Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Information Technology and Electrical Engineering
Dept. of Information Security and Communication Technology

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Personal Data Processing and Privacy in the Norwegian Power Grid

Master's thesis in Information Security
Supervisor: Sule Yildirim Yayilgan
Co-supervisor: Mohamed Abomhara
June 2021

NTNU
Kunnskap for en bedre verden

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Abstract

Smart meters and other smart digital devices are facilitating the transition of the Norwegian power grid towards becoming a smart grid. This transition has already started with smart meters being installed more than 97% of Norwegian homes and appliances with computational intelligence becoming more common. These smart meters and other digital devices are processing large amounts of data that become personal data when they are tied to the persons living in the home. Since it is personal data the processing of the data is subject to the general data protection regulation (GDPR), and any processing must comply with this regulation to be legal.

At the same time, the power grid is subject to legislation intended to make the grid operate in a safe and rational manner to the benefit of society. Recent changes in the regulations for the power grid seek to make it more efficient and take advantage of new technology like smart meters, but also require processing of personal data. These processing requirements does not necessarily comply with GDPR requirements and may be the cause for privacy challenges.

This thesis has investigated how data controllers in the Norwegian power gird have organized with regards to processing of personal data, and what privacy challenges arise from this. The thesis gathered data through a literature review and a questionnaire sent to actors in the Norwegian power grid. The thesis has discovered who are the data controllers for different personal data in the grid, and on what grounds they process this data. This is visualized in two models showing the current and ideal state in the Norwegian power grid with regards to personal data processing, and who has the controller role.

The thesis uncovers several privacy challenges with regards to GDPR compliance. The most serious violation is that landlords in some cases have access to their tenants' personal data through access to smart meter consumption data in Elhub.

Sammendrag

Det norske strømnettet utvikler seg i retningen av et smart strømnett (smart grid) gjennom introduksjonen av smarte strømmålere og andre smarte digitale enheter. Mer enn 97% av norske hjem har fått installert smarte strømmålere og det blir stadig mer vanlig at husholdnings apparater har en grad av digital smarthet. Dette innebærer at det genereres og smales inn store mengder data fra disse enhetene. Når denne dataen blir knyttet opp mot en person er den å regne som persondata etter Personvernforordningen (GDPR), og må overholde den for at behandlingen skal være lovlig.

Samtidig er strømnettet underlagt lovgivning som skal sikre av nettet driftes på en trygg og samfunnsmessig rasjonell måte. I nyere tid har det kommer endringer i denne lovgivningen som ønsker å gjøre strømnettet mer effektivt gjennom å introdusere og ta i bruk ny teknologi. Dette innebærer krav som utløser behandling av persondata. Denne behandlingen møter ikke nødvendigvis kravene i GDPR og kan skape personvernutfordringer.

Denne masteroppgaven har sett på hvordan behandlingsansvarlige i det norske strømnettet har tilpasset seg GDPR og lovgivningen for strømnettet når det kommer til behandling av persondata i strømnettet, og hvilke personvernutfordringer som eksisterer i nettet i dag. Datainnsamlingen er gjort gjennom en litteraturstudie og en spørreundersøkelse sendt til behandlingsansvarlige og databehandlere i det norske strømnettet. Oppgaven avdekker hvem som er behandlingsansvarlig for de ulike typene persondata som behandles i strømnettet. Dette har blitt visualiser i to modeller hvor en viser dages situasjon og den andre viser en ønsket situasjon.

Det er avdekket flere personvernutfordringer med dagens organisering og situasjon. Den mest alvorlige av disse er at utleiere i noen tilfeller har tilgang til leieboernes persondata i form av forbruks data fra smarte strømmålere lagret i Elhub.

Acknowledgements

I would like to express my gratitude to Associate Professor Sule Yildirim Yayilgan and Researcher Mohamed Abomhara who have been my supervisors for this thesis. Their guidance, suggestions and feedback have greatly contributed to the finished product of this thesis.

I would also like to extend my thanks to Elhub and the power and grid companies who answered the questionnaire. Their answers have been an important contribution to the thesis.

Finally, I wish to thank my wife for her support and patience throughout my work with this thesis.

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Chapter 1

Introduction

Today power grids are evolving towards becoming smart grids [1].The new smart grids use distributed digital smart devices to monitor and control the power grid. This has many advantages over traditional grids and offer new possibilities for control, management, monitoring and cost reduction. There are several areas where this transition to a smart grid will affect consumers[2–4]. The most noticeable of these are probably smart meters[5] that have been, or are being, rolled out in several countries. Smart Meters are advanced digital devices that in addition to measuring consumption can communicate with other devices in real-time, as well as being controlled remotely. In Norway most households had smart meters installed by the deadline 01.01.2019[1] and in the EU-28 (EU + UK) most countries plan to have achieved a 80% smart meter share by 2030 or earlier [6].

Smart meters and other distributed digital (smart) devices make it possible to measure and control the grid in new ways. This allows for possibilities like Demand Side Management [7, 8], load forecasting, peak shaving and plus customers/prosumers[2] to name a few. What these possibilities have in common is that they offer ways to manage the grid that is more cost and energy effective. These possibilities are facilitated by the new technology that can provide more data and are capable of remote control.

Many of these smart grid devices are found in private households. As a result, the data they produce is considered personal data [9]. This is because it is possible to infer a lot of information about the person(s) living in the household based on the data. Either when looking at a single data set or analyzing data from multiple sources. There are several studies that show that data from smart meters can be used to reveal information about a household [10–12]. For example, it is possible to infer if a household observes Ramadan based on a shift in daily routines during the holiday period observed through smart meter consumption measurements [13]. This again implies that the persons living in the house are Muslims.

In 2018 the General Data Protection Regulation(GDPR)[14] came into effect in the European Union (EU) and the European Economic Area (EEA). This is an EU regulation that aim to protect the personal data of consumers. The GDPR provides

[1] https://www.nve.no/stromkunde/smarte-strommalere-ams/, 01.05.21

consumers with rights regarding their personal data, as well as a set of requirements that companies and others must meet if they are to process personal data. This was great for consumers, called data subjects in the GDPR, as they got a clearly stated set of legal rights, and the companies have a legal obligation to safeguard data subjects' rights. However, the question is how the GDPR can be implemented in the power grid with its many entities and various legal regulations.

The power grid is large, complex, and needs to be in balance at all times to function correctly. It is also considered critical infrastructure as most of society rely on electricity to function, including other critical services and infrastructures. Therefore, the grid is subject to its own laws and regulations the purpose of which is to ensure that the grid operates properly [15, 16]. These laws relating to the operation of the power grid do not necessarily consider the same privacy concerns that the GDPR does, and this may cause conflict or divergences between the power grid legislation and the GDPR [17].

This thesis investigates the Norwegian power grid and how the actors in the grid have organized themselves with regards to GDPR and power grid regulation, and what privacy challenges arise from this. Since the Norwegian power grid is a complex entity with a large number of companies that varies from small private companies to large state enterprises and directorates the term "entities" will be used when referring to all or many of these companies. For the subset of the entities that have a controller or processor role after GDPR the term "actors" will be used.

1.1 Problem Description

The Norwegian power grid developing towards becoming a smart grid with an increasing number of digital smart devices being deployed throughout the grid[18]. Many of these devices can be found in private homes with the most prevalent being smart meters. These digital smart devices are collecting and processing data that in many cases is personal data. Since personal data is subject to the GDPR the actors in the grid will need to comply with GDPR to legally process the data.

At the same time, the grid is subject to regulations intended to ensure secure and efficient operation of the grid[15]. This puts some constraints on how the actors in the grid can comply with the requirements in GDPR. There is also a large number of actors in the grid making it difficult for a consumer to have control and overview of how their personal data is processed, by who, and on what grounds after GDPR Art. 6(1).

With two potentially conflicting sets of legal regulations dictating how the actors in the grid should process personal data[17] it is likely that there will be challenges related to consumer privacy. The challenges may arise from adhering to on set of regulations over the other, or from failing to meet the requirements in the GDPR.

The main goal of this thesis to develop a model that shows how the various actors in the power grid relate to each other from a GDPR point of view. The model aims to show who is the data controller for different personal data in the grid, and on what legal grounds the data is processed. The finished model will be used to highlight privacy challenges in the power grid with regards to processing of personal data.

1.2 Justification and Motivation

Currently there is (to the best of the authors knowledge) no good representation of how personal data is processed in the Norwegian power grid. Due to the power grid being complex with many entities, such a representation should be made to meet GDPR requirements like transparency (Art.5(1)) and the concept of informed consent (Art.4(11)) [14].

Such a representation is needed since the way the power grid is regulated means that consumers (data subjects) do not have an option but accept that their personal data will be processed by actors in the grid if they are to have access to electricity. This is due to regulatory requirements like [16] stating that power and grid companies must process personal data when they provide electricity to a consumer. When considering that the distribution grid that consumers are connected to is a monopoly, the need for a clear representation is even more apparent. Since there is only one grid operator in a geographical area, consumers do not have a choice if they wish to share their personal data with that grid company or not. Therefore, there should be no doubt as to how and why actors in the grid process personal data, who they share it with and for what reasons.

With the power grid evolving to becoming a smart grid, the possibilities with smart devices distributed in the grid become more feasible and realistic. In October 2020 Statnett and the power company Tibber did a successful experiment where they used panel heaters in private homes to balance the power grid[2]. This is just one example of how electric devices in private homes can be used to balance the grid. By further developing this kind of concepts it is possible to have a more efficient power grid with both environmental and economic benefits. This kind of programs require processing of personal data and the consumers agreeing to the remote control needed to use the appliance to regulate the grid. This is where a clear representation of the flow of personal data is needed. Both to meet requirements in GDPR, but also to establish sufficient trust that the data is treated in an appropriate manner and to clearly distinguish between what is mandatory to share and what is optional.

In literature much is written about both privacy in smart grids and the GDPR[13, 19–23]. And there are many who raise the concern about privacy when it comes to data collected from digital smart devices in the grid. However, very little is written about how the personal data in the power/smart grid is processed with regards to

[2] https://www.tu.no/artikler/brukte-hundrevis-av-panelovner-til-a-regulere-stromnettet/507237, 01.05.21

GDPR. And even less when you narrow the scope to the Norwegian power grid.

1.3 Research Questions

To find an answer to the problem stated for this thesis the following research questions were developed.

1. What are the legal requirements pertaining to personal data in the Norwegian power grid?
2. How is the Norwegian grid structured, who are the actors and how do they interact?
3. What roles do the actors in the grid have according to GDPR?
4. What legal grounds do the controllers have/need for processing personal data?
5. What smart grid technologies involving personal data can/will be implemented in the Norwegian power grid, and who is the responsible data controller?

1.4 Contributions

The main contributions of this thesis are as follows:

1. This thesis developed two models that shows how actors in the Norwegian power grid are organized in a GDPR setting from a consumer/data subject point of view. The first model shows the current situation, and the second shows a more ideal situation. The models shows the various types of personal data that is processed in the grid, and how it flows from the consumer to the actors in the grid. The models also shows what types of personal data is mandatory and voluntary to provide to the actors in the grid.
2. This thesis investigated the power and grid companies in Norway through a questionnaire to understand their roles as data controllers/processors and discover what grounds according to GDPR Art. 6(1) they claim for processing various personal data.
3. This thesis highlights privacy challenges that arise from how personal data is processed in the power grid.
4. This thesis shows that there is a serious privacy challenge in the grid today where landlord have access to the personal data of their tenants.
5. The model developed in this thesis can be used as a tool to meet the transparency principle in GDPR, and as a way to achieve informed consent.

1.5 Limitations

This section provides the limitations of scope and content of this thesis. The purpose of these limitations is to align the workload of writing the thesis to a level appropriate for a Master Thesis.

The thesis only looks at the Norwegian power grid. Looking at multiple countries power grids would have necessitated a much more superficial approach and looking at even one more country would have significantly increased the workload.

While the thesis focus on how actors in the grid comply with GDPR. It does this with a focus on organization and legal grounds, and not how this is technically implemented. The thesis does not look at how controllers and processors comply with GDPR beyond what their role are, and on what grounds they process personal data. It does not look at e.g. how carries out the processing on behalf of the controller and how they meet technical security requirements.

When discussing smart grid technology, the thesis will not go into details on how the technology works beyond identifying the personal data involved.

1.6 Thesis Outline

The rest of the thesis is organized as follows:

- Chapter 2: Background is the theoretical part of the thesis and provides the theoretical knowledge needed to support the discussion as well as providing answers for some of the research questions.
- Chapter 3: Methodology outlines how the work with the thesis have been carried out. There is an explanation of the chosen methods and the intention behind choosing them.
- Chapter 4: Results presents the answers to the research questions based on a condensed presentation of key points from chapter 2 and the data collected from the questionnaire. Finally, the chapter presents the models that are the main contribution of this thesis.
- Chapter 5: Discussion is a discussion of the thesis with a focus on the results, privacy challenges and methodology.
- Chapter 6: Conclusion concludes the discussion and provides suggestions for future work.

Chapter 2

Background

This chapter provide readers with the necessary background knowledge to read the rest of the paper. There are four main topics that will be covered in this chapter. Section 2.1 is about the Norwegian power grid, how its entities are organized and the laws that regulate it. Section 2.2 is about the smart grid, what this is and where the Norwegian grid is in this transition. Section 2.3 covers relevant parts of the GDPR and how it is implemented through the Norwegian "Personverforordningen". Section 2.4 covers how the problem in this thesis have been addressed in literature.

2.1 The Norwegian Power Grid

This section presents background about the Norwegian power grid. It is important to keep in mind that the thesis investigates privacy challenges in the grid with regards to how the actors in the grid have organized themselves according to the GDPR. As such, there is no need for a technical in depth presentation of the grid.

Due to a lack of suitable scholarly sources for an overview of the Norwegian power grid much of the information in this section is from energifaktanorge.no[1]. This is an information page operated by the Ministry of Petroleum and Energy[2] which is the ministry that has the overall administrative responsibility for the power grid.

2.1.1 The Physical Grid

The Norwegian power grid is divided into three levels. Transmission grid, regional grid and distribution grid. If one where to follow EU standards both the regional grid and distribution grid is considered as distribution grids.

The transmission grid is the nationwide backbone grid that connects the regional and distribution grids in the rest of the country. Statnett[3] is the transmission

[1] https://energifaktanorge.no/norsk-energiforsyning/kraftnett/, 17.04.21
[2] https://www.regjeringen.no/en/dep/oed/id750/, 01.05.21
[3] https://www.statnett.no/en/, 20.05.21

system operator (TSO) for the Norwegian transmission grid and is responsible for the correct operation of the grid[4]. The regional grid main purpose is to connect the transmission grid to the distribution grids together and may also provide grid connection for producers or large consumers. There are no private consumers that are connected to these grids, and as such there is no personal data being processed in this part of the grid. The data that the distribution system operators (DSOs) send to the TSO as part of grid operations do not include personal data as this is at a much coarser level then a single household consumption.

The distribution grid is the local grid that supplies power to end users. It is this grid that is most relevant to this thesis, since it is as part of the operation of this grid that the distribution system operators (DSOs) process personal data[16]. Due to the nature power grids they are expensive to build, but relatively cheap to maintain. As a result, all of the distribution grids are monopolies as it does not make sense with two or more competing grids[5]. To avoid that the DSOs take advantage of their monopoly they are regulated by The Norwegian Energy Regulatory Authority's (NVE-RME). NVE-RMEs main objective is to "...to promote social and economic development through an efficient and environmentally sound energy production, as well as efficient and reliable transmission, distribution, trade and efficient use of energy."[6]. Note that NVE-RME do not have a responsibility to preserve consumer privacy.

The important take away from this section is that consumers are connected to the distribution grid, and this is the only option for a consumer to get electricity from the national grid. Each DSO, commonly known as grid companies, has a monopoly in each geographical area where they own and operate the grid. The DSOs are regulated by NVE-RME to, among other things, ensure that they do not exploit the monopoly. NVE-RME does not have a dedicated obligation to ensure consumer privacy.

2.1.2 Organization Hierarchy

This section outlines how various entities in the power grid are organized with regards to each other. Also, it provides a description of each of the entity types in the grid. This description will be generic for entities that there are many of, like grid companies, and specific for entities that are unique like NVE and Statnett. It is also important to note that the various entities are connected in multiple ways, and it is not a goal of this thesis to uncover all of these.

