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Value of grid friendly flexibility from smart water heaters

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ide

IDE is a large-scale demonstration project, partly funded by Enova

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Report

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ABOUT THE REPORT

This report examines experiences gained from BattFlex, which is one of four pilot projects in the large-scale demonstration project, “Intelligent Distribution of Electricity” (IDE).

The IDE project is partly funded by Enova from 2019 to 2024, and managed by a consortium led by the Norwegian Smartgrid Centre. The consortium consists of grid companies Elvia, BKK, Tensio, Norgesnett, Lede and Glitre Nett, as well as NTNU and EPOS Consulting.

The report describes the effects and benefits of grid batteries in low-voltage grids, customers’ smart water heaters, and bilateral agreements with end customers. The pilot project demonstrates the importance of good collaboration between grid companies and suppliers. In BattFlex, collaboration has led to innovation and product development that can reduce voltage quality issues in weak or exposed low-voltage networks, which is more cost-effective than conventional grid reinforcement measures.

Value of grid friendly flexibility from smart water heaters

How voltage support from smart water heaters contributes to better utilization of the low voltage grid, increased flexibility, and reduced energy cost for end customers.

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1 Summary

BattFLEX is a project with a high level of innovation and is one of four subprojects in the large-scale demonstration project IDE. The IDE project was started in autumn 2019, and is being executed by a consortium led by The Norwegian Smartgrid Centre. Other participants in the consortium include the distribution system operators (DSOs) BKK, Elvia, Tensio, Agder Energi, Norgesnett and LEDE, along with NTNU (Norwegian University of Science and Technology) and Epos Consulting.

In 2018, Eidsiva Nett executed the KAFFI project in collaboration with Thema Consulting. The objective was to survey the need and potential for activating local flexibility in the distribution grid. The survey covered the use of alternative solutions for 17 selected transformer circuits, and the analyses showed that such solutions could result in a saving of 75% compared with conventional measures in the grid.

The objective of BattFLEX has been to demonstrate and highlight the impacts and utility values of grid batteries in the low-voltage grid, smart water heaters at customers and bilateral agreements with end customers. The primary goal of the project has been to verify that such solutions can reduce problems related to voltage quality, in weak or vulnerable low-voltage grids, more cost-effectively than conventional grid reinforcement.

The project succeeded in achieving its goals, and the results were excellent. Three factors in particular have created synergies and contributed to the whole being greater than the sum of its parts in this project.

- The strategy drawn up for the development of the project
- Collaboration with suppliers and product development
- Customer dialogue and digital collaboration

These have contributed to innovation and product development in several important areas:

- OSO Charge functionality has been developed for grid-friendly activation of consumer flexibility, with control algorithms based on dynamic voltage parameters and market price. Results from test activities (see section 7.5) show that this functionality can contribute with significant voltage support and improve voltage quality in the low voltage grid.
- OSO Charge is an autonomous smart device that can be controlled without customer involvement or via the *OSO inCharge* app.
- As a result of the development of OSO Charge, in spring 2022 Enova introduced a new support scheme for end customers who are thinking about installing smart water heaters.
- BattFLEX was recently awarded The Norwegian Smartgrid Centre's innovation prize for 2022.

The large-scale introduction of such a solution requires a fully digital collaboration process with customers. To date, few DSOs have developed system support for such a process, and this constitutes a major barrier to cost-effective rollout and operation of distributed resources at customers. To remove this barrier, BattFLEX has developed a process that covers the digitalisation of bilateral agreements between Elvia and the end customers, and that facilitates digital collaboration between Elvia, the customers and the suppliers of products and services.

A robust delivery process to end customers is dependent on four elements: (1) a digitalised collaboration process, (2) autonomous and user-friendly products, (3) the customer experience relating to installation and service, and (4) a scalable business and delivery model.

The collaboration process has formed the basis for developing a new business model that covers collaboration between Elvia, OSO Energy and installers, as well as the incentivisation of customers to activate consumer flexibility. This constitutes a unique basis for further development of business models, products and delivery processes.

2 Introduction and project background

> ***The basic assumption of the REV (Reforming the Energy Vision) is that the problems occurring at the grid edge are best solved at the grid edge.***
>
> ***Investing in significant new infrastructure to integrate DERs would not only make DERs redundant, but increase the costs of running the grid, the thinking goes. Instead, utilities will develop distributed system platforms (DPS) that leverage DERs to drive system efficiencies.***
>
> *Audrey Zibelman, chairwoman of the New York Service Commission*

The electricity grid and supply infrastructure in Norway have largely been built in the same manner for over 100 years. In recent decades other industries have undergone groundbreaking technological changes and development, whereas the electricity system has in many ways remained unchanged since the electrification of Norway began. The system is constructed so as to have sufficient capacity during the limited number of hours in the year when demand is at its highest. Low utilisation time and a poor level of grid utilisation result in high system costs, and major changes in both the energy system and load factors are resulting in a reduction in power balance and security of supply.

Norway's supply of electricity is moving into an unparalleled period of change. The number of electric vehicles is increasing rapidly, with a corresponding increase in rapid charging and home charging. We are seeing increasing access to mature technology within distributed energy resources (DER), including solutions for the production and storage of energy at customers, and we are seeing major changes and variations in consumption patterns and power requirements. There are high ambitions to expand the use of solar and wind power on a large scale, which will require corresponding access to balancing power from other energy sources, combined with access to fast power reserves to safeguard system balance, stability and security of supply.

Such fundamental system changes involve major challenges regarding how the grid is to be constructed, operated and maintained in the future. Nevertheless, these challenges are also creating new opportunities to make the grid more cost-effective. The challenges that arise on the customer side will be solved most effectively on the customer side. New technology is making this possible, and by utilising the potential for flexibility that such technology may help to realise, it will be possible to "supply more energy with less grid infrastructure" and thereby create powerful drivers for system efficiency.

In 2018, Eidsiva Nett executed the KAFFI project in collaboration with Thema Consulting. The objective was to survey the need and potential for activating local flexibility in the distribution grid. The survey covered the use of alternative solutions for 17 selected transformer circuits with complex challenges (transformer overload, conductor overload, voltage drop in excess of 10%) in the distribution grid ten years from now. The analyses showed that this could result in a saving of 75% compared with conventional measures in the grid. For the 17 circuits, this would provide a saving of NOK 9 million during this period.

The results from KAFFI formed the basis for the development of BattFLEX. BattFLEX is a project with a high level of innovation and is one of four work packages in the IDE project. The IDE project was started in autumn 2019 and is being executed by a consortium led by The Norwegian Smartgrid Centre. Other participants in the consortium include the DSOs BKK, Elvia, Tensio, Agder Energi, Norgesnett and LEDE, along with NTNU and Epos Consulting.

3 The project’s objectives

> ***The electricity system is going through a period of unprecedented change. Through the past decade we have seen a rapid deployment of renewable generation on our networks. More recently, we are also seeing the emergence of new distributed energy resources (DER) such as storage and electric vehicles (EVs) and changing electricity usage patterns of our customers.***
>
> ***These fundamental system changes are challenging both how we maintain and operate our network today, as well as creating opportunities for us to do so more efficiently in the future.***
>
> ***UK Power Networks, Flexibility Roadmap – Future Smart***

The objective of BattFLEX has been to demonstrate and highlight the impacts and utility values of grid batteries in the low-voltage grid, smart water heaters at customers and bilateral agreements with end customers. The primary goal has been to verify how such solutions can help to reduce problems relating to voltage quality, and the potential to activate consumer flexibility.

Operational targets

Efficiency, innovation and satisfied customers are key operational targets for Elvia that are supported by the project.

Project objectives

Description	Success criteria
- Verified cost–benefit analyses of alternative solutions employed to address challenges relating to increased power draw, voltage problems and production at end customers	- Key findings included in the power system report
- Cost-effective solutions for compliance with the Quality of Supply Regulation and to reduce grid investment costs	- Prepared project proposal for expanded use of grid batteries and smart water heaters
- Improved reputation and customer insight through direct contact and collaboration with end customers	- Reputation survey shows improved reputation among customers

KPIs

Description	Success criteria
- Practical experience with grid batteries	- Installed two grid batteries
- Practical experience with consumer flexibility and bilateral agreements with end customers	- Established bilateral customer agreements - Installed smart water heaters at grid customers to utilise potential for flexibility
- Evaluate to what degree the two solutions resolve the challenges of undervoltage and overload in the low-voltage grid	- Conducted trial operations - Prepared experience memorandum
- Compare costs for the two solutions and check the savings estimated in KAFFI	- Prepared profitability calculation

The role of BattFLEX in the IDE project

BattFLEX forms part of the national large-scale project IDE (Intelligent Distribution of Electricity). It is led by The Norwegian Smartgrid Centre, which is also responsible for goal attainment in the large-scale project.

The primary objective of the IDE project is to demonstrate new technologies and digital solutions on a large scale, verify how they function, and highlight utility values and scaling potentials so that these contribute to solutions being adopted on a large scale.

4 Technological description

4.1 Primary technological description

The technologies and solutions used in the demonstration project are described below.

Technologies and solutions	Comments
Smart water heaters: **Supplier** OSO Energy AS	Smart water heaters are installed in the homes of approximately 80 customers with bilateral agreements on flexibility, in two different transformer circuits. See functional description in section 4.2
Multifunctional energy-storage system for distribution grid: **Supplier**: Pixii AS	Electric batteries are installed on three transformer circuits in the low-voltage grid. See functional description in section 4.2
Digital bilateral agreements with grid customers Internally developed system support for digital customer process	Digital bilateral agreements are an innovative agreement model that have been developed to simplify and digitalise the customer process, create increased collaboration with customers, and secure the DSO access to flexibility when needed. During the project, it will be assessed whether the throttling function in AMS meters can be used for the same purpose. The same bilateral agreements can be used here to throttle access to power at the consumption point at customers during those hours when grid load is highest. This must be seen in the context of important trade-offs around ICT security in the solution.
AMS Internal system from the supplier Aidon AS	AMS and historical AMS data is used to analyse transformer circuits and impacts in the low-voltage grid, and also to measure and verify the testing of relevant functions. There has been a partnership with DIGIN on the use of the grid tariff API.
Measurement in substations	The substations involved in the demonstration will be equipped with either multi-instruments or measuring instruments with a better resolution, if this proves to be necessary.
Local control	Local control will normally be available via battery/consumer-flexibility products, but this requires an integration with a centralised control system.

4.2 Technology application and functionality

The application and functionality for grid batteries, smart water heaters and the digital customer process are outlined below.

Multifunctional energy-storage system Pixii AS	To be installed on selected transformer circuits in the low-voltage grid	- Reduction in power peaks to avoid overload on transformer - Reduction in voltage drops - Compensation for skewed load distribution - Reduction of reactive power
Smart water heaters OSO Energy AS	- New OSO water heaters, with OSO Charge at end customers - OSO Charge retrofitted on existing water heaters at end customers	- Reduction in power peaks to reduce load on transformer and in the low-voltage grid - Grid friendly activation for voltage support to reduce voltage drops in the low-voltage grid - Main element in digital bilateral agreements on consumer flexibility - Reducing customers' energy costs
Digital customer process with bilateral agreements Elvia AS	- Internally developed system support for customer dialogue and digital agreement management	- Agreement on participation - Entry into standard agreement - Compensation for participation - Entry into bilateral agreement on consumer flexibility - Analyses and presentation on My Page

4.3 Physical installations in the grid

Grid batteries are installed in the low-voltage grid on three selected transformer circuits. 78 smart water heaters are installed at a total of 72 customers on two selected transformer circuits. On one of these circuits, in Sjusjøen, where there are a lot of holiday cabins, a grid battery has been installed in the low-voltage grid and smart water heaters have been installed at customer properties to test out and verify the potential for coordination between the two solutions.

Installation levels in the grid are illustrated in Figures 1 and 2 below.

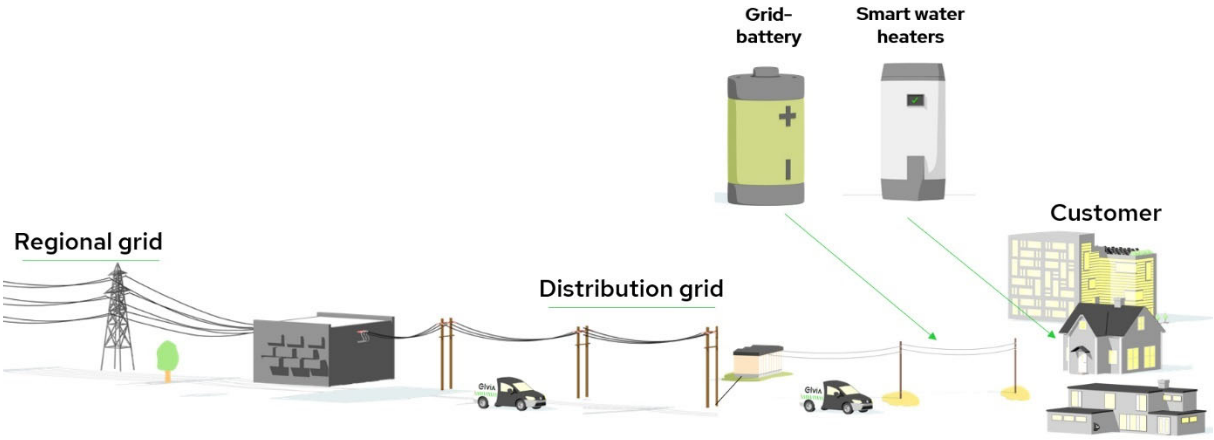


Figure 1 – Illustration of installation levels in the grid

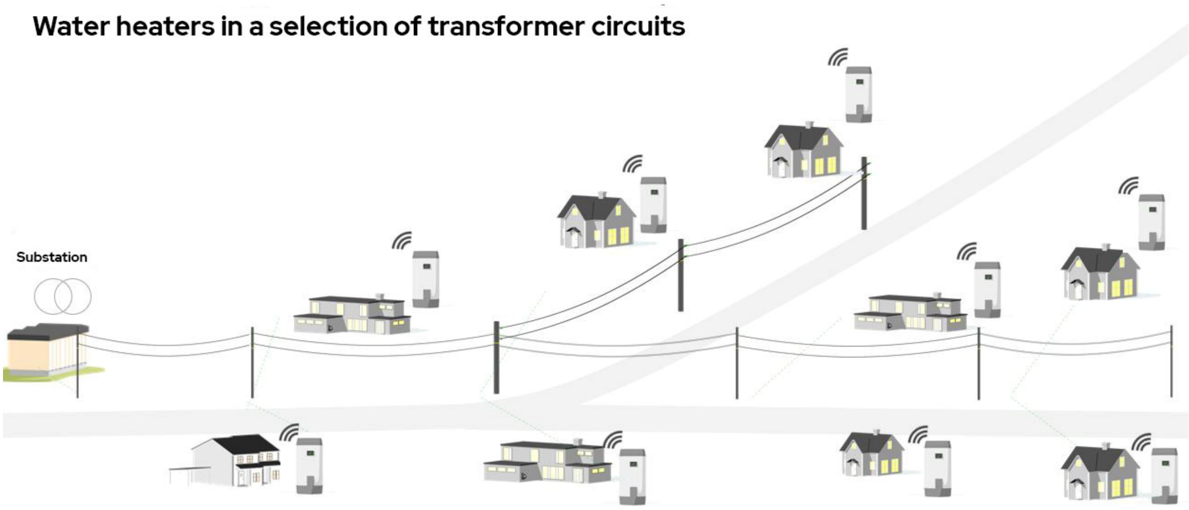


Figure 2 – Water heaters in a selection of transformer circuits

5 Utility effects and scaling potentials

If we're going to maximize the benefits of clean energy, we need to ensure that our power is being consumed more efficiently by end-users at scale. This applies to individuals, residences, businesses, and State-owned buildings alike. We also know that energy efficiency is the most cost-effective way to reduce greenhouse gas emissions.

