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VTT’S LIWE Facades OPV Solar Cell Efficiency

Efficiency testing of solar cells behind various materials

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This thesis studies the efficiency of organic photovoltaic (OPVs) solar panels provided by VTT Technical Research Centre of Finland. They have been developing ultra-thin, light-weight and flexible solar cells through their LIWE Facades "Feathery façades for positive energy buildings" project. Their project is briefly explained, as well as what OPVs are and how they function. The most important electrical characteristics of OPVs and how to calculate their efficiency conversion are also discussed.

VTT provided twelve solar panels, but this thesis will only look at six of them. Each solar panel was tested with four different materials at four different angles, making a total of ninety-six tests with calculated efficiencies. It was assumed that OPV solar panels could be a replacement of traditional heavy, silicon photovoltaic solar panels.

Keywords	OPV, PV, photovoltaic, solar cell, solar technology, VTT, efficiency conversion

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List of Abbreviations

FF	Fill Factor
Impp	Maximum Power Point Current
Isc	Short Circuit Current
I-V	Current vs Voltage
OPV	Organic Photovoltaic
Pmax	Maximum Power Point
PV	Photovoltaic
P-W	Power vs Voltage
R2R	Roll-to-roll
STC	Standard Test Conditions
Vmmp	Maximum Power Point Voltage
Voc	Open Circuit Voltage

1 Introduction

In a time of depleting natural resources, such as oil, natural gas, coal and timber, the world is slowly turning to renewable energy resources like solar energy, hydro power, geothermal energy, bio energy and wind power. Solar power has becoming a real contender in the renewable energy sector and its usage around the globe is steadily increasing since the 2000s.

Solar energy comes in many different forms: Photovoltaic (PV) systems which produce electricity directly from solar rays, solar hot water which involves heating water with solar energy, solar electricity which uses the sun's radiation to produce electricity, and various other forms. Since solar energy is a renewable resource, it eliminates the use of harmful use of fossil fuels which are a leading cause of global warming. It also is abundantly available all over the world and sustainable. Some of solar energy's downfalls consist of its high development cost, its inability to be mass produced, efficiency, and the large land area required to farm solar energy.

When looking specifically at Organic Photovoltaic (OPV) and Photovoltaic (PV) solar cells, their efficiency to convert useable energy has always been questionable. In the days of the very first solar cells back in the 1800s, the efficiency was a mere 1% which was hardly considered a useful amount of energy. This efficiency later increased to 6% thanks to Bell Labs in 1954. Modern day solar panels are quoted to have an efficiency of 19-21%, but there is still room for improvement. Researchers have managed to achieve 46% efficiency in a controlled lab environment. Unfortunately, since they designed those solar panels with more expensive materials, overall making them not cost-effective for homeowners. [7]

Another one of the top draw-backs is the amount of space used by solar energy farms, one of largest solar farms in the world spans around 53 km^2 in India. For a typical homeowner, the roof has sufficient space to house the desired panels, but they do not always fit properly.

VTT Technical Research Centre of Finland has been in the process of developing Ultra-thin, lightweight and flexible solar cells through their LIWE Facades project. Their ultimate goal is to produce light-weight solar panels into building facades to help promote

zero or even positive energy targets of future green, sustainable buildings. Using printing technology to manufacture approximately ~1 kg/m^2 solar cells, VTT hopes to replace heavy, silicon photovoltaic solar panels with these new tailored printed solar cells.

This thesis analyses the max efficiency of 6 panels (ATCJ-I-52 to ATCJ-I-57), that were kindly provided of VTT Technical Research Centre of Finland, with no cover, a polycarbonate sheet, 3 mm glass and 6 mm glass on top of the OPV panels throughout the test. Tests were carried out at 4 different angles (90°, 60°, 45° & 30°) to help simulate angle of the sun's rays throughout the day. All the raw data and graphs can be found in the appendix of this thesis and efficiency calculations can be found under the Results chapter. How the efficiency was calculated can be found under the Methodology chapter. In the next chapter, Theoretical Background, VTT's LIWE Facades Project, the theory of OPVs, solar cell characteristics, and the required properties for ideal materials are addressed.

2 Theoretical Background

2.1 VTT LIWE Façade Project

"Feathery façades for positive energy buildings", better known as the LIWE Façades, was originally a project submitted for Challenge Finland by VTT researchers, Sanna Rousu, Tapio Ritvonen and Pälvi Apilo, back in 2016. The purpose of the project was to create a solution to help introduce light-weight solar panels into building facades to balance out the energy target of future green, sustainable buildings that are trying to reduce their carbon footprint. Heavy weight silicon photovoltaic (PV) solar panels are more commonly used, but they are not always the most effective, practical, visually-appealing or cost-effective choice. VTT's vision is for their new light-weight OPV panels is to solve most if not all of these problems. Using printing technology, the OPV solar panels can be tailored to fit any building surfaces at a low installation costs as well as low manufacturing cost. [5]

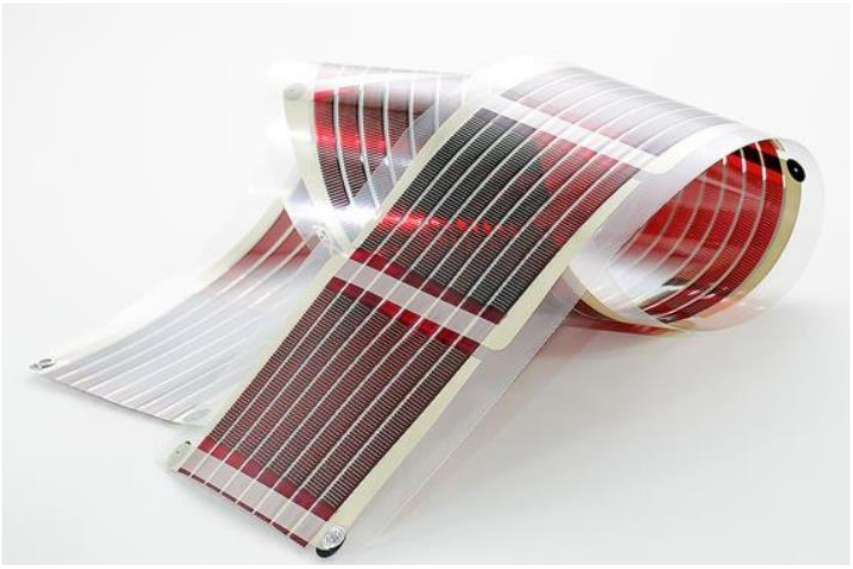
Kuvio 1. VTT's printed OPV solar panels. [5] [6]

VTT's OPV solar panels can be designed in any shape or fashion, like in Figure 1 above, which is a huge improvement over the heavy silicon PVs that can be generally found on rooftops. According to VTT's web article [5], manufacturing roll to roll (R2R) technology has the following benefits: flexible, lightweight and ultra-thin (~200 µm in total), if printed (not coated), unlimited designs on any shape is possible, giving true design freedom, large or small area modules possible – customised electrical performance, low-cost production, and environmental sustainability. The next section will explore organic photovoltaic solar panels and their mechanics.

2.2 Organic Photovoltaics Solar Panels

2.2.1 Brief Overview

In order to be Organic Photovoltaic (OPV) solar panels, they must be made of carbon-based materials instead of the traditional silicon solar panels. They can be dissolved in ink and printed onto thin rolls of plastic, mainly known as Roll-to-Roll (R2R) technology. The main purpose of OPV solar panels is to convert solar energy, from the sun's rays, to electrical energy. In order to create an OPV solar panel, one or several photoactive materials are flattened between two electrodes like in the Figure 2 below.

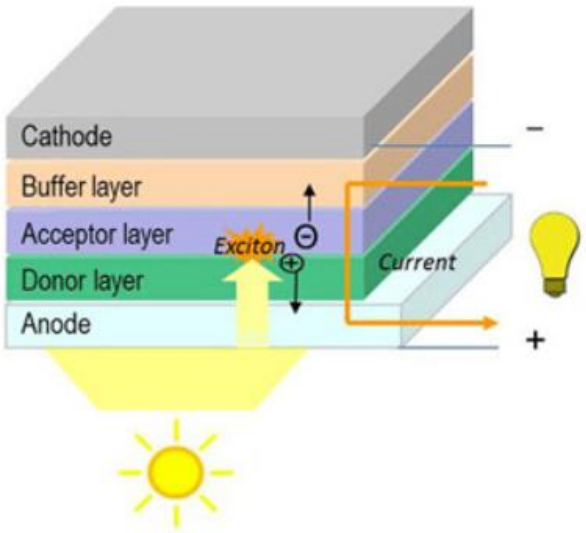


Kuvio 2. Printed OPV solar panel. [9]

Commercial photovoltaics (PVs) convert generally about 15-22% of sunlight, whereas silicon based solar panels can convert up to 27%. Unfortunately, OPVs can only convert about half this amount and there have not been any technological advances to increase their efficiency. The next section will discuss the mechanics of OPV solar panels.

2.2.2 Mechanics

The basic make-up of an OPV solar panel contains a heterojunctions (BHJ) which are created using a mix of an electron-donor (p-type semiconductor) and electron-acceptor (n-type semiconductor), which can be seen in Figure 3 below.



Kuvio 3. Structure of an OPV solar panel. [8]

The donor material donates electrons and mainly transports holes and the acceptor material withdraws electrons and mainly transports electrons. [9] The main advantage of this technology is its weigh-light and flexible materials as well as its cost-effectiveness. The downfall of this technology is its effectiveness in comparison to the traditional bulky silicon solar panel counterparts. In order to increase their effectiveness, the donor and acceptor materials in the OPV need to have good extinction coefficients, which can be improving the optical absorption spectrum and maximizing the charge transport. The mechanics of OPVs include 4 processes: light absorption, exciton diffusion, charge separation and finally charge transport and collection.

Light absorption, also known as exciton formation, is the first process of the mechanics of OPV solar panels. It leads to the exciton formation process. For the most efficient OPVs, the donor and acceptor layers need to have board absorbance lines and high extinction coefficients. This produces a high optical density for thin films.

Exciton migration or diffusion is the most important process that differentiates OPV solar panels from traditional silicon solar cells. For the cell to generate a current, formation and disassociation is essential. The structure of the organic cells includes a component that corresponds to an electron donor and a component that corresponds to an electron acceptor. In order to reach the point of the most efficient exciton diffusion, the distance between the interfaces must be precise. If the film is too thick, the migration takes too long. If the film is too thin, only a few photons manage to be absorbed, reducing the

efficiency yet again. Deciding the thickness of the film is the major obstacle that engineers face when designing OPV solar cells. The cell must be thick enough to absorb an adequate quantity of photons, but at the same time, the cell must also be thin enough so that the generated excitons can reach the interface efficiently.

Charge separation, also known as exciton dissociation, happens when the exciton reaches the interface. Potential, which in this case is considered an exothermic process, is created when the electron begins to drift toward the cathode and when the hole drifts toward the anode. If there is no potential, the electron and hold just disperse without any direction to their motion. The lowest energy state is the ground state of the electron and hole. Depending on where the exciton is formed, it is labelled D* if formed within the donor. Then the exciton must be transferred to the acceptor which creates a charge transfer state ($D^+ A^-$). These positive and negative charges must move away from each other in other to form a charge separated state. It is mandatory to have both a charge transfer state (CT) as well as a charge separation state (CS). If there is recombination between the hole and the electron, which can occur when they are next to each other, it would lead to the ground state. If recombination would occur, this would lower the efficiency of the charge separation process. This is considered the main reason for the low efficiencies of OPV solar panels. In order to maximize the charge transfer and the charge separation phases, as well as minimize the possibility of recombination, the rate of transfer needs to be maximized while the rate of recombination needs to be minimized.

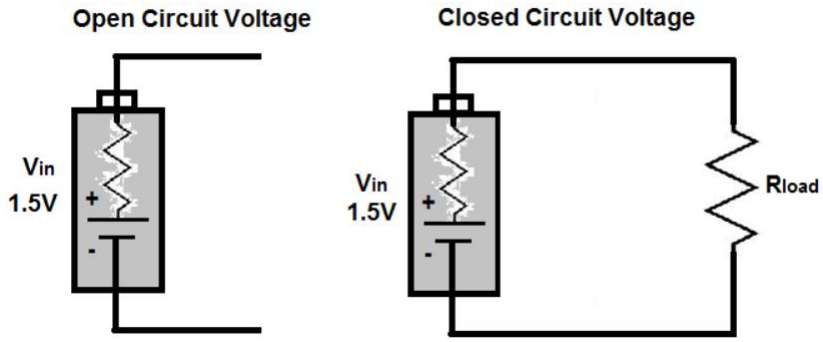
The next section will discuss the electrical characteristics of an OPV solar panel and how they can be calculated. The most important characteristics to be considered are the open circuit voltage (V_{oc}), open circuit current (I_{sc}), the fill factor (FF), the maximum power point voltage (V_{mpp}), the maximum power point current (I_{mpp}), the maximum power point (P_{max}), and how irradiance and load can affect them.

2.3 Solar cell characterization

This chapter will discuss the most important characteristics of an OPV module. This will help create a strong base knowledge of how to determine the efficiency of a solar module which will be discussed more in the next section.

2.3.1 Open circuit voltage (Voc)

Open circuit voltage, calculated with no load, is the number of volts that the solar panel outputs. This is normally measured at an irradiance of 1000 W/m^2 and when the cell's temperature is at 25℃ which are considered the standard test conditions (STC). The Voc of a solar cell is simply measured with a voltmeter between the plus and minus nodes. Since it is called an open circuit voltage, it means that there is no load and no current as seen in the figure below.



Kuvio 4. Difference between an open and closed-circuit voltage. [10]

The V_{oc} is considered the maximum possible voltage that the solar cell can produce under standard test conditions making it an important number to determine.

2.3.2 Short circuit current (I_{sc})

The short circuit current (I_{sc}) is the number of amps (A) that the solar module can produce when not connected to a load. In order to get the I_{sc}, the plus and minus wires are connected to each other and the reading can be taken using an ammeter at standard test conditions (STC). This value is the highest current that the circuit can produce at STC.

2.3.3 Maximum power point voltage (V_{mpp})

The maximum power point voltage (V_{mpp}) is voltage when the power of the solar module is the greatest. This is the number seen on the device that is being used to measure the voltage on the system at STC.

2.3.4 Maximum power point current (I_{mpp})

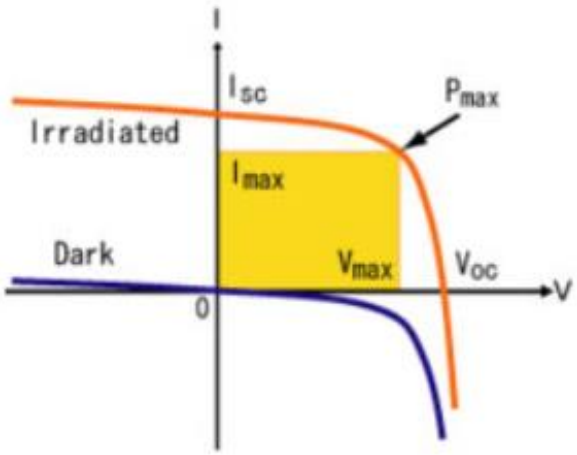
The maximum power point current (I_{mpp}) is current when the power of the solar module is the greatest. This is the number seen on the device that is being used to measure the amps on the system at STC.

2.3.5 Maximum power point (P_{max})

The maximum power point is a combination of when the volts and amps of the solar module are the greatest and produce the greatest wattage. It is simply calculated with the formula below.

$$Pmax = Vmpp * Impp$$

For the solar panel to be the most efficient, a maximum power point tracking (MPPT) charge controller or inverter can be installed to try to maintain this value. If the relationship between the current and voltage (I-V curve) would be graphed, the P_{max} occurs at the “knee” of the curve like in the graph below.

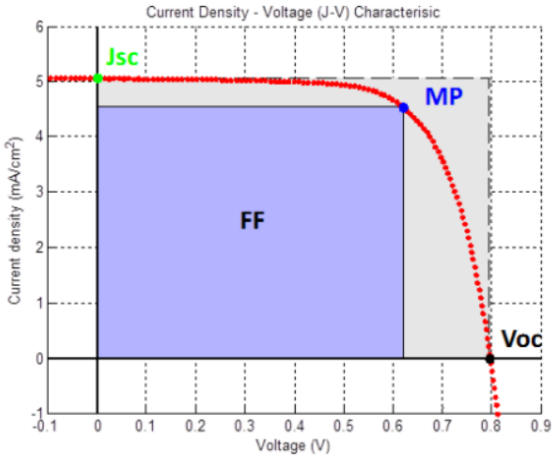


Kuvio 5. P_{max} on an I-V curve. [11]

P_{max} is essential to determine the efficiency of a solar cell at STC.

2.3.6 Fill factor (FF)

The fill factor is the ratio between the maximum power and the product of the short-circuit current density and the open-circuit voltage or the ratio between the product of maximum power point current density and the voltage and the product of the short-circuit density and the open-circuit voltage. The FF can be easily visualized in a J-V curve like the one in the figure below.



Kuvio 6. Current density vs voltage (J-V) to show FF. [12]

The FF can also be calculated using a formula that uses the voltage (V_{mpp}) and current (I_{mpp}) at maximum power point as well as the short circuit current (I_{sc}) and short circuit voltage (V_{oc}). This formula can be written as follows:

$$FF = \frac{Vmpp * Impp}{Voc * Isc},$$

Where the FF is the ratio between the rectangle with sides V_{mmp} and I_{mmp}, and the area with the sides of the open-circuit voltage and the short-circuit current density. This means that we can express the maximum power density as a product of the FF, the open-circuit voltage and the short-circuit current density. Therefore, it is impossible for a solar cell to have a FF equal to 1. This value defines the behaviour of a solar module.

2.4 Conversion efficiency

Efficiency for a solar cell is ratio of electrical power compared to the solar input into the OPV cell. The efficiency can be calculated using the formula(s) below.

$$\eta = \frac{Isc * Voc * FF}{Psolar} = \frac{Pmax}{Psolar} = \frac{Impp * Vmpp}{Psolar} = \frac{Impp * Vmpp}{E * Ac}$$

In this case, P_{solar} is calculated using the P_{max} which is calculated by multiplying the maximum power point voltage (V_{mpp}) and maximum power point current (I_{mpp}) and comparing that value to the active area of the solar cell and multiplying it by the irradiance of the light-source whether it is a lamp or the sun. For the purpose of this thesis, this formula was used to determine the efficiency of the 6 solar panels provided by VTT. The next chapter will explore the methods used to carry out the testing of the solar modules provided, the materials and equipment needed, the data collection methods, what calculations were used, and the limitations of the experiments.

3 Methodology

3.1 Experimental Setup

In this thesis, the efficiency of the solar panels was tested behind three different panels, 3 mm polycarbonate, 3 mm glass and 6 mm glass, and then compared to that of the efficiency of the solar modules without any cover on top of them. The light source is set at a standard distance away from the cells to provide as close as possible to an irradiance of 100 W/m^2 when the incident angle is at 0°, or 90° depending on reference plane. Steps have also been taken to eliminate any possibility of shading during the tests. Any shift in position to change the variables in the tests occurred perpendicular to the light source, thus removing the concern of distorting the incident light. However, this was shown to be a non-issue as the shadow cast is minuscule and requires an angle more extreme that any of the angles we test.

The transparent polycarbonate plate that was used as the foundation for the cells was chosen for several reasons. The first reason was to make working on the electronic components as easy as possible by maximizing visibility, and to easy prevent any issues with debris that may interfere with the quality of the tests, such as small objects adhering to either the cell or the plate and bending or otherwise distorting the test conditions. The

second reason was to prevent distortion of test results based on incorrect heating values with the cells. The lamp was tested during testing produced significant heat and having the base be as unresponsive to that heat as possible was considered important.

The build itself is designed to quickly accommodate 4 angles of incident light: 90°, 60°, 45° and 30°. This is done through the joint at the top where the arms extend. This allows the light source to be untouched and all angles/other possible variables to remain unchanged and isolate just the incident angle itself as a variable.

For this thesis, only 6 solar panels out of 12 where used for the testing due to time constraints. For each panel, there were tests done for four materials (no cover, 3 mm polycarbonate, 3 mm glass and 6 mm glass) at four different angles (90°, 60°, 45° and 30°) meaning that one panel required 16 experiments total. This means that for 6 panels, a grand total of 96 tests were conducted to determine their I-V curves and efficiencies.

3.2 Materials and Equipment

Before the experiments could take place, a testing apparatus must be built where the angle can be changed accordingly. All the materials can be found from a local hardware store. The two main materials consisted of a 3*1000*1000mm clear polycarbonate sheet and equal-sided hard PVC stick. In Figure 7, you can see one of the pieces, the polycarbonate sheet, used to create the apparatus. The solar cell was attached to this material during the experiments.

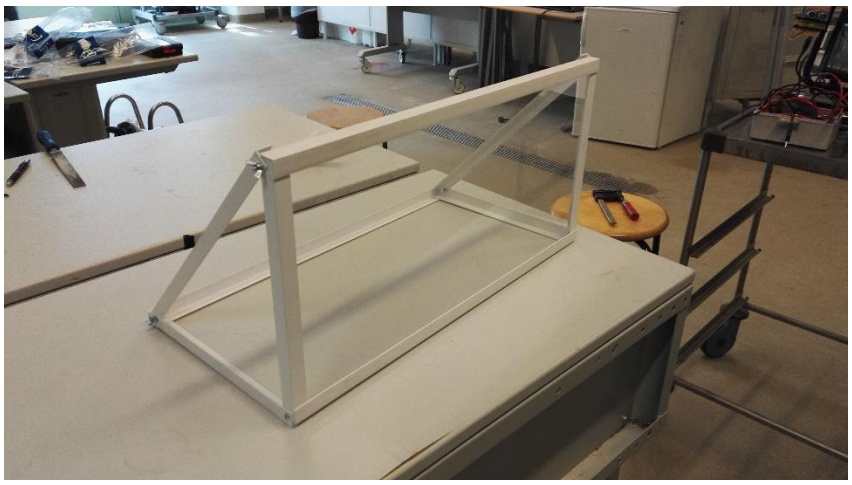
Kuvio 7. Polycarbonate sheet used to create testing apparatus.

This polycarbonate material is also one of the covers used for experiments since it is a common material for windows at cottages in Finland. Below you can see the other

important material used for apparatus, its main purpose was to create support and determine the angels of the apparatus.

Kuvio 8. Equal-sided hard PVC piece used for building the apparatus.

Other materials that were used to build the apparatus consisted of a heavy plywood piece for the bottom which provides the base of the testing apparatus, duct tape, screws and construction silicon. Four holes were drilled into the equal-angled hard PVC side support in order to make changing the angle of the setup simple and quick. In Figure 9 below, the final version of the setup can be seen.



Kuvio 9. Testing apparatus built for testing.

The solar cell can be attached to the clear polycarbonate sheet with either sticky-tack or with tape.

For the testing setup, a Tenmars TM-208 UV light meter was used to record the irradiance of the lamp being used as a light source in Figure 10 below.

Kuvio 10. Tenmars TM 208 UV Light Meter.

Irradiance must be recorded with every measurement taken since it is essential for calculating the max efficiency.

The other material needed consist of a voltmeter, a volt-ohm-milliammeter and a device that can produce a load on the circuit which can be called a “dummy load”. This equipment can be seen in the Figure11 below.

Kuvio 11. Generic voltmeter (top right), volt-ohm-milliammeter (top left) and device that creates a load (bottom).

All these devices needed to be connected to the solar panel that was being tested in a round. The voltmeter is used to measure the voltage, the volt-ohm-milliammeter is used to measure the current and the dummy load device can change on the load on the circuit. The dummy load device is the only variable changed during a test. Each time the load was changed, the voltage and current were recorded along with what load was used and what the irradiance was. During the one test, the load had to be changed enough so an I-V curve could be created on a graph which could determine the Pmax value of the solar module.

3.3 Data Collection Methods

All the data was collected straight into Microsoft Excel, thus a visual representation of the I-V curve could be seen right away. All the data collected can be found in the Appendices 2-7 of this thesis. A total of 24 Excel files were created which contained the data for all four angles on different sheets for one solar panel with one cover material. On one Excel sheet, there is the data collected (voltage, current, calculated power, irradiance and load) for that test in a table, then one graph containing current vs voltage (I-V) curve and another graph containing a voltage vs power (V-P) curve in relation to the I-V curve. In the data table, the power is calculated by multiplying the voltage column by the current column. The irradiance values in the table are in units' watts per meter squared (W/m^2) and load the is in ohms (Ω). From this data, an approximate value for P_{max} can be derived.

3.4 Calculations needed

The max efficiency was calculated using the maximum power output (W) divided by the irradiance multiplied by the active area of the panel, as seen in the formula below.

$$\eta max = \frac{Pmax}{(E * Apanel)},$$

On the basis of the data gathered during the testing, this formula would give the most accurate results for the max efficiency.

3.5 Limitations

Another measurement that could have been taken during the experiments is the surface temperature of the solar cell. During previous project testing, this temperature was taken but was found to be quite inaccurate due to the temperature gun used for testing. It was also considered unviable to also be taking a 5th measurement (on top of voltage, current, irradiance and load) because it could cause a higher margin of error since one person had to record 5 values manually at once into an Excel.

4 Results

4.1 VTT Reference Values

In Table 1, the VTT reference values can be seen. The complete data set can be found in Appendix 1, all reference values were acquired at 90°.

Taulukko 1. Efficiencies from VTT's reference values at 90, also seen in Appendix 1.

Panel	Efficiency (%)	Irradiance (W/m^2)
ATCJ-I-52	2.529672	1000
ATCJ-I-53	2.412419	1000
ATCJ-I-54	2.496214	1000
ATCJ-I-55	2.446978	1000
ATCJ-I-56	2.462992	1000
ATCJ-I-57	2.538538	1000

All the tests taken for the thesis, were taken at only 100 W/m2 instead of 1000 W/m2, so the efficiencies were less than what is referenced by VTT.

4.2 Panel ATCJ-I-52

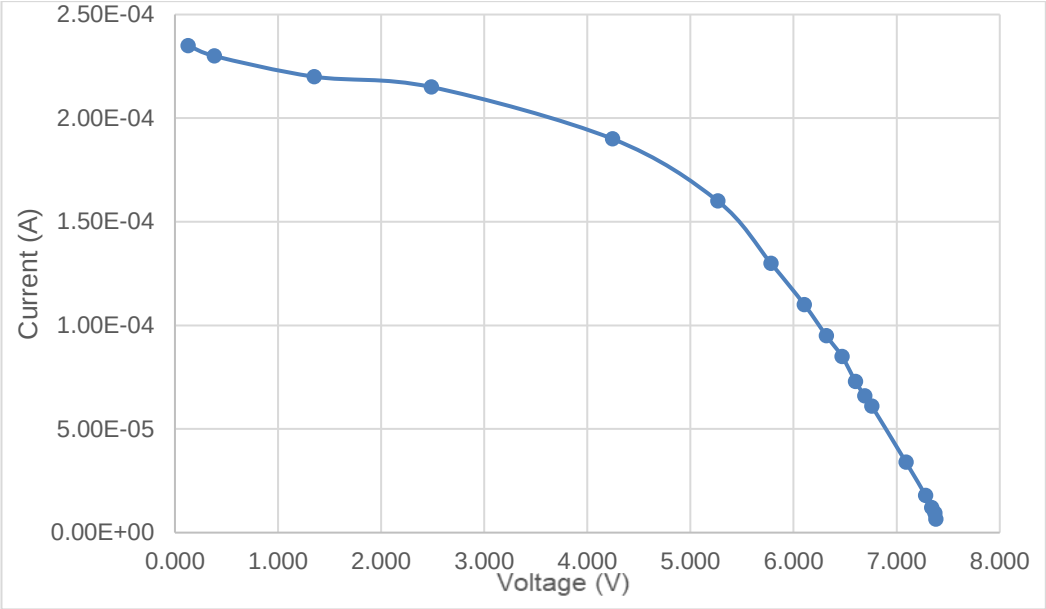
In Table 2, the results of the testing for panel ATCJ-I-52 can be found. Keep in mind that the effective area of the solar panel is 2851mm^2. The irradiance of each test can be found in Appendix 2.

Taulukko 2. Tests results for panel ATCJ-I-52.

Panel	Angle	Cover	P_{max} (W)	P_{in} (W)	Efficiency (%)
ATCJ-I-52	90°	None	$8.64 \cdot 10^{-4}$	0.2851	0.303%
		3 mm polycarbonate	$8.42 \cdot 10^{-4}$	0.28738	0.293%
		3 mm glass	$9.08 \cdot 10^{-4}$	0.28624	0.317%
		6 mm glass	$8.65 \cdot 10^{-4}$	0.28624	0.302%
	60°	None	$7.37 \cdot 10^{-4}$	0.27027	0.273%
		3 mm polycarbonate	$6.12 \cdot 10^{-4}$	0.27113	0.226%
		3 mm glass	$6.84 \cdot 10^{-4}$	0.28339	0.241%
		6 mm glass	$6.40 \cdot 10^{-4}$	0.2583	0.248%
	45°	None	$6.31 \cdot 10^{-4}$	0.23435	0.269%
		3 mm polycarbonate	$4.66 \cdot 10^{-4}$	0.2372	0.197%
		3 mm glass	$5.14 \cdot 10^{-4}$	0.24946	0.206%
		6 mm glass	$4.92 \cdot 10^{-4}$	0.21753	0.226%
	30°	None	$3.94 \cdot 10^{-4}$	0.18389	0.214%
		3 mm polycarbonate	$2.76 \cdot 10^{-4}$	0.19102	0.145%
		3 mm glass	$2.99 \cdot 10^{-4}$	0.20043	0.149%
		6 mm glass	$3.09 \cdot 10^{-4}$	0.16536	0.187%

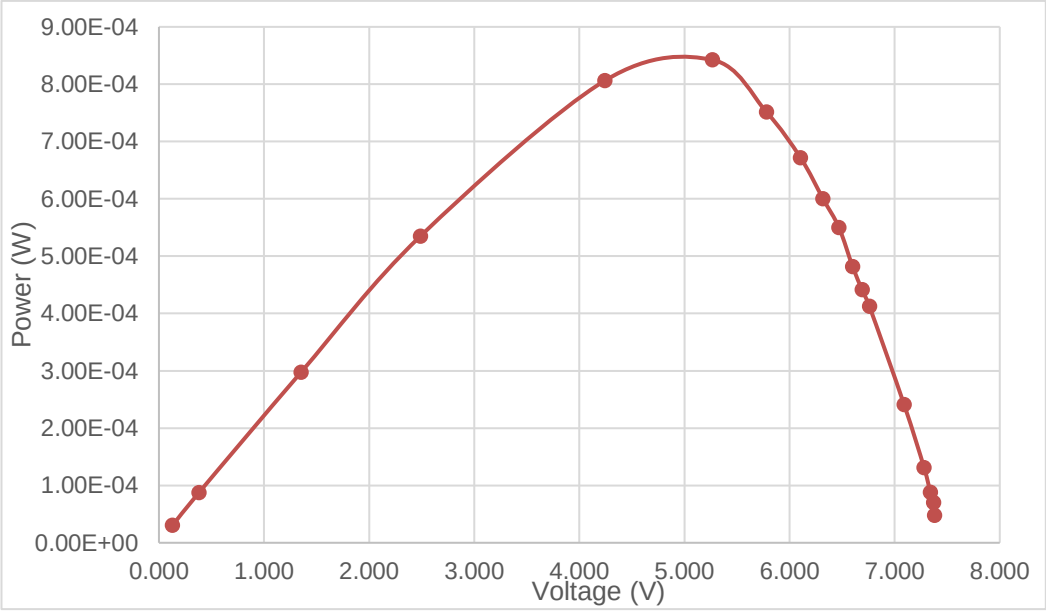
P_{max} was taken from the P-V curve also seen in Appendix 2. P_{in} was calculated by multiplying the irradiance (W/m^2) by the effective area of the solar panel (2851 mm^2).

As an example of a current vs voltage (I-V) curve, one can be seen in Figure 12 below. The results from that graph were taken from the test with the polycarbonate sheet at 90°.



Kuvio 12. Voltage (V) vs Current (I) curve for panel ATCJ-I-52 polycarbonate cover at 90°.

As an example of a power vs voltage (P-V) curve, one can be seen in Figure 13 below. The results from that graph were taken from the test with the polycarbonate sheet at 90°. P_{max} can be easily determined using this graph.



Kuvio 13. Voltage (V) vs Power (W) curve for panel ATCJ-I-52 with polycarbonate cover at 90°.

All the other I-V and P-V curves can be found in Appendices 2-7.

4.3 Panel ATCJ-I-53

In Table 3, the results of the testing for panel ATCJ-I-53 can be found. Keep in mind that the effective area of the solar panel is 2851mm^2. The irradiance of each test can be found in Appendix 3.

Taulukko 3. Tests results for panel ATCJ-I-53.

Panel	Angle	Cover	P_{max} (W)	P_{in} (W)	Efficiency (%)
ATCJ-I-53	90°	None	$8.62 \cdot 10^{-4}$	0.28681	0.301%
		3 mm polycarbonate	$7.08 \cdot 10^{-4}$	0.28824	0.246%
		3 mm glass	$7.47 \cdot 10^{-4}$	0.28567	0.261%
		6 mm glass	$8.19 \cdot 10^{-4}$	0.28795	0.284%
	60°	None	$6.96 \cdot 10^{-4}$	0.2583	0.270%
		3 mm polycarbonate	$5.34 \cdot 10^{-4}$	0.26229	0.204%
		3 mm glass	$6.01 \cdot 10^{-4}$	0.26001	0.231%
		6 mm glass	$6.57 \cdot 10^{-4}$	0.26685	0.246%
	45°	None	$5.35 \cdot 10^{-4}$	0.21782	0.246%
		3 mm polycarbonate	$4.34 \cdot 10^{-4}$	0.22209	0.196%
		3 mm glass	$4.78 \cdot 10^{-4}$	0.22038	0.217%
		6 mm glass	$5.31 \cdot 10^{-4}$	0.23093	0.230%
	30°	None	$3.36 \cdot 10^{-4}$	0.17049	0.197%
		3 mm polycarbonate	$2.74 \cdot 10^{-4}$	0.16963	0.161%
		3 mm glass	$3.01 \cdot 10^{-4}$	0.16992	0.177%
		6 mm glass	$3.16 \cdot 10^{-4}$	0.17619	0.179%

P_{max} was taken from the P-V curve also seen in Appendix 3. P_{in} was calculated by multiplying the irradiance (W/m^2) by the effective area of the solar panel (2851 mm^2).

4.4 Panel ATCJ-I-54

In Table 4, the results of the testing for panel ATCJ-I-54 can be found. Keep in mind that the effective area of the solar panel is 2851mm^2. The irradiance of each test can be found in Appendix 4.

Taulukko 4. Tests results for panel ATCJ-I-54.

Panel	Angle	Cover	P_{max} (W)	P_{in} (W)	Efficiency (%)
ATCJ-I-54	90°	None	$8.81 \cdot 10^{-4}$	0.28339	0.309%
		3 mm polycarbonate	$6.99 \cdot 10^{-4}$	0.28282	0.247%
		3 mm glass	$8.50 \cdot 10^{-4}$	0.28653	0.297%
		6 mm glass	$8.02 \cdot 10^{-4}$	0.28653	0.280%
	60°	None	$6.95 \cdot 10^{-4}$	0.25887	0.268%
		3 mm polycarbonate	$5.25 \cdot 10^{-4}$	0.25688	0.204%
		3 mm glass	$6.54 \cdot 10^{-4}$	0.24975	0.262%
		6 mm glass	$5.92 \cdot 10^{-4}$	0.25345	0.233%
	45°	None	$5.01 \cdot 10^{-4}$	0.21725	0.231%
		3 mm polycarbonate	$3.50 \cdot 10^{-4}$	0.22523	0.155%
		3 mm glass	$5.13 \cdot 10^{-4}$	0.20727	0.248%
		6 mm glass	$4.13 \cdot 10^{-4}$	0.20898	0.198%
	30°	None	$2.52 \cdot 10^{-4}$	0.16735	0.151%
		3 mm polycarbonate	$1.76 \cdot 10^{-4}$	0.17591	0.100%
		3 mm glass	$3.01 \cdot 10^{-4}$	0.15367	0.196%
		6 mm glass	$2.29 \cdot 10^{-4}$	0.15481	0.148%

P_{max} was taken from the P-V curve also seen in Appendix 4. P_{in} was calculated by multiplying the irradiance (W/m^2) by the effective area of the solar panel (2851 mm^2).

4.5 Panel ATCJ-I-55

In Table 5, the results of the testing for panel ATCJ-I-55 can be found. Keep in mind that the effective area of the solar panel is 2851mm^2. The irradiance of each test can be found in Appendix 5.

Taulukko 5. Tests results for panel ATCJ-I-55.

Panel	Angle	Cover	P_{max} (W)	P_{in} (W)	Efficiency (%)
ATCJ-I-55	90°	None	$9.79 \cdot 10^{-4}$	0.28481	0.379%
		3 mm polycarbonate	$8.39 \cdot 10^{-4}$	0.28624	0.293%
		3 mm glass	$8.46 \cdot 10^{-4}$	0.28539	0.296%
		6 mm glass	$7.79 \cdot 10^{-4}$	0.28624	0.272%
	60°	None	$7.94 \cdot 10^{-4}$	0.27256	0.291%
		3 mm polycarbonate	$6.42 \cdot 10^{-4}$	0.2717	0.236%
		3 mm glass	$6.58 \cdot 10^{-4}$	0.26457	0.249%
		6 mm glass	$6.00 \cdot 10^{-4}$	0.26343	0.228%
	45°	None	$6.24 \cdot 10^{-4}$	0.23378	0.267%
		3 mm polycarbonate	$4.40 \cdot 10^{-4}$	0.23264	0.189%
		3 mm glass	$4.85 \cdot 10^{-4}$	0.22494	0.215%
		6 mm glass	$5.14 \cdot 10^{-4}$	0.22266	0.231%
	30°	None	$4.16 \cdot 10^{-4}$	0.17705	0.209%
		3 mm polycarbonate	$2.89 \cdot 10^{-4}$	0.17534	0.165%
		3 mm glass	$3.27 \cdot 10^{-4}$	0.1722	0.190%
		6 mm glass	$3.14 \cdot 10^{-4}$	0.17334	0.181%

P_{max} was taken from the P-V curve also seen in Appendix 5. P_{in} was calculated by multiplying the irradiance (W/m^2) by the effective area of the solar panel (2851 mm^2).

4.6 Panel ATCJ-I-56

In Table 6, the results of the testing for panel ATCJ-I-56 can be found. Keep in mind that the effective area of the solar panel is 2851mm^2. The irradiance of each test can be found in Appendix 6.

Taulukko 6. Tests results for panel ATCJ-I-56.

Panel	Angle	Cover	P_{max} (W)	P_{in} (W)	Efficiency (%)
ATCJ-I-56	90°	None	$8.62 \cdot 10^{-4}$	0.28624	0.301%
		3 mm polycarbonate	$7.38 \cdot 10^{-4}$	0.2851	0.259%
		3 mm glass	$7.39 \cdot 10^{-4}$	0.28481	0.260%
		6 mm glass	$7.40 \cdot 10^{-4}$	0.2851	0.260%
	60°	None	$6.90 \cdot 10^{-4}$	0.26229	0.263%
		3 mm polycarbonate	$5.42 \cdot 10^{-4}$	0.25802	0.210%
		3 mm glass	$5.69 \cdot 10^{-4}$	0.26201	0.217%
		6 mm glass	$5.58 \cdot 10^{-4}$	0.26372	0.212%
	45°	None	$5.80 \cdot 10^{-4}$	0.23122	0.251%
		3 mm polycarbonate	$4.14 \cdot 10^{-4}$	0.22067	0.188%
		3 mm glass	$4.42 \cdot 10^{-4}$	0.22209	0.199%
		6 mm glass	$4.23 \cdot 10^{-4}$	0.22637	0.187%
	30°	None	$3.92 \cdot 10^{-4}$	0.17762	0.221%
		3 mm polycarbonate	$2.58 \cdot 10^{-4}$	0.17135	0.151%
		3 mm glass	$2.74 \cdot 10^{-4}$	0.17192	0.160%
		6 mm glass	$2.60 \cdot 10^{-4}$	0.17363	0.150%

P_{max} was taken from the P-V curve also seen in Appendix 6. P_{in} was calculated by multiplying the irradiance (W/m^2) by the effective area of the solar panel (2851 mm^2).

4.7 Panel ATCJ-I-57

In Table 7, the results of the testing for panel ATCJ-I-57 can be found. Keep in mind that the effective area of the solar panel is 2851mm^2. The irradiance of each test can be found in Appendix 7.

Taulukko 7. Test results for panel ATCJ-I-57.

Panel	Angle	Cover	P_{max} (W)	P_{in} (W)	Efficiency (%)
ATCJ-I-57	90°	None	$9.23 \cdot 10^{-4}$	0.285385	0.323%
		3 mm polycarbonate	$6.93 \cdot 10^{-4}$	0.2851	0.243%
		3 mm glass	$8.73 \cdot 10^{-4}$	0.284815	0.307%
		6 mm glass	$8.52 \cdot 10^{-4}$	0.28624	0.298%
	60°	None	$7.39 \cdot 10^{-4}$	0.258871	0.286%
		3 mm polycarbonate	$5.40 \cdot 10^{-4}$	0.260581	0.207%
		3 mm glass	$6.80 \cdot 10^{-4}$	0.261437	0.260%
		6 mm glass	$6.38 \cdot 10^{-4}$	0.260581	0.245%
	45°	None	$5.38 \cdot 10^{-4}$	0.217531	0.248%
		3 mm polycarbonate	$4.23 \cdot 10^{-4}$	0.219527	0.193%
		3 mm glass	$5.33 \cdot 10^{-4}$	0.221238	0.241%
		6 mm glass	$4.85 \cdot 10^{-4}$	0.219812	0.221%
	30°	None	$3.58 \cdot 10^{-4}$	0.166498	0.210%
		3 mm polycarbonate	$2.29 \cdot 10^{-4}$	0.165643	0.138%
		3 mm glass	$3.39 \cdot 10^{-4}$	0.167354	0.202%
		6 mm glass	$2.99 \cdot 10^{-4}$	0.166498	0.180%

P_{max} was taken from the P-V curve also seen in Appendix 7. P_{in} was calculated by multiplying the irradiance (W/m^2) by the effective area of the solar panel (2851 mm^2).

5 Discussion

When comparing the data values used to calculate VTT's max efficiency and the calculated maximum efficiency at 90° from the testing, one can see that VTT's value is lower than the one calculated from the tests. This might suggest that there were human errors, equipment issues or another variable that caused inaccuracy in the data. On the basis of the very low efficiencies (< 1%) of these OPV solar panels, it can be concluded that the efficiency is very poor in comparison to other more traditional solar panels. Once this efficiency is increased, then they would provide to be a better solution to the most common heavy silicon PV solar panels on rooftops.

One would assume that the efficiency derived from the testing would be slightly lower than the reference efficiencies since the tests only used 100 W/m instead of 1000 W/m^2. However, there was a 10% decline is efficiency which is quite unusual. The most likely cause of this decline could be caused by the lamp that was used. For future testing, a proper UV lamp would be recommended instead of a generic work floodlight. Another improvement would also be to consider the surface temperature of the solar cell as well as automate majority of the values being recorded to minimize human error. During testing, it was very hard to measure, and record three out of the four values required for the data: voltage, current and irradiance. The current was mainly stable whereas the voltage and irradiance values on the corresponding measurement devices were fluctuating constantly. If these fluctuating values would have been more stable, it is possible that the human error when recording the values would be minimized. Automating the calculation system would also provide less human error and it would save time during the experimentation process. It can also be concluded that the best cover surface to provide the highest efficiency is no cover of all and the worst is the polycarbonate sheet. More testing would need to be conducted to determine whether 3 mm glass is causes a better efficiency than 6 mm glass and vice versa. The results seem to vary between panels so adding more replicate tests would be a good idea in order to spot any trends in the data.

In the future, it would be best to automate the entire system and get a proper lighting source. The lamp that was used could be replaced by another lamp that creates light more like the sun's rays. Since there was a budget and time constraint on this thesis, in future work it would be recommended to replace the light source used. Overall the results of the experiments were not disappointing since they were still quite close to the data provided by VTT.

Conclusion

This thesis went through the theory of OPV solar technology, briefly looked at VTT's printed OPV solar panels, and calculated the efficiency for ninety-six sets of tests for six solar panels provided by VTT. The main objective was to see if these OPV solar panels are a viable source of power in terms of conversion efficiency. Compared to traditional silicon PV solar panels, these printed OPV solar modules' efficiency is no where near to the 46% efficiency produced by silicon PVs.

More research and testing is required to increase the efficiency of these printed OPV panels. Once it has been increased to at least 15%, then they would be a better alternative to their silicon PV counterparts. Another downfall of these OPV panels was also their life-span. Since they are printed, they are much more vulnerable to degradation, which would mean that they would need to be replaced more often than silicon PV modules.
Future testing could be done on the 6 other remaining panels provided by VTT. However, before testing them, it would be recommended to automate the measurement system and replace the lamp. A lamp that gives off a stable source of UV light would be the best option. In addition to replacing the lamp, temperature measurements of the surface of the OPV cell would be an interesting and informative variable to analyse. Besides those, the test setup for this thesis was sturdy and reliable.

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Appendix 1: Data Provided by VTT

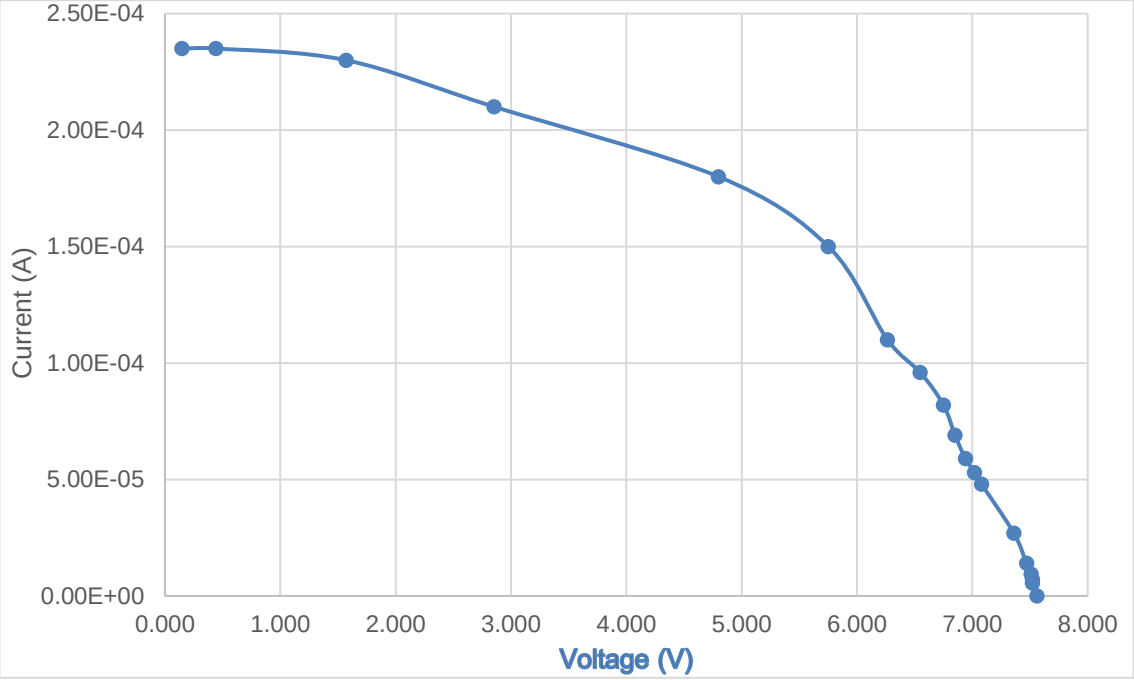
Taulukko 8. Reference data provided by VTT for panels I_052 to I_057 measured at 1000 W/m2.

	I_052	I_053	I_054	I_055	I_056	I_057
ISC[A]:	-0.01391	-0.01378	-0.01367	-0.01384	-0.01404	-0.01398
JSC [mA/cm2]:	-0.48795	-0.48346	-0.4794	-0.48535	-0.49236	-0.49017
Voc [V]:	9.690537	9.724816	9.711633	9.683915	9.759902	9.786903
Pmpp [mW]:	72.12096	68.77806	71.16705	69.76335	70.2199	72.37371
Vmpp [V]:	6.7	6.55	6.75	6.55	6.65	6.7
Impp [A]:	-0.01076	-0.0105	-0.01054	-0.01065	-0.01056	-0.0108
FF:	0.53499	0.513109	0.536156	0.520628	0.51255	0.529168
PCE [%]:	2.529672	2.412419	2.496214	2.446978	2.462992	2.538538
Solar Cell Area [mm2]:	2851	2851	2851	2851	2851	2851
Corr. ISC of ref. Cell [mA]:	0	0	0	0	0	0
Solar sim. intensity [mW/cm2]:	100	100	100	100	100	100

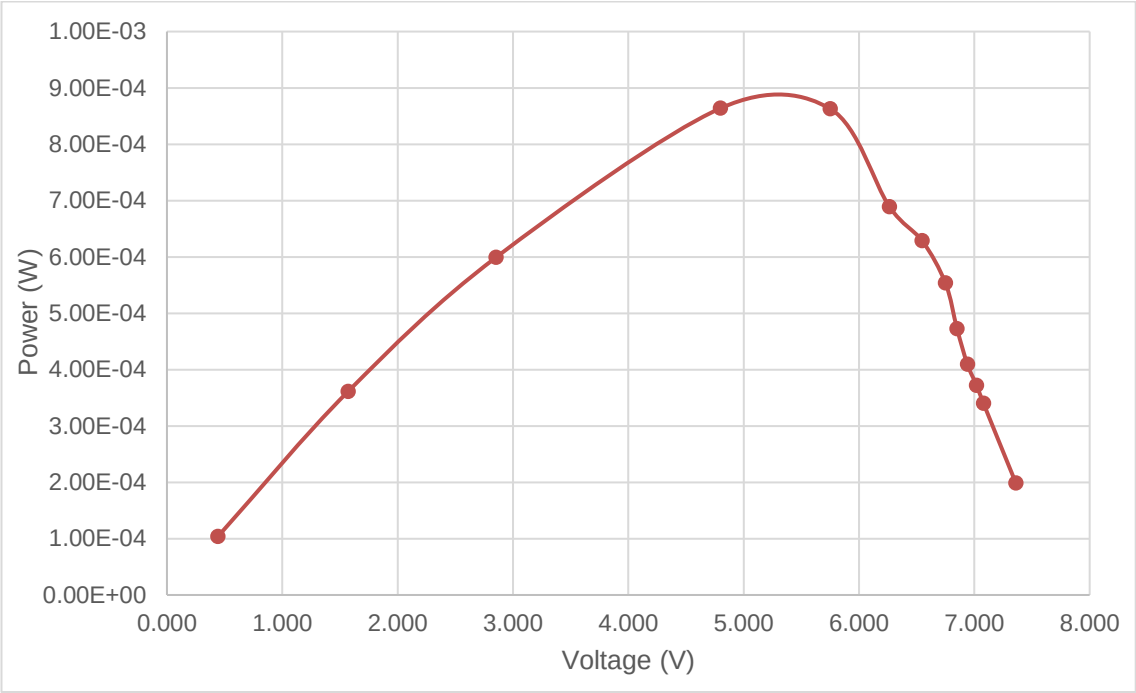
Appendix 2: Panel I_052

Taulukko 9. Results for panel ATCJ-I-52 with no cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.148	2.35E-04	3.48E-05	100.5	-
0.441	2.35E-04	1.04E-04	99.8	1,000
1.570	2.30E-04	3.61E-04	100.1	5,000
2.854	2.10E-04	5.99E-04	99.7	10,000
4.799	1.80E-04	8.64E-04	100.0	20,000
5.752	1.50E-04	8.63E-04	100.4	30,000
6.264	1.10E-04	6.89E-04	99.4	40,000
6.548	9.60E-05	6.29E-04	99.5	50,000
6.750	8.20E-05	5.54E-04	100.3	60,000
6.850	6.90E-05	4.73E-04	100.4	70,000
6.940	5.90E-05	4.09E-04	99.5	80,000
7.020	5.30E-05	3.72E-04	100.2	90,000
7.080	4.80E-05	3.40E-04	99.8	100,000
7.360	2.70E-05	1.99E-04	100.0	200,000
7.470	1.40E-05	1.05E-04	99.8	400,000
7.510	9.40E-06	7.06E-05	99.9	600,000
7.520	7.10E-06	5.34E-05	100.5	800,000
7.520	5.60E-06	4.21E-05	100.3	1,000,000



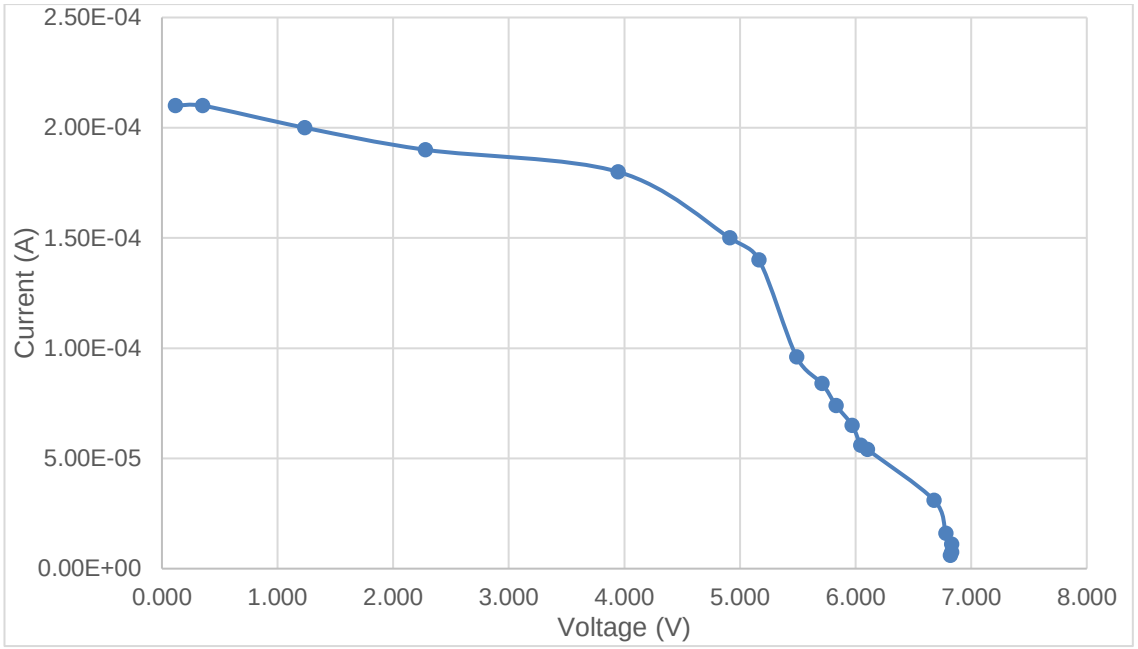
Kuvio 14. Voltage (V) vs Current (I) curve for panel ATCJ-I-52 with no cover at 90°.



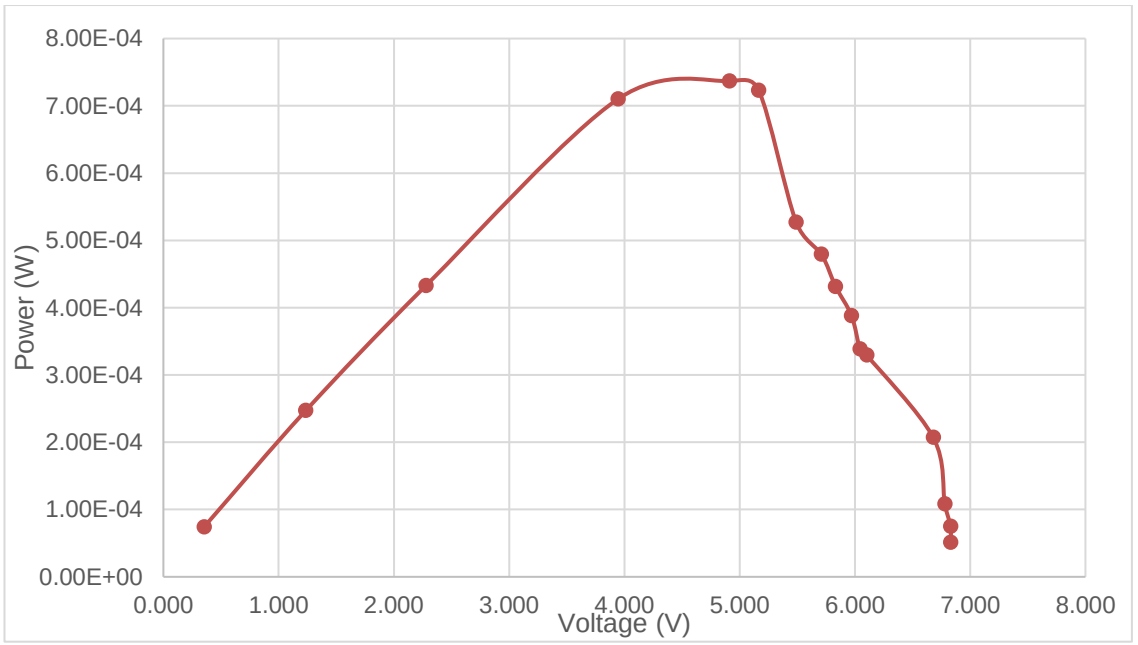
Kuvio 15. Voltage (V) vs Power (W) curve for panel ATCJ-I-52 with no cover at 90°.

Taulukko 10. Results for panel ATCJ-I-52 with no cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.118	2.10E-04	2.48E-05	95.1	-
0.353	2.10E-04	7.41E-05	95.3	1,000
1.236	2.00E-04	2.47E-04	94.6	5,000
2.279	1.90E-04	4.33E-04	95.0	10,000
3.946	1.80E-04	7.10E-04	94.8	20,000
4.912	1.50E-04	7.37E-04	94.8	30,000
5.165	1.40E-04	7.23E-04	94.9	40,000
5.490	9.60E-05	5.27E-04	95.1	50,000
5.709	8.40E-05	4.80E-04	94.9	60,000
5.832	7.40E-05	4.32E-04	94.4	70,000
5.971	6.50E-05	3.88E-04	94.3	80,000
6.044	5.60E-05	3.38E-04	94.5	90,000
6.102	5.40E-05	3.30E-04	94.6	100,000
6.680	3.10E-05	2.07E-04	95.0	200,000
6.780	1.60E-05	1.08E-04	94.8	400,000
6.830	1.10E-05	7.51E-05	94.2	600,000
6.830	7.50E-06	5.12E-05	94.7	800,000
6.820	6.00E-06	4.09E-05	94.4	1,000,000



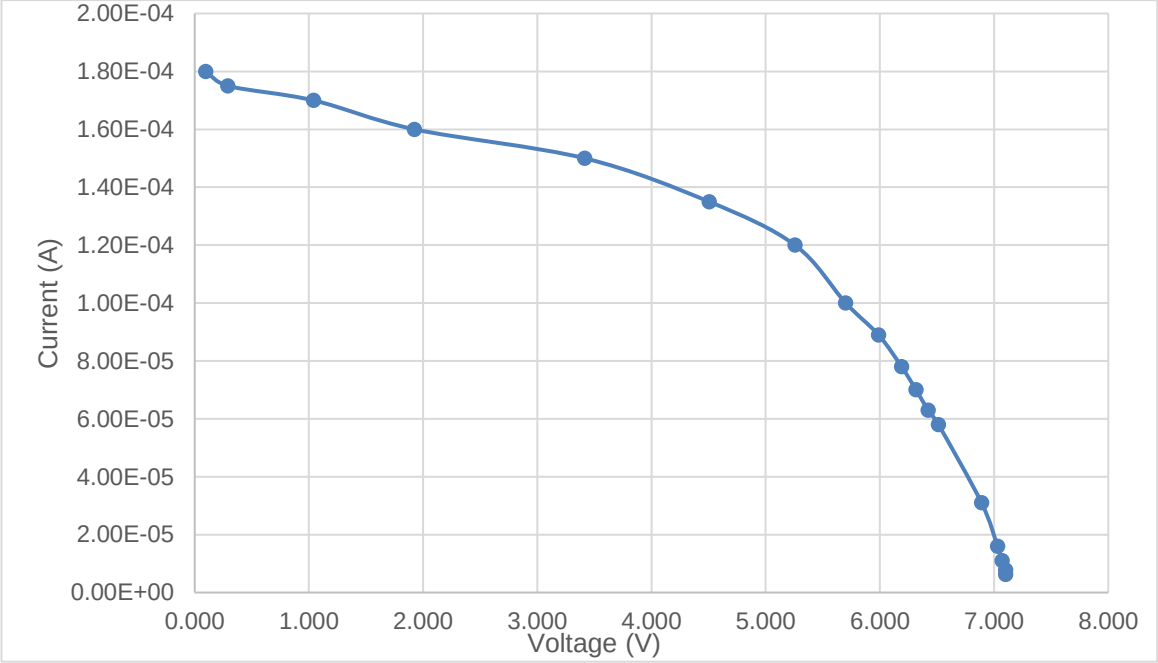
Kuvio 16. Voltage (V) vs Current (I) curve for panel ATCJ-I-52 with no cover at 60°.



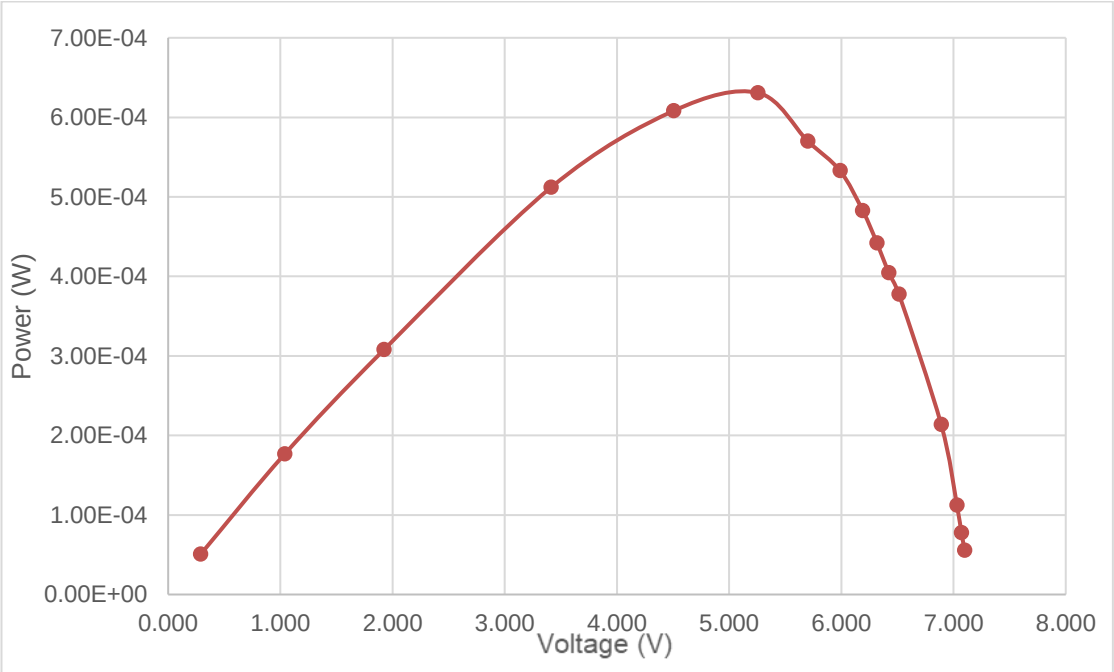
Kuvio 17. Voltage (V) vs Power (W) curve for panel ATCJ-I-52 with no cover at 60°.

Taulukko 11. Results for panel ATCJ-I-52 with no cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.097	1.80E-04	1.75E-05	81.4	-
0.290	1.75E-04	5.08E-05	81.9	1,000
1.040	1.70E-04	1.77E-04	81.5	5,000
1.925	1.60E-04	3.08E-04	81.9	10,000
3.414	1.50E-04	5.12E-04	82.2	20,000
4.505	1.35E-04	6.08E-04	81.2	30,000
5.257	1.20E-04	6.31E-04	82.2	40,000
5.701	1.00E-04	5.70E-04	82.4	50,000
5.988	8.90E-05	5.33E-04	82.1	60,000
6.190	7.80E-05	4.83E-04	81.7	70,000
6.317	7.00E-05	4.42E-04	82.1	80,000
6.422	6.30E-05	4.05E-04	82.3	90,000
6.513	5.80E-05	3.78E-04	82.6	100,000
6.890	3.10E-05	2.14E-04	82.0	200,000
7.030	1.60E-05	1.12E-04	82.2	400,000
7.070	1.10E-05	7.78E-05	82.3	600,000
7.100	7.80E-06	5.54E-05	82.0	800,000
7.100	6.25E-06	4.44E-05	82.5	1,000,000



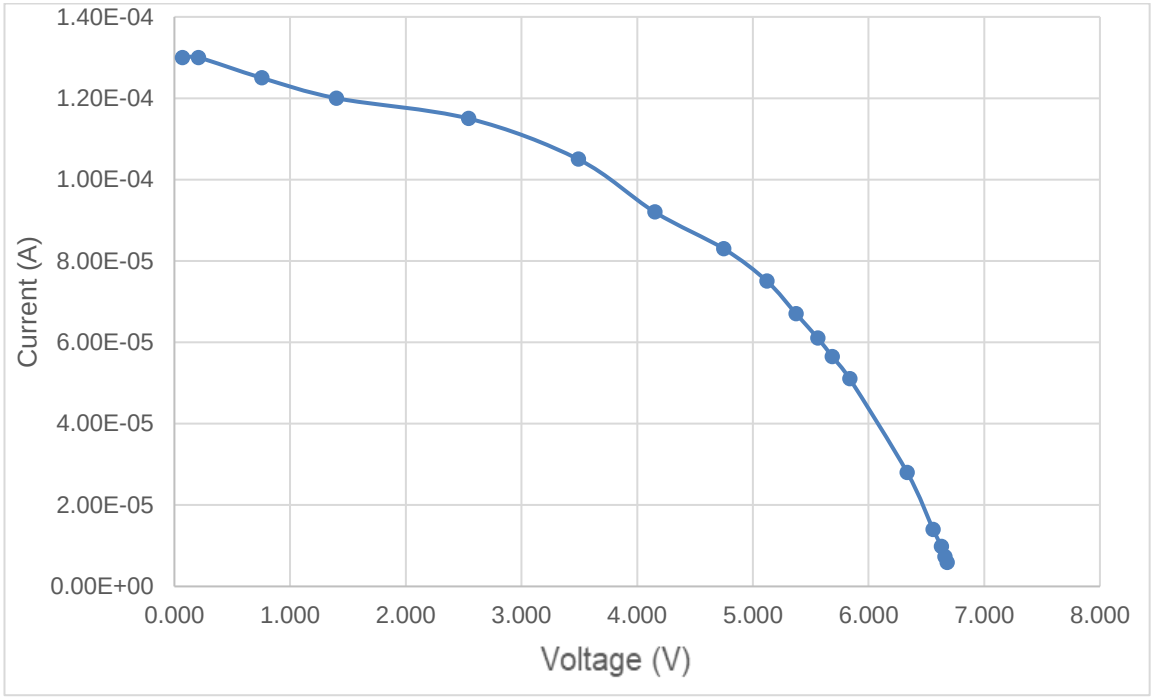
Kuvio 18. Voltage (V) vs Current (I) curve for panel ATCJ-I-52 with no cover at 45°.



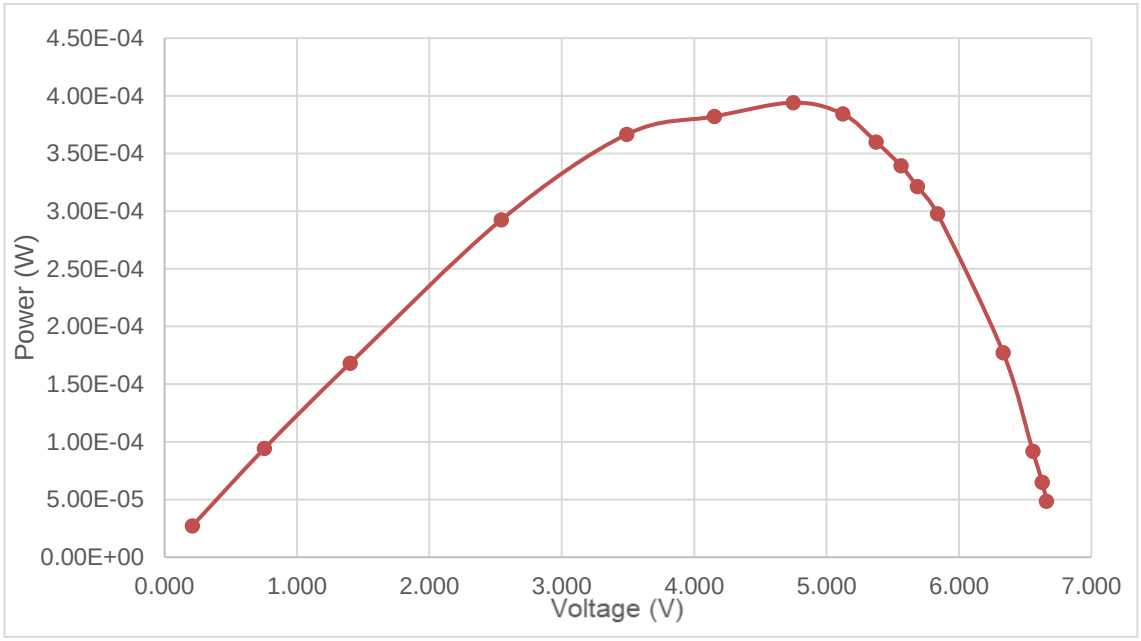
Kuvio 19. Voltage (V) vs Power (W) curve for panel ATCJ-I-52 with no cover at 45°.

Taulukko 12. Results for panel ATCJ-I-52 with no cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.070	1.30E-04	9.10E-06	64.4	-
0.209	1.30E-04	2.72E-05	64.3	1,000
0.755	1.25E-04	9.44E-05	64.5	5,000
1.401	1.20E-04	1.68E-04	64.9	10,000
2.544	1.15E-04	2.93E-04	64.5	20,000
3.491	1.05E-04	3.67E-04	65.0	30,000
4.153	9.20E-05	3.82E-04	64.7	40,000
4.748	8.30E-05	3.94E-04	64.5	50,000
5.123	7.50E-05	3.84E-04	64.5	60,000
5.374	6.70E-05	3.60E-04	64.9	70,000
5.562	6.10E-05	3.39E-04	64.6	80,000
5.686	5.65E-05	3.21E-04	64.6	90,000
5.838	5.10E-05	2.98E-04	64.9	100,000
6.334	2.80E-05	1.77E-04	64.8	200,000
6.558	1.40E-05	9.18E-05	64.7	400,000
6.630	9.80E-06	6.50E-05	64.7	600,000
6.660	7.30E-06	4.86E-05	64.3	800,000
6.680	5.90E-06	3.94E-05	64.6	1,000,000



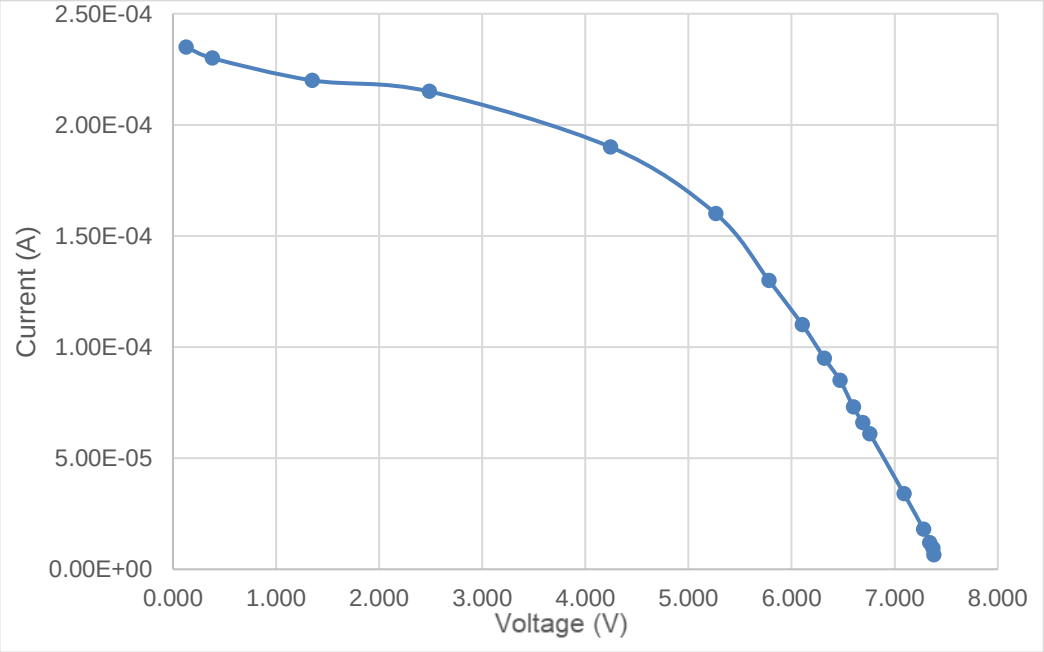
Kuvio 20. Voltage (V) vs Current (I) curve for panel ATCJ-I-52 with no cover at 30°.



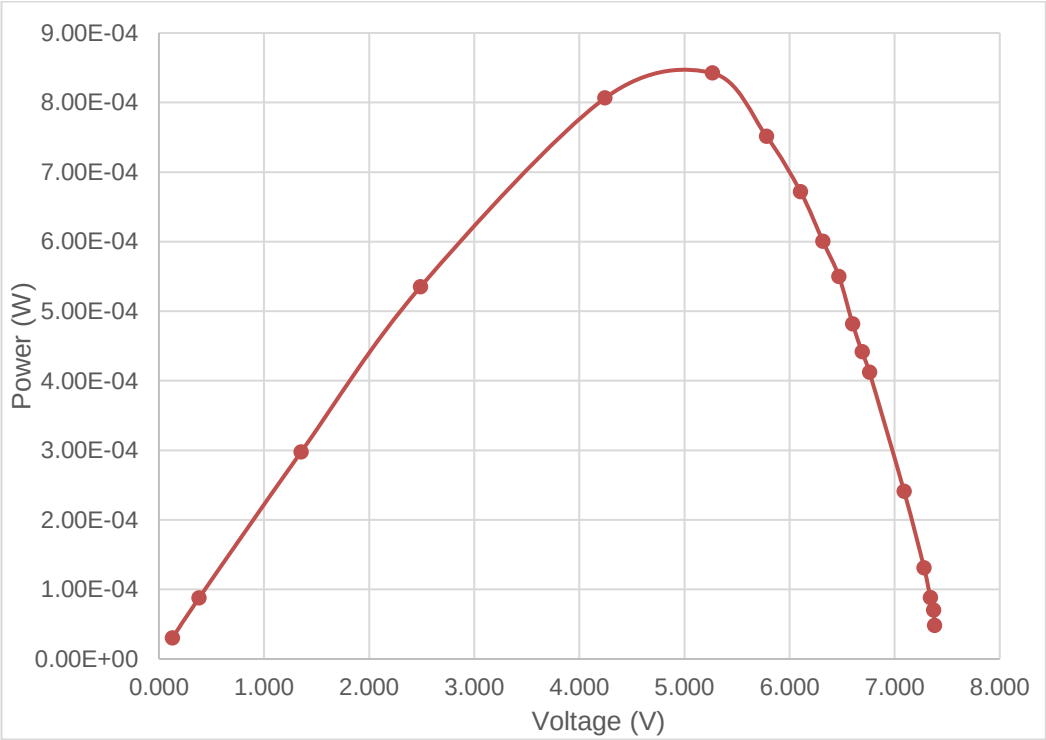
Kuvio 21. Voltage (V) vs Power (W) curve for panel ATCJ-I-52 with no cover at 30°.

Taulukko 13. Results for panel ATCJ-I-52 with polycarbonate cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.129	2.35E-04	3.03E-05	100.6	-
0.381	2.30E-04	8.76E-05	100.6	1,000
1.352	2.20E-04	2.97E-04	100.4	5,000
2.488	2.15E-04	5.35E-04	100.9	10,000
4.244	1.90E-04	8.06E-04	100.7	20,000
5.265	1.60E-04	8.42E-04	100.8	30,000
5.780	1.30E-04	7.51E-04	100.2	40,000
6.105	1.10E-04	6.72E-04	100.4	50,000
6.318	9.50E-05	6.00E-04	100.2	60,000
6.470	8.50E-05	5.50E-04	100.7	70,000
6.600	7.30E-05	4.82E-04	100.3	80,000
6.690	6.60E-05	4.42E-04	100.3	90,000
6.760	6.10E-05	4.12E-04	100.1	100,000
7.090	3.40E-05	2.41E-04	100.3	200,000
7.280	1.80E-05	1.31E-04	100.0	400,000
7.340	1.20E-05	8.81E-05	100.4	600,000
7.370	9.50E-06	7.00E-05	100.5	800,000
7.380	6.50E-06	4.80E-05	100.4	1,000,000



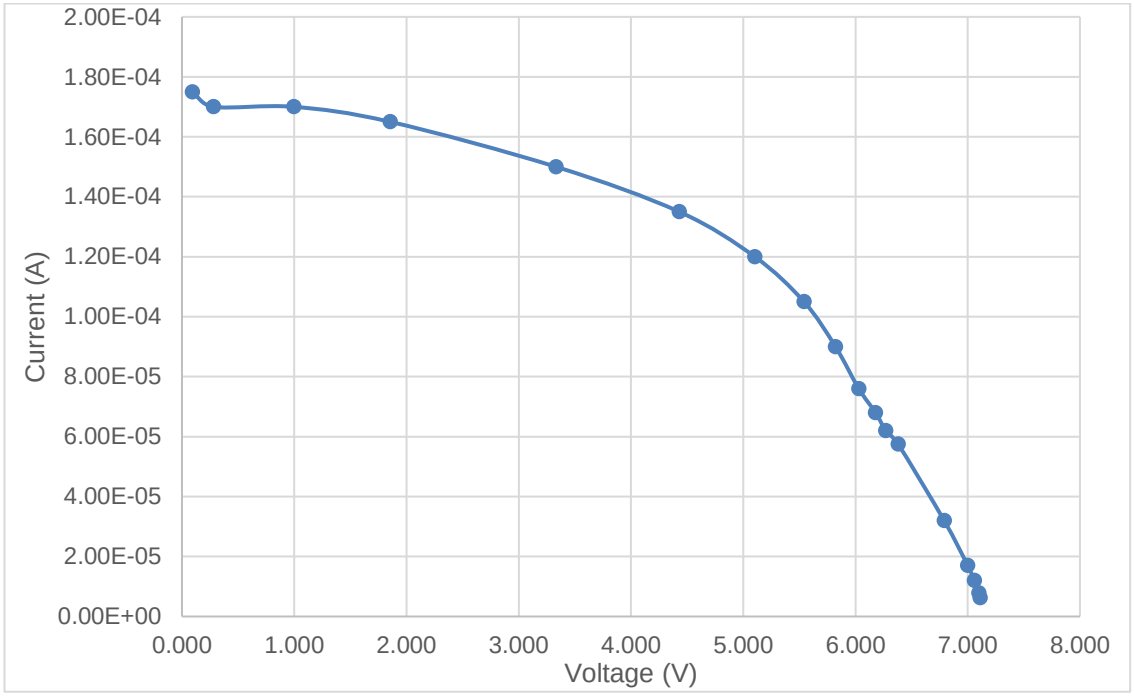
Kuvio 22. Voltage (V) vs Current (I) curve for panel ATCJ-I-52 polycarbonate cover at 90°.



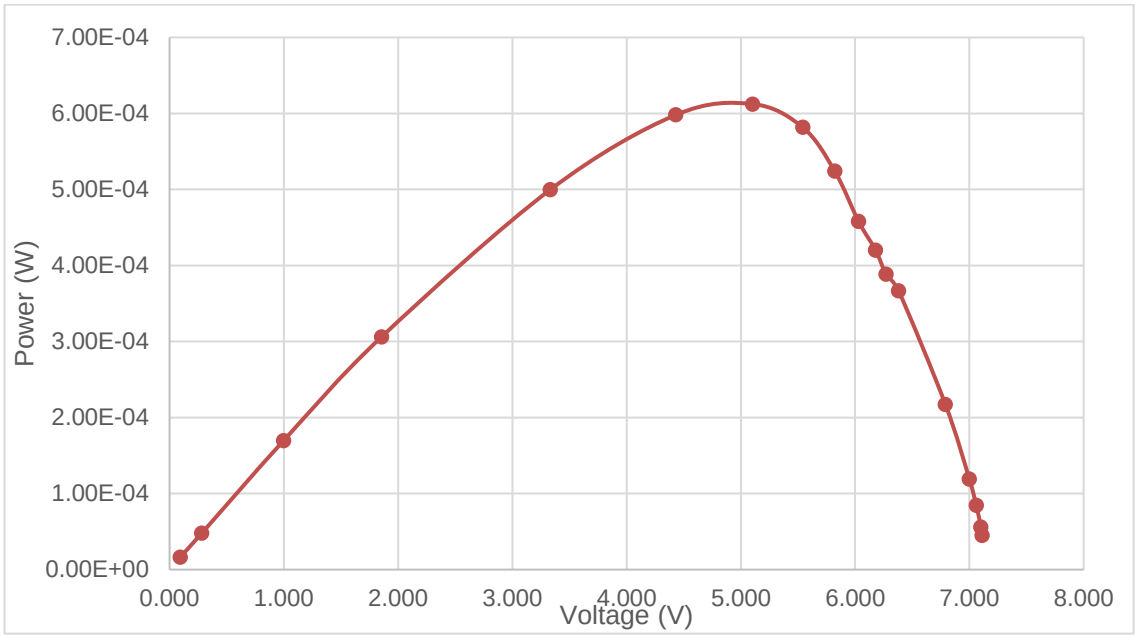
Kuvio 23. Voltage (V) vs Power (W) curve for panel ATCJ-I-52 with polycarbonate cover at 90°.