[4]https://energifaktanorge.no/norsk-energiforsyning/kraftnett/, 20.05.21

[5]https://www.regjeringen.no/no/tema/energi/stromnettet/stromforsyning-og-stromnettet/id2353792/, 20.05.21

[6]https://www.nve.no/norwegian-energy-regulatory-authority/, 20.05.21

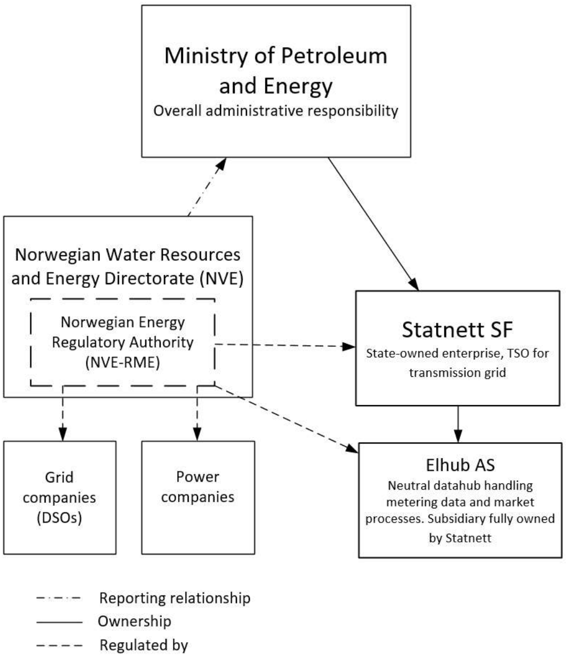

Figure 2.1: Figure showing the regulatory relationships in the power grid.

Regulatory authorities

It is the Ministry of Petroleum and Energy(MoPE) that has the overall administrative responsibility for the power grid on behalf of the Government[7]. MoPE is also responsible for the laws and regulations that apply to the power grid. These laws and regulations will be covered in section 2.1.3.

The directorate that carries out MoPE responsibility for the power grid is the Norwegian Water Resources and Energy Directorate(NVE)[8]. The regulatory authority is the Norwegian Energy Regulatory Authority – NVE-RME. NVE-RME has its authority delegated from the Energy Act[15], and is independent from NVE with its own budget. RME used to be a department in NVE up until 1. November 2019 then the EU third energy package was ratified in Norwegian law. Among the tasks that fall to NVE-RME is the regulation of the TSO and DSOs. Figure 2.1 shows the relationship between the entities that have regulatory and administrative responsibility.

Grid and Power Companies

The grid companies that are relevant to this this thesis are DSOs since it is they that process personal data as described in section 2.1.1. As of May 2021, there

[7]https://energifaktanorge.no/en/om-energisektoren/statlig-organisering/, 23.04.21
[8]https://www.nve.no/about-nve/?ref=mainmenu, 23.04.21

were 123 companies holding a license for operating a distribution grid[9]. Not all of these companies deliver electricity to private households, as some of these companies are dedicated to serving energy intensive industry. The number of DSOs is declining with there being 143 DSOs in 2017[24], and there was several DSOs that merged in 2020[10][11].

The DSOs in Norway vary greatly in size. Both when you look at number of employees and customers they serve. For instance Elvia AS has more than 2 million customers and over 800 employees[12], whereas Valdres Energi Nett has 15 000 customers(approximately half of these are vacation homes) and 33 employees[13]. In 2019 there were 7 DSOs with more than 100 000 customers. These 7 had approximately 58% of the total customers. That means that the remaining 43% was divided on the remaining 113 DSOs serving the consumer market at that time[25].

The DSOs have a license from NVE to build, own and operate the distribution grid in their area. Since the distribution grids are monopolies there is only one DSO in each license area. As a condition for holding the license the DSOs have an obligation to provide electricity to everyone living in their area[15]. This of course can become a privacy challenge if the DSOs do not comply with GDPR and other relevant privacy regulations.

When it comes to power companies there has historically been a close integration between power and grid companies, but legislation changes in recent years seek to implement a separation[14]. Norway changed the regulation for the consumer energy market to an open market with the Energy Act of 1991[15]. This change meant that any company, holding a license, could buy electricity on the market and sell it to consumers. This makes for a mix of power companies where some have ties to the old production/grid companies, and some are new companies with no ties to production that simply by electricity in the market and sell this to consumers.

As mentioned in the previous paragraph power and grid companies have historically been integrated as one company/group/enterprise, but regulations seek to implement a separation. In 2016 the Norwegian Parliament passed an amendment to the Energy Act [15]. This amendment states that DSOs and TSO must be a separate legal entity also if the company is part of an enterprise/group. In addition, there must be a separation of functionality inside an enterprise between grid operations and any other activity in the enterprise, provided there are more than 10 000 grid customers. Further, after a regulation change[26] that came into force 1 January 2021 DSOs have to clearly distinguish themselves from power companies and other parts of an enterprise they may be a part of. This requirement for

[9] https://www.nve.no/reguleringsmyndigheten/omsetningskonsesjon/liste-over-konsesjonaerer/?ref=mainmenu, 21.05.21

[10] https://www.elvia.no/hva-er-elvia/hvem-er-elvia, 17.04.21

[11] https://www.tromskraftnett.no/om/tromskraft/arva, 17.04.21

[12] https://www.elvia.no/hva-er-elvia, 17.04.21

[13] https://www.valdresenerginett.no/om-oss/, 17.04.21

[14] https://energifaktanorge.no/norsk-energiforsyning/kraftmarkedet/, 17.04.21

separation is good from a privacy point of view as it will make it easier for consumers to separate between the grid company they must have a relationship with, and the power company that they can choose on the open market.

Figure 2.2 shows a typical group organization for energy enterprises/groups in Norway. The example is Agder Energi and as the figure shows it has multiple companies in the group that operate within different areas of the power grid and energy system. To comply with the requirement of legal and functional unbundling the grid operation in AE Nett has a separate board as denoted by the dashed line.

The main difference between the grid companies and power companies when it comes to the topic of this thesis is that the customers are free to choose which ever power company they want. As of May 2021, there was 95 power companies[15]. From a privacy point of view this choice has the advantage that a consumer can choose which company to buy electricity from and change if they do not agree with the terms, or feel that their data is processed in an unsafe manner. However, it is worth noting that in many cases the different companies are just different brands in a group/enterprise.

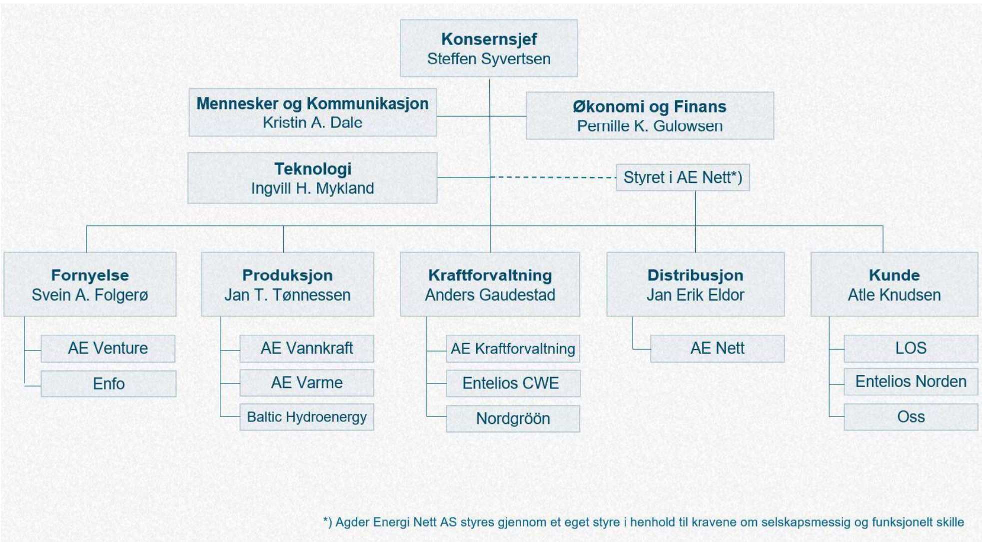

Figure 2.2: Agder Energi concern structure with he grid part(AE Nett) as a separate entit[16].

Elhub

Elhub AS is a subsidiary that is fully owned by Statnett. It was created after instruction by NVE, and its function is regulated in [16]. Elhub is a neutral datahub that handles all metering data and market processes in the Norwegian end user

[15]https://www.bytt.no/strom/stromleverandorer, 21.05.21
[16]https://www.ae.no/om-agder-energi/organisasjon-og-ledelse/artikkelside/, 21.05.21

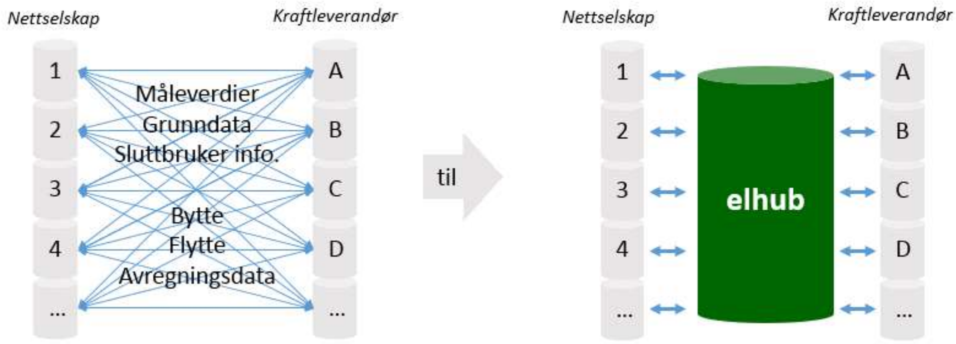

Figure 2.3: Data exchange between grid and power companies before and after Elhub came online[19].

electricity market[17]. What this means is that all transactions are processed by/-through Elhub. DSOs report who their customers are and the metering data etc. to Elhub. At the same time power companies reports who their customers are and get their consumption data for billing from Elhub. Before Elhub all this was handled directly between all the different grid and power companies. This is shown in figure 2.3. As the figure shows the situation used to be that each grid company had to communicate with all power companies that had customers in their area and vice versa. Now all companies communicate through Elhub. As a result of this Elhub is processing large amounts of personal data and storing it for at least 3 years. What Elhub receives of personal data from the grid and power companies is regulated in Regulation 301[16].

Elhub has a privacy statement that is detailed and easily understandable[18]. The current version from May 14. 2019 lists what data is processed, for what purpose, how long the data is stored and who Elhub gets the data from. In addition, Elhub gives an account of the grounds they have for processing the data, mainly drawn from Regulation 301[16].

2.1.3 Laws Regulating the Power Grid

It is the Ministry of Petroleum and Energy that is the governmental entity that is responsible for making the laws for the power grid and the energy sector. For the power grid it is the Energy Act [15] that is the most important. In addition to the Energy Act there are several regulations that further regulate the energy sector. All these laws and regulations can be found on lovdata.no.

The following regulations are given fully, or partly, on the basis of the Energy Act. It is not a comprehensive list of all regulations based on the Energy Act, but

[17]https://elhub.no/en/about-elhub/what-and-why/, 18.04.21
[18]https://elhub.no/personvern-og-sikkerhet/elhubs-personvernerklaering/, 23.05.21
[19]https://elhub.no/om-elhub/hva-og-hvorfor/, 17.04.21

a selection of regulations that to varying degrees affect the processing of personal data in the power grid.

- **Regulation 301 [16]**: Short title in Norwegian is "Forskrift om kraftomsetning og nettjenester". Regulates transactions of electricity and grid services etc. Highly relevant for this thesis as it regulates smart meters, Elhub and minimum information requirements for establishing a new electricity plan and more.
- **Regulation 302 [27]**: Short title in Norwegian is "Forskrift om kontroll av nettvirksomhet". Purpose is to regulate grid operations to ensure an effective grid.
- **Regulation 194 [28]**: Short title in Norwegian is "Forskrift om rapporteringsplikt for kraftleveringsavtaler". Regulation to ensure that power companies provide clear and understandable information about their electricity plans.
- **Regulation 1413 [26]**: Short title in Norwegian is "Forskrift om nettregulering og energimarkedet (NEM)". Purpose is to facilitate for an effective energy market operated in a rational manner. Also regulates separation of grid operations from other parts of a enterprise.
- **Regulation 959 [29]**: Short title in Norwegian is "Energilovforskriften". Regulates several aspects of the power grid.

Of the 5 regulations listed above there are 3 that is is worth taking a deeper look at. In regulation 301 there are multiple paragraphs that trigger processing of personal data. E.g. § 2-3 require that an electricity plan contract must include the consumers name and social security number. § 2-4 requires that this information is also sent to Elhub. § 2-5 and 2-6 requires Elhub to send name and social security number to both grid and power companies. Chapter 4 in the regulation requires the installation of Advanced Metering System (AMS)/smart meters, as well as functional requirements for smart meters. Chapter 6 regulates Elhub, who is responsible and what data is collected by whom and stored for how long. for instance § 6-16 states that Elhub shall store hourly consumption measurements for 3 years.

Regulation 194 has the purpose of making the terms and conditions of electricity plans clear and understandable for consumers. This may be relevant for plans where the consumers receive a discount if they participate in demand side management programs (what this is will be covered in section 2.2). However, the regulation in its current from does not consider this beyond that it should be clear what the consumer pays for.

Regulation 1413 is relevant for this thesis since it regulates separation of the DSO from other services within an enterprise. § 4-17 dictates that a person that participates in leading a DSO cannot participate in leading the enterprise. § 4-18 requires that DSOs clearly separates themselves from power companies and other companies in an enterprise. These paragraphs were added in June 2020 and came into effect January 1. 2021. As a result there was a lot of re-branding/name changes in the last part few months of 2020.

The Energy Act it self also includes elements that are relevant for this thesis. Particularly, § 4-6 and 4-7 are worth noting since it is these paragraphs that enforce the legal and functional unbundling of DSOs from the rest of an enterprise they may be a part of. As of March 2021, there is a requirement for legal unbundling for all DSOs (§ 4-6), but there is an exception for the functional unbundling in § 4-7 for DSOs with less than 10 000 grid customers.

2.2 Smart Grid

This section presents the smart grid with a particular focus on personal data and the Norwegian power grid. The section is divided into three subsections. Section 2.2.1 presents the Smart Grid and what this is as a concept. Section 2.2.2 will look at Smart Grid technologies with a focus on the processing of personal data. Section 2.2.3 will look at the Norwegian grid and how "smart" it has become in early 2021.

2.2.1 What is the Smart Grid?

There are several definitions of smart grids, but they mostly agree on the core concepts [1, 4]. This concept is that traditional power grids become smart grids through the integration of digital "smart" devices and communication technology in the grid. This integration gives the possibility for bidirectional flow of electricity and communication illustrated in figure 2.4. This opens for new control and management options, as well as new functionality. A survey paper [4] presents an overview, advantages and challenges of smart grid technology and applications. A comprehensive knowledge of everything smart grid is not needed for this thesis. A conceptual understanding of what separates the smart grid from the traditional grid, and knowledge of the applications and technologies that process personal data is sufficient.

The smart grid comes with many advantages over the traditional grid and opens up for even more as the technology develops [1]. Improved control, reliability, security, and efficiency are just a few of the advantages. In addition comes support for distributed energy resources(DER) like household solar panels and variations of demand side management programs for balancing the grid[8]. By taking advantage of the possibilities in a smart grid it is possible to achieve great benefits to society by reduced investment costs in the power grid, environmental benefits by more efficient or reduced energy consumption and giving consumers more control over their energy consumption. One of the factors facilitating for this is the deployment of digital smart devices that makes it possible to collect large amounts of data from the power grid[31, 32]. When these devices are in private homes the data becomes personal data[3, 33]. And when there is processing of large amounts of personal data there are privacy challenges with balancing consumer privacy against legitimate applications[34], data leaks, sharing and profiling[35].

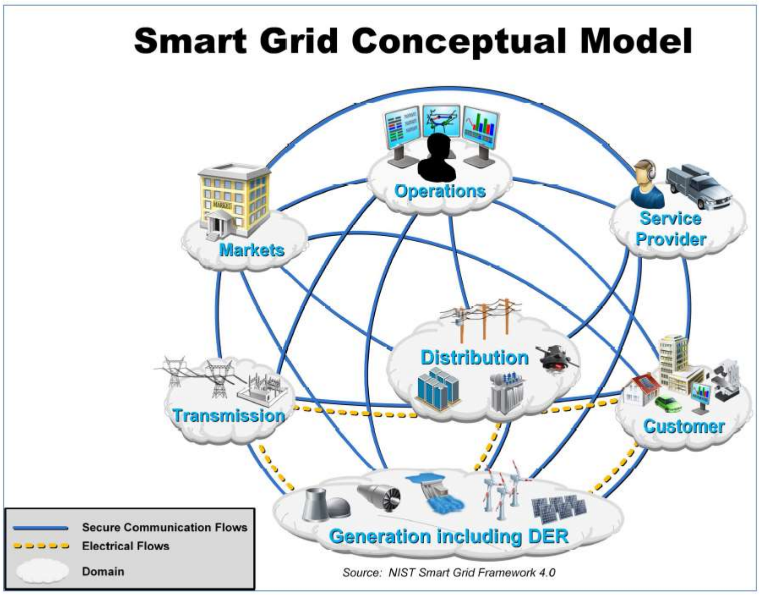

Figure 2.4: Conceptual model of data and electricity flows according to the NIST Smart Grid Framework 4.0[30].

