Indian Institute of Science

Design of Photovoltaic Systems

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NPTEL Online Certification Course

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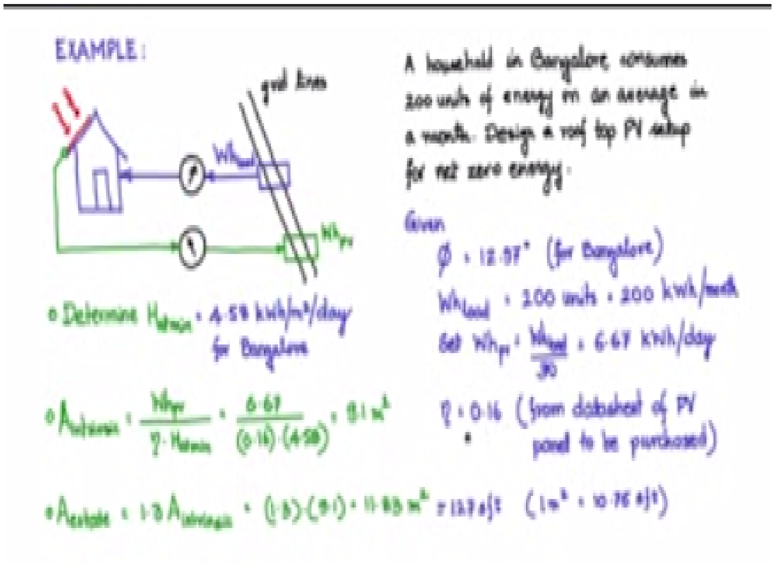

Let us now consider an example where we would like to design or size the photovoltaic panel that needs to be installed on the roof top of a building. So this is the scenario the problem statement is like this a household in Bangalore consumes 200 units of energy on an average in a month so monthly based building design a roof top PV setup so that the net energy is 0, so we are given with latitude we know because the problem mentions that the place is located in Bangalore and latitude of Bangalore is 12.97 and that our load is also given which is 200 units and it is same as 200kWh/month so this 200 units is consumed in a month.

So now we can set $Wh_{pv}=Wh_{load}/30$ in order to get the daily consumption, so we would like to see how much we would like to put into the grid from the PV on a daily basis so that will be equal to $Wh_{load}/30$ so this works out to be around 6.67kWh/day. Efficiency of 16% this is from the datasheet recall that PV panels have data sheets and once you have decided which PV panels you would like to buy you would like to go for which manufacturer you would like to go for take that data sheet and from that datasheet look up the efficiency parameter for that model of the PV panel and take that.

Now once you have these parameters you can now start your design process, so first determine H_{at}min you have to find out what is the incident energy that is falling on a tilted flat plate collector at that place with atmospheric conditions and work it out for the entire year day number varying from 1 to 365 and find out the minimum value of H_{at} for that entire year and this we have just previously discussed and for Bangalore we know it is 4.58kWh/m^2/day so this value is known.

And now you are ready to calculate a intrinsic area of the PV panels which is given by Wh_{pv} by efficiency into H_{at} min and this will work out to be 6.67/(0.16) and H_{at} min is 4.58 so this unit is in kWh/day this unit is kWh/m^2/day so you will have the intrinsic area coming out as 9.1m^2. Now this is the intrinsic area the area that will be occupied by the solar PV pane. Now you need to work out what is the actual real estate that is needed recall that we indicated that we need some space for maintenance for personal to install clean and all those things therefore the real estate actually needed would be 1.3 times the intrinsic area approximately and that works out to be around 11.83m^2 or 12 m^2.

If you are comfortable in square feet 12m^2 will work out to be around approximately 127 sft the conversion factor is 1m2=10.75 square feet, so you can use that and convert it so this much amount of roof top area should be made available so that you can fit the panels within that area. However, note that the power output is given only by the panels which are within this 9.1m^2 so 9.1m^2 is the active power generating area and this area is capable of giving 6.67 kWh/day.

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Let us take another example this is a live example you see here a picture is a picture of my department on the top roof top of the department there are PV panels mounted, there are two sets of PV panels you see that you will be able to distinguish this is one type of panel one set of panel and this is connected to a commercial inverter and feeding to the grid these are another set of panels these are reins wall of panels and this is connected to inverters design and developed by the students and then feeding to the grid.

Now let us look at this set of panels here there are 100 panels here in the set what I am showing through the mouse cursor and let us try to calculate what is the maximum capacity of the set of I.

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The output from this panel is fed to the grid using the set of inverters here.

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Let us look at some close-up shots of the photovoltaic panels we are mono crystalline panels.

