NOVA Consultants, Inc.
Engineering, Environmental & Energy Services

SOLAR SYTEM BASICS

A NOVA Consultants Learning Series – presentation

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Engineering, Environmental & Energy Services

ABOUT NOVA

NOVA Consultants, Inc. (NOVA) is a Michigan based engineering, environmental and energy services consulting firm specializing in:

- Photovoltaic Engineering.
- Energy Conservation.
- Solar Energy and Energy Audits throughout Michigan, Ohio and Indiana.
- Civil, Structural, and Architectural Engineering.
- Remediation.
- Underground Storage Tanks (UST).
- Waste Water Construction.
- Facility Assessment.
- Green House Gas Emissions (40 CFR).

Established 1992

Minority Owned

Profitable every year since Inception

Certified as Small Business Enterprise with WCAA

Certified as Minority Business Enterprise in Michigan

0 Recordable injuries

0 Lost time injuries

Financially Viable

Providing Service in US, Canada, and Mexico

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SERVICES

Engineering

We provide the following engineering, construction management and surveying services on an efficient and cost-effective basis.

Environmental

Full service environmental team consisting of talented engineers (Civil, Mechanical, Electrical and Chemical), Geologists, Hydrogeologists, Toxicologists, Certified Industrial Hygienists, and Technicians.

Energy

NOVA's engineering, procurement, permitting and construction management projects include Energy conservation, Project Management, and PV solar ground mount, roof mount, and canopy structures; with interconnections from 240V single phase to 41.57kV, three phase.

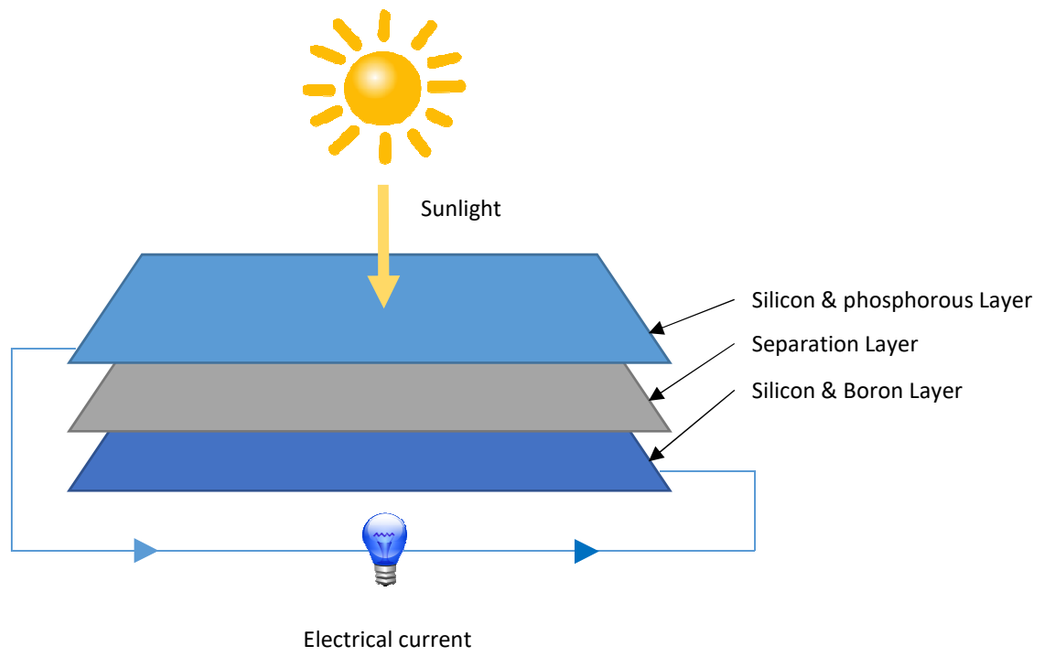
PHOTOVOLTAIC CELL

A Photovoltaic (PV) Cell converts sunlight to direct current (DC) electricity.

Basic Solar cells generally consist of 3 layers, a Top and Bottom silicon layer and a separation layer.

When Sunlight hits the upper silicon layer the photons in the sunlight excite the electrons in the upper layer, causing the loose electrons to be attracted to the atoms of the lower layer.

This flow of electrons from one layer to the other is what causes your electrical current.



PHOTOVOLTAIC PANEL

PV Panels are manufactured by wiring the PV cells together in series.

The output of a Panel depends on the number of cells and their efficiency and size.

The larger and more efficient cells will produce more watts per square foot.

Panels utilizing the higher efficiency cells will tend to be more expensive.

