

Product

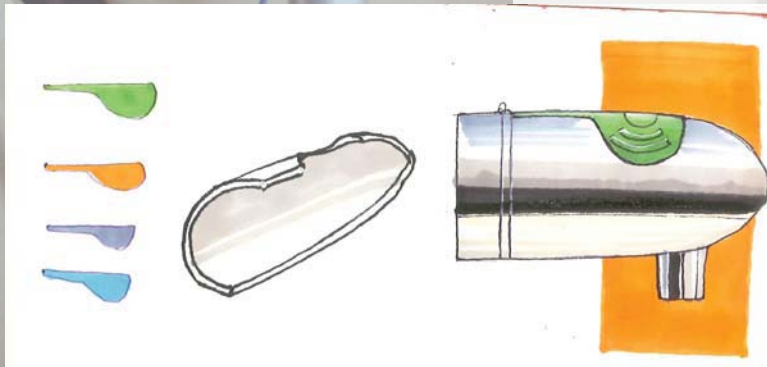
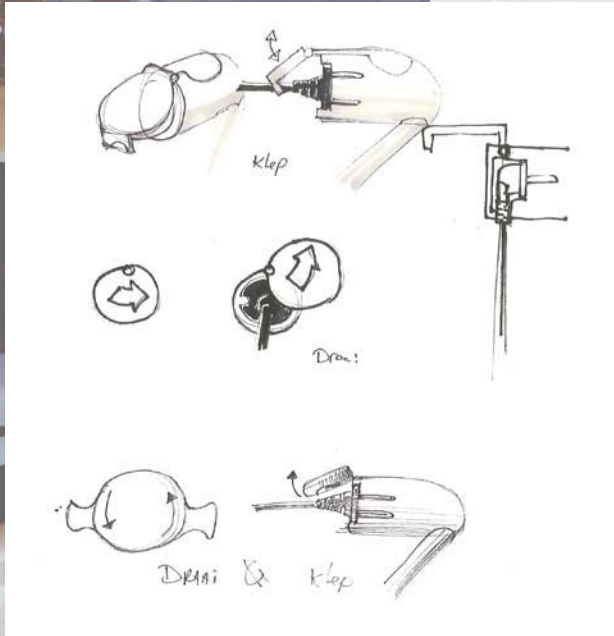
Introduction

After the individual design phase, the JUICE! members came together to decide which design or combinations of designs should be taken into the final design. It was decided that Christopher's idea with the climbing plant was the best. The reason for this choice is its relative easiness to build and install, and its sustainable look and combination possibilities with street furniture. Jordy's idea about using the maintenance hatch of a lamppost, for electricity excess is chosen as the best option to get electricity. The reason for this is that lampposts are at basically every parking area and so the electricity infrastructure is also presented at these locations.

The process

During the design process a number of companies, people and local governments were contacted and asked how they thought about the design and whether they see potential problems.

Alliander, the company which controls the public lighting in and around Amsterdam informed us about the possibility to use electricity from the lightning grid. Alliander told us that using the public lighting grid is only possible if certain adjustments are made to the electricity grid (the mail conversation can be read in the appendix). The public lighting system in Amsterdam for example runs on only 6 Ampere to light a 250W lamp bulb. This means for us that the amount of electricity in the grid is not enough, the JUICE! charging spot needs at least 3.3kW. Alliander also mentuined the transform units along the road, it can be adjusted but probably new cables that are capable to transport a higher amount of electricity should be



installed. What is basically meant is that a new cable between the actual charging unit and the main cable under the road is needed. The government also has certain legislation which says it is not allowed to have two points using electricity on one post. The local government in Amsterdam informed JUICE! about this problem and a solution is to install a small post with a fuse box close to the lamppost or to make a separate chamber inside the lamppost which includes fuses. During the production of the prototype, there is another solution recovered, another group of students is building a lamppost working on solar panels which means that the JUICE! charging unit is the only unit which takes electricity from the grid.