Reforming the Energy Vision REV New York City

5.1 Expected utility effects of the project

The use of conventional solutions to reinforce the grid in order to address problems such as overload in distribution transformers and overload and voltage problems in high- and low-voltage powerline and cable grids is normally very expensive. The primary expectation of the project has therefore been that the solutions being tested should contribute to reducing such problems more cost-effectively than conventional grid reinforcement, by utilising current and future potential for consumer flexibility.

- Grid batteries installed in the low-voltage grid will contribute to reducing power peaks, avoiding overload on distribution transformers, compensating for reactive power, and reducing voltage drop and skewed load distribution in the low-voltage grid.
- Smart water heaters installed at end customers, controlled with the correct parameters and algorithms, will contribute to a reduction in power load and power peaks, without resulting in reduced comfort or the need for any effort on the part of the customers. If water heaters are also controlled by voltage parameters, they will contribute to reducing power peaks without resulting in increased voltage drops or undesirable rebound effects in the grid. Trialling smart water heaters will also contribute practical experience with the activation of consumer flexibility and bilateral agreements for this purpose.
- AMS and AMS data provide an accurate basis to analyse where measures should be introduced and how they should be dimensioned to ensure the greatest utility value, to verify results, and to provide control parameters for the technologies on trial.
- The digitalisation of the customer process for managing bilateral agreements is expected to provide utility values in the form of process efficiency improvements, digital document management, increased customer satisfaction and increased collaboration with customers. In addition, a digital customer and agreement process will be fundamental to providing an overview of and securing access to consumer flexibility on a large scale.

5.2 Analysis of utility values and scaling potentials

Analyses and documentation of utility values and scaling potentials for the solutions demonstrated in the project will be undertaken in collaboration with the other DSOs in the IDE project, based on the following principles:

- A utility value can be defined as "an effect that creates value for a company, a customer or society in general".
- Utility values can generally be divided into four main categories, where the objective is that the categories should be mutually exclusive in order to define the type of utility value and relevant target figures.

The four utility value categories are defined as follows:

- *Economic:* reduced costs, or increased deliverables for the same cost, as a result of increased efficiency in systems and processes, and increased utilisation time of installations and solutions in general.
- *Quality and security of supply:* Energy security, power security and operational security, and a reduction in disruptions and disturbances in the energy system.
- *Environment:* Reduced negative impacts and damage from climate change to human health and ecosystems due to emissions and pollution.
- *Safety for personnel and installations:* Reduction in undesired incidents, injuries to personnel and damage to installations.

Figure 3 below shows examples of how the various categories can be defined, the causes/effects that lead to utility values, and how they can be measured and/or calculated.

Category	Expected benefit	Cause / effect	Measure / data / calculation	Uncertainty
			How to measure and calculate the expected benefits	*Visualise the calculations degree of uncertainty*
Financial • NOK	• Reduced CAPEX • Reduced OPEX • Reduced KILE • Reduced network loss	• Reduced peak load • Process improvements • Reduced downtime • Reduced network loss	• Measure / calculate impacts • Statistics / key measures • Down time statistics • TSO tariff • Estimations	• Moderate • Significant • High • not quantifiable
Environmental • Defined measures / Ranking	• Reduced climate emissions • Reduced environmental impact	• Reduced energy consumption • Reduced loss in regional and distribution networks • Introduction of RDSI	• Measures for emissions / Climate impact	
Security of supply and power quality • Defined measures / Ranking	• Improved power quality • Improved energy security, power security, operational security	• Reduced load • Consumer flexibility • Access to fast frequency reserves	• Relevant measures for supply and power quality	
HSE & ICT Security • Defined measures / Ranking	• Reduction in damages to people and assets • Improved ICT security	• Automation • Improved assets security • Improved process security	• Relevant measures and statistics for supply and power quality • HSE statistics • Fault statistics	

Figure 3 – Illustration: systematisation of expected utility values from demonstrated solutions

Figure 4 below illustrates how measurements and analyses of the results for the substations and end customers included in BattFLEX can be used as a basis for analysing the scaling potentials for Elvia and the DSOs in Norway as a whole.

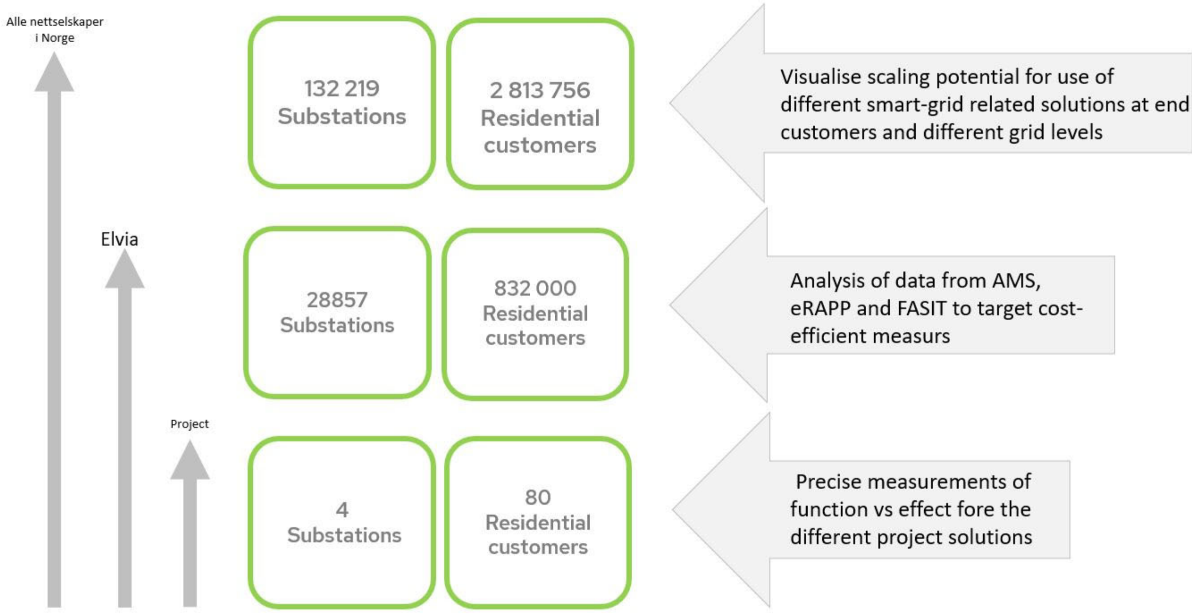


Figure 4 – Illustration: methodology for highlighting scaling potentials, in the project vs Elvia vs Norway

6 Project execution

In the KAFFI project, which was completed in autumn 2018, the technological focus was on the use of grid batteries. In 2019, market research was conducted, along with a procurement process involving relevant suppliers of this type of technology, with the result that Pixii AS was selected to supply their solution: a multifunctional battery-storage system for distribution grids.

A dialogue was subsequently set up with Ringerikskraft Nett on their experiences with the demonstration of smart water heaters in the EffektPILOT project. As a result, it was decided to expand the scope of the project to encompass the demonstration of smart water heaters, to address the project's goal of developing bilateral customer agreements to utilize consumer flexibility for improving voltage quality in the low-voltage grid.

As smart water heaters would be installed at a representative number of grid customers, the bulk of demonstration activities were directed towards smart water heaters, bilateral agreements and the digital customer process. Therefore, the following sections of this report primarily focus on information on execution, results and experiences from these activities.

6.1 Project strategy

In the work to develop this project, particular emphasis was placed on three strategy elements, as described below.

Strategy for procurement

- Conducting market research and dialogue with stakeholders, suppliers and other projects.
- Form of competition involving RFI (request for information), and ordinary competition thereafter. Operating such a procurement process over multiple stages is resource-demanding, but helps to ensure equal treatment of suppliers and to securing external experience and expertise for development and execution.
- Separate procurement processes for grid batteries and smart water heaters. The processes were organised using the same model: the procurement of grid batteries was executed first, and experiences from this process were utilised in the procurement of smart water heaters. A key, mandatory requirement to the procurement of smart water heaters was development of functionality for voltage measurement and grid friendly activation, to provide voltage support for the low-voltage grid.

Strategy for collaboration with suppliers and product development

- Build further on experiences and results from other projects, rather than "reinventing the wheel". As part of the project preparations, therefore, an information search from relevant projects was conducted on consumer flexibility, both in Norway and internationally. A reference list of such projects can be found in section 0, References.
- Collaboration with suppliers with the ability to deliver, the ability to take end-to-end responsibility and experience from other projects. This was important in order to secure access to market experience in areas where we were lacking.
- Collaboration with suppliers that have a business model that dovetails with the project's development goals and success – so-called supplier-driven development. This provides access to much greater development resources and expertise than would be possible in an internal development process within a monopoly. In addition, this contributes to securing sustainable development, where the collaboration model demonstrated can be continued and scaled up in operation following the pilot.

Strategy for digital collaboration with customers and suppliers

Elvia has developed solutions for the digitalisation of processes for collaboration with customers and suppliers in connection with the rollout of AMS in the former Hafslund. Such a platform could form the basis for rapid development in the following areas:

- Digitalisation of customer processes enables effective collaboration across various roles and information systems. A digital end-to-end customer process is necessary to ensure efficiency, quality and user-friendliness in customer dialogue and agreement management in subsequent upscaling of devices at customers.
- The digitalisation of work processes is necessary to ensure effective information exchange between the links in a value chain. The digitalisation of interfaces with suppliers (B2B) improves efficiency and quality for planning, installation, service, documentation and commercial transactions. For smart water heaters, the digital supplier process must also include technical quality processes such as inspections, workflow and checklists for installers, along with automatic system reporting from connected water heaters (IoT).

6.2 Project organisation

The project organisation is shown in the figure below. The project has been organised with participants from relevant departments in Elvia and has enjoyed an active collaboration with the suppliers Pixii and OSO Energy, covering both development and implementation activities.

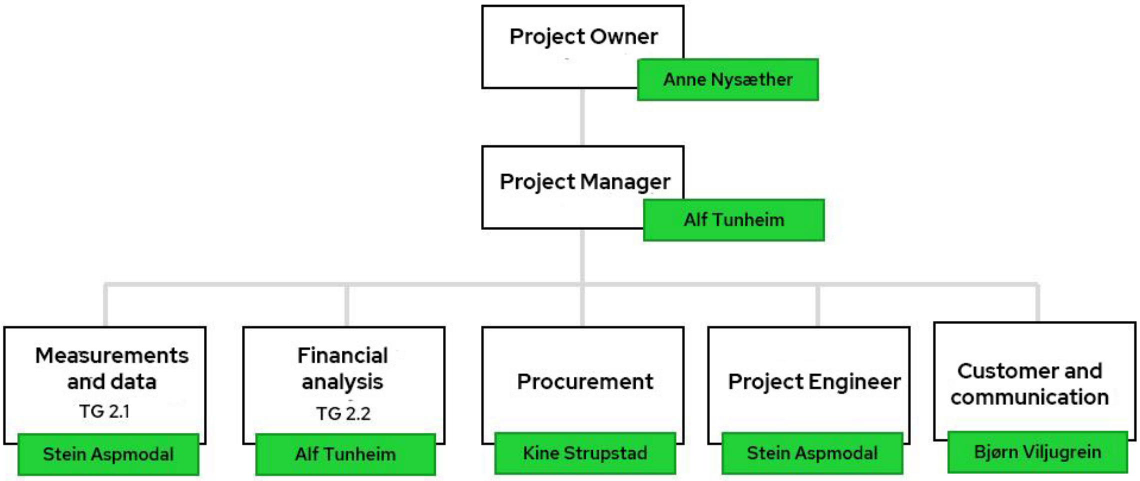


Figure 5 – Project organisation

BattFLEX is part of the national large-scale project IDE, which is led by The Norwegian Smartgrid Centre. Other partners in IDE include BKK Nett, Tensio TN, Agder Energi Nett, Norgesnett, LEDE, Epos Consulting and NTNU.

7 Project results and goal achievement

Due to common control signals an increase of simultaneity and thus higher power peaks can be expected. With a certain penetration of these components and concepts, negative impacts on the local distribution grid are likely if insufficient measures are implemented within the grid domain.

Although a market driven activation of flexibility (without consideration of the local grid) is already offered by some market players in Austria, a grid friendly activation for local grid services has yet to be developed.