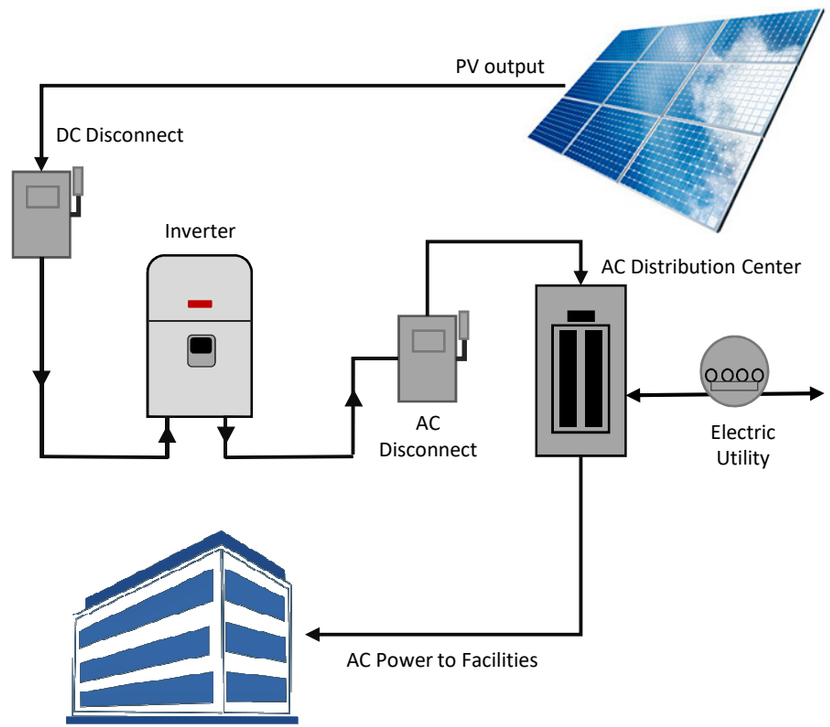
SOLAR INVERTER

A solar inverter, or converter or PV inverter, converts the variable direct current (DC) output of a photovoltaic solar panel into a utility frequency alternating current (AC) that can be fed into a commercial electrical grid or used by a local, off-grid electrical network. It is a critical component in a PV System, allowing the use of ordinary AC-powered equipment.

TYPICAL PV GRID-TIE SYSTEM

In the typical PV Grid-Tie system the PV panels generate DC power which is converted to AC power by the Inverter. Output from the Inverter is connected to your AC distribution center which feeds the rest of your Facilities.

When the PV system is generating power, your electricity needs up to the capacity of the system are being provided for by the system. When your site needs to draw more electricity than your system is providing, such as at night or on cloudy days, power is provided by the energy company in the normal manner.

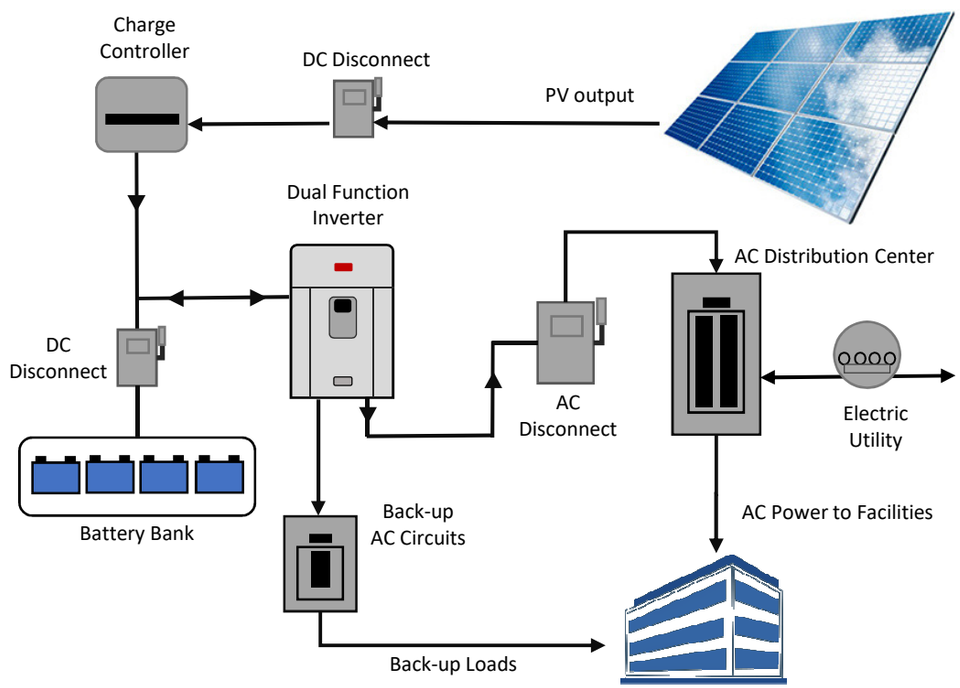


TYPICAL HYBRID PV GRID-TIE SYSTEM

The typical Hybrid PV system incorporates a Charge controller and Dual function Inverter to create a grid tied system with a battery back-up.