One of the key pieces of technology that contribute to the transition to a smart grid is smart meters[5, 36]. Smart meters are also the devices that most consumers will be affected by as they are installed in most homes as part of the smart grid transition[6]. When a smart meter have been installed the consumers electricity consumption is recorded in a much higher resolution than with traditional meters. The exact functionality of each type of smart meter will vary from model to model, but a list of common functionality is listed after this paragraph. The list is from [36] which is an article from 2013. However, when comparing the list with the required functions in Norwegian smart meters given in § 4-2 of Regulation 301[16] the requirements are the similar. Smart meters can measure consumption in real time and report this at set intervals, typically ranging from every 15 minutes to 24 hours. They can also communicate with other devices over standardized interfaces and be remotely controlled by the grid operator. It is this functionality that is the reason why smart meters contribute to the transition towards a smart grid. By providing consumers, DSOs, and power companies with more information and functionality it will enable new ways to manage the grid as well as providing incentives for consumers to save energy.

Smart Meter Functionality:

- Two-way communication
- Data collection
- Data recording
- Data storing

- Load control
- Programming
- Security
- Display
- Billing

Another area of the smart grid that is closely related to the consumers is the home area network(HAN). In the context of smart grids HANs are networks of connected smart devices inside a house that is connected to a smart meter [37]. The devices connected in the HAN can be water heaters, fridges, electric vehicle (EV) chargers, or any other device that consumes electricity that also has the processing intelligence to participate in the HAN. Setting up a HAN is voluntary in Norway[16] and is something the consumer has to decide to do. Data collection and control through HANs can facilitate for several smart grid technologies like demand side management and load forecasting.

2.2.2 Smart Grid Technology Involving Personal Data

As the title states this section title says this section will look at smart grid technology that involve processing personal data. Using the term technology in this section might be a bit misleading since in some cases what one actually are talking about is models, programs or systems utilizing technology to manage the grid. What is considered personal data is covered in section 2.3, but when reading this section it is necessary to understand that data is considered personal data if it contains information about a person when it is connected to an identifier that ties it to a specific person. E.g. consumption measurements are considered personal data because they can tell a lot about person X when you know that they are from the house of person X.

The most prominent piece of technology, both when it comes to the Smart Grid and personal data, is smart meters. The reason for this is that they are mandatory, widely deployed and their primary function, measuring consumption, generates personal data. How much data depends on how frequent the measurements are, but hourly measurements are more than sufficient to infer personal data[10, 11]. In the Norwegian grid the smart meters that are deployed must be able to measure consumption between every 60 and 15 minutes, with the current setting being every 60 minutes[16]. One of the things that frequent consumption measurements allow for is variations of Real-Time-Pricing (RTP) and Time-of-Use pricing(TOU) programs[38]. These concepts work by billing consumers depending on when they used the electricity and use this as an incentive to avoid using electricity during peak-load hours.

Closely tied to smart meters is the previously mentioned HANs. HANs can be used by consumers to get real time information from their smart meters about consumption and prices. Depending on the setup third party companies can be given access to devices connected to the HAN and collect data or, in some cases actively control the device in order to affect the electricity usage for the house-

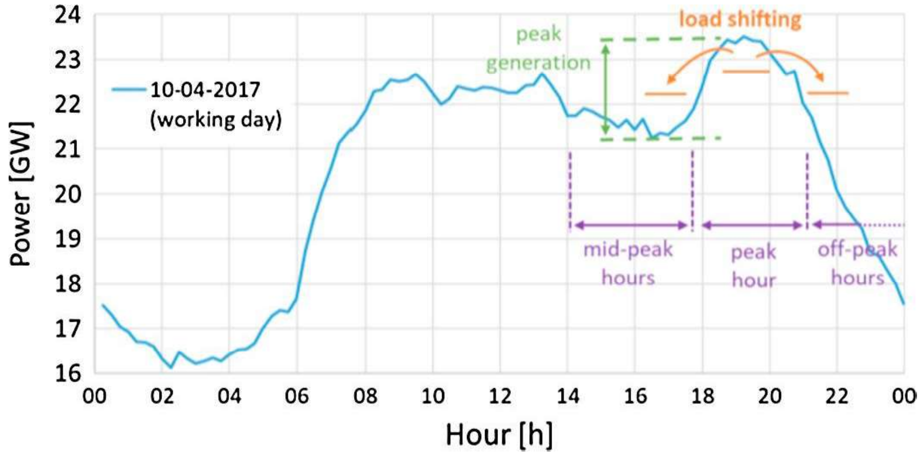

Figure 2.5: Figure taken from [33] showing the variation of the load in the grid over the course of a day.

hold[33]. The HAN can be used to collect large amounts of data and information about the devices that are connected to it. This again can be analyzed to identify personal data.

The smart grid concept that will involve personal data is probably various programs under the Demand-Side Management (DSM) umbrella. There are multiple definitions of DMS but this thesis will use the following from [39]: "Demand-side management (DSM) refers to technologies, actions and programmes on the demand-side of energy metres that seek to manage or decrease energy consumption, in order to reduce total energy system expenditures or contribute to the achievement of policy objectives such as emissions reduction or balancing supply and demand.". What this essentially means is that in order to maintain the balance in the grid DSM seek to influence or manage the demand on order to match the supply. Figure 2.5 shows how the demand varies greatly throughout the day. By using DSM it is possible to flatten the load curve to make it easier to adjust supply to demand and reduce the need for transmission and generation capacity in the grid.

DSM are typically divided into two categories: Energy efficiency/conservation and demand response (DR)[40]. Energy efficiency is largely static measures taken to reduce the energy consumption. This will typically be extra insulation, new windows etc. This category is not that interesting with regards to this thesis since it does not involve personal data. Demand Response can be divided into two main categories which are incentive based and price based. Both can involve processing personal data.

The price based DR aim to influence the consumption by increasing the cost of consumption at times when the supply is low or the grid is at peak capacity[38]. Incentive based DR rewards the consumer with refunds or reduced prices if they participate in DR programs. Through e.g. Direct load control (DLC) the consumer allows a company to control when appliances are to use electricity, and the com-

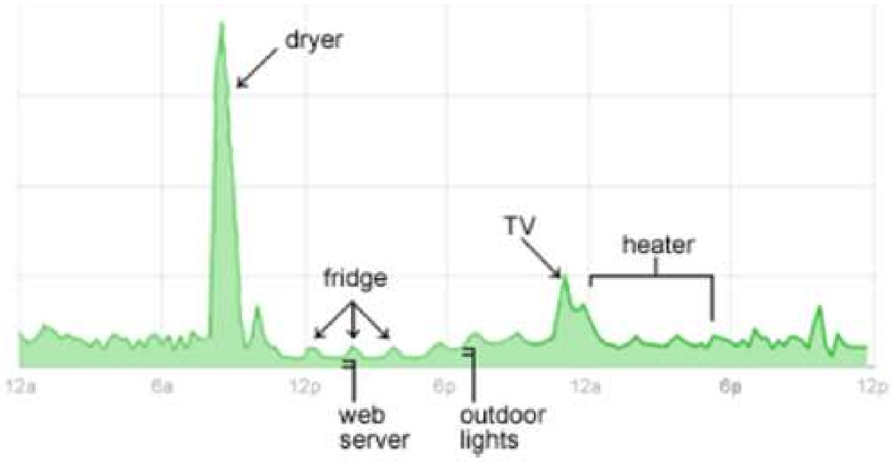

Figure 2.6: Various appliances identified in a consumption time series [22]

pany uses this to increase/decrease the load in the grid as needed[38]. Both price and incentive based DR programs rely on personal data. Price based through frequent consumption measurements, and incentive based through detailed information about the state of consumer appliances.

Of the above mentioned incentive DR programs, it is DLC programs that are most relevant for this thesis. By giving a company access to control and monitor one or more devices and appliances in the household a lot of information can be read out of this. Figure 2.6 shows how different appliances have different signatures in their consumption making it possible to identify when they are used. Knowing when an appliance is using electricity might not reveal that much data in it self. However, when combined with access to general consumption data it is easier to "fill in the blanks" when knowing parts of the picture. This might be the case if a grid company hosts the DR program and have access to both data sets.

Another area where data from household appliances and smart meters can be used is in load forecasting. Load forecasting is an important part of the operation of the grid as it is one of the tools used to keep the grid in balance[41]. Through load forecasting the generation need for the next 24 hours is estimated each day. Previously there has been no good method or purpose to forecast load at a household level. However, with new methods it is possible to do this kind of forecasting with a reasonable accuracy and use this in conjunction with DSM[42, 43].

To summarize this section the main sources for personal data in the power grid is smart meters and household appliances that are enrolled in a DSM program. While it usually is mandatory to have a smart meter, it is voluntary to participate in DSM schemes that require additional data beyond what the smart meter collects. It is well established that it is possible to infer personal data from smart meter data, and by adding detailed information about additional appliances this will become easier as it helps fill in the picture of what the consumption is being used for.

2.2.3 How Smart is the 2021 Norwegian Grid?

The term smart grid is used frequently in this thesis. However, the Norwegian power grid as of 2021 is not fully transitioned from a traditional grid to a smart grid. Rather it is somewhere in between, with more and more smart grid technology being deployed. This section will look at the current status of the Norwegian grid and its transition to becoming a smart grid. The main focus will be on changes that affect the consumers and not so much on changes in e.g. the transmission grid.

One of the main steps towards a smart grid in Norway is the widespread deployment of smart meters. The regulatory deadline for the deployment was 01.01.2019 and by that time the rollout was at 97%[25]. As of February 2019, Elhub as a central data hub for the Norwegian grid was operational. This has already had the effect that Norwegian consumers are billed after a real time pricing model at a hourly level. NVE-RME also considered a regulation including a "power tariff" which falls under the price based DR category, but decided not to do so[44]. The same regulation allows for Time-of-Use pricing programs for the DSOs.

There are many research and development projects related to smart grid in the Norwegian energy sector. In [18] from 2014 the authors address several projects that was ongoing at that time and the creation of the Norwegian Smart Grid Centre in 2010. This center was established by NTNU[20] and SINTEF[21] and today it has 47 members from academia and industry. On the Smart Grid Center website under the research and development section there is an overview of the project the center and its members are or have been participating in[22]. From this list it is clear that there are a lot of research and development within the scope of smart grid i Norway.

While there are also a lot of R&D projects that try to find out how the grid should become smarter. It seems that there are few of these projects that involve consumers that have been deployed outside of demos or test labs[23]. One exception to this is the implementation of distributed energy resources (DERs) and prosumers (consumers that also produce electricity) which is becoming more common. Typically through solar panels installed on house roofs[2]. Another example is the emergence of smart EV charging where one tries to match the charging time to hours when the electricity price is low[24][25]. This can either be managed manually by the consumer or automatically by the power company depending on the setup.

[20]https://www.ntnu.no, 02.05.21
[21]https://www.sintef.no, 02.05.21
[22]https://smartgrids.no/fou/, 02.05.21
[23]https://www.statnett.no/en/about-statnett/research-and-development/our-prioritised-projects/norflex/, 02.05.21
[24]https://tibber.com/no/smart-styring/elbillading, 02.05.21
[25]https://www.los.no/elbillader/, 02.05.21

To summarize this section, it seems that the Norwegian grid is in a transitional phase to becoming "smarter". In the last decade there has been a lot of R&D looking specifically at how to make the Norwegian grid to a smart grid and this process has now started. A key step in this process was the roll out of smart meters before 2019. In the consumer domain the process has started with consumers having some options to participate in some forms of DSM programs. However, this is still far from the norm.

2.3 GDPR

EU regulation 2016/679, known as the General Data Protection Regulation (GDPR), is an EU regulation that came into effect in 2018 whose purpose it is to "...protection of natural persons with regard to the processing of personal data and rules relating to the free movement of personal data." [14]. Since Norway is not a member of the EU the GDPR had to be passed into national legislation as a part of a national law. This was done through "Personopplysningsloven"[45]. This law has some aspects that is specific to Norway, but beyond this it is a direct adaption of the GDPR. It is also given in the law that in the case of conflict between GDPR and the law, it is the GDPR that will take precedence[26]. Therefore, the reset of this section, and the thesis overall, will mainly use the term GDPR. This also avoids any translation issues as the GDPR is in English.

The rest of this section will give a general overview of the GDPR as well as deeper review of the most relevant parts for the rest of the thesis. In addition, there will be some important definition with regards to personal data in general and specifically for the power grid.

2.3.1 GDPR

The GDPR has 99 articles divided on 11 chapters. In additions to the articles there are recitals from the making from the regulation that further explains the articles and chapters[14]. Not everything in the GDPR is relevant for this thesis and this will not be a comprehensive covering of the regulation, but rather an extract of the relevant parts. This section will follow the layout of GDPR and will begin by looking at relevant definitions before moving on to GDPR principles, data subject rights and controller/processor obligations.

Definitions from the GDPR

The thesis will use relevant definitions from the GDPR. The following is a set of definitions from the GDPR that is relevant for this thesis.

[26] https://www.datatilsynet.no/regelverk-og-verktoy/lover-og-regler/om-personopplysningsloven-og-nar-den-gjelder/, 02.05.21

The following definition of personal data will be used in the thesis: Personal, Sensitive and Public data. The division is based on the GDPR definition of personal data and special categories of personal data.

- **Personal data:** *"Any information relating to an identified or identifiable natural person ('data subject'). An identifiable natural person is one who can be identified, directly or indirectly, in particular by reference to an identifier such as a name, an identification number, location data, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person (Art.4(1) of GDPR)."*
- **Sensitive data:** *"Data revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation (Art.9 of GDPR)."*
- **Public data:**Any data not included in Private and Sensitive data. An example may be tariffs/price information that can be communicated to the smart meter.

The GDPR uses the term processing when it talks about handling personal data and provides the following definition.

- **Data Processing:**" *Any operation or set of operations which is performed on personal data or on sets of personal data, whether or not by automated means, such as collection, recording, organisation, structuring, storage, adaptation or alteration, retrieval, consultation, use, disclosure by transmission, dissemination or otherwise making available, alignment or combination, restriction, erasure or destruction of data (Art.4(2) of GDPR)."*

According to the GDPR there are two roles an entity may have when it comes to processing personal data. These roles are controller and processor with the controller determining why data is to be processed, and processors carrying out the processing on behalf of a controller.

- **Controller:**" *The natural or legal person, public authority, agency or other body which, alone or jointly with others, determines the purposes and means of the processing of personal data; where the purposes and means of such processing are determined by Union or Member State law, the controller or the specific criteria for its nomination may be provided for by Union or Member State law (Art.4(7) of GDPR)."*
- **Processor:**" *A natural or legal person, public authority, agency or other body which processes personal data on behalf of the controller (Art.4(8) of GDPR)."*

Another important definition is the term consent and what this is defined as in the GDPR.

- **Consent:**" *Any freely given, specific, informed and unambiguous indication of the data subject's wishes by which he or she, by a statement or by a clear af-*

firmative action, signifies agreement to the processing of personal data relating to him or her (Art.4(11) of GDPR).”

GDPR Principles for Processing Personal Data

Chapter 2 (Art.5-11) of the GDPR lays out the principles for processing personal data. Of particular interest is Art. 5, 6 and 7. These articles dictates some principles that must be met for the processing of personal data to comply with the GDPR. Art. 5 lists a set of principles that apply to the processing of personal data. These principles are listed below with a short description. The full detailed description can be found in [46].

- Lawfulness, Fairness and Transparency: Personal data shall be processed lawfully, fairly and in a transparent manner in relation to the data subject.
- Purpose Limitation: Personal data shall be collected for specified, explicit and legitimate purposes.
- Data Minimisation: Personal data shall be relevant and limited to what is necessary in relation to the purposes for which they are processed.
- Accuracy: Personal data shall be accurate and inaccurate data must rectified.
- Storage Limitation: Personal data shall be stored for no longer than is necessary for the purposes for which the personal data are processed.
- Integrity and Confidentiality: Personal data shall be processed in a manner that ensures appropriate security of the personal data.
- Accountability: The controller shall be responsible for, and be able to demonstrate compliance with, the principles listed above.

Art. 6(1) list 6 legal grounds for processing personal data of which at least one must be in place in order for the processing to meet the lawfulness principle. The 6 legal ground are listed below. Further details on what is meant and understood by the 6 legal grounds can be found in the recitals that explain them in more detail. Relevant recitals are 39-50.

- Consent: The data subject has given consent to the processing of his or her personal data for one or more specific purposes.
- Performance of a Contract: Processing is necessary for the performance of a contract to which the data subject is party or in order to take steps at the request of the data subject prior to entering into a contract.
- Legal Obligation: Processing is necessary for compliance with a legal obligation to which the controller is subject.
- Vital Interest: Processing is necessary in order to protect the vital interests of the data subject or of another natural person.
- Public Task: Processing is necessary for the performance of a task carried out in the public interest or in the exercise of official authority vested in the controller.
- Legitimate Interest: Processing is necessary for the purposes of the legitimate interests pursued by the controller or by a third party, except where such

interests are overridden by the interests or fundamental rights and freedoms of the data subject which require protection of personal data, in particular where the data subject is a child.

