# IV Measurement

**Subject:** Taking IV measurements of laboratory-created PV cells

*Requires special equipment*

**Grade Levels:** College

**Lesson length:** 15-20 minutes

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Photovoltaic IV testers (see fig. 1) are able to accurately give measurements of solar cells' voltage (V) and current (I) with light sources designed to recreate the sun's intensity and light spectrum. The result of these IV tests is an IV curve (see fig. 2), which is generated from a short-circuit current (ISC) (Amperes, A) point and an open-circuit voltage (VOC) (Volts, V) point. The cell's actual measurements are compared to an ideal curve, which is generated by the short-circuit current (ISC) and open-circuit voltage (VOC) and the ratio of coverage by the actual curve is the fill factor (FF) (%). For this activity, the relationship between short-circuit current (ISC) and open-circuit voltage (VOC), the factors affecting them, their effect on fill factor (FF), and the physical use of an IV tester will be explored. This activity is designed for 4-8 participants with 1-2 instructors.

## OBJECTIVES

- *Participants will learn how to use the Solar Powered Laboratory's IV tester to measure their cells' optimal IV curves. Therefore, they will conceptually learn what ISC, VOC, and FF are and how they relate to each other.*

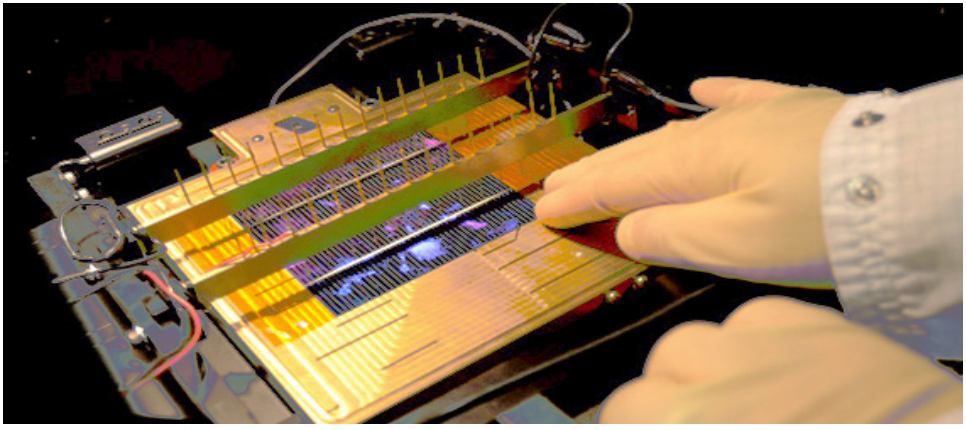
## Materials

- Soldering workstation
  - Soldering wand
  - Silver ribbons
  - Wire (for actual soldering)
- Scissors
- Rubber gloves
- Solar cell(s)
- Solar Cell Measurement worksheets
- Case to transport cells to soldering workstations

## Instructions

Each group will need to complete measurement for 10 cells. Six of these cells have compatible ISC's so groups can make a 4-cell module (and have two cells for backup in case of breakage). The other 4 cells will be used to make 1-cell modules.

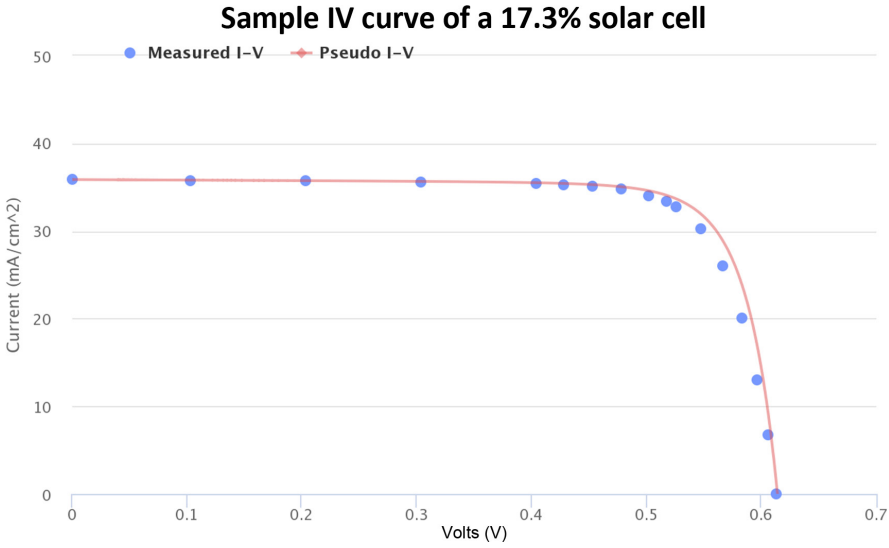
1) Begin with discussing voltage (the potential for electrons to move, similar to everyday objects' potential energy when on something like a table) and current (the flow of electrons through something conductive, e.g. metal).
2) Follow up by discussing how voltage is generated within the solar cell (energy from the sunlight is measured in the quantum "photons". These photons excite electrons within the silicon and create a voltage due to the "Photoelectric Effect").
3) Display a sample IV curve and discuss what ISC, VOC, and FF are.
4) Discuss what affects ISC, VOC, and FF. The factors affecting ISC include:
   a. area of the solar cell
   b. number of photons received (i.e. the power of the incident light source)
   c. spectrum of the incident light
   d. optical properties (absorption and reflection) of the solar cell
   e. collection probability of the solar cell



5) Demonstrate the appropriate way to handle solar cells (e.g., use of tweezers and noting how easily they break).
6) Demonstrate the steps to use the IV tester, then let students measure their own cells. Each student should measure at least 1 pre-made cell first. Have them record the results on the Solar Cell Measurement worksheet.
7) Calculate percent discrepancy with actual voltages and currents using the formula

$$|\text{Theoretical-Actual}| \,/\, \text{Theoretical} \cdot 100$$

where the theoretical value is the given voltage and current values, and the actual value is the measured voltage and current values.
8) Separate out 6 cells which are compatible to make their 4-cell module. The additional 4 should be for their individual modules.
9) Guide students through the calculation of the expected voltage and current of their 4-cell module, explaining the effect of constructing a series circuit on voltage and current. They should record their expected voltage and current on the measurement worksheet.




## Assessment Opportunities

What is voltage? What is current? Voltage is the potential for electrons to move. Current is the rate at which they move.