The Dual Function inverter can supply the excess power to the Utility as in a typical Grid-tie system, and will provide power to selected essential AC circuits when the grid is down.

The charge controller will keep the battery's fully charged while the grid is live.

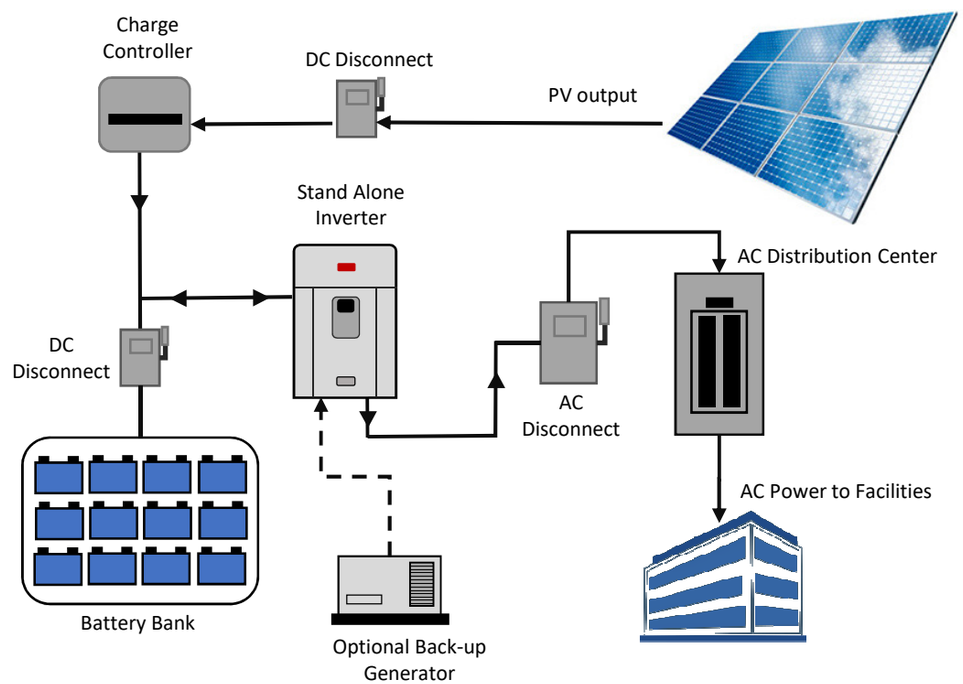


TYPICAL PV OFF-GRID STANDALONE SYSTEM

The Off-Grid or Stand-Alone PV System relies on large amounts of battery storage to provide power when the sun is not available (cloudy days and Nights).

The array of solar panels must be large enough to provide all the energy needs at the facility/site and recharge the batteries at the same time. The Battery Bank must be large enough to store enough energy for those periods of time when no sun is available.

Most Off-Grid systems benefit from the installation of more than one energy generator and may include Wind and often utilize a gas generator is emergency backup power.



DUAL AXIS TRACKER MOUNTING SYSTEMS

Dual Axis Tracker

Dual axis trackers allow for tracking of the suns azimuth and elevation at the same time, allowing the panels to capture more of the suns power

ROOF MOUNTING SYSTEMS

A PV system can be mounted on a rooftop.

For Flat roofs the array is mounted with each panel aligned at an angle. Most of these systems rely on light weight racking or plastic wedges ballasted to the roof.

For Sloped roofs the array is usually mounted on rails mounted to the roof.

GROUND MOUNTED SYSTEMS

Ground-mounted PV systems are usually large scale, utility type power stations.

The PV array consists of solar panels held in place on permanent racks or frames attached to a ground support.

Ground supports are usually one of the following:

- Poles driven into the ground, or Helical piers screwed into the ground.
- Ballasted footing mounts made of concrete bases that use their weight to secure the panels and rack in place. Thereby avoiding ground penetration.

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DESIGN

Feasibility

Evaluate energy consumption, establish a baseline, and identify the size of PV array that can be placed based on available area and any economic constraints. Then provide a Cost analysis based on these criteria.