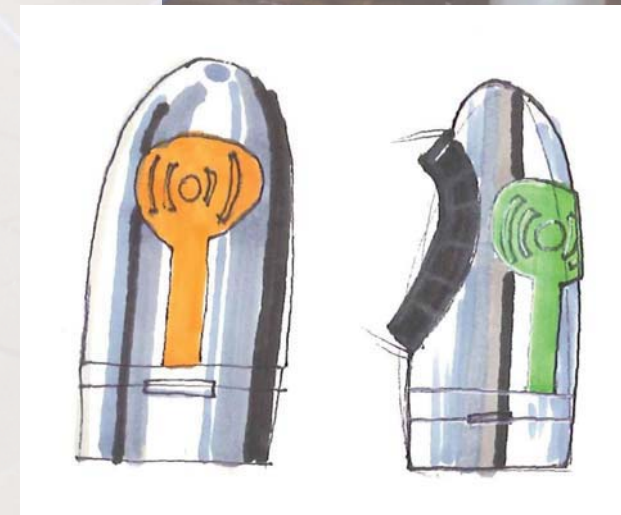
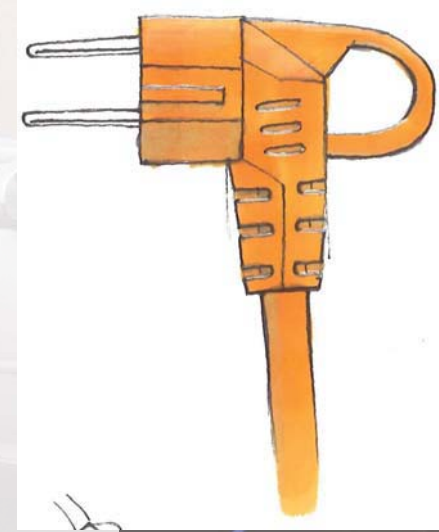
JUICE! has also designed an individual charging post with only one electricity point, so any problems containing government legislation are prevented. This post also gives the possibility to supply charging places where there are no light posts. The actual charging unit is similar to the one designed for the lamppost. This is an economically preferable solution, because the units can be produced cheaper and faster in this way.

During the PowerPoint presentation given in the fifth week of explore-lab the problem of vandalism came across. In the first sketches of our combined designs a hose was presented on the outside of the lamppost as a design feature. The idea was that electric vehicle drivers could easily show where a charging possibility is available, but the hose could also be misused to climb the lamppost and it could be cut easily. So the decision was made to move the hose inside the post, in a way that the post gives the protection. This decision also means that electric vehicle drivers are not able anymore to easily detect a charging spot, so a yellow sticker is made to show which lamppost are having a charging possibility.

At a later stage, the first CAD model of the final design was analyzed. Now every part in the design should have a reason and the materials and production possibilities were decided. The conclusion was made that some parts should be put together in a way that assembly and disassembly are facilitated.

It was decided that the housing should be one part which also includes the ring. The hinge is also integrated in the housing; this basically means that four parts are integrated into one piece after the first redesign. The lip on the lid is removed because it can be easily destroyed by vandalism. This change means that it is easier to produce but more difficult to open the lid.

The design consists of several elements to make the production and assembly cheap and easy.





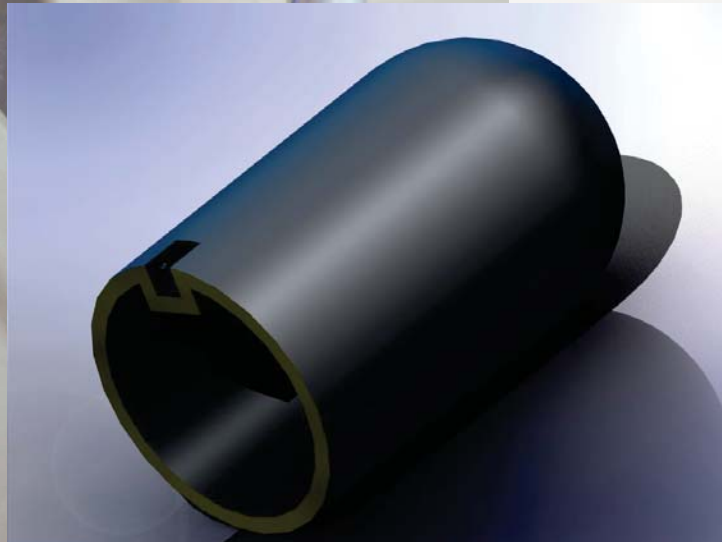
The design

Some parts of the charging unit are made of same materials, like the lid and the housing and some are made of different materials. The electronic board which is also needed is not designed by JUICE!. Electronic boards are specialized parts and can therefore better be designed by specialized firms, the capabilities of this JUICE!'s electronic board are known and so it could be designed and purchased elsewhere.

