Preliminary Requirements Specification for the ElectricitySaverApp (ESA)

Final Version

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Document version history:

- 0.1 - Start 25.09.2022
- 0.2 - Analyzing current documentation and similar products / Petri Kaukopuro 03.10.2022
- 0.3 - Add preliminary requirements table / Jyri Hakala 05.10.2022
- 0.4 - PESTE-Analysis / Petri Kaukopuro 05.10.2022
- 0.5 - Add Background and current situation / Mikko Kaukonen 05.10.2022
- 0.6 - Add user descriptions / Jyri Hakala 09.10.2022
- 0.7 - Stakeholder Analysis / Petri Kaukopuro 10.10.2022
- 0.8 - Product, scope and environment / Johannes Hartelin 11.10.2022
- 0.9 - Methods and timetable for requirements gathering / Mikko Kaukonen 12.10.2022
- 0.10 - Purpose of this document, Table of Contents, Abbreviations, page numbers, footnotes, fine tuning / Petri Kaukopuro 12.10.2022
- 1.0 - Phase 1 Complete 16.10.2022
- 1.1 - PESTE – analysis rewritten according to feedback. / Petri Kaukopuro 3.11.2022
- 1.2 - Use case diagram 1st version / Johannes Hartelin 4.11.2022
- 1.3 - Example use cases / Petri Kaukopuro 6.11.2022
- 1.4 - Entity/Concept diagram version 1 / Mikko Kaukonen 8.11.2022
- 1.5 - Entity/Concept diagram version 2 / Mikko Kaukonen 9.11.2022
- 1.6 - Add navigation diagram / Jyri Hakala 9.11.2022
- 1.7 - Background and current situation analysis rewritten according to feedback. / Mikko Kaukonen 13.11.2022
- 1.8 - Entity/Concept diagram version 3 / Mikko Kaukonen 13.11.2022
- 1.9 - Methods and timetable for requirements gathering rewritten according to feedback. / Mikko Kaukonen 19.11.2022
- 1.10 - User interface / Mikko Kaukonen 20.11.2022
- 1.11 - Update requirements table and add descriptions of example requirements / Jyri Hakala 20.11.2022
- 1.12 - Open issues and Ideas for further development / Petri Kaukopuro 20.11.2022
- 2.0 - Phase 2 Complete 20.11.2022
- 2.1 - Update navigation diagram, clarify naming / Jyri Hakala 30.11.2022
- 2.2 - Entity/Concept diagram updated according to feedback / Mikko Kaukonen 04.12.2022
- 2.3 - Added explanatory text to the Gantt chart / Mikko Kaukonen 04.12.2022
- 2.4 - User interfaces wireframes updated according to feedback / Mikko Kaukonen 04.12.2022
- 2.5 - Small fixes to explanatory texts for stakeholders and example use cases. / Petri Kaukopuro 04.12.2022
- 2.6 - Use case diagram updated according to feedback / Johannes Hartelin 07.12.2022
- 2.7 - Update user descriptions, touch ups throughout / Jyri Hakala 11.12.2022
- 3.0 - Final version complete 11.12.2022

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1. Introduction

1.1. Contents and purpose of this document

This document is a preliminary requirements specification document for the mobile application ElectricitySaverApp (ESA). This document is meant as a consultation analysis work for the client company Von Chilly Electronics.

The general purpose of this document is to a) cover all the necessary requirements of the system, b) to find all the stakeholders involved and c) to create a visual model of the system. The document does not cover the full technical details of the actual implementation work, nor is the document meant as a technical manual for the ESA.

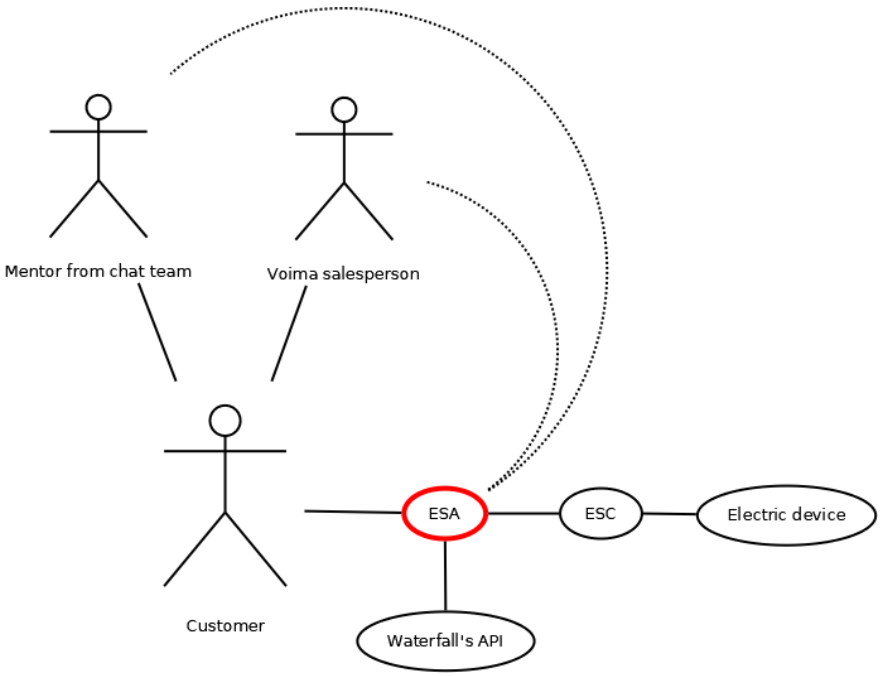
This document is to be released in two phases. Phase 1 of the document covers the initial requirements gathering plan. Phase 2 covers the requirements in more detail, with diagrams and wireframe models of the system.