PV Array Production Summary

Utilize the SAM software from the National Renewable Energy Laboratory (NREL) to verify the kilowatt hour (kWh) production of the array.

Preliminary Design

Create preliminary design documents and models for the layout of the array

Shading

Provide shading analysis models.

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FINANCIALS

Solar Power Purchase Agreement (PPA)

A solar power purchase agreement (PPA) is a financial agreement where a developer arranges for the design, permitting, financing and installation of a solar energy system on a customer's property at little to no cost.

The developer sells the power generated to the host customer at a fixed rate that is typically comparable to the local utility's retail rate, this sale along with any tax credits and incentives is applied towards the construction and maintenance of the system. PPAs typically range from 10 to 25 years, and the developer remains responsible for the operation and maintenance of the system during the duration of the PPA. Typically at the end of the PPA contract term the system is turned over to the customer.

Investment Tax Credit (ITC)*

The Investment Tax Credit (ITC) is currently a 30 percent federal tax credit, based on "Installed Cost" (materials and labor) and claimed against the tax liability of residential (Section 25D) and commercial and utility (Section 48) investors in solar energy property. The Section 25D residential ITC allows the homeowner to apply the credit to his/her personal income taxes. This credit is used when homeowners purchase solar systems outright and have them installed on their homes. In the case of the Section 48 credit, the business that installs, develops and/or finances the project claims the credit.

Modified Accelerated Cost Recovery System (MACRS)*

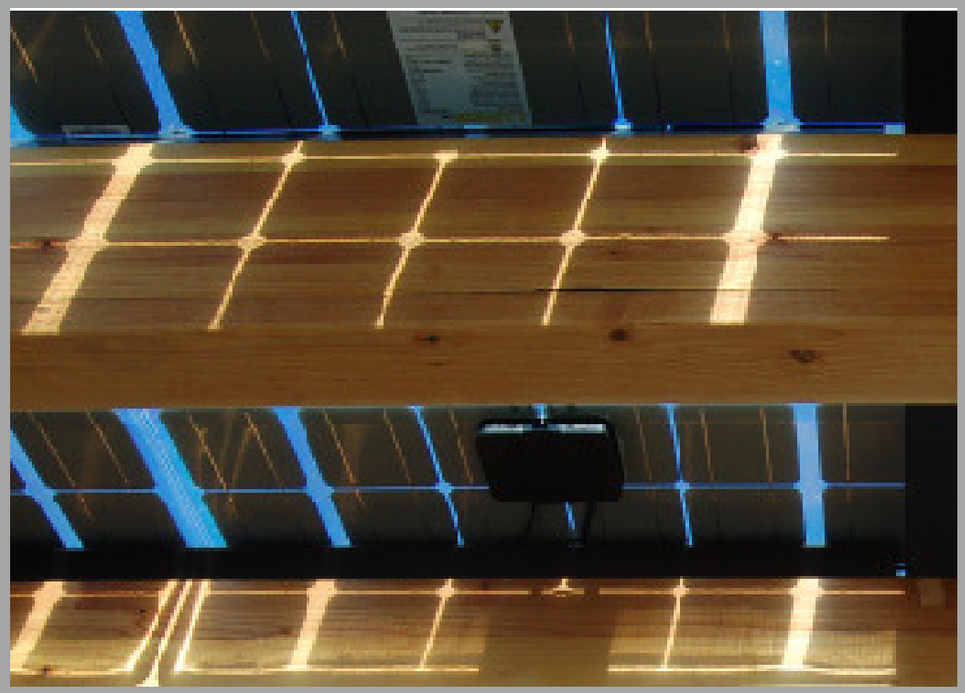
Under the federal Modified Accelerated Cost-Recovery System (MACRS), businesses may recover investments in certain property through depreciation deductions.

The 5-year schedule for most types of solar, geothermal, and wind property has been in place since 1986.

A 50% first-year bonus depreciation for eligible renewable-energy systems acquired and placed in service. Equipment placed in service before January 1, 2018 can qualify for 50% bonus depreciation. Equipment placed in service during 2018 can qualify for 40% bonus depreciation. And equipment placed in service during 2019 can qualify for 30% bonus depreciation.

* Non-Profit organizations cannot directly take advantage of federal tax benefits like ITC and MACRS and must look for other funding options such as a PPA or GRANTS.