LEAFS – Austria 2019

The project succeeded in achieving its goals, and the results were excellent. Three factors in particular have created synergies and contributed to the whole being greater than the sum of its parts. These are illustrated in Figure 6 below.

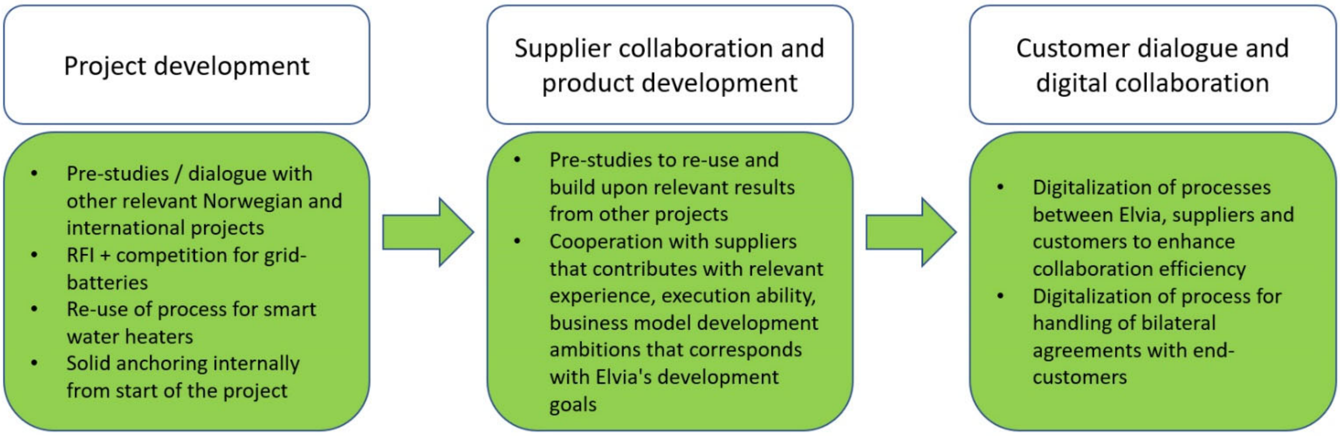


Figure 6 – Three factors that have greatly contributed to the results

7.1 Project development

Project development began by conducting studies of, and opening dialogue with, other projects in Norway and abroad. The objective was to be able to use the knowledge gained as a basis for project development, rather than starting with a blank canvas. As a result, we were able to develop a project that in many ways has been a serial innovation from other projects, and that has given quick results in both product and process development.

In the procurement process, we wanted to find suppliers that had the ability to deliver and a business model that supported the success criteria for the project. Our preference was to collaborate with suppliers that could take end-to-end responsibility and that could demonstrate experience with doing so, so that we could thereby gain access to market experience and expertise in areas where we were lacking internally.

The procurement process was started with an RFI (request for information) and dialogue with suppliers, followed by an ordinary tender competition. As a result, we were able to establish effective collaborations with the two main suppliers, Pixii AS and OSO Energi AS. In this way we were able to create a supplier-driven development process, in which the suppliers provided us with expertise and development resources of a completely different scale than what we had capacity for internally.

Another very important success factor is that the project has been firmly embedded at Elvia right from the start, and that the project has had good access to resources with expertise from various relevant parts of the organisation.

7.2 Supplier collaboration and innovation

The choice of suppliers has contributed to establishing a good, mutual collaboration model, with access to expertise and capacity on the technology front from the suppliers, and access to information about customers, consumption patterns and relevant grid and AMS data from Elvia.

The supplier collaboration has been very successful, with a development plan that was based partly on experiences from existing research and partly on further development of solutions from other projects. A report from the Austrian LEAFS project, which was published in autumn 2019, showed that market-driven activation of flexibility resources will drive increased simultaneous connection and disconnection, resulting in negative impacts on the low-voltage grid. The analyses were conducted based on two perspectives:

- Avoiding negative effects from market-driven activation
- Achieving positive effects from "grid-friendly activation"

This has been a central element in the demonstration objective for BattFLEX, and has contributed to innovation and product development in several important areas:

- Verification of the analyses from LEAFS (see section 7.5 Results of the test activities for more information).
- OSO Charge functionality has been developed for grid-friendly activation, with control algorithms for activation based on dynamic voltage parameters and market price.
- OSO Charge is an autonomous smart device that can be controlled without customer involvement or via the *OSO inCharge* app.
- As a result of the development of OSO Charge, in spring 2022 Enova introduced a new support scheme for end customers who are thinking about installing smart water heaters.
- BattFLEX was recently awarded The Norwegian Smartgrid Centre's innovation prize for 2022.

Activation of consumer flexibility has major potential to generate utility values at all levels in the energy system, from improving voltage quality in the low-voltage grid and reducing/postponing investments in the distribution and regional grids to contributing to fast frequency reserves (FFR) at system operations level. Digital collaboration and digital bilateral agreements with end customers are a precondition for being able to activate flexibility quickly and on a large scale.

- In connection with the rollout of smart water heaters, Elvia has developed a digital process for customer dialogue and managing bilateral agreements on the activation of flexibility with end customers.

A robust and scalable delivery process to end customers is dependent on four key elements: a digitalised customer process, functionality and autonomy in the products to be installed, the customer experience relating to installation and service, and not least a scalable business and delivery model.

- During the preparations for the rollout and installation of water heaters and OSO Charge, the project has developed a digital collaboration process linking the customers, Elvia, OSO Energy and installers, to manage the installation and service of the water heaters.
- The collaboration process has formed the basis for developing a new business and delivery model that covers collaboration between Elvia, OSO Energy and installers, as well as the incentivisation of customers to activate consumer flexibility. This constitutes a unique basis for further developing business models that are both profitable and suitable for large-scale rollout.

7.3 Customer dialogue and customer processes

The energy industry is going through a period characterised by major system changes, changes in the energy market, the introduction of distributed renewable (and non-dispatchable) production and electric vehicles on a large scale, changed consumption patterns on the end-user side and increasing power load. All this creates major challenges in terms of how the grid is to be constructed, operated and maintained in the future. Such challenges will be difficult to resolve in a cost-effective manner and on a large scale by conventional grid reinforcement alone.

Many of the challenges faced by the DSOs are on the customer side, for example as a result of changed consumption patterns, increasing power draw and the increased introduction of solar farms. To the extent possible, these challenges should be resolved on the customer side by employing new technology on a large scale. There are suitable technologies and solutions on the market that can already be used or that can be further developed for such purposes.

- BattFLEX has contributed to the further development of OSO Charge, and the results show that such a solution can be far more cost-effective than conventional solutions.
- BattFLEX has demonstrated that such a solution can also create value for the customers – value that they can understand in the form of increased comfort and reduced cost.
- BattFLEX has also demonstrated that such solutions create opportunities for constructing, operating and maintaining a more cost-effective grid in the future. Large-scale rollout of solutions such as OSO Charge, with "grid-friendly activation" of consumer flexibility, can create value at all levels in the energy system.

The introduction of such a solution on a large scale requires collaboration with customers – and such collaboration must be by means of a digital process. All DSOs have a digital customer process for MAFI (a Norwegian acronym for *måling* (measurement), *avregning* (settlement), *fakturering* (invoicing) and *innfordring* (debt recovery)). However, few DSOs have further developed such processes in order to actively collaborate with end customers. This constitutes one of the biggest barriers to large-scale rollout of technology at customers in order to facilitate the activation of consumer flexibility on a large scale.

To remove this barrier, BattFLEX has gradually developed a digital customer process that facilitates active and effective collaboration with customers and suppliers. This type of end-to-end digital process is necessary to ensure efficiency, quality and user-friendliness in customer dialogue and agreement management in subsequent upscaling. It also helps create value for all stakeholders. The processes are illustrated in Figures 7 and 8.

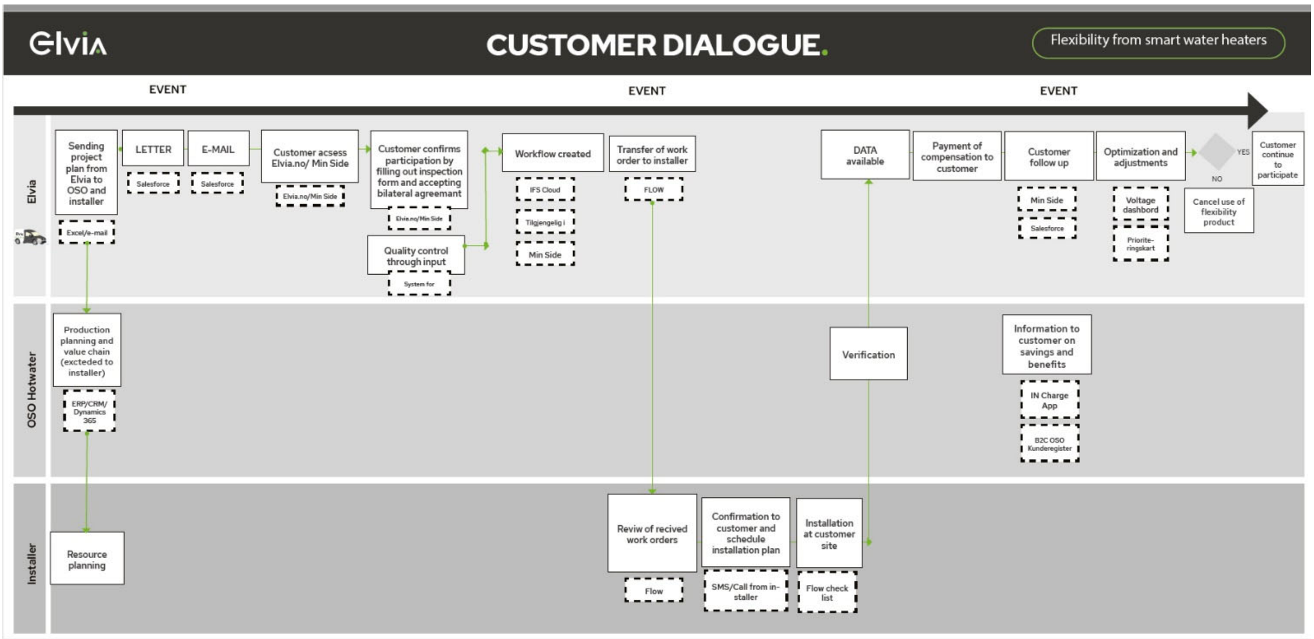


Figure 7 – Digital process for collaboration with customers

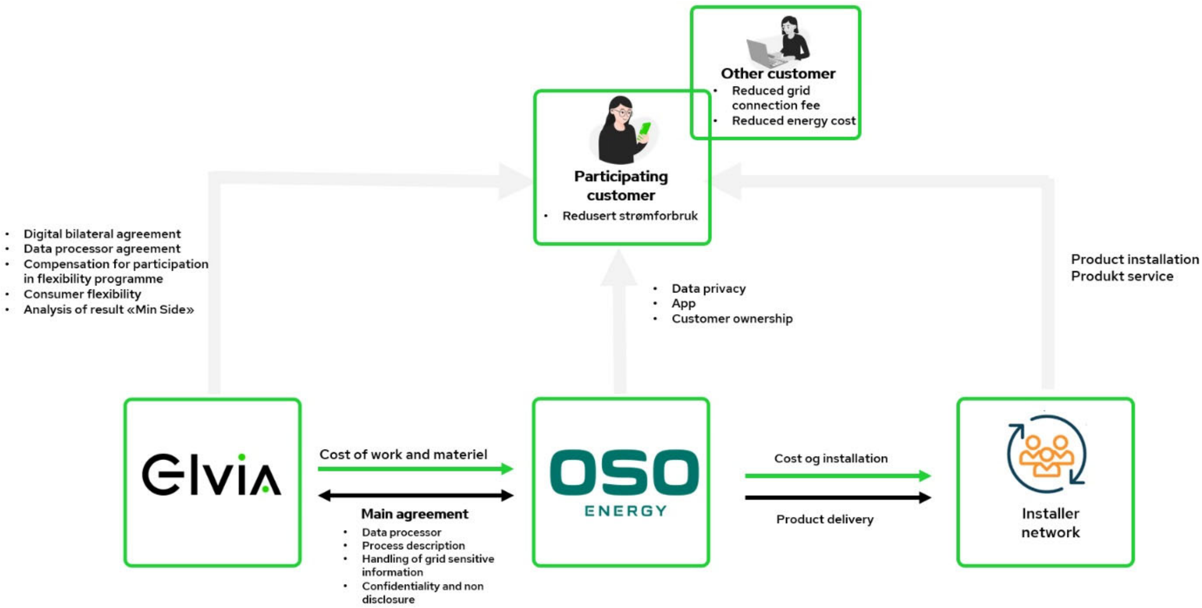


Figure 8 – Illustration – digital collaboration process between Elvia, customers, OSO Energy and installers

7.4 Development and demonstration of OSO Charge

The first generation of OSO Charge was developed as part of the demonstration project EffektPILOT carried out by Ringerikskraft between 2019 and 2020. The development activities and innovations in BattFLEX are largely based on simulations and analyses from other projects, and have focused on trials and testing in actual operations in Elvia's grid.

The results of other projects, including Ringerikskraft Nett's and LEAFS, have played a key role in enabling OSO Energy, in collaboration with Elvia, to develop a solution, in less than two years, that encompasses:

- Control algorithms to optimise the activation of smart water heaters based on both price signals and dynamic voltage parameters.
- Control algorithms that maintain security, primary performance (hot water) and grid-friendly activation locally (power and voltage level) that are also designed to activate fast frequency reserves at DSO and TSO level.
- A fleet of water heaters that can cooperate autonomously on load reduction during periods of local voltage problems in the grid, without impacting customer comfort.
- Price optimisation for customers while enabling each heater to contribute voltage support relative to its position in the grid, and in this way contribute to balanced aggregation from a fleet of heaters with available flexibility.
- Local meter readings from each heater mean that heaters are activated autonomously in real time.

