# SL160-24M190 Solar Panel from Sunlink PV

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Specifications

| | |
|---|---|
| **Electrical Characteristics** | |
| STC Power Rating $P_{mp}$ (W) | 190 |
| Open Circuit Voltage $V_{oc}$ (V) | 45.4 |
| Short Circuit Current $I_{sc}$ (A) | 5.44 |
| Voltage at Maximim Power $V_{mp}$ (V) | 36.2 |
| Current at Maximim Power $I_{mp}$ (A) | 5.25 |
| Panel Efficiency | 14.9% |
| Fill Factor | 76.9% |
| Power Tolerance | -2.00% ~ 2.00% |
| Maximum System Voltage $V_{max}$ (V) | 1000 |
| Maximum Series Fuse Rating (A) | |
| **Temperature Coefficients** | |
| Temperature Coefficiency of $I_{sc}$ | 0.055 % |
| Temperature Coefficiency of $V_{oc}$ | -0.35 % |
| Temperature Coefficiency of $P_{mp}$ | -0.45 % |
| **Mechanical Characteristics** | |
| Cell Type | Monocrystalline Cell |
| Cell Size(mm) | |
| Cells | 72 |
| Dimensions | 1580.0 × 808.0 × 35.0mm (31.8 × 62.2 × 1.4 inch) |
| Weight | 15.0Kg (33.1 lbs) |
| Junction Box (Safety Rating, Bypass Diodes) | |
| Positive Cable (Length, Cable Cross-Section) | |
| Negative Cable (Length, Cable Cross-Section) | |
| Plug Connector (Type, Safety) | cable MC new |
| Front Cover (Thickness,Material) | |
| Backsheet Cover (Color, Thickness, Material) | |
| Encapsulation Materials | |
| Frame Material | aluminum |
| **Operation Conditions** | |
| Nominal Operating Cell Temperature (NOCT) | |
| Operating Temperature | |
| Maximum Load | |
| Hail Storm Rating | |
| Fire Safety Rating | |
| **Warranty & Certification** | |

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|---|
| Certificates |
| Defects & Workmanship Warranty Period |
| 90% Power Output Warranty Period |
| 80% Power Output Warranty Period |
| Are Warranties Insured By Third Party |

## Photovoltaic Panel Efficiency and Performance

This page describes the major properties of a solar panel which are used to measure solar panel efficiency and solar panel performance. The data for each property is collected in or calculated from our solar panel database. All data in the database are from manufacturers' product datasheets, but we do not guarantee the accuracy.

A photovoltaic panel or a solar panel is an interconnected assembly of solar cells and is the basic component of a photovoltaic system. Photovoltaic panel consists of transparent front side, encapsulated solar cells and backside. It is framed with an aluminum frame, occasionally with a stainless steel or with a plastic frame. The front side material (superstrate) is usually low-iron, tempered glass. Most common backside materials (substrate) are EVA (ethylene-vinyl-acetate) and PVB (polyvinyl-burial). According to the solar cell technology popular photovoltaic panels are classified as monocrystalline, polycrystalline and amorphous solar panels, and the last one is also called thin-film panels.

Photovoltaic panel electrical performance depends on environmental conditions such as the temperature, solar irradiance, angle-of-incidence, solar spectral(air mass), and the types of PV cells. Each PV panel is rated under industrial Standard Test Conditions (STC) of solar irradiance of 1,000 W/m² with zero angle of incidence, solar spectrum of 1.5 air mass and 25°C cell temperature. Electrical characteristics from manufacturers include maximum rated power, open circuit voltage, short circuit current, maximum power voltage, maximum power current, and temperature coefficients.

**Maximum Rated Power $P_m$ (Watt):** The maximum power output from a PV panel at STC which is usually labeled on the panel nameplate. The actual power output can be estimated by

$$P_{real} = P_m * S / 1000 * [1 - \lambda(T_{cell} - 25)]$$

$$T_{cell} = T_{ambient} + S / 800 * (T_{NOCT} - 20)$$

where S - the solar radiation on the panel surface, $T_{ambient}$ - the ambient temperature, $T_{NOCT}$ - the Nominal Operating Cell Temperature, and λ - Maximum Power Temperature Coefficient.

**Rated Power Tolerance δ (%):** The specified range within which a panel will either overperform or underperform its rated power $P_m$ at STC. Power tolerance can vary greatly, from as much as +10% to -10%. A 200 watt panel with ±10% rated power tolerance may produce only 180 Watts or as much as 220 watts out of the box. To ensure expected power output, look for panels with a small negative (or positive only) power tolerance.

**Panel Efficiency (%):** The ratio of output power to input power from the sunlight, i.e., what percentage of light energy that hits the panel gets converted into electricity. The higher the efficiency value, the more electricity generated in a given space. You must be aware, however, that the solar cell efficiency doesn't equal the panel efficiency. The panel efficiency is usually 1 to 3% lower than the solar cell efficiency due to glass reflection, frame shadowing, higher temperatures etc.

**Fill Factor (%):** The ratio of actual rated maximum power $P_m$ to the theoretical (not actually obtainable) maximum power ($I_{sc}$ x $V_{oc}$ ). This is a key parameter in evaluating the performance of solar panels. Typical commercial solar panels have a fill factor > 0.70, while grade B solar panels have a fill factor range from 0.4 to 0.7. A higher fill factor solar panel has less losses due to the series and parallel resistances within the cells themselves.

**Series Fuse Rating (Amps):** Current rating of a series fuse used to protect a panel from overcurrent under fault conditions. Each panel is rated to withstand a certain number of amps. Too many amps flowing through the panel(perhaps backfed amps from paralleled panels or paralleled strings of panels) could damage the panel if it's not protected by an overcurrent device rated at specification. Backfeeding from other strings is most likely to exist if one series string of panels stops producing power due to shading or a damaged circuit. Because PV panels are current-limited, there are some cases where series fusing may not be needed. When there is only one panel or string, there is nothing that can backfeed, and no series string fuse is needed. In the case of two series strings, if one string stops producing power and the other string backfeeds through it, no fuse is needed because each panel is designed to handle the current from one string. Some PV systems even allow for three strings or more with no series fuses. This is due to 690.9 Exception B of the NEC and is possible when the series fuse specification is substantially higher than the panel's shortcircuit current ($I_{sc}$). When required, series fuses are located in either a combiner box or in some grid-connected inverters.

**Connector Type:** Panel output terminal or cable/connector configuration. Most panels come with "plug and play" weatherproofed connectors to reduce installation time in the field. Connectors such as Solarlok (manufactured by Tyco Electronics), and MC and MC4 (manufactured by Multi-Contact USA) are lockable connectors that require a tool for opening. Because so many PV systems installed today operate at high DC voltages, lockable connectors are being used on panels in accessible locations to prevent untrained persons from "unplugging" the paneles, per 2008 NEC Article 690.33(C). Due to this new code requirement, most PV manufacturers are updating their connectors to the locking type. Depending on how fast this change is reflected in the supply chain, connectors on a particular panel may be an older version.

**Materials Warranty (Years):** A limited warranty on panel materials and quality under normal application, installation, use, and service conditions. Material warranties vary from 1 to 10 years. Most manufacturers offer full replacement or free servicing of a defective panel.

**Power Warranty (Years):** A limited warranty for panel power output based on the minimum peak power rating (STC rating minus power tolerance percentage) of a given panel. The manufacturer guarantees that the panel will provide a certain level of power for a period of time (at least 20 years). Most warranties are structured as a percentage of minimum peak power output within two different time frames: (1) 90% over the first 10 years and (2) 80% for the next 10 years. Panel replacement value provided by most power warranties is generally prorated according to how long the panel has been in the field.

