumers in Northern Dhaka.
Dhaka Electric Supply Company Ltd (DESCO)	Bangladesh	BD Energy Monitoring and Recharge	Provides electricity supply and consumption tracking for residential and commercial users.
EcoOptimize	Germany	ML/AI-based Service	Provider of machine learning and AI-based energy optimization services.
Greenly	Sweden	Energy Efficiency App	Tracks smart meter data to recommend energy-saving measures and monitor renewable energy.
GreenMonitor	Austria	Energy Monitoring	Provides real-time energy monitoring services
SolarConnect	Switzerland	Renewable Integration	Specializes in solar energy optimization.
Watty	Sweden	AI-Based Monitoring	Uses AI to analyze device-level energy consumption and provide optimization tips.
Wien Energy	Austria	Energy Monitoring and Payment	Provides electricity, gas, monitoring energy, payment, and yearly cost information.

A.2 Pilot Study Data

aWATTar	Austria	Dynamic electricity tariffs	aWATTar is an electricity provider offering dynamic tariffs based on hourly prices from the electricity exchange. A smart meter is required to use such tariffs, allowing for real-time measurement of household electricity consumption, automatic billing, and access to fluctuating tariff prices.
Bernhard Halbauer	Germany	Monitoring	Visualization of the provided energy data on the smartphone via graphs.
colombine GmbH	Germany	Monitoring	Visualization of the provided energy data on the smartphone via graphs.
Hugo Energy Pro	UK	Monitoring and AI based service	The Hugo Energy Pro is an app that connects to a Dashboard to visualize your smart meter data. Here it is also possible to set a budget for electricity and if you exceed it you will get an alarm in the app. And there is another feature called “Home AI” where smart meter data is read and an algorithm predicts what was going on in the household and divides the energy data of a smart meter into categories like Cooking, Dishwasher, Refrigerator, TV, etc so one can see where the energy is used.
Openvoltt	Remote European	Data infrastructure	Unlocks access to smart meter data in Europe through a developer-friendly API. Apparently, it is challenging to access the smart meter data, and Openvoltt connects major data hubs in the UK, Spain, France, the Netherlands, and Finland for seamless smart meter API integration and data access.

A.2 Pilot Study Data

Sense	USA	Monitoring	The company Sense connects to your smart meter and processes the data via an app or on the web, understand the energy consumption data better (it's displayed on a dashboard) and control it in real time, as well as see the current costs and thus make better and more resource-efficient use of energy.
SolarEdge	Israel	ML/AI based service	The SolarEdge ONE platform collects and analyzes data from smart meters and sources like weather forecasts to optimize energy usage. Advanced algorithms decide whether to consume, store, or sell/trade generated electricity for applications such as charging electric vehicles or operating heat pumps. By incorporating variable electricity tariffs, the platform also determines when to draw from the grid or use stored energy to minimize costs.
SOLARMAN	China	Monitoring Hardware	SOLARMAN has developed a range of smart meter products and apps or web pages, so they can understand energy consumption, and make corresponding energy management decisions based on the data. And it also offers hardware like smart meters, data logger, weather stations, etc.
Afriso-Euro-Index GmbH	Germany	Smart Home Solutions	Offers smart home solutions.
DTWISE	Greece	Optimization	Focuses on optimization solutions.
ElectraLink	UK	Sustainable Energy	Specializes in sustainable energy solutions.
Electricity Maps	Denmark	Carbon Tracking	Provides carbon tracking services.

A.2 Pilot Study Data

K-Electric	Pakistan	Monitoring	Manages generation, transmission, and distribution of electricity in Karachi, offering energy consumption data access and net metering services.
Lahore Electric	Pakistan	Monitoring	Provides electricity and energy consumption data access to customers in Lahore.
OhmConnect	USA	Energy Management	Rewards users for reducing energy during peak hours, leveraging smart meter data to track energy savings.
Wiener Energy	Austria	Energy Monitoring	Provides energy monitoring services.
Wiener Energy	Austria	Internet and TV	Offers internet and TV services.
Wiener Energy	Austria	Heat	Provides heating solutions.
Wiener Energy	Austria	Solar Energy	Offers solar energy solutions.
Wiener Energy	Austria	E-mobility	Provides e-mobility services.

A.3. Service Categories and Frequencies

Table A.1.: Full list of categorized services used in the analysis.

Category	Count
Advertisement	2
AI based Thermostats	1
AI Savings	1
AI/IoT for Energy	1
AI/ML	1
AI/ML-based Service	1
AI-Based Monitoring	1
AI-Driven Analytics	1
AI-powered Energy Management	1
Analysis Monitor	2
Association	1
Basic Smart Metering	1
BD Energy Monitoring and Recharge	1
Carbon Tracking	1
Cloud Computing	1
Comprehensive Smart Home Solutions	1
Data Aggregation	1
Data Analytics and Monitoring	1
Data infrastructure	1
Data Interface (API)	1
Data Provider	1
Data Visualization and Analysis	1
Data-driven Service, Management	1
Demand Response Programs (DRP)	1
Demand Response System	1
Digital Meter	1
Dynamic electricity tariffs	1
Dynamic Pricing	1
Electric Supply	1
Electrical Engineering	2
Electricity Monitoring	2
E-mobility	1
Energy Analytics	1
Energy Audits and Consultancy (Private Sector)	2
Energy consumption monitoring and analytics	1

Continued on next page

Table A.1.: Full list of categorized services used in the analysis.

Category	Count
Energy Efficiency	1
Energy Efficiency App	1
Energy Efficiency, AI Integration	1
Energy Management	11
Energy Management - Monitoring - Visualization	1
Energy Management - Usage Monitoring	1
Energy Management & Reporting Live Data	1
Energy Management Solutions (Private Sector)	1
Energy Management Systems	1
Energy Market Analysis	1
Energy Monitoring	5
Energy Monitoring and Management	1
Energy Monitoring and Payment	1
Energy Monitoring Systems (Private Sector)	2
Energy Provider	4
Energy Sales	1
Energy Supply and Services	1
Fossil Fuels to Renewable Energy, AI & ML	1
Governmental Statistical Service	1
Green energy & solar	1
Green Energy and AI Optimization	1
Green Energy Management	1
Green Energy Management and Production	1
Green Energy Production	6
Green Energy Production (Feed-in Tariffs)	1
Green Energy Production and Monitoring	1
Green Energy Production, Monitoring, and Optimization	1
Heat	1
Heat Control	1
Home Solutions	1
Homeassistant	1
Informational Dashboard	1
International Energy Market Analysis	1
Internet and TV	1
IT & Telecommunication	1
Live Energy Monitoring	1
Load Forecasting, Grid Stabilization	1
Machine Learning/AI Solutions	1

Continued on next page

Table A.1.: Full list of categorized services used in the analysis.

Category	Count
Main Electricity Provider (Public Sector)	1
Management	1
Management Service	1
Metering	3
Mixed Energy (Fossil Fuels to Renewable)	1
ML/AI	5
ML/AI	1
ML/AI & Monitoring	1
ML/AI based service	1
ML/AI based service & Smart Grids	1
ML/AI Solutions	2
ML/AI Visualisation	1
ML/AI, energy IoT company	1
ML/AI, Monitoring	1
ML/AI-based energy management	2
ML/AI-based energy monitoring	2
ML/AI-Based Service	7
ML/AI-based Solutions	2
ML/AI-Driven Energy Efficiency Solutions	1
Monitoring	46
Monitoring & AI	1
Monitoring & Consumption Recommendation	1
Monitoring & Cost Management	1
Monitoring & ML/AI Solutions	1
Monitoring & Optimization	2
Monitoring & Renewable Integration	1
Monitoring & Reporting Live Data	1
Monitoring & Smart Management and Optimization	1
Monitoring and AI based service	1
Monitoring and Controlling	2
Monitoring Hardware	1
Monitoring, Dynamic Pricing	1
Monitoring, ML/AI Solutions	2
Monitoring, Predictive Maintenance	2
Monitoring/Advisory & Optimization	1
Monitoring/Electrical Engineering	1
Oil and Gas Exploration & Production	1
Optimization	2

Continued on next page

Table A.1.: Full list of categorized services used in the analysis.

Category	Count
Power Usage Control	1
Private Sector	1
Private Sector (IoT and Data Analytics)	1
Private Sector (Renewable Energy Solutions)	2
Provider of Energy Monitoring Devices	1
Public Sector	2
Real-Time Monitoring	1
Regulatory Authority	1
Remote Monitoring and Alerting	1
Renewable Energy	3
Renewable Energy and Utilities	1
Renewable energy integration	1
Renewable Energy Solutions	1
Renewable energy supply	1
Renewable Energy, AI & ML	1
Renewable Integration	1
Renewables	1
Research Institute (Public Sector)	1
Self-Learning Models for Smart Grids	1
Service Provider	1
Smart Energy Management System	1
Smart Energy Solutions	1
Smart Home	1
Smart Home Devices	1
Smart Home Management	1
Smart Home Solutions	2
Smart Home Technology	1
Smart Home/AI	1
Smart Meter Products (Private Sector)	1
Software	1
Software service provider	1
Solar and Wind Power, AI & ML	1
Solar Energy	1
Strategies for Optimized Energy Supply	1
Sustainable Energy	1
Tariffs	1
Utilities and Renewable Energy	1
Visualization	1

A.4 Target Group Interview Guide

Interviewfragen:

- Beschäftigst du dich mit Umweltthemen?
  - Wenn ja, welche? Nachhaltiger leben (Konsum)
  - Wenn nein, warum nicht?
- Hast du dich schon einmal mit deinem Energiekonsum beschäftigt?
- Siehst du dich als eine technikaffine Person?
- Hast du schon von der Digitalisierung im Energiebereich gehört?
  - Wenn ja, welche Themen kennst du?
  - Wenn nein, was kannst du dir darunter vorstellen?
- Hast du einen Smart Meter zu Hause?
  - Wusstest du, dass du damit deinen Verbrauch übersichtlich nachverfolgen kannst?
  - Was kannst du dir sonst noch vorstellen, was man mit diesen Verbrauchsdaten machen kann?
- Hier wäre eine Applikation namens N-ergy View. Diese soll aus dem Verbrauch Prognosen für die Zukunft ableiten können. Der Nutzer bekommt dann Rückmeldung, ob er über oder unter den Prognosen liegt. Sollte er darüber liegen, erhält er Feedback zu Energiespartipps.
  - Was hältst du von dieser Idee?
  - Würdest du so eine App verwenden?
  - Siehst du als Nutzer einen Vorteil für dich?
  - Siehst du etwaige Nachteile?
  - Welche weiteren Features könntest du dir noch für so eine App vorstellen?
  - Welche Rückmeldungen würdest du als positiv sehen?
  - Welche Rückmeldungen würdest du als negativ (nervig) empfinden?
- Wäre dir die Darstellung und Prognose von Kosten auch wichtig?
  - Wärst du bereit, dadurch mit der App Details zu deinen Kosten zu teilen? (Grundpreis der kWh für die Berechnung)
    - Wenn nein, welche Bedenken hast du?
- Wäre für dich die Darstellung, wie viel Energie man gespart hat, oder die Darstellung der gesparten Kosten wichtiger?
- Hast du eine Idee oder Vorstellung, welche anderen Darstellungen möglich oder interessant wären in diesem Kontext?
- Eine weitere Option wäre die Darstellung von „emotionalen Bildern“ über deinen Konsum. Zum Beispiel ein Eisbär ohne Eis oder ausgetrockneter Boden bei hohem

A.4 Target Group Interview Guide

Energiekonsum (Überschreitung der Prognosen) bzw. bei energiesparendem Konsum (unter den Prognosewerten) ein grüner Wald mit blauem Fluss oder ein paradiesischer Strand.

- Wärst du bereit, mit so einem Service deine Daten zu teilen?
  - Wenn nein, was sind deine Gründe?
- Glaubst du, du könntest damit deinen Energieverbrauch besser im Griff haben?
- Glaubst du, so ein Service käme der Umwelt zugute?

- Würdest du auch etwas für so eine App zahlen?
  - Wenn nein, warum nicht?
  - Wenn ja, wie viel etwa?

Interview 1 – N-Ergy View (11.03.2024)

So schauen wir mal, ob das Mal geht. Also ich denke das wird schon ganz gut funktionieren. So willkommen zu meinem Interview für meine Masterbett.

Danke.

Und im Rahmen.. brauche ich ein paar qualitative Daten über eine App, die ich machen möchte. Und da wollte ich mal kurz Fragen, beschäftigst du dich mit irgendwelchen Umweltthematiken.

Im Alltag jetzt?

Ja, genau. Was fällt dir dazu ein?

Ja halt so Mülltrennung und Recycling. So ein Thema. Aber auch eben Öff-Nutzung. Also jetzt vielleicht auch mal das Rad verwenden oder zu Fuß gehen anstatt das Auto zu verwenden. Und ja, auch beim.. beim.. Lebensmittelverschwendung. Einfach schauen, dass man halt so wenig Wegschmeißt wie möglich.

OK, hast du dich auch schon mal mit dem Energiekonsum beschäftigt?

Ja, vor allem als die Preise angestiegen sind. Da habe ich mir mehr Gedanken darüber gemacht, wieviel ich jetzt halt Verbrauch und hab ich eh in jedem Raum das Licht abgeschalten. Und.. Ist.. ist es jetzt wirklich nötig einzuheizen oder kannst noch warten? Aber.. und vorher, bevor diese Preise so hoch waren, bin ich eher so erzogen worden, dass man halt eher darauf achtet, wie das Licht immer nur aufzudrehen, wenn man es braucht und solche Dinge. Aber am meisten halt, dass die Preise so gestiegen waren, also sind.

Mhm, aber du hast dich jetzt nicht so damit beschäftigt. Zum Beispiel dass, wenn du was einschaltest, dass das jetzt auch irgendwie Kilowattstunden verbraucht und dadurch ja auch irgendwo... Keine Ahnung, ein Dieselgenerator läuft oder ein Kohlekraftwerk.

Jetzt soweit bis zu dem Kohlekraftwerk habe ich es nie nachvollzogen, halt eher natürlich, es verbraucht Strom, es ist etwas.. Ich hab eher meinen Aspekt dahinter gesehen. Ich zahl, ich muss dafür zahlen und das wird teuer. Ich hab wenig darüber nachgedacht, dass da jetzt irgendwo ein Kraftwerk läuft und.. oder eine Turbine oder sonst was. Das habe ich nicht so mitbedacht.

Mhm.

Hast du oder siehst du dich eher auch als eine technikaffine Person, die mit Technik auch so Klimasachen im Griff bekommen könnte, oder?

Also ich bin schon jemand, der sich schon mit der Technik auseinandersetzt und jetzt auch im alltäglichen Leben damit gut zurechtkommt. Ob ich jetzt.. Ich weiß es nicht, wie war die Frage, dass ich jetzt?

Ja, dass du halt generell würdest du Technik verwenden, sei das jetzt Software oder Hardware, was auch immer oder irgendwelche anderen Sachen um irgendwelche... Ja, um das Klima zu helfen zum Beispiel.

Nich.. wenn es solche Technologien gibt, die dafür sorgen, dann ja, und wenn die halt auch alltagstauglich sind und ich sie anwenden kann, dann ja dann würde ich sie schon einsetzen.

OK, aber so selber machst du wahrscheinlich jetzt.. oder hast du damit irgendwas mal gemacht? Irgendwelche Apps oder?

Interview 1 – N-Ergy View (11.03.2024)

Nein, gar nicht. Da bin ich nicht-Techniker.

OK. Hast du schon von der Digitalisierung im Energiebereich gehört?

Mhm. Nur bissl, aber jetzt nicht wirklich.

OK, also ich gebe das jetzt mal als Nein. Also was kannst du oder was welche sagen so welche Thematiken kennst du da so oder was kannst du dir darunter vorstellen?

Dass man halt Daten sammelt. Die Smart Meter ist das nicht auch so etwas?

Genau

Ja, also die Smartmieter eben. Da fand ich halt cool, dass man so ein bisschen auf seinen eigenen Überblick drüber hat. Es wäre schon toll, das genau und leichter nachschauen zu können. Wann verbrauche ich mehr also Zeitpunkt technisch noch.. Es wäre cool, wenn es sowas gäbe, wo es stehen würde, der Kühlschrank verbraucht so und so viel, die Kaffeemaschine so und so viel. Dass man da eben dann hat man, finde ich, glaube ich auch mehr Überblick darüber und kann selber genau gezielter eigentlich handeln. Wenn ich jetzt weiß, meine Kaffeemaschine auf Standby verbraucht unnötigen Strom und ich seh das auf diesem Smart Meter oder über eine App. Dann kann ich das besser steuern.

Mhm. Weißt, ob du einen Smart Mieter zu Hause hast

Ja, ich hab einen Smartmieter.

Hast du jemals auch die. quasi App oder halt diese Übersicht mal verwendet, die meistens dann mitgeliefert wird.

Nein. Weiß nicht.

Genau, damit kannst du ja theoretisch deinen Energieverbrauch zwar einsehen und du kannst den relativ granular, auch nachschauen. Also ich glaube viertelstündlich ist das granularste, das es in Österreich geht. Was könntest du darunter vorstellen, was man mit so Verbrauchsdaten machen kann? Irgendwas, was du dir vorstellen kannst oder notwendig oder wozu man die gebrauchen könnte.

Stell mir halt vor für.. Für gewisse Unternehmen einfach das die, wenn jetzt das Ziel ist, dieser Unternehmen, dass wir das Klima schützen, dass wir umweltfreundlicher denken, ja, dann könnte man mit den Daten natürlich schauen, okay, welche Geräte brauchen mehr oder so? Und vielleicht kann man das dann senken, also Kontrolle drüber und den Gedanken hatte ich gerade, dass. Dass du halt auch weißt, zum Beispiel um die und die Uhrzeit verbraucht Österreich oder Wien den meisten Strom. Dass du auch deine Kraftwerke oder deine wo du den Strom herbekommst, dass du eben das so einteilen kannst, dass der zu gewissen Zeitpunkt einfach mehr Strom im System ist oder zur Verfügung steht, oder eine Ahnung.

Mhm.

Ich muss zugeben, ich kenn mich da jetzt. Nicht aus,

Ja, kein Problem.

Also die Applikation, die ich machen möchte, die heißt Energy View. Mhm und die Grundidee also man hat natürlich die eine Grundfunktion, die die historischen Daten natürlich visualisiert, so wie diese, ja, „Standardapp“ die jetzt mitkommt vom Smart Meter oder von dem Provider und Netzbetreiber. Und das Hauptziel, ich möchte mit diesen Verbrauchsdaten Prognosen erstellen

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über den Verbrauch. Das heißt der Nutzer bekommt eine Prognose für den nächsten Viertelstunden Wert oder nächste Stunde oder für den nächsten Tag oder auch sogar nächste Woche. Jeden Tag bekommt er Prognosen und ich möchte das halt so machen, es kommen ja dann halt die tatsächlichen Werte, die ja dann langsam rein, nachdem man die Prognosen erstellt hat und da möchte ich matchen, ob jetzt der Verbrauch tatsächlich so eingetreten ist oder ist, liegt er halt quasi drüber da drunter. Und je nachdem, ob er drüber ,drunter ist, würden verschiedenste Feedbacks kommen. Das heißt, wenn wir zum Beispiel drüber ist, dann würde er zum Beispiel Energiespartipps bekommen. Umgekehrt, wenn er halt drunter ist, dann würde man ja dazu noch animieren halt weiter zu machen. Was hältst du von seiner App und kommt das dann zum Beispiel zu deinen Idee? (inaudible) oder ist es auch, was du dir zum Beispiel vorgestellt hast? Das was ich dich vorher gefragt?

Ich finde es gut, was ich nicht verstehe ist, muss man mehr verbrauchen, weil es geheißen hat, wenn ich zu wenig verbrauch, dann sagt er mir animiere mich Strom zu verbrauchen. Ist es eh nicht gut, wenn ich wenig verbrauche?

Nein eh. Ich meinte, wenn du halt drunter bist, dass das animiert halt weiterzumachen. Also wenn du unter diesen Prognosen bist, dann bekommst du ja halt ein bisschen.. also wirst du animiert halt weiter zu sparen. Da kann man es.

So weiter zu sparen okay.

Ja, da könnte ...ich mein... Da wären Sie, die die...

Ja, dann habe ich es falsch verstanden.

Irgendwelche Rabatte für irgendwelche PV anlagen oder..?

OK, ja dann hab ich es falsch verstanden. Ja, ich find es ganz gut, auch einen Überblick zu haben. Ich kann mir auch vorstellen, für meinen Vater jetzt das dem das extrem interessieren wird, der dann wahrscheinlich sitzen wird und sich das anschauen wird. Wieviel verbraucht er wann? Und ja, also ich glaub schon, dass es, dass es Vorteile bringt, wenn man es sich und wenn es bedienungs.. also. Wenn ich jetzt dann meine Elterngeneration denk, dass es halt benutzerfreundlich ist und nicht viel Schnickschnack und leicht zu bedienen,

Mhm. Ähm. Also für dich persönlich siehst du diese Rückmeldungen würdest du dir als positiv sehen oder glaubst du könntest du auch sehen, dass es auch. Negativ sind im Sinne.

Ich persönlich jetzt würde wahrscheinlich irgendwann nach der dritten Meldung für hier sind Tipps zum Sparen ist wahrscheinlich eher so Spam nicht mehr wirklich anschauen.

Mhm.

Aber ich bin auch die in meinem Haushalt, die.. die nicht so sehr auf diesen, also schon darauf achtet, dass wir nicht zu viel verbrauchen. Aber diese technischen Sachen macht meistens mein Partner. Am. Und ich weiß nicht, wenn ich jetzt wirklich zum fünften Mal schon den gleichen Spartipp krieg. Würde ich es mir am Anfang vielleicht noch anschauen, aber ich glaube beim 5. 6.7. Mal würde es mich nicht mehr so interessieren. Vielleicht würde ich mir denken, okay, es ist.. jetzt muss ich mal was machen, weil anscheinend Verbrauch ich so viel, dass ich das immer bekomme. Die Rabatte und so, je nachdem wenn ich halt gut in dem... Also ich glaube, wenn ich dafür gut belohnt werden würde, dass ich in dieser Range bin oder drunter bin und dann Rabatte für irgendwas bekomme, vielleicht animiert das einen mehr, dass man dann in

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diesem Bereich ist. Ich glaube, dass diese App sicher es Leute gibt, die das extrem interessiert. Ja, ob ich jetzt jemand bin, der sich das damit viel beschäftigt, weiß ich nicht.

Okay. Würdest du da irgendwelche Features sehen, die dich da zusätzlich dir vorstellen könntest? Siehst du da irgendwelche Ideen dazu?

Ich weiß nicht. Ich seh mit der App wann.. wo, wie Stromverbrauch, wieviel, wann, wieviel?

Genau wann wieviel und das erstellte dann auch ein Prognosewert oder Werte sogar zur Verfügung für die..

Ja.

Zukünftigen Werte, quasi unseren...

Ich meine, es ist schon spannend zu wissen, ich habe jetzt um 18:00 Uhr am meisten verbraucht und dann kann ich, muss ich halt selber darüber nachdenken, was habe ich um 18:00 Uhr gemacht. Noch cooler, aber ich glaub das geht einfach noch nicht vom Kast.. von diesem Kasterl, auch nicht vom Smart Meter her, dass man eben wissen würde, genau welche Geräte sind das

Ja, also es gibt halt bei diesen Smartmieter ist es halt quasi wirklich der Hauptmeter von dem Ganzen, der ganzen Wohnung und theoretisch... Es geht dann halt schon die Funktion jetzt nicht in der App, aber jetzt einfach allgemein, dass man mit KI kann man halt schon das so rausfiltern, wieviel ungefähr ein Gerät verbraucht... Jetzt von diesem Allgemeinstrom her. Beziehungsweise müsstest du halt sonst auch mit so IOT, also so Plugs, die kennst du ja vielleicht, wenn man mit so Alexa die Sachen steuert, man dort halt die einzelnen Geräte auch anstecken sozusagen, da sieht man was halt wirklich da an dieser Steckdose verbraucht wird. Nur ein bisschen so Backgroundinformation.

Mhm.

Aber mehr viel..

Aber würdest du dann zum Beispiel sowas dann notwendiger sehen? Also dass man wirklich sagt, diese Einzelverbrauchssachen werden auch essentiell, oder würd...

Ich würde es interessant finden, ob es essentiell ist.. Essentiell würde ich es nicht nennen aber..

OK, also das heißt du würdest...

Spannend einfach zu sehen. Aber essen selber, die es nicht finden.

Nein. OK, also es. Für dich würde auch genügen, wenn du wüsstest, OK, im allgemeinen Stromverbrauch wäre jetzt zukünftig so oder schaut so und.

So, ja genau und einfach zu wissen. OK, wir verbrauchen also mein Haushalt, wir verbrauchen jetzt nicht so viel oder einfach auch beruhigter zu sein auch.

Welche.. Ich weiß nicht, ob du gerne diese Apps kennst, aber halt, es gibt ja genug so Sachen wo du Graphen und solche Sachen siehst und du hast das es auch gesagt benutzerfreundlich. Wie sollte glaubst du sowas ausschauen? Also könntest du das irgendwie beschreiben, vorstellen oder irgendwelche Sachen wo du sagst das, das und das müsste sie können bei der Visualisierungen.

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Boah, Cool wäre, wenn man eine Tageswelt, wenn man dann zurückschauen kann, also einen Rückblick hat, die Woche, den Tag des Monats, das Jahr, dass man halt immer wieder mit den Daten und zurückgehen kann und schauen kann. Weiß nicht im Jänner 23 hab ich noch so und so viel mehr verbraucht als im April 23. Also so Features wo man leicht rückgehen kann und eine Übersicht bekommt. Keine überladenen Daten oder.. oder Statistiken also so anzeigen Diagramme. Sondern einfach.. einfach.. so einfach und simpel und.. und vom Design her sehr so klassisch und schlicht, damit es eben wirklich für jedermann ist und nicht nur für die, die sich mit diesen Themen auseinandersetzen und auskennen. Das würde ich wichtig finden. Dass man eben, vielleicht gibt es nur Zusatzfunktionen wo du noch mehr Details siehst oder der Grund.. die Grundansicht, dass die sehr auf aufs Simpelste gehalten ist im ersten Blick und dann kann man auf einen extra Klick noch auf Sachen hinzufügen, keine Ahnung. Das würd ich halt als benutzerfreundlich empfinden und irgendwie die Farbe grün oder blau, aber kein Stechendes, sondern. Eher so.. aber das ist jetzt nur designfragen. Ja, ja.

Ja, klar, aber natürlich, die sind ja auch essentiell, gerade für solche Thematiken.

Irgendwie grün oder blau, irgendwie grün wegen ja.. Thematik.

Da vielleicht noch kurz wieder auf diese Geschichte mit dem Feedback. Also eine Idee ist jetzt zum Beispiel, dass wenn man diese App hat, sei es jetzt auf ein Computer oder Laptop oder...

Ja, da fällt mir glaube ich, darf ich dir kurz was, was mir einfällt sein. Ich würde keine E-Mails bekommen wollen.

Ja.

Mhm.

Also wenn das Feedback kommt, dann in der App. Von mir aus gibt es da so einen kleinen.. Vielleicht auch ein.. ein, ein Symbol oder ein maskottchenartiges Ding, das dann irgendwie so oder oben ist so eine Bubble und es gibt im Menü irgendwo so Nachrichten und man bekommt in der App eben eine Nachricht darüber: Hier ist dein Feedback der Woche oder hier ist ein Feedback des Tages oder so. Aber so eine extra E-Mail möchte ich immer nicht bekommen. So würde ich nicht wollen.

Mhm selbst auch zum Beispiel, wenn du jetzt.. du jetzt auf einmal aus irgendeinem Grund auch immer jetzt dein Energieverbrauch jetzt auf einmal um 100% gestiegen ist, würdest du so..

Dann würde ich eher von der App eine Notification wollen, aber keine E-Mail. Ich will nicht meinen Spam Ordner voll haben. Ich finde wir kriegen alle schon genug E-Mails, wenn dann so, dass man so wie bei anderen Apps irgendwie so eine Notification bekommt, das... Weiß nicht.. Achtung irgendwie Energieverbrauch um 100% erhöht, keine Ahnung. Eher so ne.. ja App notification am Handy, aber nicht jetzt ne E-Mail.

Mhm,

So, wenn bei einer Social Media Plattform dich dir jemand das Like, dass du das einstellen kannst und dann kommt ja auch oben dieses Popup oder wenn du eine Nachricht erhältst, kommt ja auch ein Popup auf deinem Handy und so halt vielleicht da ein Popup mit Energieverbrauch.

Also die, was jetzt mal so vorgesehen wäre, ist tatsächlich ganz simpel. Einfach eine Lampe, die entweder grün leuchtet, wenn du drunter bist und halt quasi sparst oder halt unter den Prognosen bist und rot, wenn du halt so rüber bist und halt selbst..