OSO Charge is a solution that allows smart water heaters to control themselves autonomously based on price and voltage parameters. The platform the solution is built on can be further developed to include new functions, for example to facilitate local and regional operational optimisation and controlled activation of fast frequency reserves (FFR). An enhanced solution will make it possible to activate flexibility and generate utility values at all levels of the energy system. A sketch of the platform is shown in Figure 9.

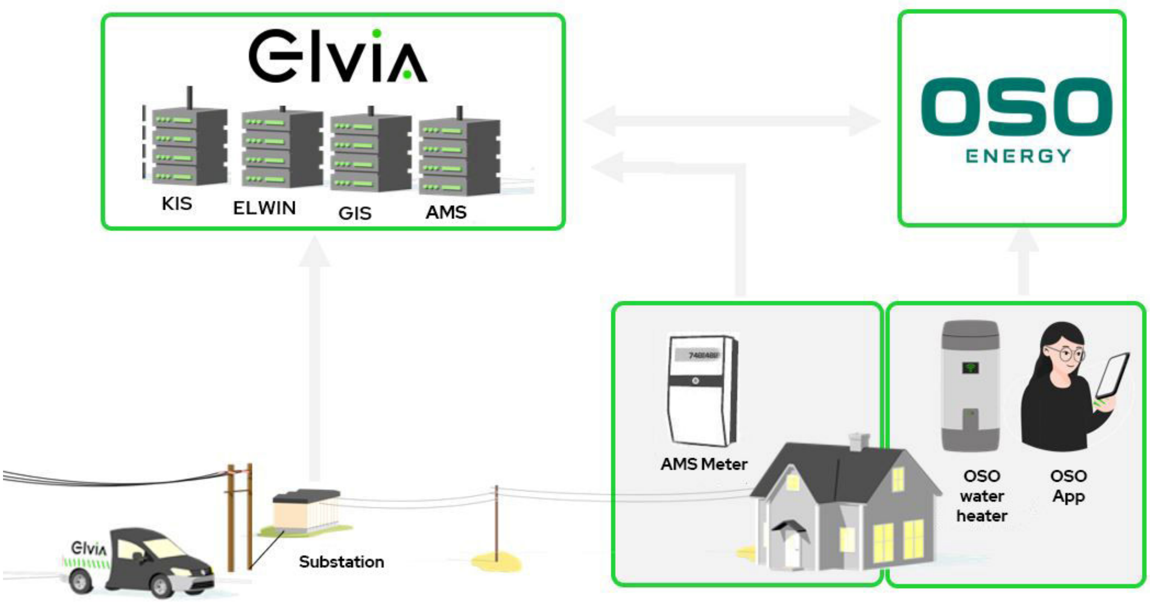


Figure 9 – System overview – OSO Charge.

7.5 Results of the test activities

The project has conducted various tests to verify how smart water heaters can be activated to provide voltage support and improve voltage quality in the low-voltage grid, while avoiding activation that negatively impacts the grid. The tests were carried out in the period December 2021 to March 2022. The results of the tests are presented in Table 1 below. The table shows the percentage change in voltage level, referenced to the tolerance range specified in the Quality of Supply Regulation of +/- 23 V in relation to the rated voltage of 230 V.

	Period 1	Period 2	Period 3	Period 4
Control	Thermostat	Price + Voltage	Price	Voltage
U_{Low}	207,4	215,4	207,9	218,9
$U_{Low\ average}$	210,9	217	209,8	219,7
Improvement Low		17,4 %	1,1 % -16,3 %	25,0 % 23,9 %
Improvement Low average		15,0 %	-16,3 %	20,9% 6,0%
Comment	Baseline		16,3 % Deterioration from period 2	23,9 % Deterioration from period 3

Table 1 – improvement in voltage level at various control parameters

Test period 1: conventional thermostat control – November 2021
Test period 2: control of voltage parameters and price signal – December 2021
Test period 3: control of spot price signal – February 2022
Test period 4: control of voltage parameters – March 2022

In January 2022, various small-scale tests were carried out to prepare for the project. The data set from this period has not been included as a reference or test result. The tests were based on a sample of 21 water heaters. In a normal period in November 2021, the tests show that the accumulated load from heaters was around 50%/25 kW in hours with the highest load, with some readings up 60%/30 kW. Voltage fluctuations in the various test periods are shown in Figure 10 below. The measurements are based on hourly values from AMS measured at the far end of the circuit, and from reference measurements along the circuit in multiple tests.

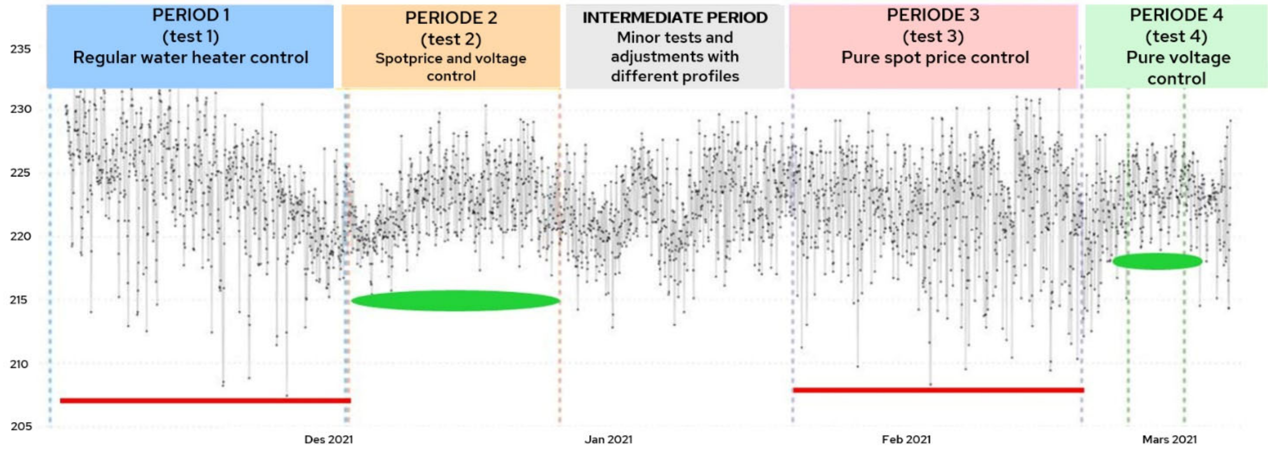


Figure 10 – Fluctuation in voltage values in the various test periods

The tests carried out as part of BattFLEX show some clear trends:

- Due to the high degree of storage between water heaters, conventional thermostat control negatively impacts the voltage level, all the way down to the Quality of Supply Regulation threshold of 207 V.
- Control based on price has the same negative impact on voltage levels as conventional thermostat control, but also creates value for customers in the form of reduced grid rental and electricity costs.
- Control based on voltage provides significant voltage support and improve the lowest voltage level, by 17–25% compared to thermostat and pure price control.
- Control based on price in combination with voltage has largely the same impact as control on voltage. As with pure price control, this form of control creates value for customers through reduced grid rental and electricity costs.

Issues relating to market-driven activation highlighted in the LEAFS project have been confirmed by the results of the tests carried out in the BattFLEX project. Figure 11 below illustrates the rebound effect, as well as the instantaneous load increase generated by test heaters connected following a power outage. The load step is approximately 100% in relation to the average load during normal operation. If a fleet of devices is controlled purely based on price signals, a corresponding negative impact could occur. Smart electric car chargers are now being rapidly rolled out. Managing such fleets based purely on price signals could significantly exacerbate voltage problems in vulnerable low-voltage grids.

Figures 12 and 13 on the following page show fluctuations in the voltage level at customers and in the overlying substation during the same power outage.

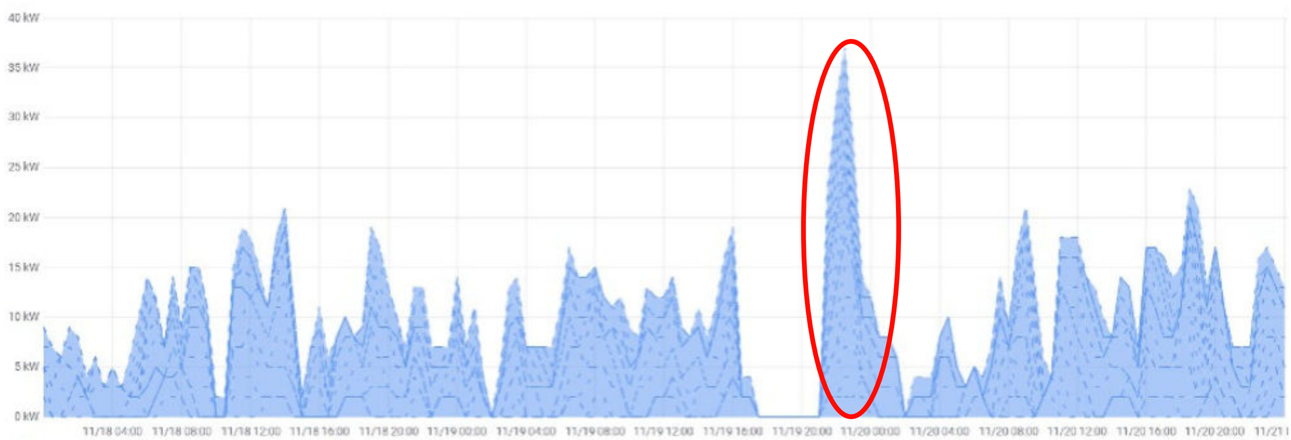


Figure 11 – example of instantaneous load increase when multiple water heaters are reconnected

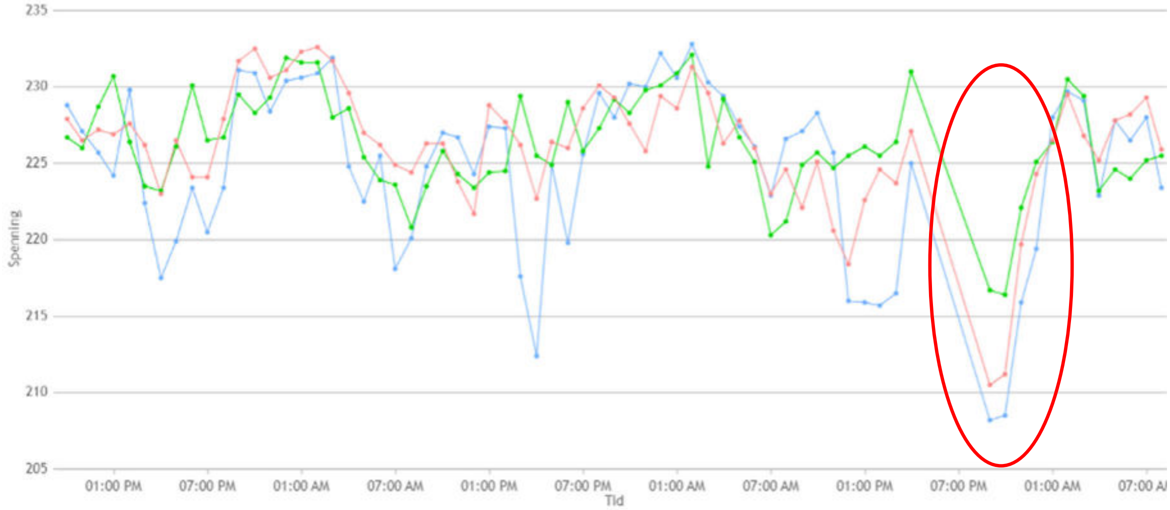


Figure 12 – Voltage data from customers during the power outage

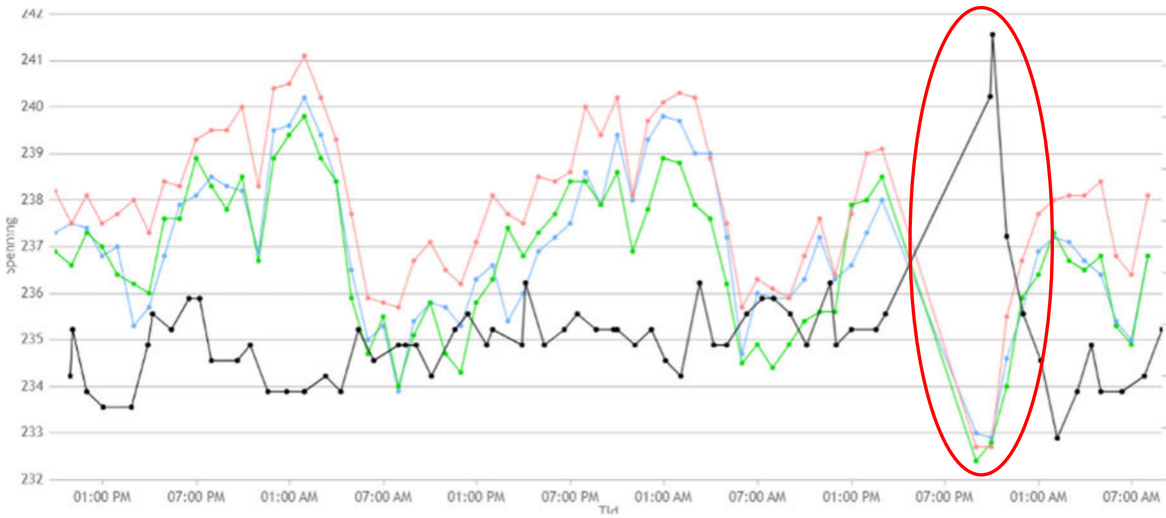


Figure 13 – Voltage data from the substation during the power outage

7.6 Utility values – preliminary analyses and assessments

Section 7.5, Results, shows results from test activities carried out over a period of four months. A series of tests was carried out to identify physical impacts and impacts from the use of smart water heaters from OSO in order to reduce/manage power draw in the low-voltage grid.

As shown in Table 1 in section 7.5, one expected and important utility value for the DSO is achieved through a significantly improved voltage level in vulnerable low-voltage circuits. The intended large-scale roll-out of the solution will trigger other utility values in the form of:

- increased customer satisfaction and reduced operating costs through digital collaboration with customers
- reduced capital costs, from reduced and/or postponed grid investments
- reduced grid rental (power component) from the central grid, from reduced power peaks
- reduced loss costs, particularly in the low-voltage grid, from reduced load levels

As mentioned in section 5.2, no further analyses of these utility values have been carried out. However, such analyses will be conducted in collaboration with the other DSOs as part of the IDE project. Preliminary analyses and assessments from the KAFFI project estimate that Elvia could save NOK 1,127 million over a ten-year period. However, this estimate is subject to significant uncertainty.

