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Final Project Proposal - Mobile EV Charging Stations

Introduction: What is the need for this product?

Electric vehicles are, without a doubt, on the rise across the United States and the world as a whole. New York has pledged to ban the sale of new gas vehicles by 2035, and with this in mind, it is important that we consider the charging infrastructure which is required to support this host of electric vehicles. One of the primary issues hindering the success of EV's is charging them. Charging an electric vehicle is oftentimes much less convenient that fueling up a combustion engine vehicle. Furthermore, the charging infrastructure simply is not there. In the United States, there are presently 46,000 charging stations, compared to 150,000 gas stations (Domonoske, Cronin 2022). This discrepancy means that for most people, EV ownership is just less attainable. In addition to this, some urban environments are faced with an additional problem. While at-home overnight charging is often touted as one of the benefits of EVs, not everybody in urban environments like New York City has access to a driveway with charging access. As a result, people in these communities are additionally disadvantaged when it comes to EV ownership. Thus, there is a fundamental need for an innovation which seeks to fill the gaps left by sparse electric vehicle charging stations, both in the five boroughs and beyond. Another problem associated with EV usage is range anxiety, which is caused by the fact that the range of electric vehicles can be limiting for some. In 2021, the average range of an electric vehicle was 217 miles, and while this is an increase of 152% from one decade ago, the median range of

gasoline-powered cars for the same year was 413 miles (Bhutada, 2022). Therefore, our mobile EV chargers serve to combat the range anxiety associated with EV's.

Other Innovations: What other solutions have been proposed?

Other ideas include just charging your electric car normally but the problem with this is that it takes a lot of time for this to happen. Also this has many reasons as to why it is not really an effective thing to do because it has many reasons why it does not work which are:broken connectors, network failures and unresponsive screens. Something else which has been proposed to alleviate EV charging frustrations has been to simply build more chargers, however, this is often easier said than done. The reason why this is not a practical solution just comes down to cost: DCFC stations often cost $25-50K in equipment alone, and another $50-100k in electrical service upgrades (nyserda.ny.gov). Therefore, it is wildly impractical to just build hundreds or thousands of new charging stations across the country.

Benefits of EV Charging Stations:

The benefits of having EV charging stations are numerous, one of them being that it will reduce the amount of carbon dioxide that is emitted into the atmosphere. Just by doing this it will make a huge impact in the entire country by making a clearer sky, it will provide healthier water because these greenhouse gasses impact the amount of oxygen in rainwater which therefore lead to lower levels of rainfall. Also it will lessen the effects of climate change, because when carbon dioxide is emitted into the atmosphere it raises the temperature which therefore leads to global warming, research has shown that the earth's atmosphere has raised 1.5 degrees celsius since 1880, this slight change has contributed to extreme seasonal temperatures and has also intensified rainfall and has brought droughts. Additionally, this increase in temperature has

contributed to the melting of sea ice which is a big problem that can cause floods. To put it into perspective, scientists calculated that if all of the glaciers on earth were to melt then sea levels would rise to 70 feet which is more than enough to flood every coastal city on the planet. Lastly, this benefits us because we will be able to breathe clean air which would help to clean our lungs and live healthier lives.

Technical Description: How will our mobile charging station work?

The concept of our mobile charging station is rather simple: it is effectively a battery on wheels that brings the charger to you instead of requiring you to go to the charger. The basic design is rather simple in nature. We decided to go with a cargo van platform, due to the fact that we wanted something large and spacious enough to house the internal batteries. The dimensions which we chose for the vehicle are about 250 inches long, 110 inches tall, and about 81 inches wide. One of the design elements of our mobile charging stations will be the solar panels fitted to the roof of the vehicle. The purpose of fitting solar panels to the roof is to allow the vehicle to regain/recuperate some energy while on the road, even if it is not a huge amount.

Our specific mobile charging stations will be fitted with solar panels on the roof, which will draw power from the sun when it is out, thus allowing the battery packs inside to passively gain some energy throughout the day. The van itself will be powered by a 68 kWh battery,

Figure 1 above depicts the basic design for our mobile charging station which we estimate to provide about 120-130 miles of total range.

Figure 2 on the left depicts the idea for the solar panels which we plan to mount to the roof of the vehicle to allow for some energy to be regained on the road.

In terms of the actual battery/batteries which will be used to charge the EVs, our mobile charging station is intended to feature a series of batteries with a total capacity of between 350 and 400 kWh in the cargo compartment of the van.