Interview 1 – N-Ergy View (11.03.2024)

An dem Kästchen ist diese Lampe. Wo befindet sich diese Lampe?

In in der App jetzt zum Beispiel, wenn die App aufmachst, wäre es so eines der ersten Sachen, die du siehst.

Ja, das kann ich mir auch vorstellen. Genau das ging ja.

Du hast gesagt, dass man..

Oder das Design der.. der.. Der App ist irgendwie.. dann auf einmal ist der Hintergrund oder irgendwas irgendwo rot und sonst grün und blau. Ja, das wäre auch eine Option, aber es wär schön eine Notifikation irgendwie mit der App an sich zusammenhängt und es nicht noch eine E-Mail. Sonst was gibt.

Mhm. Was fällt, wenn es sonst ist eigentlich so ein? Du hast jetzt, wir haben jetzt ein bisschen über die Vorteile geredet, aber was glaubst du, siehst du auch irgendwelche Nachteile von so einer App?

Ich sehe sie jetzt.. direkt soo.. jetzt nicht, aber ich kann mir vorstellen, dass es gewisse Personen gibt, die dann sich überwacht fühlen und die dagegen wahrscheinlich sagen: Ah, jetzt werden wir überwacht und jetzt wir haben irgendwelche Konzerne meiner Energiedaten, können mir Produkte andrehen und solche Dinge halt. Ich persönlich habe jetzt keine Angst davor, aber ich könnte mir vorstellen, dass gewisse Personen davor vielleicht Angst hätten, dass Energiekonzerne dann meine Daten haben und ja.

Also die Idee ist mit dieser App.. Also es gibt so ein diese Thematik die heißt Dataspace und die Idee ist eigentlich also da, so funktioniert auch dann dieses EU Projekt namens EDDIE. Da versucht man ja quasi, dass die Konsumenten ja davor einwilligen, dass du diese Daten ja weiterverarbeiten lässt. Und das musst du eher auch dem Netzbetreiber auch bestätigen, dass die halt weiter diese Daten auch weitergeben dürfen. Dann an dieses Service.

OK.

Wärst du selber bereit, deine Daten dafür zu teilen? Mit so einer App?.

Ja, wenn ich eben dann nicht von Wiener Energie dann 10 nachrichten kroege: Wir haben gesehen bla bla wollen sie dich der Tarif wechseln? Also wenn das in keinem Zusammenhang ist.

Weil es.. du jetzt vielleicht auf das wieder zurückkommst, aber könntest du das auch dann auch als Animation.. aber so animiert fühlen zum Energiesparen, dann bietet dir die Wien Energie zum Beispiel einen besseren...

Ja, so klingt es wieder toll. Nur ich habe halt, ich hätte dann angst, dass ich dann ständig was krieg und..

OK,

Ich bin einfach kein Fan von ständigem Spam Mails und... so Sachen. Ich mein.. Ja, wenn wenn.. wenn da, wenn das Programm merkt ich verbrauch Verbrauch sehr wenig.. und mein.. ob das zusammenhängt und das dann irgendwie erkennt ich bin in einem sehr hohen Tarif eingestuft und ich daraufhin an ein günstigeres Energieangebot bekomme, ja, dann seh ich ein Vorteil darin wieder. Dann ist es aber.. aber weiß ich nicht ob das soweit reicht, also ob das. Geht.

Mhm . Könntest du dir vorstellen, zum Beispiel.., wenn jetzt diese App zum Beispiel auch eben so Vertragsdaten braucht wie dann Tarif und so glaubst du, könntest du dir auch vorstellen zu

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teilen, also, dass du deine App beteiligt okay ja. Ich zahle jetzt bei Wien Energie so und so viel Grundpauschale plus halt so und so viel pro Kilowattstunde oder so.

Es Vorteile für mich hat. Ja dann ist es mir egal.

Mhm.

Dann kann ich es teilen.

Glaubst du auch, dass wir mit so einer App dann den Energieverbrauch auch besser im Griff haben würdest? Glaubst du, hier ist der..?

Ja, schon, ich glaub schon, ich seh, ich bin nur auf dem grünen Bereich, dann bin ich wahrscheinlich relaxter wenn ich seh ich bin oft im Roten vielleicht bin ich dann eher jemand, der sich denkt, oh nein, ich muss mehr drauf achten eben die Geräte nicht auf Standby zu haben oder sonstiges. Je nachdem jetzt die genauen Ding. Aber ja, ich sehe mich dann schon motiviert mehr dafür zu sorgen, dass.. dass ich im grünen Bereich bin.

Mhm.

Glaubst du also käme so ein Service auch der Umwelt zugute? Also hat das glaubst du jetzt nicht nur.

Ja, ich glaube schon. Wenn dann mehr Leute sich animiert fühlen, im grünen Bereich zu sein, also weniger zu verbrauchen. Dann ist es natürlich gut, also würde ich sagen, es ist gut, wenn die Leute weniger Energie verbrauchen.

Mhm und letzte Frage, glaubst du wirst doch bereits für so eine App zu zahlen. Also du sagst OK, du musst halt die Daten teilen, aber du müsstest auch was zahlen, also...

Kommt darauf an, wieviel uns im Rahmen ist. Also wenn es nur ein paar Euro sind, weil wenn es jetzt schon... Es kommt drauf an, wieviel Zahlen müsste.

Ja, also überleg mal, was wäre deine Schmerzgrenze? Also wenn du sagst, du müsstest jetzt.. ein Monat..

15€ im Monat,

Im Monat OK,

Wäre mein Schmerzgrenze, wenn ich halt wirklich Vorteile sehe. Wenn ich dann nicht wirklich einen Vorteil sehe, dann wäre es schön, wenn man jederzeit wieder kündigen könnte oder so. Keine Ahnung, weil kommt auf die Bindungen, ja. Aber am Anfang würd ich wahrscheinlich, wenn es neu ist, eher wollen, dass ich noch weniger Zahl. Wenn ich dann seh, dass.. dass es gut ist und dass es mir was bringt.

Und..

Wäre ich bereit, die 15 zu zahlen

Zeigen ja und wärst du nehme an, das ist jetzt ein privates Unternehmen, wärst du dafür eher bereit deine Daten und solche Sachen zu teilen, das zu bezahlen oder wärst du eher bereit, wenn es von einem vertrauten... Energieunternehmen kommt das man kennt zum Beispiel.

Ich denke mir, jeder muss mal klein anfangen. Jede große Firma war mal eine kleine Firma und man sollte den Kleinen sozusagen auch.. oder diesen Startups oder sonstigen auch mal eine

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Chance geben, denke ich. Nicht nur die Großen, die den Energiemarkt beherrschen, sondern auch kleinere Alternativen finde ich ganz in Ordnung.

OK, cool, super, danke für das Interview.

Interviewfragen:

Beschäftigst du dich mit Umwelt thematiken?

Mülltrennung, Recycling, Öffi Nutzung, Radfahren, Autofahren, lebensmittelverscwehung

Wenn ja welche?

Wenn nein waru nicht?

Hast du dich mit deinem Energiekonsum schon einmal beschäftigt?

Ja, vor allem als di preis gestiegen sind. Mehr gedanken gemacht. Nötig zu heizen?

Vorher, nur sachen aufdrehen die braucht.

Soweit noch nie gedacht über Produktion.

Siehst du dich als eine technikaffine Person?

Technikauseinander setzen. Alltags tauglich

Hast du schon von der Digitalisierung im Energiebereich gehört?

> Wenn ja, welche Thematiken kennst du du so?
>
> Wenn nein, was kannst du dir darunter vorstellen?
>
> Eher nein: Daten sammeln, Smart Meter, eigenn überblick, genau und leichter nachschauen zu können. Wann verbrauche ich was? Welche geräte verbrauchen was. Besseren überblick. Gezielter handeln.

Hast du einen Smart Meter zuhause?

Ja. Verwendet nicht

Wusstest du, dass du damit deinen Verbrauch überschaubar nachsehen kannst?

Was kannst du dir sonst vorstellen, was man mit diesen Verbrauchsdaten machen kann?

Für Unternehmen. Ziel Klima schützen. Welche geräte brauchen mehr. Besser senken/ kontrollieren. Wissen um welvhe uhrzeit wien am meisten strom verbraucht. Strom im system

Hier wäre eine Applikation Namens N-ergy View. Diese soll aus dem Verbrauch Prognose ableiten können für die Zukunft. Der Nutzer bekommt dann Rückmeldung, ob er dann über oder unter den Prognosen ist (mit den zukünftigen Werten). Sollte er darüber sein, bekommt er Feedback zu Energiespartipps.

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Was hälst du von dieser Idee? Würdest du so eine App verwenden?

Siehst du als Nutzer einen Vorteil für dich?

Siehst du etwaige Nachteile?

Was für weitere features könntest du dir noch vorstellen für so seine App?

Was für Rückmeldungen würdest du als positiv sehen?

Welche als negativ?(nervig?)

Wärst du bereit mit so einem Service deine Daten zu teilen?

- Wenn nein, was sind deine Gründe?

Glaubst du könntest du damit deinen Energieverbrauch besser im Griff haben?

Glaubst du käme so ein Service der Umwelt zu gute?

Würdest du auch was zahlen für so eine app?

- Wenn nein warum nicht?
- Wenn ja wie viel etwa?

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Cool, dann würde ich mal sagen, wenn es für dich passt, würde ich loslegen. So ja dann willkommen zu meinem Interview für meine Masterarbeit.

Passt.

Ich will dich halt ein paar Fragen über eine gewisse App, aber davor möchte ich dich kurz mal fragen, ob du dich mit gewissen Umweltthematiken beschäftigst derzeit. Ist das wegen einer Thematik...? Gibt es irgendwelche Thematiken, dich interessieren oder beschäftigst dich sehr mit welchen bestimmten?

Also im Zuge meiner Masterarbeit setze ich mich auch gerade mit dem Thema Energiegemeinschaften, erneuerbare Energien und Dezentralisierung des aktuellen Energienetzes auseinander. Wobei es weniger aus einem Umweltaspekt mehr aus einem technischen Aspekt. Abgesehen davon versuche ich Müll beim Einkaufen zu vermeiden. Wenn.. wenn es geht, öffentlichen Verkehr und das Fahrrad zu nutzen. Das ist mein.. und auf Fleisch weitestgehend zu verzichten, das ist vielleicht mein Beitrag. Ich bin jetzt kein Vegetarier, aber.. Aber ich muss jetzt nicht jeden Tag Fleisch essen.

Du hast jetzt eh erwähnt, dass du dich ja auch schon mit dem Energiebereich ja schon ein bisschen beschäftigt hast. Aber hast du dich auch mit deinem eigenen Konsum schon beschäftigt?

Energiekonsum.

Mhm.

Tatsächlich nicht, nein.

Ok, das heißt, du hast dich jetzt nie Gedanken über Preise oder ja generell wieviel kwh du verbrauchst oder ob du jetzt irgendwelche carbon footprints..

Nein

Gar nicht? Siehst du dich als eine technikaffine Person an?

Also auf einer Skala von 1 bis 10.. eins, null zehn ja würde ich sagen 6.

Okay. Hast du schon von der Digitalisierung im Energiebereich gehört?

Ja.

Ja, was.. was kennst du da für so Thematiken? Also was fällt dir da so spontan ein?

Das ist einen Trend von konventionellen Grid hin zum Smart Grid und Micro Grid gibt und dass man halt eben dadurch, dass man jetzt immer mehr erneuerbare Energien in den Mix hinein tut. Und aufgrund der schweren Planbarkeit von erneuerbaren Energiequellen, verstärkt auf IT gestützte Systeme setzt um den Energiebedarf sicherzustellen oder möglichst gut auszusteuern.

Genau sind eh viele Thematiken, die du da angesprochen hast. Gerade eben beim Smart Grid. Da fällt mir eben auch ein die Frage.. oder wollte ich hier fragen, hast du ein Smart Meter zufällig zu Hause auch?

Ja, dann haben Sie uns dieses Jahr oder letztes Jahr im Haus.. Also, ja sie haben uns ausgetauscht gegen einen Smart Meter.

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Mhm, also wusstest du auch, dass du dadurch halt auch deinen Verbrauch überschaubar nachschauen kannst in..

Ja

Also hast du das auch zum Gebrauch mal gemacht, dass du diese Daten einziehst oder den Verbrauchern einsiehst?

Nein. Hab ich nicht.

Okay ja. Könntest du genrell vorstellen... Also die Visualisierung passiert ja durch die ganzen Verbrauchsdaten. Könntest du ja sonst andere Sachen vorstellen, wo du halt Verbrauchsdaten gebrauchen kannst. Irgendwelche anderen Thematiken oder Services et cetera.

Um wieder auf meine eigene Masterarbeit zurückzukommen, ja. Die.. die einzige voraus oder eine der wenigen? Ja ich glaub die einzige Voraussetzung die es derzeit gibt, rechtlich gesehen um eine Energiegemeinschaft zu bilden ist, dass man einen Smart Meter hat und meine Masterarbeit beschäftigt sich auch mit der Thematik. Wenn ich jetzt einen eine Gemeinschaft habe von unterschiedlichen Haushalten, sogenannten Prosumern, die sowohl Energie erzeugen als auch verbauchen.. ja, dass man diese Daten Smart Meter messen eben auch nutzt, um des möglichst effizient auszusteuern.

Mhm.

Also eine Idee, die ich jetzt habe und dann auch umsetzen möchte, ist eine Applikation namens N-Ergy View. Die Idee ist, dass aus Verbrauchsdaten sollen Prognosen abgeleitet werden für die Zukunft und der.. der.. der Verbraucher bekommt dann Rückmeldung, ob er drüber oder unter diesen Prognosen ist. Das heißt, wenn er drüber ist, bekommt er ein Feedback. Also quasi, wenn er zu viel konsumiert, bekommt er Feedback und das sagt: ah Moment, du bist über deinen Prognosen, hier sind irgendwelche Energiespartipps ZB. Was hältst du von so einer Idee? Würdest du so eine App verwenden wollen würden?

Ich persönlich nicht, nein.

Hast du irgendwelche Gründe dafür? Also..

Mir gefällt der Überwachungsgedanke dahinter nicht und auch dieser Steuerungsgedanke.

Mhm.

Meine persönliche Einstellung dazu.

Okay, also du siehst eigentlich theoretisch keine Vorteile für dich?

Für mich persönlich nicht. Also ich.. allgemein ja, natürlich. Wer auf sowas steht oder wer sowas mag, für den wird das super sein. Ich für mich persönlich mag das nicht, nein?

Wenn man dich mit.. Wenn du.. also die Idee ist ja auch, dass du Energie sparen sollst und halt dadurch oder halt besseren Überblick über deinen Konsum hast, könnte man dich dann trotzdem irgendwie animieren die App verwenden, wenn du dadurch irgendwelche Vorteile trotzdem bekommst? Dass du dann sagst. Ich bekomme einen besseren Tarif von meinem Energy Provider. Ich bekomme Rabatt auf irgendwelche PV Anlagen oder sonstige Green Technology.. Technologies oder sonstige Sachen. Ist es da irgendwas wo man dich auch animieren könnte?

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Das ist natürlich dann noch gruseliger, um ehrlich zu sein, das klingt so ein bisschen nach dem Social Credit System in China.

Was könntest du dir für Features vorstellen sonst zum Ändern, die dich dann animieren würde, diese App zu verwenden. Gibt es irgendwelche Sachen was man ändern könnte wo du sagst: ah, da bin ich doch bereit das zu verwenden.

Vielleicht so ein bisschen, also.. sollte das jemand wirklich komplett aus dem Verbrauch herausstechen und diese Person aber eigentlich einen regulären Haushalt führen und man dann vergleichen kann, warum ist jetzt einfach auch wirklich so massiv viel höher als ein vergleichbarer anderer Haushalt, dann wäre es durchaus interessant zu erfahren, welche Geräte vielleicht den höchsten Verbrauch haben? Ja, aber es ist jetzt auch nur also extremen Fällen eigentlich, weil das vielleicht ein Haushalt mal hier, wie soll ich sagen, ein bisschen mehr Strom verbraucht, weil manche Leute kochen, mehr verwenden, den Herd einfach öfter, der andere bestellt halt öfter essen. Was soll denn der da mehr kocht großartig an seinem Verbrauch ändern, so nach dem Motto. Schwierig.. also, wie gesagt, bei extremen Fällen, wenn man halt irgendwie 2 Haushalte miteinander vergleicht, die sich halbwegs vergleichen lassen und da wirklich ein signifikanter Unterschied ist, wäre es interessant zu erfahren, warum der eine so extrem viel sparsam als der andere ist oder der andere so extrem viel mehr verbraucht, dass der andere je nachdem. Aber ansonsten ja, ich weiß halt nicht wie die stark Haushalte im Schnitt auseinander divergieren.

Mhm, das heißt quasi wirklich. Um das kurz zu fassen, da ein genereller Vergleich zu anderen Haushältern, wäre vielleicht für dich auch ideal zu sehen also. Oder so seine..

Genau welche Geräte verbrauchen, fast eigentlich tatsächlich den meisten Strom? Und gibt es da etwas, wo man vielleicht dann.. liegt es daran, dass das Gerät alt ist und es vielleicht neuere Geräte gibt, die von selbst weniger verbrauchen oder sind es eher Gewohnheiten? Irgendwer hat ein besonders stromintensives Hobby. Da wird es dann halt auch schwierig werden, so nach dem Motto.

Abseits jetzt davon, ob du jetzt diese App verwenden würdest oder nicht, die Idee ist ja, dass du dann halt Rückmeldungen bekommen würdest. Das heißt visuelle, aber auch vielleicht irgendwelche Benachrichtigungen. Würdest du solche Rückmeldungen positiv oder eher negativ sehen?

Gib mir ein Beispiel für eine Rückmeldung.

Die Idee so mal wäre zum Beispiel dass du.. du öfnest die App und eines der ersten Sachen die du sehen solltest ist diese ein ein Licht oder halt ein visuelles Feedback zum Beispiel ein grüner, roter Punkt zum Beispiel würde sagen du bist über den Verbrauch über die Prognosen quasi und hast einen erhöhten Verbrauch umgekehrt grün wenn du halt unter den Prognosen bist und auf einem guten Weg bist Energie zu sparen sozusagen. Würde dir sowas gefallen oder würdest du auch das OK finden, wenn du zum Beispiel irgendwelche Nachrichten bekommst? Quasi alerts dein Konsum steigt auf einmal sehr hoch an.

Also nochmal, ich persönlich sage mal, nein, ich gehöre zu den Menschen, die generell jede Art von Benachrichtigungsfunktionen bei jeder App immer sofort deaktiviert. Ja klar. Also wenn jetzt irgendwas komplett aus dem Ruder läuft oder irgendwas. Wenn Not am Mann ist oder ein Notfall, dann wäre sowas natürlich wahrscheinlich. Kann sowas sinnvoll sein? Ansonsten noch einmal also meine persönliche Meinung: nein, möchte ich nicht. Allgemein betrachtet für Leute die sowas lustig finden, das ist natürlich wahrscheinlich sehr praktisch.

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Mhm.

Das ist dann präferenzgeschichte.

Das heißt.. du wärst eher einer, der wenn. Du, du. Diese Information eher suchen wollen als jetzt genudgt werden zu dieser Information sozusagen, wenn du sagst, ich möchte jetzt im Moment wissen, schau ich halt lieber selber nach, anstatt dass es gewarnt werde oder irgendwas.

Ja, das. Das trifft ganz gut an.

Ja. Wieder abseits ob du jetzt die App verwenden willst oder nicht, wär dir auch eine Darstellung der Prognosen von gesparten Kosten auch wichtig oder essentiell. Also würdest du sagen, das ist ein wichtiger Punkt oder genügte oder würde auch der Konsum nur genügen?

Na, das wird mir tatsächlich schon.. Also das, das finde ich schon einen interessanten Aspekt, wenn man halt wirklich sagen kann: im Vergleich zum Vormonat.. Ich mein, man sieht es ja dann auf der Stromrechnung am Ende des Jahres ja eh so ein bisschen unter Anführungsstrichen, aber wenn man das schon zwischendurch so ein bisschen nachschauen kann, wie, wo liege ich jetzt im Vergleich zum letzten Jahr oder zum Vergleichszeitraum vom letzten Jahr? Das finde ich durchaus interessant.

Mhm.

Genau. Also da gibt es halt so verschiedenste Überlegungen, also zum Beispiel ja, wie du gesagt hast, dass man das irgendwie historisch betrachtet: Ich hab jetzt durch meinen Konsum so und so gespart. Gleichzeitig halt auch so und so viel eben nicht gespart oder ausgegeben, weil mein teures Hobby so viel Strom verlangt hat zum Beispiel. Daher wäre die Frage. Ob du dann zum Beispiel mit dieser App dann Details zu deinen aktuellen Tarifen dann teilen würdest? Würdest du bereit sein, bisschen Information okay ich zahle jetzt gerade so und so viel pro KWH, damit diese Berechnungen dann funktionieren würden.

Kannst du die Frage noch mal wiederholen.

Also ich müsste ja also die Informationen für diesen Vertrag, also du hast ja irgendeinen einen Energieliefervertrag mit dem einen Provider und da hast du ja meistens die grundpauschale, glaube ich, und dann hast du diesen Preis pro kwh. Und diese Information müsste man halt der App mitgeben. Halt sozusagen. Wärst du bereit diese Daten zu teilen.

Aso

Um halt diese, um dieses Feature halt quasi nützen zu können zum Beispiel.

Das ist ne. Eigentlich muss ich ja oder ich muss es.

Ja, eben genau. Also du müsstest halt teilen, damit ich die, die, die oder damit die App halt weiß. Wieviel KWH du dann sapren oder Euro sparen würdest pro KWH oder mehr ausgeben würdest

nur für dieses letzte Feature, nur für den Preisvergleich.

Ja, genau, nur für den Preisvergleich.

Ja gut, wenn ich wissen will und es keine andere Möglichkeit gibt, es ohne das Teil zu machen. Wenn ich teilen muss ich... Ich habe jetzt nicht wirklich eine Wahl oder?

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Natürlich ja. Also es könnte, wenn maximal, vielleicht noch auf Schätzungen funktionieren, aber grundsätzlich ja, wenn du es wirklich genau haben müsstest oder haben möchtest, dann ja. Müsste es halt teilen.

Wie dann wirklich den Vertrag? Man könnte auch einfach nur die Daten selber händisch eingeben, auch ohne dass man als Betreiberdaten oder irgendwie, man kann ja sagen, ich zahle bei meinem Betreiber ohne den zu nennen, diesen Preis.

Ja, genau.

So als Vergleichstool wäre es dann vielleicht gar nicht so uninteressant zu sagen okay wenn ich jetzt bei einem anderen Betreiber wäre, der mir das hier bietet, wir würden das aufs Jahr hochgerechnet Rauschen oder irgendwas.

Mhm, ja stimmt, das ist eine gute Idee. Weiterhin also.. Wie wäre die Darstellung für dich wichtig, wie man Energie da also spart, werde ich also.. blöde Frage.. wäre für dich halt die Darstellung wieviel du Energie gespart hast oder eher die Kosten gespart hast. Wäre dir das wichtiger dadurch also was wäre da von den zwei Dingern.

Ja.

Ich persönlich ist die Kosten, weil ich mein, was das klingt, weil das zu wissen, dass ich jetzt Energie gespart hab, ist schön, aber was heißt das jetzt für mich, weil für mich als Verbraucher, als Konsument ist mir ja unter Anführungsstrichen völlig egal, wie viel Energie verbraucht hat, mich interessiert nur, was ich dann zahle dafür. Also ich glaub der finanzielle Aspekt wäre wahrscheinlich der das das ist ja das was die Leute interessiert, wie.. wie schaffe ich es möglichst wenig zu zahlen. Aber ich denk mal noch einmal, das ist so n bisschen so.. ohne zu wissen wo jetzt tatsächlich der meiste Stromverbrauch anfällt zu sagen, ja du hast jetzt weniger Strom verbraucht, denkst du okay cool, aber wodurch eigentlich, wenn ich jetzt die Waschmaschine 5 mal weniger laufen lassen im Monat oder weil..? Das Spannende wäre eher zu wissen, welches Gerät verbraucht jetzt eigentlich tatsächlich wieviel?

Ja, genau, Mhm. Genau. Weil du es jetzt irgendwie ansprichst mit den Geräten. Aber wer hat da zum Beispiel irgendeine andere Darstellung noch irgendwie interessant für dich, die Nebenkosten und Energie noch dargestellt werden könnte, zusätzlich.

Die Geräte, wenn man also, wenn das irgendwie möglich ist überhaupt aber wahrscheinblich braucht jedes Gerät halt wieder einen eigenen Smart Meter um das messbar machen zu können, oder ich weiß es nicht, ich weiß nicht wie ein Smart Meter genau funktioniert, oder?

Ja, also es gibt mehr Varianten tatsächlich. Also du könntest... Also es gibt dieses Submetering, wie du gesagt hast, es bräuchte halt einen eigenen Meter sozusagen. Es gäbe auch glaube ich Algorithmen, KI Funktionen, die das aufschlüsseln und herausfiltern könnten natürlich auch. Genau das heißt für dich wär halt diese Geräteaufschlüsselung noch auch ein.. ein wichtiger Faktor oder eine mögliche Darstellung.

Ansonsten weiß ich gar nicht, wie ich jetzt Energie sparen soll so das Moto. Sonst wäre quasi Folge einfach alles weniger zu machen, oder?

Ja.

Wenn klar ist, dass ein Gerät ganz besonders stark dazu beiträgt, dann kann man sagen: ja, das ist das Ding.

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Genau. Eine weitere Option, die überlegt, ist dann auch die Darstellung von emotionalen Bildern über deinen Konsum. Zum Beispiel ein Eisbär ohne Eis bei hohem Konsum zum Beispiel. Oder ein Bild vom getrockneten Boden irgendwo. Umgekehrt natürlich, wenn du positiv.. Also ein positiv.. ein.. ein guten Energie oder guten Energiekonsum klingt jetzt auch komisch, aber wenn du ein ein.. also eher auf einen energiesparenden Weg bist, würde halt natürlich dann irgendwie ein.. ein grüner Wald erscheinen. Genau. Würdest du so eine Art Feedback auch cool finden oder ist es dann... Also dass es sich ein bisschen dynamisch dann irgendwie anpasst dann auch die App. Wenn du sie öffnest, verwendest.

Also da habe ich auch wieder persönlich ein ziemlich großes Problem damit, weil ich ganz allgemein das ziemlich Scheiße finde das irgendwie gefühlt immer der Verbraucher an allem immer schuld ist und ständig irgendwie geshamet wird, wenn man überlegt, dass der Großteil der Klimakatastrophe von der Schwerindustrie und der Landwirtschaft verursacht werden und der Individualverbraucher einen schwindet kleinen Anteil an der Ganzen. Aber dass bei dem immer irgendwie so dann noch einmal nachgeschoben und nachgedrückt wird und: du musst jetzt aufs Auto verzichten und du musst jetzt und darfst nicht mehr auf Urlaub fahren und jetzt kriegst du noch in deiner App an deinen ausgedörrten Boden angezeigt, nur weil du halt irgendwie 3% überm Schnitt gelegen bist im Verbrauch oder irgendwas... Also ich verstehe schon die Idee dahinter, weil Gesamtpolitisch ist ziemlich ekelhaft, also. Das ist meine Meinung.

OK, verstehe ja sicher das, das ist ja schon klar, das ist auch gut.

Das ist eh schon n bisschen angesprochen, aber nur um da jetzt noch klar nach zu Fragen, also wärst du generell bereit deinen Energieverbrauchsdaten mit so einem Service zu teilen? Also würdest du Consent geben und sagen, ja, kannst halt nutzen.

Naja, also wenn ich so eine App verwenden würde, dann müsste ich es ja tun, weil sonst würde es ja wahrscheinlich nicht. Oder ist noch mal so eine Frage kommen.

Natürlich ja. Also du, man müsste halt deine Verbrauchsdaten wissen.

Ja, also wenn ich die App nutzen würde, dann muss ich es ja eh machen. Habe ich eh keine Wahl.

Ja.

Wenn nicht, dann nicht. Dann stellt sich die Frage.

Aber auch noch mal da quasi zu fixieren. Du hast ja auch vorher gemeint, du würdest so eine Art von App nicht verwenden wollen, wenn ich das richtig verstanden habe.

Schwer zu sagen. Also wie gesagt, wenn ich dann tatsächlich irgendwie für mich brauchbare Rückschlüsse draus ziehen kann, wo ich in meinem Haushalt tatsächlich sinnvollerweise Strom sparen kann und ohne dass das Ding ist irgendwie zur Überwachung eingesetzt wird oder um mich zu „shamen“, wenn ich über irgendeinem fiktiven Durchschnitt liege oder irgendwas. Könnte ich mir schon vorstellen. Wäre ich auch bereit, die Daten und sonst irgendwie alles zu teilen, weil wir wie gesagt ansonsten funktioniert ja eh ned so nach dem Motto. So den Eindruck habe ich, dass die App bringt mir jetzt eigentlich nicht viel, außer dass ich mich ständig irgendwie schlecht fühle, wenn ich da hineinschaue. Dann wahrscheinlich eher nicht.