All standard components used in the design are ordered, for example, the screws and cables; these parts do not have to be designed by JUICE!. Nevertheless, it is necessary to choose the right screws with right dimensions and shapes so it won't spoil the design.

The socketframe

As shown above and mentioned earlier, the design consists of separate parts. One of the most important parts is the socket frame, because it determines the main shape of the product. The socket frame is designed in such a way that it blends into its environment as it uses a shape, the rounded cylinder, commonly seen in the urban landscape as posts or bollards. The shape also provides for more water resistancy (less slits or cracks through which the water can seep in). The socket frame is made of aluminum and produced with injection molding. This production method is chosen because it is suitable for mass production, cheap and the resulting quality is sufficient. This socket frame is made of aluminum because this material has good properties like high melting point and young's modulus, which means it is robust. The last property is very important, because this cover has to be strong enough against vandalism. Besides these properties, it is also corrosion resistant, non-flammable and thermal conductive so the warmth caused by charging can be emitted. It is also cheap and it satisfies the sustainable aspect, because it is 100% recyclable and non-toxic. All this information about the properties of aluminium comes from the CES EduPack program.

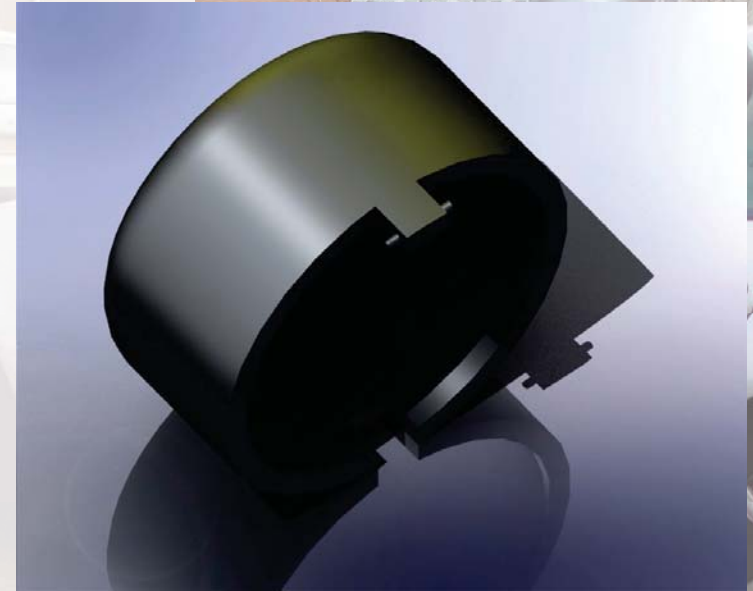


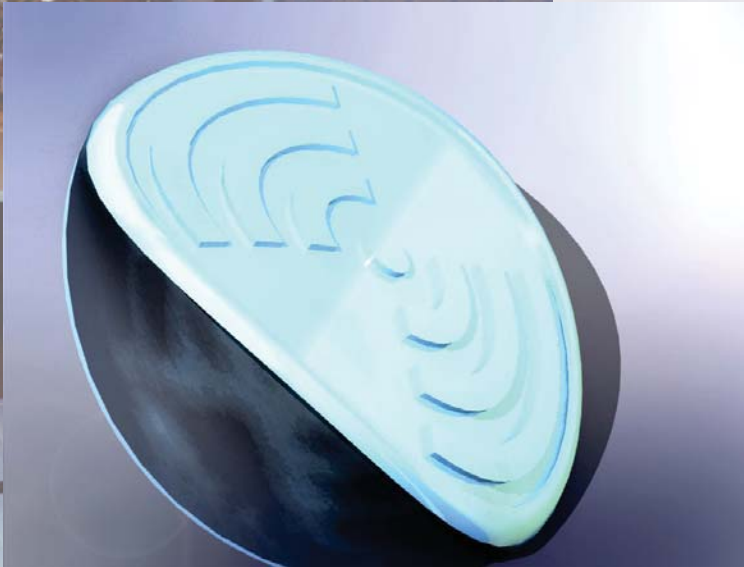
The lid

The lid is designed in such a way that the user of the charging unit is able to easily open it, without harming himself. It has no protruding parts to keep potential damage low as there are no parts to break off. After the user has scanned his keyfob, the charging point unlocks (as shown on page 10). After that the plug is plugged-in, the lid closes nicely and softly assisted by a spring, in such a way that no water can enter and that the plug can not be disconnected by someone else. The material used to fabricate the lid is also aluminum and is produced with injection molding. This part should be robust too to prevent people to destroy it.