Taulukko 14. Results for panel ATCJ-I-52 with polycarbonate cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.094	1.75E-04	1.65E-05	95.4	-
0.281	1.70E-04	4.78E-05	95.2	1,000
0.997	1.70E-04	1.69E-04	94.4	5,000
1.855	1.65E-04	3.06E-04	95.1	10,000
3.332	1.50E-04	5.00E-04	95.0	20,000
4.430	1.35E-04	5.98E-04	95.1	30,000
5.103	1.20E-04	6.12E-04	95.1	40,000
5.541	1.05E-04	5.82E-04	95.6	50,000
5.822	9.00E-05	5.24E-04	95.5	60,000
6.029	7.60E-05	4.58E-04	95.0	70,000
6.179	6.80E-05	4.20E-04	95.5	80,000
6.270	6.20E-05	3.89E-04	95.3	90,000
6.380	5.75E-05	3.67E-04	95.5	100,000
6.790	3.20E-05	2.17E-04	95.6	200,000
7.000	1.70E-05	1.19E-04	95.8	400,000
7.060	1.20E-05	8.47E-05	94.8	600,000
7.100	7.90E-06	5.61E-05	95.6	800,000
7.110	6.30E-06	4.48E-05	95.3	1,000,000



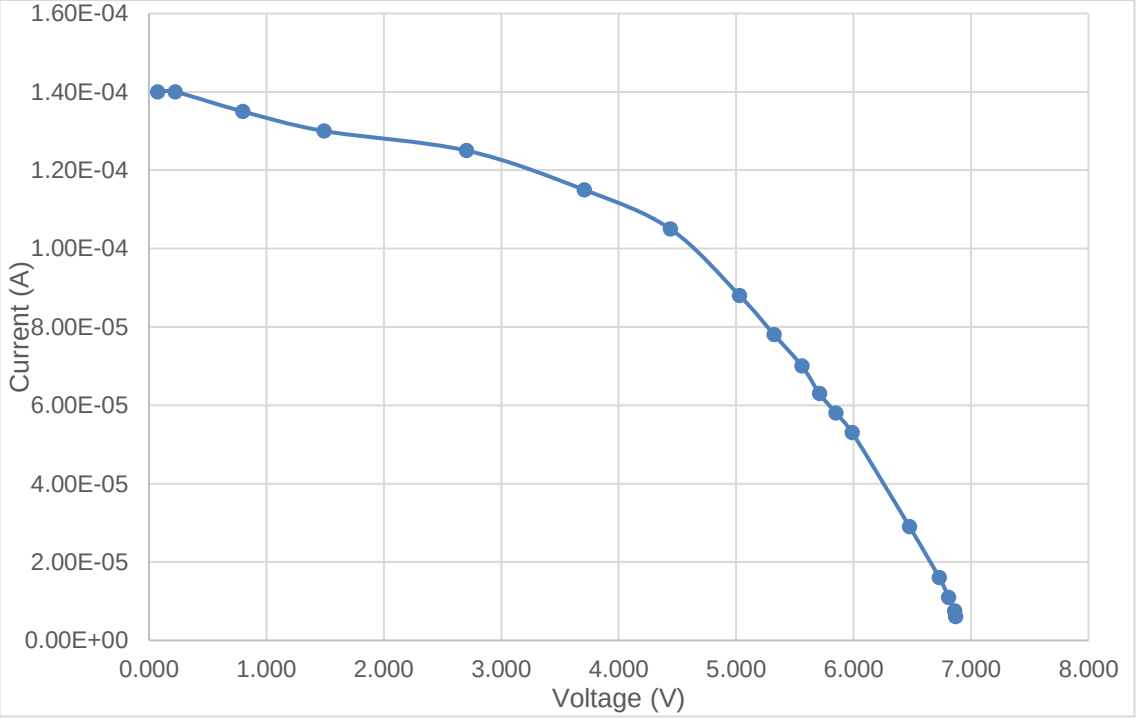
Kuvio 24. Voltage (V) vs Current (I) curve for panel ATCJ-I-52 polycarbonate cover at 60°.



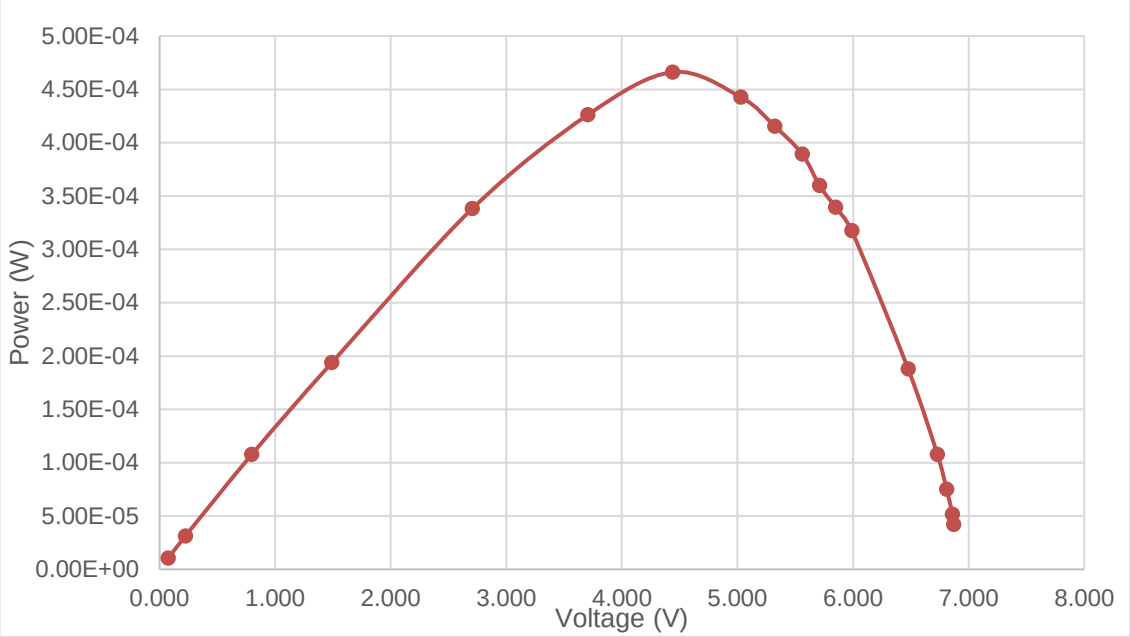
Kuvio 25. Voltage (V) vs Power (W) curve for panel ATCJ-I-52 with polycarbonate cover at 60°.

Taulukko 15. Results for panel ATCJ-I-52 with polycarbonate cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.075	1.40E-04	1.05E-05	83.4	-
0.223	1.40E-04	3.12E-05	83.4	1,000
0.798	1.35E-04	1.08E-04	83.5	5,000
1.490	1.30E-04	1.94E-04	83.6	10,000
2.705	1.25E-04	3.38E-04	83.2	20,000
3.706	1.15E-04	4.26E-04	83.4	30,000
4.440	1.05E-04	4.66E-04	83.2	40,000
5.030	8.80E-05	4.43E-04	83.0	50,000
5.324	7.80E-05	4.15E-04	83.2	60,000
5.561	7.00E-05	3.89E-04	83.1	70,000
5.710	6.30E-05	3.60E-04	82.9	80,000
5.850	5.80E-05	3.39E-04	82.9	90,000
5.989	5.30E-05	3.17E-04	83.4	100,000
6.477	2.90E-05	1.88E-04	83.2	200,000
6.730	1.60E-05	1.08E-04	83.5	400,000
6.810	1.10E-05	7.49E-05	83.6	600,000
6.860	7.50E-06	5.15E-05	83.6	800,000
6.870	6.10E-06	4.19E-05	83.5	1,000,000



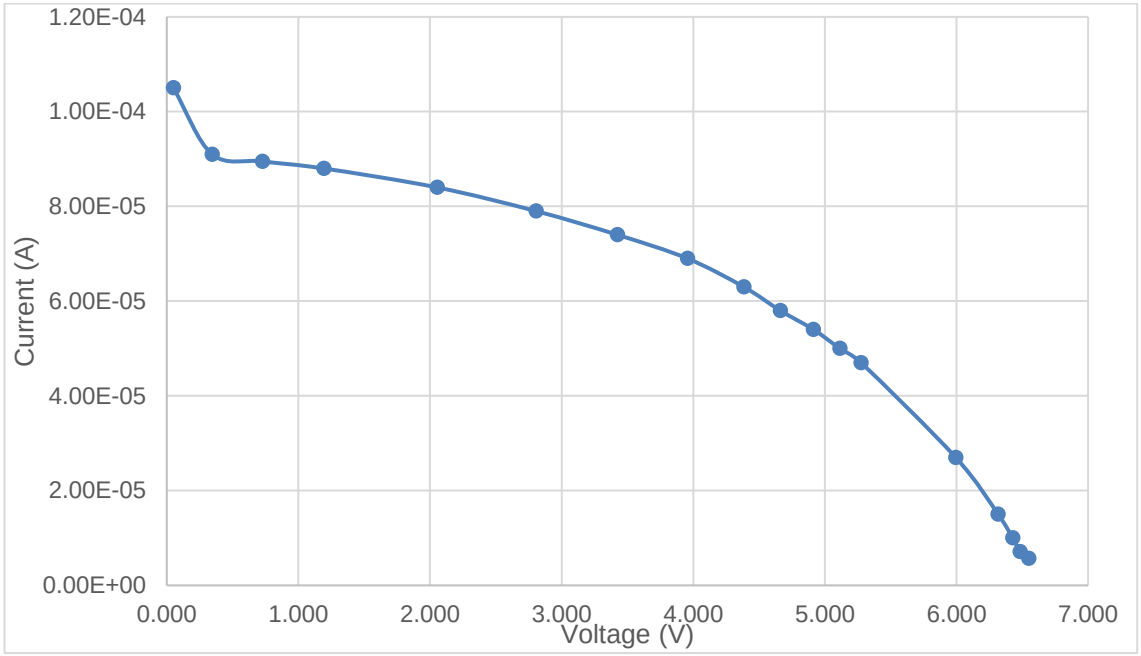
Kuvio 26. Voltage (V) vs Current (I) curve for panel ATCJ-I-52 polycarbonate cover at 45°.



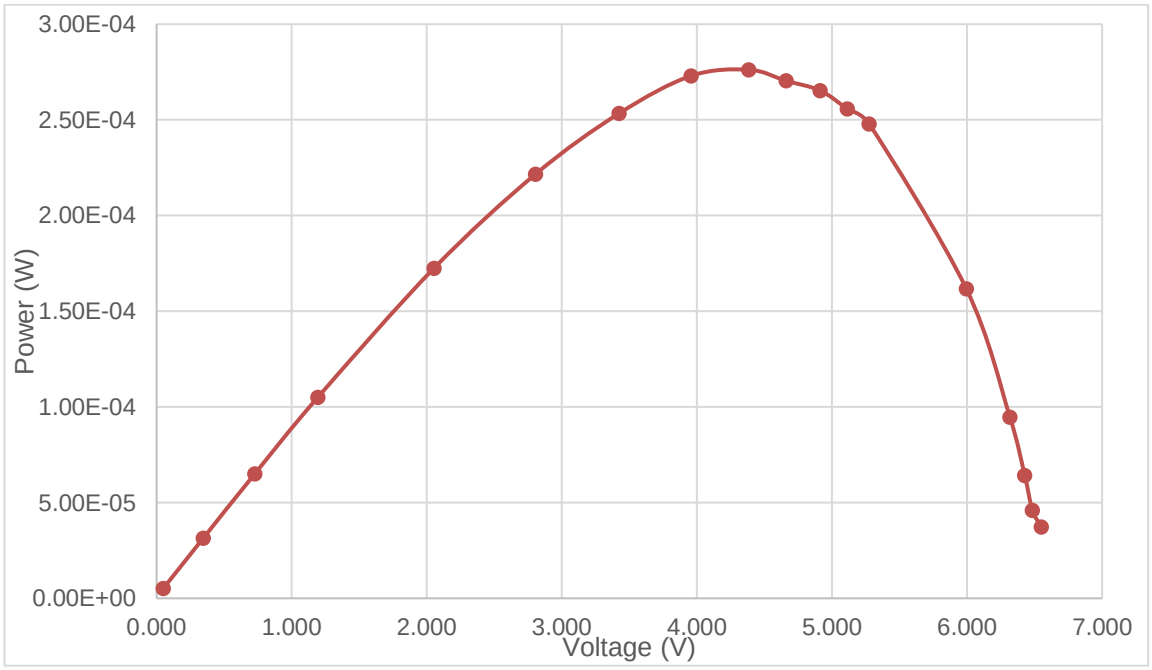
Kuvio 27. Voltage (V) vs Power (W) curve for panel ATCJ-I-52 with polycarbonate cover at 45°.

Taulukko 16. Results for panel ATCJ-I-52 with polycarbonate cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.050	1.05E-04	5.25E-06	66.9	-
0.345	9.10E-05	3.14E-05	66.5	1,000
0.727	8.95E-05	6.51E-05	66.7	5,000
1.193	8.80E-05	1.05E-04	66.1	10,000
2.054	8.40E-05	1.73E-04	66.9	20,000
2.806	7.90E-05	2.22E-04	66.8	30,000
3.424	7.40E-05	2.53E-04	66.6	40,000
3.956	6.90E-05	2.73E-04	66.9	50,000
4.384	6.30E-05	2.76E-04	67.0	60,000
4.662	5.80E-05	2.70E-04	66.5	70,000
4.913	5.40E-05	2.65E-04	66.8	80,000
5.114	5.00E-05	2.56E-04	66.9	90,000
5.275	4.70E-05	2.48E-04	67.0	100,000
5.994	2.70E-05	1.62E-04	66.7	200,000
6.317	1.50E-05	9.48E-05	67.0	400,000
6.427	1.00E-05	6.43E-05	66.8	600,000
6.484	7.10E-06	4.60E-05	67.2	800,000
6.550	5.70E-06	3.73E-05	66.9	1,000,000



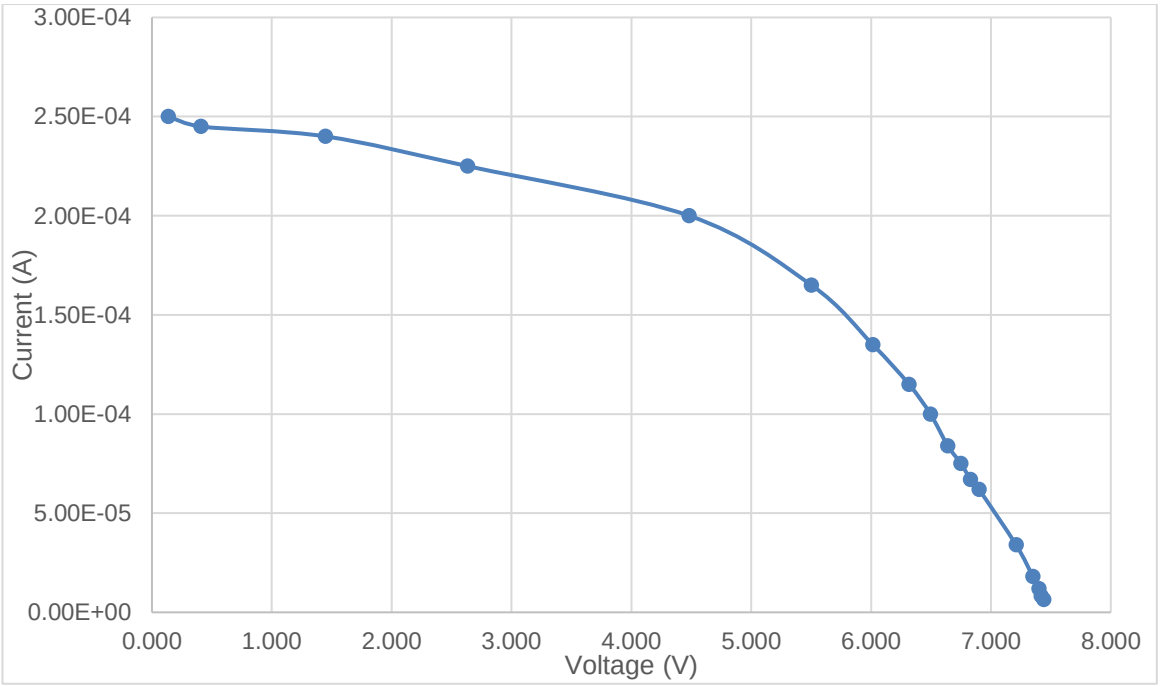
Kuvio 28. Voltage (V) vs Current (I) curve for panel ATCJ-I-52 polycarbonate cover at 30°.



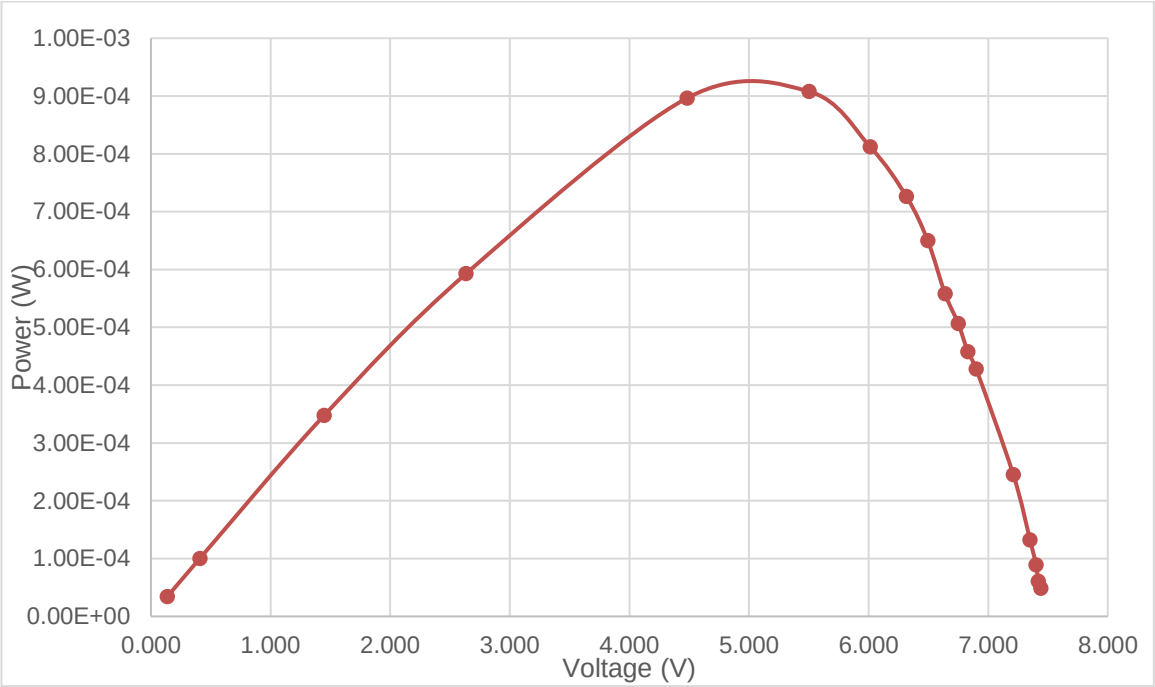
Kuvio 29. Voltage (V) vs Power (W) curve for panel ATCJ-I-52 with polycarbonate cover at 30°.

Taulukko 17. Results for panel ATCJ-I-52 with 3mm glass cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.136	2.50E-04	3.40E-05	99.8	-
0.409	2.45E-04	1.00E-04	100.4	1,000
1.448	2.40E-04	3.48E-04	100.1	5,000
2.634	2.25E-04	5.93E-04	100.3	10,000
4.482	2.00E-04	8.96E-04	100.2	20,000
5.502	1.65E-04	9.08E-04	100.4	30,000
6.014	1.35E-04	8.12E-04	100.2	40,000
6.316	1.15E-04	7.26E-04	100.5	50,000
6.495	1.00E-04	6.50E-04	99.9	60,000
6.640	8.40E-05	5.58E-04	100.0	70,000
6.750	7.50E-05	5.06E-04	99.9	80,000
6.830	6.70E-05	4.58E-04	99.8	90,000
6.900	6.20E-05	4.28E-04	100.2	100,000
7.210	3.40E-05	2.45E-04	100.3	200,000
7.350	1.80E-05	1.32E-04	100.0	400,000
7.400	1.20E-05	8.88E-05	99.8	600,000
7.420	8.20E-06	6.08E-05	99.5	800,000
7.440	6.50E-06	4.84E-05	100.3	1,000,000



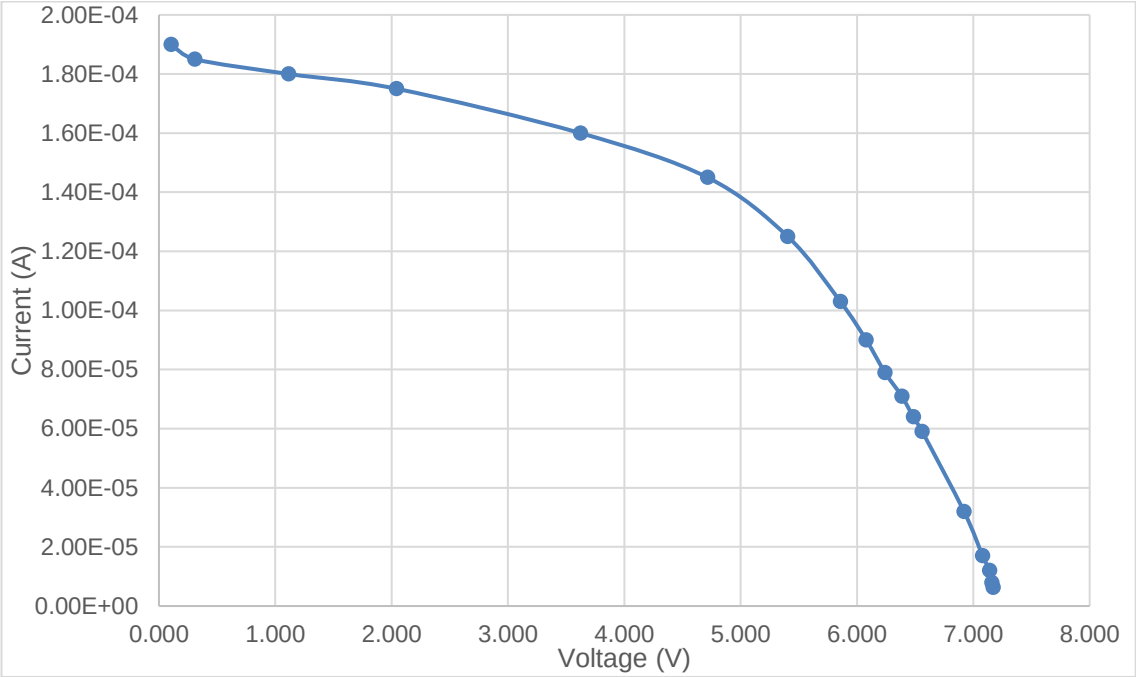
Kuvio 30. Voltage (V) vs Current (I) curve for panel ATCJ-I-52 3mm glass cover at 90°.



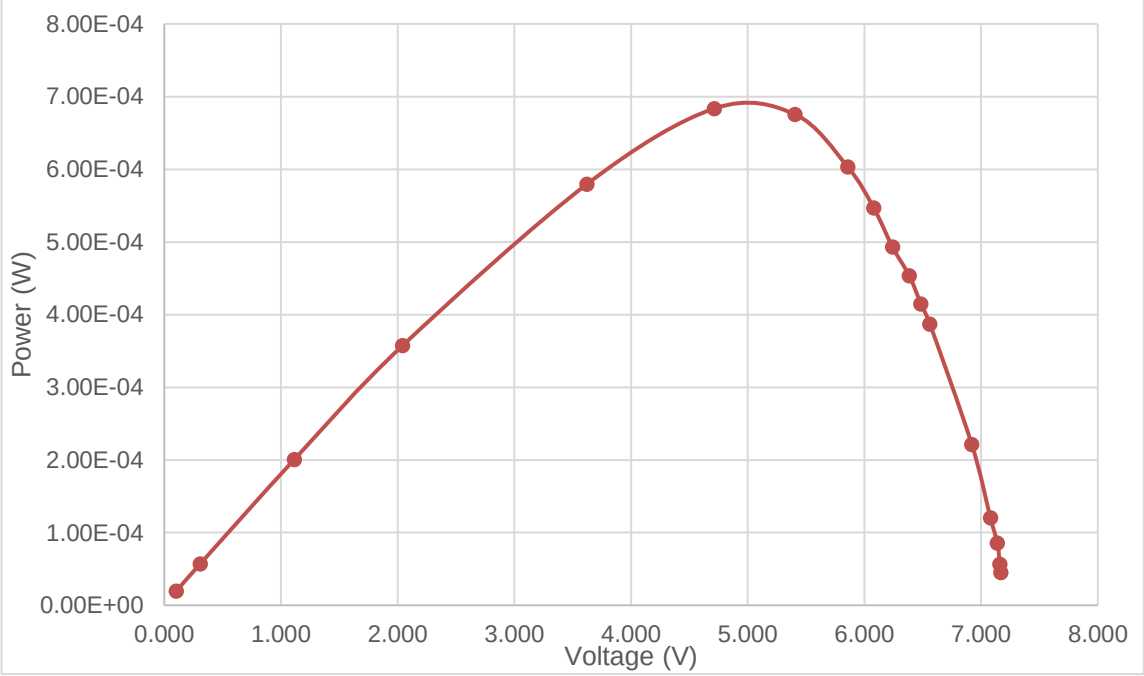
Kuvio 31. Voltage (V) vs Power (W) curve for panel ATCJ-I-52 with 3mm glass cover at 90°.

Taulukko 18. Results for panel ATCJ-I-52 with 3mm glass cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.104	1.90E-04	1.98E-05	99.7	-
0.309	1.85E-04	5.72E-05	99.4	1,000
1.114	1.80E-04	2.01E-04	99.8	5,000
2.042	1.75E-04	3.57E-04	99.3	10,000
3.623	1.60E-04	5.80E-04	99.6	20,000
4.715	1.45E-04	6.84E-04	99.4	30,000
5.405	1.25E-04	6.76E-04	99.2	40,000
5.857	1.03E-04	6.03E-04	99.9	50,000
6.079	9.00E-05	5.47E-04	99.9	60,000
6.241	7.90E-05	4.93E-04	99.1	70,000
6.385	7.10E-05	4.53E-04	99.5	80,000
6.484	6.40E-05	4.15E-04	99.9	90,000
6.561	5.90E-05	3.87E-04	100.2	100,000
6.920	3.20E-05	2.21E-04	99.5	200,000
7.080	1.70E-05	1.20E-04	100	400,000
7.140	1.20E-05	8.57E-05	99.6	600,000
7.160	7.90E-06	5.66E-05	99.5	800,000
7.170	6.30E-06	4.52E-05	99.6	1,000,000



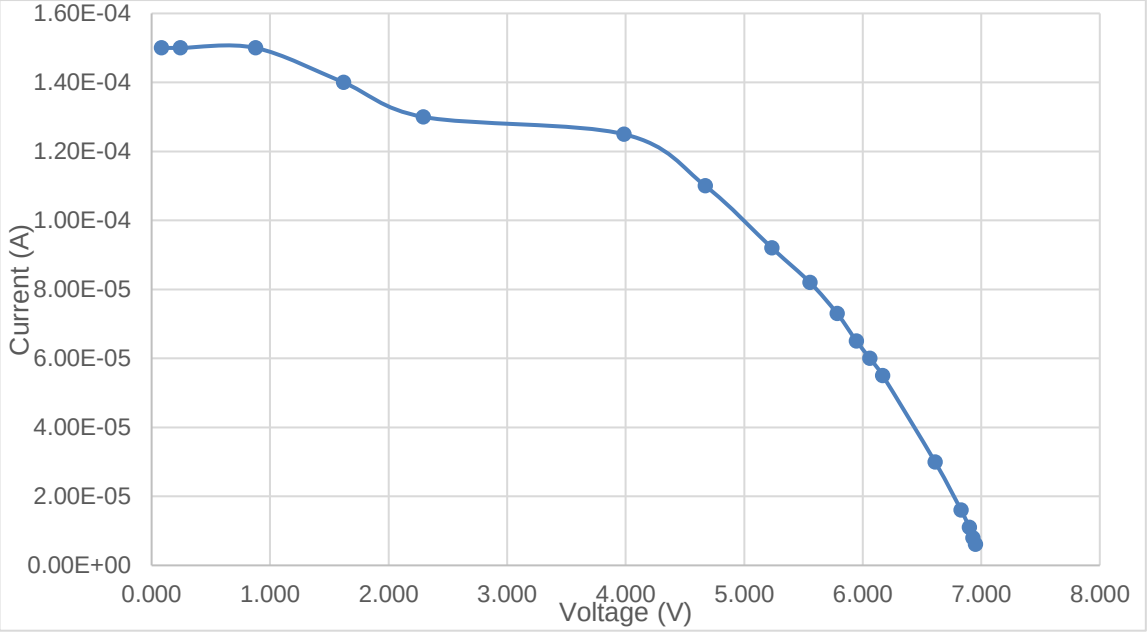
Kuvio 32. Voltage (V) vs Current (I) curve for panel ATCJ-I-52 3mm glass cover at 60°.



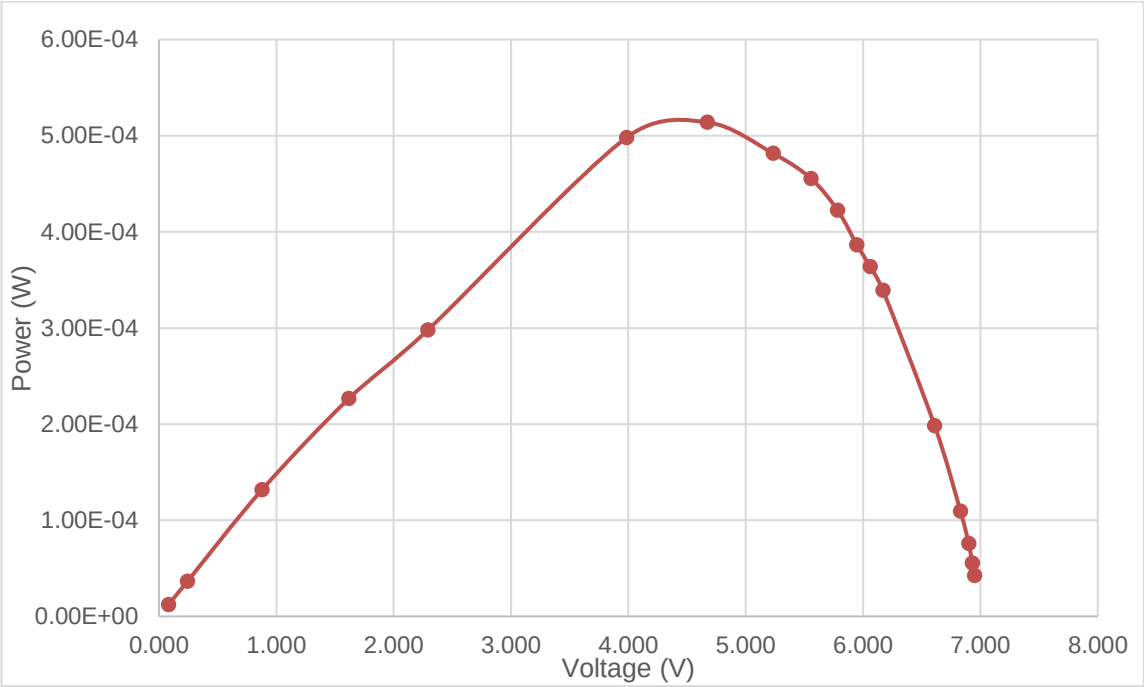
Kuvio 33. Voltage (V) vs Power (W) curve for panel ATCJ-I-52 with 3mm glass cover at 60°.

Taulukko 19. Results for panel ATCJ-I-52 with 3mm glass cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.082	1.50E-04	1.23E-05	87.4	-
0.243	1.50E-04	3.65E-05	86.9	1,000
0.878	1.50E-04	1.32E-04	87.2	5,000
1.619	1.40E-04	2.27E-04	87.0	10,000
2.292	1.30E-04	2.98E-04	87.0	20,000
3.985	1.25E-04	4.98E-04	87.3	30,000
4.672	1.10E-04	5.14E-04	87.5	40,000
5.234	9.20E-05	4.82E-04	87.1	50,000
5.555	8.20E-05	4.56E-04	86.4	60,000
5.784	7.30E-05	4.22E-04	87.5	70,000
5.947	6.50E-05	3.87E-04	87.8	80,000
6.061	6.00E-05	3.64E-04	87.6	90,000
6.169	5.50E-05	3.39E-04	87.3	100,000
6.610	3.00E-05	1.98E-04	87.1	200,000
6.830	1.60E-05	1.09E-04	87.4	400,000
6.900	1.10E-05	7.59E-05	87.3	600,000
6.930	8.00E-06	5.54E-05	87.4	800,000
6.950	6.10E-06	4.24E-05	87.7	1,000,000



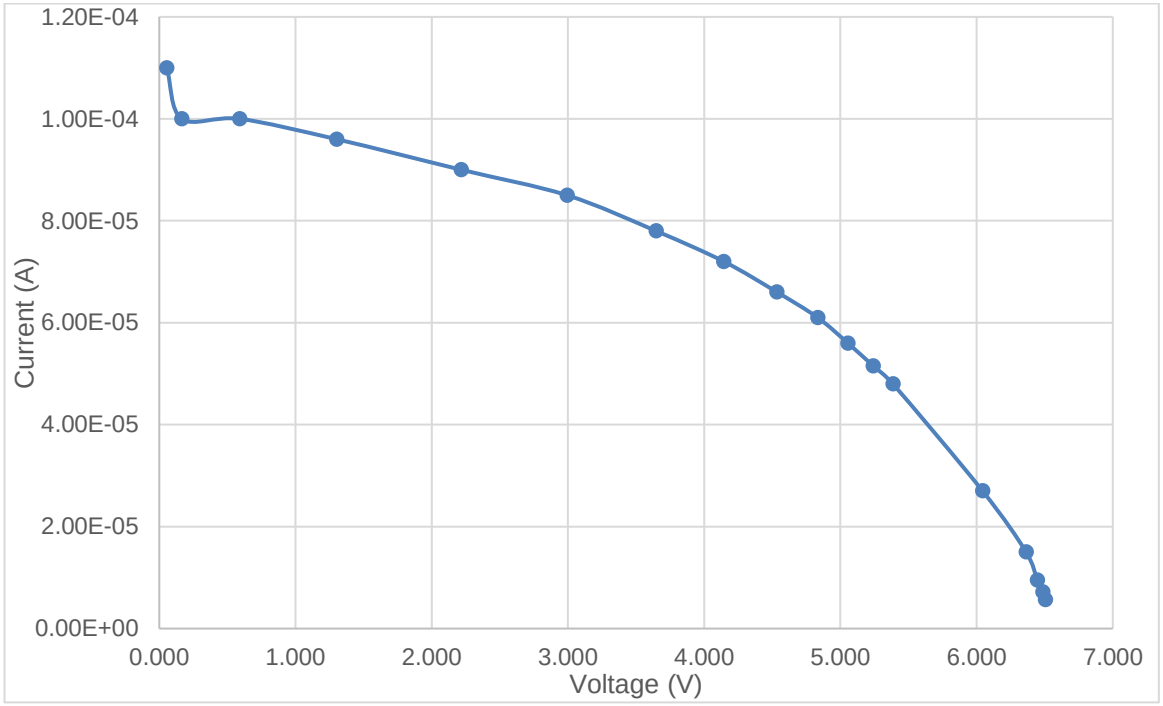
Kuvio 34. Voltage (V) vs Current (I) curve for panel ATCJ-I-52 3mm glass cover at 45°.



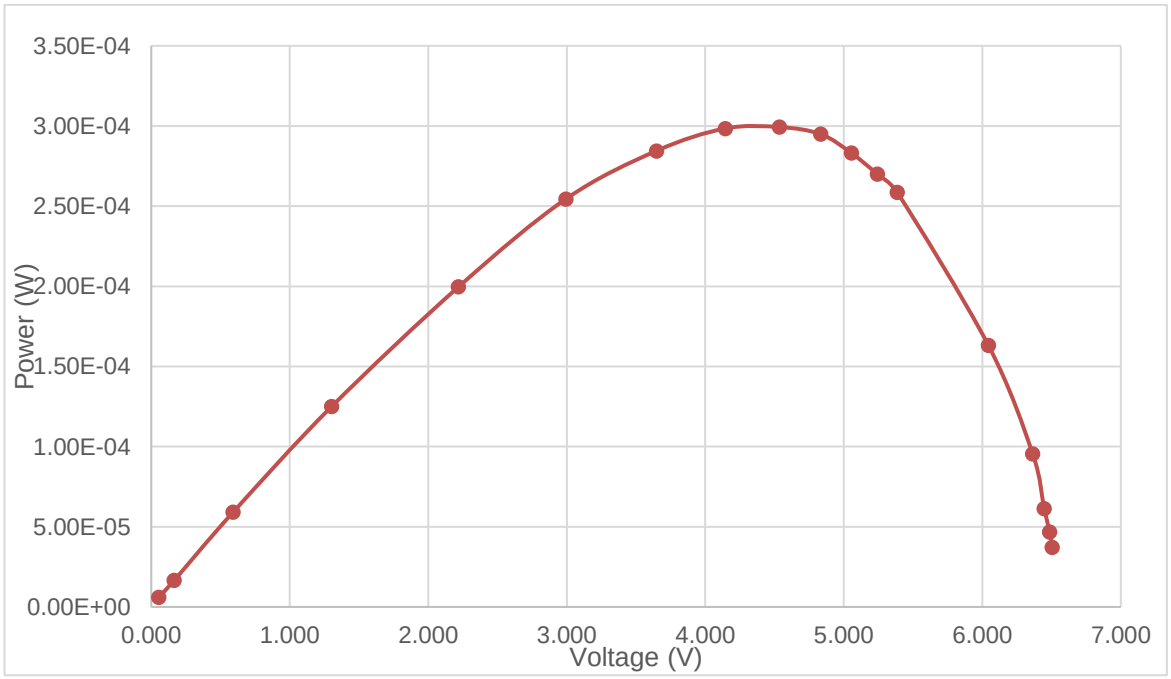
Kuvio 35. Voltage (V) vs Power (W) curve for panel ATCJ-I-52 with 3mm glass cover at 45°.

Taulukko 20. Results for panel ATCJ-I-52 with 3mm glass cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.055	1.10E-04	6.05E-06	70.3	-
0.166	1.00E-04	1.66E-05	70.4	1,000
0.591	1.00E-04	5.91E-05	70.3	5,000
1.302	9.60E-05	1.25E-04	70.2	10,000
2.218	9.00E-05	2.00E-04	70.0	20,000
2.994	8.50E-05	2.54E-04	70.3	30,000
3.647	7.80E-05	2.84E-04	70.5	40,000
4.145	7.20E-05	2.98E-04	70.5	50,000
4.535	6.60E-05	2.99E-04	70.3	60,000
4.834	6.10E-05	2.95E-04	69.7	70,000
5.055	5.60E-05	2.83E-04	70.0	80,000
5.242	5.15E-05	2.70E-04	70.5	90,000
5.386	4.80E-05	2.59E-04	70.4	100,000
6.044	2.70E-05	1.63E-04	70.4	200,000
6.364	1.50E-05	9.55E-05	70.8	400,000
6.447	9.50E-06	6.12E-05	70.7	600,000
6.487	7.20E-06	4.67E-05	70.5	800,000
6.505	5.70E-06	3.71E-05	70.5	1,000,000



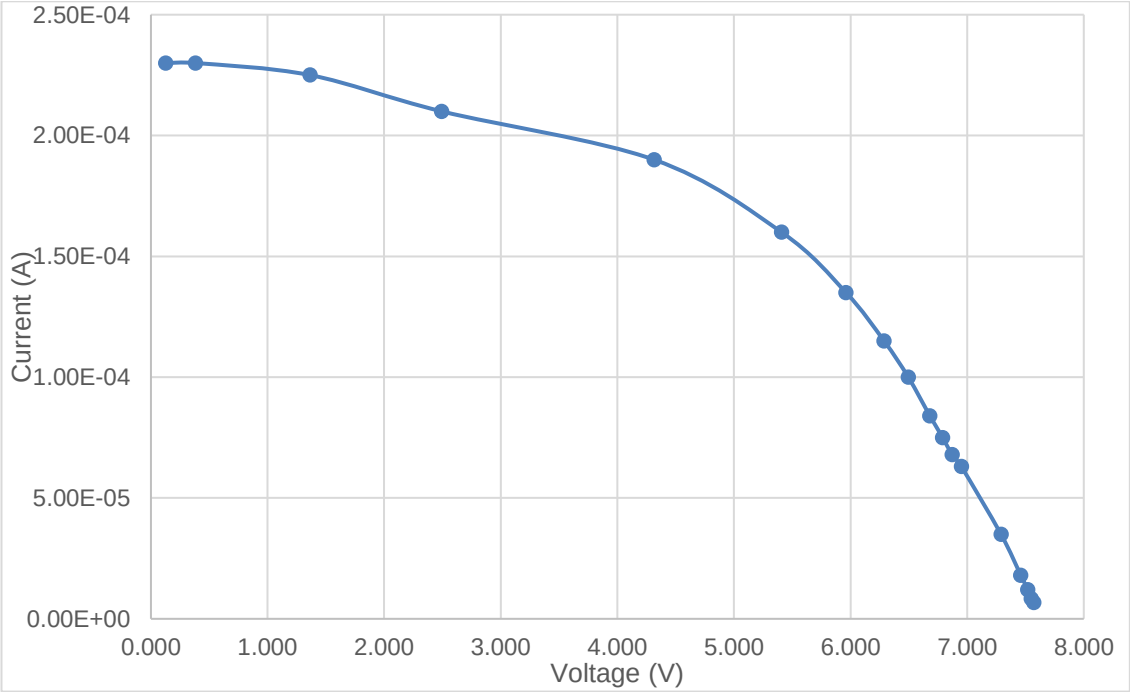
Kuvio 36. Voltage (V) vs Current (I) curve for panel ATCJ-I-52 3mm glass cover at 30°.



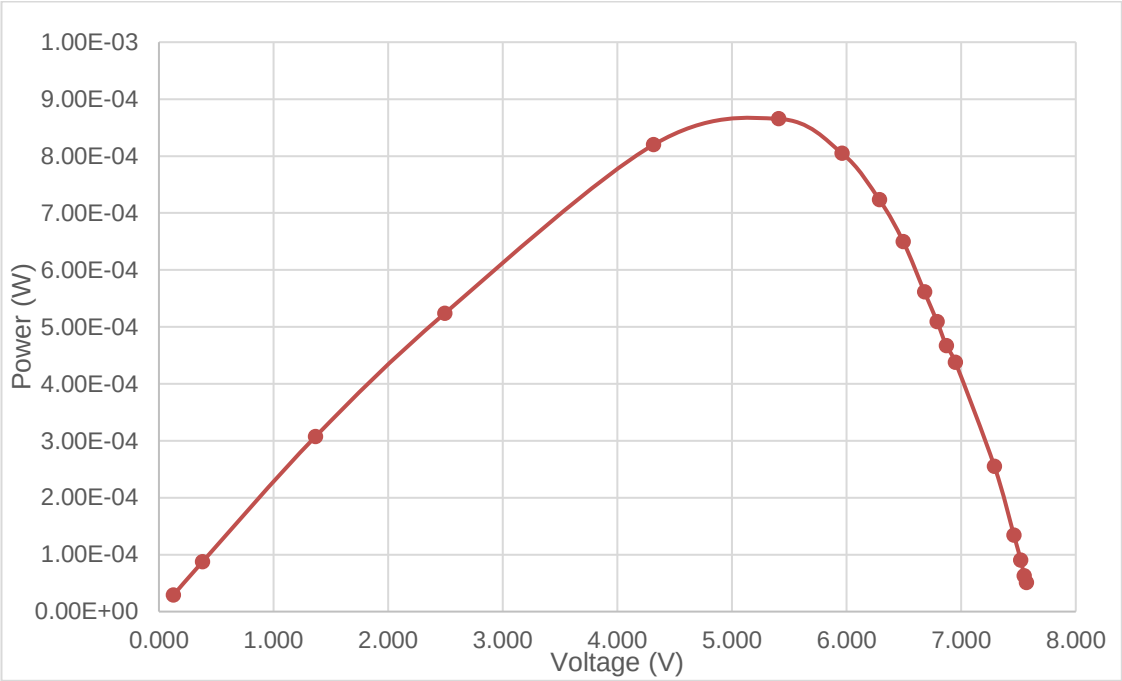
Kuvio 37. Voltage (V) vs Power (W) curve for panel ATCJ-I-52 with 3mm glass cover at 30°.

Taulukko 21. Results for panel ATCJ-I-52 with 6mm glass cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.126	2.30E-04	2.90E-05	101.1	-
0.381	2.30E-04	8.76E-05	100.0	1,000
1.366	2.25E-04	3.07E-04	100.0	5,000
2.494	2.10E-04	5.24E-04	100.1	10,000
4.315	1.90E-04	8.20E-04	100.0	20,000
5.408	1.60E-04	8.65E-04	100.4	30,000
5.961	1.35E-04	8.05E-04	100.6	40,000
6.287	1.15E-04	7.23E-04	100.5	50,000
6.495	1.00E-04	6.50E-04	100.3	60,000
6.680	8.40E-05	5.61E-04	10.7	70,000
6.790	7.50E-05	5.09E-04	100.2	80,000
6.870	6.80E-05	4.67E-04	100.2	90,000
6.950	6.30E-05	4.38E-04	100.6	100,000
7.290	3.50E-05	2.55E-04	100.5	200,000
7.460	1.80E-05	1.34E-04	100.6	400,000
7.520	1.20E-05	9.02E-05	100.9	600,000
7.550	8.30E-06	6.27E-05	100.2	800,000
7.570	6.70E-06	5.07E-05	101.1	1,000,000



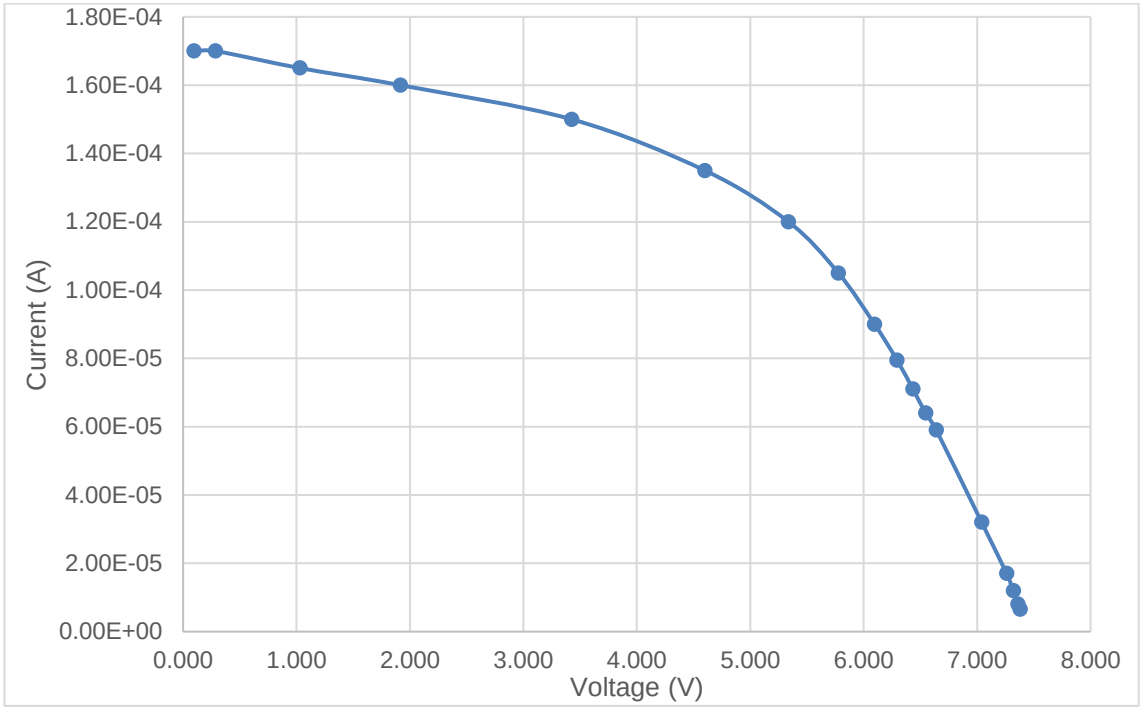
Kuvio 38. Voltage (V) vs Current (I) curve for panel ATCJ-I-52 6mm glass cover at 90°.



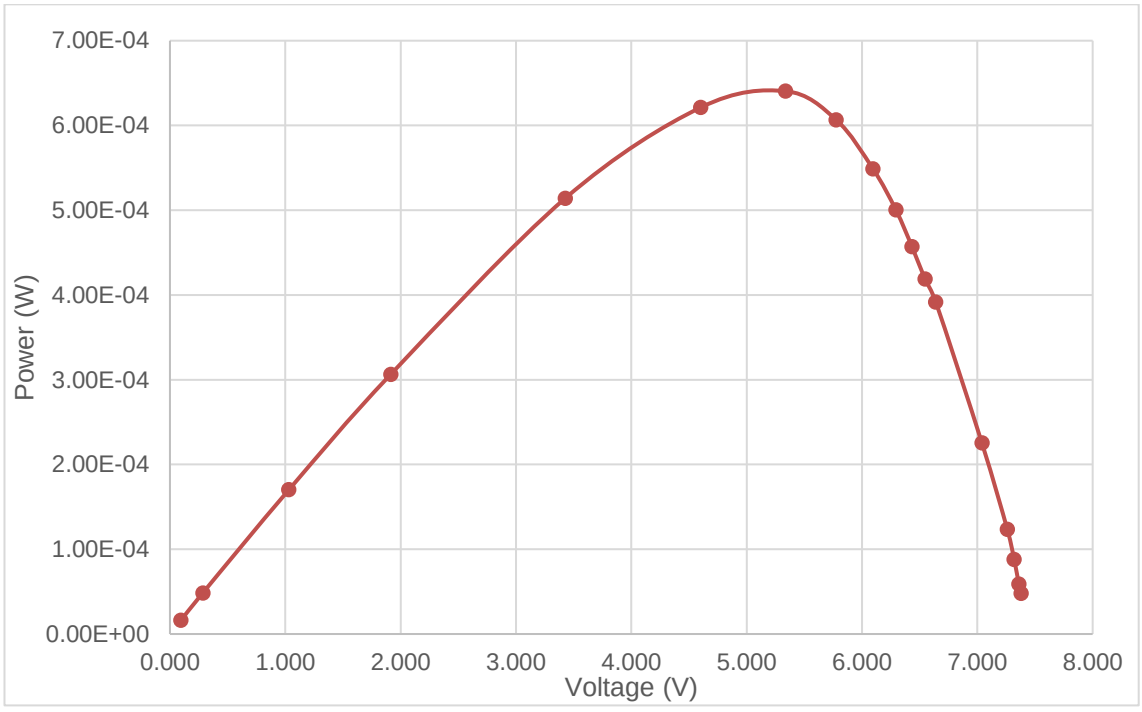
Kuvio 39. Voltage (V) vs Power (W) curve for panel ATCJ-I-52 with 6mm glass cover at 90°.

Taulukko 22. Results for panel ATCJ-I-52 with 6mm glass cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.095	1.70E-04	1.62E-05	90.2	-
0.285	1.70E-04	4.85E-05	90.4	1,000
1.031	1.65E-04	1.70E-04	90.4	5,000
1.915	1.60E-04	3.06E-04	90.6	10,000
3.427	1.50E-04	5.14E-04	90.3	20,000
4.601	1.35E-04	6.21E-04	90.4	30,000
5.337	1.20E-04	6.40E-04	90.6	40,000
5.777	1.05E-04	6.07E-04	90.6	50,000
6.096	9.00E-05	5.49E-04	90.3	60,000
6.294	7.95E-05	5.00E-04	90.5	70,000
6.434	7.10E-05	4.57E-04	90.1	80,000
6.546	6.40E-05	4.19E-04	90.4	90,000
6.640	5.90E-05	3.92E-04	90.6	100,000
7.040	3.20E-05	2.25E-04	90.4	200,000
7.260	1.70E-05	1.23E-04	90.6	400,000
7.320	1.20E-05	8.78E-05	90.6	600,000
7.360	8.00E-06	5.89E-05	90.5	800,000
7.380	6.50E-06	4.80E-05	90.6	1,000,000



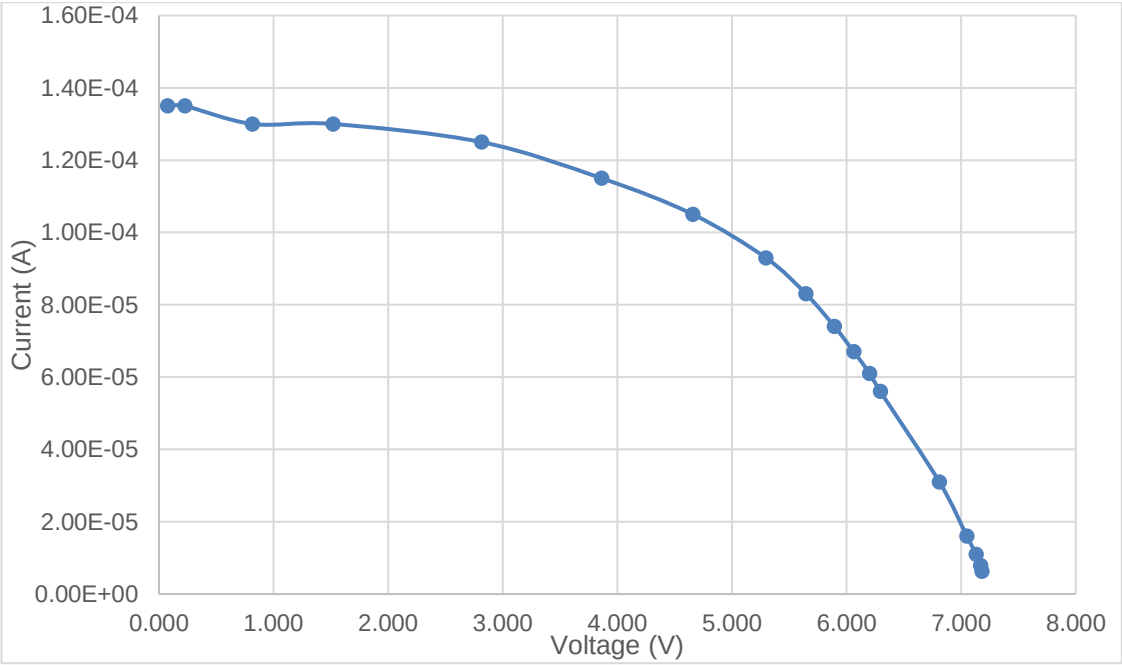
Kuvio 40. Voltage (V) vs Current (I) curve for panel ATCJ-I-52 6mm glass cover at 60°.



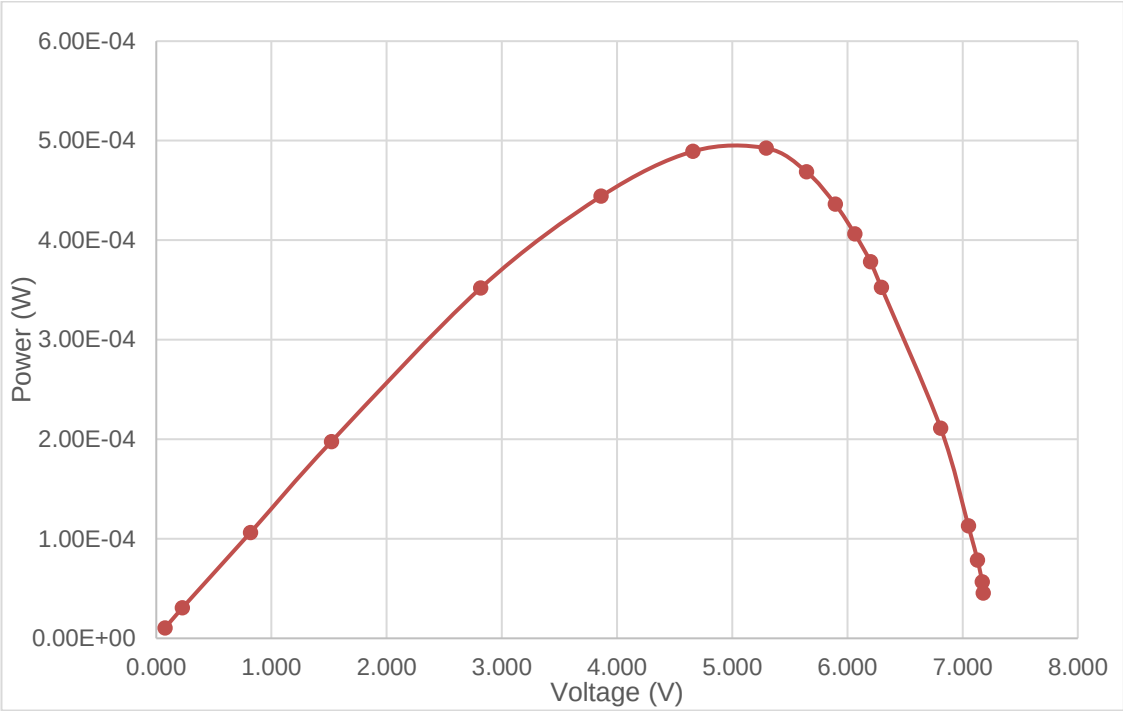
Kuvio 41. Voltage (V) vs Power (W) curve for panel ATCJ-I-52 with 3mm glass cover at 60°.

Taulukko 23. Results for panel ATCJ-I-52 with 6mm glass cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.075	1.35E-04	1.01E-05	76.5	-
0.226	1.35E-04	3.05E-05	76.1	1,000
0.817	1.30E-04	1.06E-04	76.5	5,000
1.520	1.30E-04	1.98E-04	76.5	10,000
2.815	1.25E-04	3.52E-04	76.4	20,000
3.862	1.15E-04	4.44E-04	76.5	30,000
4.660	1.05E-04	4.89E-04	76.5	40,000
5.295	9.30E-05	4.92E-04	76.3	50,000
5.646	8.30E-05	4.69E-04	76.4	60,000
5.894	7.40E-05	4.36E-04	76.7	70,000
6.064	6.70E-05	4.06E-04	76.7	80,000
6.201	6.10E-05	3.78E-04	76.5	90,000
6.295	5.60E-05	3.53E-04	76.2	100,000
6.810	3.10E-05	2.11E-04	76.7	200,000
7.050	1.60E-05	1.13E-04	76.6	400,000
7.130	1.10E-05	7.84E-05	76.4	600,000
7.170	7.90E-06	5.66E-05	76.6	800,000
7.180	6.30E-06	4.52E-05	76.4	1,000,000



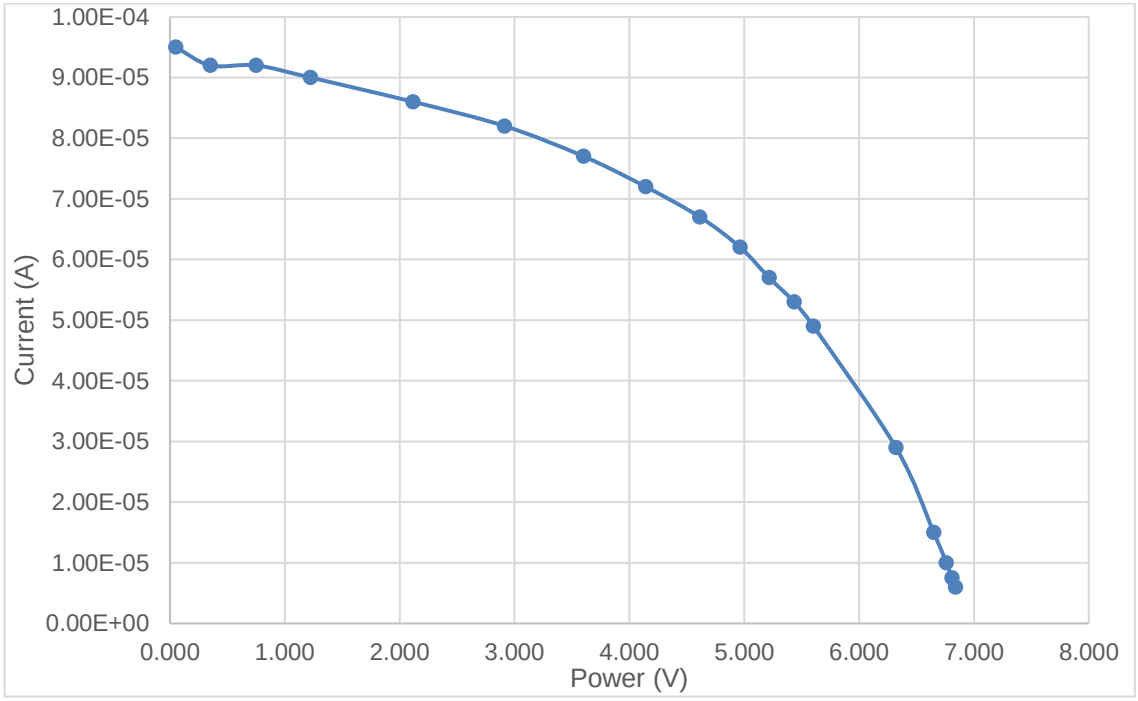
Kuvio 42. Voltage (V) vs Current (I) curve for panel ATCJ-I-52 6mm glass cover at 45°.



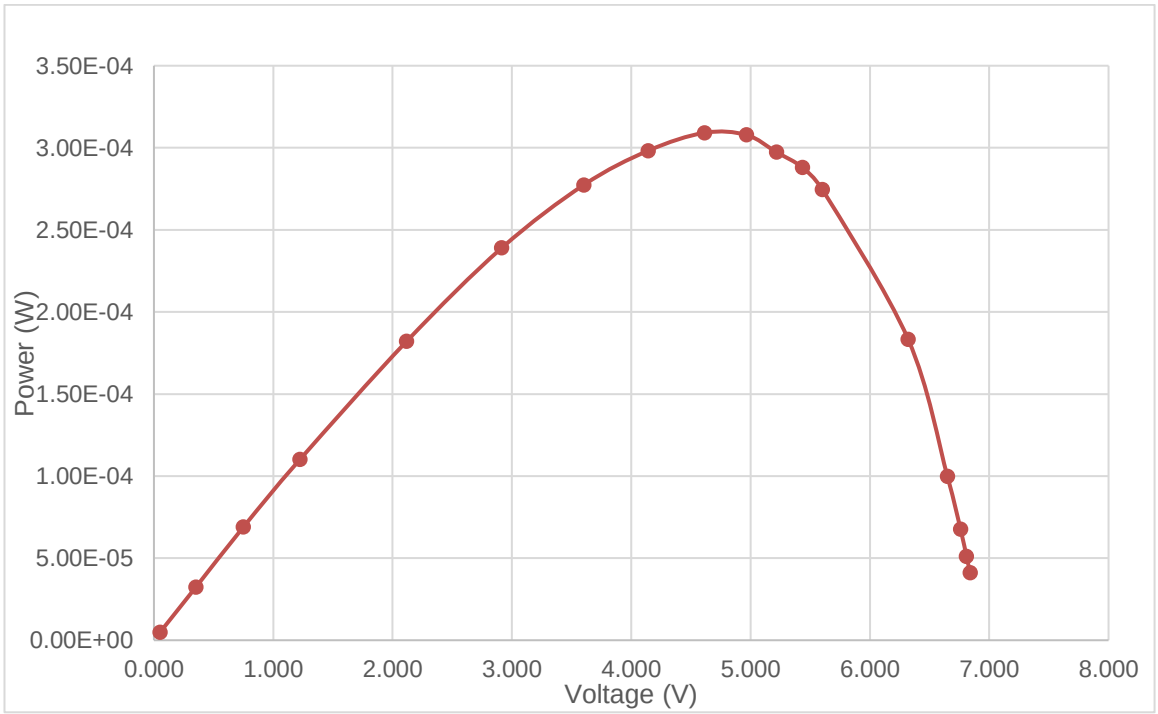
Kuvio 43. Voltage (V) vs Power (W) curve for panel ATCJ-I-52 with 6mm glass cover at 45°.

Taulukko 24. Results for panel ATCJ-I-52 with 6mm glass cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.050	9.50E-05	4.75E-06	57.9	-
0.352	9.20E-05	3.24E-05	58.0	1,000
0.750	9.20E-05	6.90E-04	58.0	5,000
1.223	9.00E-05	1.10E-04	57.9	10,000
2.117	8.60E-05	1.82E-04	57.9	20,000
2.914	8.20E-05	2.39E-04	57.9	30,000
3.602	7.70E-05	2.77E-04	58.0	40,000
4.142	7.20E-05	2.98E-04	57.8	50,000
4.614	6.70E-05	3.09E-04	58.0	60,000
4.965	6.20E-05	3.08E-04	57.9	70,000
5.217	5.70E-05	2.97E-04	58.0	80,000
5.435	5.30E-05	2.88E-04	57.9	90,000
5.602	4.90E-05	2.74E-04	58.0	100,000
6.321	2.90E-05	1.83E-04	58.2	200,000
6.650	1.50E-05	9.98E-05	57.8	400,000
6.760	1.00E-05	6.76E-05	58.3	600,000
6.810	7.50E-06	5.11E-05	58.2	800,000
6.840	6.00E-06	4.10E-05	58.0	1,000,000



Kuvio 44. Voltage (V) vs Current (I) curve for panel ATCJ-I-52 6mm glass cover at 30°.

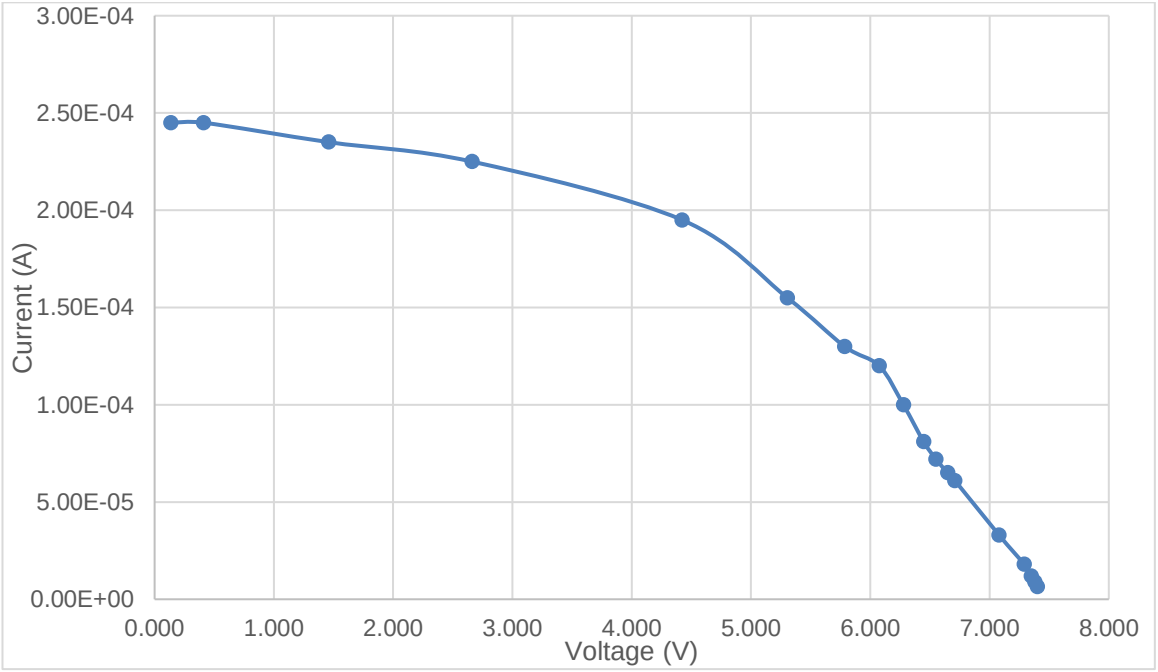


Kuvio 45. Voltage (V) vs Power (W) curve for panel ATCJ-I-52 with 6mm glass cover at 30°.

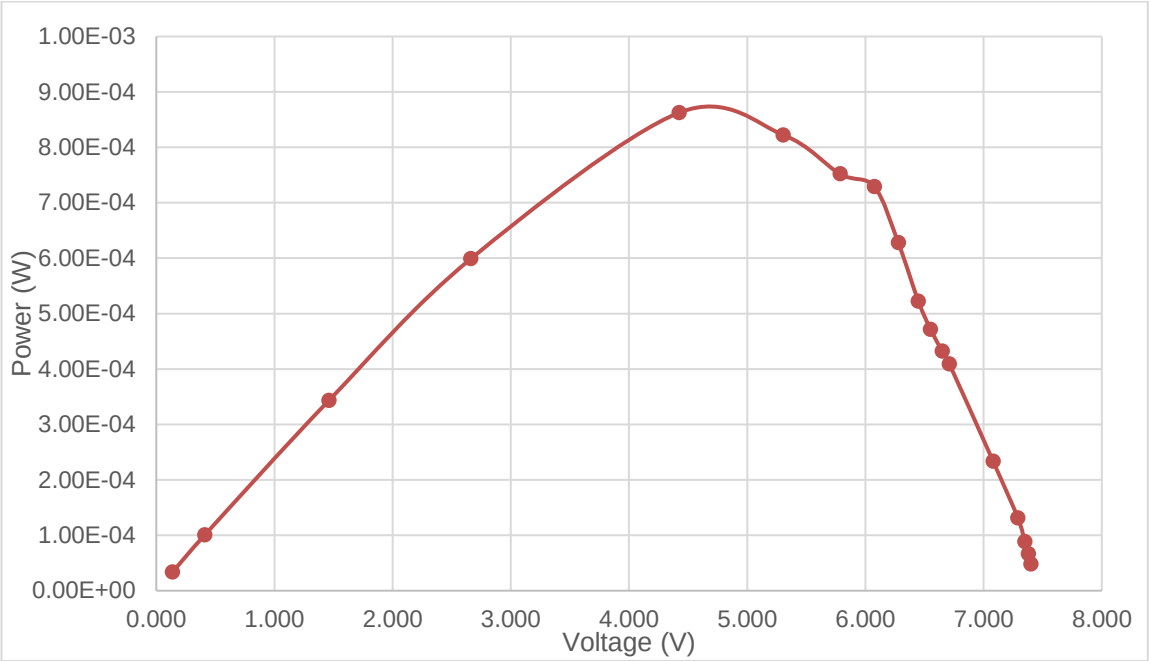
Appendix 3: Panel I_053

Taulukko 25. Results for panel ATCJ-I-53 with no cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.136	2.45E-04	3.33E-05	99.7	-
0.411	2.45E-04	1.01E-04	99.8	1,000
1.460	2.35E-04	3.43E-04	99.9	5,000
2.662	2.25E-04	5.99E-04	100.4	10,000
4.423	1.95E-04	8.62E-04	100.6	20,000
5.305	1.55E-04	8.22E-04	100.0	30,000
5.785	1.30E-04	7.52E-04	99.8	40,000
6.075	1.20E-04	7.29E-04	100.4	50,000
6.278	1.00E-04	6.28E-04	100.7	60,000
6.448	8.10E-05	5.22E-04	100.5	70,000
6.551	7.20E-05	4.72E-04	100.5	80,000
6.650	6.50E-05	4.32E-04	100.6	90,000
6.710	6.10E-05	4.09E-04	100.4	100,000
7.080	3.30E-05	2.34E-04	100.6	200,000
7.290	1.80E-05	1.31E-04	100.7	400,000
7.350	1.20E-05	8.82E-05	100.2	600,000
7.380	9.00E-06	6.64E-05	100.7	800,000
7.400	6.50E-06	4.81E-05	100.7	1,000,000



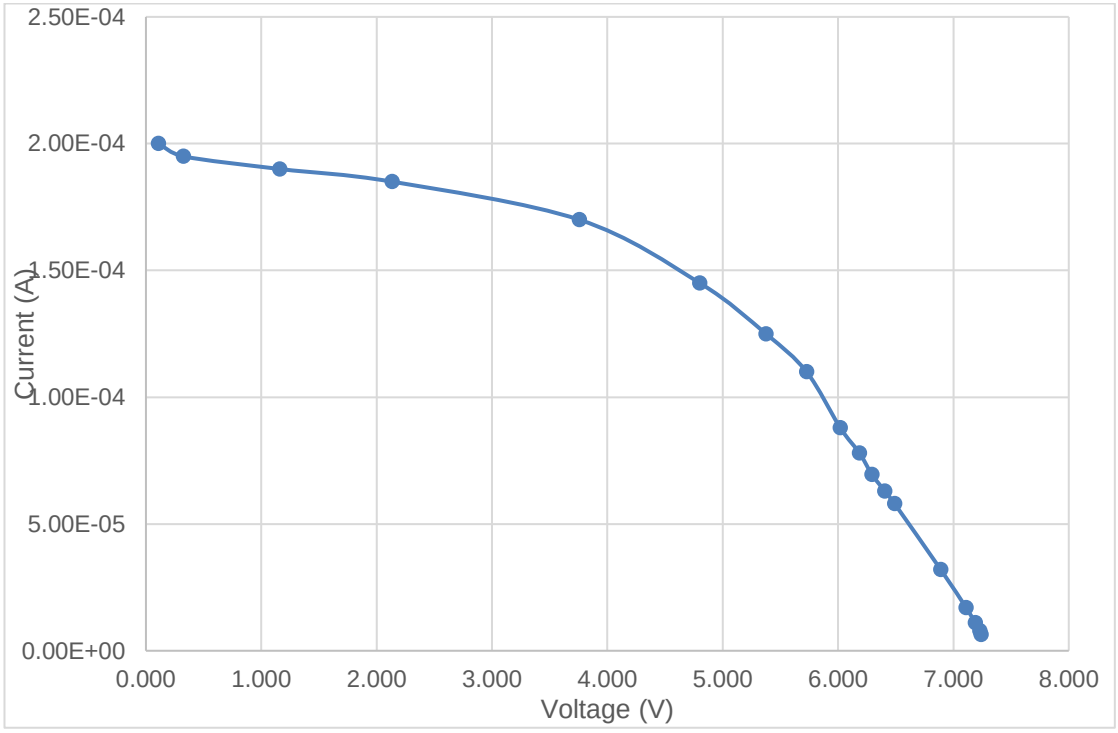
Kuvio 46. Voltage (V) vs Current (I) curve for panel ATCJ-I-53 with no cover at 90°.



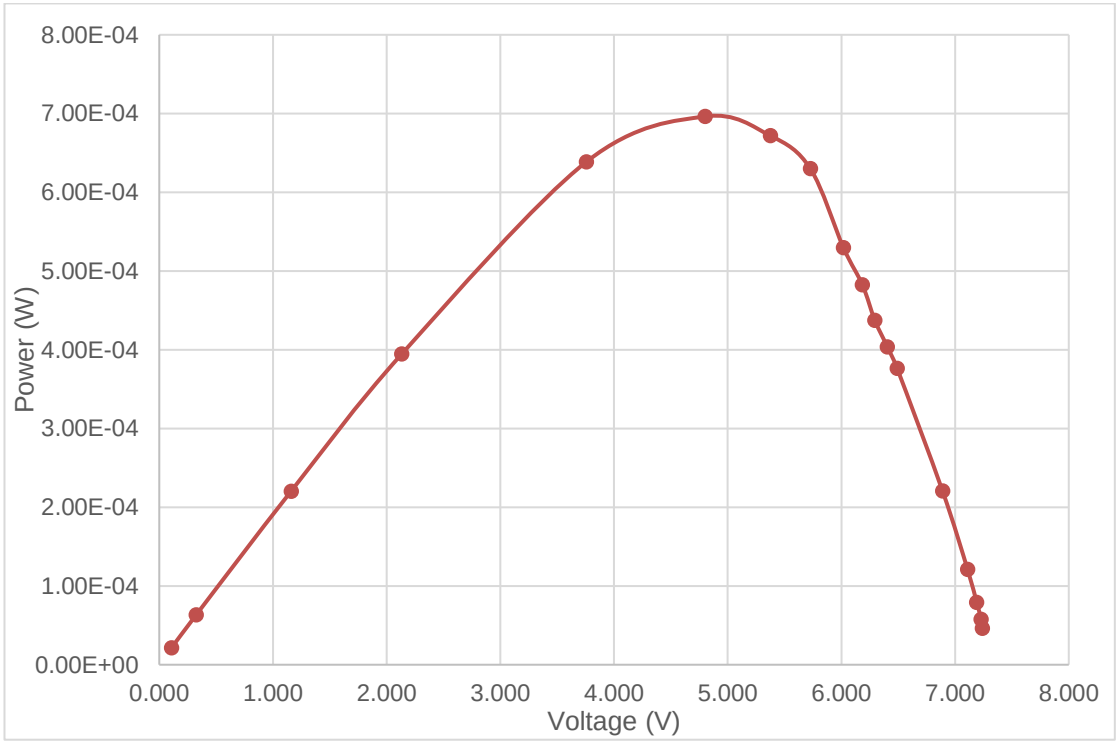
Kuvio 47. Voltage (V) vs Power (W) curve for panel ATCJ-I-53 with no cover at 90°.

Taulukko 26. Results for panel ATCJ-I-53 with no cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.108	2.00E-04	2.16E-05	90.5	-
0.325	1.95E-04	6.34E-05	90.6	1,000
1.160	1.90E-04	2.20E-04	90.2	5,000
2.134	1.85E-04	3.95E-04	90.2	10,000
3.757	1.70E-04	6.39E-04	90.6	20,000
4.802	1.45E-04	6.96E-04	90.6	30,000
5.375	1.25E-04	6.72E-04	90.3	40,000
5.727	1.10E-04	6.30E-04	90.1	50,000
6.018	8.80E-05	5.30E-04	90.2	60,000
6.185	7.80E-05	4.82E-04	90.5	70,000
6.294	6.95E-05	4.37E-04	90.5	80,000
6.405	6.30E-05	4.04E-04	90.4	90,000
6.490	5.80E-05	3.76E-04	90.7	100,000
6.890	3.20E-05	2.20E-04	90.5	200,000
7.110	1.70E-05	1.21E-04	90.5	400,000
7.190	1.10E-05	7.91E-05	90.3	600,000
7.230	7.95E-06	5.75E-05	90.5	800,000
7.240	6.40E-06	4.63E-05	90.2	1,000,000



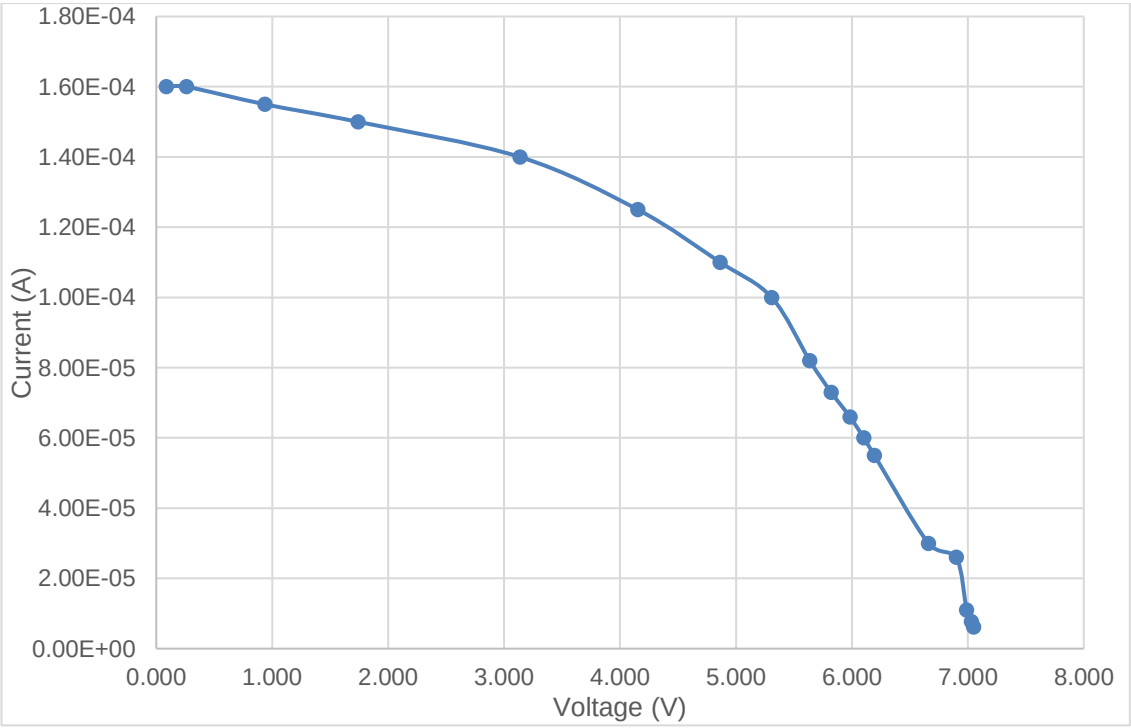
Kuvio 48. Voltage (V) vs Current (I) curve for panel ATCJ-I-53 with no cover at 60°.