When looking at the legal grounds for processing listed above it is clear that consent is different from the 5 others as it is the only legal ground that is entirely subject to the data subjects wishes. In addition to the previously given definition of consent Article 7 of the GDPR gives the conditions for consent. After Art. 5 it is the controllers responsibility to be able to demonstrate that the data subject has given consent. Consent can also be withdrawn at any time, and to do so should be as easy as it was to give consent. When it comes to whether consent is freely given particular care should be taken to see if the consent is a condition for performing a contract/service that does not require the processing of personal data.

The rest of chapter 2 in the GDPR, Art. 8-11, are not that relevant for this thesis as they cover specific cases that is not relevant for the power grid. The exception may be art. 9 regarding processing of special categories of personal data. It can be argued that this is relevant for the power grid as it is possible to observe the observation of religious holidays based on consumption data[10]. Art. 9 of the GDPR prohibits such processing, but also provides exceptions for when it is allowed.

Data Subject Rights

Chapter 3 (Art. 12-23) of the GDPR concerns the rights of the data subject. Art. 12 gives data controllers an obligation to provide any information and communication in a "...concise, transparent, intelligible and easily accessible from, using clear and plain language...", as well as making it easy for the data subject to exercise their rights.

Art. 13 and 14 relates to information that the data controller shall provide to the data subject when collecting personal data. Art. 13 covers when data is collected from the data subject and Art. 14 when the data is not obtained from the data subject. The information that the controller is obligated to provide similar for both articles and include contact information for the controller, the purpose and legal grounds for processing, storage period etc. Art.15 gives the right to obtain information from a controller if they process data and access to that data where that is the case.

Art. 16-22 gives a data subject a set of rights with regards to their personal data. Among these rights are the right to rectification of incorrect data(Art. 16), right to erasure/be forgotten(Art. 17), restriction of processing(Art. 18), data portability(Art. 20), right to object(Art. 21) and right to not be subject to automated individual decision-making(Art.22).

All in all chapter 3 of the GDPR gives data subjects rights to have access to transparent an intelligible information about who are processing their data, for what purpose, on what grounds. They also have the right to get information about the processing and to object within the scope of the GDPR.

Data Controller and Processor Responsibilities

Chapter 4 (Art. 24-43) of the GDPR covers the data controller and processor responsibilities. Who it is that have these roles are defined in Art. 4(7) and 4(8), while chapter 4 goes into detail on their responsibilities and obligations. Several of the articles in chapter 4 is about technical and organizational measures that controllers and processors must implement if they are to process or collect personal data. This is outside the scope of this thesis and will not be covered further.

2.3.2 Personal Data in the Power Grid

The personal data that exists in the Power Grid can be divided into two categories. The fist category is general personal data that are non-specific to the power grid. That is personal data that exists outside of the grid context and is considered personal data in other situations as well. Typical examples here are names, addresses and other contact information.

The second category is personal data that is specific to the power grid. That is that they are created and mainly exist in the grid. Typical examples here are hourly consumption measurements from smart meters, and information related to electric installations in private homes. For this thesis this second category is further divided into two subcategories. The first subcategory is grid specific data that is collected because it is a requirement in regulations like [16] to do so. The second subcategory is grid specific/related data that there is no regulatory requirement to share. This personal data hierarchy is shown in figure 2.7. The second subcategory is interesting with regards to the topic of this thesis since this is the only personal data that actually is optional for the data subject to share. There is a possibility for overlap between these two subcategories as a data subject/consumer may choose to share data with a third party that they already are required to share with grid/power companies.

2.4 State of the Art

This section will try to cover the state of the art when it comes to the smart grid, GDPR compliance and the Norwegian grid in this context. Smart grid privacy and security challenges have long since been acknowledged as a challenge in literature with many papers and publications having been published on the subject. However, the GDPR was first published in 2016 and came into effect in 2018 meaning that there actually have not been that long to adapt to it. This can be exemplified by there being uncertainties around if Elhub, DSOs and power companies are joint controllers after Art. 26 in May 2019[27], the conclusion that this was not the case in December 2020[28]. This, combined with the Norwegian grid only staring to

[27]https://elhub.no/documents/2019/08/20190620-presentasjon-elhub-bransjerad.pdf/, 09.05.21

[28]https://www.energinorge.no/contentassets/0731898125c34b4d820eff585e4fe13c/veileder-bransjestandard-personopplysningsloven-energi-norge-v1_0_4_1_2021.pdf, 08.05.21

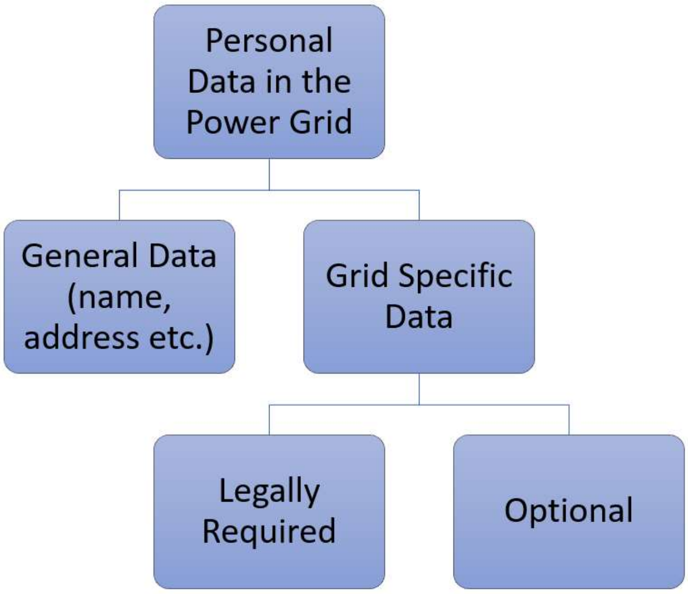

Figure 2.7: Figure showing the types of personal data that exist in the power grid organized in the categories that will be used in this thesis.

make the transition to a smart grid ref section 2.2.3, means that there is a limited amount of information available.

One source that is relevant is a Master Thesis from the University of Oslo titled "Personvernrettslige problemstillinger ved smarte strømmålere og Elhub" from 2018 that specifically looks at the legality in collecting and storing consumption measurements for 3 years[17]. It concludes that storing hourly consumption measurements for 3 years does not comply with the principle of data minimisation in GDPR, and that the lack of choice is a concern. According to the thesis this puts Elhub, DSOs and power companies in a situation where they either must break power grid regulations or the GDPR. It has not been possible to find a source that counters this assessment, or any other fallout from this.

Another relevant source is [22] this is a publication that look at smart grid challenges from a GDPR point of view. In the paper they look at challenges related to GDPR principles for processing personal data, data subjects rights and obligations for controllers and processors. The paper highlights many of the challenges that serve as a motivation for this thesis showing the complexity with the actors involved. Among the issues that are highlighted in the paper is the possible challenges with complying with principles like data minimisation and purpose limitation for consumption measurements and the need for consent from consumers.

What becomes apparent when searching for sources is that there are many papers concerning privacy and security in the smart grid, but few that concern themselves with the GDPR beyond a justification/motivation for that privacy is important. An example of this is a Scpous search for *smart grid privacy* yielding over 2000 hits, while *smart grid privacy gdpr* yields only 12. Of the papers that do consider GDPR more specifically it is mainly with regards to the technical compliance with the concepts of privacy-by-design, getting consent, encryption and other security issues. While this is important it does not provide insight into how entities in the power grid have organized themselves with regards to GDPR.

Chapter 3

Methodology

This chapter describes how work with this thesis was carried out. It includes a recounting of the methods that have been applied, why these was chosen and why other methods were not used. There are two factors that have heavily influenced the choice of methods used in this thesis. The first is that the author works full time in addition to studying part time. This means that the thesis is written over the course of two semesters, and that the chosen methodology needed to facilitate a work schedule that would frequently change on short notice. The second is that the topic of the thesis is in a field that is currently seeing a lot of changes and development that is yet to be documented in literature. This necessitated finding other sources for data and information.

The rest of this chapter will cover each part of the methodology in a chronological order. At least chronological in so far as when the method was first applied as several parts have been parallel or recurring as time or new information have necessitated. Section 3.1 provides a preface and background for the thesis problem. Section 3.2 covers the literature review and information gathering from other sources. Section 3.3 covers the data gathering done through a questionnaire sent to actors in the power grid, and section 3.4 covers the analysis of the data and the work with producing the results. Each section includes an evaluation of the chosen method and, where applicable, why another method was not chosen.

3.1 Step 0: Defining the Problem

The first work with this thesis was started with the pre-project in January 2020. In the pre-project the planned problem was to look at privacy preserving schemes for smart meter consumption data, and which of these comply with the legal regulation of the power grid. However, it quickly became apparent that there was few of the proposed schemes that are applicable with the current regulations. In addition, those that were applicable would require large investments from consumers as well as largely being suitable for house owners. Examples of applicable schemes are Battery-based Load Hiding or best-effort schemes using DERs[20].

Both require investing in a large battery or solar panels provided you have the opportunity and can afford it.

As a result, the thesis problem was redefined to its current form, as presented in section 1.1, in August/September 2020. Based on this new problem the research questions listed in section 1.3 was defined, and the methodology outlined in this chapter was chosen as way to answer them.

3.2 Step 1: Literature Review

The purpose of the literature review in this thesis was to use it to get sufficient background knowledge about the topic, cover relevant research and gather information from relevant sources. As such the preliminary literature review started before defining the problem to have enough information as a basis for formulating the problem. As mentioned earlier it has been difficult finding suitable scholarly sources for information for parts of this thesis. Because of this the decision was made to use open source/web resources as information sources for some topics. Particularly for information about the Norwegian power grid this was found purposeful. The following subsection covers the 3 main information sources used in this thesis.

3.2.1 Scholarly Sources

For this thesis the literature review have been done in a semi-systematic manner[47] in multiple iterations. The first being with the pre-project in January 2020, and the last in May 2021. In this period there have been shifts in the focus as the thesis have developed. E.g. the change of problem from the pre-project to the actual thesis. That the literature review has been a recurring activity repeated multiple times over a period of 1,5 year has the advantage of making it possible to follow the most recent developments in the field and see trends that are evolving. It must be mentioned that while there have been frequent literature searches throughout the period, there have only been a few sessions when there have been an in dept semi-systematic literature search. A non-exhaustive list of search terms, keywords and search engines is shown in 3.1. This lists the most used keywords that directly relate to the thesis problem. In addition, there have been searches for more auxiliary topics like "demand side management" and "demand response".

3.2.2 Legal Sources

When it comes to the Norwegian legal documents references in this thesis the source have been *lovdata.no*. Lovdata is operated by a private foundation and its purpose is, among other things, to make Norwegian laws available online. All new laws and regulations in Norway is made available in Lovdata and updated with any changes.

Search Engine	Keywords Used
Google Scholar	smart grid GDPR "smart grid" GDPR "power grid" GDPR "general data protection regulation" "Smart grid" strømnettet GDPR smart grid privacy smart meter privacy
IEEE Xplore	"smart grid" GDPR Power grid GDPR GDPR
Scopus	GDPR smart grid "general data protection regulation" "Smart grid" Smart grid privacy Smart grid privacy gdpr

Table 3.1: Table showing a non-exhaustive list of search engines and keyword combinations used during literature searches.

Since all the legal sources/documents references in this thesis have been available all the time in a known place the question has been to discover **which** laws and regulations are relevant. This have been done in three ways. The first is starting with the Energy Act and using the functionality in Lovdata allowing you to see regulations related to the law. The second is looking at web sites that have information about the legal framework for the grid and collaborate this with the documents identified in the first step. Third way was to look up any legal documents that was referenced in other sources and check them for relevance and if they already were in the list.

An important caveat regarding the legal documents included and referenced in this thesis is that the thesis author is not a lawyer and have not studied law. This means that there is no guarantee that the legal documents have been interpreted correctly.

3.2.3 Open Sources

As it has been mentioned a lack of other suitable sources for information about the Norwegian power grid meant that open sources have been used. By open sources it is meant information sources that are publicly available online, that has not been subject to a peer-review and no guarantee that it will remain unchanged and/or available. In order to mitigate this, there have been a screening process of the websites that have been used and where possible have the information collaborated from multiple sources.

The website that has been used the most as a reference for information is *https://energifaktanorge.no*. This is a site that contains information about most parts of the Norwegian energy sector, the grid, legislation and more. The entity that is responsible for the website is the Norwegian Ministry of Petroleum and Energy, and as such is considered a reliable source of information. Another much used source is *https://www.nve.no* where the responsible entity is The Norwegian Water Resources and Energy Directorate. This is also considered a reliable source of information for this thesis.

For some information, the reference is the website of a company or a news article. This is the case when there has been no other source of information available. In most of these cases the references are used to support or exemplify something that is largely accepted, and not to support something that is new or disputed.

Another information source that is used is annual reports or similar documents published by companies and other entities. These reports will not change like websites are likely to do, and it should be possible to find them based on the title and known publisher. This makes this kind of reports a good source of information.

3.3 Step 2: Questionnaire

After the literature review it became apparent that there was insufficient information and data available to answer all the research questions listed in section 1.3. Particularly research question 3, 4 and 5 was difficult to answer with the information available in the fall 2020. In order to collect data that could be used to answer these questions the options was to either send out a questionnaire or conduct interviews. Both methods have pros and cons with regards to the data collected and the practical execution of the method. Some of these pros and cons are shown in table 3.2. Note that the pros and cons with regards to the execution of the methods is specific to this thesis and must not be considered as general or universal.

After some consideration it was decided to use a questionnaire as the method for data gathering. There are two main reasons for this. The first is that a questionnaire methodology is more compatible with the part time student working full time constraint under which the thesis work was being done. The passive data collection after the questionnaire was sent out is more compatible this. And since the thesis was written over the course of 2 semester there was ample time for getting responses to the questionnaire. The second reason is that with more than 170 grid/power companies a questionnaire is the only feasible way to try to reach out to all of them.

As the pros and cons table shows there are advantages that comes from performing interviews over taking a questionnaire approach. And it is likely that performing interviews would have yielded data and information that the questionnaire was unable to capture. And as such there is an argument to be made for that a combination approach with a few interviews and a questionnaire might have been better as it gives the "best of both worlds". However, it was decided to only focus on the questionnaire, and spend the available time on this and other parts of the thesis.

Method	Pros	Cons
Questionnaire	Broad distribution Passive data collection	Response rate Not possible with follow up questions Cannot adapt to new information
Interviews	Known/controlled response rate Follow up questions Subject can volunteer information	Time consuming Subject availability Lower possible sample size

Table 3.2: Table listing pros and cons with questionnaire and interviews as a methodology in this thesis.

3.3.1 Target Population and Distribution

Once the decision was made to make a questionnaire the next step was to decide who was the target population for the questionnaire. As the thesis is investigating who it is that processes personal data in the grid, with a particular focus on processing required by law, it became clear that the target population was grid companies(DSOs), power companies and Elhub. This definition of the target population omits any third parties that might process personal data originating in the power grid. However, these third parties have no legal obligation to process the data, and the interaction is purely voluntary for the consumer. This makes it less critical to discover their stance on their role in a GDPR setting since it is a more traditional consumer- service provider relationship. In addition, several of the power companies are offering similar services as the third party service provider, and since they have no regulatory grounds for this processing they need the same kinds of legal grounds after Art. 6 of GDPR as the third parties. The questionnaire can therefore give insight into this with the chosen target population.

For finding the DSOs that make up that part of the target population the list of companies that hold a license for operating a distribution grid was found on NVE-RME's website. DSOs that do not serve private consumers was omitted from the target population. Then there was a process of finding contact information for each of the DSOs. This involved varying degrees of difficulty depending on their online presence and for some companies there was nothing to be found with a reasonable amount of effort. When this process was done the list numbered 91 DSOs.

For finding the power companies the comprehensive list of all companies that sells electricity to the consumer market from *https://www.bytt.no/strom/* was used. Then there was a process of finding contact information for all the companies and at the same time verify that the list from bytt.no contained relevant companies. The final list of power companies numbered 82 companies.

The distribution of the questionnaire was done using e-mail with a link to the questionnaire. The wanted point of contact in order of priority was data protection officer (DPO), CEO/equivalent, company mail and customer service mail. The final mailing lists was a mix of these. There were some challenges with several grid and power companies being part of the same group/enterprise. This makes it difficult to distinguish between what is contact information for grid and what is for power. Particularly where these historically have been the same company and brand. This was somewhat helped by new regulation requiring a clear separation of grid and power by 01.01.21. However, in November/December 2020 when the list was compiled this was implemented to varying degrees and was a source for confusion as contact information for company X-grid and company X-power in several cases was the same. In addition, the companies that was part of the same group often shared the same DPO for grid and power. The solution to this was to split the mailing list into two, with one for grid and one for power companies, and including a caveat in the questionnaire to ensure that they replied on behalf of the "correct" company type. While not a perfect solution it likely mitigated some errors and also did not require a disproportionate amount of work to find the correct point of contact or handle all the cases with a single point of contact separately.

The questionnaire was sent out 16.02.2021, with one mail going to the grid companies and one to the power companies. All the recipients were added as blind copies (BCC) to not disclose the mailing list to the recipients. Along with the link to the questionnaire the mail included an introduction text that presented the thesis, the purpose of the questionnaire and a confidentiality statement about how the collected data would be handled. In addition to the first mail there was a presentation about the thesis with a request for participation made in a ECoDiS[1] workshop on the 12.03.2021, and a reminder mail was sent out 14.03.2021.