The electronics housing

The electronic housing is a plastic part inside the socket frame; it is used to keep the electronic parts inside this housing steadily and to make the whole unit watertight. In addition, this part should have a high electrical resistance so the electricity won't be conducted to the housing. This is very important to the safety of use. Another important property for safety that the material of this part should have is a reasonable thermal conductivity. This is because during charging, there is lot of heat is produced by the electronics. The housing should not be heated because it can harm people, but on the other hands, the heat should be released so the inside of the housing won't get overheated. Plastics have high electric resistance and low thermal conductivity. From our research (see appendix I), PE is most appropriate for the electronic housing. It has a reasonable high thermal conductivity and high electric resistance compared to the other plastics.





Identifier

The identifier is made of polyethylene, same material as the electronic housing. This material is chosen because it is watertight and able for a signal to penetrate. Using the same materials will lower the cost of manufacturing. This plastic part is produced by injection molding. The most important reason is because it is very cheap compared to other production methods. The shape is made so it suits the shape of the housing. There are some ribs on it because it represents the symbol of signal and wireless connection.

Socket

A socket is used, because it's a standardized component. Using a standardized component means that it is not necessary for car manufacturers to design special plugs or adapters.

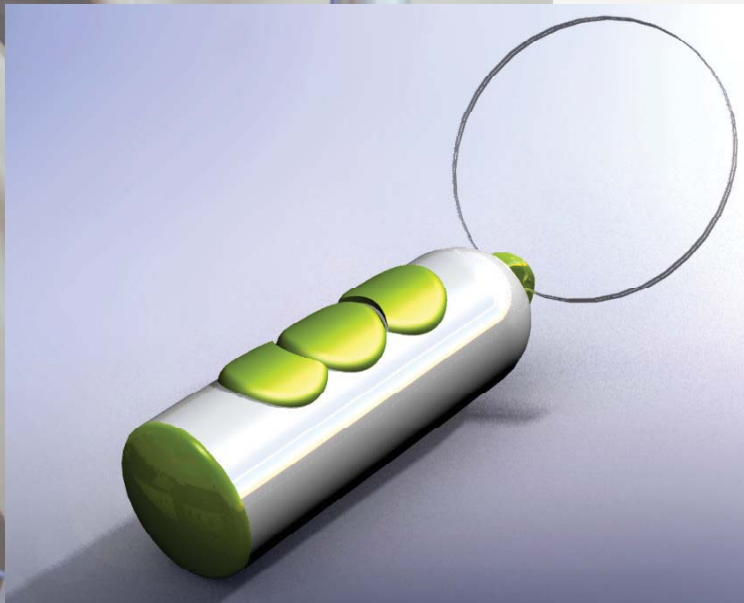
Keyring

Also the key which controls the charging unit is designed by Juice. JUICE!'s identification system works by scanning or sweeping a key ring over the identifier positioned on the charging point itself. The principle is similar to private parking lot principles, were you sweep your ID to get into the parking lot. Once the user is identified through JUICE!'s registration technology payment is done automatically.

The JUICE key ring contains a flexible LCD screen to indicate the mode and whether the scanning was complete. It contains 3 charging modes; fast charging, eco charging and standard charging.

Fast charging means that the electrical vehicle battery start to recharge as soon as it is plugged in. The consequence is that it will also charge during peak hours as can be seen in the figure. During these peak hours the price of electricity is the highest, this means that JUICE! buys the electricity for a higher price and also sells it for a higher price in such a way that the electricity price gap, the price JUICE! pays for it's electricity and the price JUICE! charges for the electricity, as described in the businessplan stays equal 20 cents per kWh. The fast charging mode will be used by people who do not need their electrical vehicle soon and just want it have a charged battery.