NEW TRENDS



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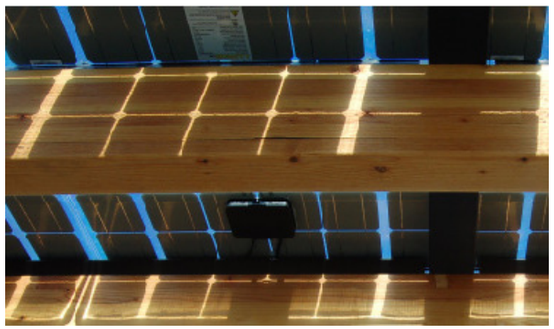
SOLAR PV
CANOPIES

Utilizing frameless modules to provide a unique aesthetic value.



Often referred to as Glass on Glass units, the smaller gaps between the PV cells provide the shading while still allowing a substantial amount of natural light to filter through and radiate the space underneath.

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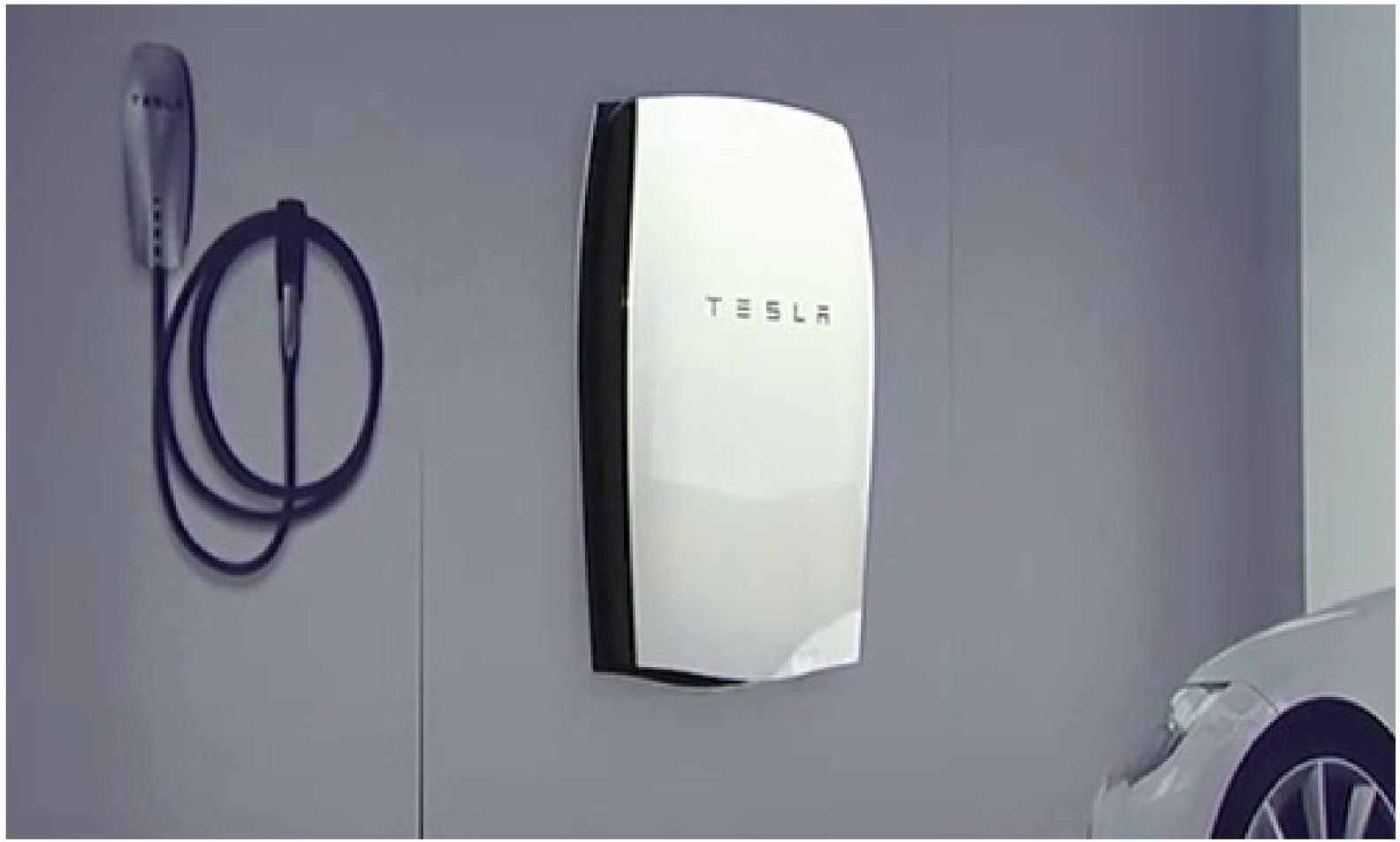

TESLA
POWER WALL

The TESLA Powerwall stores electricity generated by solar panels during the day and makes it available in the evening. Each Powerwall has a 6.4 kWh storage capacity. Multiple batteries can be installed together for greater energy needs

This bridges the gap between peak solar and peak demand, allowing you to use your solar power when you need it.