1.2. Product, scope and environment

The product is called ElectricitySaverApp, or ESA for short. It will be a mobile application, which will let customers control their ESC devices. The purpose of our company in this project is to ensure, that the requirements for the application are done properly, so that the application itself can be implemented with success.

The purpose of the products is to let customers control the use of their electric devices more effectively depending on the price of electricity. The biggest benefit is a reduced electric bill. It can also provide multiple smaller benefits, such as giving more lifetime to electric devices since their usage could be more limited.

Diagram 1. Early concept diagram



Our early concept diagram (Diagram 1) shows how the product is related to customers, customer services, Waterfall's API and an electric device through an ESC. Red is used to mark the product. The

customer will be using ESA, which controls the ESC device. ESA also fetches information about price of electricity through Waterfall's API. The ESC device, which gets the instructions from ESA, controls the electric device. The customer can also contact a mentor from the chat team if help with ESA is needed. If a customer has bought one or more ESCs from Voima, their salespersons can also help with ESA.

1.3. Users and purpose of use

The system has two main types of users: people who have purchased, or otherwise acquired, an ESC and wish to control it, and Voima sales representatives who will provide assistance in setting up and using the application. Henceforth these groups will be called customers and guides, respectively. There may be minor overlap between the groups e.g., some sales representatives may also own ESCs.

Customers' main use environment is their home, whereas guides' is their workplace. Most customers can be expected to have signed an electricity contract with hourly market pricing. Some users can be expected to forgo automation and purely control their connected devices manually, thus making their use very frequent, even hourly. Yet others may automate their devices right away, making their usage very "fire-and-forget". Guides' usage hinges purely on the number of customers asking them for help. Therefore, frequency of use varies unpredictably and shouldn't be a driving motivator in design.

Customers may be further divided into subgroups of users. First and foremost are those living in houses/apartments with electric heating. This group has the most to gain from using ESCs to time the peaks of their electricity usage according to market rates, for example by running their heating only during the night. They can be expected to be both able and willing to spend some upfront to benefit in the long term and are thus the most important users. The second group are those with other means of heating their homes. Their cost-to-benefit ratio is largely unknowable (to us) and their motivation for using ESC personal.

Users are expected to have basic smartphone-related skills, such as input and interaction on a touchscreen. They may require assistance with app-specific functionalities such as connecting to an ESC. This training is to be provided by the guides. Guides should acquaint themselves with the app and its documentation. Both groups should have access to a user guide. Advanced use, that is automation with rules, requires some understanding of computer logic.

System is currently envisioned as a *multi-user environment with a singular main user acting as a local administrator. The main user is the one connecting ESCs to their application and then providing access to said devices to other users via family groups. No other admins exist within the system for reasons of security and privacy.*

Majority of customers are expected to speak Finnish and thus it should be the applications main language. Swedish is the second language in Finland and should be added. English is the most spoken language in the world and many Finns, including those whose main language isn't either of the two mentioned above, understand it. Adding support for English is a no-brainer. It also facilitates expanding ESCs market beyond Finland's borders.

1.4 Terms, definitions and abbreviations

API	Application Programming Interface
ESA	ElectricitySaverApp
ESC	ElectricitySaverCube
VCE	Von Chilly Electronics
WEC	Waterfall electricity company

2. Requirements gathering plan

2.1. Background and current situation

Due to the war in Ukraine, the price of electricity is high these days and electricity companies have almost completely stopped offering long-term fixed-price electricity contracts. Consequently, the consumer has become more dependent on the real-time fluctuation of the price of electricity. For now, there is currently no solution available for this need that would allow the consumer to conveniently check the price of electricity in the same place and schedule/adjust their electrical device to work accordingly.

Currently on the market, there are mobile smart sockets as well as applications that can monitor the price of electricity. But since these are their own systems, their joint use is difficult and time-consuming. *The customer company has developed an answer to this problem a smart electrical plug "ESC = ElectricitySaverCube" and now the plan is to create a mobile application "ESA = ElectricitySaverApp" which would make it possible to use the ESC. The application should be compatible with Waterfall electricity company's price tracking API and use this to retrieve the current price of electricity.*

Unlike now, with the mobile application, the user can either manually monitor prices and turn on certain devices when the price is suitable, receive notifications when the price drops below a certain limit, or even automate certain devices to start when the price of electricity drops below the limit. This should make it easier to compare the price of electricity and help save money for its users.

