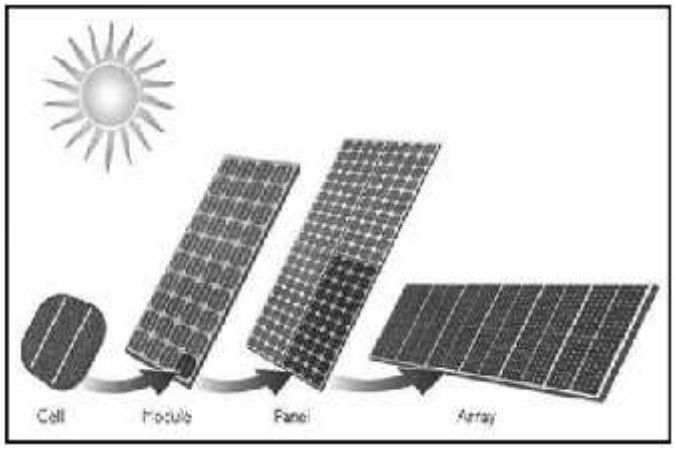
Solar PV Module

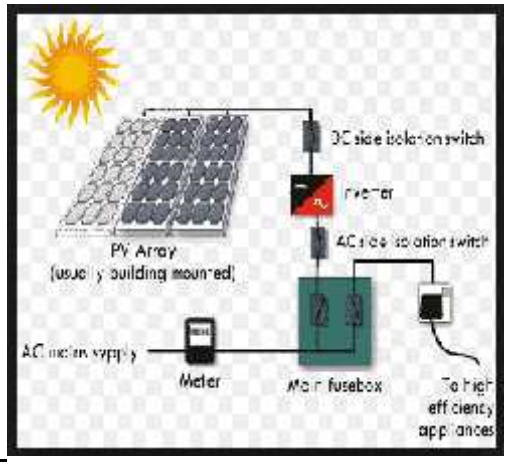
Purpose and Description

The purpose of this exercise is to analyze the DC and AC load flow of a solar PV module.

Theoretical Concepts

PV array is one of the important elements of renewable energy, micro-grid, smart grid, etc. It converts solar radiation energy into direct current using semiconductors and then to electric power through inverters as shown below. ETAP PV Array is used to represent individual panels connected in series and parallel combinations with a grid tied inverter and represents blocks of PV power. As shown below, a number of modules make up a typical PV panel that can be connected in a string configuration in order to achieve a desired current and voltage at the inverter input.





The physics of the PV cell is very similar to the classical p-n junction diode. When light is absorbed by the junction, the energy of the absorbed photons is transferred to the electron system of the material, resulting in the creation of charge carriers that are separated at the junction. The charge carriers may be electron-ion pairs in a liquid electrolyte or electron hole pairs in a solid semiconducting material. The charge carriers in the junction region create a potential gradient, get accelerated under the electric field and circulate as the current through an external circuit.

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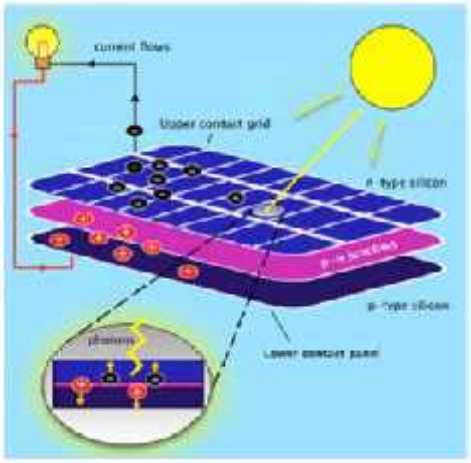
The current squared times the resistance of the circuit is the power converted into electricity. The remaining power of the photon elevates the temperature of the cell.



Several PV cells make a module and several modules make an array. In ETAP we define the PV panel information and specify the number of panels connected in series and parallel that make up the final PV array.

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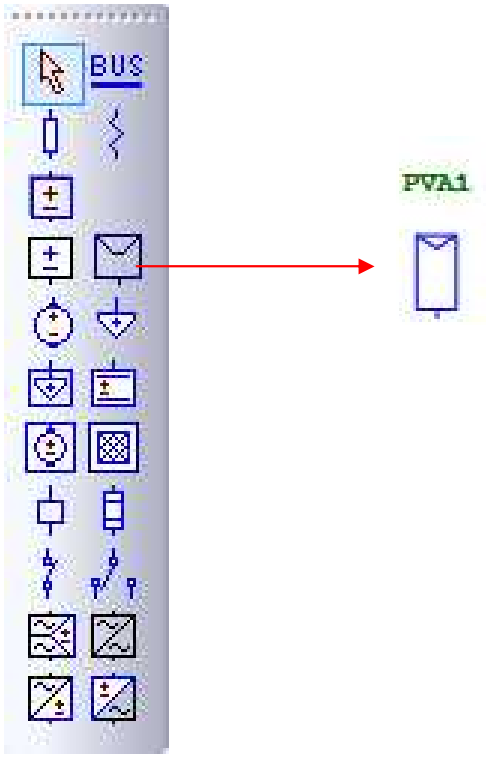
Solar PV Module

Procedure

1. Open Solar_PV example OTI file from Solar PV Array folder.
2. Drag and drop a PV Array on OLV from DC Editor Toolbar



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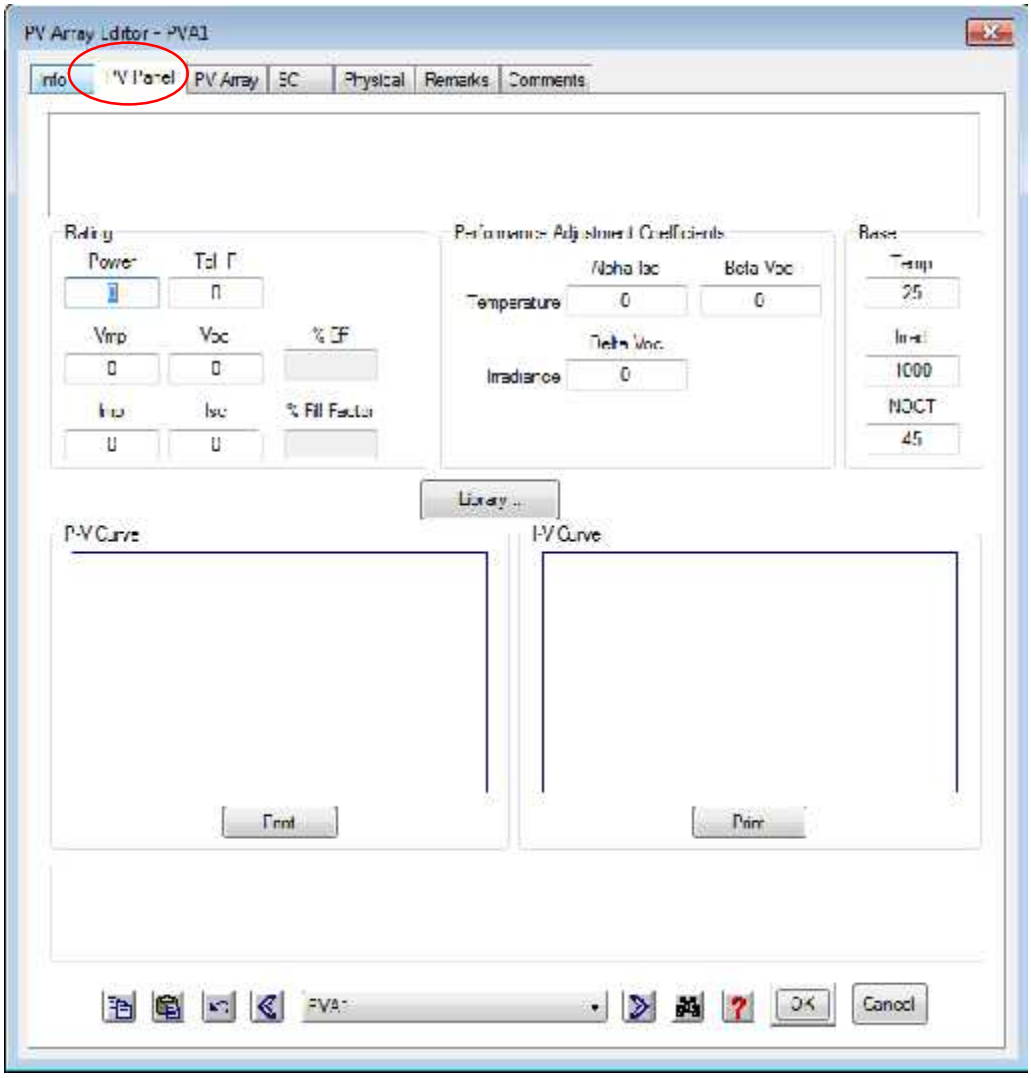
3. Double click on PV Array (PVA1) and go to PV Panel tab as shown below.