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BIPV MODULES
PV GLASS

Building Integrated Photovoltaic (BIPV) Modules are not the traditional photovoltaic module designed for ground installations. It has been designed specially as safety glass for buildings in order to comply with the Technical Code of the Building.

This bridges the gap between peak solar and peak demand, allowing you to use your photons when you need them.

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SOLAR PV
AWNINGS

Solar PV Awnings like Canopies provide shade and, help to reduce your cooling expenditures during the summer months.

For little to no footprint you can add PV panels to your facility for power generation.

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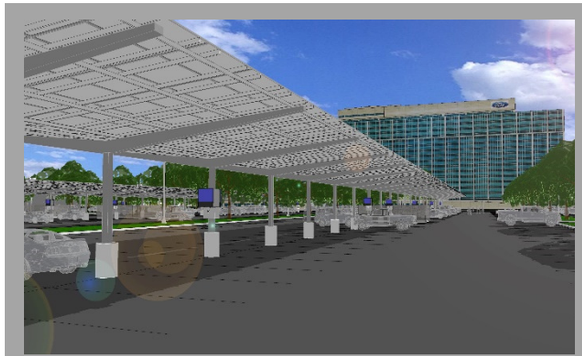
PROJECT BRIEFS



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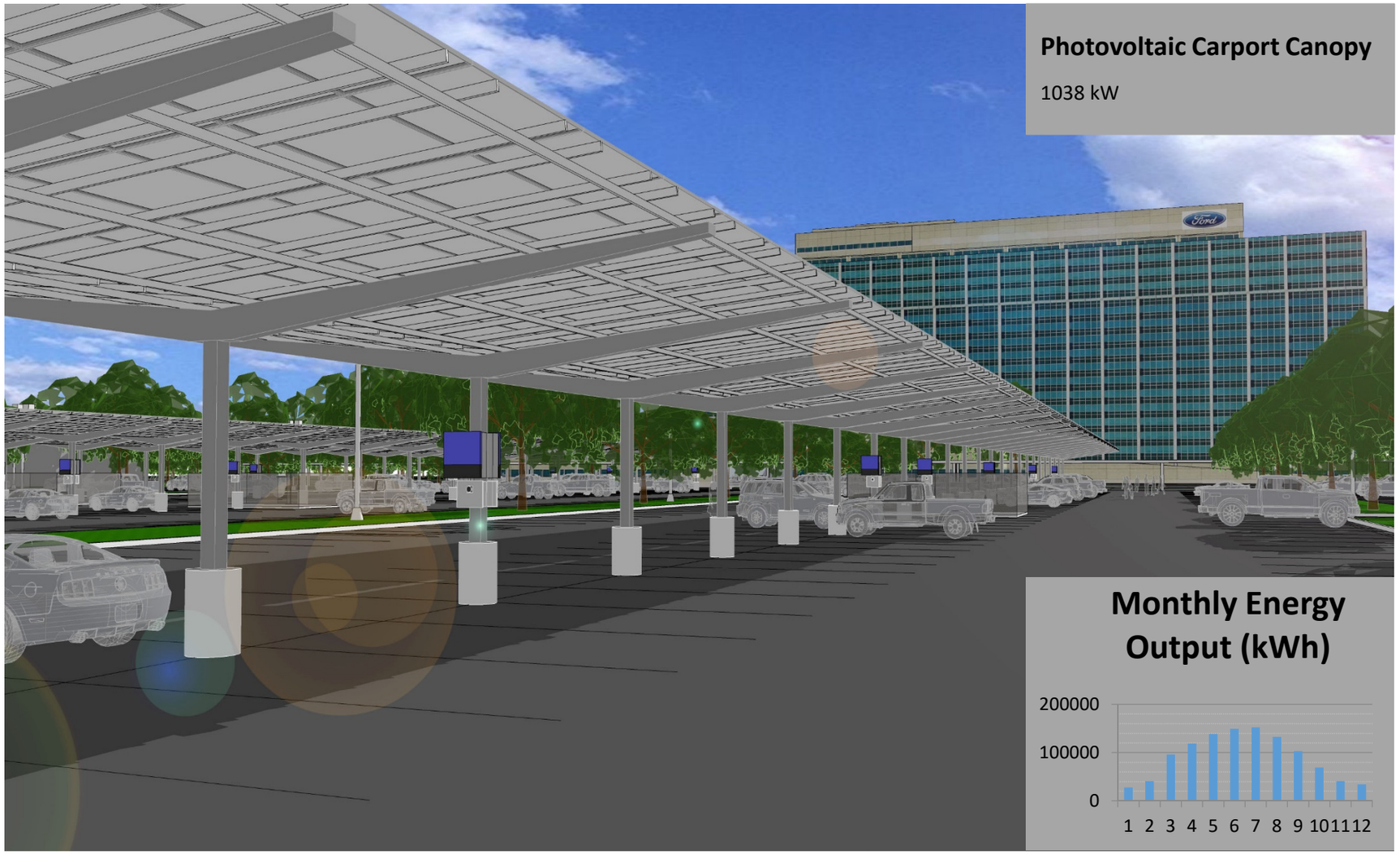
FORD WORLD HEADQUARTERS