The confidentiality statement can be summarized in that all data would be treated confidentially, and only be shared with the supervisors for the thesis. The data would not be copied or shared. Any data presented in the thesis would be anonymized in such a way that it would not be possible to trace it back to the companies. All raw data that have not been anonymized will be deleted within 180 days of the time it was collected.

There was one exception to this and that is Elhub. As Elhub is a unique entity in the power grid there is no way that the information collected from Elhub could be anonymized and still be presented in a meaningful way. Therefore, a separate mail was sent to Elhub making it clear that any information they provided in the questionnaire would/could be presented as being from Elhub.

[1]https://www.sintef.no/prosjekter/2019/ecodis-engineering-and-condition-monitoring-in-digital-substations/, 15.03.21

3.3.2 Questionnaire Design

One of the first things that became apparent when making the questionnaire was that it would include branching/ skip logic as there would be different questions for data controllers and data processors. Hence, the questionnaire tool needed to support this. After some research it was found that Nettskjema[2] would provide this along with other desirable attributes. Nettskjema is a tool provided by the University of Oslo and offer a secure questionnaire service that meets that requirements for processing personal data. The questionnaire in this thesis did not collect personal data. But having a questionnaire tool that maintains confidentiality was necessary.

The main purpose of the questionnaire is to discover what role after GDPR the grid and power companies and Elhub have with regards to the various types of personal data shown in figure 2.7. As the figure shows there are 3 categories of personal data that are of interest: General, grid specific legally required and grid specific optional. As a result, the questionnaire has 4 part, one for each of the personal data categories and a fourth for feedback. In addition, there is an introduction section that provides further information about the purpose and collects some meta information. The questionnaire can be seen in its entirety in Norwegian in appendix A.

Introduction

The initial introduction section has 2-4 questions depending on answers and what the participant wants to respond to. Question 1 is "Which company do you answer on behalf of?". This question is there to make it possible to do a further analysis of answers by comparing them to e.g. privacy statements for that company. You do not have to answer this question to proceed with the questionnaire. This is to allow for collecting data from companies that do not want to identify themselves. Question 1.1 ask for the number of employees in the company. The purpose behind this question is to check a hypothesis that larger companies should have better control with regards to GDPR as they are more likely to have dedicated persons for this. This is also an optional question.

Question 2 is a multiple choice(MC) question about what kind of company it is that is responding to the survey. This is a mandatory question to continue the questionnaire. This is because it is necessary to know if it is a grid or power company that is answering. This question also has the text clarifying that if you are e.g. DPO for a group you should answer as either grid or power company depending on the subject field in the mail. The answer options are grid company, power company and other. If you answer "other" you will be asked an additional question 2.1 where you are asked to provide the company type you represent. If you select either of the other 2 options, you go directly to part 1 and question 3.

[2]https://www.uio.no/tjenester/it/adm-app/nettskjema/, 15.05.21

Part 1-4

Part 1, 2 and 3 are similar and have the same questions, but each part covers one of the three personal data types shown in figure 2.7. There is a slight difference in part 3 as this is about data that it is optional to collect and there is an additional screening question. Part 1 and 2 are identical but asks about different categories of personal data with part 1 covering the general data category and part 2 the mandatory grid specific category.

Part 1 begins by giving a brief description of what is meant by general personal data and that the questions in part 1 relate to this kind of data. The first question, question 3, is a MC question about whether the company is a data controller or data processor after GDPR. These are also the MC options plus an "Don't know" option. Depending on the answers there are 3 paths, or branches, that continues the questionnaire. If the respondent checked that they are a data controller they are taken to question 3.1. Here they are asked which of the 6 legal grounds for processing after GDPR Art. 6(1) they claim as data controller. There is also an option that is "Don't know". If the respondent checked that they are a data processor they are taken to question 3.2 where they are asked if they have a processing agreement with the data controller. The answer options are yes, no and do not know. If they check for yes, they are asked to provide the company type they have an agreement with in question 3.2.1. Answering do not know on question 3.1 takes you directly to part 2 and question 4.

Part 2 has identical layout and questions as part 1 but is about grid specific personal data that it is mandatory to process. The respondents are asked to respond based on their role with regards to consumption data from smart meters. Beyond this the questions in part 2 are the same as in part 1, with the same branching and options, but you continue to part 3 when finished.

Part 3 is similar to part 1 and 2 in that it starts with a description of the type of personal data that the following questions relate to. In this case data about consumption from other devices than smart meters. Where it differs is that question 5 is a question about whether they are collecting this type of data. It is a MC question with the options yes, no, intends to start collecting and do not know. Answering yes or intents to start collecting will take the participant to question 5.1, and no and do not know will take the participant to part 4. From question 5.1 part 3 is identical to part 1 and 2 with questions for controllers about legal grounds and for processor about processing agreements.

The questionnaire finish with part 4 which is a possibility to provide feedback and make comments about the questionnaire.

3.4 Step 3: Answering the Research Questions

This section outlines how the final structured analysis of the collected literature and questionnaire results was carried out. There has been ad-hoc analysis over the course of doing the literature search and with the initial responses to the questionnaire, but the final analysis was carried out when all the data was collected and structured.

The research questions were made to answer the problem in the thesis problem and served as the starting point for the analysis. First the research questions were answered based on the information found in the literature review. Then research questions were answered based on the results from the questionnaire. Finally, the research questions were answered based on both the literature review and questionnaire results. Answering the research questions in this way made it possible to gain more insight into the problem. By only using the information that is publicly available to answer the RQs it also serves as a check of whether a normal consumer theoretically could get correct overview with only publicly available information. By answering the RQs based on each of the two data sets separately first it was easy to see if there are discrepancies between what theory dictates and what was found in the questionnaire. Then these discrepancies could be investigated further before finally answering the RQs based on both sets of information.

In addition to the text answers to the RQs visual representations, models, was made. The models have been developed in multiple iterations over the work with the thesis and was updated as new information came to light.

Chapter 4

Results

This chapter presents the main results of this thesis. Section 4.1 answers the research questions based in the information found in the literature/open source study. Section 4.2 uses the data collected from the questionnaire to answer the same RQs. Section 4.3 answers the research questions based the information found in section 4.1 and 4.2 combined. Section 4.4 presents two alternative models showing who processes what personal data as data controllers in the Norwegian Power Grid.

4.1 Findings from Literature/Open Source Study

This section will use information presented in chapter 2 to answer the research questions as a starting point to finding an answer to the problem statement. The RQs will be answered chronologically as far as it was possible to find answers in literature/open sources.

RQ 1

RQ 1 is "What are the legal requirements pertaining to personal data in the Norwegian power grid?". To answer this there are two sets of legislation that must be looked. The first set is the Energy Act with related regulations, and the second is the Personal Data Act and its incorporation of the GDPR into Norwegian law.

Section 2.1.3 gives an account of the Energy Act with regulations. The main purpose of this legislation is to manage the grid, but to do so it also requires processing of personal data. Regulation 301 is the regulation that has the most requirements for processing personal data. § 2-3 to § 2-6 in this requires the exchange personal data like name, address, and social security number between Elhub, grid and power companies. Chapter 4 requires that grid companies install smart meters by 01.01.2019, § 4-2 list the functional requirements for the smart meters with a minimum of hourly consumption measurements and capability for measuring every 15 minutes. Regulation 194 and 1413 do not directly involve personal data, but they are relevant with regards to GDPR compliance as they require easily understood electricity contracts and a separation of DSO activity from other activity in an enterprise/group.

Section 2.3 covers the Personal Data Act and the GDPR. The purpose of this legislation is to "...protection of natural persons with regard to the processing of personal data and rules relating to the free movement of personal data.". This is a general legislation intended to protect data subjects in all situations, and not just in the case of the power grid. In section 2.3 important definitions and relevant articles from the GDPR is presented. The actors in the grid must comply with the requirements presented there for their processing of personal data to be legal.

RQ 2

RQ 2 is "How is the Norwegian grid structured, who are the actors and how do they interact?". Section 2.1 answers this by looking at the Norwegian grid and how it is regulated. Through this section it becomes clear that the actors that process personal data are Elhub, power companies and grid companies(DSOs). Other entities like Statnett and NVE/NVE-RME are not directly involved in personal data processing, and there is no need to go into detail on them here. Figure 2.3 shows how the grid and power companies exchange data through/with Elhub, as well as the historical situation before Elhub when each grid company had to communicate with each power company and vice versa.

Some other relevant pieces of information from section 2.1 are that DSOs have a monopoly in the area they operate, and as a result consumers cannot choose their DSO. Historically power companies and grid companies have been integrated in the same enterprise/group. But from the early 1990's there has come more and more requirements for separation, and there is now a requirement that grid operations are "legally and functionally unbundled" and clearly distinguished from the rest of the enterprise/group. There also are significant differences in the company size and number of customers for both grid and power companies with the number of employees ranging from less than 10 to several hundred.

There is a possible fourth actor that can be a data controller for personal data in the power grid. This is third party service providers that may offer services like analysis of consumption etc. to give insights and help reduce consumption/cost. They may also offer the option to participate in various DSM schemes where they e.g. buy load flexibility from consumers and sell this back to the grid. This is services that can be provided by grid and power companies, but it is possible for an independent third party to offer the same. More details on this is provided in section 2.2.2.

RQ 3

RQ 3 is "What roles do the actors in the grid have according to GDPR?". As identified in the answer to RQ 2 it is Elhub, power and grid companies that process personal data in the Norwegian power grid. Discovering the role for Elhub was easy as they have a good privacy statement on their website. This clearly states Elhub's role as data controller and specifically lists what personal data they process for what purpose and what the source is. In many cases the source is the grid and/or power companies which helps to fill in the picture of personal data processing in the power grid.

Finding the role for grid and power companies was initially difficult due to the share number of companies, varying quality of privacy statements and privacy statements found online only including information about cookies and not grid data. Fortunately, Energi Norge published an industry standard for privacy in December 2020. From this it becomes clear that both grid and power companies should be independent data controllers for personal data they process.

RQ 4

RQ 4 is "What legal grounds do the controllers have/need for processing personal data?". This has already been partly discussed in relation to RQ 1 and how Regulation 301 requires the processing of personal data. This provides a legal obligation and/or public task after GDPR Art.6(1) as presented in section 2.3.1. Any processing of data that do not come as a result of regulations will require other grounds after Art. 6(1). This means that if the companies want to do anything else with the data than what they are tasked with in Regulation 301, they will need other legitimate legal grounds for this.

In [22] the authors state that in a smart grid setting the legal grounds for processing should be consent and contract. They also point out the need to distinguish between what data and/or processing that happens as part of fulfilling the contract and what is based on consumer consent. While this paper does not take into account that there might be legal grounds given through other regulation, it provides the theory to support that any additional processing must be based on either consent or contract.

RQ 5

RQ 5 is "What smart grid technologies involving personal data can/will be implemented in the Norwegian power grid, and who is the responsible data controller?". The answer to the first part of this question, i.e. what smart grid technology will be implemented in the Norwegian grid, is largely found in section 2.2.2. Smart meters are already installed in most homes in the Norwegian grid. By activating the HAN port on the smart meter, it is possible to read out even more information/data that may be shared with third parties. More and more electronic appliances come with some form of computational intelligence and options for remote connectivity. This means that information from EV-chargers, AC-units, water heaters and more can be collected and analyzed. It is also possible to control these appliances and use them in various DSM programs. This is services that currently are being offered or tested by various grid and power companies in Norway. For

	Distributed	Responses	Response rate(%)
Power companies	81	15	18,52 %
Grid companies	91	24	26,37 %
Total	172	39	22,67 %

Table 4.1: Table showing response rate to the questionnaire.

the second part of the question, who is the responsible data controller, it is reasonable to assume that the actor offering the service involving processing of the personal data should be the data controller.

4.2 Results from Questionnaire

This section presents the processed results from the questionnaire used to collect data as a part of this thesis. The questionnaire can be viewed(in Norwegian) in appendix A. The data have been anonymized so that the data cannot be traced back to the company that provided them. There is one exception to this which is Elhub. Since Elhub is a unique actor in the grid there is no meaning full way to analyze their response without identifying the company, and they are therefore identified as Elhub. This section is divided into five subsections to present the data. Section 4.2.1 presents a brief metadata analysis of the collected data. Section 4.2.2 presents the results with regards to who has the controller or processor role and relates to RQ 3. Section 4.2.3 presents what legal grounds for processing is claimed by each company and relates to RQ 4. Section 4.2.4 presents the role and processing grounds for data that is grid related but voluntary to share and relates to RQ 5. Section 4.2.5 presents the answers to the questionnaire from Elhub.

4.2.1 Metadata Analysis

Table 4.1 shows some statistics about the response rate for the questionnaire. As the table shows, the overall response rate is almost 23%. While this is not as high as one could wish for and a higher response rate would have been better. It is within one standard deviation(SD) of what is to be expected when doing surveys with organizations according to [48]. When looking at the responses for grid and power companies separately the response rate for grid companies is highest at 26,4%, but 18,5% for power companies is still within one SD.

In addition to the 39 companies that responded to the survey there was one company that made contact per e-mail. They said that after an internal discussion they had decided to not participate in the survey. Another recipient of the questionnaire had recently separated the power company from the enterprise/group and as such at least one of the intended recipients did not receive the questionnaire.

To be able to follow the answers from each company from one table to the next they have been given a unique ID with the power companies being named P1 to P15 and the grid companies being named G1 to G24.

Company	General Personal Data	Grid Personal Data
P1	Controller	Controller
P2	Controller	Controller
P3	Controller	Controller
P4	Controller	Controller
P5	Controller	Controller
P6	Controller	Controller
P7	Controller	Controller
P8	Don't Know	Don't Know
P9	Controller	Controller
P10	Controller	Controller
P11	Controller	Controller
P12	Controller	Controller
P13	Processor	Controller
P14	Don't Know	Don't Know
P15	Controller	Controller

Table 4.2: Controller and processor roles claimed by power companies for general and mandatory grid specific personal data.

4.2.2 Controller and Processor Role

Table 4.2 shows how the power companies answered question 3 and 4 in the questionnaire about whether they are controllers or processors for general personal data and mandatory grid specific personal data. By far most of the companies identify as data controllers for both categories of personal data with 80% for general data and 87% for grid specific data. The exceptions are P8 and P14 that have answered that they do not know what role they have under GDPR for either category of data. P14 used the comment section of the questionnaire to comment that "We use Elhub as processor/controller for customer consumption and are subject to their GDPR." This implies a lack of control/understanding of GDPR and the industry standard from Energi Norge. Another exception is P13 that checked for being a processor for general personal data. They answered that they have a processing agreement with a "computer company". It is assumed that they are buying services from a third party that handles website, customer database etc. For grid specific data P13 checked for being data controllers in compliance with the industry standard.

P8 and P14 are omitted from the rest of the tables. As they did not know if their role was controller or processor, they were not asked about the legal grounds for processing.

Table 4.3 shows the same as table 4.2, but with the results from the grid companies. Out of the 24 grid companies that responded all except G20 answered that they are controllers for general personal data, and all 24 answered that they are controllers for grid specific data. Similar to P13, G20 has answered that they have a processing agreement for general personal data with a "software provider" and also here it is assumed that they are buying services from a third party that handles website, customer database etc.

4.2.3 Legal Grounds for Processing

Table 4.4 shows the legal grounds after GDPR Art. 6(1) claimed by power companies for processing general and mandatory grid specific personal data. After Art. 6(1) there are six possible legal grounds for processing persona data as presented in section 2.3.1. What is apparent when looking at the table is that while there are some grounds the power companies largely agree on, there are some that only a few have claimed. When looking at the table we see that all the power companies except P13 claim contract for general data, and most also claim the same for grid specific data. Most have checked for consent for general personal data, but only three have done so for specific personal data.Just under half of the respondents have checked for legal obligation for general personal data. Legal obligation and/or public task is only claimed by approximately 2/3 of the power companies for either data type. Neither P2, P4, P5, P9 and P12 claims either of these, even if they can justify this in Regulation 301.

Another observation is that P10 has checked for all six possible legal grounds for general personal data and five for specific personal data. The question about this is whether this is a serious response or lack of control and checking everything to be safe. In any case claiming vital interest is strange as the Norwegian DPA states that this is a legal ground in life and death or health situations[1]. Neither of which is the case here.