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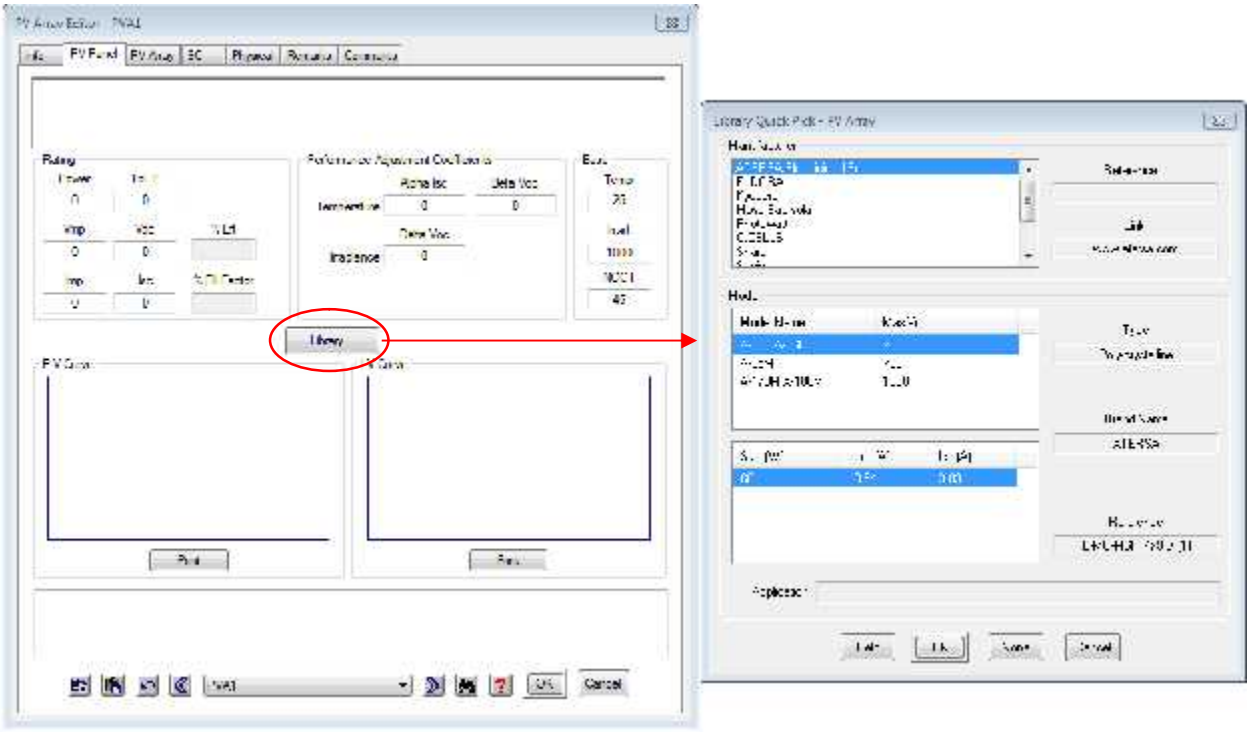
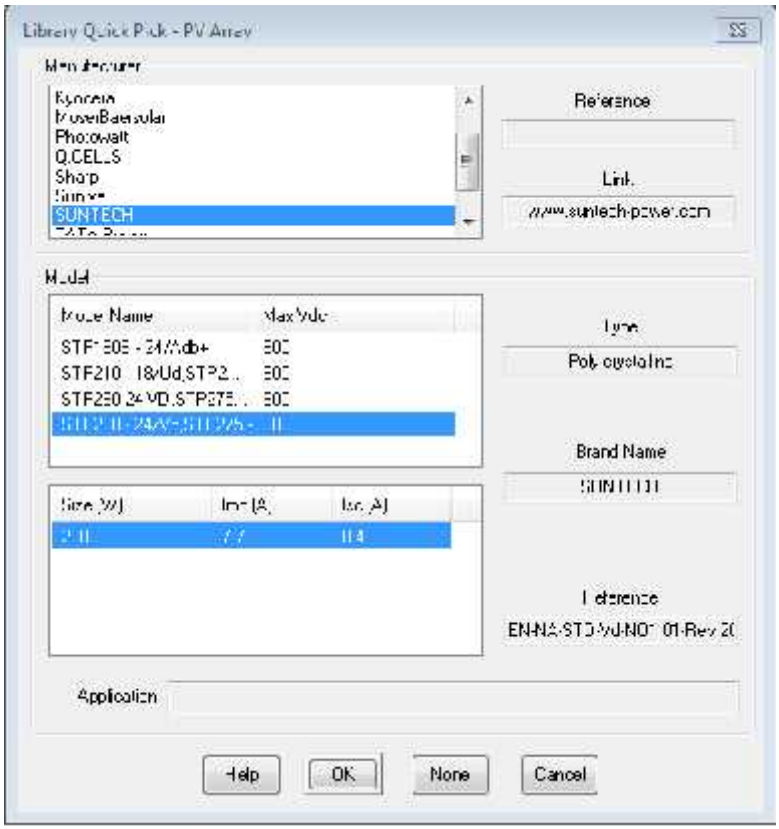
Solar PV Module

4. Click on the Library to select a PV module.



5. Select Manufacturer and Model as shown below and click on OK.



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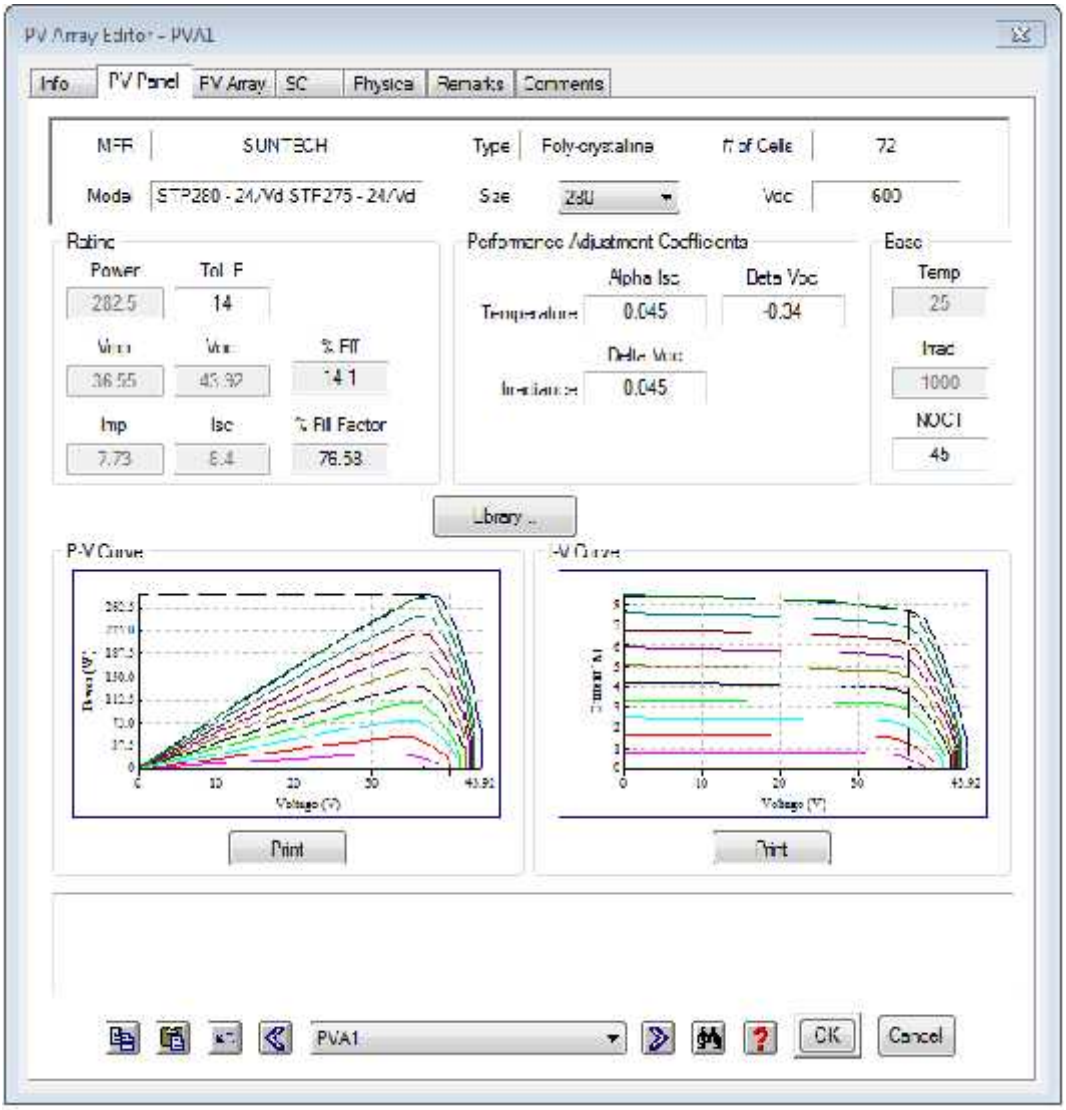
Solar PV Module