2.2. Analyzing current documentation and similar products

Our only document for the product thus far is an email from the representatives of the Von Chilly Electronics company (VCE). VCE is an electronic devices and components manufacturer in Finland. Their company slogan is "Don't be Silly be Chilly".

In the email, VCE have asked us to do a preliminary analysis for a mobile application (ESA) to their product (ESC). The email described in sufficient detail the desired functions of the ESA, and after doing some covert high-tech industrial espionage (Google), some similar, though not completely, products were found. For example:

A product with a mobile application that monitors the electricity consumption of nearby devices directly:

https://www.amazon.com/Sense-Energy-Monitor-Electricity-Usage/dp/B075K6PHJ9

A product that monitors the electricity meter (countries that have electricity meters in their homes, such as the UK, Australia, etc.) and sends information to user by mobile app:

https://www.powerpal.net/

There are also many examples of mobile apps that calculate the electricity usage of devices by their average hourly consumption:

https://play.google.com/store/apps/details?id=com.yoslines.meteranku&hl=en_US&gl=US

https://play.google.com/store/apps/details?id=com.smappee.app&hl=fi&gl=US

https://play.google.com/store/apps/details?id=at.topfen.ecas&hl=en_US&gl=US

A Finnish mobile app that monitors the price of electricity by the hour may also be of interest:

https://vappi.fi/

2.3. PESTE

Political

Political factors can have a huge impact on ESA, as the current state of the world is very much uncertain. Most unfortunate factor is the present war in the Ukraine. It has already affected the price of electricity in Finland and the possible risk of cyber-attacks to electricity networks has been an open issue. Another uncertain political issue are taxes affecting ESA, for example, at present in Finland about one third of the price of electricity is tax.

Another important political factor is the current and possible future regulations about the use of user's personal data. The latest European union law for personal data - The General Data Protection Regulation (GDPR) is from 2018.

Economic

Because politics and economics go hand in hand, the current state of the world economic situation can have unforeseen consequences especially to energy related products such as the ESC. Since Russia is a big energy exporter for the whole world, it remains to be seen how far-reaching effect the war in Ukraine will have to the price of energy. The higher the price goes, the better in some sense, because there will be more demand for electricity-saving products like the ESC.

However, Customers of the ESC will want to save electricity and money, so the price of the product itself must be reasonable, to be useful to people and help them save money.

Sociological

Already was mentioned the question of personal data, which is an important one. Sensitive user information can be used in all kinds of malicious social engineering threats. Potential users want their personal information to be secure.

Another factor is electricity transfer costs in Finland since they can be different by region. Usually, electricity transfer cost to urban areas is cheaper than rural areas. This means that the product has higher potential value in rural areas of Finland.

Technological

Firstly, there seems to be no major issues for the application itself, only some technical details, and these will be addressed in the development process.

Secondly, since the ESC is connected to other electric devices, the question is how many current electrical devices are compatible, and will future devices be compatible as well?

Lastly there is also the unlikely hypothetical possibility that someone discovers a virtually endless source of free energy. This will be a great thing for humankind, but less so for the ESC.

Environmental

How will global energy usage change as global warming worsen? According to some if not most modelling, there will be a modest net decrease in energy consumption, because a high proportion of energy consumption is used for warming.

In addition, even if some energy is required to maintain the apps databases, the product and the App will potentially help save much more energy, so it will be a net positive for the environment.

2.4. Stakeholder analysis

From the client's email, we have recognized several preliminary stakeholder groups (Table 1). The groups listed are in order of their perceived impact on the project. More stakeholders might be identified later as the development proceeds.

Table 1. Different stakeholders and their roles and participations.

Stakeholder class	Stakeholder	Role, justification of the stakeholder	Required participation	Perceived impact of project on stakeholder	Areas of influence
User, Client	Von Chilly Electronics	User and Financer	Specifications for ESA. They need demos during development.	High	Product goals, Restrictions, Functionality
Content consumer	Customers of the ESC	End User	We can gather user surveys etc. After product launch	High	Ultimate success of the product
Developer	Developer company	Developer of the ESA.	Development after needed specifications.	High	User Interface, Security, Functionality
Content provider	Waterfall electricity company	Provides the price tracker API.	Development of their API, before ESA development. Maintain after.	Medium	Functionality, Technical restrictions
Content provider	RadioChips	Provides the RadioChips API.	Development of their API, before ESA development. Maintain after.	Medium	Functionality, Technical restrictions
Tester	ESC Early Adopters	Test Group	Testing once ESA is in a testable state.	Medium	Quality Assurance
Support	Von Chilly Electronics Chat team	Customer support	Support after the ESA is released.	Low	Customer support
Sales	Voima	Retail sales and in-store customer support.	After product release. They need technical documents.	Low	Sales and marketing

2.5. Preliminary requirements and their categorization

Table below (Table 2) describes recognized requirements for the application. Requirements in the table have an id, a priority, and a type. Priorities run from 1 (must have) to 2 (should have) and 3 (could have). Types are described by the following: (R)estriction, (F)unctional, and (N)on-(F)unctional.

