PROPOSAL FOR
SOLAR AND ENERGY STORAGE INSTALLATIONS
FOR CITY SITES
CITY OF ANN ARBOR
RFP # 23-15

Submitted To

City of Ann Arbor
c/o Customer Service
301 East Huron Street
Ann Arbor, MI 48107

Submitted By
NOVA Consultants, Inc.
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Table of Contents

A. PROFESSIONAL QUALIFICATIONS 1
A.1 Company Information 1
A.2 Sub-proposer 1
A.3 Personnel 2
A.4 Summary of Main Qualifications of Key Personnel 3
A.5 Company History and Unique Qualifications 6
B. Past involvement with Similar Projects 7
C. Work Plan 10
D. Preliminary System Designs 11
D.1 Inverter locations 11
D.2 Product Specification Sheets 11
D.3 Product Warranty 13
D.4 First Year Monthly Energy Production Estimates 14
D.5 20-Year Energy Production 14
D.6 Battery Readiness 15
D.7 City Hall / Justice Center 15
D.8 Ann Arbor Fire Station 1 16
D.9 Ann Arbor Fire Station 3 16
D.10 Justice Center 16
D.11 Bryant Community Center 16
D.12 Buhr Park 17
D.13 Southeast Area Park 17
D.14 West Park 17
D.15 Veterans Park 18
D.16 Allmendinger Park 18
D.17 Argo Canoe Livery 18
D.18 Gallup Park Maas Shelter 19
D.19 Gallup Park Fast Shelter 19
D.20 Gallup Park Parking Area 19

D.21 Wheeler Service Center 20
D.22 Water Recovery Plant 20
E. Fee Proposal 20
F. Authorized Negotiator 20
G. Attachments 20

Attachments

Attachment 1	**Detailed proposal, 66 pages**
Attachment 2	Helioscope model simulation reports
Attachment 3	Equipment datasheets
Attachment 4	Personnel resumes
Attachment 5	JRanck Electric company information and project experience
Attachment 6	Required bid forms
Attachment 7	Cost proposal (in separate envelope)

THIS PROPOSAL CONFORMS TO THE 10-PAGE (20-SIDE) LIMIT OF THE RFP. FOR A LONGER AND MORE DETAILED PROPOSAL INCLUDING IMAGES AND LAYOUTS, PLEASE REFER TO ATTACHMENT 1

Proposal for RFP # 23-15
Solar and Energy Storage Installations for City Sites

NOVA Consultants, Inc. (NOVA) is pleased to present this proposal to the City of Ann Arbor (City) in response to RFP # 23-15 for Solar and Energy Storage Installations for City Sites. NOVA has received and carefully reviewed the Request For Proposals (RFP) and subsequent Addendum 1 and Addendum 2.

A. PROFESSIONAL QUALIFICATIONS

A.1 Company Information

- Full name of organization: NOVA Consultants, Inc.
- Address: 21580 Novi Road
  Suite 300
  Novi, MI 48375

- NOVA Consultants, Inc. (NOVA) operates as a corporation, and is incorporated in the State of Michigan.
- NOVA is licensed to operate and practice in the State of Michigan.
- If awarded a contract, the address shown above would be used for all correspondence.
- Person authorized to receive and sign a resulting contract and / or subsequent assignment(s):

Sunil Agrawal, *PhD, PE.*
President
NOVA Consultants, Inc.
21580 Novi Road, Suite 300
Novi, MI 48375
sunil.agrawal@novaconsultants.com
Office: 248-347-3512 x 114
Cell: 248-866-1476

- Certification and Addendum Acknowledgment forms are included at the end of this RFP as part of NOVA's proposal response.

A.2 Sub-proposer

NOVA will utilize JRanck Electric (JRE), a union electrical contractor based in Mt. Pleasant, for the installation of the solar PV, battery storage, and electric vehicle (EV) chargers. The NOVA and JRE team has successfully completed almost 30 projects for DTE since 2009.

A.3 Personnel

NOVA has complete design and engineering services in-house including professional electrical, civil, structural, and geotechnical engineers registered in the State of Michigan as Professional Engineers (PE).

- NABCEP certified Solar PV Installer
- Electrical engineering, including PE stamping by Michigan registered engineer
- Structural engineering, including PE stamping by Michigan registered engineer
- Geotechnical engineering, including PE stamping by Michigan registered engineer
- Civil engineering, including PE stamping by Michigan registered engineer
- Construction oversight
- Project Management / Construction Management

JRE has complete electrical construction capabilities in-house in terms of construction equipment and personnel. The NOVA and JRE team has extensive resources available that can demonstrate to the City the **Team's ability to handle several projects simultaneously**. At this time, JRE has approximately 300 personnel. Being a Union affiliated firm, JRE can hire additional skilled tradesmen from the local Union Hall as necessary for the successful and timely completion of U-M projects. Additionally, the **Team has a demonstrated and proven track record of design and building almost 30 projects for DTE at multiple locations in Michigan under one contract.**

To better serve City needs, NOVA has clearly identified various teams within NOVA that can better address U-M project requirements as they occur from project concept to final closeout. NOVA and JRE have the following personnel either as full- or part-time employees, or accessible as sub-consultants or as skilled-tradesmen through the local Union Hall.

The following personnel are available to work this project. Summary qualifications are provided below. Resumes are attached as requested. Percentage availability for these personnel for the current project will vary from 10% to 100% depending upon the activities in progress at any given time. For example, our electrical engineer may be engaged 100% of the time during the design phase, but the field supervisor may only have 10% involvement at that stage of the project. The effort may be reversed during the construction phase between these two personnel. All personnel are direct employees of NOVA and located in the metro-Detroit area.

Program Director	Sunil Agrawal, *PhD, PE*
Project Coordinator	Sachit Verma, *MS*
Project Manager	Jeff Eckhout
	James Mann (JRE)
Electrical Engineers	Jerry Young, *PE*
	Clayton Cox, PE

Civil Engineer	Paul Baluja, *MS, PE*
Structural Engineer	Mark Mahajan, *MS, PE*
Registered Architect	Mike McKelvey
Registered Architect	George Kachadoorian
PV System design/layout	John Witte, NABCEP Cert. Installer
PV System modelling	Rick Marble
AutoCAD Specialist	Rick Marble
AutoCAD operator	Bruce Dickieson
Contract Supervisor	Joe Ruffing
Accounts	Sushma Agrawal
Safety Officer	Greg Wagner, *BA*
NOVA Site Supervisors	John Gembarski
Electrical Supervisors	Several
Electricians	Master Electricians, Journeymen, and Apprentices
Installers	Several PV installers via the Union Hall
Field Foremen	Jason LeCreux (JRE)

1. **Physical Location of Key Personnel:** Novi, Michigan and Mt. Pleasant, MI
2. **Functions each Key Personnel will perform:**
   - Program Manager/Contractor Representative: Sachit Verma will be responsible for overall program management and will serve as the single point of contact for the contract
   - Project Manager: Jeff Eckhout will be responsible for the design and construction management of each project
   - Clayton Cox and Mark Mahajan will provide electrical and structural design assistance respectively
   - Site Superintendent: John Gembarski will provide oversight for the onsite inspections
   - Rick Marble will lead the AutoCAD team
3. **Current Chronological Résumés:** Resumes are attached as requested.

A.4 Summary of Main Qualifications of Key Personnel

Program Director **Dr. Sunil Agrawal, PhD, P.E. Length of Time with NOVA: 30 Years**

Dr. Sunil Agrawal will be the Executive-in-charge of the entire team and will be the managerial contact person regarding all contractual matters. Dr. Agrawal has over twenty-five years of experience including his leadership of NOVA Consultants for over fifteen years. His specialties include value engineering, out of the box technical approach, alternative energy, energy savings, steam plants and environmental engineering projects.

BS, Civil Engineering, University of Jabalpur, India
MS, Environmental Engineering, Asian Institute of Technology, Bangkok, Thailand
PhD, Civil/Environmental Engineering, University of Windsor, Canada

Registered Professional Engineer - State of Michigan
Diplomate - American Academy of Environmental Engineers

Program Manager Sachit Verma, MS Length of Time with NOVA: 28 Years
Mr. Verma has been in the engineering field for over 20 years. He specializes in the energy/solar field. He is the program manager for the Detroit Edison 15 MW solar program. He is responsible for technology selection, and ensuring consistency of processes across various projects, and overall project management.
M.S., Chemical Engineering, Louisiana State University, Baton Rouge, LA
B.S., Chemical Engineering, I.I.T.

Project Manager Jeff Eckhout, *BS*
Length of Time with NOVA: 28 Years
Mr. Eckhout has over 15 years of experience as a project engineer/project manager for a variety of environmental, facilities, and energy projects. He has successfully managed several DTE Energy projects including ground-mount and roof-mount projects totaling about 3 MW. His duties include the oversight of engineering, communication between DTE Energy and the customer, equipment procurement, budgeting, health and safety management, and construction oversight.
BS, University of Michigan, Ann Arbor, Michigan
Certifications: Engineer-In-Training (EIT)
40 Hour HAZWOPER
8 Hour Annual Refresher for HAZWOPER

Senior Electrical Engineer Jerry Young, *P.E.*
Length of Time with NOVA: 10 Years
Mr. Gerald A. Young, P.E. has more than 35 years of experience as an electrical engineer. He has designed electrical systems over 4 MW of solar photovoltaic projects. Mr. Young has extensive experience in the design of electrical power systems, both medium voltage and low voltage. He has also designed many lighting systems, including industrial and commercial lighting and roadway and other outdoor lighting. He has considerable experience in resolving construction issues in the field.
Education:
MBA, Wayne State University, Detroit, MI
BS, Electrical Engineering, University of Detroit, Detroit, MI
Registered Professional Engineer – State of Michigan

Senior Civil Engineer Paul Baluja, *MS, P.E.*
Length of Time with NOVA: 12 Years
Mr. Baluja has more than 35 years of civil engineering experience. He has engineered the grading plan for several solar projects to ensure adequate site drainage following

precipitation events. Additional tasks include design of access roads and driveways to access the site and various pieces of equipment. Mr. Baluja also designs the fences around the array area and the inverter area to prevent unauthorized access to the electrical equipment. His experience includes civil engineering, foundation design, grading and drainage of solar fields, engineering design, resource optimization, process engineering, and project management.

BS, Civil Engineering, University of Nebraska
MS, Structural Engineering, University of Nebraska
Registered Professional Engineer - State of Michigan and State of Nebraska

Senior Structural Engineer **Mark Mahajan, *MS, P.E.***
Length of Time with NOVA: 12 Years
Mr. Mark Mahajan has had over 20 years of civil and structural engineering experience. He will provide engineering services related to structural analysis for carports, racking structures, and building roof load calculations.
MS, Civil (Structural) Engineering, Wayne State University, Detroit, MI
MS, Geotechnical Engineering, Indian Institute of Technology, Bombay, India
BS, Civil Engineering, Victoria Jubilee Technical Institute, Bombay, India

AutoCAD and Computer software specialist **Rick Marble**
Length of Time with NOVA: 7 Years
Mr. Marble is responsible for Construction Document and report preparation, PV Array modeling and shade analysis, and other activities as necessary for the successful implementation of the solar PV projects.
Education and Professional Certifications: Production Drafting degree

Document Control Supervisor/Reg. Architect **Michael McKelvey, *RA***
Length of Time with NOVA: 10 Years
Mr. Michael McKelvey will act as the Document Control Supervisor/Registered Architect. Mr. McKelvey has had more than 35 years of experience in architectural design. His responsibilities include design of many PV solar arrays. Currently he is involved in the design of numerous solar car ports, code compliance, and as built drawings, etc. Mr. McKelvey will manage all documents related to bid specifications, drawings, and AIA (American Institute of Architects) specifications.
BS, Architecture, University of Michigan, Ann Arbor, Michigan
Registered Architect – State of Michigan

Accounts Specialist **Joe Ruffing, *BS***
Length of Time with NOVA: 8 Years
Mr. Ruffing is responsible for tracking accounts payable and receivable, making payments to contractors, payroll processing etc.

Education: BS, Accounting

Safety Officer **Greg Wagner, *BA***
Length of Time with NOVA: 22 Years
Mr. Greg Wagner will coordinate and manage all the health and safety aspects of this project during the construction and commissioning phases of this project. He is certified and experienced in many areas of health and safety systems. He has worked in this capacity on several projects.
Education: BA, Earth Sciences, Adrian College, Adrian, Michigan
Certifications:
Contractor/Supervisor for Asbestos, Michigan
Certified Asbestos Building Inspector, Michigan (A20617) Certified Lead Inspector/Risk Assessor, Michigan (P-1615) NITON XRF Trained
OSHA 40-Hour HAZWOPER
OSHA Confined Space Entry - Entrant/Attendant/Supervisor
Troxler Nuclear Moisture/Density Gauge

Site Supervisor **John Gembarski, *Licensed Electrician***
Length of Time with NOVA: 11 Years
Mr. John Gembarski has had more than 20 years of electrical installations and project management experience. He has successfully completed and supervised several solar PV projects for NOVA under the DTE Energy program.

A.5 Company History and Unique Qualifications

NOVA Consultants, Inc. (NOVA) was founded in Novi, Michigan in 1992, and continues to operate from its office in Novi 32 years later. Over the years, NOVA has provided a variety of professional engineering services such as engineering, environmental, energy (including renewable energy – solar and wind) to various clients in the industrial sector as well as in the public sector. It has maintained profitability continually since inception and carries zero debt. Through its ownership, it has maintained a Minority Business Enterprise (MBE) status and is committed to Equal Employment Opportunity (EEO) objectives. It has distinguished itself by its high degree of professional integrity, flexibility in meeting client needs, and providing high quality cost-effective services.

For the last 14 years, NOVA has been extensively involved in solar PV projects, both as Owner's Advisor (often referred as Owner's Engineer) as well as a contractor for Engineering, Procurement, and Construction (EPC) based on client preference.

Owner's Engineer Services
Owner's Engineer Services refers to the approach where an independent engineering firm assists the client (City of Ann Arbor in this case) with site evaluation and selection, and subsequently prepares the construction documents for the project. The construction work is then bid out to several bidders and one or more bidders are selected for the work based on various selection criteria.

NOVA **has provided Owner's Engineer and EPC services for DTE Energy** Solar Currents program for a portfolio of almost 30 projects totaling about 70MW of solar PV capacity from 2009 until the end of the program in 2017. NOVA has also **provided Owner's Engineer services to Consumers Energy** for their 6 MW Solar Gardens project.

NOVA is currently **providing Owner's Engineer services to Ann Arbor Public Schools** for solar PV projects for eight school projects and is on track to complete additional projects in future. Additionally, NOVA is currently **providing Owner's Engineer services for the State of Michigan to MDOT and the St. Louis Correctional Facility** for solar PV projects.

EPC Services
EPC Services refers to the approach where a complete turnkey contract is awarded to a firm for completing the project from start to finish. The awarded firm can subcontract various project tasks to subcontractors, but essentially the process follows a single award process to the EPC firm instead of the two-step process implemented for the Owner's Engineer approach with one contract with the design firm and a separate contract with the construction firm.

Both processes have their advantages and disadvantages and both are commonly utilized in the construction industry. NOVA has provided services to clients under both arrangements, depending upon client preference.

NOVA has provided EPC services to DTE Energy for several solar PV projects in Michigan, as well as to City of Ann Arbor (DDA), City of Wyandotte, City of Ferndale, City of Petoskey, and City of Huntington Woods.

B. PAST INVOLVEMENT WITH SIMILAR PROJECTS
Since 2009, NOVA has been actively engaged in the design and installation of solar PV systems across metro Detroit, including Ann Arbor, as well elsewhere in Michigan and other states. Currently, NOVA is serving as Owner's Engineer for Ann Arbor Public Schools (AAPS). Under this program, nine schools in the AAPS District have already installed or are in the process of installing solar PV systems at their facilities. Additionally, NOVA is currently the Owner's Engineer for the Michigan Dept. of Transportation (MDOT) for three solar PV

systems, and for the St. Louis Correctional Campus in St. Louis, Michigan for possibly two solar PV systems to be installed at their facilities.

Prior to these projects for AAPS, MDOT and others, NOVA served as the Owner's Engineer as well as EPC contractor for several solar PV projects for DTE Energy and other clients. A partial list of such projects is included below.

The Solar PV Limited Project Summary in the table below includes projects that have been completed over the last few years, along with relevant information such as PV system size, racking etc. **This is only a sample subset of projects successfully completed by NOVA**.

Project Name	Type of Install.	kW DC
Consumers Energy GVSU	Ground mount with driven post	3,700 kW
Greenwood Energy Center	Ground mount with driven post	1,900 kW
Wolverine Power	Ground mount with driven post	1,200 kW
Ford World HQ	Solar PV Carport Canopy	1.038 MW
Domino's Farms	Ground Mount with Helical Piers	1,089 kW
McPhail Properties	Ground Mount with Helical Piers	816 kW
Thumb Solar	Ground Mount	665 kW
Sisters, Servants of the Immaculate Heart of Mary	Ground Mount with Helical Piers	518 kW
St. Clair Regional Education Service Agency	Ground Mount	517 kW
GM - Hamtramck Assembly Plant	Ballasted Ground Mount	516 kW
Riopelle Farms	Ground Mount with Helical Piers	514 kW
Monroe County Community College	Ground Mount with driven post	513 kW
Leipprandt Orchard	Ground Mount with (3 kW) Edu. Array	511 kW
Ford Wayne Assembly Plant	Ballasted Ground Mount	502 kW
Huron Clinton Metroparks-Indian Springs Park	Ground Mount with Helical Piers	495 kW
Wil-Le Farms	Ground Mount with Helical Piers	485 kW
Hartland Consolidated Schools	Ground Mount with (3 kW) Educational Array	444 kW

Project Name	Type of Install.	kW DC
University of Michigan North Campus Research Complex	Ground Mount with Helical Piers	430 kW
Mercy High School	Ballasted Roof Mount	402 kW
DTE - Training and Dev. Center	Ground Mount Helical Piers	391 kW
GM Orion Assembly Plant	Ground Mount with Helical Piers in Concrete	345 kW
University of Michigan Information, Science and Technology	225kW Fixed Ground Mount with 17kW on 7 Dual-Axis Trackers	241 kW
Blue Cross Blue Shield	Ballasted Roof Mount	220 kW
Warren Consolidated Schools	Ballasted Roof Mount	189 kW
WMS Water Tank Solar Array	Ballasted Roof Mount	162 kW
MDOT Grand Rapids Canopy	Solar PV Carport Canopy	100 kW

With the extensive experience shown above, the NOVA team is the most experienced in the State of Michigan, especially with regard to city, municipality, and state projects, and will provide the best value to the City of Ann Arbor for this work.

Please see the list of references below for projects within the last five years:

1. Ann Arbor Public Schools, Solar PV projects at 9 schools mentioned above
   Jason Bing
   Construction Projects Auditor, Capital Projects
   (734) 994-8118
   bingj@aaps.k12.mi.us

2. MDOT/Office of Passenger Transportation – Pontiac & Southfield Terminals
   Sheryl Ananich
   Project Director DTMB Design & Construction
   (517) 243-7605
   ananichS@michigan.gov

3. DTMB/St. Louis Correctional Facility Solar Project
   Susan Wheaton
   Project Director DTMB | State Facilities Administration| Design and Construction Division
   (517) 242-9945

wheatons1@michigan.gov

4. DTE Energy 31 Solar Currents Projects mentioned above
   Timothy O'Connor, CHMM | Project Engineer
   Major Enterprise Projects
   (734) 309-6181
   tim.oconnor@dteenergy.com

C. WORK PLAN

Management Summary

The solar PV projects will be managed by a very capable and experienced NOVA team with several years of hands-on project experience and a proven track record of successfully delivering solar PV projects on time and under budget. Though all personnel mentioned above in Section II-3 will be available, the primary personnel include Sachit Verma (Program Manager), Jeff Eckhout (Project Manager), Clayton Cox (Electrical PE), Mark Mahajan (Structural & Geotechnical PE), John Gembarski (Site Supervisor), Rick Marble (AutoCAD lead), John Witte (NABCEP certified professional), Joe Ruffing (Administrative tasks and accounts).

Site Visits

Site visits will be required to gather additional existing information about the sites such as as-built drawings, especially those showing the electrical infrastructure. NOVA will require information about existing underground utilities in the proposed installation area, as well as geotechnical information for the soils to evaluate foundation design for the solar PV system involving solar carports.

Rooftop projects will require a structural evaluation of the structure to ensure that the roof can successfully support the additional loads resulting from the installation of the solar PV system on the roof.

Construction Documents

Once the site information is available, NOVA will develop construction documents and submit to the City for review at various completion levels. The objective is to address any issues early on in the design phase since a particular early decision may affect several other later decisions in a cascading manner.

Duration for the design varies by size of project. **Time needed by City staff for review is determined by them and can be added accordingly.**

	Small Site < 10 kW	Intermediate Site < 50kW	Large Site < 350 kW

30% completion	3 days	1 week	2 weeks
60% completion	3 days	2 weeks	4 weeks
90% completion	3 days	1 weeks	1 week
100% completion	3 days	1 weeks	1 week
Total	**2 weeks**	**5 weeks**	**8 weeks**

During construction, NOVA will provide Construction Administration – Office Services and Construction Administration – Field Inspection services as necessary to ensure the successful and timely completion of all projects.

Construction Administration - Office services include responding to contractor submittals for Request for Information (RFI), reviewing contractor submittals, answering questions, providing clarifications, evaluating the use of substitute products, and other tasks as necessary.

