Indian Institute of Science

Design of Photovoltaic Systems

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NPTEL Online Certification Course

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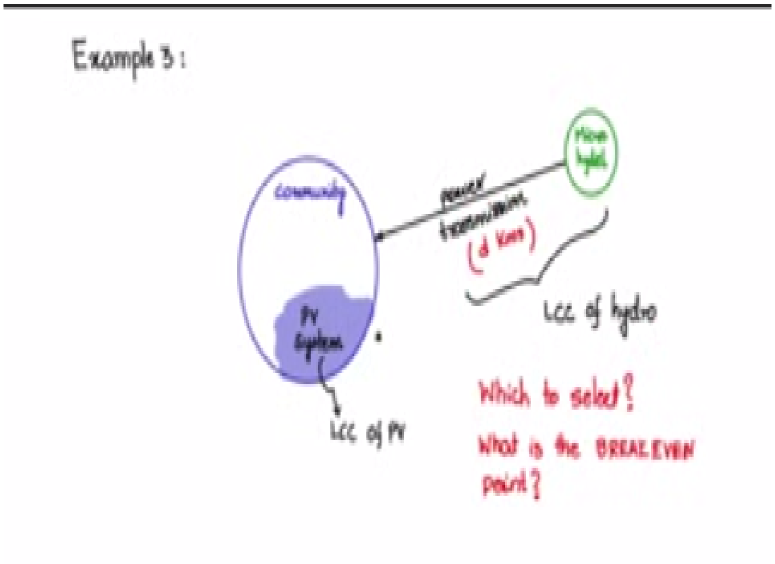

Let us now consider one more example in this example let us see if lifecycle costing will help us in performing a break even analysis consider this situation I have a community and at some distance there is a stream which can generate some amount of power let us say we have a micro hydel plant and this micro hydel plant can transmit power through lines and reach the community to power the communities electrical requirement, now let us say the distance between this micro hydel plant and the community is d kilometers.

Now the other option is within the community we could have setup a PV system so one possibility to have micro hydel plant transmit power to the community and other possibility to have a local PV system to take care of the communities electrical requirements, now there is an LCC hydro system and then there is an LCC of this PV system, which one to select is the question so the LCC analysis will give an economic analysis and then we could also perform break even so that we can say what is the breakeven point.

Beyond a particular kilometers I should go for PV system and less than this particular kilometers I should go for micro hydel system, so this kind of decision can be made from a the help of this lifecycle cost analysis, so let us see in this example how we can benefit from LCC in this respect.

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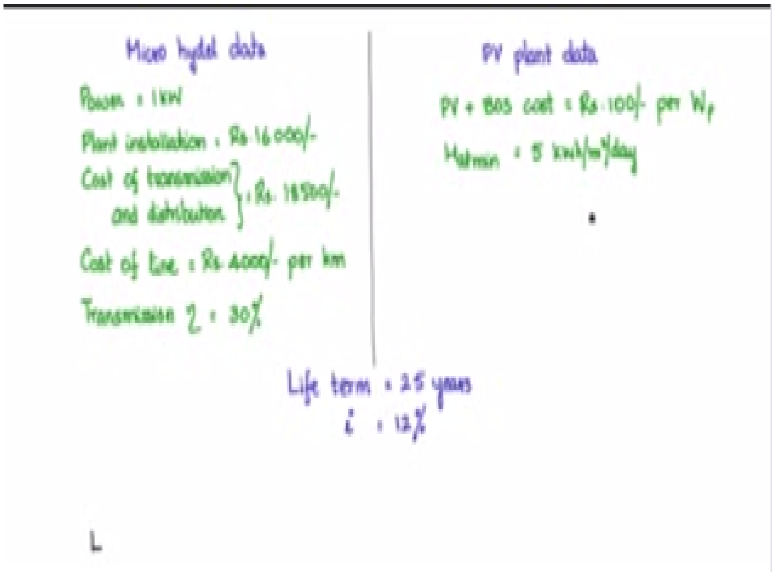

So let me now put on the data for the micro hydel plant and the PV plant side by side for the micro hydel plant let us say the power is 1kw the plant installation is 16000 cost of transmission and distribution is rupees 18500 again these are conceived values one will have to do a market survey and routine realistic values cost of the line is 4000rp/km and again I want to stress that the importance here is in trying to follow the process of this LCC to determine breakeven these exact values we can always determine from the market process.