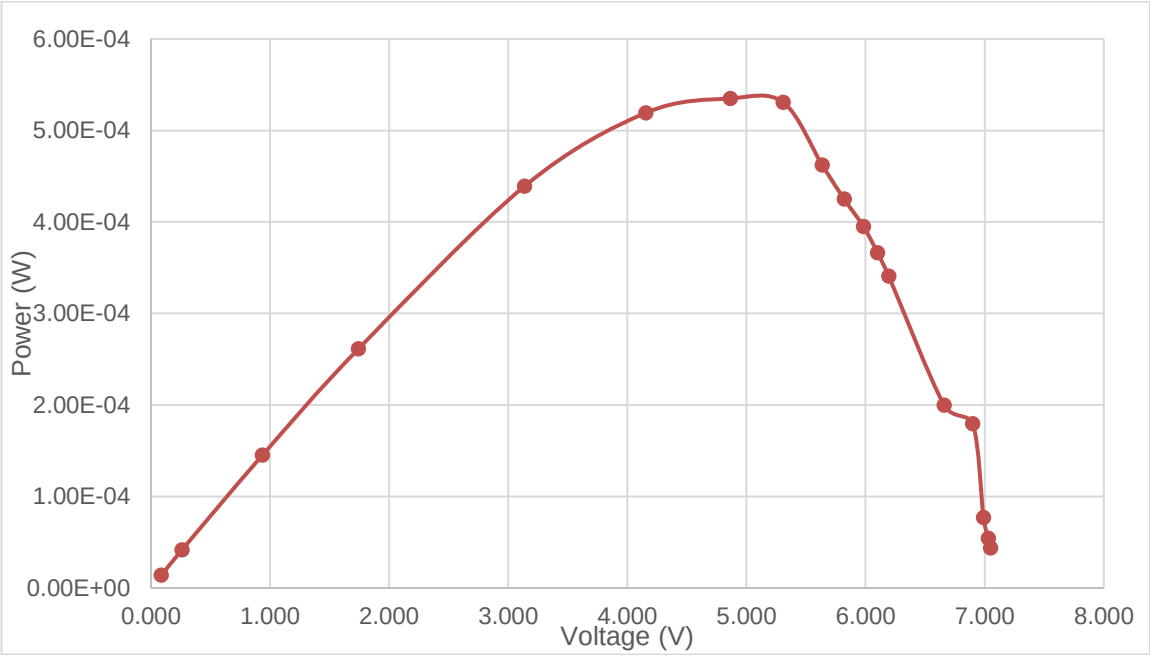
Kuvio 49. Voltage (V) vs Power (W) curve for panel ATCJ-I-53 with no cover at 60°.

Taulukko 27. Results for panel ATCJ-I-53 with no cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.087	1.60E-04	1.39E-05	76.7	-
0.260	1.60E-04	4.16E-05	76.7	1,000
0.936	1.55E-04	1.45E-04	76.7	5,000
1.741	1.50E-04	2.61E-04	76.6	10,000
3.137	1.40E-04	4.39E-04	76.6	20,000
4.154	1.25E-04	5.19E-04	76.2	30,000
4.864	1.10E-04	5.35E-04	76.4	40,000
5.308	1.00E-04	5.31E-04	76.5	50,000
5.636	8.20E-05	4.62E-04	76.5	60,000
5.821	7.30E-05	4.25E-04	76.3	70,000
5.983	6.60E-05	3.95E-04	76.2	80,000
6.102	6.00E-05	3.66E-04	76.3	90,000
6.195	5.50E-05	3.41E-04	76.3	100,000
6.660	3.00E-05	2.00E-04	76.3	200,000
6.900	2.60E-05	1.79E-04	76.3	400,000
6.990	1.10E-05	7.69E-05	76.4	600,000
7.030	7.70E-06	5.41E-05	76.2	800,000
7.050	6.20E-06	4.37E-05	76.1	1,000,000



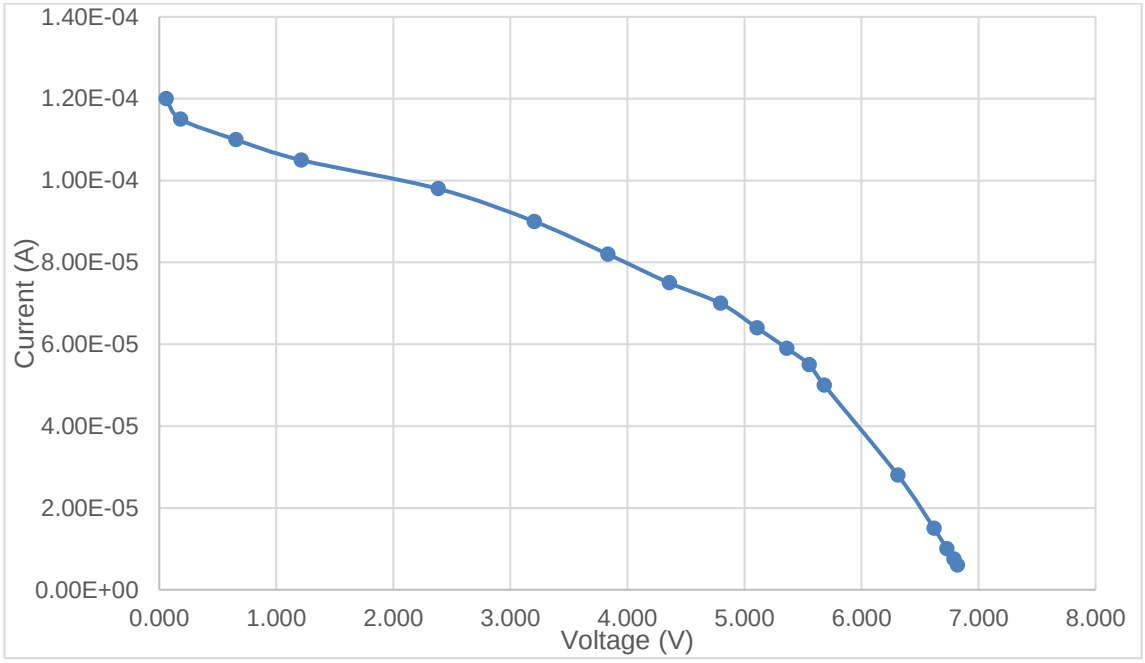
Kuvio 50. Voltage (V) vs Current (I) curve for panel ATCJ-I-53 with no cover at 45°.



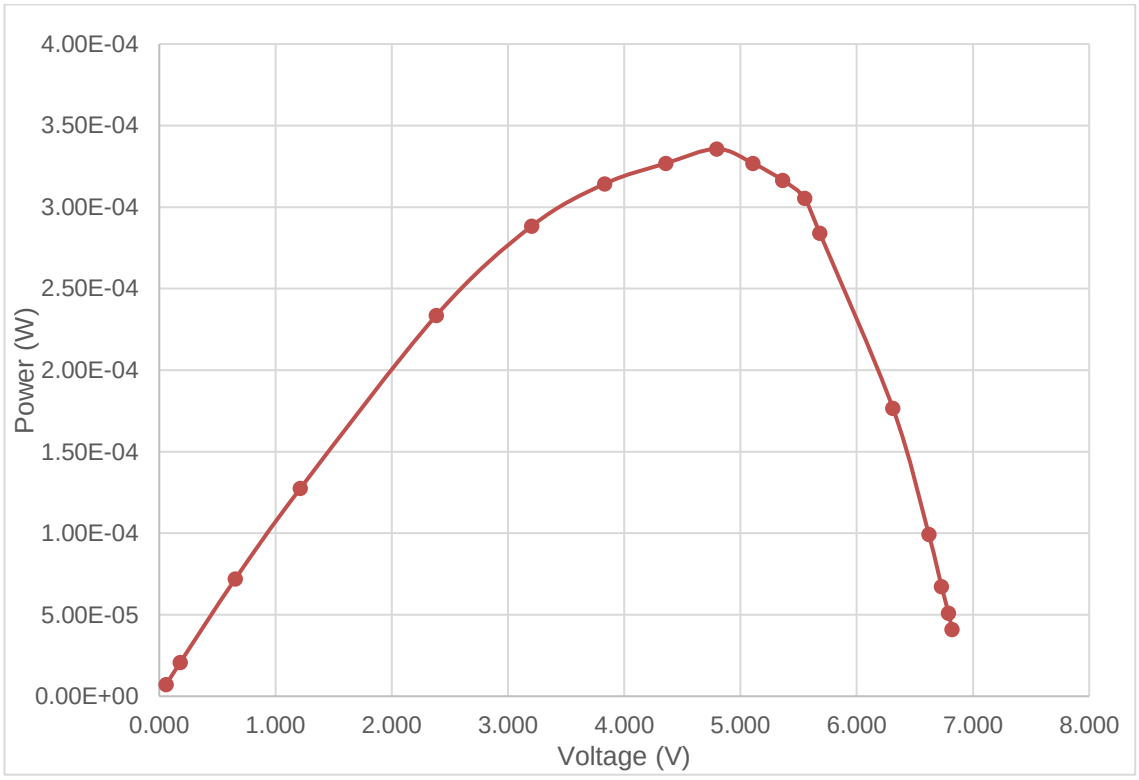
Kuvio 51. Voltage (V) vs Power (W) curve for panel ATCJ-I-53 with no cover at 45°.

Taulukko 28. Results for panel ATCJ-I-53 with no cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.060	1.20E-04	7.20E-06	59.8	-
0.181	1.15E-04	2.08E-05	59.9	1,000
0.654	1.10E-04	7.19E-04	59.8	5,000
1.214	1.05E-04	1.27E-04	60.0	10,000
2.383	9.80E-05	2.34E-04	59.6	20,000
3.204	9.00E-05	2.88E-04	59.9	30,000
3.833	8.20E-05	3.14E-04	59.9	40,000
4.357	7.50E-05	3.27E-04	59.9	50,000
4.795	7.00E-05	3.36E-04	59.8	60,000
5.107	6.40E-05	3.27E-04	59.9	70,000
5.363	5.90E-05	3.16E-04	59.6	80,000
5.553	5.50E-05	3.05E-04	60.0	90,000
5.682	5.00E-05	2.84E-04	59.8	100,000
6.311	2.80E-05	1.77E-04	59.9	200,000
6.620	1.50E-05	9.93E-05	59.7	400,000
6.730	1.00E-05	6.73E-05	59.7	600,000
6.790	7.50E-06	5.09E-05	59.8	800,000
6.820	6.00E-06	4.09E-05	60.0	1,000,000



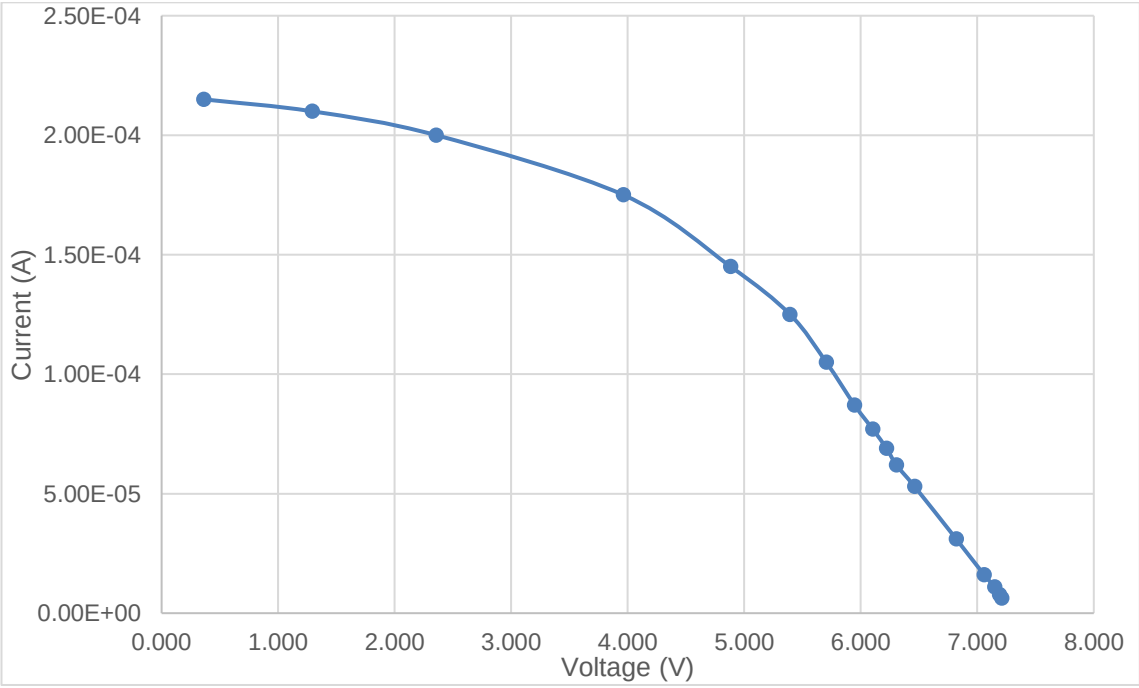
Kuvio 52. Voltage (V) vs Current (I) curve for panel ATCJ-I-53 with no cover at 30°.



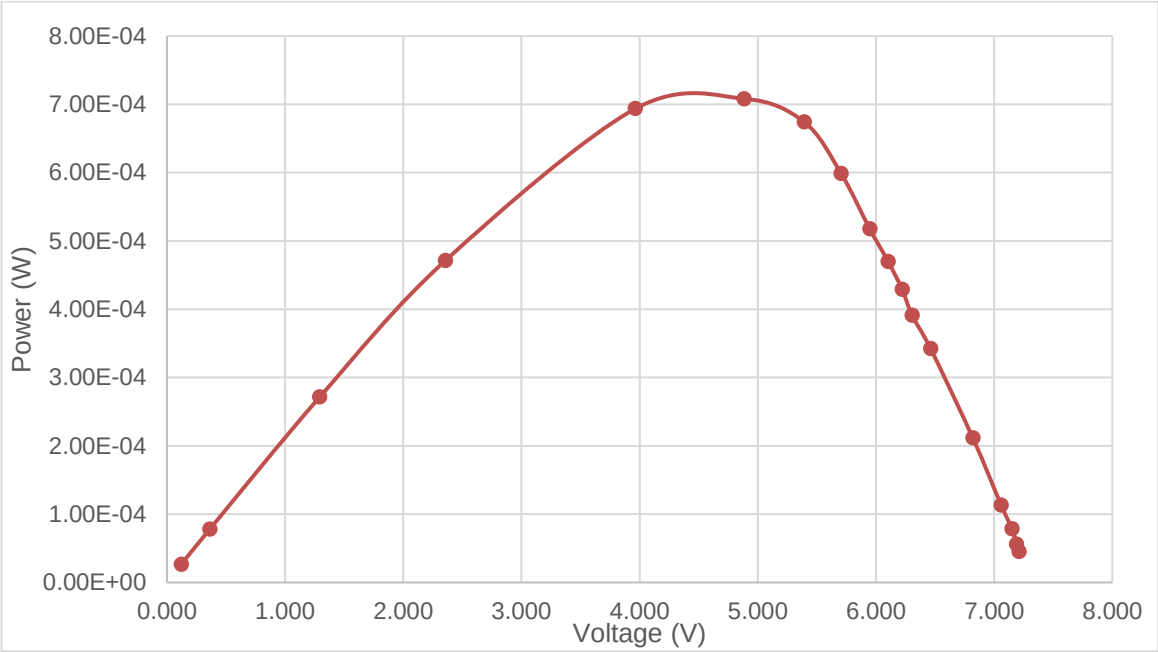
Kuvio 53. Voltage (V) vs Power (W) curve for panel ATCJ-I-53 with no cover at 30°.

Taulukko 29. Results for panel ATCJ-I-53 with polycarbonate cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.121	2.20E-04	2.66E-05	100.6	-
0.362	2.15E-04	7.78E-05	101.0	1,000
1.293	2.10E-04	2.72E-04	100.3	5,000
2.357	2.00E-04	4.71E-04	100.8	10,000
3.964	1.75E-04	6.94E-04	101.1	20,000
4.884	1.45E-04	7.08E-04	101.1	30,000
5.393	1.25E-04	6.74E-04	100.7	40,000
5.704	1.05E-04	5.99E-04	100.6	50,000
5.948	8.70E-05	5.17E-04	101.0	60,000
6.103	7.70E-05	4.70E-04	100.9	70,000
6.221	6.90E-05	4.29E-04	101.1	80,000
6.306	6.20E-05	3.91E-04	101.1	90,000
6.462	5.30E-05	3.42E-04	101.3	100,000
6.820	3.10E-05	2.11E-04	101.4	200,000
7.060	1.60E-05	1.13E-04	101.3	400,000
7.150	1.10E-05	7.87E-05	101.4	600,000
7.190	7.80E-06	5.61E-05	101.5	800,000
7.210	6.30E-06	4.54E-05	101.3	1,000,000



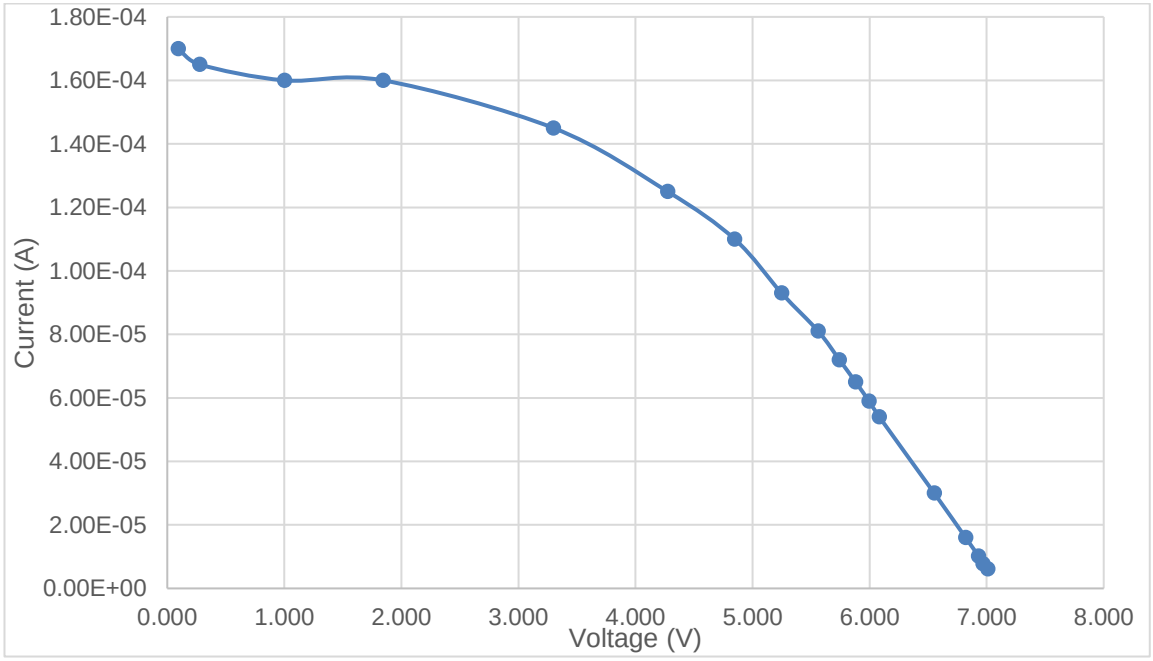
Kuvio 54. Voltage (V) vs Current (I) curve for panel ATCJ-I-53 polycarbonate cover at 90°.



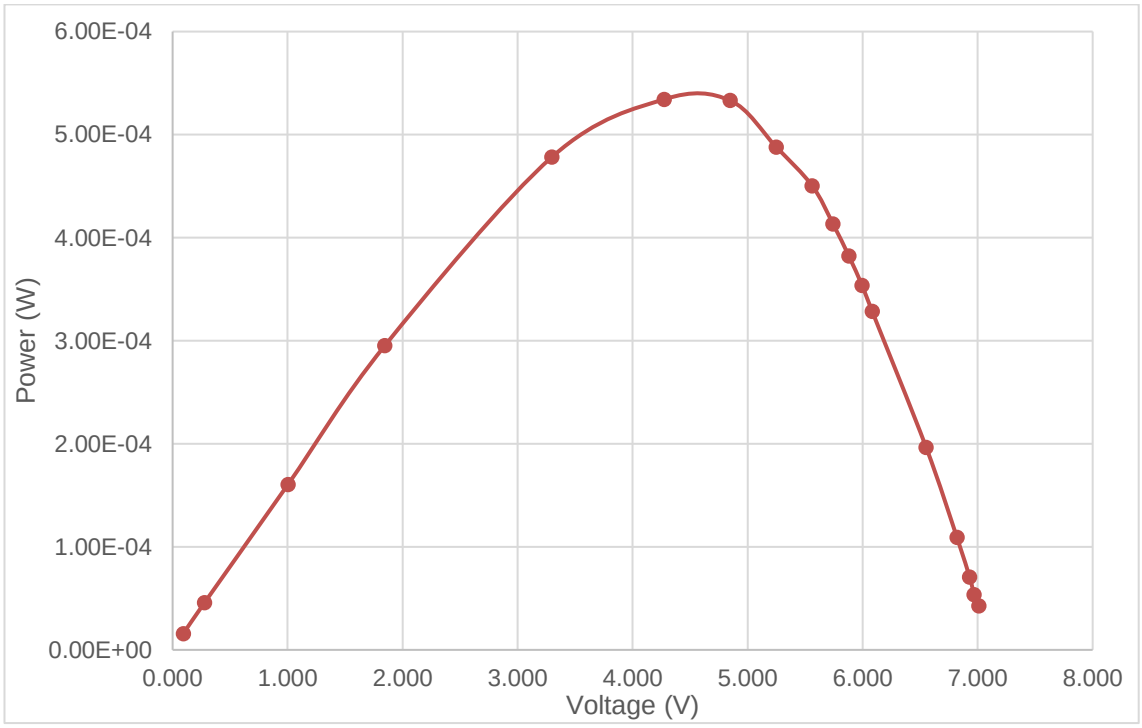
Kuvio 55. Voltage (V) vs Power (W) curve for panel ATCJ-I-53 with polycarbonate cover at 90°.

Taulukko 30. Results for panel ATCJ-I-52 with polycarbonate cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.093	1.70E-04	1.58E-05	92.0	-
0.278	1.65E-04	4.59E-05	91.7	1,000
1.003	1.60E-04	1.60E-04	91.9	5,000
1.845	1.60E-04	2.95E-04	92.1	10,000
3.299	1.45E-04	4.78E-04	92.2	20,000
4.274	1.25E-04	5.34E-04	92.0	30,000
4.847	1.10E-04	5.33E-04	91.6	40,000
5.248	9.30E-05	4.88E-04	91.4	50,000
5.561	8.10E-05	4.50E-04	92.1	60,000
5.742	7.20E-05	4.13E-04	92.1	70,000
5.880	6.50E-05	3.82E-04	91.9	80,000
5.995	5.90E-05	3.54E-04	92.3	90,000
6.083	5.40E-05	3.28E-04	92.1	100,000
6.552	3.00E-05	1.97E-04	92.1	200,000
6.820	1.60E-05	1.09E-04	91.9	400,000
6.930	1.02E-05	7.07E-05	91.8	600,000
6.970	7.70E-06	5.37E-05	92.0	800,000
7.010	6.10E-06	4.28E-05	92.3	1,000,000



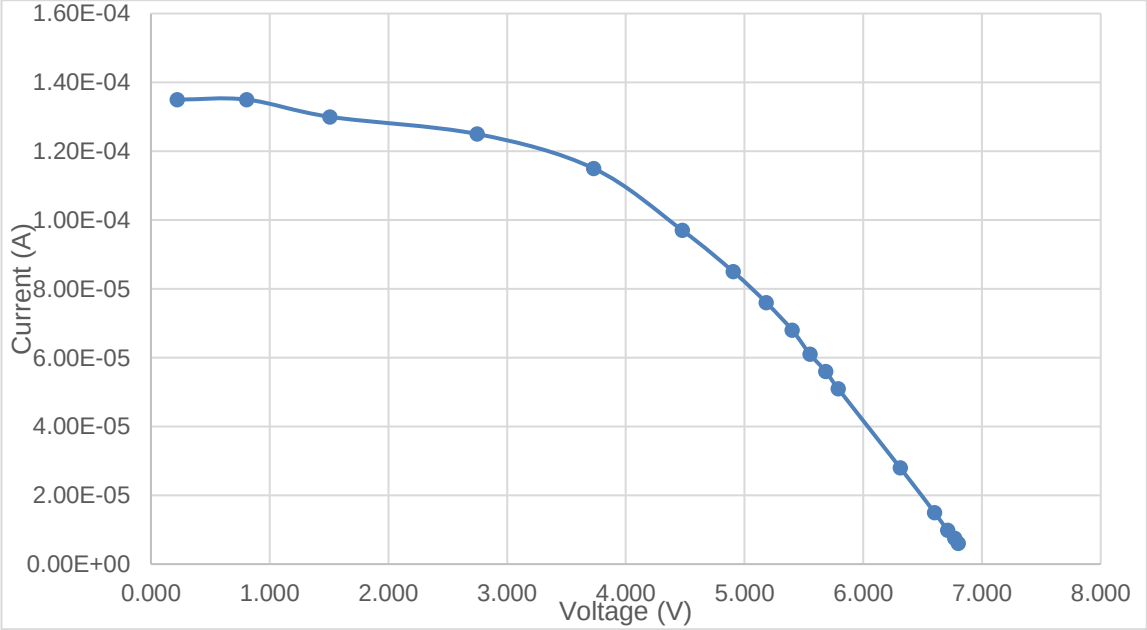
Kuvio 56. Voltage (V) vs Current (I) curve for panel ATCJ-I-53 polycarbonate cover at 60°.



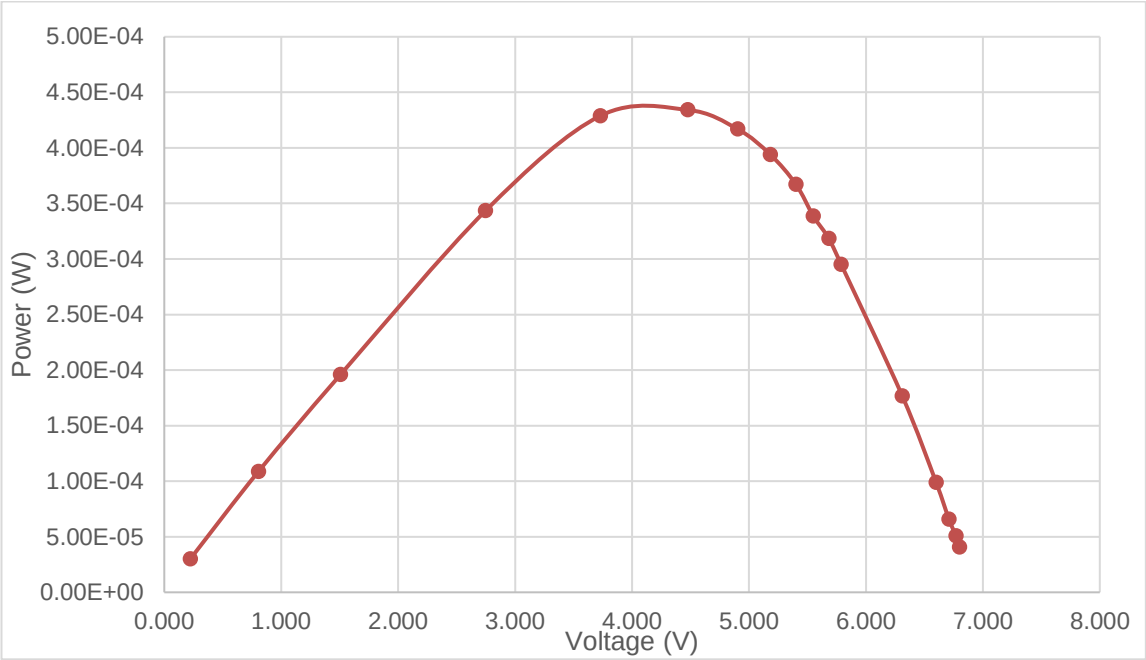
Kuvio 57. Voltage (V) vs Power (W) curve for panel ATCJ-I-53 with polycarbonate cover at 60°.

Taulukko 31. Results for panel ATCJ-I-52 with polycarbonate cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.075	1.35E-04	1.01E-05	78.2	-
0.222	1.35E-04	3.00E-05	78.1	1,000
0.806	1.35E-04	1.09E-04	78.1	5,000
1.508	1.30E-04	1.96E-04	78.6	10,000
2.748	1.25E-04	3.44E-04	78.3	20,000
3.729	1.15E-04	4.29E-04	78.4	30,000
4.476	9.70E-05	4.34E-04	77.9	40,000
4.904	8.50E-05	4.17E-04	78.2	50,000
5.183	7.60E-05	3.94E-04	78.3	60,000
5.401	6.80E-05	3.67E-04	78.7	70,000
5.551	6.10E-05	3.39E-04	78.1	80,000
5.684	5.60E-05	3.18E-04	78.2	90,000
5.788	5.10E-05	2.95E-04	78.5	100,000
6.311	2.80E-05	1.77E-04	78.0	200,000
6.600	1.50E-05	9.90E-05	78.0	400,000
6.710	9.80E-06	6.58E-05	78.1	600,000
6.770	7.50E-06	5.08E-05	78.3	800,000
6.800	6.00E-06	4.08E-05	78.2	1,000,000



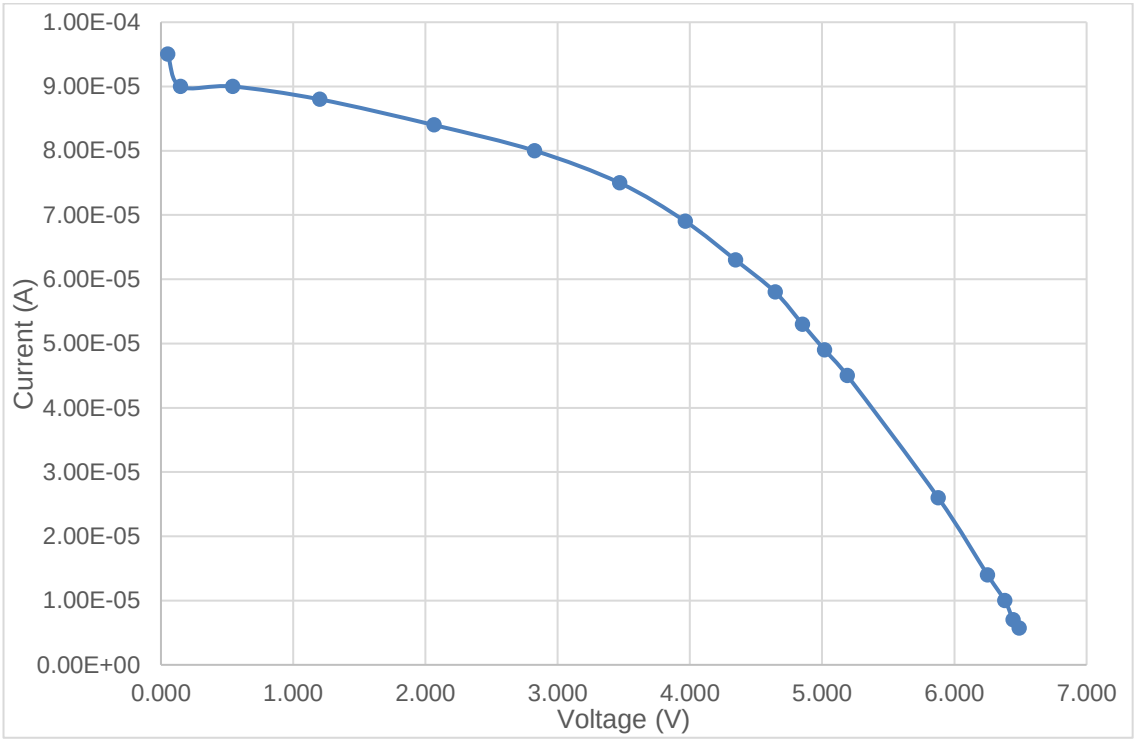
Kuvio 58. Voltage (V) vs Current (I) curve for panel ATCJ-I-53 polycarbonate cover at 45°.



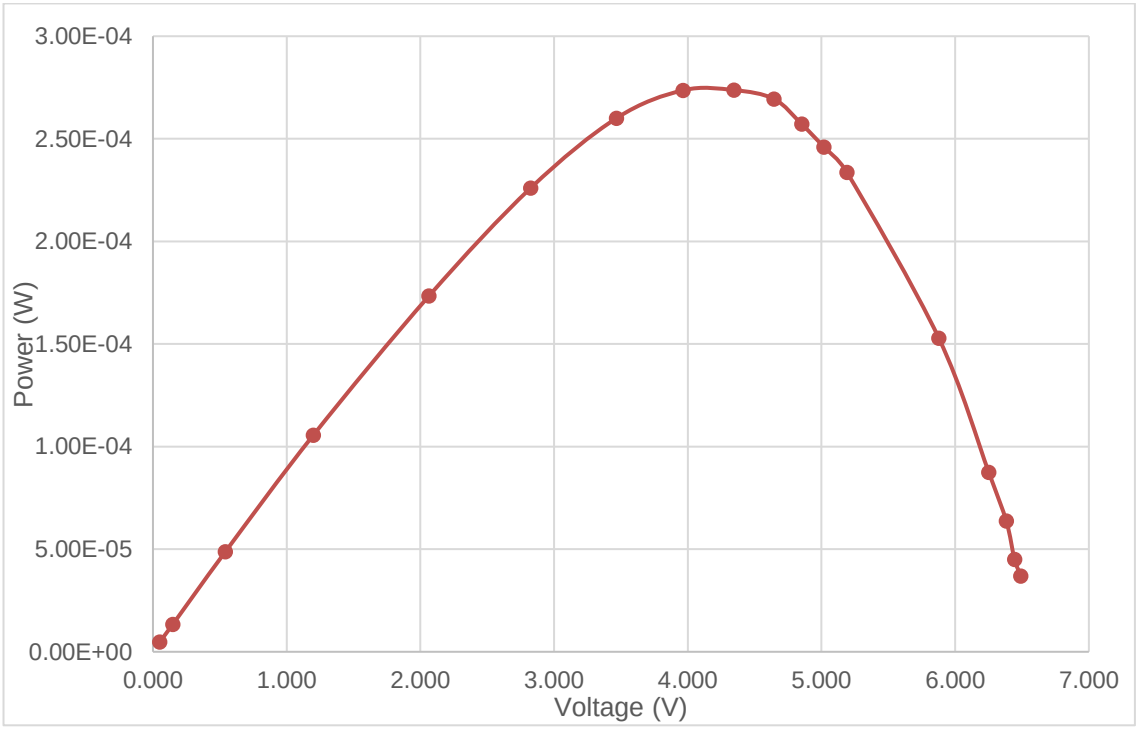
Kuvio 59. Voltage (V) vs Power (W) curve for panel ATCJ-I-53 with polycarbonate cover at 45°.

Taulukko 32. Results for panel ATCJ-I-52 with polycarbonate cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.050	9.50E-05	4.75E-06	59.5	-
0.149	9.00E-05	1.34E-05	59.2	1,000
0.542	9.00E-05	4.88E-05	59.5	5,000
1.200	8.80E-05	1.06E-04	59.3	10,000
2.065	8.40E-05	1.73E-04	59.4	20,000
2.826	8.00E-05	2.26E-04	59.5	30,000
3.468	7.50E-05	2.60E-04	59.5	40,000
3.966	6.90E-05	2.74E-04	59.4	50,000
4.345	6.30E-05	2.74E-04	59.5	60,000
4.645	5.80E-05	2.69E-04	59.5	70,000
4.852	5.30E-05	2.57E-04	59.4	80,000
5.019	4.90E-05	2.46E-04	59.3	90,000
5.191	4.50E-05	2.34E-04	59.5	100,000
5.878	2.60E-05	1.53E-04	59.6	200,000
6.251	1.40E-05	8.75E-05	59.5	400,000
6.382	1.00E-05	6.38E-05	59.5	600,000
6.444	7.00E-06	4.51E-05	59.4	800,000
6.491	5.70E-06	3.70E-05	59.3	1,000,000



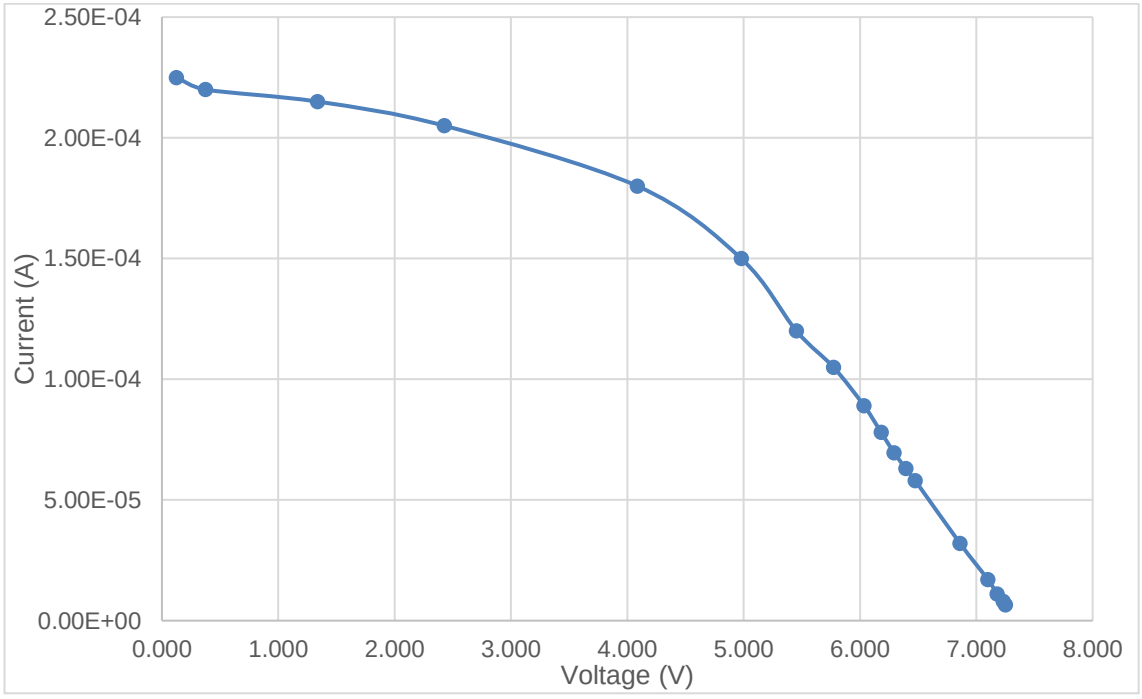
Kuvio 60. Voltage (V) vs Current (I) curve for panel ATCJ-I-53 polycarbonate cover at 30°.



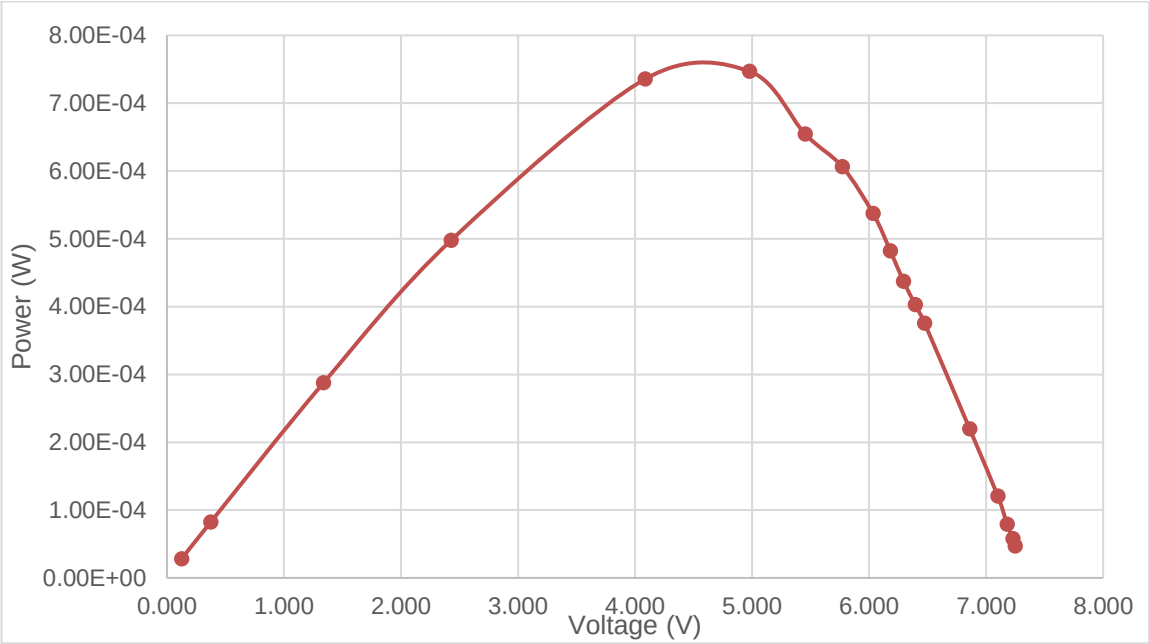
Kuvio 61. Voltage (V) vs Power (W) curve for panel ATCJ-I-53 with polycarbonate cover at 30°.

Taulukko 33. Results for panel ATCJ-I-53 with 3mm glass cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.125	2.25E-04	2.81E-05	100.4	-
0.375	2.20E-04	8.25E-05	100.4	1,000
1.338	2.15E-04	2.88E-04	100.4	5,000
2.428	2.05E-04	4.98E-04	100.2	10,000
4.087	1.80E-04	7.36E-04	100.0	20,000
4.979	1.50E-04	7.47E-04	100.2	30,000
5.454	1.20E-04	6.54E-04	100.0	40,000
5.772	1.05E-04	6.06E-04	99.7	50,000
6.035	8.90E-05	5.37E-04	100.2	60,000
6.182	7.80E-05	4.82E-04	100.5	70,000
6.294	6.95E-05	4.37E-04	100.4	80,000
6.395	6.30E-05	4.03E-04	100.0	90,000
6.475	5.80E-05	3.76E-04	100.7	100,000
6.860	3.20E-05	2.20E-04	100.2	200,000
7.100	1.70E-05	1.21E-04	100.3	400,000
7.180	1.10E-05	7.90E-05	100.4	600,000
7.230	8.00E-06	5.78E-05	100.6	800,000
7.250	6.50E-06	4.71E-05	100.5	1,000,000



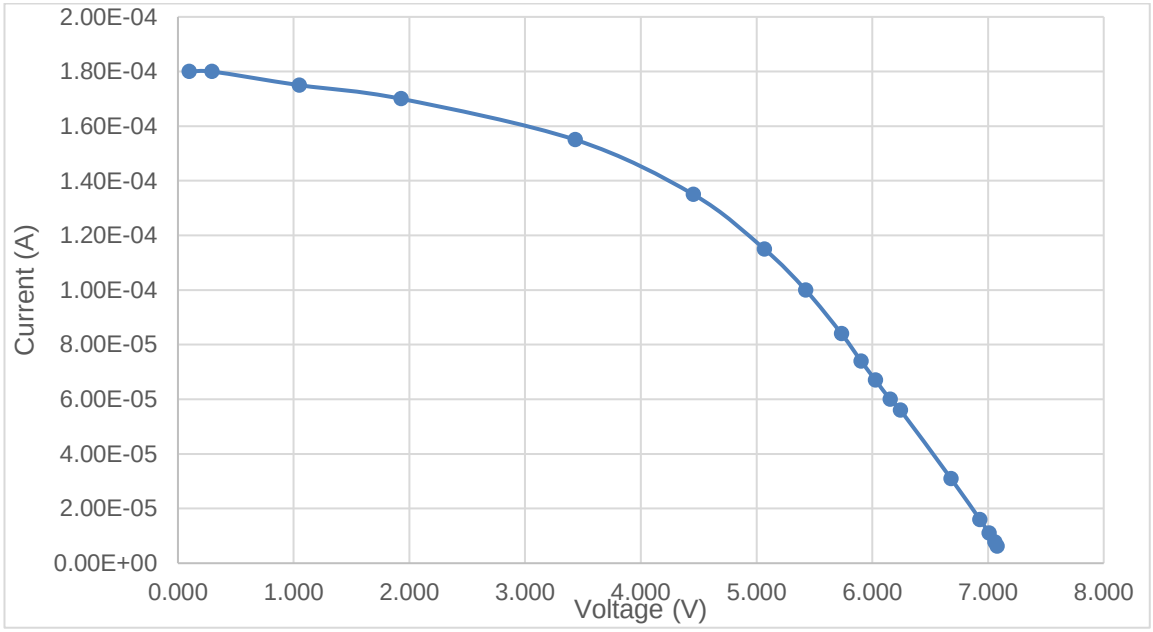
Kuvio 62. Voltage (V) vs Current (I) curve for panel ATCJ-I-53 3mm glass cover at 90°.



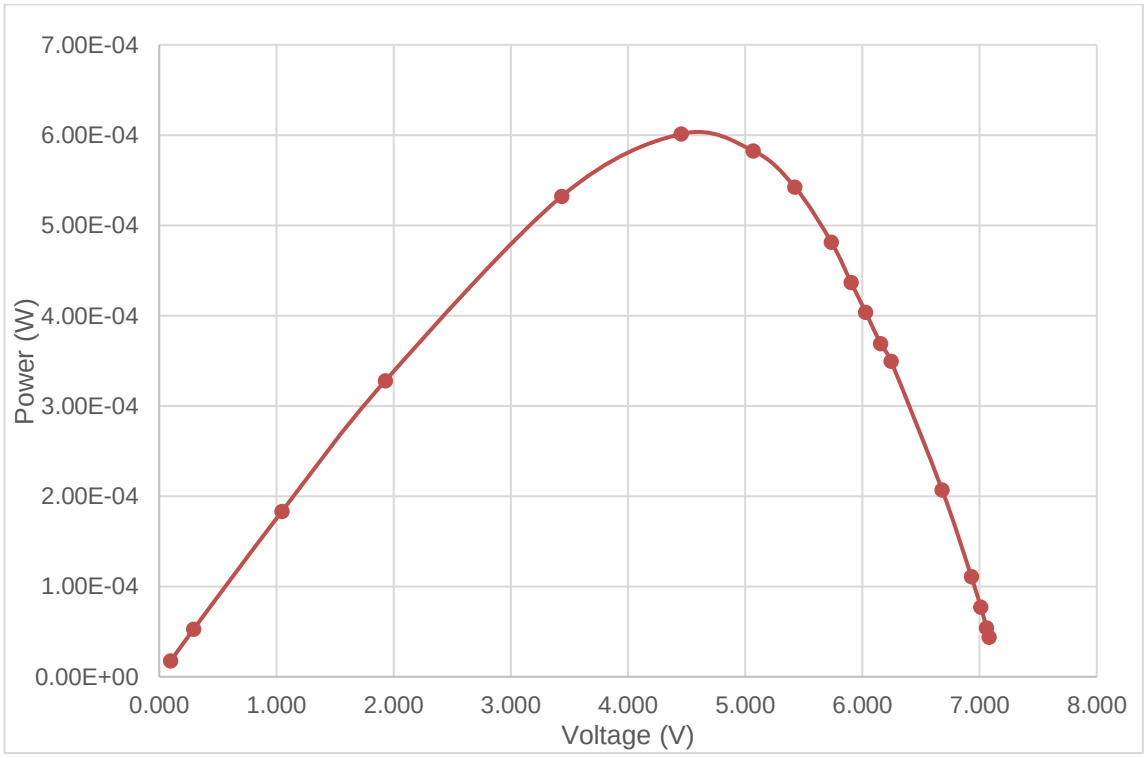
Kuvio 63. Voltage (V) vs Power (W) curve for panel ATCJ-I-53 with 3mm glass cover at 90°.

Taulukko 34. Results for panel ATCJ-I-53 with 3mm glass cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.098	1.80E-04	1.76E-05	91.2	-
0.293	1.80E-04	5.27E-05	91.1	1,000
1.048	1.75E-04	1.83E-04	91.1	5,000
1.929	1.70E-04	3.28E-04	91.4	10,000
3.434	1.55E-04	5.32E-04	91.5	20,000
4.454	1.35E-04	6.01E-04	91.2	30,000
5.067	1.15E-04	5.83E-04	91.6	40,000
5.424	1.00E-04	5.42E-04	91.3	50,000
5.734	8.40E-05	4.82E-04	91.1	60,000
5.903	7.40E-05	4.37E-04	91.2	70,000
6.028	6.70E-05	4.04E-04	90.8	80,000
6.154	6.00E-05	3.69E-04	91.3	90,000
6.244	5.60E-05	3.50E-04	91.2	100,000
6.680	3.10E-05	2.07E-04	91.3	200,000
6.930	1.60E-05	1.11E-04	91.3	400,000
7.010	1.10E-05	7.71E-05	90.7	600,000
7.060	7.70E-06	5.44E-05	91.3	800,000
7.080	6.20E-06	4.39E-05	91.2	1,000,000



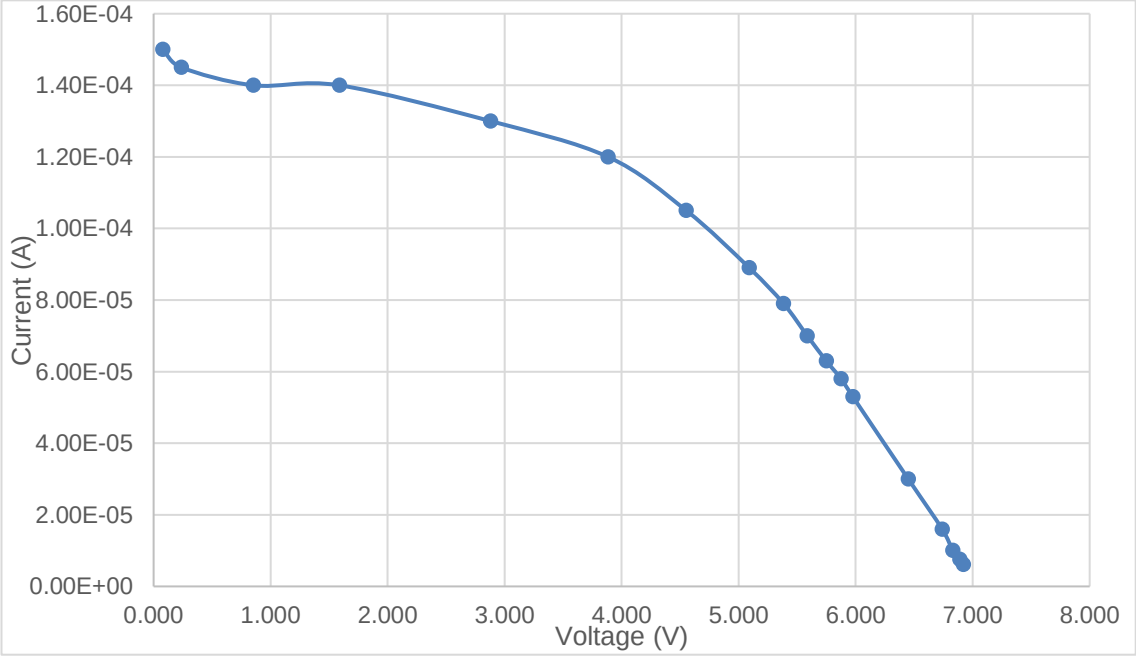
Kuvio 64. Voltage (V) vs Current (I) curve for panel ATCJ-I-53 3mm glass cover at 60°.



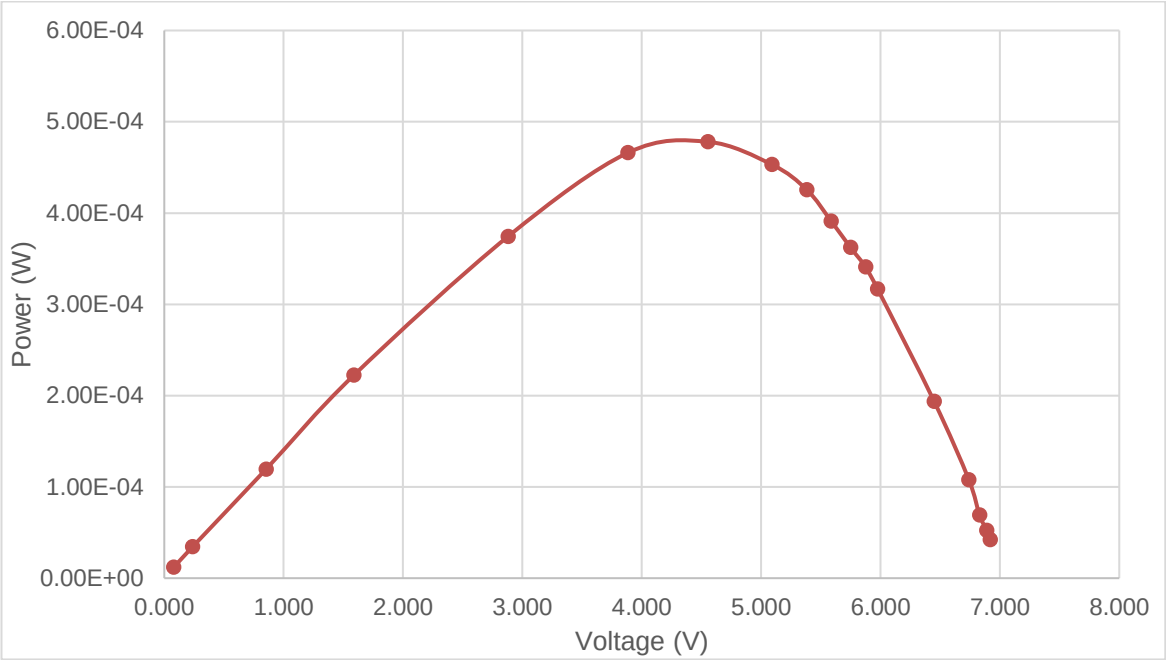
Kuvio 65. Voltage (V) vs Power (W) curve for panel ATCJ-I-53 with 3mm glass cover at 60°.

Taulukko 35. Results for panel ATCJ-I-53 with 3mm glass cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.079	1.50E-04	1.19E-05	77.2	-
0.237	1.45E-04	3.44E-05	77.7	1,000
0.853	1.40E-04	1.19E-04	77.6	5,000
1.588	1.40E-04	2.22E-04	77.5	10,000
2.880	1.30E-04	3.74E-04	77.5	20,000
3.884	1.20E-04	4.66E-04	77.5	30,000
4.553	1.05E-04	4.78E-04	77.3	40,000
5.091	8.90E-05	4.53E-04	77.3	50,000
5.384	7.90E-05	4.25E-04	77.8	60,000
5.587	7.00E-05	3.91E-04	77.7	70,000
5.749	6.30E-05	3.62E-04	77.8	80,000
5.876	5.80E-05	3.41E-04	77.8	90,000
5.976	5.30E-05	3.17E-04	77.6	100,000
6.450	3.00E-05	1.94E-04	77.5	200,000
6.740	1.60E-05	1.08E-04	77.7	400,000
6.830	1.01E-05	6.90E-05	77.6	600,000
6.890	7.60E-06	5.24E-05	77.7	800,000
6.920	6.10E-06	4.22E-05	77.8	1,000,000



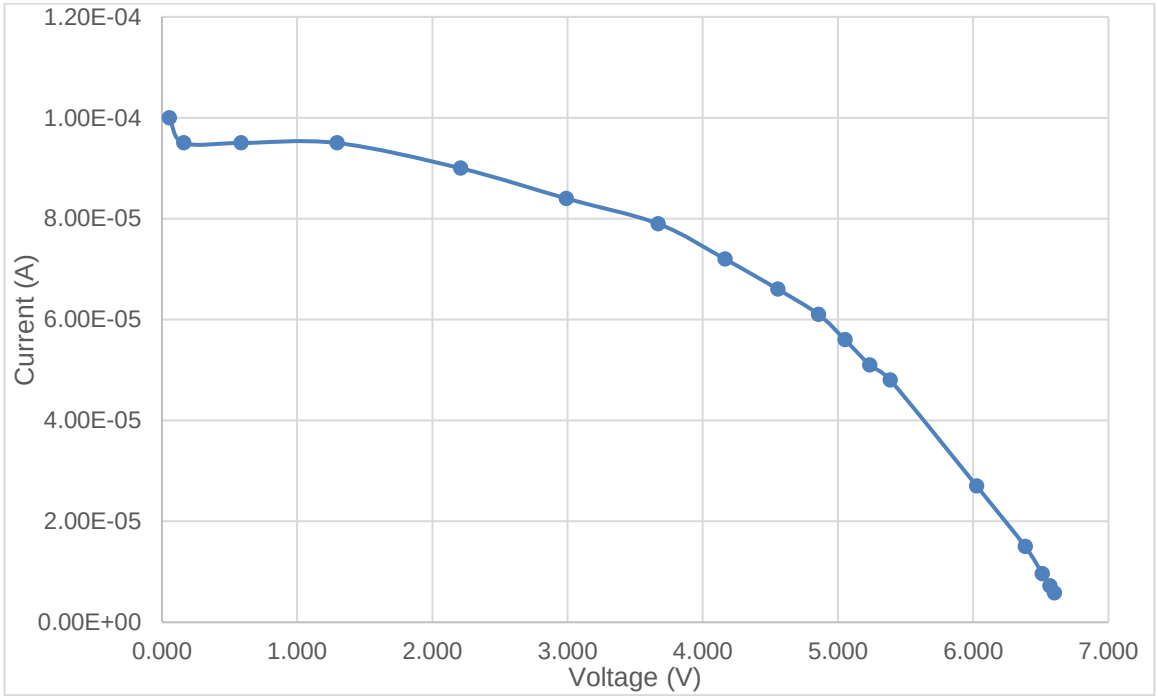
Kuvio 66. Voltage (V) vs Current (I) curve for panel ATCJ-I-53 3mm glass cover at 45°.



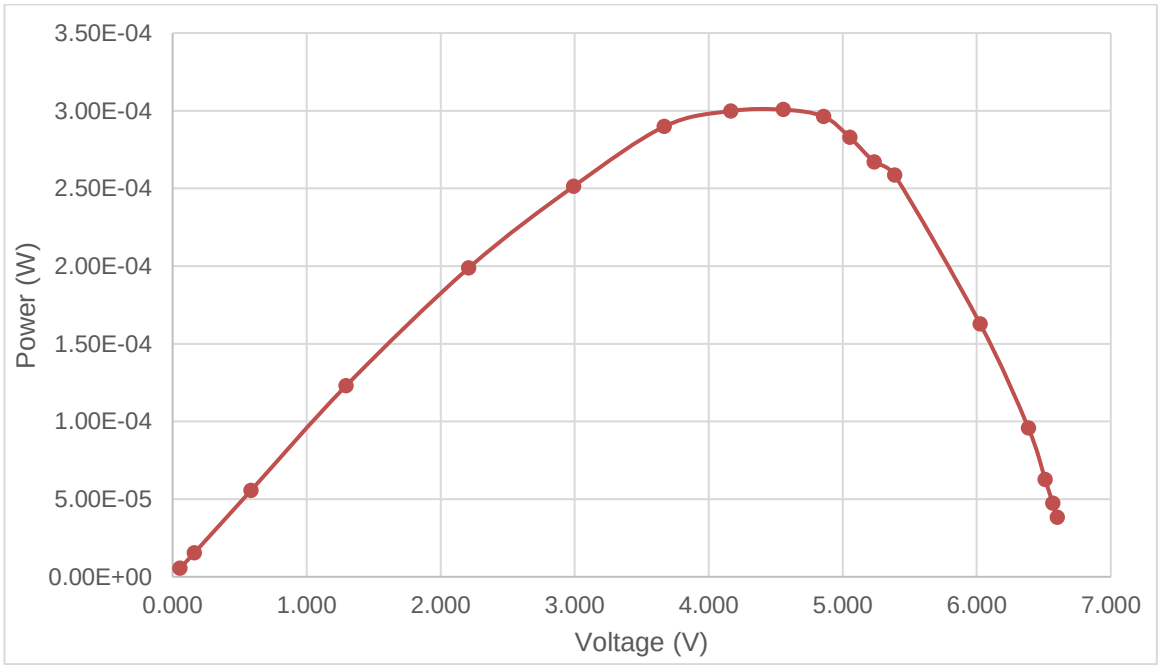
Kuvio 67. Voltage (V) vs Power (W) curve for panel ATCJ-I-53 with 3mm glass cover at 45°.

Taulukko 36. Results for panel ATCJ-I-53 with 3mm glass cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.054	1.00E-04	5.40E-06	59.5	-
0.162	9.50E-05	1.54E-05	59.7	1,000
0.584	9.50E-05	5.55E-05	59.6	5,000
1.295	9.50E-05	1.23E-04	59.6	10,000
2.208	9.00E-05	1.99E-04	59.7	20,000
2.991	8.40E-05	2.51E-04	59.2	30,000
3.669	7.90E-05	2.90E-04	59.5	40,000
4.164	7.20E-05	3.00E-04	59.4	50,000
4.556	6.60E-05	3.01E-04	59.6	60,000
4.857	6.10E-05	2.96E-04	59.5	70,000
5.052	5.60E-05	2.83E-04	59.4	80,000
5.235	5.10E-05	2.67E-04	59.4	90,000
5.387	4.80E-05	2.59E-04	59.4	100,000
6.026	2.70E-05	1.63E-04	59.4	200,000
6.385	1.50E-05	9.58E-05	59.6	400,000
6.511	9.60E-06	6.25E-05	59.5	600,000
6.567	7.20E-06	4.73E-05	59.5	800,000
6.600	5.80E-06	3.83E-05	59.4	1,000,000



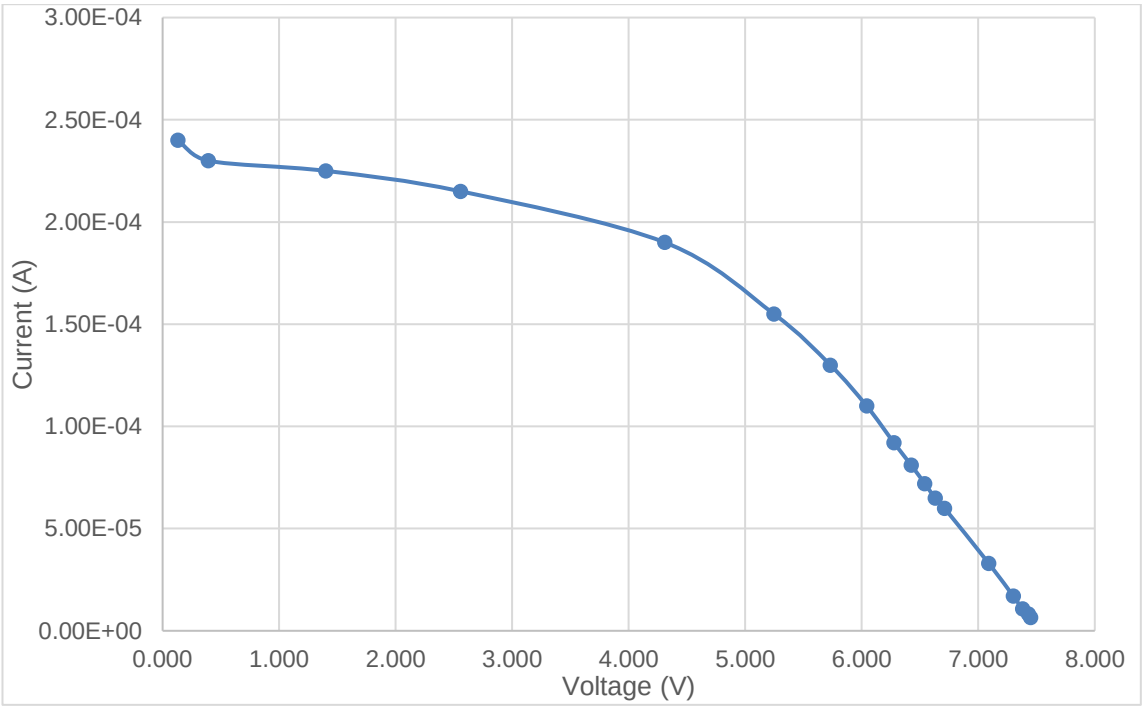
Kuvio 68. Voltage (V) vs Current (I) curve for panel ATCJ-I-53 3mm glass cover at 30°.



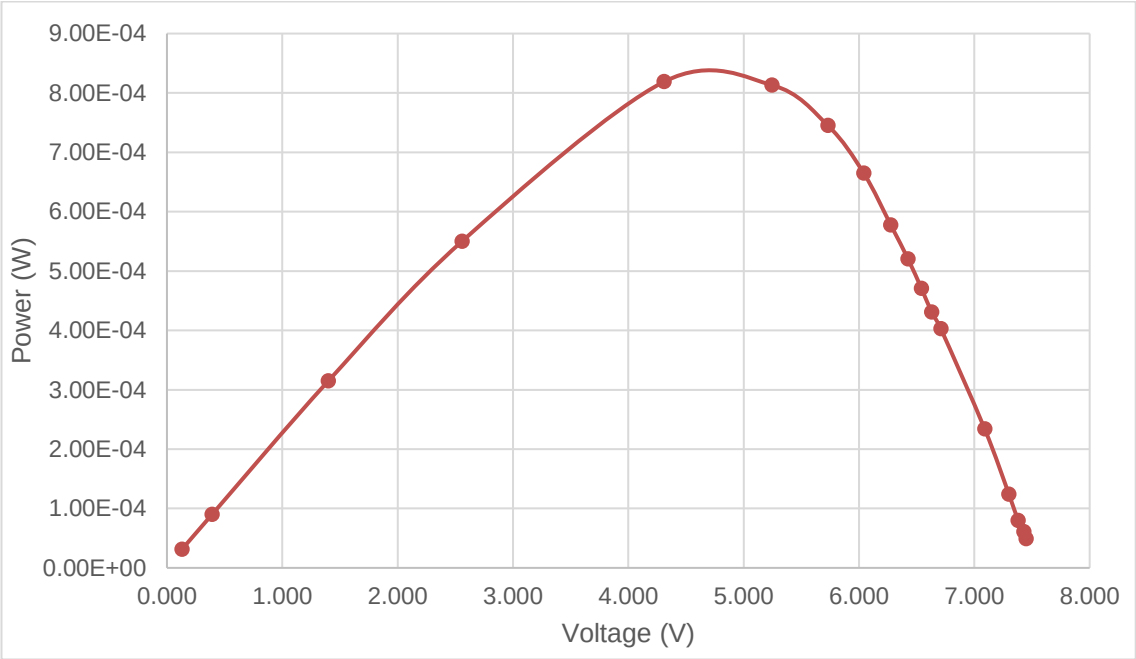
Kuvio 69. Voltage (V) vs Power (W) curve for panel ATCJ-I-53 with 3mm glass cover at 30°.

Taulukko 37. Results for panel ATCJ-I-53 with 6mm glass cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.131	2.40E-04	3.14E-05	100.7	-
0.391	2.30E-04	8.99E-05	101.4	1,000
1.400	2.25E-04	3.15E-04	101.6	5,000
2.558	2.15E-04	5.50E-04	101.2	10,000
4.310	1.90E-04	8.19E-04	101.0	20,000
5.246	1.55E-04	8.13E-04	101.7	30,000
5.731	1.30E-04	7.45E-04	101.7	40,000
6.042	1.10E-04	6.65E-04	101.5	50,000
6.276	9.20E-05	5.77E-04	101.7	60,000
6.425	8.10E-05	5.20E-04	101.6	70,000
6.541	7.20E-05	4.71E-04	101.9	80,000
6.630	6.50E-05	4.31E-04	101.8	90,000
6.710	6.00E-05	4.03E-04	101.4	100,000
7.090	3.30E-05	2.34E-04	102.0	200,000
7.300	1.70E-05	1.24E-04	101.8	400,000
7.380	1.08E-05	7.97E-05	101.4	600,000
7.430	8.20E-06	6.09E-05	101.8	800,000
7.450	6.60E-06	4.92E-05	102.0	1,000,000



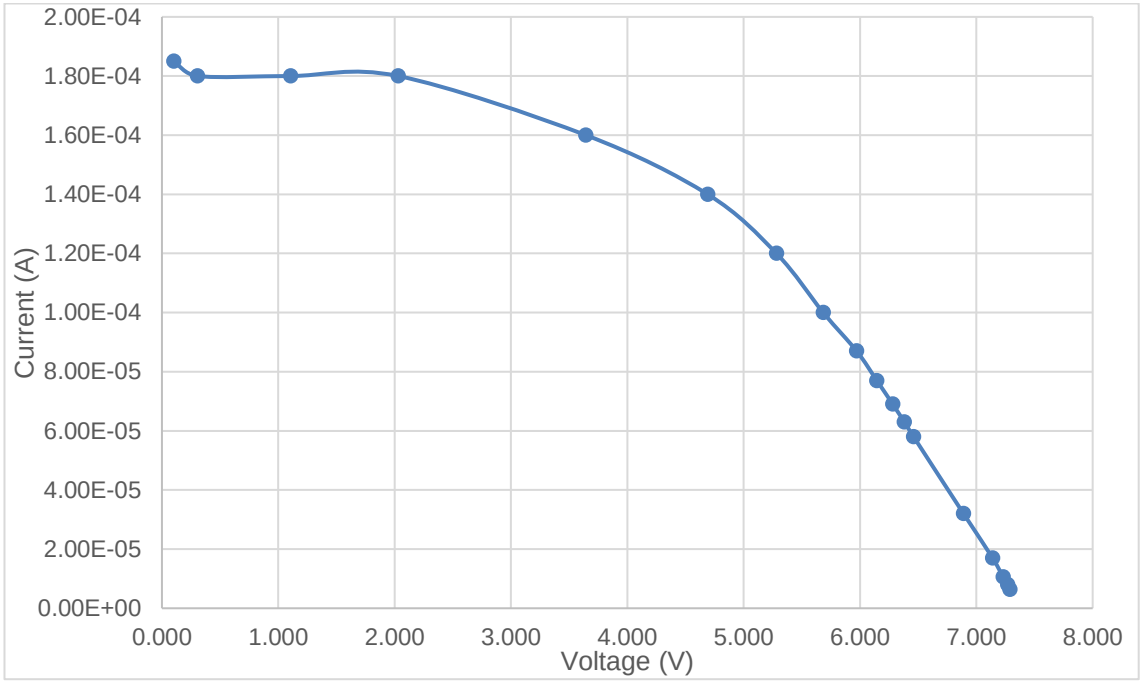
Kuvio 70. Voltage (V) vs Current (I) curve for panel ATCJ-I-53 6mm glass cover at 90°.



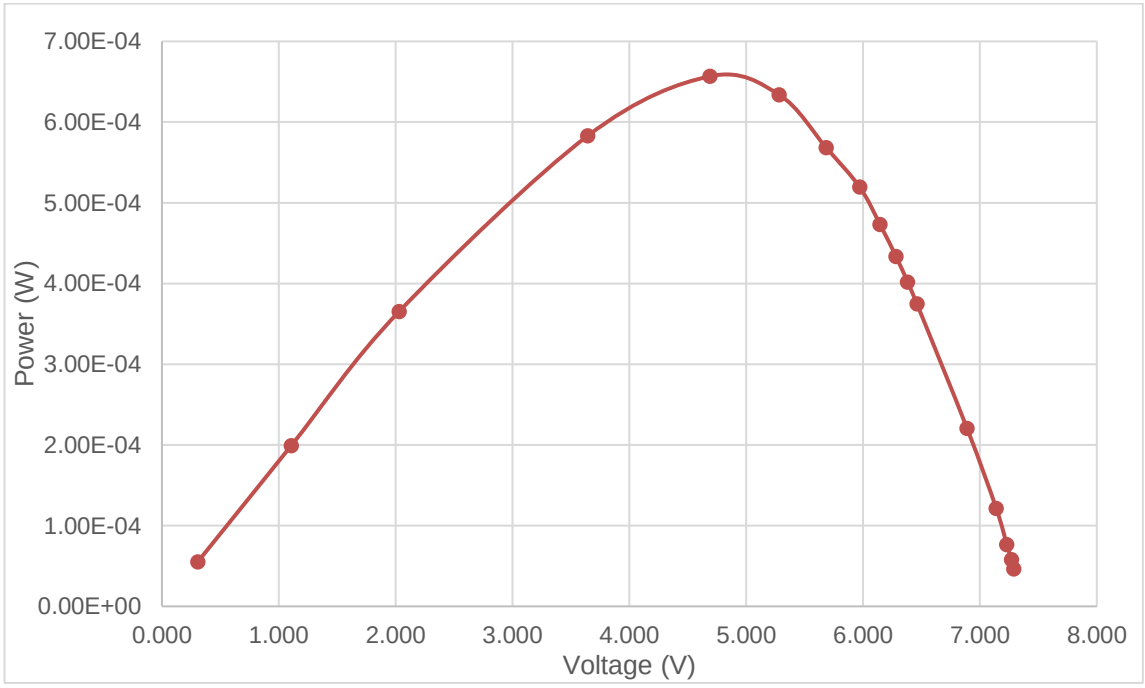
Kuvio 71. Voltage (V) vs Power (W) curve for panel ATCJ-I-53 with 6mm glass cover at 90°.

Taulukko 38. Results for panel ATCJ-I-53 with 6mm glass cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.102	1.85E-04	1.89E-05	93.0	-
0.307	1.80E-04	5.53E-05	93.9	1,000
1.107	1.80E-04	1.99E-04	94.1	5,000
2.030	1.80E-04	3.65E-04	93.7	10,000
3.644	1.60E-04	5.83E-04	93.7	20,000
4.691	1.40E-04	6.57E-04	93.6	30,000
5.282	1.20E-04	6.34E-04	93.6	40,000
5.684	1.00E-04	5.68E-04	93.8	50,000
5.971	8.70E-05	5.19E-04	93.7	60,000
6.145	7.70E-05	4.73E-04	93.9	70,000
6.282	6.90E-05	4.33E-04	93.8	80,000
6.381	6.30E-05	4.02E-04	93.9	90,000
6.461	5.80E-05	3.75E-04	93.8	100,000
6.890	3.20E-05	2.20E-04	93.3	200,000
7.140	1.70E-05	1.21E-04	93.9	400,000
7.230	1.06E-05	7.66E-05	94.1	600,000
7.270	8.00E-06	5.82E-05	94.1	800,000
7.290	6.40E-06	4.67E-05	93.8	1,000,000



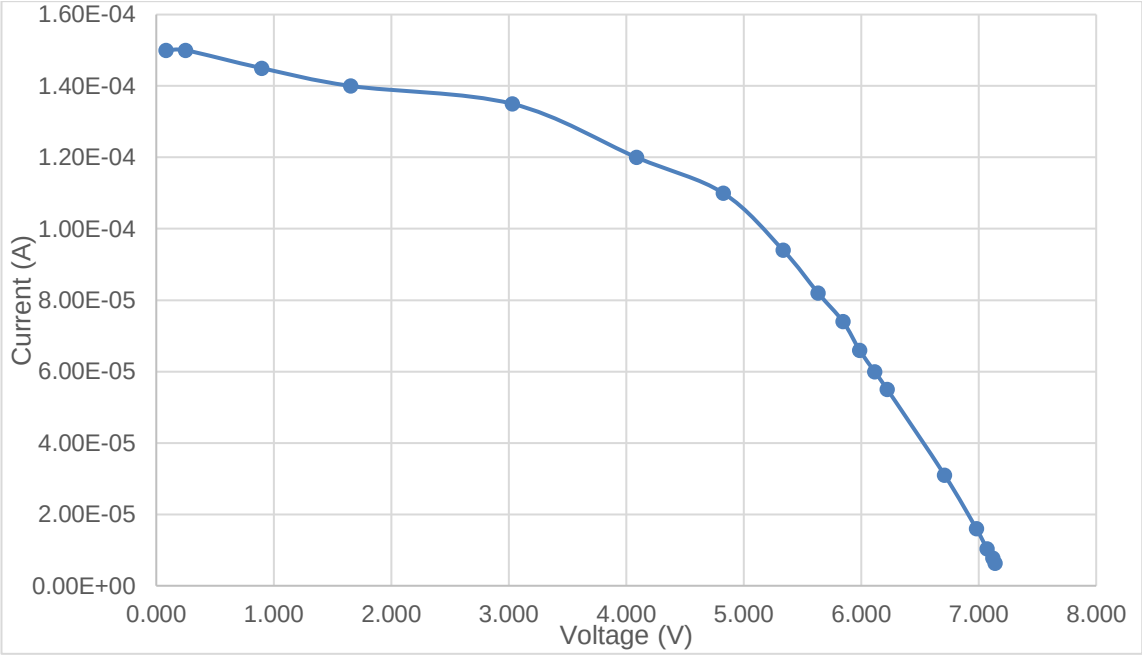
Kuvio 72. Voltage (V) vs Current (I) curve for panel ATCJ-I-53 6mm glass cover at 60°.



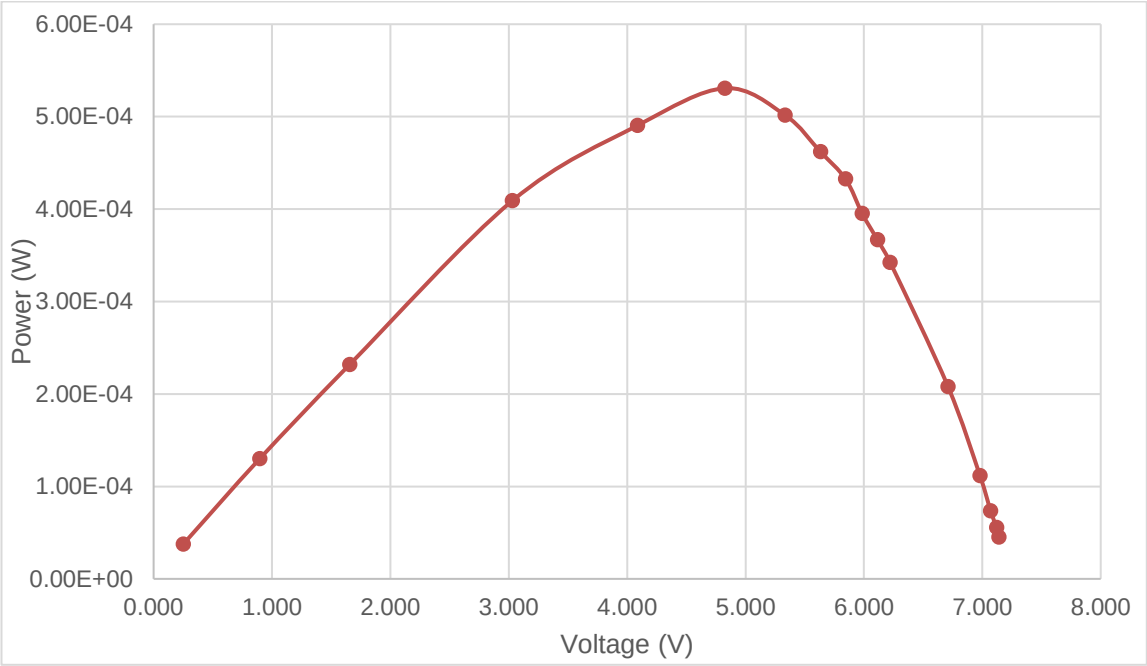
Kuvio 73. Voltage (V) vs Power (W) curve for panel ATCJ-I-53 with 6mm glass cover at 60°.

Taulukko 39. Results for panel ATCJ-I-53 with 6mm glass cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.083	1.50E-04	1.25E-05	80.9	-
0.250	1.50E-04	3.75E-05	81.1	1,000
0.897	1.45E-04	1.30E-04	81.2	5,000
1.656	1.40E-04	2.32E-04	80.8	10,000
3.030	1.35E-04	4.09E-04	80.9	20,000
4.087	1.20E-04	4.90E-04	80.7	30,000
4.825	1.10E-04	5.31E-04	81.0	40,000
5.335	9.40E-05	5.01E-04	80.5	50,000
5.633	8.20E-05	4.62E-04	81.1	60,000
5.845	7.40E-05	4.33E-04	81.3	70,000
5.986	6.60E-05	3.95E-04	80.6	80,000
6.114	6.00E-05	3.67E-04	80.9	90,000
6.222	5.50E-05	3.42E-04	80.4	100,000
6.710	3.10E-05	2.08E-04	81.0	200,000
6.980	1.60E-05	1.12E-04	81.2	400,000
7.070	1.04E-05	7.35E-05	81.4	600,000
7.120	7.80E-06	5.55E-05	81.2	800,000
7.140	6.30E-06	4.50E-05	81.0	1,000,000



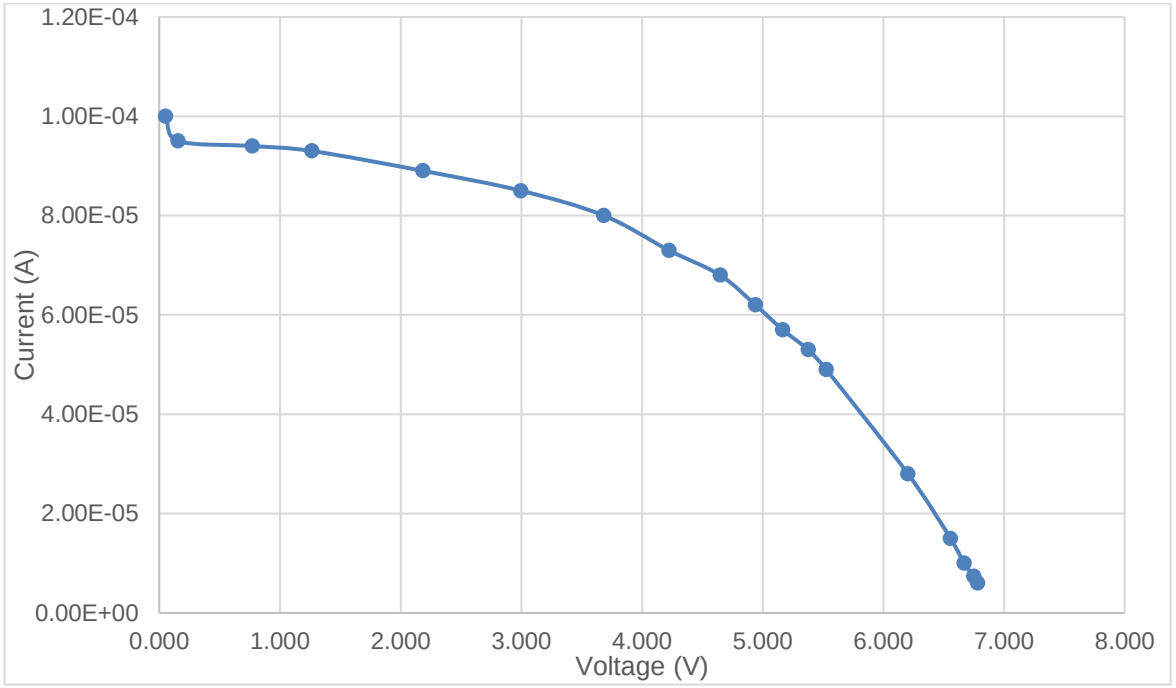
Kuvio 74. Voltage (V) vs Current (I) curve for panel ATCJ-I-53 6mm glass cover at 45°.