Construction Administration - Field inspections include site visits at regular intervals to monitor construction progress, ensure construction quality, perform construction testing if required, and address contractor concerns as necessary.

D. PRELIMINARY SYSTEM DESIGNS

Preliminary system designs are provided below in compliance with the RFP requirements. Detailed model simulation reports created using Helioscope software are attached. The Helioscope reports also contain the PV system design parameters such as array location, tilt, azimuth, and first year energy production.

D.1 Inverter locations

Rooftop solar	Flat roof - either on the roof or in or near the electrical room
	Pitched roof – on the ground near the electrical room
Carport	Inverters will be mounted on carport support columns

D.2 Product Specification Sheets

Product specification sheets are attached for PV modules, inverters, racking, and carports. The reasoning for selecting certain products is discussed below in accordance with RFP requirements.

Material Selection Rationale

NOVA has paid careful attention to material selection. It not necessarily based on lowest cost, but what is best suited for this particular portfolio, and for each specific installation.

PV module selection

NOVA only uses PV modules from global top Tier 1 manufacturers with a proven track record of supporting solar PV projects in USA. This approach ensures a high-quality product, with the backing and support of a reliable company in the event that warranty service is needed. NOVA remains open to using PV modules from any one of several global Tier 1 manufacturers to ensure product availability and maintain project schedule. Some examples include JA Solar, Jinko Solar, Trina Solar, VSun, Heliene, Longi and others. At this time NOVA has selected JA Solar, but actual product selection will be determined during the design engineering phase of the project, in addition to pricing and availability at the time of ordering.

Inverter selection

Due to the different voltages across the sites, different PV system sizes, and types of PV systems (rooftop, carport), NOVA is seeking to utilize different inverter models from the same brand so that monitoring can be provided under the same platform for all sites. Inverter brands such as Fronius, SolarEdge, and AP Systems meet this requirement, along with few other brands. At this time NOVA has selected Fronius, but actual product selection will be determined during the design engineering phase of the project, in addition to pricing and availability situation prevailing at the time of ordering.

Racking selection – Ballasted rooftop

NOVA has selected the Ecolibrium Ecofoot2+ rooftop ballasted racking for this project. It is made of synthetic materials so that there is no metal-to-roof contact that could potentially result in a roof puncture, thus causing roof leaks. This particular racking utilizes wind deflectors on the back side to reduce the effects of wind uplift on the solar panel. The reduced wind uplift results in a lower ballast requirement. This racking has only three main components, and can be shipped at low cost due to easy stacking on a pallet.

Racking selection – Pitched roof (Shingles)

Racking for pitched roof requires a system of rails and clamps to attach PV modules to the roof. NOVA will use metal racking components from proven companies such as Unirac, Ironridge, Everest, K2 or other reputable manufacturers. A key component is the attachment to the roof that requires roof penetration. NOVA always uses attachments that are flashed in beneath roof shingles to ensure a long-life water tight seal. Attachments that rely purely on sealant to prevent water leaks may be risky since the sealants get weathered and may crack over time.

Racking selection – Pitched roof (Standing seam metal roof)

For standing seam roofs, NOVA utilizes S-5! Clamps to attach the PV modules directly to the roof seams without any roof penetrations. This is the lowest cost approach as well as the most secure in terms of roof leaks since no penetrations are required.

Carport Selection

NOVA is proposing the use of carports from Sinclair located in Albion, Michigan. It is one of the leading solar carport manufacturers and can offer low shipping cost to Ann Arbor. NOVA has successfully used their carport on several projects, and JRE is familiar with the installation procedure, having recently installed one for MDOT in Pontiac, Michigan.

EV Charger Selection

NOVA is proposing EV chargers from Mid-Cour, a Michigan company, to save material shipping costs and personnel travel costs, ensure prompt local service for commissioning, and easy warranty service if needed. The company is familiar with DTE rebate requirements for Level 2 EV chargers currently available to EV charger owners that own a publicly accessible EV charger. The charger complies with City requirements for a Level 2 charger on a 40 A circuit.

Battery Storage Selection

At this time, NOVA is proposing that battery storage be added at a later date to allow collection of necessary information that is required for the proper selection of the battery and associated components. For example, the following information is required:

1. Existing site one-line wiring diagram to see where the battery would connect, and which loads are to be backed up
2. Is there a climate-controlled space available at each location for the battery? The batteries available today are sensitive to operating temperature, and capacity may be significantly reduced at extreme ambient temperatures.
3. A control mechanism is necessary to make the utility service, generator (if present), battery, and solar PV system all work together seamlessly in a trouble-free manner. It is not a trivial matter to ensure that all three or four power sources work properly within their operating parameters in a safe and efficient manner. It would take a considerable effort, collaboration with manufacturers, and significant engineering to achieve this objective.

D.3 Product Warranty

The various PV system products carry the following **transferable** warranties:

PV modules	10-year warranty on minimum of 90% nameplate energy production and 25-year warranty on minimum of 80% nameplate energy production
Inverters	10 years
Racking	25 years

D.4 First Year Monthly Energy Production Estimates

NOVA utilized Helioscope software to prepare PV system layouts and energy production estimates based on the proposed materials. The first year monthly production is shown in the Helioscope model simulation reports.

D.5 20-Year Energy Production

Long term energy production over 20-years is provided below. An annual degradation of 0.5% is assumed for the PV modules.

Year	City Hall / Justice Center	Fire Station 1	Fire Station 3	Bryant Community Center	Buhr Park	Southeast Area Park	West Park
1	146,792	104,455	32,930	24,691	137,902	76,264	59,828
2	146,058	103,933	32,765	24,568	137,212	75,882	59,529
3	145,328	103,413	32,601	24,445	136,526	75,503	59,231
4	144,601	102,896	32,438	24,323	135,843	75,126	58,935
5	143,878	102,382	32,276	24,201	135,164	74,750	58,640
6	143,159	101,870	32,115	24,080	134,488	74,376	58,347
7	142,443	101,360	31,954	23,960	133,816	74,004	58,056
8	141,731	100,854	31,794	23,840	133,147	73,634	57,765
9	141,022	100,349	31,635	23,721	132,481	73,266	57,476
10	140,317	99,848	31,477	23,602	131,819	72,900	57,189
11	139,615	99,348	31,320	23,484	131,160	72,535	56,903
12	138,917	98,852	31,163	23,367	130,504	72,173	56,619
13	138,223	98,357	31,007	23,250	129,851	71,812	56,336
14	137,531	97,866	30,852	23,134	129,202	71,453	56,054
15	136,844	97,376	30,698	23,018	128,556	71,095	55,774
16	136,160	96,889	30,545	22,903	127,913	70,740	55,495
17	135,479	96,405	30,392	22,788	127,274	70,386	55,217
18	134,801	95,923	30,240	22,674	126,637	70,034	54,941
19	134,127	95,443	30,089	22,561	126,004	69,684	54,666
20	133,457	94,966	29,938	22,448	125,374	69,336	54,393

Year	Veterans Park	Allmendinger Park	Argo Canoe Livery	Gallup Park - Maas Shelter	Gallup Park - Fast Shelter	Gallup Park - Parking	Wheeler Service Center	Water Recovery Plant
1	50,264	5,729	6,665	5,935	7,071	114,557	381,957	172,484
2	50,013	5,701	6,632	5,905	7,035	113,985	380,047	171,622
3	49,763	5,672	6,599	5,876	7,000	113,415	378,147	170,763
4	49,514	5,644	6,566	5,846	6,965	112,848	376,256	169,910
5	49,266	5,616	6,533	5,817	6,930	112,283	374,375	169,060

Year	Veterans Park	Allmendinger Park	Argo Canoe Livery	Gallup Park - Maas Shelter	Gallup Park - Fast Shelter	Gallup Park - Parking	Wheeler Service Center	Water Recovery Plant
6	49,020	5,588	6,500	5,788	6,896	111,722	372,503	168,215
7	48,775	5,560	6,468	5,759	6,861	111,163	370,640	167,374
8	48,531	5,532	6,435	5,730	6,827	110,608	368,787	166,537
9	48,288	5,504	6,403	5,702	6,793	110,054	366,943	165,704
10	48,047	5,477	6,371	5,673	6,759	109,504	365,109	164,876
11	47,807	5,449	6,339	5,645	6,725	108,957	363,283	164,051
12	47,568	5,422	6,308	5,617	6,691	108,412	361,467	163,231
13	47,330	5,395	6,276	5,588	6,658	107,870	359,659	162,415
14	47,093	5,368	6,245	5,560	6,625	107,331	357,861	161,603
15	46,858	5,341	6,214	5,533	6,591	106,794	356,072	160,795
16	46,624	5,314	6,183	5,505	6,558	106,260	354,291	159,991
17	46,390	5,288	6,152	5,478	6,526	105,729	352,520	159,191
18	46,158	5,261	6,121	5,450	6,493	105,200	350,757	158,395
19	45,928	5,235	6,090	5,423	6,461	104,674	349,004	157,603
20	45,698	5,209	6,060	5,396	6,428	104,151	347,259	156,815

D.6 Battery Readiness

NOVA is proposing AC-coupled battery systems that can be installed at a future date. For most outdoor locations such park shelters and carports, there may not be a suitable temperature-controlled enclosed space to keep the battery. Commercial batteries available today are very sensitive to temperature and may not be able to operate in Michigan weather that may range from -20F to 120F over the year. Secondly load data is not available at this time to perform battery sizing calculations to determine the required battery power (kW) or energy (kWh). Keeping the batteries AC-coupled will allow the PV system installation to proceed with any inverter that is acceptable for the project without requiring battery compatibility. A control method will be required to ensure that the utility service, generator (if present), solar PV system, and battery can operate together properly with necessary safety procedures in place.

D.7 City Hall / Justice Center

City guidance for PV system	Carport or Rooftop solar + storage
City estimate for system size	100 kW – 120 kW
Prorated 365-day site usage	3,027,270 kWh

NOVA proposal

PV system type	Ballasted rooftop + future storage
DC size	111.8 kW

AC size	90 kW
Assumed site voltage	480V / 277V three phase
First year solar PV generation	146,791.9 kWh
DTE energy offset	4.8%

D.8 Ann Arbor Fire Station 1

City guidance for PV system	Rooftop + storage
City estimate for system size	120 kW – 150 kW
Prorated 365-day site usage	222,723 kWh

NOVA proposal

PV system type	Ballasted rooftop + future storage
DC size	79.9 kW
AC size	60 kW
Assumed site voltage	208V / 120V three phase
First year solar PV generation	104,455.2 kWh
DTE energy offset	46.9%

D.9 Ann Arbor Fire Station 3

City guidance for PV system	Ground + storage
City estimate for system size	50 kW – 80 kW
Prorated 365-day site usage	43,007 kWh

NOVA proposal

PV system type	Ballasted rooftop + future storage
DC size	25.4 kW
AC size	20 kW
Assumed site voltage	208V / 120V three phase
First year solar PV generation	32,929.8 kWh
DTE energy offset	76.6%

D.10 Justice Center

As mentioned by the City in Addendum 1, the Justice Center and City Hall share the same electrical service and meter. Hence, this PV system is combined with City Hall as shown in Section D.7 above. The green roof is not being proposed for solar PV since the proposed PV system size is already consistent with City guidance.

D.11 Bryant Community Center

City guidance for PV system	Rooftop + storage
City estimate for system size	40 kW – 50 kW
Prorated 365-day site usage	42,301 kWh

NOVA proposal

PV system type	Attached flush mount rooftop + future storage
DC size	22.7 kW
AC size	17.6 kW
Assumed site voltage	240V / 120V single phase
First year solar PV generation	24,691.2 kWh
DTE energy offset	58.4%

D.12 Buhr Park

City guidance for PV system	Carport solar + EV Charger + storage
City estimate for system size	100 kW – 110 kW
Prorated 365-day site usage	306,712 kWh

NOVA proposal

PV system type	Carport solar + EV Charger + future storage
DC size	108 kW
AC size	90 kW
Assumed site voltage	240V / 120V single phase
First year solar PV generation	137,901.5 kWh
DTE energy offset	45%

D.13 Southeast Area Park

City guidance for PV system	Carport solar + EV Charger + storage
City estimate for system size	50 kW – 60 kW
Prorated 365-day site usage	4,734 kWh

NOVA proposal

PV system type	Carport solar + EV Charger + future storage
DC size	58.3 kW
AC size	48 kW
Assumed site voltage	240V / 120V single phase
First year solar PV generation	76,263.8 kWh
DTE energy offset	1,611%

D.14 West Park

City guidance for PV system	Carport solar + EV Charger + storage
City estimate for system size	20 kW – 50 kW
Prorated 365-day site usage	782 kWh

NOVA proposal

PV system type	Carport solar + EV Charger + future storage

DC size	48.6 kW
AC size	40 kW
Assumed site voltage	240V / 120V single phase
First year solar PV generation	59,828.1 kWh
DTE energy offset	7,649%

D.15 Veterans Park

City guidance for PV system	Carport solar + EV Charger + storage
City estimate for system size	20 kW – 40 kW
Prorated 365-day site usage	69,753 kWh

NOVA proposal

PV system type	Carport solar + EV Charger + future storage
DC size	38.9 kW
AC size	30 kW
Assumed site voltage	240V / 120V single phase
First year solar PV generation	50,264.2 kWh
DTE energy offset	72.1%

D.16 Allmendinger Park

City guidance for PV system	Rooftop solar + storage
City estimate for system size	40 kW – 50 kW
Prorated 365-day site usage	2,119 kWh

NOVA proposal

PV system type	Rooftop solar + future storage
DC size	4.32 kW
AC size	3.8 kW
Assumed site voltage	240V / 120V single phase
First year solar PV generation	5,729.4 kWh
DTE energy offset	270%

D.17 Argo Canoe Livery

City guidance for PV system	Rooftop solar + storage
City estimate for system size	40 kW – 50 kW
Prorated 365-day site usage	4,710 kWh

NOVA proposal

PV system type	Rooftop solar + future storage
DC size	5.94 kW
AC size	5 kW

Assumed site voltage	240V / 120V single phase
First year solar PV generation	6,665.3 kWh
DTE energy offset	142%

D.18 Gallup Park Maas Shelter

City guidance for PV system	Rooftop solar
City estimate for system size	5 kW – 10 kW
Prorated 365-day site usage	No data available

NOVA proposal

PV system type	Rooftop solar
DC size	6.48 kW
AC size	5 kW
Assumed site voltage	240V / 120V single phase
First year solar PV generation	5,791.9 kWh
DTE energy offset	No data available

D.19 Gallup Park Fast Shelter

City guidance for PV system	Rooftop solar
City estimate for system size	5 kW – 10 kW
Prorated 365-day site usage	No data available

NOVA proposal

PV system type	Rooftop solar
DC size	6.48 kW
AC size	6 kW
Assumed site voltage	240V / 120V single phase
First year solar PV generation	7,070.6 kWh
DTE energy offset	No data available

D.20 Gallup Park Parking Area

City guidance for PV system	Carport solar + EV Chargers + Storage
City estimate for system size	70 kW – 80 kW
Prorated 365-day site usage	No data available

NOVA proposal

PV system type	Carport solar + EV chargers + future storage
DC size	90.7 kW
AC size	75 kW
Assumed site voltage	240V / 120V single phase
First year solar PV generation	114,557.4 kWh

DTE energy offset	No data available

D.21 Wheeler Service Center

City guidance for PV system	Carport solar + EV Chargers + Storage
City estimate for system size	50 kW – 300 kW
Prorated 365-day site usage	1,766,352 kWh

NOVA proposal

PV system type	Carport solar + EV chargers + future storage
DC size	311 kW
AC size	255 kW
Assumed site voltage	480V / 277V single phase
First year solar PV generation	381,956.9 kWh
DTE energy offset	21.6%

D.22 Water Recovery Plant

City guidance for PV system	Rooftop solar+carport solar+EV Chargers+Storage
City estimate for system size	60 kW – 70 kW
Prorated 365-day site usage	12,489,551 kWh

NOVA proposal

PV system type	Rooftop solar+carport solar+EV charger+future storage
DC size	101 kW
AC size	75 kW
Assumed site voltage	480V / 277V single phase
First year solar PV generation	127,483.7 kWh
DTE energy offset	1.0%

E. FEE PROPOSAL

The fee proposal is provided in separate envelope as requested.

F. AUTHORIZED NEGOTIATOR

Person authorized to receive and sign a resulting contract and / or subsequent assignment(s):

Please refer to Section A of this document for this information.

G. ATTACHMENTS

The requested forms are filled out completely and attached as requested.

Sunil Agrawal, President

Attachment 1 – Detailed Proposal, 66 pages

PROPOSAL FOR
SOLAR AND ENERGY STORAGE INSTALLATIONS
FOR CITY SITES
CITY OF ANN ARBOR
RFP # 23-15

Submitted To

City of Ann Arbor
c/o Customer Service
301 East Huron Street
Ann Arbor, MI 48107

Submitted By
NOVA Consultants, Inc.
21580 Novi Road, Suite 300
Novi, MI 48375

(248) 347-3512
www.novaconsultants.com

April 14, 2023

Table of Contents

A. PROFESSIONAL QUALIFICATIONS 1
A.1 Company Information 1
A.2 Sub-proposer 2
A.3 Personnel 2
A.4 Summary of Main Qualifications of Key Personnel 6
A.5 Company History and Unique Qualifications 9
B. Past involvement with Similar Projects 15
C. Work Plan 26
D. Preliminary System Designs 32
D.1 Inverter locations 32
D.2 Product Specification Sheets 33
D.3 Product Warranty 38
D.4 First Year Energy Production Estimates 39
D.5 20-Year Energy Production 40
D.6 Battery Readiness 41
D.7 City Hall / Justice Center 42
D.8 Ann Arbor Fire Station 1 44
D.9 Ann Arbor Fire Station 3 46
D.10 Justice Center 48
D.11 Bryant Community Center 49
D.12 Buhr Park 50
D.13 Southeast Area Park 52
D.14 West Park 53

Table of Contents (Continued)

D.15 Veterans Park 54
D.16 Allmendinger Park 55
D.17 Argo Canoe Livery 57
D.18 Gallup Park Maas Shelter 58
D.19 Gallup Park Fast Shelter 59
D.20 Gallup Park Parking Area 60
D.21 Wheeler Service Center 62
D.22 Water Recovery Plant 64
E. Fee Proposal 66
F. Authorized Negotiator 66
G. Attachments 66

Attachments

Attachment 2 Helioscope model simulation reports
Attachment 3 Equipment datasheets
Attachment 4 Personnel resumes
Attachment 5 JRanck Electric company information and project experience
Attachment 6 Required bid forms
Attachment 7 Cost proposal (in separate envelope)

Proposal for RFP # 23-15
Solar and Energy Storage Installations for City Sites

NOVA Consultants, Inc. (NOVA) is pleased to present this proposal to the City of Ann Arbor (City) in response to RFP # 23-15 for Solar and Energy Storage Installations for City Sites. NOVA has received and carefully reviewed the Request For Proposals (RFP) and subsequent Addendum 1 and Addendum 2.

A. PROFESSIONAL QUALIFICATIONS

A.1 Company Information

- Full name of organization: NOVA Consultants, Inc.
- Address: 21580 Novi Road
Suite 300
Novi, MI 48375

- NOVA Consultants, Inc. (NOVA) operates as a corporation, and is incorporated in the State of Michigan.

- NOVA is licensed to operate and practice in the State of Michigan.

- If awarded a contract, the address shown above would be used for all correspondence.

- Person authorized to receive and sign a resulting contract and / or subsequent assignment(s):

Sunil Agrawal, *PhD, PE.*
President
NOVA Consultants, Inc.
21580 Novi Road, Suite 300
Novi, MI 48375

sunil.agrawal@novaconsultants.com
Office: 248-347-3512 x 114
Cell: 248-866-1476

- Certification and Addendum Acknowledgment forms are included at the end of this RFP as part of NOVA's proposal response.

A.2 Sub-proposer

NOVA will utilize JRanck Electric (JRE), a union electrical contractor based in Mt. Pleasant, for the installation of the solar PV, battery storage, and electric vehicle (EV) chargers. The NOVA and JRE team has successfully completed almost 30 projects for DTE since 2009.

A.3 Personnel

NOVA has complete design and engineering services in-house including professional electrical, civil, structural, and geotechnical engineers registered in the State of Michigan as Professional Engineers (PE).

- NABCEP certified Solar PV Installer
- Electrical engineering, including PE stamping by Michigan registered engineer
- Structural engineering, including PE stamping by Michigan registered engineer
- Geotechnical engineering, including PE stamping by Michigan registered engineer
- Civil engineering, including PE stamping by Michigan registered engineer
- Construction oversight
- Project Management / Construction Management

JRE has complete electrical construction capabilities in-house in terms of construction equipment and personnel. The NOVA and JRE team has extensive resources available that can demonstrate to the City the **Team's ability to handle several projects simultaneously**. At this time, JRE has approximately 300 personnel. Being a Union affiliated firm, JRE can hire additional skilled tradesmen from the local Union Hall as necessary for the successful and timely completion of U-M projects. Additionally, the **Team has a demonstrated and proven track record of design and building almost 30 projects for DTE at multiple locations in Michigan under one contract.**

To better serve City needs, NOVA has clearly identified various teams within NOVA that can better address U-M project requirements as they occur from project concept to final closeout. NOVA and JRE have the following personnel either as full- or part-time employees, or accessible as sub-consultants or as skilled-tradesmen through the local Union Hall.