Okay.

Glaubst du wieder hat so eine App generell oder würde sie dir dabei helfen, deinen Energieverbrauch besser im Griff zu haben, als was jetzt davor geben würde.

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Wenn ich sinnvolle Erkenntnisse aus der Sache ziehen kann. Dann ja klar.

Mhm.

Glaubst du käme so ein Service auf der Umwelt zugute? Du hast die Sachen davor schon auch ein bisschen angesprochen, aber.

Aggregiert auf die Gesamtbevölkerung. Wenn das jeder macht, eventuell.

Mhm.

Und ja, letzte Frage, dann würdest du auch was zahlen für so eine App, also könntest du dir irgendein Bezahlmodell für so eine App vorstellen nebenbei, das sollte auch die Daten teilst.

Naja wie gesagt, da muss ja quasi die Ersparnis, die du aus deiner Erkenntnis dieser App ziehen größer sein als das was die App kostet und wie wilslt du das messen und das ist dann schwierig.

Würdest du da halt irgendwie ein monatliches Abo zum Beispiel in Betracht ziehen oder wäre das eher eine Einmalzahlungsgeschichte zum Beispiel?

Gibt es heutzutage noch Einmalzahlungen für Junge?

Ja haha denke eh nicht, das stimmt, aber könntest du zum Beispiel vorstellen, ich weiß es nicht, könnte auch eine oder in in Kooperation mit einem von den Energieprovidern vorstellen. Du sagst: OK ich zahl 2€ oder ich weiß nicht paar Euro halt monatlich damit ich dieses diese Art Datenanalyse bekomme und noch zusätzlich im Prognosewerte. Könntest du da irgendwie einen Geldbetrag vorstellen den du bereit wärst zu zahlen monatlich?

Wie gesagt, solange. Ersparnis, die ich daraus generieren kann. Höher ist als das, was ich dafür zahle. Ja, aber ja wie gesagt, wenn ich tatsächlich jetzt irgendwie damit 50,00€ im Jahr Strom sparen kann, dann darf das Ding noch nicht mehr als 50€ Kosten im Jahr.

Ja.

Also der Preis orientiert sich an dem, was man sich tatsächlich spart. Gleichzeitig kann man sich auch überlegen, wenn ich mir jetzt genau 50€ spare, das Ding kostet nur 50€ habe ich auch nichts gewonnen.

Natürlich ja.

Es gibt.. Ich habe schon mitbekommen, es gibt so Energiefanatiker, die finden es ultra geil permanent Stromverbrauch in jeder Sekunde Echtzeit nach zuschauen. Denen kann man wahrscheinlich jeden Preis dafür verlangen, weil sie einfach irgendwie keine Ahnung, die Illusion von Kontrolle oder irgendwas haben und dafür zahlen sie dann halt auch gerne, aber. Ich gehör da nicht dazu.

Ok, um das ein bisschen rauskitzeln von dir jetzt. Sagen wir, wärst du bereit, du hast. 50€ erwähnt aber sagen wir mal 20€ im Monat oder so.

Wenn ich mir 20,00€, wenn ich mir 21€. Jahr sparen kann oder im Monat sparen können.

Ja. Oder okay. Das ist halt wirklich ein so... Einen genauen Betrag möchtest du nicht erwähnen.

Was soll ich sagen, Nicki ist halt wirklich so. Ich werde nicht fü etwas zahlen extra noch, wenn wenn es mir nichts bringt, also.

Nichts bringt.. natürlich, das ist dann eh klar.

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Also ich muss halt irgendwas daraus ziehen. Wie gesagt, denn heute gibt es geil finden und sowas nachschauen zu können und das ist es ihnen schon wert etwas dafür zu zahlen, passt dann, ich gehöre nicht dazu.

Ok.

Ich gebe für andere Dinge Geld als wo andere sich denken würden, warum macht er das?

Genau okay. Das heißt, du möchtest dich nicht auf einen genauen Betrag äußern, solange der halt positiv ist.

Die Differenz aus Ersparnis und Kosten muss halt positiv sein.

Ok passt. Gibt.

Es da irgendwelche AI gestützten User trainierten Tools, die dann das perfekte dynamische Preismodell vorschlagen. Thema für die nächste.. für die Doktorarbeit dann.

Genau. Okay cool, danke für das Interview. Dann stoppe ich das Recording und hier?

Interviewfragen:

Beschäftigst du dich mit Umwelt Thematiken?

Wenn ja welche? aUCH MA mit energe eher aus technischer aspekt. Sonst müll vermeiden, öffis, rad, felisch verzicht

Wenn nein warum nicht?

Hast du dich mit deinem Energiekonsum schon einmal beschäftigt?

Eher nein

Siehst du dich als eine technikaffine Person?

6 von 10 skala

Hast du schon von der Digitalisierung im Energiebereich gehört?

> Wenn ja, welche Thematiken kennst du du so?
>
> Trend von konventiellen grod zu mart grid, erneubares strom, schwere planbarkeit der erneubaren, energie bedarf steuer
>
> Wenn nein, was kannst du dir darunter vorstellen?

Hast du einen Smart Meter zuhause?

ja

Wusstest du, dass du damit deinen Verbrauch überschaubar nachsehen kannst?

Was kannst du dir sonst vorstellen, was man mit diesen Verbrauchsdaten machen kann?

Ja, vorausstezung smart meter für ECs, prosumer

Hier wäre eine Applikation Namens N-ergy View. Diese soll aus dem Verbrauch Prognose ableiten können für die Zukunft. Der Nutzer bekommt dann Rückmeldung, ob er dann über oder

Interview 2 – N-Ergy View (13.03.2024)

unter den Prognosen ist (mit den zukünftigen Werten). Sollte er darüber sein, bekommt er Feedback zu Energiespartipps.

Was hälst du von dieser Idee? Würdest du so eine App verwenden?

Eher nicht,

Siehst du als Nutzer einen Vorteil für dich?

Siehst du etwaige Nachteile?

Was für weitere Features könntest du dir noch vorstellen für so seine App?

Was für Rückmeldungen würdest du als positiv sehen?

Welche als negativ?(nervig?)

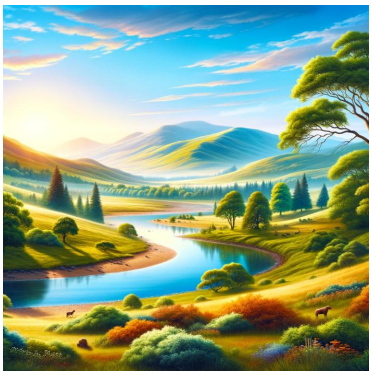
Wäre dir die Darstellung und Prognose von Kosten auch wichtig?

> Wärst du bereit dadurch mit der App Details zu deinen Kosten zu teilen? (Grundpreis der kwh für die Berechnung)
>
> > Wenn nein, welche Bedenken hast du?

Wäre für dich die Darstellung wie viel Energie man gespart hat oder die Darstellung der gesparten Kosten wichtiger?

Hast du eine Idee oder Vorstellung, welche andere Darstellungen möglich oder Interessant wären in diesem Kontext.

Eine weitere Option wäre die Darstellung von „emotionalen Bildern“ über deinen Konsum. Zb. Eisbär ohne Eis oder getrockneter Boden bei einem hohen Energiekonsum (Übersteigung der Prognosen) bzw. bei einem energiesparenden Konsum (Unter den Prognosewerten) wird ein grüner Wald mit blauen Fluss oder ein paradiesischer Strand gezeigt.

Wärst du bereit mit so einem Service deine Daten zu teilen?

> Wenn nein, was sind deine Gründe?

Glaubst du könntest du damit deinen Energieverbrauch besser im Griff haben?

Glaubst du käme so ein Service der Umwelt zugute?

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Würdest du auch was zahlen für so eine app?

Wenn nein warum nicht?

Wenn ja wie viel etwa?

Interview 3 – N-Ergy View (14.03.2024)

Interviewfragen:

Beschäftigst du dich mit Umwelt Thematiken?

Projekt mit Energie, beruflich involviert, interessiert sich für energieverbauch, kostentechnisch

Wenn ja welche?

Wenn nein warum nicht?

Hast du dich mit deinem Energiekonsum schon einmal beschäftigt?

Siehst du dich als eine technikaffine Person?

Wichtig für nachhaltigkeit

Hast du schon von der Digitalisierung im Energiebereich gehört?

Wenn ja, welche Thematiken kennst du du so? Breiter begriff viele möglichkeiten, ähnlich verlauft in anderen domänen, daten zugänglichkeit, kontrolle

Wenn nein, was kannst du dir darunter vorstellen?

Hast du einen Smart Meter zuhause?

Wusstest du, dass du damit deinen Verbrauch überschaubar nachsehen kannst?

Was kannst du dir sonst vorstellen, was man mit diesen Verbrauchsdaten machen kann?

Hier wäre eine Applikation Namens N-ergy View. Diese soll aus dem Verbrauch Prognose ableiten können für die Zukunft. Der Nutzer bekommt dann Rückmeldung, ob er dann über oder unter den Prognosen ist (mit den zukünftigen Werten). Sollte er darüber sein, bekommt er Feedback zu Energiespartipps.

Was hälst du von dieser Idee? Würdest du so eine App verwenden? Kontrolle und Planbarkeit

Siehst du als Nutzer einen Vorteil für dich?

Siehst du etwaige Nachteile?

Was für weitere Features könntest du dir noch vorstellen für so seine App?

Was für Rückmeldungen würdest du als positiv sehen?

Welche als negativ?(nervig?)

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Wärst du bereit dadurch mit der App Details zu deinen Kosten zu teilen? (Grundpreis der kwh für die Berechnung)

Wenn nein, welche Bedenken hast du?

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Prognosen) bzw. bei einem energiesparenden Konsum (Unter den Prognosewerten) wird ein grüner Wald mit blauen Fluss oder ein paradiesischer Strand gezeigt.

Audiodatei

Neue Aufnahme 6 2.m4a

Transkript

Dann legen wir bloß gleich los. Ja, danke, also willkommen zu meinem Interview und danke für deine Zeit.

Gerne.

Also ich brauche paar qualitative Daten für meine Masterarbeit und möchte da halt im Rahmen davon ein bisschen paar Konzepte überprüfen. Und ich frag dich einfach mal gleich vorweg, ob du dich derzeit mit irgendwelchen Umweltthematiken beschäftigst. Ist irgendwas was? Du zu Hause da irgendwie immer überlegst oder generell?

Ah, warte ich. Nur ganz kurz. Ja, los geht's. Ja, also ich srbeite bei einem Projekt, das eigentlich mit Energie zu tun hat und bin dementsprechend eigentlich auch beruflich involviert in die Thematik und würde sagen ich interessiere mich eigentlich auch sonst generell so um für Energieverbrauch vielleicht Nachhaltigkeitslösungen, Umwelt und so. Also finde ich eigentlich schon noch der wichtigste Thema. Und ja, und es interessiert mich auch irgendwie persönlich so vielleicht was ich so für. .wie.. wieviel Energiedaten, dass ich für was verbrauchen, vor allem auch kostentechnisch so was ich was es kostet eigentlich ähm.. genau.

Mhm.

Ja, du hast da eh... das schon erwähnt, dass du dich halt mit dem Energiekonsum auch beschäftigst, denk ich mal. Also hast du da irgendwelche Erfahrungen auch vielleicht schon gemacht, dass du sagst, ich hab irgendwie meine Energie, meinen Strom irgendwo nachgeschaut oder so?

Ja, also ich hab.. Wo ich noch, als ich nach Wien gekommen bin, habe ich das Konzept mit dem Smart Meter, das habe ich noch nicht gekannt, dass man da die Daten... ähm.. Und ich habe, also ich habe mich sonst ein bisschen, ist halt schwierig, das selbst finde ich so als Laie, dass sich selbst probieren die Daten zugänglich zu machen und erkenntlich zu machen und die Umrechnung mit was das genau ist und so und.. aber ich hab mich eigentlich immmer so im privaten Rahmen, einfach damit auseinandergesetzt, auch so mit die Abrechnungen angeschaut so was.. was hat mich was gekostet, eben irgendwie so ein bisschen abzuschätzen und vielleicht auch mich mal informiert was kostet es eigentlich ein Kühlschrank am Laufen zu halten, einen Monat oder was, was kostet es, wenn ich eine einfach so privaten Interesse was kostet es wenn ich eine Glühbirne am Tag brennen lasse solche Geschichten.

Also hast du da den Stromverbrauch oder diese Daten hast du die eher so granular, dass du wirklich dann einen Tag nachschauen kannst? Oder hast du das dann eher, dass du mal sagst, nach einem Jahr kriegst du halt die Energierechnung, dass man es da mal kontrolliert?

Das.. das war eher so.. Was ist das, glaube ich, irgendwie, was monatlich oder vielleicht quartalsmäßig? Ich weiß es nicht mehr, aber ich hab mir da die Abrechnung einfach eher angeschaut und ich hab auch versucht so direkt am Smart Meter, dass das.. das Ding auch zu lesen aber also da kann man ja einfach immer den aktuellen Stand ablesen und wie sich dann das verändert hat, aber. Ja.

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Genau das ist jetzt noch von da, wo du herkommst, dass du einen Smart Meter hast oder hast du jetzt in Wien einen?

Da hab ich in Wien einen.

Das war..

Ja ja, also ich hatte einen vor dem, ich umgezogen bin, jetzt hab ich keinen mehr glaub ich.

Ah okay verstehe. Du hast diese Thematiken jetzt ein bisschen erwähnt schon, aber würdest du dich halt als auch eine technikaffine Person ansehen.

Ja, würde ich schon sagen. Ja.

Findest du, dass so Technik auch wichtig ist, um so Umweltthematiken oder halt diese Umwelt.., ja Klimawandel et cetera zu lösen, irgendwie

Ja, definitiv, würde ich sagen, Technik ist eigentlich neben den gesellschaftlichen Aspekten.. Also ich glaub es braucht immer die technische Komponente und das ist glaub ich auch für die Zukunft Nachhaltigkeitsentwicklung sehr wichtig, dass man technische Lösungen erfindet für Probleme die sich technisch auch lösen lassen und ich glaube da gibt es eben mit der Umweltproblematik ziemlich viele Geschichten, die sich technisch lösen lassen. Und dann braucht man immer auch die gesellschaftliche, politische Komponente sozusagen, dass man da ja.., dass man die technischen Lösungen entsprechend einbindet in die gesellschaftlichen und politischen Dimensionen.

Mhm. Genau,so vielleicht das dann überzuleiten, hast du schon von der . sierung im Energiebereich gehört? Sagte diese Thematik was?

Sagt mir was ja

Ja, was stellst du dir so darunter vor?

Puh weit.., ich würd sagen das ist ein breiter Begriff, da gibt es viele, viele Möglichkeiten wie man sich das vorstellen kann, aber ich würde eigentlich sagen ich stelle mir darunter vor, dass es eigentlich wie.. ähnlich verläuft wie überall auch alles andere, das auch digitalisiert wurde und ich stelle mir vor, dass das schlussendlich einfach dazu führt, für mich persönlich jetzt als Nutzer, dass die Daten zugänglicher werden als die Energiedaten irgendwie einsichtlicher werden und die Kontrolle, dass die Kontrolle erhöht wird dadurch, dass das digitalisiert wird und dass ich sozusagen als Endnutzer eigentlich mehr Möglichkeiten hab, sowohl zur Einsicht wie auch zur Kontrolle eigentlich und auf der, sagen wir mal politischen oder gesellschaftlichen Ebene, würde ich sagen, dass das wirtschaftliche Konsequenzen hat ja, wie halt alles das digitalisiert wird. Und ja.

Genau also du hast da eh viele Sachen da erwähnt. Also also stimmt auch viel, also Daten sind ja ein wichtiger Punkt. Und wie du sagst dass es kann ja für alles mögliche angewendet werden also es beginnt ja eben mit dem Smart Meter sozusagen. Du hast ja gesagt du hast oder hattest mal einen zuhause zumindest also kennst du diese Thematiken. Eben Kontrolle hast du erwähnt, dass man die Sachen nachschauen kann. Natürlich geht es dann auch ein bisschen in den Grid auch hinein, also dass du halt beim Energieproduzenten wird ja auch viel digitalisiert. Natürlich, dass man zum konventionellen Grid zu diesem Smart Grid ist ja quasi das Topic auch. Und.. ja, eben auch die Thematik erneuerbare Energien zum Beispiel, nicht? Dass man die besser planen kann, oder sind so ein paar Sachen.

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Genau.

Du hast es dann eh auch erwähnt. Verbrauchsdaten natürlich sind ja wichtig in diesem Kontext, zu dieser Thematik. Kannst du dir irgendwie vorstellen für was die so gebraucht werden oder halt irgendwelche Ideen, was ja.. für was die eben genutzt werden.

Also für meinst du jetzt vom Endnutzer her sozusagen

Generell. Also es kann Endnutzer, es kann im System sein und auf eine Makroebene sein.

Ja, also ich glaube eben auf, es gibt einfach die 2 Ebenen sozusagen und eben auf der sozusagen der Endnutzerebene eben glaube ich, dass es.. das eigentlich dafür benutzt werden kann, um eben die Kontrolle zu erhöhen vom Endnutzer, dass man mehr Übersicht hat, was man eigentlich verbraucht und dementsprechend auch irgendwie den Stromverbrauch, den persönlichen Stromverbrauch irgendwie regulieren kann und überblicken kann und vom sozusagen auf der institutionellen Ebene würde ich eben sagen, dass es.. Das.. dasselbe aber auch in (inaudible) wird, wahrscheinlich irgendwie das ganze auch eingebunden in irgendwie einen wirtschaftlichen Gebrauch mit denen Energiedaten, also im Handel und.. Ja würd ich sagen, daß das das das halt wie immer irgendwie das Zusammenspiel von diesen beiden Ebenen.

Mhm.

Genau also eben diese Kontrolle ist gleich eben auch ein wichtiger Punkt halt für die.., also halt für den Endnutzer nehm ma so. Und es gäbe... Oder es gibt jetzt die Idee für eine Applikation, die heißt N-Ergy-View. Die natürlich den Verbrauch einfach mal darstellt natürlich und gewisse Analysen macht aber ein wichtiger Teil ist, dass dann von diesem Verbrauch, historischen Verbrauch quasi, werden Prognosen erstellt, die dazu dienen, um den User Rückmeldung dann geben zu können, wenn er über oder drunter diesen Prognosen ist. Das heißt, wenn ich drüber bin heißt das ich hab.. konsumiere eher.. oder bin auf dem Weg mehr Energie zu konsumieren und würde dementsprechend mehr Feedback bekommen mit: Halt stopp Moment oder da ist.. Also oder Achtung quasi pass auf quasi oder umgekehrt wenn du drunter bist, würde es dich halt animieren weiter zu sparen oder auf diesem Weg zu bleiben mit.. da kann man jetzt irgendwie überlegen, irgendwelche Anreize die es so gibt. Also Rabatte, bessere Tarife etc. Was hältst du von so einer Idee?

Ja, finde ich grundsätzlich eigentlich sehr cool. Finde ich eine gute Idee.

Mhm, würdest du so eine App auch nützen wollen?

Ja, würde ich auch nützen.

Also siehst du da auch einen Vorteil für dich? So als Nutzer.

Ja, ich würde schon.. Ich würde schon sagen, ja.

Was könntest du dir so vorstellen, was für Vorteile du rausbekommst?

Also erstens mal würde ich eben sagen, dass das was, was du schon gesagt hast, sozusagen dass man.. Die.. den Überblick und die Kontrolle ist, dass man die eigenen Energiedaten hat, wirklich selbst verwalten kann. Und weiter würde ich sagen, dass es eben spannende Möglichkeiten gibt, wie man irgendwie.. ähm.. Was man da alles einbauen könnte, was man als Endnutzer sozusagen verwenden könnte. Ich denke irgendwie zum Beispiel, was ich spannend wäre, wären so Futures wie irgendwie. Dass man keine Ahnung angeben kann: OK, ich plane jetzt demnächst ein Elektroauto zu kaufen oder ich plane demnächst einen zweiten Kühlschrank

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oder was auch immer eine neue Lampe zu kaufen und dass man das irgendwie.. ähm.. eingeben kann dort und dann zeigt es irgendwie so die Prognose wie.. was wie sich der Stromverbrauch dadurch ändert und wie die Kosten sich dadurch verändern so das..also da fände ich eigentlich gibt es sehr viele Möglichkeiten so von dieser Basis dass die als Endnutzer sozusagen die Energiedaten zugänglich werden in dieser App gibt. Fände ich gibt es viele coole Möglichkeiten.

Genau, es werden.. Vielleicht können wir da eh kurz drüber reden, also was wären das so weitere Features. Also du hast das erwähnt mit der Planbarkeit, dass du die überlegst welche Geräte man da so quasi anschaffen könnte und da die Kosten sich.. anpassen oder wie die das halt verändern. Gibt es da noch irgendwas, was du dir wünschen würdest, wo du sagst das wäre cool, wenn das diese App auch könnte?

Ja, es gibt... Ich find eben... Es gibt endlos viel würd ich sagen, Möglichkeiten wie man das.. ähm.. Eben es gibt auch irgendwie die Idee, dass man das dann, dass man das mit anderen teilen kann, sozusagen, denn Energieverbrauch irgendwie in Vergleich stellen zu anderen Leuten, die die App nutzen und dass man da irgendwie so eine Art witzige Spiele draus machen kann, mit irgendwie, wenn man das mit dem Nachbar vergleicht und dann irgendwie gibt es keine Ahnung einen Preis für jede Woche.. Bessere Energienutzer, besser Energie sparen oder keine Ahnung irgendsowas. Und das finde ich eigentlich.. also so ein bisschen auch die spielerische Art irgendwie habe ich das Gefühl, das hilft irgendwie viel. Erstens mal den Leuten Anreiz zu geben, die App zu nutzen und andererseits auch tatsächlich irgendwie Energie zu sparen halt schlussendlich, wenn wenn wenn das das Ziel ist.

Ja, das sind coole Ideen tatsächlich. Also ich glaube auch, dass man da vieles... ja, anpassen kann. Egal jetzt halt von diesen ganzen Features oder vielleicht nicht egal. Aber halt wenn du halt sowas überlegst. Gäbe es da irgendwelche Nachteile du auch siehst mit so einer App.

Also Ich würde sagen halt die grundsätzlichen Bedenken so wie überall, wenn Daten digitalisiert werden und zugänglich gemacht werden, wäre sicher die Datensicherheit und ja da müsste man halt irgendwie.. Also es wäre halt wichtig, dass man klar als Endnutzer informiert ist, wo genau die Daten hingehen. Wer Einsicht zu den Daten hat und ob die.. ja, das also das wäre so, eigentlich würde ich sagen so der Haupt.. Haupt.., mein Hauptbedenken so als Nutzer von dieser App, dass meine Energiedaten missbraucht werden könnten, potenziell, weil es ist ja schon ziemlich... Sind schon ziemlich wichtige Daten, die man, wenn man schauen kann der Energie.. anhand von Energieverbrauch kann man schon ziemlich viel schließen auf die eigene Person würde ich sagen, wie man den Haushalt führt, wann man aufsteht, wann.. Und deshalb würde ich sagen, ja, das eigentlich so. Datensicherheit, glaube ich wäre mein Hauptbedenken.

Ich greif vielleicht diese Frage schon vor, würdest du halt mit so einem Service deren Daten teilen. Dann auch. Weil du es nicht gerade ansprichst, also. Wenn diese Versprechen würden, ja. Wir passen natürlich auf. Sicher genug, oder?

Ja, also ich würde mir glaube ich durchlesen, wo genau die Daten gespeichert werden, so ob die irgendwie ja wo die hingehen, ob die lokal bleiben oder ob die also was.., aber das ist ja eben trotzdem, ich meine, die Daten sind ja sowieso schon vorhanden von diesem Smart Meter, von dem her ist es eh schon... ähm..

Genau, ich mein, du müsstest ja theoretisch, also der Netzbetreiber müsste noch halt den.. die Freigabe von dir bekommen, dass du sagst vielleicht teile ich eh die Daten, nicht? Also es wär halt schon Teil von dir quasi sagt eh quasi ja ich möchte halt diese Daten freigeben. Alsodu hast schon eine gewisse Kontrolle über die Datenverwendung, sag ich mal, ja. Natürlich, ob die App dann irgendeinen Datenleak mal hat, das kann man nicht..

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Genau. Genau, ja. Kann man nicht ausschließen.

Genau, ausschließen

Ich würd sagen ja, also grundsätzlich

OK, cool. Ich hab davor erwähnt, dass du so Rückmeldungen bekommst über den Verbrauch, also sei es wenn du rot oder grün, wenn der Verbrauch ja, je nachdem wie er ist. Siehst du.. würdest du sowas als positiv sehen oder als negativ? So Rückmeldungen oder wie könntest du dir vorstellen wie das ausschauen könnte sonst.

Ich würde sagen ich würds positiv wahrnehmen. So lang sozusagen unter Voraussetzung, dass man wissen selbst steuern kann wie die Rückmeldungen aussehen also vielleicht irgendwie das nicht, wenn sie die im Standard so Default Implementierung, dass es irgendwie jedes mal ein Alarm losgeht, wenn ich ein bisschen drüber bin, dass das fände ich nicht cool, aber wenn man das selbst kalibrieren kann. Wieviel das man sozusagen.. Wie viele Mitteilungen, dass man da kriegt, dann fände ich es eigentlich cool, ja.

Ähm. Genau, wäre da zum Beispiel auch eine Darstellung der Kosten dafür, auch wichtig eigentlich, du hast eh schon angesprochen aber jetzt würde man vom Smart Meter nur Verbrauchswerte bekommen, aber würdest du Kosten auch haben wollen?

Ja, ja, sehr. Also das finde ich eigentlich so eines der wichtigsten Elemente, weil ich glaub, viele Leute können sich eigentlich nicht, also ja, man kann sich halt viel mehr darunter vorstellen, wenn man ja nicht.. deshalb.. viele Leute würden, das glaube ich, auch nutzen. Großen Teil auch wegen den ökonomischen Komponenten, dass man eben die Kosten.. dass man den eigenen Kostenhaushalt regulieren kann. Also ja, würde ich sagen, sehr ja.

Ähm.. Jetzt ist es natürlich ein bisschen schwierig, Details über diese Kosten zu bekommen. Also gerade wenn man die wirklich detailliert haben möchte. Das heißt, du müsstest als Endnutzer mit dieser App auch halt Details über den Vertrag liefern, wie vielleicht Grundpreis, aber natürlich halt der Grundpreis pro kWh wäre dann wichtig. Wärst du halt auch bereit, solche Details mit der App zu teilen. Damit du die Funktion freischaltest ja.

Ja, wenn du sagst.. Ja und ich ich finde auch keine Ahnung also mir könnt ihr auch selbst wenn man die Daten nicht teilt irgendwie ein Feature einbauen dass sozusagen die generell irgendwie einen Durchschnittswert berechnet oder irgendwas..

Natürlich.

Ja aber grundsätzlich wäre ich eigentlich auch bereit so.. also...die.. die.. Ja, es hat nur die Voraussetzung, dass auch, was ich cool fände, wenn irgendwie in der App dann eine, vielleicht eine kleine Anleitung steht, wo genau, dass man die Preisauflistung findet und so weiter, weil was die Kilowattstunde jetzt genau kostet und so und aber dann wird ja, wenn es einfach ein Feld gibt, wo man das eingeben kann, dann finde ich eigentlich kein Problem.

Könntest du dir auch vorstellen, dass man dann zum Beispiel Tarife vergleicht, auch obwohl du sagst okay wenn ich jetzt Wiener Energie da hätte, aber wenn ich jetzt das wechselt gegen KELAG keine Ahnung.

Ja, das finde ich. Auch cool, ja. Ja. Genau, ja,

OK, cool. Hättest du da grundsätzlich irgendwelche anderen Bedenken? Sonst wenn du solche Sachen teilst oder Details über den Vertrag? Hättest du irgendwelche Bedenken, oder?

Interview 3 – N-Ergy View (14.03.2024)

Eigentlich nicht, weil ich glaub, da teilt man ja nur, wenn man jetzt die Kosten, also es wäre vielleicht was anderes, wenn man jetzt irgendwie den PDF vom Vertrag uploaden müsste, dann wär es vielleicht ein bisschen bedenklich, aber sonst? Eigentlich..

Wenn du nur die Kosten dann besser erklären.

Genau ja.

Das heißt, du hast eh schon ein bisschen erwähnt, aber halt das heist.. Also was wäre dir wichtig? Die Darstellung von der.. wieviel Energie man gespart hat oder eher Kosten? Also was wäre da halt..?