6. The electrical characteristics of PV module will be reflected as shown below.



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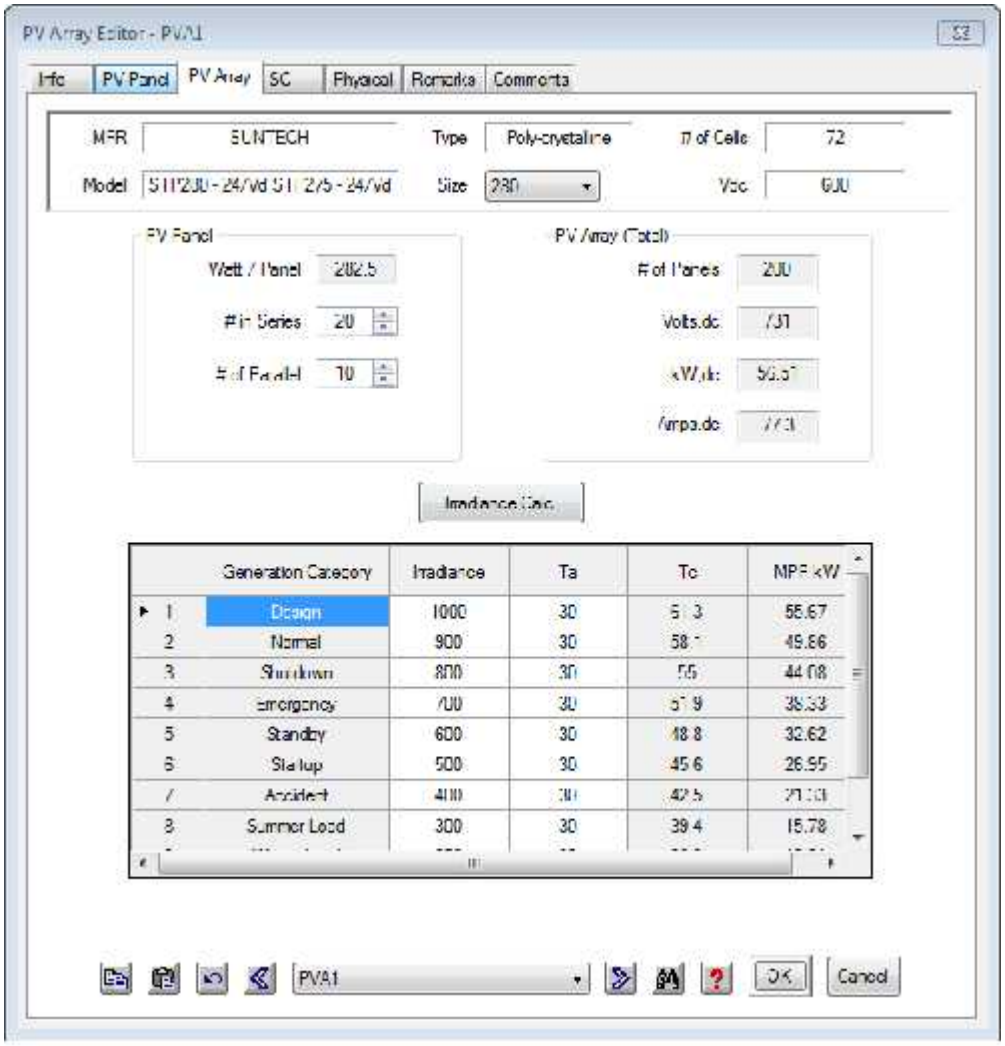
Solar PV Module

7. Go to PV Array, select the desired no of series modules and no of parallel modules as shown below and click in OK.



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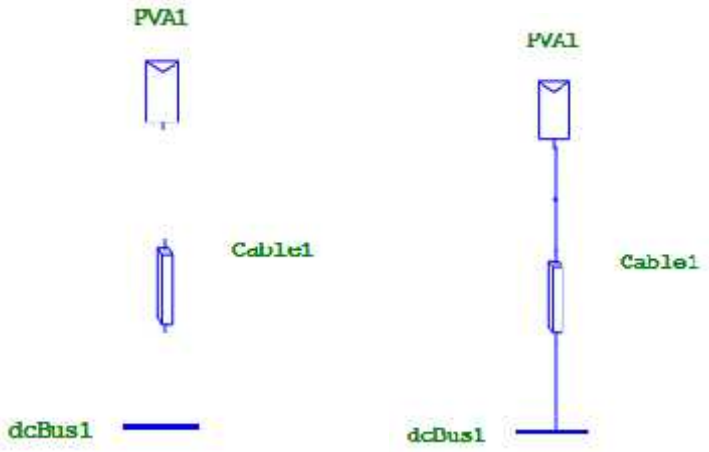
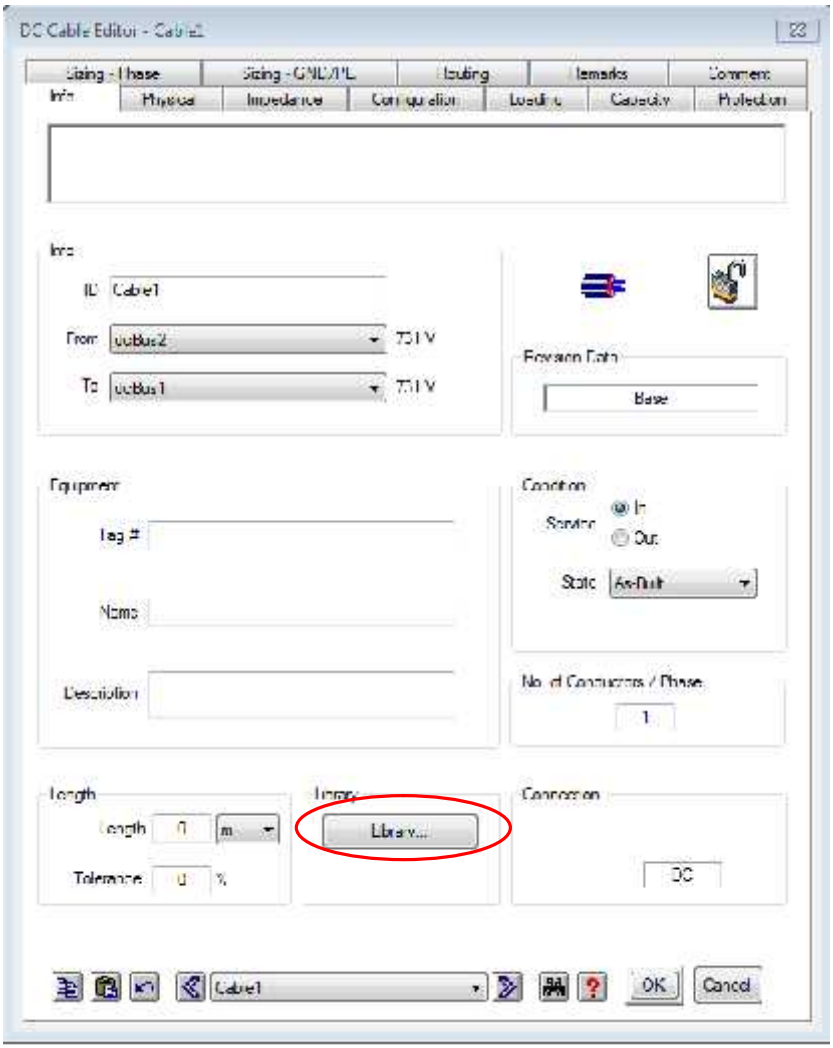
Solar PV Module