The following personnel are available to work this project. Summary qualifications are provided below. Resumes are attached as requested. Percentage availability for these personnel for the current project will vary from 10% to 100% depending upon the activities in progress at any given time. For example, our electrical engineer may be engaged 100% of the time during the design phase, but the field supervisor may only have 10% involvement at that stage of the project. The effort may be reversed during the construction phase between these two personnel. All personnel are direct employees of NOVA and located in the metro-Detroit area.

Management

Program Director	Sunil Agrawal, *PhD, PE*

Project Coordinator	Sachit Verma, *MS*
Project Manager	Jeff Eckhout
	James Mann (JRE)

Professional Engineers

Electrical Engineers	Jerry Young, *PE*
	Clayton Cox, PE
Civil Engineer	Paul Baluja, *MS, PE*
Structural Engineer	Mark Mahajan, *MS, PE*

Registered Architects

Registered Architect	Mike McKelvey
Registered Architect	George Kachadoorian

Solar

PV System design/layout	John Witte, *NABCEP Cert. Installer*
PV System modelling	Rick Marble

AutoCAD

AutoCAD Specialist	Rick Marble
AutoCAD operator	Bruce Dickieson

Administration

Contract Supervisor	Joe Ruffing
Accounts	Sushma Agrawal

Safety

Safety Officer	Greg Wagner, *BA*

Field Personnel

NOVA Site Supervisors	John Gembarski
Electrical Supervisors	Several
Electricians	Master Electricians, Journeymen, and Apprentices
Installers	Several PV installers via the Union Hall
Field Foremen	Jason LeCreux (JRE)

1. **Physical Location of Key Personnel:** Novi, Michigan and Mt. Pleasant, MI

2. **Functions each Key Personnel will perform:**

- Program Manager/Contractor Representative: Sachit Verma will be responsible for overall program management and will serve as the single point of contact for the contract
- Project Manager: Jeff Eckhout will be responsible for the design and construction management of each project
- Clayton Cox and Mark Mahajan will provide electrical and structural design assistance respectively
- Site Superintendent: John Gembarski will provide oversight for the onsite inspections
- Rick Marble will lead the AutoCAD team

3. **Current Chronological Résumés:** Resumes are attached as requested.

A.4 Summary of Main Qualifications of Key Personnel

Program Director **Dr. Sunil Agrawal, PhD, P.E.**
Length of Time with NOVA: 30 Years
Dr. Sunil Agrawal will be the Executive-in-charge of the entire team and will be the managerial contact person regarding all contractual matters. Dr. Agrawal has over twenty-five years of experience including his leadership of NOVA Consultants for over fifteen years. His specialties include value engineering, out of the box technical approach, alternative energy, energy savings, steam plants and environmental engineering projects.
BS, Civil Engineering, University of Jabalpur, India
MS, Environmental Engineering, Asian Institute of Technology, Bangkok, Thailand
PhD, Civil/Environmental Engineering, University of Windsor, Canada
Registered Professional Engineer - State of Michigan
Diplomate - American Academy of Environmental Engineers

Program Manager **Sachit Verma, MS Length of Time with NOVA: 28 Years**
Mr. Verma has been in the engineering field for over 20 years. He specializes in the energy/solar field. He is the program manager for the Detroit Edison 15 MW solar program. He is responsible for technology selection, and ensuring consistency of processes across various projects, and overall project management.
M.S., Chemical Engineering, Louisiana State University, Baton Rouge, LA
B.S., Chemical Engineering, I.I.T.

Project Manager **Jeff Eckhout, *BS***
Length of Time with NOVA: 28 Years
Mr. Eckhout has over 15 years of experience as a project engineer/project manager for a variety of environmental, facilities, and energy projects. He has successfully managed several DTE Energy projects including ground-mount and roof-mount projects totaling about 3 MW. His duties include the oversight of engineering, communication between DTE Energy and the customer, equipment procurement, budgeting, health and safety management, and construction oversight.
BS, University of Michigan, Ann Arbor, Michigan
Certifications: Engineer-In-Training (EIT)
40 Hour HAZWOPER
8 Hour Annual Refresher for HAZWOPER

Senior Electrical Engineer **Jerry Young, *P.E.***

Length of Time with NOVA: 10 Years

Mr. Gerald A. Young, P.E. has more than 35 years of experience as an electrical engineer. He has designed electrical systems over 4 MW of solar photovoltaic projects. Mr. Young has extensive experience in the design of electrical power systems, both medium voltage and low voltage. He has also designed many lighting systems, including industrial and commercial lighting and roadway and other outdoor lighting. He has considerable experience in resolving construction issues in the field.

Education:

MBA, Wayne State University, Detroit, MI

BS, Electrical Engineering, University of Detroit, Detroit, MI

Registered Professional Engineer – State of Michigan

Senior Civil Engineer **Paul Baluja, *MS, P.E.***

Length of Time with NOVA: 12 Years

Mr. Baluja has more than 35 years of civil engineering experience. He has engineered the grading plan for several solar projects to ensure adequate site drainage following precipitation events. Additional tasks include design of access roads and driveways to access the site and various pieces of equipment. Mr. Baluja also designs the fences around the array area and the inverter area to prevent unauthorized access to the electrical equipment. His experience includes civil engineering, foundation design, grading and drainage of solar fields, engineering design, resource optimization, process engineering, and project management.

BS, Civil Engineering, University of Nebraska

MS, Structural Engineering, University of Nebraska

Registered Professional Engineer - State of Michigan and State of Nebraska

Senior Structural Engineer **Mark Mahajan, *MS, P.E.***

Length of Time with NOVA: 12 Years

Mr. Mark Mahajan has had over 20 years of civil and structural engineering experience. He will provide engineering services related to structural analysis for carports, racking structures, and building roof load calculations.

MS, Civil (Structural) Engineering, Wayne State University, Detroit, MI

MS, Geotechnical Engineering, Indian Institute of Technology, Bombay, India

BS, Civil Engineering, Victoria Jubilee Technical Institute, Bombay, India

AutoCAD and Computer software specialist **Rick Marble**

Length of Time with NOVA: 7 Years

Mr. Marble is responsible for Construction Document and report preparation, PV Array modeling and shade analysis, and other activities as necessary for the successful implementation of the solar PV projects.

Education and Professional Certifications: Production Drafting degree

Document Control Supervisor/Reg. Architect **Michael McKelvey, *RA***

Length of Time with NOVA: 10 Years

Mr. Michael McKelvey will act as the Document Control Supervisor/Registered Architect. Mr. McKelvey has had more than 35 years of experience in architectural design. His responsibilities include design of many PV solar arrays. Currently he is involved in the design of numerous solar car ports, code compliance, and as built drawings, etc. Mr. McKelvey will manage all documents related to bid specifications, drawings, and AIA (American Institute of Architects) specifications.

BS, Architecture, University of Michigan, Ann Arbor, Michigan

Registered Architect – State of Michigan

Accounts Specialist **Joe Ruffing, *BS***

Length of Time with NOVA: 8 Years

Mr. Ruffing is responsible for tracking accounts payable and receivable, making payments to contractors, payroll processing etc.

Education: BS, Accounting

Safety Officer **Greg Wagner, *BA***

Length of Time with NOVA: 22 Years

Mr. Greg Wagner will coordinate and manage all the health and safety aspects of this project during the construction and commissioning phases of this project. He is certified and experienced in many areas of health and safety systems. He has worked in this capacity on several projects.

Education: BA, Earth Sciences, Adrian College, Adrian, Michigan

Certifications:

Contractor/Supervisor for Asbestos, Michigan

Certified Asbestos Building Inspector, Michigan (A20617) Certified Lead Inspector/Risk Assessor, Michigan (P-1615) NITON XRF Trained

OSHA 40-Hour HAZWOPER
OSHA Confined Space Entry - Entrant/Attendant/Supervisor
Troxler Nuclear Moisture/Density Gauge

Site Supervisor **John Gembarski, *Licensed Electrician***
Length of Time with NOVA: 11 Years
Mr. John Gembarski has had more than 20 years of electrical installations and project management experience. He has successfully completed and supervised several solar PV projects for NOVA under the DTE Energy program.

A.5 Company History and Unique Qualifications

NOVA Consultants, Inc. (NOVA) was founded in Novi, Michigan in 1992, and continues to operate from its office in Novi 32 years later. Over the years, NOVA has provided a variety of professional engineering services such as engineering, environmental, energy (including renewable energy – solar and wind) to various clients in the industrial sector as well as in the public sector. It has maintained profitability continually since inception and carries zero debt. Through its ownership, it has maintained a Minority Business Enterprise (MBE) status and is committed to Equal Employment Opportunity (EEO) objectives. It has distinguished itself by its high degree of professional integrity, flexibility in meeting client needs, and providing high quality cost-effective services.

For the last 14 years, NOVA has been extensively involved in solar PV projects, both as Owner's Advisor (often referred as Owner's Engineer) as well as a contractor for Engineering, Procurement, and Construction (EPC) based on client preference.

Owner's Engineer Services

Owner's Engineer Services refers to the approach where an independent engineering firm assists the client (City of Ann Arbor in this case) with site evaluation and selection, and subsequently prepares the construction documents for the project. The construction work is then bid out to several bidders and one or more bidders are selected for the work based on various selection criteria.

NOVA **has provided Owner's Engineer and EPC services for DTE Energy** Solar Currents program for a portfolio of almost 30 projects totaling about 70MW of solar PV capacity from 2009 until the end of the program in 2017. NOVA has also **provided Owner's Engineer services to Consumers Energy** for their 6 MW Solar Gardens project.

NOVA is currently **providing Owner's Engineer services to Ann Arbor Public Schools** for solar PV projects for eight school projects and is on track to complete additional projects in future. Additionally, NOVA is currently **providing Owner's Engineer services for the State of Michigan to MDOT and the St. Louis Correctional Facility** for solar PV projects.

EPC Services

EPC Services refers to the approach where a complete turnkey contract is awarded to a firm for completing the project from start to finish. The awarded firm can subcontract various project tasks to subcontractors, but essentially the process follows a single award process to the EPC firm instead of the two-step process implemented for the Owner's Engineer approach with one contract with the design firm and a separate contract with the construction firm.

Both processes have their advantages and disadvantages and both are commonly utilized in the construction industry. NOVA has provided services to clients under both arrangements, depending upon client preference.

NOVA has provided EPC services to DTE Energy for several solar PV projects in Michigan, as well as to City of Ann Arbor (DDA), City of Wyandotte, City of Ferndale, City of Petoskey, and City of Huntington Woods.

Unique Qualifications and Differentiators

Over the years, NOVA has developed certain unique capabilities that set it apart from the competition. These differentiators will be very helpful for the City projects.

1. **Local company**

   Being local in metro-Detroit, it would be very easy and inexpensive for NOVA personnel to attend meetings in-person, and provide construction oversight and inspections at low cost. Flights, airfare, hotels, rental cars, and per-diem charges would not be required.

2. **Experience with municipal solar PV projects**

   NOVA has extensive experience with municipal solar PV projects. Examples include:

   a. Three rooftop solar projects for **Wyandotte Municipal Services**

b. One solar carport canopy for **City of Ann Arbor**, DDA
c. One solar carport canopy project for **City of Ferndale**
d. One rooftop solar project for **City of Petoskey**
e. One rooftop solar project for **City of Huntington Woods**

3. Extensive Solar PV Experience

NOVA has provided services for solar PV projects to several clients already including DTE Energy (almost 30 projects over 70 MW total), AAPS, MDOT and others. As a result, NOVA is well versed and familiar with typical tasks, scope of work, site evaluation, preparation of construction documents, communication protocols, construction oversight, report preparation and such matters. Obviously, each project has certain unique requirements that will be need to be addressed, but overall, we do not need to start from scratch and go through a steep learning curve to understand the project.

4. Solar PV Project at Wastewater Treatment Plant

NOVA is currently working on a solar PV project at a wastewater treatment plant in Pennsylvania. The lessons and learnings from that project can be implemented at the City project at the Wastewater Treatment Plant.

5. Projects in Ann Arbor

Over the years, NOVA has successfully completed several projects in Ann Arbor, and as well as neighboring areas, including one in downtown Ann Arbor, one at Domino Farms, two at the University of Michigan, and two in Scio Township.

6. **Rapid Response**

   Being a small company with wide capabilities allows NOVA to respond quickly to rapidly changing project requirements. This flexibility and rapid response ensure that the project stays on schedule with no delays and associated cost overruns.

7. **Low overheads and hourly rates**

   Being a small local company allows NOVA to operate with low overhead costs. The resulting savings are passed on to our clients and reflected in low hourly rates for our personnel.

8. **Stable and consistent staffing**

   As can be seen from the staffing profiles, a majority of the NOVA personnel available to work on the City project have been with NOVA for several years, and have worked extensively on prior solar PV projects where NOVA has provided identical services to what is required for this RFP.

9. **Working with JRE since 2009**

   NOVA and JRE have a proven track record of working together since 2009. JRE has built almost 30 solar PV projects designed and engineered by NOVA, and our personnel have an excellent working relationship, communication, and cooperation.

10. Equipment

It is imperative that the firm that is awarded this contract should have sufficient equipment, including heavy equipment, to service the various job locations. NOVA's installation Partners own hundreds of items of equipment including semi-trucks, excavators, backhoes, bucket trucks, trailers, pickup trucks, street sweepers, trailers, scissor lifts, booms, trailers, generators, air compressors, electrical test equipment, bob cats, bulldozers, compactor, boring machines, mini excavator, forklifts, several trucks, hammer drills, jack hammer, lifts, plasma cutter, trailers, trenchers, welders, generators etc. Having hundreds of pieces of equipment available allows NOVA and its installation Partners to perform electrical work at multiple projects simultaneously.

11. Financial Strength

Both NOVA and JRE are financially sound firms that can easily carry the expenses associated with equipment costs, payroll, overhead costs, insurance, and inventory until payment is received from U-M.

<u>NOVA Advantage</u>

1. **NOVA is a** minority owned **enterprise**
2. **Installation partners is** Union affiliated **electrical contractors**
3. **NOVA and JRE are** located in Michigan **near Ann Arbor**
4. Ability to **handle several projects simultaneously**
5. Both NOVA and installation Partners are **financially sound firms**

B. PAST INVOLVEMENT WITH SIMILAR PROJECTS

Since 2009, NOVA has been actively engaged in the design and installation of solar PV systems across metro Detroit, including Ann Arbor, as well elsewhere in Michigan and other states. Currently, NOVA is serving as Owner's Engineer for Ann Arbor Public Schools (AAPS). Under this program, nine schools in the AAPS District have already installed or are in the process of installing solar PV systems at their facilities. Additionally, NOVA is currently the Owner's Engineer for the Michigan Dept. of Transportation (MDOT) for three solar PV systems, and for the St. Louis Correctional Campus in St. Louis, Michigan for possibly two solar PV systems to be installed at their facilities.

Prior to these projects for AAPS, MDOT and others, NOVA served as the Owner's Engineer as well as EPC contractor for several solar PV projects for DTE Energy and other clients. A partial list of such projects is included below.

All these projects were completed by the same team of NOVA personnel. Hence, personnel are not indicated separately for each project mentioned below.

- Sachit Verma, *MS* — Program Manager
- Jeff Eckhout — Project Manager
- John Gembarski — Construction Supervisor
- Jerry Young, *PE* — Electrical Engineer
- Clayton Cox , *PE* — Electrical Engineer
- Paul Baluja, *PE* — Civil Engineer
- Mark Mahajan, *PE* — Structural Engineer

- Sunil Agrawal, *PE* Civil / Wastewater Engineer
- Greg Wagner Safety Officer
- Joe Ruffing Scheduler, Document Control

Owner's Advisor Projects for Ann Arbor Public Schools (AAPS)

1. Huron High School
2. Forsythe Middle School
3. A2STEAM Elementary
4. Haisley Elementary
5. Bryant Elementary
6. Pioneer High School
7. Westerman Early Education Center
8. Tappan Middle School
9. Scarlett Middle School

EPC Turnkey <u>Project in Ann Arbor</u> for Downtown Development Authority (DDA)

1. Solar photovoltaic carport canopy, parking lot at 4^{th} & Catherine, Ann Arbor

EPC Turnkey Contractor <u>Solar PV Project at Wastewater Treatment Plant</u>

1. Solar photovoltaic canopy over treatment tanks, Lower Bucks County, PA (currently in progress)

EPC Turnkey Contractor for General Contractors

1. Washtenaw High Point School for Clark Construction
2. Ypsilanti Public Library for O'Neal Construction

Owner's Advisor / EPC Turnkey Contractor for DTE Energy Projects

1. Blue Cross Blue Shield
2. Domino's Farms
3. DTE HQ Solar Carport
4. Ford Wayne Assembly Plant
5. Ford World HQ Solar Carport
6. GM Hamtramck
7. GM Orion
8. DTE Greenwood
9. GM Warren
10. Hartland Schools
11. Huron County Metropark
12. IHM Sisters
13. Leipprandt Orchards
14. McPhail Properties
15. Mercy High School
16. Monroe County Community College
17. Riopelle Farms
18. St. Claire RESA
19. Scio Twp.
20. DTE Training & Development Center
21. Thumb Solar
22. University of Michigan IST
23. University of Michigan NCRC
24. Warren Consolidated Schools

25. Wil-Le Farms
26. Ypsilanti Highlands
27. DTE Brownstown
28. DTE Demille
29. DTE Turrill
30. DTE O'Shea Park
31. DTE Romulus

Owners Engineer for State of Michigan

1. MDOT/Office of Passenger Transportation – Pontiac & Southfield Terminals
2. DTMB/St. Louis Correctional Facility Solar Project

Owner's Engineer for Consumers Energy Project

1. Grand Valley State University Solar Gardens project, Allendale, MI
2. Circuit West project, Grand Rapids, MI

EPC Turnkey Contractor for General Contractors

3. Washtenaw High Point School for Clark Construction
4. Ypsilanti Public Library for O'Neal Construction

Photographs from few prior projects

Photographs from few prior projects are included below to demonstrate the variety of projects that NOVA has worked on. There is a diversity of installation locations (roof vs. ground), as well as installation types (embedded posts, ballasted ground, curved roof, attached roof, ballasted roof, carport canopy).

- 20 kW rooftop PV system for **City of Huntington Woods**

- 12 kW carport canopy at for **City of Ann Arbor**, Michigan.

- 1 MW carport canopy at Ford World Headquarters, Dearborn, Michigan

- 80 kW rooftop PV system for **US Fish & Wildlife Service, Trenton, MI**

- 27 kW carport canopy at for **City of Ferndale**, Michigan

- 400 kW ballasted rooftop at Mercy High School, Farmington Hills, Michigan

- 500 kW ground mount at IHM Sisters, Monroe, Michigan

- 15 kW on rooftop of Lansing Board of Water and Light

- 210 kW rooftop PV systems for **City of Wyandotte**, Michigan

The Solar PV Limited Project Summary in the table below includes projects that have been completed over the last few years, along with relevant information such as PV system size, racking etc. **This is only a sample subset of projects successfully completed by NOVA**.

Project Name	Type of Install.	kW DC
Consumers Energy GVSU	Ground mount with driven post	3,700 kW
Greenwood Energy Center	Ground mount with driven post	1,900 kW
Wolverine Power	Ground mount with driven post	1,200 kW
Ford World HQ	Solar PV Carport Canopy	1.038 MW
Domino's Farms	Ground Mount with Helical Piers	1,089 kW
McPhail Properties	Ground Mount with Helical Piers	816 kW
Thumb Solar	Ground Mount	665 kW
Sisters, Servants of the Immaculate Heart of Mary	Ground Mount with Helical Piers	518 kW
St. Clair Regional Education Service Agency	Ground Mount	517 kW
GM - Hamtramck Assembly Plant	Ballasted Ground Mount	516 kW
Riopelle Farms	Ground Mount with Helical Piers	514 kW
Monroe County Community College	Ground Mount with driven post	513 kW
Leipprandt Orchard	Ground Mount with (3 kW) Edu. Array	511 kW
Ford Wayne Assembly Plant	Ballasted Ground Mount	502 kW
Huron Clinton Metroparks-Indian Springs Park	Ground Mount with Helical Piers	495 kW
Wil-Le Farms	Ground Mount with Helical Piers	485 kW
Hartland Consolidated Schools	Ground Mount with (3 kW) Educational Array	444 kW

Project Name	Type of Install.	kW DC
University of Michigan North Campus Research Complex	Ground Mount with Helical Piers	430 kW
Mercy High School	Ballasted Roof Mount	402 kW
DTE - Training and Dev. Center	Ground Mount Helical Piers	391 kW
GM Orion Assembly Plant	Ground Mount with Helical Piers in Concrete	345 kW
University of Michigan Information, Science and Technology	225kW Fixed Ground Mount with 17kW on 7 Dual-Axis Trackers	241 kW
Blue Cross Blue Shield	Ballasted Roof Mount	220 kW
Warren Consolidated Schools	Ballasted Roof Mount	189 kW
WMS Water Tank Solar Array	Ballasted Roof Mount	162 kW
MDOT Grand Rapids Canopy	Solar PV Carport Canopy	100 kW

With the extensive experience shown above, the NOVA team is the most experienced in the State of Michigan, especially with regard to city, municipality, and state projects, and will provide the best value to the City of Ann Arbor for this work.

