

Make Electric Vehicles more Efficient and Affordable

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Introduction

This proposal focuses on the need for more efficient and affordable electric cars. The solution for this would be to have a sharing battery system, where the battery of the electric car is removed during the time a customer makes the purchase of the vehicle. This way customers will not be paying for the battery itself. Batteries would instead be rented out and battery stations would be available for charging batteries.

Electric vehicles have many benefits. They have a crucial role in dealing with climate change. “There are already over 10 million electric cars on the world’s roads” (Broom, 2021). So, what’s holding electric vehicles from taking over the industry? The main concerns arise from the reliability, cost, and range of these cars. Prices of electric cars have been much higher than diesel or petrol vehicles. However, one would spend less money in maintenance and servicing costs, as well as less fuel costs. The main issue arises with charging stations. There are just not enough of them, and the charge doesn't last very long. (Broom, 2021)

To make electric cars more affordable and efficient, we must know what makes the price of an electric car so expensive and inefficient.

Take the example of Tesla Model 3, the price of model 3 is from: \$43,900. Where the average compact SUV cost is only \$32,258 (“Average new-vehicle prices”, 2021). One may ask: what makes the Tesla Model 3 so expensive? The answer is the battery, it cost nearly \$16,000 to replace the Tesla Model 3’s battery pack (“How much does a Tesla Model 3 battery replacement

cost”, 2021). The battery makes up nearly 1/3 of the car price, this is unacceptable to a customer, we need to change the situation and let the price go down.

The charging is another problem that makes electric cars inefficient. Unlike traditional gas cars, electric cars need to get charged from time to time. When the car needs charging at home, it becomes extremely inconvenient for some users who don't have a garage, because electric cars need a charging spot, but the problem is most people have their parking lot on the street. And the charging process takes a long time. It'll be better if we can have the electric cars recharged within minutes as the gas cars get refueled in a gas station.

The concept of battery swapping would allow customers to come into a battery station, remove their depleted batteries and replace them with fully charged ones. Battery stations would need to be widely available for customers. Unlike charging stations which would fast charge electric car batteries, causing the battery to degrade much faster, swapping allows for the batteries to last longer. However, much of electric vehicle interest and battery swapping has been in Europe and Asia. Another major obstacle this innovation may face is centered around the concept that the battery of a car is its major component. Carmakers tend to take a lot of pride in the way their car batteries operate, and so many think that it would be difficult to implement battery swapping in places other than fleet vehicles.

Engineering innovations

There were many innovations that had been proposed, like improving the battery to have a greater range, ultra-fast charging to reduce the charging time, or wireless charging to make charging more flexible. Those technologies may work well but will cost more because all needs

additional equipment. This is not what we want, we as consumers need to reduce the cost and make the car more efficient.

Technical Description of Innovation

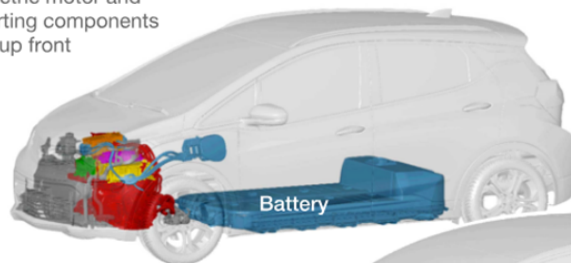
Removable battery

To implement the “battery sharing system”, our first problem is how to make the battery removable. The battery is in the bottom of the car as the image shows:

Electric-vehicle powertrain architectures vary, even among the newest models.

Opel Ampera-e

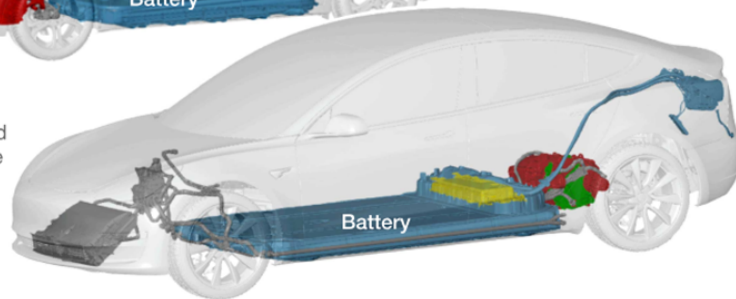
In the Opel Ampera-e, the electric motor and supporting components are all up front



- Electric motor
- Inverter/converter module
- High-voltage charger
- High-voltage junction box
- DC-DC converter

Tesla Model 3

In the Tesla Model 3, the electric motor and power electronics are in the back, with the DC-DC converter and high-voltage charger integrated in battery pack



Source: A2Mac1; McKinsey Center for Future Mobility

Figure 1: the battery in the car (Tesla Model 3, 2021)

As we see, the battery is under the car and hard to be removed. When the battery needs to be changed, we have to lift the car and dismantle the battery, this is very inconvenient, and we can definitely improve that.