Table 2. Requirements

ID	Priority	Source	Type	Description
1	1	Frame story	R	Support majority of mobile OS's (iOS/Android)
2	1	Frame story	F	Retrieve electricity price data from Waterfall API
3	2	Frame story	NF	Display Waterfall logo in app
4	1	Frame story	NF	Display current electricity price
5	1	Frame story	F	Users can connect to any number of ESCs with a code & key via RadioChips API
6	2	Frame story	NF	On/off status for each connected ESC visible at a glance
7	*3*	Frame story	NF	Users can name connected devices
8	1	Frame story	F	Users can control ESC on/off status via RadioChips API
9	2	Frame story	NF	Push notifications when electricity price falls under user-specified threshold
10	2	Frame story	F	Users can set rules for when an ESC should turn on/off
11	1	Frame story	NF	Require user authentication before adding ESCs or changing settings
12	2	Frame story	NF	Secure storage for ESC info & settings
13	1	Frame story	NF	Do not send commands to devices acting unexpectedly
14	2	Frame story	NF	"Testing mode": Connect to dummy devices and control them as if they were real
15	2	Frame story	NF	Users can request help & chat with VCE representatives
16	2	Email	F	Users can create groups for side-users
17	2	Email	F	Users can manage created groups and their members
18	2	Email	F	Users can join and leave usergroups
19	2	Survey	F	Users can export & import their settings between app installations
20	1	Meeting	R	Application is built using React Native
21	1	Meeting	R	All stored/transmitted data is in JSON format
22	2	Meeting	R	Minimize bandwidth usage
23	2	Brainstorming	NF	Push notifications when a device is acting unexpectedly
24	2	Brainstorming	NF	Create & send logs on malfunctioning devices
25	2	Usability study	NF	Support screen readers
26	3	Usability study	NF	High contrast difference for device on/off status
27	3	Usability study	NF	Users can change font size
28	3	Usability study	NF	Users can send feedback on app
29	2	Meeting	F	Backwards compatibility throughout lifecycle
30	1	Meeting	NF	App is GDPR compliant
31	3	Brainstorming	NF	Connecting to devices takes no more than 5 seconds

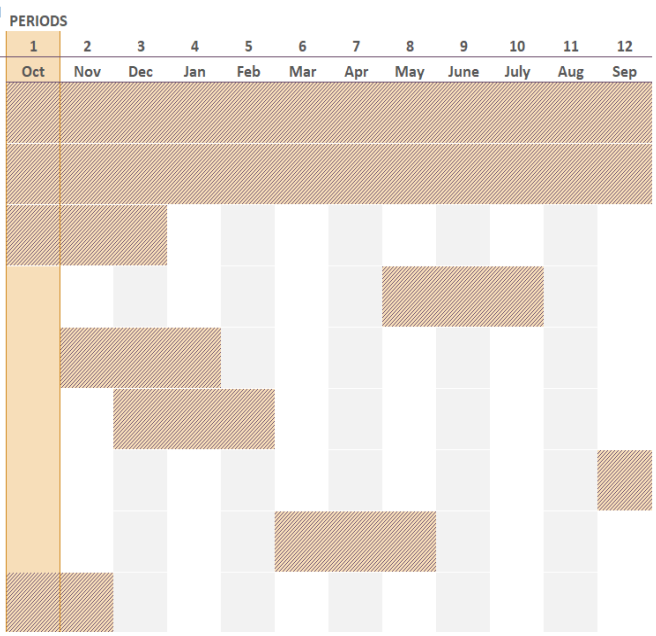
2.6. Methods and timetable for requirements gathering

The Gantt chart below (Table 3) describes the requirements collection methods and schedule of our project.

Table 3. Methods and timetable for requirements gathering

Timetable for requirements gathering

Stakeholder	Partisipants	Methods	DURATION MONTHS
Von Chilly electronic VCE		Monitoring the process	12
Developer	VCE	Wekkly meetings and brainstormig	12
End user (initial research)	VEC & developer	Online survey	3
End user (product testing)	VCE & developer	Usability study	3
Content provider RadioChip	VCE & developer	Developer meeting	3
WEC provider price tracker API	Developer	Developer meeting	3
Sales Voima	VCE & developer	Developer meeting	1
Tester	VCE, use & developer	Preliminaru user test	3
Officials and Politicians	VCE	Meetings and information acquisition	2



Timetable for requirements gathering

- The customer *VCE and the developer* are in close contact throughout the process and shape the requirements as the process progresses.

- At the beginning, requirements could be collected from end users through an online survey.

