

# A.Y. 2022-2023 Software Engineering 2 - RASD Project

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# 1 Introduction

## 1.1 Purpose

The global climate crisis displays one of the biggest threats to humanity and the planet. The loss of biodiversity, the impact on society and extreme weather conditions are only a few potential consequences if we don't act quickly and reduce the emissions of greenhouse gasses in every sector possible. One important sector in this fight is the transportation sector, especially cars that emit 27% of total greenhouse gas emissions in the U.S making it the largest contributor.<sup>1</sup> To deal with this problem more and more people need to buy electric cars instead of traditional ones. But one problem with electric cars is that you can't just drive to a gas station and refill in a few minutes. You need to know where charging stations are and moreover if they are free. Depending on the car's battery the charging process can take between 4-10 hours<sup>2</sup> and therefore needs to be scheduled carefully to fit in the daily schedule of the people using electric cars.

To make electronic mobility more accessible and to reduce the carbon footprint of the transportation sector, eMall tackles this problem by offering a software that allows you to know about the nearest charging station, its prices and if it is free for you to use. It simplifies the charging process of electric cars and makes them therefore more suitable for everyday use. (maybe more information on the software)

### 1.1.1 Goals

Goal	Description
G1	Users use eMSP to look for the best (depending on charging station's location, price, special offers) charging option nearby
G2	Users use eMSP for the charging process (book a charge in a specific charging station for a certain timeframe, start charging, pay for service)
G4	CPOs use CPMS to handle energy needs of the connected charging stations (acquisition of energy from different DSOs or of connected batteries, distribution of energy to the connected stations)
G5	CPOs use CPMS to handle the pricing (set price or set special offer) for a charging
G6	CPOs use CPMS to decide to store energy in batteries at the charging station
G7	CPMS can handle the CPO's decisions of G4-G6 automatically without CPO

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<sup>1</sup> <https://www.epa.gov/transportation-air-pollution-and-climate-change/carbon-pollution-transportation>

<sup>2</sup> <https://monta.com/uk/blog/how-long-does-it-take-to-charge-an-electric-car/>

## 1.2 Scope

eMall is a system that allows users of electric cars to easily find and book a charging station and allows charging point operators to handle their energy acquisition and distribution and based on this the cost of their service.

The actors that we need to consider for this are the end user who wants to charge his car and the charging point operator who wants to manage his charging stations.

(more on application domain?)

As a group of three students we have to assume that the eMSP subsystem interacts with CPMSs of multiple CPOs. (Explain which one of the options we chose for groups of three)

### 1.2.1 World Phenomena

Identifier	Description
WP1	Amount of people who want to charge their cars in certain timeframe
WP2	DSOs change energy prices
WP3	Fluctuations in available energy resources
WP4	User frees up the charging station
WP5	User blocks a charging station

### 1.2.2 Shared Phenomena

Identifier	Description
SP1	User searches for a charging station
SP2	User books a charging process
SP3	User starts a charging process
SP4	User pays for a charging
SP5	User ends a charging process (also consider that a user could leave early?)
SP6	CPO buys energy from DSOs
SP7	CPO uses battery's energy instead of DSO's
SP8	CPO sets the price/ special offer for a charging station
SP9	CPO changes DSO he buys energy from
SP10	CPO stores energy in batteries of charging station

SP11	CPO decides on energy distribution for his charging stations
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## 1.3 Definitions, Acronyms, Abbreviations

### 1.3.1 Definitions

Word	Definition
Charging station	A station with at least one slot where electric cars can recharge their batteries. In some stations an additional battery is connected that can store energy or give the energy to a connected car through the charging station.