Please see the list of references below for projects within the last five years:

1. Ann Arbor Public Schools, Solar PV projects at 9 schools mentioned above
   Jason Bing
   Construction Projects Auditor, Capital Projects
   (734) 994-8118
   bingj@aaps.k12.mi.us

2. MDOT/Office of Passenger Transportation – Pontiac & Southfield Terminals
   Sheryl Ananich
   Project Director DTMB Design & Construction
   (517) 243-7605
   AnanichS@michigan.gov

3. DTMB/St. Louis Correctional Facility Solar Project
   Susan Wheaton
   Project Director DTMB | State Facilities Administration| Design and Construction Division
   (517) 242-9945
   Wheatons1@michigan.gov

4. DTE Energy 31 Solar Currents Projects mentioned above
   Timothy O'Connor, CHMM | Project Engineer
   Major Enterprise Projects
   (734) 309-6181
   tim.oconnor@dteenergy.com

C. WORK PLAN

Management Summary

The solar PV projects will be managed by a very capable and experienced NOVA team with several years of hands-on project experience and a proven track record of successfully delivering solar PV projects on time and under budget. Though all personnel mentioned above in Section II-3 will be available, the primary personnel include Sachit Verma (Program Manager), Jeff Eckhout (Project Manager), Clayton Cox (Electrical PE), Mark Mahajan (Structural & Geotechnical PE), John Gembarski (Site Supervisor), Rick Marble (AutoCAD lead), John Witte (NABCEP certified professional), Joe Ruffing (Administrative tasks and accounts).

NOVA and JRE will commence the project with a kick-off meeting at the City with all stakeholders, including but not limited to City personnel, local facility personnel knowledgeable about the existing infrastructure, schedules, constraints, and risks at each facility. All these factors must be considered early in the project to ensure smooth and timely completion without causing undue hardship to facility users.

The preliminary design engineering phase of the project will take into consideration relevant and critical information from the kick-off meeting, information gathered during site visits and from as-built documents, along with site electrical usage details to be used for PV system sizing calculations.

Site Visits

Site visits will be required to gather additional existing information about the sites such as as-built drawings, especially those showing the electrical infrastructure. NOVA will require information about existing underground utilities in the proposed installation area, as well as geotechnical information for the soils to evaluate foundation design for the solar PV system involving solar carports.

Rooftop projects will require a structural evaluation of the structure to ensure that the roof can successfully support the additional loads resulting from the installation of the solar PV system on the roof.

The following tasks will be covered during site visits:

- Decide location of inverters and associated electrical equipment
- Determine conduit routing pathway from the PV array area to the inverter location that is clear of interferences
- Establish location of communication and monitoring equipment

- Discuss work schedule, access control, material staging areas, etc. with facility personnel, especially at occupied sites such as City Hall and Justice Center, so that the PV system installation does not cause inconvenience to facility employees and visitors.
- Take photographs of rooftops, electrical gear, PV installation areas
- Record PV area measurements to develop accurate layout drawings

Construction Documents

Once the site information is available, NOVA will develop construction documents and submit to the City for review at various completion levels. The objective is to address any issues early on in the design phase since a particular early decision may affect several other later decisions in a cascading manner. It is obviously much quicker and lower cost to make changes on paper rather than after construction.

Typical submittal levels are:

1. Preliminary design (30% completion)
2. Intermediate design (60% completion)
3. Final design (90% completion)
4. Issued for construction (100% completion)

Typical drawings

Most solar PV system require the following drawings as part of the construction drawing set:

1. Cover sheet containing project and client details
2. General Notes containing project requirements

3. Site Plan showing site relative to surrounding areas
4. Electrical site plan showing PV system, main disconnect, meter location, etc.
5. DC power plan showing DC wiring from array area to inverters
6. PV Module wiring plan showing wiring between PV modules
7. AC power plan showing wiring from inverters to point of interconnection
8. One-line diagram showing all electrical equipment, wiring, conduits etc.
9. Grounding plan showing grounding system details
10. Electrical details showing service rack, grounding detail, equipment mounting
11. Communication plan showing monitoring system details
12. Civil details showing transformer pad, road, driveway detail, fence detail etc.
13. Rooftop ballast details from racking company
14. Pitched roof rail installation, attachments, and module mounting detail
15. Carport installation details from carport supplier including foundations
16. Material datasheets

Duration for the design varies by size of project. For example, a small site such as a park shelter may take less than a week, while City Hall/Justice Center may take 4-6 weeks. Similarly, City staff may need less than a day to review a submittal for a park shelter PV system, but one week for the Water Recovery Plant. An overall project schedule is shown below. **Time needed by City staff for review is determined by them and can be added accordingly.** A key element is the approval of the DTE Interconnection Application, which is up to DTE to approve and over which NOVA has no control. Sometimes DTE may come back with questions and/or clarifications which adds to the project schedule. The approval time is typically 3 weeks for small sites, but may be 6 weeks or more for large sites that have a more complex electrical system, such as multiple transformers, generators etc.

	Small Site **< 10 kW**	**Intermediate Site** **< 50kW**	**Large Site** **< 350 kW**
30% completion	3 days	1 week	2 weeks
60% completion	3 days	2 weeks	4 weeks
90% completion	3 days	1 weeks	1 week
100% completion	3 days	1 weeks	1 week
Total	**2 weeks**	**5 weeks**	**8 weeks**

Following the issuance of construction drawing sets, NOVA will work closely with JRE to ensure a smooth construction process that is safe, reliable, and provides a high-quality installation of the solar PV system that should last a very long time, and allow the facility to benefit from this zero-emission energy source.

During construction, NOVA will provide Construction Administration – Office Services and Construction Administration – Field Inspection services as necessary to ensure the successful and timely completion of all projects.

Construction Administration - Office services include responding to contractor submittals for Request for Information (RFI), reviewing contractor submittals, answering questions, providing clarifications, evaluating the use of substitute products, and other tasks as necessary.

Construction Administration - Field inspections include site visits at regular intervals to monitor construction progress, ensure construction quality, perform construction testing if required, and address contractor concerns as necessary.

Quality

Each project requires its own project-specific written quality assurance / quality control (QA/QC) plan to ensure the design engineering is of a high quality resulting in a project free of defects. The QA/QC has several forms related to QA/QC that must be filled out to document project quality. Any quality issues are thus prevented to the extent possible, or identified early in the process so that they can be addressed immediately without schedule impact. Drawing checklists are used at each stage to ensure that the required information is included, is accurate, and has been reviewed before sending to the client.

Safety

Safety is paramount in any NOVA project. The City project will require a site-specific safety plan that will include risk mitigation measures to address foreseeable safety concerns. Potential safety concerns for each project task will need to be addressed to prevent employee injury. Such tasks may include trenching, cutting, welding, rigging, lifting, manlift use, ladder safety, heavy equipment use etc.

By means of the above very strong differentiators and specialized skills and advantages, NOVA has demonstrated the merits of this proposal and the benefits to the City should NOVA be selected for this project.

D. PRELIMINARY SYSTEM DESIGNS

Preliminary system designs are provided below in compliance with the RFP requirements. Detailed model simulation reports created using Helioscope software are attached. The Helioscope reports also contain the PV system design parameters such as array location, tilt, azimuth, and first year energy production.

NOVA has carefully analyzed the energy consumption data provided by the City and calculated the pro-rated 365-day (one year) energy consumption at each site, since the downloaded data duration was for approximately 420 days. The PV systems have been sized close to City estimates when possible. In some instances, the target capacity could not be met for various reasons that are discussed for each location.

D.1 Inverter locations

Rooftop solar	Flat roof - either on the roof or in or near the electrical room
	Pitched roof – on the ground near the electrical room
Carport	Inverters will be mounted on carport support columns


Examples of inverter on roof and mounted on column

D.2 Product Specification Sheets

Product specification sheets are attached for PV modules, inverters, racking, and carports. The reasoning for selecting certain products is discussed below in accordance with RFP requirements.

Material Selection Rationale

NOVA has paid careful attention to material selection. It not necessarily based on lowest cost, but what is best suited for this particular portfolio, and for each specific installation.

PV module selection

NOVA only uses PV modules from global top Tier 1 manufacturers with a proven track record of supporting solar PV projects in USA. This approach ensures a high-quality product, with the backing and support of a reliable company in the event that warranty service is needed. The PV module industry is very dynamic and pricing and availability cannot be guaranteed until the order is actually placed. Hence, NOVA remains open to using PV modules from any one of several global Tier 1 manufacturers to ensure product availability and maintain project schedule. Some examples include JA Solar, Jinko Solar, Trina Solar, VSun, Heliene, Longi and others. At this time NOVA has selected JA Solar, but actual product selection will be determined during the design engineering phase of the project, in addition to pricing and availability at the time of ordering.

Inverter selection

Due to the different voltages across the sites, different PV system sizes, and types of PV systems (rooftop, carport), NOVA is seeking to utilize different inverter models from the same brand so that monitoring can be provided under the same platform for all sites. Inverter brands such as Fronius, SolarEdge, and AP Systems meet this requirement, along with few other brands. At this time NOVA has selected Fronius, but actual product selection will be determined during the design engineering phase of the project, in addition to pricing and availability situation prevailing at the time of ordering.

Racking selection – Ballasted rooftop

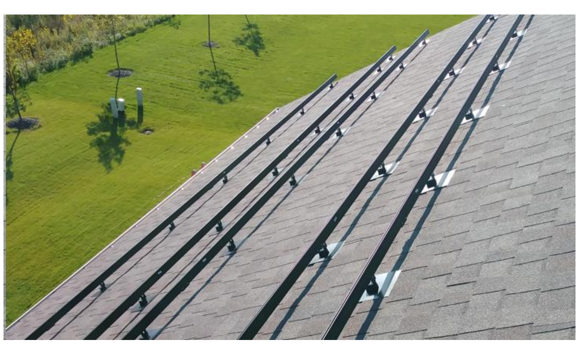
The primary objective of rooftop racking is to support the PV modules. A key requirement is that the PV installation should result in low cost and low weight installation. For a ballasted PV system, it is important to keep the ballast weight as low as possible to avoid overloading the roof, while providing the necessary resistance against wind uplift at the same time.

With these competing requirements in mind, NOVA has selected the Ecolibrium Ecofoot2+ rooftop ballasted racking for this project. It is made of synthetic materials so that there is no metal-to-roof contact that could potentially result in a roof puncture, thus causing roof leaks. This particular racking utilizes wind deflectors on the back side to reduce the effects of wind uplift on the solar panel. The reduced wind uplift results in a lower ballast requirement.

This racking has only three main components, and can be shipped at low cost due to easy stacking on a pallet.

Racking selection – Pitched roof (Shingles)

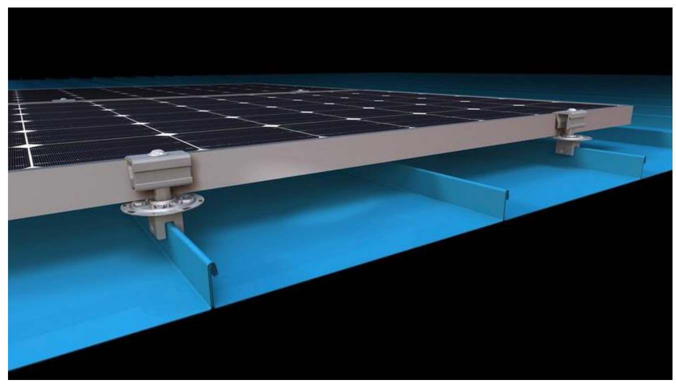
Racking for pitched roof requires a system of rails and clamps to attach PV modules to the roof. NOVA will use metal racking components from proven companies such as Unirac, Ironridge, Everest, K2 or other reputable manufacturers. A key component is the attachment to the roof that requires roof penetration. NOVA always uses attachments that are flashed in beneath roof shingles to ensure a long-life water tight seal. Attachments that rely purely on sealant to prevent water leaks may be risky since the sealants get weathered and may crack over time.



Solar panel installation on shingle roof

Racking selection – Pitched roof (Standing seam metal roof)

For standing seam roofs, NOVA utilizes S-5! Clamps to attach the PV modules directly to the roof seams without any roof penetrations. This is the lowest cost approach as well as the most secure in terms of roof leaks since no penetrations are required.



Solar panel attached directly to metal roof

Carport Selection

NOVA is proposing the use of carports from Sinclair located in Albion, Michigan. It is one of the leading solar carport manufacturers and can offer low shipping cost to Ann Arbor. NOVA has successfully used their carport on several projects, and JRE is familiar with the installation procedure, having recently installed one for MDOT in Pontiac, Michigan.

Sample single and double row carports

EV Charger Selection

NOVA is proposing EV chargers from Mid-Cour, a Michigan company, to save material shipping costs and personnel travel costs, ensure prompt local service for commissioning, and easy warranty service if needed. The company is familiar with DTE rebate requirements for Level 2 EV chargers currently available to EV charger owners that own a publicly accessible EV charger. The charger complies with City requirements for a Level 2 charger on a 40 A circuit.

The charger will be on the EV Connect network via a cellular connection. Charger location, status, and availability will be visible to users so they can plan their travels accordingly. One charger will be mounted on a dual pedestal so that a second charger can be added at a later date. The City can set its own pricing for EV charging for customers.

Battery Storage Selection

At this time, NOVA is proposing that battery storage be added at a later date to allow collection of necessary information that is required for the proper selection of the battery and associated components. For example, the following information is required:

1. Existing site one-line wiring diagram to see where the battery would connect, and which loads are to be backed up
2. Is there a climate-controlled space available at each location for the battery? The batteries available today are sensitive to operating temperature, and capacity may be significantly reduced at extreme ambient temperatures.
3. A control mechanism is necessary to make the utility service, generator (if present), battery, and solar PV system all work together seamlessly in a trouble-free manner. It is not a trivial matter to ensure that all three or four power sources work properly within their operating parameters in a safe and efficient manner. It would take a considerable effort, collaboration with manufacturers, and significant engineering to achieve this objective.

D.3 Product Warranty

The various PV system products carry the following **transferable** warranties:

PV modules	10-year warranty on minimum of 90% nameplate energy production and 25-year warranty on minimum of 80% nameplate energy production
Inverters	10 years
Racking	25 years

NOVA will need information from the City regarding existing flat roof construction and warranties. Most roofing membrane manufacturers allow the installation of solar PV systems on their roof as long as certain installation procedures are followed, and the roof passes post-installation roofing inspection by the roof manufacturer. NOVA assumes that all roofs are currently in good condition and ready for solar PV system installation. Costs for roof upgrades are not included.

D.4 First Year Energy Production Estimates

NOVA utilized Helioscope software to prepare PV system layouts and energy production estimates based on the proposed materials.

Site No.	Site	First year PV Generation, kWh
1	City Hall / Justice Center	146,792
2	Fire Station 1	104,455
3	Fire Station 3	32,930
4	Justice Center - **See 1 above**	
5	Bryant Community Center	24,691
6	Buhr Park	137,902
7	Southeast Area Park	76,264
8	West Park	59,828
9	Veterans Park	50,264
10	Allmendinger Park	5,729
11	Argo Canoe Livery	6,665
12	Gallup Park - Maas Shelter	5,935
13	Gallup Park - Fast Shelter	7,071
14	Gallup Park - Parking	114,557
15	Wheeler Service Center	381,957
16	Water Recovery Plant	127,484
	Total portfolio	**1,282,524**

D.5 20-Year Energy Production

Long term energy production over 20-years is provided below. An annual degradation of 0.5% is assumed for the PV modules.

Year	City Hall / Justice Center	Fire Station 1	Fire Station 3	Bryant Community Center	Buhr Park	Southeast Area Park	West Park
1	146,792	104,455	32,930	24,691	137,902	76,264	59,828
2	146,058	103,933	32,765	24,568	137,212	75,882	59,529
3	145,328	103,413	32,601	24,445	136,526	75,503	59,231
4	144,601	102,896	32,438	24,323	135,843	75,126	58,935
5	143,878	102,382	32,276	24,201	135,164	74,750	58,640
6	143,159	101,870	32,115	24,080	134,488	74,376	58,347
7	142,443	101,360	31,954	23,960	133,816	74,004	58,056
8	141,731	100,854	31,794	23,840	133,147	73,634	57,765
9	141,022	100,349	31,635	23,721	132,481	73,266	57,476
10	140,317	99,848	31,477	23,602	131,819	72,900	57,189
11	139,615	99,348	31,320	23,484	131,160	72,535	56,903
12	138,917	98,852	31,163	23,367	130,504	72,173	56,619
13	138,223	98,357	31,007	23,250	129,851	71,812	56,336
14	137,531	97,866	30,852	23,134	129,202	71,453	56,054
15	136,844	97,376	30,698	23,018	128,556	71,095	55,774
16	136,160	96,889	30,545	22,903	127,913	70,740	55,495
17	135,479	96,405	30,392	22,788	127,274	70,386	55,217
18	134,801	95,923	30,240	22,674	126,637	70,034	54,941
19	134,127	95,443	30,089	22,561	126,004	69,684	54,666
20	133,457	94,966	29,938	22,448	125,374	69,336	54,393

Year	Veterans Park	Allmendinger Park	Argo Canoe Livery	Gallup Park - Maas Shelter	Gallup Park - Fast Shelter	Gallup Park - Parking	Wheeler Service Center	Water Recovery Plant
1	50,264	5,729	6,665	5,935	7,071	114,557	381,957	172,484
2	50,013	5,701	6,632	5,905	7,035	113,985	380,047	171,622
3	49,763	5,672	6,599	5,876	7,000	113,415	378,147	170,763
4	49,514	5,644	6,566	5,846	6,965	112,848	376,256	169,910
5	49,266	5,616	6,533	5,817	6,930	112,283	374,375	169,060
6	49,020	5,588	6,500	5,788	6,896	111,722	372,503	168,215
7	48,775	5,560	6,468	5,759	6,861	111,163	370,640	167,374

Year	Veterans Park	Allmendinger Park	Argo Canoe Livery	Gallup Park - Maas Shelter	Gallup Park - Fast Shelter	Gallup Park - Parking	Wheeler Service Center	Water Recovery Plant
8	48,531	5,532	6,435	5,730	6,827	110,608	368,787	166,537
9	48,288	5,504	6,403	5,702	6,793	110,054	366,943	165,704
10	48,047	5,477	6,371	5,673	6,759	109,504	365,109	164,876
11	47,807	5,449	6,339	5,645	6,725	108,957	363,283	164,051
12	47,568	5,422	6,308	5,617	6,691	108,412	361,467	163,231
13	47,330	5,395	6,276	5,588	6,658	107,870	359,659	162,415
14	47,093	5,368	6,245	5,560	6,625	107,331	357,861	161,603
15	46,858	5,341	6,214	5,533	6,591	106,794	356,072	160,795
16	46,624	5,314	6,183	5,505	6,558	106,260	354,291	159,991
17	46,390	5,288	6,152	5,478	6,526	105,729	352,520	159,191
18	46,158	5,261	6,121	5,450	6,493	105,200	350,757	158,395
19	45,928	5,235	6,090	5,423	6,461	104,674	349,004	157,603
20	45,698	5,209	6,060	5,396	6,428	104,151	347,259	156,815

D.6 Battery Readiness

NOVA is proposing AC-coupled battery systems that can be installed at a future date. For most outdoor locations such park shelters and carports, there may not be a suitable temperature-controlled enclosed space to keep the battery. Commercial batteries available today are very sensitive to temperature and may not be able to operate in Michigan weather that may range from -20F to 120F over the year. Secondly load data is not available at this time to perform battery sizing calculations to determine the required battery power (kW) or energy (kWh). Keeping the batteries AC-coupled will allow the PV system installation to proceed with any inverter that is acceptable for the project without requiring battery compatibility. A control method will be required to ensure that the utility service, generator (if present), solar PV system, and battery can operate together properly with necessary safety procedures in place.