**Cell Type:** The type of silicon that comprises a specific cell, based on the cell manufacturing process. Each cell type has pros and cons. Monocrystalline PV cells are the most expensive and energy intensive to produce but usually yield the highest efficiencies. Though polycrystalline and ribbon silicon cells are slightly less energy intensive and less expensive to produce, these cells are slightly less efficient than monocrystalline cells. However, because both poly- and ribbon silicon panels leave fewer gaps on the panel surface (due to square or rectangular cell shapes), these panels can often offer about the same power density as monocrystalline modules. Thin-film panels, such as those made from amorphous silicon cells, are the least expensive to produce and require the least amount of energy and raw materials, but are the least efficient of the cell types. They require about twice as much space to produce the same power as mono-, poly-, or ribbon-silicon panels. Thin-film panels do have better shade tolerance and high-temperature performance but are often more expensive to install because of their lower power density. Sanyo's "bifacial" HIT panels are composed of a monocrystalline cell and a thin layer of amorphous silicon material. In addition to generating power from the direct rays of the sun on the panel face, this hybrid panel can produce power from reflected light on its underside, increasing overall panel efficiency.

**Cells in Series:** Number of individual PV cells wired in series, which determines the panel design voltage. Crystalline PV cells operate at about 0.5V. When cells are wired in series, the voltage of each cell is additive. For example, a panel that has 36 cells in series has a maximum power voltage ($V_{mp}$) of about 18V. Why 36? Historically, panels known as 12V were designed to push power into 12V batteries. But to deliver the 12V, they needed to have enough excess voltage (electrical pressure) to compensate for the voltage loss due to high temperature conditions. Panels with 36 ("12V") or 72 ("24V") cells are designed for battery-charging applications.
Panels with other numbers of cells in series are intended for use in grid-tied systems. Due to the increased availability of step-down/MPPT battery charge controllers, grid-tied panels can also be used for battery charging, as long as they stay within the voltage limitations of the charge controller.

**Maximum Power Voltage $V_{mp}$:** The voltage where a panel outputs the maximum power. Grid-tied inverters and MPPT charge controllers are built to track maximum power point throughout the day, and $V_{mp}$ of each panel array, as well as array operating temperatures must be considered when sizing an array to a particular inverter or controller. Series string sizing software programs for grid-tied inverters allow you to input both the high and low temperatures at your installation site, and calculate the correct number of panels in series to maximize system performance.

**Maximum Power Current $I_{mp}$:** The maximum amperage where a panel outputs the maximum power. This specification is most commonly used in calculations for PV array disconnect labeling required by NEC Article 690.53(1), as the rated maximum power-point current for the array must be listed. Maximum power current is also used in array and charge controller sizing calculations for battery-based PV systems.

**Open-Circuit Voltage $V_{oc}$:** The maximum voltage generated by a PV panel exposed to sunlight with no load connected. All major PV system components (panels, wiring, inverters, charge controllers, etc.) are rated to handle a maximum voltage. Maximum system voltage must be calculated in the design process to ensure all components are designed to handle the highest voltage that may be present. Under certain low-light conditions (dawn/dusk), it's possible for a PV system to operate close to open-circuit voltage. PV voltage will increase with decreasing air temperature, so $V_{oc}$ is used in conjunction with historic low temperature data to calculate the absolute highest maximum system voltage. Maximum system voltage must be shown on the PV array disconnect label required by NEC code.

**Short-Circuit Current $I_{sc}$:** The maximum amperage generated by a PV panel exposed to sunlight with the output terminals shorted. The PV circuit's wire size and overcurrent protection (fuses and circuit breakers) calculations per NEC Article 690.8 are based on panel short-circuit current. The PV system disconnect(s) must list short-circuit current (per NEC 690.53).

**Short-Circuit Current Temperature Coefficient α (%/°C):** The change in panel short-circuit current per degree Celsius at temperatures other than 25°C. It is most commonly used to calculate maximum system current (per NEC Article 690.7) for system design and labeling purposes. For example, consider a series string of ten 8A ($I_{sc}$) panels installed at a site with a record low of 15°C. Given a $I_{sc}$ temperature coefficient 0.04%/°C), the decrease in current will be 0.32A, making for an overall maximum system current of 7.68A.

**Open-Circuit Voltage Temperature Coefficient β (%/°C):** The change in panel open-circuit voltage at temperatures other than 25°C. If given, It is most commonly used to calculate maximum system voltage (per NEC Article 690.7) for system design and labeling purposes. For example, consider a series string of ten 43.6V ($V_{oc}$) panels installed at a site with a record low of -10°C. Given a $V_{oc}$ temperature coefficient of -160mV/°C, The voltage per panel will rise 5,600mV (= 160mV x (-10°C – 25°C)), making for an overall maximum system voltage of 492V (= 10 x (5.6V + 43.6V)), which is under the 600VDC limit for PV system equipment.

**Maximum Power Temperature Coefficient δ(%/°C):** The change in panel output power for temperatures other than 25°C. It is used to calculate how much panel power will be lost or gained due to temperature changes. In hot climates, cell temperatures can reach an excess of 70°C (158°F). Consider a panel maximum power rating of 200W at STC, with a temperature coefficient of -0.5%/°C. At 70°C, the actual output of this panel would be approximately 155W. Panels with lower power temperature coefficients will fare better in higher-temperature conditions. Thin-film panels have relatively low temperature coefficients which reflects better high-temperature performance.

**Nominal Operating Cell Temperature:** The temperature of each panel at an irradiance of 800 W/m2 and an ambient air temperature of 20°C and wind speed is 1 m/s at a module tilt angle 45°C. NOCT is a very critical parameter that is required by various performance, qualification and energy rating standards/methods. It can be used with the maximum power temperature coefficient to get a better real-world estimate of power loss due to temperature increase. The cell temperature of open-rack panels , however, is governed by several external factors such as ambient temperature, irradiance level, wind speed, wind direction, and tilt-angle of the panel in an array. The difference in cell temperature and ambient temperature is dependent on sunlight's intensity (W/m2). For example, if a particular panel has an NOCT of 40°C and a maximum power temperature coefficient of -0.5%/°C, power losses on temperature can be estimated at about 7.5%(=0.5% x (40°C – 25°C)).

**Panel certification:** Panel certifications are required to get the approval for federal and state rebates in USA. Every Market region has specific sets of standards which must be met by solar panels. Most popular certification standards are

- IEC 61215 (crystalline silicon performance), IEC 61646 (thin film performance), IEC 61730 ((crystalline modules, safety), IEC 62108(concentrating PV performance), IEC 61701 (salt resistance) ) for Europe
- UL 1703, UL 8703 (CPV) for USA and Canada
- CE mark (European Union, Iceland, Liechtenstein, Norway, Switzerland, Turkey)
- TÜV or VDE certificates indicate the panels have passed the testing of IEC standards, while UL certificate implies the UL 1703 testing
- IEC standard allows 1000 volt maximum system voltage, while UL allows 600 volt only. The maximal system voltage limits how many panels can be cascaded in one single string. For example, given panels with 40V of Voc, 25 panels can be cascaded in one series string in Europe, but only 15 panels are allowed to do so in USA and Canada.
- Beside the common certifications, some countries and regions have extra requirements. Some USA states require PTC rating of California CEC, UK requires its MCS certification, while Australia requires panels have to meet Application Class A, or Class C of IEC 61730.

