Fundamentals of Electric Vehicles
Technology and Economics
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Lecture 73
Economics of Public Chargers in Context

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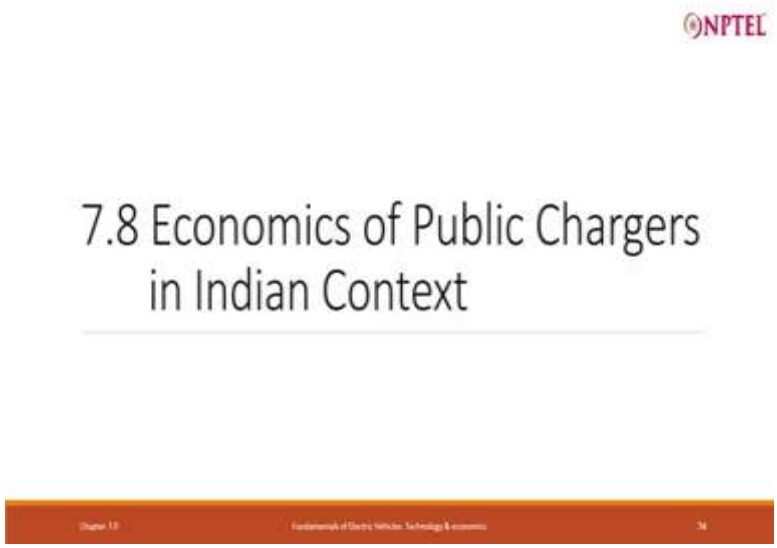

Welcome to the class. This is my last lecture today. With this, we would have completed 7 chapters. There is only one more hour after this left for chapter 8 where we will look at the role that analytics and monitoring can play in electric vehicles. What I was doing in the last class was looking at variety of chargers. We looked at onboard charger, 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 todays 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 has been lot of talk go and put public chargers may be government can provide subsidy. The question is if a business puts these 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 than they are not going to install the charger, 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 is only few vehicles probably petrol pumps did not make money.

At that time government provided subsidy, but after sometime the petrol pump started making money. In fact, it is one of the most profitable business and people used to contained with each other some of the businesses saying can I get a right to set up a petrol pump because I know it is a guaranteed money, vehicles will come in they will fill up the petrol and I will get my commission.

Ultimately public chargers has to be come at the same manner. What difference between petrol pump and public chargers is petrol pump fills petrol in a vehicle for in 3 minutes, 5 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 charger for 1 hour it will take at least 1 hour to charge.

And one of the problem is when it is one hour to charge the person will come, park the car, go away somewhere he is not going to sit there 1 hour nobody is going to sit there. So, person may not come back exactly in 1 hour. So, there are issues involved in public chargers and we will deal with the economics of public chargers.

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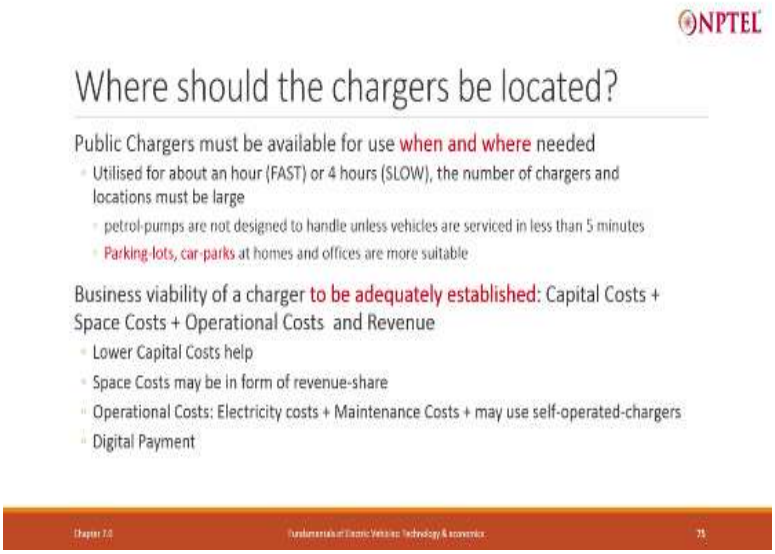

So, public charger must be available wherever it is needed I am not going to drive long distance to go and find a public charger. Petrol pumps are available pretty much close to wherever you are. Of course, it may be half a kilometer or kilometer away and there could be

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

The other important thing is suppose there is a public charger where there are 4 chargers. Out of the 4 chargers one of the chargers is 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 1 hour. Slow ones can charge in 4 hours, 5 hours let us take 4 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 I had earlier also talked about that the petrol pumps are not designed to handle unless vehicles are serviced in less than 5 minutes.