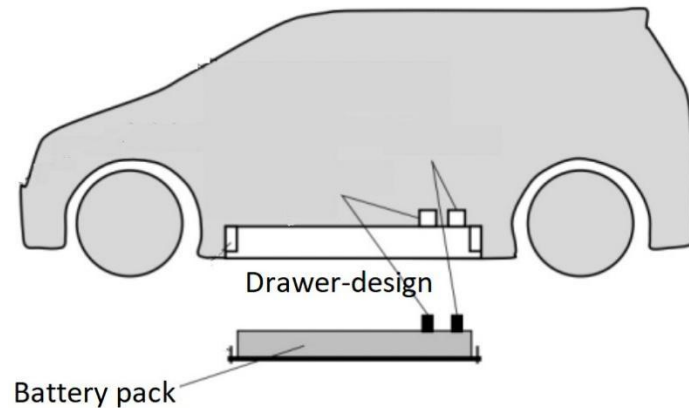
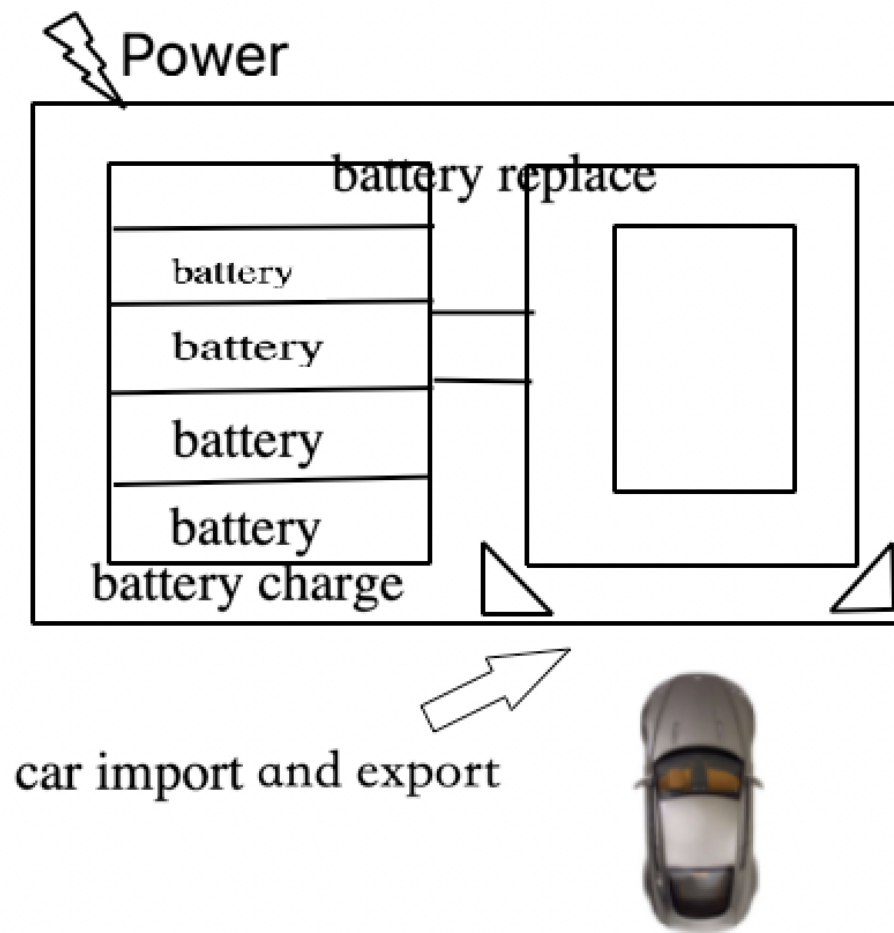


Figure 2: drawer-design enable the battery swapping

Drawer-design: We can redesign the way the battery pack is installed in the car. Instead of attaching the battery under the car, we can redesign the bottom of the car to be like a drawer and make the connection between the car and battery pack more flexible, the drawer-design will have a battery slot in the bottom of the car. For security reasons, the battery slot can only be opened by professionals or at a battery station. With this design, we can have the battery changed much faster than before because we don't need to lift the car anymore.

Battery sharing system: As the name suggests, the shared battery is used for battery replacement. The appearance is similar to a garage, with different boxes in it, each box stores a battery. There is usually a display screen or a QR code at the door of the garage, which can display the

operation QR code of the cabinet. Use the display to control the opening of the garage door and then drive your own electric car in. The machine inside will automatically remove the battery for you and replace it with a fully charged battery. At the same time, the replaced battery will be stored in a box in the garage, and the box will automatically charge the battery. Electric vehicles can use the shared battery system to realize self-service battery replacement.