Expected economic utility values for customers include reduced electricity costs and reduced grid rental charges. Experiences from the project to date also indicate some utility value in the form of an overview of the use of hot water, as well as opportunities for digital collaboration with the DSO.

The economic utility values for the customers derive from:

- reduced electricity costs, which could vary considerately in line with the spot price level, price fluctuations over the day and consumption levels and opportunities to move water-heater-based heating from hours with a high spot price to hours with a low spot price.
- reduced grid rental costs, which will vary with the price for the level for power draw, and to some extent with the energy component between day and night/weekends.

OSO Energy has analysed fluctuations in spot prices on Nord Pool in zone NO1 in 2022. The results of the analysis are presented in Table 2.

Table 2 – Fluctuation in spot prices in Nord Pool zone NO1 2022, excluding taxes

Spot price 2022 – NOK	High	Low	Average
Lowest price: 24 hours	5.59	0.00	1.61
Highest price: 24 hours	7.82	0.63	2.4
Average price: 24 hours	6.5	0.23	2.0
High vs low price: 24 hours	4.55	0.04	0.82
Average spot price throughout 2022			**2.00**
Average variation between 3 highest and 3 lowest hours in a 24-hour period			0.65

Based on the figures in Table 2, savings will be realised through lower electricity costs, using readings from household customers who have participated in BattFLEX, as shown in Table 3. The savings are split between large, average-sized and small families, based on typical energy use for heating hot water. Note that the savings depend largely on the volatility of power prices throughout the day.

Table 3 – Reduced electricity costs for household customers, including taxes

	Large family	Average-size family	Small family
Typical consumption per day – kWh	17.50	14.00	10.50
Annual savings – NOK	2,600	2,100	1,500

Another way to highlight savings resulting from reduced electricity costs for private customers is to consider the number of private customers, their energy use, typical consumption for heating hot water and the average spot price in 2022. Table 4 shows an overview of average energy savings for Elvia's private customers (figures from NVE eRAPP 2019), split between main residences and holiday homes.

Table 4 – Overview of private customers, energy use and average savings

Customer group	Number	Total energy use kWh	Average energy use kWh	Heater consumption kWh	Savings NOK/year
Households	793,392	11,498,027	14,492	2,898	**2,318**
Cabins and holiday homes	38,608	276,118	7,151	1,072	**852**

*) Enova key figures. 20% of energy use for heating homes, adjusted to 15% for holiday homes

Savings through reduced grid rental costs vary in line with the structure of the new grid rental model. Since 1 July 2022, Elvia's grid rental model has had the following components:

- An energy component that varies between day and night/weekend, from 43.10 to 36.85 øre/kWh, a price variation of 6.25 øre/kWh.
- A fixed component for the highest power draw per month. At Level 1 (0–2 kW), the monthly price is NOK 125/kW; the price rises by NOK 125/kW for the next levels: T2 2–5 kW; T3 5–10 kW; T4 10–15 kW and T5 15–20 kW. This shows that the actual savings achieved through a reduced power component will depend on the actual relationship between deliberate or accidental reduction in power consumption between the various power levels. Assuming a 50% probability of being able to reduce the power draw by one level, these savings would total NOK 67.5 per month.

Based on the analyses and assumptions outlined above, Table 5 shows the aggregate savings Elvia's customers could achieve by using smart water heaters, split between households (main residences) and holiday homes.

Table 5 – Total savings for private customers – households and holiday homes, including taxes

Savings	Power NOK	Grid capacity NOK	Grid energy NOK	Total savings NOK/year
Households	2,405	810	181	**3,399**
Cabins and holiday homes	890	810	67	**1,767**

8 Key experiences and findings

BattFLEX was started in autumn 2019, as one of four work packages in the large-scale project IDE. The project has a wide remit and a long time horizon and has proved very instructive for Elvia. Project development work has mainly focused on supplier collaboration, further development of OSO Charge, digital collaboration and agreement management with customers, as well as collaboration processes for ordering, installation and servicing of OSO Charge. In this section, we highlight key experiences and findings, which we hope will add value in new projects.

8.1 Project development and execution

- In developing the project, Elvia drew on experiences and results from other projects, including the LEAFS project carried out in Austria and Ringerikskraft Nett's EffektPILOT project.
- This provided a platform for driving serial innovation in all stages of project development, including during the procurement process and in the selection of suppliers.
- The goal of supplier-driven development secured the project access to critical expertise and capacity that Elvia does not possess in-house. It also gave the suppliers access to unique expertise and grid data as well as consumption profiles and relevant Elvia customer data. This in turn provided a basis for further development and testing of the solutions in real-life operation.
- The results from the LEAFS project in Austria allowed us to focus from the outset on the fact that the activation of consumer flexibility had to be "grid friendly" and not just based on price signals. This facilitated the development of control algorithms in OSO Charge that optimise the activation of smart water heaters, both based on price and on dynamic voltage parameters.

Together, these factors have helped BattFLEX develop – in a period of just two years – advanced control algorithms for smart water heaters as part of OSO Charge, as well as digital collaboration processes for customer dialogue and management of bilateral agreements, and a collaboration process and business model for installation and service for collaboration between Elvia, pilot customers, OSO Energy and installers.

8.2 Digital collaboration

Innovation in business models and collaboration processes is necessary to be able to realise the cost-effective roll-out of solutions for activating large-scale consumer flexibility. With approximately 2.8 million private grid customers in Norway, collaboration processes across DSOs, product suppliers, installers and customers must be fully digitalised.

The procurement strategy secured the project a supplier collaboration where both the product strategy and business model supported our project goals. The collaboration has resulted in a digital collaboration process and a business model that encompasses Elvia as DSO, OSO Energy as producer and service provider, an installer network and active collaboration with customers.

The collaboration process is customer centric. Each individual customer can select and determine the level of service based on their own needs. In addition, the agreement structure between the stakeholders makes the allocation of responsibilities and incentive structure transparent. For example, OSO Energy is responsible for products and safety in OSO Charge, while installers are responsible for installation and servicing. This means that all suppliers in the supply chain have an incentive structure that helps ensure the quality level of the total deliverable to the end customers.

Another important point is that the business and collaboration model create value for all stakeholders, including the customers, through reduced costs and increased comfort. This provides a good basis for further development of business models and collaboration processes that are robust and scalable and that can generate value at multiple levels in the energy system.

8.3 Utility values and scaling potential

In 2021, on commission from the Norwegian Water Resources and Energy Directorate (NVE), THEMA Consulting prepared the report "Value of flexibility from electrical storage water heaters". One main conclusion of the report is:

"The value of flexible resources in the electricity system is set to increase with the transition to a future low-carbon and renewable electricity system. Flexibility in many forms and locations will be needed in the balancing of the market itself, but also in grid management and to defer massive grid investments, and locally, behind the fuse and in local smart grids. Electrical water heaters (ESWH) represent a distributed and highly flexible resource that is already utilized in several systems. The future value of the flexibility of ESWHs depends on the availability and costs of other solutions as well. However, while new solutions and new technologies are developed, ESWHs represent an existing and proven flexibility resource."

Water heaters represent a unique, controllable energy storage option for customers. The heaters used in the project had a rated power of 2 and 3 kW and a storage capacity of 14 and 21 kWh, respectively. The primary function of a water heater is to supply hot water that meets customers' expectations in terms of quality and comfort.

Around 2.7 million water heaters are currently installed in main residences and holiday homes in Norway. If we introduce the term "installed consumer flexibility", and conservatively assume an average output of 2 kW, this represents a potential of more than 5,000 MW. Based on the test results outlined in section 7.5, indicating an aggregate load of 50% during peak hours, this represents 2,500 MW in "available consumer flexibility".

Areas of note here include the significant overlapping interests and synergies to be leveraged by activating flexibility from smart water heaters across DSOs, customers and suppliers. Through innovation in digital collaboration and new business models, BattFLEX has highlighted that utility values can be created for:

- Customers, directly through reduced costs and increased comfort, and indirectly through better quality of supply.
- The DSOs through improved voltage quality, reduced capital costs, active collaboration with customers and increased customer satisfaction.
- Product and service suppliers through increased market potential for new products and services.
- Society, at all levels in the energy system, through increased energy security, power security and operational security; see illustration in Figure 14.

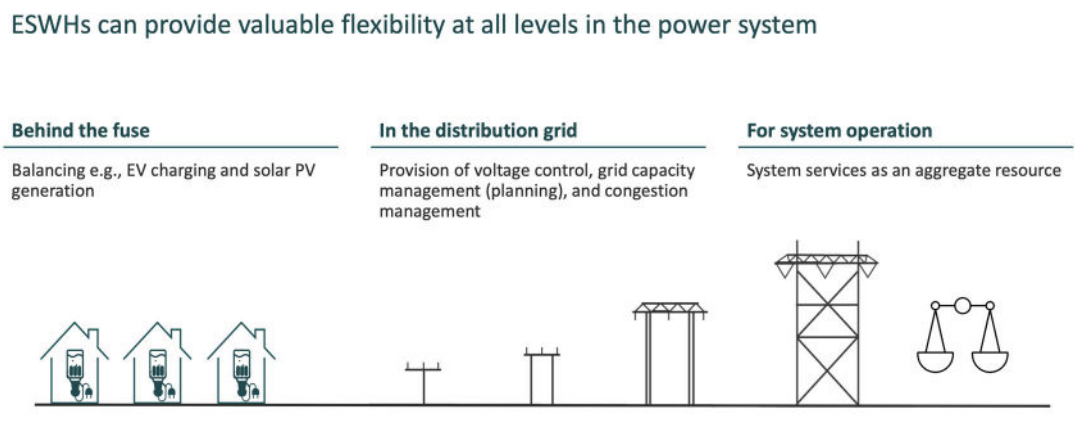


Figure 14 – Source: THEMA Consulting – "Value of flexibility from electrical storage water heaters"

8.4 Sustainability

The project has demonstrated that grid batteries and water heaters can be deployed to utilise existing low-voltage grids more efficiently. This reduces the need for traditional investments in the grid. Such investments could to some degree impede the transition to a more sustainable society.

The load equalisation that the solutions can contribute will also support other parts of the power system, for example by providing frequency support or control based on the power price. This in turn improves resource utilisation.

One thing the solutions have in common is that they improve resource utilisation and promote sustainability and socio-economic and corporate profitability. Specific issues relating to the solutions are discussed below.

8.4.1 Sustainability and grid batteries

Large-scale use of batteries has been somewhat limited by the availability of rare elements used in the batteries. Extracting these metals can also be resource intensive. This has led to the development of alternatives that do not use such metals. The Pixii PowerShaper is designed to exploit different battery chemistries. Pixii has also delivered solutions that utilise used batteries from Nissan Leaf cars as an energy store. There are therefore not considered to be any particular sustainability challenges around using grid batteries on a larger scale.

8.4.2 Sustainability and smart water heaters

Smart water heaters are expected to be gradually installed through a process of natural replacement. This assumes that customers thinking of installing a new water heater will opt for a smart water heater. However, it is also possible to retrofit control technology. The OSO Charge control unit is backwards compatible with OSO heaters from 2017 and later. The project has also tested sensors/technology that are backwards compatible with pre-2017 heaters. However, this technology has not yet been commercialised.

With retrofitting, the solution will be almost as good as a new heater. This has also been tested with some customers in the pilot. Retrofitting the units to existing water heaters or installing smart water heaters to replace old devices is a very cost- and resourceefficient way of rolling out smart water heaters. It is also key to the socio-economic profitability of the solution.

In times of low energy prices, as was the case before 2021, it will not usually be cost-effective to replace a heater. However, in times of high and volatile prices, as we have seen since 2021, it can be worth replacing a water heater. Similarly, special grid-related needs can also justify such a replacement in limited cases. In such situations, the installer will normally take the old water heater away with them. Well-maintained used water heaters are reused on construction sites and similar places with temporary needs. Other heaters are delivered for materials recycling and energy recovery. There are therefore not considered to be any particular sustainability challenges around using smart water heaters on a larger scale.

8.5 Growing challenges relating to voltage quality

The test results presented in section 7.5 Results of the test activities confirm that market price control increases instantaneous load variations, which in turn reduce voltage quality in weak low-voltage grids. These negative impacts will increase as more devices are introduced and will be amplified in existing vulnerable grid areas and propagate outwards to new grid areas.

Higher instantaneous load variations will also aggregate to regional grids and exacerbate existing bottleneck problems and challenges relating to the power balance at system operation level.

Systematisation of AMS data on voltage level and voltage fluctuations at end customers show that Quality of Supply Regulations non-conformances could be significantly higher than the DSOs have so far assumed. The introduction of distributed resources at customers will rise markedly in the years ahead. The test results from BattFLEX and the analyses from LEAFS clearly indicate that this could significantly exacerbate problems relating to voltage levels and voltage quality in the low-voltage grid. This makes it important that measures, both technological and regulatory, are quickly established and implemented to prevent such a development.

8.6 Barriers

- Assessments and visualisation of the value potential offered by digital collaboration with end customers, both through direct costs (OPEX) and indirectly through, for example, increased customer satisfaction and activation of fast frequency reserves (FFR). BattFLEX has demonstrated that all customer processes can be digitalised, relatively quickly and easily.
- Regulation from the Norwegian Energy Regulatory Authority (RME) and incentives from Enova. The regulatory regime and support schemes are constantly changing. Dialogue with RME and Enova on results from projects such as BattFLEX and LEAFS will help remove any barriers and ensure the necessary regulation. The project recommends avoiding large-scale installation of solutions at customers that cannot be activated/controlled based on voltage parameters and that do not have the necessary autonomy to avoid exacerbating problems relating to voltage quality and voltage level in the low-voltage grid. This can be achieved in several ways, including through technical or regulatory requirements, supplier dialogue or financial incentives.
- Knowledge of the development of new business models and collaboration processes, and in particular the fact that values are created through collaboration. The models must be robust, scalable and create value for all parties, including customers. BattFLEX has highlighted increased voltage quality for the DSO, higher profitability for suppliers and reduced costs for customers as "three different values" that are created through a single collaboration process. And that is just one process.
- Knowledge and a comprehensive understanding of installed vs available capacity in dispatchable vs non-dispatchable renewable sources. Knowledge of challenges and the need for increased flexible power and access to FFR, and the potential that smart water heaters and smart home chargers present in this context.