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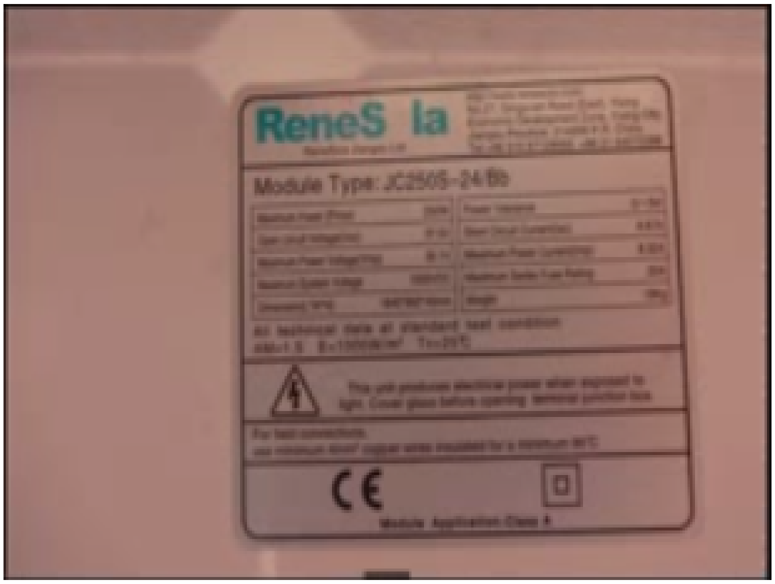

And at the back of the panel you will see the name plate reading a capture become camera and you have the details given in this steam plate it is from Rene solar manufactured in China and you have the various parameters the maximum power open circuited short circuit current all these parameters also note here all this data has been performed under standard test condition here mass 1.5 insulation 1000W/m^2 or 1kW/m^2 and that 25°C temperature.

Now let us come to this part the dimension length and width and height which is 40mm, now the area is what we want to find out what is the intrinsic area now you have here 1640mm/992mm which means it is 1.64m/0.992m. Now let us go back to the white board.

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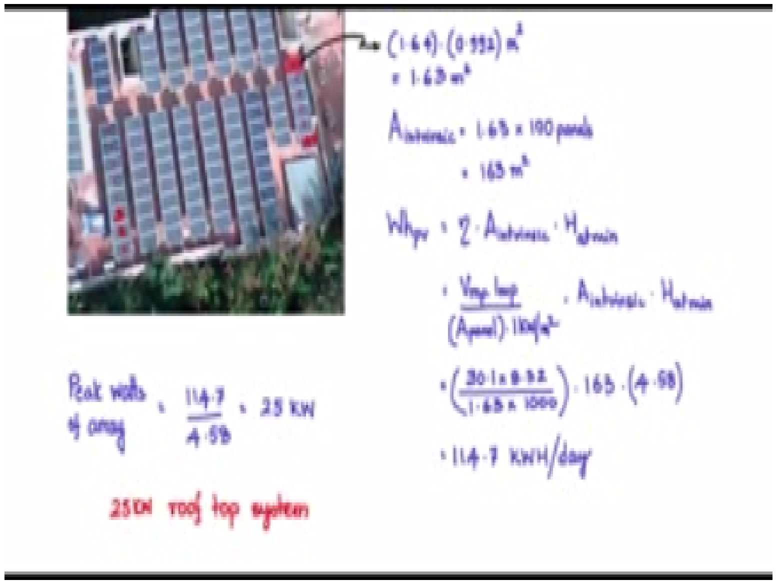

Considers across the short of this route roof top PV panels head start counting from here 1, 2, 3 so on and so forth and then you will see that on counting everything you will have 100 panels. Now if you take a typical panel like this we saw that the area is 1.64x0.992m^2 and this works out to be 1.63m^2 you can verify it in the name plate panel here 1.64mx0.992m this is the length and the width, so this 1.63m^2 is the area of the panel area of each panel is 1.63m^2. Now let us try to find what is the intrinsic area of the entire array, the intrinsic area is each panel area 1.63 into there are 100 numbers of the panels so into 100 panels and this workout with 163m^2.

So now let us calculate what is the WhPV of the entire array and how much it can pump into the grid, so what our PV is equal to efficiency into $A_{intrinsic}xH_{at}$min for that place the efficiency can be obtained from the datasheet are also from the name plate readings. Now if you have to obtain on the name plate readings you can use P_{out}/P_{in} P_{out} is nothing but V_{mp} I_{mp} voltage at maximum power and into current at maximum power divided by the area of the panel area of each panel into 1kW/m^2 standard insulation.

So 1kW/m^2 into the area of the panel would give you power input and at the standard insulation what is the power output which will be V_{mb} into I_{mp} so this will give you the efficiency multiplied by $A_{intrinsic}$ and multiplied by H_{at}min. Now let us look at the name plate readings and then see what are the values of V_{mp} I_{mp} observed here max power voltage V_{mp} is 30.1volt max power current I_{mp} is 8.32 ampere.

Let us use this value substitute them in our equation here, so you have 30.1x8.32/1.63 which is the area of the panel into 1000 W/m^2 $A_{intrinsic}$ it is $163m^2 H_{at}$min for Bangalore we know that it is $4.58kWh/m^2/day$, now this works out to now let me make some space this works out to 114.7kWh/day, now the peak wattage of the entire array system can also be calculated and that is 114.7kWh/day that has put that down, now divided by the number of hours where you put how effective insulation and that is H_{at} min 4.58 so divided by 4.58 will give you 25kW so this way you can 4.58 is numerically equivalent to H_{at} min but we are using here the units 4.58 hours of standard insulation.

So that would give you a 25 kW system here, so this whole array is a 25kW roof top system, so in this way you can ascertain for any given array or a field PV array or PV field you can find out what is the system rating or what is the system output power rating and energy ratings.