- After the application is completed, a usability study is conducted among end users.

- The suppliers of the chip (RadioChips) are contacted right at the beginning of the project and inquired if there are any requirements for the program on behalf of the chip.

- The supplier of the price tracker application is also contacted in the initial stages to ensure that the applications are compatible.

- Technical documents must be submitted to the reseller company Voima by the time the product is released.

- Preliminary tests when the product is in such a condition that tests can be performed.

- Social and political requirements should be clarified at the beginning of the project.

3. Requirements and modeling the system

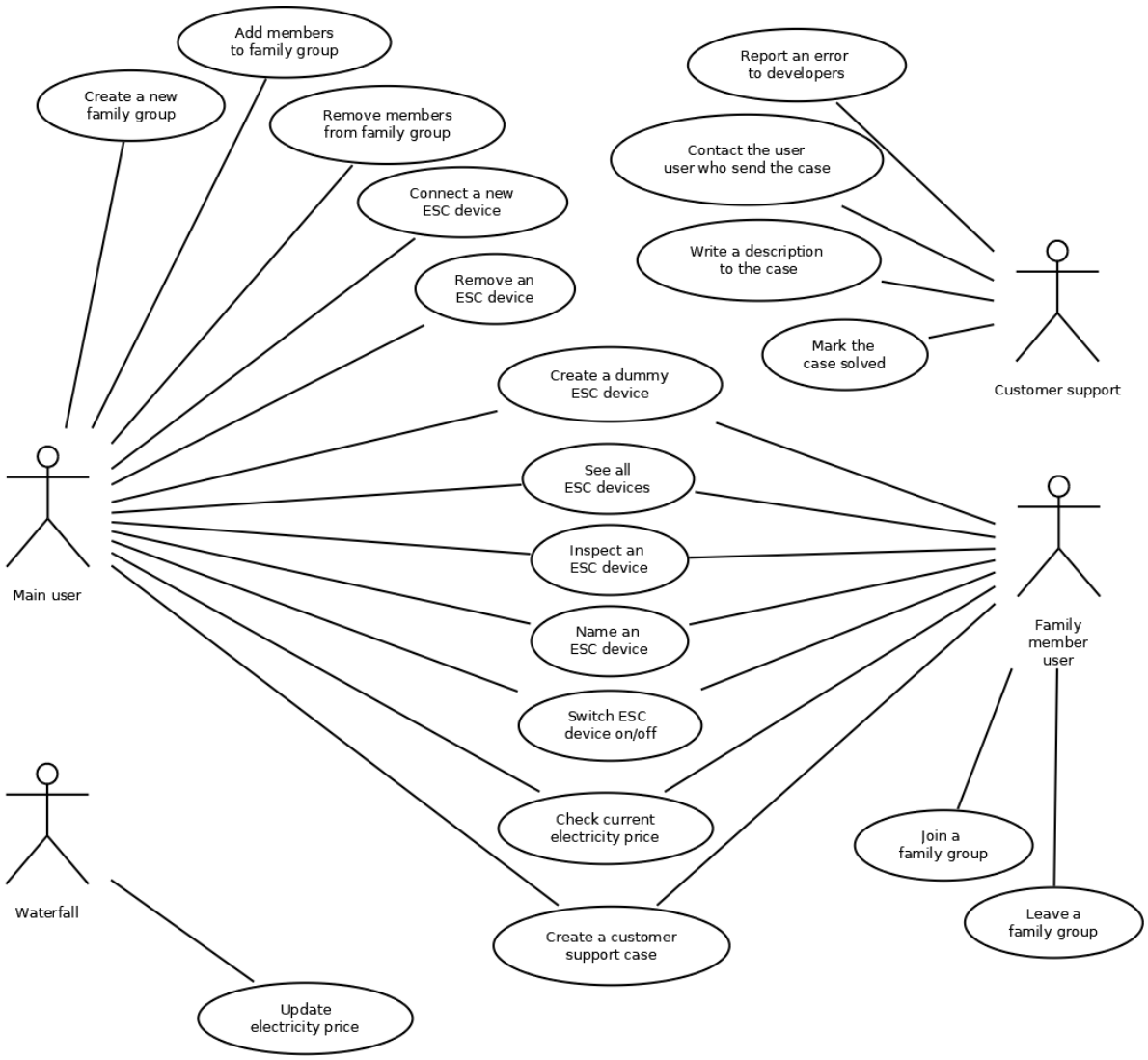
3.1. Modeling (diagrams)

This chapter contains use case, entity and navigation diagrams that may be used to guide application development. Also includes two more specific examples of use cases.