D.7 City Hall / Justice Center

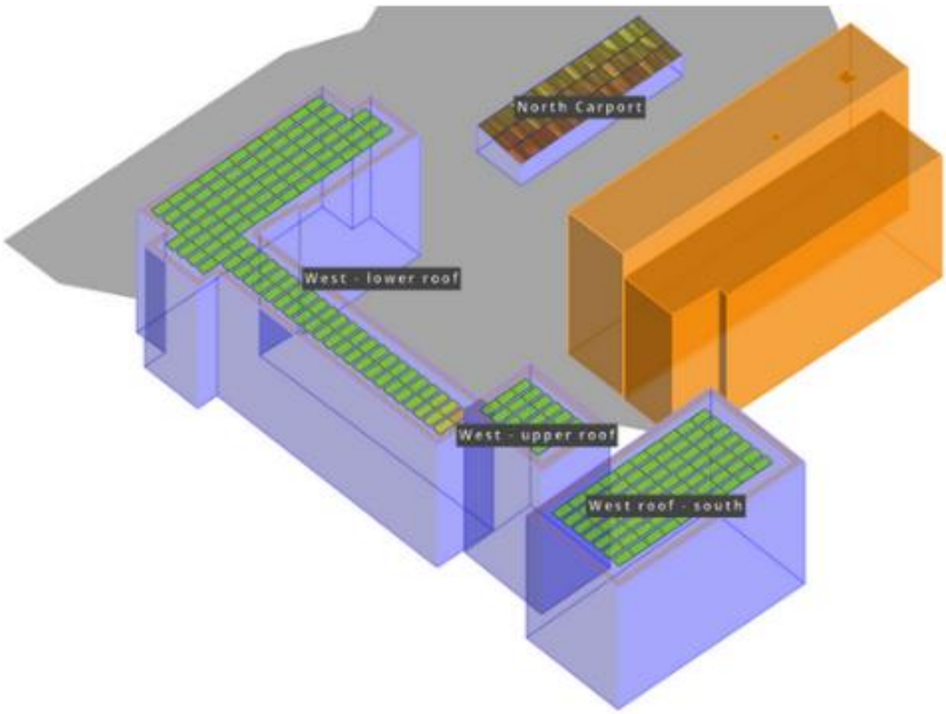
City guidance for PV system	Carport or Rooftop solar + storage
City estimate for system size	100 kW – 120 kW
Prorated 365-day site usage	3,027,270 kWh

NOVA proposal

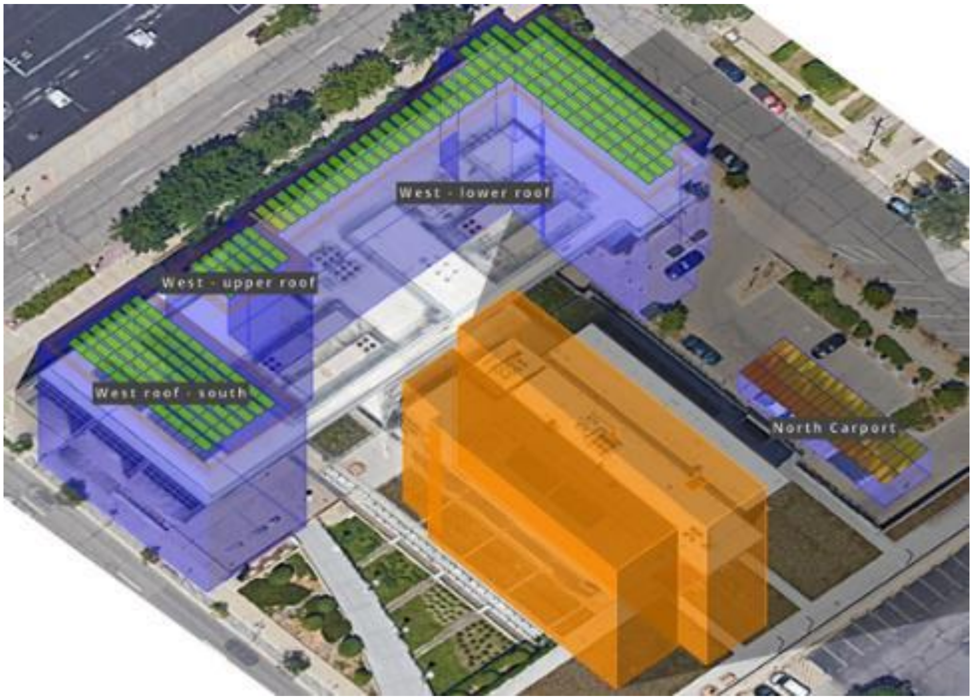
PV system type	Ballasted rooftop + future storage
DC size	111.8 kW
AC size	90 kW
Assumed site voltage	480V / 277V three phase
First year solar PV generation	146,791.9 kWh
DTE energy offset	4.8%

The proposed PV system size is consistent with that estimated by the City. NOVA is proposing a ballasted rooftop PV system for this location. No roof penetrations would be needed. It is likely that few roof attachments may be required due to building height and City Hall classification as critical infrastructure which requires a higher safety factor in the design calculations.

NOVA considered a carport for this location and modeled the location in 3D software. Modeling and simulation results indicate that the tall building will cause severe shading on the parking area which would result in significant production loss from the solar carport. Hence, the carport option is not being proposed at this location. Please see images below. The yellow to red shading of the canopy indicates the extent of production relative to unshaded areas.



Carport shaded by building, southwestern angle



Carport shaded by building, southeastern angle

Proposed layout for City Hall

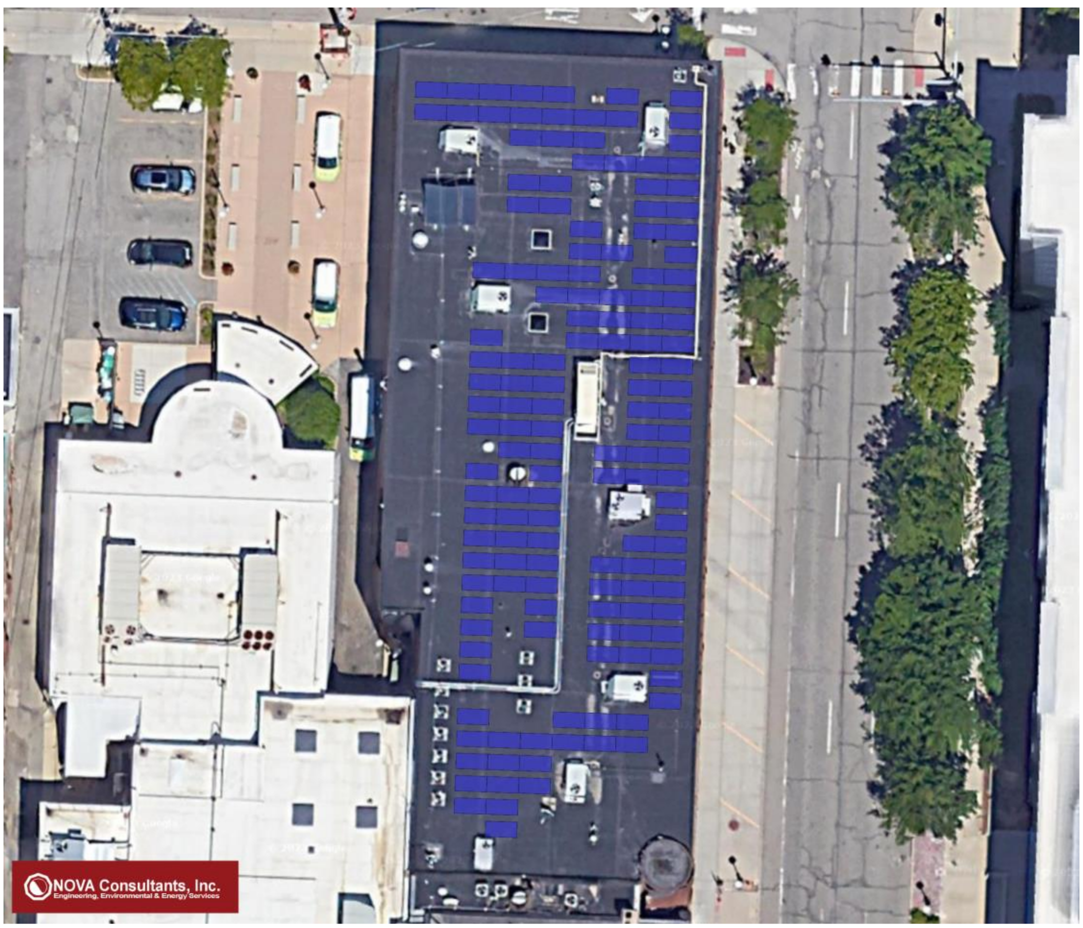
D.8 Ann Arbor Fire Station 1

City guidance for PV system	Rooftop + storage
City estimate for system size	120 kW – 150 kW
Prorated 365-day site usage	222,723 kWh

NOVA proposal

PV system type	Ballasted rooftop + future storage
DC size	79.9 kW
AC size	60 kW
Assumed site voltage	208V / 120V three phase
First year solar PV generation	104,455.2 kWh
DTE energy offset	46.9%

The proposed PV system size is smaller than the City estimate, primarily due to the presence of a gas line running north-south on the west side of the roof. This results in a loss of useable roof area for PV system installation.



Proposed layout for Fire Station 1

D.9 Ann Arbor Fire Station 3

City guidance for PV system	Ground + storage
City estimate for system size	50 kW – 80 kW
Prorated 365-day site usage	43,007 kWh

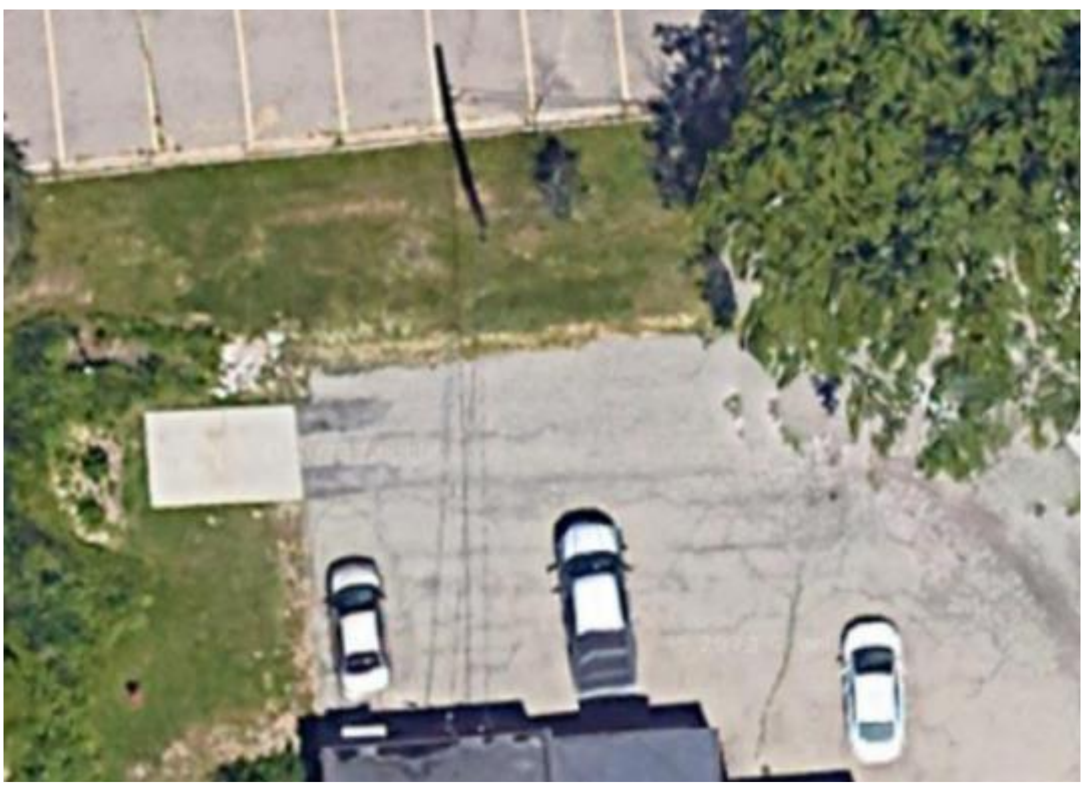
NOVA proposal

PV system type	Ballasted rooftop + future storage
DC size	25.4 kW
AC size	20 kW
Assumed site voltage	208V / 120V three phase
First year solar PV generation	32,929.8 kWh
DTE energy offset	76.6%

The proposed PV system is a rooftop system instead of a ground system as estimated by the City, due to lack of suitable ground space at the site. The front of the building has a flagpole and a tree that cause shade, while the rear portion has an overhead utility line. A solar PV system cannot be built beneath it due to utility easement and safety concerns.

Additionally, the rooftop area is insufficient to support a PV system of the size desired by the City. Please see images of the ground obstructions and the proposed rooftop layout below.

Flagpole and tree in front area



Overhead utility lines over the rear area

Proposed layout for Fire Station 3

D.10 Justice Center

As mentioned by the City in Addendum 1, the Justice Center and City Hall share the same electrical service and meter. Hence, this PV system is combined with City Hall as shown in Section D.7 above. The green roof is not being proposed for solar PV since the proposed PV system size is already consistent with City guidance.

D.11 Bryant Community Center

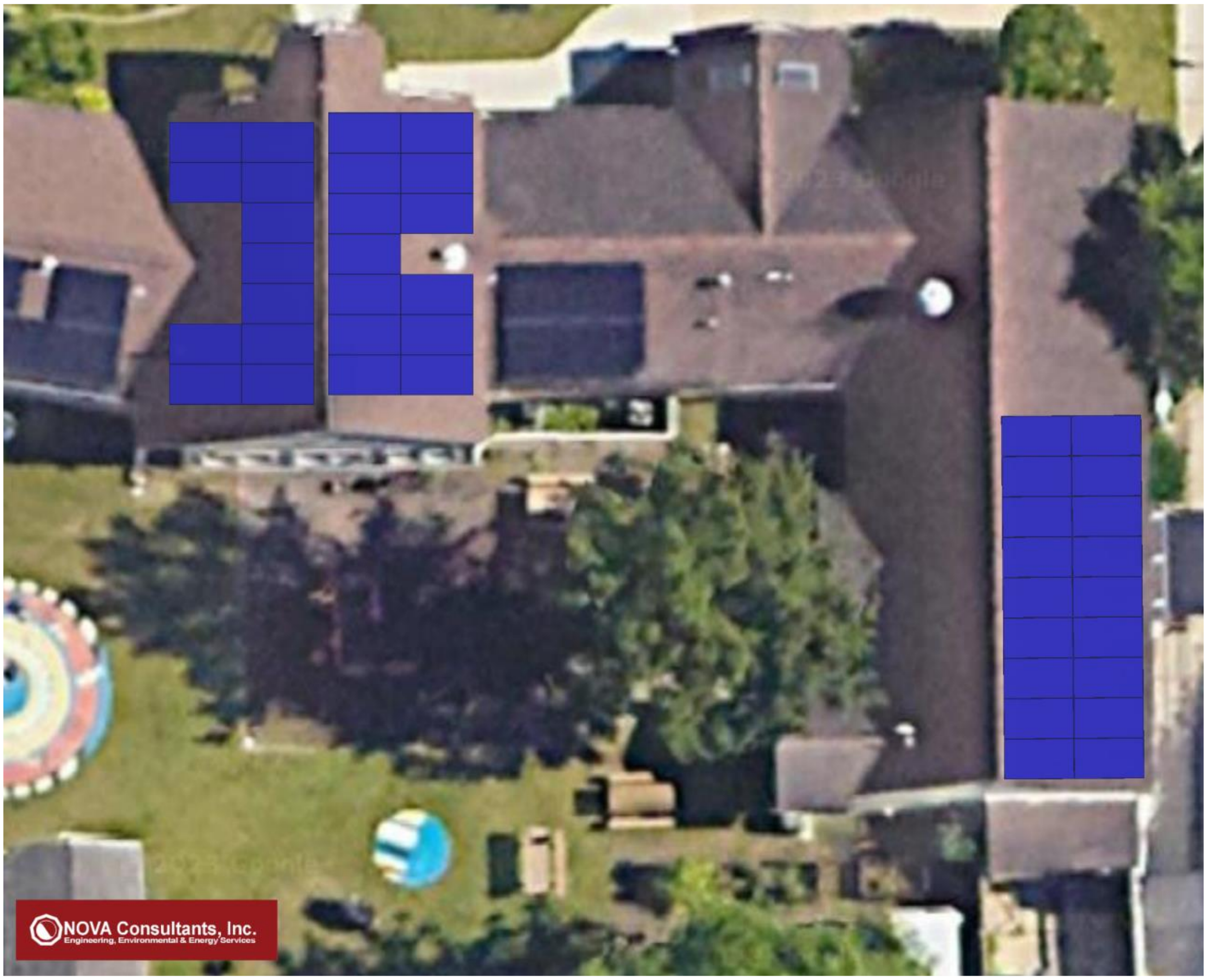
City guidance for PV system	Rooftop + storage
City estimate for system size	40 kW – 50 kW
Prorated 365-day site usage	42,301 kWh

NOVA proposal

PV system type	Attached flush mount rooftop + future storage
DC size	22.7 kW
AC size	17.6 kW
Assumed site voltage	240V / 120V single phase
First year solar PV generation	24,691.2 kWh
DTE energy offset	58.4%

The proposed PV system is smaller than that estimated by the City. The primary reason is lack of sufficient suitable roof space at the site. There appears to be an existing solar PV system, as well as several trees that may cause shading. Limited suitable rooftop areas are available, and have been selected for the proposed PV system. Please note the large trees around the roof in the image below. Since removal of trees is not an option under this RFP, the shaded areas were not considered for the installation of a solar PV system.

Some unobstructed roof areas are available on the north facing side of the roof. These roof areas are considered unsuitable for the installation of solar PV systems as these areas would receive limited sun due their north orientation.



Proposed layout for Bryant Community Center

D.12 Buhr Park

City guidance for PV system	Carport solar + EV Charger + storage
City estimate for system size	100 kW – 110 kW
Prorated 365-day site usage	306,712 kWh

NOVA proposal

PV system type	Carport solar + EV Charger + future storage
DC size	108 kW

AC size	90 kW
Assumed site voltage	240V / 120V single phase
First year solar PV generation	137,901.5 kWh
DTE energy offset	45%

The proposed PV system size is consistent with that estimated by the City. One EV charger will be installed beneath the carport. As advised by the City in Addendum 2, the EV charger will be Level 2 on a 40 A circuit. The single charger will be installed on a dual port pedestal so that a second charger can be installed at a later date on the same pedestal. **There is room for expansion using another carport.**

Proposed layout for Buhr Park

D.13 Southeast Area Park

City guidance for PV system	Carport solar + EV Charger + storage
City estimate for system size	50 kW – 60 kW
Prorated 365-day site usage	4,734 kWh

NOVA proposal

PV system type	Carport solar + EV Charger + future storage
DC size	58.3 kW
AC size	48 kW
Assumed site voltage	240V / 120V single phase
First year solar PV generation	76,263.8 kWh
DTE energy offset	1,611%

The proposed PV system size is consistent with that estimated by the City. **It is significantly oversized relative to existing usage.** One EV charger will be installed beneath the carport. As advised by the City in Addendum 2, the EV charger will be Level 2 on a 40 A circuit. The single charger will be installed on a dual port pedestal so that a second charger can be installed at a later date on the same pedestal.

Proposed layout for Southeast Area Park

D.14 West Park

City guidance for PV system	Carport solar + EV Charger + storage
City estimate for system size	20 kW – 50 kW
Prorated 365-day site usage	782 kWh

NOVA proposal

PV system type	Carport solar + EV Charger + future storage
DC size	48.6 kW
AC size	40 kW
Assumed site voltage	240V / 120V single phase
First year solar PV generation	59,828.1 kWh
DTE energy offset	7,649%

The proposed PV system size is consistent with that estimated by the City. **It is significantly oversized relative to existing usage.** One EV charger will be installed beneath the carport. As advised by the City in Addendum 2, the EV charger will be Level 2 on a 40 A circuit. The single charger will be installed on a dual port pedestal so that a second charger can be installed at a later date on the same pedestal.

Proposed layout for West Park

D.15 Veterans Park

City guidance for PV system	Carport solar + EV Charger + storage
City estimate for system size	20 kW – 40 kW
Prorated 365-day site usage	69,753 kWh

NOVA proposal

PV system type	Carport solar + EV Charger + future storage
DC size	38.9 kW
AC size	30 kW
Assumed site voltage	240V / 120V single phase
First year solar PV generation	50,264.2 kWh
DTE energy offset	72.1%

The proposed PV system size is consistent with that estimated by the City. One EV charger will be installed beneath the carport. As advised by the City in Addendum 2, the EV charger will be Level 2 on a 40 A circuit. The single charger will be installed on a dual port pedestal so that a second charger can be installed at a later date on the same pedestal. **There is room for expansion using a larger carport.**

Proposed layout for Veterans Park

D.16 Allmendinger Park

City guidance for PV system	Rooftop solar + storage
City estimate for system size	40 kW – 50 kW
Prorated 365-day site usage	2,119 kWh

NOVA proposal

PV system type	Rooftop solar + future storage

DC size	4.32 kW
AC size	3.8 kW
Assumed site voltage	240V / 120V single phase
First year solar PV generation	5,729.4 kWh
DTE energy offset	270%

The proposed PV system size is significantly smaller than that estimated by the City, but **significantly oversized relative to existing usage.** The City has requested a rooftop solar PV system, but there is insufficient suitable rooftop area for a PV system of the requested size.

Proposed layout for Allmendinger Park

D.17 Argo Canoe Livery

City guidance for PV system	Rooftop solar + storage
City estimate for system size	40 kW – 50 kW
Prorated 365-day site usage	4,710 kWh

NOVA proposal

PV system type	Rooftop solar + future storage
DC size	5.94 kW
AC size	5 kW
Assumed site voltage	240V / 120V single phase
First year solar PV generation	6,665.3 kWh
DTE energy offset	142%

The proposed PV system size is significantly smaller than that estimated by the City, but **significantly oversized relative to existing usage.** The City has requested a rooftop solar PV system, but there is insufficient suitable rooftop area for a PV system of the requested size. Solar panels will be installed on two sides of the roof as shown in the image below.

Proposed layout for Argo Canoe Livery

D.18 Gallup Park Maas Shelter

City guidance for PV system	Rooftop solar
City estimate for system size	5 kW – 10 kW
Prorated 365-day site usage	No data available

NOVA proposal

PV system type	Rooftop solar
DC size	6.48 kW
AC size	5 kW
Assumed site voltage	240V / 120V single phase
First year solar PV generation	5,791.9 kWh
DTE energy offset	No data available

The proposed PV system size is consistent with that estimated by the City. Solar panels will be installed on three sides of the roof as shown below.

Proposed layout for Gallup Park – Maas Shelter

D.19 Gallup Park Fast Shelter

City guidance for PV system	Rooftop solar
City estimate for system size	5 kW – 10 kW
Prorated 365-day site usage	No data available

NOVA proposal

PV system type	Rooftop solar

DC size	6.48 kW
AC size	6 kW
Assumed site voltage	240V / 120V single phase
First year solar PV generation	7,070.6 kWh
DTE energy offset	No data available

The proposed PV system size is consistent with that estimated by the City. Solar panels will be installed on three sides of the roof as shown below.