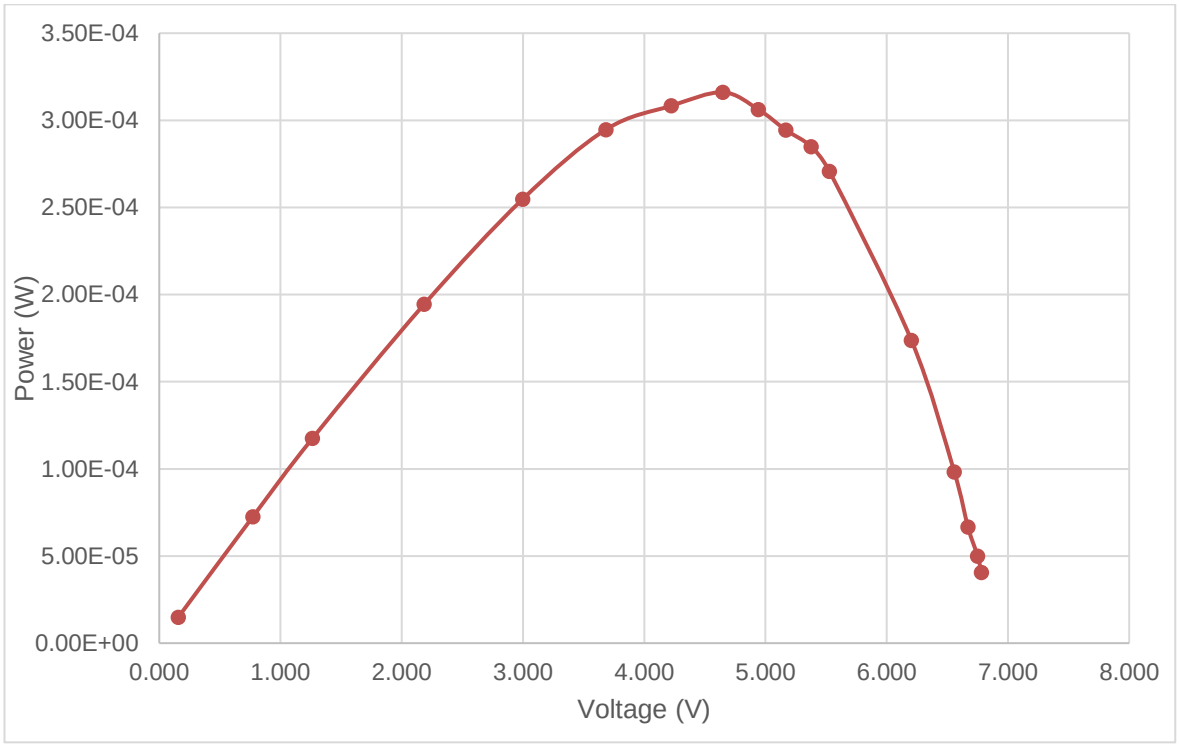
Kuvio 75. Voltage (V) vs Power (W) curve for panel ATCJ-I-53 with 6mm glass cover at 45°.

Taulukko 40. Results for panel ATCJ-I-53 with 6mm glass cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.052	1.00E-04	5.20E-06	62.0	-
0.156	9.50E-05	1.48E-05	61.9	1,000
0.771	9.40E-05	7.25E-05	62.3	5,000
1.264	9.30E-05	1.18E-04	62.0	10,000
2.185	8.90E-05	1.94E-04	62.2	20,000
2.997	8.50E-05	2.55E-04	62.1	30,000
3.684	8.00E-05	2.95E-04	62.2	40,000
4.224	7.30E-05	3.08E-04	62.3	50,000
4.648	6.80E-05	3.16E-04	61.8	60,000
4.940	6.20E-05	3.06E-04	62.2	70,000
5.167	5.70E-05	2.95E-04	62.0	80,000
5.377	5.30E-05	2.85E-04	62.3	90,000
5.527	4.90E-05	2.71E-04	62.2	100,000
6.204	2.80E-05	1.74E-04	62.2	200,000
6.557	1.50E-05	9.84E-05	61.8	400,000
6.670	1.00E-05	6.67E-05	61.8	600,000
6.750	7.40E-06	5.00E-05	62.1	800,000
6.780	6.00E-06	4.07E-05	62.0	1,000,000



Kuvio 76. Voltage (V) vs Current (I) curve for panel ATCJ-I-53 6mm glass cover at 30°.

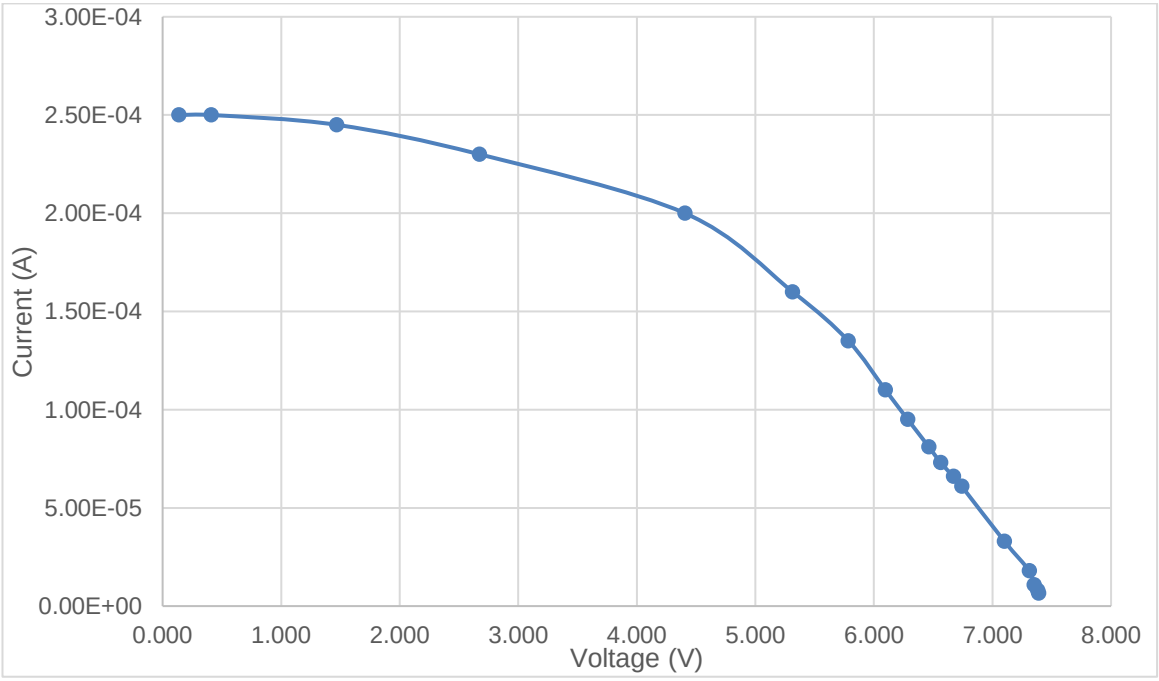


Kuvio 77. Voltage (V) vs Power (W) curve for panel ATCJ-I-53 with 6mm glass cover at 30°.

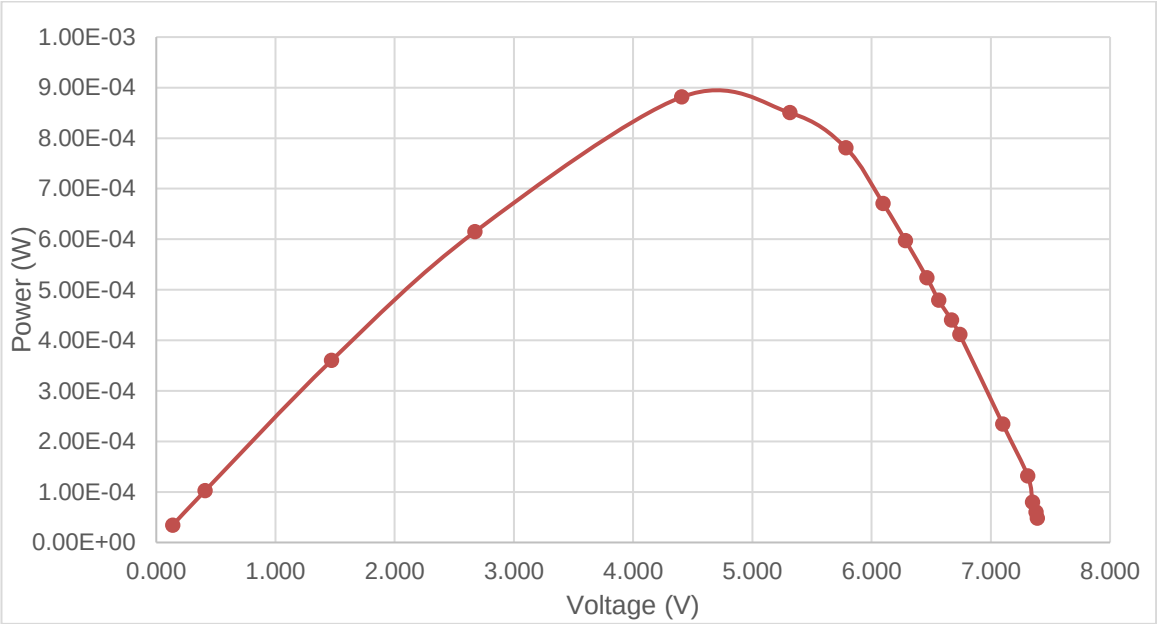
Apendix 4: Panel I_054

Taulukko 41. Results for panel ATCJ-I-54 with no cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.137	2.50E-04	3.43E-05	99.8	-
0.410	2.50E-04	1.03E-04	100.1	1,000
1.469	2.45E-04	3.60E-04	100.0	5,000
2.673	2.30E-04	6.15E-04	100.4	10,000
4.406	2.00E-04	8.81E-04	99.9	20,000
5.314	1.60E-04	8.50E-04	99.5	30,000
5.784	1.35E-04	7.81E-04	100.0	40,000
6.097	1.10E-04	6.71E-04	100.3	50,000
6.285	9.50E-05	5.97E-04	100.0	60,000
6.464	8.10E-05	5.24E-04	100.1	70,000
6.563	7.30E-05	4.79E-04	99.2	80,000
6.670	6.60E-05	4.40E-04	100.3	90,000
6.740	6.10E-05	4.11E-04	100.2	100,000
7.100	3.30E-05	2.34E-04	100.2	200,000
7.310	1.80E-05	1.32E-04	100.7	400,000
7.350	1.08E-05	7.94E-05	100.8	600,000
7.380	8.10E-06	5.98E-05	99.8	800,000
7.390	6.50E-06	4.80E-05	100.4	1,000,000



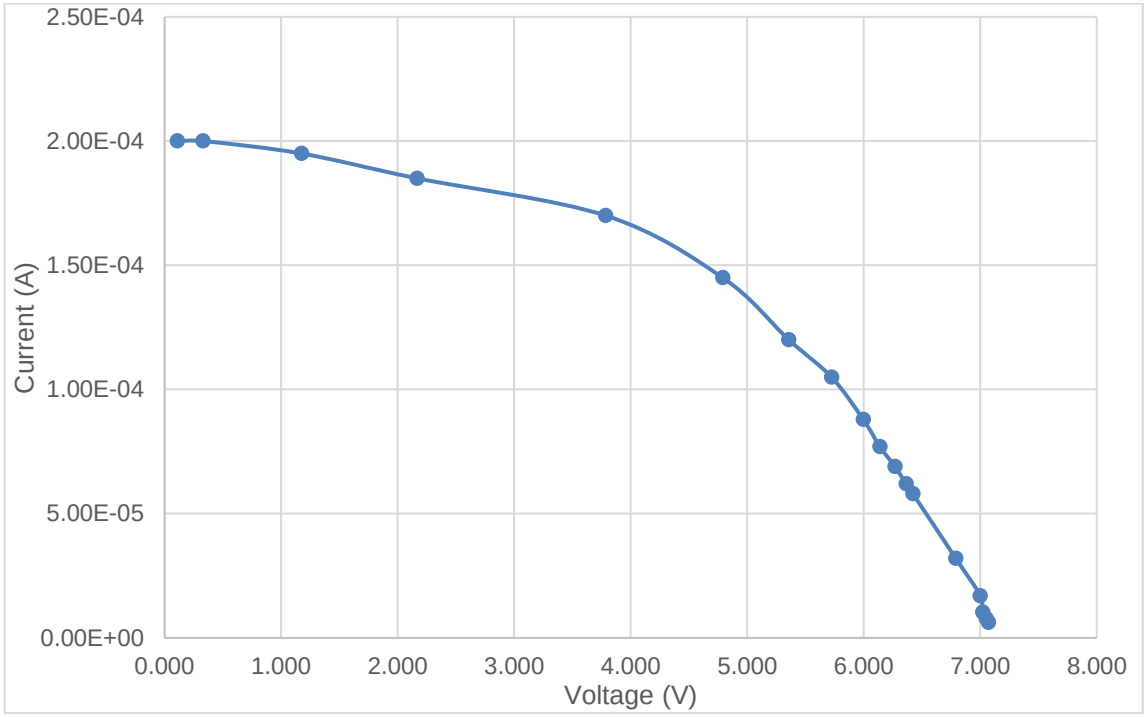
Kuvio 78. Voltage (V) vs Current (I) curve for panel ATCJ-I-54 with no cover at 90°.



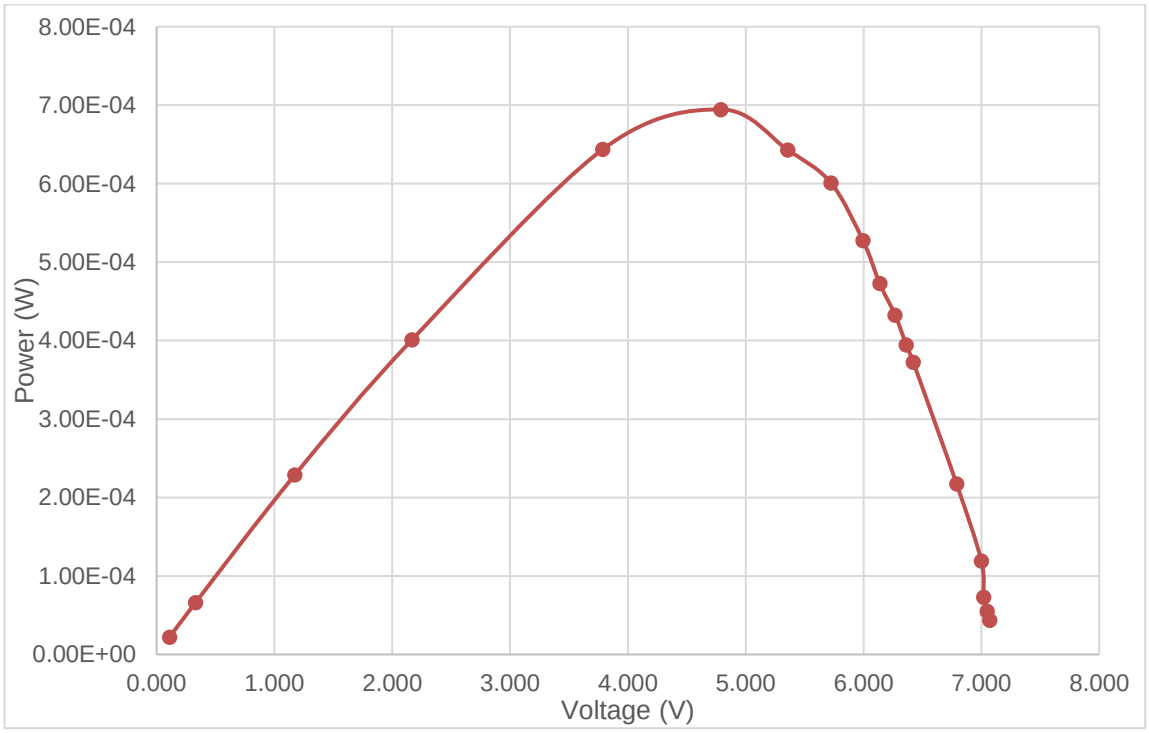
Kuvio 79. Voltage (V) vs Power (W) curve for panel ATCJ-I-54 with no cover at 90°.

Taulukko 42. Results for panel ATCJ-I-54 with no cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.110	2.00E-04	2.20E-05	90.9	-
0.330	2.00E-04	6.60E-05	90.9	1,000
1.174	1.95E-04	2.29E-04	90.2	5,000
2.167	1.85E-04	4.01E-04	90.8	10,000
3.786	1.70E-04	6.44E-04	90.8	20,000
4.790	1.45E-04	6.95E-04	90.8	30,000
5.357	1.20E-04	6.43E-04	90.4	40,000
5.723	1.05E-04	6.01E-04	90.4	50,000
5.995	8.80E-05	5.28E-04	90.7	60,000
6.138	7.70E-05	4.73E-04	90.4	70,000
6.268	6.90E-05	4.32E-04	90.8	80,000
6.363	6.20E-05	3.95E-04	90.6	90,000
6.422	5.80E-05	3.72E-04	90.7	100,000
6.790	3.20E-05	2.17E-04	90.4	200,000
7.000	1.70E-05	1.19E-04	90.3	400,000
7.020	1.04E-05	7.30E-05	90.7	600,000
7.050	7.80E-06	5.50E-05	90.8	800,000
7.070	6.20E-06	4.38E-05	90.6	1,000,000



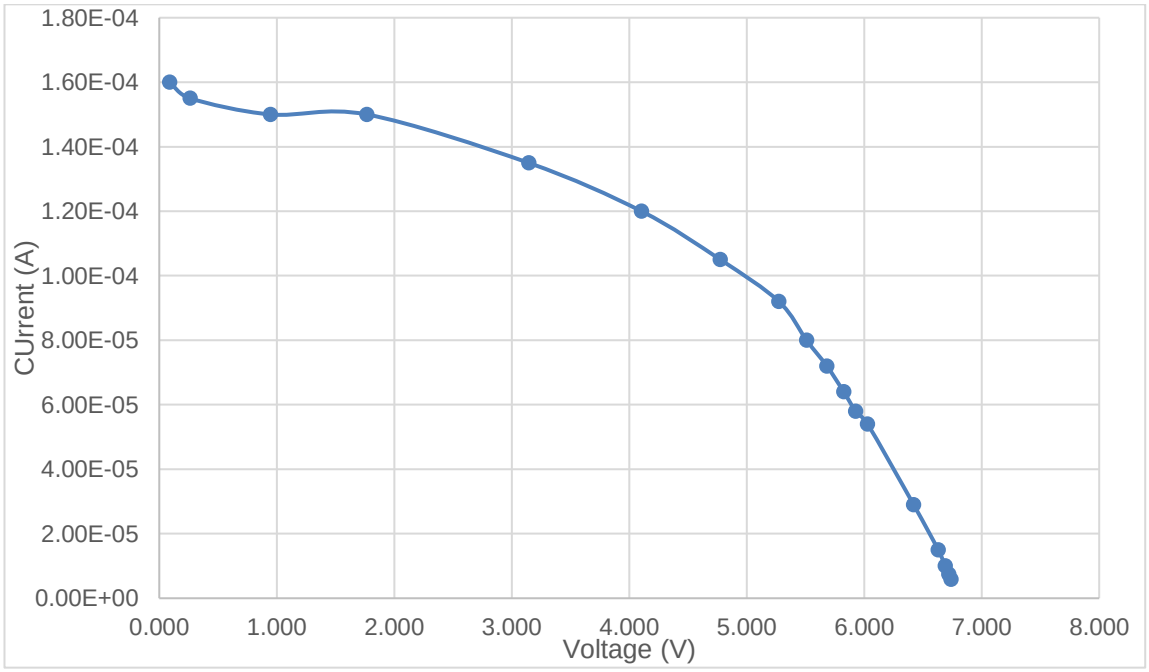
Kuvio 80. Voltage (V) vs Current (I) curve for panel ATCJ-I-54 with no cover at 60°.



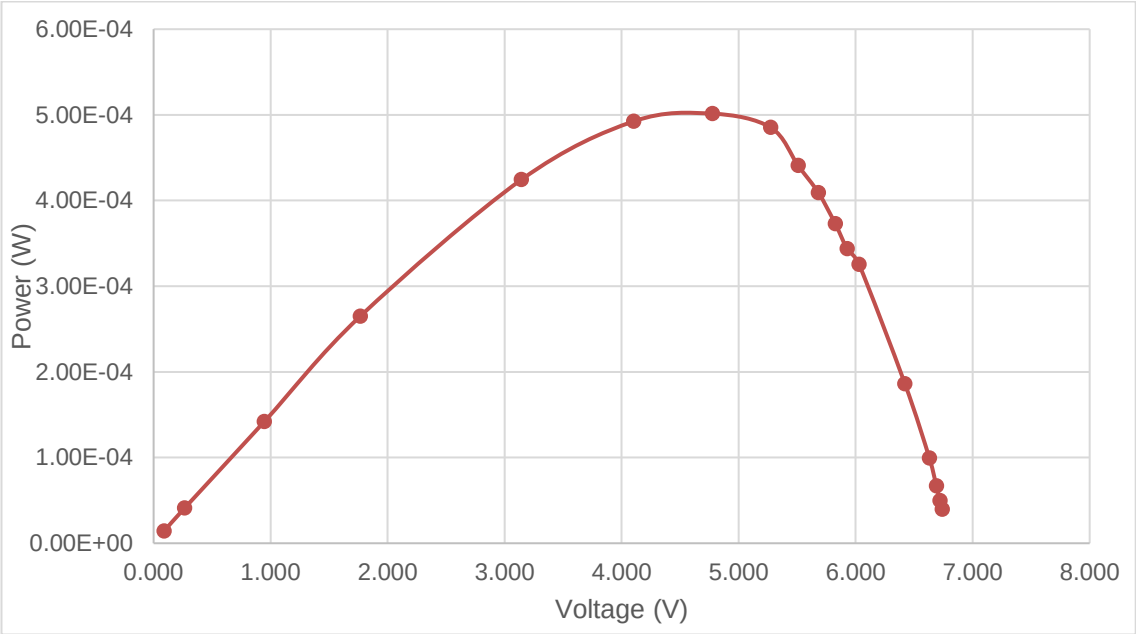
Kuvio 81. Voltage (V) vs Power (W) curve for panel ATCJ-I-54 with no cover at 60°.

Taulukko 43. Results for panel ATCJ-I-54 with no cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.089	1.60E-04	1.42E-05	76.8	-
0.264	1.55E-04	4.09E-05	76.6	1,000
0.947	1.50E-04	1.42E-04	76.4	5,000
1.767	1.50E-04	2.65E-04	76.8	10,000
3.144	1.35E-04	4.24E-04	76.6	20,000
4.104	1.20E-04	4.92E-04	76.7	30,000
4.775	1.05E-04	5.01E-04	76.2	40,000
5.274	9.20E-05	4.85E-04	76.9	50,000
5.509	8.00E-05	4.41E-04	77.1	60,000
5.682	7.20E-05	4.09E-04	76.9	70,000
5.826	6.40E-05	3.73E-04	76.5	80,000
5.927	5.80E-05	3.44E-04	77.0	90,000
6.029	5.40E-05	3.26E-04	76.9	100,000
6.421	2.90E-05	1.86E-04	76.8	200,000
6.630	1.50E-05	9.95E-05	77.0	400,000
6.690	1.00E-05	6.69E-05	76.7	600,000
6.720	7.40E-06	4.97E-05	76.6	800,000
6.740	5.90E-06	3.98E-05	77.0	1,000,000



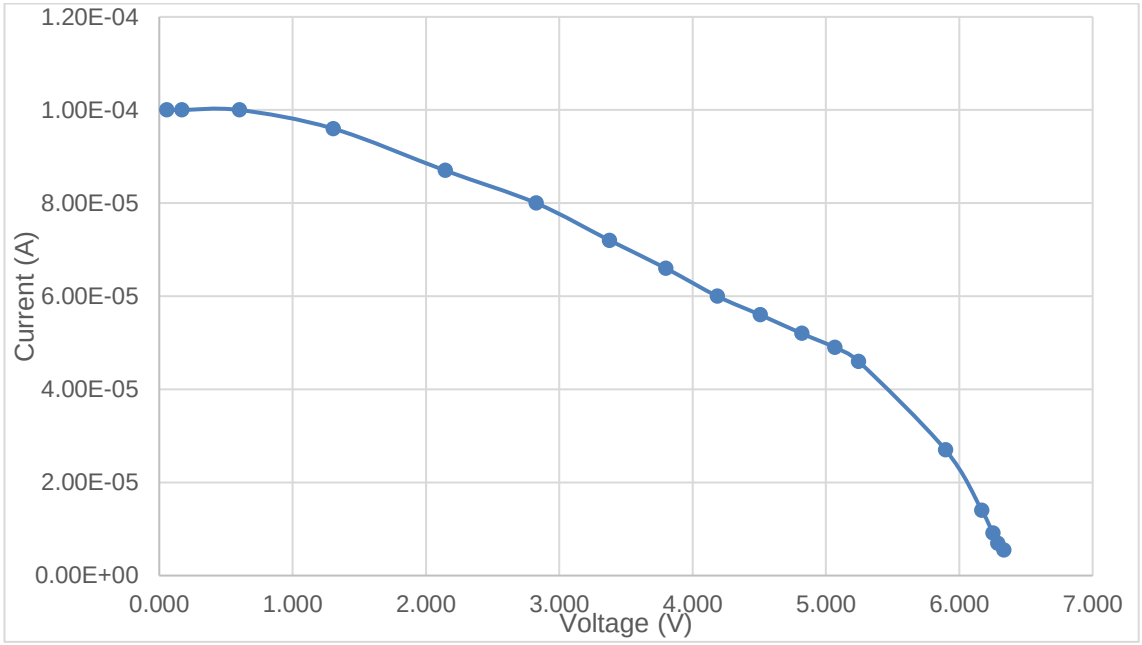
Kuvio 82. Voltage (V) vs Current (I) curve for panel ATCJ-I-54 with no cover at 45°.



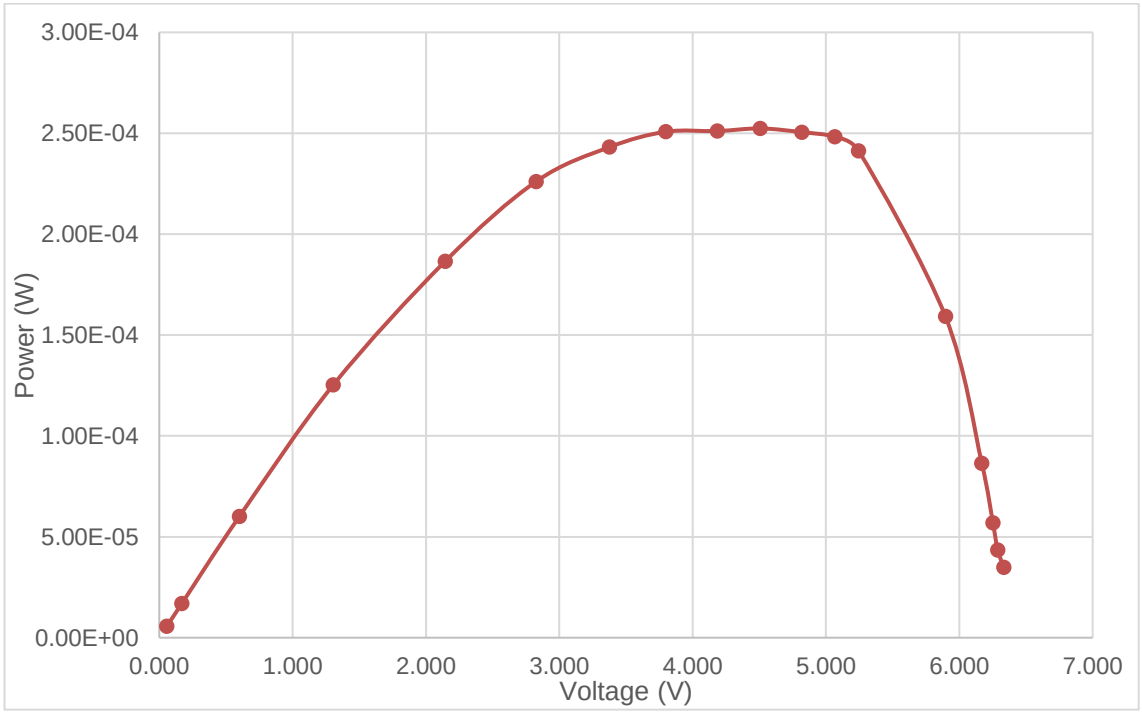
Kuvio 83. Voltage (V) vs Power (W) curve for panel ATCJ-I-54 with no cover at 45°.

Taulukko 44. Results for panel ATCJ-I-54 with no cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.056	1.00E-04	5.60E-06	58.6	-
0.169	1.00E-04	1.69E-05	58.8	1,000
0.601	1.00E-04	6.01E-05	58.9	5,000
1.305	9.60E-05	1.25E-04	59.1	10,000
2.144	8.70E-05	1.87E-04	58.8	20,000
2.826	8.00E-05	2.26E-04	58.2	30,000
3.377	7.20E-05	2.43E-04	59.0	40,000
3.799	6.60E-05	2.51E-04	58.7	50,000
4.185	6.00E-05	2.51E-04	58.9	60,000
4.507	5.60E-05	2.52E-04	58.7	70,000
4.818	5.20E-05	2.51E-04	59.1	80,000
5.066	4.90E-05	2.48E-04	58.6	90,000
5.245	4.60E-05	2.41E-04	59.2	100,000
5.896	2.70E-05	1.59E-04	58.9	200,000
6.169	1.40E-05	8.64E-05	59.2	400,000
6.252	9.10E-06	5.69E-05	59.0	600,000
6.288	6.90E-06	4.34E-05	58.7	800,000
6.334	5.50E-06	3.48E-05	59.2	1,000,000



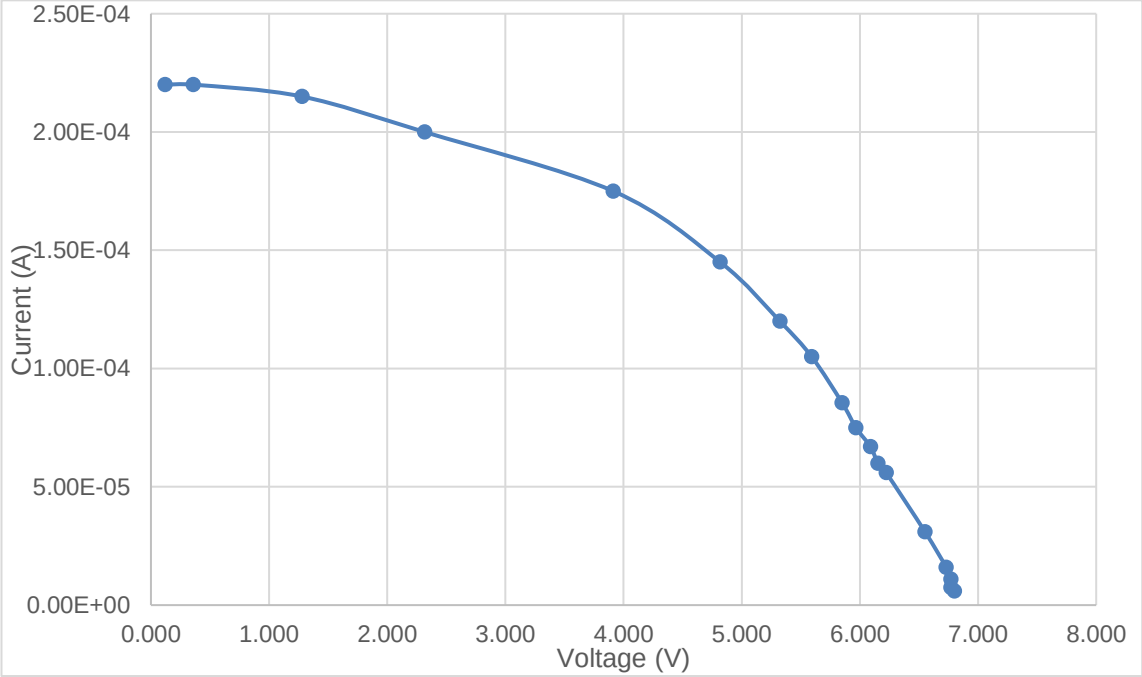
Kuvio 84. Voltage (V) vs Current (I) curve for panel ATCJ-I-54 with no cover at 30°.



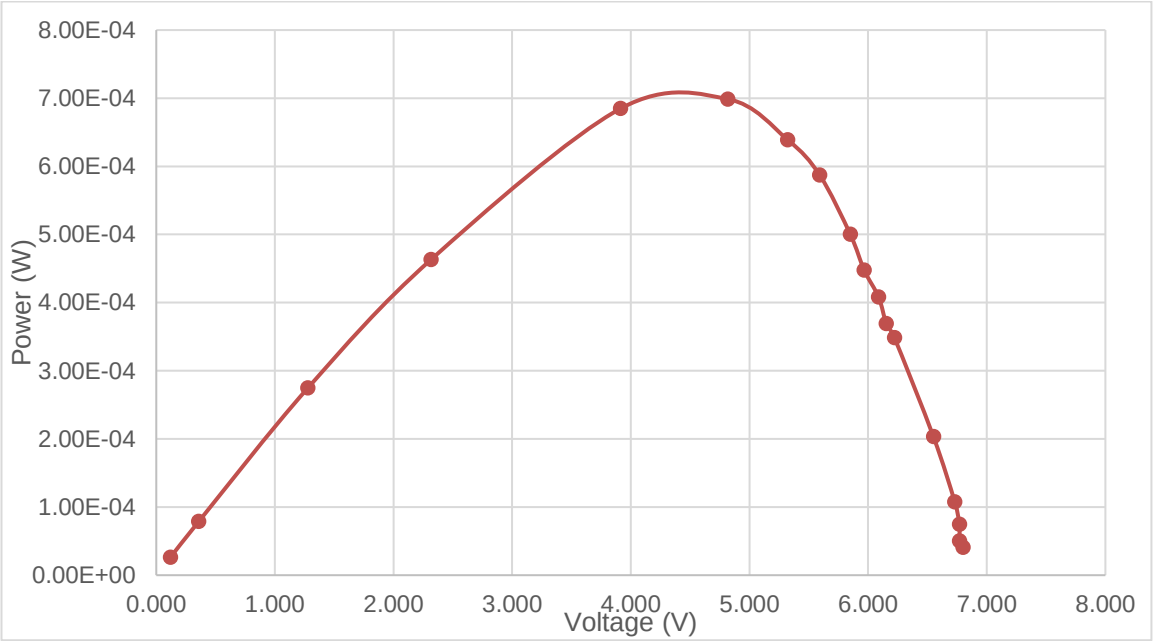
Kuvio 85. Voltage (V) vs Power (W) curve for panel ATCJ-I-54 with no cover at 30°.

Taulukko 45. Results for panel ATCJ-I-54 with polycarbonate cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.120	2.20E-04	2.64E-05	99.7	-
0.358	2.20E-04	7.88E-05	99.3	1,000
1.278	2.15E-04	2.75E-04	99.7	5,000
2.316	2.00E-04	4.63E-04	99.8	10,000
3.913	1.75E-04	6.85E-04	99.5	20,000
4.818	1.45E-04	6.99E-04	99.2	30,000
5.323	1.20E-04	6.39E-04	99.2	40,000
5.592	1.05E-04	5.87E-04	98.4	50,000
5.850	8.55E-05	5.00E-04	99.7	60,000
5.967	7.50E-05	4.48E-04	99.3	70,000
6.089	6.70E-05	4.08E-04	99.5	80,000
6.153	6.00E-05	3.69E-04	99.4	90,000
6.222	5.60E-05	3.48E-04	98.9	100,000
6.551	3.10E-05	2.03E-04	99.2	200,000
6.730	1.60E-05	1.08E-04	99.4	400,000
6.770	1.10E-05	7.45E-05	99.2	600,000
6.770	7.40E-06	5.01E-05	99.0	800,000
6.800	6.00E-06	4.08E-05	99.0	1,000,000



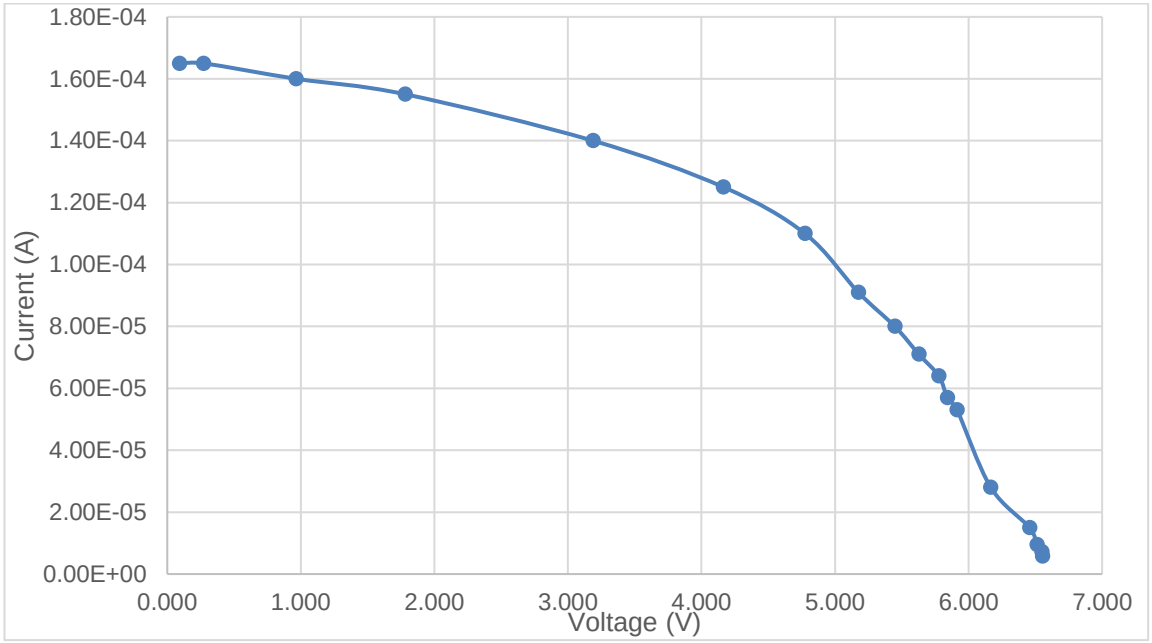
Kuvio 86. Voltage (V) vs Current (I) curve for panel ATCJ-I-54 polycarbonate cover at 90°.



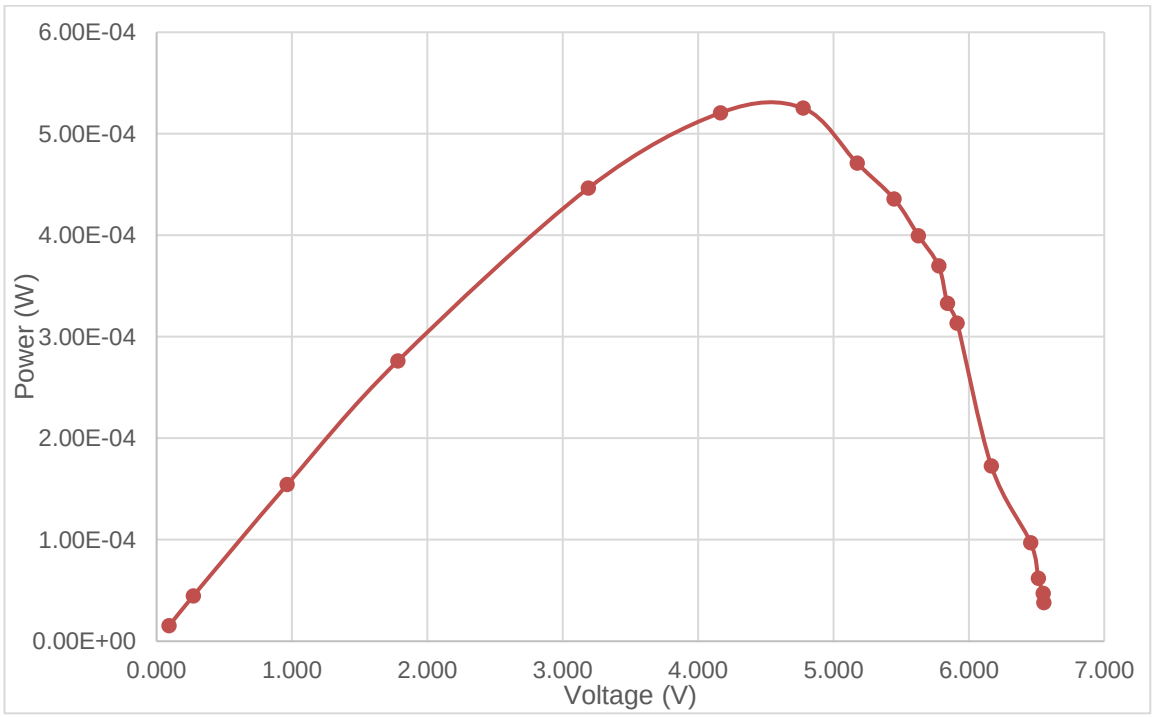
Kuvio 87. Voltage (V) vs Power (W) curve for panel ATCJ-I-54 with polycarbonate cover at 90°.

Taulukko 46. Results for panel ATCJ-I-54 with polycarbonate cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.092	1.65E-04	1.52E-05	90.3	-
0.271	1.65E-04	4.47E-05	89.6	1,000
0.965	1.60E-04	1.54E-04	90.1	5,000
1.782	1.55E-04	2.76E-04	88.8	10,000
3.188	1.40E-04	4.46E-04	90.1	20,000
4.165	1.25E-04	5.21E-04	90.1	30,000
4.775	1.10E-04	5.25E-04	90.1	40,000
5.175	9.10E-05	4.71E-04	89.9	50,000
5.448	8.00E-05	4.36E-04	89.4	60,000
5.628	7.10E-05	4.00E-04	90.0	70,000
5.777	6.40E-05	3.70E-04	90.1	80,000
5.841	5.70E-05	3.33E-04	90.4	90,000
5.914	5.30E-05	3.13E-04	90.6	100,000
6.166	2.80E-05	1.73E-04	90.5	200,000
6.457	1.50E-05	9.69E-05	90.5	400,000
6.514	9.50E-06	6.19E-05	90.1	600,000
6.549	7.20E-06	4.72E-05	90.4	800,000
6.554	5.80E-06	3.80E-05	90.6	1,000,000



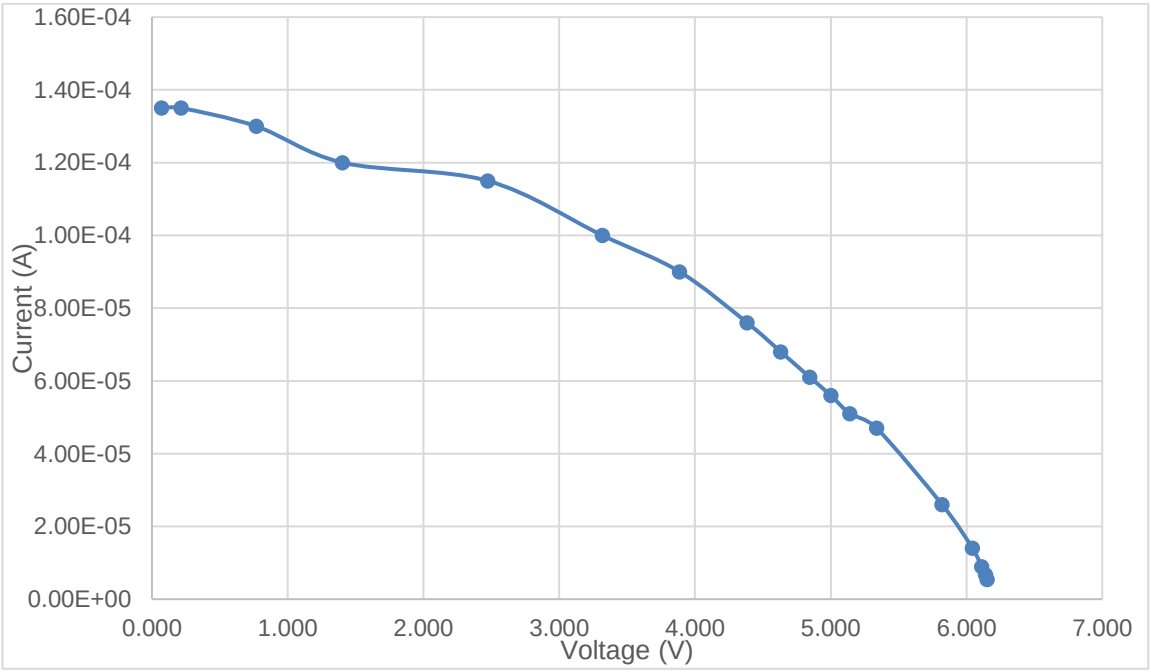
Kuvio 88. Voltage (V) vs Current (I) curve for panel ATCJ-I-54 polycarbonate cover at 60°.



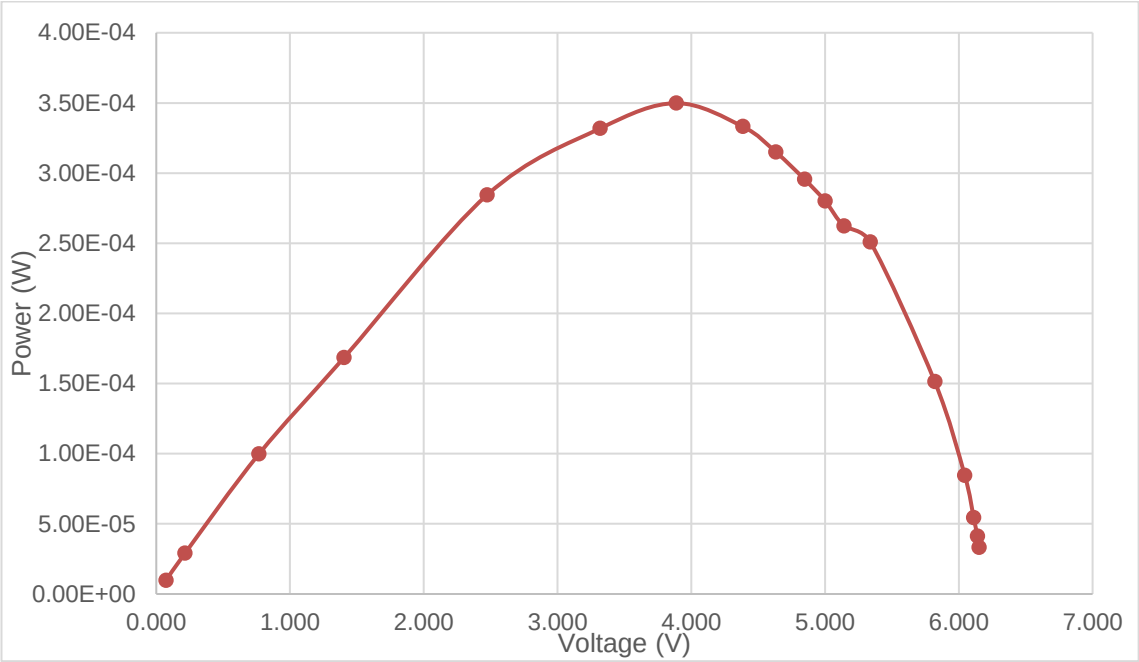
Kuvio 89. Voltage (V) vs Power (W) curve for panel ATCJ-I-54 with polycarbonate cover at 60°.

Taulukko 47. Results for panel ATCJ-I-54 with polycarbonate cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.072	1.35E-04	9.72E-06	78.8	-
0.215	1.35E-04	2.90E-05	78.5	1,000
0.768	1.30E-04	9.98E-05	78.3	5,000
1.404	1.20E-04	1.68E-04	78.2	10,000
2.473	1.15E-04	2.84E-04	79.2	20,000
3.318	1.00E-04	3.32E-04	78.4	30,000
3.887	9.00E-05	3.50E-04	79.0	40,000
4.384	7.60E-05	3.33E-04	78.6	50,000
4.632	6.80E-05	3.15E-04	78.9	60,000
4.846	6.10E-05	2.96E-04	78.4	70,000
5.001	5.60E-05	2.80E-04	78.8	80,000
5.141	5.10E-05	2.62E-04	79.1	90,000
5.338	4.70E-05	2.51E-04	78.7	100,000
5.820	2.60E-05	1.51E-04	78.7	200,000
6.044	1.40E-05	8.46E-05	78.7	400,000
6.111	8.90E-06	5.44E-05	78.6	600,000
6.139	6.70E-06	4.11E-05	78.5	800,000
6.152	5.40E-06	3.32E-05	78.3	1,000,000



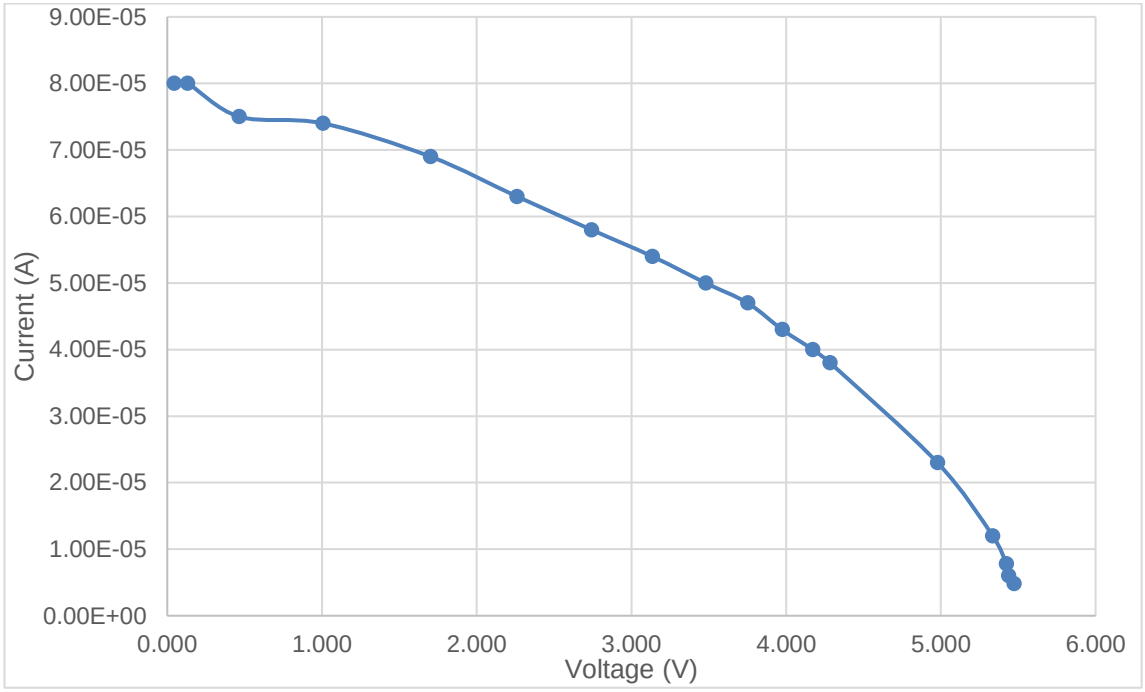
Kuvio 90. Voltage (V) vs Current (I) curve for panel ATCJ-I-54 polycarbonate cover at 45°.



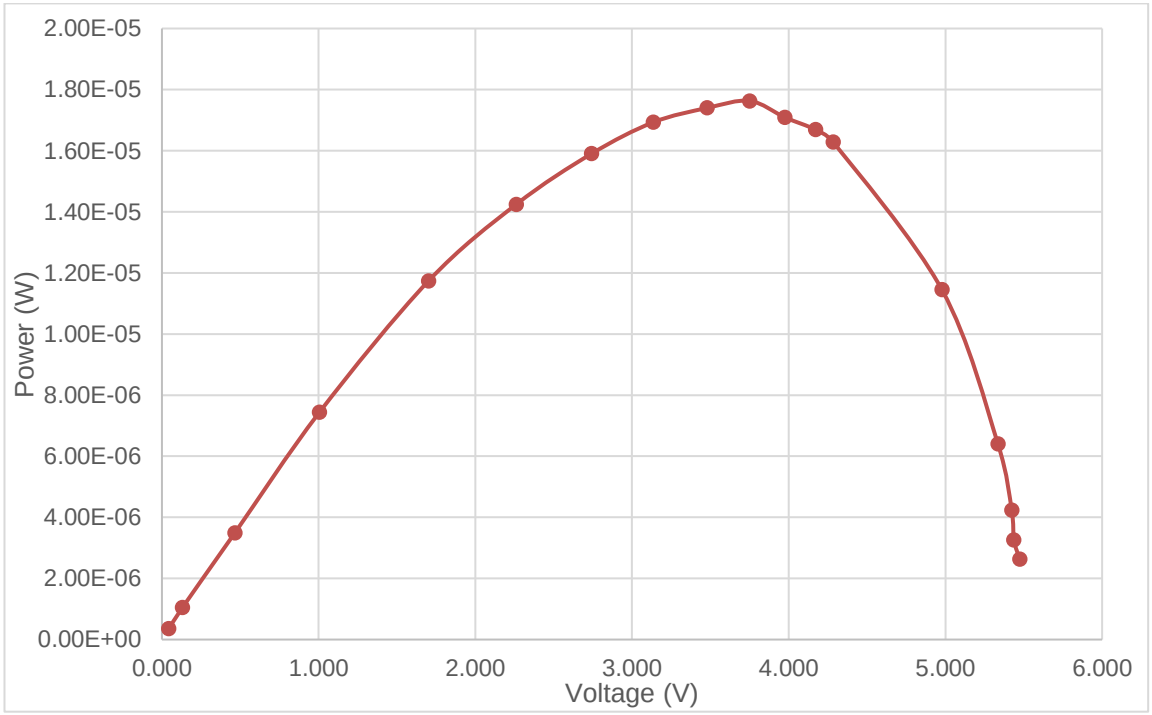
Kuvio 91. Voltage (V) vs Power (W) curve for panel ATCJ-I-54 with polycarbonate cover at 45°.

Taulukko 48. Results for panel ATCJ-I-54 with polycarbonate cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.044	8.00E-05	3.52E-06	62.9	-
0.131	8.00E-05	1.05E-05	61.8	1,000
0.465	7.50E-05	3.49E-05	61.4	5,000
1.006	7.40E-05	7.44E-05	61.3	10,000
1.701	6.90E-05	1.17E-04	62.0	20,000
2.261	6.30E-05	1.42E-04	61.7	30,000
2.742	5.80E-05	1.59E-04	61.8	40,000
3.135	5.40E-05	1.69E-04	61.8	50,000
3.480	5.00E-05	1.74E-04	61.2	60,000
3.751	4.70E-05	1.76E-04	61.7	70,000
3.975	4.30E-05	1.71E-04	61.7	80,000
4.172	4.00E-05	1.67E-04	61.6	90,000
4.284	3.80E-05	1.63E-04	61.7	100,000
4.978	2.30E-05	1.14E-04	61.8	200,000
5.335	1.20E-05	6.40E-05	61.8	400,000
5.423	7.80E-06	4.23E-05	61.7	600,000
5.437	6.00E-06	3.26E-05	61.2	800,000
5.474	4.80E-06	2.63E-05	61.4	1,000,000



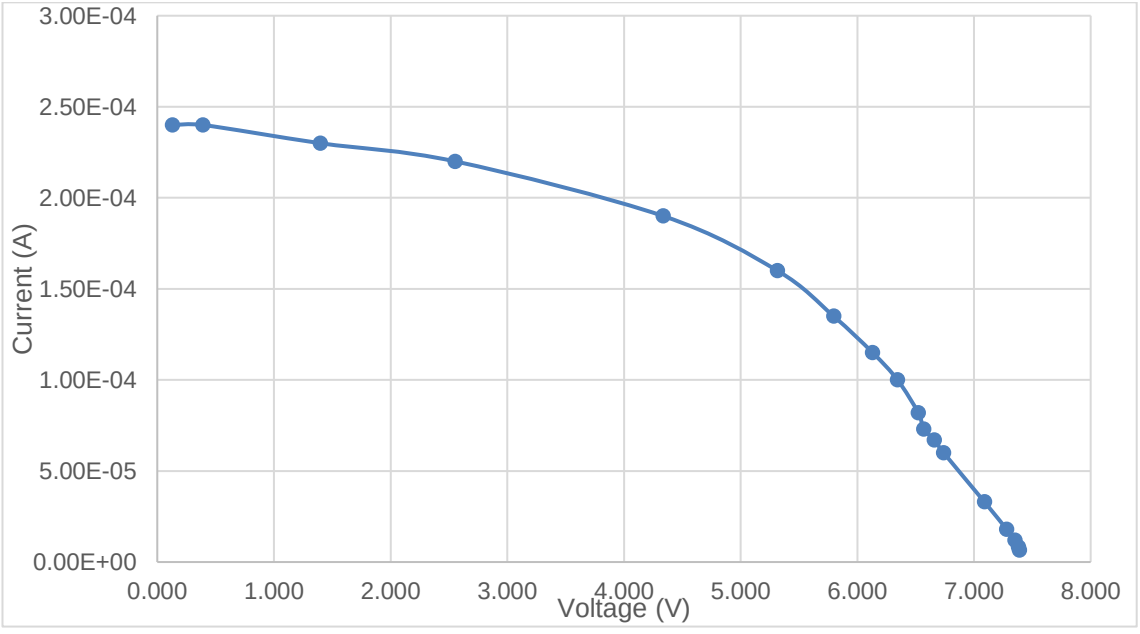
Kuvio 92. Voltage (V) vs Current (I) curve for panel ATCJ-I-54 polycarbonate cover at 30°.



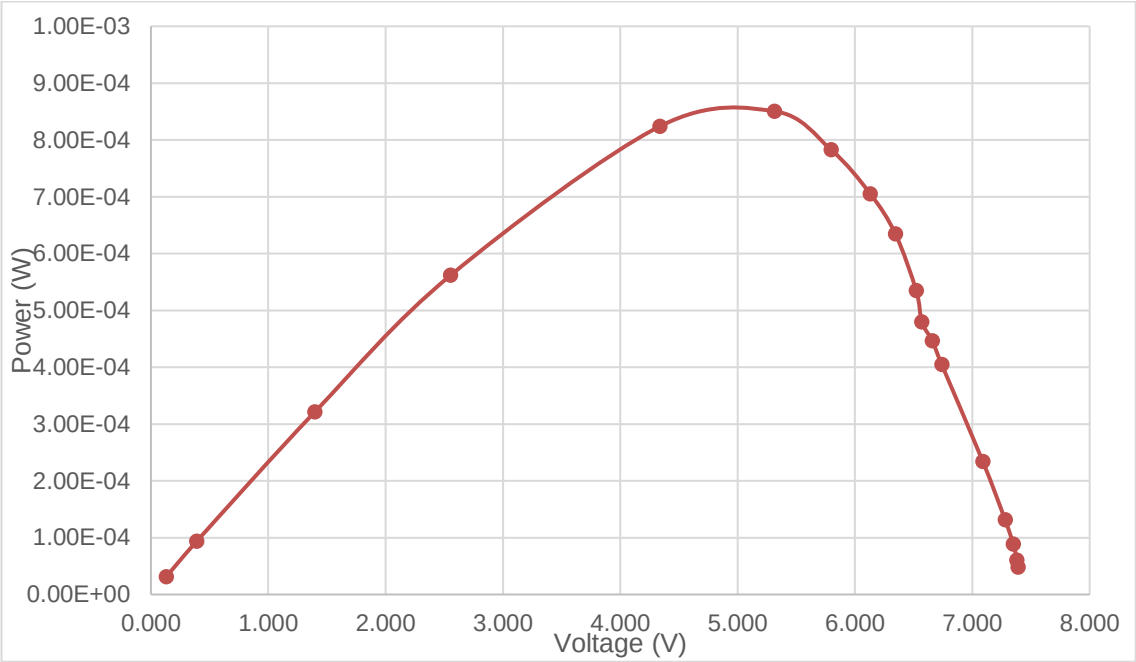
Kuvio 93. Voltage (V) vs Power (W) curve for panel ATCJ-I-54 with polycarbonate cover at 30°.

Taulukko 49. Results for panel ATCJ-I-54 with 3mm glass cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.130	2.40E-04	3.12E-05	100.1	-
0.390	2.40E-04	9.36E-05	99.8	1,000
1.397	2.30E-04	3.21E-04	100.5	5,000
2.554	2.20E-04	5.62E-04	100.0	10,000
4.337	1.90E-04	8.24E-04	100.2	20,000
5.315	1.60E-04	8.50E-04	100.5	30,000
5.797	1.35E-04	7.83E-04	99.8	40,000
6.131	1.15E-04	7.05E-04	100.2	50,000
6.345	1.00E-04	6.35E-04	100.4	60,000
6.522	8.20E-05	5.35E-04	100.3	70,000
6.570	7.30E-05	4.80E-04	100.5	80,000
6.660	6.70E-05	4.46E-04	100.8	90,000
6.740	6.00E-05	4.04E-04	100.9	100,000
7.090	3.30E-05	2.34E-04	100.8	200,000
7.280	1.80E-05	1.31E-04	101.2	400,000
7.350	1.20E-05	8.82E-05	101.2	600,000
7.380	8.20E-06	6.05E-05	101.0	800,000
7.390	6.50E-06	4.80E-05	100.8	1,000,000



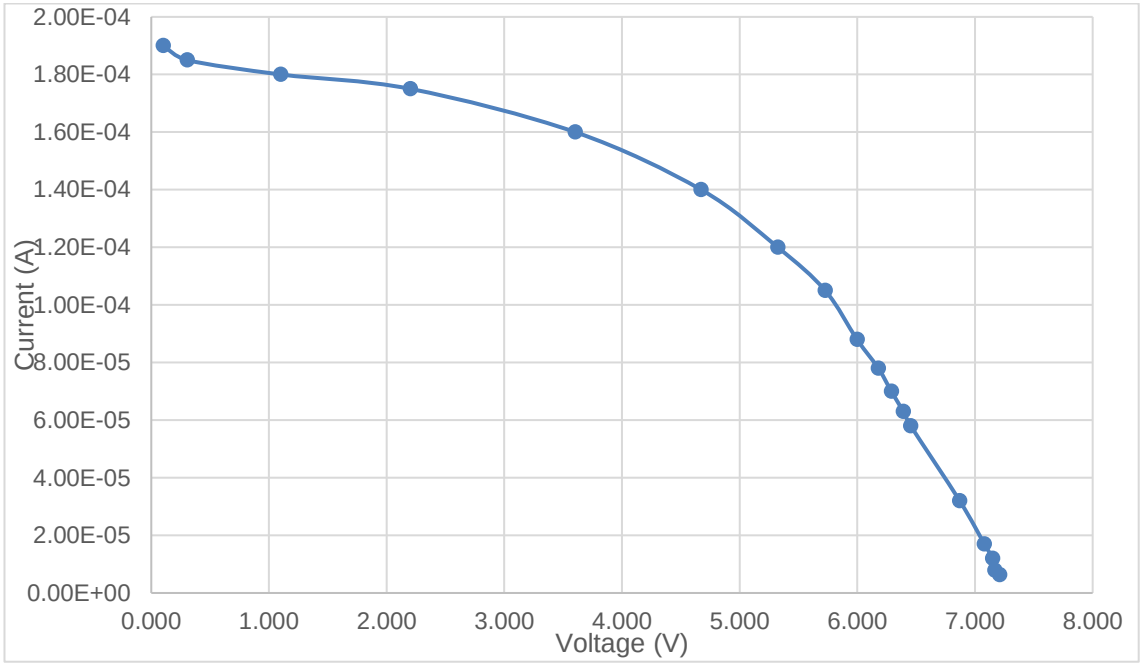
Kuvio 94. Voltage (V) vs Current (I) curve for panel ATCJ-I-54 3mm glass cover at 90°.



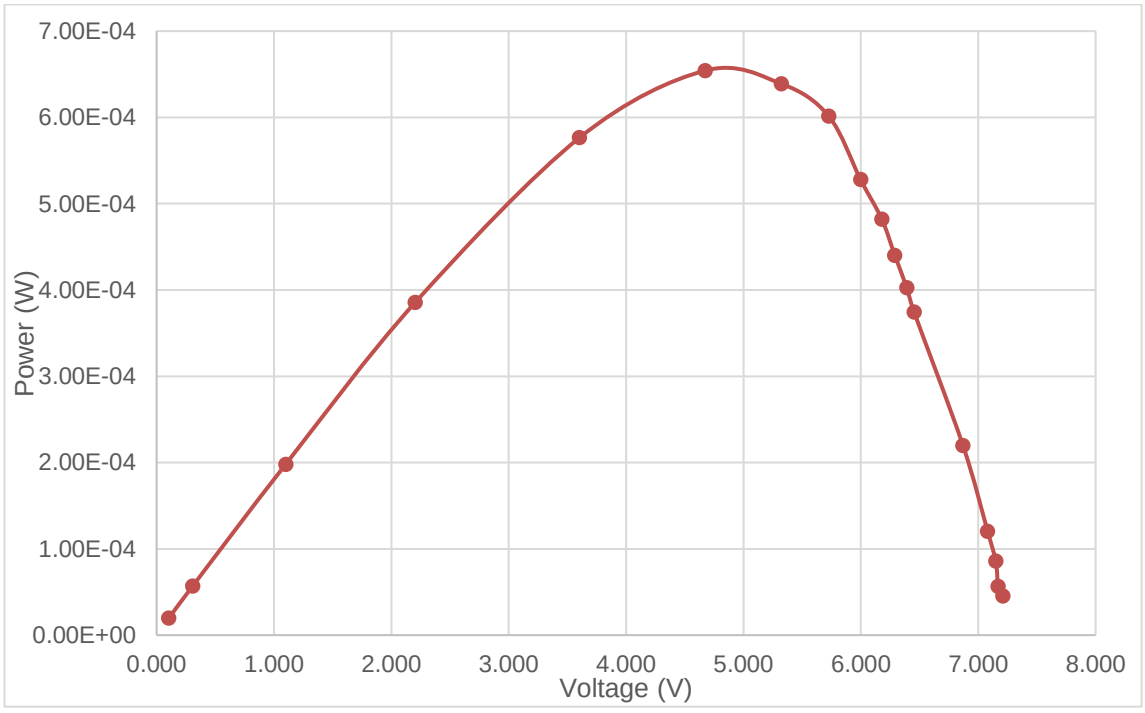
Kuvio 95. Voltage (V) vs Power (W) curve for panel ATCJ-I-54 with 3mm glass cover at 90°.

Taulukko 50. Results for panel ATCJ-I-54 with 3mm glass cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.103	1.90E-04	1.96E-05	87.5	-
0.307	1.85E-04	5.68E-05	87.6	1,000
1.100	1.80E-04	1.98E-04	87.7	5,000
2.203	1.75E-04	3.85E-04	87.5	10,000
3.603	1.60E-04	5.76E-04	87.6	20,000
4.673	1.40E-04	6.54E-04	87.6	30,000
5.324	1.20E-04	6.39E-04	87.1	40,000
5.727	1.05E-04	6.01E-04	87.9	50,000
5.998	8.80E-05	5.28E-04	87.4	60,000
6.179	7.80E-05	4.82E-04	87.9	70,000
6.289	7.00E-05	4.40E-04	87.6	80,000
6.391	6.30E-05	4.03E-04	87.4	90,000
6.454	5.80E-05	3.74E-04	87.8	100,000
6.870	3.20E-05	2.20E-04	87.5	200,000
7.080	1.70E-05	1.20E-04	87.7	400,000
7.150	1.20E-05	8.58E-05	87.9	600,000
7.170	7.90E-06	5.66E-05	87.2	800,000
7.210	6.30E-06	4.54E-05	87.7	1,000,000



Kuvio 96. Voltage (V) vs Current (I) curve for panel ATCJ-I-54 3mm glass cover at 60°.

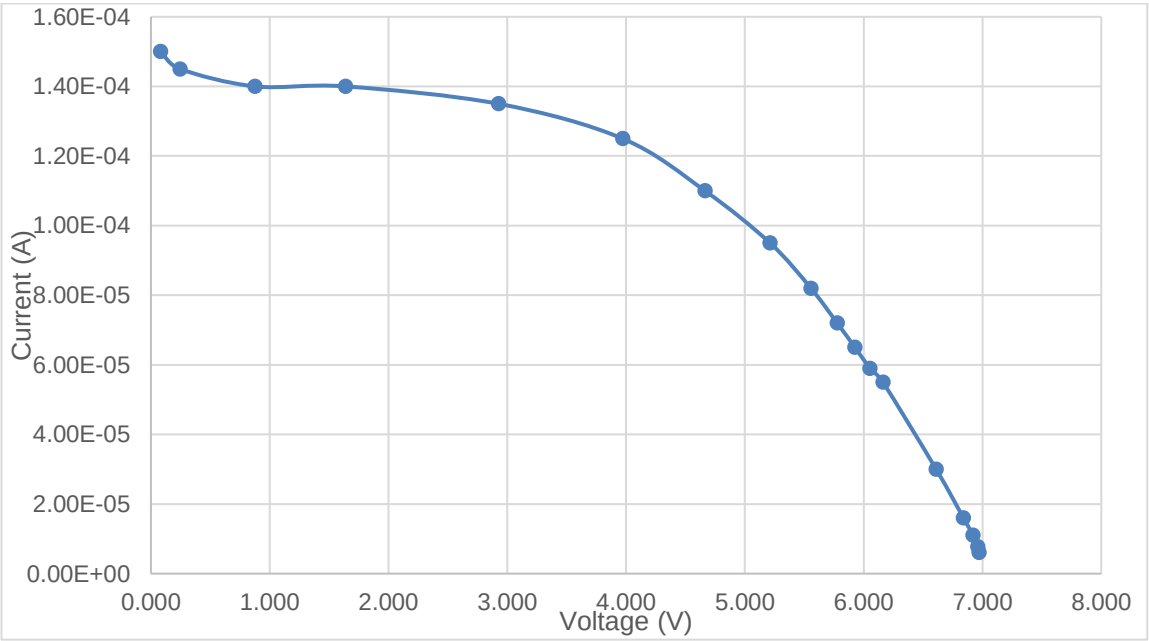


Kuvio 97. Voltage (V) vs Power (W) curve for panel ATCJ-I-54 with 3mm glass cover at 60°.

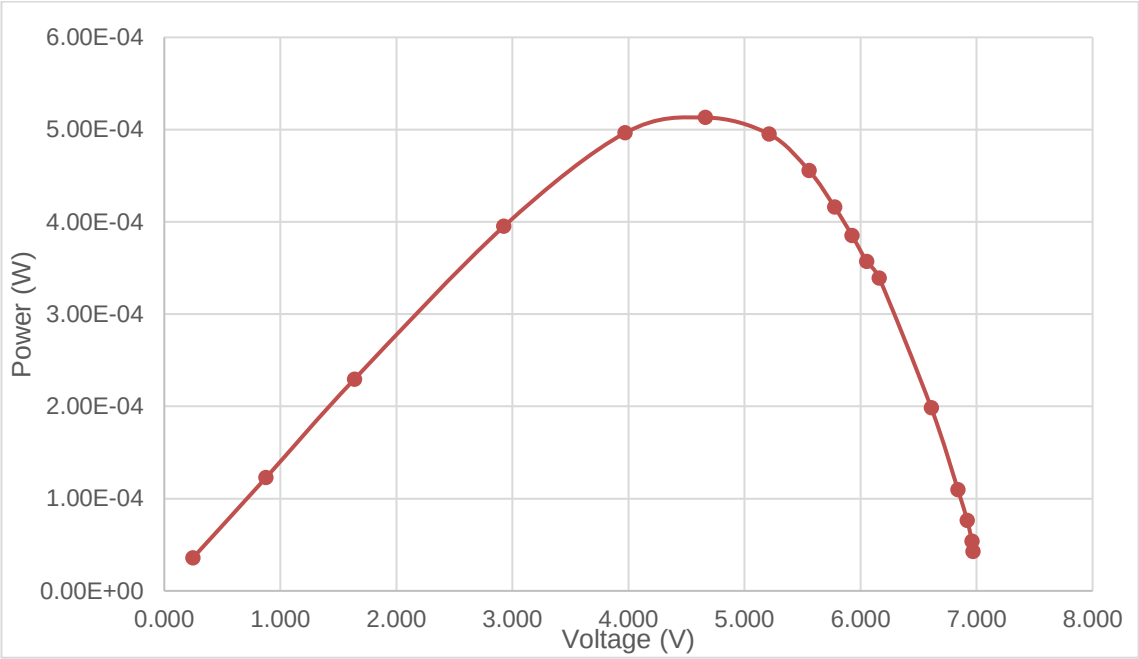
Taulukko 51. Results for panel ATCJ-I-54 with 3mm glass cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.082	1.50E-04	1.23E-05	72.4	-
0.246	1.45E-04	3.57E-05	72.6	1,000
0.876	1.40E-04	1.23E-04	72.4	5,000
1.639	1.40E-04	2.29E-04	72.4	10,000
2.926	1.35E-04	3.95E-04	72.7	20,000
3.971	1.25E-04	4.96E-04	73.0	30,000
4.664	1.10E-04	5.13E-04	72.7	40,000
5.212	9.50E-05	4.95E-04	72.6	50,000
5.556	8.20E-05	4.56E-04	73.1	60,000
5.777	7.20E-05	4.16E-04	72.7	70,000
5.927	6.50E-05	3.85E-04	72.6	80,000
6.053	5.90E-05	3.57E-04	72.4	90,000
6.162	5.50E-05	3.39E-04	72.7	100,000
6.610	3.00E-05	1.98E-04	72.7	200,000
6.840	1.60E-05	1.09E-04	72.4	400,000
6.920	1.10E-05	7.61E-05	72.9	600,000
6.960	7.70E-06	5.36E-05	73.0	800,000
6.970	6.10E-06	4.25E-05	72.6	1,000,000

0.025



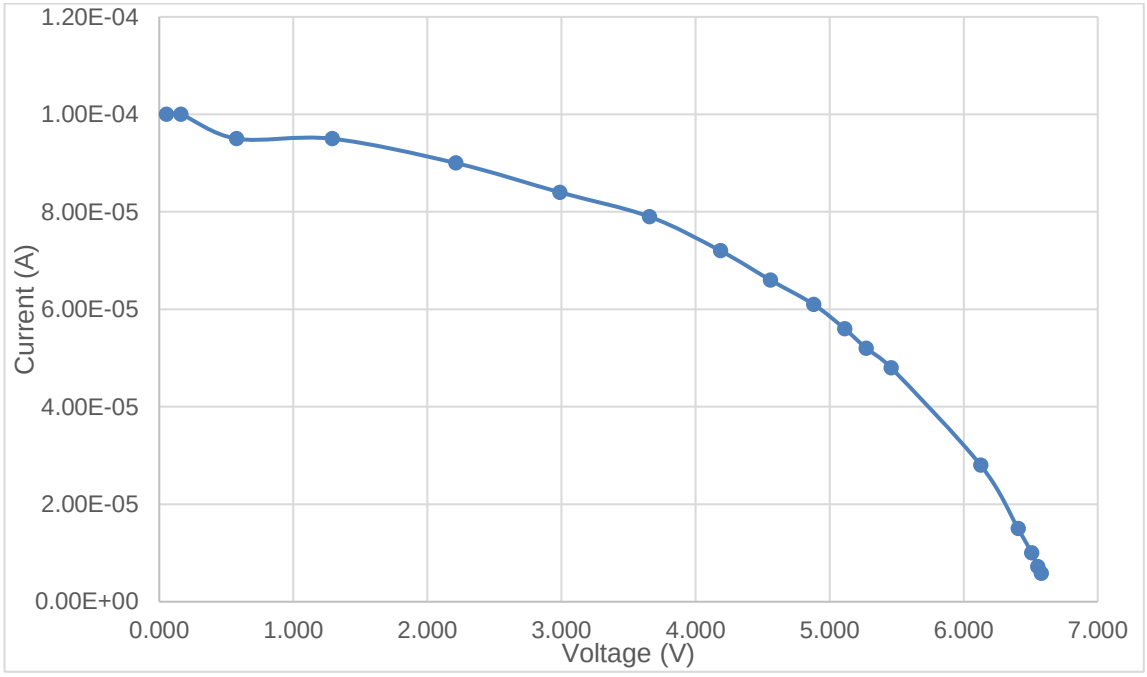
Kuvio 98. Voltage (V) vs Current (I) curve for panel ATCJ-I-54 3mm glass cover at 45°.



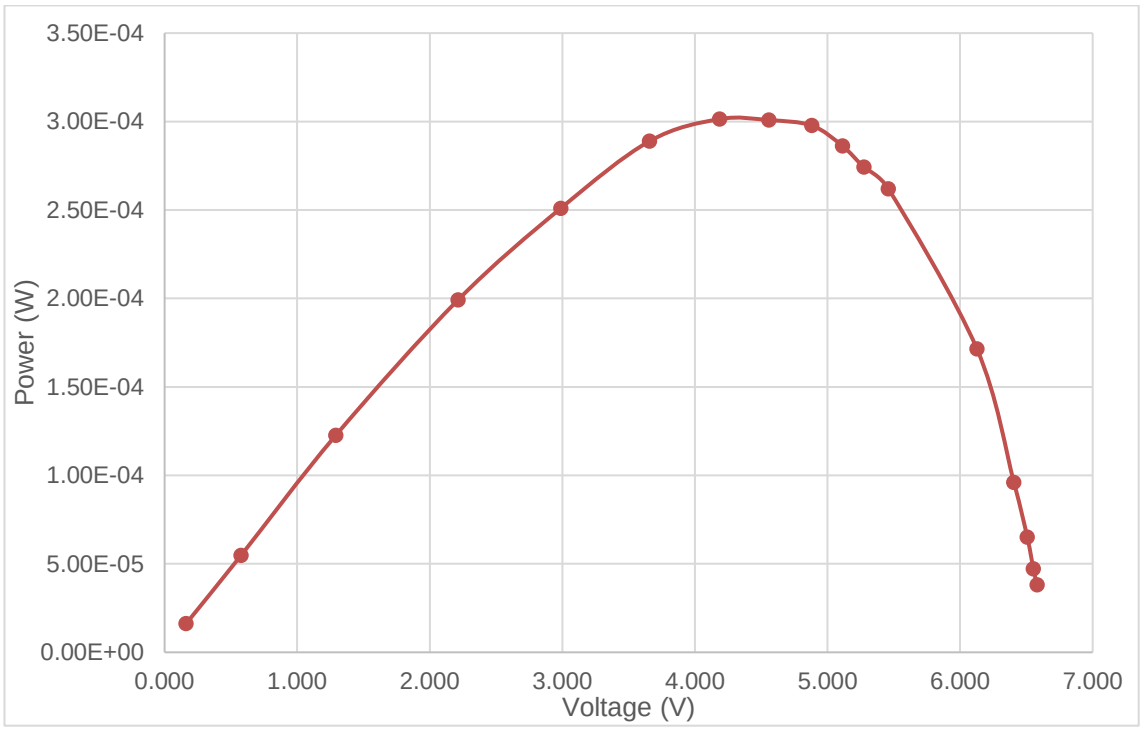
Kuvio 99. Voltage (V) vs Power (W) curve for panel ATCJ-I-54 with 3mm glass cover at 45°.

Taulukko 52. Results for panel ATCJ-I-54 with 3mm glass cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.054	1.00E-04	5.40E-06	53.5	-
0.162	1.00E-04	1.62E-05	53.8	1,000
0.577	9.50E-05	5.48E-05	53.3	5,000
1.290	9.50E-05	1.23E-04	53.6	10,000
2.213	9.00E-05	1.99E-04	53.7	20,000
2.988	8.40E-05	2.51E-04	53.7	30,000
3.657	7.90E-05	2.89E-04	53.7	40,000
4.186	7.20E-05	3.01E-04	53.8	50,000
4.558	6.60E-05	3.01E-04	53.9	60,000
4.881	6.10E-05	2.98E-04	53.6	70,000
5.112	5.60E-05	2.86E-04	53.9	80,000
5.274	5.20E-05	2.74E-04	53.7	90,000
5.459	4.80E-05	2.62E-04	53.9	100,000
6.127	2.80E-05	1.72E-04	54.0	200,000
6.406	1.50E-05	9.61E-05	53.9	400,000
6.507	1.00E-05	6.51E-05	53.9	600,000
6.553	7.20E-06	4.72E-05	53.9	800,000
6.580	5.80E-06	3.82E-05	53.8	1,000,000



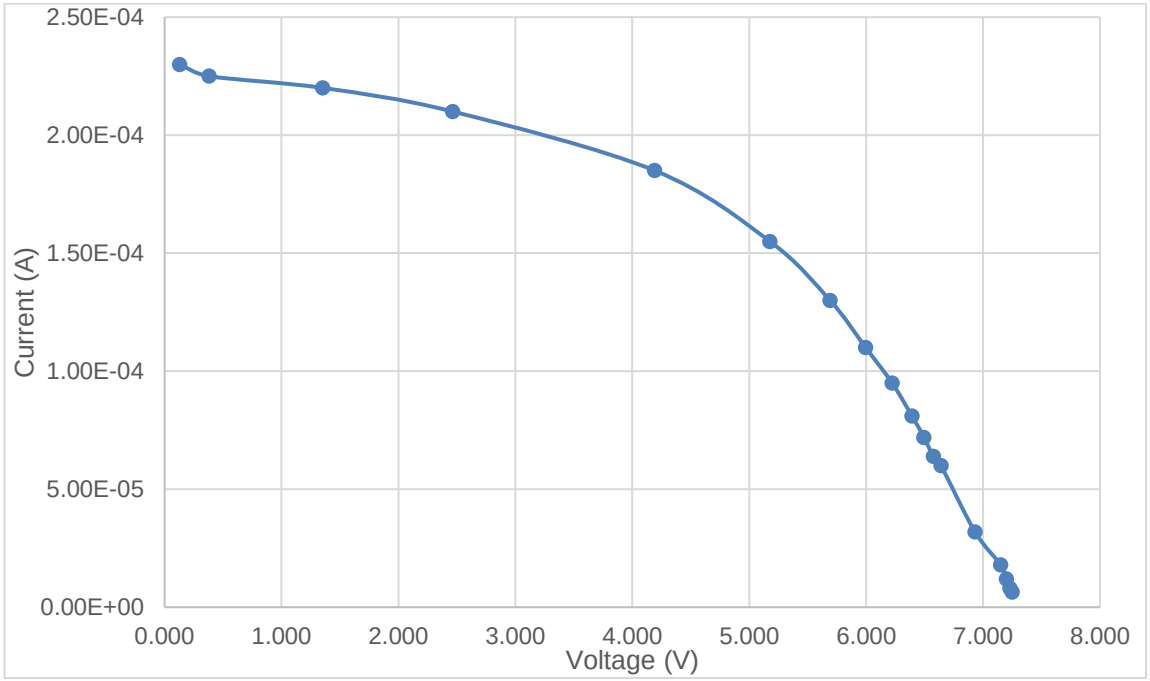
Kuvio 100. Voltage (V) vs Current (I) curve for panel ATCJ-I-54 3mm glass cover at 30°.



