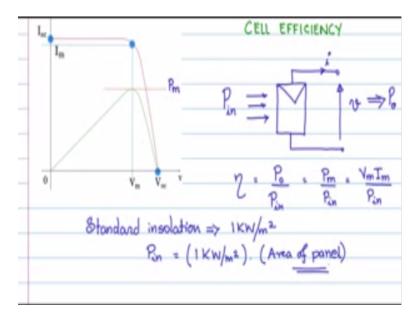
Indian Institute of Science

Design of Photovoltaic Systems

Prof. L. Umanand Department of Electronic Systems Engineering Indian Institute of Science, Bangalore

NPTEL Online Certification Course

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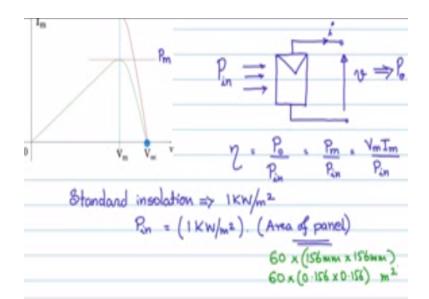
Consider the baby Cell as drawn here so it has the two terminals V and I, the input is the incident solar radiation, so what is the power input and what is the corresponding power output that this PV cell is capable of gives you an idea of efficiency which is given by P_0/P_{in} now which is equal to P_0 at peak power, so what is maximum power that the PV cell is capable of giving at any particular installation is this peak power P_m .

So we will call this one as P_m and this is what is the output of the PV cell by P_{in} and we know that P_m is nothing but $V_m I_m/P_{in}$ now what is P_{in} , is that the standard insulation is one kilowatt per meter square and P_{in} is given by one kilowatt per meter square into area of panel, what is the area of the panel? (Refer Slide Time: 02:57)

Polycrystalline 210W-	240W			."	1012121		
Module Type	BLD240-60P	BLD230-60P	BLD225-	I _{st}	9-97A		
Peak Power	240 Wp	230 Wp	225 Wp		1. *7.56A		
Max. Power Voltage (Vmp)	30.18 V	29.82 V	29.52 V				
Max. Power Current (Imp)	7.96 A	7.72 A	7.63 A			240%	
Open Circuit Voltage (Voc)	36.72 V	36.10 V	36.30 V			anore	
Short Circuit Current (Isc)	8.99 A	8.73 A	8.62 A		IKW/+		
Cell Efficiency	16.50 %	16.00 %	15.75%		/m		
Module Efficiency	14.66 %	14.05 %	13.74 %		1KW/1 2		
Maximum System Voltage			DC 1000 V		6 72 1	-	
Temp. Coeff. of Isc		+0	045 %/K				
Temp. Coeff. of Voc		-	0.34 %/K	-	0		2
Temp. Coeff. of Pmax		-	0.47 %/K	0		Ý.,	V _{se}
Series Fuse Rating			15 A			30-18Y	
Celh	5x10 pieces pr	olycrystalline so	lar cells serie	(156 m	in x 150mm)		
Junction Box	with 3 bypass						
front Class	toughened safe	ety plass 3.2 m					

Go back to the data sheet, the data sheet look at this row the sense there are 6×10 pieces so the poly crystalline cell between 60 cells and each cell having this area has indicated 0.156 m x 0.156 m so let us use this in our calculation to arrive at what is power input case, so going back to the.

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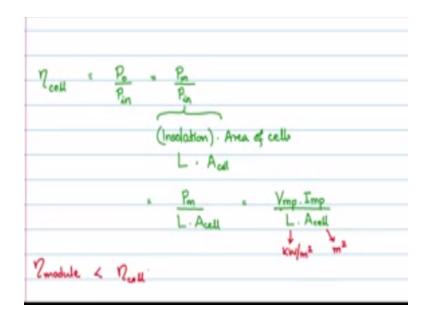
So you see the area of the panel is 16 numbers of the cells each having 156 mm x 156 mm area so let us convert them to meters so it is $16 \times 0.156 \times 0.156$ meter square.