This PV Array consists of three basically identical Photovoltaic Carport Canopy's at 346 kW each.

This system is unique in that half the array is oriented westward, while the other half is oriented eastward. Each side is tilted at 5°.

NOVA Consultants acted as the designated engineering, procurement, and construction contractor, and designed and managed the construction of the project. The installation subcontractor for the project was Ferndale Electric Company.



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Photovoltaic Array

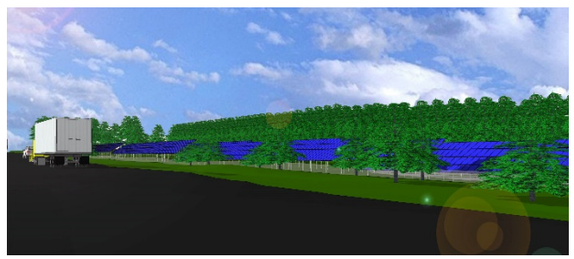
1,089 kW

Monthly Energy Output (kWh)

DOMINO'S FARMS

This PV Array consists of 4,032 270 watt solar panels, and will provide enough electricity to power 185 homes.

The array is big enough to cover the football field at Michigan Stadium, the array covers 9.37 acres of Domino's Farms property on the north side of M-14 west of Earhart Road near the US-23 interchange.



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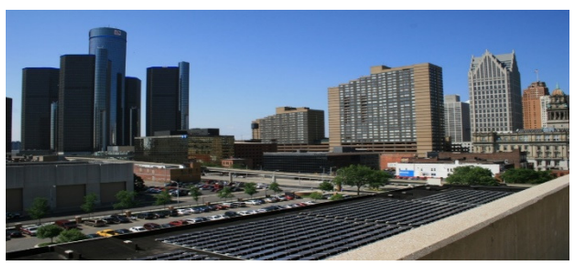
BLUE CROSS BLUE SHIELD
OF MICHIGAN

220 kW roof-mounted solar PV system at BlueCross/Blue Shield of Michigan, 600 E. Lafayette Blvd, Detroit, Michigan.



Engineer: NOVA Consultants Inc.
Construction Subcontractor: Scott Walker
J. Ranck Electric, Inc.