Mir persönlich wahrscheinlich also gut.. Mir persönlich wahrscheinlich eher Kosten. Das ist so irgendwie.. Was mich wahrscheinlich so, aber das ist ja auch miteinander verbunden so. Also ich meine keine Ahnung, wenn. Ja, beides. Aber so jetzt als erster.. Erster Gedanke hatte ich eigentlich so eher an die Kost.., an den eigenen Kostenverbrauch gedacht, ja.

Okay. Werden irgendwelche anderen Darstellungen wichtig für dich in diesem Kontext noch? Also das wir haben kosten, wir haben Energie, irgendwas anderes was du dargestellt haben.

Ich würd also ich find zum Beispiel immer so Durchschnittswert finde ich so sinnvoll, wenn man irgendwie zum Beispiel den eigenen Energieverbrauch in Relation zum Durchschnitt sehen könnte, was es irgendwie so was ist der durchschnittliche Nutzer in Wien. Für den müssen wir irgendwelche Kriterien haben, um den Durchschnitt zu berechnen, das keine Ahnung, Alter, Quadratfläche, Wohnfläche und so weiter. Weiß ich.., weiß ich auch nicht, aber.. und dass man irgendwie sehen kann, OK, ich bin voll über dem Durchschnitt oder ich bin voll unter dem Durchschnitt, sowohl vom Preis, ja als auch irgendwie von der konkreten Energienutzung, das finde ich eigentlich noch cool.

Auch noch über generelle Darstellungsfrage, weil da geht es nicht mehr um Visualisierungen und Design. Aber was stellst du dir meistens davor, wenn Kosten oder Energie aufgeschlüsselt wird, was wären da so deine Wünsche zu.

Also du meinst um welche Art von Diagramm?

Ja genau, würd dir da einfach einen Linechart reichen, einen Barchart oder irgendwas ganz Verrücktes auch zum Beispiel, das vielleicht mehr Sinn ergibt, dass du ein bisschen.. bisschen Data Exploration machen kannst, aber ja..

Mhm. Also ich finde es grundsätzlich cool, wenn man das als User anpassen könnte, so wenn man irgendwie, wenn es verschiedene Möglichkeiten gibt, die da die das darzustellen und man kann sich eine davon aussuchen. Aber ich glaube, irgendwie wäre es sinnvoll, wenn man irgendwie mit dem möglichst simplen.. sim.. möglichst simplen Darstellung beginnt. Ich hab jetzt kein spezifisches Bild, ich glaub das ist eigentlich keine Ahnung... Ja.. dass, dass man mit der möglichsten simplen Darstellung beginnt und dann kann man irgendwie auswählen, OK, was für Komponenten will ich da einfügen und in welche Darstellung wie ich das haben, ja.

Okay. Genauso zum Beispiel eine Überlegung auch für die Darstellung, wär das dynamisch, wenn je nachdem Konsum zum Beispiel auch emotionale Bilder zu zeigen. Zum Beispiel, wenn du jetzt einen hohen Verbrauch in Eisbär ohne Eis oder getrockneter Boden. Oder wenn der Konsum eher so wieder auf einem energiesparenden Weg bist, dann kommt so ein grüner Wald mit einem schönen Fluss. Also da hätte ich zum Beispiel 2 Beispiele irgendwie, die dann

Interview 3 – N-Ergy View (14.03.2024)

vielleicht angezeigt werden oder in der App verändert werden. Wie würdest du sowas empfinden? Wäre das irgendwie cool oder ist das dann irgendwie so okay ja nervig, weil jetzt die App immer anders ausschaut oder ich weiß nicht welche andere Gründe.

Schwierige Frage. So finde ich irgendwie auf dem ersten Eindruck finde ich so bisschen grenzwertig irgendwie so also ich weiß nicht, ob ich so... ob ich so als User irgendwie so geshamet werden möchte. So, wenn du einen zu hohen Verbrauch hast. Also ich persönlich fände es irgendwie sinnvoller, wenn ich irgendwie, also ich würde mir mehr wünschen, irgendwie keine Ahnung es steht du verbrauchst.. du zahlst momentan so und so viel zu viel anstatt zu sehen irgendwie du bist die Ursache dafür, dass jetzt ein Eisbär keine Eisfläche mehr hat weißt du, ich meine das.. das wird, das wär glaub ich so meine..

Ja, klar.

Sicher ok, verstehe. Wir sind kurz vorm Ende, aber glaubst du, käme so eine App der Umwelt zugute? Also glaubst du siehst du da Vorteile, dass man klimatechnisch da das anpassen könnte oder verändern könnte.

Können ja definitiv, finde ich, hat seh.. sehr großes Potenzial.

Cool. Könntest du dir irgendwie auch vorstellen, weil auch.. Also du hast gesagt, du hast bereit die Daten zu teilen. Könntest du auch vorstellen, noch extra dazu auch was zu zahlen zum Beispiel?

Kommt auch bisschen auf die Leistung drauf an? So grundsätzlich würde ich sagen ja, aber das wird dann halt wirklich so konkret drauf ankommen, was genau.. die App kann wie sie aussieht?

Mhm.

Ja, ja, könntest du dir auch vorstellen.. Also vielleicht ganz klassisch einfach ein Monatsabo, was wäre da zum Beispiel irgendeine Schmerzgrenze, wo du sagst, OK, das müsste.. das, das würdest du halt monatlich zahlen wollen für so eine App um Analysen und Prognosen zu erhalten.

Nur für die Basic Implementierung so.

Ja oder halt auch mit der Kostenaufschlüsselung zum Beispiel.

Pro Monat.

Zum Beispiel, ja.

Ich würd sagen keine Ahnung, so rein aus dem Bauch raus vielleicht.. Keine Ahnung. Schwierig zu sagen. 5,00€ wobei.. ich weiß es nicht was da der.. Schwierig zu sagen so aber so rein aus dem Bauch raus ist mir das irgendwie so meistens keine Ahnung 5€ aber ich weiß nicht ob das vielleicht ist das viel zu wenig oder viel zu viel, nein viel zu viel wahrscheinlich nicht.

Ja.

Es sind so. Ist halt interessant zu wissen was halt so Schmerzgrenzen sind natürlich.

Ja, ja. Also ich würd wahrscheinlich, sagen wir mal so, wenn es jetzt irgendwie keine Ahnung 50€, dann würde ich es nie machen, so weil das fände ich viel zu viel für das, dass es...

Ja.

Aber so 5€? Fänd ich irgendwie wäre wahrscheinlich so die...

Interview 3 – N-Ergy View (14.03.2024)

Nehmen wir jetzt rein hypothetisch an. Also du würdest zum Beispiel.. es kostet jetzt 50€ im Monat. Aber du würdest quasi auch im Monat durch diese Energiespartipps und halt diese Prognose et cetera würdest du 100€ sparen, also würdest du da trotzdem auch das dann zahlen wollen oder..

Irgendwie so, weil ich das.. Es sind halt immer so Dinge, die ich zuerst gerne sehen will, dass das, dass mir dann das wirklich 100€ spart, weil keine Ahnung, ich bin ein bisschen skeptisch bei vielen solchen Geschichten, die wo die irgendwelche Apps und so, die sagen, ja, du wirst damit so und so viel sparen, um dann schlussendlich zahlst du einfach die Kosten und aber wenn sich das rein hypothetisch, wenn man da wirklich tatsächlich 100€ sparen könnte, und das wäre irgendwie, das kann man irgendwie nachweisen und das wär ersichtlich so als User, dass es.. dann schon, weil dann.. Ist ja ein keine Ahnung.. ist eine simple Rechnung. Ja du spart.. du zahlst die Hälfte und die Hälfte sparst du also fände ich OK.

Mhm.

Okay cool, passt. Danke fürs Interview, gerne.

Wärst du bereit mit so einem Service deine Daten zu teilen?

Wenn nein, was sind deine Gründe?

Glaubst du könntest du damit deinen Energieverbrauch besser im Griff haben?

Glaubst du käme so ein Service der Umwelt zugute?

Würdest du auch was zahlen für so eine app?

Wenn nein warum nicht?

Wenn ja wie viel etwa?

Interview 4 – N-Ergy View (19.03.2024)

Audiodatei

Neue Aufnahme 8 8.m4a

Transkript

Sprecher

So da. Ja, willkommen zu meinem Interview. Danke, dass du dir Zeit genommen hast, über meinen Lord und Saviour zu sprechen.

Sprecher 2

Haha Mal gucken.

Sprecher 1

Genau, ich würde halt, ich brauche halt diese Interviews für meine Masterarbeit, weil ich möchte ein paar qualitative Daten sammeln. Und ich frage dich gleich vorhin weg ob du dich gerne mit irgendwelchen Umweltthematiken beschäftigst?

Spreche 2

Ja,

Sprecher 1

Welche so konkret?

Sprecher 2

Uff. Also ich meine Umweltthematiken sind vielseitig. Also einerseits beschäftige ich mich auch in meiner eigenen Forschung ein bisschen mit Müllvermeidung, das ist jetzt vielleicht eher ein bisschen off Topic für Eddie, aber sonst interessiere ich mich natürlich für alles, was dem Klimawandel sich entgegensetzen kann und vermag. Sprich wie ist das da die thermodynamischen Gesetze am Ende ist halt doch alles irgendwie in erster Linie nur Energie die sich umgewandelt hat. Und insofern setze ich mich natürlich auch damit auseinander, wieviel Energie ich so verbrauche, zu Hause und auch für andere, also nicht nur zu Hause, sondern auch generell, also auch für Reise, oder?

Sprecher

Ja.

Sprecher 1

Also dein CO 2 Footprint und so.

Sprecher 2

Ja, ich mein nicht, nicht super intensiv damit auseinandersetzen. Wie groß jetzt mein Print ist, aber man schaut halt trotzdem irgendwie, dass man so tut, was man kann.

Sprecher

Mhm

Sprecher 2

Interview 4 – N-Ergy View (19.03.2024)

Und wo es halt irgendwie sinnvoll ist. Darauf zu achten ne.

Sprecher 1

Genau, du hast es eh schon auf, du beschäftigst dich eh mit einem Energiekonsum. Also was machst du da so konkret, wenn ich fragen darf.

Sprecher 2

Also ich führe recht präzise Aufzeichnungen über meinen Energiekonsum also so.. Also ich mein unmittelbar, glaube ich, habe ich für mehrere Stunden oder Tage glaube ich habe ich Sekundenwerte und dann sobald die Daten 10 Tage alt sind werden sie aggregiert in so 5 Stunden und sobald sie 2.. Nein 5 Minuten und sobald sie ein paar Monate alt sind werden sie so in stundenwerte aggregiert glaube ich.

Sprecher

Mhm. Mhm also.

Sprecher 2

Genau das habe ich. Noch mal, was war die Frage?

Sprecher 1

Gerne mit dem eigenen Energiekonsum beschäftigen.

Sprecher 2

Ja genau, und ich hab halt eben nicht nur Daten zu meinem gesamten Energieverbrauch zu Hause, sondern ich hab zum Teil auch Daten zu einzelnen Geräten. Sprich mit der Visualisierung, die ich jetzt gerade zu Hause hab, seh ich auch ein bisschen die Relationen von unterschiedlichen Geräten oder den Impact. Also zum Beispiel war auffällig, dass halt so eine Stunde oder 2 Flugsimulator simulieren, schnell mal schwer ins Gewicht fällt was den täglichen Energiekonsum angeht.

Sprecher 1

Okay du das heißt, du hast ein eigenes Art Setup zu Hause.

Sprecher 2

Ich habe ein relativ mittelkomplexes Setup zu Hause mit viel Hardware, die offene lokale Schnittstellen anbietet, die ich dann abgreifen kann.

Sprecher

Mhm.

Sprecher 1

Das heißt, du würdest dich auch als eher eine Technikaffine Person sehen?

Sprecher 2

Ja.

Sprecher 1

Das schon. Findest du, dass Technik auch wichtig ist, um den Klimawandel und sonstige Sachen zu bekämpfen?

Interview 4 – N-Ergy View (19.03.2024)

Sprecher 2

Also ich glaube auf jeden Fall. Ich glaube auch, dass das nicht die einzige Lösung sein wird, also. Mein.. Technik ist halt so vielseitig, ne, also es kann natürlich sein, dass die Technik uns jetzt hilft dabei Energie zu sparen, indem effizientere Geräte entwickelt werden, indem energieeffizienter verbraucht werden kann, also weniger Verluste entstehen. Und natürlich glaube ich auch, dass die Technik an und für sich in der nachhaltigen Produktion von Energie eine wichtige Rolle spielt. Sprich weiß ich nicht. Windkraft, Solarkraft mit Einschränkungen, auch die Wasserkraft. Also dass die, dass die Fortschritte da auch eine Rolle spielen werden. Ich glaube weniger an Carbon Capture, um ehrlich zu sein, das ist nicht so wirklich ein Topic, von dem ich überzeugt bin, dass uns das mehr oder weniger den Ausweg leiten wird.

Sprecher 1

Mhm, hast du schon von der Digitalisierung im Energiebereich gehört?

Sprecher 2

Also. Ist ja ein bisschen ein breiter, ein breiter Begriff, würde ich sagen. Ich mein. Was ist die Digitalisierung im Energiebereich? Für mich bedeutet das jetzt würde ich sagen, dass ich zu Hause einen Smart Meter hab, den ich auch, also dessen Daten ich auch Abgreife am zweiten Wohnsitz habe ich einen, wo ich das sogar in Echtzeit mache. Und sonst hab ich mich auch vor kurzem bei den Wienernetzen mal auf eine Stelle beworben, wo es um so Projektingenieur/IOT ging, wo es halt um die Digitalisierung der Stromnetze an und für sich gegangen wäre. Ja.

Sprecher 1

Genau das ist ja dann eher die Makroebene, denke ich.

Sprecher 2

Mal. Das betrifft mich dann nicht mehr als Konsument so sehr aber betrifft natürlich die Netzbetreiber ganz essentiell, weil die ja auch einfach dann besseren Überblick haben über die notwendige Dimensionierung der Netze an den jeweiligen in den jeweiligen Gebieten oder Bereichen.

Sprecher 1

Genau, du hast ja gemeint, du hast ein Smart Meter zu Hause. Also du hast auch das eigene Setup, aber verwendest du dadurch auch den Smart Meter? Auch irgendwie.

Sprecher 2

Also in meinem Hauptwohnsitz verwende ich den Smart Meter. Der ist da, den haben sie mir eingebaut, weil ich irgendwann mal so eine Kleinsterzeugungsanlage angesteckt habe und mein Zähler noch rückwärts gelaufen wäre. Also mein alter Zähler. Der ist zwar da und ich habe am Anfang ein paar Mal in die Daten hinein geschaut, um zu validieren, dass die Daten, die ich selbst Messe also kohärent sind mit den Daten, die der Smart Meter ausspuckt. Das ist ein geeichtes Messgerät, das muss ja mehr oder weniger die richtigen Daten liefern.

Sprecher 2

Und am Zweitwohnsitz verwende ich da die P 1 Schnittstelle, die der hat, also der hat diese. Rj 11 glaube ich, heißt die Steckschnittstelle und da hängt bei mir so ein Smart Meter Auslesegerät dran, dass mir im Sekundentakt die Daten ausliest und mir schickt auf über MQTT meinen dort laufenden Home Assistant.

Sprecher 1

Interview 4 – N-Ergy View (19.03.2024)

Du meintest das beim Hauptwohnsitz also auch die Anlage?

Sprecher 2

Ja, die.. die.. ich hab dort eine Kleinsterzeugungsanlage genau, also eine Stromanlage. Aber ich hab am Nebenwohnsitz auch in Kürze, also ich hab da schon eine, die geht in Kürze online, also mein Wechselrichter der den bring ich heute zur Post den sie mir austauschen.

Sprecher 1

Okay cool hast du da auch in dem Portal, also Wiener Netze oder wo auch immer, irgendwie auch die Produktion nachsehen können.

Sprecher 2

Nein, also ich meine, ich könnte mal reinschauen, das wär tatsächlich interessant. Ich hab sie bis jetzt noch nicht noch nicht nachgeschaut wie das ist, wenn das negativ wird, weil es gibt Stunden wo es grundsätzlich overall negativ war oder auch Viertelstunden Intervalle die müsste ich sehen können. Ist eine interessante Frage. Ist.. hilft das, wenn ich das jetzt live mache oder ist das also wenn ich da reinschaue.

Sprecher 1

Du kannst gerne wenn du magst. Ich sage nicht nein

Sprecher 2

Ja, ich meine, es ist für.. Ist für mich auch interessant tatsächlich.

Sprecher 1

Ja, also wenn du willst, dass das auch auf der Aufnahme drauf ist, dann.

Sprecher 2

Ja, warum nicht? Ich schau schnell nach. Ich muss mich nur einloggen. Gleich kommt der Chatbot ..

Sprecher 1

Wie heißt die Claudia irgendwas?

Sprecher 2

Mona Netze.

Sprecher 1

Aja Mona.

Sprecher 2

Okay und wie logge ich mich ein?

Sprecher 1

Vielleicht das Smart Meter Porttal.

Sprecher 2

Da bin ich gerade ein. Ah hier ist log in. Wieso ist das irgendwo ganz weit unten auf inaudible? Ja das stört mich hier nicht, das finde ich ja super, dass das ein bisschen SSO für die Stadtmacht dann.

Interview 4 – N-Ergy View (19.03.2024)

Sprecher 1

Ja, wir haben jetzt dieses Login der das vereinheitlich.

Sprecher 2

So Log me in. Password Manager ist da. Auswahl akzeptieren. Gelesen. Dann wollen wir doch mal sehen.

Sprecher 1

Heute ist ja eh sonnig fort he record

Sprecher 2

Heute krieg ich natürlich die Daten erst morgen hinein. Das ist, das ist die Krux an den Smart Meter.

Sprecher 1

Aja, das stimmt auch. Aber gestern haben wir eigentlich auch.

Sprecher 2

So wie finde ich das jetzt hier. Ich geh mal auf Details bei der grafischen Darstellung. Da kommen wir vielleicht auf eine andere Seite und dann schauen wir uns den Tag an und zwar.. Gut, das dürfte eh gestern gewesen sein, als der geht nicht unter 0 hier. Na also, es ist es ist Bottomt aus bei 0. Selbst wenn Energie zurückgeht, die ich selbst Messe, weil es ins Netz zurückgeht. Weil das sehe ich an und für sich. Der Smart Meter zeigt mir das nicht an, dass es da einen negativen Wert gegeben hätte.

Sprecher 1

Ah ja, okay. Ja das wär ganz interessant für das Datenformat dann von den Wiener Netzen wie es da ausschaut dann auch die Produktionsdaten. Das da zumindest in den Daten irgendwie widergespiegelt wird oder ob das jetzt nur eine grafische Darstellung von der Web Oberfläche ist.

Sprecher 2

Ja, aber da ist.. also unter 0.

Sprecher 1

OK, aber eh ein cooles Zeichen zumindest, dass das..

Sprecher 2

Wenn du möchtest, kann ich dann noch ein Screenshot schicken oder so. Hier zum Beispiel da um 09:00 Uhr Bottomt das einfach aus bei 0 und macht erstmal nicht weiter.

Sprecher 1

Ah ja, stimmt. Ah ja, cool. Witzig.

Sprecher 2

Also, cool wäre natürlich, wenn ich sehen könnte, was ich eingespeist hätte.

Sprecher 1

Interview 4 – N-Ergy View (19.03.2024)

Das ist Ja voll. Aber kriegst du dann so, weil ich das nur gesehen hab, aber kriegst du wahrscheinlich keine Sonne mehr, wahrscheinlich so direkt drauf.

Sprecher 2

Später.. also meine Paneele sind ganz ostseitig ausgerichtet, also Ost/ Südostseite, das heißt ab 12 ist es dann irgendwie schon nur noch so 20 Watt oder maximal 30,40 ich weiß es nicht.

Sprecher 1

Mhm. Ja, verstehe. Okay cool. Ahm. Da hätte ich dann eh vielleicht so ein bisschen die Frage, ich mein.

Sprecher 2

Hier ist die Lastkurve. Die ist vielleicht noch spannender und eigentlich ein bisschen mehr so.

Sprecher 1

Aja cool

Sprecher 2

Die Bottomt dann halt einfach aus.

Sprecher 1

Das ist schon cool, witzig.

Sprecher 2

Ich mache dir einen Screenshot davon.

Sprecher 1

Ja, sehr gerne. Also kannst du das schicken?

Sprecher 2

Und das war der 13. März die korrespondierenden Daten dazu aus meinem eigenen System. Wenn es geht. Die sind hier. 13 oder das sieht dann so aus für mich. Da ist halt diese eine Stunde, wo es ganz gelb ist, der Balken nur Eigenproduktion und dann ein kleiner Zipfel unten violett. Das war die Einspeisung, das heißt, das ist definitiv in dieser einen Stunde ist netto mehr Energie ins Netz geflossen als hinaus genommen worden und es sind auch, es ist gar keine Energie aus dem Netz genommen worden oder fast keine erstmal zum Anlaufen von den..

Sprecher 1

Ah ok.

Sprecher 2

..0 Kilowattstunden sind in die Wohnung hineingegangen, zu diesem Zeitpunkt oder in diesem Zeitraum.

Sprecher 1

Cool.

Sprecher 2

Genau.

Interview 4 – N-Ergy View (19.03.2024)

Sprecher 1

Ja, das ist ziemlich nice.

Sprecher 2

Macht dir einen Screenshot von den korrespondierenden Daten. Dann kann ich dir dann beides zukommen lassen, wenn du möchtest.

Sprecher 1

Sehr gerne. Das ist jetzt eh ganz cool, weil ich meine Fragen dazu ein bisschen anders dann stellen würd. Aber du hast jetzt eh gesehen.. okay man hat jetzt diese Energie oder Verbrauchsdaten, was kannst du dir halt vorstellen, was man so damit anfängt. Natürlich jetzt diese Visulisierungen halt und so, aber du kannst dir eigentlich vorstellen, dass man..

Sprecher 2

Ich meine, ich habe natürlich selbst Erfahrungen damit gemacht auch. Für mich war irgendwie vieles als Feature in Home Assistant implementiert worden ist, relativ bald spannend, einfach mal irgendwie sich einen Überblick zu verschaffen. Also ich hab damals noch keinen Smart Meter gehabt.

Sprecher

Mhm.

Sprecher 2

Glaube ich ja ne, noch kein Smart Meter gehabt. Sozusagen eh gar keinen Zugriff. Also meine einzige Möglichkeit wäre gewesen, ich gehe einmal am Tag runter in den Keller und schaue den Zählerstand an und weiß dann nachher, wieviel Energie ich an diesem einen Tag verbraucht hab oder ich schau halt auf meine Abrechnung und rechne mir aus, wieviel es durchschnittlich ist und darauf baue ich dann halt auf. Ähm. Diese reinen Verbrauchsdaten, die habe ich am Anfang genutzt, bevor ich Detaildaten hatte von einzelnen Geräten und hab dann irgendwie einfach mal. Das war damals. Da ist dann Ukraine und so aufgekommen in ein paar Monate nachdem diese Energiedaten verfügbar waren. Für mich glaub ich. Also die Energiekrise in Europa, die ganze Energiekrise mehr oder weniger ist aufgekommen, wo man sich halt aus mehreren Gründen nochmals eines Energieverbrauchs bewusst geworden ist. Und sich auch selbstbewusst gemacht hat.

Sprecher 1

Ja.

Sprecher 2

Und was hab ich da gemacht? Ich hab dann halt einfach mal geschaut, wie das ist, wenn ich hab halt Echtzeitdaten gehabt, sprich ich konnte einzelne Geräte in meinem Haushalt abstecken. Und live sehen wie der direkte Stromkonsum halt gesunken ist oder sinkt ne, also sprich wenn ich dann ich hab lange Zeit irgendwie versucht, wie minimiere ich jetzt den idle Stromverbrauch in der Wohnung? Ja, indem ich einfach gerät abgesteckt hab und geschaut hab wieviel die brauchen, dann kommen das... Die Sachen weiß man zum Teil implizit eben also ein angestecktes handyladegerät verbraucht keinen nennenswerten Strom auch wenn also wenn kein Handy dransteckt und das Ladegerät einfach bleibt das ist nicht nennenswert, genauso wie es nicht nennenswert ist, dass der Fernseher im Standby steht, weil da gibt es ja diese ganzen EU Regularien schon wieviel das verbrauchen darf und so. Das heißt das ist eh.. also ich mein wenn das halt 0,1 Watt oder so braucht, dann summiert sich das nicht mal übers Jahr zu irgendeinen nennenswerten Betrag auf oder Energieverbrauch auf. Sprich dieses alles

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zwanghaft abstecken was angesteckt ist, ist nicht so unbedingt mein Ding, aber was ich schon gemerkt hab ist, dass es einzelne Geräte gibt die obwohl sie einem recht passiven Eindruck machen, trotzdem Energie verbrauchen. Und das konnte ich eben dadurch erkennen, dass ich die dann halt einfach gesucht habe oder geschaut an welchen Steckdosen wird überhaupt noch Strom gezogen in meiner Wohnung? Und dann Geräte abgesteckt und gesehen, was das halt für ne Auswirkung, also in Echtzeit halt gesehen was das für ne Auswirkungen auf den direkten Strombezug hatte und ein so ein Fall war ich hab so eine Luftreiniger, also ein Hepafilter der halt Luft umwälzt im Wohnzimmer und der ist halt irgendwie immer in so einer Low also low rpm Idle dings gewesen und hat aber währenddessen eigentlich immer 20 Watt Strom gezogen, das ist gar nicht nach.. also das ist gar nicht mehr nichts würde ich sagen, dafür dass der entweder fast keinen Mehrwert bietet.

Sprecher 1

Okay.

Sprecher 2

Und den habe ich dann halt eben mit meinem Home Assistant so umprogrammiert, dass der tatsächlich erst ab einem bestimmten mindest gemessenen Mindeststaubbelastungswert überhaupt anspringt.

Sprecher 1

Okay cool. OK, ja, das heißt du hast. Eh zumindest mit diesen Verbrauchsdaten viele ja, Möglichkeiten

Sprecher 2

Ja, also sogar mit den Überblicksdaten, also mit den summa summarum Daten wieviel wieviel Energie fließt gerade in die Wohnung hinein oder hinaus, mit denen konnte ich schon so die ersten interessanten.. Also konnte ich die ersten Optimierungsmaßnahmen setzen, vielleicht auch sozusagen die wichtigsten, weil man sieht ja eh schon eigentlich, was passiert. Spannender ist halt eigentlich dann trotzdem gewesen, einzelne Geräte mit Messgeräten zu versehen und zu sehen, wie halt jetzt der Verbrauch so in der Relation aussieht. Also alles was da drinnen ist miteinander, also sprich was ist der Tiefkühler, welchen Anteil hat der Tiefkühler, welchen Anteil hat der Kühlschrank, welchen Anteil hat ich, weiß nicht der Fernseher.

Sprecher 1

Ja

Sprecher 2

Und also ich mein, meine Beobachtung ist so, aufs Jahr gesehen ist glaub ich mein größter Verbraucher. Das ist eine Steckdose, da stecken halt ein paar Sachen dran, das ist der Fernseher. Nicht unbedingt als der Fernseher, sondern halt das, was die Sachen dort in diesem Kasten die ganze Zeit idle läuft. Das ist halt Modem, Router, Raspberry Pi Server mit USV. Und.. also WLAN Access ist halt ein bisschen so ein kleines Haustechnik.

Sprecher 1

Ja, genau.

Sprecher 2

Also hausnetzwerktechnik Kasterl und das zieht halt irgendwie durchgehend so 30,40 Watt und das aber halt so das ganze Jahr durch 24 Stunden am Tag ja.

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Sprecher 1

Genau. Ja, okay.

Sprecher 2

Das heißt, der Idleverbrauch ist halt mindestens bei 80 Watt insgesamt in der Wohnung und damit geht halt dann It's jugging Alone nicely.

Sprecher 1

Yes, ich verstehe ich. Okay cool, ja, ich. Du hast da mit dieser Home Assistance sehr viele Funktionen. Ich hätte eine Applikation oder eine Forschungsapplikation, die habe ich jetzt N-Ergy View getauft. Und ich meine, ich habe eh schon erzählt, aber ich erklär es nochmal, du würdest aus dem Verbrauch verschiedenste Prognosen ableiten können für die Zukunft und der Nutzer würde irgendwelche Rückmeldungen bekommen wenn er über oder drunter dber diese Prognosen wäre. Und würde halt, wenn er vielleicht zu drüber ist, irgendwie Energiespartipps bekommen. Wenn er unterhalb ist, würde er vielleicht irgendwelche Anreize bekommen, dass er halt weiter Energie spart. Wäre so ein Geschäftsmodell. Was hältst du von seiner Idee grundsätzlich und würdest du so eine App auch verwenden wollen oder diese Funktionen davon zumindest?

Sprecher 2

Also die finde Prognosen schon spannend, glaube ich. Halt alles was dann so gameifications Incentives oder oder ich mein Gut Tipps sind jetzt nicht notwendigerweise ein Shaming, aber können dann vielleicht auch so interpretiert werden.