**Flash Report:** Most manufacturers provide flash reports of their solar panels sold, including every single panel's flash test data. During a flash test, a solar panel is exposed to a short (1 - 30 millisecond), bright (1 watt per $M^2$) flash of xenon light source. The spectrum of the flash light is designed to be close to the spectrum of the sun. The output is collected by a testing computer and the data is compared to a pre-configurated reference solar panel which has its power output calibrated to standard solar irradiation. The results of the flash test are compared to the specifications of the pv module datasheet and are printed somewhere on the pv panel. The flash testing system is usually re-corrected by the reference panel in certain interval (usually two hours). The data in a flash report includes the pv panel barcode, $P_{max}$, $V_{oc}$, $I_{sc}$, $I_m$ and $V_m$. Your supplier should be given these data before you hit final buying trigger or after you sign the purchase contract.

**Common Solar Panel Defects:** The following defects are common during solar panel quality testing:

- Scratches on the frame and/or glass
- Excessive or uneven glue marks on glass or frame
- Gap between frame and glass due to poor sealing
- Always lower output than stated in data sheet
- Always lower fill factor than indirectly stated in data sheet
- Inconsistant cell colors
- Inconsistant cell alignments
- Undurable panel label printing

**Solar Panel Grading:** Based on the types and degrees of above defects, solar panel grading comes to play. Grade A normally means a panel has no above defect and is covered by manufacturer's standard warranty, while you may not be able to find "Grade A" in manufacturer's documents at all. Grade B usually means the panel has some "cosmetic imparfections" or "cosmetic blemishes" of the above, but has the "same" electrical output as Grade A. Grade B is rarely covered by manufacturer's standard warranty and is usually traded underneath the market. If the nameplate of your panel has word "Grade x" or the like, you are alerted to check with the manufacturer what it means.

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**Open-Circuit Voltage $V_{oc}$:** The maximum voltage generated by a PV panel exposed to sunlight with no load connected. All major PV system components (panels, wiring, inverters, charge controllers, etc.) are rated to handle a maximum voltage. Maximum system voltage must be calculated in the design process to ensure all components are designed to handle the highest voltage that may be present. Under certain low-light conditions (dawn/dusk), it's possible for a PV system to operate close to open-circuit voltage. PV voltage will increase with decreasing air temperature, so $V_{oc}$ is used in conjunction with historic low temperature data to calculate the absolute highest maximum system voltage. Maximum system voltage must be shown on the PV array disconnect label required by NEC code.

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**Open-Circuit Voltage Temperature Coefficient β (%/°C):** The change in panel open-circuit voltage at temperatures other than 25°C. If given, It is most commonly used to calculate maximum system voltage (per NEC Article 690.7) for system design and labeling purposes. For example, consider a series string of ten 43.6V ($V_{oc}$) panels installed at a site with a record low of -10°C. Given a $V_{oc}$ temperature coefficient of -160mV/°C, The voltage per panel will rise 5,600mV (= 160mV x (-10°C – 25°C)), making for an overall maximum system voltage of 492V (= 10 x (5.6V + 43.6V)), which is under the 600VDC limit for PV system equipment.

**Maximum Power Temperature Coefficient δ(%/°C):** The change in panel output power for temperatures other than 25°C. It is used to calculate how much panel power will be lost or gained due to temperature changes. In hot climates, cell temperatures can reach an excess of 70°C (158°F). Consider a panel maximum power rating of 200W at STC, with a temperature coefficient of -0.5%/°C. At 70°C, the actual output of this panel would be approximately 155W. Panels with lower power temperature coefficients will fare better in higher-temperature conditions. Thin-film panels have relatively low temperature coefficients which reflects better high-temperature performance.

**Nominal Operating Cell Temperature:** The temperature of each panel at an irradiance of 800 W/m2 and an ambient air temperature of 20°C and wind speed is 1 m/s at a module tilt angle 45°C. NOCT is a very critical parameter that is required by various performance, qualification and energy rating standards/methods. It can be used with the maximum power temperature coefficient to get a better real-world estimate of power loss due to temperature increase. The cell temperature of open-rack panels , however, is governed by several external factors such as ambient temperature, irradiance level, wind speed, wind direction, and tilt-angle of the panel in an array. The difference in cell temperature and ambient temperature is dependent on sunlight's intensity (W/m2). For example, if a particular panel has an NOCT of 40°C and a maximum power temperature coefficient of -0.5%/°C, power losses on temperature can be estimated at about 7.5%(=0.5% x (40°C – 25°C)).

**Panel certification:** Panel certifications are required to get the approval for federal and state rebates in USA. Every Market region has specific sets of standards which must be met by solar panels. Most popular certification standards are

- IEC 61215 (crystalline silicon performance), IEC 61646 (thin film performance), IEC 61730 ((crystalline modules, safety), IEC 62108(concentrating PV performance), IEC 61701 (salt resistance) ) for Europe
- UL 1703, UL 8703 (CPV) for USA and Canada
- CE mark (European Union, Iceland, Liechtenstein, Norway, Switzerland, Turkey)
- TÜV or VDE certificates indicate the panels have passed the testing of IEC standards, while UL certificate implies the UL 1703 testing
- IEC standard allows 1000 volt maximum system voltage, while UL allows 600 volt only. The maximal system voltage limits how many panels can be cascaded in one single string. For example, given panels with 40V of Voc, 25 panels can be cascaded in one series string in Europe, but only 15 panels are allowed to do so in USA and Canada.
- Beside the common certifications, some countries and regions have extra requirements. Some USA states require PTC rating of California CEC, UK requires its MCS certification, while Australia requires panels have to meet Application Class A, or Class C of IEC 61730.

**Flash Report:** Most manufacturers provide flash reports of their solar panels sold, including every single panel's flash test data. During a flash test, a solar panel is exposed to a short (1 - 30 millisecond), bright (1 watt per $M^2$) flash of xenon light source. The spectrum of the flash light is designed to be close to the spectrum of the sun. The output is collected by a testing computer and the data is compared to a pre-configurated reference solar panel which has its power output calibrated to standard solar irradiation. The results of the flash test are compared to the specifications of the pv module datasheet and are printed somewhere on the pv panel. The flash testing system is usually re-corrected by the reference panel in certain interval (usually two hours). The data in a flash report includes the pv panel barcode, $P_{max}$, $V_{oc}$, $I_{sc}$, $I_m$ and $V_m$. Your supplier should be given these data before you hit final buying trigger or after you sign the purchase contract.

**Common Solar Panel Defects:** The following defects are common during solar panel quality testing:

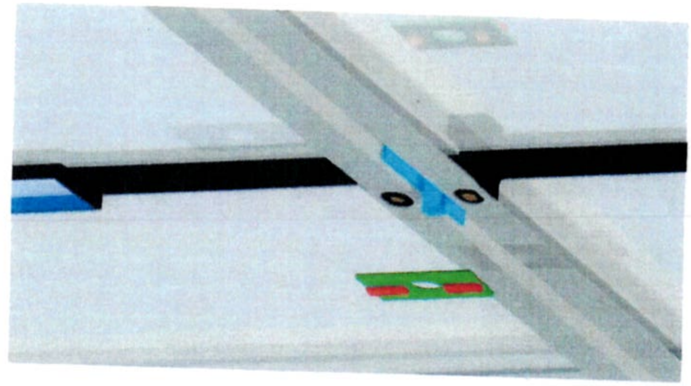
- Scratches on the frame and/or glass
- Excessive or uneven glue marks on glass or frame
- Gap between frame and glass due to poor sealing
- Always lower output than stated in data sheet
- Always lower fill factor than indirectly stated in data sheet
- Inconsistant cell colors
- Inconsistant cell alignments
- Undurable panel label printing

**Solar Panel Grading:** Based on the types and degrees of above defects, solar panel grading comes to play. Grade A normally means a panel has no above defect and is covered by manufacturer's standard warranty, while you may not be able to find "Grade A" in manufacturer's documents at all. Grade B usually means the panel has some "cosmetic imparfections" or "cosmetic blemishes" of the above, but has the "same" electrical output as Grade A. Grade B is rarely covered by manufacturer's standard warranty and is usually traded underneath the market. If the nameplate of your panel has word "Grade x" or the like, you are alerted to check with the manufacturer what it means.