Petrol pumps are designed basically can hold may be 4 or 5 vehicles small petrol pumps. So, there can be two pumps so the two pumps are getting failed, two are behind may be one or two are leaving that is all that is 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 may be more so charging putting it for fast charging is perfectly all right. In office or homes you can do slow chargers. Parking lots is also you can do slow charging as well as fast charging.

Somebody will park and then you would stay for 4, 5 hours can just park there. A movie one is going so park it slow charging is okay. On the other hand if you are going for a 45 minutes, 1 hour even purchasing something you like to do fast charging. So, parking lots, car parks etcetera are more suitable. The important thing that most people do not understand is that it is not enough to have a technically a good charger.

Technically a good charger 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 charger. Capital cost involves not just the cost to the charger, but also you have to draw power line so the

power 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 1 hour somebody has to pay for the space.

Of course if it 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 this cost will be and what will be the revenue and it should finally the energy operator who will put the charger must make money. Of course one can say there can be lower capital cost which will of course help.

Because as you remember repeatedly I have pointed out the capital cost is not just the capital cost, depreciation is also the interest cost especially in India. Space cost may be a revenue share either the person is 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 daily 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 take into account the subsidy and still it has be business viable.

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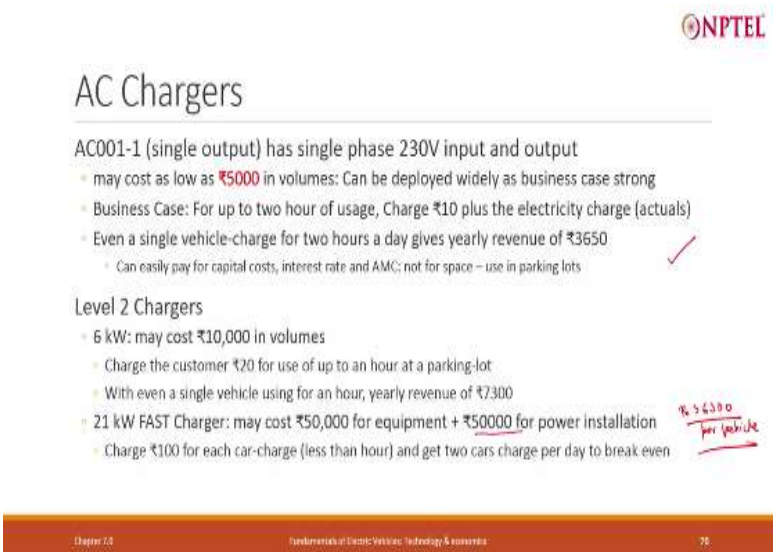

Start with a AC-001 single output charger, 15 ampere plug point and you are trying to charge a 2-wheeler or may be a 3-wheeler or even a small 4-wheeler say about let us say 3, 4 hours slow charging. Normally a 230 volt input and output will be what the vehicle needs. A simple

outlet like this what does the outlet consist of? Outlet has a essentially a AC plug with all the protection AC comes from the 3-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 may be 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 ofcourse it is only going to draw 3 kilowatt of electricity.

So while whatever rate the electricity supplier gives you, you charge them as per the rate plus you charge a 10 rupees as long as you park the car there for 2 hours and charge it. If you use it for 4 hours charge 20 rupees. So, suppose you do this even a single vehicle charge 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 if there is only one vehicle and 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, AC-001 kind of 230 volt make sense as long as at least once a day it is used if it is used twice a day you are in a very-very good situation, but you put about 5 or 10 charger not everything will be used all the time once a day is a good enough may be sometime twice a day. If you get 1.5 times a day ES 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 cost, 1 year interest is not going to be very large it can straight away do that, but this is important. The point that I am making is that business is viable AC-001 is fine. Suppose you take level 2 charger, 6 kilowatt 3-phase. Remember, I had discussed level 2 if a vehicle has a 6 kilowatt onboard charger it is a 3-phase 6 kilowatt is a standard, 21 kilowatt is a fast charger standard so 6 kilowatt.

Suppose, one does that larger vehicle there may be a truck is there. So it is a little larger battery so if you are trying to draw 6 kilowatt. So it is a slow charging, you charge for let us say 4 hours you are able to get 25 kilowatt you have 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 charge vehicle charge for 1 hour it will cost you 7500 rupees.