Sprecher 1

Ja.

Sprecher 2

Genau angeht weiß ich nicht, ob ich da so. Also für mich ist die Motivation, Energie zu sparen schon eher intrinsisch, als dass ich dazu jetzt dann noch irgendeine extri.. also extrinsischen Motivator bräuchte. Nichtsdestotrotz sind, glaube ich, Prognosen an und für sich recht spannend. Mich würd in dem Zusammenhang halt als technikaffine Personen interessieren, wie die zustande kommen auch also... Ja. Weil also ich kann mir vorstellen, dass ich schnell das Gefühl bekommen würde, hier ist eine Prognose und ich bin drunter, also ich, ich erreiche sie nicht, ich bin drüber mit meinem Energieverbrauch, fühl mich aber eigentlich vollkommen unschuldig daran, weil die Prognose vielleicht doch irgendwie einfach Parameter falsch evaluiert hat vorher und dann werde ich nachher gescholten dafür, dass ich zu viel Energie verbraucht habe.

Sprecher 1

Ja, genau.

Sprecher 2

Dann...Oder dann bekomme ich nachher Tipps, wie ich mehr Energie spare. Aber in Wirklichkeit war das Problem, dass halt die Heizung zweimal öfter angesprungen ist, weil die Wärmepumpe zweimal öfter angesprungen ist, weil das Wetter nicht sonnig war, wie die..? Ja genau.

Sprecher 1

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Ja, natürlich. Natürlich wäre das die ein oder andere Geschichten. Aber du würdest da schon Vorteile für dich sehen generell bei so Prognosewerten.

Sprecher 2

Also ich, ich kann mir vorstellen, dass halt sozusagen der.. Wenn ich, wenn ich eine Kurve vor mir sehen würde, die sozusagen hier eine Prognose für den Rest des Tages oder so darstellen würde. Kann ich mir schon vorstellen dass ich Ambitionen entwickeln könnte zu sagen haha da bleibe ich jetzt drunter ja das das schaffe ich oder denen zeige ich es oder keine Ahnung ja und dass ich da dann sozusagen diese Challenge so annehmen würde und dann schauen dass ich halt darunter bleibe probiere ich jetzt halt ich meine es ist immer so eine Frage meistens bedeutet verzichte auf Energiekonsum auch Verzicht auf eine Form von Komfort. Also ich verbrauche Energie nicht einfach zum Spaß.

Sprecher 1

Ja, sicher, natürlich ich mein es könnten halt irgendwelche Stellen sein die du halt übersehen hast, nicht. Ich mein du hast Sicher einen guten Überblick mit deinem Home Assistant, aber.

Sprecher 2

Die Frage ist für mich dann irgendwie eher so. Ja dann sagt mir die Prognose, so viel Energie werde ich heute noch verbrauchen und bitte bleibt drunter, aber ich muss heute die 60er waschen, was mache ich dann? Dann peake ich drüber und dann.

Sprecher 1

Ja, klar. Dann wirst du doch geshamet.

Sprecher 2

Ja, wird ich geshamet oder hab ich halt irgendwie was blödes gemacht und eigentlich ist es für mich aber alternativlos gewesen oder? Keine Ahnung, diese Energie muss ich irgendwann verbrauchen, ja.

Sprecher 1

Ja klar, ich meine, du könntest es auch so sehen, dass wenn du eh brav warst in Anführungszeichen jetzt und da gute Energie gespart hast, dass du sagst, OK. Jetzt gönne ich mir die Ladung.

Sprecher 2

Jetzt gönne ich mir die Ladung Wäsche. Nein, ich frage mich schon eher irgendein bisschen, also diese Patterns, die man da drin halt dann finden kann, worauf oder was kann man mit denen dann machen? Also wie, wie regelmäßig ist das Leben um dann halt.. ich mein, wenn man jetzt sagt, OK, gut, die Prognosen beziehen sich eh nur auf Tageswerte oder so oder wochenwerte, dann ist es vielleicht was anderes, dann ist es irgendwie mehr so ein Jahr, irgendwann averaged sich halt der Verbrauch ein bisschen aus.

Sprecher 1

Ja.

Sprecher 2

Aber ich meine. Ja, also ich kann mir vor.., also es ist halt so. Die, die ein. Ich sehe die einzigen Möglichkeiten, Energie zu sparen, sind halt sozusagen irgendwo auf die auf die Komfort Overheads die man sich gönnt zuverzichten zum Teil also das ist in meinem Fall vielleicht einfach, ich spiele eine Stunde kürzer mit dem Flugsimulator. Genau, und das macht einen großen Impact. Aber es sind halt

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einfach so. Energie ist halt auch einfach in sehr vielen, also in sehr großer Hinsicht einfach eine necessity für das tägliche Leben, wo man auch einfach nicht sagen kann..

Sprecher 1

Eben.

Sprecher 2

Jetzt, da dreh ich jetzt runter oder so. Ja also ich..

Sprecher 1

Ja, genau.

Sprecher 2

Kann mich natürlich anstatt meine 2 Bildschirme am Arbeitsplatz fürs Homeoffice zu verwenden, kann ich mich auch mit dem Laptop auf die Couch setzen, halb so produktiv sein und doppelt so viel Kreuzschmerzen bekommen. Aber ist es deswegen eine gute Idee, oder soll dann das Tool mich dazu incentivieren das zu machen?

Sprecher 1

Ja, sicher, natürlich. Es sind halt immer die Fragen, wo du halt herumschraubst so Geschichten halt. Genau. Ich wollte dich ja eh einfach weiterfragen was du für weitere Features vorstellen könntest oder ein bisschen diskutieren also eine Idee wäre zum Beispiel dass du dann auch Daten über deinen Vertrag also aktuellen Energievertrag teilst im Sinne zumindest im Preis. Und den dann auch quasi in die Prognosewerte rein gibst oder halt auch für spätere Analysen, jetzt so gespart hättest du oder wärst du energiesparend unterwegs, hättest du so und so viel Euro gespart, zum Beispiel. Könntest du A sowas auch vorstellen, Daten zu teilen und B gefällt dir das Feature.. Also ist das ein cooler Faktor irgendwie für dich?

Sprecher 2

Ich glaube, es könnte sich entfalten. Wenn man, also ich mein gut einerseits, ich kann natürlich eingeben, meine Energie kostet so und so viel Cent pro Kilowattstunde, da ist halt der Mehrwert, glaube ich, halt gut, dann ist es stets einmal da. Spannender ist es vielleicht bei so Tagesfloatarifen, wo die Energiepreise tatsächlich variabel ist.

Sprecher 1

Mhm.

Sprecher 2

Wo man dann auch einfach mit der Prognose und den variablen Energiepreis vielleicht dann tatsächlich irgendwann sagt, OK, gut, ich möchte heute Abend eigentlich noch einen 60er waschen, aber der Strompreis ist gerade voll in der Höhe und wird möglicherweise morgen früh niedriger sein dann mache ich diese, stell ich diese Überlegung vielleicht an und sag mir gut, ich wasch die Wäsche morgen inder früh.

Sprecher 1

Mhm.

Sprecher 2

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Ja, aber so für ganz statische Strom oder Energiepreise weiß ich nicht. Müsste ich nicht aus meinem Vertrag heraus Daten teilen, sondern da würd ich mich glaub ich wohler fühlen, wenn ich sag, ich trag das einfach ein.

Sprecher 1

Händisch ein OK. Was würdest du auch dann zum Beispiel davon halten, wenn du so gewisse Analysen über den Verbrauch hast als auch Haushaltsmäßig? Du verbrauchst so und so viel Killowatt und dass du dann ein bisschen so Sergleiche siehst mit den ja entweder umliegenden Haushälten oder ähnlichen Haushälften. Wäre das auch für eine coole Option für dich?

Sprecher 2

Also ich glaube, damit eine tatsächliche Vergleichbarkeit gewährleistet ist, müssen ziemlich viele Parameter aus dem persönlichen Leben einfließen. Also da geht es einerseits auch um so.. Weiß ich nicht. Special Needs die man vielleicht hat, da geht es anderseits auch um, ist das ein Familienhaushalt mit Kindern, die automatisch einen viel höheren Energiebedarf haben?

Sprecher 1

Genau.

Sprecher 2

Äh. Also ich glaube, ich bräuchte diese soziale Einordnungskomponente für mich.. nicht.

Sprecher 1

Nicht so. OK.

Ich seh s nicht, also ich mein einerseits so ich mein gut.. einerseits glaub ich würd ich meine eigenen Daten nicht so gerne dafür zur Verfügung stellen..

Sprecher 1

Natürlich.

.. also auf die auf die bisschen was auf die Gefahr hin, dass das dann halt irgendwie auch dass ich der einzige Datenpunkt in deinem Vergleichsset bin und dann vergleicht es.

Sprecher 2

Direkt und andererseits auch. Ja, nein, das ist vielleicht der Grund und die andere Richtung ist, was hab ich davon, wenn ich mich mit anderen Vergleich. Na ich seh, dass ich ein ganz schlimmer war oder ich seh, dass ich hier super brav bin.

Sprecher 1

Vielleicht das nicht, aber wenn du sagst, ich nehme jetzt mal an, du kannst das relativ gut vergleichen, du kannst halt anhand weil personenanzahl, Quadratmeter und ähnliches verhalten.

Sprecher 2

Also es werden halt auch alles Parameter, die ich einfach beim beim Erstellen meines Accounts oder so eingeben würde

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Sprecher 1

Vielleicht halt zum Beispiel, nicht? Du gibst an wie viele Personen. Also das könnte man machen zum Beispiel. Und wenn du jetzt das so relativ Daumen mal Pi vergleichen könntest, würdest du da auch einen Vorteil sehen, so ah OK, jemand der so ähnlich lebt wie ich, verbraucht nur so und so viel. Wie schafft er das obwohl relativ ähnlich. Okay spielt auch gern Flight Simulator oder..

Sprecher 2

Ja, also für mich ist es nicht super interessant. Also ich mein ich, ich kenn auch Leute aus meinem Umfeld die halt weiß ich nicht energiesparsamer leben als ich weil sie nicht so viel oder nicht so große Technologiebegeisterung wie ich haben und halt dann irgendwie viel Zeug zu Hause. Die halt ja oder halt Ich weiß nicht klassisch ist irgendwie oder klassisches Beispiel nicht unbedingt aber ein naheliegendes Beispiel ist ein Kollege, ein Studienkollege von mir der bei mir im selben Haus eingezogen ist und im Erdgeschoss wohnt. Und halt irgendwie tatsächlich kaum Energie verbraucht und seinen Computer so gebaut hat, dass der Passiv gekühlt ist und underclockt undervoltet und was weiß ich was alles.

Sprecher 1

OK, cool

Sprecher 2

Und. Ja ich mein wir sind jetzt ein 2 Personen Haushalt und er ist ein Einpersonen Haushalt das heißt er ist natürlich nochmal weniger aber viel von dem Energieverbrauch den ich hab der ist halt irgendwie eher beeinflusst von langfristigen Investitionen wie mein Fernseher ist groß und er hat keinen Fernseher oder Ich weiß nicht ich Kauf den Kühlschrank mit a plus plus plus plus oder ich Kauf halt den billigen Kühlschrank den ich einstellen kann weil ich ihn mir Grad leisten kann.

Sprecher 1

Genau

Sprecher 2

Auf vielerlei Energie verbrauch.. oder Ich glaube so für die die großen Verbraucher die in Summe dann die viele Energie verbrauchen, habe ich eigentlich kurzfristig keinen Einfluss und das würde mich dann vielleicht eher frustrieren wenn ich mich im Vergleich mit anderen Leuten sehe und dann so ah ja gut damit ich den jetzt damit Ich weiß nicht im Ranking aufsteige auch nur implizit irgendwo in eine andere Perzentile komme, müsste ich jetzt meinen Kühlschrank austauschen oder meinen Fernseher wo neu kaufen und das ist glaube ich, dann halt also.. Ja, die großen Energiespargelegenheiten sind nicht, wie viele sich ergeben. In vielerlei Hinsicht ist man ja.. In diesem Fall finde ich es Gott sei Dank ausreichend bevormundet mit so viel darf halt ein Fernseher im Standby ziehen.

Sprecher 1

Ja genau, okay cool. Jetzt haben wir viel über Features fällt, fällt dir noch irgendwie ein Feature ein, was du gerne hättest zum Beispiel wo du sagst, ah, das wäre super das könnte die App noch machen.

Sprecher 2

Also ich meine generell ich.. Wie soll ich sprechen als jemand, der noch nicht genaueres über das Eddie Framework und die Datenstrukturen weiß? Oder soll ich sprechen als jemand, der einfach ins..

Sprecher 1

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Sprich einfach aus Kaspars Sicht.

Sprecher 2

Okay naja gut, also ich mein ich, ich bin ja großer Fan von Echtzeit oder von den Echtzeit Daten die halt die das Privileg zu verarbeiten ich genieße. Also wenn wir über Prognosen reden, kann ich mir irgendwie schon vorstellen, dass ich das ganz cool finden würde, dass es Prognosen gibt, die unterschiedliche Pfade aufzeigen, die abhängig sind von unterschiedlichen Entscheidungen, die ich treffe. Okay also so stelle ich mir halt vor, dass ich mir dann mehr oder weniger, wenn ich diese Visualisierung vor mir hab, so OK gut, wenn du jetzt Wäsche wäscht, dann wird es so gehen. Wenn du jetzt den Flugsimulator anmachst wird so gehen und wenn du jetzt einfach schlafen gehst, dann..(inaudible)

Sprecher 1

Ja, genau.

Sprecher 2

ist das alles ein. Ob das dann auch tatsächlich irgendwie einen Unterschied macht oder nicht ist dahingestellt. Vielleicht also ich mein, ich will da auch irgendwie nicht dann, wenn ich irgendwas mache, ein schlechtes Gewissen dabei haben.

Sprecher 1

Okay ja, verstehe schon.

Sprecher 2

Finde ich. Also es ist halt irgendwie schwierig. Oder beziehungsweise wenn ich das dann bekomme, das schlechte Gewissen, dann ist die App sehr schnell wieder deinstalliert.

Sprecher

Ja. Ja, okay verstehe. Ähm. Genauso vielleicht Back to the.. dieser Grundfunktion von dieser App mit den Prognosen. Du würdest halt.. eine Idee ist zum Beispiel, dass du ein Lämpchen hast in der App auf dem Interface das leuchtet grün, zum Beispiel beim energiesparenden Konsum und rot halt bei einem energieingieintensiven Konsum. Was würdest du da für Rückmeldungen positiv sehen? Also reicht dir das in der App, wenn das einfach so erscheint oder könntest du dir auch vorstellen, dass da ziemliche Alerts bekommst oder so genudged wirst? Auch irgendwie..

Sprecher 2

Also. Geht es um Energie oder um Leistung und kriegst du diese Daten in Echtzeit? Also ich mein, wenn ich im Nachhinein genudged werde, dann glaube ich, bin ich so äh, wenn ich so live jetzt so eine Benachrichtigung bekomm so irgendwie deine Wohnung zieht gerade über 8 KW.

Sprecher

Mhm.

Sprecher 2

Ist alles in Ordnung? Oder hast du irgendwo einen kurzen?

Sprecher 1

Ja voll.

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Sprecher 2

Dann finde ich, ist es irgendwie ja spannender. Ansonsten glaube ich Benachrichtigungen, persönliche Präferenz ich unterbinde mittlerweile Benachrichtigungen von allen Apps die mir schreiben wollen aus welchen Gründen auch immer und also mein iPad ist überhaupt so aufgesetzt dass mir nichts eine Benachrichtigung schicken kann und das genieße ich sehr also ich glaub I'm over it wie das mit anderen ausschaut kann ich natürlich schwer beurteilen.

Sprecher 1

Verstehe. Ja, klar.

Sprecher 2

Sonst gesagt, dass dieses Grüne oder rote Licht oder so ist halt auch Echtzeitdaten spannend, verspätete Daten halt so. Ja, was hätt ich machen sollen? Gefühlt ja oder dumm gelaufen.

Sprecher 1

Es sollte schon zumindestens den Weg halt anzeigen können. Ja so welchen eben auch Trend du dich halt Grad bewegst (inaudible) Ich mein natürlich cool wäre und später soll es auch hoffentlich funktionieren, dass du halt schon relativ das Echtzeit dann bekommst. Genau. Ähm. Genau kurz zu dem Feedback noch. Es wäre auch eine Möglichkeit. Zum Beispiel überlegt, wer oder ist, dass du auch emotionale Bilder gezeigt bekommst beim Konsum.

Sprecher 2

So wie beim Rauchen.

Sprecher 1

So in der Art halt nicht? Du bekommst zum Beispiel, ich zeig dir ein paar Bilder. Also hier eben wäre so ein Bild von getrockneter Erde und halt ja ein bisschen düster oder wenn du auf dem energiesparender Weg bist wird es ein grüner Fluss und schön Wald.

Sprecher 2

Aber ist das, wenn ich die App aufmache?

Sprecher 1

Ja genau, es wird sich halt dann dynamisch das Interface anpassen.

Sprecher 2

Und gibt es einen Gradienten dazwischen, wo das verläuft, oder ist das so? Entweder oder oder mehrere Stufen oder wie?

Sprecher 1

Könnte man natürlich ein bisschen auch machen. Ja, oder halt ein bisschen unterschiedlich, dass du auch zum Beispiel ein Eisbären oder Eis siehst.

Sprecher 2

Ich muss sagen, ich find es ein bisschen edgy, aber..

Sprecher 1

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Also das wäre eine Option halt. Ich weiß nicht was empfindest du da oder was? Was ist deine Meinung?

Sprecher 2

Persönlich möchte ich glaube ich in so einer App die Daten sehen und nicht eine nicht eine emotionale Manipulation. Dafür würde ich sie dann halt irgendwie nicht installieren wollen, sondern wenn ich sie installieren will, dann möchte ich ja irgendwie so einen Nutzen oder so daraus haben und.

Sprecher

Okay. Mhm.

Sprecher 2

Ich mein ich, ich seh schon woher das kommt. Das ist. So die die Bilder auf den Zigarettenpackerl will auch kein Raucher freiwillig drauf haben. Ja und er muss aber weil er von außen gezwungen wird, das heißt solange der Zwang nicht da ist solche Bilder in der App drin zu haben. Ich mein wenn man das tatsächlich in irgend eine, Gamificationschiene schieben will, wo dann halt irgendwie jeder gute gesparte Energie tagt, dann irgendwo ein Bäumchen wachsen lässt oder so und dann sieht dann halt, dass es besser wird oder irgendwelche Punkte sammeln okay.

Sprecher 1

Genau das wird sicher auch ne Idee erhalten. Ja.

Sprecher 2

Vielleicht.

Sprecher 1

Mhm.

Sprecher 2

Eher aber halt einfach nur so. Ja etwas wieder viel Energie verbraucht und die Erde versauert. OK cool ja sorry guys.

Sprecher 1

Genau it`s your fault. Genau.. dann generell noch so ein bisschen zur Visualisierungen also.. Hast du da irgendwelche Präferenzen bei der Aufschlüsselung oder halt Aufschlüsselung aber wie? Also Verbrauch ist meistens eh klar was da dargestellt wird, aber zum Beispiel auch Visualisierung wo du sagst ah das wär jetzt noch cool eben. Kannst du da irgendwas vorstellen noch? Also werden zum Beispiel auch die Kosten irgendwie, die Visualisierung halt eine wichtige Sache auch.

Sprecher 2

Wie visualisiert man die Kosten also ich meine Ich habe an und für sich auch so ein kostenberechnungsding in meinem Home System drin dass man sagt wieviel die Energie jetzt in einem jeweiligen Tag mich ungefähr gekostet haben hätte sollen oder?

Sprecher 1

Okay.

Sprecher 2

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Äh, ob jetzt dann jeder Balken eine eigene, einen eigenen Preis bekommen muss oder so weiß ich.. Nicht ob mir wichtig wäre. Vielleicht die Sub, also die Geräte einzeln, wenn die irgendwie einen Energiepreis bekommen, das ist vorstellbar, aber auch irgendwie vielleicht dann also ja. Setzt vielleicht etwas in einen Kontext, der dann irgendwie also. Kann ich mir schon eher vorstellen, dass ich sag, so hier einzelnes Gerät so und so viele Kilowattstunden ist gleich Preis dieser und jener für den Betrieb für Zeitraum XY. Ist dir das so wert oder nutzt du das mehr als das dir vielleicht wert ist? Oder ich weiß nicht, oder das ist dann pro Betriebsminute so und so viel Geld, dass man vielleicht auch was, was man dann noch mit hineinnehmen könnte. Ja, kann ich mir vorstellen, aber für mich glaube ich eher interessant auf Geräte-Ebene als auf ja, als auf makroebene, weil halt so, ja.

Sprecher 1

Also Makroebene.

Sprecher 2

Die Rechnung kriege ich ja eh.

Sprecher 1

Ja klar.

Sprecher 2

Und einen wirklichen Einfluss habe ich dann halt auch irgendwie nicht so. Ich mein interessant wäre, wenn man halt wirklich so einen super floater Floattarif hat, der sich tagsüber im Preis ändert, dass sich halt irgendwo meine Leistungsaufnahme geplottet gegen die Preiskurve sehe, sozusagen, ja.

Sprecher 1

OK, verstehe.

Sprecher 2

Das weiß ich nicht. Wenn ich dann irgendwie schaff, dass sich die Kurven einfach genau gegengleich bewegen, ja dann hab ich mein Ziel erreicht, sozusagen, dass ich die Energie nur dann verbraucht hab, wenn sie günstig war oder so.

Sprecher 1

Ja genau, ich überleg nur, gerade weil du ja auch die kleine Anlage hast ob da irgendwie auch zum Beispiel noch oder was Wichtiges wäre, was du darstellen hättest wollen, also zum Beispiel eben die Prognosen vielleicht wären cooler eben.

Sprecher 2

Habe ich

Hast du eh. Mhm.

Sprecher 2

Gibt's da eine API die sind halt so lala.

Sprecher 1

Mhm,

Interview 4 – N-Ergy View (19.03.2024)

Sprecher 2

Weil Verschattung nicht hineingerechnet werden kann so.. Einfach.. Funktioniert, aber es funktioniert halt so bedingt. Meistens ist es über den Tag gesehen optimistischer, also wirklich produzieren kann aber über die Stunde dann vielleicht auch manchmal ein bisschen pessimistisch.

Sprecher 1

Mhm, aber dass du sagst, OK, du ich mein theoretisch könntest du auch mal den Strom verkaufen. Zum Beispiel könnte man das auch irgendwie gegenrechnen, würde das auch irgendeine Option für dich das man sagt ok wen du so und so viel Strom produzierst würdest du sowas erhalten und gegengerechnet am Verbrauch.

Sprecher 2

Finde ich ganz cool, fände ich spannend. Derweil ist es halt so rechtlich Netzbetreiber, Energieversorger mäßig, so dass die Kleinsterzeugungsanlagen einfach ins Netz Hineinspeisen, ohne jemals dafür zurück vergütet zu werden. Ich mein, wenn halt irgendwie, dann so. Ja gut, du hast eine Kleinerzeugungsanlage und speist zurück ein und das fließt halt in dieses Ding hinein und dann kommt durch die Gamification da ein Bäumchen mehr auf dem verdorrten Land, wenn du eingespeist hast oder halt ein spezielles Blümchen oder so zum Beispiel

Sprecher 1

Ja, genau,..

Sprecher 2

Ja, dann kann man sich auf die Schulter klopfen dafür, dass man zu viel Geld ausgegeben hat für eine Kleinerzeugungsanlage auf der Terrasse, die kein Mensch eigentlich braucht.

Sprecher 1

Ja, aber trotzdem cool irgendwie.

Sprecher

Ähm.

Sprecher 1

Dann noch vielleicht generell so Zeitreihen Visualisierung ich mein du kennst natürlich eh klassisch Line Chart, Barcharts natürlich. Würdest du da auch irgendwie sehen wollen, dass man irgendwelche coolen anderen Visualisierungstechniken anwenden kann, das du so Data Exploration machst irgendwelche Heatmaps, aber es gibt auch sehr verrückte andere Darstellungen.

Sprecher 2

So, ich überlege gerade, welche Dimensionen so eine Heatmap haben könnte, dass es auch Sinn ergibt ne, weil wenn ich halt jetzt eine Heatmap mache, die irgendwie so Stunden über den Tag und das Ganze dann auf einen Monat oder so oder so. 30 * 24 ein Raster vielleicht und so und dann hast du das.

Sprecher 1

So was zum Beispiel ich da so pro Datenpunkt irgendwie..

Interview 4 – N-Ergy View (19.03.2024)

Sprecher 2

Und dann siehst du halt wie sich das über die Tage verteilt also wieder sich.

Sprecher

Ja.

Sprecher 1

Also würdest du das grundsätzlich.

Sprecher 2

Also ich würde es mir mal anschauen wollen, aber ob ich es dann so wertvoll finde, kann ich jetzt grad schwer einschätzen. Also ich selber bin schon ein großer Fan von den Barcharts.

Sprecher 1

Ja, genau. Barcharts halt.

Sprecher 2

Weil halt irgendwie. Also ich finde, sie repräsentieren gut, dass da eine Zeit Komponente im Spiel ist und ein Zeitraum immer gesehen wird, weil immer wenn du eine Kilo. also wenn es um den Verbrauch von Energie geht. Ist immer ein Zeitraum maßgeblich. Verbrauchsleistung im Moment, dafür sind ein Linechart ganz günstig, aber sobald es halt um einen Zeitraum geht, in dem du Energie verbraucht hast, finde ich, ist der Barchart, dessen Fläche dann halt mehr oder weniger das verbrauchte, die verbrauchte Energien repräsentiert, das richtige Werkzeug um das darzustellen. Also für jetzt wie viele Kilowattstunden hast du hier und da verbraucht einen Line Chart zu verwenden finde ich glaube ich verkehrt einfach, also es ist nicht die richtige Datenrepräsentation.

Sprecher 1 Okay cool,

Sprecher 2

Also ich mein, der der Graph würde halt auch voll komisch ausschauen, glaub ich dann.

Sprecher 1

Ja klar,

Sprecher 2

Also anders ist es natürlich mit kumulativen Visualisierungen, wo man jetzt so sieht ja hier geht, die Kurve über den Tag nach oben und so, wieviel Energie halt und dann bist du oben am Ende angekommen, da macht natürlich ein Line Chart dann mehr Sinn als ein Barchart.

Sprecher 1

Ja auch für die Prognosen würdest du das dann auch irgendwie so sehen wollen dass es in diesen Charts dann reinkommt oder würde es dir auch reichen dass du sagst da ist ein, wo ich dann ein Zähler oder irgendein Prognosewert du wirst am Tag so und so viel kWh

Sprecher 2

Also.

Sprecher 1

Interview 4 – N-Ergy View (19.03.2024)

Oder würdest du schon so, dass du ein ich sage mal Linechart wo ein roter Strich dann für die zukünftigen Werte..

Sprecher 2

Ich mag das Paradigma, das bei Home Assistant bei den Solar, also bei der Solarvisualisierung vollendet wird, eigentlich ganz gerne. Da ist die Prognose für die Produktion ist eine gestrichelte Linie und die Energie, die dann tatsächlich produziert wird, sind Bartcharts, sprich die Prognose ist halt irgendwie so eine Outline von dem was da kommen könnte und die bleibt auch stehen den ganzen Tag.

Sprecher 1

Ah ok. Ja.

Sprecher 2

Und die wird dann halt mehr oder weniger von unten so aufgefüllt mit den mit den Barchats. Das find ich ist eigentlich ganz cool, dass halt wenn man diese Tagesdaten hat, dann geht das ganz.

Sprecher 1

Gut, ja genau, Mhm.

Sprecher 2

Es ist, wenn wir, du solltest, das eh sehen in dem Screenshot, den ich dir geschickt habe. Das ist ein Tag ohne Prognose, aber ich kann dir das gerne auch noch schicken, wie das ausschaut.

Sprecher 1

Ja, gerne voll. Das ist ja sicher (inaudible)

Sprecher 2

Damit du das siehst. Today. Drücken wir noch Prognose. Voll das sieht dann so aus. Und..

Sprecher 1

Aja. Aber es ist wieder ja.

Sprecher 2

Dann sieht man halt irgendwie so, wie die Prognose ausgesehen hätte und wo man tatsächlich war. Und bei mir ist halt in der früh einfach so.. sind 2 so Fichten, die Schatten auf meine Paneele werfen. Das heißt, die ersten paar Stunden geht es halt noch nicht so, wie es soll und dann später, wenn die Sonne hoch genug steht bin ich genau unter der Prognose eigentlich genau unter der Kurve, wie es sein sollte.