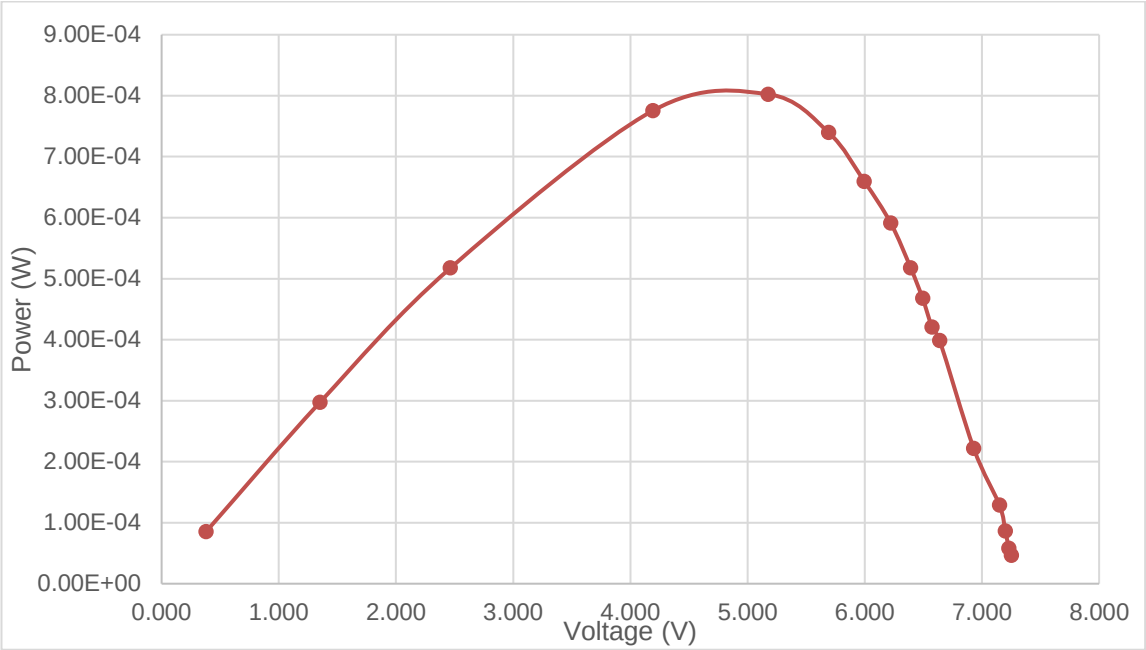
Kuvio 101. Voltage (V) vs Power (W) curve for panel ATCJ-I-54 with 3mm glass cover at 30°.

Taulukko 53. Results for panel ATCJ-I-54 with 6mm glass cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.128	2.30E-04	2.94E-05	100.2	-
0.379	2.25E-04	8.53E-05	100.1	1,000
1.352	2.20E-04	2.97E-04	100.6	5,000
2.464	2.10E-04	5.17E-04	100.4	10,000
4.191	1.85E-04	7.75E-04	100.6	20,000
5.176	1.55E-04	8.02E-04	100.5	30,000
5.691	1.30E-04	7.40E-04	100.5	40,000
5.996	1.10E-04	6.60E-04	100.0	50,000
6.222	9.50E-05	5.91E-04	100.5	60,000
6.392	8.10E-05	5.18E-04	100.4	70,000
6.494	7.20E-05	4.68E-04	100.5	80,000
6.574	6.40E-05	4.21E-04	100.5	90,000
6.640	6.00E-05	3.98E-04	100.5	100,000
6.930	3.20E-05	2.22E-04	100.7	200,000
7.150	1.80E-05	1.29E-04	100.5	400,000
7.200	1.20E-05	8.64E-05	100.3	600,000
7.230	8.00E-06	5.78E-05	100.6	800,000
7.250	6.40E-06	4.64E-05	100.4	1,000,000



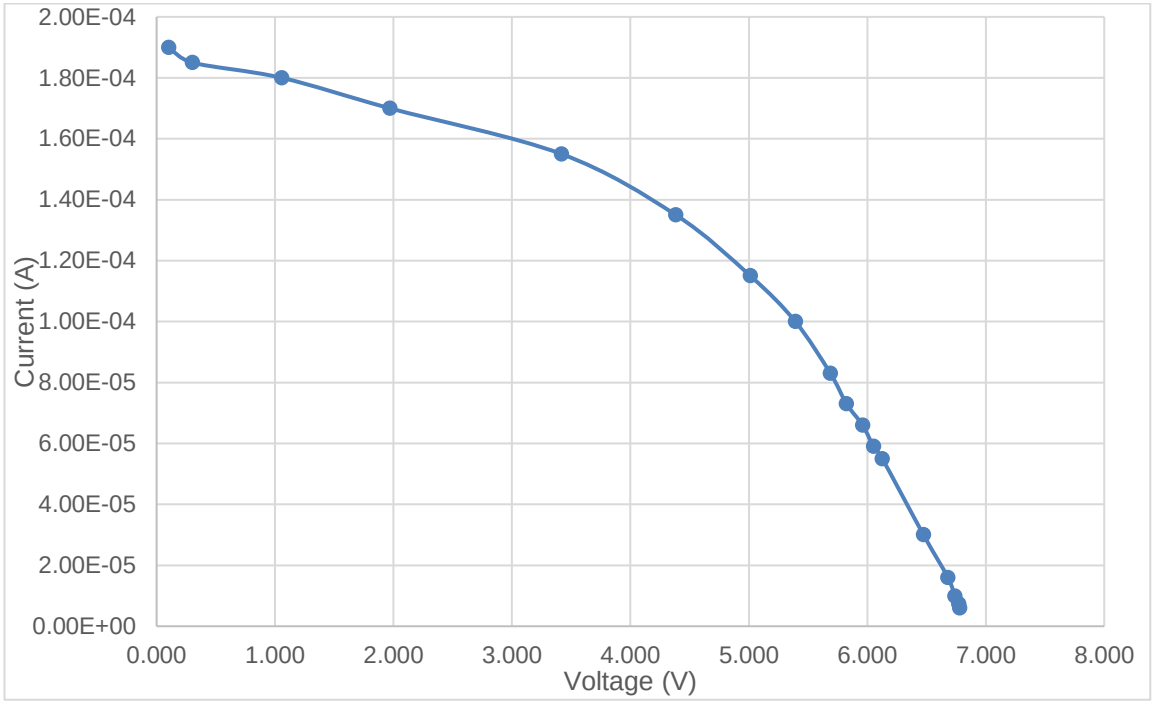
Kuvio 102. Voltage (V) vs Current (I) curve for panel ATCJ-I-54 6mm glass cover at 90°.



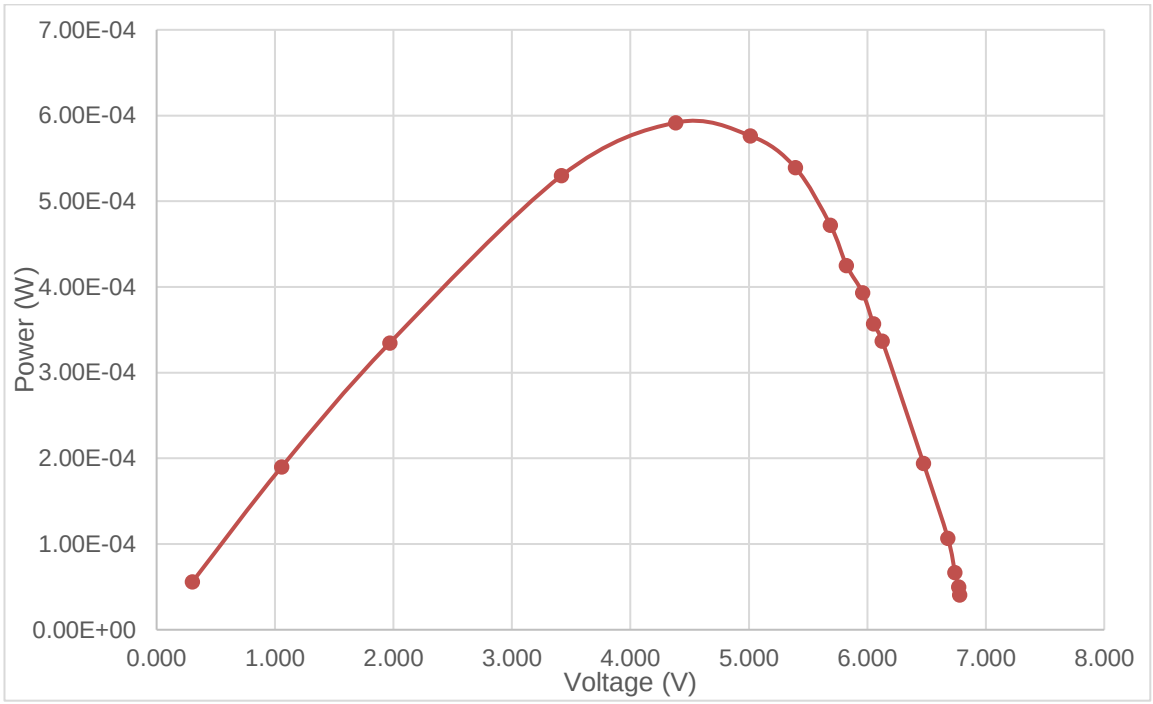
Kuvio 103. Voltage (V) vs Power (W) curve for panel ATCJ-I-54 with 6mm glass cover at 90°.

Taulukko 54. Results for panel ATCJ-I-54 with 6mm glass cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.101	1.90E-04	1.92E-05	89.2	-
0.302	1.85E-04	5.59E-05	89.2	1,000
1.056	1.80E-04	1.90E-04	88.9	5,000
1.969	1.70E-04	3.35E-04	89.0	10,000
3.418	1.55E-04	5.30E-04	89.0	20,000
4.383	1.35E-04	5.92E-04	88.9	30,000
5.012	1.15E-04	5.76E-04	89.1	40,000
5.392	1.00E-04	5.39E-04	89.2	50,000
5.688	8.30E-05	4.72E-04	89.1	60,000
5.824	7.30E-05	4.25E-04	88.5	70,000
5.960	6.60E-05	3.93E-04	88.6	80,000
6.052	5.90E-05	3.57E-04	88.8	90,000
6.126	5.50E-05	3.37E-04	89.1	100,000
6.474	3.00E-05	1.94E-04	88.7	200,000
6.680	1.60E-05	1.07E-04	88.4	400,000
6.740	9.90E-06	6.67E-05	88.8	600,000
6.770	7.40E-06	5.01E-05	89.1	800,000
6.780	6.00E-06	4.07E-05	88.8	1,000,000



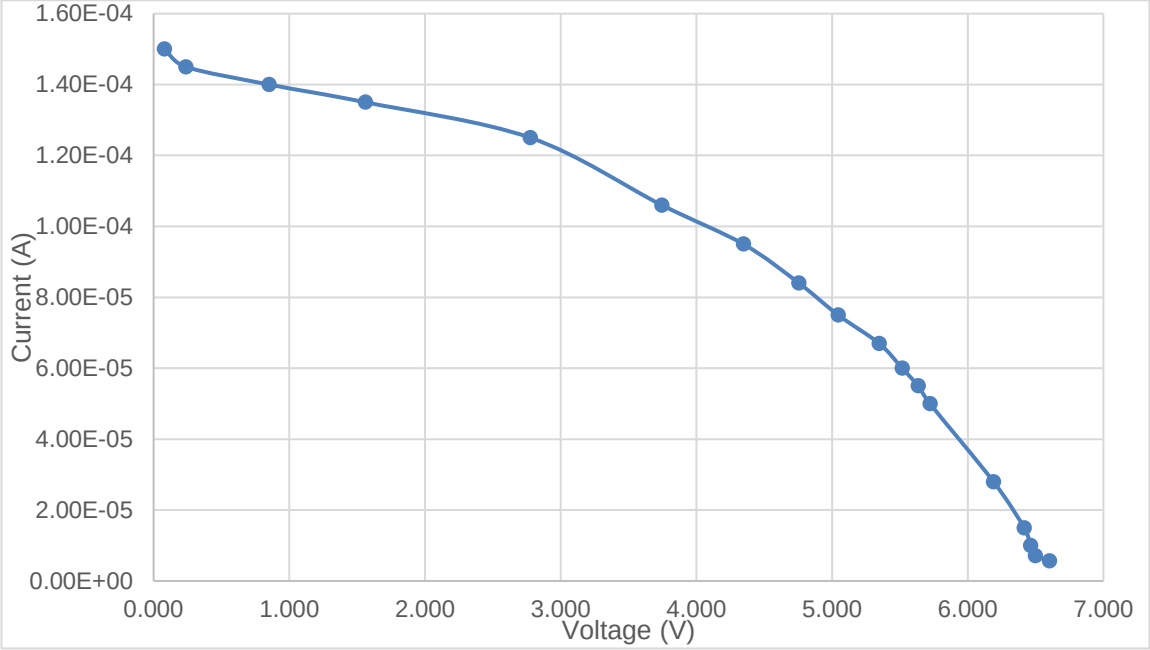
Kuvio 104. Voltage (V) vs Current (I) curve for panel ATCJ-I-54 6mm glass cover at 60°.



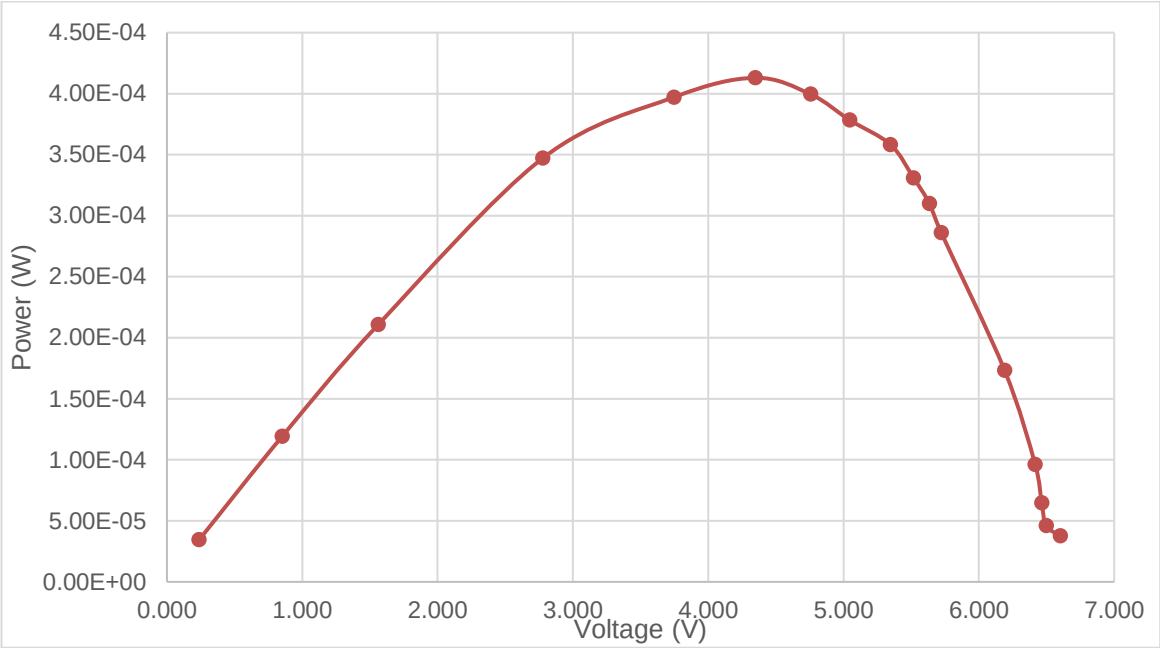
Kuvio 105. Voltage (V) vs Power (W) curve for panel ATCJ-I-54 with 6mm glass cover at 60°.

Taulukko 55. Results for panel ATCJ-I-54 with 6mm glass cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.080	1.50E-04	1.20E-05	73.7	-
0.238	1.45E-04	3.45E-05	73.7	1,000
0.852	1.40E-04	1.19E-04	73.7	5,000
1.561	1.35E-04	2.11E-04	73.5	10,000
2.777	1.25E-04	3.47E-04	73.5	20,000
3.746	1.06E-04	3.97E-04	73.5	30,000
4.347	9.50E-05	4.13E-04	73.3	40,000
4.756	8.40E-05	4.00E-04	73.7	50,000
5.045	7.50E-05	3.78E-04	73.7	60,000
5.347	6.70E-05	3.58E-04	73.8	70,000
5.517	6.00E-05	3.31E-04	73.9	80,000
5.635	5.50E-05	3.10E-04	74.1	90,000
5.722	5.00E-05	2.86E-04	73.7	100,000
6.190	2.80E-05	1.73E-04	73.8	200,000
6.416	1.50E-05	9.62E-05	73.8	400,000
6.464	1.00E-05	6.46E-05	74.0	600,000
6.498	7.10E-06	4.61E-05	73.8	800,000
6.603	5.70E-06	3.76E-05	73.4	1,000,000



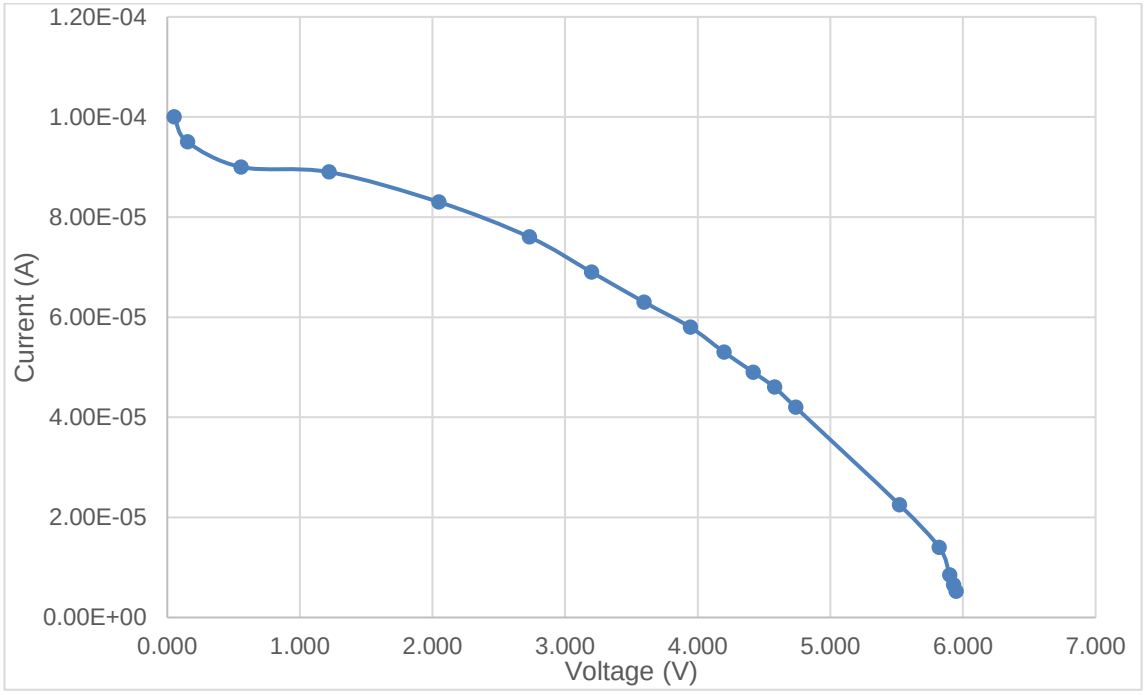
Kuvio 106. Voltage (V) vs Current (I) curve for panel ATCJ-I-54 6mm glass cover at 45°.



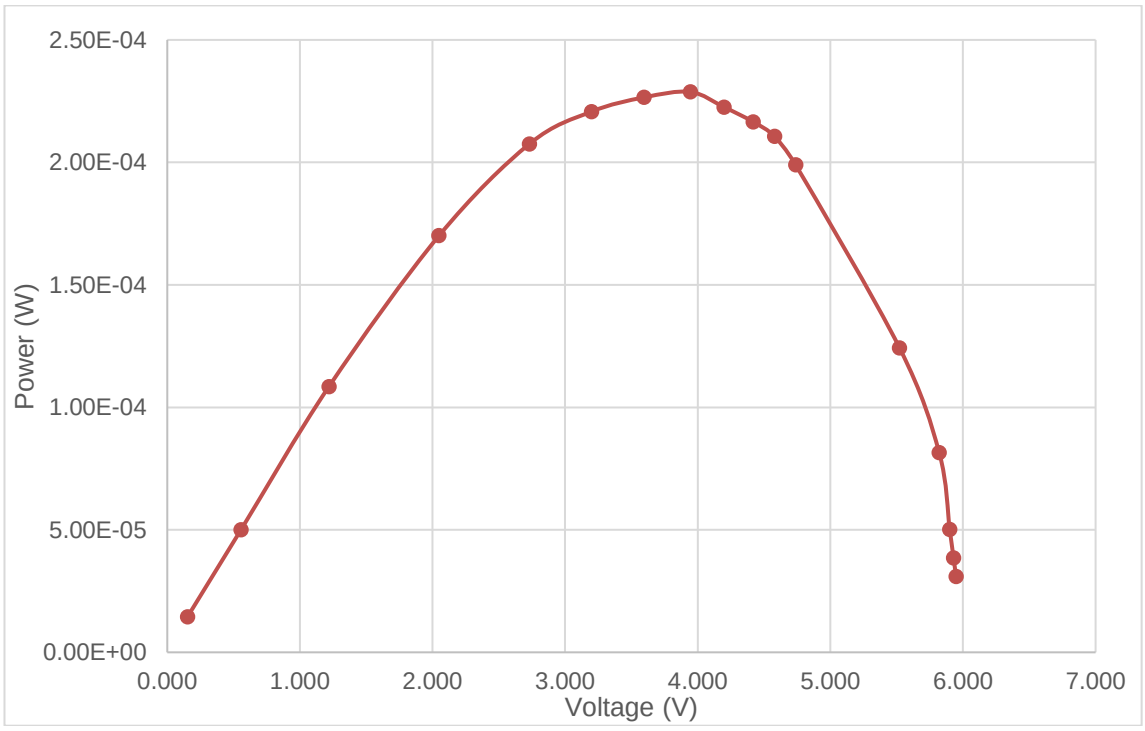
Kuvio 107. Voltage (V) vs Power (W) curve for panel ATCJ-I-54 with 6mm glass cover at 45°.

Taulukko 56. Results for panel ATCJ-I-54 with 6mm glass cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.052	1.00E-04	5.20E-06	54.5	-
0.153	9.50E-05	1.45E-05	54.3	1,000
0.556	9.00E-05	5.00E-05	54.5	5,000
1.219	8.90E-05	1.08E-04	54.5	10,000
2.049	8.30E-05	1.70E-04	54.2	20,000
2.731	7.60E-05	2.08E-04	54.4	30,000
3.199	6.90E-05	2.21E-04	54.4	40,000
3.596	6.30E-05	2.27E-04	54.4	50,000
3.944	5.80E-05	2.29E-04	54.3	60,000
4.199	5.30E-05	2.23E-04	54.5	70,000
4.419	4.90E-05	2.17E-04	54.2	80,000
4.579	4.60E-05	2.11E-04	54.4	90,000
4.738	4.20E-05	1.99E-04	54.3	100,000
5.522	2.25E-05	1.24E-04	54.4	200,000
5.821	1.40E-05	8.15E-05	54.5	400,000
5.900	8.50E-06	5.02E-05	54.5	600,000
5.929	6.50E-06	3.85E-05	54.3	800,000
5.948	5.20E-06	3.09E-05	54.3	1,000,000



Kuvio 108. Voltage (V) vs Current (I) curve for panel ATCJ-I-54 6mm glass cover at 30°.

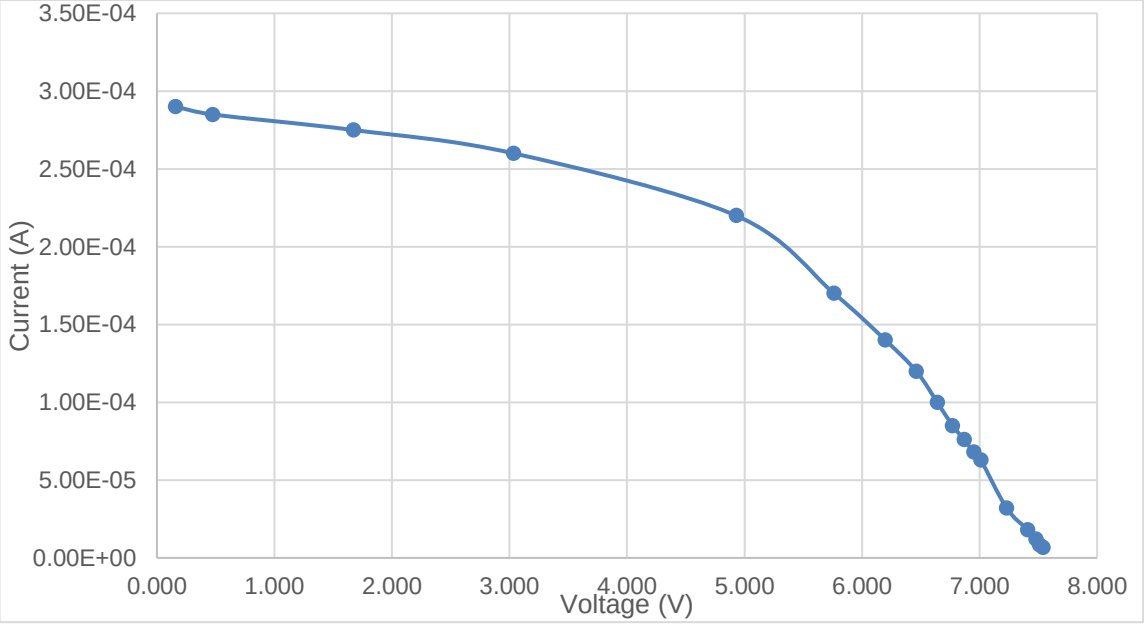


Kuvio 109. Voltage (V) vs Power (W) curve for panel ATCJ-I-54 with 6mm glass cover at 30°.

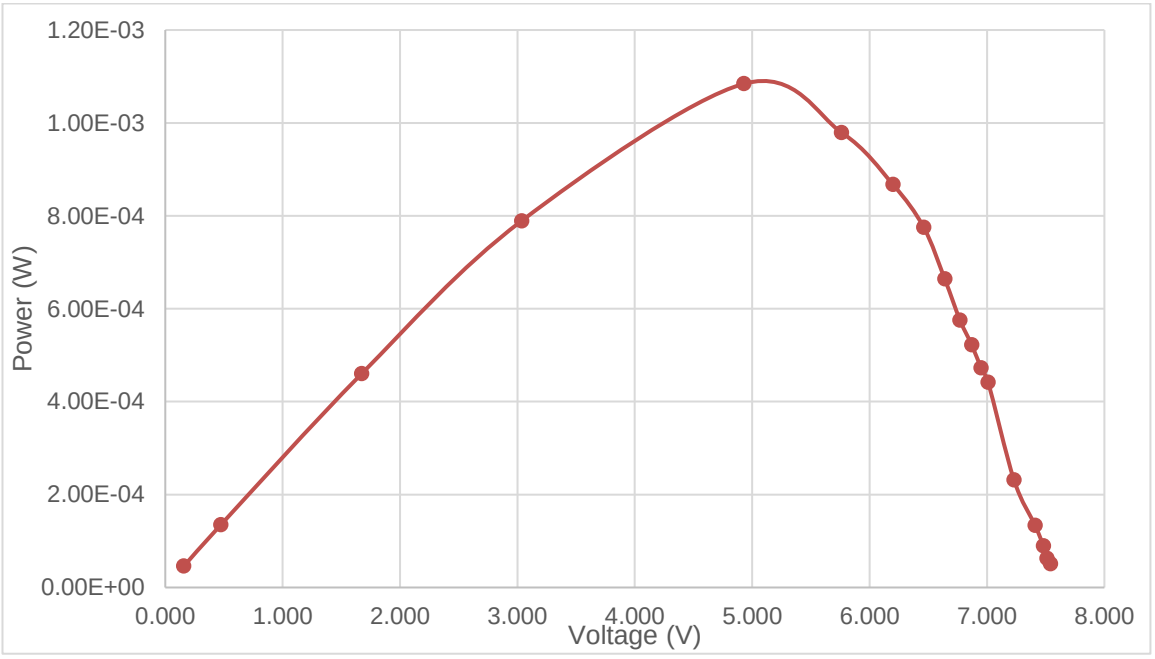
Appendix 5: Panel I_055

Taulukko 57. Results for panel ATCJ-I-55 with no cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.158	2.90E-04	4.58E-05	100.5	-
0.473	2.85E-04	1.35E-04	100.7	1,000
1.673	2.75E-04	4.60E-04	100.5	5,000
3.035	2.60E-04	7.89E-04	100.5	10,000
4.929	2.20E-04	1.08E-03	100.4	20,000
5.761	1.70E-04	9.79E-04	99.9	30,000
6.198	1.40E-04	8.68E-04	100.4	40,000
6.461	1.20E-04	7.75E-04	100.4	50,000
6.640	1.00E-04	6.64E-04	100.3	60,000
6.770	8.50E-05	5.75E-04	100.0	70,000
6.870	7.60E-05	5.22E-04	99.9	80,000
6.950	6.80E-05	4.73E-04	100.1	90,000
7.010	6.30E-05	4.42E-04	100.2	100,000
7.230	3.20E-05	2.31E-04	100.3	200,000
7.410	1.80E-05	1.33E-04	100.4	400,000
7.480	1.20E-05	8.98E-05	100.4	600,000
7.510	8.30E-06	6.23E-05	100.5	800,000
7.540	6.80E-06	5.13E-05	100.6	1,000,000



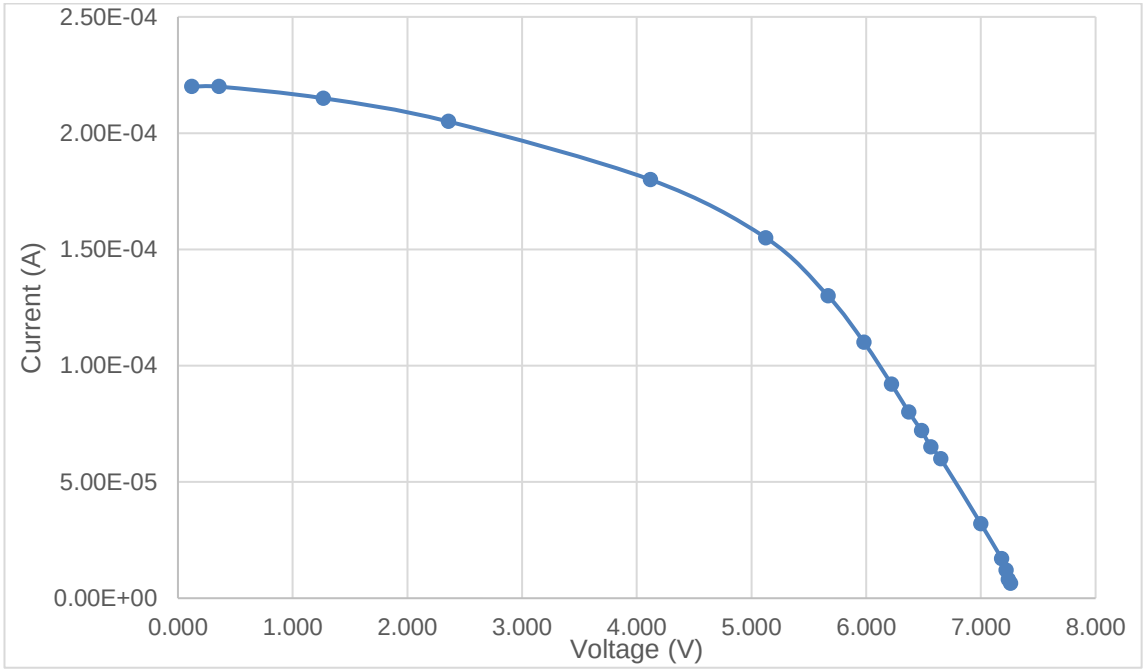
Kuvio 110. Voltage (V) vs Current (I) curve for panel ATCJ-I-55 with no cover at 90°.



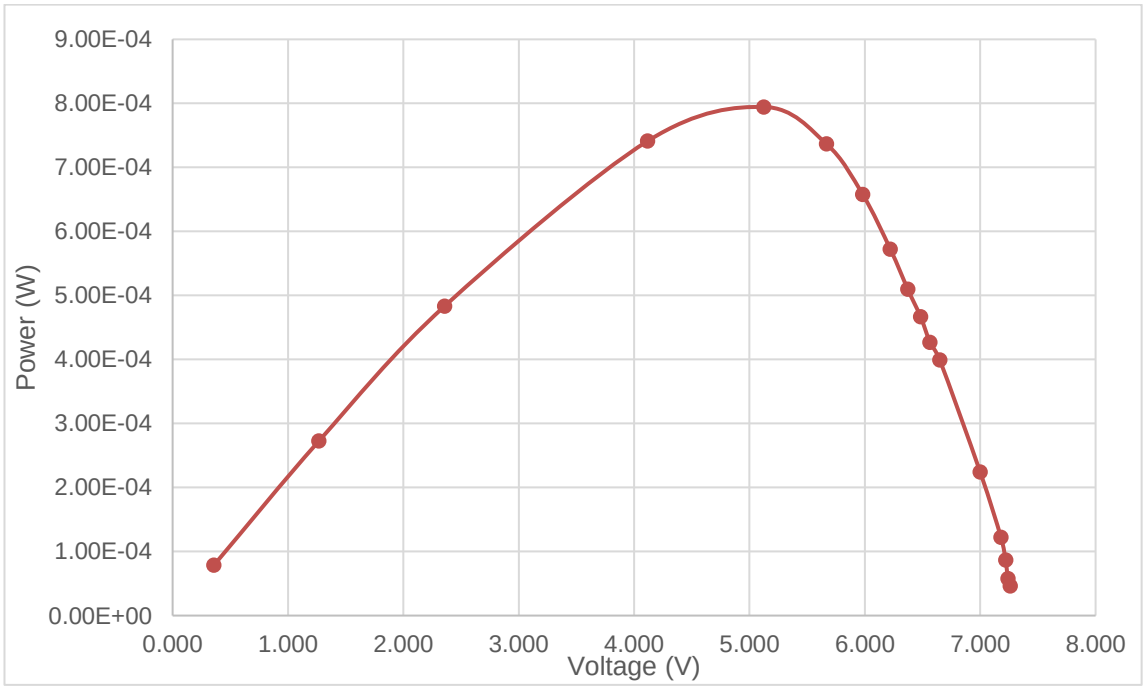
Kuvio 111. Voltage (V) vs Power (W) curve for panel ATCJ-I-55 with no cover at 90°.

Taulukko 58. Results for panel ATCJ-I-55 with no cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.119	2.20E-04	2.62E-05	95.2	-
0.358	2.20E-04	7.88E-05	95.6	1,000
1.268	2.15E-04	2.73E-04	95.5	5,000
2.358	2.05E-04	4.83E-04	95.0	10,000
4.118	1.80E-04	7.41E-04	95.6	20,000
5.125	1.55E-04	7.94E-04	95.6	30,000
5.667	1.30E-04	7.37E-04	95.7	40,000
5.981	1.10E-04	6.58E-04	95.0	50,000
6.221	9.20E-05	5.72E-04	95.5	60,000
6.372	8.00E-05	5.10E-04	95.4	70,000
6.483	7.20E-05	4.67E-04	95.4	80,000
6.565	6.50E-05	4.27E-04	95.3	90,000
6.650	6.00E-05	3.99E-04	95.7	100,000
7.000	3.20E-05	2.24E-04	95.6	200,000
7.180	1.70E-05	1.22E-04	95.5	400,000
7.220	1.20E-05	8.66E-05	95.1	600,000
7.240	8.00E-06	5.79E-05	95.4	800,000
7.260	6.40E-06	4.65E-05	95.4	1,000,000



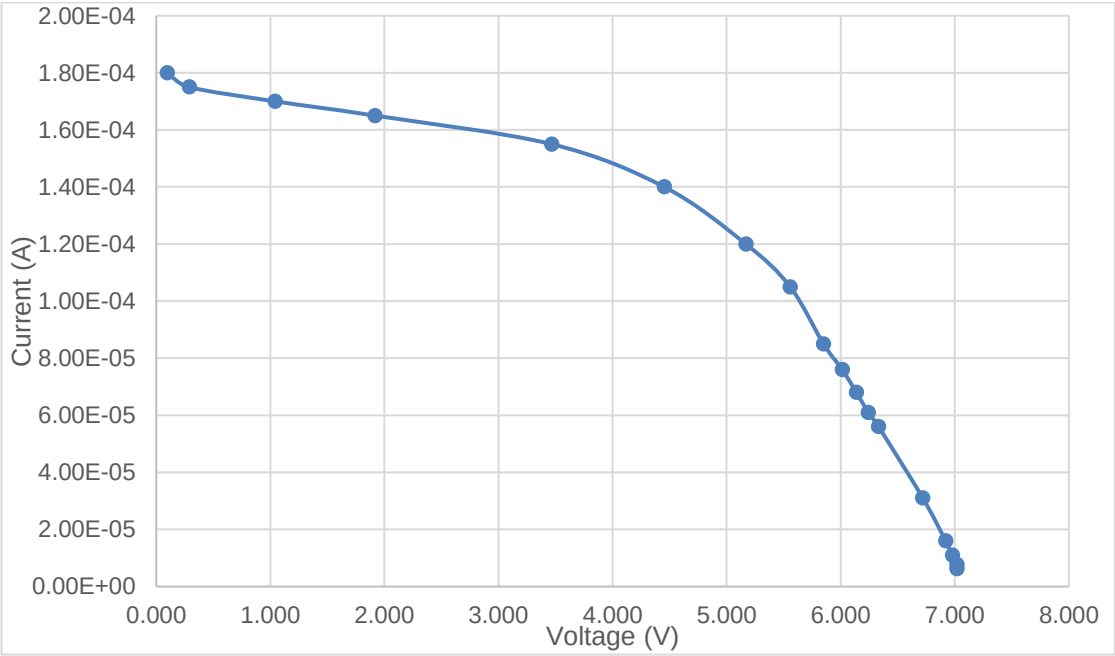
Kuvio 112. Voltage (V) vs Current (I) curve for panel ATCJ-I-55 with no cover at 60°.



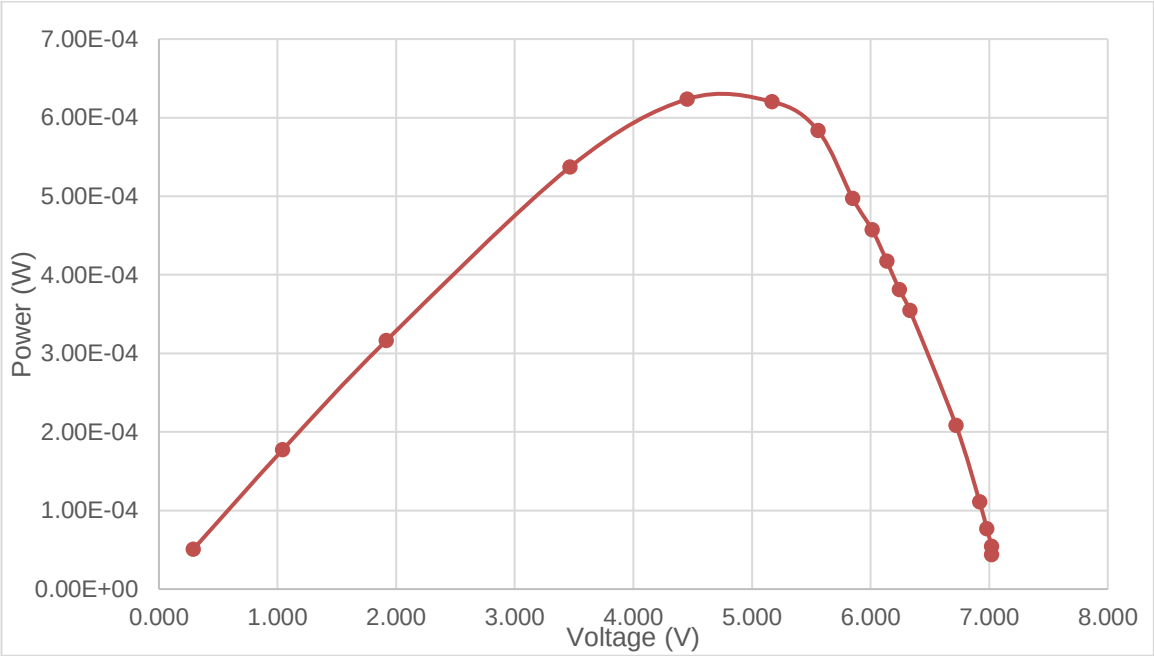
Kuvio 113. Voltage (V) vs Power (W) curve for panel ATCJ-I-55 with no cover at 90°.

Taulukko 59. Results for panel ATCJ-I-55 with no cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.097	1.80E-04	1.75E-05	82.0	-
0.289	1.75E-04	5.06E-05	91.9	1,000
1.042	1.70E-04	1.77E-04	81.9	5,000
1.917	1.65E-04	3.16E-04	82.0	10,000
3.466	1.55E-04	5.37E-04	81.9	20,000
4.454	1.40E-04	6.24E-04	82.0	30,000
5.169	1.20E-04	6.20E-04	81.9	40,000
5.557	1.05E-04	5.83E-04	81.2	50,000
5.849	8.50E-05	4.97E-04	81.8	60,000
6.014	7.60E-05	4.57E-04	81.8	70,000
6.137	6.80E-05	4.17E-04	81.7	80,000
6.243	6.10E-05	3.81E-04	81.9	90,000
6.332	5.60E-05	3.55E-04	81.3	100,000
6.720	3.10E-05	2.08E-04	81.8	200,000
6.920	1.60E-05	1.11E-04	81.6	400,000
6.980	1.10E-05	7.68E-05	81.9	600,000
7.020	7.70E-06	5.41E-05	91.9	800,000
7.020	6.20E-06	4.35E-05	82.1	1,000,000



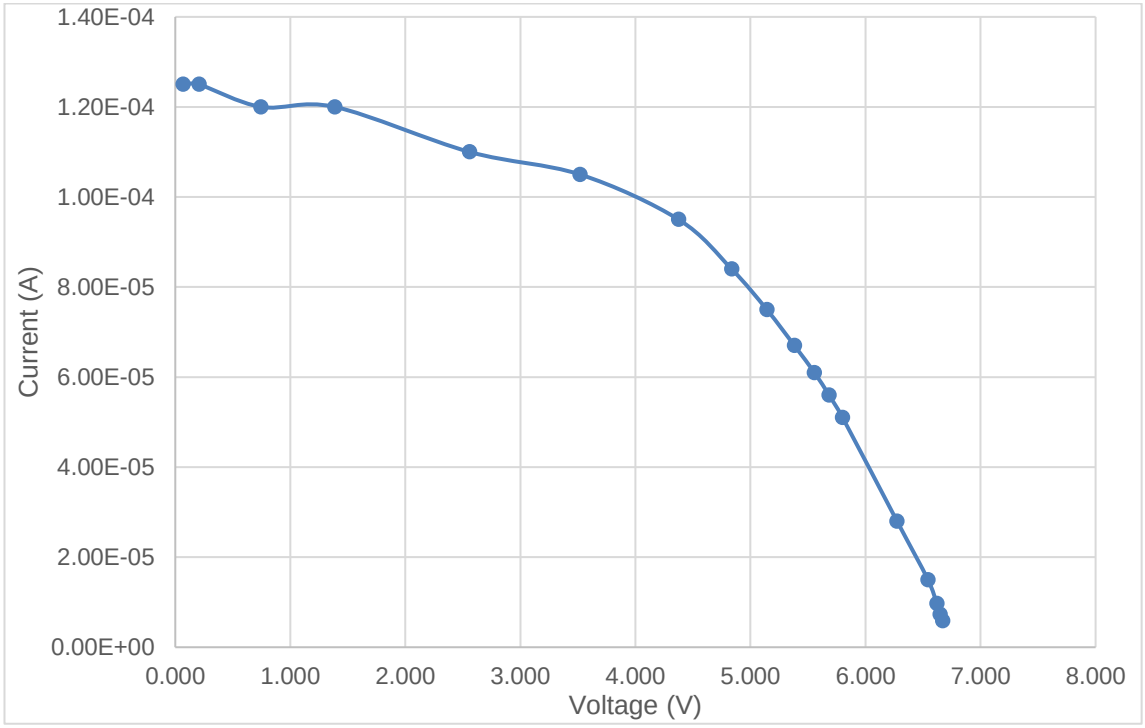
Kuvio 114. Voltage (V) vs Current (I) curve for panel ATCJ-I-55 with no cover at 45°.



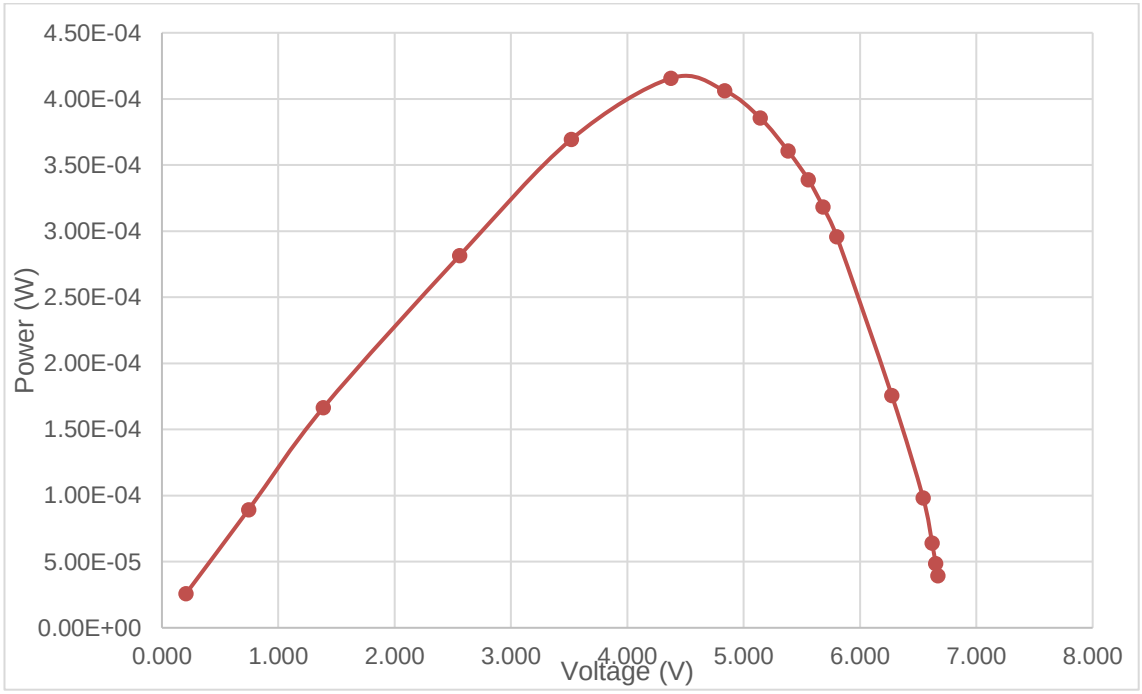
Kuvio 115. Voltage (V) vs Power (W) curve for panel ATCJ-I-55 with no cover at 45°.

Taulukko 60. Results for panel ATCJ-I-55 with no cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.068	1.25E-04	8.50E-06	62.2	-
0.206	1.25E-04	2.58E-05	62.4	1,000
0.745	1.20E-04	8.94E-05	62.1	5,000
1.388	1.20E-04	1.67E-04	62.3	10,000
2.559	1.10E-04	2.81E-04	62.2	20,000
3.518	1.05E-04	3.69E-04	62.0	30,000
4.375	9.50E-05	4.16E-04	62.1	40,000
4.836	8.40E-05	4.06E-04	62.3	50,000
5.142	7.50E-05	3.86E-04	62.0	60,000
5.382	6.70E-05	3.61E-04	62.4	70,000
5.556	6.10E-05	3.39E-04	62.3	80,000
5.683	5.60E-05	3.18E-04	62.3	90,000
5.801	5.10E-05	2.96E-04	62.4	100,000
6.274	2.80E-05	1.76E-04	62.3	200,000
6.543	1.50E-05	9.81E-05	62.4	400,000
6.620	9.70E-06	6.42E-05	62.4	600,000
6.650	7.30E-06	4.85E-05	62.2	800,000
6.670	5.90E-06	3.94E-05	62.3	1,000,000



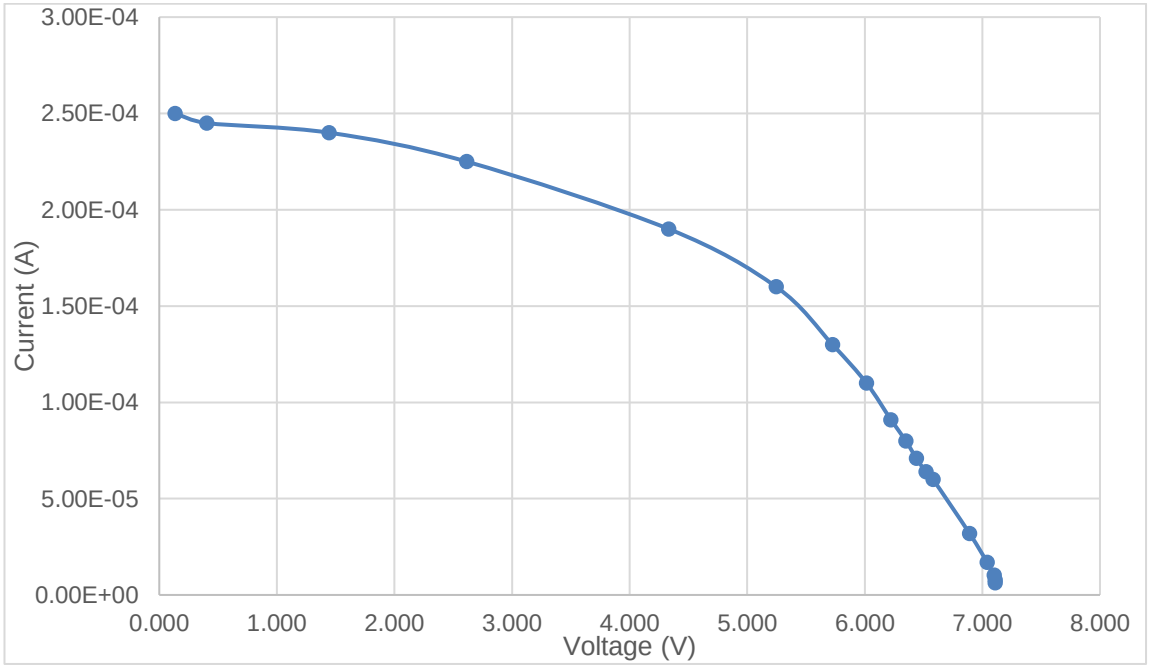
Kuvio 116. Voltage (V) vs Current (I) curve for panel ATCJ-I-55 with no cover at 30°.



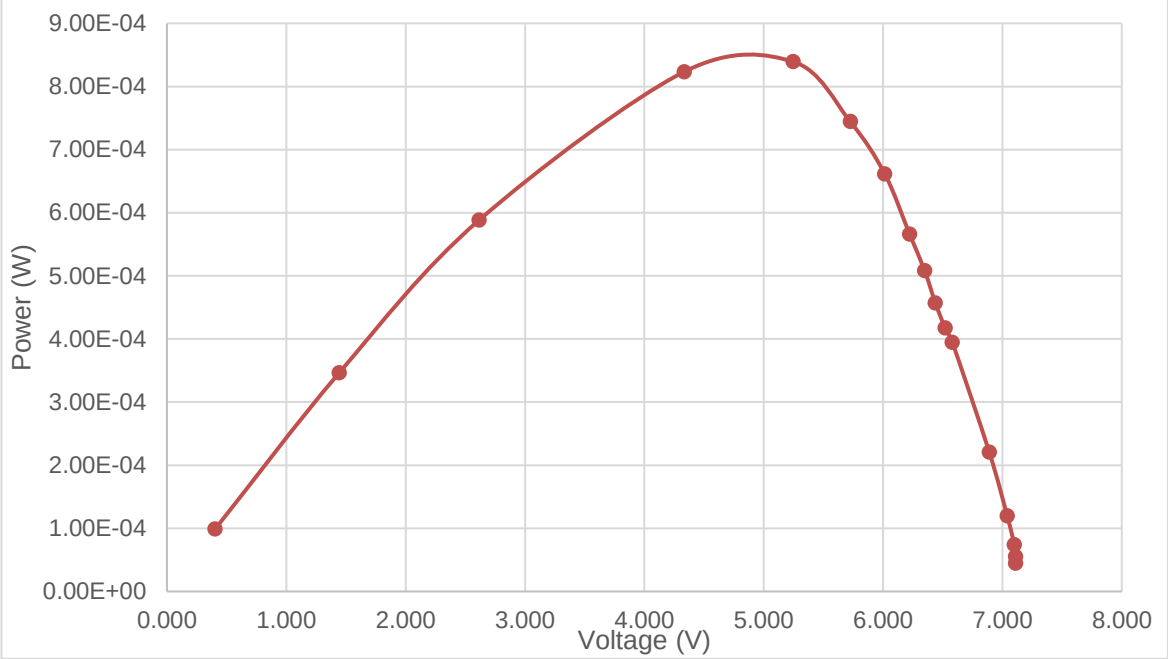
Kuvio 117. Voltage (V) vs Power (W) curve for panel ATCJ-I-55 with no cover at 30°.

Taulukko 61. Results for panel ATCJ-I-55 with polycarbonate cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.135	2.50E-04	3.38E-05	100.3	-
0.403	2.45E-04	9.87E-05	100.5	1,000
1.444	2.40E-04	3.47E-04	100.8	5,000
2.614	2.25E-04	5.88E-04	100.9	10,000
4.333	1.90E-04	8.23E-04	100.8	20,000
5.246	1.60E-04	8.39E-04	100.4	30,000
5.725	1.30E-04	7.44E-04	100.6	40,000
6.014	1.10E-04	6.62E-04	100.7	50,000
6.222	9.10E-05	5.66E-04	100.6	60,000
6.349	8.00E-05	5.08E-04	100.6	70,000
6.438	7.10E-05	4.57E-04	100.7	80,000
6.520	6.40E-05	4.17E-04	100.8	90,000
6.580	6.00E-05	3.95E-04	101.0	100,000
6.890	3.20E-05	2.20E-04	100.7	200,000
7.040	1.70E-05	1.20E-04	100.5	400,000
7.100	1.04E-05	7.38E-05	100.8	600,000
7.110	7.80E-06	5.55E-05	100.4	800,000
7.110	6.30E-06	4.48E-05	100.7	1,000,000



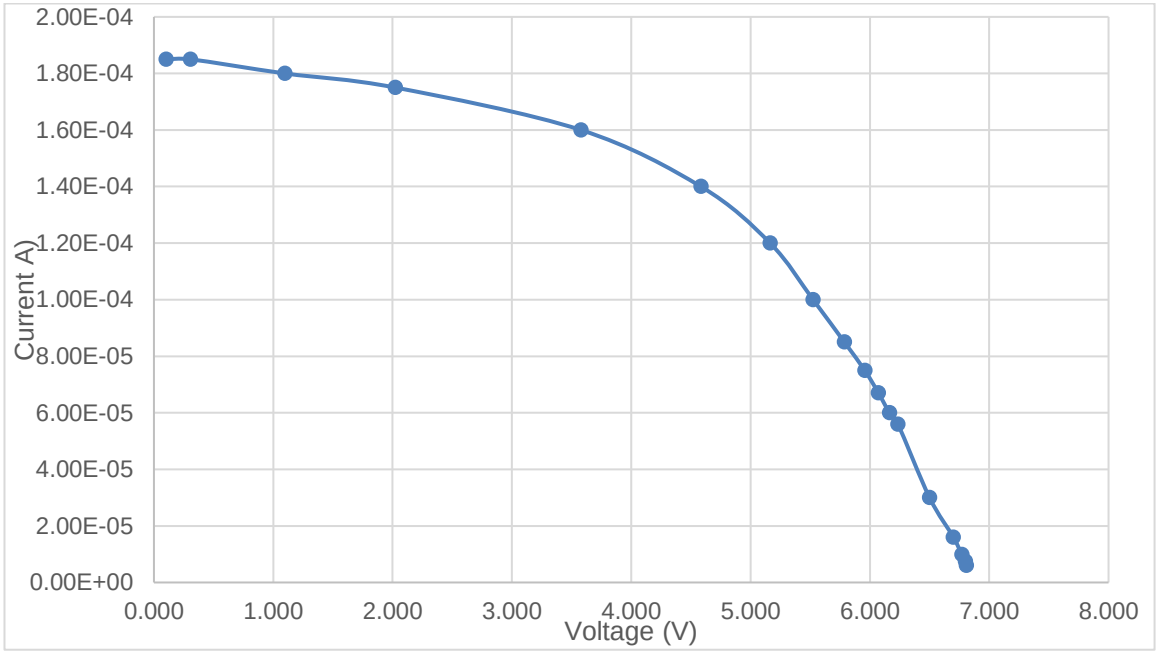
Kuvio 118. Voltage (V) vs Current (I) curve for panel ATCJ-I-55 polycarbonate cover at 90°.



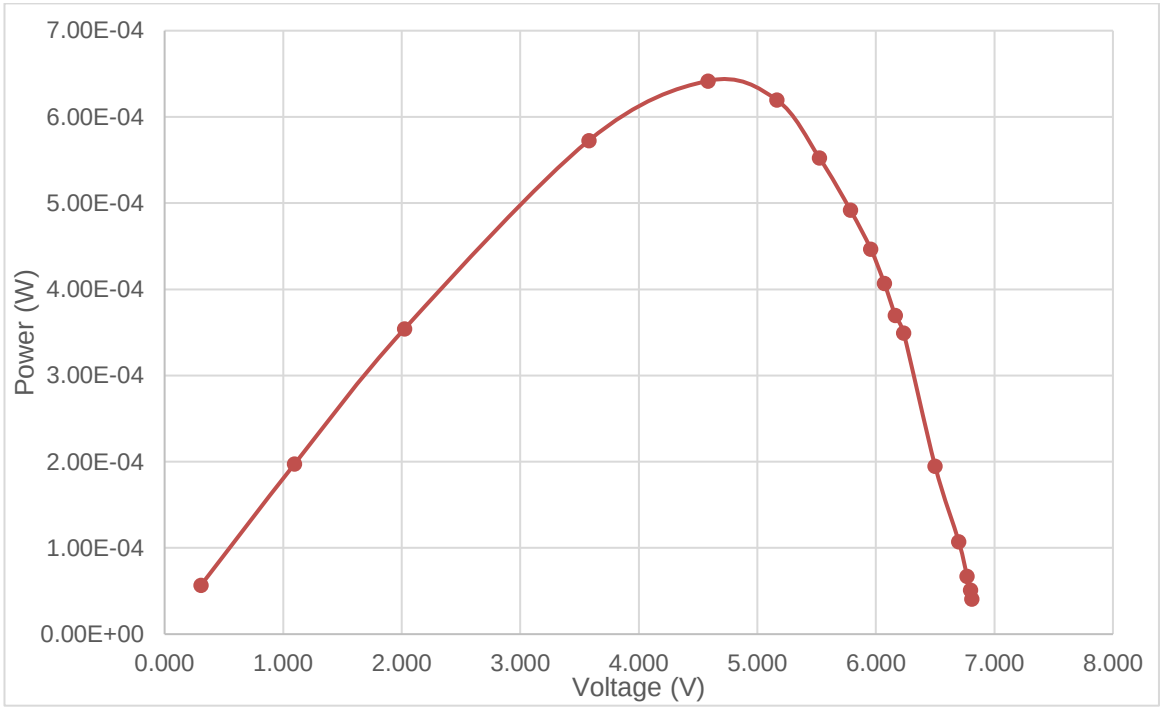
Kuvio 119. Voltage (V) vs Power (W) curve for panel ATCJ-I-55 with polycarbonate cover at 90°.

Taulukko 62. Results for panel ATCJ-I-55 with polycarbonate cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.102	1.85E-04	1.89E-05	94.9	-
0.306	1.85E-04	5.66E-05	95.0	1,000
1.097	1.80E-04	1.97E-04	94.9	5,000
2.024	1.75E-04	3.54E-04	95.0	10,000
3.579	1.60E-04	5.73E-04	95.2	20,000
4.584	1.40E-04	6.42E-04	95.3	30,000
5.164	1.20E-04	6.20E-04	95.2	40,000
5.524	1.00E-04	5.52E-04	95.2	50,000
5.786	8.50E-05	4.92E-04	95.1	60,000
5.957	7.50E-05	4.47E-04	95.0	70,000
6.072	6.70E-05	4.07E-04	95.2	80,000
6.164	6.00E-05	3.70E-04	95.3	90,000
6.235	5.60E-05	3.49E-04	94.9	100,000
6.500	3.00E-05	1.95E-04	95.1	200,000
6.700	1.60E-05	1.07E-04	95.6	400,000
6.770	9.90E-06	6.70E-05	95.3	600,000
6.800	7.50E-06	5.10E-05	95.6	800,000
6.810	6.00E-06	4.09E-05	95.5	1,000,000



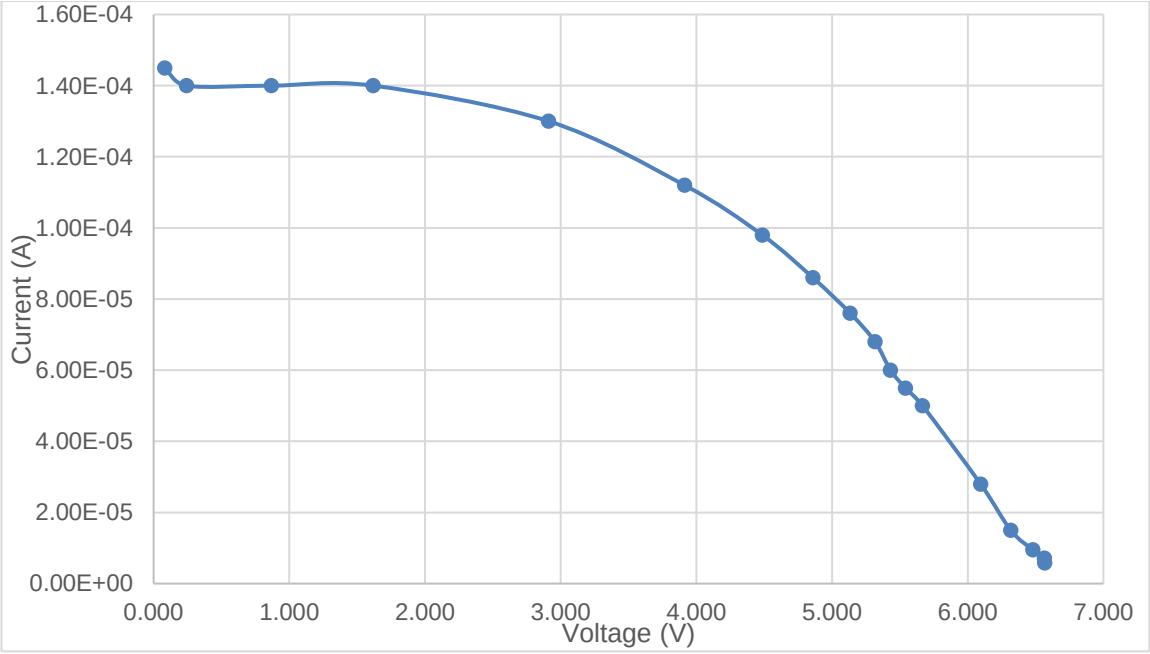
Kuvio 120. Voltage (V) vs Current (I) curve for panel ATCJ-I-55 polycarbonate cover at 60°.



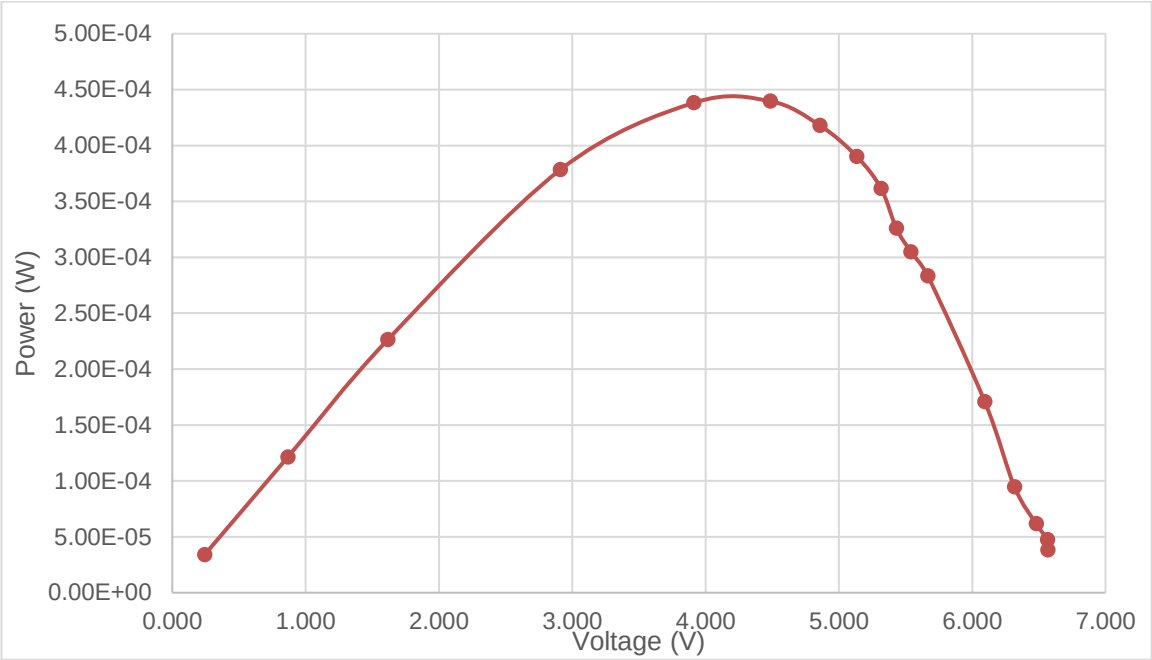
Kuvio 121. Voltage (V) vs Power (W) curve for panel ATCJ-I-55 with polycarbonate cover at 60°.

Taulukko 63. Results for panel ATCJ-I-55 with polycarbonate cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.082	1.45E-04	1.19E-05	81.7	-
0.243	1.40E-04	3.40E-05	81.8	1,000
0.867	1.40E-04	1.21E-04	81.3	5,000
1.617	1.40E-04	2.26E-04	81.5	10,000
2.911	1.30E-04	3.78E-04	81.4	20,000
3.913	1.12E-04	4.38E-04	81.8	30,000
4.486	9.80E-05	4.40E-04	81.6	40,000
4.859	8.60E-05	4.18E-04	81.4	50,000
5.134	7.60E-05	3.90E-04	81.8	60,000
5.317	6.80E-05	3.62E-04	81.6	70,000
5.431	6.00E-05	3.26E-04	81.8	80,000
5.541	5.50E-05	3.05E-04	81.6	90,000
5.667	5.00E-05	2.83E-04	81.3	100,000
6.095	2.80E-05	1.71E-04	81.5	200,000
6.317	1.50E-05	9.48E-05	81.7	400,000
6.480	9.50E-06	6.16E-05	81.6	600,000
6.565	7.20E-06	4.73E-05	81.9	800,000
6.568	5.80E-06	3.81E-05	81.4	1,000,000



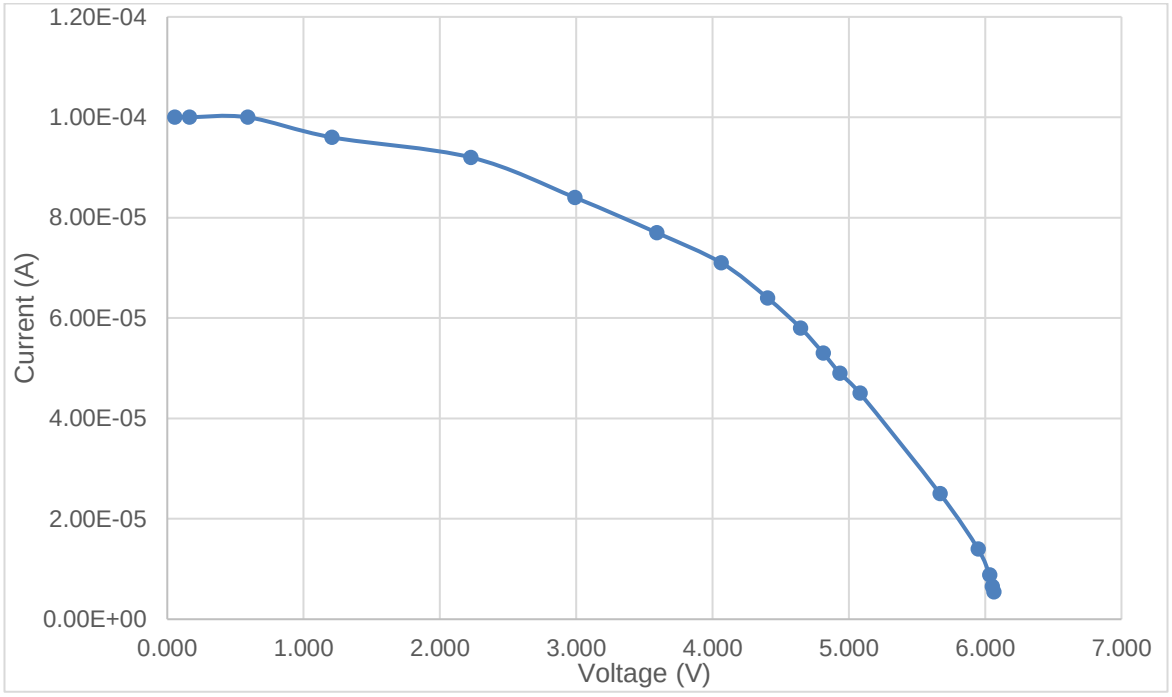
Kuvio 122. Voltage (V) vs Current (I) curve for panel ATCJ-I-55 polycarbonate cover at 45°.



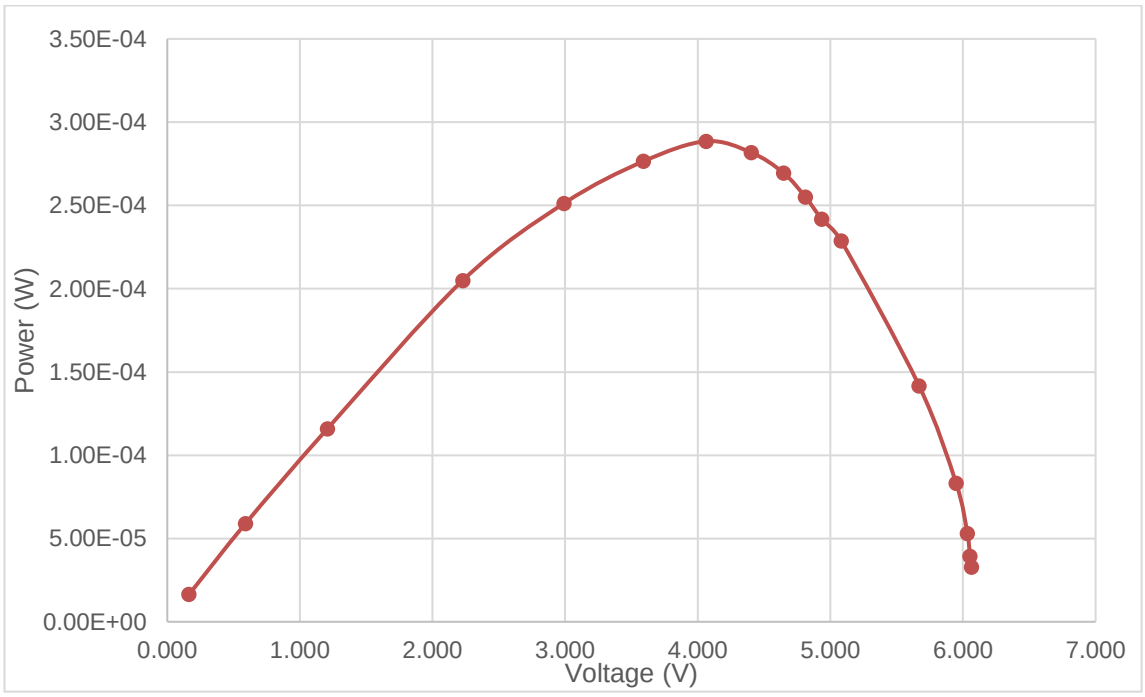
Kuvio 123. Voltage (V) vs Power (W) curve for panel ATCJ-I-55 with polycarbonate cover at 45°.

Taulukko 64. Results for panel ATCJ-I-55 with polycarbonate cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.055	1.00E-04	5.50E-06	61.5	-
0.164	1.00E-04	1.64E-05	61.6	1,000
0.590	1.00E-04	5.90E-05	61.3	5,000
1.208	9.60E-05	1.16E-04	61.8	10,000
2.228	9.20E-05	2.05E-04	61.7	20,000
2.991	8.40E-05	2.51E-04	61.5	30,000
3.591	7.70E-05	2.77E-04	61.3	40,000
4.064	7.10E-05	2.89E-04	61.5	50,000
4.403	6.40E-05	2.82E-04	61.6	60,000
4.647	5.80E-05	2.70E-04	61.8	70,000
4.812	5.30E-05	2.55E-04	61.5	80,000
4.935	4.90E-05	2.42E-04	61.7	90,000
5.082	4.50E-05	2.29E-04	61.7	100,000
5.669	2.50E-05	1.42E-04	61.6	200,000
5.948	1.40E-05	8.33E-05	61.5	400,000
6.033	8.80E-06	5.31E-05	61.4	600,000
6.053	6.50E-06	3.93E-05	61.7	800,000
6.065	5.40E-06	3.28E-05	61.6	1,000,000



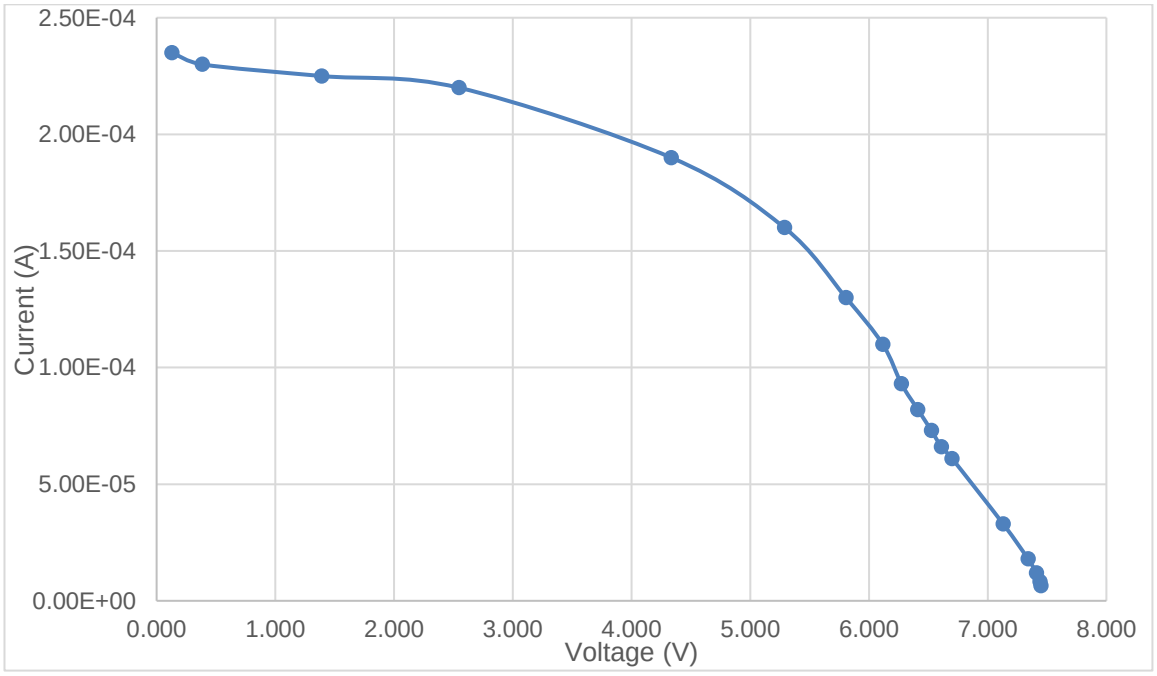
Kuvio 124. Voltage (V) vs Current (I) curve for panel ATCJ-I-55 polycarbonate cover at 30°.



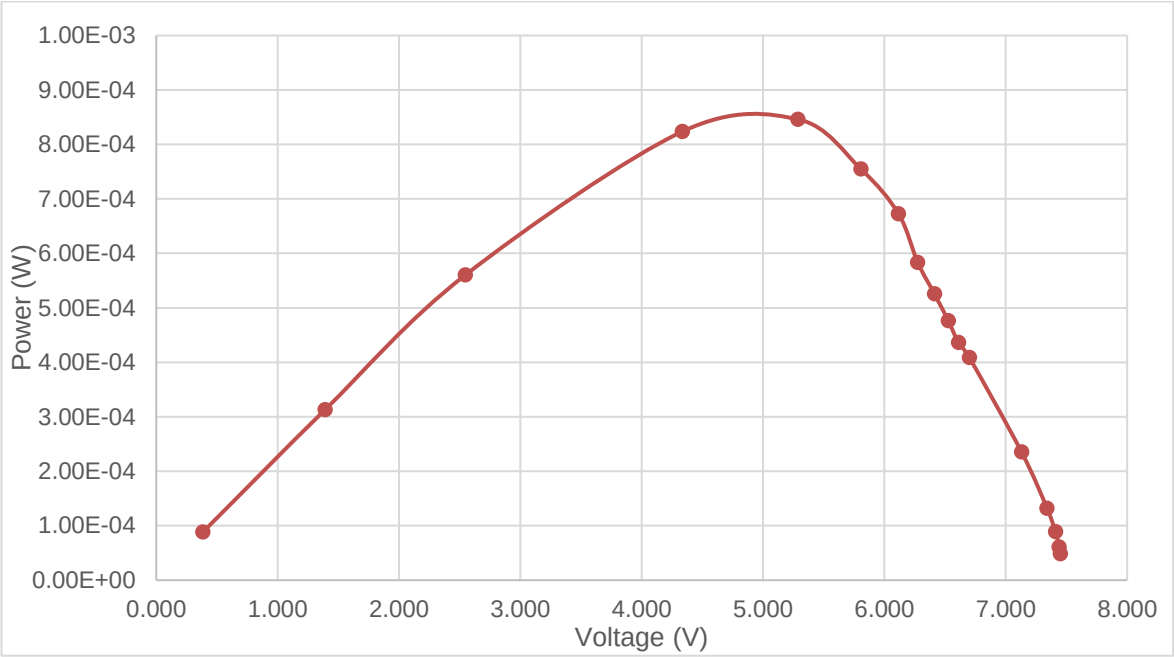
Kuvio 125. Voltage (V) vs Power (W) curve for panel ATCJ-I-55 with polycarbonate cover at 30°.

Taulukko 65. Results for panel ATCJ-I-55 with 3mm glass cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.129	2.35E-04	3.03E-05	100.5	-
0.384	2.30E-04	8.83E-05	99.9	1,000
1.391	2.25E-04	3.13E-04	100.1	5,000
2.546	2.20E-04	5.60E-04	100.3	10,000
4.336	1.90E-04	8.24E-04	100.4	20,000
5.288	1.60E-04	8.46E-04	100.1	30,000
5.806	1.30E-04	7.55E-04	100.0	40,000
6.116	1.10E-04	6.73E-04	100.5	50,000
6.274	9.30E-05	5.83E-04	100.4	60,000
6.412	8.20E-05	5.26E-04	100.7	70,000
6.526	7.30E-05	4.76E-04	100.1	80,000
6.610	6.60E-05	4.36E-04	100.3	90,000
6.700	6.10E-05	4.09E-04	99.9	100,000
7.130	3.30E-05	2.35E-04	100.5	200,000
7.340	1.80E-05	1.32E-04	100.6	400,000
7.410	1.20E-05	8.89E-05	100.6	600,000
7.440	8.20E-06	6.10E-05	100.7	800,000
7.450	6.50E-06	4.84E-05	100.2	1,000,000



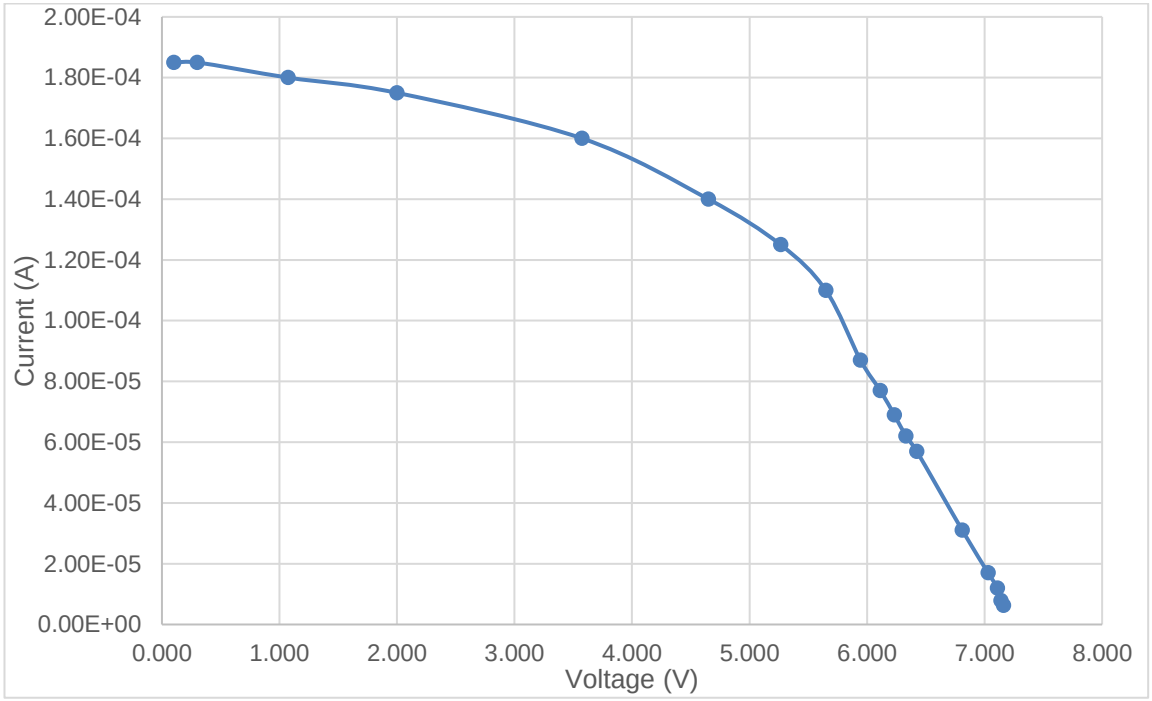
Kuvio 126. Voltage (V) vs Current (I) curve for panel ATCJ-I-55 3mm glass cover at 90°.