The transmission efficiency is around 30% and for the PV the following data is available so the PV plus balance of system cost is Rs.100/ pw the Hat minimum at that place is 5kw hours /m^2/day this means that if you take standard insulation of 1kw/m^2 for 5 hours you will get this insulation available to give you the same amount of energy incident energy, now the life term for both we will consider quantify years and for both we will take interest rate of 12% per year.

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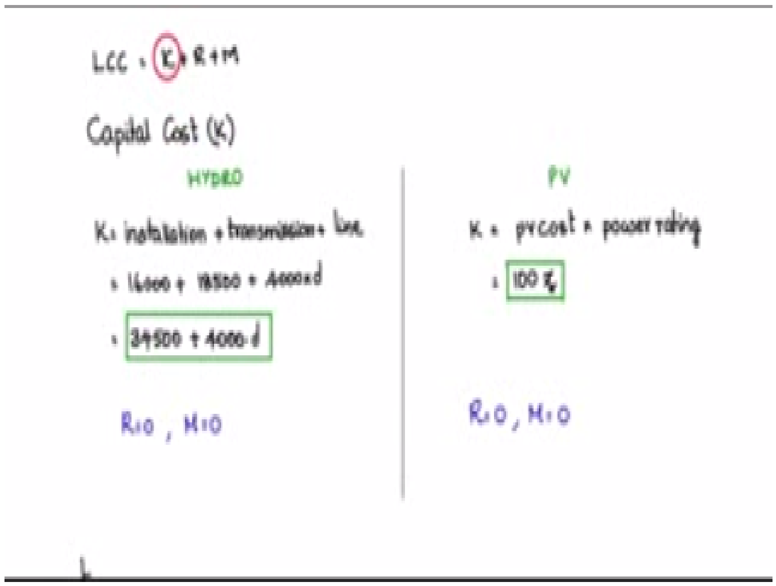

Now let us perform this LCC which is K+R+M now here let us consider only the capital cost again just for understanding the process of breakeven analysis they are been definitely be replacements in both the systems and there will definitely be maintain cost in both the systems, but for the purpose of this analysis because we have seen in previous examples how to go about calculating for replacement and maintenance I would like to focus more on how to find the breakeven points therefore.

For the purpose of this example I will take R = 0 and M = 0 for both the systems without loss of generality, so let us just think about the capital cost for now and see how to do breakeven analysis now for both the systems hydro and PV let us find out the capital cost, now the capital cost is the installation cost plus the transmission distribution cost plus the line cost, so we saw that the 16000Rs for installation 18500rps for transmission distribution 14000/km so into d is the distance between the hydro electric power plant.

The micro hydel plant and the community so we land up with 34500 + 4000d now in the case were PV the PV cost into the power rating of the PV, so let us say the PV cost is given as 100Rs per/q into x equals now let us say the power in the PV is x you will see that the x will cancel of our breakeven, so it could be any PV here rating for now probably it could be 1kw rating so these two are the capital cost the capital cost will deepened upon how much power you want to and decide for the PV array now we are taking R = 0 and M = 0 R = 0 at M = 0 in both the cases and now.

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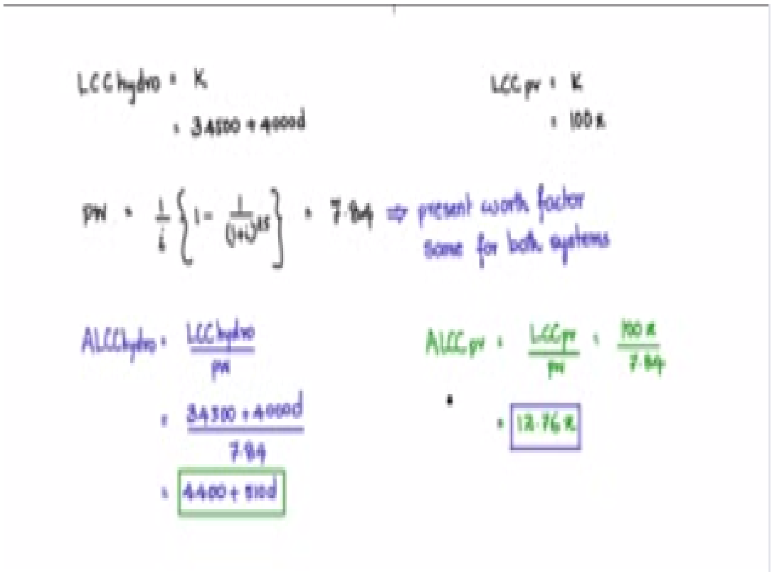

