

Fundamentals of Electric Vehicles: Technology and Economics
Professor. Ashok Jhunjhunwala
Indian Institute of Technology Madras
Lecture 33

Economics of Public Chargers in Context

(Refer Slide Time: 00:17)



7.8 Economics of Public Chargers in Indian Context

Welcome to the class. This is my last lecture today. With this we would have completed 7 chapters. There is only one more hour after this left for chapter 8, where we look at the role that analytics and monitoring can play in Electric Vehicles. What I was doing in the last class was looking at variety of chargers. We looked at onboard chargers. We looked at public chargers, we looked at bulk chargers and Dr. Prabhjot has given you a fairly good understanding of the various public chargers and bulk chargers.

In today's talk, I am going to do something fairly minimum and yet is important. Coming back to India, in Indian context, the economics of public chargers there is been a lot of talk go and put public chargers maybe government can provide subsidy. The question is, if a business puts this chargers public chargers for people to use, will the business make money?


Yes, some subsidy can be there. But with what subsidy when can business make money if the energy operator who installs the chargers, do not make money then, they are not going to install the chargers they will take into account the subsidy. But finally, the chargers have to be there for the vehicles to be used to use them and ply in a large scale. It is like a question of petrol pumps.

Do petrol pumps make money? In the beginning when there are only very few vehicles, probably petrol pumps did not make money and that time government provided subsidy. But after some time, the petrol pump started making money, making money in fact is one of the most profitable businesses and people used to contend with each other some other businesses think, can I get a right to set up a petrol pump because I know it is a guaranteed money vehicle will come in they will fill up the petrol and I will get my commission.

For ultimately public chargers has to become the same manner. One difference between petrol pump and public chargers is, petrol pump fills petrol in a vehicle for an in three minutes, five minutes and the vehicle goes away. So theoretically at a peak time, almost 15 vehicles can get petrol filled.

Whereas as far as the chargers are concerned, even if I put fast chargers for one hour, it would take at least one hour to chargers and one of the problem is when it is one hour to chargers the person will come park the car go away somewhere, he is not going to sit there one hour. Nobody is going to sit there. So, person may not come back exactly in one hour. So there are issues involved in public chargers and we will deal with the economics of public chargers.

(Refer Slide Time: 04:16)



Where should the chargers be located?

Public Chargers must be available for use **when and where** needed

- Utilised for about an hour (FAST) or 4 hours (SLOW), the number of chargers and locations must be large
- petrol-pumps are not designed to handle unless vehicles are serviced in less than 5 minutes
- Parking-lots, car-parks** at homes and offices are more suitable

Business viability of a charger **to be adequately established**: Capital Costs + Space Costs + Operational Costs and Revenue

- Lower Capital Costs help
- Space Costs may be in form of revenue-share
- Operational Costs: Electricity costs + Maintenance Costs + may use self-operated-chargers
- Digital Payment

Chapter 7.0 Fundamentals of Electric Vehicles: Technology & economics 75

So public chargers must be available wherever it is needed, I am not going to drive long distance to go and find a public charger, petrol pumps are available pretty much close to wherever you are. Now of course it may be half a kilometer a kilometer away and there could be today's world

it is easy we can put on a mobile phone where your nearest public chargers and you can actually go there.

The other important thing is suppose there is a public charger, where there are four chargers, are the four chargers, one of the chargers free if somebody else is using them. You may have to wait for one hour to just or 45 minutes just to insert the charger to even start the charger. So, you can have an app which will tell you where are the chargers available and where is it free, you can book it and then go.

So, I will take into account here a fast charger, which will charge in one hour, slow one's can charge in four hours, five hours, let us take four hours. Now, for me as a vehicle owner for the chargers to be available, there has to be large number of such chargers. The first point I want to repeat at earlier also talked about that the petrol pumps are not designed to handle unless vehicles are serviced in less than five minutes.

Petrol pumps are designed basically can hold maybe four or five vehicles small petrol pump. So there can be two pumps. So, the two pumps are getting filled two pumps are two are behind maybe one or two are leaving that is all that's the size of a petrol pump small petrol pump, larger ones may have larger numbers. If you put vehicle chargers, whether fast or slow, just takes too longer time, it is not the right place to put the chargers public chargers.

What are the right places? Parking lots, car parks, homes, offices, cinema halls, malls. Why? Because, restaurants, because if you go to these places you are going to at least, if you are going to restaurant at least 40 minutes 45 minutes maybe more. So charging putting it for charging even for fast charging is perfectly alright. In office or homes you can do slow chargers. Parking lots also you can do slow charging, as well as fast charging. Somebody will park and then you will stay for five hours can just park there.