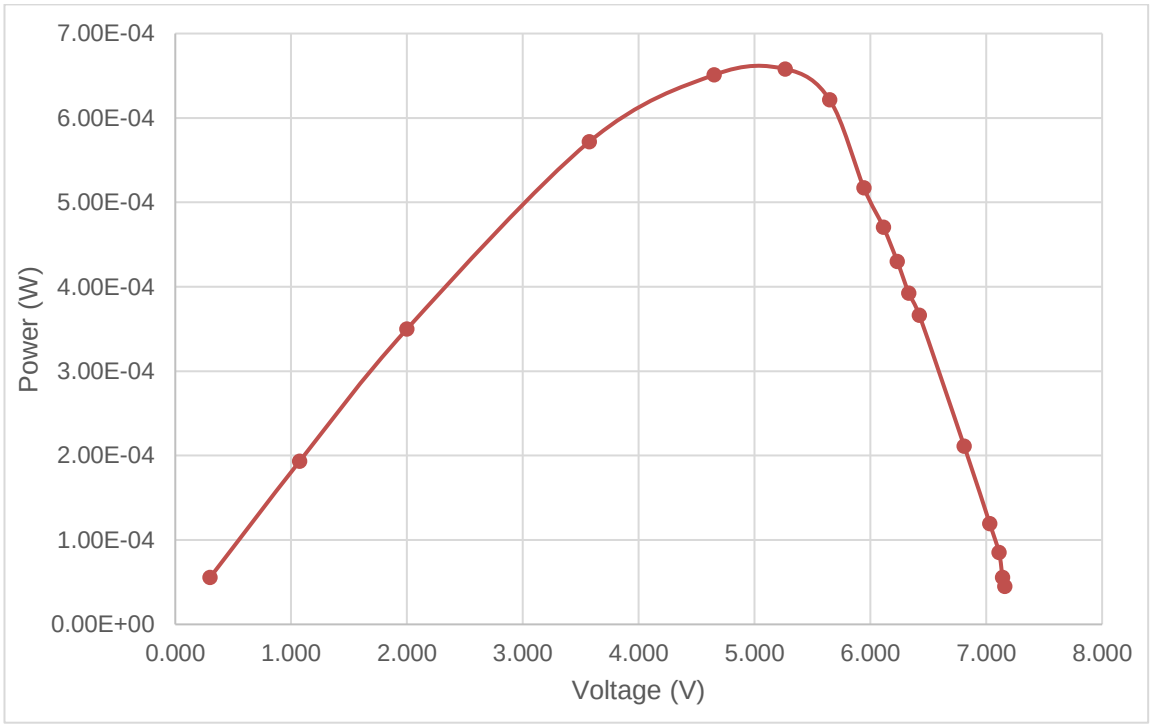
Kuvio 127. Voltage (V) vs Power (W) curve for panel ATCJ-I-55 with 3mm glass cover at 90°.

Taulukko 66. Results for panel ATCJ-I-55 with 3mm glass cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.100	1.85E-04	1.85E-05	92.5	-
0.301	1.85E-04	5.57E-05	92.7	1,000
1.074	1.80E-04	1.93E-04	92.5	5,000
1.999	1.75E-04	3.50E-04	92.4	10,000
3.575	1.60E-04	5.72E-04	92.4	20,000
4.650	1.40E-04	6.51E-04	92.3	30,000
5.264	1.25E-04	6.58E-04	92.8	40,000
5.649	1.10E-04	6.21E-04	92.4	50,000
5.944	8.70E-05	5.17E-04	92.8	60,000
6.112	7.70E-05	4.71E-04	92.8	70,000
6.232	6.90E-05	4.30E-04	92.5	80,000
6.331	6.20E-05	3.93E-04	92.4	90,000
6.423	5.70E-05	3.66E-04	92.6	100,000
6.810	3.10E-05	2.11E-04	92.4	200,000
7.030	1.70E-05	1.20E-04	92.6	400,000
7.110	1.20E-05	8.53E-05	92.8	600,000
7.140	7.80E-06	5.57E-05	92.6	800,000
7.160	6.30E-06	4.51E-05	92.6	1,000,000



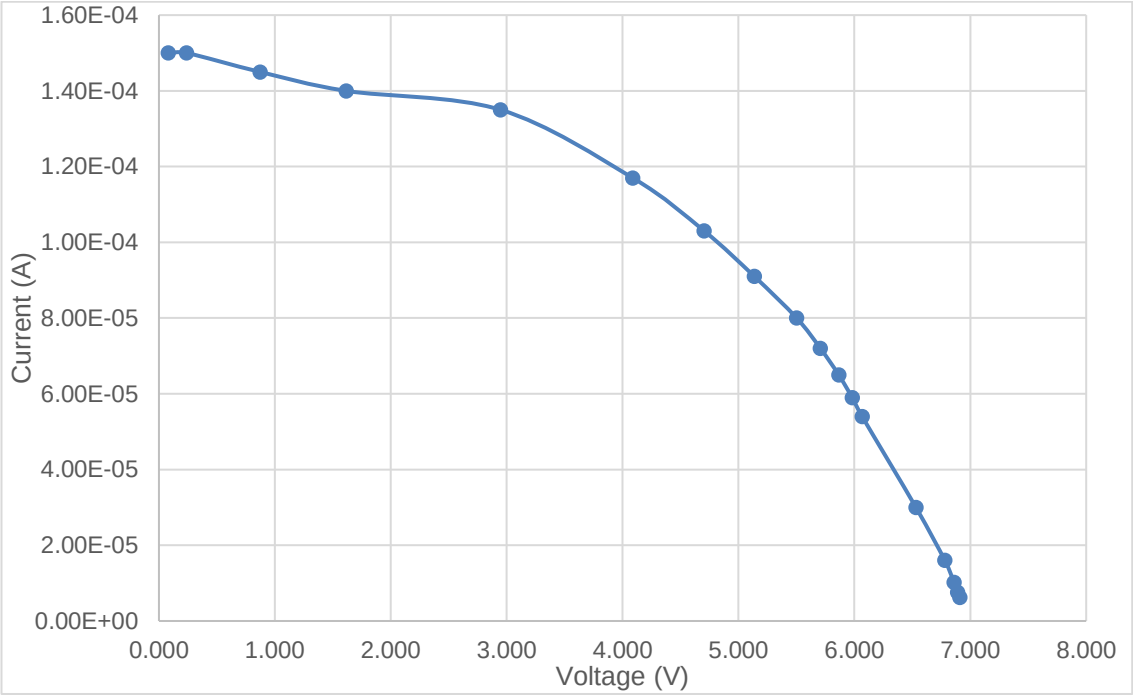
Kuvio 128. Voltage (V) vs Current (I) curve for panel ATCJ-I-55 3mm glass cover at 60°.



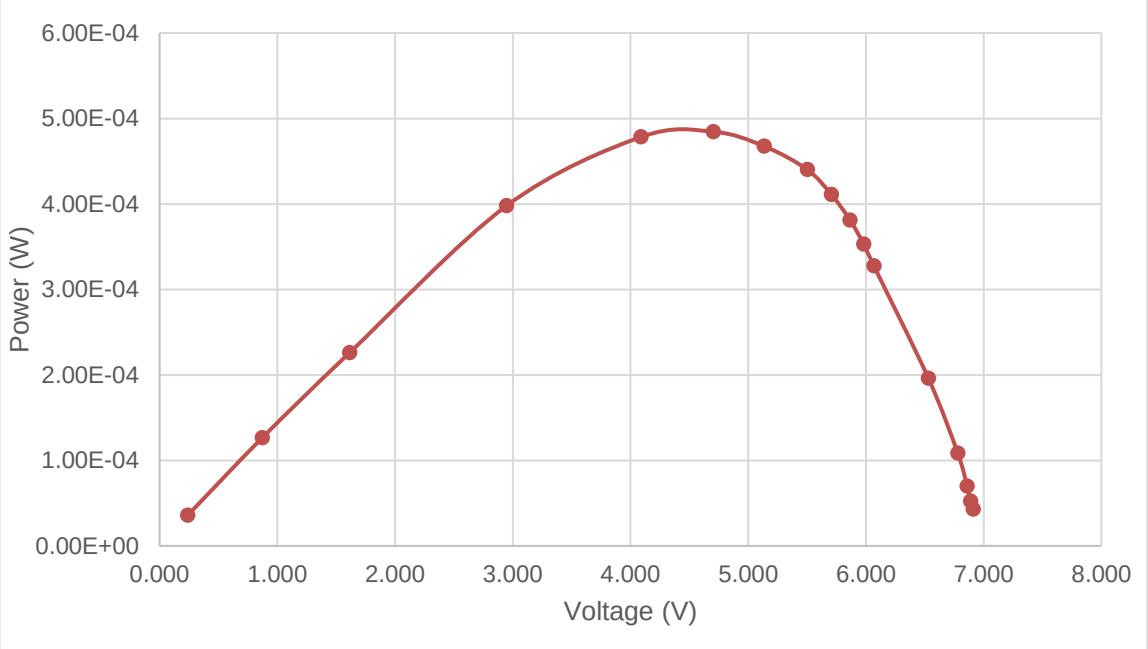
Kuvio 129. Voltage (V) vs Power (W) curve for panel ATCJ-I-55 with 3mm glass cover at 60°.

Taulukko 67. Results for panel ATCJ-I-55 with 3mm glass cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.080	1.50E-04	1.20E-05	79.0	-
0.239	1.50E-04	3.59E-05	78.6	1,000
0.873	1.45E-04	1.27E-04	79.1	5,000
1.615	1.40E-04	2.26E-04	78.9	10,000
2.947	1.35E-04	3.98E-04	78.8	20,000
4.088	1.17E-04	4.78E-04	79.1	30,000
4.704	1.03E-04	4.85E-04	78.9	40,000
5.137	9.10E-05	4.67E-04	79.2	50,000
5.502	8.00E-05	4.40E-04	78.9	60,000
5.707	7.20E-05	4.11E-04	79.0	70,000
5.865	6.50E-05	3.81E-04	79.0	80,000
5.981	5.90E-05	3.53E-04	79.0	90,000
6.067	5.40E-05	3.28E-04	78.7	100,000
6.531	3.00E-05	1.96E-04	78.9	200,000
6.780	1.60E-05	1.08E-04	78.8	400,000
6.860	1.02E-05	7.00E-05	79.0	600,000
6.890	7.60E-06	5.24E-05	78.8	800,000
6.910	6.20E-06	4.28E-05	78.8	1,000,000



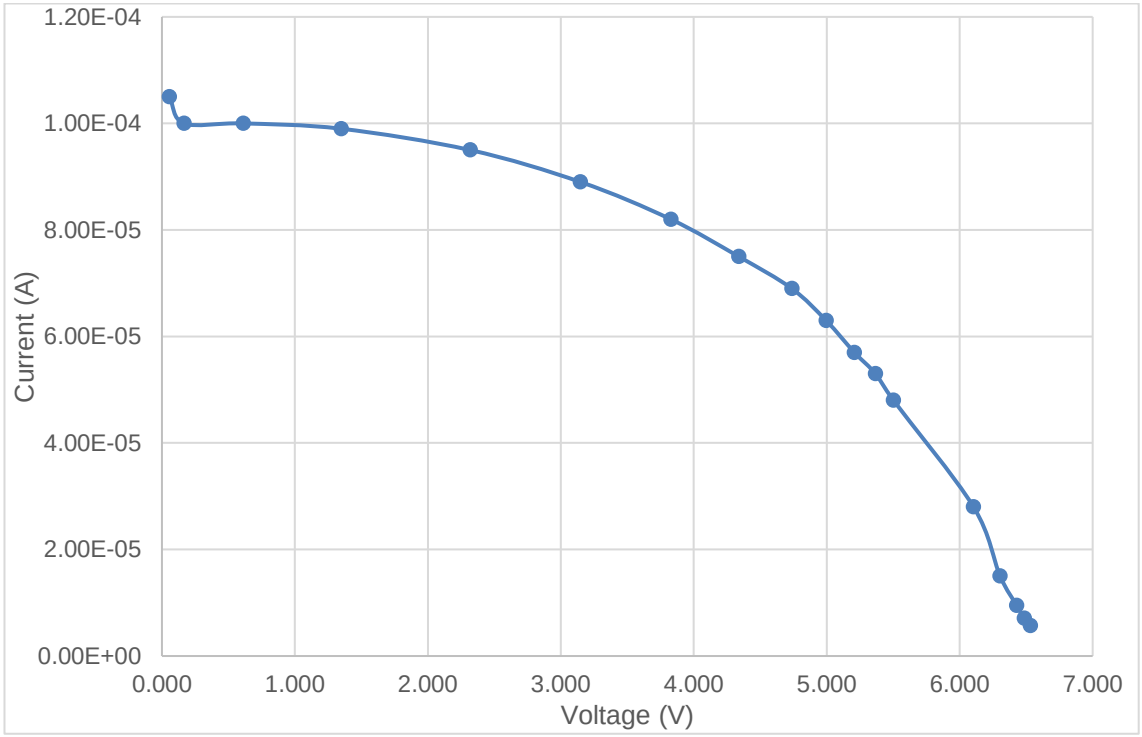
Kuvio 130. Voltage (V) vs Current (I) curve for panel ATCJ-I-55 3mm glass cover at 45°.



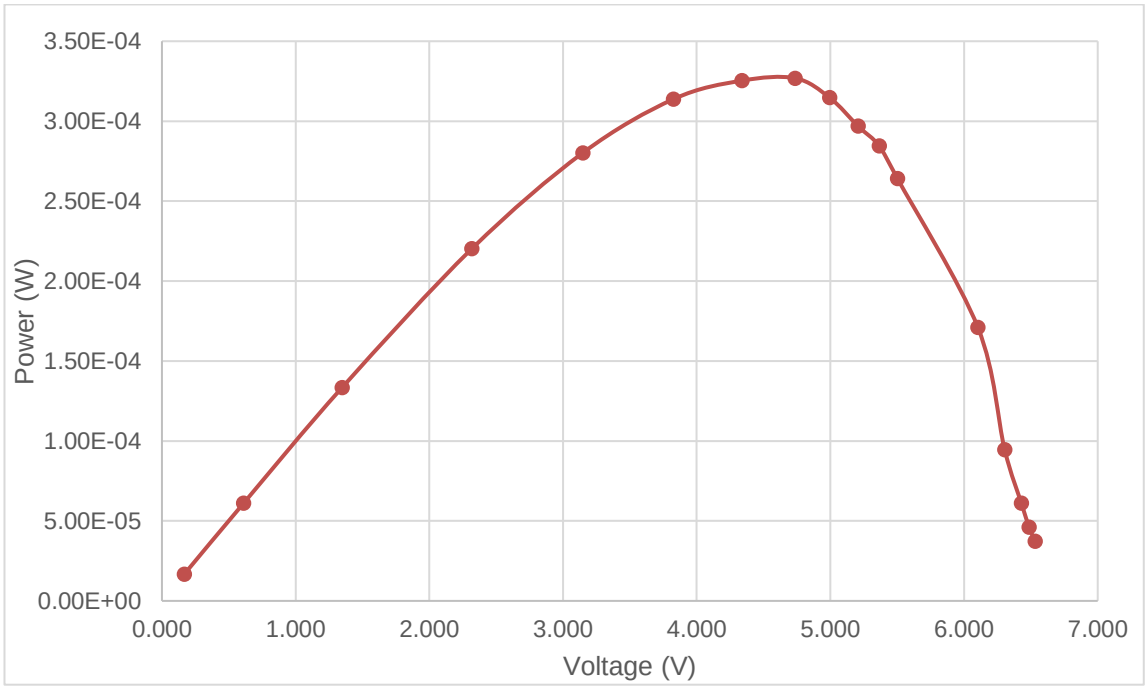
Kuvio 131. Voltage (V) vs Power (W) curve for panel ATCJ-I-55 with 3mm glass cover at 45°.

Taulukko 68. Results for panel ATCJ-I-55 with 3mm glass cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.056	1.05E-04	5.88E-06	60.8	-
0.167	1.00E-04	1.67E-05	60.4	1,000
0.611	1.00E-04	6.11E-05	60.6	5,000
1.348	9.90E-05	1.33E-04	60.8	10,000
2.318	9.50E-05	2.20E-04	60.5	20,000
3.148	8.90E-05	2.80E-04	60.4	30,000
3.827	8.20E-05	3.14E-04	60.5	40,000
4.338	7.50E-05	3.25E-04	60.4	50,000
4.737	6.90E-05	3.27E-04	60.4	60,000
4.995	6.30E-05	3.15E-04	60.5	70,000
5.208	5.70E-05	2.97E-04	60.4	80,000
5.367	5.30E-05	2.84E-04	60.6	90,000
5.502	4.80E-05	2.64E-04	60.5	100,000
6.104	2.80E-05	1.71E-04	60.4	200,000
6.304	1.50E-05	9.46E-05	60.6	400,000
6.429	9.50E-06	6.11E-05	60.3	600,000
6.487	7.10E-06	4.61E-05	60.7	800,000
6.532	5.70E-06	3.72E-05	60.4	1,000,000



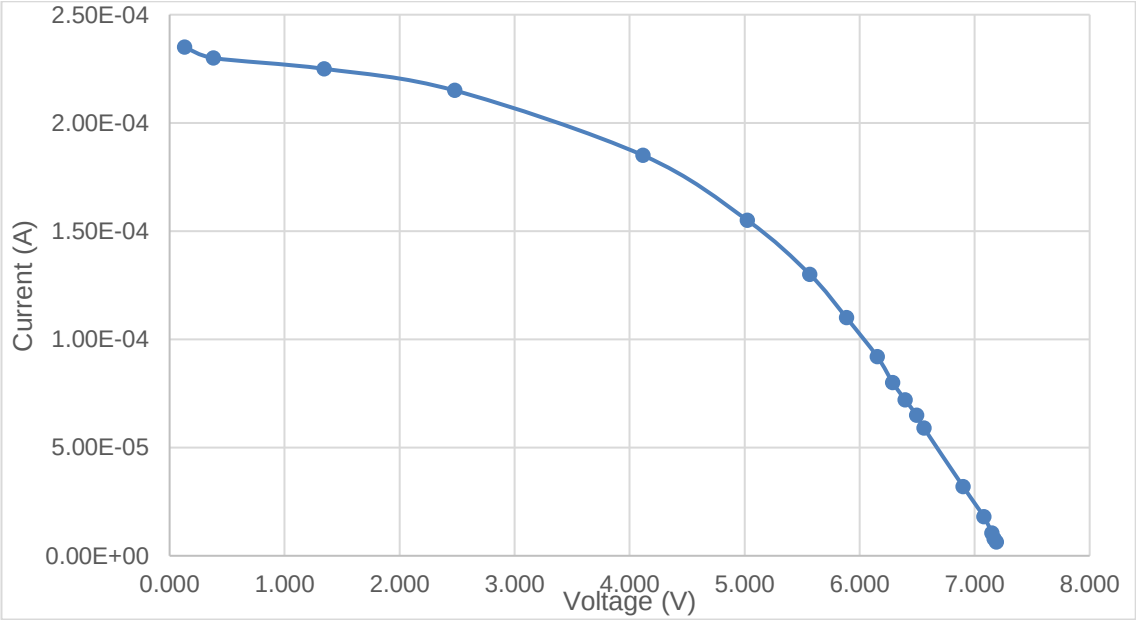
Kuvio 132. Voltage (V) vs Current (I) curve for panel ATCJ-I-55 3mm glass cover at 30°.



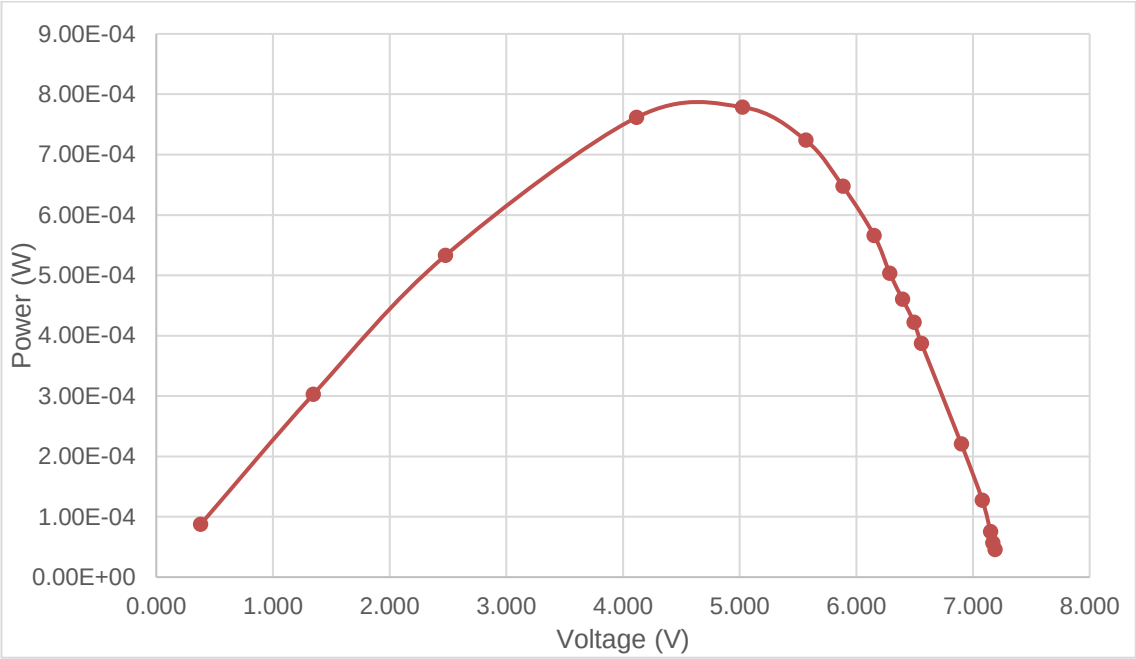
Kuvio 133. Voltage (V) vs Power (W) curve for panel ATCJ-I-55 with 3mm glass cover at 30°.

Taulukko 69. Results for panel ATCJ-I-55 with 6mm glass cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.129	2.35E-04	3.03E-05	100.7	-
0.381	2.30E-04	8.76E-05	100.4	1,000
1.345	2.25E-04	3.03E-04	100.3	5,000
2.478	2.15E-04	5.33E-04	100.3	10,000
4.117	1.85E-04	7.62E-04	100.6	20,000
5.024	1.55E-04	7.79E-04	100.4	30,000
5.567	1.30E-04	7.24E-04	100.7	40,000
5.885	1.10E-04	6.47E-04	100.4	50,000
6.153	9.20E-05	5.66E-04	100.7	60,000
6.288	8.00E-05	5.03E-04	100.3	70,000
6.396	7.20E-05	4.61E-04	100.2	80,000
6.495	6.50E-05	4.22E-04	100.7	90,000
6.559	5.90E-05	3.87E-04	100.8	100,000
6.900	3.20E-05	2.21E-04	100.4	200,000
7.080	1.80E-05	1.27E-04	100.3	400,000
7.150	1.05E-05	7.51E-05	100.4	600,000
7.170	7.90E-06	5.66E-05	100.3	800,000
7.190	6.30E-06	4.53E-05	100.5	1,000,000



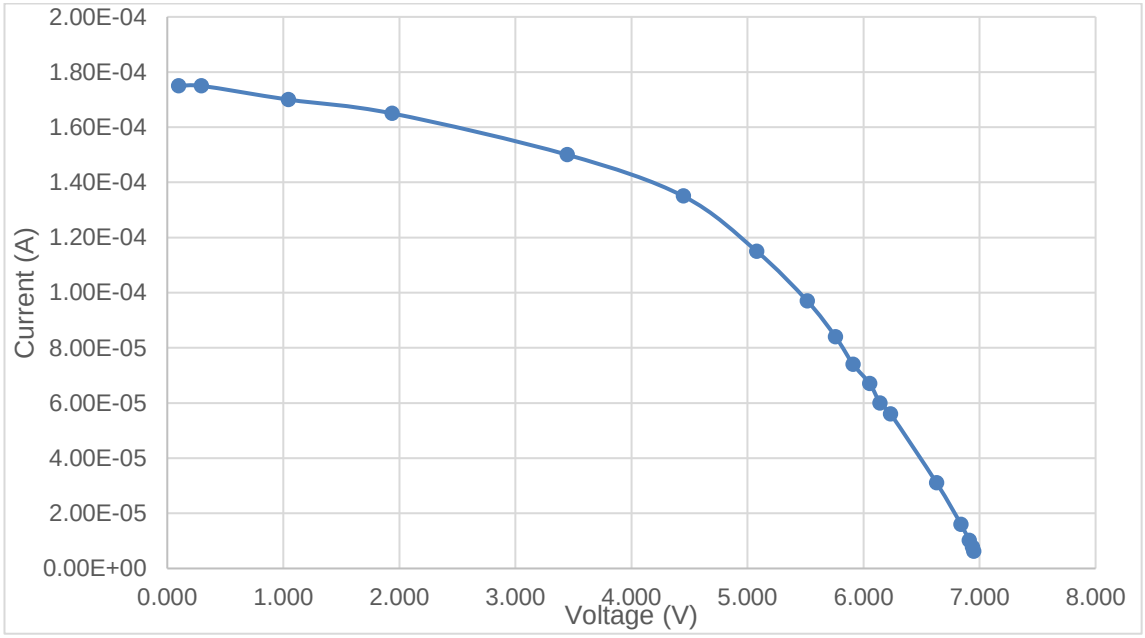
Kuvio 134. Voltage (V) vs Current (I) curve for panel ATCJ-I-55 6mm glass cover at 90°.



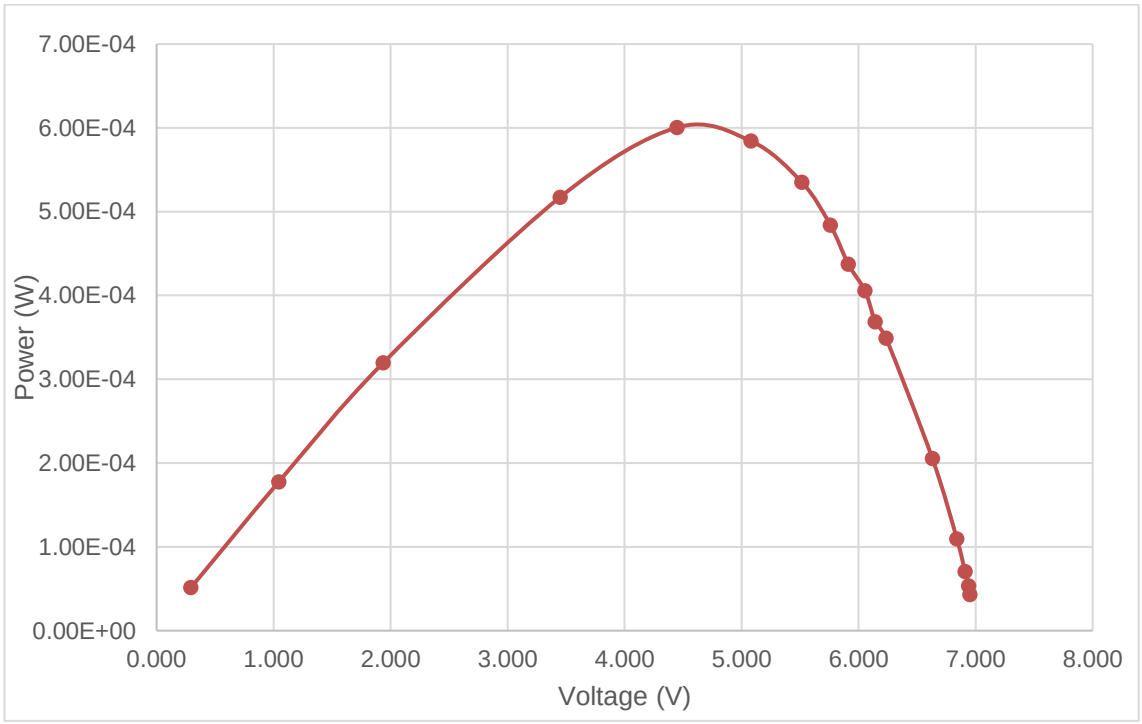
Kuvio 135. Voltage (V) vs Power (W) curve for panel ATCJ-I-55 with 6mm glass cover at 90°.

Taulukko 70. Results for panel ATCJ-I-55 with 6mm glass cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.098	1.75E-04	1.72E-05	92.7	-
0.293	1.75E-04	5.13E-05	92.7	1,000
1.044	1.70E-04	1.77E-04	92.5	5,000
1.937	1.65E-04	3.20E-04	92.2	10,000
3.448	1.50E-04	5.17E-04	92.5	20,000
4.447	1.35E-04	6.00E-04	92.4	30,000
5.080	1.15E-04	5.84E-04	92.3	40,000
5.515	9.70E-05	5.35E-04	92.1	50,000
5.759	8.40E-05	4.84E-04	92.6	60,000
5.911	7.40E-05	4.37E-04	92.2	70,000
6.054	6.70E-05	4.06E-04	92.6	80,000
6.142	6.00E-05	3.69E-04	92.5	90,000
6.234	5.60E-05	3.49E-04	92.5	100,000
6.630	3.10E-05	2.06E-04	92.2	200,000
6.840	1.60E-05	1.09E-04	92.6	400,000
6.910	1.02E-05	7.05E-05	92.3	600,000
6.940	7.70E-06	5.34E-05	92.3	800,000
6.950	6.20E-06	4.31E-05	92.4	1,000,000



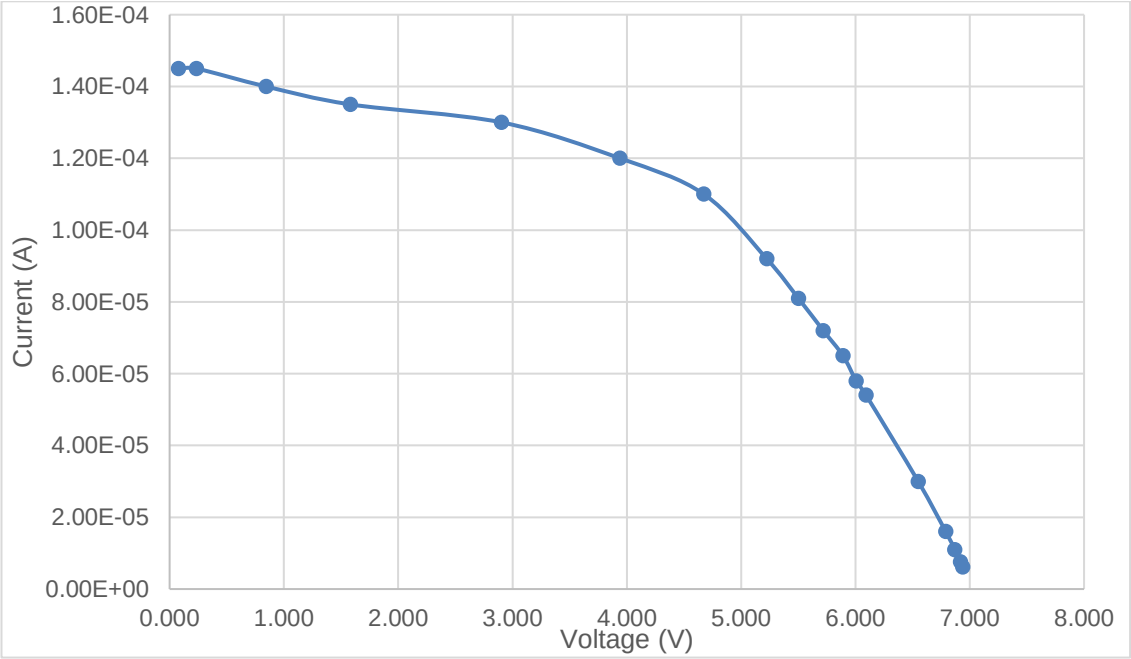
Kuvio 136. Voltage (V) vs Current (I) curve for panel ATCJ-I-55 6mm glass cover at 60°.



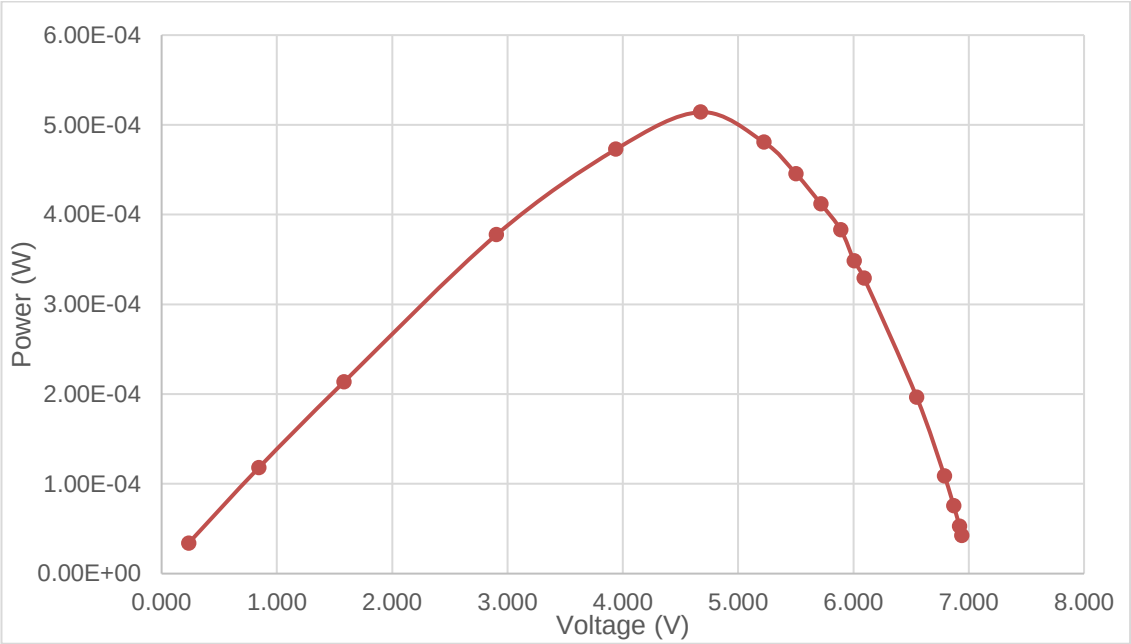
Kuvio 137. Voltage (V) vs Power (W) curve for panel ATCJ-I-55 with 6mm glass cover at 60°.

Taulukko 71. Results for panel ATCJ-I-55 with 6mm glass cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.078	1.45E-04	1.13E-05	78.6	-
0.234	1.45E-04	3.39E-05	78.3	1,000
0.844	1.40E-04	1.18E-04	78.4	5,000
1.583	1.35E-04	2.14E-04	78.6	10,000
2.904	1.30E-04	3.78E-04	78.6	20,000
3.940	1.20E-04	4.73E-04	78.6	30,000
4.674	1.10E-04	5.14E-04	78.1	40,000
5.224	9.20E-05	4.81E-04	78.6	50,000
5.501	8.10E-05	4.46E-04	78.6	60,000
5.719	7.20E-05	4.12E-04	78.4	70,000
5.891	6.50E-05	3.83E-04	78.6	80,000
6.006	5.80E-05	3.48E-04	78.7	90,000
6.093	5.40E-05	3.29E-04	78.4	100,000
6.549	3.00E-05	1.96E-04	78.3	200,000
6.790	1.60E-05	1.09E-04	78.1	400,000
6.870	1.10E-05	7.56E-05	78.3	600,000
6.920	7.60E-06	5.26E-05	78.4	800,000
6.940	6.10E-06	4.23E-05	78.6	1,000,000



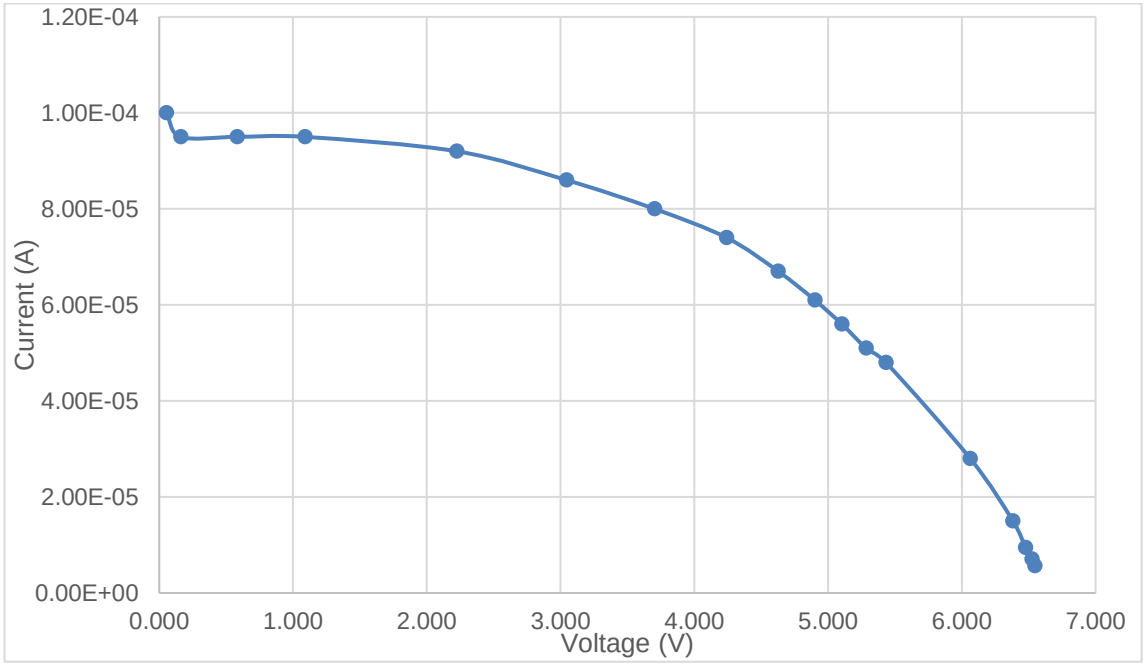
Kuvio 138. Voltage (V) vs Current (I) curve for panel ATCJ-I-55 6mm glass cover at 45°.



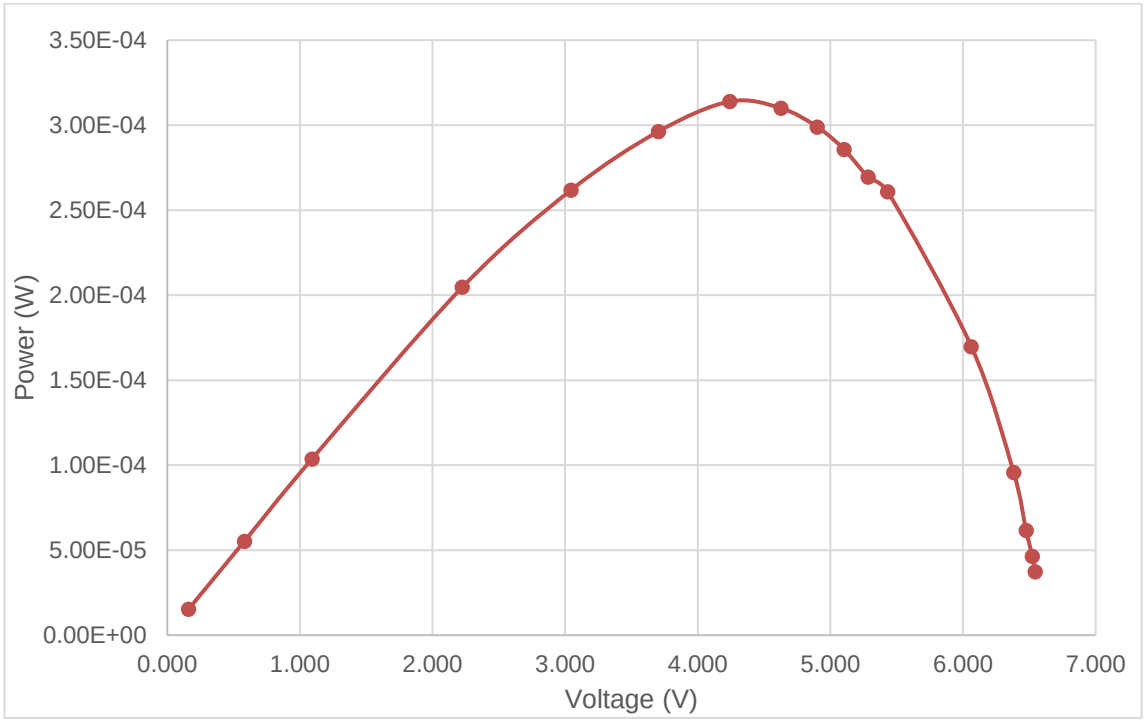
Kuvio 139. Voltage (V) vs Power (W) curve for panel ATCJ-I-55 with 6mm glass cover at 45°.

Taulukko 72. Results for panel ATCJ-I-55 with 6mm glass cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.054	1.00E-04	5.40E-06	60.5	-
0.161	9.50E-05	1.53E-05	60.5	1,000
0.582	9.50E-05	5.53E-05	60.4	5,000
1.091	9.50E-05	1.04E-04	60.5	10,000
2.225	9.20E-05	2.05E-04	60.4	20,000
3.044	8.60E-05	2.62E-04	60.6	30,000
3.703	8.00E-05	2.96E-04	60.6	40,000
4.242	7.40E-05	3.14E-04	60.8	50,000
4.627	6.70E-05	3.10E-04	60.9	60,000
4.901	6.10E-05	2.99E-04	60.6	70,000
5.103	5.60E-05	2.86E-04	60.4	80,000
5.284	5.10E-05	2.69E-04	60.5	90,000
5.433	4.80E-05	2.61E-04	60.6	100,000
6.063	2.80E-05	1.70E-04	60.6	200,000
6.382	1.50E-05	9.57E-05	60.5	400,000
6.476	9.50E-06	6.15E-05	60.5	600,000
6.524	7.10E-06	4.63E-05	60.4	800,000
6.545	5.70E-06	3.73E-05	59.8	1,000,000



Kuvio 140. Voltage (V) vs Current (I) curve for panel ATCJ-I-55 6mm glass cover at 30°.

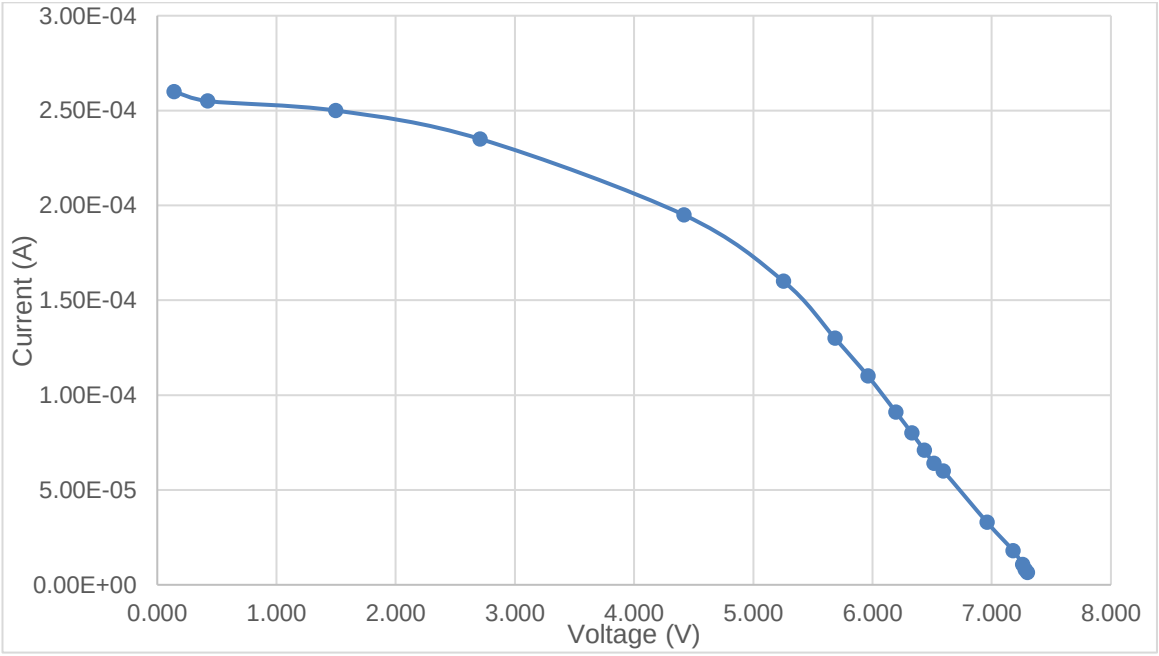


Kuvio 141. Voltage (V) vs Power (W) curve for panel ATCJ-I-55 with 6mm glass cover at 30°.

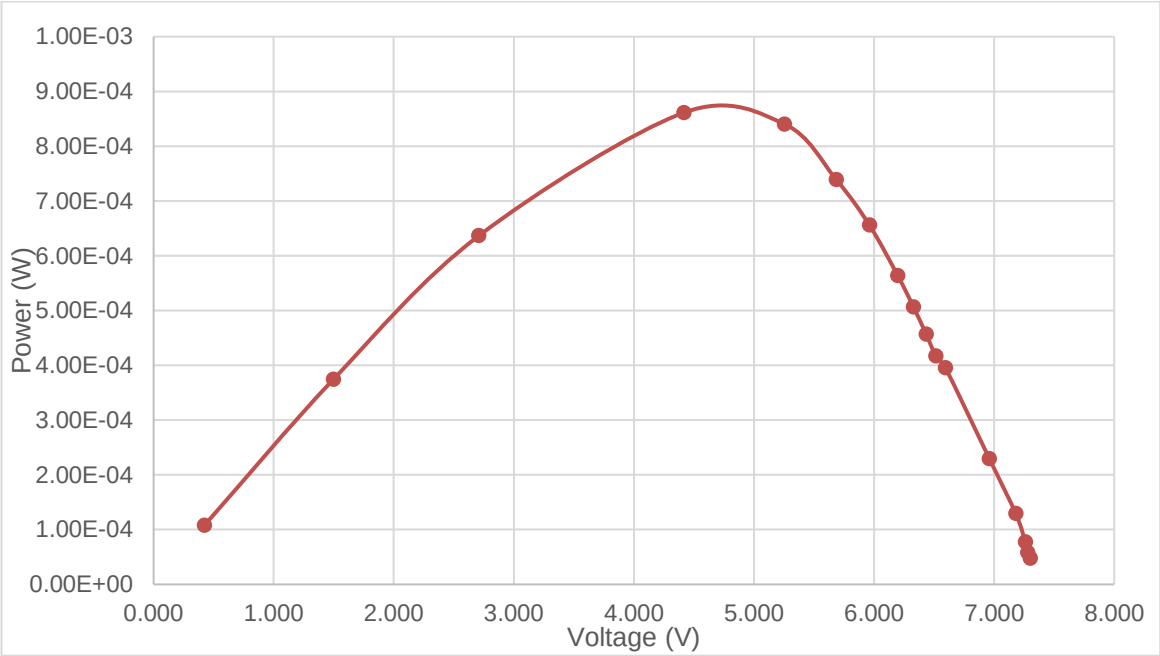
Appendix 6: Panel I_056

Taulukko 73. Results for panel ATCJ-I-56 with no cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.141	2.60E-04	3.67E-05	100.7	-
0.423	2.55E-04	1.08E-04	100.5	1,000
1.498	2.50E-04	3.75E-04	100.6	5,000
2.709	2.35E-04	6.37E-04	100.4	10,000
4.418	1.95E-04	8.62E-04	100.4	20,000
5.253	1.60E-04	8.40E-04	100.4	30,000
5.685	1.30E-04	7.39E-04	100.7	40,000
5.962	1.10E-04	6.56E-04	100.7	50,000
6.197	9.10E-05	5.64E-04	100.5	60,000
6.329	8.00E-05	5.06E-04	100.7	70,000
6.434	7.10E-05	4.57E-04	100.6	80,000
6.515	6.40E-05	4.17E-04	100.8	90,000
6.594	6.00E-05	3.96E-04	100.2	100,000
6.960	3.30E-05	2.30E-04	100.5	200,000
7.180	1.80E-05	1.29E-04	100.9	400,000
7.260	1.07E-05	7.77E-05	100.8	600,000
7.280	8.00E-06	5.82E-05	101.0	800,000
7.300	6.50E-06	4.75E-05	101.0	1,000,000



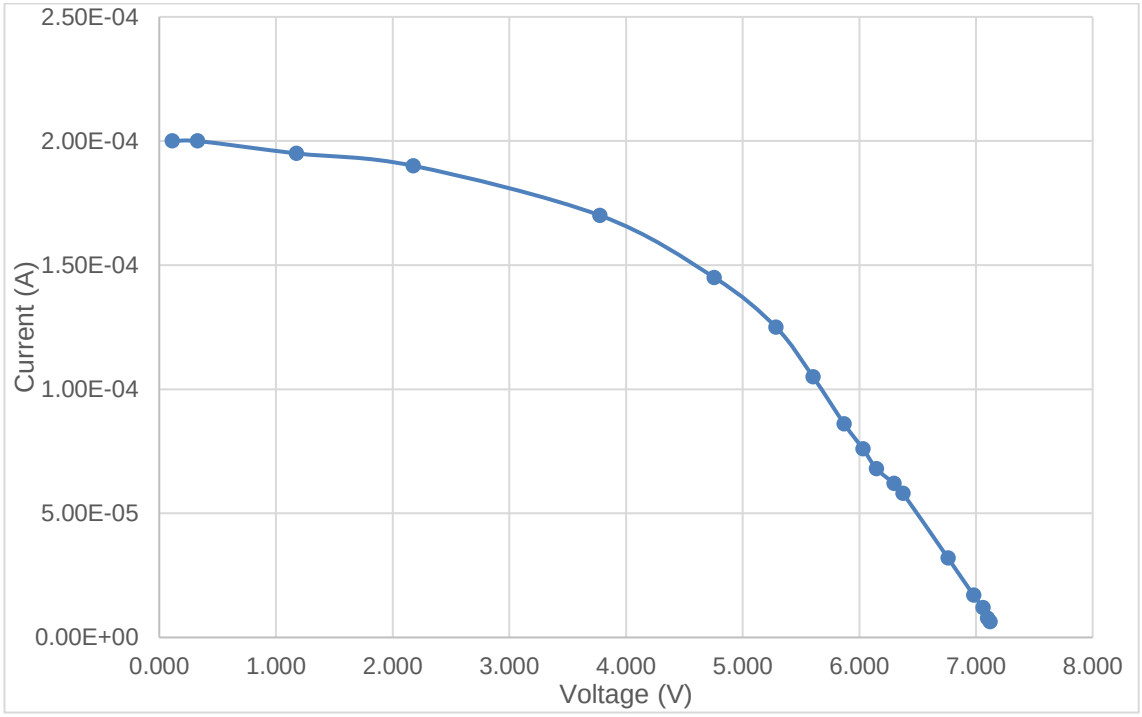
Kuvio 142. Voltage (V) vs Current (I) curve for panel ATCJ-I-56 with no cover at 90°.



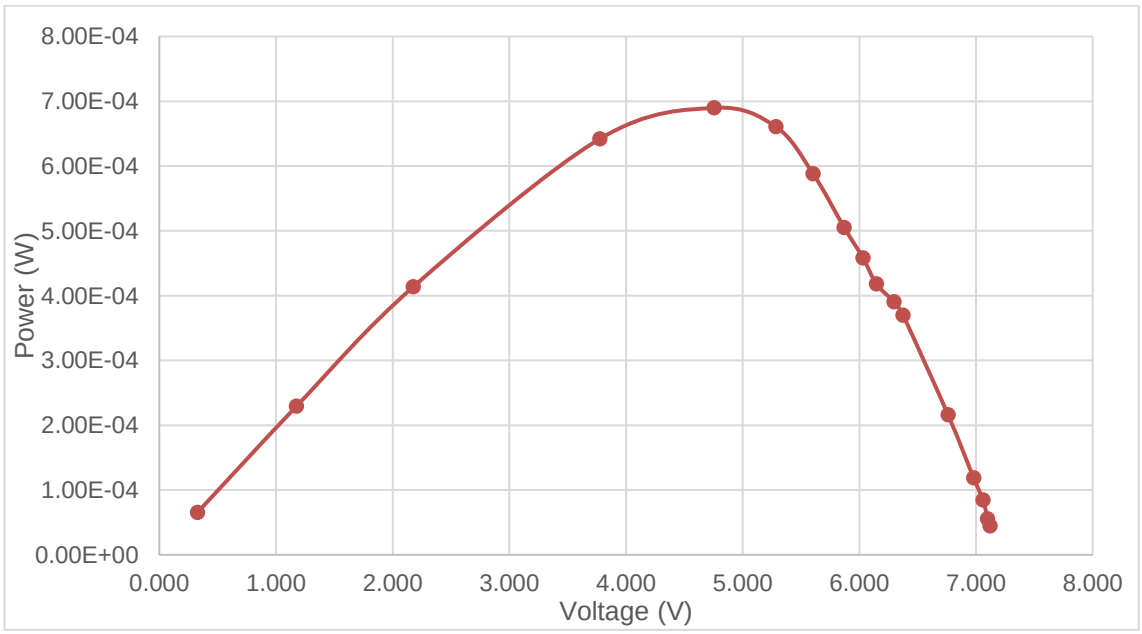
Kuvio 143. Voltage (V) vs Power (W) curve for panel ATCJ-I-56 with 6mm glass cover at 90°.

Taulukko 74. Results for panel ATCJ-I-56 with no cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.110	2.00E-04	2.20E-05	92.1	-
0.327	2.00E-04	6.54E-05	92.1	1,000
1.176	1.95E-04	2.29E-04	91.9	5,000
2.177	1.90E-04	4.14E-04	92.4	10,000
3.777	1.70E-04	6.42E-04	92.3	20,000
4.757	1.45E-04	6.90E-04	92.0	30,000
5.285	1.25E-04	6.61E-04	92.3	40,000
5.603	1.05E-04	5.88E-04	92.0	50,000
5.871	8.60E-05	5.05E-04	92.2	60,000
6.031	7.60E-05	4.58E-04	92.5	70,000
6.147	6.80E-05	4.18E-04	92.3	80,000
6.297	6.20E-05	3.90E-04	94.6	90,000
6.375	5.80E-05	3.70E-04	95.0	100,000
6.760	3.20E-05	2.16E-04	95.0	200,000
6.980	1.70E-05	1.19E-04	94.7	400,000
7.060	1.20E-05	8.47E-05	94.7	600,000
7.100	7.80E-06	5.54E-05	95.1	800,000
7.120	6.30E-06	4.49E-05	95.0	1,000,000



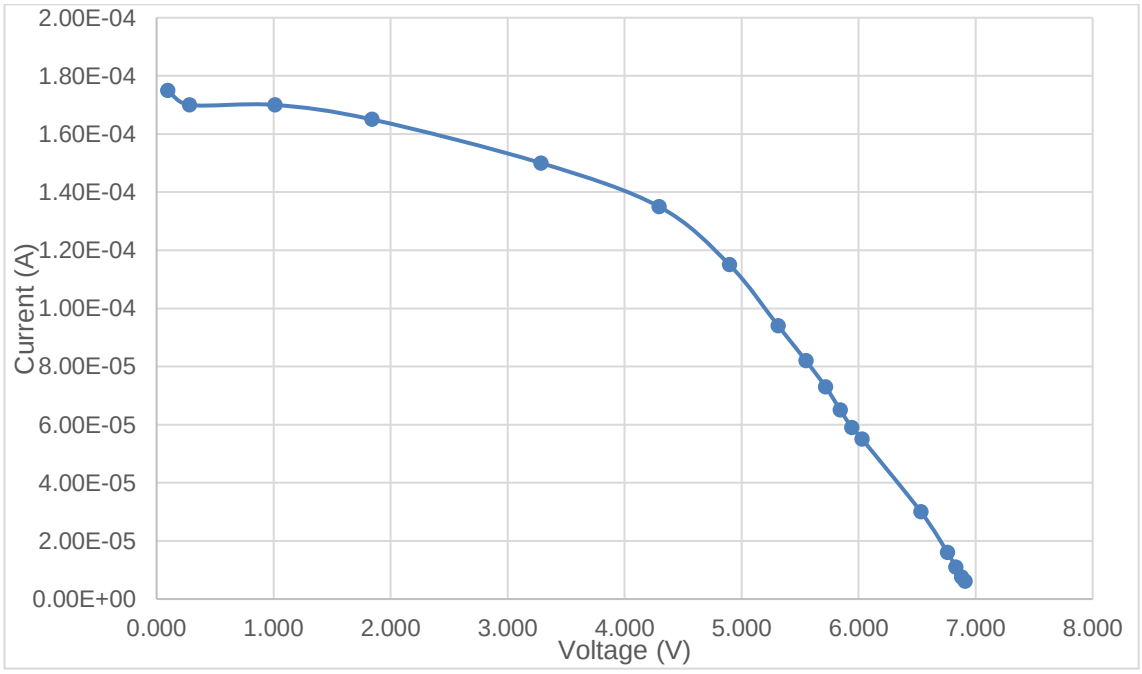
Kuvio 144. Voltage (V) vs Current (I) curve for panel ATCJ-I-56 with no cover at 60°.



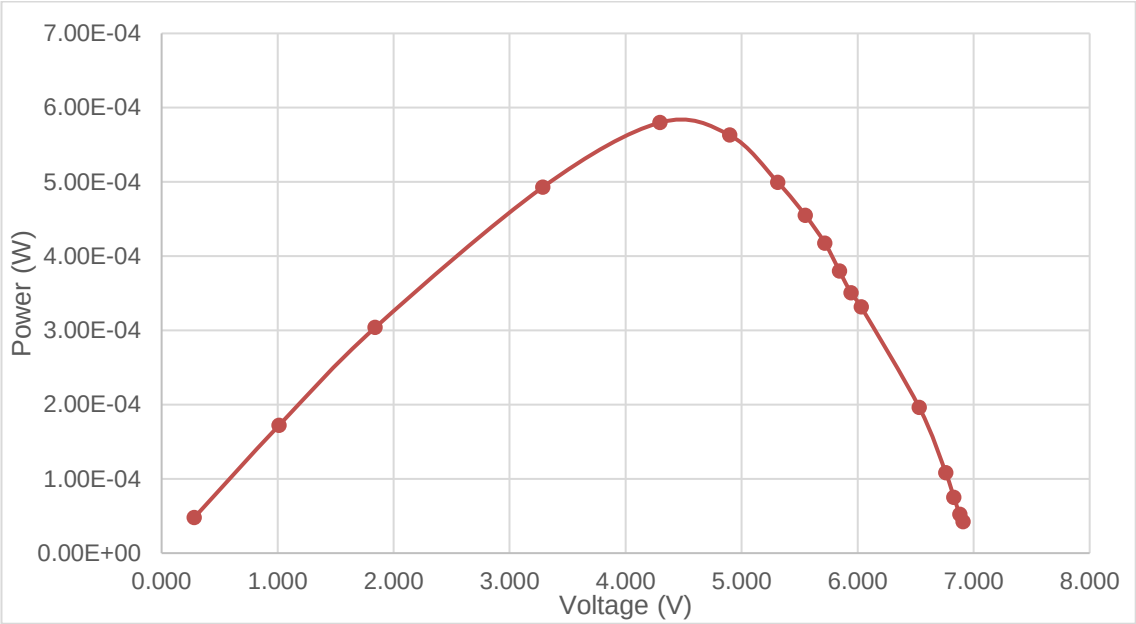
Kuvio 145. Voltage (V) vs Power (W) curve for panel ATCJ-I-56 with no cover at 60°.

Taulukko 75. Results for panel ATCJ-I-56 with no cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.095	1.75E-04	1.66E-05	80.5	-
0.281	1.70E-04	4.78E-05	80.8	1,000
1.012	1.70E-04	1.72E-04	80.6	5,000
1.841	1.65E-04	3.04E-04	80.6	10,000
3.285	1.50E-04	4.93E-04	80.7	20,000
4.295	1.35E-04	5.80E-04	81.1	30,000
4.896	1.15E-04	5.63E-04	81.2	40,000
5.312	9.40E-05	4.99E-04	81.0	50,000
5.549	8.20E-05	4.55E-04	80.6	60,000
5.718	7.30E-05	4.17E-04	80.6	70,000
5.844	6.50E-05	3.80E-04	80.7	80,000
5.942	5.90E-05	3.51E-04	80.9	90,000
6.030	5.50E-05	3.32E-04	80.8	100,000
6.532	3.00E-05	1.96E-04	81.3	200,000
6.760	1.60E-05	1.08E-04	81.1	400,000
6.830	1.10E-05	7.51E-05	81.0	600,000
6.880	7.60E-06	5.23E-05	81.3	800,000
6.910	6.10E-06	4.22E-05	81.4	1,000,000



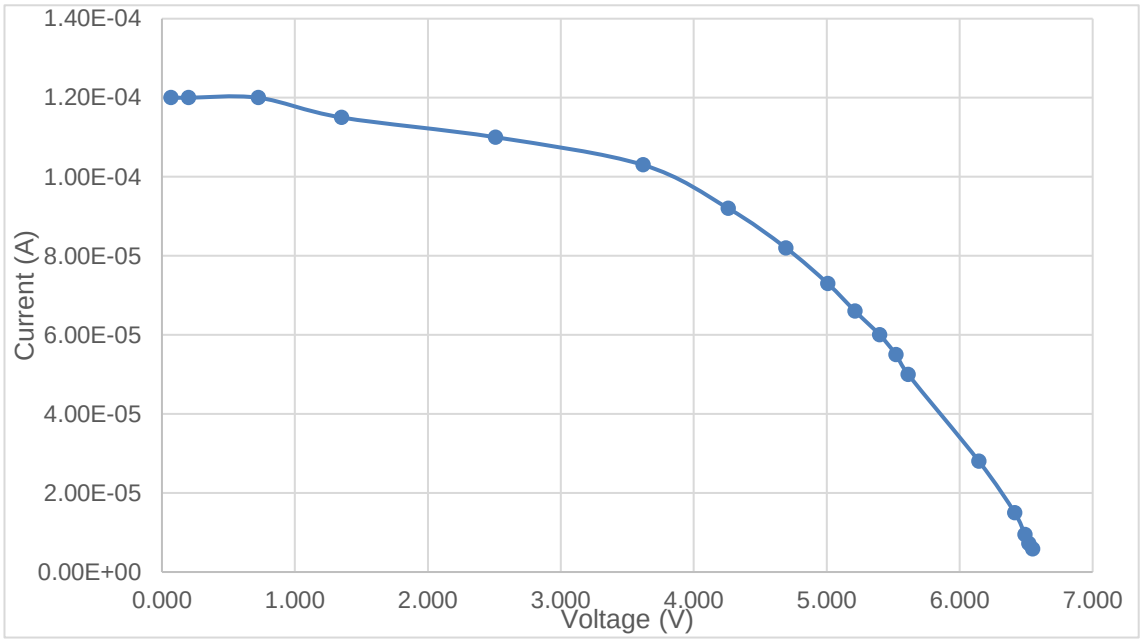
Kuvio 146. Voltage (V) vs Current (I) curve for panel ATCJ-I-56 with no cover at 45°.



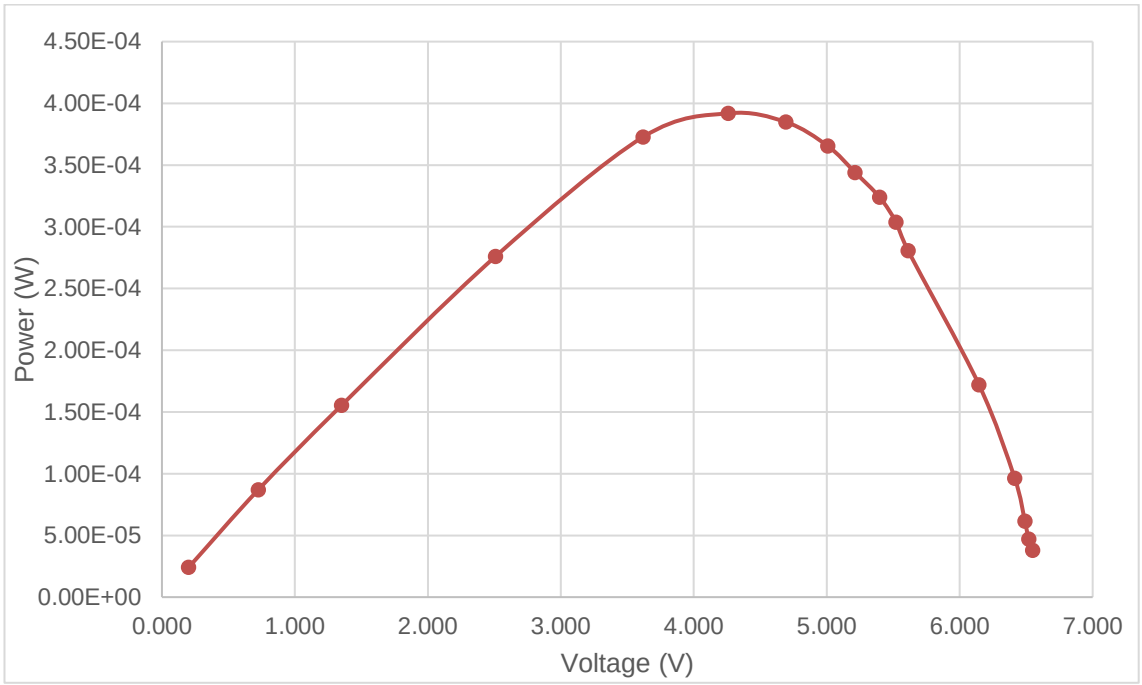
Kuvio 147. Voltage (V) vs Power (W) curve for panel ATCJ-I-56 with no cover at 45°.

Taulukko 76. Results for panel ATCJ-I-56 with no cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.067	1.20E-04	8.04E-06	62.2	-
0.201	1.20E-04	2.41E-05	62.3	1,000
0.725	1.20E-04	8.70E-05	62.3	5,000
1.351	1.15E-04	1.55E-04	62.1	10,000
2.510	1.10E-04	2.76E-04	62.2	20,000
3.619	1.03E-04	3.73E-04	62.3	30,000
4.260	9.20E-05	3.92E-04	62.3	40,000
4.693	8.20E-05	3.85E-04	62.2	50,000
5.007	7.30E-05	3.66E-04	62.2	60,000
5.213	6.60E-05	3.44E-04	62.2	70,000
5.398	6.00E-05	3.24E-04	62.2	80,000
5.521	5.50E-05	3.04E-04	62.2	90,000
5.612	5.00E-05	2.81E-04	61.8	100,000
6.145	2.80E-05	1.72E-04	61.9	200,000
6.414	1.50E-05	9.62E-05	62.2	400,000
6.490	9.50E-06	6.17E-05	62.3	600,000
6.519	7.20E-06	4.69E-05	62.3	800,000
6.549	5.80E-06	3.80E-05	62.2	1,000,000



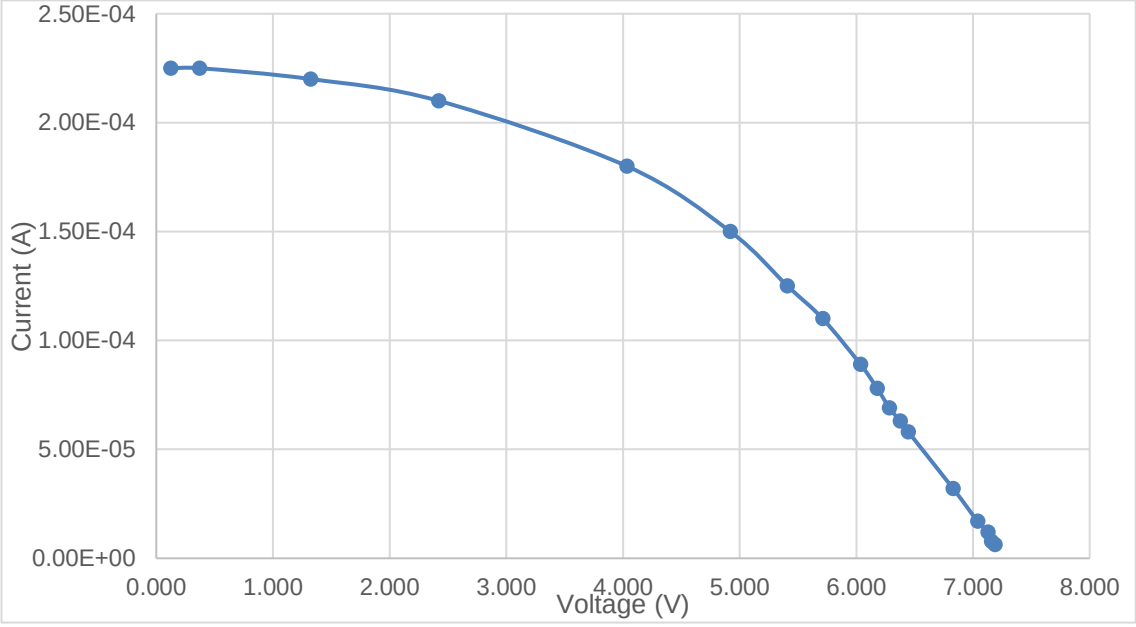
Kuvio 148. Voltage (V) vs Current (I) curve for panel ATCJ-I-56 with no cover at 30°.



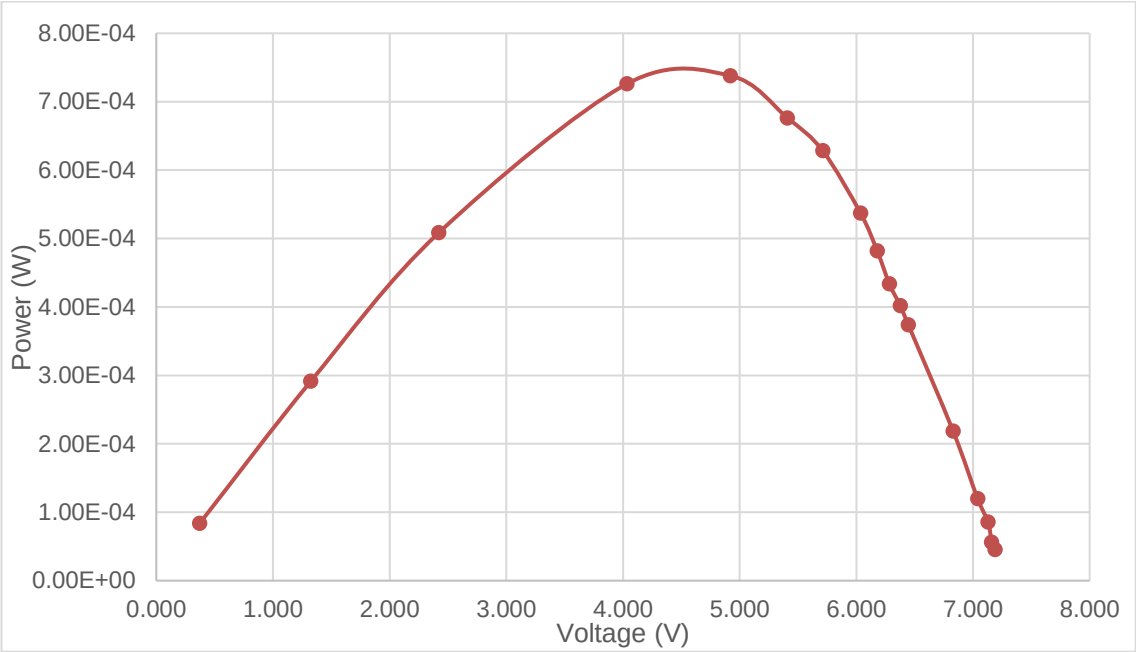
Kuvio 149. Voltage (V) vs Power (W) curve for panel ATCJ-I-56 with no cover at 30°.

Taulukko 77. Results for panel ATCJ-I-56 with polycarbonate cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.124	2.25E-04	2.79E-05	100.0	-
0.371	2.25E-04	8.35E-05	100.2	1,000
1.325	2.20E-04	2.92E-04	100.0	5,000
2.421	2.10E-04	5.08E-04	99.8	10,000
4.034	1.80E-04	7.26E-04	100.0	20,000
4.920	1.50E-04	7.38E-04	100.0	30,000
5.410	1.25E-04	6.76E-04	100.5	40,000
5.712	1.10E-04	6.28E-04	100.8	50,000
6.036	8.90E-05	5.37E-04	100.6	60,000
6.179	7.80E-05	4.82E-04	100.6	70,000
6.284	6.90E-05	4.34E-04	100.5	80,000
6.377	6.30E-05	4.02E-04	99.9	90,000
6.446	5.80E-05	3.74E-04	100.6	100,000
6.830	3.20E-05	2.19E-04	100.7	200,000
7.040	1.70E-05	1.20E-04	100.2	400,000
7.130	1.20E-05	8.56E-05	100.3	600,000
7.160	7.80E-06	5.58E-05	100.5	800,000
7.190	6.30E-06	4.53E-05	100.1	1,000,000



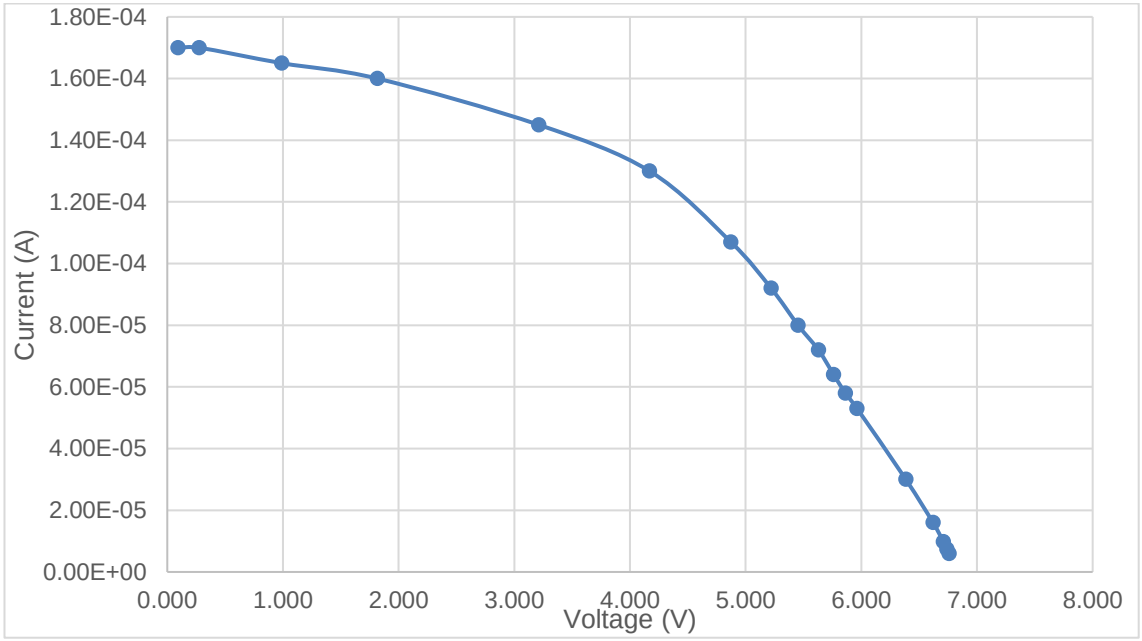
Kuvio 150. Voltage (V) vs Current (I) curve for panel ATCJ-I-56 polycarbonate cover at 90°.



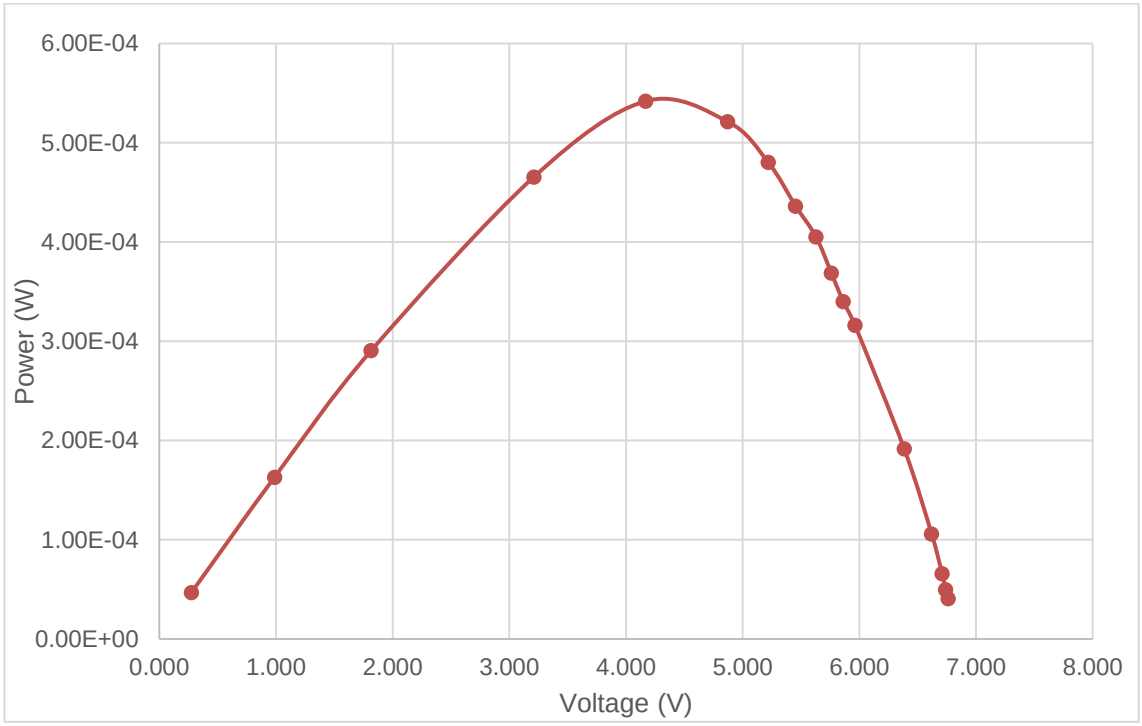
Kuvio 151. Voltage (V) vs Power (W) curve for panel ATCJ-I-56 with polycarbonate cover at 90°.

Taulukko 78. Results for panel ATCJ-I-56 with polycarbonate cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.092	1.70E-04	1.56E-05	90.5	-
0.276	1.70E-04	4.69E-05	90.5	1,000
0.988	1.65E-04	1.63E-04	90.8	5,000
1.816	1.60E-04	2.91E-04	90.5	10,000
3.211	1.45E-04	4.66E-04	90.6	20,000
4.169	1.30E-04	5.42E-04	90.5	30,000
4.872	1.07E-04	5.21E-04	90.6	40,000
5.220	9.20E-05	4.80E-04	90.6	50,000
5.454	8.00E-05	4.36E-04	90.5	60,000
5.629	7.20E-05	4.05E-04	90.4	70,000
5.761	6.40E-05	3.69E-04	90.5	80,000
5.862	5.80E-05	3.40E-04	90.4	90,000
5.963	5.30E-05	3.16E-04	90.5	100,000
6.385	3.00E-05	1.92E-04	90.7	200,000
6.620	1.60E-05	1.06E-04	90.6	400,000
6.710	9.80E-06	6.58E-05	90.5	600,000
6.740	7.40E-06	4.99E-05	90.2	800,000
6.760	6.00E-06	4.06E-05	90.5	1,000,000



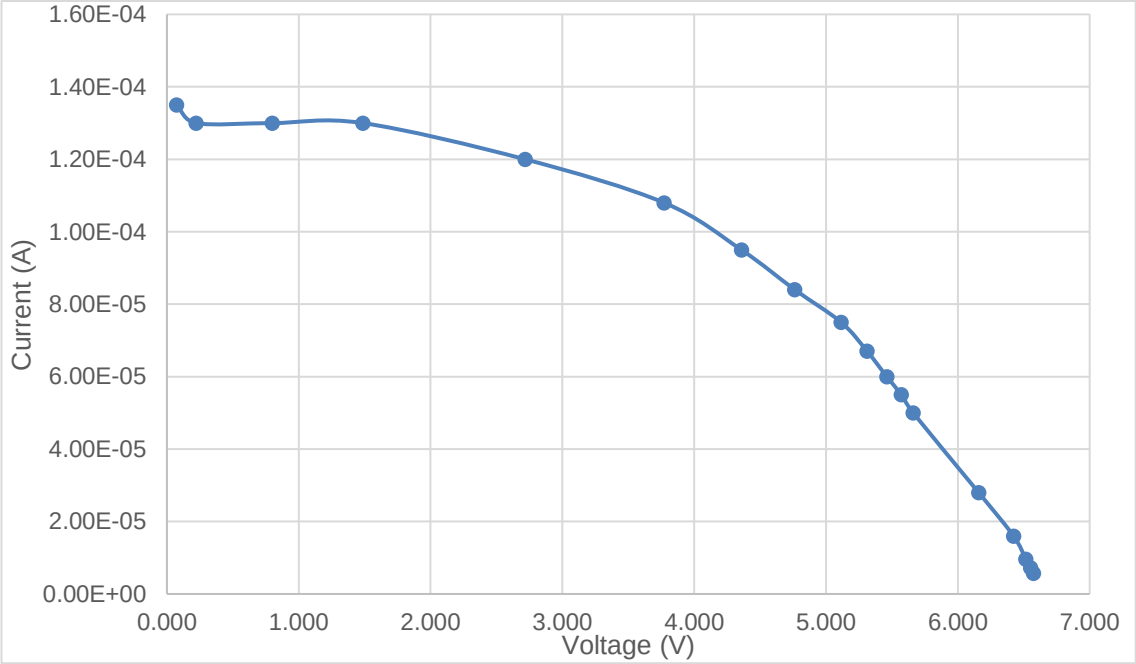
Kuvio 152. Voltage (V) vs Current (I) curve for panel ATCJ-I-56 polycarbonate cover at 60°.