Sprecher 1

Genau jetzt haben wir eh schon ziemlich viel geredet. Noch ein paar letzte Fragen also bald sind wir fertig. Generell noch ein bisschen zu andere Fragen wären dann zum Beispiel ob du jetzt eigentlich gerne bereit wärst mit so einem Service die Daten zu teilen also gerade Energiedaten halt wärst du bereit die zu teilen wo du sagst bitte verarbeitet sie und..

Sprecher 2

Es kommt für mich halt irgendwie so auf den Austausch aus, auf das, was mir im Austausch dafür halt geboten wird.

Interview 4 – N-Ergy View (19.03.2024)

Sprecher 1

Im Sinne von Qualität der Leistungen im Service.

Sprecher 2

Ja oder was ist der Service das mir angeboten wird? Was kann das, was ich nicht selber. Erstens und zweitens.. Ja was also ich mein wenn ich meine Daten halt übermittle dass die bearbeitet werden zahle ich dann auch noch Geld dafür? Weil ich ja mehr oder weniger dann ich übermittle den ja meine Daten nicht zum Spaß haben dass die mir eine Dienstleistung erbringen und wenn man nicht mit Geld zahlt, zahlt man mit seinen Daten. möchte ich das dann machen, was auch immer das bedeuten soll? Ah. Also im Augenblick kann ich mir im Vergleich zu dem, was ich schon zu Hause hab, ehrlich gesagt natürlich einfach kein Service ausdenken, dass mir bessere Leistungen bieten würde, als was ich schon habe, aber ich bin auch nicht der Standortkonsument.

Sprecher 1

Ja.

Sprecher 2

Der sich sowieso nicht, sich so intensiv mit dem Thema auseinandergesetzt hat und sich das schon so genau angeschaut hat. Ich mein.. Also ich hab nicht so intensiv drüber nachgedacht, ob dann halt, wenn jemand anderer auf meine Daten schaut, sagt so ja hey, da kommt nur das und das optimieren oder was weiß ich was. Aber.. Wenn man nicht mit Strom heizt dann ist glaub ich das Optimierungspotenzial gar nicht so groß. Auch ja, also ich mein natürlich kann jeder sagen ui ihr Kühlschrank verbraucht aber viel Energie. Aber davon hab ich wahrscheinlich relativ wenig, oder..

Sprecher 1

Ja.

Sprecher 2

Also ich mein, wenn es nicht darum geht zu sehen, so Ah ja gut, in diesem Zimmer wurde zu viel geheizt, da ist wahrscheinlich das irgendwo das zugig ist, ein Loch in der Fensterdichtung oder weiß nicht was da wenn man das austauscht dann kann man da was sparen, dann ja voll geil ja. Also wenn halt jemand daherkommt und sich das anschaut und mehr Interpretationswissen hat dazu, dann sehe ich das schon irgendwo ein, aber ansonsten derweil kann ich mir eben keinen Service ausmalen, den Mehrwert bietet, dass ich meine Daten hergeben müsste dafür was ich nicht selber mehr oder weniger besser schon zu Hause machen kann.

Sprecher 1

Ja. Vielleicht gleich die Frage. trotzdem stell ich trotzdem, aber du müsstest halt die Daten teilen, wärst du eben auch bereit dafür zu zahlen, also.

Sprecher 2

Es kommt halt auf den Austausch an. Also man könnte ja sowas sagen wie ja he, wir bieten dir einen Service an mit Geld zurück Garantie, wir sparen dir..

Sprecher 1

Ja.

Sprecher 2

Interview 4 – N-Ergy View (19.03.2024)

So viel Prozent oder Euro Energiekosten ein und du zahlst uns halt dann, wenn sie nicht einen Zehner, wenn wir das gemacht haben. Oder du zahlst uns Prozentuell von diesen Ersparnissen im ersten Jahr diesen und jenen Betrag. Dann, wenn es halt no risk attached für mich als Konsument ist, mehr oder weniger, dann kann ich drüber nachdenken, ob sie mir das wert sein. Oder nicht? Wenn ich eigentlich die pauschal für seinen Service dann Geld bezahlen muss. Und am Ende ist das Ergebnis aber, dass ich 0,40€ Energie spare...

Sprecher 1

Es ist halt so.

Sprecher 2

Dann fühle ich mich wahrscheinlich über den Tisch gezogen. Ja, so, jetzt habe ich denen meine Daten gegeben und Geld gezahlt und am Ende habe ich nichts davon

Sprecher 1

Verstehe schon.

Sprecher 2

Ja, genau. Für so einen reinen Visualisierungsservice glaube ich würde ich, wäre ich nicht bereit Geld auszugeben.

Sprecher 1

Mhm aber wenn es jetzt halt schon eben gute Erkenntnisse zeigen würde und Analysefunktion hätte.. Oder wär es dir eher wichtig, dass du die Ersparnis auch hättest, sag ich mal so was, wenn du sagst, du sparst doch was oder ist es halt auch die Analyse ah OK, jetzt habe ich wirklich Einblick in meinen Daten oder Verbrauch in meine Patterns.

Sprecher 2

Ich finde es ist non trivial, weil es müssten insights sein, die mir mein Open Source Tool, das ich verwende, nicht auch liefern kann, dass ich sagen würde, OK, gut, dass ich mir, also ich mein zum Beispiel für die Prognose von den Daten, den Solarproduktionsdaten für die API zahle ich ein paar Euro im Jahr. Oder weiß nicht, vielleicht sind es 10,00€ oder 12,00€ im Jahr also 1€ im Monat oder so, dass ich die in höherer Auflösung und für mehrere Tage in die Zukunft hab. Das ist nur Spielerei eigentlich aber da gebe ich tatsächlich Geld auch aus dafür das ist halt irgendwie so der Value ist irgendwo da da weil ich halt dann sagen kann gut jetzt hab ich die höhere Auflösung jetzt könnte ich genauer sagen wann ich welche Geräte einschalten möchte aber eigentlich wollte ich es glaube ich nur haben weil ich mehr als einen Tag in der Zukunft sehen wollte was der Wetterbericht sagt für meine Solarpaneele und..

Sprecher 1

Ja.

Sprecher 2

Es halt dazu kommt, dass es irgendwie ein kleiner Entwickler, der das als Hobby Projekt irgendwo hostet und dann fällt es noch mal leichter zu sagen hier, das ist ein cooles Projekt, da möchte ich supporten und dann zahle ich die API.

Sprecher 1

Interview 4 – N-Ergy View (19.03.2024)

Okay wenn du das so ein bisschen ansprichst oder wenn du sagst okay ist jetzt ein kleines Startup, jetzt dieses N-Ergy View, die das macht,. Würdest du auch sagen Ja ok, mal für einen Probemonat zahle ich mal für ein paar Euro. Einfach zu schauen, ob das alles passt?

Sprecher 2

Ich weiß. Nicht ich mein Startup ist imemr so.. Für mich ist Startup irgendwie eher negativ konnotiert, muss ich sagen.

Sprecher 1

Okay.

Sprecher 2

Weil die.. mein Eindruck ist immer, dass es ein irgendeine Idee haben, dann conflaten, was es alles kann, an den nächstgelegenen Investor verkaufen sich vertschüssen und die Mitarbeiter, die man halt auf dem Weg ausgebrannt hat, die sitzen dann da drinnen fest in einem silly Product, das eigentlich kein Mensch braucht, ja.

Sprecher 1

Ja, okay verstehe.

Sprecher 2

Ähm. Mir ist es schon sympathisch, mein Ich bin deswegen bereit gewesen, Geld zu bezahlen, weil das Halt eine Einzelperson ist, die das als Hobby.

Sprecher 1

Ja, genau.

Sprecher 2

Gemacht hat. Da ist halt da ist halt Zeit und Lust hineingeflossen und es gibt nie wirklich einen Drang, dass das eine wirtschaftliche, also irgendeine wirtschaftliche Komponente haben muss, eine große, sondern es ist mehr oder weniger ein, es gibt einen gratis Zugang für die grundlegenden Daten und danach, wenn man halt so ein bisschen das genauere haben will, zahlt man einen Euro und eigentlich ist es halt irgendein dude in seiner Garage der eine Kleinigkeit gemacht und gar nicht Ambitionen hat, dass das jetzt ein..

Sprecher 1

So ein rießen Ding wird.

Sprecher 2

Wäre ja also das jetzt vom Start Up zum Scale Up oder kommerziell wird, sondern also der muss halt sein Hosting bezahlen können.

Sprecher 1

Ja klar, okay.

Sprecher 2

Interview 4 – N-Ergy View (19.03.2024)

Vielleicht kann der sein Hosting auch gut bezahlen und lebt von dem Ding ganz gut. Das kann natürlich sein, aber die Präsentation von dem Ganzen ist halt trotzdem irgendwie noch so bescheiden, dass man irgendwie nicht das Gefühl hat, der der blendet jemand undda hat jemand irgendwie so vor was.

Sprecher 1

Ja, klar.

Sprecher 2

Ein großes Geschäft daraus zu machen sollen, das ist halt irgendwie mehr so ein ich bin Enthusiast. Ich habe das selber entwickelt.

Sprecher 1

Ja.

Sprecher 2

Please für das Hosting 1€ Genau.

Sprecher 1 Okay cool,

Sprecher 2

Also ich hab das Gefühl, bei einem Startup würde ich halt zahlen mit meinem Geld und mit meinen Daten, weil die dann halt irgendwie meine Daten auch weiter verwenden für alles mögliche und ich hab über das Gefühl, dass Startups so auf ihrem Weg nach oben einen relativ ruthlessen Umgang haben mit den Ressourcen, die sie zur Verfügung gestellt bekommen. Seien das Menschen, die dort arbeiten oder auch.. Ja, also Geld und oder Daten auf diese halt zugreifen können.

Sprecher 1

Ja, verstehe. Ja, so ein bisschen abschießend jetzt noch. Du.. glaubst du mit so einer App grundsätzlich würdest du deinen Energieverbrauch im Griff haben können? Wenn du sagst, du kriegst Prognosen und eben Visualisierungen et cetera. Könntest du jetzt da glaubst d zum besten..

Sprecher 2

Also ich mein. Also als als mitteljunger Erwachsener und so find ich bekommt man im Leben jetzt tief häufig das Gefühl, sowieso nix im Griff zu haben und alles ist eigentlich das ganze Leben, spielt sich eigentlich fremdbestimmt ab in vielerlei Hinsicht und das Gleiche finde ich jetzt bei der Energie schon auch viel der Fall. Also ich hab nicht unbedingt was im Griff nur weil ich die Daten seh oder hab, sondern vieles von dem Energieverbrauch den ich hab sind halt necessities. Ja natürlich kann ich mein Modem und meinen Servern was weiß ich was alles abschalten, aber eigentlich ist das Infrastruktur die ich betreibe für mich. Ja es ist irgendwie nicht wirklich..

Sprecher 1

Verstehe natürlich ja.

Sprecher 2

Ich hab. Ja, also es ist. Die die schwingende, mitschwingende Implikation ist halt immer, dass ich Energie verschwenden würde, und das muss ich in den Griff bekommen. Aber ich hab das Gefühl, dass wir eigentlich gesellschaftlich ein recht gutes Bewusstsein dafür haben, wie wir mit Energie umzugehen. Ich muss gestehen, ich koch manchmal mehr Wasser als ich brauch, weil der

Interview 4 – N-Ergy View (19.03.2024)

Wasserkocher halt mindestens einen halben Liter Wasser drinnen haben will. Ja dann steht halt nachher Wasser, das ist wieder auskühlt, das ist tatsächlich verschwendete Energie, ist nirgendwo hingegangen, wo sie nützlich war.

Sprecher 1

Ja, weg von den Eis, von den Eisbären.

Sprecher 2

Eine Eisschole weniger für.. Wie heißt der Knut?

Sprecher 1

Letzte Frage, glaubst du kämst du den Service auf der Umwelt zugute?

Sprecher 2

Also ich kann.. In meinem Fall würde ich sagen, ist das Hosting und der Betrieb und der Aufwand, das zu entwickeln und so teurer als der Nutzen, denn die Umwelt dann davon hat. Ob das skaliert und ob das bei anderen Menschen anders wirkt kann ich, ich kann es mir vorstellen.

Sprecher1

Mhm.

Sprecher 2

Ich trau mich aber keine definitive Antwort zu geben, ob das jetzt sowieso nicht, aber ich sag es ist im Raum des möglichen und ich sage, es ist sogar realistisch. Also es ist nicht unwahrscheinlich so. Glaube es ist..

Sprecher 1

Perfekt.

Sprecher 2

Möglich mit Tendenz zu wahrscheinlich. Soweit ich mein, ich bin halt ich bin ein Ausreißer in dieser Hinsicht und ich ich weiß genau, dass ich nicht der durchschnittliche Mensch bin und über meinen, also über meinen Energieverbrauch so maximal überdurchschnittlich oder halt eigentlich schon so absolut überinformiert bin, wenn man es genau in meinem Verhältnis und dass das irgendwie aus meiner Perspektive heraus natürlich überhaupt keinen zusätzlichen oder kaum einen zusätzlichen Mehrwert, Prognosen natürlich sind was anderes, liefern würde, aber aus der Perspektive von jemandem, der.

Sprecher 1

Ja. Genau.

Sprecher 2

Sich überhaupt nicht damit auseinandergesetzt hat und das vielleicht auch dann gar nicht intensiv machen muss. Kann ich mir schon sehr gut vorstellen, dass das interessant ist. Mein Leben am interessantesten mit Echtzeit und unter also unter Submetering Daten natürlich, aber. auch so mit Tagesverbrauchsdaten kann ich mir vorstellen, wenn das halt so zugänglich ist als das, was die Wiener Netze oder die anderen Netzbetreiber so bieten und halt, ich weiß nicht, wir haben auch schon mal glaub ich drüber gesprochen. Dieses in den Wiener Netzen Online Tool kann man so Events eintragen

Interview 4 – N-Ergy View (19.03.2024)

das man zu einem bestimmten Zeitpunkt irgendwas gemacht hat, wie zum Beispiel hier, da an dem Tag habe ich den neuen energiesparenden Kühlschrank angeschlossen oder hier an dem Tag habe ich dieses und jenes Gerät abgesteckt. Man kann so Flags setzen und dann glaube ich halt irgendwie so diese Flags sehen in der Visualisierung und dann daraus mehr oder weniger..

Sprecher 1

Sachen aus..

Sprecher 2

Ja, abzuleiten, ob das jetzt was gebracht hat oder nicht. Aber mit der Verzögerung der Daten ist das eine super, langwierig, langweilige Angelegenheit, bis man dann irgendwie weiß, was da jetzt passiert.. was da jetzt passiert ist, wenn ich was bestimmtes gemacht hab, dass ich das irgendwie nie, ich wär nie auf die Idee gekommen, das zu nutzen. Aber wenn das halt irgendwie nicht bedeutet, dass ich mein Smart Meter Portal einloggen muss, mich mühsam dorthin navigieren und bla bla bla sondern wenn das irgendwie sein schnell erreichbarer Hotkey ist, wo ich sagen kann, da ist ja ein Event, das irgendwie wichtig ist, dann kann ich mir eher vorstellen, dass man daraus halt dann irgendwie noch was zieht oder halt eben, wie auch schon gesagt, das automatische Erkennen von solchen Events, wie das irgendwie..

Sprecher 1

Ja, dass es halt..

Sprecher 2

ein bestimmtes Gerät jetzt ausgeschaltet worden ist, oder?

Sprecher

Mhm.

Sprecher 2

Ja, sowas.

Sprecher 1

Ja cool, danke vielmals für das Interview. Hat mir viel geholfen.

Interviewfragen:

Beschäftigst du dich mit Umwelt Thematiken?

Wenn ja welche? Ja, müllvermeidung, interesse sich klimawandeln, thermodynam gesetze, energieverbrauch, für reisen

Wenn nein warum nicht?

Hast du dich mit deinem Energiekonsum schon einmal beschäftigt?

Führt Aufzeichnungen, Sekundenwerte, aggregiert in Stundenwerte, Daten zu einzelnen geräten, visualisierungen, impact von geräten, eigenes setup

Interview 4 – N-Ergy View (19.03.2024)

Siehst du dich als eine technikaffine Person?

Ja

Technik wichtig für klimawandel zu ändern, nachhaltige produktion

Hast du schon von der Digitalisierung im Energiebereich gehört?

Wenn ja, welche Thematiken kennst du du so? Zuhause einen Smart meter, auch in zweit wohnsitz, Iot, dimensionierung der netz

Wenn nein, was kannst du dir darunter vorstellen?

Hast du einen Smart Meter zuhause?

Nicht im hauptwohnsitz, verlgiech mit eigenen daten, 2.t wohnsitz p1 schnittstelle mit auslesegeräte

Wusstest du, dass du damit deinen Verbrauch überschaubar nachsehen kannst?

Einzelne geräte nachsehen können, geschaut an welchen steckdosen strom gezogen wird, luftreiniger,

Was kannst du dir sonst vorstellen, was man mit diesen Verbrauchsdaten machen kann?

Hier wäre eine Applikation Namens N-ergy View. Diese soll aus dem Verbrauch Prognose ableiten können für die Zukunft. Der Nutzer bekommt dann Rückmeldung, ob er dann über oder unter den Prognosen ist (mit den zukünftigen Werten). Sollte er darüber sein, bekommt er Feedback zu Energiespartipps.

Was hälst du von dieser Idee? Würdest du so eine App verwenden?

Siehst du als Nutzer einen Vorteil für dich?

Siehst du etwaige Nachteile?

Was für weitere Features könntest du dir noch vorstellen für so seine App?

Was für Rückmeldungen würdest du als positiv sehen?

Welche als negativ?(nervig?)

Wäre dir die Darstellung und Prognose von Kosten auch wichtig?

Wärst du bereit dadurch mit der App Details zu deinen Kosten zu teilen? (Grundpreis der kwh für die Berechnung)

Wenn nein, welche Bedenken hast du?

Wäre für dich die Darstellung wie viel Energie man gespart hat oder die Darstellung der gesparten Kosten wichtiger?

Hast du eine Idee oder Vorstellung, welche andere Darstellungen möglich oder Interessant wären in diesem Kontext.

Barchart, andere vislualisierungen optinla oder zum proberen

Eine weitere Option wäre die Darstellung von „emotionalen Bildern“ über deinen Konsum. Zb. Eisbär ohne Eis oder getrockneter Boden bei einem hohen Energiekonsum (Übersteigung der Prognosen) bzw.

Interview 4 – N-Ergy View (19.03.2024)

bei einem energiesparenden Konsum (Unter den Prognosewerten) wird ein grüner Wald mit blauen Fluss oder ein paradiesischer Strand gezeigt.

Wärst du bereit mit so einem Service deine Daten zu teilen?

Wenn nein, was sind deine Gründe?

Glaubst du könntest du damit deinen Energieverbrauch besser im Griff haben?

Glaubst du käme so ein Service der Umwelt zugute?

Es könnte zu gute

Würdest du auch was zahlen für so eine app?

Wenn nein warum nicht?

Wenn ja wie viel etwa?

Interview 5 – N-Ergy View (20.03.2024)

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Neue Aufnahme 10 3.m4a

Transkript

Sprecher 1

Dann drücke ich auf record und sag danke. Also willkommen zu meinem Interview. Genau also danke für deine Zeit. Kurze Background.. Also ich brauche halt ein paar qualitative Daten für meine Masterarbeit eben..

Sprecher

Ja, gut.

Sprecher 1

..und ich möchte im Rahmen meiner Masterarbeit quasi eine App evaluieren. Und ich frag dich einfach gleich vorweg, ob du dich derzeit mit irgendwelchen Umweltthematiken beschäftigst.

Sprecher 2

Mehr oder weniger. Also ich versuche ein wenig nachhaltiger zu leben und entsprechend mich auch,ja, zum Beispiel mich weniger ins Auto zu setzen und solche Dinge, aber ansonsten nicht unbedingt, aber ich würde sehr gerne mehr darüber lernen, tatsächlich.

Sprecher 1

Ja. Was verstehst du unter Nachhaltigkeit? Das ist jetzt eher dein Konsum über bestimmte Sachen, oder?

Sprecher 2

Ja genau. Und dass ich zum Beispiel nicht bestimmte Gegenstände kaufe oder Objekte kaufe, die, die ich sofort wieder wegwerfen muss, sondern die ich zum Beispiel öfter verwenden kann. Und jetzt zum Beispiel in die Richtung oder genau dann zum Beispiel beim Autofahren, oder, dass ich versuche.. Ich mein, ich kann schwierig auf andere Energien oder so weiter umsteigen zu diesem Zeitpunkt aber ich versuche mich zumindest in die Richtung ein wenig fortzubilden und zumindest zu wissen, was man ein bisschen besser machen könnte, auch wenn man es gerade selber nicht tun kann.

Sprecher 1

Ja klar ist dann ein bisschen eine Schwierigkeit. Da vielleicht noch zum Nachhaken aber hast du jemals dich mit deinem eigenen Energiekonsum schon beschäftigt?

Sprecher 2

Ziemlich wenig leider.

Sprecher 1

Okay. Würdest du dich auch so als technikaffine Person eigentlich sehen?

Sprecher 2

Ja, das schon.

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Sprecher 1

Ja, also wärst du auch der Meinung, dass man mit Technik eben Umweltprobleme lösen könnte? Oder siehst du das auch eher.. Ja, ja.

Sprecher 2

Ja, fix, auf jeden Fall. Also ich habe zum Beispiel früher selber mit Sensoren programmiert und ich war zum Beispiel bei einem Forschungsteam tätig, wo wir mithilfe von Sensoren Umwelt- ..ähm probleme praktisch früher diagnostizieren konnten in Richtung von Überschwemmungen und so weiter. Also das sind jetzt Extrembeispiele, aber ich finde es an sich sehr interessant solche Daten zu sammeln und auszuwerten.

Sprecher 1

Okay cool, ja. Da auch gleich die Frage, aber hast du auch von der Digitalisierung im Energiebereich gehört? Also wenn du eh schon über Digitalisierung redest von so IoT Sachen.

Sprecher 2

Ähm. Leider.. also im Sinne von Sensoren schon, aber davon abgesehen leider ziemlich wenig.

Sprecher

Mhm..

Sprecher 2

Aufgrund der Tatsache, dass es gefühlt so viele verschiedene Dinge gibt. Also ich wüsste jetzt gar nicht, wo jetzt was die beste Alternative jetzt überhaupt ist.

Sprecher 1

Genau, es ist halt tatsächlich so, dass.. Ja, durch verschiedenste Regulierungen, jetzt zum Beispiel auch von der EU, von.. verschiedensten Richtlinien da gekommen sind. Eine davon ist eine Richtlinie von 2019, die auch sagt, dass da jetzt der Energiekonsument quasi aktiver werden soll, zum Beispiel am Energie Markt, slash (/) Bereich oder im Sektor und das deswegen halt auch zum Beispiel diese Smart Meter Rollouts ein wichtiger Punkt ist von der .alisierung im Energiebereich, also natürlich ist es so wie du sagst eh ziemlich breit, also man.. es sind ja verschiedenste andere Sachen, es geht ja auch... Diese.. Trend hinzu den Smart Grids, eben zu Dezentralisierung oder halt verschiedenste Technologien die man braucht halt für erneuerbare Energien. Aber ich würd mich tatsächlich da hier im Rahmen des Interviews mehr auf diese Smart Meter fokussieren wollen und da wollte ich dich fragen, hast du tatsächlich einen oder weißt du ob du einen Smart Meter zu Hause hast?

Sprecher 2

Ich glaube leider nicht tatsächlich.

Sprecher 1

Okay, du hast noch quasi die alten ähm.. klassischen Zähler wahrscheinlich dann.

Sprecher 2

Also.. also ich mein.. Ich bin jetzt theoretisch umgezogen, also ich bin mir jetzt unbedingt gar nicht sicher.

Interview 5 – N-Ergy View (20.03.2024)

Sprecher 1

Ja.

Sprecher 2

Aber zumindest in der alten Wohnung hatten wir die die alten Systeme, wo dann immer ich glaub ein oder zweimal pro Jahr eine Person gekommen ist und die Abmessungen gemacht hat.

Sprecher

Aja.

Sprecher 2

Falls es das.

Sprecher 1

Genau. Ja genau, natürlich. Dieses Gerät wurde dann halt quasi in Anführungszeichen digitalisiert beziehungsweise einfach ausgetauscht gegen halt so ein Smart Meter das quasi..

Sprecher 2

Okay.

Sprecher 1

Die. ..mit dem Grid kommunizieren kann. Genau, du hast dann besseren Einblick auch selber, du als Konsument. Also ich weiß nicht.. ich mein ich kann dir kleine Funktionen erklären, aber du natürlich du kannst schon von deinem Netzbetreiber könntest du dann theoretisch halt die Verbrauchsdaten relativ granular nachschauen, also ich glaub du kannst stündliche Werte haben und tatsächlich könntest du, wenn du.. da gibt es eine Opt-In Klausel. Kannst du auch sogar viertelstündliche, also quasi „near realtime“ sagt man dazu. Genau und dann später oder halt, was eigentlich auch möglich, dass du mit dem Interface am Smart Meter könntest du auch wirklich die Sekundenwerte auslesen können, aber dazu brauchst du halt ein Lesegerät. Und ich überleit es gleich auch weiter zur nächsten Frage aber könntest du dir auch vorstellen, wozu man diese Verbrauchsdaten gebrauchen könnte?

Sprecher 2

Vermutlich um aktiv zu merken, wann am meisten Energie verbraucht wird und dass man dementsprechend dann zu diesen Zeitpunkten dagegenwirkt, oder ist das für andere Dinge?

Sprecher 1

Na du kannst ja kreativ sein. Ich weiß nicht, was dir einfällt, also wenn du sagst, ich mein natürlich, das ist ein Ding, aber weiß nicht, fällt dir noch irgendwas zum Beispiel ein?

Sprecher 2

Also das wäre für mich persönlich am interessantesten, weil dann wüsste ich genau, wieviel brauche ich zu diesem Zeitpunkt und so weiter oder auch abhängig von den verschiedenen Jahreszeiten. Wenn es zum Beispiel Winter ist, ob ich dann wirklich so viel höhere Heizkosten habe als in anderen Jahreszeiten. Finde ich spannend. Ansonsten. Also für mich ist alles was das betrifft mehr mit wie warm ist es?

Sprecher 1

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Ja, genau.

Sprecher 2

Jetzt ist aber deswegen ist es ein wenig schwierig, irgendwie noch etwas zu differenzieren. Aber ich weiß nicht, was wäre weitere Beispiele.

Sprecher 1

Ja, also da kann ich dir quasi bisschen die Idee meiner Masterarbeit vorstellen. Also ich möchte eine Applikation machen, die heißt N-Ergy-View. Und die soll natürlich halt den historischen Verbrauch auch darstellen können. Also das kann zwar meistens die mitgelieferte Funktion von Smartmieter ja natürlich auch, oder halt von dem Webportal, aber ein weiterer Punkt wäre, dass du aus diesem Verbrauch auch gewisse Prognosen ableiten könntest für die Zukunft.

Sprecher 2

Ah.

Sprecher 1

Die Idee wäre, dass du dann dem User dann auch Rückmeldungen gibst im Sinne von du hast dann verschiedenste Prognosen erstellt für den.. ja nächsten Stunden oder so und du vergleichst dann halt dann wirklich die tatsächlichen Werte, die dann so langsam reinkommen und kannst demnach sehen, ob der User bissel höher oder drunter liegt über diesen Prognosen. Wenn er halt natürlich über diesen Prognosen ist, heißt das natürlich, dass er einen höheren Konsum hat, ist er darunter, dann ist er auf einem energiesparenden Weg. Und dementsprechend sollen natürlich auch gewisse Rückmeldungen kommen. Natürlich mit, wenn du einen hohen Verbrauch hast mit quasi“ Ah, Vorsicht, da ist was“ und du könntest dem User auch irgendwelche Energiespartipps mitgeben, so quasi ah das schaut so aus, dass.. ich weiß nicht.. da läuft irgendein Gerät halt zu lang, dass viel Strom verbraucht, schaltet es ab oder andere Kleinigkeiten, was man immer so verändern kann am Verhalten. Umgekehrt solltest du darunter sein, könntest du dann auch animiert werden mit irgendwelchen Anreizen sei es jetzt bessere Tarife oder irgendwelche Prozente auf irgendwelche PV Anlagen etc. Ganz allgemein. Was hältst du von so einer App?

Sprecher 2

Ja, fände ich extrem interessant. Es wäre voll cool, wenn man dann zum Beispiel live irgendwie eine Art Limit einstellen könnte. So, wo man dann eine Meldung bekommt ja Achtung, also so wie beim Datenvolumen am Handy, Achtung 80% des Limits ist erreicht, versuche vielleicht deine Kosten zu minimieren oder irgendetwas in die Richtung.

Sprecher 1

Mhm, ja, das ist ein cooles Feature. Ja, sicher.

Sprecher 2

Wär vielleicht auch cool.

Sprecher 1

Würdest du auch so eine App verwenden wollen?

Sprecher 2

Interview 5 – N-Ergy View (20.03.2024)

Ja, fix. Also finde ich sehr interessant.