This will allow us to reliably charge electric vehicles of varying capacities. Another thing which we had to consider when designing our mobile charging station is how we are going to maintain the batteries at an optimal

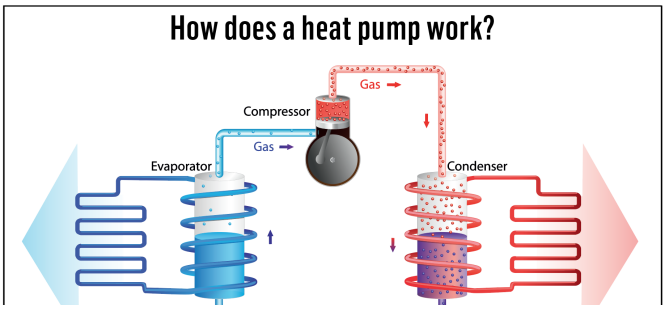

Figure 3, shown above, depicts how a heat pump in an EV works

temperature. Lithium-ion batteries are designed to operate safely between temperatures of -20 and 60 degrees Celsius, but they are their most efficient, and therefore their best between 10 and 30 degrees Celsius (VanZwol, 2022). Due to this being the case, and also knowing that our EV charging stations might find themselves in climates colder than this, we opted to include a

comprehensive heating system in the interior to ensure optimal battery performance. The type of heat pump we opted for was a reversible heat pump, which works by compressing the refrigerant that flows through the cooling system, since refrigerants get hot when compressed, and then moving the heat to where it is needed in the vehicle (Beedham, 2021).

Another facet of EV charging design which we had to take into account when designing our innovation was the specific charging speed we aimed to offer. In general, charging speeds for EVs can be broken down into the following three categories: Levels 1, 2 and 3 charging. Level 1 charging is 120V, and usually involves using a typical household-style outlet. While level 1 charging is readily available, it is far from ideal, due to the fact that it can only provide 3 to 5 miles of range per hour of charging, making it rather slow. Next is level 2 charging, which is 240V, and this can provide 20-30 miles of range per hour. Lastly is level 3 charging, otherwise known as DC Fast Charging, which can provide up to 10 miles of range per minute (Wiesenfelder, 2021). In the case of our mobile charging station, we aim to provide customers with reliable level 2 fast charging, and we aim to do this by providing a standard level 2 charger, which features 40 amps and should be good for 38 miles of range per hour.

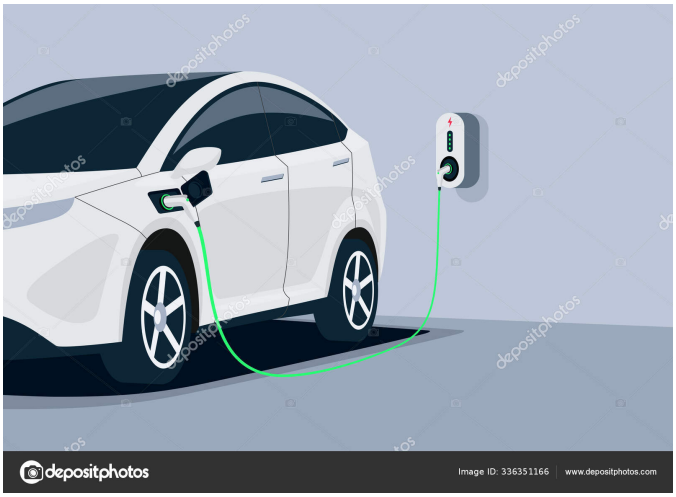

Figure 4 on the left depicts a typical charging scenario, with an at-home level 2 charger. We aim to provide this type of charging on the go.

Innovation Process: How is it going to be made? + Costs

Due to the fact that electric vans and mobile charging stations are a relatively new concept, it is difficult to ascertain specific numbers on how much it would cost to assemble our own electric van. However, we can look at other similar products and see how much other manufacturers are charging. For instance, the Ford E-Transit electric cargo van costs approximately $50-60K, and so we estimate the cost of our product to be around that ballpark. This does not tell the full story, though, because we must consider the cost of the batteries which we'll use to charge other vehicles. Unfortunately, over the past year we have seen a rise in the cost of lithium-ion batteries. The volume-weighted average cost for lithium-ion batteries rose to a staggering $151 per kWh in 2022 (Henze, 2022). Assuming we opt for a 350 kWh battery capacity in our product, that amounts to $52,850 in batteries alone. Furthermore, a level 2 car charger costs about $350-900 on average (homeguide.com, 2022). This is another factor worth considering, since we aim to provide a level 2, 38 amp charger on-board.

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