8. Drag and drop a DC bus, DC cable from DC Editor Toolbar and connect them as shown below.



9. Double click on Cable1, go to Info page and click on Library.



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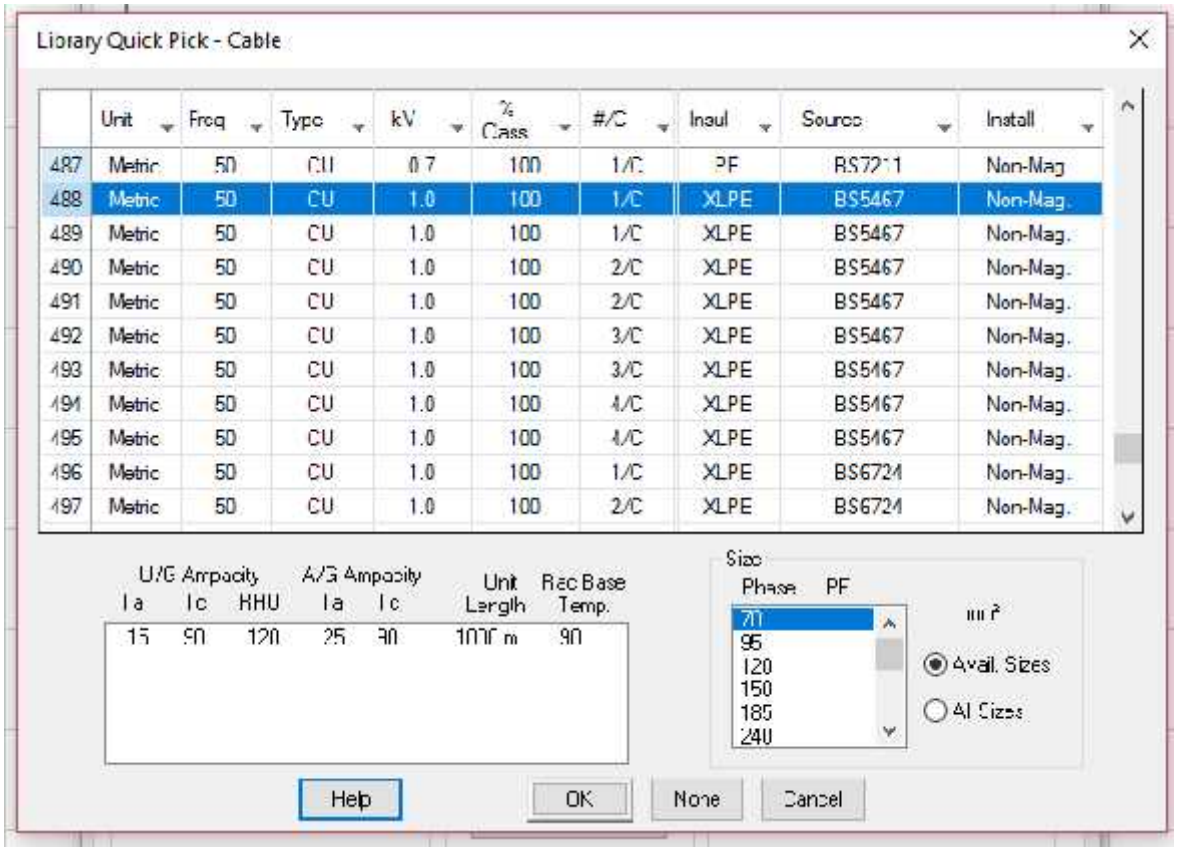
10. Select the cable from Library as shown below and click on OK.



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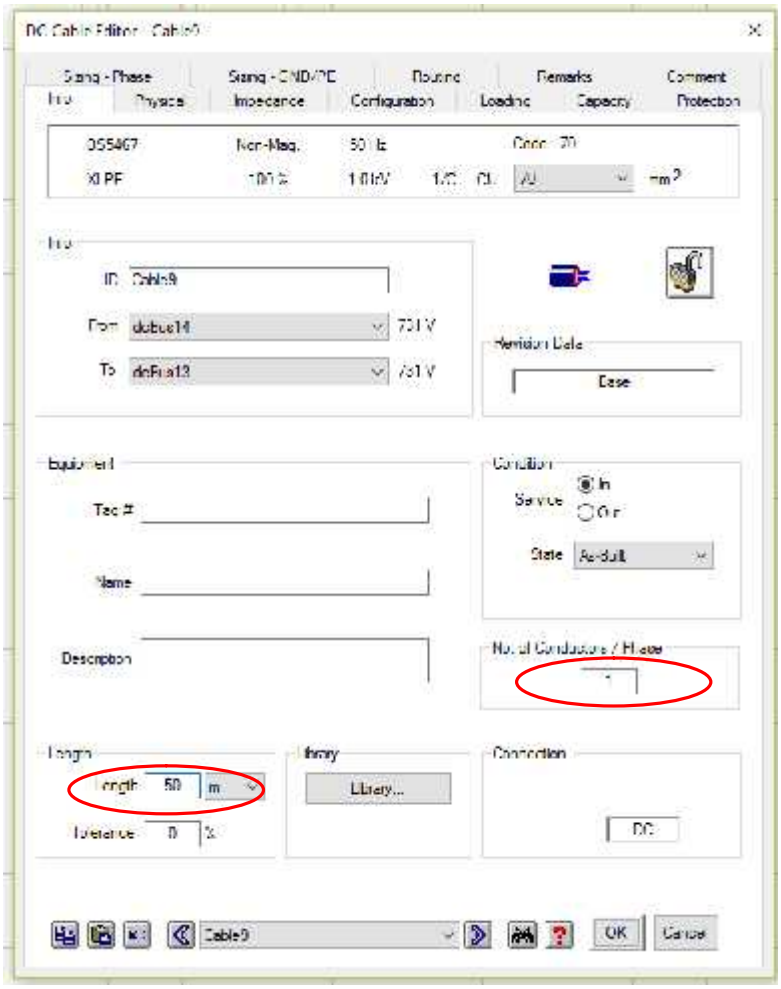
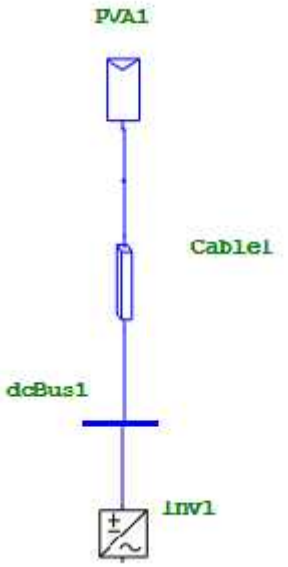
11. Enter the Length of cable and no. of conductors/phase in Info page as shown below.



12. Drag and drop Inverter and connect it to dcBus1 as shown below.



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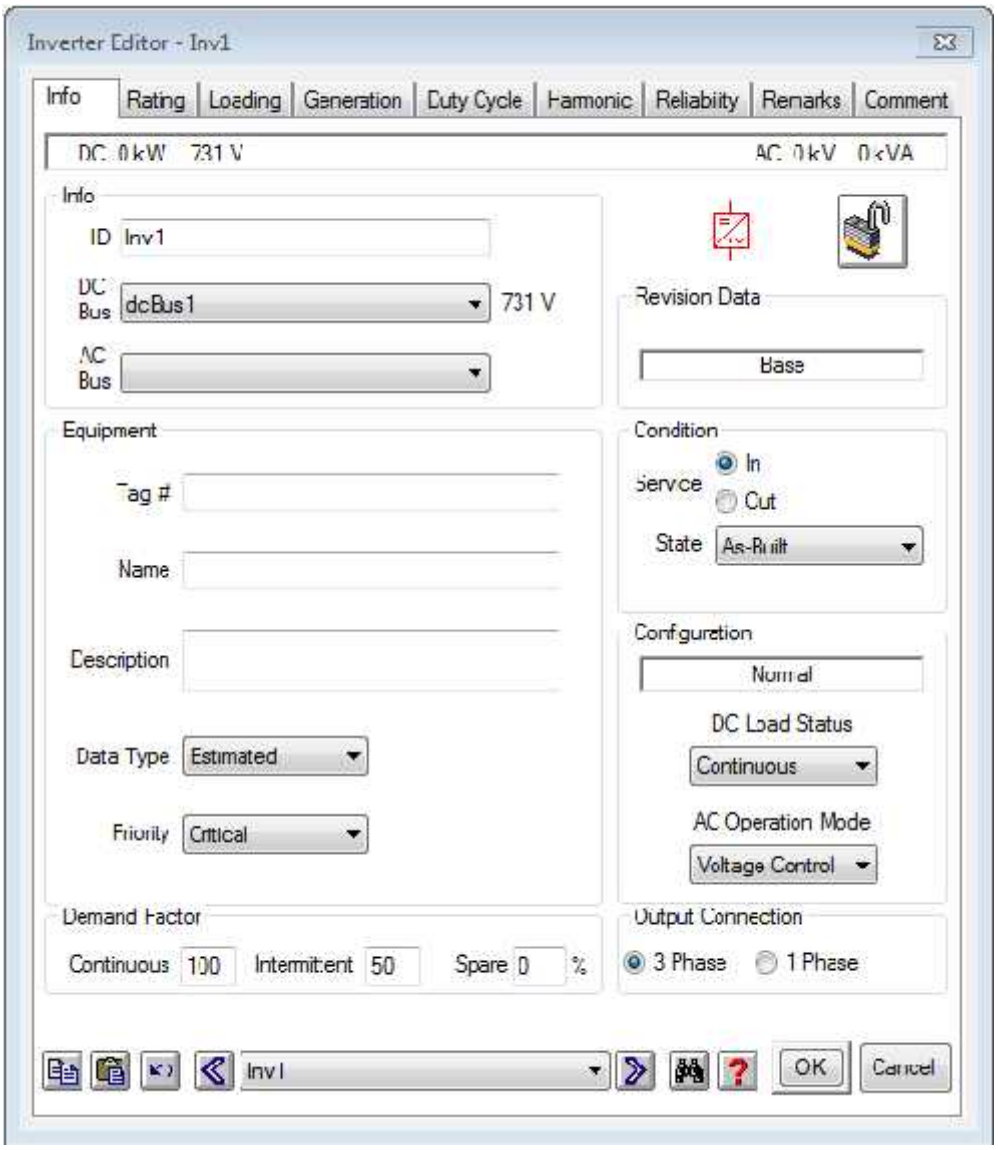
Solar PV Module