## Appendix B: AstralENERGY Solar Manufacturing Company, Ltd.

AstralENERGY is based on the concept of building a better solar power product that addresses all of the fallibilities of the current products in the market.

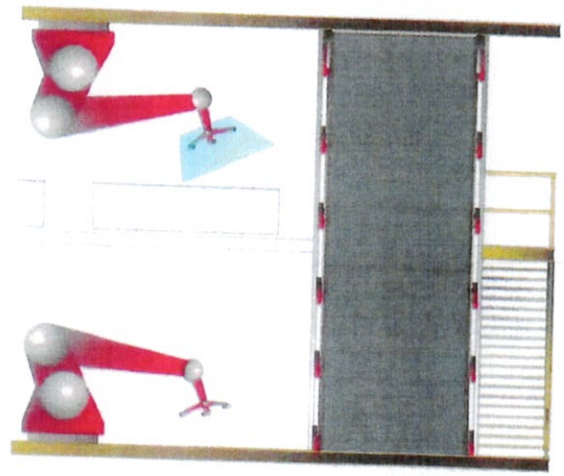
The company has been built from the experiences of the EPC division of Engineered Systems Incorporated and has designed new solar photovoltaic panels that are simpler and easier to install. This is a critical development as subsidies for solar projects are diminishing and readily accessible cost savings in the PV panels have already been made, any available overall installation cost savings much come from the so-called Balance of System (BOS). Balance of System items now account for over 60% of total costs and include such items as racking, wiring, installation and electrical costs.



Traditional panels are installed on racking systems and the wires are connected and then tied up to prevent friction damage from them dragging on a roof or hanging out where they can be damaged by animals, birds, rodents, weather or environmental conditions. Normally this process of terminating and tying up all of the connecting wires takes a significant amount of time, has to be performed by a licensed electrician and costs extra, as it requires additional materials to secure the wiring. On large installations this can involve a larger construction loan driven by the additional time, the additional materials and manpower and can significantly add delays and unforeseen technical challenges to a project because of the complex wiring. Furthermore, solar panels by current standards are dumb, merely converting photovoltaic energy into electricity and then being connected up in large banks of "solar batteries". If something should happen to a panel – micro-fractures, broken wiring, damaged junction box, missing bypass diode, missing protection diode or some other "hidden issue" it has to be solved by an electrician in a manner that is similar to building a 10,000 piece puzzle backwards and upside down.

We have designed a new patent pending interconnection system that eliminates 95% of all the wiring and the remaining wiring is co-moulded into integral panel connectors solving the issue of improper connections called the SpeedLOCK System. Furthermore, because the SpeedLOCK system is built using printed circuit technology we can easily integrate a microprocessor on board in order to communicate with a data logger based at the inverter. This allows each panel to communicate over the power cables and gives each panel a unique address and eliminates the guesswork of determining faults, replacing correct panels, not wasting time figuring out which panel is not performing, and allowing for true preventive maintenance based on actual measurements of voltage, current, apparent power, temperature and performance over time for each individual panel with true real time feedback.

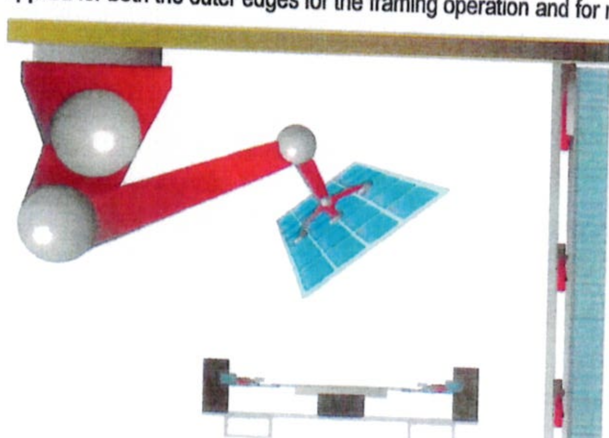
## Appendix C: SpeedLOCK Solar Manufacturing Modular Platform - Operating Description



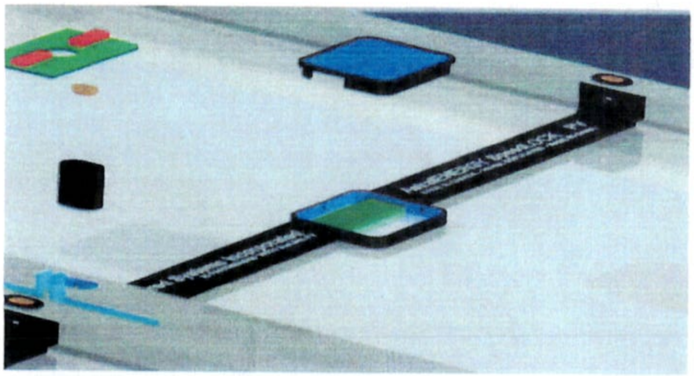
The machine uses an incoming shuttle that transports and houses enough glass for 12000 panels. Fully built glass modules are shipped in specialized shipping containers[a] that allow 100 panels at a time to be loaded into the deck in a cartridge format both for lot tracking and loading purposes. Each panel has a built in bar code and RF ID tag that allows for inventory control checks to be performed. The panels are tested before shipping and this test is attributed to the serial number on each so that the tracking continues here at the facility. In the machine, the panels are individually tested on insertion into the deck for matching power characteristics, breakage, uniform variability and orientation. This shuttle array allows us to hold inventory for the assembly machines and feeds a double layered deck system.

With the double layer deck design we have a central robotic unit that feeds four assembly stations on each level. The machine is built in two identical platforms with a common input shuttle deck and a common output shuttle deck.

In each of the deck areas, a centralized robot picks the available glass module from the exit handler, after the panel welding tabs are lifted and bent into position to accommodate the slots in the printed circuit electronic assembly that will go on top of it, and then chooses the appropriate available assembly station to build the PV Panel. In the assembly station, as the module is inserted onto an air table, adhesive is applied with an automated gun that travels a set path and retracts when complete; adhesive is applied for both the outer edges for the framing operation and for mounting the electronic assemblies. A fixture is lowered to clamp the panel in place and provide guidance for the fully built electronics[b] to be placed for the top and bottom of the panels. The electronic assemblies in their plastic molded skins are located with the fixture and placed on top of the adhesive which will permanently bond them to the panel while allowing for flexibility, a water proof seal, and structural stability over the life of the panel. Once the plastic assemblies have been seated, the table moves to the next position with the fixture following. As the table drops into position, the framing components are loaded for the side and the top and bottom into a precision positioning system. The sides of the frame are placed onto the module first and inserted over the electronic / plastic assemblies (SpeedLOCK) that are held in place with the fixture system, the adhesive penetrates into the groove on each and creates a watertight seal between the frame and the sides of the laminated glass module. The bottom and top are similarly located and the shark tooth retainer pin on each is centered in the acceptance slot on the receiving side and the top and bottom are pressed into place until the shark tooth insertion pin bottoms out and the frame is properly squared and located about the panel. The framing machine then compresses and locks the panel frame and in doing so fully contains the SpeedLOCK Assemblies in addition to the PV Module.