We will calculate LCC, LCC for hydro electric plant micro hydel is 34500 + 4000d and LCC for the PV is 100 into x, x in watts the present worth is given by $1 - 1 + I^{25}$ now remember that we are again taking inflation as 0 1 can as well take the inflation values from market forces and apply the formula which contains inflation, so you can find the present worth we have discuss that so this is 7.84 for the interest given interest given and this is same for both the systems so this is the present worth factor.

Same for both in systems next let us find ALCC for hydro which is LVV hydro by present worth which is 34500 + 4000d divided by 7.84 which will be 4400 + 500nd so this is the LCC and your LCC lifecycle cost for the hydro micro hydro system and ALCC for PV is LCC Pv / pw which is 100x /7.84 so this is 12.76x so this is the ALCC for the PV system.

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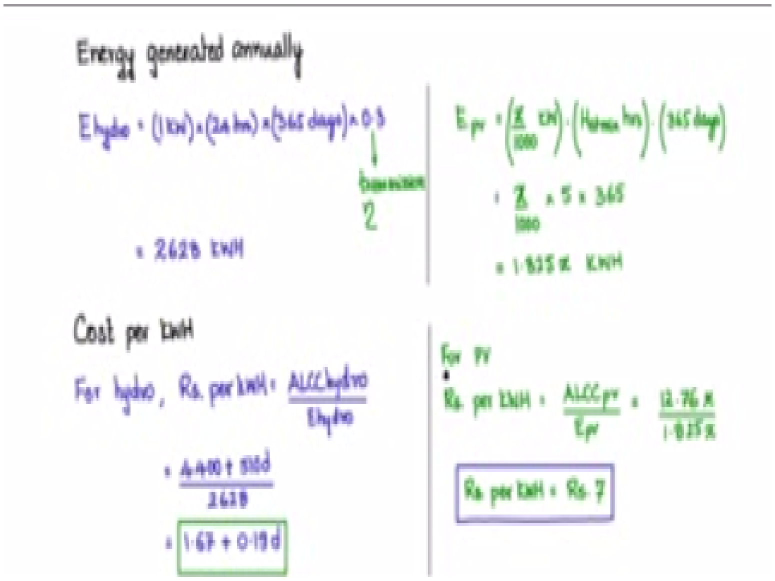

So next let us calculate estimate the energy generated annually now for the hydro we know 1kw system into 24 hours because it is capable of delivering 1kw in 24 hours, so hydel system into 365 days into transmission efficiency of 0.3 so we will get the energy that is actually usable generators 2628kwh, now for the PV plant E_{PV} we know xw is the rating so x / 100kw into hat minimum hours of operation into 365 days will give you into 5 into 365 which is 1.825x, x being the rating in vantage.

So this will be the this will be the energy generated by PV, now let us look at the cost/kw the cost/kwh is also called unit so cost per unit so for hydro Rs per unit or Rs/kw hour is ALCC hydro by energy generator annually by the hydro so both are annual terms 4400 + 510d / 262 a so you will get 1.67 + 0.19d this is the linear equation quite it will be straight line when you draw graph of the unit cost versus b now for the PV Rs/kw hour or Rs per unit is ALCC PV by energy generated by the PV which is 12.76x / 1.825x, x will cancel of and the Rs/ kw is 7Rs so this is the cost / kw.