13. Double click on Inverter and the below window pops up.



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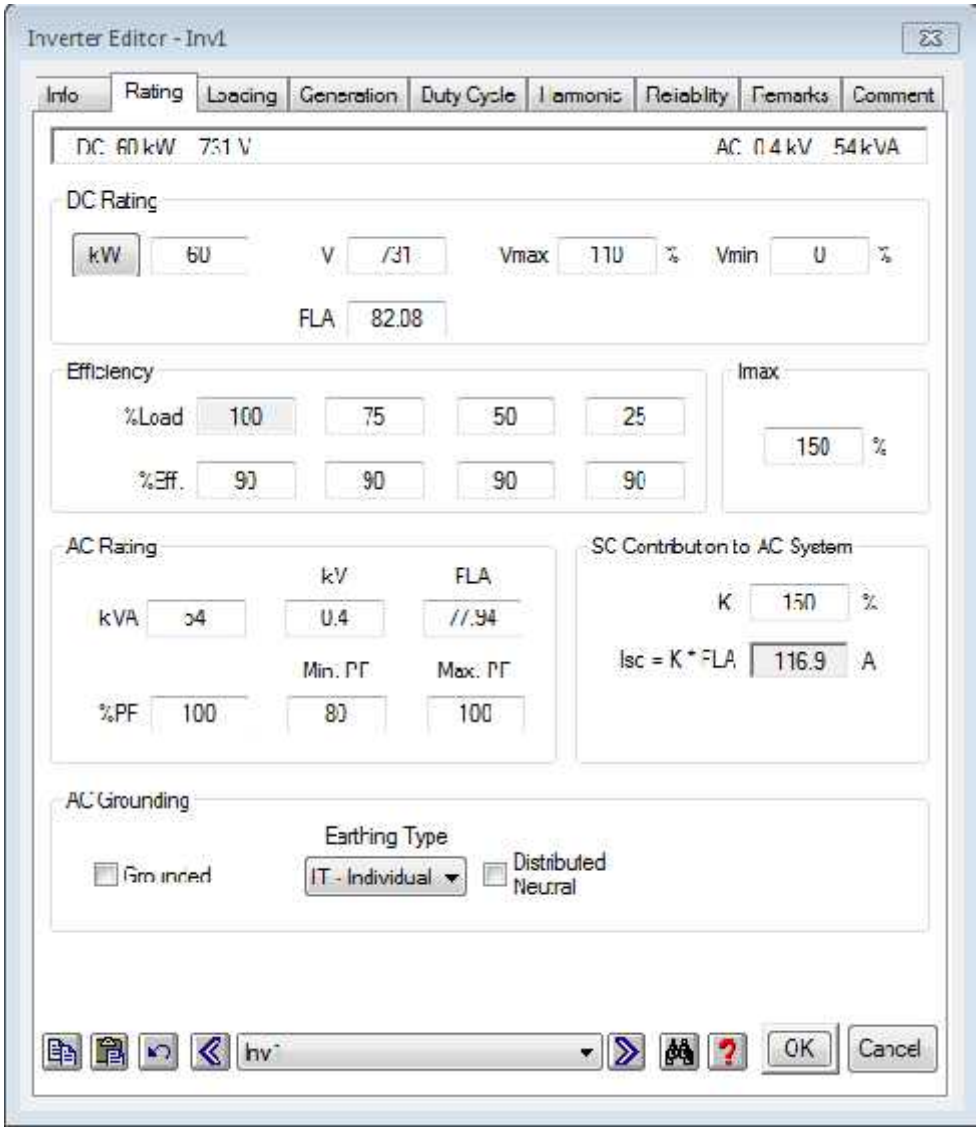
14. Go to Rating Page and enter the below parameters as shown and click on OK.



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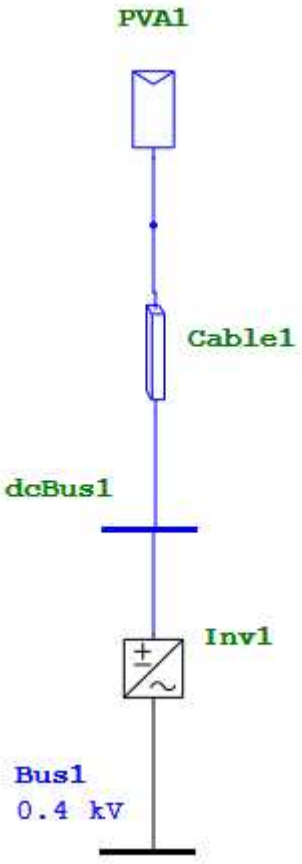
Solar PV Module

15. Drag and drop an AC bus from AC Editor Toolbar as shown below and connect to inverter.



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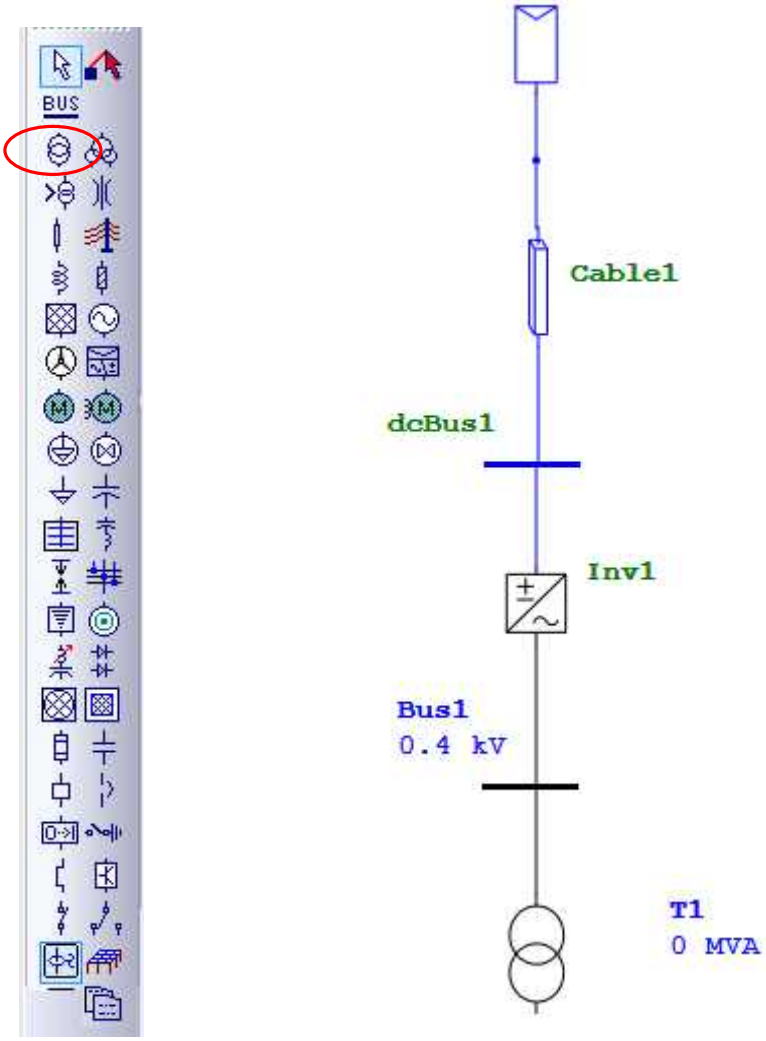
16. Drag and drop a transformer from AC Editor Toolbar as shown below and connect to AC bus as shown below.



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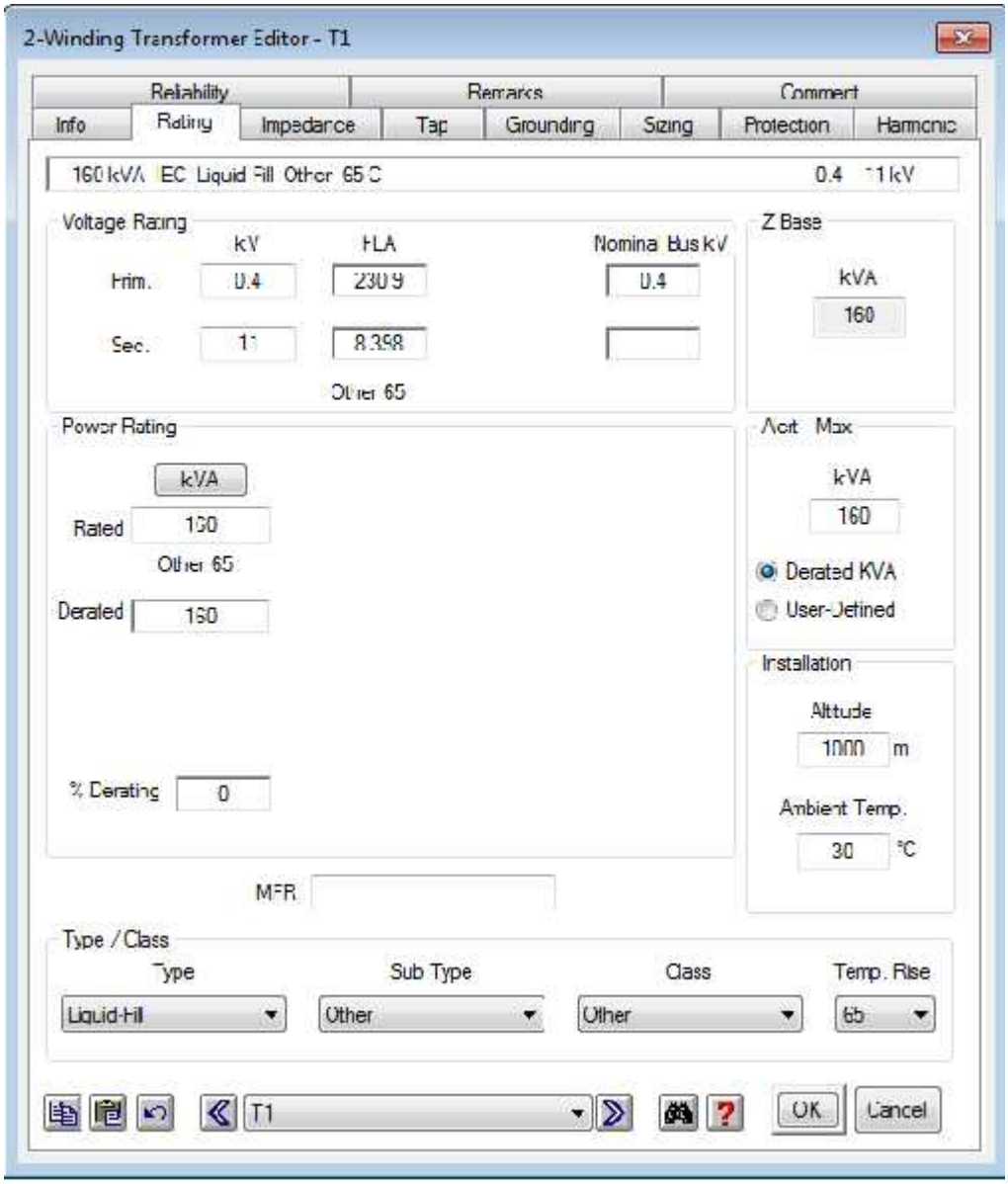
Solar PV Module