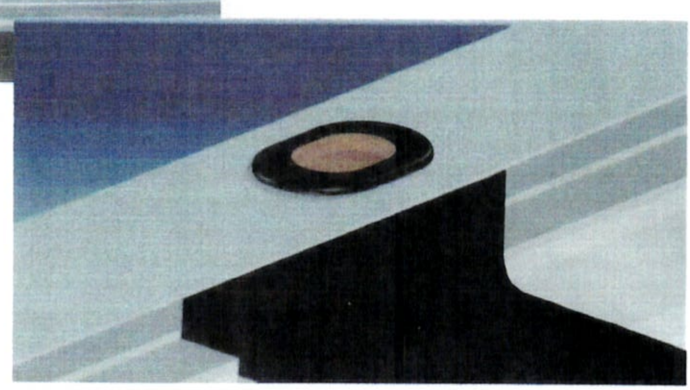


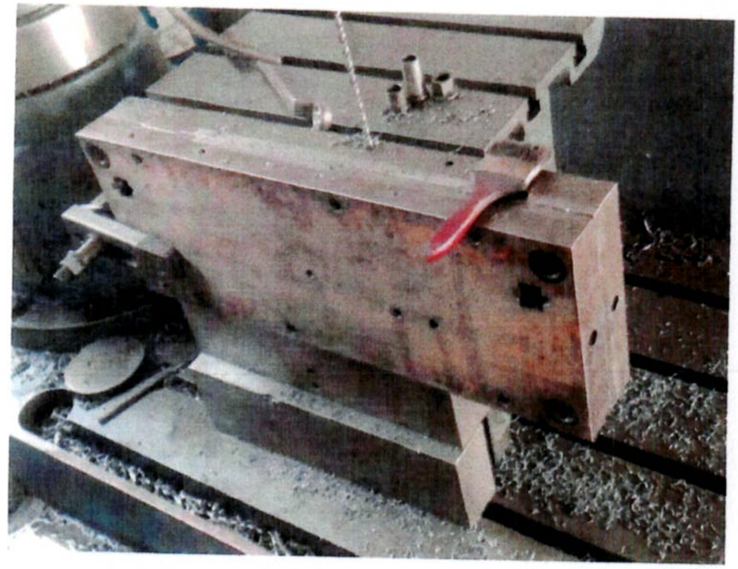
With the fixtures and framing machine in place, the contact inserts are inserted through the slots on the rail of the frame and locked into place. Each contact is laser welded and so are the tabs from the solar module to the printed circuit. Probes are lowered and the panel is flash tested in place and then after the probes are retracted the cap is inserted onto the back of the SpeedLOCK Assemblies to cover and seal the printed circuit controller cavity. The robot then lifts out the fully assembled panel after the fixtures have been retracted and deposits it into the receiving station for the exit shuttle.



Using new Selenium Telluride technology grown upon a gallium arsenide infused silicon dioxide base with heavy doping of indium and boro-disilicate tri-phosphate; combining polycrystalline growth based technology with amorphous spray based technology, we have created cells with a much longer half life and a very long degradation period because of the additional electrons available with the doping and higher valence electrons involved. This means a longer lifespan with a much higher output over time than traditional panel technology. This unique manufacturing process also allows us to achieve a much greater spectral response, which enables us to perform better under adverse conditions by 30% over our closest competitor. In conjunction with structural glass, lighter stronger framing, a smaller overall footprint and an additional savings in the amount of racking, these panels produce a higher output over area, better performance in practically all measurable metrics, and a greater return on investment by eliminating the key sources of maintenance and lack of performance as the system ages - the wiring and interconnections.

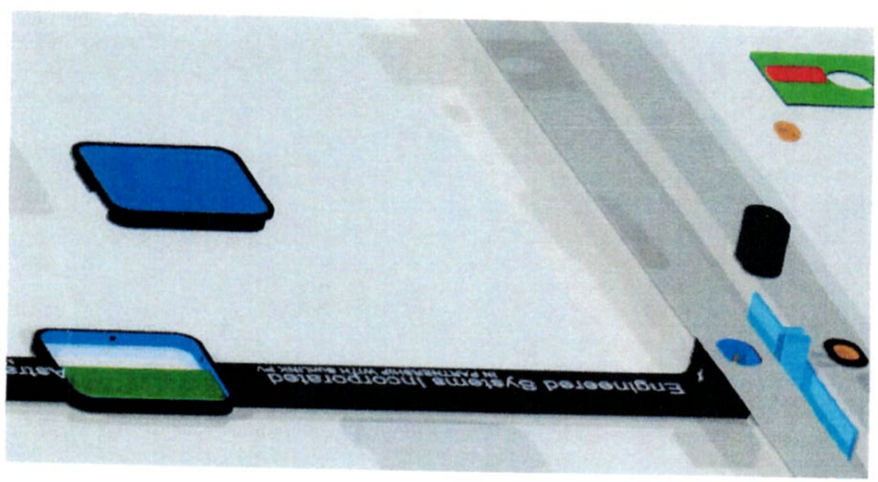
By pairing this technology and the SpeedLOCK system we believe that we have created the perfect solar panel system. The system is self-diagnosing, easily maintained, simple to install, has less wear components, and not only reduces the overall cost of a project by 25% to 38% but increases the return on investment significantly, usually lowering the total cost of ownership by almost 40%.





The exit shuttle is not just a holding area. The shuttle allows for the panels to dry and cure as they pass through the conveyor system to the final exit point. The exit station does a full flash test on the panel and then places a label and the characteristic curve for the panel on the rear surface of the module. Panels are palletized, secured and then transferred to the holding/loading area for transport via truck, rail, or air to wherever they are required by our customers.

Machine time is such that we can produce a new panel every 1/8 of a second but it scaled to ¼ of a second, running at full speed. This number has been further derated to account for down time, maintenance, availability, work time of 220 days per annum and 75% capacity due to possible production shortages. The modular double deck design of the machines is such that maintenance and repair can be accomplished on one deck while the other is operating and if required can be used to double capacity by adding one operator. The component hoppers, input and output shuttles are common to both decks of the assembly machine.



a) Shipping containers break down into roughly 1/7th of their size to allow for a more compact package to return to the main supply facility in Windsor, Ontario.

b) The SpeedLOCK assemblies are prebuilt with printed circuits inside, locator pins and PCB assembly for either the lower pass through system or the upper microcontroller that is used to measure temperature, voltage, current, apparent power, actual power, degradation, and performance, in addition to allowing the panel to be located by the unique serial number, allowing it to bypass should there be a problem detected and allowing it to communicate via digital paquet format over the power cables back to a receiving control computer that has a CAD drawing of the entire array and is able to retrieve real time data from each panel and identify maintenance issues, power trends, etc for the entire system and make proactive changes to improve performance. These assemblies are built at supplier factories, prototyped and programmed in house and then loaded into each assembly station.

Posted by **Tina Kassaeian** on **August 4, 2023**

Are you tired of ever-increasing electricity bills and want to reduce your carbon footprint and make a positive impact on the environment in Canada? Going off-grid with a solar system can be a sustainable and cost-effective solution you've been seeking.

In this guide, tailored for the Canadian, we'll walk you through the essential steps to select the best off-grid solar system for your home and explore the costs associated with different options in 2023.

## #1 Determining Your Power Needs

Before you embark on the exciting journey of setting up an off-grid solar system for your home, it's crucial to have a clear understanding of your power needs. Knowing your daily energy consumption will help you determine the right size for your solar system and ensure

For example, if you have ten LED light bulbs in your house, each consuming 10 watts per hour, you'll have a total lighting load of 100 watts per hour. Next, analyze your heating and cooling needs, especially during extreme weather conditions in Canada. If you have electric heating systems or air conditioning units, factor in their power consumption.

Suppose your heating system requires 1,500 watts per hour and you use it for five hours on a winter day. In that case, your heating load would be 1,500 watts per hour multiplied by 5 hours, totaling 7,500 watt-hours for the day. Repeat this process for other appliances and electronics to get a comprehensive overview of your daily energy usage.