Proposed layout for Gallup Park – Fast Shelter

D.20 Gallup Park Parking Area

City guidance for PV system	Carport solar + EV Chargers + Storage
City estimate for system size	70 kW – 80 kW
Prorated 365-day site usage	No data available

NOVA proposal

PV system type	Carport solar + EV chargers + future storage
DC size	90.7 kW
AC size	75 kW
Assumed site voltage	240V / 120V single phase
First year solar PV generation	114,557.4 kWh
DTE energy offset	No data available

The proposed PV system size is larger than that estimated by the City. This park appears to have significant usage based on aerial images of the parking lot. Hence, NOVA is proposing increasing the size of this carport to offset the size decreases at other sites and compensate for the loss of renewable energy capacity. Secondly, a carport of this size will cover the entire row of parking spaces which would be aesthetically pleasing. **There is room for expansion by adding more carports.**

One EV charger will be installed beneath the carport. As advised by the City in Addendum 2, the EV charger will be Level 2 on a 40 A circuit. The single charger will be installed on a dual port pedestal so that a second charger can be installed at a later date on the same pedestal.

Proposed layout for Gallup Park – Parking Area

D.21 Wheeler Service Center

City guidance for PV system	Carport solar + EV Chargers + Storage
City estimate for system size	50 kW – 300 kW
Prorated 365-day site usage	1,766,352 kWh

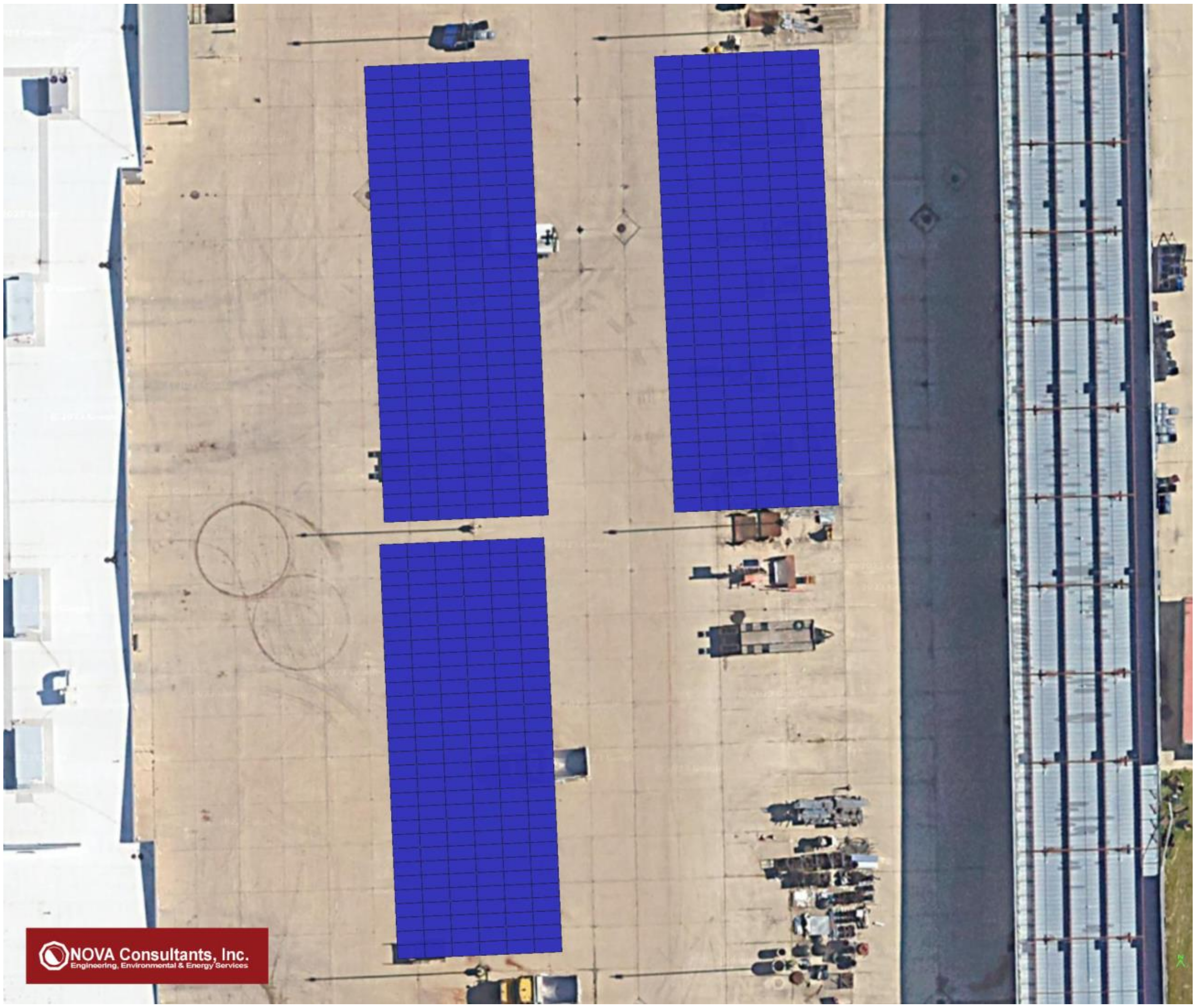
NOVA proposal

PV system type	Carport solar + EV chargers + future storage

DC size	311 kW
AC size	255 kW
Assumed site voltage	480V / 277V single phase
First year solar PV generation	381,956.9 kWh
DTE energy offset	21.6%

The proposed PV system size is slightly larger than that estimated by the City. NOVA is proposing increasing the size of this carport to offset the size decreases at other sites and compensate for the loss of renewable energy capacity. Secondly, a carport of this size will cover the entire row of parking spaces between existing light poles which would be aesthetically pleasing. **There is significant room for expansion by the addition of more carports.**

One EV charger will be installed beneath one of the carports. As advised by the City in Addendum 2, the EV charger will be Level 2 on a 40 A circuit. The single charger will be installed on a dual port pedestal so that a second charger can be added at a later date.



Proposed layout for Wheeler Center

D.22 Water Recovery Plant

City guidance for PV system	Rooftop solar+carport solar+EV Chargers+Storage
City estimate for system size	60 kW – 70 kW
Prorated 365-day site usage	12,489,551 kWh

NOVA proposal

PV system type	Rooftop solar+carport solar+EV charger+future storage

DC size	101 kW
AC size	75 kW
Assumed site voltage	480V / 277V single phase
First year solar PV generation	127,483.7 kWh
DTE energy offset	1.0%

The proposed PV system size is slightly larger than that estimated by the City. NOVA is proposing increasing the size of this carport to offset the size decreases at other sites and compensate for the loss of renewable energy capacity. Secondly, a carport of this size will cover the entire row of parking spaces which would be aesthetically pleasing. One EV charger will be installed beneath the carport. As advised by the City in Addendum 2, the EV charger will be Level 2 on a 40 A circuit. The single charger will be installed on a dual port pedestal so that a second charger can be added at a later date. **There is significant room for expansion.**

Proposed layout for Water Recovery Center

E. FEE PROPOSAL

The fee proposal is provided in separate envelope as requested.

F. AUTHORIZED NEGOTIATOR

Person authorized to receive and sign a resulting contract and / or subsequent assignment(s):

Sunil Agrawal, *PhD, PE.*
President
NOVA Consultants, Inc.
21580 Novi Road, Suite 300
Novi, MI 48375

sunil.agrawal@novaconsultants.com
Office: 248-347-3512
Cell: 248-866-1476

G. ATTACHMENTS

The requested forms are filled out completely and attached as requested.

Attachment 2 – Helioscope Reports

Proposed City of Ann Arbor - City Hall / Justice Center, 301 E. Huron St. Ann Arbor, MI 48104

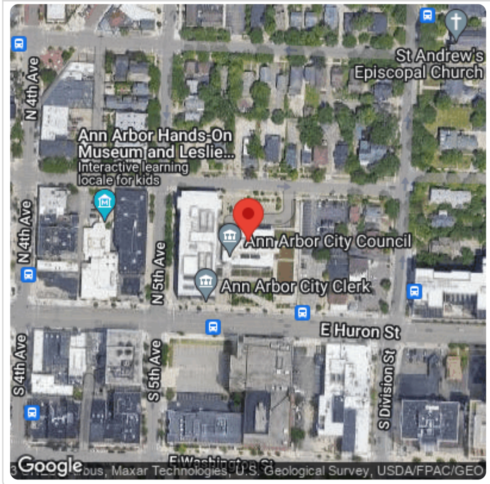
Report

Project Name	City of Ann Arbor - City Hall / Justice Center
Project Address	301 E. Huron St. Ann Arbor, MI 48104
Prepared By	Sachit Verma sachit.verma@novaconsultants.com

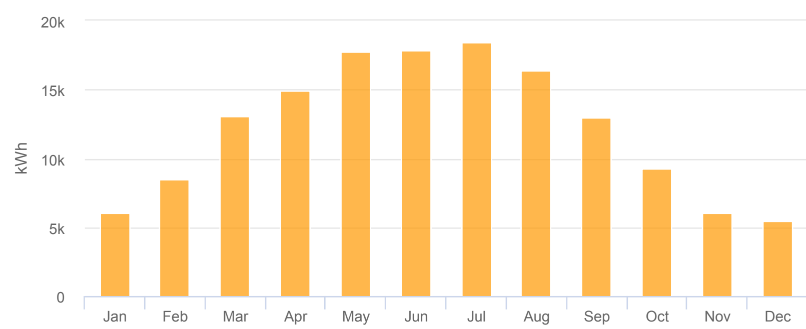
System Metrics

Design	Proposed
Module DC Nameplate	111.8 kW
Inverter AC Nameplate	90.0 kW Load Ratio: 1.24
Annual Production	146.8 MWh
Performance Ratio	85.1%
kWh/kWp	1,313.2
Weather Dataset	TMY, 10km grid (42.25,-83.75), NREL (prospector)
Simulator Version	06c4414b94-fb80585900-1d3828b8b5-c6b0074249

Project Location

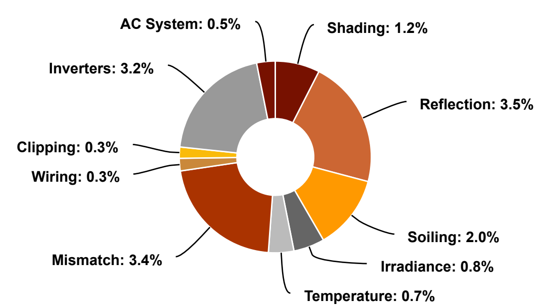


Monthly Production



Month	GHI (kWh/m^2)	POA (kWh/m^2)	Shaded (kWh/m^2)	Nameplate (kWh)	Grid (kWh)
January	51.5	63.0	60.7	6,310.2	6,084.1
February	72.7	85.4	84.0	8,791.5	8,500.9
March	118.7	131.3	130.1	13,728.1	13,104.4
April	145.3	153.6	152.5	16,178.6	14,894.2
May	182.0	187.0	185.6	19,729.7	17,738.8
June	188.1	191.4	190.0	20,214.1	17,900.7
July	193.7	197.7	196.3	20,862.3	18,406.1
August	168.0	176.3	175.1	18,598.9	16,398.0
September	126.1	138.1	137.1	14,524.4	12,966.2
October	85.5	97.1	96.1	10,107.4	9,274.6
November	53.3	63.9	62.1	6,492.4	6,041.2
December	47.0	59.1	55.6	5,780.0	5,482.7

Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,432.0	
	POA Irradiance	1,543.8	7.8%
	Shaded Irradiance	1,525.3	-1.2%
	Irradiance after Reflection	1,472.6	-3.5%
	Irradiance after Soiling	1,443.2	-2.0%
	Total Collector Irradiance	**1,443.1**	**0.0%**
Energy (kWh)	Nameplate	161,317.4	
	Output at Irradiance Levels	159,972.6	-0.8%
	Output at Cell Temperature Derate	158,876.7	-0.7%
	Output After Mismatch	153,424.6	-3.4%
	Optimal DC Output	152,904.7	-0.3%

Condition Set

Description	Condition Set 1											
Weather Dataset	TMY, 10km grid (42.25,-83.75), NREL (prospector)											
Solar Angle Location	Meteo Lat/Lng											
Transposition Model	Perez Model											
Temperature Model	Sandia Model											
Temperature Model Parameters	Rack Type	a	b	Temperature Delta								
	Fixed Tilt	-3.56	-0.075	3°C								
	Flush Mount	-2.81	-0.0455	0°C								
	East-West	-3.56	-0.075	3°C								
	Carport	-3.56	-0.075	3°C								
Soiling (%)	J	F	M	A	M	J	J	A	S	O	N	D

	Constrained DC Output	152,442.7	-0.3%
	Inverter Output	147,529.5	-3.2%
	Energy to Grid	**146,791.9**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		11.1 °C
	Avg. Operating Cell Temp		18.4 °C
Simulation Metrics			
	Operating Hours		4641
	Solved Hours		4641

	2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5%		
Cell Temperature Spread	4° C		
Module Binning Range	-2.5% to 2.5%		
AC System Derate	0.50%		
Trackers	Maximum Angle	Backtracking	
	60°	Enabled	
Module Characterizations	Module	Uploaded By	Characterization
	JAM72S30-540/MR (1000V) (JA Solar)	HelioScope	Spec Sheet Characterization, PAN
Component Characterizations	Device	Uploaded By	Characterization
	Fronius Symo 10.0-3 (480V) (Fronius USA)	HelioScope	CEC 2014-08-16
	Fronius Symo 12.5-3 (480V) (Fronius USA)	HelioScope	CEC 2014-08-16
	Symo Advanced 15.0-3 / 480_OND (Fronius USA)	HelioScope	Default Characterization

Components

Component	Name	Count
Inverters	Symo Advanced 15.0-3 / 480_OND (Fronius USA)	6 (90.0 kW)
Strings	10 AWG (Copper)	15 (1,179.5 ft)
Module	JA Solar, JAM72S30-540/MR (1000V) (540W)	207 (111.8 kW)

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Rooftop	-	5-17	Along Racking
Carport	-	-	Along Racking
Green roof	-	-	Along Racking
Middle bldg roof	-	-	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
West - lower roof	Fixed Tilt	Landscape (Horizontal)	10°	181.9°	1.6 ft	1x1	119	119	64.3 kW
West - upper roof	Fixed Tilt	Landscape (Horizontal)	10°	182°	1.6 ft	1x1	18	18	9.72 kW
West roof - south	Fixed Tilt	Landscape (Horizontal)	10°	182°	1.6 ft	1x1	70	70	37.8 kW

Detailed Layout

Design 1 City of Ann Arbor - Fire Station 1, 111 North 5th Avenue, Ann Arbor, Michigan, 48104

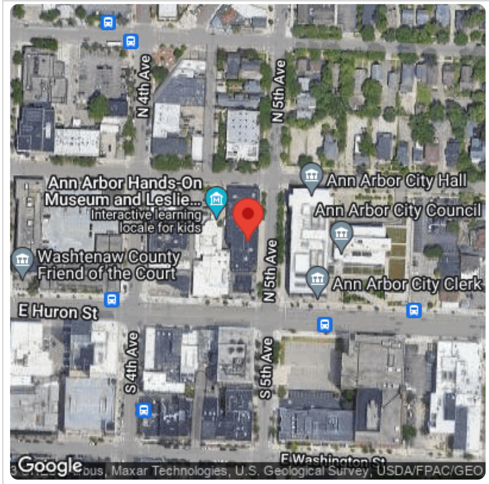
Report

Project Name	City of Ann Arbor - Fire Station 1
Project Address	111 North 5th Avenue, Ann Arbor, Michigan, 48104
Prepared By	Sachit Verma sachit.verma@novaconsultants.com

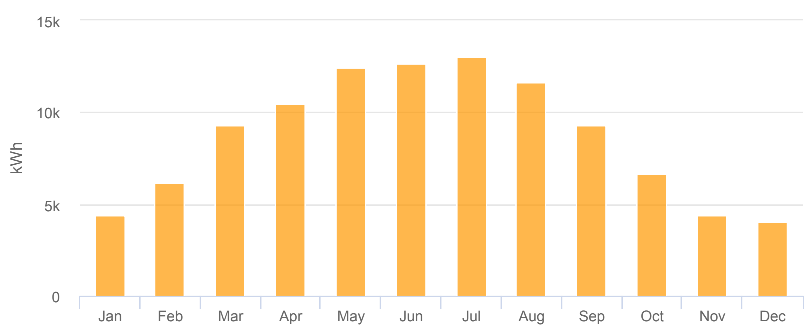
System Metrics

Design	Design 1
Module DC Nameplate	79.9 kW
Inverter AC Nameplate	60.0 kW Load Ratio: 1.33
Annual Production	104.5 MWh
Performance Ratio	84.7%
kWh/kWp	1,307.0
Weather Dataset	TMY, 10km grid (42.25,-83.75), NREL (prospector)
Simulator Version	06c4414b94-fb80585900-1d3828b8b5-c6b0074249

Project Location

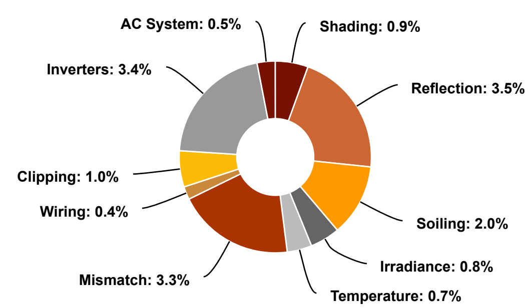


Monthly Production



Month	GHI (kWh/m²)	POA (kWh/m²)	Shaded (kWh/m²)	Nameplate (kWh)	Grid (kWh)
January	51.5	63.0	61.2	4,549.4	4,422.6
February	72.7	85.4	84.5	6,324.0	6,144.7
March	118.7	131.3	130.5	9,842.4	9,320.7
April	145.3	153.6	152.7	11,583.3	10,485.4
May	182.0	187.0	185.9	14,125.8	12,456.3
June	188.1	191.4	190.3	14,472.4	12,622.2
July	193.7	197.7	196.6	14,935.8	13,016.1
August	168.0	176.3	175.3	13,315.5	11,659.1
September	126.1	138.1	137.4	10,401.8	9,259.9
October	85.5	97.1	96.5	7,256.3	6,672.4
November	53.3	63.9	62.6	4,678.5	4,385.6
December	47.0	59.1	56.2	4,175.8	4,010.2

Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m²)	Annual Global Horizontal Irradiance	1,432.0	
	POA Irradiance	1,543.8	7.8%
	Shaded Irradiance	1,529.7	-0.9%
	Irradiance after Reflection	1,476.6	-3.5%
	Irradiance after Soiling	1,447.0	-2.0%
	Total Collector Irradiance	**1,447.0**	**0.0%**
Energy (kWh)	Nameplate	115,661.1	
	Output at Irradiance Levels	114,702.7	-0.8%
	Output at Cell Temperature Derate	113,919.9	-0.7%
	Output After Mismatch	110,217.4	-3.3%
	Optimal DC Output	109,822.2	-0.4%

Condition Set

Description	Condition Set 1
Weather Dataset	TMY, 10km grid (42.25,-83.75), NREL (prospector)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.075	3°C
Flush Mount	-2.81	-0.0455	0°C
East-West	-3.56	-0.075	3°C
Carport	-3.56	-0.075	3°C

Soiling (%)	J	F	M	A	M	J	J	A	S	O	N	D

	Constrained DC Output	108,719.5	-1.0%
	Inverter Output	104,980.1	-3.5%
	Energy to Grid	**104,455.2**	**-0.5%**

Temperature Metrics	
Avg. Operating Ambient Temp	11.1 °C
Avg. Operating Cell Temp	18.4 °C

Simulation Metrics	
Operating Hours	4641
Solved Hours	4641

	2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5%
Cell Temperature Spread	4° C
Module Binning Range	-2.5% to 2.5%
AC System Derate	0.50%

Trackers		
	Maximum Angle	Backtracking
	60°	Enabled

Module Characterizations			
	Module	Uploaded By	Characterization
	JAM72S30-540/MR (1000V) (JA Solar)	HelioScope	Spec Sheet Characterization, PAN

Component Characterizations			
	Device	Uploaded By	Characterization
	Symo Advanced 15.0-3 / 480_OND (Fronius USA)	HelioScope	Default Characterization

Components

Component	Name	Count
Inverters	Symo Advanced 15.0-3 / 480_OND (Fronius USA)	4 (60.0 kW)
Strings	10 AWG (Copper)	12 (835.5 ft)
Module	JA Solar, JAM72S30-540/MR (1000V) (540W)	148 (79.9 kW)