Using the standard charging mode means that the electrical vehicle starts to recharge as soon



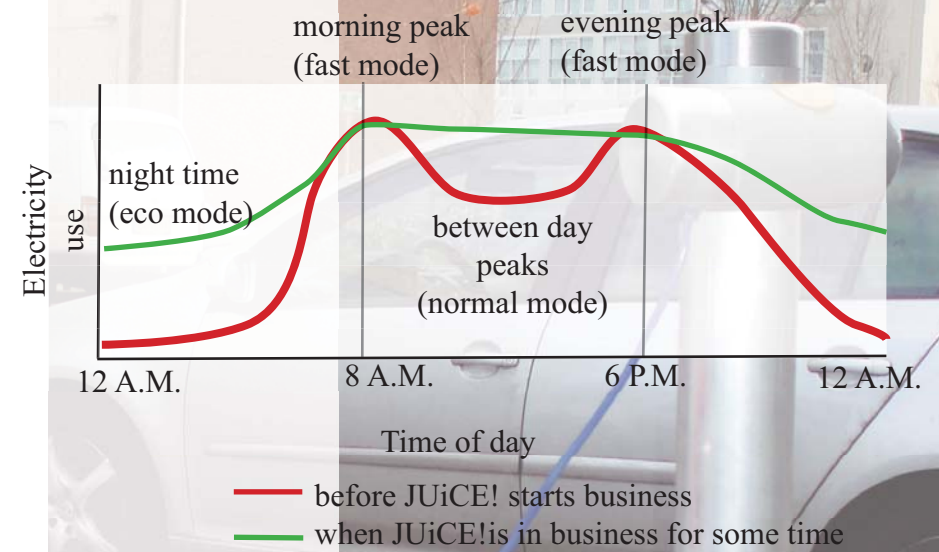
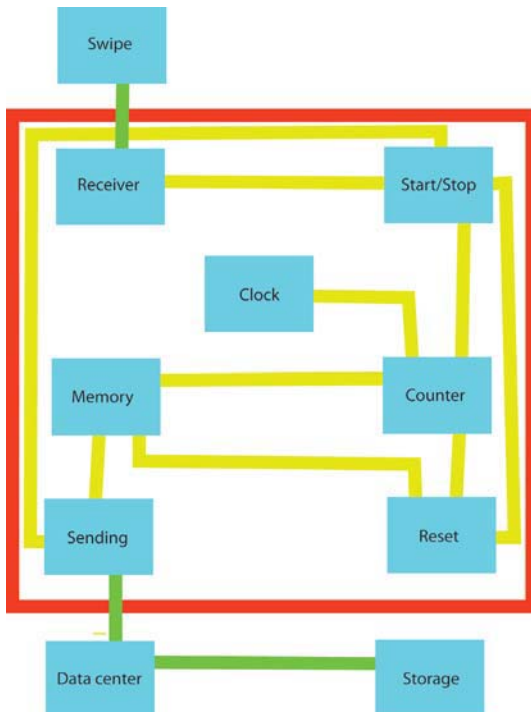
as the peak in the power consumption is over. This means that the price of electricity is lower for JUICE! and so for the client as well, such that the electricity gap stays equal. The standard charging mode will be used by people who will drive in the morning to their work and drive back home in the evening, such that is recharged between the peaks.

Using the eco-mode means that the electrical vehicle is charged during the night, this means a low energy price. As well as in the other modes the electricity gap stays equal.

People who are going to use this mode are people who are not using their car during the night; this probably means a lot of people. Also for people who want to save money it's the best mode.