So this also seems very good because 10000 rupees is your cost, simple 3-phase connection I do not think cost will be very much and you get 7300. Suppose, you now get a higher equipment 21 kilowatt fast charger and let us say in this case equipment cost is some let us say is high 50000 rupees plus this cannot be directly connected with a simple 3-phase where simple 3-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 extra line and they will charge you may be 50000 rupees remember that. So in cost becomes 1 lakh rupees, but ofcourse 20 kilowatt you can get almost 20 kilowatt charging in an hour. So now you may charge let us say 100 rupees. Will the person is willing to pay 100 rupees? Well, if the person is not charging at home he is using that plug point they will have to pay about 100 rupees for 20 kilowatt electricity 100 rupees.

May be willing to pay extra 100 rupees and 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 36500 rupees, so 36500 rupees if one vehicle is charged per day now that is not good enough 1 lakh is your expenditure, 36500 you land up paying depreciation interest other maintenance cost may be space cost and you will soon start getting new trouble.

You need at least two vehicles to be charged per day. If you do get two vehicles per 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 with a subsidy of let us say 50 percent for the second charger 21 kilowatt. In which case even one vehicle per day is good enough may be in the beginning government may give subsidy may be 30 percent, 35 percent and in the beginning you can start with one vehicle and the year 2, year 3 it can be 2 or 3 vehicle.

So this is what is required for AC chargers to breakeven. AC chargers are easier to breakeven either do AC-001 or level 2 charger and that can be done fairly quickly.

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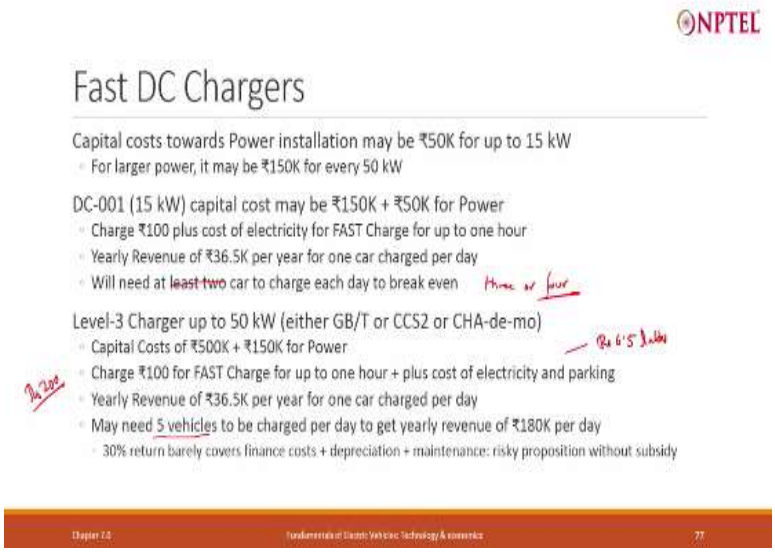

What about fast DC chargers? Now I am moving away from AC charger and we are coming to DC charger. So, if I take a 15 kilowatt DC charger. Power installation itself may cost you 50 kilowatt 50000 rupees because you are doing 15 kilowatt again you will require a special line. Electricity board will say oh to give you a line I will cost take 50000 rupees. For larger power of 50 kilowatt they may charge 1.5 lakh.

This is a typical chargers that electricity board will charge so you have to pay that. So, suppose the DC-001 charger this is a 15 kilowatt charger. The capital cost is 150000 rupees suppose this is the capital cost and 50000 rupees you are paying to the electricity board. So you are investing 2 lakh rupees plus ofcourse all the space and other things. Let us assume again it is a self-charging so person comes, connects it and use it.

And let us say it is you charge 100 rupees for each charge in one hour you can charge the low end vehicle is Mahindra and Tata's vehicles at DC-001 you can charge that. You are charging them 100 rupees premium over the electricity charger they will pay not much a problem most people we will pay. Yearly revenue comes to only 36500 rupees and you have invested 2 lakhs (())(18:57) land up into trouble.

Actually you need at least not 2, but I will say not 2, 3 or 4. This is where the subsidy becomes very important. If government subsidize half of it and give you 75000 rupees subsidy so you only pay 75 plus 50; 125000 and if two vehicle 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 take a higher charger, 50 kilowatt charger. You can do GB by T CCS2 or Chademo 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 150000 rupees. So your investment is 6.5 lakh rupees. Suppose, you again charge only 100 rupees for up to an hour charge plus electricity plus parking well it will only give you 36.5 thousand.

Forget about it will never breakeven. You need 5 vehicles per day, 5 vehicles per day will give you 180000 rupees. 180000 rupees is still only 30 percent of your 6.5 lakh and that barely will cost take care of finance cost, depreciation plus maintenance even with 5 vehicle being using it every day it is a risky proposition. Now if there is a 30 percent or 40 percent subsidy 4 vehicles will breakeven.