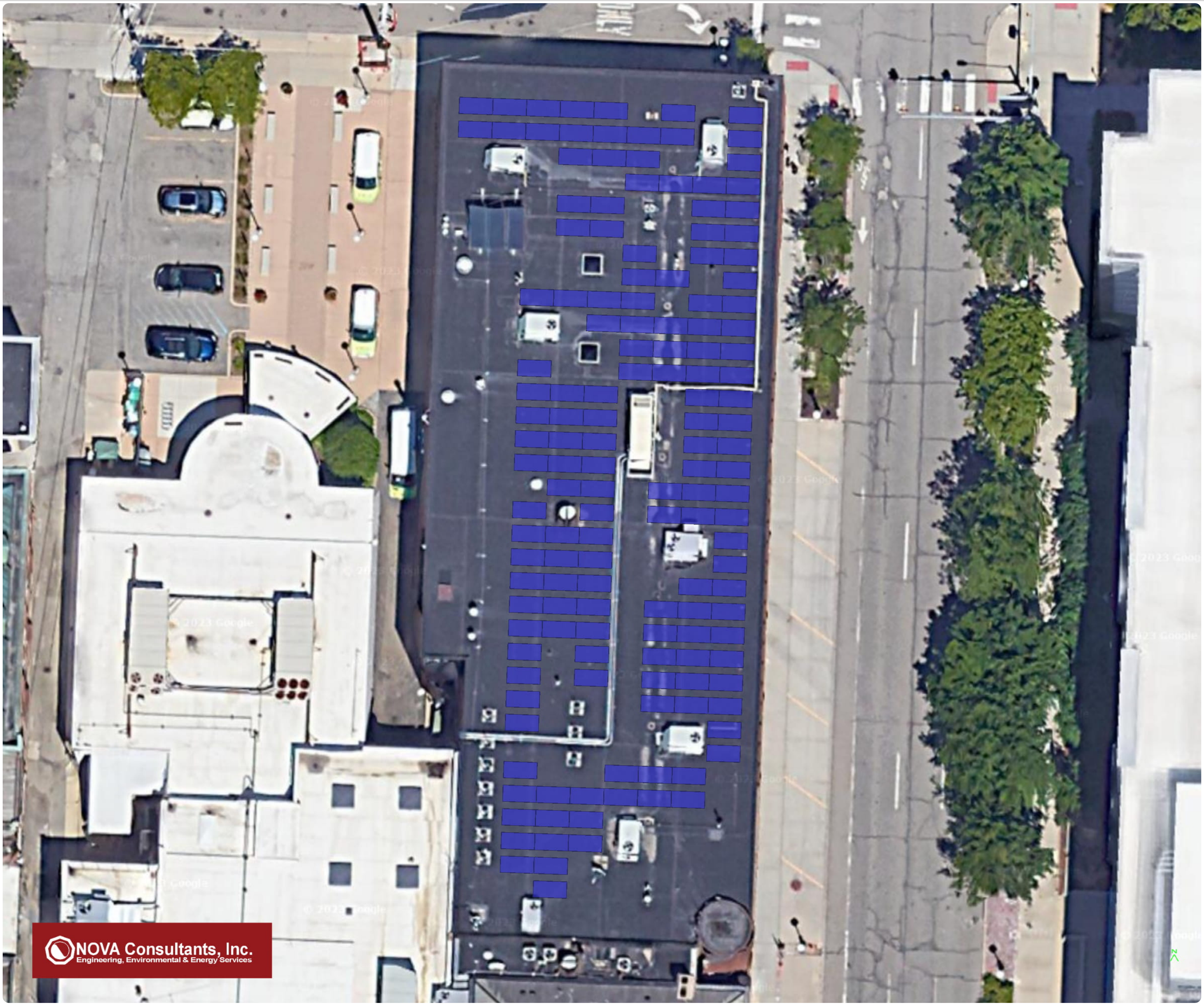
Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	-	5-17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Fixed Tilt	Landscape (Horizontal)	10°	182°	1.6 ft	1x1	148	148	79.9 kW

Detailed Layout



Design 1 City of Ann Arbor - Fire Station 3, 2130 Jackson Ave., Ann Arbor, MI 48103

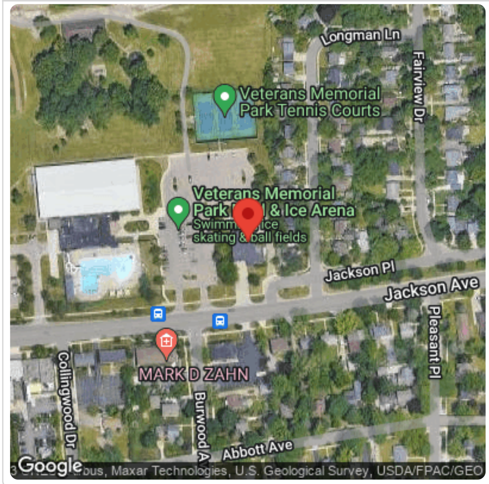
Report

Project Name	City of Ann Arbor - Fire Station 3
Project Address	2130 Jackson Ave., Ann Arbor, MI 48103
Prepared By	Sachit Verma sachit.verma@novaconsultants.com

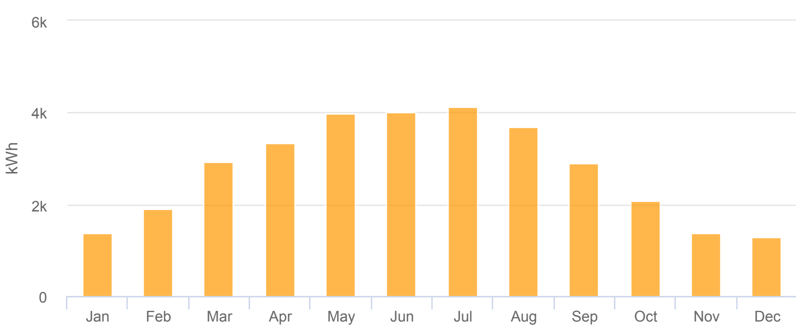
System Metrics

Design	Design 1
Module DC Nameplate	25.4 kW
Inverter AC Nameplate	20.0 kW Load Ratio: 1.27
Annual Production	32.93 MWh
Performance Ratio	84.1%
kWh/kWp	1,297.5
Weather Dataset	TMY, 10km grid (42.25,-83.75), NREL (prospector)
Simulator Version	06c4414b94-fb80585900-1d3828b8b5-c6b0074249

Project Location

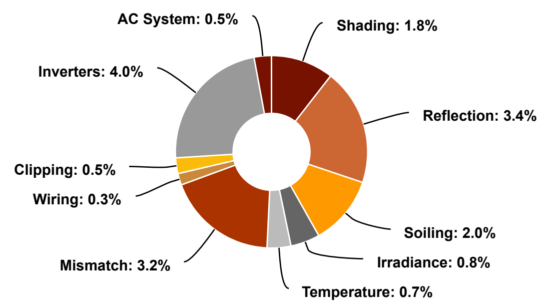


Monthly Production



Month	GHI (kWh/m²)	POA (kWh/m²)	Shaded (kWh/m²)	Nameplate (kWh)	Grid (kWh)
January	51.5	63.0	59.8	1,413.0	1,361.0
February	72.7	85.4	83.3	1,982.8	1,914.9
March	118.7	131.1	128.6	3,083.3	2,912.3
April	145.3	153.7	151.6	3,655.3	3,329.6
May	182.0	187.1	185.0	4,468.1	3,982.8
June	188.1	191.5	189.4	4,578.8	4,020.1
July	193.7	197.7	195.2	4,713.8	4,117.5
August	168.0	176.2	174.0	4,199.9	3,674.2
September	126.1	138.1	136.0	3,273.1	2,891.0
October	85.5	97.1	95.1	2,274.6	2,078.7
November	53.3	63.7	61.8	1,466.6	1,373.2
December	47.0	59.0	56.0	1,321.7	1,274.7

Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m²)	Annual Global Horizontal Irradiance	1,432.0	
	POA Irradiance	1,543.7	7.8%
	Shaded Irradiance	1,515.8	-1.8%
	Irradiance after Reflection	1,464.8	-3.4%
	Irradiance after Soiling	1,435.5	-2.0%
	Total Collector Irradiance	**1,435.3**	**0.0%**
Energy (kWh)	Nameplate	36,430.8	
	Output at Irradiance Levels	36,123.9	-0.8%
	Output at Cell Temperature Derate	35,875.8	-0.7%
	Output After Mismatch	34,729.6	-3.2%
	Optimal DC Output	34,614.3	-0.3%

Condition Set

Description	Condition Set 1
Weather Dataset	TMY, 10km grid (42.25,-83.75), NREL (prospector)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.075	3°C
Flush Mount	-2.81	-0.0455	0°C
East-West	-3.56	-0.075	3°C
Carport	-3.56	-0.075	3°C

Soiling (%)	J	F	M	A	M	J	J	A	S	O	N	D

	Constrained DC Output	34,457.6	-0.5%
	Inverter Output	33,095.3	-4.0%
	Energy to Grid	**32,929.8**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		11.1 °C
	Avg. Operating Cell Temp		18.3 °C
Simulation Metrics			
	Operating Hours		4641
	Solved Hours		4641

	2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5%		
Cell Temperature Spread	4° C		
Module Binning Range	-2.5% to 2.5%		
AC System Derate	0.50%		
Trackers	**Maximum Angle**	**Backtracking**	
	60°	Enabled	
Module Characterizations	**Module**	**Uploaded By**	**Characterization**
	JAM72S30-540/MR (1000V) (JA Solar)	HelioScope	Spec Sheet Characterization, PAN
Component Characterizations	**Device**	**Uploaded By**	**Characterization**
	Symo Advanced 10.0-3 / 208_OND (Fronius USA)	HelioScope	Default Characterization

Components

Component	Name	Count
Inverters	Symo Advanced 10.0-3 / 208_OND (Fronius USA)	2 (20.0 kW)
Strings	10 AWG (Copper)	6 (226.3 ft)
Module	JA Solar, JAM72S30-540/MR (1000V) (540W)	47 (25.4 kW)

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	-	5-10	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
West roof	Fixed Tilt	Landscape (Horizontal)	10°	175°	1.6 ft	1x1	19	19	10.3 kW
East roof	Fixed Tilt	Landscape (Horizontal)	10°	175°	1.6 ft	1x1	28	28	15.1 kW

Detailed Layout

Design 1 City of Ann Arbor - Bryant Community Center, 3 W Eden Ct, Ann Arbor, MI 48108

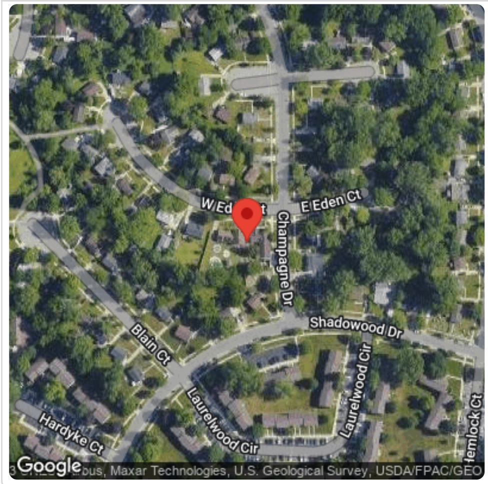
Report

Project Name	City of Ann Arbor - Bryant Community Center
Project Address	3 W Eden Ct, Ann Arbor, MI 48108
Prepared By	Sachit Verma sachit.verma@novaconsultants.com

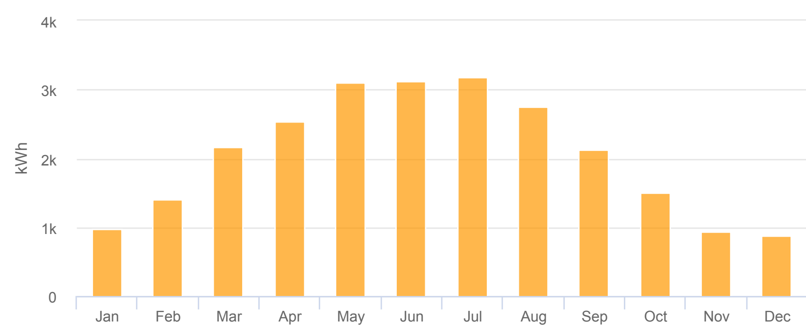
System Metrics

Design	Design 1
Module DC Nameplate	22.7 kW
Inverter AC Nameplate	17.6 kW Load Ratio: 1.29
Annual Production	24.69 MWh
Performance Ratio	79.5%
kWh/kWp	1,088.7
Weather Dataset	TMY, 10km grid (42.25,-83.75), NREL (prospector)
Simulator Version	06c4414b94-fb80585900-1d3828b8b5-c6b0074249

Project Location

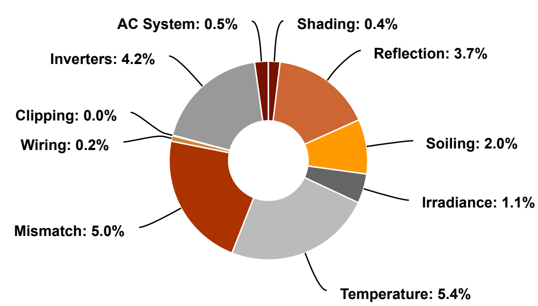


Monthly Production



Month	GHI (kWh/m^2)	POA (kWh/m^2)	Shaded (kWh/m^2)	Nameplate (kWh)	Grid (kWh)
January	51.5	50.9	50.5	1,062.1	979.9
February	72.7	72.4	72.0	1,524.9	1,401.3
March	118.7	113.9	113.3	2,419.7	2,166.5
April	145.3	138.7	138.0	2,965.2	2,541.2
May	182.0	172.8	172.4	3,712.9	3,099.1
June	188.1	178.9	178.3	3,848.0	3,128.9
July	193.7	183.3	182.6	3,936.3	3,176.3
August	168.0	158.2	157.6	3,387.4	2,742.8
September	126.1	121.0	120.5	2,584.0	2,135.3
October	85.5	81.8	81.4	1,730.3	1,497.9
November	53.3	50.5	50.3	1,055.3	940.7
December	47.0	46.4	46.1	961.9	881.1

Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,432.0	
	POA Irradiance	1,368.8	-4.4%
	Shaded Irradiance	1,363.0	-0.4%
	Irradiance after Reflection	1,312.9	-3.7%
	Irradiance after Soiling	1,286.6	-2.0%
	Total Collector Irradiance	**1,286.7**	**0.0%**
Energy (kWh)	Nameplate	29,188.0	
	Output at Irradiance Levels	28,874.5	-1.1%
	Output at Cell Temperature Derate	27,316.8	-5.4%
	Output After Mismatch	25,956.8	-5.0%
	Optimal DC Output	25,904.9	-0.2%

Condition Set

Description	Condition Set 1
Weather Dataset	TMY, 10km grid (42.25,-83.75), NREL (prospector)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters			
Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.075	3°C
Flush Mount	-2.81	-0.0455	0°C
East-West	-3.56	-0.075	3°C
Carport	-3.56	-0.075	3°C

Soiling (%)	J	F	M	A	M	J	J	A	S	O	N	D

	Constrained DC Output	25,899.0	0.0%
	Inverter Output	24,815.3	-4.2%
	Energy to Grid	**24,691.2**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		11.1 °C
	Avg. Operating Cell Temp		24.7 °C
Simulation Metrics			
	Operating Hours		4641
	Solved Hours		4641

	2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5%		
Cell Temperature Spread	4° C		
Module Binning Range	-2.5% to 2.5%		
AC System Derate	0.50%		
Trackers	**Maximum Angle**	**Backtracking**	
	60°	Enabled	
Module Characterizations	**Module**	**Uploaded By**	**Characterization**
	JAM72S30-540/MR (1000V) (JA Solar)	HelioScope	Spec Sheet Characterization, PAN
Component Characterizations	**Device**	**Uploaded By**	**Characterization**
	Fronius Primo 7.6-1 (240V) (Fronius USA)	HelioScope	CEC 2014-08-16
	Primo 10.0-1 / 240_OND (Fronius USA)	HelioScope	Default Characterization

Components

Component	Name	Count
Inverters	Fronius Primo 7.6-1 (240V) (Fronius USA)	1 (7.60 kW)
Inverters	Primo 10.0-1 / 240_OND (Fronius USA)	1 (10.00 kW)
Strings	10 AWG (Copper)	4 (109.8 ft)
Module	JA Solar, JAM72S30-540/MR (1000V) (540W)	42 (22.7 kW)

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
West	-	2-17	Along Racking
East	-	7-17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Flush Mount	Portrait (Vertical)	26°	270°	0.0 ft	1x1	11	11	5.94 kW
Field Segment 2	Flush Mount	Portrait (Vertical)	26°	90°	0.0 ft	1x1	13	13	7.02 kW
Field Segment 3	Flush Mount	Portrait (Vertical)	30°	89.5°	0.0 ft	1x1	18	18	9.72 kW

Detailed Layout

Design 1 City of Ann Arnor - Buhr Park, 2751 Packard St, Ann Arbor, MI 48104

Report

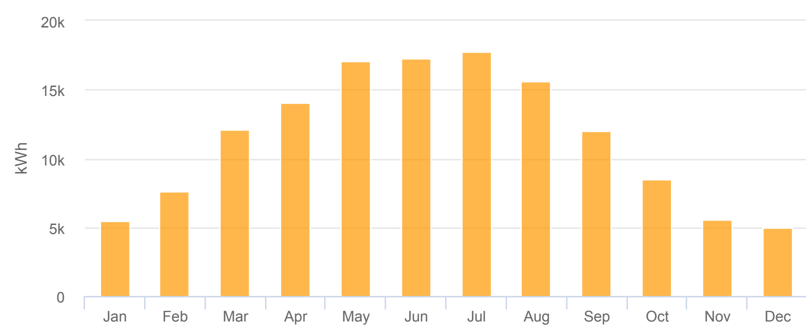
Project Name	City of Ann Arnor - Buhr Park
Project Address	2751 Packard St, Ann Arbor, MI 48104
Prepared By	Sachit Verma sachit.verma@novaconsultants.com

System Metrics

Design	Design 1
Module DC Nameplate	108.0 kW
Inverter AC Nameplate	90.0 kW Load Ratio: 1.20
Annual Production	137.9 MWh
Performance Ratio	86.2%
kWh/kWp	1,276.9
Weather Dataset	TMY, 10km grid (42.25,-83.75), NREL (prospector)
Simulator Version	3f06082235-dbb59b10a7-3d838af5f5-ec3db6ed90

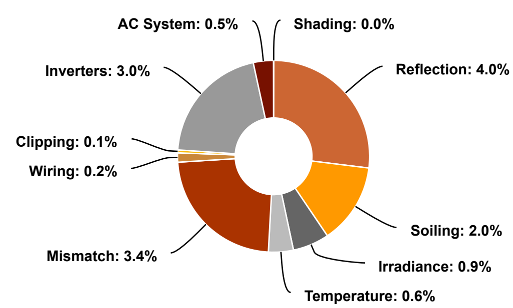
Project Location

Monthly Production



Month	GHI (kWh/m^2)	POA (kWh/m^2)	Shaded (kWh/m^2)	Nameplate (kWh)	Grid (kWh)
January	51.5	56.7	56.7	5,619.4	5,480.0
February	72.7	78.0	78.0	7,810.2	7,617.4
March	118.7	124.7	124.7	12,640.9	12,143.4
April	145.3	148.6	148.6	15,172.0	14,080.3
May	182.0	183.7	183.7	18,799.5	17,076.9
June	188.1	189.0	189.0	19,371.0	17,250.8
July	193.7	195.6	195.6	20,024.7	17,723.3
August	168.0	172.2	172.2	17,615.5	15,563.7
September	126.1	131.3	131.3	13,368.9	11,965.6
October	85.5	91.0	91.0	9,180.1	8,464.5
November	53.3	58.8	58.8	5,870.5	5,518.0
December	47.0	52.6	52.6	5,195.4	5,017.7

Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,432.0	
	POA Irradiance	1,482.1	3.5%
	Shaded Irradiance	1,482.0	0.0%
	Irradiance after Reflection	1,423.4	-4.0%
	Irradiance after Soiling	1,394.9	-2.0%
	Total Collector Irradiance	**1,394.9**	**0.0%**
Energy (kWh)	Nameplate	150,668.1	
	Output at Irradiance Levels	149,313.1	-0.9%
	Output at Cell Temperature Derate	148,387.9	-0.6%
	Output After Mismatch	143,342.0	-3.4%
	Optimal DC Output	143,010.8	-0.2%

Condition Set

Description	Condition Set 1
Weather Dataset	TMY, 10km grid (42.25,-83.75), NREL (prospector)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.075	3°C
Flush Mount	-2.81	-0.0455	0°C
East-West	-3.56	-0.075	3°C
Carport	-3.56	-0.075	3°C

Soiling (%)	J	F	M	A	M	J	J	A	S	O	N	D

	Constrained DC Output	142,907.7	-0.1%
	Inverter Output	138,594.5	-3.0%
	Energy to Grid	**137,901.5**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		11.1 °C
	Avg. Operating Cell Temp		18.1 °C
Simulation Metrics			
	Operating Hours		4641
	Solved Hours		4641

	2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5%		
Cell Temperature Spread	4° C		
Module Binning Range	-2.5% to 2.5%		
AC System Derate	0.50%		
Trackers	Maximum Angle	Backtracking	
	60°	Enabled	
Module Characterizations	Module	Uploaded By	Characterization
	JAM72S30-540/MR (1000V) (JA Solar)	HelioScope	Spec Sheet Characterization, PAN
Component Characterizations	Device	Uploaded By	Characterization
	Symo Advanced 15.0-3 / 440_OND (Fronius USA)	HelioScope	Default Characterization

Components

Component	Name	Count
Inverters	Symo Advanced 15.0-3 / 440_OND (Fronius USA)	6 (90.0 kW)
Strings	10 AWG (Copper)	12 (1,135.1 ft)
Module	JA Solar, JAM72S30-540/MR (1000V) (540W)	200 (108.0 kW)

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Short canopy	-	5-17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Short canpy	Carport	Portrait (Vertical)	7°	230.5°	0.0 ft	1x1	200	200	108.0 kW

Detailed Layout

Design 1 City of Ann Arbor - Southeast Area Park, 2901 E Ellsworth Rd, Ann Arbor, MI 48108