3.1.1. Use case diagram(s)

We have included a single use case diagram (Diagram 2). It contains the four actors, who handle different things in day-to-day use. Main user and family member user have the most actions, most of which are shared by them. *The main differences are that how they interact with the family group: a main user is the only one who can create a group and add or delete members from it. A family member user on the other hand can join or leave a family group*. *The other minor difference is that only the main user can add or remove an ESC device*. The other two actors are Waterfall and customer support. Waterfall's crucial action is to update the electricity price. *Customer support's action is to handle a customer support case, and to do so it can report a bug, contact the user who has sent the case to be handled, write a description to a case so that the user as well as other customer support personnel can learn from it, and at last mark the case solved.*

Diagram 2. Use case diagram



3.1.1.1 Example use case 1

Example use case 1: Connect a new ESC device to ESA (Table 4). This is a core function of ESA. When an ESC device is connected to ESA it can then be operated.

Table 4. Example Use Case 1

Use case:	**Connect a new ESC device to ESA**
Actors:	Main ESA account user. ESC Device to be added.
Description:	User wants to register new ESC device to ESA.
Preconditions:	User logged in to ESA. User has the ESC chip-code for registration.
Process:	Main ESA User can add a new device to ESA. First the user must find the ESC device code. User selects the option to add a new device in the ESA and inputs the code. If all goes well, the device is then registered to users ESA and is ready for operation.
Postconditions:	*The new device is registered to the users account and can be operated and shared to other family group users with the ESA.*
Exceptions:	*Invalid ESC device code or code is in use already. Not the main user*

3.1.1.2 Example use case 2

Example use case 2: Adding new members to family group (Table 5). The main user has created a family group and can add other users to his/her group.

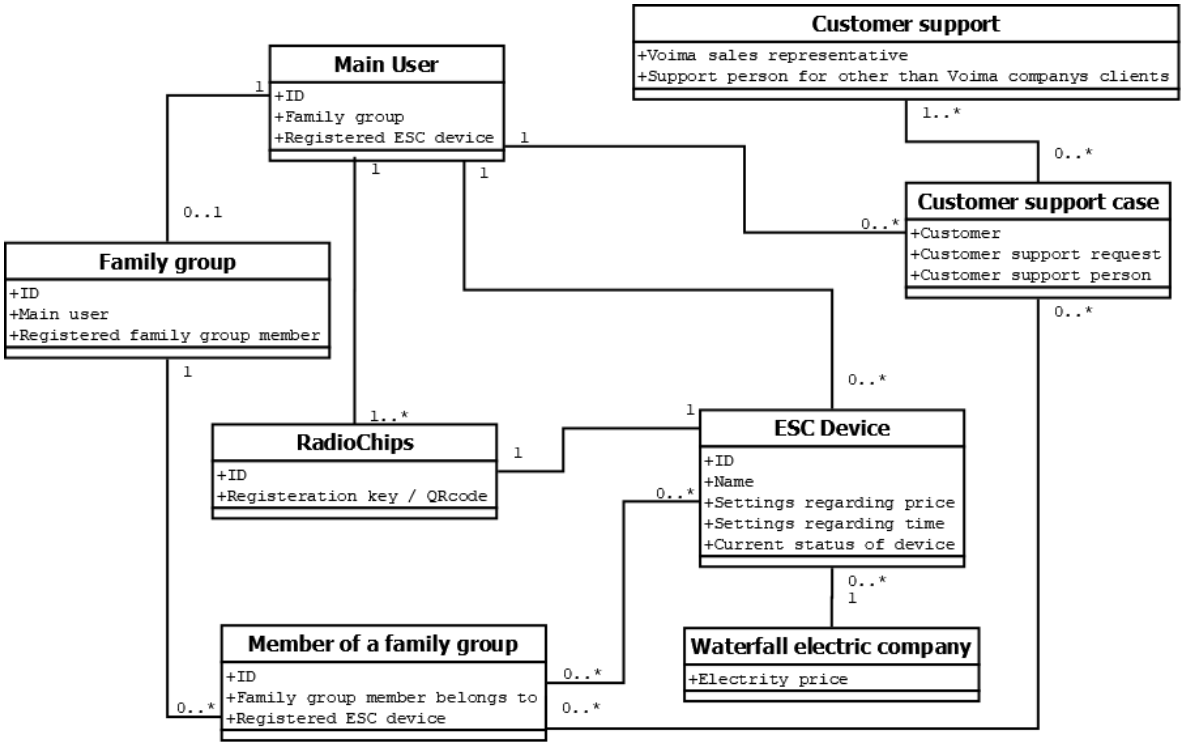
Table 5. Example Use Case 2

Use case:	**Add member to family group**
Actors:	User A: Main account. User B: Another ESA user to be added.
Description:	User A wants to invite User B to User A's family group.
Preconditions:	User A has the authorization to add new members and is logged in to ESA. User B ESA account exists.
Process:	User A has created a family group in the ESA. User A sends via the ESA to User B's ESA the invitation to join User A's family group. User B will then be prompted to join User A's family group.
Postconditions:	If user B accepts the invitation, they now belong to User A's family group.
Exceptions:	User A doesn't have the rights to add new users. User B doesn't exist.