In table 4.5 we see that the situation is much the same for grid companies as it was for power companies, but with some differences. There is a significantly lower share of the grid companies that claim consent for general personal data and a higher share that claim public task compared with the power companies. This could be expected considering that grid companies are required to carry out

[1]https://www.datatilsynet.no/rettigheter-og-plikter/virksomhetenes-plikter/behandlingsgrunnlag/veileder-om-behandlingsgrunnlag/nodvendig-for-a-beskytte-vitale-interesser/, 23.05.21

Company	General personal data	Grid personal data
G1	Controller	Controller
G2	Controller	Controller
G3	Controller	Controller
G4	Controller	Controller
G5	Controller	Controller
G6	Controller	Controller
G7	Controller	Controller
G8	Controller	Controller
G9	Controller	Controller
G10	Controller	Controller
G11	Controller	Controller
G12	Controller	Controller
G13	Controller	Controller
G14	Controller	Controller
G15	Controller	Controller
G16	Controller	Controller
G17	Controller	Controller
G18	Controller	Controller
G19	Controller	Controller
G20	Processor	Controller
G21	Controller	Controller
G22	Controller	Controller
G23	Controller	Controller
G24	Controller	Controller

Table 4.3: Controller and processor roles claimed by grid companies for general and mandatory grid specific personal data.

more tasks that fall in the public task category. And claiming consent when you have a monopoly is difficult. Other things to note are G7, G9 and G18 all claiming vital interest for general personal data and G7 and G18 claiming all six grounds for one or both data types. Claiming vital interest is strange for the same reasons

Company	Consent	Contract	Legal Obligation	Vital Interest	Public Task	Legitimate Interest
P1	1,2	1,2	1,2			
P2	1	1,2				
P3	1	1			1,2	
P4	1	1,2				
P5		1,2				
P6	1	1,2	1			
P7	1,2	1,2	1,2		1,2	
P9		1,2				
P10	1	1,2	1,2	1,2	1,2	1,2
P11	1	1	1,2		1	
P12		1,2				
P13			2			
P15	1,2	1,2	1,2			1,2

Table 4.4: Legal grounds after Art. 6(1) claimed by power companies. 1 = general personal data, 2 = mandatory grid personal data

as stated with regards to P10 in the previous paragraph.

Six of the grid companies claimed neither legal obligation nor public task for their processing grounds. This is strange considering that there are regulatory requirements for the grid companies to process personal data. The remaining 75% of the grid companies claim at least one of the two.

4.2.4 Voluntary Grid Specific Data

Table 4.6 presents the grid and power companies that that they either are collecting or have intentions to start collecting data about electric consumption from other sources then smart meters. In total 10 companies fall in this category divided 50/50 on grid and power companies. All 10 answered that they are, or would be, the data controller for the collected data. Which legal grounds after Art. 6(1) they claim is shown in table 4.6. Unfortunately, there was some ambiguity in how the question 5.1 was posed that may have caused misunderstandings when the data was collected. Specifically, there was not explicitly stated that the question was about devices in private homes. And that data that smart meters collect by default need not be considered. G23 is marked with an asterisk because they commented that they receive alarms about voltage and ground faults which is not the type of

Company	Consent	Contract	Legal Obligation	Vital Interest	Public Task	Legitimate Interest
G1					1,2	
G2		1	2		1,2	
G3	1,2		1,2		1,2	
G4	2	1,2				
G5		1,2				
G6		1,2	1		1	1
G7	1	1,2	1,2	1	1,2	1,2
G8					1,2	
G9		1	1,2	1	1,2	
G10	1,2	1,2	1,2			
G11		1,2	1,2		1,2	
G12	1,2	1,2			1,2	
G13		1,2	1,2			
G14		1,2				
G15	1,2	1,2			1,2	
G16	2	1,2			1,2	
G17		1,2				
G18	1,2	1,2	1,2	1,2	1,2	1,2
G19	1	1,2	1,2		1,2	
G20		2				
G21		1,2	1		1	
G22		1,2				
G23		1,2				
G24		1,2	1,2			

Table 4.5: Legal grounds after Art. 6(1) claimed by grid companies. 1 = general personal data, 2 = mandatory grid personal data

data the question really was about. Since at least one respondent misunderstood the question, this must be taken into account when considering the rest of the answers. Particularly from the grid companies as they might have misunderstood in the same way as G23.

Company	Consent	Contract	Legal Obligation	Vital Interest	Public Task	Legitimate Interest
P1	3	3				
P3	3					
P4					3	
P6		3				
P11		3				
G7		3	3		3	3
G8					3	
G11	3				3	
G18	3	3	3			
G23*		3				

Table 4.6: Legal grounds claimed by companies after Art.6(1) for processing personal data from other sources than smart meters.

4.2.5 Response from Elhub

As discussed, the responses from Elhub has to be attributed to Elhub in order to have value for analysis. Therefore, it was made clear to Elhub that any answers they gave to the questionnaire could/would be presented in this thesis. Elhub's answers to the questionnaire is presented in table 4.7. Elhub states that they are the data controller for both general personal data and mandatory grid specific data. They also state that they do not and will not collect/process any additional voluntary data. The only legal grounds for processing data they claim is legal obligation for both types of data they collect. This makes sense as they are a state-owned company whose purpose is defined in Regulation 301.

Company	Consent	Contract	Legal Obligation	Vital Interest	Public Task	Legitimate Interest
Elhub			1,2			

Table 4.7: Legal grounds claimed by Elhub after Art.6(1) for processing personal data.1 = general data, 2 = mandatory grid data.

4.3 Combined Results

When looking at the findings in section 4.1 and 4.2 combined it is possible to provide further answers to the research questions. However, there is not much to add to the answers to RQ 1 and 2 in section 4.1. The answers RQ 3, 4 and 5 benefits from the information collected through the questionnaire. This section will discuss how the theory based answers to these three questions from section 4.1 change based on the results from the questionnaire.

RQ 3

For RQ 3 the initial conclusion with regards to grid and power companies was that they are data controllers for personal data that they process. However, based on the result presented in table 4.2 and 4.3 this is not the case. P13 and G20 have answered that a third party service provider has the role of controller for general personal data, while they are controllers for grid specific data. This makes for a constellation where a third party is the data controller for general personal data that grid and power companies must process after Regulation 301. At the same, time they are data controllers for the grid specific personal data they must process after the same regulation. In addition to this, P8 and P14 stated that they do not know which role they have for the personal data they process.

That being said, Elhub and the majority of the grid and power companies confirmed that they have the role of data controller for the personal data being processed in the grid. This is also what the industry standard states.

RQ 4

For RQ 4 there is a lot of new data that is provided with the questionnaire results. Mainly this is which grounds after Art. 6(1) that the various companies claim as legal grounds for processing the various types of personal data. There is some spread in the responses, but it seems that necessary to fulfill a contract combined with legal obligation and/or public task is the most common grounds for processing general and mandatory grid specific data. This aligns with what was found in section 4.1. Furthermore, this is supported by Elhub only claiming legal obligation as their grounds for processing. This collaborates the legal obligation/public task grounds, and it makes sense that the companies have contractual grounds for additional services like billing etc.

One thing to note is that 16 of 39 companies claim consent for processing general personal data. This is not necessarily wrong since this can be a legitimate reason if the company wants to do additional processing on this data. However, considering that some of this data is required by Regulation 301 it might be difficult for the companies to prove that they comply with the principles in GDPR Art. 5 and requirements for consent in Art. 4(11). The same is the case for the 10 companies that claim consent for processing mandatory grid specific data.

Table 4.6 shows the legal grounds for processing grid related personal data with no grounds from regulations and laws. However, the wording of the question in the questionnaire was ambiguous as discussed in section 4.2.4. This means that the table must be read with this in mind. Particularly with the grid companies having checked for legal obligation and public task. With the power companies it is a little easier as they do not typically have the same kind of "public" tasks involving the type of data collection causing at least one misunderstanding with G23. When only looking at the power companies we see that 4 of 5 have selected either consent or contract which better aligns with theory. And it is worth noting that the same is the case with the grid companies with 4 of 5.

RQ 5

With regards to RQ 5 the results from the questionnaire does not provide more insight into new technologies that will involve processing personal data beyond what is default in the smart meter. However, it does provide insight into who it is that will be the data controller for this data. All 10 companies that are collecting or intending to collect this kind of data stated that they are or would be the data controller. Even with the issues with the question wording already discussed this is relatively unanimous.

4.4 Models

The models presented in this section shows the controller/processor relationships in the power grid, and the flows of personal data as they have been found as a part of this thesis. The first model can be viewed in figure 4.1 and is a version where grid/power companies may be processors for general personal data. The second model can be viewed in figure 4.2 and is a version where all grid/power companies are controllers for all types of data. As with most models they are a simplification of reality and will not capture all nuances and possible variations but shows the most common ones.

The models use the three categories of personal data shown in figure 2.7, with each category being represented with its own color. To simplify discussing the model each personal data category is called type 1, 2 or 3 to make it easy to distinguish between them. Type 1 data is shown as red in the model and is general personal data. Type 2 data is shown as light blue and is mandatory grid specific personal data required by e.g.. Regulation 301. Type 3 data is shown as green and is grid/consumption data that it is voluntary to share. The data flows for the data types in the model are indicated by lines that are either solid, dashed or dotted-dashed based on the controller/processor role for the data. This is explained in the legend for the model. The color of the line indicates the data type.

The models have five types of actors. There is the consumer which is the data subject after GDPR and the owner of the personal data. Elhub is the central data hub for the Norwegian end user market. Elhub is the data controller for all data they process in both models. Grid companies are the DSOs that operate the grid which the consumers are connected to. In model 4.1 the grid companies are data controllers for type 2 and 3 data, and in most cases for type 1. In some few cases they are data processors for type 1 data. In model 4.2 the grid companies are data controllers for all data they process. In both models Elhub and grid companies have a black dashed border around their box. This is to show that a consumer cannot chose which grid company to use, and that processing by the grid company and Elhub is mandatory.

The power companies are the companies that sell electricity to the consumer. Same as the grid companies they are data controllers for type 2 and 3 data, and in most cases for type 1 data in figure 4.1, and controllers for all data types in figure 4.2. A third party service providers can be any company or actor that process personal data. However, the models only show the cases where they process data due to a customer relationship with the consumer or is the data controller for type 1 data with regards to a grid or power company. In other words, the models only capture third party service providers if they are acting in the role as a data controller, and not all the possible processor roles. It is reasonable to assume that many of the grid and power companies and Elhub has third party service providers that are acting as data processors on their behalf, but this is not shown in the models.

What the models does not capture completely is what the legal grounds for processing the various data types are. They do show it for type 3 data since there really only are the two grounds mentioned in the models that are 100% certain for processing this type of data. Legitimate interest could be claimed but this would be more uncertain and open for discussion. The reason why the models are unable to show the legal grounds for type 1 and type 2 data is that there is legal obligation for processing both types of data, but this does not cover all types of processing of that data. In addition, there can be data that fall in the type 1 category that fall outside the legal obligation grounds but are needed for a contract. So, while the processing grounds after GDPR for type 1 and 2 data is a combination of consent, contract, legal obligation and/or public task this is not shown in the models with the current level of detail.

Type 1: General Personal Data

As the red lines in the models shows, type 1 data is the most universally processed personal data. Grid and power companies get their data from the consumer and typically are the data controller, as denoted by the solid lines. However, in some few cases, a third party may be the data controller for this data while grid and power are the processors. This is based on the responses to the questionnaire in section 4.2 and shown by the dashed red line from third party to power and grid companies. Elhub and the power and grid companies are all data controllers for type 1 data and may therefore exchange this back and forth without a processing agreement. This is illustrated by the arrows between Elhub and power-

/grid companies being bidirectional. Note that there is no red line between grid and power companies. This is because all data exchange happens through Elhub ref. figure 2.3. What the model in figure 4.1 does not show is how the relationship between Elhub and the power and grid companies that are processors are. Do they have/need a processing agreement? Or do they no need one based on legal grounds for both parties after Regulation 301? But would not that would make all parties controllers? These are questions that will not be answered in this thesis.

The red line from consumer to third party is dotted-dashed. This is to visualize that there is no regulation with regards to the power grid that requires the processing of type 1 data by third parties. Such processing will therefore have to be based on either contract or consent.

The red line from third part to Elhub symbolizes two things. The first is that Elhub may collect some personal data from third parties as described in the Elhub privacy statement. The second is more uncertain and is, in the cases where a grid/power company is the processor and third party the controller, do the data go directly to Elhub? And while it is likely that this is the case technically, what is the case with regards to the roles after GDPR. This is also an unknown that will not be answered in this thesis.

Type 2: Mandatory Grid Data

The light blue lines in the models show how type 2 data flow between the actors.The source is the consumers smart meter, and the data is collected by the grid company. The grid company sends the data to Elhub where it can be accessed by the power companies. This is the path of the solid light blue lines, and all the actors are data controllers for this data. Same as it was with type 1 data, there is no exchange between grid and power companies directly. If the power and grid companies wish to do more processing of type 2 data than what is required by regulations, they need to define this in a contract or get consent from the consumer.

The light blue dotted-dashed line from Elhub to third party is an example of this kind of consent/contract based processing. If a third party would like to process e.g. consumer consumption data, they would need to establish a legal grounds either through a contract or by consent. Then they would be able to collect the consumption data from Elhub once the consumer has confirmed to Elhub that they agree to this processing. This kind of processing could be to offer analysis and saving tips based on consumption.

The solid light blue line from Elhub illustrates that consumers with a smart meter can sign into Elhub and access their consumption data from the last 3 years. Here they also have the option to download this data.

Type 3: Voluntary Grid Data

The green lines for type 3 data are all dotted-dashed. This is because there are no legal regulations that require processing of this type of data. This means that the data controller needs to get the consumers consent or base the processing on a contract in order to comply with GDPR. As the arrows in the model shows it is the actor processing the data that is the data controller for the data. There is no limit on which third parties may process type 3 data provided they have consent or a contract allowing them to do so.

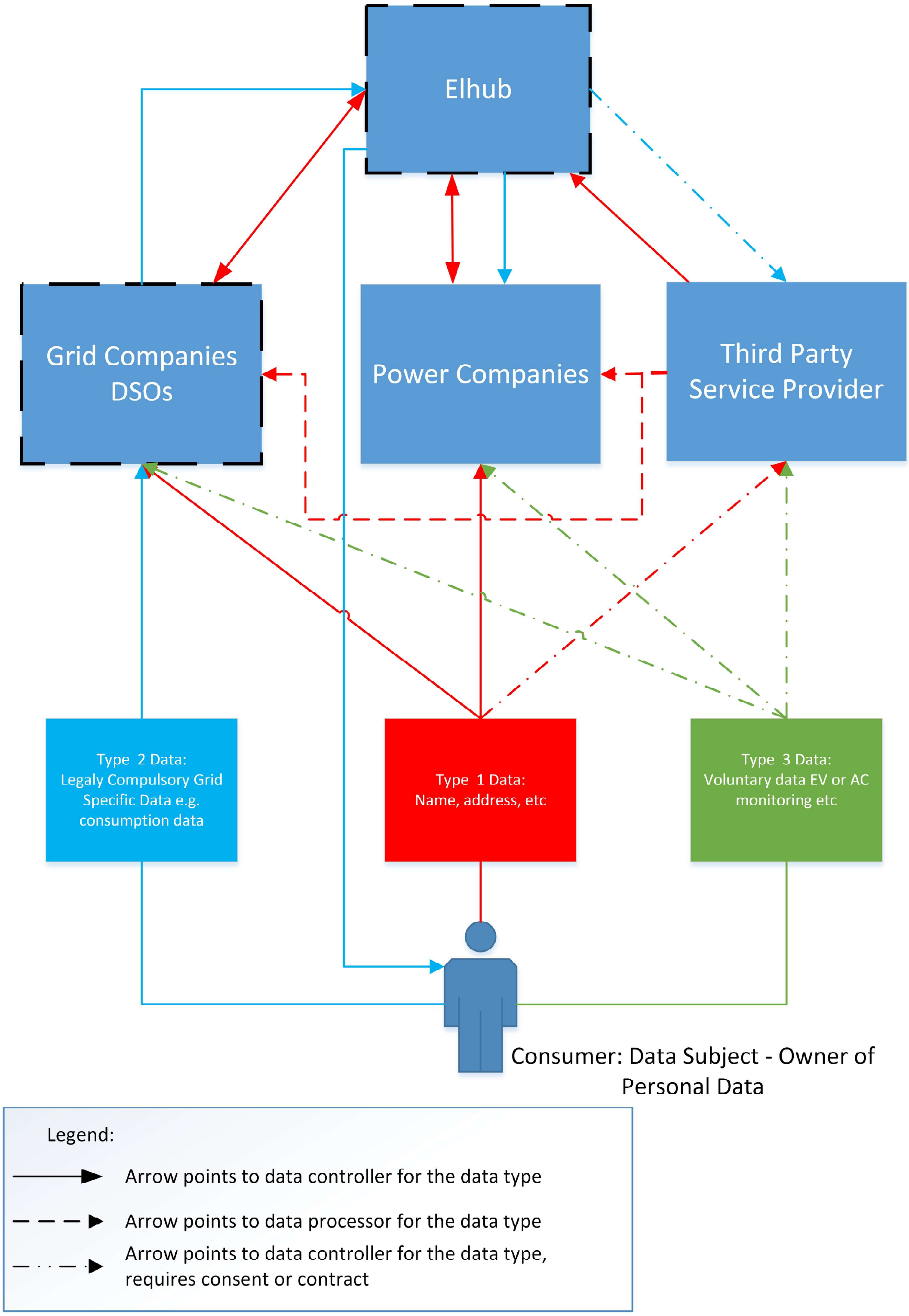

Figure 4.1: Model showing the flow of personal data between actors in the Norwegian power grid that are data controllers or processors.