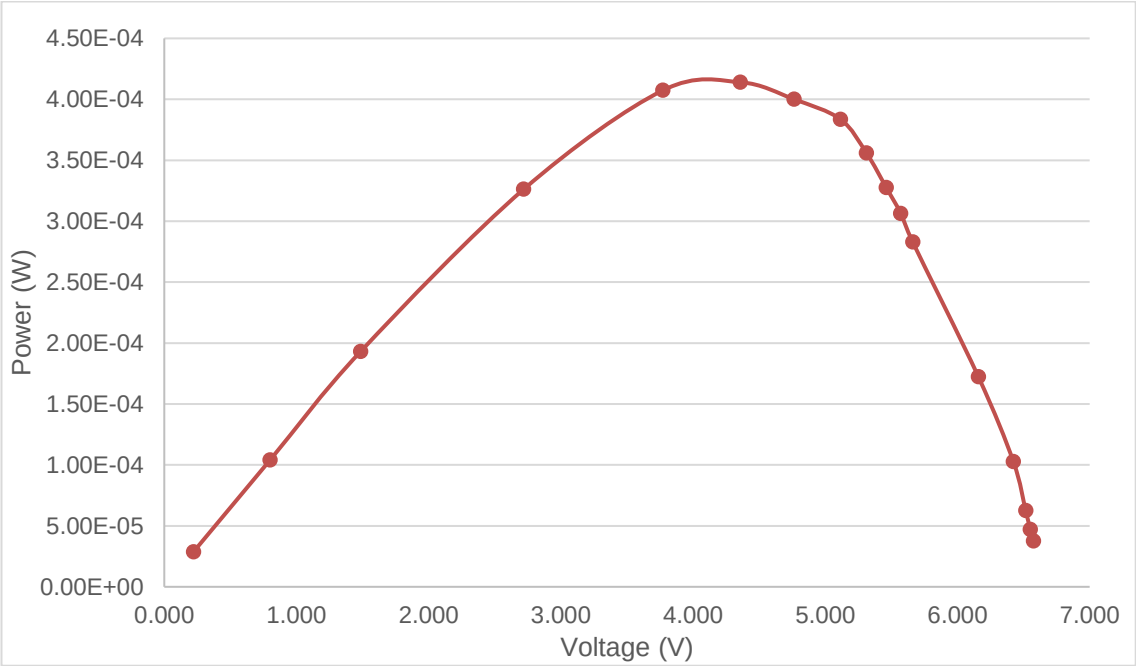
Kuvio 153. Voltage (V) vs Power (W) curve for panel ATCJ-I-56 with polycarbonate cover at 60°.

Taulukko 79. Results for panel ATCJ-I-56 with polycarbonate cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.074	1.35E-04	9.99E-06	77.5	-
0.221	1.30E-04	2.87E-05	77.3	1,000
0.800	1.30E-04	1.04E-04	77.4	5,000
1.486	1.30E-04	1.93E-04	77.2	10,000
2.718	1.20E-04	3.26E-04	77.3	20,000
3.772	1.08E-04	4.07E-04	77.7	30,000
4.358	9.50E-05	4.14E-04	77.4	40,000
4.763	8.40E-05	4.00E-04	77.5	50,000
5.115	7.50E-05	3.84E-04	77.4	60,000
5.312	6.70E-05	3.56E-04	77.4	70,000
5.461	6.00E-05	3.28E-04	77.3	80,000
5.571	5.50E-05	3.06E-04	77.4	90,000
5.661	5.00E-05	2.83E-04	77.0	100,000
6.158	2.80E-05	1.72E-04	77.4	200,000
6.423	1.60E-05	1.03E-04	77.4	400,000
6.516	9.60E-06	6.26E-05	77.5	600,000
6.551	7.20E-06	4.72E-05	77.3	800,000
6.575	5.70E-06	3.75E-05	77.5	1,000,000



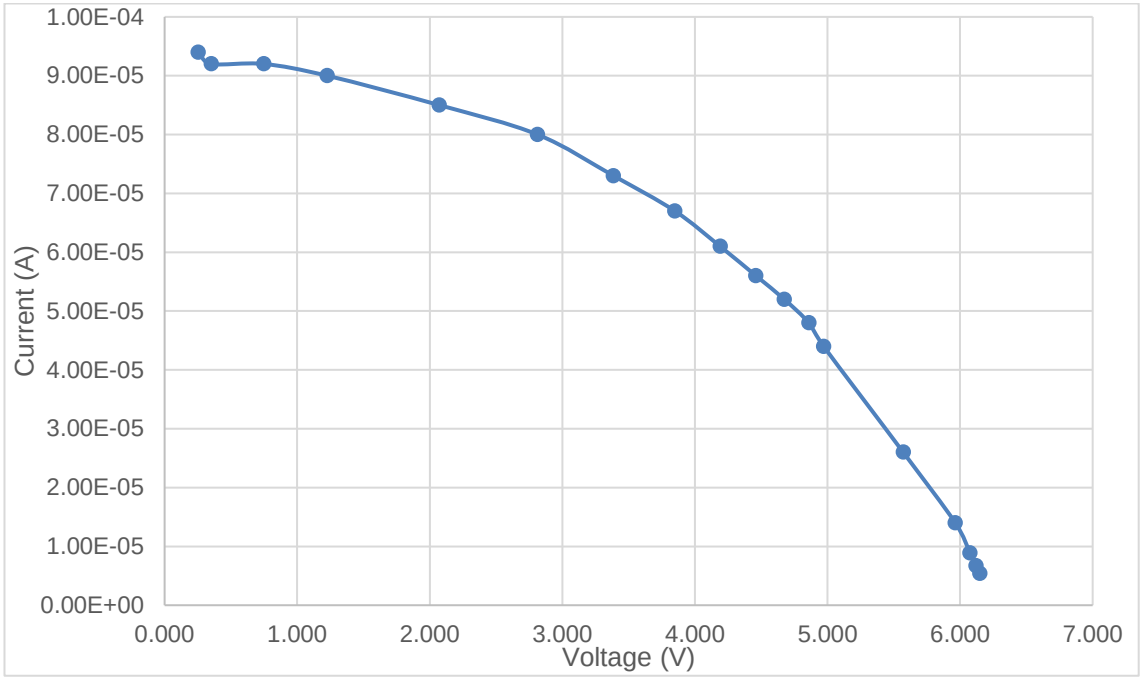
Kuvio 154. Voltage (V) vs Current (I) curve for panel ATCJ-I-56 polycarbonate cover at 45°.



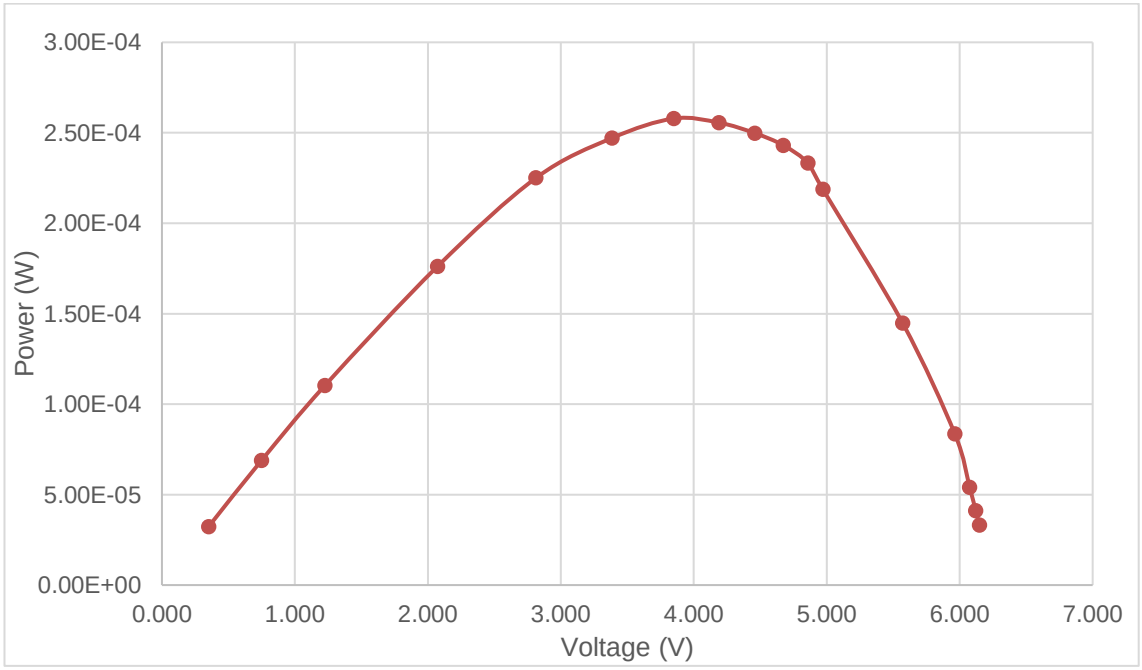
Kuvio 155. Voltage (V) vs Power (W) curve for panel ATCJ-I-56 with polycarbonate cover at 45°.

Taulukko 80. Results for panel ATCJ-I-56 with polycarbonate cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.254	9.40E-05	2.39E-05	60.0	-
0.351	9.20E-05	3.23E-05	59.8	1,000
0.749	9.20E-05	6.89E-05	60.0	5,000
1.226	9.00E-05	1.10E-04	59.9	10,000
2.072	8.50E-05	1.76E-04	60.0	20,000
2.813	8.00E-05	2.25E-04	60.0	30,000
3.385	7.30E-05	2.47E-04	60.1	40,000
3.849	6.70E-05	2.58E-04	60.1	50,000
4.190	6.10E-05	2.56E-04	60.0	60,000
4.460	5.60E-05	2.50E-04	60.1	70,000
4.674	5.20E-05	2.43E-04	60.2	80,000
4.859	4.80E-05	2.33E-04	60.0	90,000
4.971	4.40E-05	2.19E-04	60.1	100,000
5.571	2.60E-05	1.45E-04	60.1	200,000
5.964	1.40E-05	8.35E-05	60.0	400,000
6.075	8.90E-06	5.41E-05	59.8	600,000
6.121	6.70E-06	4.10E-05	60.1	800,000
6.148	5.40E-06	3.32E-05	60.1	1,000,000



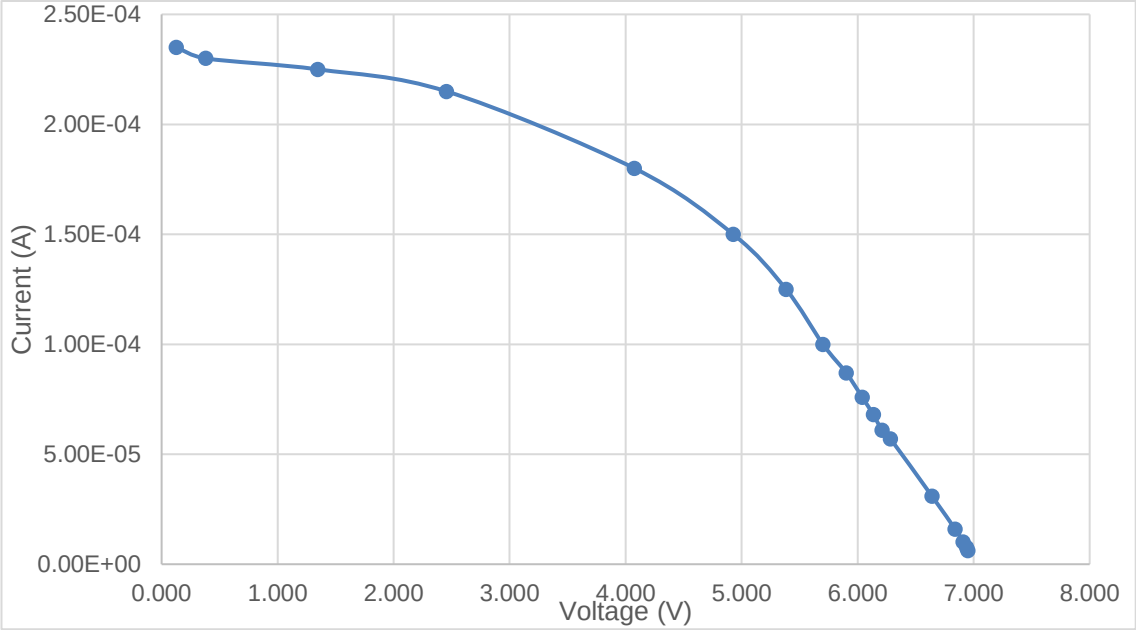
Kuvio 156. Voltage (V) vs Current (I) curve for panel ATCJ-I-56 polycarbonate cover at 30°.



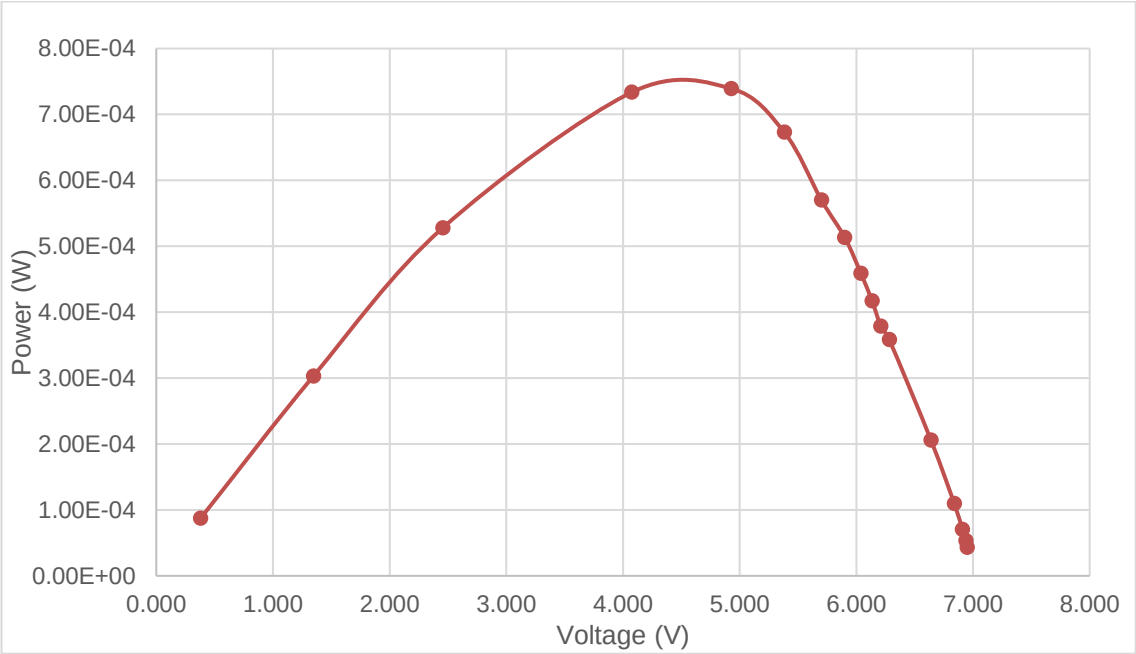
Kuvio 157. Voltage (V) vs Power (W) curve for panel ATCJ-I-56 with polycarbonate cover at 30°.

Taulukko 81. Results for panel ATCJ-I-56 with 3mm glass cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.127	2.35E-04	2.98E-05	99.9	-
0.379	2.30E-04	8.72E-05	99.7	1,000
1.347	2.25E-04	3.03E-04	99.9	5,000
2.456	2.15E-04	5.28E-04	99.9	10,000
4.076	1.80E-04	7.34E-04	100	20,000
4.928	1.50E-04	7.39E-04	99.9	30,000
5.383	1.25E-04	6.73E-04	99.7	40,000
5.701	1.00E-04	5.70E-04	99.4	50,000
5.901	8.70E-05	5.13E-04	99.3	60,000
6.039	7.60E-05	4.59E-04	99.9	70,000
6.135	6.80E-05	4.17E-04	99.5	80,000
6.210	6.10E-05	3.79E-04	99.6	90,000
6.283	5.70E-05	3.58E-04	99.1	100,000
6.640	3.10E-05	2.06E-04	99.4	200,000
6.840	1.60E-05	1.09E-04	99.3	400,000
6.910	1.02E-05	7.05E-05	99.5	600,000
6.940	7.70E-06	5.34E-05	99.7	800,000
6.950	6.20E-06	4.31E-05	99.5	1,000,000



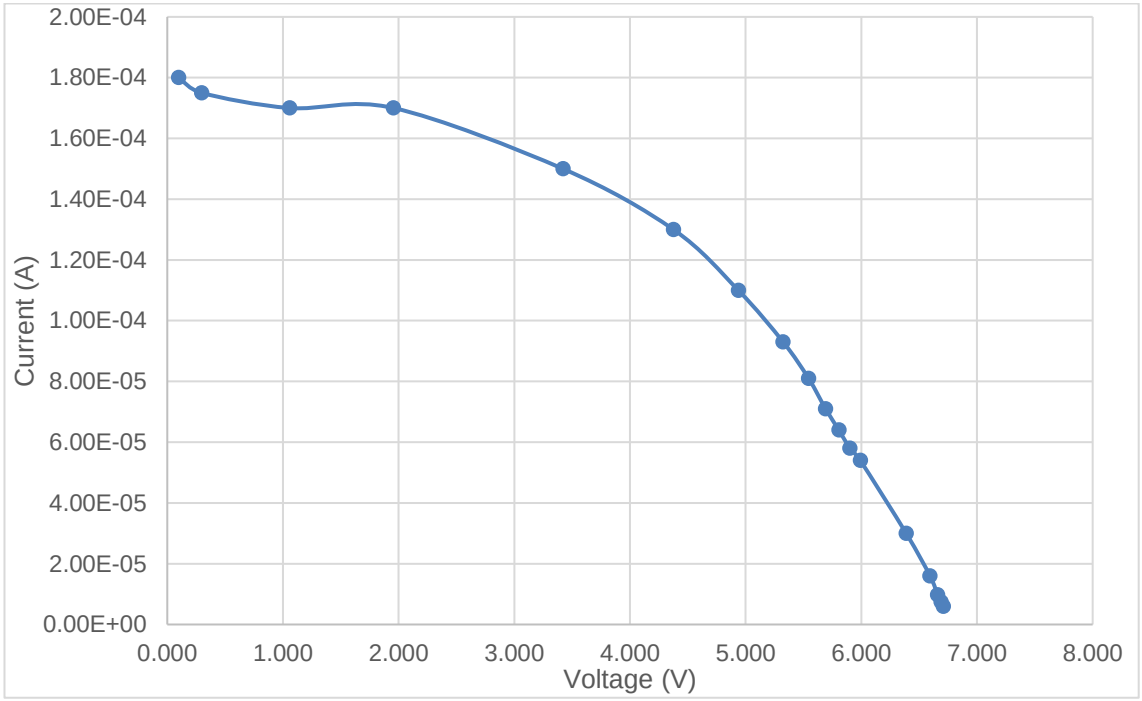
Kuvio 158. Voltage (V) vs Current (I) curve for panel ATCJ-I-56 3mm glass cover at 90°.



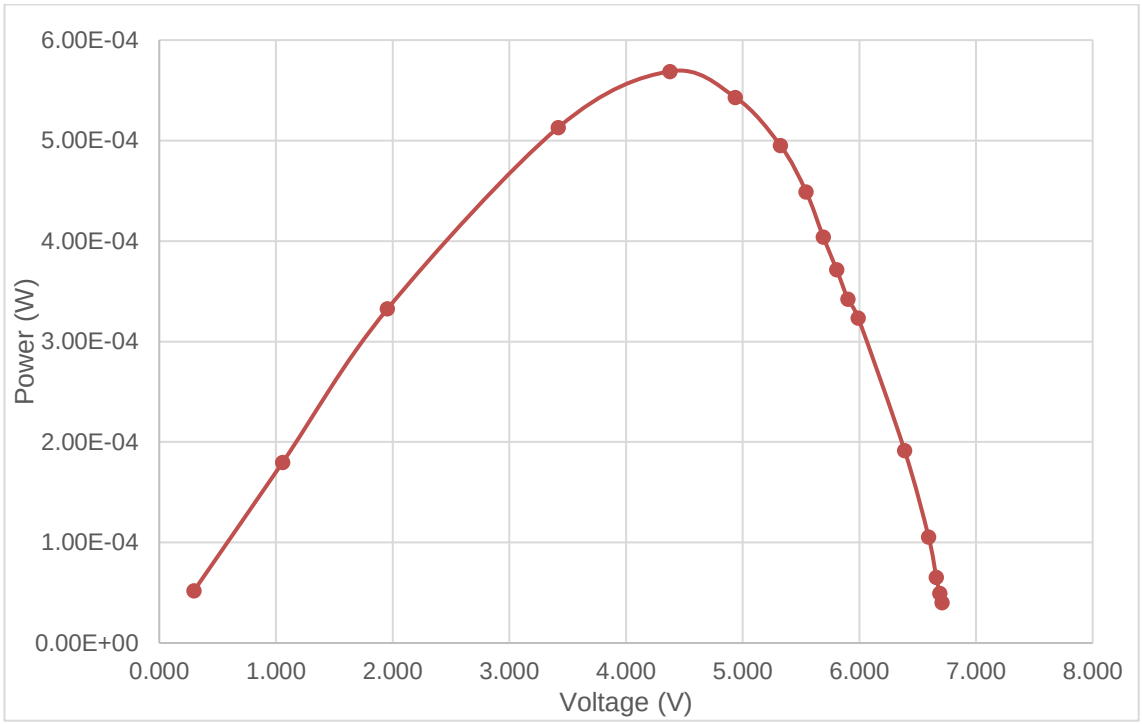
Kuvio 159. Voltage (V) vs Power (W) curve for panel ATCJ-I-56 with 3mm glass cover at 90°.

Taulukko 82. Results for panel ATCJ-I-56 with 3mm glass cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.099	1.80E-04	1.78E-05	92.0	-
0.297	1.75E-04	5.20E-05	92.1	1,000
1.057	1.70E-04	1.80E-04	91.7	5,000
1.956	1.70E-04	3.33E-04	91.9	10,000
3.421	1.50E-04	5.13E-04	92.1	20,000
4.376	1.30E-04	5.69E-04	91.9	30,000
4.937	1.10E-04	5.43E-04	92.1	40,000
5.324	9.30E-05	4.95E-04	92.0	50,000
5.544	8.10E-05	4.49E-04	92.1	60,000
5.691	7.10E-05	4.04E-04	92.1	70,000
5.806	6.40E-05	3.72E-04	91.8	80,000
5.902	5.80E-05	3.42E-04	92.0	90,000
5.991	5.40E-05	3.24E-04	91.9	100,000
6.388	3.00E-05	1.92E-04	92.2	200,000
6.594	1.60E-05	1.06E-04	92.0	400,000
6.660	9.80E-06	6.53E-05	92.0	600,000
6.690	7.40E-06	4.95E-05	91.1	800,000
6.710	6.00E-06	4.03E-05	91.8	1,000,000



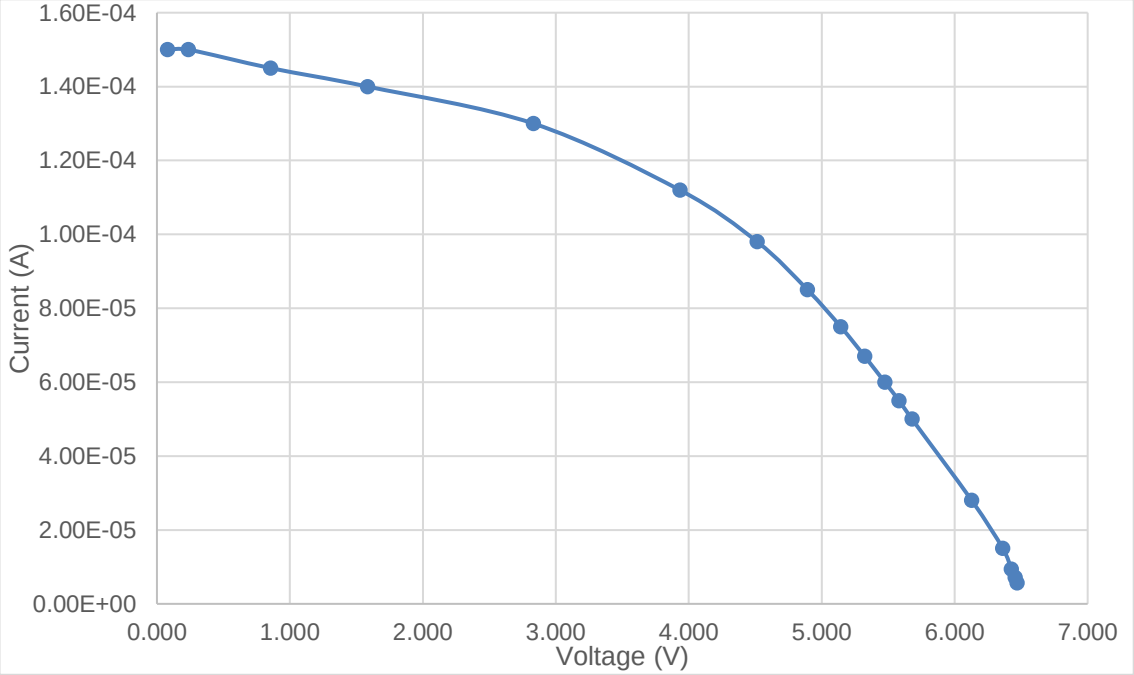
Kuvio 160. Voltage (V) vs Current (I) curve for panel ATCJ-I-56 3mm glass cover at 60°.



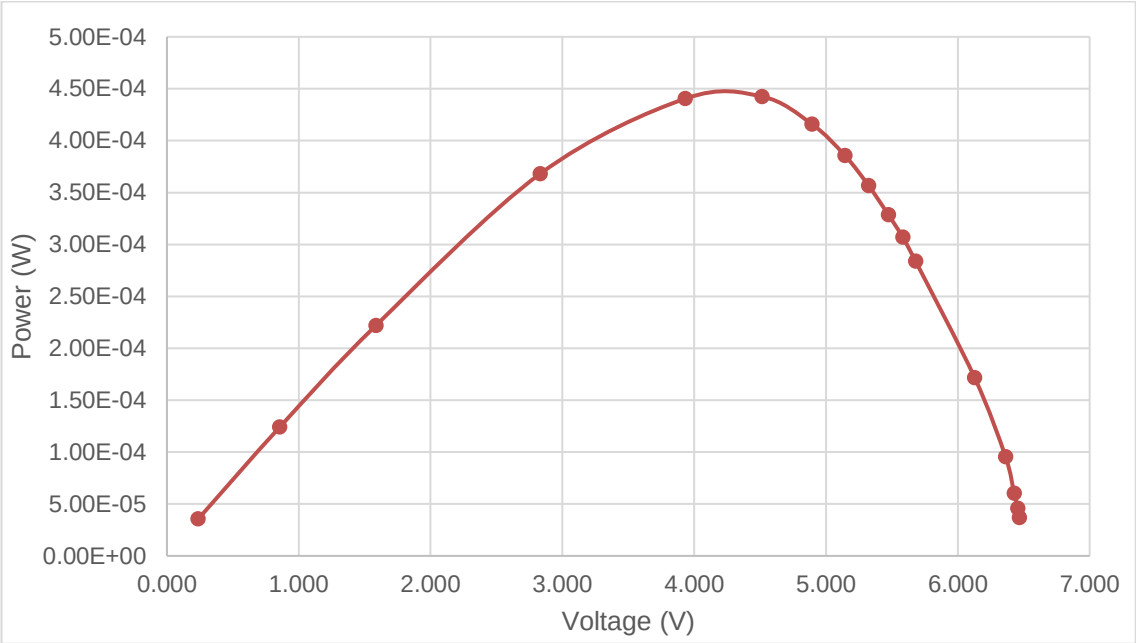
Kuvio 161. Voltage (V) vs Power (W) curve for panel ATCJ-I-56 with 3mm glass cover at 60°.

Taulukko 83. Results for panel ATCJ-I-56 with 3mm glass cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.079	1.50E-04	1.19E-05	78.3	-
0.237	1.50E-04	3.56E-05	78.0	1,000
0.856	1.45E-04	1.24E-04	78.0	5,000
1.585	1.40E-04	2.22E-04	78.4	10,000
2.832	1.30E-04	3.68E-04	77.9	20,000
3.933	1.12E-04	4.40E-04	77.9	30,000
4.515	9.80E-05	4.42E-04	77.9	40,000
4.893	8.50E-05	4.16E-04	78.2	50,000
5.143	7.50E-05	3.86E-04	77.9	60,000
5.323	6.70E-05	3.57E-04	77.9	70,000
5.474	6.00E-05	3.28E-04	78.0	80,000
5.582	5.50E-05	3.07E-04	78.0	90,000
5.679	5.00E-05	2.84E-04	77.9	100,000
6.128	2.80E-05	1.72E-04	78.0	200,000
6.362	1.50E-05	9.54E-05	78.2	400,000
6.427	9.40E-06	6.04E-05	78.0	600,000
6.455	7.10E-06	4.58E-05	78.0	800,000
6.468	5.70E-06	3.69E-05	77.9	1,000,000



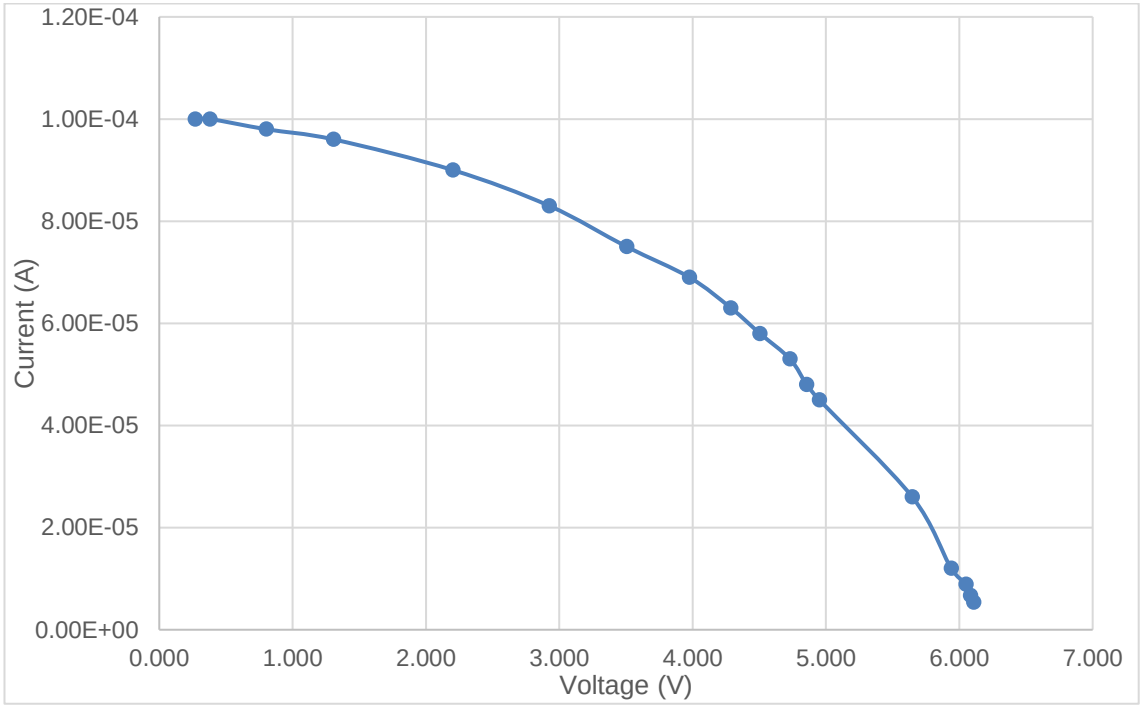
Kuvio 162. Voltage (V) vs Current (I) curve for panel ATCJ-I-56 3mm glass cover at 45°.



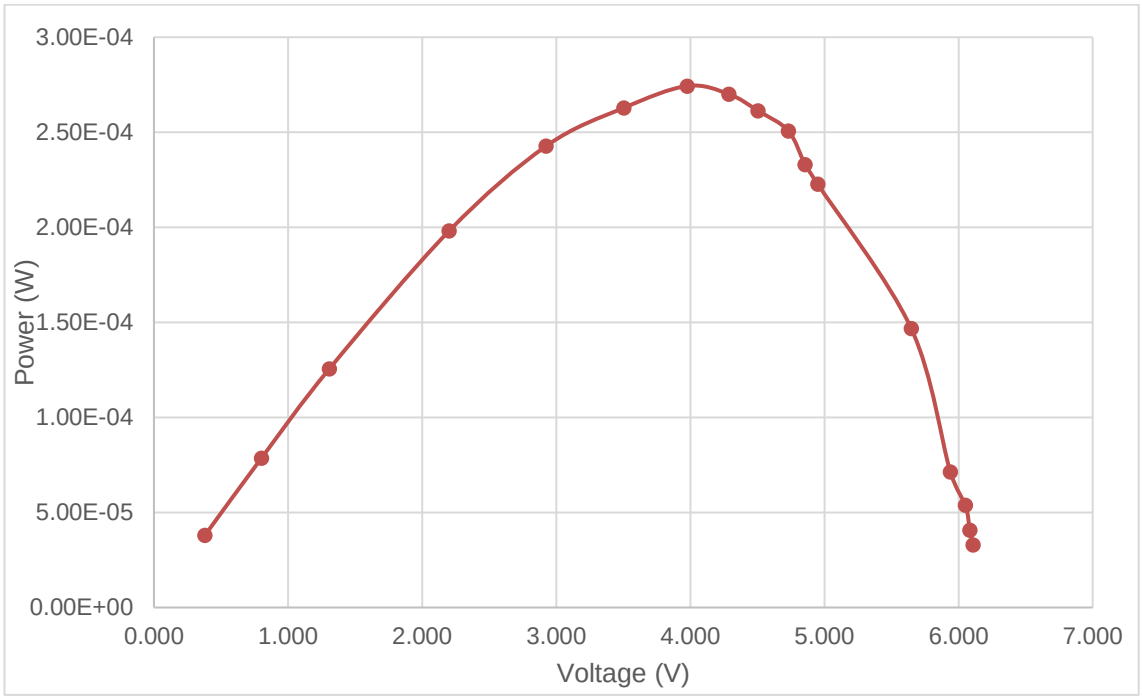
Kuvio 163. Voltage (V) vs Power (W) curve for panel ATCJ-I-56 with 3mm glass cover at 45°.

Taulukko 84. Results for panel ATCJ-I-56 with 3mm glass cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.271	1.00E-04	2.71E-05	59.9	-
0.380	1.00E-04	3.80E-05	60.0	1,000
0.802	9.80E-05	7.86E-05	60.1	5,000
1.308	9.60E-05	1.26E-04	60.2	10,000
2.202	9.00E-05	1.98E-04	60.1	20,000
2.925	8.30E-05	2.43E-04	60.0	30,000
3.505	7.50E-05	2.63E-04	60.1	40,000
3.976	6.90E-05	2.74E-04	60.3	50,000
4.287	6.30E-05	2.70E-04	60.0	60,000
4.505	5.80E-05	2.61E-04	60.3	70,000
4.731	5.30E-05	2.51E-04	60.3	80,000
4.855	4.80E-05	2.33E-04	60.2	90,000
4.950	4.50E-05	2.23E-04	60.2	100,000
5.647	2.60E-05	1.47E-04	60.1	200,000
5.939	1.20E-05	7.13E-05	60.0	400,000
6.051	8.90E-06	5.39E-05	60.2	600,000
6.084	6.70E-06	4.08E-05	60.2	800,000
6.108	5.40E-06	3.30E-05	60.2	1,000,000



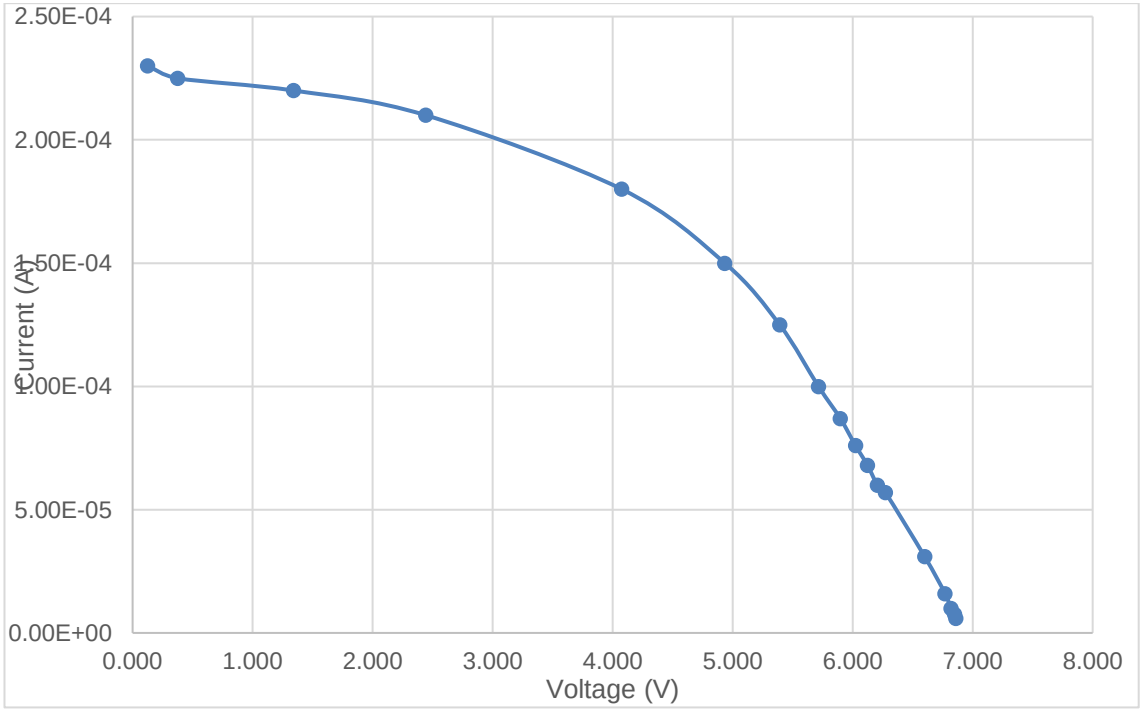
Kuvio 164. Voltage (V) vs Current (I) curve for panel ATCJ-I-56 3mm glass cover at 30°.



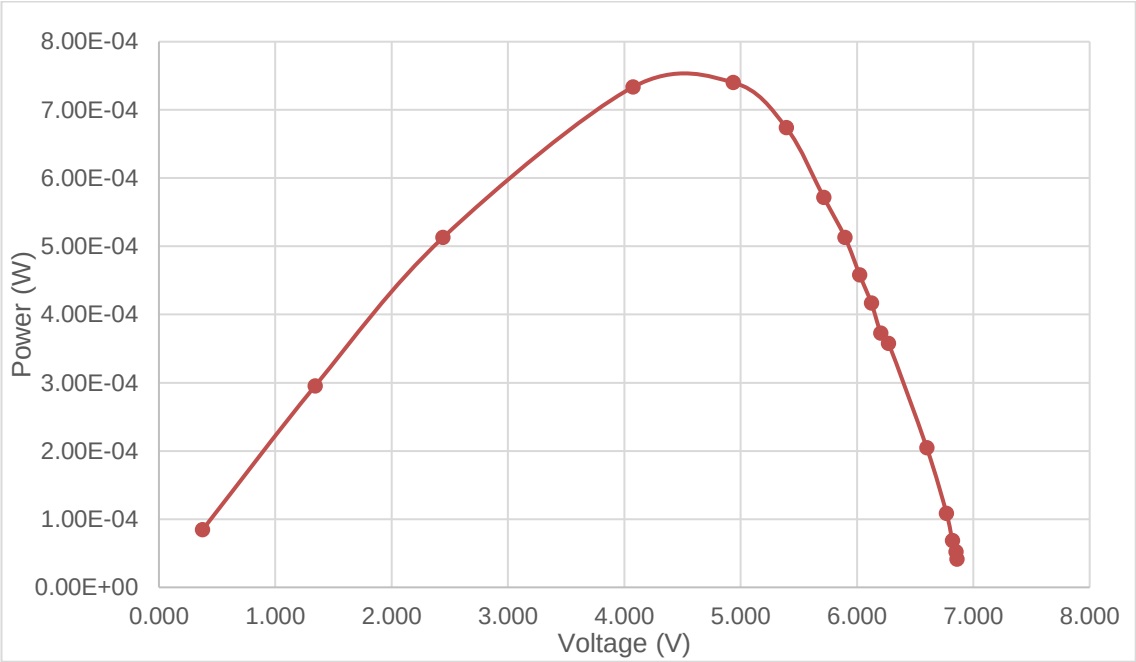
Kuvio 165. Voltage (V) vs Power (W) curve for panel ATCJ-I-56 with 3mm glass cover at 30°.

Taulukko 85. Results for panel ATCJ-I-56 with 6mm glass cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.126	2.30E-04	2.90E-05	100.0	-
0.375	2.25E-04	8.44E-05	100.0	1,000
1.342	2.20E-04	2.95E-04	100.2	5,000
2.442	2.10E-04	5.13E-04	100.2	10,000
4.075	1.80E-04	7.34E-04	100.2	20,000
4.935	1.50E-04	7.40E-04	100.0	30,000
5.392	1.25E-04	6.74E-04	99.9	40,000
5.715	1.00E-04	5.72E-04	99.7	50,000
5.897	8.70E-05	5.13E-04	100.2	60,000
6.024	7.60E-05	4.58E-04	100.3	70,000
6.124	6.80E-05	4.16E-04	99.9	80,000
6.206	6.00E-05	3.72E-04	100.0	90,000
6.272	5.70E-05	3.58E-04	100.5	100,000
6.600	3.10E-05	2.05E-04	100.4	200,000
6.770	1.60E-05	1.08E-04	100.4	400,000
6.820	1.00E-05	6.82E-05	99.7	600,000
6.850	7.60E-06	5.21E-05	100.5	800,000
6.860	6.00E-06	4.12E-05	100.5	1,000,000



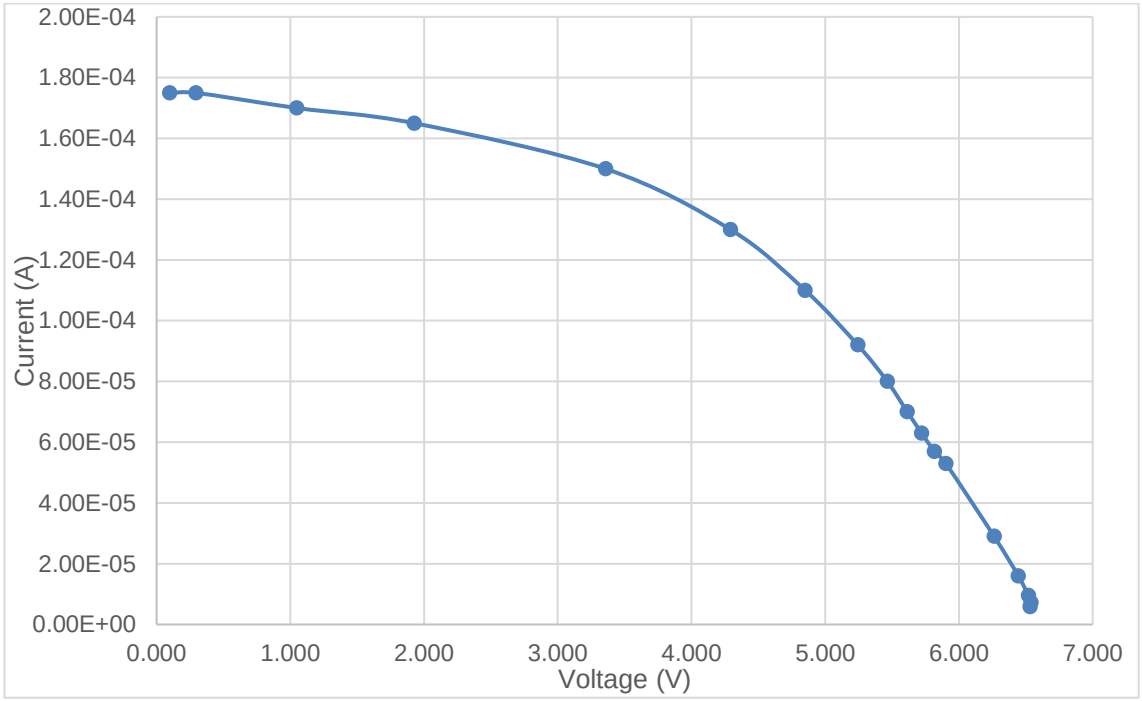
Kuvio 166. Voltage (V) vs Current (I) curve for panel ATCJ-I-56 6mm glass cover at 90°.



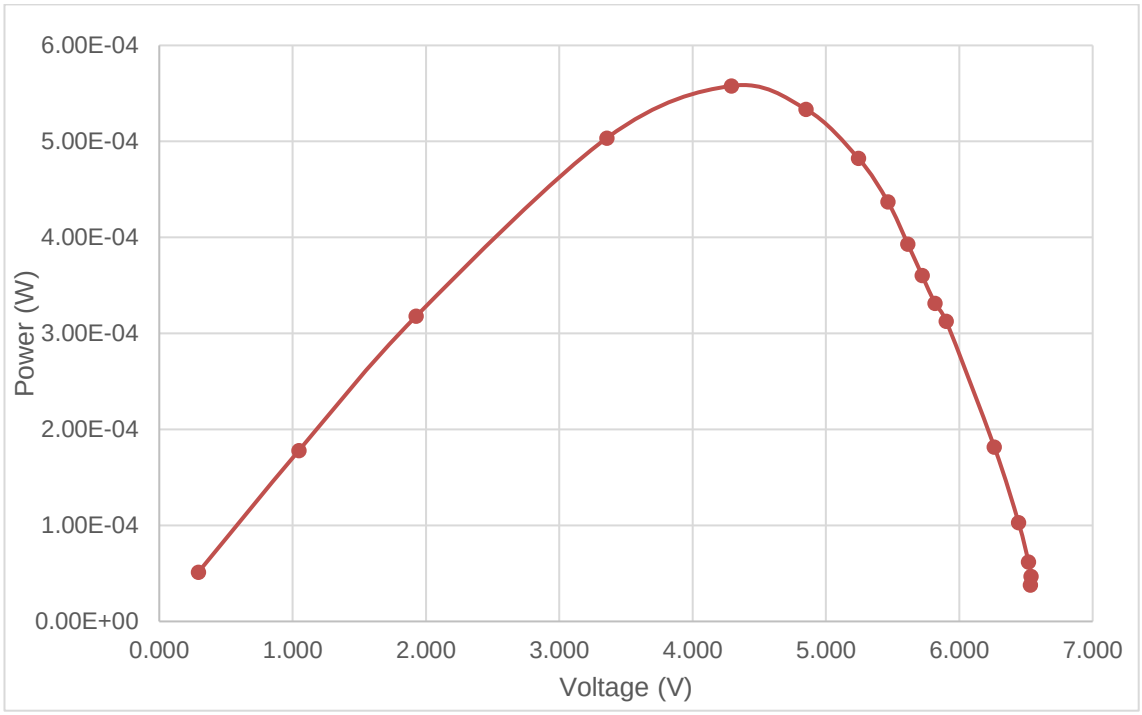
Kuvio 167. Voltage (V) vs Power (W) curve for panel ATCJ-I-56 with 6mm glass cover at 90°.

Taulukko 86. Results for panel ATCJ-I-56 with 6mm glass cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.098	1.75E-04	1.72E-05	92.6	-
0.293	1.75E-04	5.13E-05	92.6	1,000
1.048	1.70E-04	1.78E-04	92.7	5,000
1.927	1.65E-04	3.18E-04	92.6	10,000
3.357	1.50E-04	5.04E-04	92.4	20,000
4.291	1.30E-04	5.58E-04	92.5	30,000
4.850	1.10E-04	5.34E-04	92.6	40,000
5.243	9.20E-05	4.82E-04	92.4	50,000
5.464	8.00E-05	4.37E-04	92.5	60,000
5.614	7.00E-05	3.93E-04	92.7	70,000
5.721	6.30E-05	3.60E-04	92.6	80,000
5.817	5.70E-05	3.32E-04	93.0	90,000
5.902	5.30E-05	3.13E-04	93.0	100,000
6.263	2.90E-05	1.82E-04	93.0	200,000
6.444	1.60E-05	1.03E-04	92.6	400,000
6.519	9.50E-06	6.19E-05	92.8	600,000
6.539	7.20E-06	4.71E-05	92.8	800,000
6.533	5.80E-06	3.79E-05	92.7	1,000,000



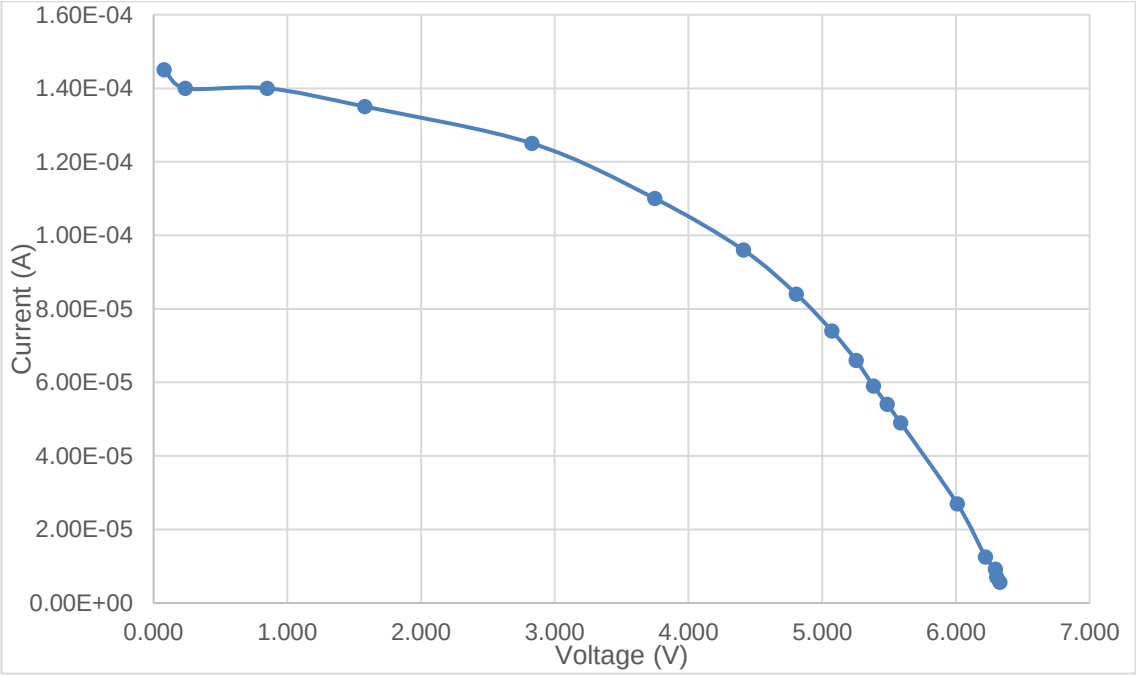
Kuvio 168. Voltage (V) vs Current (I) curve for panel ATCJ-I-56 6mm glass cover at 60°.



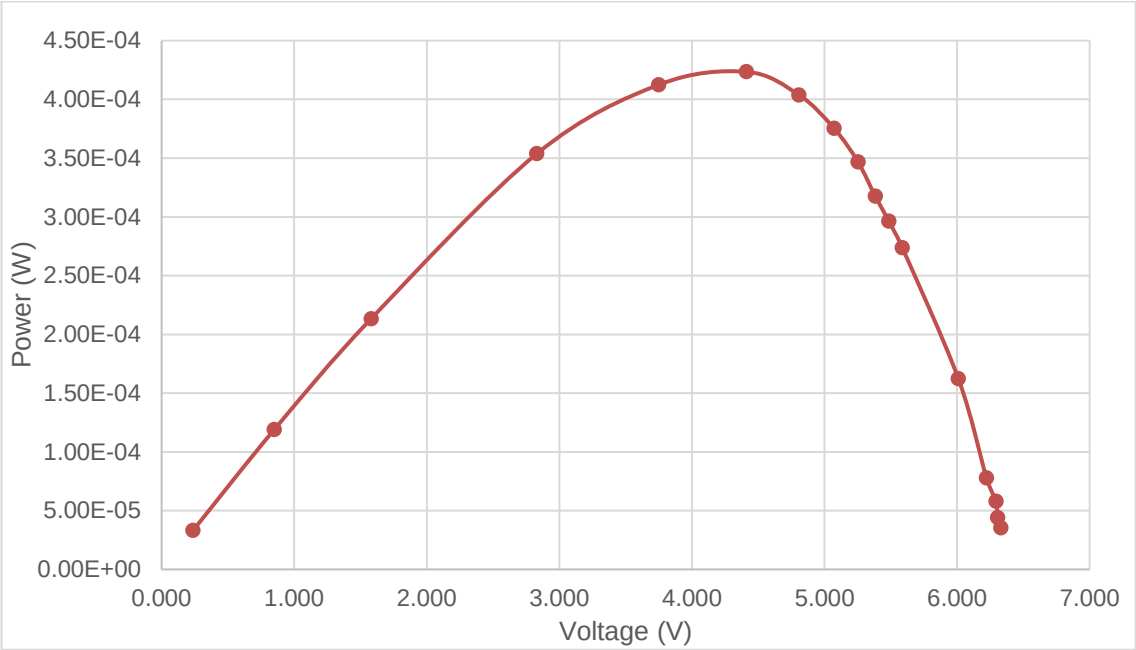
Kuvio 169. Voltage (V) vs Power (W) curve for panel ATCJ-I-56 with 6mm glass cover at 60°.

Taulukko 87. Results for panel ATCJ-I-56 with 6mm glass cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.079	1.45E-04	1.15E-05	79.2	-
0.237	1.40E-04	3.32E-05	79.1	1,000
0.850	1.40E-04	1.19E-04	79.3	5,000
1.580	1.35E-04	2.13E-04	79.1	10,000
2.830	1.25E-04	3.54E-04	79.5	20,000
3.749	1.10E-04	4.12E-04	79.3	30,000
4.411	9.60E-05	4.23E-04	79.4	40,000
4.807	8.40E-05	4.04E-04	79.4	50,000
5.072	7.40E-05	3.75E-04	79.5	60,000
5.253	6.60E-05	3.47E-04	79.6	70,000
5.383	5.90E-05	3.18E-04	79.5	80,000
5.486	5.40E-05	2.96E-04	79.4	90,000
5.587	4.90E-05	2.74E-04	79.5	100,000
6.010	2.70E-05	1.62E-04	79.6	200,000
6.222	1.25E-05	7.78E-05	79.4	400,000
6.294	9.20E-06	5.79E-05	79.6	600,000
6.305	7.00E-06	4.41E-05	79.3	800,000
6.329	5.60E-06	3.54E-05	79.5	1,000,000



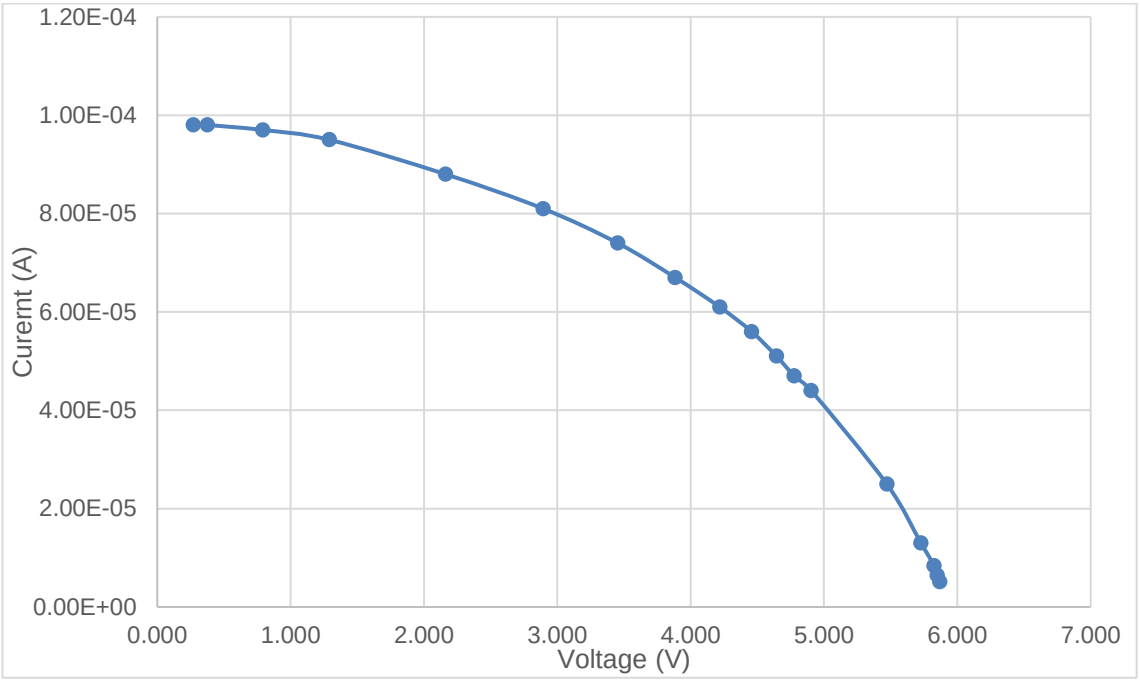
Kuvio 170. Voltage (V) vs Current (I) curve for panel ATCJ-I-56 6mm glass cover at 45°.



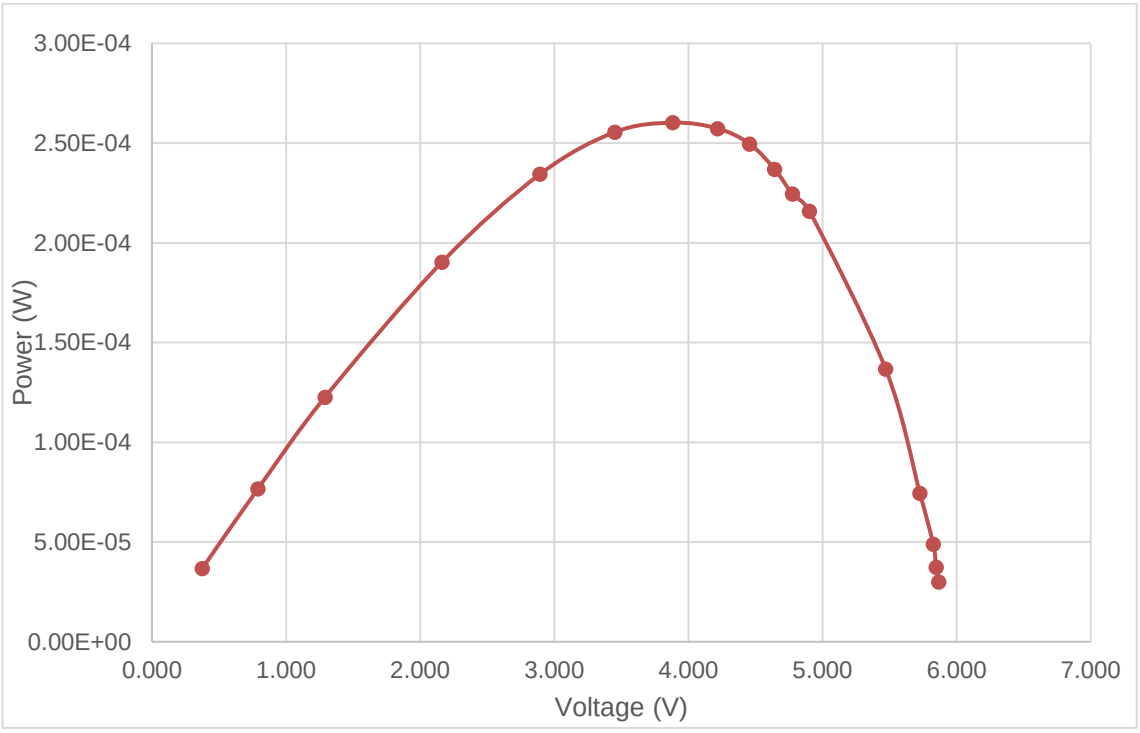
Kuvio 171. Voltage (V) vs Power (W) curve for panel ATCJ-I-56 with 6mm glass cover at 45°.

Taulukko 88. Results for panel ATCJ-I-56 with 6mm glass cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.270	9.80E-05	2.65E-05	60.9	-
0.375	9.80E-05	3.68E-05	60.6	1,000
0.791	9.70E-05	7.67E-05	61.0	5,000
1.291	9.50E-05	1.23E-04	61.0	10,000
2.162	8.80E-05	1.90E-04	61.0	20,000
2.894	8.10E-05	2.34E-04	61.1	30,000
3.453	7.40E-05	2.56E-04	61.0	40,000
3.884	6.70E-05	2.60E-04	60.9	50,000
4.218	6.10E-05	2.57E-04	61.1	60,000
4.457	5.60E-05	2.50E-04	61.0	70,000
4.644	5.10E-05	2.37E-04	61.0	80,000
4.776	4.70E-05	2.24E-04	61.0	90,000
4.904	4.40E-05	2.16E-04	61.0	100,000
5.471	2.50E-05	1.37E-04	61.0	200,000
5.727	1.30E-05	7.45E-05	60.9	400,000
5.826	8.40E-06	4.89E-05	60.9	600,000
5.848	6.40E-06	3.74E-05	60.8	800,000
5.868	5.10E-06	2.99E-05	60.8	1,000,000



Kuvio 172. Voltage (V) vs Current (I) curve for panel ATCJ-I-56 6mm glass cover at 30°.

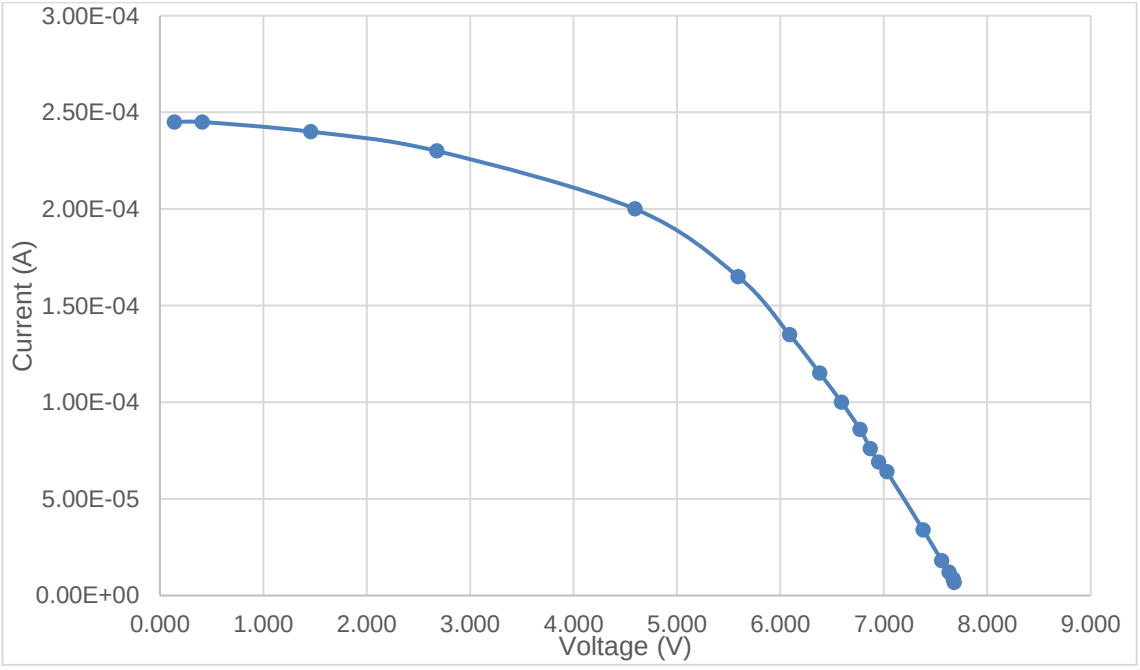


Kuvio 173. Voltage (V) vs Power (W) curve for panel ATCJ-I-56 with 6mm glass cover at 30°.

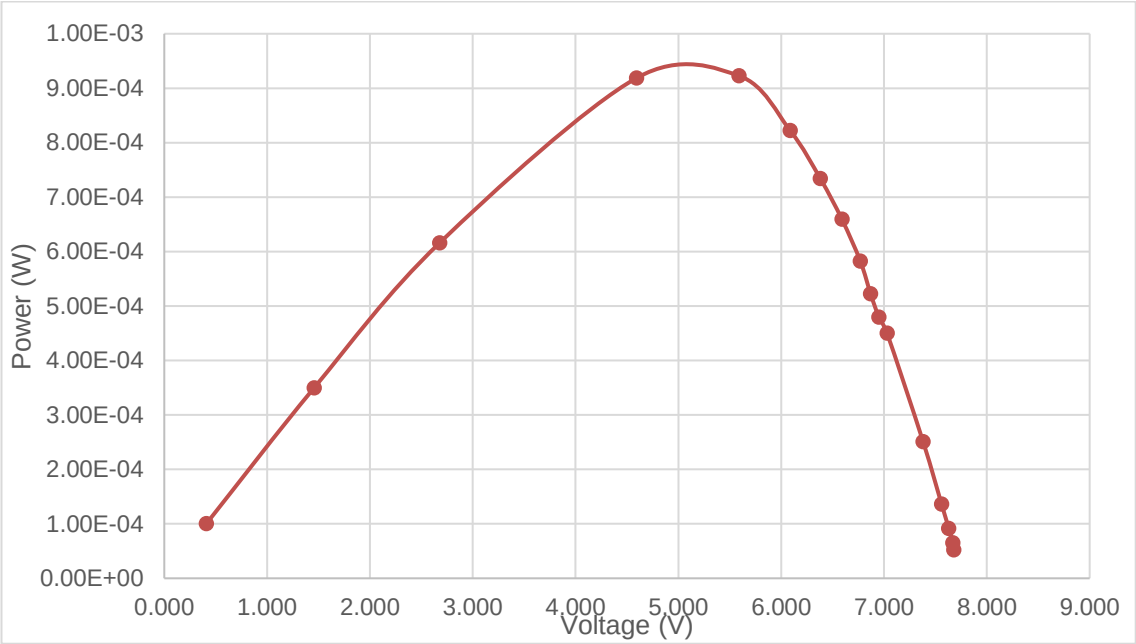
Appendix 7: Panel I_057

Taulukko 89. Results for panel ATCJ-I-57 with no cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.140	2.45E-04	3.43E-05	100.0	-
0.409	2.45E-04	1.00E-04	99.9	1,000
1.457	2.40E-04	3.50E-04	100.0	5,000
2.678	2.30E-04	6.16E-04	99.9	10,000
4.594	2.00E-04	9.19E-04	99.9	20,000
5.591	1.65E-04	9.23E-04	100.1	30,000
6.088	1.35E-04	8.22E-04	99.8	40,000
6.381	1.15E-04	7.34E-04	99.5	50,000
6.591	1.00E-04	6.59E-04	99.8	60,000
6.770	8.60E-05	5.82E-04	100.0	70,000
6.870	7.60E-05	5.22E-04	100.0	80,000
6.950	6.90E-05	4.80E-04	99.9	90,000
7.030	6.40E-05	4.50E-04	99.7	100,000
7.380	3.40E-05	2.51E-04	99.8	200,000
7.560	1.80E-05	1.36E-04	99.4	400,000
7.630	1.20E-05	9.16E-05	99.9	600,000
7.670	8.50E-06	6.52E-05	100.0	800,000
7.680	6.80E-06	5.22E-05	99.5	1,000,000



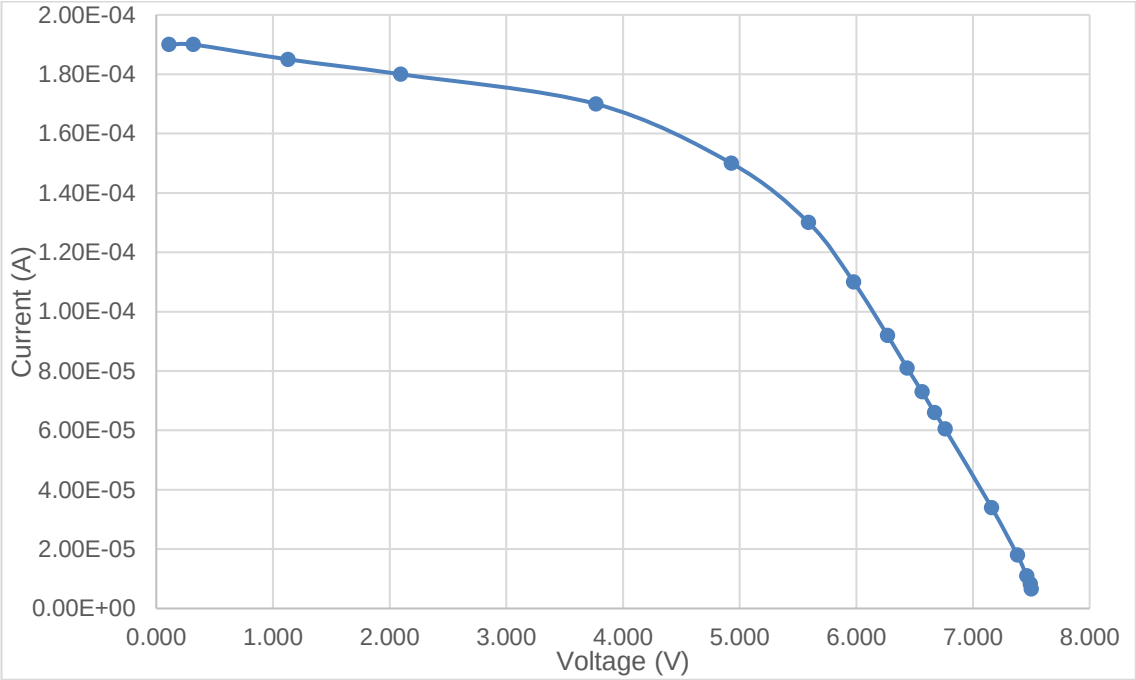
Kuvio 174. Voltage (V) vs Current (I) curve for panel ATCJ-I-57 with no cover at 90°.



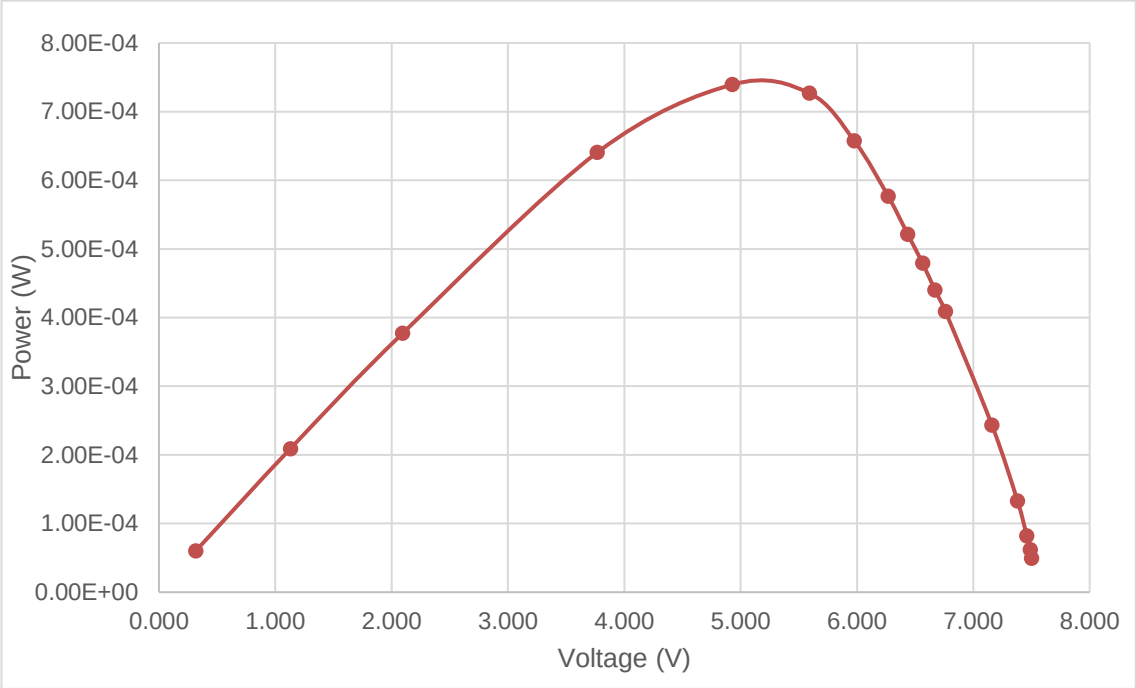
Kuvio 175. Voltage (V) vs Power (W) curve for panel ATCJ-I-57 with no cover at 90°.

Taulukko 90. Results for panel ATCJ-I-57 with no cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.107	1.90E-04	2.03E-05	90.9	-
0.316	1.90E-04	6.00E-05	90.9	1,000
1.130	1.85E-04	2.09E-04	90.9	5,000
2.095	1.80E-04	3.77E-04	90.5	10,000
3.767	1.70E-04	6.40E-04	90.6	20,000
4.929	1.50E-04	7.39E-04	90.8	30,000
5.591	1.30E-04	7.27E-04	91.0	40,000
5.977	1.10E-04	6.57E-04	91.1	50,000
6.268	9.20E-05	5.77E-04	90.9	60,000
6.436	8.10E-05	5.21E-04	90.5	70,000
6.564	7.30E-05	4.79E-04	90.6	80,000
6.670	6.60E-05	4.40E-04	90.8	90,000
6.760	6.05E-05	4.09E-04	90.9	100,000
7.160	3.40E-05	2.43E-04	91.0	200,000
7.380	1.80E-05	1.33E-04	90.8	400,000
7.460	1.10E-05	8.21E-05	90.1	600,000
7.490	8.30E-06	6.22E-05	91.1	800,000
7.500	6.60E-06	4.95E-05	91.0	1,000,000



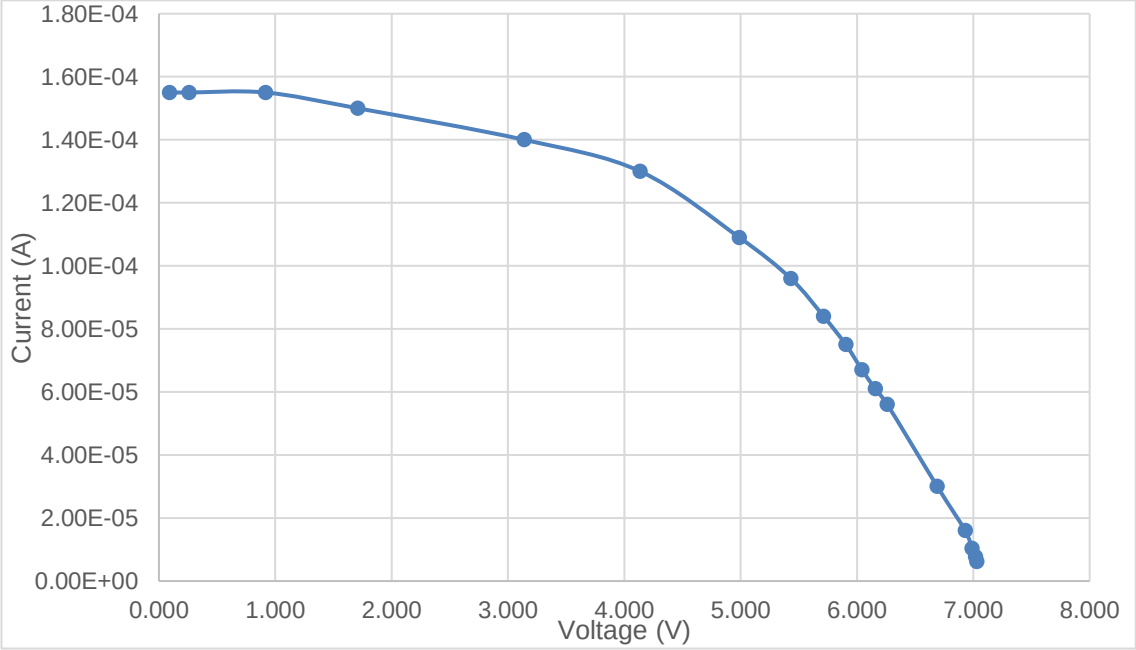
Kuvio 176. Voltage (V) vs Current (I) curve for panel ATCJ-I-57 with no cover at 60°.



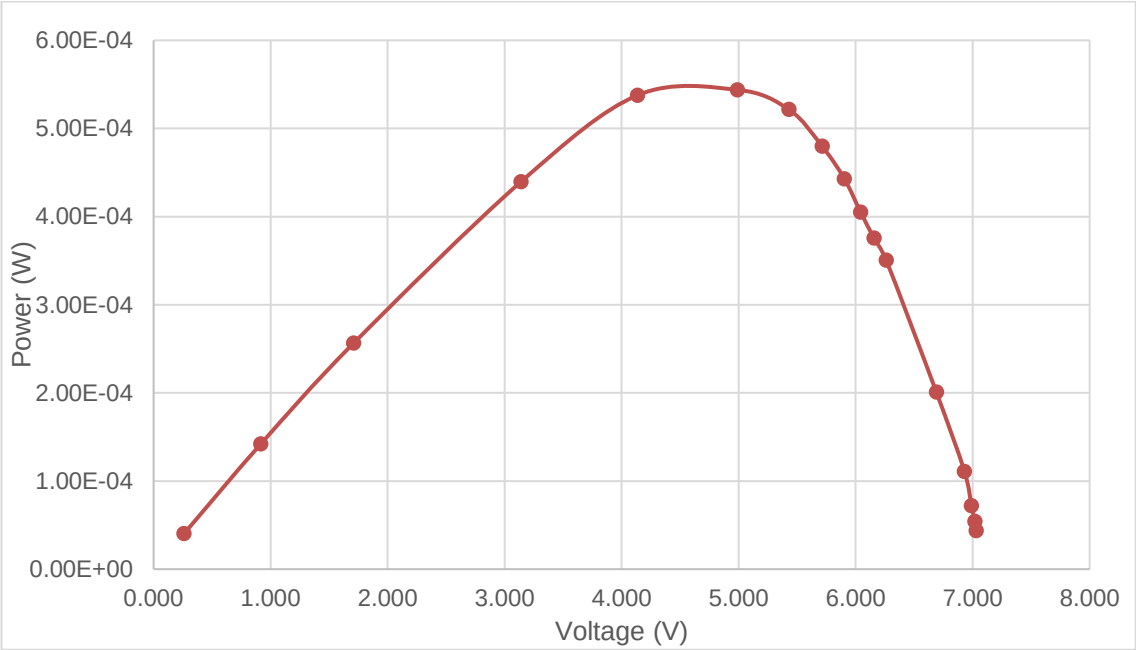
Kuvio 177. Voltage (V) vs Power (W) curve for panel ATCJ-I-57 with no cover at 60°.

Taulukko 91. Results for panel ATCJ-I-57 with no cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.090	1.55E-04	1.40E-05	77.0	-
0.259	1.55E-04	4.01E-05	76.5	1,000
0.917	1.55E-04	1.42E-04	76.8	5,000
1.709	1.50E-04	2.56E-04	76.6	10,000
3.140	1.40E-04	4.40E-04	76.9	20,000
4.136	1.30E-04	5.38E-04	76.3	30,000
4.989	1.09E-04	5.44E-04	76.8	40,000
5.431	9.60E-05	5.21E-04	77.2	50,000
5.713	8.40E-05	4.80E-04	77.2	60,000
5.904	7.50E-05	4.43E-04	76.9	70,000
6.043	6.70E-05	4.05E-04	76.7	80,000
6.157	6.10E-05	3.76E-04	76.4	90,000
6.261	5.60E-05	3.51E-04	76.9	100,000
6.690	3.00E-05	2.01E-04	76.7	200,000
6.930	1.60E-05	1.11E-04	76.7	400,000
6.990	1.03E-05	7.20E-05	77.0	600,000
7.020	7.70E-06	5.41E-05	76.8	800,000
7.030	6.20E-06	4.36E-05	76.9	1,000,000



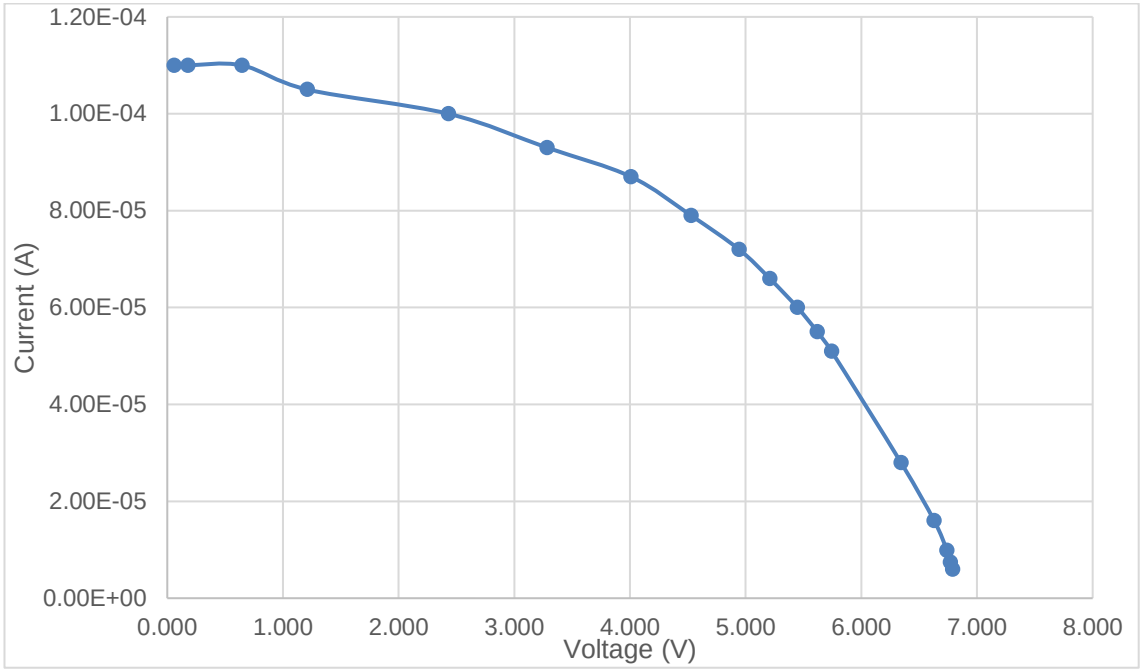
Kuvio 178. Voltage (V) vs Current (I) curve for panel ATCJ-I-57 with no cover at 45°.