A movie one is going to park it slow charging is okay. On the other end if you are going for 45 minutes-1 hour even purchasing something you like to do fast charging. So, parking lots, car park etc are more suitable. The important thing that most people do not understand is that it is not enough to have technically a good charger, technically a good chargers What does it consist of Dr. Prabhjot has already told you.

The question is business viability, business viability of the capital cost to install a chargers capital cost involves not just the cost of the chargers, but also you have to draw power line, so the power cod, DISCOM company may ask you for money to do that. Then there is a space cost if the car is going to be stayed there for one hour somebody has to pay for the space, of course there is a parking lot it is not a problem, because parking lot anyway person would have paid for parking lot.

Then all the operational cost, the cost of course of electricity is there a person needed. So, you need to determine, what all these costs will be and what will be the revenue and it should finally the energy operator who will put the chargers must make money. Of course one can say there can be lower capital costs which will of course help because as you remember repeatedly, I pointed out the capital cost is not just the capital cost depreciation is also the interest costs especially in India.

Space costs may be a revenue share, either the personal charging for parking or you may say okay, I will give you some share of the revenue that I make. Electricity cost maintenance cost may use self operated chargers generally, digital payment is like ugly to be used and you can get more or less instant payment today. So this is what is needed and if there is a subsidy you take into account the subsidy and still it has to viable business viable.

(Refer Slide Time: 09:35)



AC Chargers

AC001-1 (single output) has single phase 230V input and output

- may cost as low as ₹5000 in volumes: Can be deployed widely as business case strong
- Business Case: For up to two hour of usage, Charge ₹10 plus the electricity charge (actuals)
- Even a single vehicle-charge for two hours a day gives yearly revenue of ₹3650
 - Can easily pay for capital costs, interest rate and AMC: not for space – use in parking lots

Level 2 Chargers

- 6 kW: may cost ₹10,000 in volumes
 - Charge the customer ₹20 for use of up to an hour at a parking-lot
 - With even a single vehicle using for an hour, yearly revenue of ₹7300
- 21 kW FAST Charger: may cost ₹50,000 for equipment + ₹50000 for power installation
 - Charge ₹100 for each car-charge (less than hour) and get two cars charge per day to break even

₹3650 per vehicle

Chapter 7.0 Fundamentals of Electric Vehicles: Technology & economics 76

Start with the AC001, single output chargers 15 ampere plug point and you are trying to charge a two wheeler or maybe a three wheeler or even a small four wheelers about, let us say three four hours, slow charger. Normally a 230 volt input and output will be what the vehicle needs. A simple outlet like this, what does the outlet consist of, outlet has a essentially AC plug with all the protection.

AC comes from the three phase you derive a single phase, you put all the protection, you put the metering, you make sure that the payment mechanism is there, may be a communication with the vehicle, that is what the cost of a box like this maybe around 5000 rupees in volume. Suppose, you charge 10 rupees for up to 2 hours usage plus the cost of electricity.

Whatever the electricity it draws of course, it is only going to draw three kilowatt of electricity. So, at whatever rate the electricity supplier gives you, you charge them as per the rate, plus you charge at 10 rupees as long as you park the car there, for two hours and chargers it. If you use it for 4 hours, charge 20 rupees. So, suppose you do this. Even a single vehicle chargers in a year vehicle per day, if you do only one vehicle per day 365 days get 10 rupees, you are making 3650 rupees per year.

You can straightaway see, that there is really no serious problem 5000 rupees, simple three phase plug you do not require too much of electricity, you put that you make 3650, there is only one vehicle on the average will do, if two vehicles does you get 7000 rupees. So, essentially can easily pay for capital cost interest rate and AMC not for space, but in parking lot it is not a problem, parking lot anyway person is paying for parking.

So, is AC001 kind of 230 volt makes sense as long as at least once a day it is used, if it is used twice a day you are in good, you are in a very, very good situation. But you put about 5 or 10 chargers not everything will be used all the time, once a day is a good enough, maybe sometimes twice a day to get 1.5 times in a years time you can recover, no person is required. So, you can see the business viability you pay for your capital cost, pay for your interest costs one year interest is not going to be very large it can straightaway do that.