3.1.2. Entity/Concept diagram

The diagram below (Diagram 3) describes the entities and the relationships between them in the application.

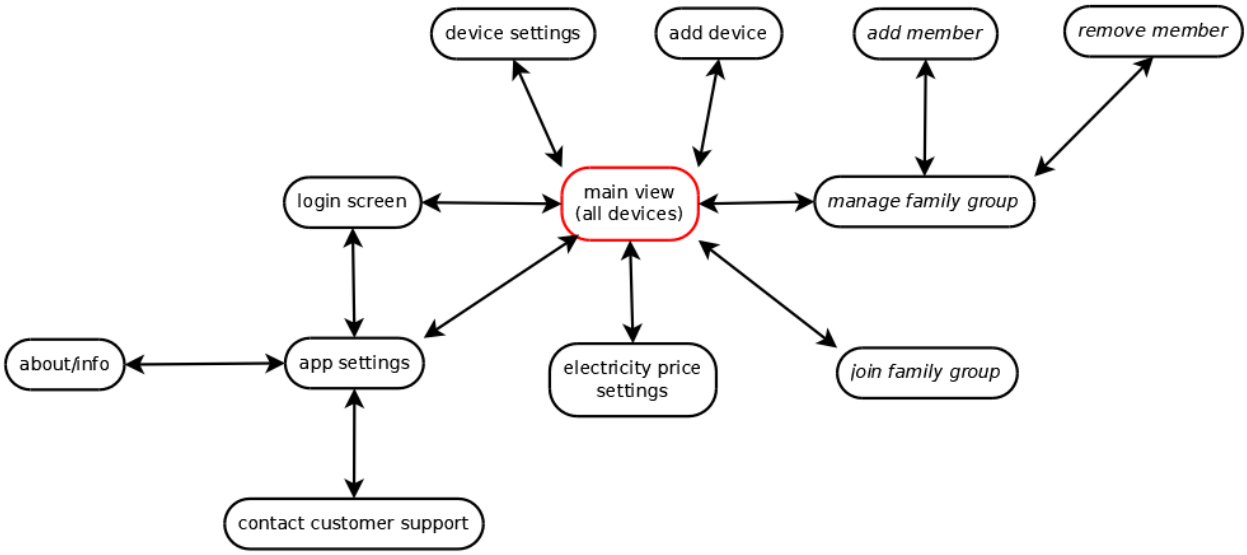
Diagram 3. Entity/Concept diagram



3.1.3. Navigation diagram

A diagram containing views of the application's main functionalities and possible ways to navigate between them (Diagram 4).

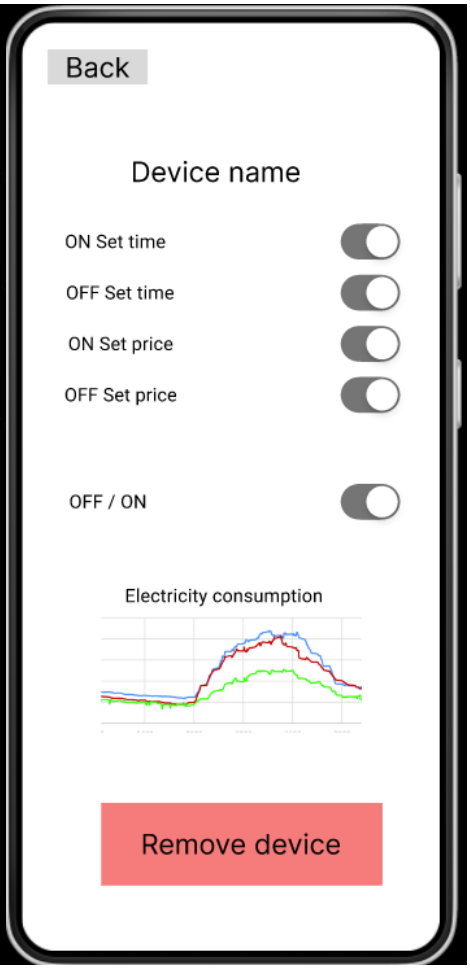
Diagram 4. Navigation diagram



3.2. User interface

Below are pictures of four wireframes of our user interface: All devices, Settings for single device, Electricity price settings, Family member views.

Picture 1. All devices view



Picture 2. Settings for single device

1. **All devices view** (Picture 1)

A view from the menu All devices where the user can

- Return to the previous menu by clicking the Back button.

- Add a new device with the Add device button. (*This is only visible to the main user.*)

- Open the dropdown menu to see all users' devices and turn them on or off if needed.

- *Move on to the Electricity price settings menu*

- *Main user can manage the family group and others can join the family group, if the main user has given them the right*

- *Move on to application settings menu*

2. **Settings view for single device** (Picture 2)

From the previous All Devices page, the user can select a single device and go to this Setting for a single view. Here the user can

- Set limits on the time and/or electricity price according to which the device switches on and off.

- To see the current status of the device and turn it off or on.

- See the device's electricity consumption and the price of consumption.