8.7 Further plans

The experiences and results from BattFLEX have provided a basis for new activities and projects. Upcoming projects include:

1. Pilot project for smart home chargers for electric cars, using technology and experience transfer from the development of smart water heaters.
2. Pilot project to improve system integration to ensure faster exchange and better utilisation of data between the AMS system and the OSO Charge platform.
3. Pilot project on collaboration with an energy service provider to further develop the collaboration process and business model used in BattFLEX, for further product development, digitalisation of the customer process and to ensure a robust and scalable business and delivery model.
4. Further development of system support and digital work flows for collaboration processes, scaled-up roll-out of smart water heaters and home chargers. Documentation of and document flow for operation and maintenance of installed devices at customers is one important focus area.

9 Appendices

9.1 General project information

Project name:	BattFLEX – Demonstration of solutions for leveraging consumer flexibility to reduce/postpone investments in the grid.
Brief description of the project:	Large-scale demonstration of multifunctional battery storage system, smart water heaters and innovative bilateral agreements, as alternative solutions for handling voltage problems in the low-voltage grid
Project owner:	Elvia AS
Project participants:	See section 6.2 Project organisation Partners: OSO Energy AS, Pixii AS
Project owner/contact information:	Anne Sagstuen Nysæter Email: anne.nysaether@elvia.no Mobile: +47 991 68 660
Project manager/contact information:	Alf Inge Tunheim Email: alf.tunheim@elvia.no Mobile: +47 959 81 280
Project duration:	Start-up: September 2019 Planned completion: September 2024
Total budget:	The IDE project, in which BattFLEX is one of four large work packages, has a budget of NOK 62.675 million, of which Elvia has committed to contribute NOK 1.2 million in cash and NOK 12.8 million in contributions-in-kind. The project period is 2019–2024.
Funding from public funding bodies:	ENOVA's programme for large-scale demonstration of new technology

9.2 Documentation from the customer process

Project information letter sent to customers

All customers have been sent a letter by post and email containing information about the pilot and the collaborative project between Elvia and OSO.

Elvia and OSO are two solid brands that have long enjoyed a high profile with customers. Although this was a research project, it was still important for customers to experience professionalism and good customer service throughout the pilot period.

Elvia

OSO ENERGY

<FORNAVN><ETTERNAVN>
<ADRESSE>
<POSTNUMMER>

Foretaksregister
Dokumentdato 04.08.2021
Vår referanse
Saksbehandler

Bli med å gjøre nettleien billigere!

Elvia inviterer deg til å være med i et pilotprosjekt som skal teste om varmtvannsberedere med styring kan bidra til at vi utnytter og drifter strømnettet vårt på en mer miljøvennlig og økonomisk måte.

Prosjektet du er invitert til å være deltager i foregår i ditt hyttenabolag på Sjusjøen, og det er 120 hytter på en felles trafokrets som er invitert. Prosjektet er planlagt å vare ut 2023.

Hva betyr deltagelsen for deg?

- Vi installerer en ny varmtvannsbereder i din hytte , med en integrert styringsenhet fra OSO. Berederen installeres helt uten kostnad for deg.
- Du bruker strøm og vann akkurat som du pleier – med samme sikkerhet og komfort som tidligere. Den nye berederen vil styre oppvarmingen til tidspunkter som er hensiktsmessige for deg og strømnettet, og vil bidra til at du sparer noen kroner.
- Deltagelsen i pilotprosjektet innebærer bruk av ny teknologi under utvikling. Gjennom tett oppfølging og dialog med dere vil vi være PÅ for å utbedre eventuelle avvik raskt.
- Som kompensasjon slipper du å betale for fastleddet på nettleien gjennom prosjektets varighet.
- Du kan når som helst trekke deg ut av piloten. Uansett resultat av prosjektet vil du beholde varmtvanns-berederen.

Høres dette spennende ut?

På **elvia.no/fleksibilitet** kan du lese mer om piloten og hva dette handler om.
Litt ned på siden finner du et avsnitt som heter; **Takker du ja til å delta?**
Ved å fylle ut skjema under dette avsnittet takker du ja til deltakelse og godtar avtalevilkårene for i piloten.
Du vil bli fulgt opp av oss og du kan når som helst angre deg.

Har du spørsmål om piloten og deltakelse, så ta kontakt med oss på:
Epost: booking@elvia.no
Telefon: 61 28 66 46

Med vennlig hilsen
Elvia AS

Bjørn Viljugrein

Bjørn Viljugrein
Kundeansvar

Elvia AS	**Besøksadresse**	**Kontakt**	**Internett**
Postboks 4100	Vangsvegen 73	+47 02024	elvia.no
2307 Hamar	2317 Hamar	firmapost@elvia.no	

Elvia

Elvia samarbeid med OSO - test av varmtvannsberedere for å øke fleksibiliteten i strømnettet.

Styring av varmtvannsberedere gir besparelser for dere og miljøet

Elvia og OSO inviterer dere til å være med i et pilotprosjekt som skal teste ut om varmtvannsberedere med styring kan bidra til at vi utnytter og drifter strømnettet vårt på en mer miljøvennlig og økonomisk måte.
Oppvarming av varmtvann står for en betydelig andel av strømregningen. Med ny teknologi ønsker man å se på muligheten for å varme opp vannet på tider av døgnet som er gunstig for dere og for strømnettet. Prosjektet dere er invitert til å være deltager i foregår i deres borettslag, og er planlagt å vare ut 2024.

Hva betyr deltagelsen for dere?

- Vi installerer nytt målersystem på varmtvannsberederanlegget i deres borettslag.
- I fase 2 av prosjektet vil det installeres styringsfunksjonalitet.
- Det nye systemet vil styre oppvarmingen til tidspunkter som er hensiktsmessig for dere og strømnettet, og vil bidra til at dere sparer noen kroner.
- Dere bruker strøm og vann akkurat som dere pleier - med samme sikkerhet og komfort som tidligere.
- Alt utstyr som installeres vil være uten kostnad for dere.
- Deltagelsen i pilotprosjektet innebærer bruk av ny teknologi under utvikling. Gjennom tett oppfølging og dialog med dere vil vi være PÅ for å utbedre eventuelle avvik raskt.
- Dere kan når som helst trekke dere ut av piloten.

Høres dette spennende ut?

Et par dager etter at dere har mottatt dette nyhetsbrevet, vil vi ta kontakt per telefon for å gi dere ytterligere informasjon om prosjektet, svare på spørsmål og eventuelt avtale et møte for befaring og undertegne avtale om deltakelse.
Vi håper at dere, i likhet med oss, ønsker å påvirke utviklingen av fremtidens kraftsystem.

Har dere spørsmål om piloten og deltakelse, så ta gjerne kontakt med oss:

Figure 15 – Project information letter

Web portal containing customer information

We established a dedicated website at an early stage where the pilot customers could learn about the purpose of the pilot and find important information about the water heater that would be installed. We have also set up a direct telephone number that customers can use to promptly resolve any challenges they may encounter.

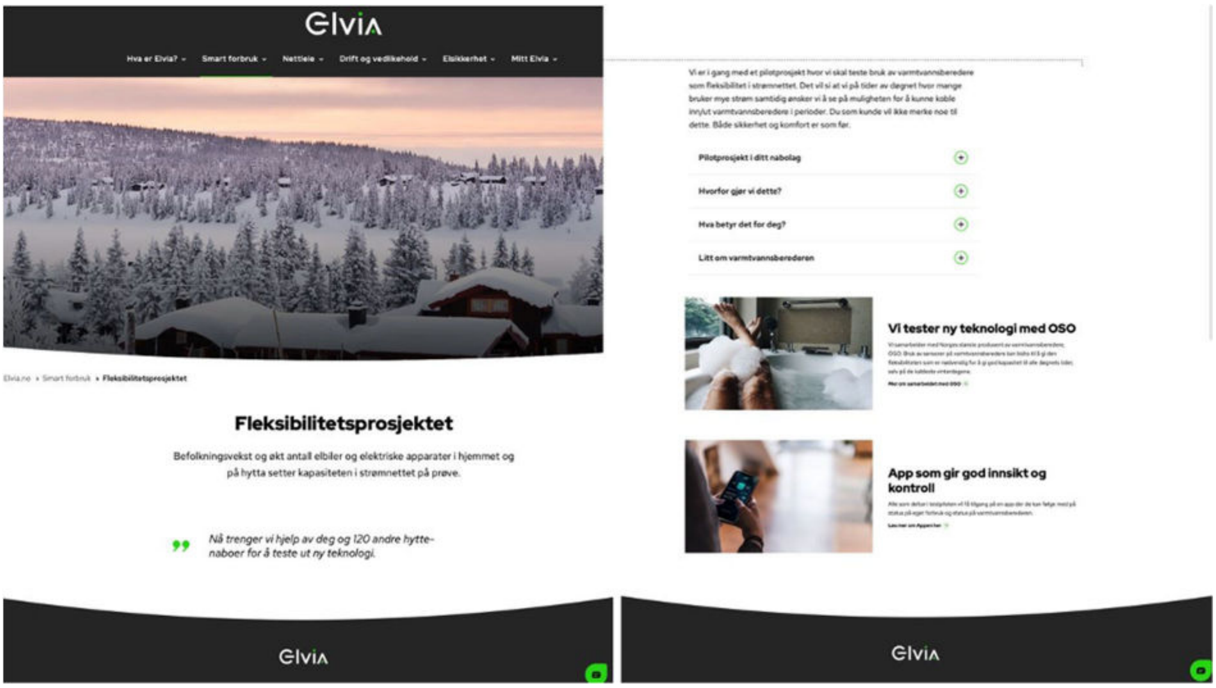


Figure 16 – Website containing project information for pilot customers

Digital inspection solution

In order to obtain the necessary information about customers' water heaters, we have set up a digital inspection solution via Elvia.no. Here customers enter the information themselves, and upload photos of their current model.

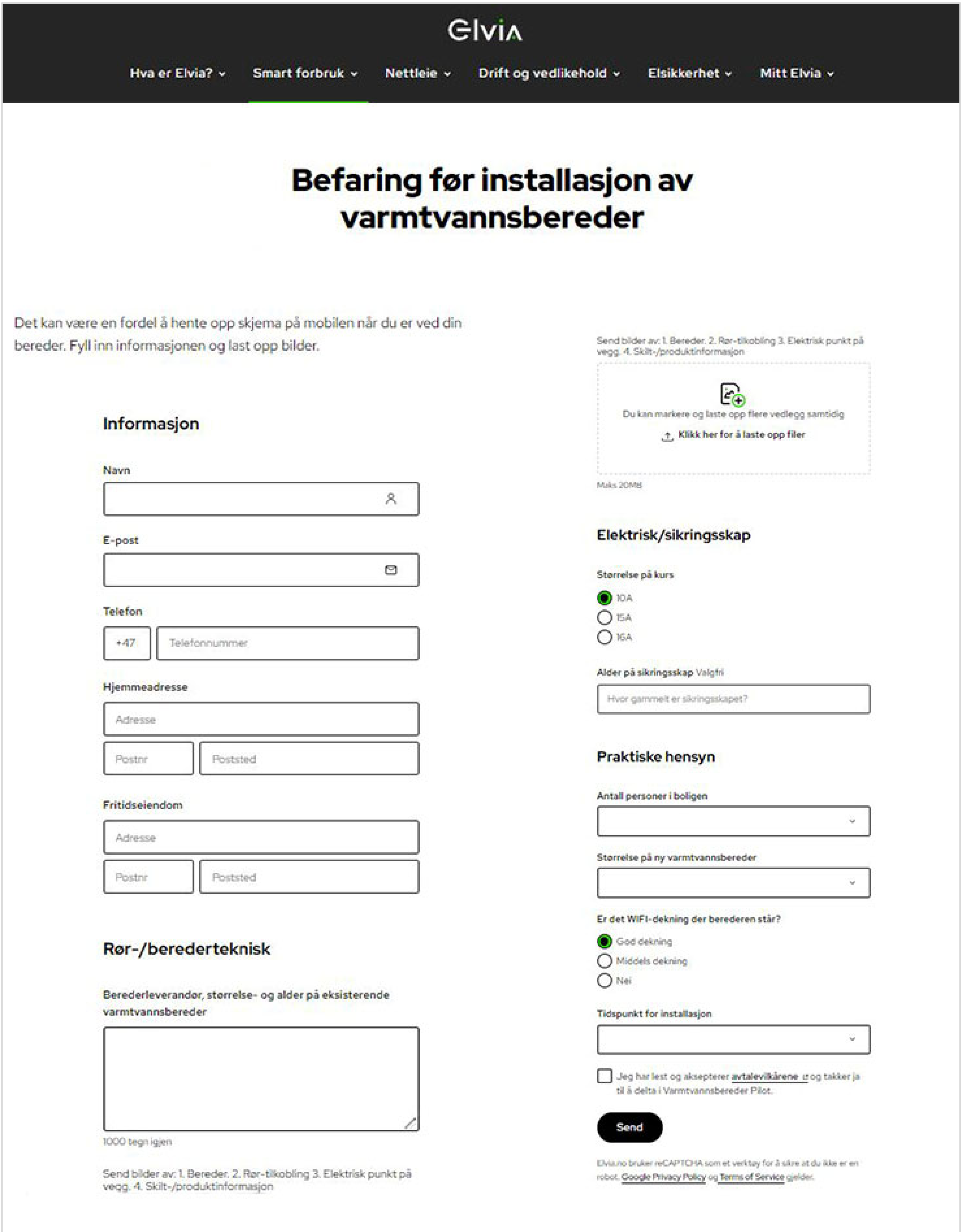
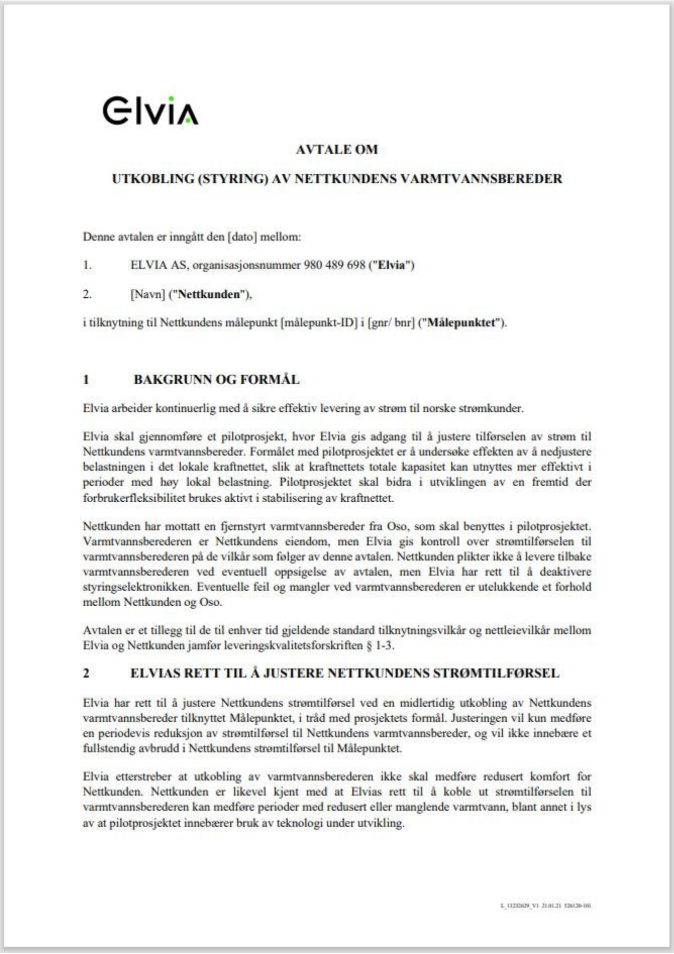