17. Double click on transformer, Go to Rating Page and enter the below parameters as shown.



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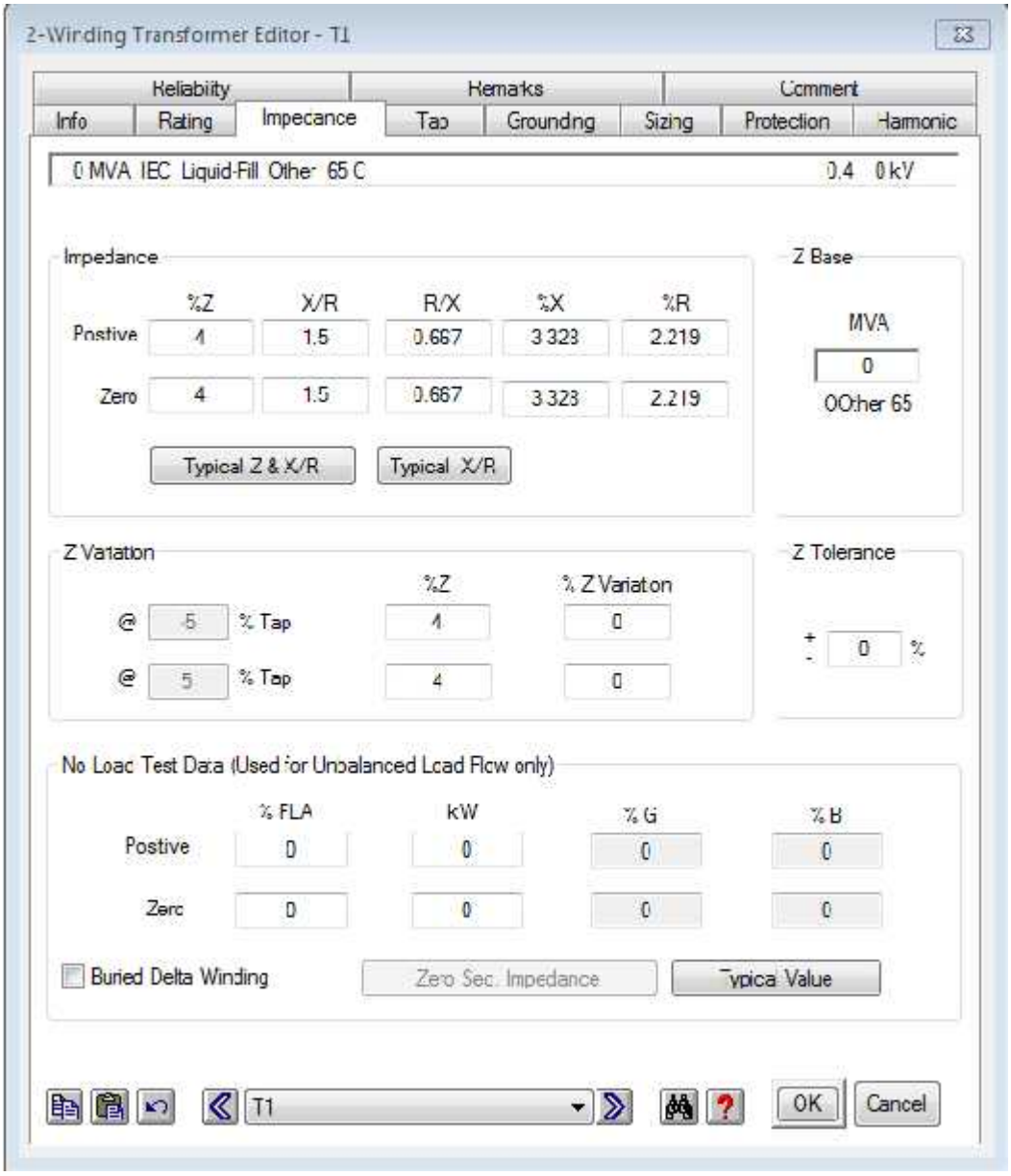
18. Go to Impedance Page and enter the impedance as shown and click on OK.



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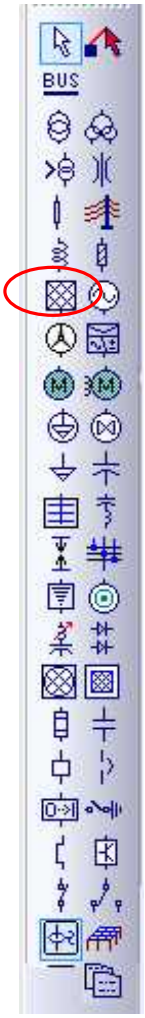
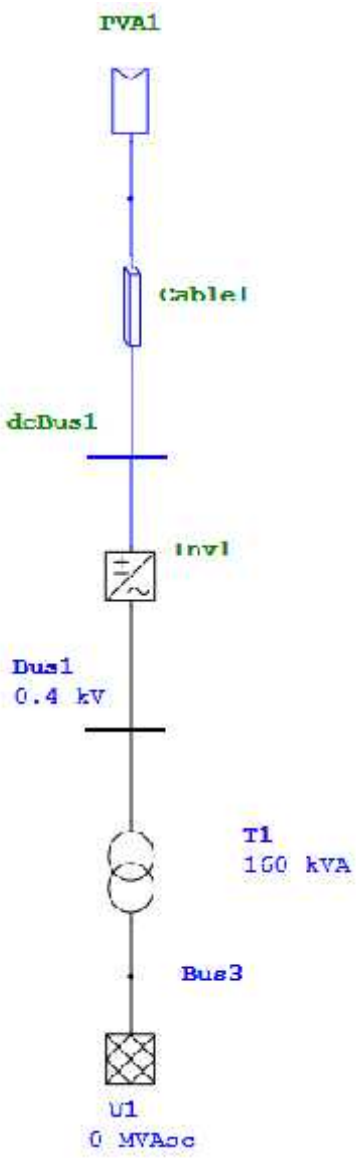
19. Drag and drop AC Grid from AC Editor Toolbar and connect to transformer as shown below.





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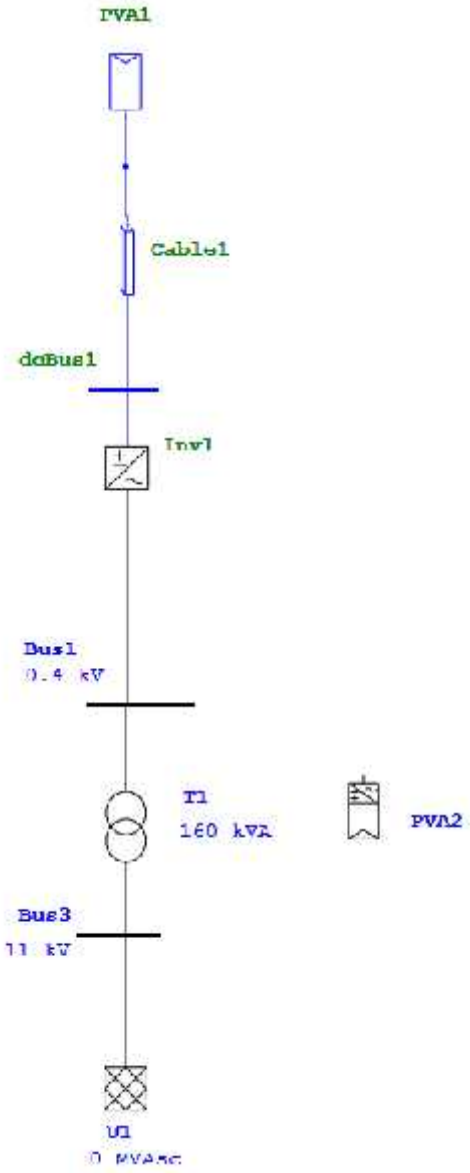
20. Drag and drop PV Array from AC Editor Toolbar as shown below.