The electronics

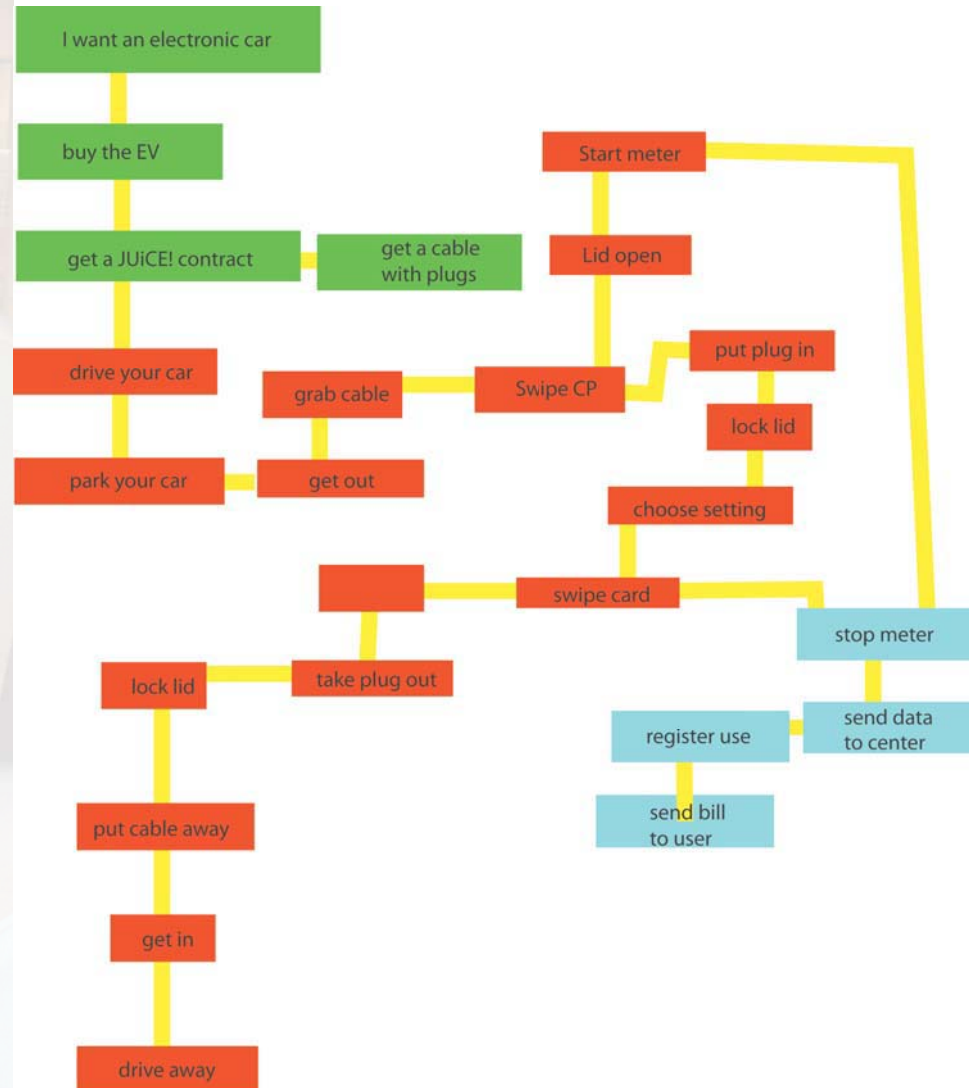
The diagram gives a schematic idea of how the electric circuitboard in the product will work.





Use

This diagram shows the user interaction with the product, combined with the actions the product takes. The use of the product basically involves scanning your keyring when you want to plug in and to scan again when you want to plug out.



Conclusions

The requirements and preferences arranged in the first period were the following:

Requirements

- Able to charge electric vehicles
- Safe to use and install
- It has to be waterproof
- It has to be water resistant
- It will not get rusty
- Standardized authorization and connection
- Impossible to 'steal' energy
- Suitable for quick mass production and installation (8,4 million produced and installed by 2020)
- Convenient for a major energy users such as municipalities and companies
- Allow for easy use of green energy

Preferences

- It fits to the surroundings
- Connection your car has to be attractive
- Attractive payment system
- It must not invite vandalism
- Exclusive design for EV only parking spots
- Low maintenance
- Design with cradle to cradle in mind
- Possible to redeliver to grid (this preference is removed, the reason is described in the chapter of the improved business plan)





Improved Businessplan

Introduction

In this chapter the business model made in the first period is improved. During the individual and final design part many difficulties were encountered, which means that the business model made during the half of the minor is not realistic anymore.

Improvements

In our original business plan JUICE! was separated into two parts. One part called JUICE! automotive which was responsible for the exploitation of the grid of charging points and the sale of cars and contracts. The other part JUICE! charging was responsible for the production, selling, maintenance and placing of the charging spots.

During the designing phase JUICE! made the decision to outsource the car sales part, because originally it was the plan that JUICE! should be the owner of the electric vehicle batteries to make an electrical vehicle more attractive to buy. We have seen a lot of difficulties, mainly financial with this and have therefore stopped working on this.