With the popularization and advancement of green and healthy energy, more people choose electric vehicles and other means of transportation. I think the battery sharing system of electric vehicles will have a big market. We can set up such a battery sharing garage every 100 kilometers, and then when the user finds that his car has no electricity, he can search through the

software to find a nearby battery that can be used. After the shared garage arrives at the place, the battery can be changed autonomously only through the upper display screen. This method is more convenient and faster, saving a lot of time. The car owner also has more time to do other things.

The process of the innovation itself and the process of building the innovation.

You will be required to address COST, TIME, MATERIALS, DESCRIPTION OF MATERIALS, LABOR-POWER... and all other necessary and important factors. (These components can be rough estimates and theoretical if need be. You can draw this information from the production and data of similar and previously invented innovations.)

Cost

Cost for renting a battery: 200\$/month, 2400\$/year, if a car is used for 5 years, the total cost will be 12000\$

The cost for buying a battery: 16000\$, has a battery around 4-5 years.

Besides that, there is cost of electricity. In NYC, the electricity cost per kwh is 0.226\$(*Average energy prices*, 2021). And A Model 3 needs to be charged every 4 days and has a capacity of 82kwh. If the charge the car at home, it will cost 1690.86\$ per year and 8454.31\$ for 5 years.

Therefore, getting the battery swapped in the station can save more money.

Time

It takes 8.5h to 10h at 220V to have model 3 get full charge. But in battery station, swapping a battery will take approximately 5 mins. Which is a lot more efficient.

Material

There is no material needed for this innovation

Labor

The battery is swapped automatically. The cost of labor is very little.

Conclusion

In conclusion, our proposal tackles a number of issues. From the battery itself, making it more affordable and efficient, to the placement of the battery in the car, making the battery easily removable and accessible, charging the battery, and places to charge the battery. These are all valid concerns, and we have a solution to each of them. As we know, previously the reason why electric cars cost so much was because a huge portion of the price was the cost of the battery. With our system, the consumer rents a battery and is able to use that battery until it runs out of charge. They can then charge it themselves when they have downtime, or if they are in a rush they have a second option, which is where our idea comes in. They make their way to a “shared garage” which is a self automated garage that takes out your car’s battery and replaces it with a new one. It takes your old battery and starts charging it, and then when another person comes into the garage their battery will be replaced with your old battery. This is a continuous cycle of people using their battery until it runs out of charge, getting a new fully charged battery at the shared garage, and then leaving their old battery to be charged for the next person. This system of shared batteries is also better for the environment because the same batteries are constantly in circulation, since the consumer isn’t technically buying a new battery each time, they are just switching it out with a battery that belonged to someone else. In order to make all this work the battery itself has to be removable, and that is why the battery will be “locked in a drawer”, to be easily removed and replaced when needed. So the car itself will be structured to make the battery easily removable intentionally. This is the core of our proposal and our aim to make

electric cars more affordable and efficient. With this system customers are not buying a battery when they buy the car, since they will likely replace it with a new one some time in the future at a shared garage, hence why they rent a battery instead of buying. And in terms of affordability renting is cheaper than buying. This also solves the charging crisis that the purchasers have because the shared garage begins charging a battery as soon as it is taken out of a person's car and replaces the battery with another battery the garage has fully charged. Now there is no more tedious charging that wastes the driver's time. This makes the battery more efficient. Not to mention, being environmentally friendly since the same batteries are in circulation instead of a new battery being created each time. As a result of all this the battery becomes much more affordable and efficient and we hope after hearing this you consider our proposal.

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Self-Reflection

Yabsira Zewdie

I was responsible for the introduction of the proposal. I came across some issues regarding the content of the introduction. I was not really sure how to write the introduction following the format required in the outline. I have been used to writing introductions in just the basic essay format, where the introduction grasps the reader's attention and then introduces the concept by talking about what will be talked about. I believe this proposal had a different format for the introduction. Some of the information which was included in this proposal's introduction was not just about what will be talked about, but rather about information surrounding the innovation. I felt a little uncomfortable including references and introducing ideas in the introduction, as I have always saved those things for the body of the paper. Finding information required for the introduction was relatively simple. I found good resources which were reliable. I was a little unsure about what to include regarding 'the technical environment' that is affected by or affecting innovation. However, I added content which I believe was sufficient for this requirement. I found the presentation component to be the most enjoyable part of the presentation. It was a little difficult to find the right short sentences to put on each slide. I also had difficulties in deciding what I should say and what I should omit from the presentation. However, I am confident in the end result. I enjoyed finding the right images for each slide. There were not many images on battery sharing, so I unfortunately was not able to include that in. Something I struggled with was deciding how long my portion of the presentation should be.