Figure 17 – Digital inspection solution

Terms and conditions of agreement

When filling in the inspection form, customers must also tick a check box at the bottom of the form (Figure 17) to confirm that they have read and accepted the terms of delivery (Figure 18)



Elvia

AVTALE OM

UTKOBLING (STYRING) AV NETTKUNDENS VARMTVANNSBEREDER

Denne avtalen er inngått den [dato] mellom:

1. ELVIA AS, organisasjonsnummer 980 489 698 ("**Elvia**")
2. [Navn] ("**Nettkunden**"),

i tilknytning til Nettkundens målepunkt [målepunkt-ID] i [gnr/ bnr] ("**Målepunktet**").

1 BAKGRUNN OG FORMÅL

Elvia arbeider kontinuerlig med å sikre effektiv levering av strøm til norske strømkunder.

Elvia skal gjennomføre et pilotprosjekt, hvor Elvia gis adgang til å justere tilførselen av strøm til Nettkundens varmtvannsbereder. Formålet med pilotprosjektet er å undersøke effekten av å nedjustere belastningen i det lokale kraftnettet, slik at kraftnettets totale kapasitet kan utnyttes mer effektivt i perioder med høy lokal belastning. Pilotprosjektet skal bidra i utviklingen av en fremtid der forbrukerfleksibilitet brukes aktivt i stabilisering av kraftnettet.

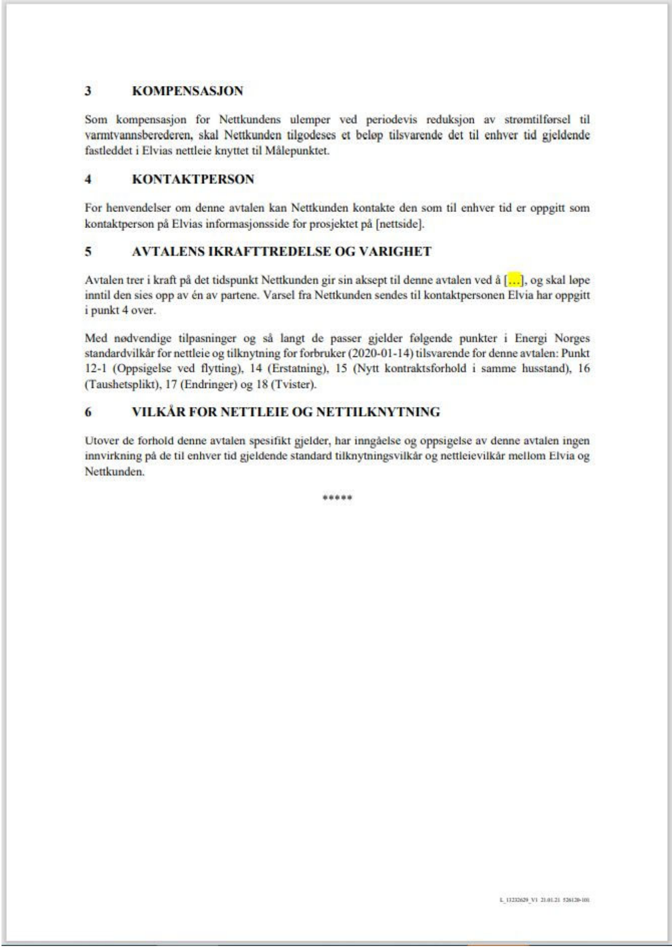
Nettkunden har mottatt en fjernstyrt varmtvannsbereder fra Oso, som skal benyttes i pilotprosjektet. Varmtvannsberederen er Nettkundens eiendom, men Elvia gis kontroll over strømtilførselen til varmtvannsberederen på de vilkår som følger av denne avtalen. Nettkunden plikter ikke å levere tilbake varmtvannsberederen ved eventuell oppsigelse av avtalen, men Elvia har rett til å deaktivere styringselektronikken. Eventuelle feil og mangler ved varmtvannsberederen er utelukkende et forhold mellom Nettkunden og Oso.

Avtalen er et tillegg til de til enhver tid gjeldende standard tilknytningsvilkår og nettleievilkår mellom Elvia og Nettkunden jamfør leveringskvalitetsforskriften § 1-3.

2 ELVIAS RETT TIL Å JUSTERE NETTKUNDENS STRØMTILFØRSEL

Elvia har rett til å justere Nettkundens strømtilførsel ved en midlertidig utkobling av Nettkundens varmtvannsbereder tilknyttet Målepunktet, i tråd med prosjektets formål. Justeringen vil kun medføre en periodevis reduksjon av strømtilførsel til Nettkundens varmtvannsbereder, og vil ikke innebære et fullstendig avbrudd i Nettkundens strømtilførsel til Målepunktet.

Elvia etterstreber at utkobling av varmtvannsberederen ikke skal medføre redusert komfort for Nettkunden. Nettkunden er likevel kjent med at Elvias rett til å koble ut strømtilførselen til varmtvannsberederen kan medføre perioder med redusert eller manglende varmtvann, blant annet i lys av at pilotprosjektet innebærer bruk av teknologi under utvikling.



3 KOMPENSASJON

Som kompensasjon for Nettkundens ulemper ved periodevis reduksjon av strømtilførsel til varmtvannsberederen, skal Nettkunden tilgodeses et beløp tilsvarende det til enhver tid gjeldende fastleddet i Elvias nettleie knyttet til Målepunktet.

4 KONTAKTPERSON

For henvendelser om denne avtalen kan Nettkunden kontakte den som til enhver tid er oppgitt som kontaktperson på Elvias informasjonsside for prosjektet på [nettside].

5 AVTALENS IKRAFTTREDELSE OG VARIGHET

Avtalen trer i kraft på det tidspunkt Nettkunden gir sin aksept til denne avtalen ved å […], og skal løpe inntil den sies opp av én av partene. Varsel fra Nettkunden sendes til kontaktpersonen Elvia har oppgitt i punkt 4 over.

Med nødvendige tilpasninger og så langt de passer gjelder følgende punkter i Energi Norges standardvilkår for nettleie og tilknytning for forbruker (2020-01-14) tilsvarende for denne avtalen: Punkt 12-1 (Oppsigelse ved flytting), 14 (Erstatning), 15 (Nytt kontraktsforhold i samme husstand), 16 (Taushetsplikt), 17 (Endringer) og 18 (Tvister).

6 VILKÅR FOR NETTLEIE OG NETTILKNYTNING

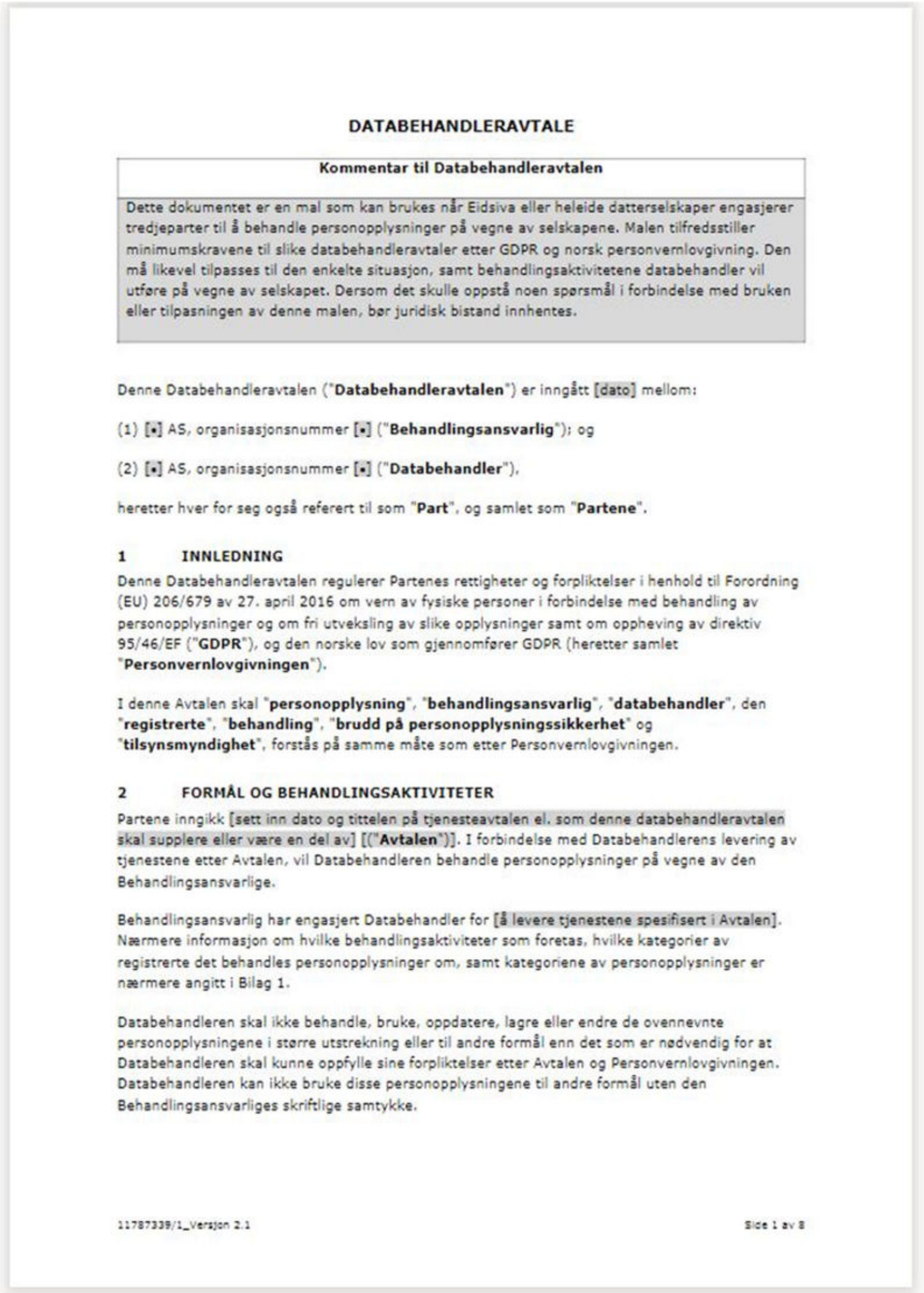
Utover de forhold denne avtalen spesifikt gjelder, har inngåelse og oppsigelse av denne avtalen ingen innvirkning på de til enhver tid gjeldende standard tilknytningsvilkår og nettleievilkår mellom Elvia og Nettkunden.

*****

Figure 18 – Terms and conditions of agreement

Information security and personal data

The supplier and various levels of subcontractors agreed to sign a data processor agreement with Elvia on start-up. OSO and Elvia signed two separate agreements on mutual data sharing. See template for data processor agreement in the figure below.



DATABEHANDLERAVTALE

Kommentar til Databehandleravtalen
Dette dokumentet er en mal som kan brukes når Eidsiva eller heleide datterselskaper engasjerer tredjeparter til å behandle personopplysninger på vegne av selskapene. Malen tilfredsstiller minimumskravene til slike databehandleravtaler etter GDPR og norsk personvernlovgivning. Den må likevel tilpasses til den enkelte situasjon, samt behandlingsaktivitetene databehandler vil utføre på vegne av selskapet. Dersom det skulle oppstå noen spørsmål i forbindelse med bruken eller tilpasningen av denne malen, bør juridisk bistand innhentes.

Denne Databehandleravtalen ("**Databehandleravtalen**") er inngått [dato] mellom:

(1) [•] AS, organisasjonsnummer [•] ("**Behandlingsansvarlig**"); og

(2) [•] AS, organisasjonsnummer [•] ("**Databehandler**"),

heretter hver for seg også referert til som "**Part**", og samlet som "**Partene**".

1 INNLEDNING

Denne Databehandleravtalen regulerer Partenes rettigheter og forpliktelser i henhold til Forordning (EU) 206/679 av 27. april 2016 om vern av fysiske personer i forbindelse med behandling av personopplysninger og om fri utveksling av slike opplysninger samt om oppheving av direktiv 95/46/EF ("**GDPR**"), og den norske lov som gjennomfører GDPR (heretter samlet "**Personvernlovgivningen**").