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Standard insolation => 1KW/m2 Pon = (1KW/m2). (Area of panel) Pin KW 1. AG KW . 16.5% Zun Pos Pm = 200 Pin = 146 EN ×

This turns out to be 1.46 meter square so P_{in} is one kilowatt per meter square into 1.46 which is 1.46 KW. Now the cell efficiency from the data sheet is given as 16.5% before $P0 = P_m$ which is the max power will be efficiency of the cell into P_m which is 1.46 KW x 16.5/100 which is equal to about approximately 240W.

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Therefore a cell efficiency I call it as efficiency subscript cell is given by the output power delivered by the PV cell to the incident input solar power, the output power at the peak power point is named as P_m we know that divided by P_{in} , and what is a P_{in} ? P_{in} is nothing but insulation which is given in kilo watt per meter square into area of cell the total area of the cells of the cells, we shall use the symbol L for insulation into the area of the cells which is area cell like this and thereby therefore after substituting you see that P_m /L which is kilo watt per meter square into the area of the cells will give you the input incident power.

Or further in terms of the peak power voltage and the currents with a $V_m V_{mp} \times I_{mp}/L \times A_{cell}$ the insulation is in kilowatt per meter square the area of the cell is in meter square, so this is the cell efficiency however one should note that the module efficiency is not the same as the cell efficiency, efficiency of the whole PV module actually is less than the efficiency of the cell, what is the difference between those two? Basically it is in the area of the cell and the area of the module now let us look at this difference.

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Consider a PV panel this is actually a 6 x 10 cells panel to each is a cell, this portion as I am indicating with the P mouse cursor is a cell there are 10 such in this column and there are 6 horizontal, now if you look at a much more closer view you will see that the cells though in the cells have some space is between, the module is actually encapsulating all these cells there are spaces at the rim the rim itself is occupying some area there are some spaces in between the cells.

Now all these area are not affected area and the solar insulation if even if it falls on this area is actually not captured, therefore the entire module is actually having a bigger area accommodating all these gaps and cases as compared to the pure cell area alone and therefore the module efficiency is definitely going to be lower than the cell efficiency.

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Polycrystalline 210W-	240W						
Module Type	BLD240-60P	BLD230-60P	BLD225-	A _{HC}	9-97A		
Peak Power	240 Wy	230 Wp	225 Wp		I. *7.56A		
Max. Power Voltage (Vmp)	30.18 V	29.82 V	29.52 V		_		
Max. Power Current (Imp)	7.96 A	7.72 A	7.63 A			240 Wp	
Open Circuit Voltage (Vic)	3672 V	36.10 V	36.30 V		wal -		
Short Circuit Current (hc)	8.99 A	8.73 A	8.62 A		IKN M2		1
Cell Efficiency			15.75%		Que		
Module Efficiency	14.66 🐿	14.05 %	13.74 %		@ 25 C		
Maximum System Voltage			DC 1000 V				
Temp. Coeff. of Isc		+ (.045 %/K				
Temp. Coeff. of Voc			0.34 %/K		/		
Temp. Coeff. of Pmax			0.47 %L/K	0		V.	V _{se}
Series Fuse Rating			15 A			30-15	٧
Cells	6x10 pieces p	olycrystalline so	lar cells serie	5 (156	mm x 156 mm)		
Junction Box	with 3 bypass	dodes					
Count Chann	to obtain a set	at a start of the second s	-				

If you come back to the datasheet and we will look at the data sheet here you have the cell efficiency and you see the cell efficiency is 16.5% and where are the module efficiency is actually 14.66% it is so in all types of panels because the module area is higher than the fuel cell area and most of the time the peak power and all these other rating the power rating as mentioned earlier here or with respect to the Pure cell area and pure cell efficiency.

Over a practical purposes whenever you are calculating for a given application the module efficiency is a much more conservative and better value to take because you will be using the more practical efficiency.