But this is important the point that I am making that businesses viable, AC001 is fine. Suppose you take level two charger 6 kilowatt three phase, remember I discuss level two if a vehicle has a 6 kilowatt onboard charger it is a three phase 6 kilowatt is a standard, 21 kilowatt is a fast

chargers standard. So 6 kilowatt suppose one does that, a vehicle larger vehicle is there, maybe a truck is there

Say it is a little larger battery, so it is who are trying to draw 6 kilowatt. So, it is a slow charging you charger for let us say four hours, you are able to get 25 kilowatt you are not necessarily complete battery, but a significant percentage can be done. So, suppose in this case, you charge about 20 rupees per an hour for 6 kilowatt. So, even a single charger vehicle charger for one hour, it will cost you 7500 rupees.

So, this also seems very good because 10,000 rupees is your cost simple three phase connection I do not think cost really very much and you get 7300. Suppose you do not get a higher equipment, 21 kilowatt fast chargers and let us say in this case, equipment costs you, let us say is high 50,000 rupees plus this cannot be directly connected to the simple three phase, where simple three phase will not give you from electricity board will not give you so much charging, because this is about 20 kilowatt.


They will have to probably draw an extra line and they will chargers you maybe 50,000 rupees. Remember that. So, your in cost becomes 1 lakh rupees. That is of course 20 kilowatt you can get almost 20 kilowatt charging in an hour. So, now you may charger let us say 100 rupees, will the person be willing to pay 100 rupees? Well, if the person is not charging at home is using that plug point, they will have to pay about 100 rupees for 20 kilowatt electricity hundred rupees may be willing to pay an extra hundred rupees will still come out much cheaper than petrol.

That is more or less the maximum that one will be willing to pay. 100 rupees will give you 36,500 rupees. So, 36,500 rupees if one vehicle is charged per day. Now that is not good enough 1 lakh is your expenditure, 36,500 you land up paying depreciation interest, other maintenance cost maybe space costs and you will soon start getting into trouble, you need at least two vehicles to be charged per day. If you do a two vehicles charge per day you have no problem you will make money. I think these are simple calculations.

Of course, now if government says government comes in with a subsidy of let us say 50 percent for this second chargers 21 kilowatt, may be which case even one vehicle per day is good enough, maybe in the beginning government may give subsidy maybe 30 percent 35 percent and in the beginning you can start with one vehicle and the year two, year three it can be two or three

vehicles. So, this is what is required for AC chargers to break even. AC chargers are easier to be breakeven either do AC001 or level two chargers and that can be done fairly quickly.

(Refer Slide Time: 17:01)



Fast DC Chargers

- Capital costs towards Power installation may be ₹50K for up to 15 kW
 - For larger power, it may be ₹150K for every 50 kW
- DC-001 (15 kW) capital cost may be ₹150K + ₹50K for Power
 - Charge ₹100 plus cost of electricity for FAST Charge for up to one hour
 - Yearly Revenue of ₹36.5K per year for one car charged per day
 - Will need at least two car to charge each day to break even *Three or four*
- Level-3 Charger up to 50 kW (either GB/T or CCS2 or CHA-de-mo)
 - Capital Costs of ₹500K + ₹150K for Power *Rs 6.5 Lakhs*
 - Charge ₹100 for FAST Charge for up to one hour + plus cost of electricity and parking
 - Yearly Revenue of ₹36.5K per year for one car charged per day
 - May need 5 vehicles to be charged per day to get yearly revenue of ₹180K per day
 - 30% return barely covers finance costs + depreciation + maintenance: risky proposition without subsidy

Chapter 7.D Fundamentals of Electric Vehicles: Technology & economics 77

What about fast DC chargers. Now moving away from AC chargers and we are coming to DC charger. So, if I take a 15 kilowatt DC charger, power installation itself may cost you 50 kilowatt, 50,000 rupees, because you are doing 15 kilowatts, again you will require a special line electricity board will say, oh to give you a line I will cost take 50,000 rupees for larger power of 50 kilowatt they will charger 1 and a half lakh crore lakhs.

This is a typical chargers that electricity board will charge, so you have to pay that. So, suppose the DC001 chargers, this is a 15 kilowatt chargers if you the capital cost is 150 thousand rupees suppose this is the capital cost and 50,000 rupees you are paying to the electricity board. So, you are investing 2 lakhs rupees plus of course all the, all the space and other things.

Let us assume again it is a self-charging, so person comes connect it and use it and let us see it is, you charge hundred rupees per for each charge in one hour you can charge the lower end vehicle is Mahindra and Tata's vehicles at AC DC001, you can charge that you are charging them 100 rupees premium over the electricity charger they will pay not much a problem. Most people weill pay. Yearly revenue comes to only 36,500 rupees and you have invested 2 lakhs, your land going to land up into trouble.

