**Indian Institute of Science**

**Design of Photovoltaic Systems**

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**NPTEL Online Certification Course**

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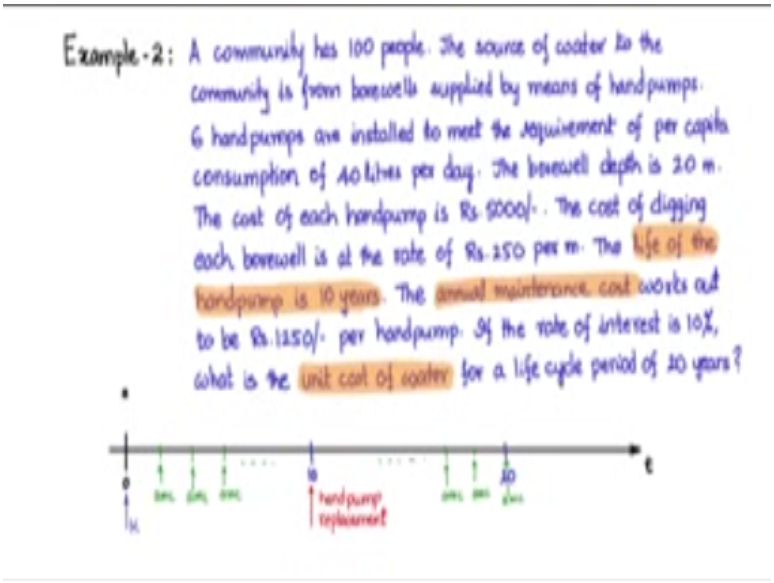


Let us consider another example and in this example the objective V is to use LCC life cycle costing analysis for finding out unit cost of water or unit cost of some item we will consider a pumping application and then say find out what is the unit cost of water rupees per liter or rupees / $m^3$ let us first then defined the problem we will take a community of 100 people and the source of water is bore well and there hand pumped by means of 6 hand pumps 6 bore wells to met the requirements of the 100 people in the community and each person consumes about 40 liters / a day.

The bore well depth is 20 m the coast of each hand pump is Rs 5000 and the cost of digging each bore well is the rate of Rs 250/ m the life of the hand pump is 10 years the annual maintains cost work so to be Rs 1250/ hand pump, so if the rate of interest is 10% what is the unit cost of water for a life cycle period of 20 years so this is the problem you must note that the numbers that have

given or contrived numbers typical numbers but they are not market numbers so you will have to focus on the process of power calculation.

How we proceed to calculate these you have to at the time of exciting the LCC analysis you have to actually go and get these numbers these Rs, price maintains cost from the market we will have to get the realistic values for now focus on how we go about doing LCC so therefore let us try to achieve our objective of finding the unit cost of water as before let us draw a time line time and I am going to have his cutting point and I am going to mark think points the this think point is 10 year another is that $20^{th}$ year.

Now we see that there is a life of the hand pump given has 10 years which means at the end of $10^{th}$ years we will have to make a replacement of hand pumps there are 6 hand pumps therefore 6 and pumps need to be replaced so this is a replacement that will come in here so replacement cost of 6 hand pumps then the antenna annual maintains cost works out to be Rs 1250 / hand pumps.

So annual maintains cots means every year 1 is paying the AMC throughout up to the 20 years 20 times we will be paying AMC this is geometric cogitation we will we know how to do that will appropriately use the equations and then at the beginning year we have to take care of the capital cost so these are the calculation that we need to do capital cost replacement cost R annul maintains cost taken together all reflected whether it be the replacement cost the maintains cots all the time frames values should be reflected to the present time frame that is the concept.

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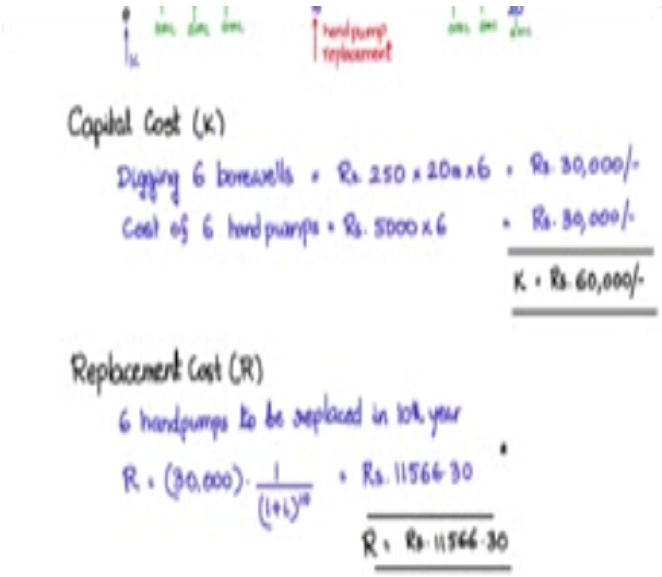


Let us now calculate the capital cost K so we should invest in digging 6 bore wells and we know it cost around 250 Rs / m x 20m and 6 of them and therefore that works out to be Rs 30000 then we have to invest in the 6 and pumps and that is Rs 1000, Rs 5000 to 56 of them in another 30000 add up all this you get K = Rs 60000 next let us find out the replacement cost R so you see that we need to do replacement of 5 hand pumps after 10 years.