Once you have a complete list of your daily energy consumption, it's essential to add some extra capacity for future power needs. This includes potential lifestyle changes, new appliances or electronics, or the possibility of accommodating guests who may use additional electricity.

Furthermore, it's crucial to account for backup power requirements during emergencies. While off-grid solar systems can provide self-sustained power, it's wise to have a contingency plan for extended periods of cloudiness or other unexpected situations.

Consider investing in a backup generator or additional battery storage to ensure a seamless power supply during adverse weather conditions. Calculating your power needs with precision will not only help you design an efficient off-grid solar system but also provide peace of mind, knowing that you're well-prepared for all eventualities in your off-grid energy journey.

## #2 Choose the Best Solar Panel

Selecting the right solar panel is vital for an efficient off-grid solar system in Canada. To ensure the best choice, consider multiple factors.

Start by evaluating the panel's efficiency and power output as higher efficiency means more electricity from limited space. Additionally, prioritize durability and weather resistance, as they are crucial for withstanding Canada's harsh climate conditions.

Next, choose between monocrystalline, polycrystalline, and thin-film panels based on their efficiency, budget, and installation needs. As you make your decision, verify longer warranties and performance guarantees to ensure the panel's reliability.

Additionally, look for certifications and standards to ensure safety and quality. Lastly, consider brand reputation, reviews, and return on investment to make a well-informed decision and contribute to a sustainable future. By carefully assessing these factors, you can select the best solar panels for your energy needs and create a successful off-grid solar system. For more detailed information, read our 101 guide to buy the best solar panels in Canada.

### *Volts Energies Experts Top Pick: Solar Panel*

Monocrystalline panels, such as the Volts Energies 200W Mono Solar Panel - V200M-48V, stand out for their exceptional efficiency and durability. Designed to excel in off-grid applications, these panels offer a powerful and reliable energy solution for Canadian homeowners.

The high efficiency of monocrystalline panels ensures they can convert more sunlight into electricity, maximizing power generation and optimizing limited space. With their sturdy construction and weather-resistant features, the Volts Energies 200W Mono Solar Panel guarantees long-lasting performance even in the face of Canada's varying weather conditions.

Moreover, another top option for off-grid solar systems in Canada is the Vsun Solar Panels. These panels are known for their excellent performance and reliability, making them a popular choice among Canadian homeowners.

Check out the picture below to see a real-life installation by Volts Energies Experts, showcasing the effectiveness of Vsun solar panels for an off-grid property in Canada.

## #3 Picking the Ideal Battery

The choice of battery is a crucial aspect of designing an efficient off-grid solar system. As a Canadian homeowner, understanding how to select the best battery for your off-grid setup is essential for maximizing energy storage and ensuring a seamless power supply.

When it comes to battery options, two primary types are commonly used in off-grid solar systems: lead-acid and lithium-ion batteries. Each type has its advantages and considerations to take into account.

Lead-acid batteries are a more traditional option and are generally less expensive upfront compared to lithium-ion batteries. They are tried and tested, with a long history of use in off-grid systems. However, lead-acid batteries require regular maintenance, including periodic water top-ups and replacement of worn-out parts. Moreover, their lifespan is generally shorter than lithium-ion batteries, which means they may need to be replaced more

On the other hand, lithium-ion batteries are known for their high efficiency, longer lifespan, and minimal maintenance requirements. While they might have a higher upfront cost, their extended life span and lower maintenance needs can offset the initial investment over time. Additionally, lithium-ion batteries tend to have a higher energy density, meaning they can store more energy in a smaller physical footprint, making them an excellent choice for installations with limited space.

By comparing lead-acid and lithium-ion batteries based on cost, lifespan, maintenance, and environmental impact, you can make an informed decision that aligns with your energy goals and contributes to a sustainable off-grid solar system for your Canadian home. For more detailed information, read our comprehensive guide to choose the best lithium batteries in Canada.

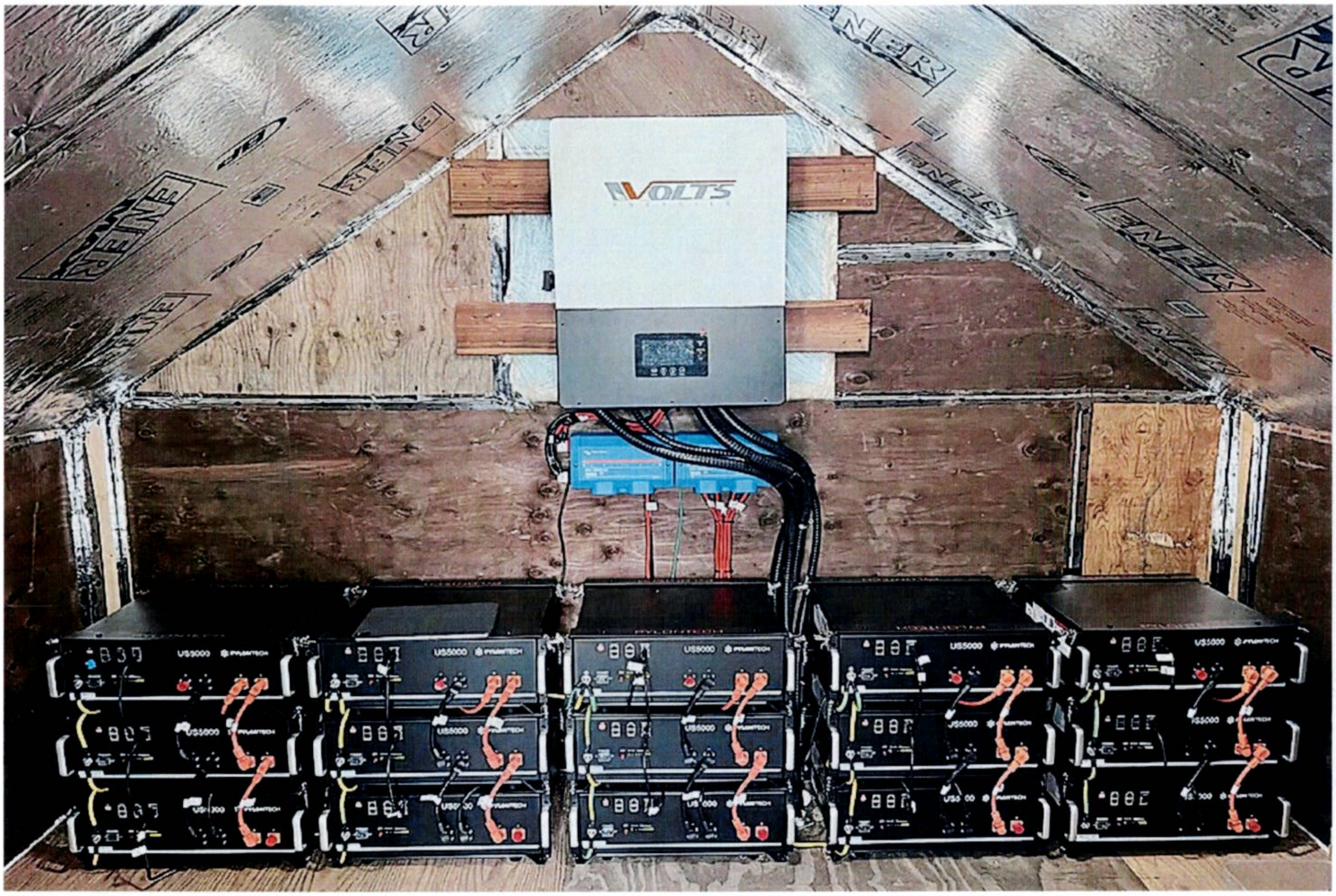
### Volts Energies Experts Top Pick: Batteries

and reliable backup power for your off-grid solar system. It's the ideal choice for Canadian homeowners seeking a sustainable and resilient energy solution.