Sprecher 1

Siehst du da auch Vorteile für dich? So als User. Also was wären so Vorteile, glaubst du?

Sprecher 2

Also ich mein, zugegeben du machst nicht.., ich würde mich im ersten Schritt sehr auf das also auf den Aspekt stützen, dass ich besser sehen könnte, wann ich wieviel ausgebe, was ich ja theoretisch jetzt hier anscheinend hätte man auch schon könnte. Doch davon abgesehen, ja fänd ich es extrem interessant auf der App eben wirklich das direkt einzusehen und dann eben vorzuberechnen also planen zu können, wann ich wieviel ausgebe, das ist schon sehr, sehr praktisch, weil oft kommt diese Meldungen immer erst im Nachhinein und da muss man halt was zahlen und das ist eigentlich immer sehr überraschend, wieviel es dann sein wird. Beispielsweise jetzt bin ich auch ein wenig nervös, weil wir sind im Winter eingezogen, mehr oder weniger und am Anfang war es sehr, sehr kalt, dann haben wir ziemlich eingeheizt und jetzt bin ich mir bis jetzt noch immer unsicher wieviel das dann eigentlich wirklich war.

Sprecher 1

Ja, sicher, das ist dann.. genau also wenn.. oder nein, ich warte noch kurz mit dieser Frage, aber natürlich, das wären dann halt so Use Cases natürlich mit dieser App, die.. oder Szenarios eben, die abgedeckt werden sollten.

Sprecher 2

Ich glaube, ich glaube, ich denke, es ist der Use Case, spezifisch oder nicht?

Sprecher 1

Ja, genau.

Sprecher 2

Voll

Sprecher 1

Könnte es du auch irgendwelche Nachteile sehen, wo du sagst, du.. beim verwenden dieser App?

Sprecher 2

Hm..

Sprecher 1

Also konkret jetzt auch mit so den Funktionalitäten. Mit diesen Feedbacks zum Beispiel. Also glaubst du, siehst du irgendwelche Nachteile irgendwie für dich auch mit diesen Rückmeldungen zum Beispiel?

Sprecher 2

Ich würde sagen, dass es eigentlich nie zu viel Information gibt. Solange man selber entscheiden kann, ob man die Information erhalten will oder nicht.

Sprecher

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Mhm.

Sprecher 2

Feedback oder wissen wir... dass diese ja.. eigentlich das Feedback bezüglich wieviel ich schon ausgegeben hab beziehungsweise wieviel da vorhanden ist ah verwendet wurde? Fänd ich persönlich sehr sehr interessant. Ich bräuchte es jetzt nicht, zugegebenermaßen täglich oder irgendeine Rückmeldung in diese Richtung, aber an sich finde ich schon sehr sehr spannend, wenn, ja, wenn ich da auch daran erinnert werden würde. Also nicht nur, dass ich es einsehen kann, sondern dass ich wirklich auch Rückmeldungen bekomme. Hey, so sieht es derzeit aus, also das finde ich eigentlich sehr positiv und nicht negativ.

Sprecher

Mhm.

Sprecher 1

Könntest du irgendwelche anderen Features noch vorstellen für so eine App, die irgendwie für dich essentiell werden als User?

Sprecher 2

Ich mein, ich glaube, ich habe vorher irgendwas gesagt, was ich jetzt schon wieder vergessen habe.

Sprecher 1

Wegen dem Einblicken also den, den den Grenzen setzen zu können zum Beispiel also, dass du..

Sprecher 2

Ja genau, voll dass man, dass man die Meldungen bekommt, eben hey, und zwar, dass war eben jetzt ein wenig viel vielleicht so über eine Woche gerechnet oder so oder einige Tage oder wie auch immer das funktioniert, genau das wäre interessant. Vielleicht wäre es auch spannend, einen Durchschnitt irgendwie zu sehen im Vergleich zu anderen Userinnen und Usern.

Sprecher 1

Okay Mhm.

Sprecher 2

Das wäre auch cool. Ich meine, das ist vermutlich ein wenig schwierig, weil das abhängig von der Wohnsituation vermutlich ist.

Sprecher 1

Ja, genau, natürlich.

Sprecher 2

Beispielsweise also die Wärme steigt ja auf oder Dachgeschosswohnungen mit bestimmten Dächern ziehen Wärme mehr an als als ja zum Beispiel Neubauten. Aber so grundsätzlich wäre.., wäre so etwas sehr spannend.

Sprecher

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Mhm.

Sprecher 2

Auch wenn schwierig.

Sprecher 1

Ja, sicher, also ihr müsst es halt eben diesen Durchschnitten vergleichbar machen mit deinem Haushalt, dass du sagst, ok,ich bin in einer 1 oder 2 Personen Haushalt mit so und so viel Quadratmeter, Neubau, Altbau etc. Nicht.

Sprecher 2

Ja, genau voll.

Sprecher 1

Ich frage dann vielleicht so ein paar andere Features. Was.. wäre zum Beispiel wenn du auch die Kosten aufschlüsseln könntest, wenn du sagst du müsstest oder du könntest halt deine Tarifsachen halt müsstest du händisch eingeben und du könntest dann zum Beispiel auch den, ja sei es entweder gesparten Energiekosten beziehungsweise auch die äh ja, die Kosten die du halt zahlen müsstest, weil der Verbrauch auf einmal zu hoch ist. Also würde so eine Darstellung auch wichtig sein, oder?

Sprecher 2

Ich finde es interessant, wenn ich wirklich nachvollziehen könnte, wie die Rechnung funktioniert. Weil wenn da im Endeffekt nur ein Wert steht und ich nicht wirklich weiß wie sich dieser Wert zusammensetzt dann würd ich mir denken OK muss ich halt Vertrauen und dann zahl ich es und wenn ich wirklich verstehen könnte wie ich selber einen Einfluss darauf haben kann davon abgesehen dass ich jetzt mehr oder weniger heize, ja dann finde ich sehr spannend eigentlich zu sehen, wie meine Aktionen aktiv etwas bewirken.

Sprecher 1

Ja, also zum Beispiel, du würdest zum Beispiel bei den Prognosen so quasi ah, wenn du jetzt so und so viel Kilowatt verbrauchst ja, in dieser nächsten Stunde halt brauchen wirst, wirst du so und so viel Zahlen zum Beispiel.

Sprecher 2

Genau, ja. Also ich glaube es wäre, ich glaube, das ist allgemein das effektivste, um Menschen irgendwie etwas beizubringen oder irgendwie etwas zu zeigen, indem man ihnen beweist, dass ihre eigenen Aktionen wirklich einen Unterschied machen.

Sprecher

Mhm. Mhm. OK ja

Sprecher 2

Und genau so stell ich mir das auch bei der Rechnung vor. Zwischenfrage, ist es eigentlich möglich sich für jeden Raum einzeln zu berechnen wieviel es kostet oder ist es eben so, dass dadurch eben das ein Smart Meter funktion.., äh vorhanden ist und das über die gesamte Wohnung gerechnet wird das nicht möglich ist?

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Sprecher

Ihh ihhhhhh.

Sprecher 1

Also im Moment wäre es so mit diesen Smart Meter, der jetzt halt wirklich installiert wird von dir, von von der Stadt Wien zum Beispiel, dass jetzt wirklich eher die Gesamtwohnung. Also so wirklich einzelne Räume ist jetzt schwierig.

Sprecher

Okay.

Sprecher 1

Was du machen kannst jetzt so auch als Privatperson ist, dass du schon du.. Man nennt das Submetering, aber du kannst ja quasi so Steckdosenmeter kaufen, die halt wirklich an der Steckdose dann den Verbrauch messen würden und da gibt es auch verschiedenste Open Source Lösungen theoretisch die das dann auch..

Sprecher

Ach cool.

Sprecher 1

Ab.. ablesen oder oder halt visualisieren könnten theoretisch.

Sprecher

OK.

Sprecher 1

Da wollte ich eh auch fragen, wer sowas dann auch irgendwie wichtig, dass du so die einzelnen Geräte dann auch irgendwie ablesen könntest in dieser App.

Sprecher 2

Ja fix, das wär auch cool. Also ich weiß nicht, wenn ich so ein Tool gewissermaßen verwenden würde, dann freue ich mich über so viel wie möglich.

Sprecher

Mhm.

Sprecher 1

Ja.

Sprecher 2

Aber ja das ist mir zum Beispiel in der letzten Wohnung sehr aufgefallen da waren bestimmte Räume extrem warm und andere komplett kalt und da war das irgendwie komisch das zu filtern oder zum Beispiel jetzt noch in der neuen Wohnung haben wir aus Sicherheitsgründen einen Schlitz oben.. also Wir haben eine Art Logia gewissermaßen oder mehr oder weniger Fenster und da ist oben ein Schlitz und den dürfte ich theoretisch nicht zukleben weil es dann auf Dauer in

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der Wohnung schimmeln könnte aber im Winter ist er durch die gesamte kalte Luft permanent reingezogen.

Sprecher

Arbeiten.

Sprecher 2

Und dann haben wir diesen. Immer zugemacht.

Sprecher 1

Ja, ja, verstehe.

Sprecher 2

Und dann war es da halt immer urkalt und in den anderen Räumen voll warm.

Sprecher

Mhm.

Sprecher 2

Ja, für solcher Zwecke wäre es zum Beispiel interessant.

Sprecher 1

Ja genau, ich meine, da ist halt dann zum Beispiel, da müsstest du halt auch andere Daten wahrscheinlich dann mitgeben müssen, weil du Informationen zum Gebäude dazu bräuchtest zum Beispiel, nicht. Ich sag mal, beim Smart Meter gibt es jetzt halt wirklich hauptsächlich um Strom, aber natürlich wenn du sagst, du musst jetzt irgendein Gerät einschalten zum Heizen, also die Bodenheizung zum Beispiel, wenn du eine hast oder elektrisch halt heizt, dann natürlich kannst du schon daraus auch vieles schließen, dann für die Heizung denke ich mal halt.

Sprecher 2

Ja.

Sprecher 1

Genau. Ja, genau, vielleicht noch mal kurz zu diesen Rückmeldungen noch zurück, aber welche Art von Rückmeldung findest du positiv? Also du hast es eh schon angesprochen, aber würdest du das okay finden, wenn dich die App immer so ein bisschen benachrichtigt zu gewissen Events, oder ich weiß nicht.. würd es dich halt auch stören, wenn du zum Beispiel, wenn du über diesen Prognosen bist und auf einen nicht so guten Weg bist quasi auch dann hingewiesen wirst?

Sprecher 2

Nein, also genau das fänd ich sehr interessant und würde ich würde mich nicht stören. Also würde mich freuen wenn ich es bekommen würde, ja.

Sprecher 1

Okay ja. Die.. also da würdest du ja auch so Alerts würden dich jetzt nicht stören, oder wie dass du jetzt so quasi auf einmal eine Nachricht poppt auf und so Hey Moment dein Verbrauch auf einmal ändert sich irgendwie.

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Sprecher 2

Ja genau, solange ich es nicht, solange ich es nicht jeden Tag stündlich bekommen würde, nicht zu viel exzessiv.

Sprecher

Okay ja.

Sprecher 2

So n bisschen ist voll okay.

Sprecher 1

Würdest du auch zum Beispiel seine tägliche Analyse bekommen wollen, zum Beispiel so, dass du sagst okay am Tag dein Tagesverbrauch wird jetzt irgendwie analysiert und du sagst ah okay, heute hast du mal im Vergleich von gestern oder vorvorgestern doch ein bisschen. energieintensiver gelebt sozusagen. Würd so eine Analyse vom Tagesverbrauch auch für dich cool finden? Wenn du sagst, OK, du bekommst jetzt so eine, ja, einen Report sozusagen.

Sprecher 2

Ich glaub teilweise schon, aber da kommt es dann ganz auf die Tage an, wenn ich also wenn ich nicht aktiv irgendetwas mache, dann würde es mich glaube ich nicht so sehr interessieren, während wenn ich dann selber wirklich mir denke, OK, heute will ich aktiv auf Heizen zum Beispiel verzichten, dann würde mich wiederum interessieren, ob das tatsächlich ein Unterschied gemacht hat.

Sprecher 1

Okay ja, cool. Mhm. Eine Darstellung auch zum Beispiel also jetzt werden das halt so verschiedenste alerts natürlich aber beim aufmachen der App zum Beispiel hätte ich mir vorgestellt dass du auch so eine Art Lämpchen hättest und das könnte jetzt zum Beispiel grün leuchten wenn das du jetzt energiesparend unterwegs bist und rot natürlich wenn du jetzt auf einem energieintensiveren Weg bist. Könntest du dir auch vorstellen, dass das ein gutes Feedback Tool ist sozusagen.

Sprecher 2

Ja fix find ich auch cool.

Sprecher 1

Ja Mhm, könntest du dir irgendeine andere Darstellung auch vorstellen irgendwie? Also würde dir so ein Lämpchen reichen.

Sprecher 2

Ja, irgendwie. Also am Display fände ich zu viel. Außer man hat bereits ein Display wo diverse Sachen angezeigt werden und dann da zum Beispiel noch etwas stehen also grundsätzlich ein eigenes Tablet oder so nur für so eine Meldung finde ich ein wenig viel. Aber so ein Lämpchen zum Beispiel wäre eigentlich perfekt.

Sprecher

Mhm.

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Sprecher 2

Nicht zu aufdringlich, irgendwie aber gleichzeitig so, dass man das so wirklich sehen kann. Eigentlich eine gute Kombination.

Sprecher 1

Mhm könntest du dir auch vorstellen dass dann bei diesen, je nachdem wie der Konsum ist, dass auch emotionale Bilder vorgestellt angezeigt werden also dass sich diese App dynamisch ein bisschen anpasst dass du zum Beispiel wenn du jetzt energieintensiver lebst also ich schicke dir da ganz kurz in den Chat ein Bild. Dass du jetzt eben ein Bild von getrockneten Boden bekommst oder ein Eisbär ohne Eis. Umgekehrt wenn du auf energiesparend unterwegs bist, dann bekommst du keine Ahnung halt einen grünen Wald. Da schicke ich dir das Bild mit einem schönen Blauen Fluss. Würdest du sowas auch cool finden, oder?

Sprecher 2

Ich glaub, dass wäre fast ein wenig zu viel, wie man nicht ich mein ich glaub ich lass mich nicht allzu leicht von diversen Dingen beeinflussen, wobei das zufällig gegebener maßen zum Beispiel der Trick an Werbung ist. Werbung funktioniert dann, wenn man denkt, dass sie nicht funktioniert. Ich glaub der Pfeil wäre ein wenig traurig, wenn ich beispielsweise immer nur das erste Bild sehen würde.

Sprecher 1

Ja, das war nicht so geil.

Sprecher 2

Und ja.

Sprecher 1

Frage wenn du zum Beispiel ein bisschen ein spielerisches Element reinbringen würdest, du sagst keine Ahnung, du bist.. versuchst eher für einen Energiegespannten Weg zu sein und du könntest jetzt sagen okay auf diesen grünen auf dieser grünen Wiese wachsen jetzt halt irgendwelche Blumen oder Bäume dafür. Dafür, dass du jetzt irgendwie so und so viel kWh jetzt am Tag gespart hast oder so, wäre das auch irgendwie eine Option,oder?

Sprecher 2

Ja, das wäre cool. Oder wenn zum Beispiel so als Tages Challenges geben würde mit 3 kleinen Aufgaben, wie zum Beispiel..keine Ahnung wie gehe heute 500 Meter zu Fuß anstatt einen kurzen Weg mit dem Auto zu fahren oder keine Ahnung was 500 Meter ist weiß ich gar nicht.. aber ich weiß nicht also nur zum Beispiel oder heize heute nicht sondern mach dieses und jenes stattdessen also mehr oder weniger kleine Challenges. Ich glaube dann ist man direkt motivierter die auch wirklich zu machen anstatt es hat sich selber vorzunehmen heute werde ich das und das weniger machen.

Sprecher 1

Ja. Ich habe ja vorher dieses Anreizsystem mal kurz angesprochen mit dem Feedback zu Energiespartipps und Energieintensiver bist du aber auch generell, dass du vielleicht auch preisliche Vorteile bekommst. Also siehst du sowas auch positiv oder ist das irgendwas was du sagst..

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Sprecher 2

Ja. Erst ich auch positiv, ja.

Sprecher 1

Schon? Ok, cool.

Sprecher 2

Vielleicht auch, dass man das einstellen kann und dass sich die App das speichert. Eigene Tipps umsetzen will und dass man dann gewissermaßen desgleichen so eine Art Programm irgendwie rein bekommt. Also dass, dass man nicht nur einmal sagt, ja, das finde ich spannend, oder genau das möchte ich haben, sondern dass man danach dann auch wirklich das permanent sieht. Und ja, nicht dass dass das wieder in Vergessenheit gerät.

Sprecher 1

Ja, genau. Eine andere Frage ist dann halt jetzt noch so wie jetzt dieser Energiekonsum und Verbrauch und die Prognosen dargestellt werden sollen. Meistens ja ganz klassisch, wenn du so eine Zeitreihe hast, dass dir so ein Linechart Barchart. Würd dir sowas meistens genügen als Darstellung? Also so eine simple art Darstellung oder hättest du schon ein bisschen was Ausgefallenes, irgendwas wie zum Beispiel eine Heatmap oder so andere Visualisierung, wo du ein bisschen so eigene Data Exploration machen könntest.

Sprecher 2

Also ich glaube, man sollte auf jeden Fall das Line- und Barchart verwenden, weil es einfach das ist woran man am meisten gewöhnt ist. Mhm. Aber es wäre vielleicht eher interessant, wirklich eine eine andere Sache auch noch zu verwenden, weil es gibt so viele verschiedene coole Datenvisualisierungsmöglichkeiten. Ist vielleicht interessant, so ein.. Eine Möglichkeit zu bieten, auch wenn es nicht sein müsste.

Sprecher

Mhm.

Sprecher 1

Okay. Die andere Sache wäre auch dann zum Beispiel die Darstellung der Prognosen. Da wäre zum Beispiel Vorgedacht, zum Beispiel beim Linechart, dass du vielleicht jetzt den aktuellen Zeitpunkt hast und dann werden jetzt die zukünftigen Werte, werden zum Beispiel in gestrichelten roten Linien noch eingezeichnet beziehungsweise bei so einem Barchart, ja weiß ich jetzt auch nicht, auch irgendwas ähnliches, dass dir die nächsten Werte so als rot eingezeichnet werde. So was würdest du auch okay finden oder hättest du eine andere Vorstellung wie Prognosen dargestellt werden könnten?

Sprecher 2

Ah nö, also das finde ich ziemlich gut.

Sprecher 1

Okay. Genau. Und während wir halt vielleicht da jetzt noch kurz auf diese Fragen zurück wegen Kosten und Energie. Aber halt, wär dir.. wie wär dir da die Darstellung irgendwie wichtiger, also

Interview 5 – N-Ergy View (20.03.2024)

wär dir A: zum einem hättest du da vorrangig die Kostendarstellung oder die Energiedarstellung sozusagen. Oder B: wär die halt eine Kombination aus beiden wichtiger.

Sprecher 2

Vielleicht eine Kombination der Beiden, dass man daszusammenzieht.

Sprecher

Okay.

Sprecher 1

Cool.

Sprecher 2

Kann ich Fragen haben, haben die anderen Personen, die du bisher interviewt hast, ähnliche Sachen gesagt.

Sprecher 1

Also gemischt halt ja so. Also ein paar Sachen wegen diesen Visualisierungen. Natürlich haben sie auch das so gleich gesagt so. Bisschen, ja. Aber natürlich, bei diesen Anreizsystemen gab es unterschiedliche Meinungen zum Beispiel, ja.

Sprecher 2

Ja, Dankeschön, OKOK.

Sprecher 1

Genau. Genau. Wir nähern uns eh dem Ende. Also ich hätte da jetzt noch ein paar andere Fragen. Natürlich, damit dieser Service jetzt funktioniert, müsstest du halt natürlich Daten teilen, also den Energieverbrauch teilen, als auch quasi eine Freigabe geben, dass du auch dann die zukünftige Werte halt mitteilst, damit diese Prognose, dieses Matching quasi funktioniert. Wärst du bereit, solche Daten zu teilen generell?

Sprecher 2

Ja, wäre ich bereit.

Sprecher 1

Also hättest du irgendwelche Bedenken sonst.

Sprecher 2

Also ich glaube es.., dass die Daten glaub ich müssten nicht unbedingt personalisiert sein, aber davon abgesehen wär ich ziemlich flexibel.

Sprecher 1

Genau okay wärst du auch zum Beispiel, weil ich das vorher erwähnt habe mit den Kosten, aber halt zum Beispiel wärst du bereit eben deine Tarifkosten da auch einzugeben, sozusagen oder mitzuteilen mit dieser App, um halt diese Kostenaufschlüsselung zu bekommen.

Sprecher 2

Interview 5 – N-Ergy View (20.03.2024)

Ja solange es auch personalis.. also nicht personalisiert ist sondern anonym weitergegeben wird.

Sprecher 1

Ja, genau. Glaubst du, könntest du mit so einer App den Energieverbrauch besser im Griff haben?

Sprecher 2

Ja, definitiv. Also ich. Ich bleibe zumindest optimistisch, aber ja, ich, ich denke schon, wenn man aktiv darauf achtet, dass man da einiges machen kann.

Sprecher 1

Ja, sicher. Mhm okay cool ja, und glaubst du käme auch der Umwelt so ein Service zugute? Also glaubst du kann man damit jetzt dem Klima helfen oder halt irgendwelche..?

Sprecher 2

Ja, fix. Also ich, ich weiß zugebenermaßen nicht wie viel das wirklich jetzt ausmacht, wenn man aktiv darauf achtet.

Sprecher

Ja.

Sprecher 2

Schlichtweg weil es viele verschiedene Möglichkeiten gibt etwas für die Umwelt zu tun beziehungsweise es gibt so viele verschiedene Baustellen. Aber ich weiß nicht, ich glaube, es wäre ein guter Schritt, weil jeder Mensch das mehr oder weniger anpassen könnte und das vermutlich auch mit relativ kleinen Veränderungen und nicht großen oder sehr sehr schwerlegenden Änderungen im Leben. Deswegen wäre es glaube ich ein guter Start das überall einzubauen.

Sprecher

Mhm.

Sprecher 1

Ok, cool, super. Und letzte Frage, wärst du auch bereit für seinen Service zu zahlen? Für so eine App?

Sprecher 2

Ja, wobei es bisschen drauf ankommt, wieviel also beispielsweise ich würde jetzt nicht 100€ zahlen oder so oder 50.

Sprecher 1

Natürlich.

Sprecher

Ja.

Sprecher 1

Interview 5 – N-Ergy View (20.03.2024)

Sag also, du kannst irgendeine Schmerzgrenze nennen. Zum Beispiel?

Sprecher 2

Ich habe so meine.. Vielleicht, wäre meine Schmerzgrenze bei so circa 10€.

Sprecher 1

Ja sicher, Mhm OK und könntest dir halt da vorstellen, einfach so monatlich da zu zahlen halt einfach als Abo.

Sprecher 2

Ja genau. Solange ich zugegebenermaßen vielleicht auch mit einer Probezeit am Anfang, sodass man merkt, OK, das was man ändert, hat wirklich einen Nutzen und wenn die Kosten, die man sich spart, nicht mehr als 10€ zum Beispiel übertreffen, dann ist das einerseits okay, solange die Daten, die man dafür erhält wirklich interessant sind bzw einem etwas bringen, auch wenn man gewissermaßen die Informationen erhält, dann etwas ändert, aber kaum Kosten spart und dann noch zusätzlich 10€ zahlt, dann würde ich glaube ich, auf Dauer wieder auflösen.

Sprecher 1

Ja sicher, Mhm versteh schon das. Ja dann hat es ja keinen Nutzen halt. Genau.

Sprecher 2

Yes.

Sprecher 1

Cool, super, perfekt. Danke für das Interview.

Sprecher 2

Yahoo.

Sprecher 1

Ich stoppe mal die Recordings.

A.5. First Iteration of Thematic Cluster from Interviews

Figure A.5.: Complete Thematic Clustering from Interview Transcripts

A.6 Evaluation: First Phase Questionnaire

LimeSurvey

Section A: N-Ergy-View

Imagine an energy monitoring application designed to help households save energy. This app analyzes a household's consumption and provides insights into current energy mixes (e.g., green vs. fossil fuel sources) and personal carbon footprints. Additionally, it predicts energy consumption for the following day, enabling users to anticipate their future energy needs. The app also allows users to compare their current fixed tariffs with dynamic pricing based on these predictions, helping them assess whether they could save on energy costs by switching to a different tariff.

A1. What is your gender?

- ☐ Male
- ☐ Female
- ☐ Other

A2. Please select your age range:

- ☐ 18-24
- ☐ 25–34
- ☐ 35–44
- ☐ 45–54
- ☐ 55–64
- ☐ 65+

A3. What is your current living situation?

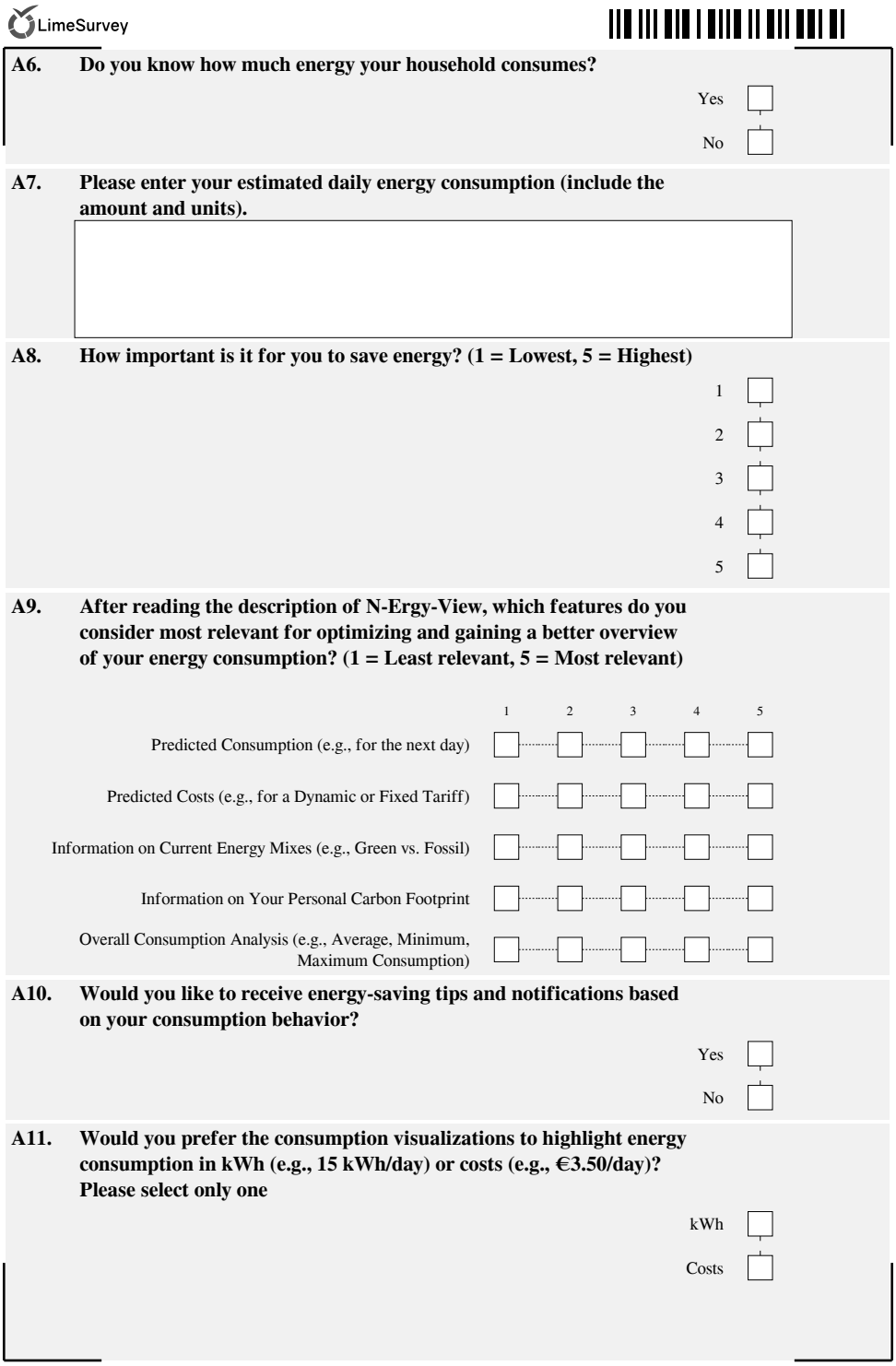
- ☐ Apartment/Flat
- ☐ Shared accommodation (e.g., with roommates)
- ☐ House
- ☐ Dormitory
- ☐ Other

A4. Do you know how much energy your fridge consumes?