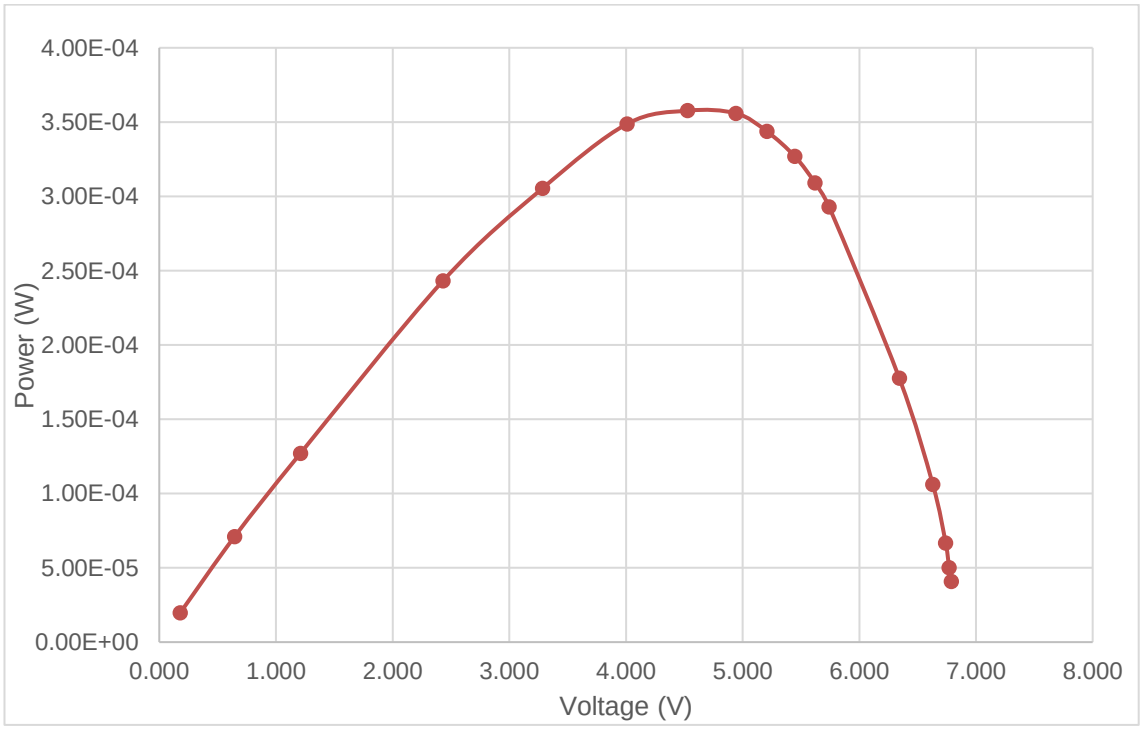
Kuvio 179. Voltage (V) vs Power (W) curve for panel ATCJ-I-57 with no cover at 45°.

Taulukko 92. Results for panel ATCJ-I-57 with no cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.060	1.10E-04	6.60E-06	58.3	-
0.179	1.10E-04	1.97E-05	58.4	1,000
0.646	1.10E-04	7.11E-05	58.3	5,000
1.210	1.05E-04	1.27E-04	58.4	10,000
2.431	1.00E-04	2.43E-04	58.1	20,000
3.284	9.30E-05	3.05E-04	58.2	30,000
4.009	8.70E-05	3.49E-04	58.3	40,000
4.528	7.90E-05	3.58E-04	58.4	50,000
4.943	7.20E-05	3.56E-04	58.4	60,000
5.208	6.60E-05	3.44E-04	58.2	70,000
5.448	6.00E-05	3.27E-04	58.4	80,000
5.620	5.50E-05	3.09E-04	58.5	90,000
5.742	5.10E-05	2.93E-04	58.3	100,000
6.343	2.80E-05	1.78E-04	58.3	200,000
6.630	1.60E-05	1.06E-04	58.1	400,000
6.740	9.90E-06	6.67E-05	58.0	600,000
6.770	7.40E-06	5.01E-05	58.1	800,000
6.790	6.00E-06	4.07E-05	58.0	1,000,000



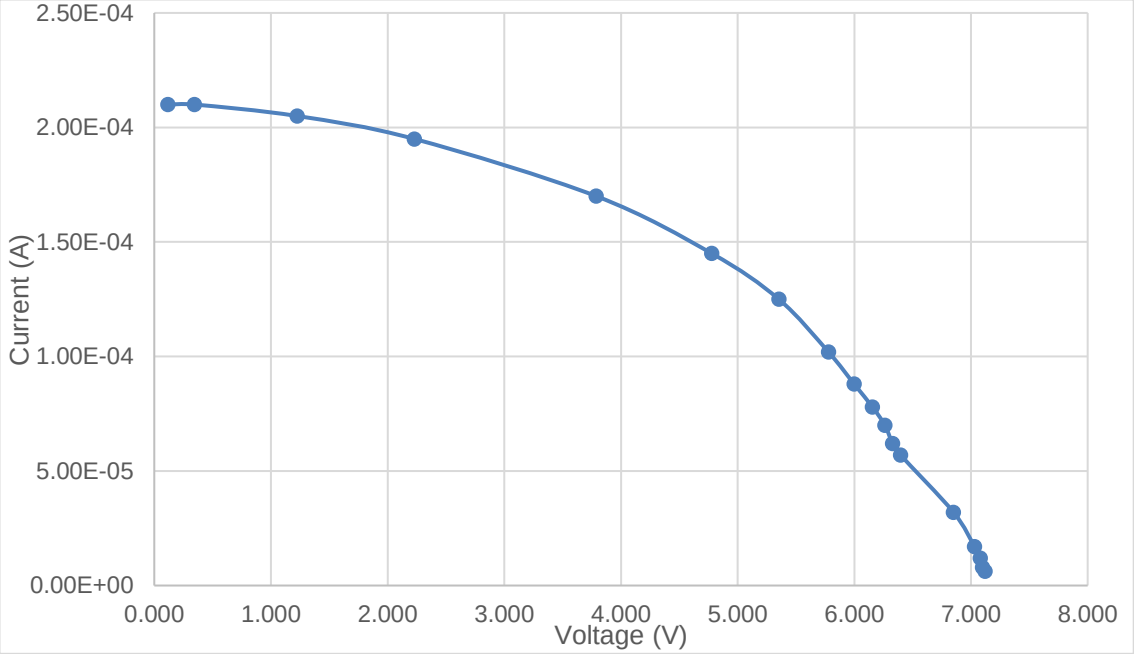
Kuvio 180. Voltage (V) vs Current (I) curve for panel ATCJ-I-57 with no cover at 30°.



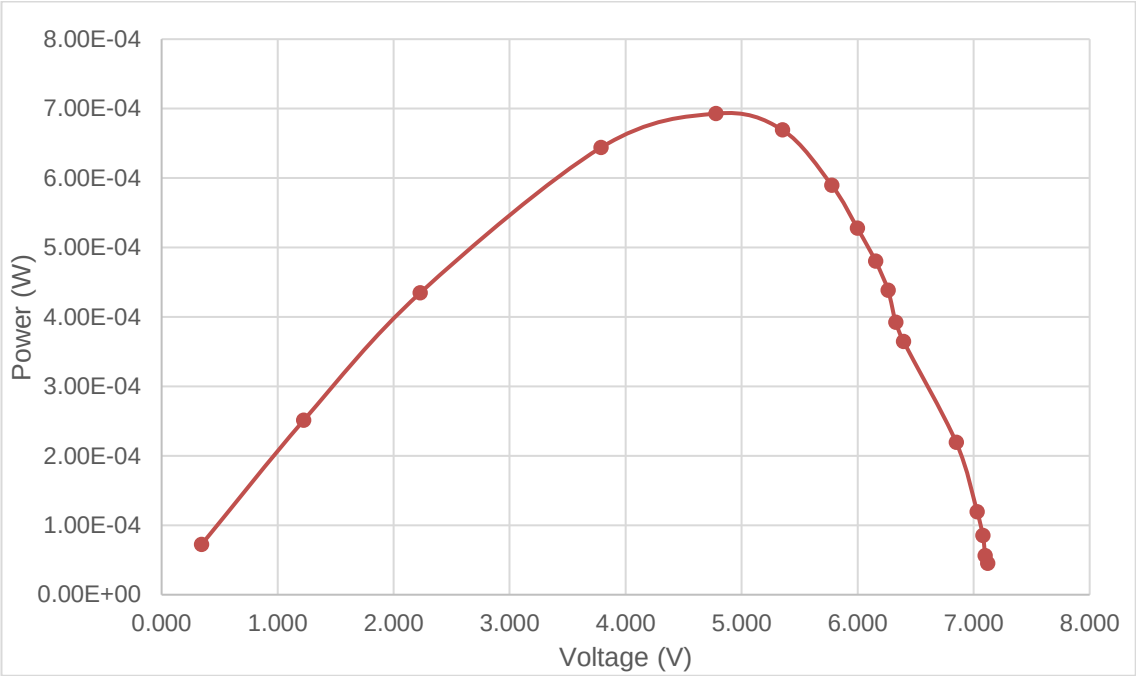
Kuvio 181. Voltage (V) vs Power (W) curve for panel ATCJ-I-57 with no cover at 30°.

Taulukko 93. Results for panel ATCJ-I-57 with polycarbonate cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.116	2.10E-04	2.44E-05	99.8	-
0.344	2.10E-04	7.22E-05	99.9	1,000
1.225	2.05E-04	2.51E-04	100.1	5,000
2.228	1.95E-04	4.34E-04	99.8	10,000
3.788	1.70E-04	6.44E-04	100.0	20,000
4.778	1.45E-04	6.93E-04	100.0	30,000
5.353	1.25E-04	6.69E-04	99.9	40,000
5.778	1.02E-04	5.89E-04	100.4	50,000
5.998	8.80E-05	5.28E-04	100.2	60,000
6.155	7.80E-05	4.80E-04	100.1	70,000
6.262	7.00E-05	4.38E-04	100.0	80,000
6.328	6.20E-05	3.92E-04	100.2	90,000
6.396	5.70E-05	3.65E-04	100.2	100,000
6.850	3.20E-05	2.19E-04	99.9	200,000
7.030	1.70E-05	1.20E-04	99.7	400,000
7.080	1.20E-05	8.50E-05	100.0	600,000
7.100	7.90E-06	5.61E-05	99.9	800,000
7.120	6.30E-06	4.49E-05	99.9	1,000,000



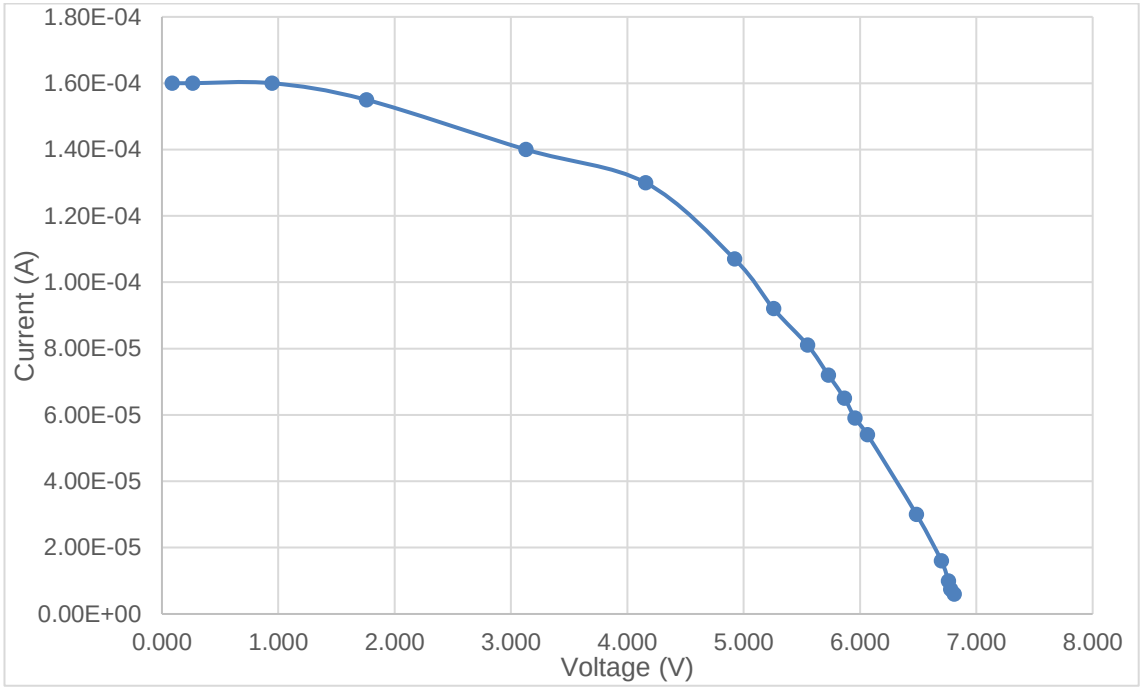
Kuvio 182. Voltage (V) vs Current (I) curve for panel ATCJ-I-57 polycarbonate cover at 90°.



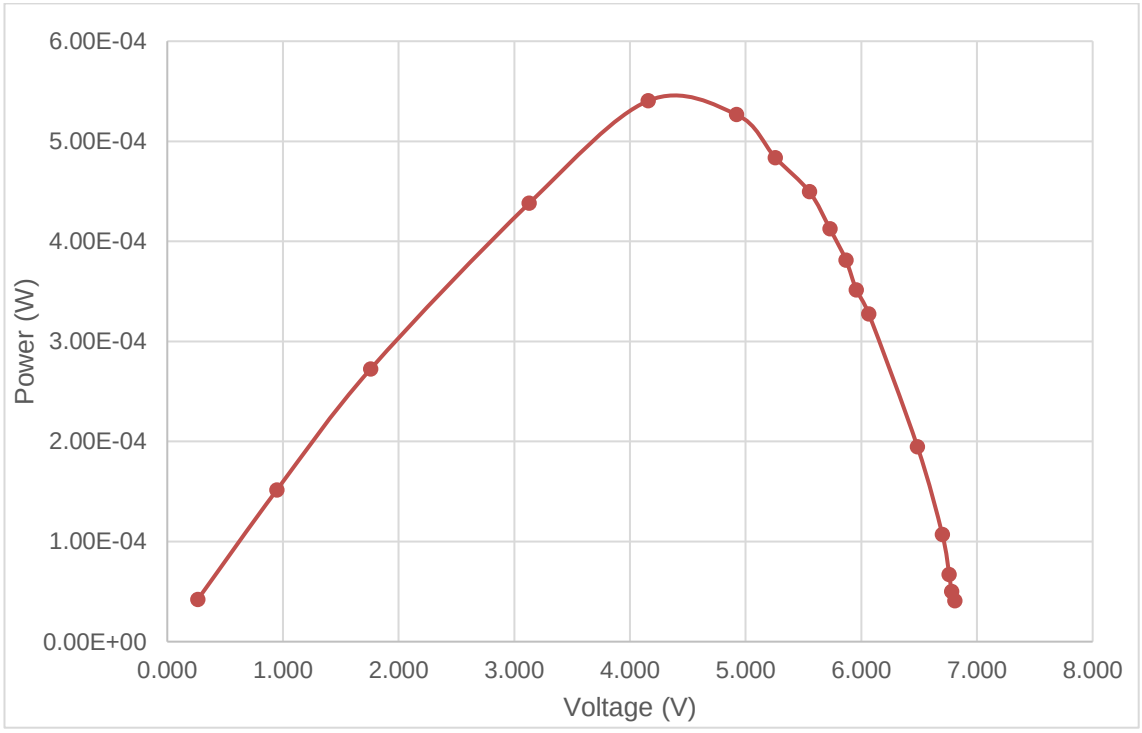
Kuvio 183. Voltage (V) vs Power (W) curve for panel ATCJ-I-57 with polycarbonate cover at 90°.

Taulukko 94. Results for panel ATCJ-I-57 with polycarbonate cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.088	1.60E-04	1.41E-05	90.8	-
0.264	1.60E-04	4.22E-05	91.2	1,000
0.947	1.60E-04	1.52E-04	91.3	5,000
1.758	1.55E-04	2.72E-04	91.4	10,000
3.129	1.40E-04	4.38E-04	91.3	20,000
4.157	1.30E-04	5.40E-04	91.4	30,000
4.922	1.07E-04	5.27E-04	91.4	40,000
5.257	9.20E-05	4.84E-04	90.9	50,000
5.551	8.10E-05	4.50E-04	91.2	60,000
5.729	7.20E-05	4.12E-04	91.1	70,000
5.867	6.50E-05	3.81E-04	90.7	80,000
5.957	5.90E-05	3.51E-04	90.7	90,000
6.065	5.40E-05	3.28E-04	90.9	100,000
6.486	3.00E-05	1.95E-04	91.0	200,000
6.700	1.60E-05	1.07E-04	91.0	400,000
6.760	9.90E-06	6.69E-05	91.0	600,000
6.780	7.40E-06	5.02E-05	90.7	800,000
6.810	6.00E-06	4.09E-05	91.2	1,000,000



Kuvio 184. Voltage (V) vs Current (I) curve for panel ATCJ-I-57 polycarbonate cover at 60°.

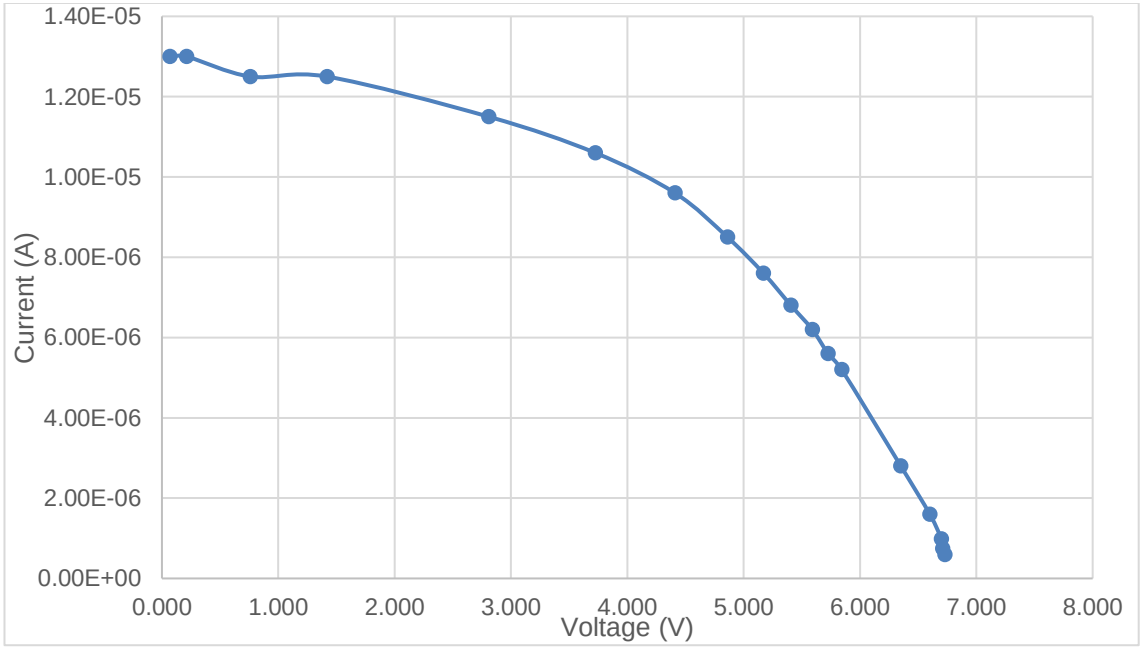


Kuvio 185. Voltage (V) vs Power (W) curve for panel ATCJ-I-57 with polycarbonate cover at 60°.

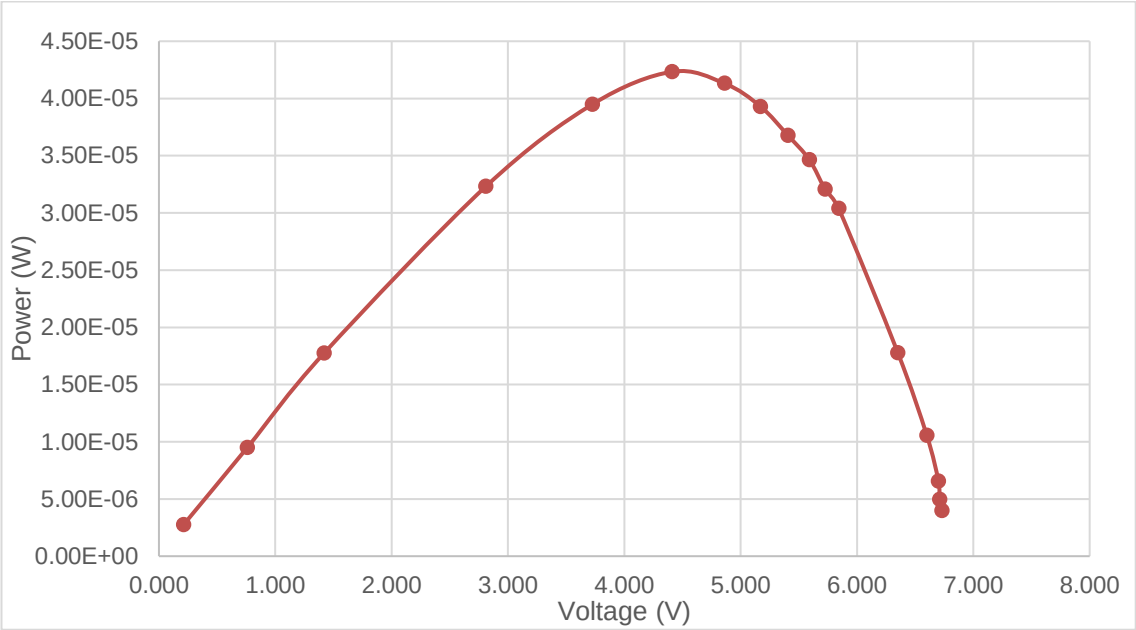
Taulukko 95. Results for panel ATCJ-I-57 with polycarbonate cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.070	1.30E-05	9.10E-07	76.8	-
0.212	1.30E-05	2.76E-06	77.1	1,000
0.760	1.25E-05	9.50E-06	77.1	5,000
1.419	1.25E-05	1.77E-05	77.1	10,000
2.810	1.15E-05	3.23E-05	77.0	20,000
3.725	1.06E-05	3.95E-05	77.0	30,000
4.410	9.60E-06	4.23E-05	77.0	40,000
4.861	8.50E-06	4.13E-05	77.1	50,000
5.171	7.60E-06	3.93E-05	77.2	60,000
5.407	6.80E-06	3.68E-05	77.0	70,000
5.590	6.20E-06	3.47E-05	77.0	80,000
5.726	5.60E-06	3.21E-05	77.0	90,000
5.843	5.20E-06	3.04E-05	77.2	100,000
6.351	2.80E-06	1.78E-05	76.8	200,000
6.600	1.60E-06	1.06E-05	77.0	400,000
6.700	9.80E-07	6.57E-06	77.2	600,000
6.710	7.40E-07	4.97E-06	76.9	800,000
6.730	5.90E-07	3.97E-06	76.9	1,000,000

0.019



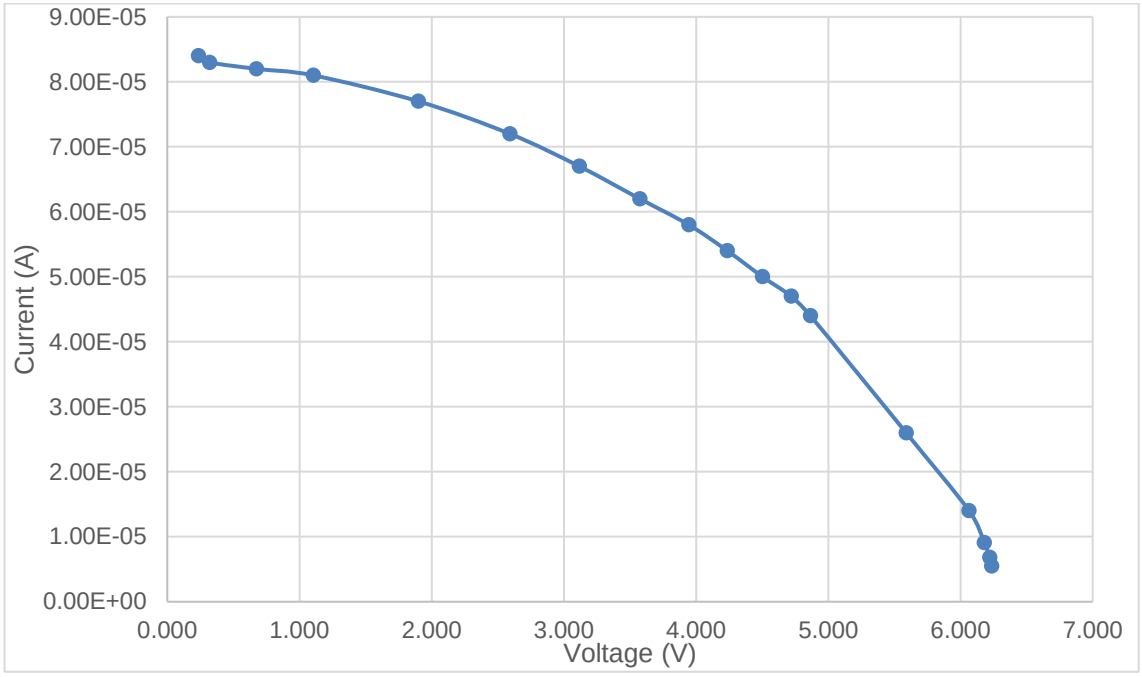
Kuvio 186. Voltage (V) vs Current (I) curve for panel ATCJ-I-57 polycarbonate cover at 45°.



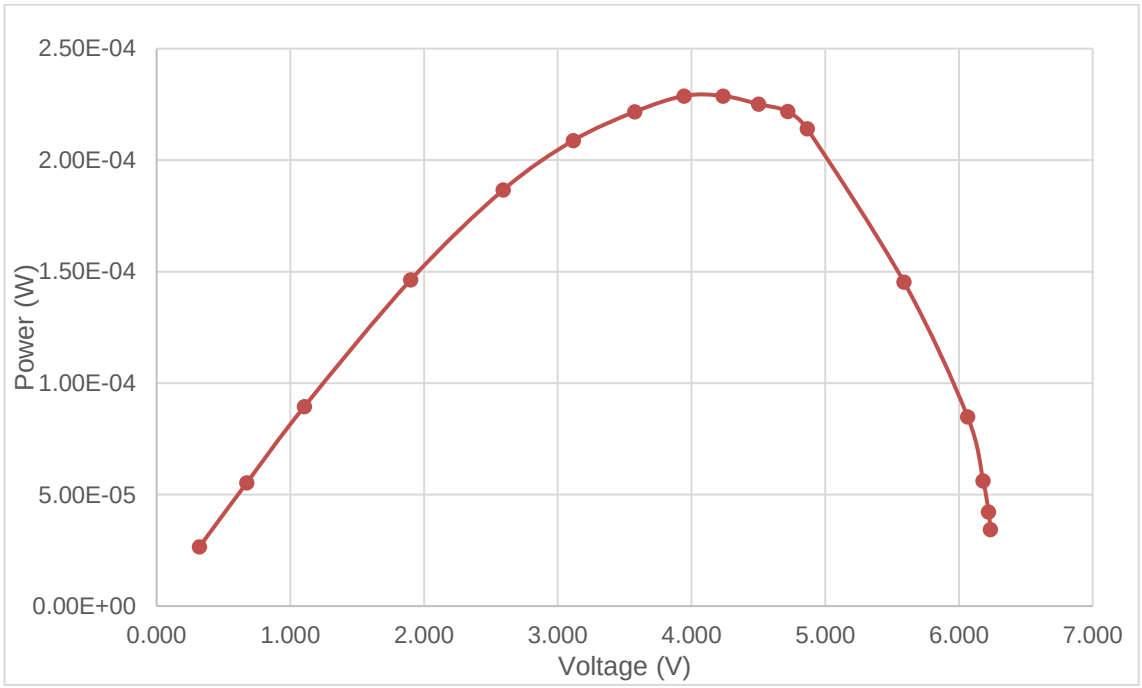
Kuvio 187. Voltage (V) vs Power (W) curve for panel ATCJ-I-57 with polycarbonate cover at 45°.

Taulukko 96. Results for panel ATCJ-I-57 with polycarbonate cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.235	8.40E-05	1.97E-05	58.0	-
0.321	8.30E-05	2.66E-05	58.0	1,000
0.674	8.20E-05	5.53E-05	57.9	5,000
1.105	8.10E-05	8.95E-05	58.0	10,000
1.900	7.70E-05	1.46E-04	58.1	20,000
2.592	7.20E-05	1.87E-04	58.1	30,000
3.117	6.70E-05	2.09E-04	58.2	40,000
3.575	6.20E-05	2.22E-04	58.0	50,000
3.945	5.80E-05	2.29E-04	58.0	60,000
4.237	5.40E-05	2.29E-04	58.1	70,000
4.503	5.00E-05	2.25E-04	58.1	80,000
4.720	4.70E-05	2.22E-04	58.2	90,000
4.865	4.40E-05	2.14E-04	58.1	100,000
5.589	2.60E-05	1.45E-04	58.1	200,000
6.065	1.40E-05	8.49E-05	58.3	400,000
6.181	9.10E-06	5.62E-05	58.1	600,000
6.222	6.80E-06	4.23E-05	58.0	800,000
6.236	5.50E-06	3.43E-05	58.0	1,000,000



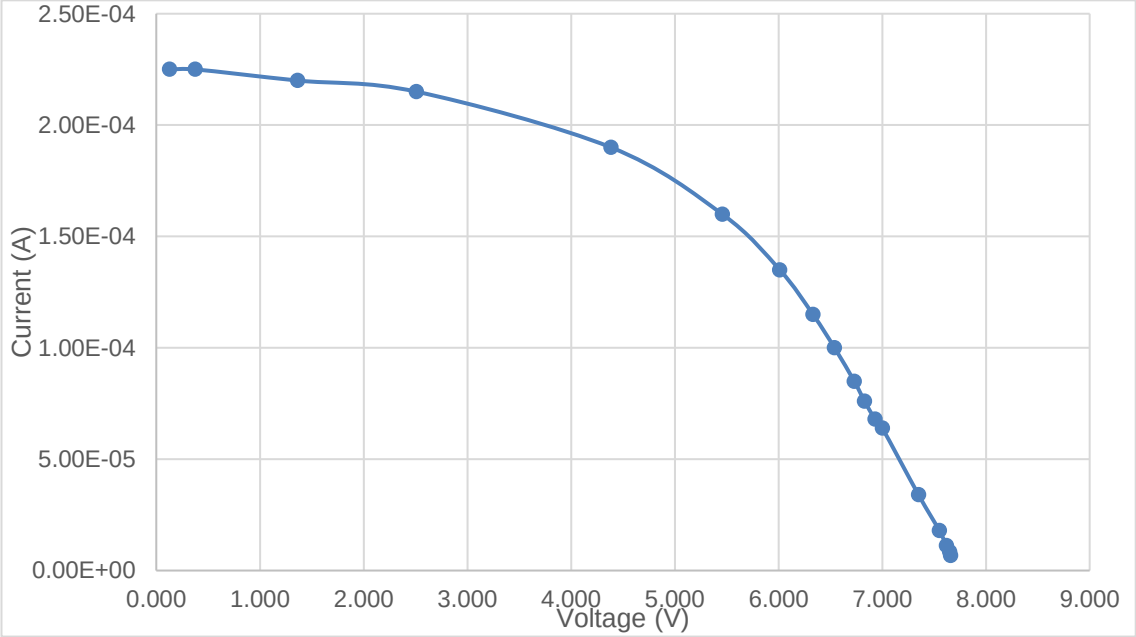
Kuvio 188. Voltage (V) vs Current (I) curve for panel ATCJ-I-57 polycarbonate cover at 30°.



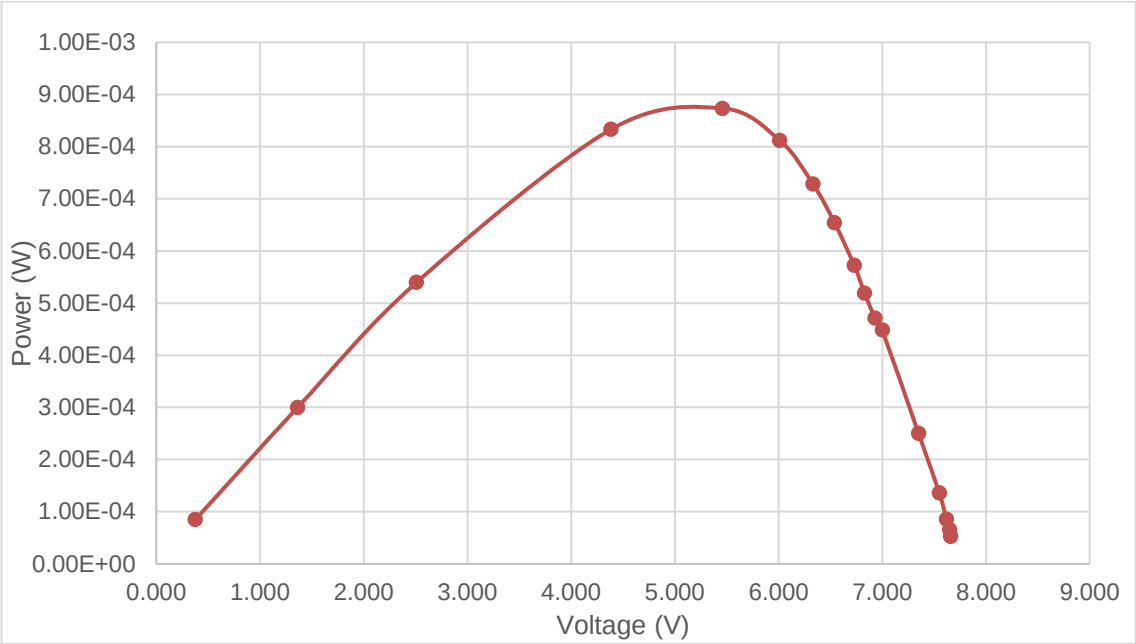
Kuvio 189. Voltage (V) vs Power (W) curve for panel ATCJ-I-57 with polycarbonate cover at 30°.

Taulukko 97. Results for panel ATCJ-I-57 with 3mm glass cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.127	2.25E-04	2.86E-05	99.6	-
0.376	2.25E-04	8.46E-05	99.5	1,000
1.363	2.20E-04	3.00E-04	99.3	5,000
2.509	2.15E-04	5.39E-04	99.9	10,000
4.384	1.90E-04	8.33E-04	99.8	20,000
5.458	1.60E-04	8.73E-04	99.9	30,000
6.012	1.35E-04	8.12E-04	100.0	40,000
6.332	1.15E-04	7.28E-04	99.8	50,000
6.540	1.00E-04	6.54E-04	100.0	60,000
6.730	8.50E-05	5.72E-04	99.7	70,000
6.830	7.60E-05	5.19E-04	100.0	80,000
6.930	6.80E-05	4.71E-04	100.0	90,000
7.000	6.40E-05	4.48E-04	100.0	100,000
7.350	3.40E-05	2.50E-04	99.4	200,000
7.550	1.80E-05	1.36E-04	100.0	400,000
7.620	1.12E-05	8.53E-05	100.0	600,000
7.650	8.50E-06	6.50E-05	99.8	800,000
7.660	6.80E-06	5.21E-05	100.0	1,000,000



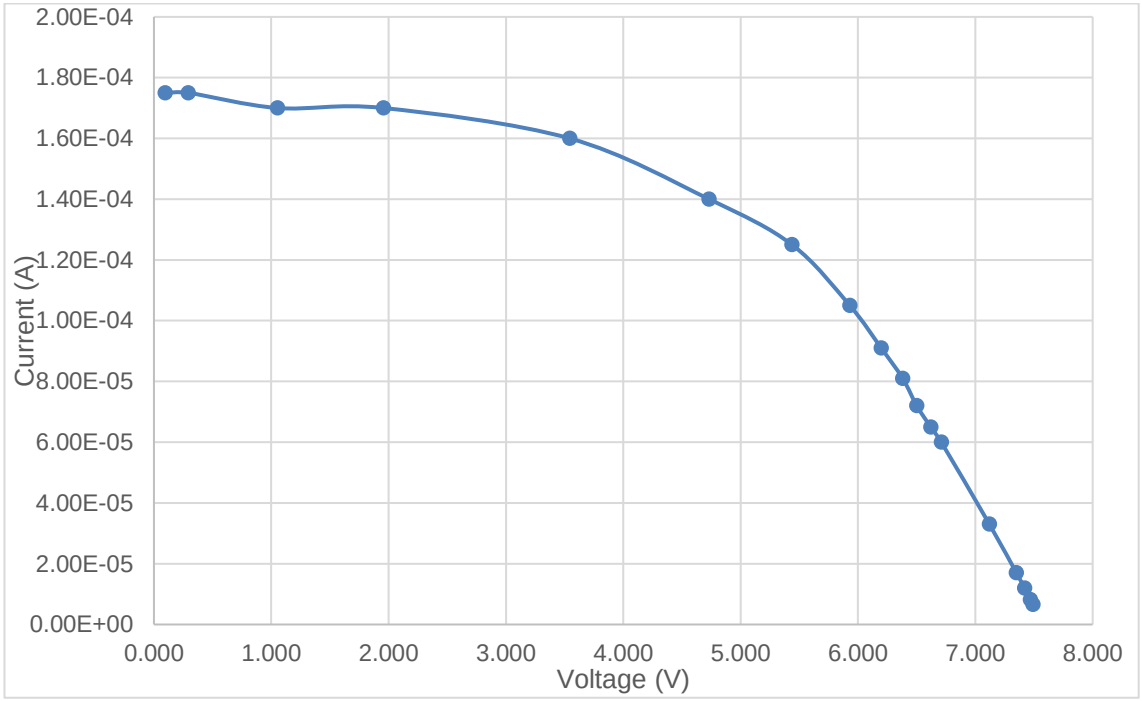
Kuvio 190. Voltage (V) vs Current (I) curve for panel ATCJ-I-57 3mm glass cover at 90°.



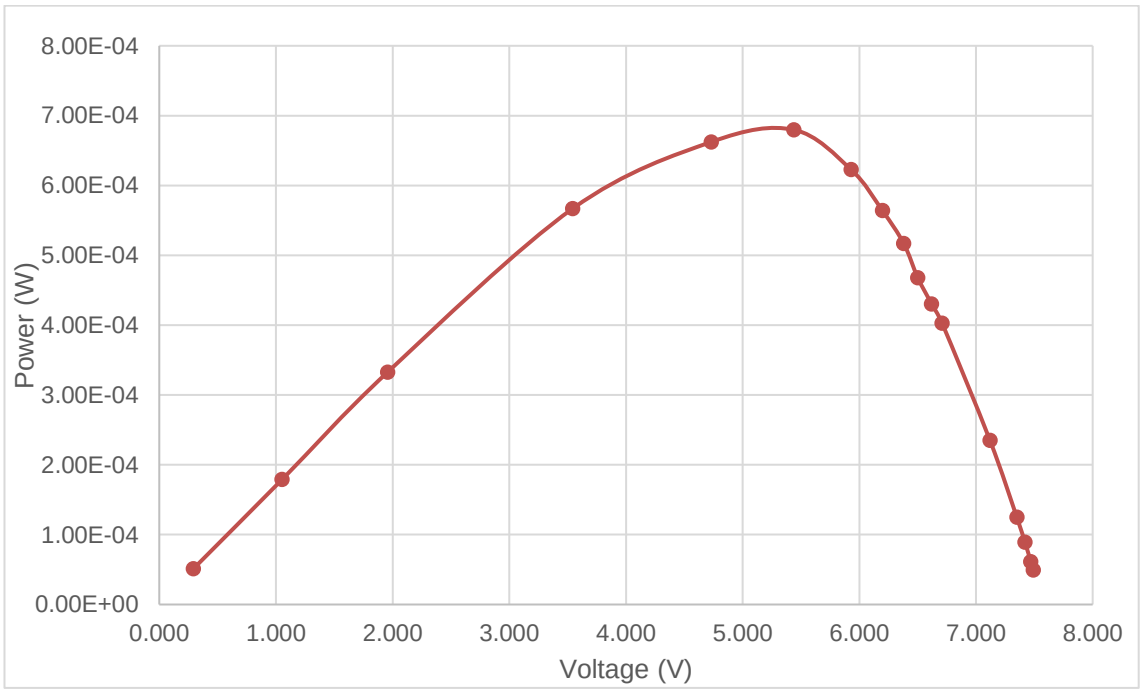
Kuvio 191. Voltage (V) vs Power (W) curve for panel ATCJ-I-57 with 3mm glass cover at 90°.

Taulukko 98. Results for panel ATCJ-I-57 with 3mm glass cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.097	1.75E-04	1.70E-05	90.9	-
0.293	1.75E-04	5.13E-05	91.5	1,000
1.053	1.70E-04	1.79E-04	91.7	5,000
1.957	1.70E-04	3.33E-04	91.6	10,000
3.544	1.60E-04	5.67E-04	91.5	20,000
4.731	1.40E-04	6.62E-04	91.6	30,000
5.438	1.25E-04	6.80E-04	91.7	40,000
5.930	1.05E-04	6.23E-04	91.5	50,000
6.198	9.10E-05	5.64E-04	91.7	60,000
6.381	8.10E-05	5.17E-04	91.8	70,000
6.501	7.20E-05	4.68E-04	91.9	80,000
6.620	6.50E-05	4.30E-04	91.6	90,000
6.710	6.00E-05	4.03E-04	91.8	100,000
7.120	3.30E-05	2.35E-04	91.8	200,000
7.350	1.70E-05	1.25E-04	92.0	400,000
7.420	1.20E-05	8.90E-05	91.9	600,000
7.470	8.20E-06	6.13E-05	91.8	800,000
7.490	6.60E-06	4.94E-05	91.6	1,000,000



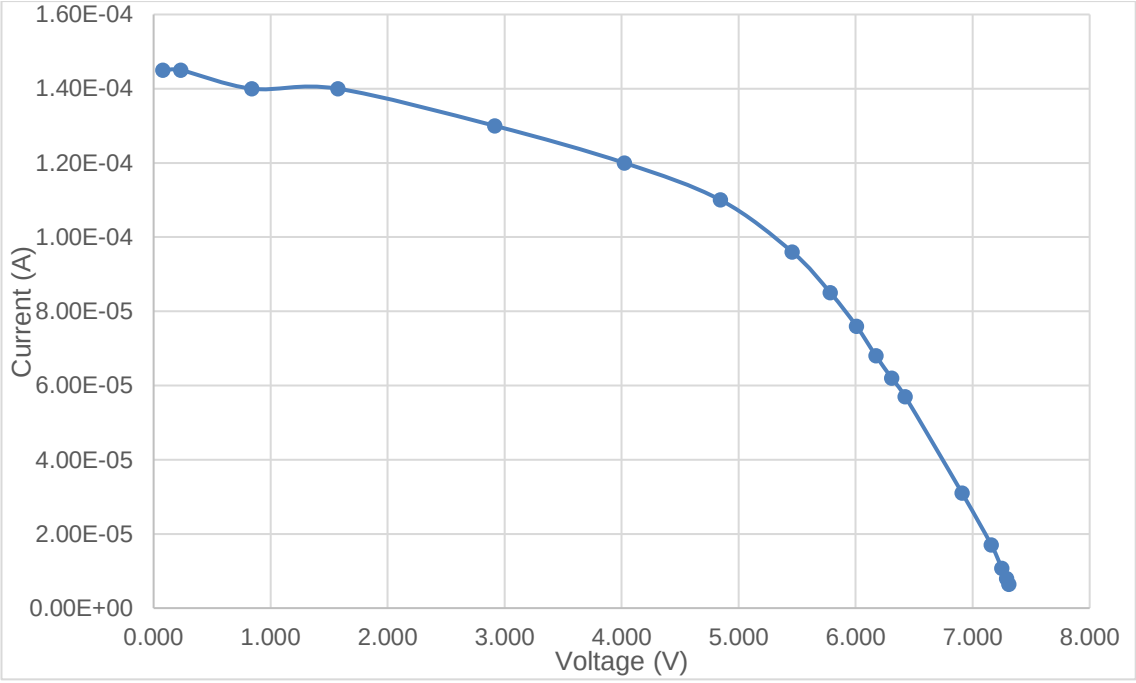
Kuvio 192. Voltage (V) vs Current (I) curve for panel ATCJ-I-57 3mm glass cover at 60°.



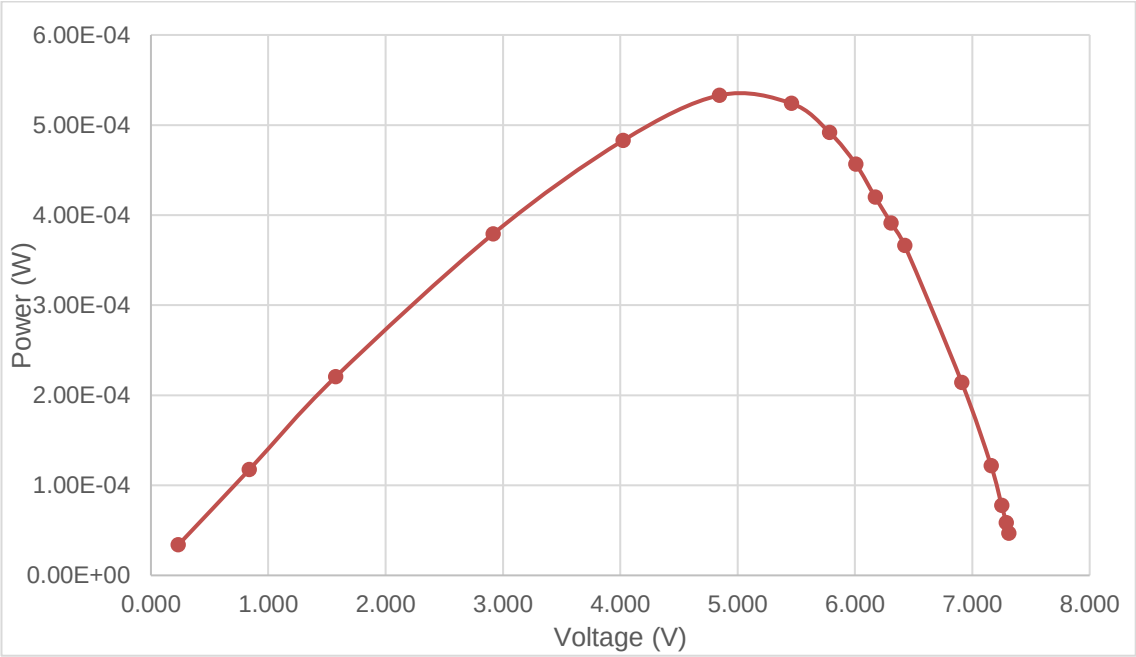
Kuvio 193. Voltage (V) vs Power (W) curve for panel ATCJ-I-57 with 3mm glass cover at 60°.

Taulukko 99. Results for panel ATCJ-I-57 with 3mm glass cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.078	1.45E-04	1.13E-05	77.5	-
0.233	1.45E-04	3.38E-05	77.4	1,000
0.839	1.40E-04	1.17E-04	77.3	5,000
1.574	1.40E-04	2.20E-04	77.4	10,000
2.916	1.30E-04	3.79E-04	77.4	20,000
4.023	1.20E-04	4.83E-04	77.4	30,000
4.845	1.10E-04	5.33E-04	77.6	40,000
5.458	9.60E-05	5.24E-04	77.5	50,000
5.784	8.50E-05	4.92E-04	77.6	60,000
6.007	7.60E-05	4.57E-04	77.5	70,000
6.173	6.80E-05	4.20E-04	77.3	80,000
6.308	6.20E-05	3.91E-04	77.5	90,000
6.424	5.70E-05	3.66E-04	77.5	100,000
6.910	3.10E-05	2.14E-04	77.8	200,000
7.160	1.70E-05	1.22E-04	77.6	400,000
7.250	1.07E-05	7.76E-05	77.6	600,000
7.290	8.00E-06	5.83E-05	77.6	800,000
7.310	6.40E-06	4.68E-05	77.5	1,000,000



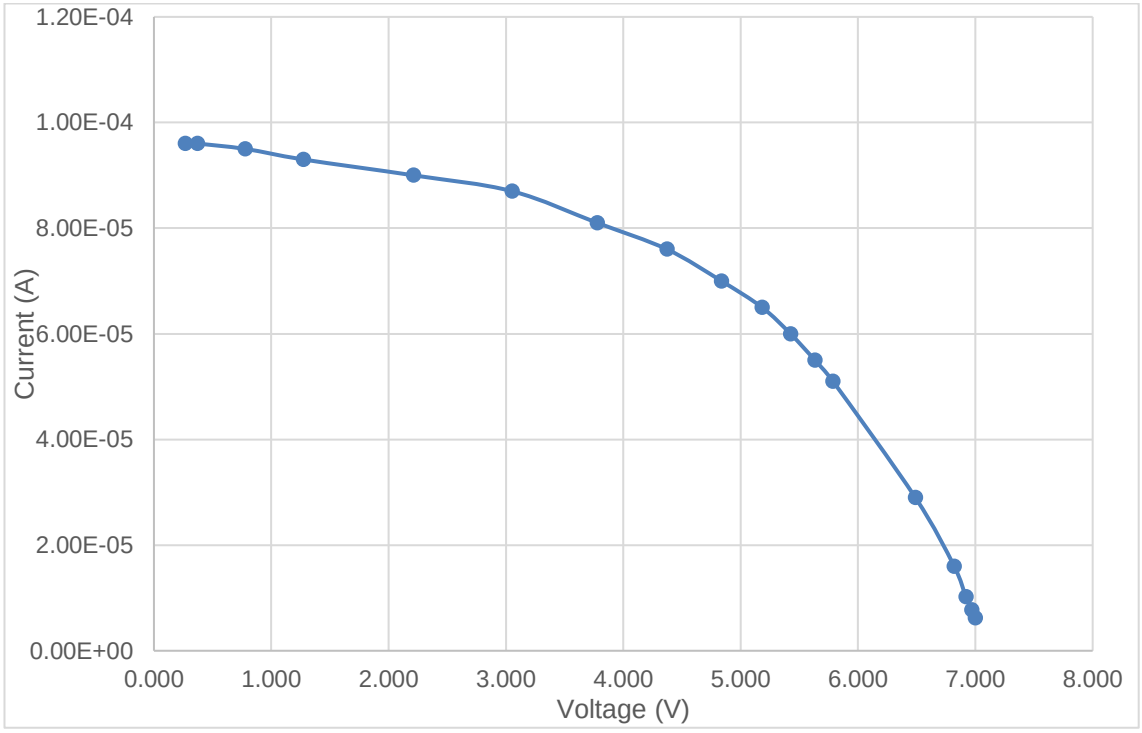
Kuvio 194. Voltage (V) vs Current (I) curve for panel ATCJ-I-57 3mm glass cover at 45°.



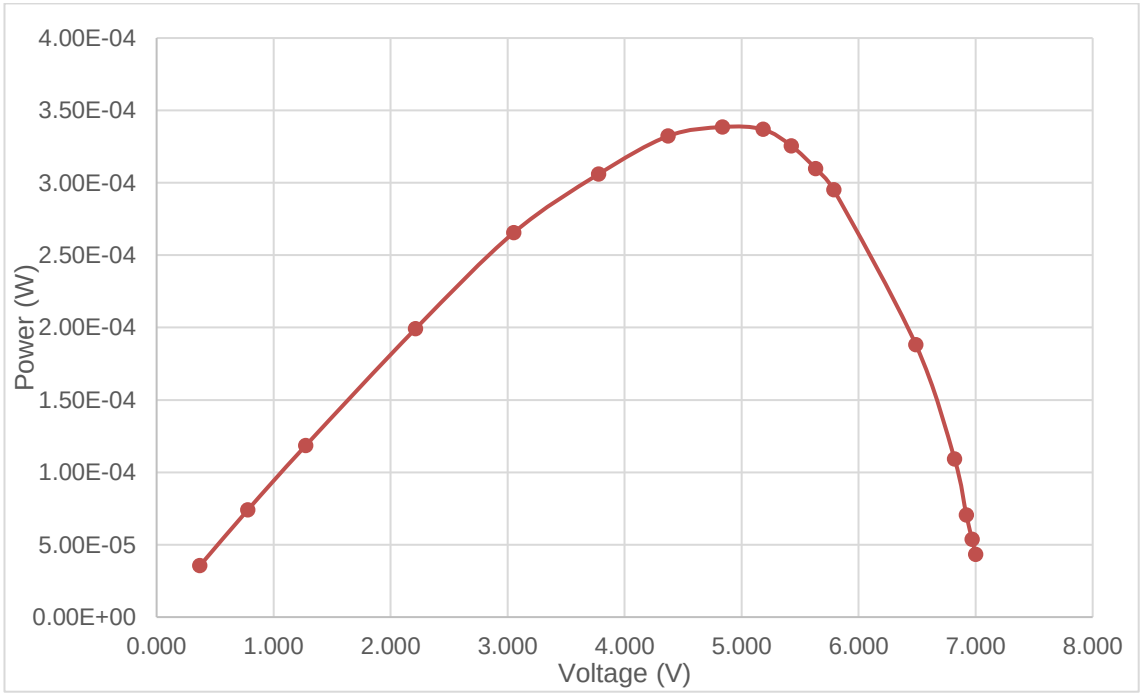
Kuvio 195. Voltage (V) vs Power (W) curve for panel ATCJ-I-57 with 3mm glass cover at 45°.

Taulukko 100. Results for panel ATCJ-I-57 with 3mm glass cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.269	9.60E-05	2.58E-05	58.5	-
0.370	9.60E-05	3.55E-05	58.7	1,000
0.779	9.50E-05	7.40E-05	58.7	5,000
1.274	9.30E-05	1.18E-04	58.7	10,000
2.213	9.00E-05	1.99E-04	58.5	20,000
3.052	8.70E-05	2.66E-04	58.7	30,000
3.778	8.10E-05	3.06E-04	58.6	40,000
4.372	7.60E-05	3.32E-04	58.7	50,000
4.836	7.00E-05	3.39E-04	58.7	60,000
5.183	6.50E-05	3.37E-04	58.8	70,000
5.425	6.00E-05	3.26E-04	58.8	80,000
5.633	5.50E-05	3.10E-04	58.5	90,000
5.787	5.10E-05	2.95E-04	58.8	100,000
6.489	2.90E-05	1.88E-05	58.9	200,000
6.820	1.60E-05	1.09E-04	58.9	400,000
6.920	1.02E-05	7.06E-05	58.8	600,000
6.970	7.70E-06	5.37E-05	58.6	800,000
7.000	6.20E-06	4.34E-05	58.7	1,000,000



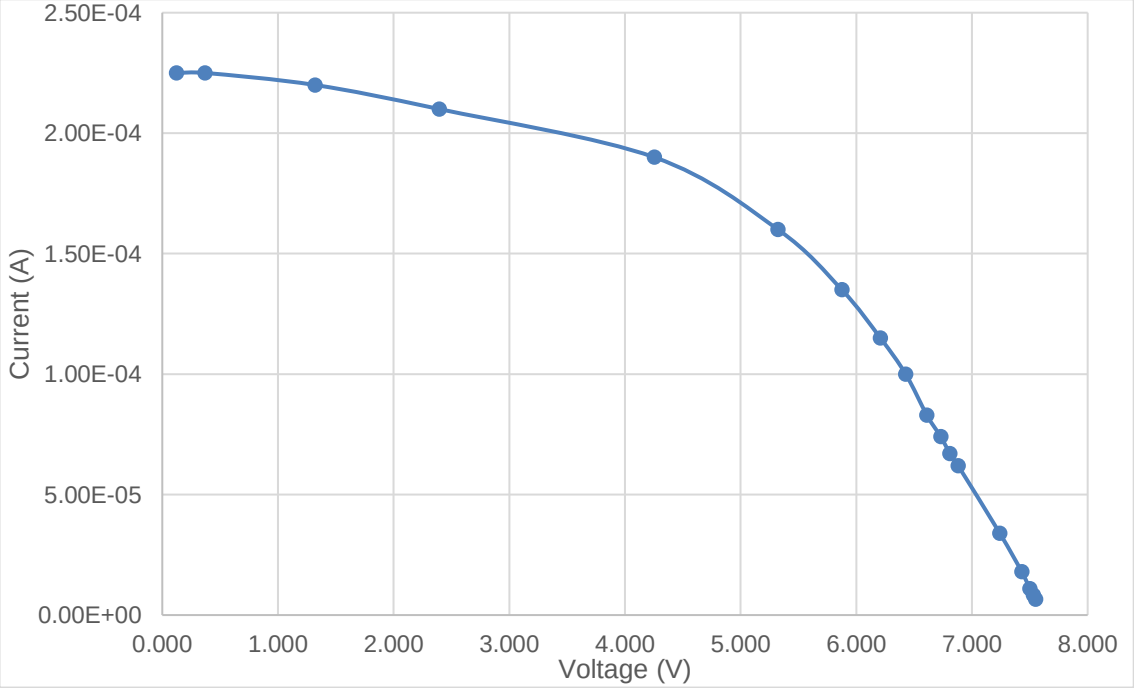
Kuvio 196. Voltage (V) vs Current (I) curve for panel ATCJ-I-57 3mm glass cover at 30°.



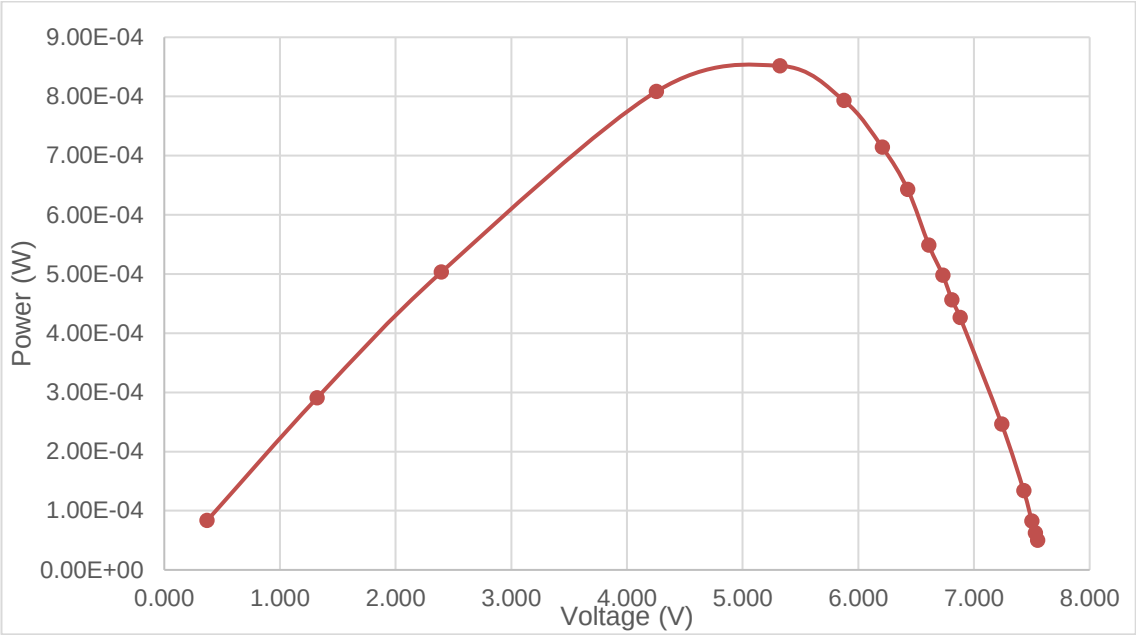
Kuvio 197. Voltage (V) vs Power (W) curve for panel ATCJ-I-57 with 3mm glass cover at 30°.

Taulukko 101. Results for panel ATCJ-I-57 with 6mm glass cover at 90°.

V (V)	I (A)	P (W)	Irradiance	Load
0.124	2.25E-04	2.79E-05	100.2	-
0.370	2.25E-04	8.33E-05	100.2	1,000
1.321	2.20E-04	2.91E-04	100.2	5,000
2.395	2.10E-04	5.03E-04	99.6	10,000
4.254	1.90E-04	8.08E-04	100.2	20,000
5.323	1.60E-04	8.52E-04	100.4	30,000
5.875	1.35E-04	7.93E-04	100.2	40,000
6.208	1.15E-04	7.14E-04	100.1	50,000
6.427	1.00E-04	6.43E-04	100.0	60,000
6.610	8.30E-05	5.49E-04	100.0	70,000
6.730	7.40E-05	4.98E-04	100.2	80,000
6.810	6.70E-05	4.56E-04	100.2	90,000
6.880	6.20E-05	4.27E-04	99.9	100,000
7.240	3.40E-05	2.46E-04	100.0	200,000
7.430	1.80E-05	1.34E-04	100.0	400,000
7.500	1.10E-05	8.25E-05	100.3	600,000
7.530	8.30E-06	6.25E-05	100.1	800,000
7.550	6.60E-06	4.98E-05	100.1	1,000,000



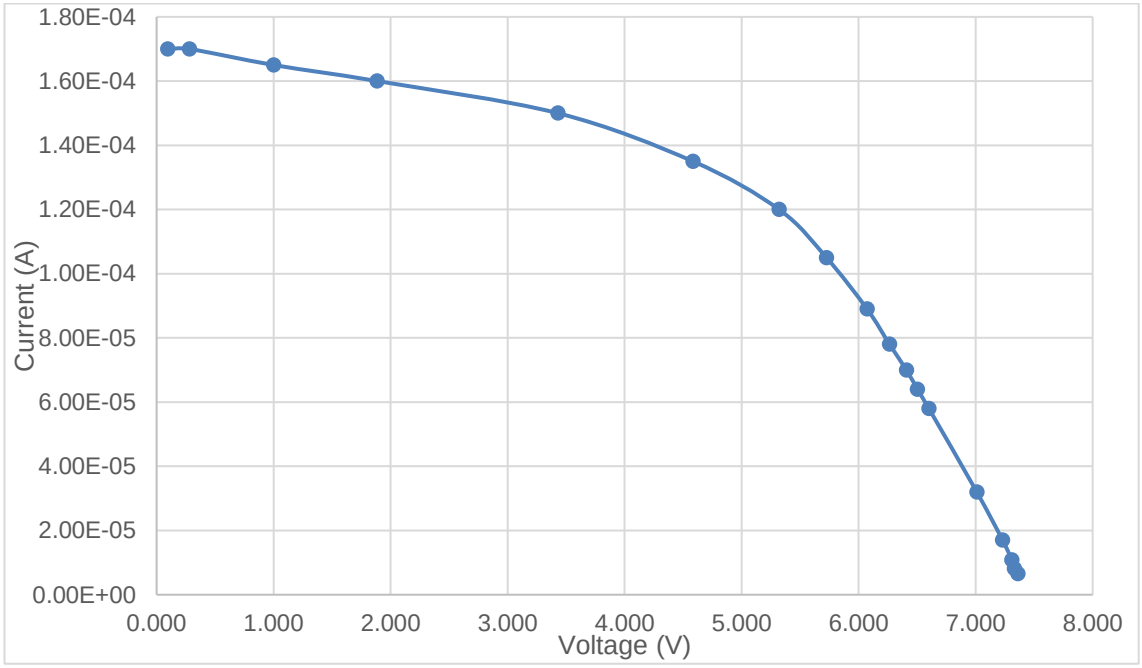
Kuvio 198. Voltage (V) vs Current (I) curve for panel ATCJ-I-57 6mm glass cover at 90°.



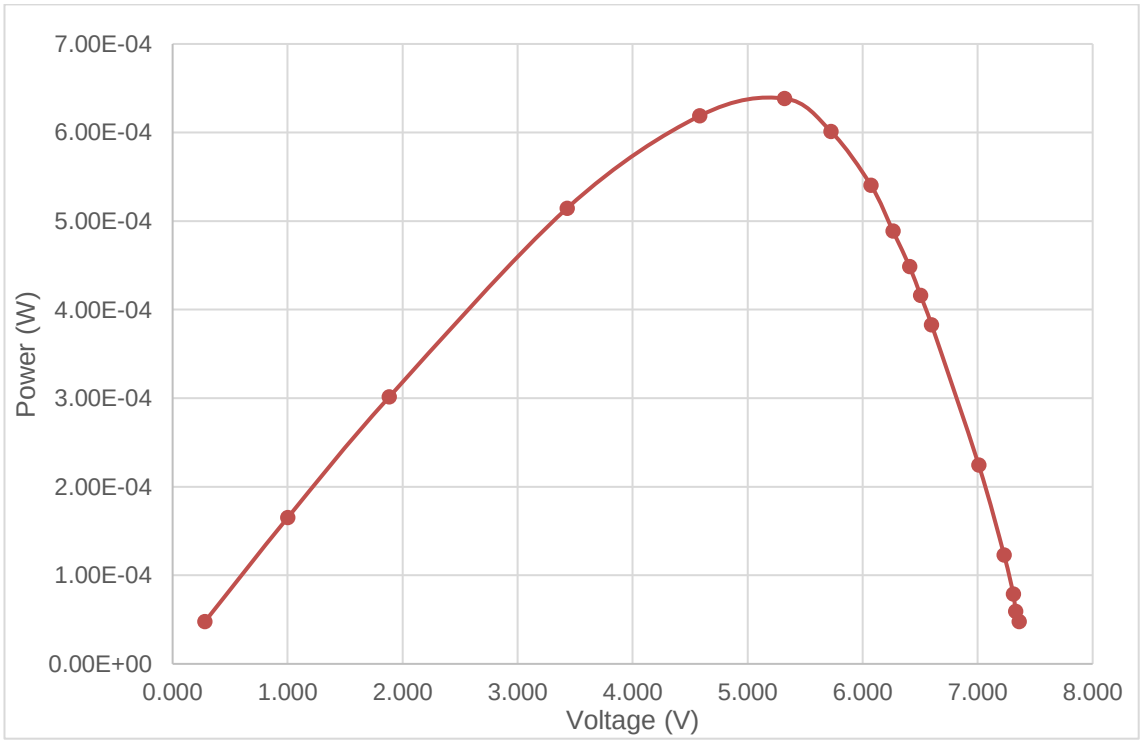
Kuvio 199. Voltage (V) vs Power (W) curve for panel ATCJ-I-57 with 6mm glass cover at 90°.

Taulukko 102. Results for panel ATCJ-I-57 with 6mm glass cover at 60°.

V (V)	I (A)	P (W)	Irradiance	Load
0.095	1.70E-04	1.62E-05	91.3	-
0.281	1.70E-04	4.78E-05	91.3	1,000
1.002	1.65E-04	1.65E-04	91.0	5,000
1.885	1.60E-04	3.02E-04	91.1	10,000
3.430	1.50E-04	5.15E-04	91.3	20,000
4.584	1.35E-04	6.19E-04	91.3	30,000
5.320	1.20E-04	6.38E-04	91.4	40,000
5.725	1.05E-04	6.01E-04	91.2	50,000
6.072	8.90E-05	5.40E-04	91.3	60,000
6.264	7.80E-05	4.89E-04	91.4	70,000
6.408	7.00E-05	4.49E-04	91.3	80,000
6.503	6.40E-05	4.16E-04	91.3	90,000
6.600	5.80E-05	3.83E-04	91.3	100,000
7.010	3.20E-05	2.24E-04	91.2	200,000
7.230	1.70E-05	1.23E-04	91.2	400,000
7.310	1.08E-05	7.89E-05	91.3	600,000
7.330	8.10E-06	5.94E-05	91.3	800,000
7.360	6.50E-06	4.78E-05	91.1	1,000,000



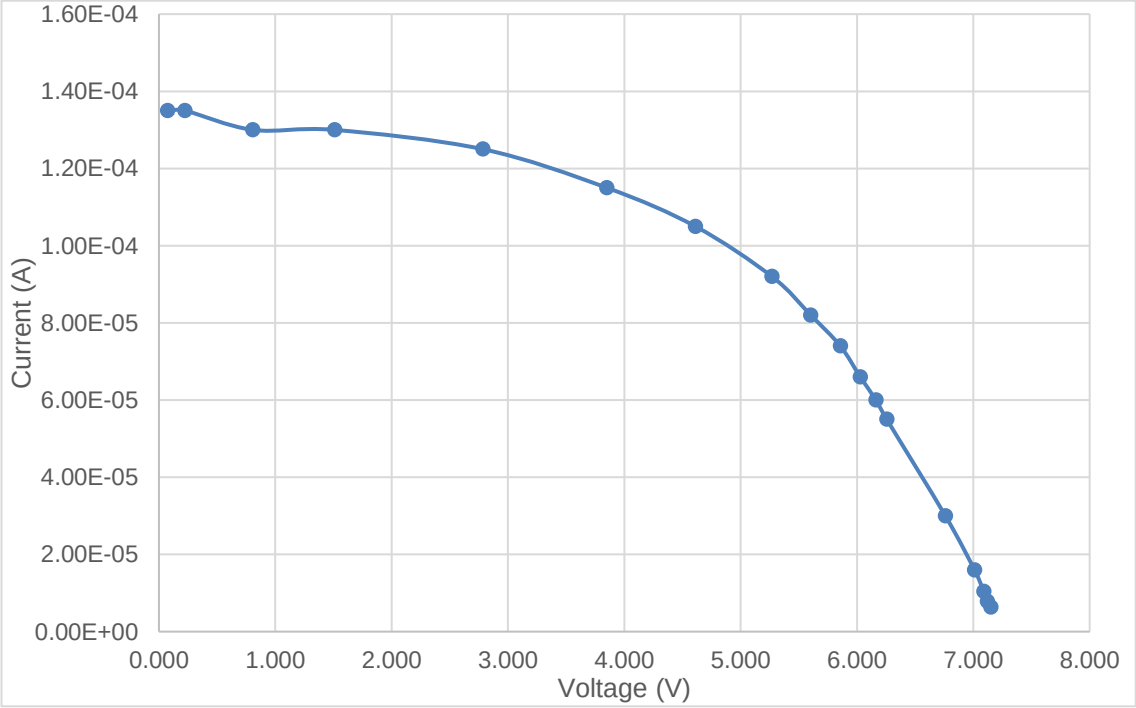
Kuvio 200. Voltage (V) vs Current (I) curve for panel ATCJ-I-57 6mm glass cover at 60°.



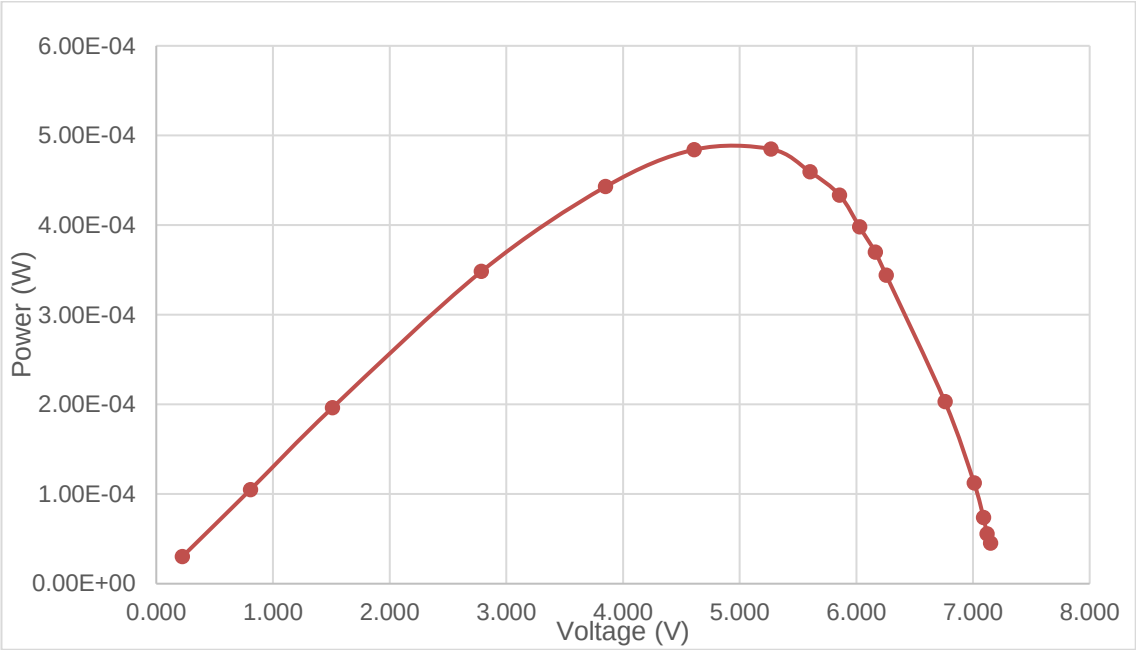
Kuvio 201. Voltage (V) vs Power (W) curve for panel ATCJ-I-57 with 6mm glass cover at 60°.

Taulukko 103. Results for panel ATCJ-I-57 with 6mm glass cover at 45°.

V (V)	I (A)	P (W)	Irradiance	Load
0.075	1.35E-04	1.01E-05	77.3	-
0.224	1.35E-04	3.02E-05	77.3	1,000
0.807	1.30E-04	1.05E-04	77.3	5,000
1.510	1.30E-04	1.96E-05	77.2	10,000
2.785	1.25E-04	3.48E-04	77.1	20,000
3.850	1.15E-04	4.43E-04	77.1	30,000
4.611	1.05E-04	4.84E-04	77.0	40,000
5.269	9.20E-05	4.85E-04	77.1	50,000
5.603	8.20E-05	4.59E-04	77.2	60,000
5.857	7.40E-05	4.33E-04	77.5	70,000
6.028	6.60E-05	3.98E-04	77.4	80,000
6.163	6.00E-05	3.70E-04	77.6	90,000
6.256	5.50E-05	3.44E-04	77.0	100,000
6.760	3.00E-05	2.03E-04	77.2	200,000
7.010	1.60E-05	1.12E-04	77.3	400,000
7.090	1.04E-05	7.37E-05	77.3	600,000
7.120	7.80E-06	5.55E-05	77.3	800,000
7.150	6.30E-06	4.50E-05	77.4	1,000,000



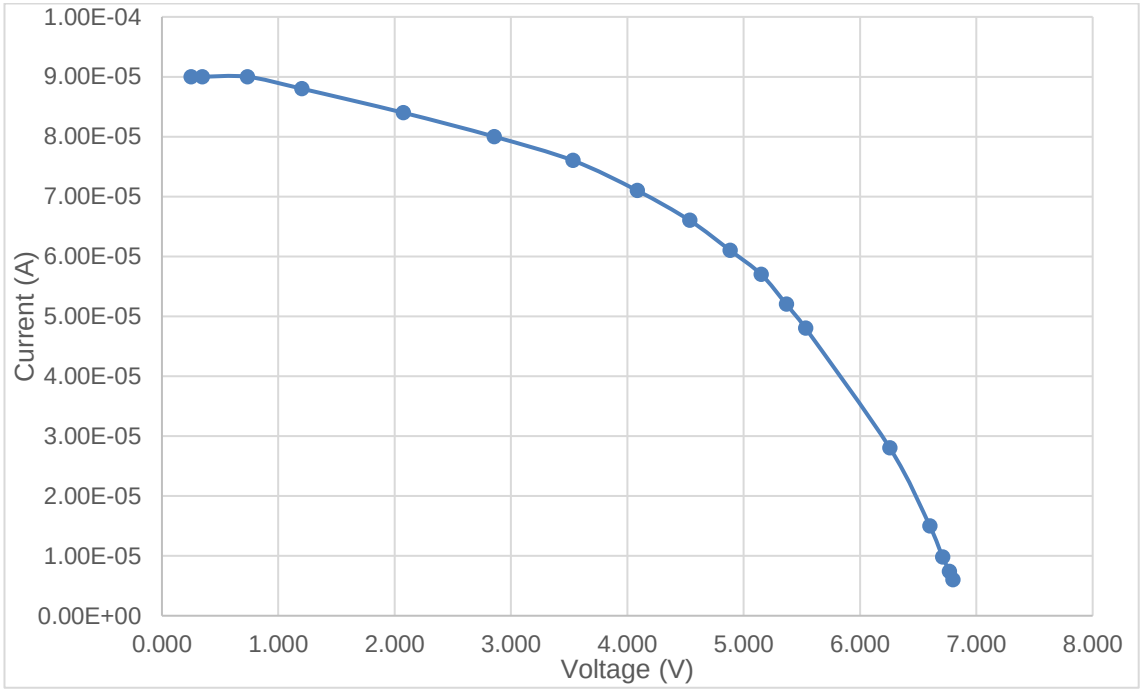
Kuvio 202. Voltage (V) vs Current (I) curve for panel ATCJ-I-57 6mm glass cover at 45°.



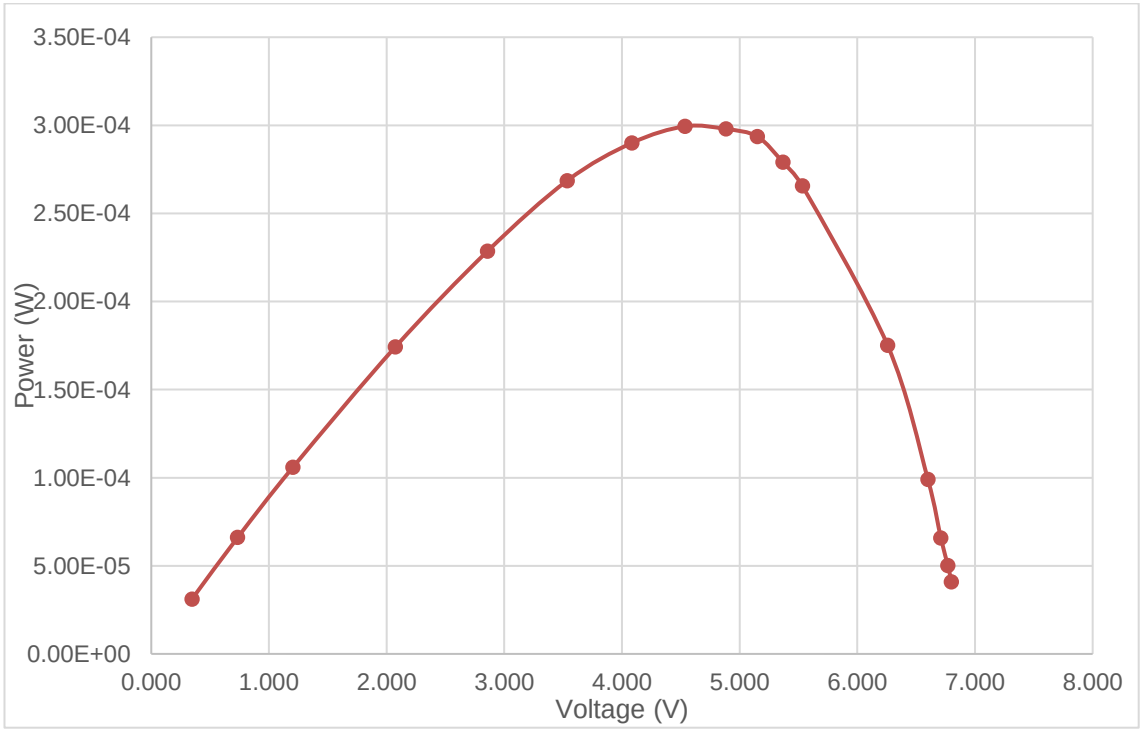
Kuvio 203. Voltage (V) vs Power (W) curve for panel ATCJ-I-57 with 6mm glass cover at 90°.

Taulukko 104. Results for panel ATCJ-I-57 with 6mm glass cover at 30°.

V (V)	I (A)	P (W)	Irradiance	Load
0.250	9.00E-05	2.25E-05	58.5	-
0.346	9.00E-05	3.11E-05	58.3	1,000
0.734	9.00E-05	6.61E-05	58.4	5,000
1.204	8.80E-05	1.06E-04	58.4	10,000
2.074	8.40E-05	1.74E-04	58.3	20,000
2.857	8.00E-05	2.29E-04	58.3	30,000
3.534	7.60E-05	2.69E-04	58.2	40,000
4.085	7.10E-05	2.90E-04	58.4	50,000
4.537	6.60E-05	2.99E-04	58.4	60,000
4.884	6.10E-05	2.98E-04	58.3	70,000
5.151	5.70E-05	2.94E-04	58.4	80,000
5.367	5.20E-05	2.79E-04	58.5	90,000
5.533	4.80E-05	2.66E-04	58.4	100,000
6.257	2.80E-05	1.75E-04	58.3	200,000
6.600	1.50E-05	9.90E-05	58.4	400,000
6.710	9.80E-06	6.58E-05	58.4	600,000
6.770	7.40E-06	5.01E-05	58.3	800,000
6.800	6.00E-06	4.08E-05	58.4	1,000,000



Kuvio 204. Voltage (V) vs Current (I) curve for panel ATCJ-I-57 6mm glass cover at 30°.



Kuvio 205. Voltage (V) vs Power (W) curve for panel ATCJ-I-57 with 6mm glass cover at 30°.