Moreover, for those looking for a flexible and scalable energy storage solution, Pylontech offers multiple options. The Pylontech US3000C Rechargeable LiFePO4 Battery boasts a capacity of 3.37kWh and is suitable for smaller off-grid systems, while the Pylontech US5000 Rechargeable LiFePO4 Battery offers a larger capacity of 4.8kWh, catering to more significant energy demands. For those with 24V systems, the Pylontech UP2500 Rechargeable LiFePO4 Battery with a capacity of 2.8kWh is an excellent choice.

## #4 The Role of an Inverter

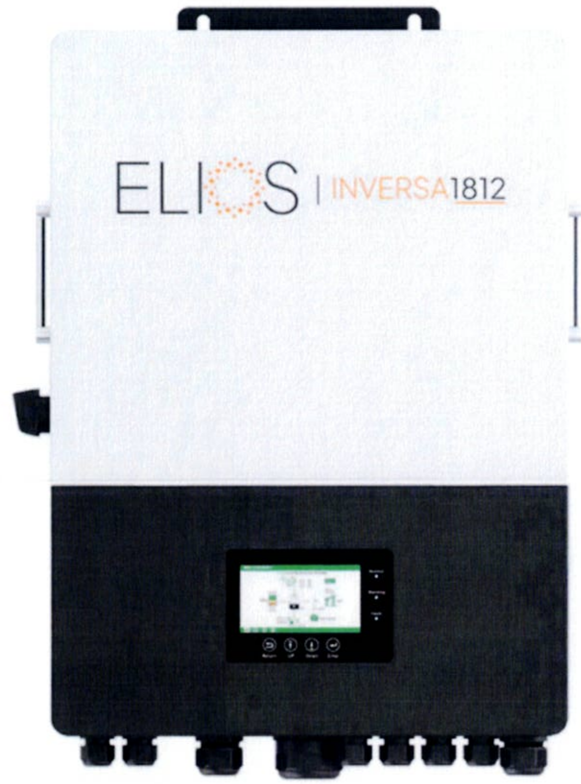
An inverter plays a pivotal role in any off-grid solar system, serving as the heart that converts operates independently. Hybrid inverters, on the other hand, offer the added benefit of integrating with battery storage systems seamlessly.




In addition to type considerations, prioritize power efficiency to ensure optimal utilization of generated electricity. A more efficient inverter means less energy wastage, resulting in greater overall system performance. Moreover, always verify the warranty period of the inverter, as this will indicate the manufacturer's confidence in its longevity and reliability. Investing in a quality inverter with a substantial warranty can provide peace of mind and long-term performance assurance for your off-grid solar system. For more detailed information, check out our complete guide how to choose the best inverter in Canada.

### *Volts Energies Experts Top Pick: Inverters*

Among the top-notch inverters offered by renowned companies, the Volts Energies 12/18KW All in one Hybrid Solar Inverter Charger, stands out as the best option for off-grid solar




One of the key features of the ELIOS Inversa1812 is its high power capacity of 12KW continuous output and 18KW peak output, making it suitable for larger energy demands. Its hybrid functionality allows it to switch between different power sources, optimizing energy utilization and reducing reliance on the grid. Additionally, the inverter comes equipped with a built-in charger, enabling it to recharge the battery using grid power or solar energy.

The ELIOS Inversa1812 also boasts a user-friendly interface with monitoring and control capabilities, allowing homeowners to keep track of their energy usage and system performance. With its advanced technology and robust design, this inverter ensures reliable and efficient operation, making it the ultimate choice for Canadian homeowners seeking a high-capacity, all-in-one solution for their off-grid solar systems.

## #5 Consider Reliable Solar Charge Controllers

Solar charge controllers regulate the energy flow between solar panels and batteries,

### ***Volts Energies Experts Top Pick: Solar Charge Controller***

Victron Energies is our top pick for solar charge controllers. Their cutting-edge MPPT technology ensures maximum power conversion and utilization from solar panels, enhancing overall energy efficiency. With comprehensive monitoring capabilities and durable design, Victron charge controllers offer a reliable and eco-friendly energy management solution for your off-grid solar system.





## The Cost of Off-Grid Solar Systems in 2023

When considering the cost of off-grid solar systems in 2023, several factors come into play. Let's start with solar panels, which can range from $200 to $400 each, depending on their capacity and efficiency(on average between 0.9 - 1.3$ per watt). For a standard off-grid system, you may require multiple solar panels to meet your energy needs, so costs can vary accordingly.

Next, batteries are a crucial component for energy storage. The price of high quality lithium batteries can vary significantly, with options ranging from $2000 to $5000 each, depending on their size and capacity. The larger the battery, the higher the cost, but it also means more energy storage for your off-grid system.

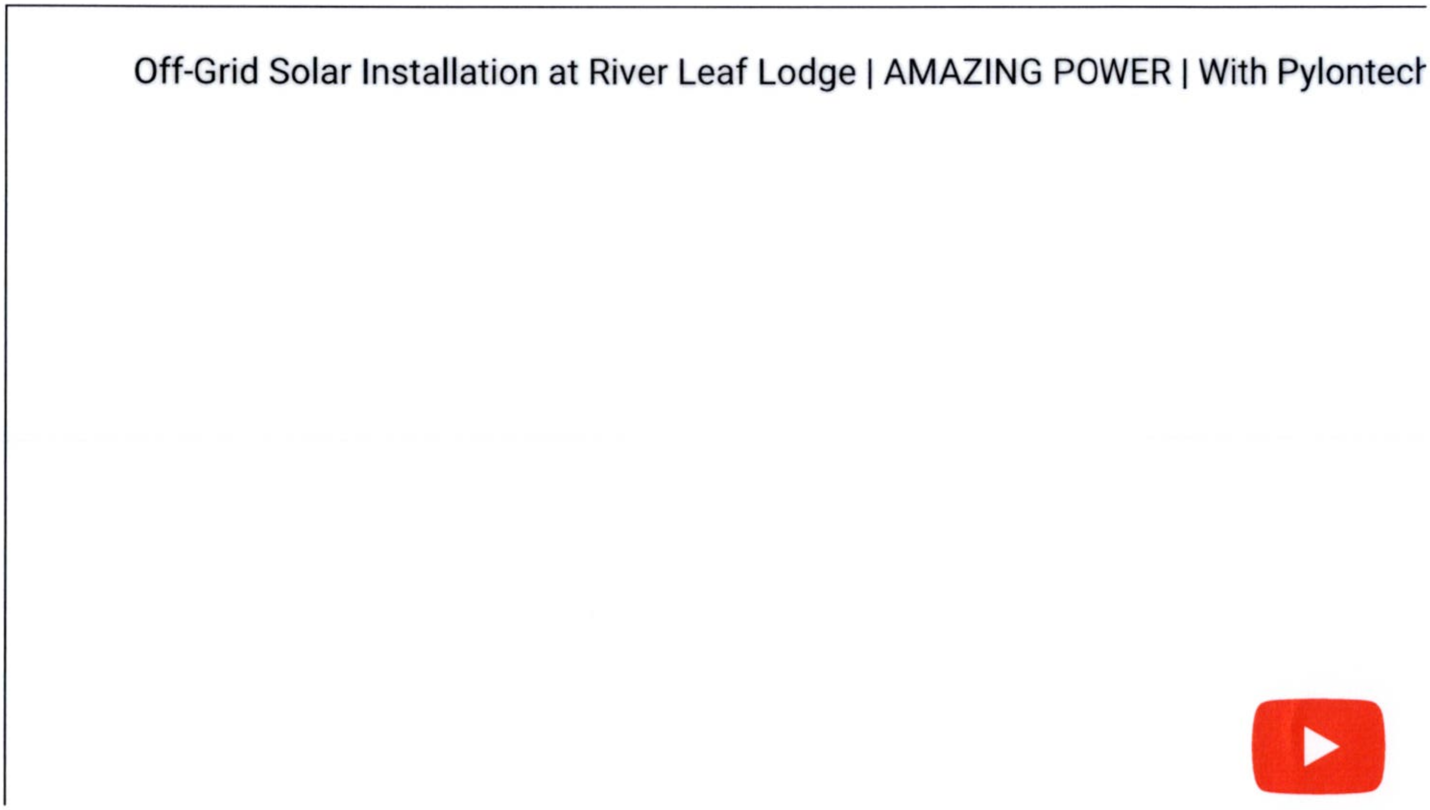
Finally, there are the balance of system parts, which include wiring, mounting hardware, and other components. These can each add up to around $200 to $1500, depending on the size of your off-grid solar system and the specific components required.