21. Double click on AC PV Array and follow steps 3 to 7 to select PV Array.
22. Go to Inverter page, click on Inverter Editor as shown below

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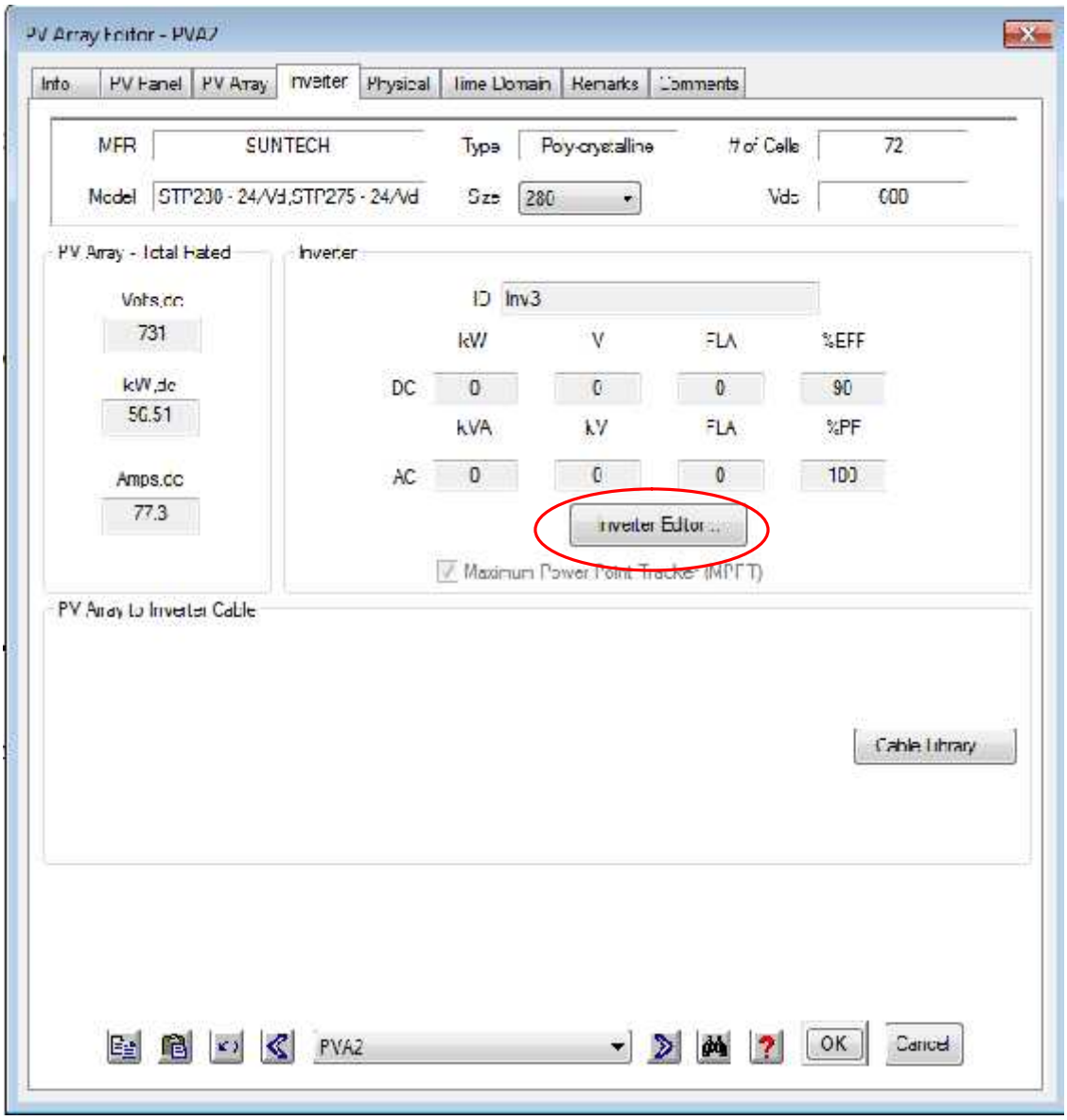

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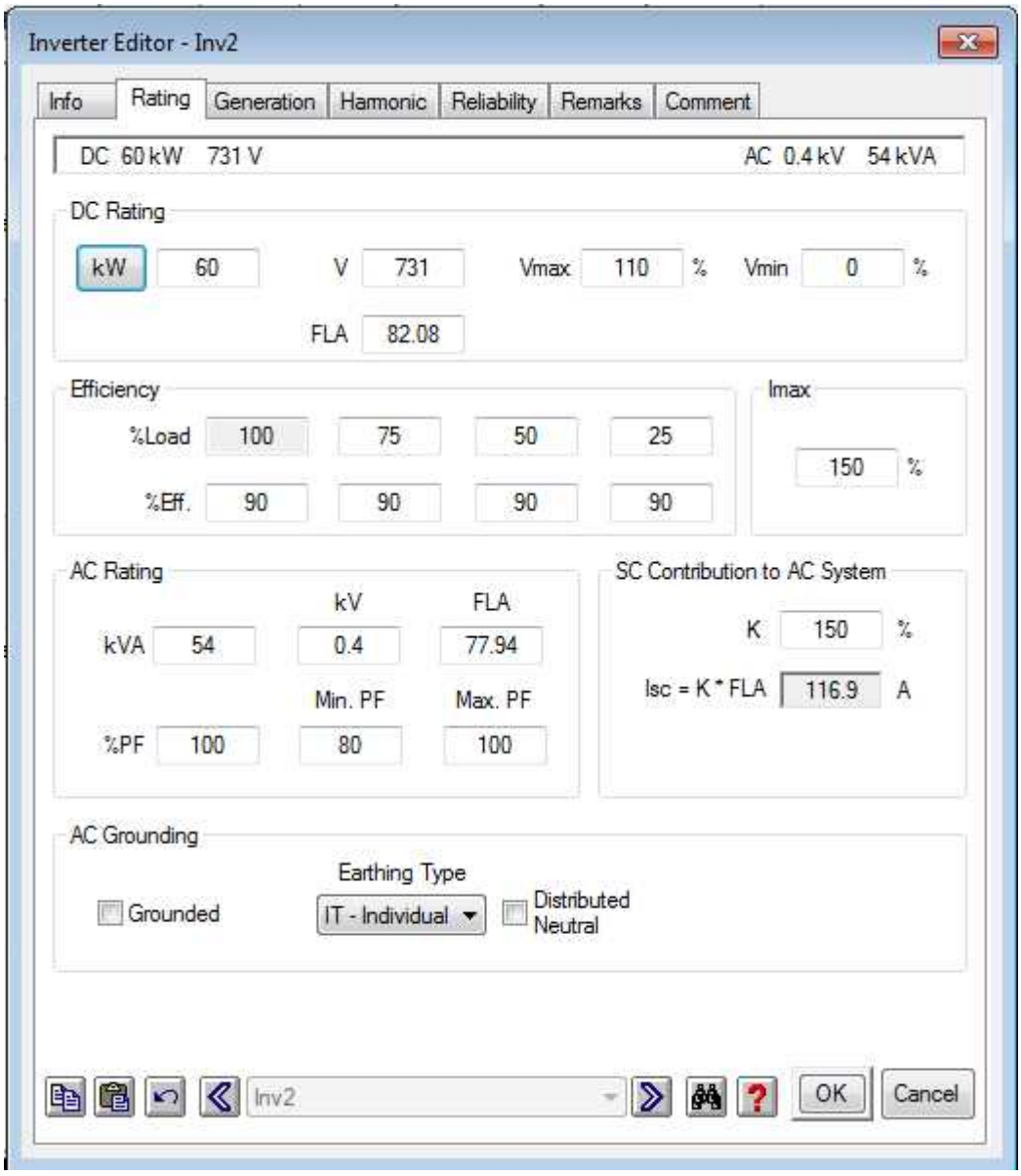
23. The below window pops up. Go to Inverter page, and enter the below shown parameters.