The option to sell the created electricity buffer to energy companies is also not taken into account anymore. The main reason to cancel this buffer is because the batteries used in the car will undergo more cycles if the buffer is used. This means that the batteries will wear out more quickly which means a lot of extra costs for the user. Another reason to cancel this option is the difficulty to develop and implement the software and hardware which are making this function possible. Hardware is needed inside the car or phone of the user so the user

can insert the probable time of parking after which the software is going to calculate at which time the batteries should start recharging with knowing the energy capacity on the net. The software should also be able to discharge the battery if electricity is needed elsewhere and the owner of the car does not need the vehicle for a while. It can be concluded that there should be software designed that can communicate independently with energy companies, which is expensive and difficult. Also the extra time the driver should spend inside the car to insert the time of leaving is not realistic, because people just want to go out of the car after parking especially when they are in a hurry.

In the new business plan JUICE! is still separated into two parts. One part JUICE! automotive is responsible for the grid of charging points and selling of contracts to clients. The other part JUICE! Charging is responsible for the production maintenance and placing of the charging spots.

If the grid of charging spots is present there is the need for a control room/helpdesk to solve certain problems encountered by the clients, this control room is part of JUICE! automotive. A work force is needed to help people who are having difficult problems to be solved by phone. The plan is to work together with the ANWB or route mobile, in such a way that we pay them a yearly amount of money so they also solve our problems.

In the original plan the focus was on people who could afford a quite expensive car to be the first target group after which also less rich people could be our clients. This idea is based on the plan that JUICE! is the owner of the car battery and thus needs money to buy these batteries before money comes in. In the new plan JUICE! is not the owner of the batteries anymore and so the starting capital needed is reduced a lot. Not focusing on rich clients means that JUICE! can deliver electricity to basically every electrical vehicle, only the vehicles are relative expensive so only people who can afford it will drive it.

The most important partner will be the local governments, from which some are already very interested in the idea of electrical driving. The reason for the governments to be interested is that electrical vehicles are not producing dust particles and polluting gasses, this means that the cities will be cleaner and healthier. The government could also save money, because important buildings do not have to be cleaned as often as is now the case and building projects are not stopped due to the fine dust concentration in the atmosphere. People living next to major roads are also having less noise pollution if cars would drive on electricity, because the engine noise is gone.

The other important partners are the electricity producers, the idea is that JUICE! is buying electricity for a relative low price and sells it a little more expensive, in this way money is



made. Later on JUiCE! could produce its own electricity, because the government will open the electricity grid. For JUiCE! this gives the opportunity to invest money in green energy producing facilities, like wind farms or digesters.

To create a real alternative for driving on fossil fuels quick charging stations needed to be produced. Quick charging stations can fully recharge a battery in minutes, which gives an electrical vehicle owner the possibility to reach every point in the country. When this is a fully operating grid hybrid cars are not needed anymore, so JUiCE! will get a market share of the people who are already trying to drive greener. JUiCE! is not going to build the quick charging station, because at the moment it is too expensive and difficult.

Another very important part of our plan is to inform the general public, companies and governments about electrical driving. A lot of people and so also companies and governments know nothing about electrical driving and so nothing about the good parts of it. Like the costs of driving, the easy maintenance and the environmental friendliness.

During the first part of explore lab it was decided based on the expected income and initial costs that a charging point should not be more expensive than 1250euro including the placing and maintenance.

It can be calculated that the final design will cost maximum 25 euro for the materials, transport and assembly including the electronic parts. The installation of the charging unit will cost about 40 euro, because the average installation time is about 1 hour and only one worker is needed to install it. The 500 euro includes the new cable (from the charging unit to the main cable which is at least 60cm under the ground) and installation of it, one cable can facilitate several units, which reduces the costs per unit. The maintenance and help desk will cost about 1 million a year, because JUiCE! will use already existing facilities. This makes the total costs per unit without maintenance 500 euro and for two units on one lamp post 565 euro. These numbers were confirmed during the conversation with the local government in Amsterdam they were mentioning that installation of the cable will cost about 350 euro per post.

In the first period the decision was made that 60% of the parking places should have an electrical vehicle charging unit. This means $0.6 \cdot 14.000.000 = 8.400.000$ parking spots by 2020. The production and installation of the optimal charging units starts by 2011 and provides 6% of the places every year, this means 840.000 units need to be produced and installed every year.