In summary, the cost of off-grid solar systems in 2023 can vary based on the specific components chosen and the size of the system. Solar panels, batteries, inverters, and other balance of system parts all contribute to the overall cost.

Additionally, installation costs are a necessary consideration to ensure your off-grid solar system is installed correctly and efficiently. By carefully evaluating your energy needs and budget, you can create a sustainable and cost-effective off-grid solar system tailored to your requirements.

Please note that the costs provided above are rough estimates and can vary based on different brands and market conditions.

battery backup and a commitment to reducing diesel consumption, this initiative not only guarantees uninterrupted power but also embodies a greener, self-reliant future.




To get a personalized recommendation and a free quote, we encourage you to contact our team of experts. They will take into account your unique energy needs and the size of your off-grid system to provide you with a detailed and accurate quote.

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# Kawasaki Ninja ZX-7R

The **Kawasaki Ninja ZX-7R** was a motorcycle in the Ninja sport bike series from the Japanese manufacturer Kawasaki produced from 1989 until 2003. It remained largely unchanged through its production. Kawasaki used inverted forks starting in 1991, added ram air using a single tube, and in 1996, twin tube ram air and Tokico six piston brakes and fully adjustable suspension. From 1989 through 1995 in the US market, Kawasaki called the **ZXR-750** and **ZXR-750R** the ZX-7 and ZX-7R respectively. Starting from 1996 Kawasaki dropped the ZXR name worldwide and the former ZXR-750 was now ZX-7R and the limited edition homologation special ZXR-750R/ZX-7R started in 1991 was now **ZX-7RR**.[5]

**Kawasaki Ninja ZX-7R**


| | |
|---|---|
| **Manufacturer** | Kawasaki Motorcycle & Engine Company |
| **Also called** | 1989 to 1995 ZXR-750 - ZXR-750R<br>1989 to 1995 US ZX-7 - ZX-7R<br>1996 to 2003 ZX-7R - ZX-7RR |
| **Parent company** | Kawasaki Heavy Industries |
| **Production** | 1989-2003 |
| **Predecessor** | GPX750R |
| **Class** | Sport bike |
| **Engine** | 748 cc (45.6 cu in) four-stroke, liquid-cooled, 16-valve DOHC, inline-four |
| **Bore / stroke** | 73.0 mm × 44.7 mm (2.87 in × 1.76 in) |
| **Compression ratio** | 11.5:1 |
| **Top speed** | 241–262 km/h (150–163 mph)[1][2][3] |
| **Power** | 77.6–81.4 kW (104.0–109.2 hp) (rear wheel) @ 11,500 rpm[3] |
| **Torque** | 71.0–76.5 N·m (52.4–56.4 lb·ft) (rear wheel) @ 9,000 rpm[3] |

## Overview

The ZX-7R has a 749 cc in-line four-cylinder, four-stroke engine.

The frame used on the ZX-7R is a lightweight aluminum twin-spar item, designed using computer-aided design to optimize strength. The rear subframe was constructed using steel, providing enough strength for a pillion passenger.

The swingarm used largely the same fabrication techniques to produce a hollow cast and pressed aluminum alloy hybrid swingarm, and the Uni-Trak rear suspension system features a predominantly lightweight alloy and aluminum construction. The Uni-Trak system was designed to provide a progressively stiffer damping and spring rate under compression. The rear suspension unit is fully adjustable in terms of damping, preload and compression.

The front suspension found on the ZX-7R comprises a fully adjustable 8-way compression and 12-way rebound 43 mm inverted cartridge fork.

Front brakes are 320 mm semi-floating front discs and Tokico six-piston calipers. Rear brakes feature a 230 mm disc with a twin-piston opposed caliper.

The ZX-7RR differs from the road model with an adjustable head-stock angle, swing arm pivot, additional increased adjustability 28-way compression and 13-way rebound to the front and 14-way rebound for the rear suspension, ten more than the R model, a solo cowl with a different aluminum subframe, and 41 mm flat-slide carburetors versus the 38mm on the base R model. It also has a close ratio gear-box fitted as standard and a crankshaft flywheel that is heavier and Nissin front brake calipers.[2][6][7]

Cycle World recorded a 0 to ¼ mi (0.00 to 0.40 km) time of 10.82 seconds at 129.68 mph (208.70 km/h).[1]

| | |
|---|---|
| **Frame type** | Aluminum twin-spar |
| **Suspension** | Front: adjustable 43 mm inverted cartridge fork<br>Rear: Uni-Trak (monoshock) swingarm |
| **Brakes** | Front: twin 320 mm (13 in) semi-floating front discs with Tokico six-piston calipers<br>Rear: 230 mm (9.1 in) disc with twin-piston opposed caliper. |
| **Tires** | 120/70ZR17, 190/50ZR17 |
| **Rake, trail** | 25.0°, 3.9 in (99 mm) |
| **Wheelbase** | 1,440 mm (56.5 in) |
| **Seat height** | 780 mm (30.9 in) |
| **Weight** | 210 kg (460 lb)[1] (dry)<br>235–239 kg (518–527 lb)[3][4] (wet) |
| **Fuel capacity** | 18 L; 4.0 imp gal (4.8 US gal) |
| **Oil capacity** | 3,600 ml (3.8 US qt) |
| **Related** | Kawasaki ZXR250<br>Kawasaki ZXR400<br>Kawasaki Ninja ZX-6R<br>Kawasaki Ninja ZX-9R<br>Kawasaki Ninja ZX-12R |

## Racing

The ZX-7RR was raced, winning 12 AMA superbike championships. Kawasaki's Road Racing team riders were Eric Bostrom, Doug Chandler and Scott Russell. Doug Toland won the 1993 Endurance FIM World Championship. Andreas Hofmann won the 1997 Macau Grand Prix.

1989 ZXR-750

1991 Kawasaki Ninja ZX-7

1992 ZXR-750R

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**Sun Link PV** SL160-24M190

| | | |
|---|---|---|
| Rated Max Power | (Pmax) | 190W |
| Minimum power tolerance | | 0~+3% |
| Current at Pmax at STC | (Imp) | 5.25A |
| Voltage at Pmax at STC | (Vmp) | 36.2V |
| Short-Circuit Current at STC | (Isc) | 5.44A |
| Open-Circuit Voltage at STC | (Voc) | 45.4V |
| Normal Operating Cell Temp | (Tnoct) | 45+/-2 C |
| Weight | | 15kg |
| Max System Voltage | | 1000V |
| Max Series Fuse Rating | | 10A |

STC: AM=1.5 E=1000W/m2 Tc=25C

Add:Zhangjiagang Economic Development Zone,Jiangsu Province,China 215600
Tel:0086-512-58166568 Fax:0086-512-581-66560

Warning:electrical hazard
This unit produces electricity if exposed to light
Do not disconnect under load

CE UKAS