Roof Mounted PV Array

220 kW

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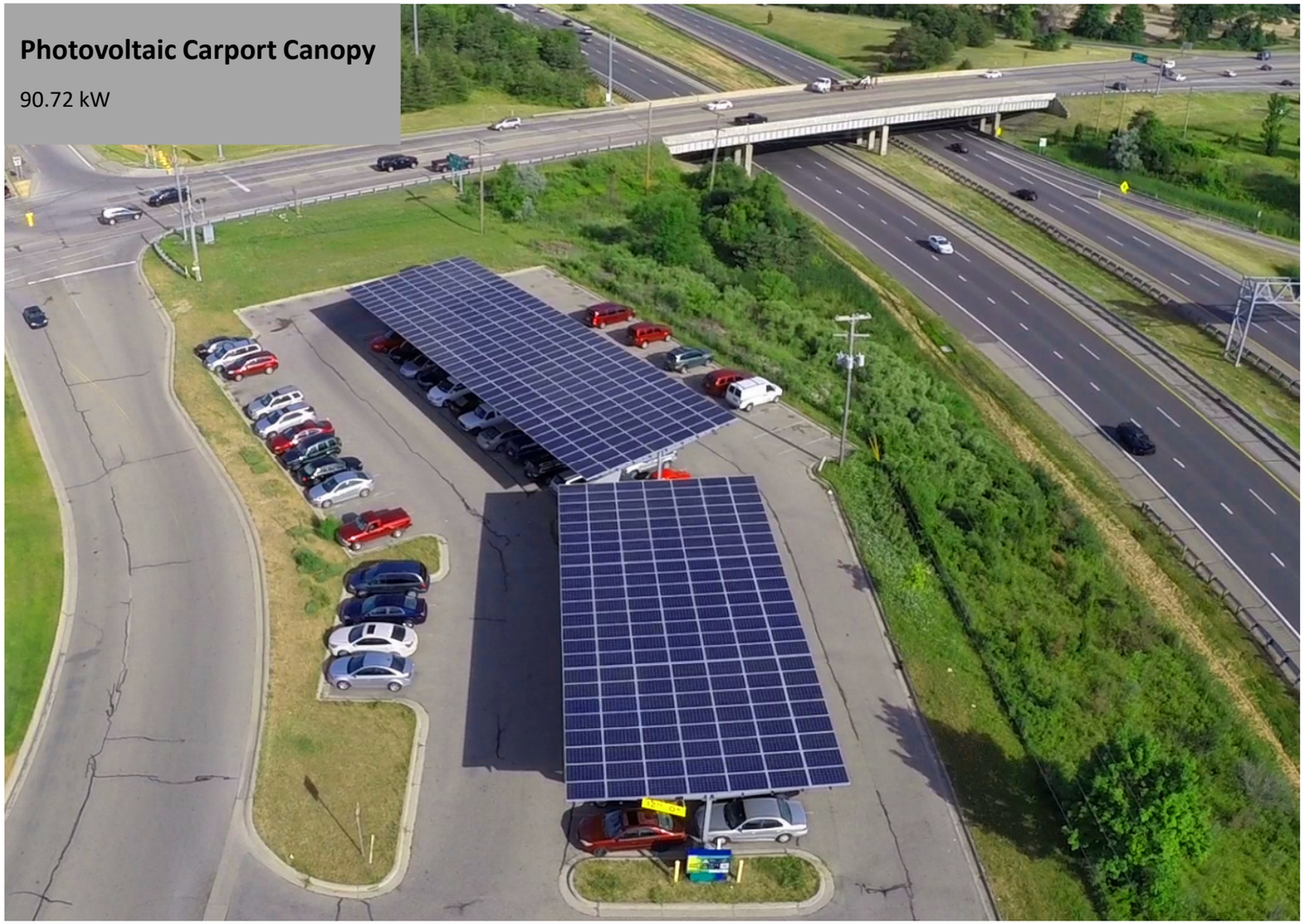
Photovoltaic Carport Canopy

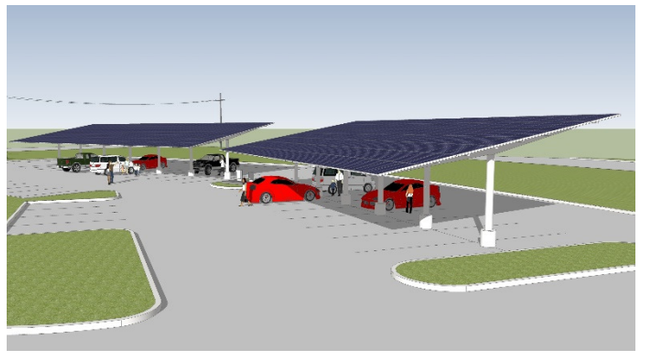
90.72 kW



MDOT
SOLAR CANOPY

The Goal of this project was to demonstrate how MDOT could reduce future operating costs and greenhouse emissions by using alternate energy technologies.

Solar-powered lighting will help keep the carpool lot and interchange at I-96 and M-44 lit, and help improve safety for motorists.



The array produces approximately 106,00 kilowatt-hours of energy per year

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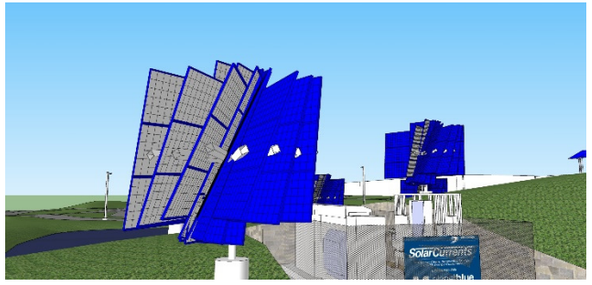
U of M

Information, Science and Technology Campus

This PV System consists of a 224.6kW fixed array, and 16.8kW in 7 dual axis trackers.

The Array has a total of 1006 solar panels over it's 1.56 acres. At full capacity the solar system will generate enough energy to power 34homes.



The solar array is made up of 25 rows of panels paired with seven dual axis trackers that will rotate the panels to align with the sun as it moves during the day.

Photovoltaic Array
Ground mount with Dual Axis Trackers
242 kW

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