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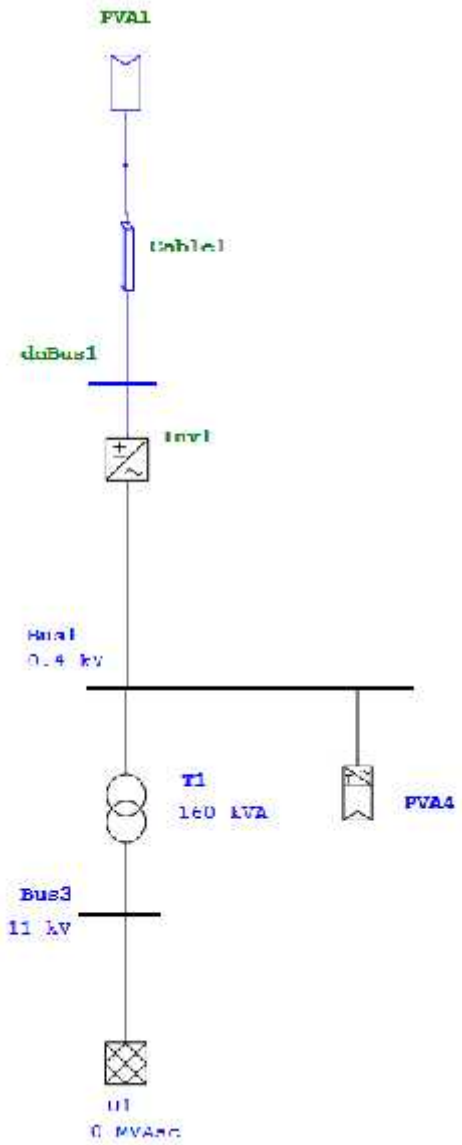
24. Connect the AC PV Array to Bus1 as shown below.



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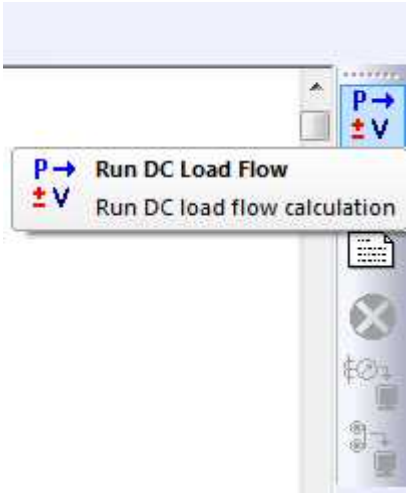
25. Go to DC Load Flow Analysis Module and Run DC Load Flow as shown below.



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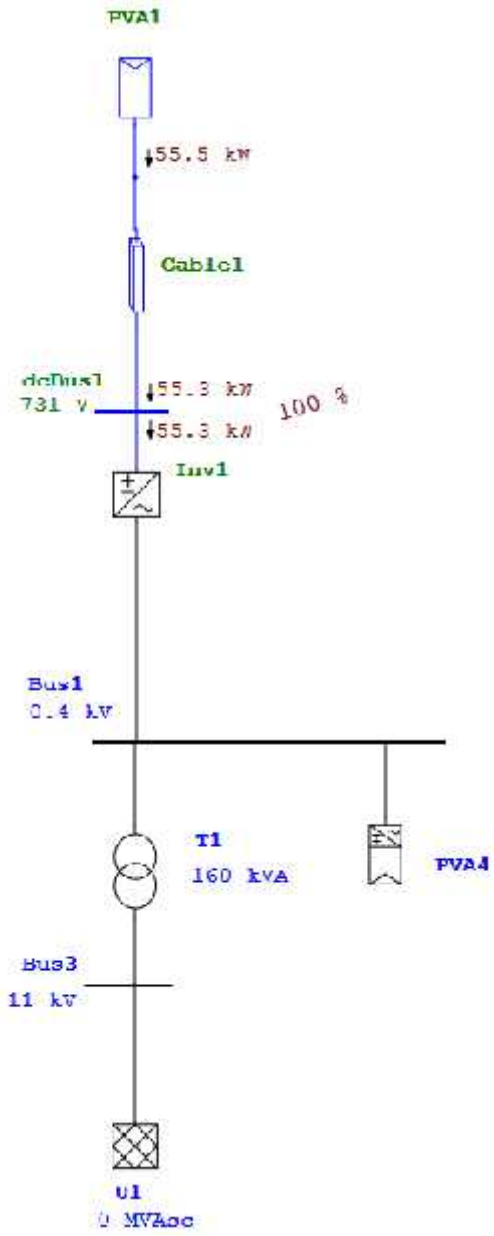
26. The DC load flow results are as shown below.



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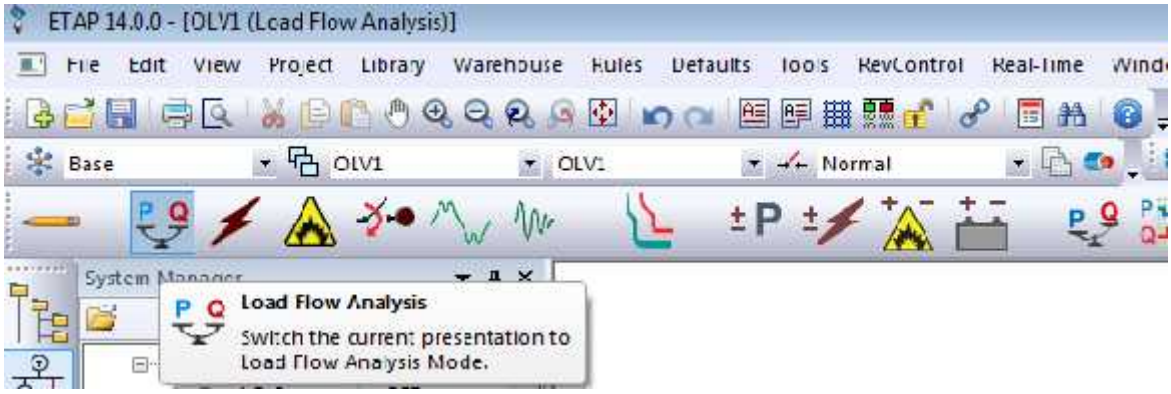
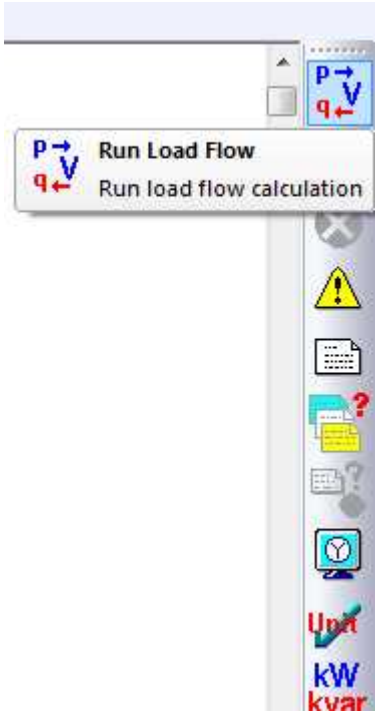
27. Go to AC Load Flow Analysis Module and Run AC Load Flow as shown below.





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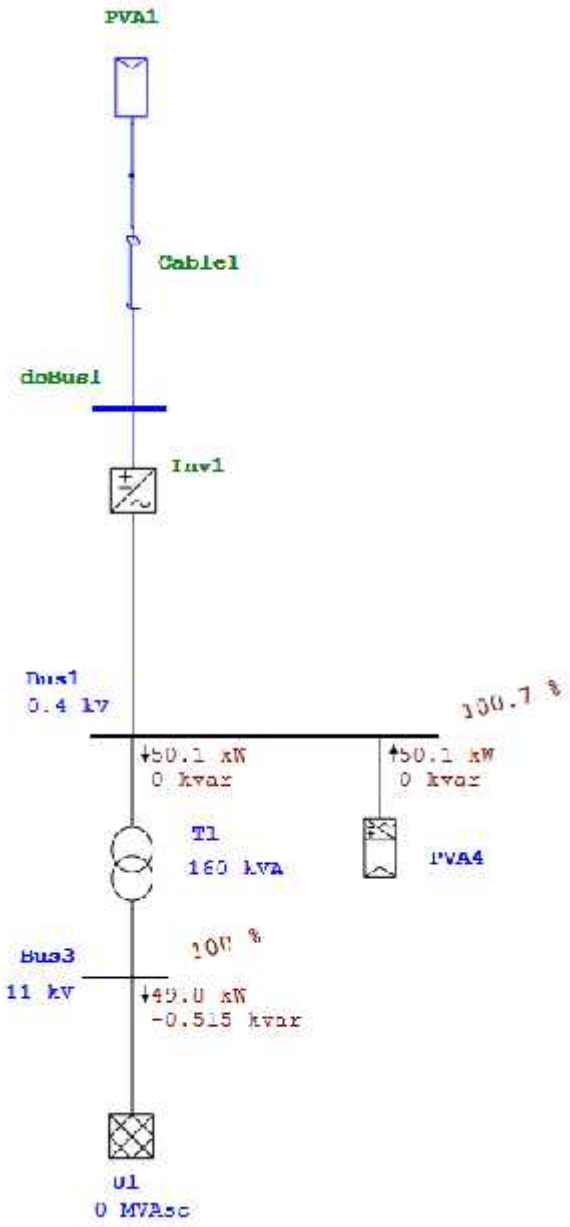
28. The AC load flow results are as shown below



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