### 1.3.2 Acronyms and Abbreviations

Word	Description
RASD	Requirements Analysis and Specification Document
WP	World Phenomena
SP	Shared Phenomena
GX	Goal number X
DX	Domain assumption number X
RX	Requirement number X
eMall	e-Mobility for All
eMSP	e-Mobility Service Providers
CPO	Charging Point Operator
CPMS	Charge Point Management System
DSO	Distribution System Operators

## 1.4 Revision History

## 1.5 Reference Documents

The requirements and conclusions mentioned in this document are all derived from the specification document "Assignment RDD A.Y. 2022-2023 Software Engineering 2".

## 1.6 Document Structure

# 2 Overall Description

## 2.1 Product Perspective

### 2.1.1 Scenarios based on shared phenomena

#### 1. User wants to use the eMSP system for the first time

The user Alice has an electric car and wants to register to the eMSP system, so that she is always able to find the best suiting and cheapest charging station close to her.

She starts the system and selects the "Register" button. In the registration form she gives all the relevant data, such as her name, Email, password, her car's battery data, her bank account information and allows access to her phone's locationing service.

Now she sends the registration form to the eMSP system, which sends her an acknowledgment Email.

#### 2. User uses eMSP to book a charge

The user Alice drives around in her electric car when a message appears on her board computer that the car runs low on battery. To find a suitable charging station she stops in a parking lot and starts the eMSP system. She logs into her account and selects the "Find closest charging station" function.

The eSMP will now locate her position and search for nearby charging stations that have free slots. Then a list will appear on her phone displaying the location of the closest stations and the cost of a charge including potential special offers.

Alice selects an option by pressing on one of the list elements. A booking window will open that shows the form necessary for the booking. She needs to choose a timeframe in which she wants to charge her car and decides on charging it for one hour from 3pm to 4pm. The form shows the offer for this hour, which Alice accepts. Now she drives to the selected charging station and the eSMP will collect the money from the bank account connected with Alice's eSMP account.

#### 3. User performs a charging process

Alice arrives with her electric car at a charging station for which she previously booked a timeslot of one hour to charge her car by using the eSMP system. She parks her car in one of the available free slots at the beginning of the chosen timeslot.

Now she attaches the charging station to the car and opens the eSMP system. There she can select her active bookings and press “Start”. Then the eSMP system sends a request to the CPMS system which starts the charging. Her car is charging now and she goes away for a walk.

After one hour she returns to her car. The eSMP system sends her a notification that the charging process is finished and requests the CPMS system to stop the charging. Now Alice can unplug her car and drive away.

#### **4. CPO wants to use the CPMS system for the first time**

The user John has some charging stations and wants to register to the CPMS system, so that he can manage his stations by distributing the energy and making decisions from which DSO to buy his energy from. Since some of his stations have batteries connected to them he can also choose them to use instead of energy from a DSO.

He starts the system and selects the “Register” button. In the registration form he gives all the relevant data, such as his name, Email, password and relevant data about his charging stations (amount of slots, whether a battery is connected, location, technical data regarding the charging process itself).

Now he sends the registration form to the CPMS system, which sends him an acknowledgment Email.

#### **5. CPO determines the price for a charging process for his charging stations**

#### **6. CPO distributes energy to charging stations**

### 2.1.2 Domain model

Class Diagram

State Diagram

2.2 Product functions

2.3 User Characteristics

2.4 Assumptions, Dependencies and Constraints

## 3 Specific Requirements

3.1 External Interface Requirements

3.1.1 User Interfaces

3.1.2 Hardware Interfaces

3.1.3 Software Interfaces

3.1.4 Communication Interfaces

3.2 Functional Requirements

3.2.1 Mapping on Requirements

3.2.2 Use Cases

3.2.3 Sequence/ Activity Diagrams

3.3 Performance Requirements

3.4 Design Constraints

3.4.1 Standards Compliance

3.4.2 Hardware Limitations

3.4.3 Other Constraint

3.5 Software System Attributes



3.5.1 Reliability

3.5.2 Availability

3.5.3 Security

3.5.4 Maintainability

3.5.5 Portability

4 Formal Analysis using Alloy

5 Effort spent

6 Reference