- ☐ Yes
- ☐ No

A5. Please enter the estimated daily energy consumption of your fridge (include amount and unit).

A.6 Evaluation: First Phase Questionnaire



LimeSurvey

A6. **Do you know how much energy your household consumes?**

- Yes ☐
- No ☐

A7. **Please enter your estimated daily energy consumption (include the amount and units).**

A8. **How important is it for you to save energy? (1 = Lowest, 5 = Highest)**

- 1 ☐
- 2 ☐
- 3 ☐
- 4 ☐
- 5 ☐

A9. **After reading the description of N-Ergy-View, which features do you consider most relevant for optimizing and gaining a better overview of your energy consumption? (1 = Least relevant, 5 = Most relevant)**

	1	2	3	4	5
Predicted Consumption (e.g., for the next day)	☐	☐	☐	☐	☐
Predicted Costs (e.g., for a Dynamic or Fixed Tariff)	☐	☐	☐	☐	☐
Information on Current Energy Mixes (e.g., Green vs. Fossil)	☐	☐	☐	☐	☐
Information on Your Personal Carbon Footprint	☐	☐	☐	☐	☐
Overall Consumption Analysis (e.g., Average, Minimum, Maximum Consumption)	☐	☐	☐	☐	☐

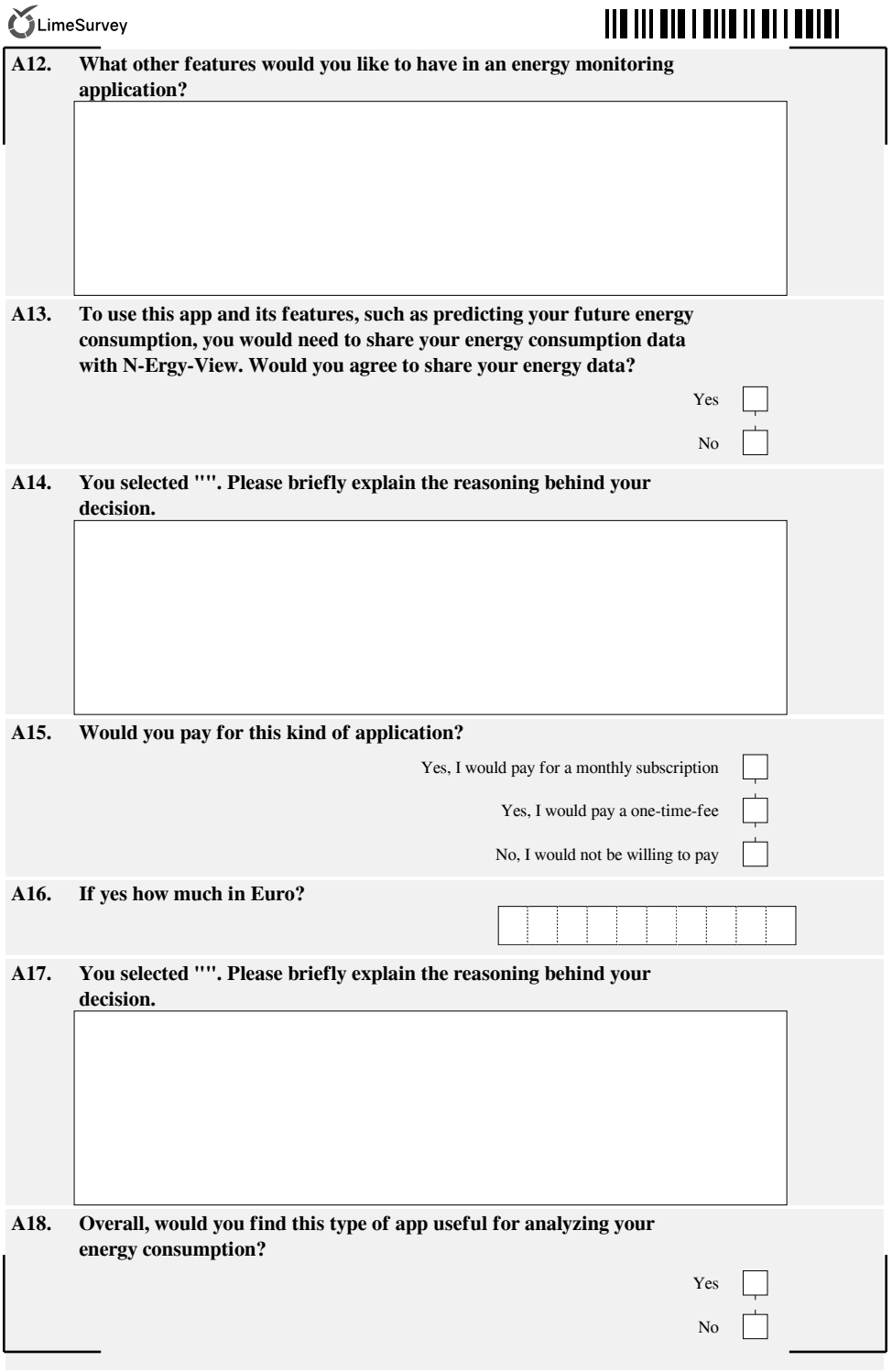
A10. **Would you like to receive energy-saving tips and notifications based on your consumption behavior?**

- Yes ☐
- No ☐

A11. **Would you prefer the consumption visualizations to highlight energy consumption in kWh (e.g., 15 kWh/day) or costs (e.g., €3.50/day)? Please select only one**

- kWh ☐
- Costs ☐

A.6 Evaluation: First Phase Questionnaire



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A12. **What other features would you like to have in an energy monitoring application?**

A13. **To use this app and its features, such as predicting your future energy consumption, you would need to share your energy consumption data with N-Ergy-View. Would you agree to share your energy data?**

- Yes ☐
- No ☐

A14. **You selected "". Please briefly explain the reasoning behind your decision.**

A15. **Would you pay for this kind of application?**

- Yes, I would pay for a monthly subscription ☐
- Yes, I would pay a one-time-fee ☐
- No, I would not be willing to pay ☐

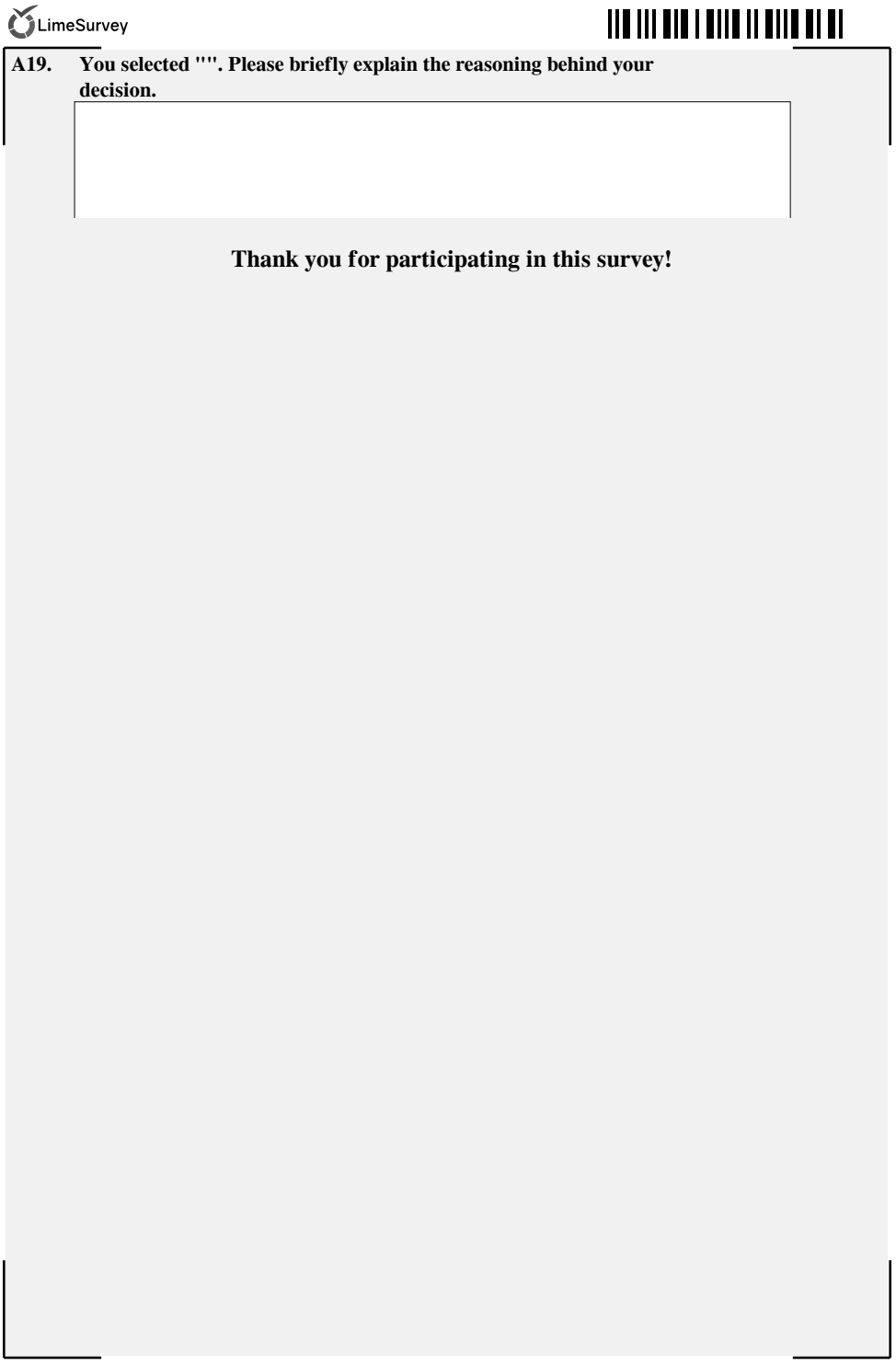
A16. **If yes how much in Euro?**

A17. **You selected "". Please briefly explain the reasoning behind your decision.**

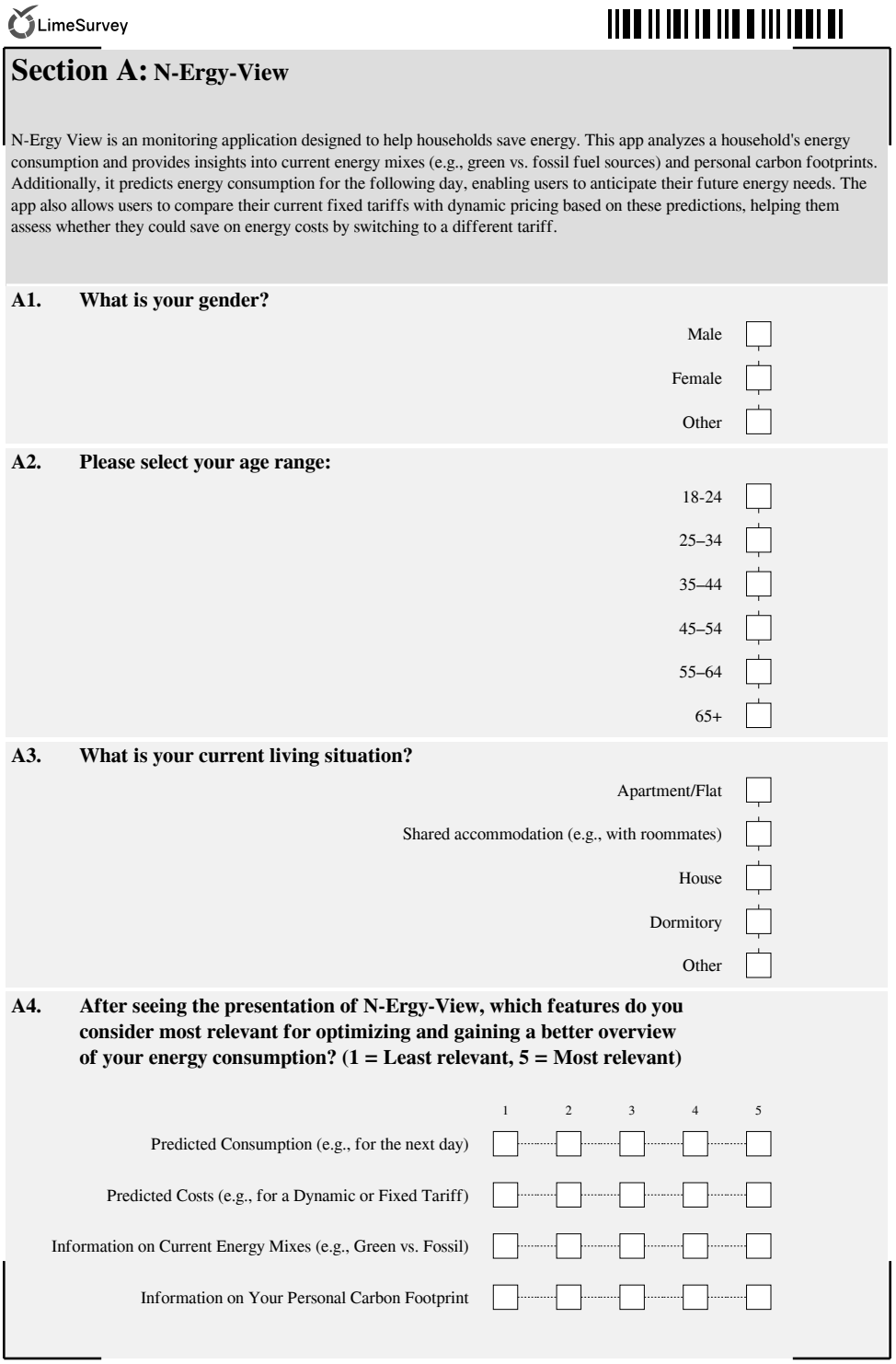
A18. **Overall, would you find this type of app useful for analyzing your energy consumption?**

- Yes ☐
- No ☐

A.6 Evaluation: First Phase Questionnaire



A.7 Evaluation: Second Phase Questionnaire



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Section A: N-Ergy-View

N-Ergy View is an monitoring application designed to help households save energy. This app analyzes a household's energy consumption and provides insights into current energy mixes (e.g., green vs. fossil fuel sources) and personal carbon footprints. Additionally, it predicts energy consumption for the following day, enabling users to anticipate their future energy needs. The app also allows users to compare their current fixed tariffs with dynamic pricing based on these predictions, helping them assess whether they could save on energy costs by switching to a different tariff.

A1. What is your gender?

- ☐ Male
- ☐ Female
- ☐ Other

A2. Please select your age range:

- ☐ 18-24
- ☐ 25–34
- ☐ 35–44
- ☐ 45–54
- ☐ 55–64
- ☐ 65+

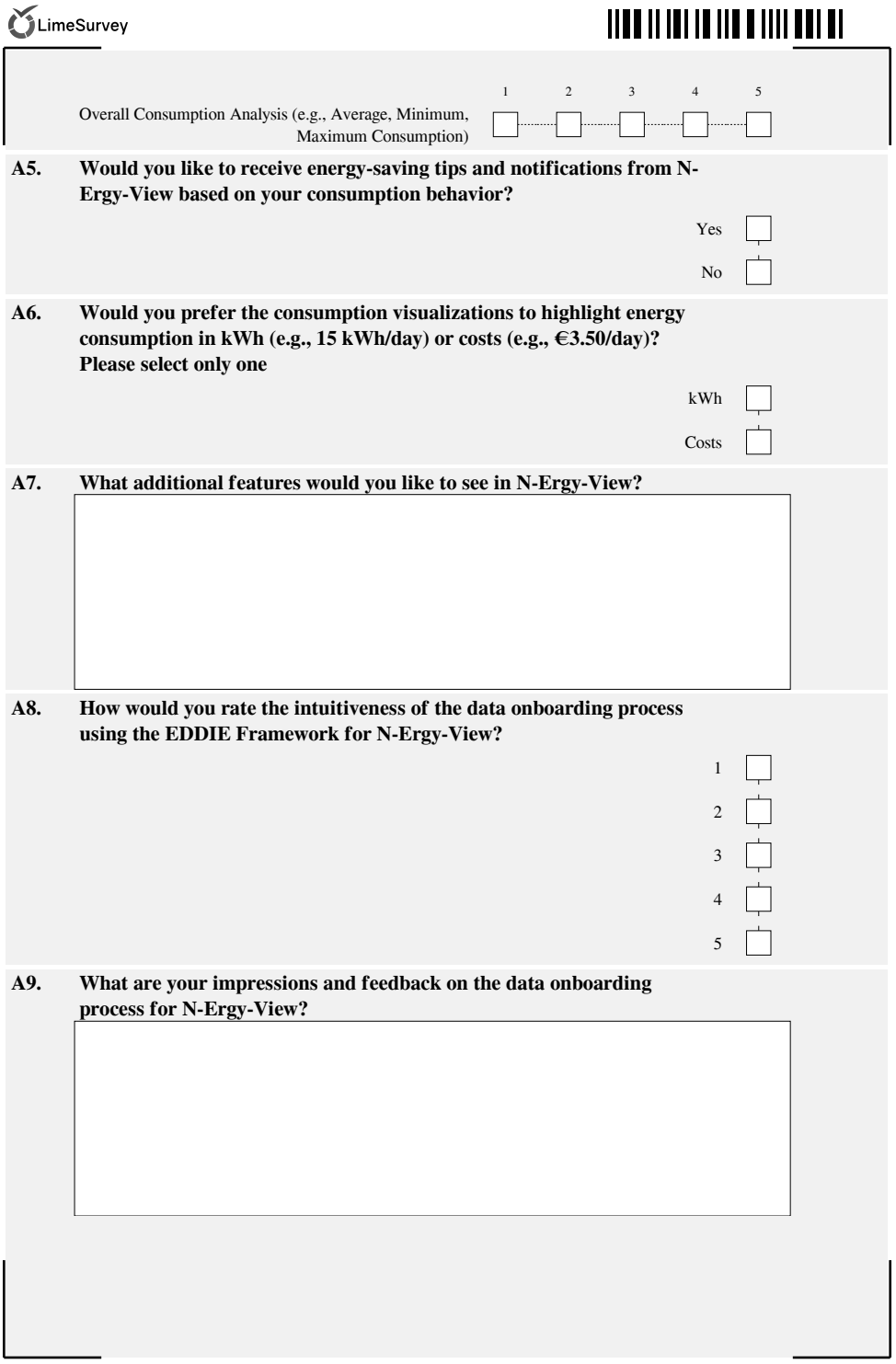
A3. What is your current living situation?

- ☐ Apartment/Flat
- ☐ Shared accommodation (e.g., with roommates)
- ☐ House
- ☐ Dormitory
- ☐ Other

A4. After seeing the presentation of N-Ergy-View, which features do you consider most relevant for optimizing and gaining a better overview of your energy consumption? (1 = Least relevant, 5 = Most relevant)

	1	2	3	4	5
Predicted Consumption (e.g., for the next day)	☐	☐	☐	☐	☐
Predicted Costs (e.g., for a Dynamic or Fixed Tariff)	☐	☐	☐	☐	☐
Information on Current Energy Mixes (e.g., Green vs. Fossil)	☐	☐	☐	☐	☐
Information on Your Personal Carbon Footprint	☐	☐	☐	☐	☐

A.7 Evaluation: Second Phase Questionnaire


LimeSurvey

Overall Consumption Analysis (e.g., Average, Minimum, Maximum Consumption) 1 2 3 4 5

A5. **Would you like to receive energy-saving tips and notifications from N-Ergy-View based on your consumption behavior?**

Yes ☐
No ☐

A6. **Would you prefer the consumption visualizations to highlight energy consumption in kWh (e.g., 15 kWh/day) or costs (e.g., €3.50/day)? Please select only one**

kWh ☐
Costs ☐

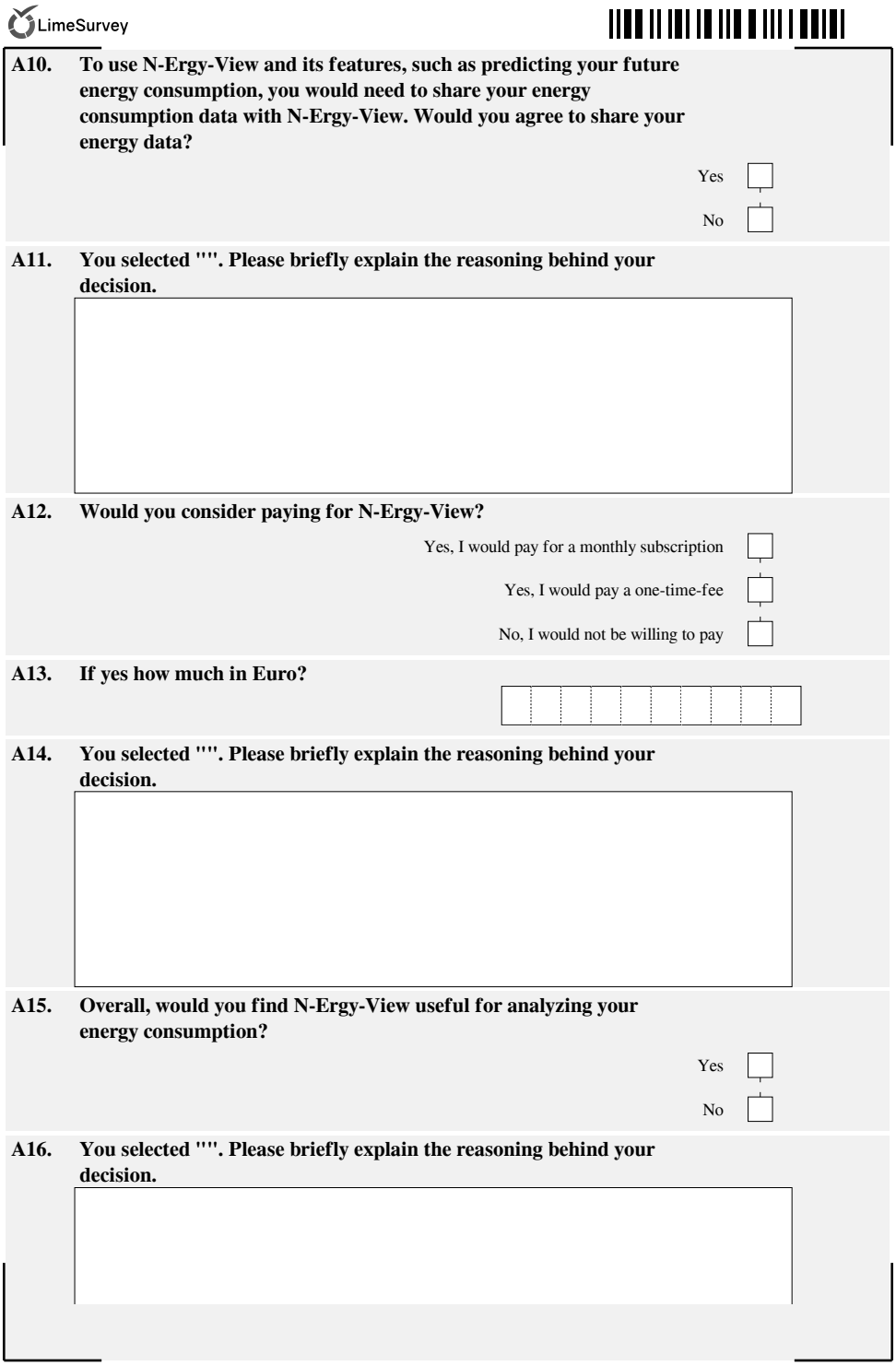
A7. **What additional features would you like to see in N-Ergy-View?**

A8. **How would you rate the intuitiveness of the data onboarding process using the EDDIE Framework for N-Ergy-View?**

1 ☐
2 ☐
3 ☐
4 ☐
5 ☐

A9. **What are your impressions and feedback on the data onboarding process for N-Ergy-View?**

A.7 Evaluation: Second Phase Questionnaire



LimeSurvey

A10. **To use N-Ergy-View and its features, such as predicting your future energy consumption, you would need to share your energy consumption data with N-Ergy-View. Would you agree to share your energy data?**

- ☐ Yes
- ☐ No

A11. **You selected "". Please briefly explain the reasoning behind your decision.**

A12. **Would you consider paying for N-Ergy-View?**

- ☐ Yes, I would pay for a monthly subscription
- ☐ Yes, I would pay a one-time-fee
- ☐ No, I would not be willing to pay

A13. **If yes how much in Euro?**

A14. **You selected "". Please briefly explain the reasoning behind your decision.**

A15. **Overall, would you find N-Ergy-View useful for analyzing your energy consumption?**

- ☐ Yes
- ☐ No

A16. **You selected "". Please briefly explain the reasoning behind your decision.**

A.7 Evaluation: Second Phase Questionnaire


LimeSurvey

A17. **How interested are you to use N-Ergy-View yourself? (1 = Least likely, 5 = Most likely)**

1 ☐
2 ☐
3 ☐
4 ☐
5 ☐

A18. **What is your overall feedback on N-Ergy-View?**

Thank you for participating in this survey!

Abstract

Due to various EU legislations, smart meters are being deployed across member states, and the collected data can be utilized for various use cases and applications, with a focus on data analytics, machine learning, and artificial intelligence. However, it remains unclear how households can effectively benefit from this collected data and the insights it could provide. This thesis therefore explores user perceptions and adoption of *N-Ergy-View*, an energy-data-driven monitoring application that analyzes consumption data from smart meters. Using a human-centered design and mixed-methods approach, this thesis aims to identify gaps in current energy data applications and research, presents practical examples from businesses and the challenges they face, and offer a categorization of various use cases within energy-data driven services. *N-Ergy-View* is developed as a practical solution, and its design and usability is evaluated through user feedback, including interviews and surveys, to address the main research question of whether this type of application, which uses smart meter data and the way it was designed, would be accepted and adopted by users, and if users would be willing to share their consumption data to gain insights and pay for such an app. The research for this thesis is structured into three consecutive phases:

Exploration Phase: This phase starts with a review of the literature and the state of the art. Use cases and applications in scientific literature that utilize this data will be analyzed to identify existing gaps. Afterwards, presentations from energy businesses are thematically analyzed to understand use cases and issues related to energy data. A pilot study then categorizes use cases in the practical field to identify business models that currently use or could potentially use smart meter data. Lastly, using human-centered design, interviews with the target group are conducted to gain insights into their behavior and preferred designs for an energy monitoring application, which will inform the system design of *N-Ergy-View*. These interviews are evaluated thematic analysis and clustering.

Implementation Phase: This phase sheds light on the design processes and decisions taken for the system design, following a human-centered design approach. A system architecture is presented to provide technical insights into the app. The functionalities are described alongside their intended impact on usability and user behavior, informed by principles of behavioral economics.

Evaluation Phase: To conclude the phases and evaluate the *N-Ergy-View* prototype, user pre- and post-surveys assess the concept, features, and usability of the app. In the first stage, the concept of *N-Ergy-View* is tested to evaluate how participants perceive its functionalities and usefulness. In the second stage, a live demo of *N-Ergy-View* is presented, and the survey investigates changes in user acceptance and usability. The primary goal of the survey is to address whether *N-Ergy-View*, as it is designed and implemented, along with its functionalities, would be adopted and accepted by users.

Kurzfassung

Diese Masterarbeit untersucht die Nutzerwahrnehmung und Akzeptanz der N-Ergy-View-App, einer webbasierten Anwendung zur Analyse und Visualisierung von Smart-Meter-Daten für Haushalte. Angesichts aktueller EU-Richtlinien, wie der Richtlinie 2019/944, die den Zugang zu Energiedaten über Smart Meter regeln, eröffnet sich ein neues Potenzial für datengestützte Energiedienstleistungen.

Ziel der Arbeit ist es, bestehende Lücken in Forschung und Praxis zu identifizieren und eine benutzerzentrierte Lösung zu entwickeln, die auf realen Anforderungen basiert.

Zur Beantwortung wurde ein dreiphasiger Forschungsansatz gewählt: eine explorative Phase (Interviews mit Energieunternehmen, Pilotstudien und Zielgruppenanalyse), eine Implementierungsphase (Design und Entwicklung der App) sowie eine Evaluationsphase (Eine Pre-und Post-Benutzerbefragungen mit und ohne Demo der App). Die Funktionen der App beinhalten unter anderem Verbrauchsprognosen, Preisvergleiche und CO_2-Berechnungen.

Die Ergebnisse zeigen, dass viele der heutigen Energieanwendungen zwar auf Systemoptimierung abzielen, der konkrete Nutzen für Privathaushalte jedoch oft unklar bleibt. Durch ein nutzerzentriertes Design und funktionale Visualisierungen, kombiniert mit Feedbackmechanismen aus der Verhaltensökonomie, konnte ein Ansatz entwickelt werden, der das Nutzerverhalten positiv beeinflussen kann. Die Umfragen zeigen zudem, dass eine breite Nutzermasse grundsätzlich bereit ist, eine solche Applikation zu nutzen, Energiedaten zu teilen und auch dafür zu bezahlen, sofern ein klarer Mehrwert geboten wird.