- To remove the device from the application. (*This is only visible to the main user.*)

Picture 3. Electricity price settings **Picture 4.** Family members view

3. **Electricity price limit settings view** (Picture 3)

On the Electricity price limit settings view page, the user can

- Choose which devices are subject to these general adjustments.

- Set the settings regarding time and/or electricity price.

- Sees the current price of electricity.

- See the development of electricity consumption and costs in the longer term.

4. **Family members –view** (Picture 4) (*This is only visible to the main user.*)

In the Family members menu, the main user

- Sees the current members from the dropdown menu.

- Can add new members

- Can remove members

3.3. Requirements

Requirements were gathered into a singular table for ease of access. See table 2 above.

Below are examples of each type of requirement recognized.

3.3.1. Example requirement 1

Users can control ESC on/off status via RadioChips API

The application should provide an easy way to control devices, such as a toggle switch for their on/off status that is clearly positioned near device identifier or name. Pressing the toggle will send a signal to the appropriate device to either begin or stop supplying power. The toggle switch will change appearance on press.

3.3.2. Example requirement 2

"Testing mode": Connect to dummy devices and control them as if they were real

Dummy devices are virtual expressions of ESCs packaged with the application, instead of physical devices. They simulate ESC behavior and are controlled similarly within the application. The intention is to provide sales personnel a way to show potential customers the applications usage and processes. Typical use would be to connect to a dummy device with an obvious ID, such as “TEST-123”, and have it displayed under all devices -view thereafter.

3.3.3. Example requirement 3

Support majority of mobile OS's (iOS/Android)

Users’ choice of mobile phone should not hinder their purchasing decision; thus, it was agreed that the application should be accessible by 99% of all mobile users. On the android side of mobile development this means targeting devices on version 6.0 (Marshmallow) and up. For iOS this translates to targeting version 14 and up.

3.4. Environment

3.4.1. Other related systems and specialties

The two most important related systems are Waterfall’s API and customer support. Waterfall’s API continuously updates the price of electricity to the system, so the system must be able to receive the price updates in the correct format. On the other hand, the Waterfall’s API must also be able to handle all requests sent through ESC-devices, so the format of these requests is crucial. It should be assumed that the device might be a success. This means that the API might get an enormous number of requests from these devices. It might be necessary to establish a private way for these ESC-

devices to make requests to the API. This way the resources needed to handle requests made by ESC-devices could be allocated separately of requests made by others. The format of the request must also be communicated clearly with Waterfall. We think that it is in the interest of all parties, that these requests are as plain as possible.

The other important consideration is the customer support system. Users can send customer support cases to the customer support through their ESAs. The format of these cases is important. It must be stated, that has the client purchased the ESC-device from Voima thus sending their case to Voima or is the case going to be sent to the other support team. Enough information must also be provided with the case, possibly some data from the ESC device itself. The system must also be able to receive data from the customer support system, so that the person who sent the case is able to see the result of the case and *do the procedures necessary to solve the case*.

3.4.2. Required connections, communication, and other environmental requirements

The ESC-device requires a connection to ESA so that it can be setup, configured and used. The ESC will continue to provide or not provide electrical power through it to the electric device even if the ESA is currently not connected (which might be due to long distance or dead battery for instance). The connection must be easy, quick, and safe to establish. It's in no one's interests that a neighbor connects to your ESC-device. It must also be quick, so that after a user has setup an ESC-device to his ESA, manually connecting is no more needed and it happens in the background. It must also be relatively quick, so that when a user wants to check the electricity price and adjust their ESC-devices according to it, it won't take long for them to open the app and see the added ESC-devices.

3.5. Ideas for further development

One possible idea for future development for ESA is an ESC automatic switching on or off depending on the time of the day. For example, in the daytime automatic switching of unnecessary lights and in the nighttime switching of other unnecessary devices. The length of the daytime, meaning the time of the day when there is enough light, could be fetched from weather service, or even set up manually.

Another possible idea for future development is that ESA users may also want to have a general statistical view screen about their app usage and how much electricity they have potentially saved, or who in the family group have operated what devices, etc.

Also, although VCE was primarily interested in a mobile application for their product, a future expansion to a browser system or even a web-based API might be of interest for some experienced users who might want to create their own ESC control scenarios.

3.6. Open issues

Question about the personal data gathering remains an open issue. How much data does VCE need or want to collect from users, and have they made the necessary legal preparations to do this? Also, when the ESA application user first time installs the app, it must ask the users for their permission to give their personal data.

VCE was concerned about the current and accurate status of the devices' on/off state, as erroneous data could lead to turning on or off devices in a manner that causes hazardous situations. So, there should be double or even triple checking of the data integrity about the accuracy of the device's status. This is a technical issue for the ESA developer team.

VCE also was also concerned about hackers and unauthorized people, so that critical devices cannot be sabotaged deliberately or otherwise. This is an open cyber security issue for the future developer of the ESA.