So 6 hand pumps to be replaced in the $10^{th}$ year so R = 30000 is the cost of the 6 hand pumps and let us multiply it by the present worth factor $1/1 + i^{10}$ which will shift the value there to the present and that is Rs 11566.30 and therefore R is 11566.30.

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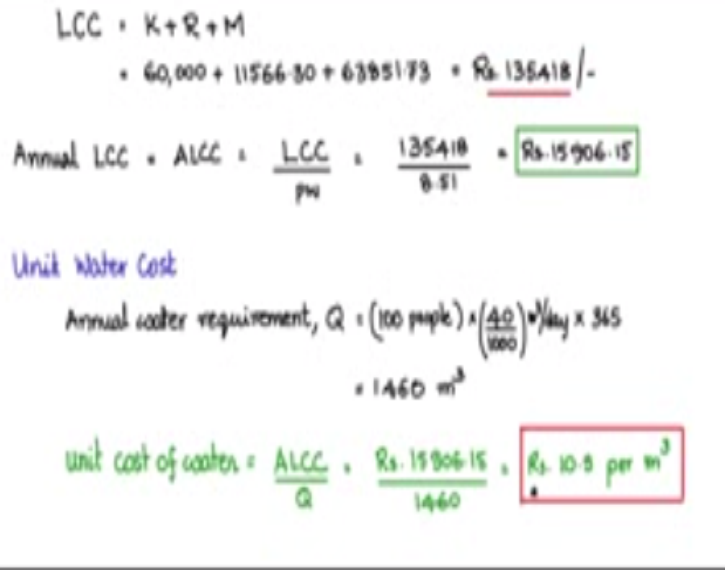


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Because that is the only replacement next we will do the maintenance cost M there is annual maintenance we know what is given is Rs 1250/ hand pump so into 2 hand pumps will become 7500 and present work factor PW I will call it 1/I 1-1 1/1 + $i^{20}$ n is 20 and that works out to be 0.51 this is the present worth factor and maintenance is basically refection of all the annual maintenances into the present time frame which is AMC x the present worth factor which is will be 7500 x 8.51 so maintenance is 63851.73.

Now LCC can be calculated K + R + M which is 60000 for capital cost + 11566.3 for the replacement cost + 63851.73 for the maintenance cost everything works out to 135418 this is the LCC life cycle cost of this particular system now let us find out what is the annual LCC now if this value the LCC which is the worth today of this whole life cycle cost today of this whole system let us see how we can distribute it equally for every year from today onwards till 20 years which is supposed to be the life term end of term.

So the annual life cycle cost ALCC is LCC / present worth we have done this before in the previous example similarly LCC value by the present worth factor which will give you Rs 15906.15 now this is the cost that would be in current every year for this particular system now let us try to find the unit cost of water the unit water sot let me move this up so annual water requirement how much water is required in a year.

So there are 100 people and we know each person take 40 liters so 40 / 1000 $m^3$/ day into 365 days in year and this will give 1460 $m^3$ this is the amount of volume of water that will be

required and now we can calculate the unit cost of water which will be the ALCC the annual cost for this whole entire system divided by the water required Q so this will be 15906.15 this is the ALCC value / 1460$m^3$ will give you Rs 10.9 / $m^3$ so this is the unit cost of water.

What it means is fir every $m^3$ of water that is used by the community the cots in cured is RS 10.9 or if someone wants to charge for would like to do a water billing for the house olds in the community then they have to charge at least so that they recover Rs 10.9 / $m^3$ this does not include the profits that the organizations the building organizations would like to have so in this way we can calculate unit cost of water unit cost of electricity depending up on what type of system that we are actually doing the life cycle cost analysis.

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I have here for you has script file EX 02.m this is the script for solving the LCC example to calculation of the unit cost of water a community has 100 people it has 6 bore wells 6 hand pumps what is the unit cost of the water for a life cycle period 20 years data is given like before I have classified into sub system data hand pump cost bore well cost life of the hand pump then systems specifications number of people.

What is the quantity of water required per person 40 liters per a day of 40/ 1000 $m^3$ per day per person number of wells 6 wells well depth number of years for life cycle costing interest AMC the annual maintenance charges Rs 1250 / hand pump so these are this specification the life cycle costing calculate K we have found the bore well cost we have found out the hand pump cost add

up these 2 you will get the capital cost K then calculate the replacement there is one replacement only for the $10^{th}$ year that is you have to replace 6 hand pumps.

The hand pump cost includes 6 hand pump divided by $1+ i^n i^{10}$ you get the replacement cost then calculate the maintenance the present worth factor is calculated and then maintenance is AMC into AMC here is 1250/ hand pump into number of hand pumps into the present worth factor will give you the maintenance calculate AL LCC and calculate ALCC the annual cube the annual water requirement is basically number of people and per person how much he consumes per day into 365 days and the unit water of water cost ALCC by annual requirement.

Which will give you in Rs per $m^3$ then I have the display section where display the various parameters so if you execute a example tool you will get the ALCC calculations for that the bore well cost capital cost 60000 replacement cost whatever we have calculated has in worth factor maintenance cost and the life cycle cost again what we had calculated annual cost and then you see the unit cost of water is 10.89 Rs / $m^{3.}$

So I will leave it to you here again for you to experiment where the different values for the system put in realistic numbers and try it for your water pumping system and try to calculate the unit cost of water using the script file and modifying this script file I will share this script file with you in the resources section