I denne Avtalen skal "**personopplysning**", "**behandlingsansvarlig**", "**databehandler**", den "**registrerte**", "**behandling**", "**brudd på personopplysningssikkerhet**" og "**tilsynsmyndighet**", forstås på samme måte som etter Personvernlovgivningen.

2 FORMÅL OG BEHANDLINGSAKTIVITETER

Partene inngikk [sett inn dato og tittelen på tjenesteavtalen el. som denne databehandleravtalen skal supplere eller være en del av] [("**Avtalen**")]. I forbindelse med Databehandlerens levering av tjenestene etter Avtalen, vil Databehandleren behandle personopplysninger på vegne av den Behandlingsansvarlige.

Behandlingsansvarlig har engasjert Databehandler for [å levere tjenestene spesifisert i Avtalen]. Nærmere informasjon om hvilke behandlingsaktiviteter som foretas, hvilke kategorier av registrerte det behandles personopplysninger om, samt kategoriene av personopplysninger er nærmere angitt i Bilag 1.

Databehandleren skal ikke behandle, bruke, oppdatere, lagre eller endre de ovennevnte personopplysningene i større utstrekning eller til andre formål enn det som er nødvendig for at Databehandleren skal kunne oppfylle sine forpliktelser etter Avtalen og Personvernlovgivningen. Databehandleren kan ikke bruke disse personopplysningene til andre formål uten den Behandlingsansvarliges skriftlige samtykke.

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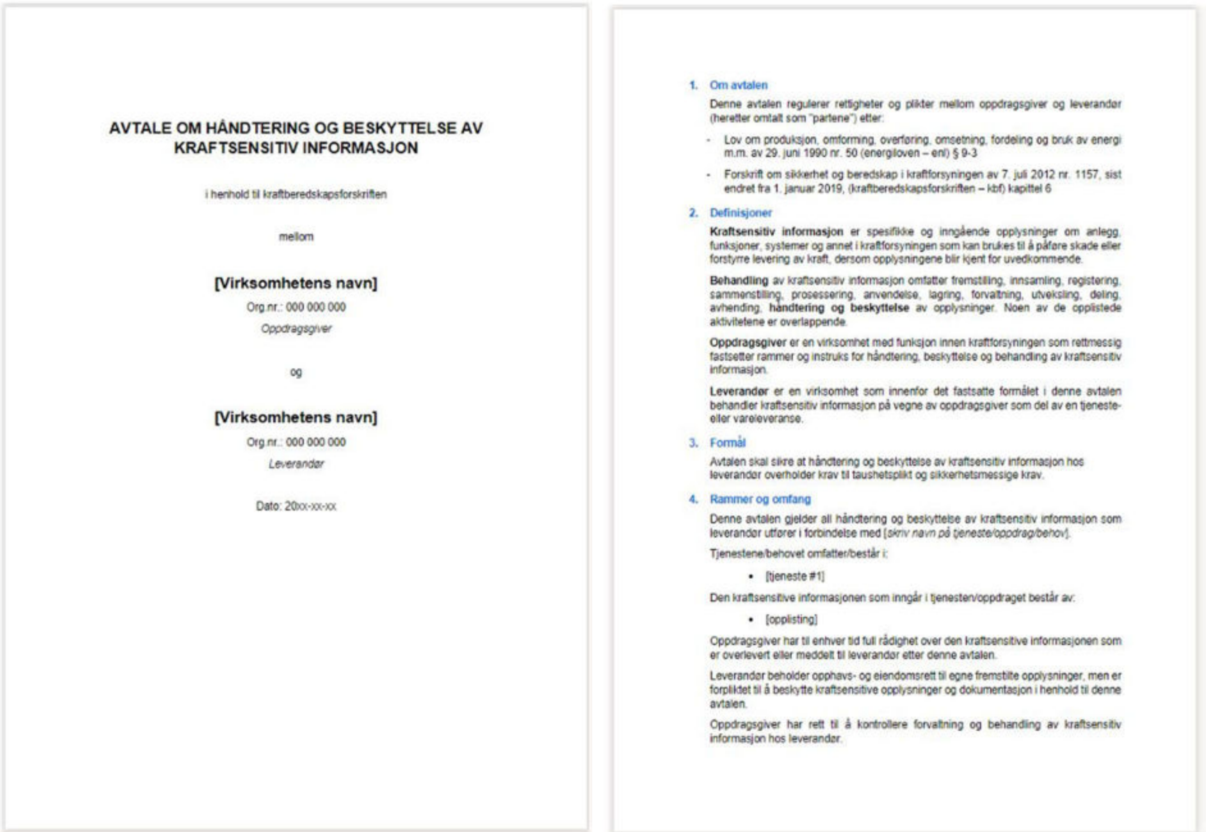
Figure 19 – Template for data processor agreement

Sensitive power system data

An agreement was signed regulating the processing of power-sensitive information. This gives the supplier access to information regulated in the requirements in Chapter 6 of the Norwegian Energy Act, Emergency Preparedness, and in the Regulation on security and emergency preparedness in the power supply system of 16 December 2002. The information to which access is granted may be sensitive information in accordance with Section 6-2 of the Power Contingency Regulation, Protection of Information, and is subject to a statutory duty of confidentiality and exempt from disclosure in accordance with Section 13 of the Norwegian Freedom of Information Act, Information subject to a duty of confidentiality, or Section 21, Exemptions out of regard for national defence and security interests, or Section 24 et al.



AVTALE OM HÅNDTERING OG BESKYTTELSE AV KRAFTSENSITIV INFORMASJON

i henhold til kraftberedskapsforskriften

mellom

[Virksomhetens navn]

Org.nr.: 000 000 000

Oppdragsgiver

og

[Virksomhetens navn]

Org.nr.: 000 000 000

Leverandør

Dato: 20xx-xx-xx

1. Om avtalen

Denne avtalen regulerer rettigheter og plikter mellom oppdragsgiver og leverandør (heretter omtalt som "partene") etter:

- Lov om produksjon, omforming, overføring, omsetning, fordeling og bruk av energi m.m. av 29. juni 1990 nr. 50 (energiloven – enl) § 9-3
- Forskrift om sikkerhet og beredskap i kraftforsyningen av 7. juli 2012 nr. 1157, sist endret fra 1. januar 2019, (kraftberedskapsforskriften – kbf) kapittel 6

2. Definisjoner

Kraftsensitiv informasjon er spesifikke og inngående opplysninger om anlegg, funksjoner, systemer og annet i kraftforsyningen som kan brukes til å påføre skade eller forstyrre levering av kraft, dersom opplysningene blir kjent for uvedkommende.

Behandling av kraftsensitiv informasjon omfatter fremstilling, innsamling, registering, sammenstilling, prosessering, anvendelse, lagring, forvaltning, utveksling, deling, avhending, **håndtering og beskyttelse** av opplysninger. Noen av de opplistede aktivitetene er overlappende.

Oppdragsgiver er en virksomhet med funksjon innen kraftforsyningen som rettmessig fastsetter rammer og instruks for håndtering, beskyttelse og behandling av kraftsensitiv informasjon.

Leverandør er en virksomhet som innenfor det fastsatte formålet i denne avtalen behandler kraftsensitiv informasjon på vegne av oppdragsgiver som del av en tjeneste- eller vareleveranse.

3. Formål

Avtalen skal sikre at håndtering og beskyttelse av kraftsensitiv informasjon hos leverandør overholder krav til taushetsplikt og sikkerhetsmessige krav.

4. Rammer og omfang

Denne avtalen gjelder all håndtering og beskyttelse av kraftsensitiv informasjon som leverandør utfører i forbindelse med [*skriv navn på tjeneste/oppdrag/behov*].

Tjenestene/behovet omfatter/består i:

- [tjeneste #1]

Den kraftsensitive informasjonen som inngår i tjenesten/oppdraget består av:

- [opplisting]

Oppdragsgiver har til enhver tid full rådighet over den kraftsensitive informasjonen som er overlevert eller meddelt til leverandør etter denne avtalen.

Leverandør beholder opphavs- og eiendomsrett til egne fremstilte opplysninger, men er forpliktet til å beskytte kraftsensitive opplysninger og dokumentasjon i henhold til denne avtalen.

Oppdragsgiver har rett til å kontrollere forvaltning og behandling av kraftsensitiv informasjon hos leverandør.

Figure 20 – Agreement on the processing of power-sensitive information

Customer insight through interviews of pilot customers

A study, in which summer students conducted interviews of the pilot customers, revealed that it would be useful to have one common platform to secure increased user-friendliness. Integrating the information from OSO's *inCharge* app with Elvia's "My Page" means that customers can now access information in one place. This will increase user-friendliness and simplify access for customers. The study further recommends integrating the option to send error messages to customers, for example to avoid errors in the operating device not being detected.

The study also recommends providing customers with more information on how they can save money using their new heater. This reflects customers' expressed desire to learn more about potential savings and when the heater was disconnected to help the grid.

The figure below shows an outline of a shared information platform on Elvia's "My Page",h including information that may be relevant.

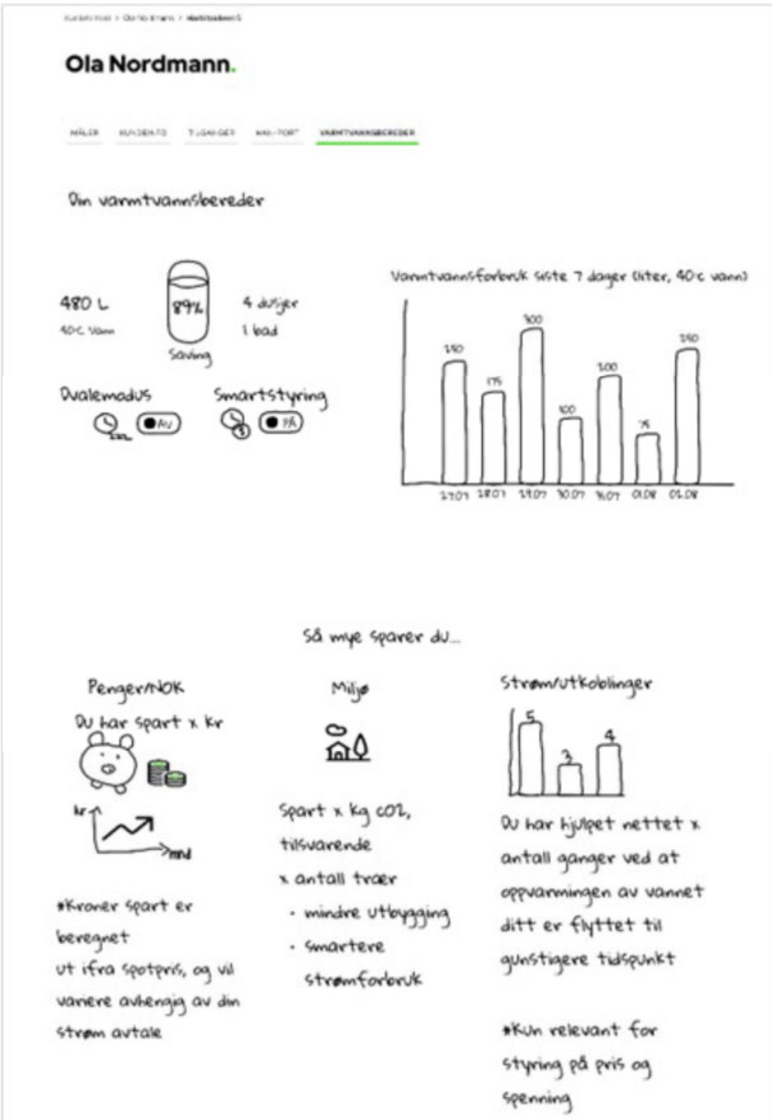


Figure 21 – Sketch of information platform

9.3 References

The list below contains references to relevant projects and documentation that have been used in the development of BattFLEX. The list also contains two internal project reports that can be requested from project manager Alf Inge Tunheim; see contact information in Appendix 9.1.

- LEAFS – *Integration of Loads and Electric Storage Systems into advanced Flexibility Schemes for LV Networks.* Austrian Research Promotion Agency, 2019. https://energieforschung.at/wp-content/uploads/sites/11/2020/12/leafs-eb-final.pdf

- UK Power Networks – Flexibility Roadmap, 2019. https://smartgrid.ukpowernetworks.co.uk/wp-content/uploads/2019/11/futuresmart-flexibility-roadmap.pdf

- Theme Consulting – *Value of flexibility from electrical storage water heaters*, 2021. https://thema.no/wp-content/uploads/TE-2020-17-Value-of-flexibility-from-electrical-storage-water-heaters-corrected-1.pdf

- The KAFFI project, Elvia, updated version spring 2021; Isak Lande.

- BattFlex test report, OSO/Elvia 2022; Stein Arne Riis (OSO), Vegar Dyreng (OSO) and Stein Roger Aspmodal (Elvia).

BATTFLEX.

Prosject Owner

Elvia AS

Project participants

See chapter 6.2 prosject organization

Collaboration partners

OSO Energy AS, Pixii AS,

Prosject Owner /contact information

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Alf Inge Tunheim

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The duration of the project

Startup: 01.09.2019

Planned completion: 01.09.2024

Elvia

Intelligent
distribusjon av
elektrisitet

The Intelligent Distribution of Electricity (IDE) project is a large-scale demonstration project, partly funded by Enova through the Norwegian Fund for Climate, Renewable Energy and Energy Transition from 2019 to 2024.

The aim of the project is to demonstrate new technologies and digital solutions on a large scale, verify how they work, and estimate the usefulness of full-scale implementation in the distribution grid across Norway.

The project unites six grid companies in Norway in a collective development driven by new technology: Elvia, BKK (formerly BKK Nett), Tensio, Norgesnett, Lede and Glitre Nett (formerly Agder Energi Nett). Epos Consulting, NTNU are also participating, along with the Norwegian Smartgrid Centre, which is leading the project.

https://ide-smartgrids.no/