Actually you need at least not two but I will say not two, three or four. This is where the subsidy becomes very important, if government subsidized half of it and gives you 75,000 rupees subsidies, so you only pay 75 plus 50, 125,000 and if two vehicles charge you can still breakeven. But I am telling you the government subsidy will become important here and you will have to worry about it. Let us stick up higher charger 50 kilowatt charger.

You can do GB by T, CCS2 or CHA-de-mo. It does not matter. All three standards you have seen. Capital cost for something like this will be 500,000 rupees and the power line will cost you 150,000 rupees, 150,000 rupees. So, your investment is 6.5 lakhs rupees. Suppose you are getting charger only 100 rupees, for up to an hour charger plus electricity plus parking, while it will only give you 36.5000 forget about it never breakeven.

You need five vehicles per day, five vehicles per day will give you 180,000 rupees. 180,000 rupees is still only 30 percent of your 6.5 lakhs and that barely will cost take care of finance costs depreciation plus maintenance, even with five vehicles being using it every day, it is a risky proposition. Now, if there is a 30 percent or 40 percent subsidy for four vehicles will breakeven, but less than four it will not break even.

This is extremely critical. Because there is a lot of clamor today, oh we will put via fast charger, who will put fast charger who will breakeven, even if some government agency or ESL does it are they going to make money? Can subsidy more than 50 percent I certainly think is not desirable. So, until you get enough number of vehicles you have a problem four vehicles and you will find the right location make sure that they do with some 50 percent subsidy for vehicles, you can you can make do this.

Of course if you can reduce the cost of around five lakhs to three lakhs or if you can somehow say that for power, they do not charge you 1.5 they charge you only 1 lakh those things will start helping. But basically the point that I am making is that you need multiple vehicles to be charged to breakeven. While there is a lot of clamor for this level three fast charge. We are also designing it, I think it is a good thing.

It is required support and maybe 100 rupees is too little, maybe you can charge in this case 200 rupees, because after all you are going to take 40-50 kilowatt maybe that will help you only but until we figure this out and what happens very often technical people push first standards just do

things without thinking, in India if you are charging 500 rupees then one vehicle would have been enough, but I do not think that people will be happy paying 500 rupees plus the cost of electricity.

That is unlikely 100 rupees I see possible 200 rupees, I think you can ask because in one hour you will probably do 30 kilowatt or 35 kilowatt hour, so that they will say okay 200 rupees premium is okay.

(Refer Slide Time: 23:17)



To Sum Up

Public Chargers and Charging Infrastructure crucial for EVs to take-off

Smaller vehicles (two-wheeler and three-wheelers) may mostly use home charging

- AC Public Slow Charger (AC-001 and Level-1) deployment is economically viable and can be set-up quickly
- Will proliferate at Parking lots, office and multi-storied residential buildings as EVs come to market

Larger vehicles take-off may be slow with home charging


- Will need Public Chargers (DC-001 or Level 3) at Parking lots and office-buildings
- Will need initial subsidy and business to build-up for viability

But the point that I am making that these are difficult business proposition. AC chargers are not that difficult, because the cost is low, the cost of installation is low DC chargers start becoming increasingly difficult and energy operator will not make money. To sum up on this chapter of chargers, public chargers and charging infrastructure are crucial for EVs to take off, there is no ifs and buts. Small vehicles we mostly use home charging and yet some public charging AC001 level one deployment is required and fortunately that is economically viable and can be quickly set up.

You can do it in parking lot, of phase multi residential, mall, building some we can also have the some kind of regulation for that, that is viable that will take off for those smaller vehicles two wheeler, three wheeler and this AC chargers can take off that can help and let us move and do that first. Larger vehicles will require DC charging DC001 or level 350 kilowatts or more can be

put in office buildings. We will need initial subsidy and wait for business to pick up. That is what is required.

(Refer Slide Time: 24:59)



Assignment 7.6

True or False

- a) AC001 has a single phase 230V input.
- b) Charging points installed at homes are recommended to be fast chargers.

Fill in the blanks

- a) Time taken for fast charging is less than ___ hrs whereas time taken for slow charging is usually more than ___ hrs.

Chapter 7.0 Fundamentals of Electric Vehicles: Technology & economics 79

There is an assignment that I am giving. Please do that. I will probably add one more assignment in then, but pretty much I have done the chapter.