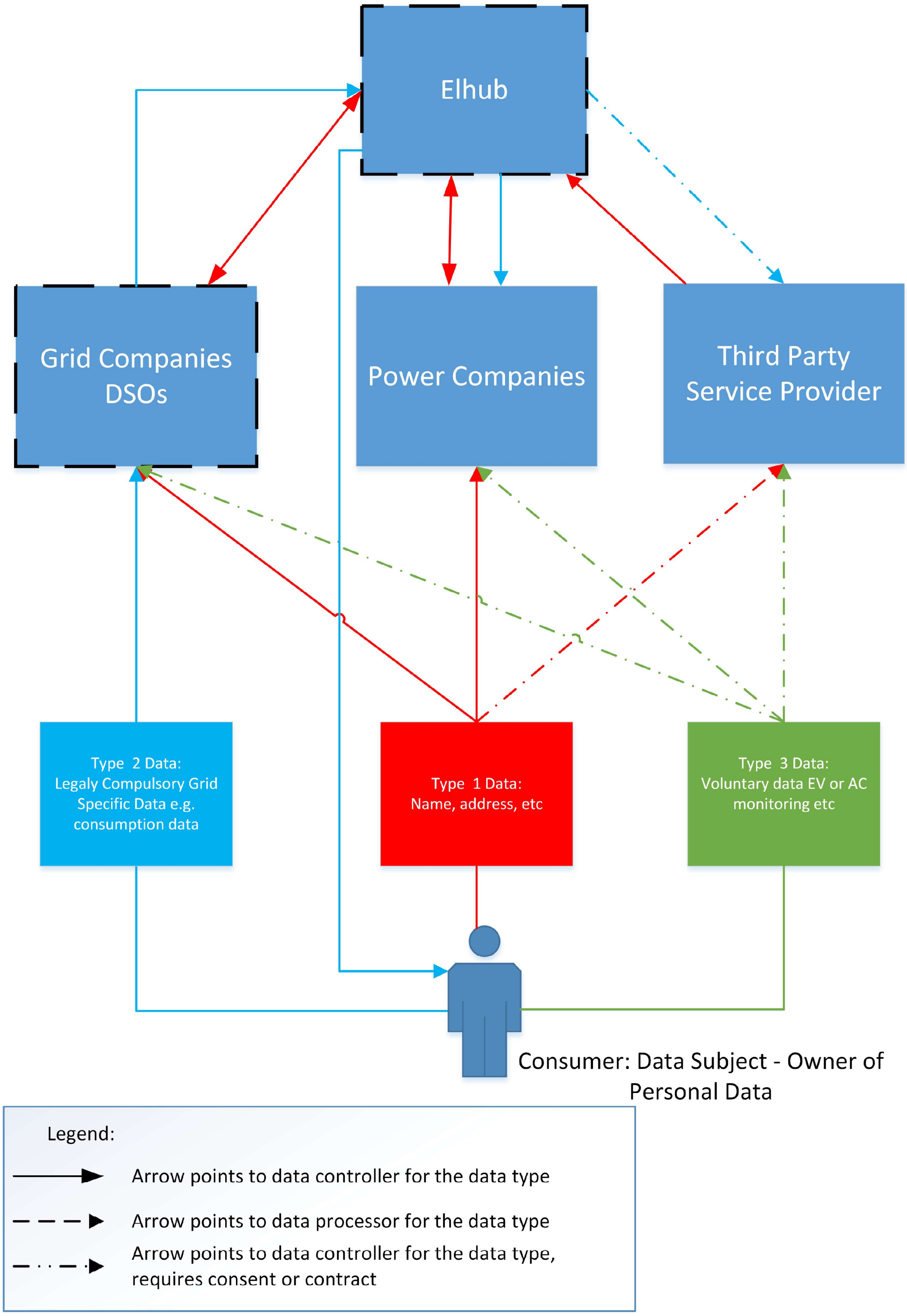

Figure 4.2: Alternative model showing the flow of personal data between actors in the Norwegian power grid when all are data controllers.

Chapter 5

Discussion

This chapter presents the discussion of the problem statement, results, and the overall thesis. The chapter is divided into three sections. Section 5.1 is a discussion of the results and the final model, and includes some thoughts on the problem statement. Section 5.2 is a discussion of the privacy challenges uncovered over the work with the thesis. Section 5.3 is a discussion of the methodology and how this may have influenced the outcome of the thesis.

5.1 Results and Model

This section will discuss the results and the final models presented in chapter 4, and whether they provide an answer to the problem statement. This will be done through a review of the research question and whether they are suited to answer the problem statement. Then there will be a discussion of whether the results provide good and valid answers to the RQs, and finally if the models provide an answer to the problem statement. The part of the problem statement regarding privacy challenges will be covered in section 5.2.

Problem Statement and Research Questions

The problem statement for this thesis is presented in section 1.1 and can be summarized with who processes what personal data, on which grounds, in the Norwegian power grid. And what privacy challenges does this cause. The problem arises from a combination of new regulations and technology significantly increasing the amount of personal data being processed in the grid, and the GDPR coming into effect in 2018. To find answer to the problem the five RQs in section 1.3 was formulated. Through the 5 questions most sides of the problem statement is highlighted. Answers to RQ 2,3 and 5 gives a good foundation for who it is that process personal data in the power grid. Answers to RQ 1 and 5 combines to answer what personal data is processed. And answers to RQ 1, 4 and 5 provides the legal grounds for processing personal data. Combined this makes a good platform to answer the problem statement and design the model to visualize it.

One thing the RQs do not cover, at least directly, is privacy concerns/challenges. This is an important element of the motivation for the thesis and has been included in analysis and discussion. A RQ asking "What are the privacy challenges in the Norwegian power grid?" could, and maybe should, have been included. In any case, the privacy challenges have been addressed in the work with the thesis and is thoroughly discussed in section 5.2.

Results

In sections 4.1, 4.2 and 4.3 the research questions are answered. There are variations in how conclusive the answers are as there is room for interpretation in some cases. There is also a question about how conclusive it is possible to be based on the questionnaire and if these results represent a valid representation of the actors in the grid.

RQ 1 is one of the research questions that have been answered conclusively. It is the Energy Act with regulation that require the processing of personal data in relation to the grid, and it is the Personal Data Act (i.e. GDPR) that regulates the requirements for processing personal data. As it has been shown in chapter 2 there is no uncertainty that e.g. Regulation 301 requires the processing of personal data, and that GDPR has a set of requirements for processing personal data. Therefore, there is a high degree of confidence that the answer is valid.

RQ 2 is mainly answered based on the information presented in section 2.1. This information was sourced mainly from online sources, with the limitations in confidence this may include. However, the online sources used was mainly owned and operated by governmental entities, and it is possible to collaborate the information from multiple sources, including legal documents. Particularly, the role and interaction between the actors who are data controllers is well documented and collaborated from multiple sources. If there are inaccuracies in the roles and interaction between other entities like NVE, NVE-RME and MoPE this would not affect the conclusion significantly as they have no direct role in the data processing.

The answers to RQ 3 are more inconclusive. Theory and the majority of the responses to the questionnaire agree that Elhub, grid and power companies are data controllers for all types of personal data they process. However, a small minority, approx. 5%, stated that they are processors for general personal data. This raises the question of whether this is correct, both with regards to whether they believe they hold this role, and if it is in compliance with the GDPR. Since the data was collected through a questionnaire there is a chance that the question was misunderstood but considering that the rest of the respondents appear to have understood it, this is an unlikely explanation. Without further data collection it is not possible to verify the answers. As for the compliance with GDPR it is difficult to answer without knowing the agreement between controller and processor.

It raises challenges that the third party is the controller. Firstly, the third party has no legal grounds for processing after Regulation 301, producing a need for consent/contract based processing. Secondly, the Elhub-grid/power company relation becomes a controller-processor relation and not a controller-controller relation. With all the complications that causes. Thirdly, there is a question of whether grid and power companies can choose **not** to be the data controller as they are explicitly mentioned in Regulation 301 with regards to processing personal data. It is therefore likely that all grid and power companies should be controllers for all the personal data they collect.

It is with the answer to RQ 4 that the data collected in the questionnaire is most diverging. Theory gives us that it is possible to claim legal obligation (or public task) as a grounds for processing some data, and that any additional data/processing would require consent or contract. This is also largely the main trends in the responses to the questionnaire, with most respondents claiming some constellation of these processing grounds. Elhub is a state-owned company that appears to be very conscious of their role as data controller, e.g. they have a very detailed privacy statement and have had a dialogue with the DPA about the processing of personal data in their capacity as a data hub[1]. As such there is reason to have confidence in their response to the questionnaire when they only claim legal obligation as grounds for processing personal data. If this translates directly to a legal obligation for grid and power companies for the same data appears more uncertain based on the responses from these companies, but that there is either a legal obligation or public task seems certain. For other data and other processing, the consensus is that this requires consent or contract as legal grounds. With close to all respondents claiming at least one of these as a grounds for processing.

The two legal grounds that have not been discussed so far are vital interest and legitimate interest. In total 4 grid and power companies have claimed vital interest as a grounds for processing. As mentioned in section 4.2.3 claiming vital interest as a processing grounds is unlikely to be valid. The Norwegian DPA considers vital interest valid in cases of life/death and health matters. It is unlikely that processing e.g. consumption measurements will fall under this category as there are no aspects of providing electricity to consumers that can affect health that is not already accounted for in regulations. 3 of the 4 companies have claimed all six grounds for processing for at least one of the data types. This might be a result of "when in doubt, press all" approach, but it is only one company, G18, that claims vital interest for general and grid specific data. This implies that the other three companies have done some reflection over what they have selected. Then again, G18 is one of the companies that says that they collect additional data, and for this they only claim consent, contract and legal obligation. So it appears that they have reflected over what grounds to claim. Making any conclusions about why the companies would claim vital interest could be conjecture at this point, but it is highly unlikely to be accepted as a legitimate grounds for processing.

Legitimate interest may be a legitimate legal grounds for processing provided the necessary balancing between data subject privacy and company interest have been performed. The questionnaire did not collect the information needed to eval-

[1]https://elhub.no/documents/2019/08/20190620-presentasjon-elhub-bransjerad.pdf/, 27.05.21

uate this and it is therefore difficult conclude anything else then that the claim for legitimate interest may be valid.

The answers to RQ 5 in chapter 4 are a bit generic. This is because there are many types of technologies that can be implemented, and any company or third party can provide the technology as a service. That being said there are some conclusions that can be made. While there is uncertainty about what type of company would be controller, it is clear that the companies offering the service involving processing the personal data will be the data controller. This is what the theory dictates, and it is supported by the responses to the questionnaire.

As for the technologies processing personal data some are already in place. Smart meters are installed in close to all Norwegian homes, and on request the HAN can be opened. Data collected from both the smart meter and HAN can be shared with third parties as the consumer wishes. Demand side management programs are being being deployed in various R&D programs, and to some degree is in use with e.g. EV chargers controlling when to charge depending upon when the electricity prices are low. Considering the number of R&D programs and that appliances are getting smarter it is likely that processing of data collected from the consumer side of the smart meter is likely to increase.

The Models

The models presented in section 4.4 is the main contribution of this thesis. As with most models they are simplifications and abstractions of reality and there are elements that have been omitted and details that are not shown. The models build on the other results and findings previously discussed in this chapter. Therefore, the discussion about the models will assume that the data is valid based on previous discussion and rather focus on how it is presented in the models. The models is described in detail in section 4.4 and this will not be repeated her.

The two models are identical with the exception of except for the case when third parties may be controllers for type 1 data for grid and power companies as is the case in figure 4.1. Or if grid and power companies are controllers for all data they process as shown in figure 4.2. The reason why there is two models is discussed in relation to RQ 3 in section 5.1, and the few companies stating that they are processors for type 1 data. Based on this discussion it can be said that figure 4.1 shows the current state in the grid today with a few companies deviating from the norm, and figure 4.2 shows a more ideal state where all companies conform to the industry standard.

The data types in the models are not explicitly defined. There is no exhaustive list of what data falls into each category. This may cause some uncertainty as to what data fall into each category. Type 1 data is any personal data that is not uniquely related to the grid, and type 2 data is grid data that is processed on the grounds of some regulation or law. If one were to use e.g. the list of these two data types from Elhubs privacy statement it would leave things out that is processed by grid and power companies. An exhaustive list of type 3 data is simply not feasible.

Anything in a house that runs on electricity and have sufficient computational intelligence would need to go on this list. Therefore, the approach has been to define these categories more conceptually and rely on the readers judgement.

One thing that the models are unable to capture is that they do not distinguish between what type 1 data collected by grid and power companies is mandatory through regulation and what is based on contract or consent. Both grid and power companies may process data that is type 1 data that they do not have a legal obligation or public task as grounds for processing. To distinguish between this would be difficult for a couple of reasons. A regulation that serves as the legal grounds for processing personal data X do not necessarily mention data X explicitly, but rather gives company Y a task that requires processing data X. Also, companies do things in different ways meaning that where company Y processes data X to solve a task based on regulation, company Z process the same data to fulfill a contract. With close to a hundred power companies and more than a hundred grid companies it is likely that any attempt to distinguish between the legal grounds likely would be wrong, without necessarily meaning that the various companies do not comply with GDPR.

On the same note the models do not capture how much data is collected and processed by the grid and power companies, versus the subset of data that is sent to Elhub. Trough Elhubs privacy statement we know what data they get from whom and how they process it. The same overview does not exist for all the grid and power companies. This also means that the models do not show what processing is done by each controller, on what grounds, for a given instance of personal data.

While the previous paragraphs have focused on the limitations of the models, there many things that the models do show. The models clearly show who are the data controllers in the power grid. Out of these data controllers they show who you are legally required to provide with personal data (Elhub, power and grid companies), and that you cannot choose your grid company, or if Elhub and the grid company is to process your data. The models clearly show that you are free to choose if you want to share data with a third party service provider. The models show who processes what personal data and how the data flows from one controller to another. The models also show what data the consumers have no choice but to share, and what they can control themselves.

5.2 Privacy Challenges

This section will present and discuss privacy challenges that have been uncovered during the work with this thesis. The challenges relate to issues that arise from how the grid is organized and regulated, and how this complies with GDPR. Technical challenges like the need for encrypted communication or organizational measures like controlling employee access to the data is not considered.

Tenants with Power Included in the Rent

The way the grid is organized today a landlord can have access to the consumption data of a tenant. This is maybe the most serious privacy challenge in the grid today. The situation occurs when tenants are renting an apartment/house with a contract where power is included in the rent. This is a common arrangement, particularly for students, and Studentsamskipnaden SiO in Oslo, with more than 8000 rental units[2], have this as their default rental contract[3]. While SiO is a student welfare organization, many private landlords have the same kind of contracts. This is a privacy challenge since the person or entity that owns the living unit and is responsible for the electricity plan is the person that have access to the consumption data stored in Elhub. It is the tenant living in the apartment that is the cause behind the consumption and whose personal data can be read out from the consumption data. But it is the landlord that have access to the data.

With the hourly consumption measurements that landlords get access to through Elhub they can infer information about their tenants. With many student apartments and dorms being small and having few appliances that use electricity it becomes easier to infer information since there is less uncertainty as to what the electricity could be used for. For instance, it would be easy to collaborate a late night noise complaint with consumption showing that the tenant likely was awake at that time.

One of the causes for this challenge is the requirement for individual smart meters per living unit[4]. However, this is interpreted differently by DSOs when it comes to student dorms[5]. Elvia in Oslo has omitted some student dorms/apartments from the requirements while Tensio[6] wants to install smart meters in Trondheim. The case in Trondheim might be raised to NVE-RME to clarify how the regulation is to be enforced. Regardless of the outcome if that were to happen, there are many tenants living in apartments where the landlord has access to the data in Elhub.

Another thing that would make this a bigger privacy challenge is if the landlord has opened the HAN-port of the smart meter. This gives the landlord access to data about the consumption in real time and could be done without the tenants' knowledge. If there is a smart home setup in conjunction to the HAN the landlord will get even more data.

Regardless of whether landlords(private persons, companies or organizations) that have tenants on contracts where power is included abuse their access to the data or not, it is a serious privacy concern that they have access to this data. One can say that they need access to the data to fulfill a contract, but there are no

[2]https://www.sio.no/bolig/boligoversikt, 28.05.21

[3]https://www.sio.no/bolig/husleie-og-kontrakt, 28.05.21

[4]https://www.nve.no/reguleringsmyndigheten/nettjenester/nettleie/individuell-maling/, 28.05.21

[5]https://www.nrk.no/trondelag/nettselskapet-tensio-krev-at-studentar-pa-moholt-i-trondheim–skal-ha-kvar-sin-straummalar-pa-rommet-1.15425302, 28.05.21

[6]https://tensio.no, 28.05.21

safeguards in place to ensure that the data is not processed for other reasons or otherwise abused.