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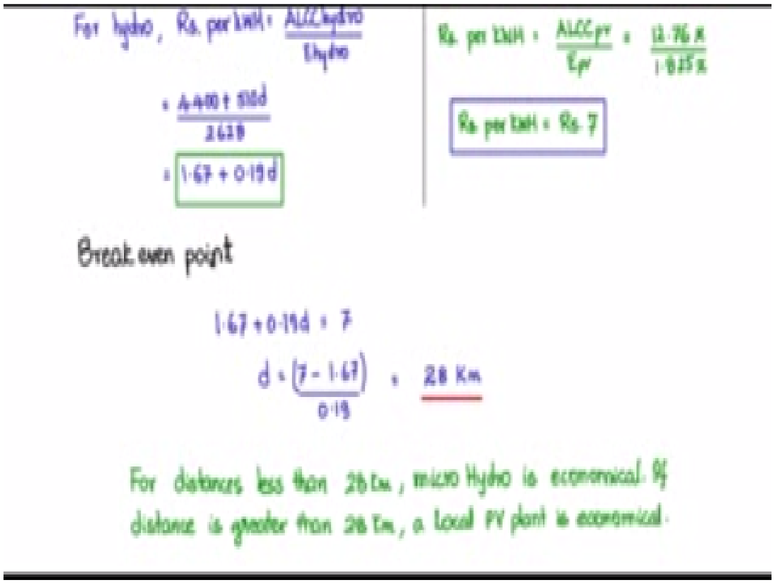

Hour now the important thing let us see how to find the breakeven point so you equate this cost should be equal to this cost so let us equate and find out what is the value of d where is 28km approximately, so this 28km is the breakeven point if the distance of the community from the micro hydel station is less than 28 kilometers you will see that the micro hydel plant is beneficial, if the distance of the community from the micro hydel plant is greater than 28km and you will see that the PV plant is beneficial.

So that is basically the take away from this breakeven analysis and if the distance greater than 28km the local PV plant would be more economical, so this is how you could use LCC even for doing a breakeven point analysis.

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I have here which mean a script 5 Ex03.m this is actually the script for solving the third LCC example and here we just now discuss how to find the breakeven point when you want to decide between two systems which on would be the better one for application and under water conditions, so this is the state number problem estimate the unit cost of power from micro hydel system as a function of transmission distance also estimate the unit cost of power of a comparable PV base system.

As a function of the PV vatage find out the breakeven between these two systems now we have worked it out annually now this script 5 will also do the same job but you can change all these specification and then try to find out the breakeven points for different conditions and different specifications I will include this and I will share this file also with you in the resource section what I have done here is basically is to classify it into the following first I have this subs system data of the hydel and sub system.

System specification with the hydel system so this is for the hydel then I have the sub system data and the systems specific in the PV so I marked here in brackets PV so that the hydel cost as machine cost distribution cost line cost all this things have put together in the some data and systems specifications like the power rating 1000w I mean efficiency AMC for the hydro I kept it as 0 you could include later on to find out what happens with the annual maintenance charges d I kept it at 0 as I just we will just see what happens.

X the rating of the PV system at 1000 and hat minimum 5amc for PV also kept it 0 then there are common specks like the life the LCC life term is for 25 years and interest of 1% that to do the LCC costing first fall the hydro system calculate k or m this fashion of course M and R will turn out to be 0 because we have taken them as 0 find out LCC find out LCC ALCC then anal energy just like we calculated this will give in watt hours and the unit energy cost is ALCC ban in energy Rs/wh.

You can convert into kw hour like as I have displayed here by dividing by 1000 multiplying by 1000 then the displace section as the display of all the parameters then you do the same exercise for the PV system calculate the capital replacement cost maintained cost and the LCC ALCC for the PV anal energy generation capability and the unit energy cost and then display even, so this is what actually descript file contains it alternates the process for calculation therefore you can quickly change the specification.

And find out for your systems now let us execute this tendency Ex03 when you execute you will see that display first you have the LCC calculate for hydro and the second part contains the LCC calculation for PV now see here the unit cost Rs/kw the 6.9 or 7Rs in the case of the PV we calculated and in the case of the hydro it is a function of d1.67 was and when be 0 so it is 1.67 + 0.19d, so d is 0 it is now only 1.67 now let us say d I change into 50 it is > 28km 50km therefore a hydro will become more expensive.

So if I re run this so you will see that hydro is 11Rs 11.38Rs more as compared to the PV, PV is more economical so if you are around that 28.4 should be off similar values you can re run them so you will see 7Rs is also 7Rs both so breakeven comes around that point so in this way you can try to use this for solving breakeven problems.