But less than 4 it will not breakeven this is extremely critical plus there is lot of claimer today oh we will put fast charger who will put fast charger, who will breakeven. Even if some government agency or ESL does it, are they going to ever make money? Can subsidy more than 50 percent I certainly think this is not desirable. So until you get enough number of vehicles you have a problem 4 vehicles and even find the right location make sure that they do which 50 percent subsidy 4 vehicles you can make with this.

Ofcourse if you can reduce the cost of around 5 lakh to 3 lakh or if you can somehow say that for power they do not charge you 1.5 they will 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 lot of claimer for this level 3 fast charge.

We are also designing it I think it is a good thing it require support and may be 100 rupees is too little may be you can charge in this case 200 rupees because after all you are going to take 40, 50 kilowatt may be that will help, but until we figure this out and what happens very often technical people push for standard just do thing without thinking. In India if you charge them 500 rupees then one vehicle would have been enough.

But I do not think the people will be happy paying 500 rupees plus the cost of electricity that is unlikely. 100 rupees I see it possible 200 rupees I think you can ask because in 1 hour you will probably do 30 kilowatt or 35 kilowatt hour. So then they will say okay 200 rupees premium is okay, 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.

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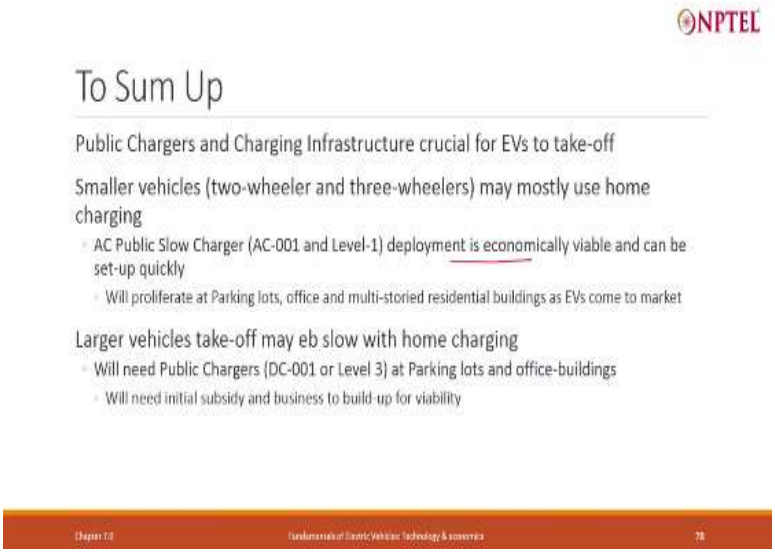

To sum up on this chapter of chargers public chargers are charging infrastructure a crucial for EVs to take off there is no ifs and buts. Small vehicle we have mostly used home charging and yet some public charging AC-001 Level 1 deployment is required and fortunately that is economically viable and can be quickly set up. You can do it in parking lot, office, multi residential building.

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 DC-001 or Level 3 50 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.

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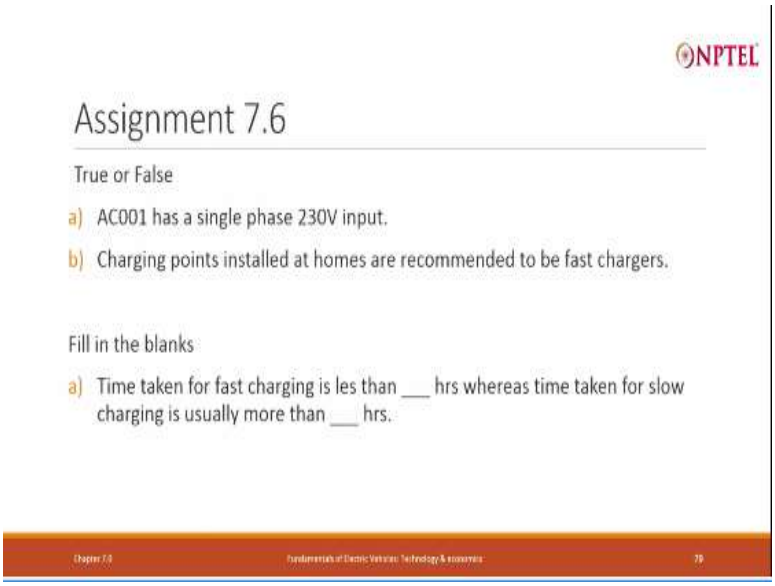

There is assignment that I am giving please do that I will probably add one more assignment in the end, but pretty much I have done the chapter.