Another case is short term tenants through services like Airbnb. If you stay for a weekend in an apartment where the owner has a HAN setup that monitors multiple individual devices, the owner will have ample opportunity to monitor your activities remotely.

Data Controller does not Know Role or Duties After GDPR

As the results in section 4.2 shows there are at least two companies that are data controllers that do not know their role after the GDPR. This is a concern for two reasons. Firstly, since they do not know their role, it is far from certain that they know their obligations to uphold the data subjects rights. This may lead to processing and disclosure of data that is in breach of the GDPR. Secondly, the exchange of personal data between Elhub and grid/power companies is based on all parties being data controllers. When data is disclosed to a party under the assumption that they are a data controller in compliance GDPR, this causes a data breach as the party is not in compliance with GDPR.

Distinguishing Between Processing Grounds for Different Processing of the Same Data

Since a lot of the processing of personal data in the power grid is based on legal obligation and/or public task it is important to distinguish when the same data is processed on other grounds. Just because a company has a legal obligation to process your consumption data as a part of managing the grid, they cannot analyze this data to e.g. offer you tips for reducing your electricity bill without your consent. A contract or privacy statement should clearly distinguish between the processing grounds for different processing with regards to the same personal data. The separation must be clear if it is to meet the requirements for consent and principles for personal data processing given in the GDPR.

Processing on Invalid Legal Grounds After Art. 6(1)

As shown in chapter 4 and discussed in section 5.1 there is not a 100% consensus on what is the legal grounds after Art. 6(1) of the GDPR for processing personal data in the power grid. This is not a concern in itself, as it is possible to claim different grounds for the same processing. What is a concern is that some companies claim vital interest as their processing grounds. As discussed, this is highly unlikely to be a valid processing grounds, and any processing based on this will be invalid.

Depending on what the actual processing being done based on the grounds of vital interest, it may well be that they have the grounds to process the data. Just not on grounds of vital interest. This makes the breach more of a formality. But it is reasonable to expect that a company that operates a monopoly with a license from the government should be able to adhere to the requirements in GDPR and have control over their processing of personal data.

Data Minimisation and Storage Limitation

Data minimisation and storage limitation are two of the principles for processing personal data after GDPR. That consumption measurements are stored with a resolution of hourly measurements for 3 years[16] have been evaluated to be in breach of these principles[17]. As a part of this evaluation the lack of choice in the matter was a deciding factor.

The argument for why the data is stored for 3 years is the need to be able to make correction to the data or reverse business processes within the limitation period of 3 years[7].

5.3 Methodology Evaluation

This section will discuss the chosen methodology, its strengths and weaknesses, and how it may have influenced the results. The discussion will follow the chronological order of the work with the thesis which is the same as it is presented in chapter 3.

The literature review or information gathering part of this thesis is very influenced by a lack of peer reviewed sources for information about the Norwegian grid. This meant that much of the information about the grid has been sourced from various websites with information about the grid and the websites of the relevant entities being described. This means that the information might be biased in favor of the publisher. To mitigate this the information was verified by multiple sources where possible. Another element is that a lot of the information is about how various regulations have been implemented. This allowed for verifying claims against legal documents. Most of the publishers are also government entities or state-owned companies which in general enjoy a high level of trust in the Norwegian population[8]. It is therefore judged that the information gathered from open sources have been sufficiently accurate for the purposes of this thesis.

When it comes to using legal documents as information sources it must be noted that the author has no formal education within law. The legal documents have therefore been viewed with layman's eyes. That being said, most of the laws and regulations referenced in this thesis are fairly uncomplicated, and the thesis avoids making interpretations without supporting this with additional sources. This could for instance be the Norwegian DPAs guide to what constitutes legal grounds after Art. 6(1).

The choice of method for data gathering was between doing interviews or a questionnaire. Of the two a questionnaire was chosen, and this has had an effect

[7]http://publikasjoner.nve.no/hoeringsdokument/2014/hoeringsdokument2014_01.pdf, 30.05.21

[8]https://ourworldindata.org/trust, 28.05.21

on the results. Doing a questionnaire allowed for a wider distribution then what would have been possible if doing interviews. That the data is collected from a higher number of sources means that it can be used to see trends and to a larger degree see a cross section of the target population.

On the other hand, a questionnaire does not allow for clearing up misunderstandings and asking follow up questions. There is two points where this thesis would have benefited from this. The first is with regards to the legal grounds claimed by the companies for processing the data. In an interview it would have been possible to ask for clarification and specification for why they claimed the various grounds for different processing. This is something the analysis would have benefited from. The second is the confirmed and possible misunderstandings with regards to question 5 of the questionnaire. In an interview setting it would have been possible to clear up this misunderstanding, which would have made for a cleaner data set with less uncertainty.

One of the advantages of doing an anonymous questionnaire is that you may get answers that the respondent might otherwise would not have been comfortable giving. It is far from likely that the two companies that responded that they do not know what their roles are after GDPR would have done so if the questionnaire was not anonymous, or that they would have participated in an interview.

Chapter 6

Conclusion

This thesis has developed two models that shows which actors in the grid are data controllers for personal data in the Norwegian power grid. The first model shows the current situation where a small minority if grid and power companies are not controllers for some of the data they process. The second model shows an ideal situation where all grid and power companies are controllers for all data they process. Both models show what personal data is processed by whom, and to a certain degree on what grounds they are processed. The models account for the ongoing transition towards a smart grid and how this will increase the amount of personal data being processing in the power grid. The models show how third party data controllers of grid related data fit into the processing.

The thesis have also discussed privacy challenges in the power grid. The major concern uncovered here is that landlords will have access to personal data in Elhub in the cases where tenants have electricity included in the monthly rent. In addition to this there are several challenges which relates to compliance with GDPR. There are companies in the grid that are unaware of their role as controllers, claim invalid grounds for processing data, and/or would struggle to demonstrate e.g. consent after the requirements in GDPR. Finally, there is a question of whether the regulation requirements for the grid is in breach of GDPR principles.

6.1 Future Work

There are some areas highlighted in this thesis that would benefit from more work or further research. These areas are listed below:

- Investigate and find solution to landlords having access to tenant's consumption data.
- Develop a standard privacy statement showing what processing of which data is required in the power grid by regulations.
- Develop industry standard for legitimate grounds for processing personal data.

- Investigate ways to meet the data minimisation principle for storing consumption data in Elhub.

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Appendix A

Questionnaire

Personvern i det norske strømnettet

Personvern i det norske strømnettet

Dette er et spørreskjema som tar for seg personvern i det norske strømnettet. Formålet med skjema er å identifisere hvilke aktører i strømnettet som har rollen som databehandler eller behandlingsansvarlig for persondata som beskrevet i GDPR/Personvernforordningen. Det er et spesielt fokus på persondata som er unike for strømnettet.

Alle data som samles inn vil behandles konfidensielt og bli anonymisert hvis de blir publisert i masteroppgaven.

Konfidensialitet
• All informasjon som samles inn vil bli behandlet konfidensielt, og kun behandles av masterstudenten som skriver oppgaven og veiledere.
• Spørreskjema vil ikke identifisere enkeltpersoner, og selskaper som identifiseres i spørreskjema vil anonymiseres i masteroppgaven.
• Dataene som samles inn vil ikke bli kopiert, eller distribuert til en tredjepart.
• Analyseresultatene kan bli publisert og/eller formidlet på akademiske og profesjonelle konferanser eller i tidsskrifter. Analyseresultatene vil være anonymiserte og ikke kunne brukes til å identifisere individer eller organisasjoner.
• Rådataene som samles inn i spørreskjema vil slettes etter at masteroppgaven er ferdigstilt og sensuren har falt, eller senest 180 dager etter at svaret er gitt.

1. På veiene av hvilken organisasjon/selskap besvarer du dette skjema?

1.1 (Valgfritt) Hvor mange (ca) ansatte er det i selskapet?

2. Velg hvilken type selskap din organisasjon er fra listen under. *

Fokuset for masteroppgaven er hvordan nett- og strøm-selskaper har organisert seg ifht. GDPR. Derfor er det ønskelig at du så lang det er mulig svarer på spørsmål med utgangspunkt i at du representerer enten et strømselskap, eller et nettselskap.

Dersom du som svarerer på undersøkelsen representerer et konsern/tilsvarende med begge selskapstyper ber vi om at du svarer med utgangspunkt i den selskapstypen som er angitt i emnefeltet i e-posten hvor undersøkelsen er sendt ut. Det skal være sendt e-post til både nett- og strøm-selskap.

Hvis du ikke representerer et nettselskap, strømselskap eller et konsern med begge deler kan du benytte "Annet"-alternativet.

- ○ Nettselskap
- ○ Strømselskap
- ○ Annet

2.1 Hva slags type organisasjon vil du betegne din organisasjon? *

Dette elementet vises kun dersom alternativet «Annet» er valgt i spørsmålet «2. Velg hvilken type selskap din organisasjon er fra listen under.»

Del 1: Generelle persondata

De neste 2(3) spørsmålene dreier seg om personvern knyttet til generelle persondata som navn, adresse og e-post. Dersom det er uklart hva som menes med generelle persondata kan du svare med utgangspunkt i at det er snakk om navn.

3. For generelle persondata som navn, adresse og e-post. Er din organisasjon behandlingsansvarlig eller databehandler etter GDPR/personvernforordningen? *

- ◯ Behandlingsansvarlig (Art. 4(7) GDPR)
- ◯ Databehandler (Art. 4(8) GDPR)
- ◯ Vet ikke

3.1. Etter personvernforordningen er det 6 gyldige grunnlag for behandling av persondata (Art. 6(1) GDPR). Med bakgrunn i hvilke av disse er din organisasjon behandlingsansvarlig? *

Dette elementet vises kun dersom alternativet «Behandlingsansvarlig (Art. 4(7) GDPR)» er valgt i spørsmålet «3. For generelle persondata som navn, adresse og e-post. Er din organisasjon behandlingsansvarlig eller databehandler etter GDPR/personvernforordningen?»

- ☐ a) Samtykke
- ☐ b) Nødvendig for å oppfylle en avtale
- ☐ c) Nødvendig for å oppfylle en rettslig plikt
- ☐ d) Nødvendig for å beskytte vitale interesser
- ☐ e) Nødvendig for å utføre en oppgave i allmennhetens interesse eller utøve offentlig myndighet
- ☐ f) Nødvendig for å ivareta legitime interesser
- ☐ Vet ikke

3.2. Har din organisasjon en databehandlingsavtale(r) med den/de behandlingsansvarlige? *

Dette elementet vises kun dersom alternativet «Databehandler (Art. 4(8) GDPR)» er valgt i spørsmålet «3. For generelle persondata som navn, adresse og e-post. Er din organisasjon behandlingsansvarlig eller databehandler etter GDPR/personvernforordningen?»

- ◯ Ja
- ◯ Nei

- [ ] Vet ikke

3.2.1. Hvem har dere databehandlingsavtale med? Svar gjerne med å angi selskapstype og ikke konkrete selskapsnavn dersom det er snakk om mange selskaper.

Dette elementet vises kun dersom alternativet «Ja» er valgt i spørsmålet «3.2. Har din organisasjon en databehandlingsavtale(r) med den/de behandlingsansvarlige?»

Del 2: Strømnett-spesifikke persondata

De neste 2(3) spørmålene er knyttet til persondata som genereres i strømnettet. Spørsmålene kan besvares med utgangspunkt i hvilken rolle din organisasjon har for strømforbruk målt med smarte strømmålere(AMS).

4. For strømnett spesifikke persondata som strømforbruk og målepunkt-ID. Er din organisasjon behandlingsansvarlig eller databehandler etter GDPR/personvernforordningen? *

- [ ] Behandlingsansvarlig (Art. 4(7) GDPR)
- [ ] Databehandler (Art. 4(8) GDPR)
- [ ] Vet ikke

4.1. Etter personvernforordningen er det 6 gyldige grunnlag for behandling av persondata (Art. 6(1) GDPR). Med bakgrunn i hvilke av disse er din organisasjon behandlingsansvarlig? *

Dette elementet vises kun dersom alternativet «Behandlingsansvarlig (Art. 4(7) GDPR)» er valgt i spørsmålet «4. For strømnett spesifikke persondata som strømforbruk og målepunkt-ID. Er din organisasjon behandlingsansvarlig eller databehandler etter GDPR/personvernforordningen?»

- [ ] a) Samtykke
- [ ] b) Nødvendig for å oppfylle en avtale
- [ ] c) Nødvendig for å oppfylle en rettslig plikt
- [ ] d) Nødvendig for å beskytte vitale interesser
- [ ] e) Nødvendig for å utføre en oppgave i allmennhetens interesse eller utøve offentlig myndighet
- [ ] f) Nødvendig for å ivareta legitime interesser
- [ ] Vet ikke

4.2. Har din organisasjon en databehandlingsavtale(r) med den/de behandlingsansvarlige? *

Dette elementet vises kun dersom alternativet «Databehandler (Art. 4(8) GDPR)» er valgt i spørsmålet «4. For strømnett spesifikke persondata som strømforbruk og målepunkt-ID. Er din organisasjon behandlingsansvarlig eller databehandler etter GDPR/personvernforordningen?»

- Ja
- Nei
- Vet ikke

4.2.1. Hvem har dere databehandlingsavtale med? Svar gjerne med å angi selskapstype og ikke konkrete selskapsnavn dersom det er snakk om mange selskaper.

Dette elementet vises kun dersom alternativet «Ja» er valgt i spørsmålet «4.2. Har din organisasjon en databehandlingsavtale(r) med den/de behandlingsansvarlige?»

Del 3: Persondata i smarte strømnett (Smart Grid)

Teknologi og digitalisering påvirker hele samfunnet. Dette er også tilfellet for strømnettet. "Internet of Things" (IoT), smarte strømmålere og andre "duppedingser" gjør det mulig å samle inn data og kontrollere komponenter på helt nye måter.
En ikke uttømmende liste med eksempler på denne type data er: måling av forbruk på enkeltstikk eller kurser, måling/styring av elbillader, måling av forbruk for enkeltkomponenter som vaskemaskin, varmtvannsbereder og AC.

Disse datane vil ofte være persondata og må håndteres etter personvernforordningen. De neste spørsmålene vil dreie seg om denne type data.

5. Samler/behandler din organisasjon inn data om strømforbruk eller elektriske komponenter som kommer i tillegg til timemålt forbruk fra smarte strømmålere(AMS)? *

- Ja
- Nei
- Har planer om å begynne å samle inn denne type data
- Vet ikke

5.1 Er din organisasjon behandlingsansvarlig eller databehandler for disse dataene etter personvernforordningen? *

Dette elementet vises kun dersom alternativet «Har planer om å begynne å samle inn denne type data» eller «Ja» er valgt i spørsmålet «5. Samler/behandler din organisasjon inn data om strømforbruk eller elektriske komponenter som kommer i tillegg til timemålt forbruk fra smarte strømmålere(AMS)?»

- ○ Behandlingsansvarlig (Art. 4(7) GDPR)
- ○ Databehandler (Art. 4(8) GDPR)
- ○ Vet ikke

5.1.1. Etter personvernforordningen er det 6 gyldige grunnlag for behandling av persondata (Art. 6(1) GDPR). Med bakgrunn i hvilke av disse er din organisasjon behandlingsansvarlig? *

ⓘ Dette elementet vises kun dersom alternativet «Behandlingsansvarlig (Art. 4(7) GDPR)» er valgt i spørsmålet «5.1 Er din organisasjon behandlingsansvarlig eller databehandler for disse dataene etter personvernforordningen?»

- ☐ a) Samtykke
- ☐ b) Nødvendig for å oppfylle en avtale
- ☐ c) Nødvendig for å oppfylle en rettslig plikt
- ☐ d) Nødvendig for å beskytte vitale interesser
- ☐ e) Nødvendig for å utføre en oppgave i allmennhetens interesse eller utøve offentlig myndighet
- ☐ f) Nødvendig for å ivareta legitime interesser
- ☐ Vet ikke

5.1.2. Har din organisasjon en databehandlingsavtale(r) med den/de behandlingsansvarlige? *

ⓘ Dette elementet vises kun dersom alternativet «Databehandler (Art. 4(8) GDPR)» er valgt i spørsmålet «5.1 Er din organisasjon behandlingsansvarlig eller databehandler for disse dataene etter personvernforordningen?»

- ○ Ja
- ○ Nei
- ○ Vet ikke

5.1.2.1. Hvem har dere databehandlingsavtale med? Svar gjerne med å angi selskapstype og ikke konkrete selskapsnavn dersom det er snakk om mange selskaper.

ⓘ Dette elementet vises kun dersom alternativet «Ja» er valgt i spørsmålet «5.1.2. Har din organisasjon en databehandlingsavtale(r) med den/de behandlingsansvarlige?»

Del 4: Tilbakemelding

Dersom du har en tilbakemelding, eller noe du ønsker å kommentere hadde vi satt pris på om du gjorde det i tekstfeltet under.

Takk for at du svarte på denne spørreundersøkelsen!

Dersom dere ønsker å kontakte oss kan dere gjøre dette på bendikwm@stud.ntnu.no.

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