The expected amount of electrical cars on the road at 2011 is 200.000 and it grows by



200.000 every year, until one million at 2015 after which it grows slowly further until 1.8 million at 2025.

Electrical vehicles will drive an average of 15.000km a year and uses about 1 kWh every 6km. This means $15.000/6=2500$ kWh needed per EV per year. Assume that 50% of the time EV owners recharge their batteries using JUICE! charging spots and 50% at home or elsewhere not using the JUICE! charger. Most EV owners will live and work in cities and so are not able to use their own driveway to park and charge; otherwise this 50% JUICE! usage is high.

Nowadays the price per kWh is about 20 euro cents, a little more during daytime and a little less during night. JUICE! is trying to charge as much as possible during night time and make price contracts with energy suppliers for around 10 cents (JUICE! is also a big energy user, due to its amount of clients). To make money JUICE! has to sell the energy for a higher price so let's say around 30 cents per kWh. This means that the gap is 20 cents.

So the gap is worth around $2500*0.20=500$ euro per EV per year. So in 2011 JUICE! assumed that there are about 200.000EV which use the JUICE! charging spots 50% of time, so 100.000 cars are only using the JUICE! charger. This means that JUICE! gets $100.000*500=50.000.000$ euro in 2011. The amount of charging spots installed is about 840.000 of which the price per unit is 500 euro so the money needed is $500*840000=420$ million, actually it is less due to the possibility to place two chargers at one light post. So the investment needed in 2011 $420-1-50=369$ million, the one is the maintenance costs. The possibility to install two chargers on one lamp post will reduce this investment by several millions.

The amount of installed charging sport per year is equal for the first 10 years after which the grid is fully operational. After ten years there are more electrical vehicles and the charging sports are installed so they can cheaply be replaced if needed, because all necessary electricity cables are present. This means that the investment needed per year goes down, especially after 2020 when the grid is fully operational.

As explained earlier after 10 years the grid is finished which basically means money can be made. There are many variables which are important and difficult to predict like the amount of EV on the road and the expected growth of this amount. Also the price per kWh and the money needed for maintenance and a control room are difficult to predict.

The price of a charging point is also difficult to predict, in the calculations 500 euro was taken into account. This amount of money could be lower if several units are installed on one light post. It is difficult to predict, because the price depends very much on the production methods, quality and the materials used.

In the future there is also the availability to earn money in different ways, by selling the buf-





fer if the technology is available, or by adding an option to sell commercial messages. What also could be a possibility is that other companies enter the market with a comparable product; this should mean that the electricity price should go down. Car manufacturers could also produce a car which is using almost no electricity; this means for JUICE! that less electricity can be sold.

In the excel sheet added to the report an easy calculation is shown of the predicted income and expenses in the first 10 years. It can be seen that 4.2 billion euro is needed to make a completely functional grid and the total income will be around 2.43 billion, this means an investment of 1.86 billion is needed. The 10 million euro invested in maintenance is not significant. As explained above the amount of money needed as investment is depending on many variables and so it is not really precise, but let's say that it is between 1 and 3 billion. JUICE! is thinking that the government and electricity companies are willing to invest, because there are economical problems at the moment. Usually economical problems mean that the government should invest in projects which are creating employment. Installing and building 840.000 charging spots every year for 10 years, and the maintenance needed will create a significant amount of jobs. Another reason for the government to invest would be to eliminate the chicken and egg story, in a way that fully electrical vehicles can be developed.

A possible company which could invest is an electricity company like Essent. By investing in JUICE! an electricity company opens a new source of clients towards they can sell electricity and JUICE! could be more efficient by enlarging the gap between the selling prices of electricity and buying prices from its investor. In the future it may become economically beneficial for the electricity companies to explore the energy buffer capacity of the batteries. By using this buffer in a smart way, the electricity grid can be used more efficient. Energy companies can save in this way money on their production expenses. At the moment and in the near future a buffer doesn't exist, to have a buffer a significant amount of electrical vehicles are needed.

Another very promising reason to invest in JUICE! is that JUICE! is entering a market with a promising product, this means that it could grow towards a multinational. When JUICE! becomes a multinational the investors could sell its shares to earn back the investments and of course they get yearly dividend on their shares. The government also gets a yearly significant amount of tax income by JUICE! and by its employees.