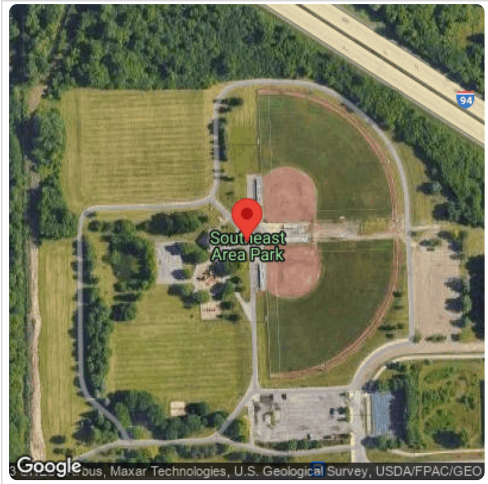
Report

Project Name	City of Ann Arbor - Southeast Area Park
Project Address	2901 E Ellsworth Rd, Ann Arbor, MI 48108
Prepared By	Sachit Verma sachit.verma@novaconsultants.com

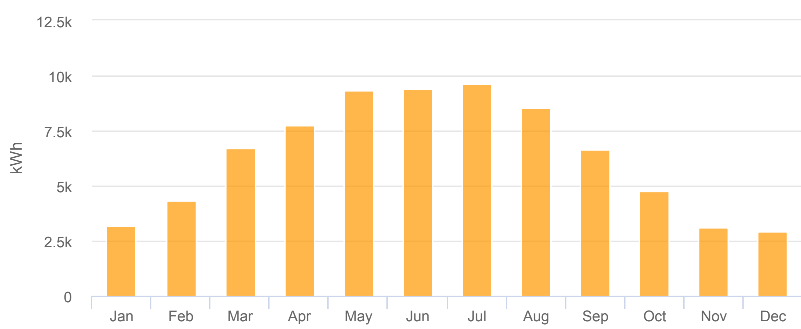
System Metrics

Design	Design 1
Module DC Nameplate	58.3 kW
Inverter AC Nameplate	48.0 kW Load Ratio: 1.22
Annual Production	76.26 MWh
Performance Ratio	86.4%
kWh/kWp	1,307.7
Weather Dataset	TMY, 10km grid (42.25,-83.75), NREL (prospector)
Simulator Version	06c4414b94-fb80585900-1d3828b8b5-c6b0074249

Project Location

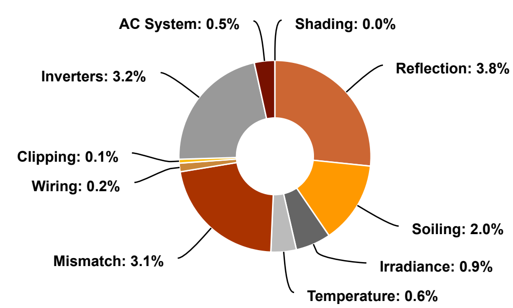


Monthly Production



Month	GHI (kWh/m^2)	POA (kWh/m^2)	Shaded (kWh/m^2)	Nameplate (kWh)	Grid (kWh)
January	51.5	59.7	59.6	3,206.0	3,145.9
February	72.7	81.8	81.8	4,437.9	4,336.4
March	118.7	127.7	127.7	7,001.1	6,725.0
April	145.3	151.5	151.5	8,359.9	7,753.8
May	182.0	186.0	186.0	10,287.2	9,325.1
June	188.1	191.0	191.0	10,575.4	9,413.4
July	193.7	197.0	197.0	10,894.7	9,641.2
August	168.0	174.2	174.2	9,628.8	8,511.1
September	126.1	134.8	134.8	7,422.0	6,654.1
October	85.5	93.8	93.8	5,123.9	4,746.0
November	53.3	60.8	60.8	3,286.5	3,111.5
December	47.0	55.6	55.6	2,980.9	2,900.2

Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,432.0	
	POA Irradiance	1,513.7	5.7%
	Shaded Irradiance	1,513.7	0.0%
	Irradiance after Reflection	1,455.4	-3.8%
	Irradiance after Soiling	1,426.3	-2.0%
	Total Collector Irradiance	**1,426.3**	**0.0%**
Energy (kWh)	Nameplate	83,204.4	
	Output at Irradiance Levels	82,492.1	-0.9%
	Output at Cell Temperature Derate	81,981.9	-0.6%
	Output After Mismatch	79,408.2	-3.1%
	Optimal DC Output	79,241.4	-0.2%

Condition Set

Description	Condition Set 1
Weather Dataset	TMY, 10km grid (42.25,-83.75), NREL (prospector)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.075	3°C
Flush Mount	-2.81	-0.0455	0°C
East-West	-3.56	-0.075	3°C
Carport	-3.56	-0.075	3°C

Soiling (%)	J	F	M	A	M	J	J	A	S	O	N	D

Constrained DC Output	79,166.2	-0.1%
Inverter Output	76,647.1	-3.2%
Energy to Grid	**76,263.8**	**-0.5%**
Temperature Metrics		
Avg. Operating Ambient Temp		11.1 °C
Avg. Operating Cell Temp		18.3 °C
Simulation Metrics		
Operating Hours		4641
Solved Hours		4641

	2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5%		
Cell Temperature Spread	4° C		
Module Binning Range	-2.5% to 2.5%		
AC System Derate	0.50%		
Trackers	Maximum Angle	Backtracking	
	60°	Enabled	
Module Characterizations	Module	Uploaded By	Characterization
	JAM72S30-540/MR (1000V) (JA Solar)	HelioScope	Spec Sheet Characterization, PAN
Component Characterizations	Device	Uploaded By	Characterization
	Fronius Symo 12.0-3 208-240 (240V) (Fronius USA)	HelioScope	CEC 2014-08-16

Components

Component	Name	Count
Inverters	Fronius Symo 12.0-3 208-240 (240V) (Fronius USA)	4 (48.0 kW)
Strings	10 AWG (Copper)	12 (677.0 ft)
Module	JA Solar, JAM72S30-540/MR (1000V) (540W)	108 (58.3 kW)

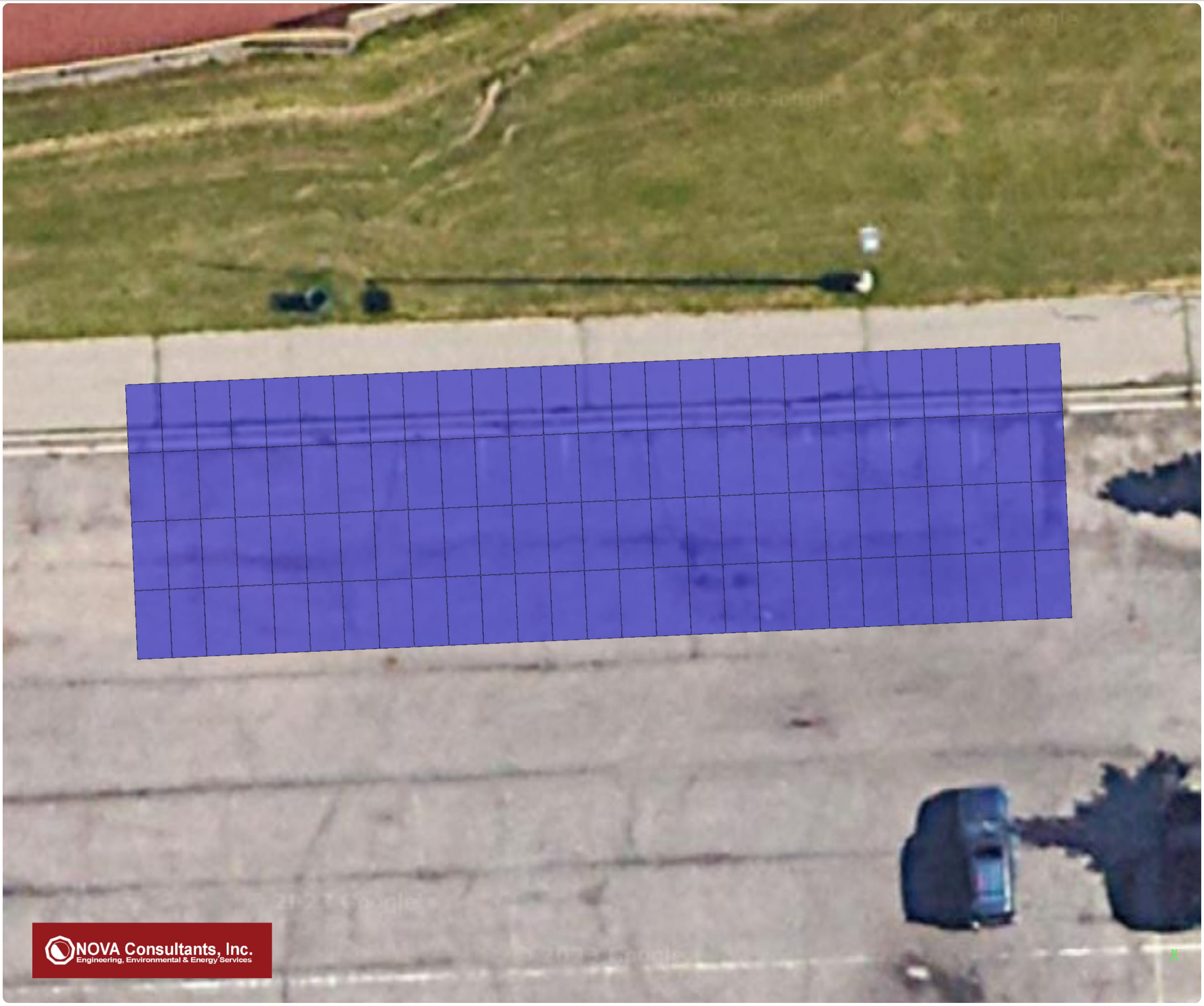
Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	-	8-10	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Carport	Portrait (Vertical)	7°	177.45035°	0.0 ft	1x1	108	108	58.3 kW

Detailed Layout



Design 1 City of Ann Arbor - West Park, 215 Chapin St, Ann Arbor, MI 48103

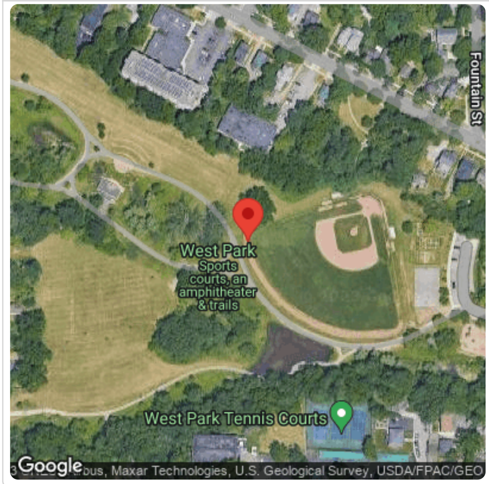
Report

Project Name	City of Ann Arbor - West Park
Project Address	215 Chapin St, Ann Arbor, MI 48103
Prepared By	Sachit Verma sachit.verma@novaconsultants.com

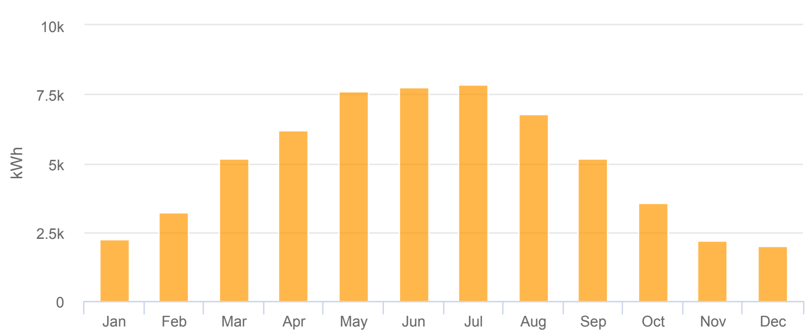
System Metrics

Design	Design 1
Module DC Nameplate	48.6 kW
Inverter AC Nameplate	40.0 kW Load Ratio: 1.22
Annual Production	59.83 MWh
Performance Ratio	85.5%
kWh/kWp	1,231.0
Weather Dataset	TMY, 10km grid (42.25,-83.75), NREL (prospector)
Simulator Version	3f06082235-dbb59b10a7-3d838af5f5-ec3db6ed90

Project Location

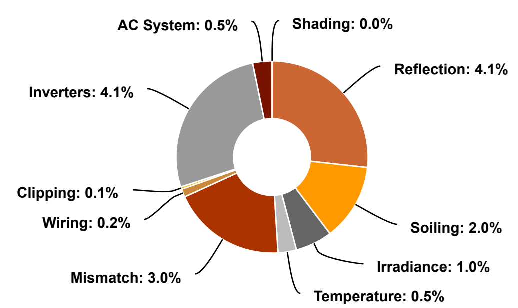


Monthly Production



Month	GHI (kWh/m^2)	POA (kWh/m^2)	Shaded (kWh/m^2)	Nameplate (kWh)	Grid (kWh)
January	51.5	52.1	52.1	2,302.9	2,222.0
February	72.7	74.1	74.1	3,329.1	3,223.0
March	118.7	119.2	119.1	5,413.7	5,173.6
April	145.3	146.3	146.3	6,712.5	6,207.9
May	182.0	183.0	183.0	8,426.6	7,624.4
June	188.1	189.4	189.4	8,736.5	7,747.1
July	193.7	194.1	194.1	8,938.4	7,875.4
August	168.0	168.1	168.1	7,724.4	6,799.5
September	126.1	127.2	127.1	5,807.9	5,179.5
October	85.5	86.0	86.0	3,890.2	3,566.2
November	53.3	53.1	53.1	2,367.6	2,200.9
December	47.0	47.6	47.6	2,105.0	2,008.5

Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,432.0	
	POA Irradiance	1,440.0	0.6%
	Shaded Irradiance	1,439.9	0.0%
	Irradiance after Reflection	1,380.5	-4.1%
	Irradiance after Soiling	1,352.9	-2.0%
	Total Collector Irradiance	**1,352.9**	**0.0%**
Energy (kWh)	Nameplate	65,754.7	
	Output at Irradiance Levels	65,124.8	-1.0%
	Output at Cell Temperature Derate	64,812.8	-0.5%
	Output After Mismatch	62,894.6	-3.0%
	Optimal DC Output	62,761.9	-0.2%

Condition Set

Description	Condition Set 1
Weather Dataset	TMY, 10km grid (42.25,-83.75), NREL (prospector)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters	Rack Type	a	b	Temperature Delta
	Fixed Tilt	-3.56	-0.075	3°C
	Flush Mount	-2.81	-0.0455	0°C
	East-West	-3.56	-0.075	3°C
	Carport	-3.56	-0.075	3°C

Soiling (%)	J	F	M	A	M	J	J	A	S	O	N	D

	Constrained DC Output	62,723.5	-0.1%
	Inverter Output	60,128.7	-4.2%
	Energy to Grid	**59,828.1**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		11.1 °C
	Avg. Operating Cell Temp		17.9 °C
Simulation Metrics			
		Operating Hours	4641
		Solved Hours	4641

	2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5%		
Cell Temperature Spread	4° C		
Module Binning Range	-2.5% to 2.5%		
AC System Derate	0.50%		
Trackers	Maximum Angle	Backtracking	
	60°	Enabled	
Module Characterizations	Module	Uploaded By	Characterization
	JAM72S30-540/MR (1000V) (JA Solar)	HelioScope	Spec Sheet Characterization, PAN
Component Characterizations	Device	Uploaded By	Characterization
	Primo 10.0-1 / 240_OND (Fronius USA)	HelioScope	Default Characterization

Components

Component	Name	Count
Inverters	Primo 10.0-1 / 240_OND (Fronius USA)	4 (40.0 kW)
Strings	10 AWG (Copper)	8 (339.9 ft)
Module	JA Solar, JAM72S30-540/MR (1000V) (540W)	90 (48.6 kW)

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
North	-	2-17	Along Racking
South	-	2-17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
North	Carport	Portrait (Vertical)	7°	103.48306°	0.0 ft	1x1	45	45	24.3 kW
South	Carport	Portrait (Vertical)	7°	88°	0.0 ft	1x1	45	45	24.3 kW

Detailed Layout

Design 1 City of Ann Arbor - Veterans Park, 2150 Jackson Ave, Ann Arbor, MI 48103

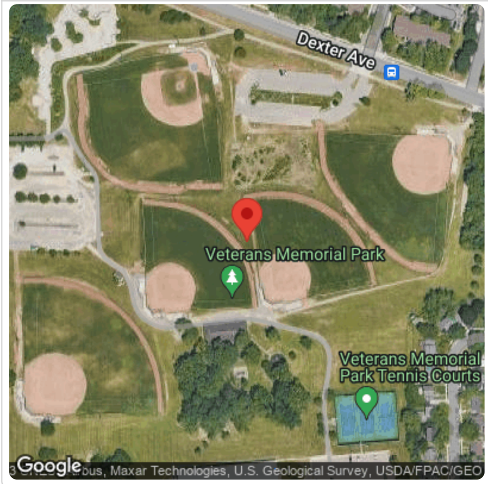
Report

Project Name	City of Ann Arbor - Veterans Park
Project Address	2150 Jackson Ave, Ann Arbor, MI 48103
Prepared By	Sachit Verma sachit.verma@novaconsultants.com

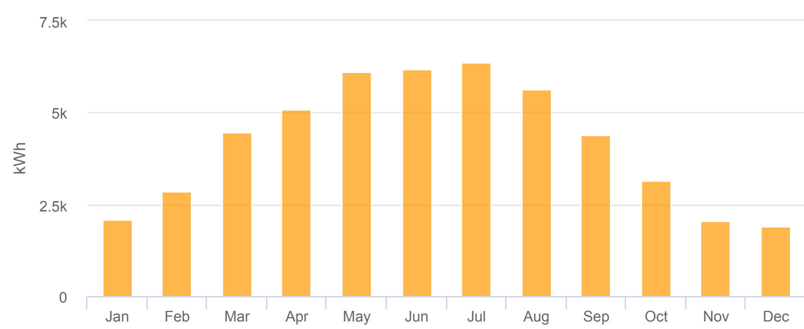
System Metrics

Design	Design 1
Module DC Nameplate	38.9 kW
Inverter AC Nameplate	30.0 kW Load Ratio: 1.30
Annual Production	50.26 MWh
Performance Ratio	85.4%
kWh/kWp	1,292.8
Weather Dataset	TMY, 10km grid (42.25,-83.75), NREL (prospector)
Simulator Version	3f06082235-dbb59b10a7-3d838af5f5-ec3db6ed90

Project Location

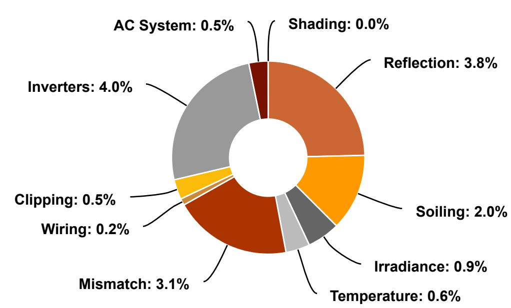


Monthly Production



Month	GHI (kWh/m²)	POA (kWh/m²)	Shaded (kWh/m²)	Nameplate (kWh)	Grid (kWh)
January	51.5	59.6	59.6	2,137.4	2,074.6
February	72.7	81.7	81.7	2,954.9	2,865.9
March	118.7	127.8	127.7	4,669.2	4,446.5
April	145.3	151.4	151.4	5,570.1	5,092.3
May	182.0	185.8	185.8	6,853.8	6,100.6
June	188.1	190.8	190.8	7,045.0	6,183.2
July	193.7	196.9	196.9	7,263.1	6,364.9
August	168.0	174.2	174.2	6,421.6	5,636.6
September	126.1	134.7	134.7	4,946.0	4,402.8
October	85.5	93.8	93.8	3,417.1	3,134.4
November	53.3	60.9	60.9	2,195.5	2,052.3
December	47.0	55.6	55.6	1,987.6	1,910.0

Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m²)	Annual Global Horizontal Irradiance	1,432.0	
	POA Irradiance	1,513.2	5.7%
	Shaded Irradiance	1,513.2	0.0%
	Irradiance after Reflection	1,455.4	-3.8%
	Irradiance after Soiling	1,426.3	-2.0%
	Total Collector Irradiance	**1,426.3**	**0.0%**
Energy (kWh)	Nameplate	55,461.4	
	Output at Irradiance Levels	54,986.5	-0.9%
	Output at Cell Temperature Derate	54,643.3	-0.6%
	Output After Mismatch	52,961.6	-3.1%
	Optimal DC Output	52,869.9	-0.2%

Condition Set

Description	Condition Set 1
Weather Dataset	TMY, 10km grid (42.25,-83.75), NREL (prospector)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.075	3°C
Flush Mount	-2.81	-0.0455	0°C
East-West	-3.56	-0.075	3°C
Carport	-3.56	-0.075	3°C

Soiling (%)	J	F	M	A	M	J	J	A	S	O	N	D

	Constrained DC Output	52,596.7	-0.5%
	Inverter Output	50,516.8	-4.0%
	Energy to Grid	**50,264.2**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		11.1 °C
	Avg. Operating Cell Temp		18.3 °C
Simulation Metrics			
	Operating Hours		4641
	Solved Hours		4641

	2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5%		
Cell Temperature Spread	4° C		
Module Binning Range	-2.5% to 2.5%		
AC System Derate	0.50%		
Trackers	Maximum Angle	Backtracking	
	60°	Enabled	
Module Characterizations	Module	Uploaded By	Characterization
	JAM72S30-540/MR (1000V) (JA Solar)	HelioScope	Spec Sheet Characterization, PAN
Component Characterizations	Device	Uploaded By	Characterization
	Primo 10.0-1 / 240_OND (Fronius USA)	HelioScope	Default Characterization

Components

Component	Name	Count
Inverters	Primo 10.0-1 / 240_OND (Fronius USA)	3 (30.0 kW)
Strings	10 AWG (Copper)	6 (180.3 ft)
Module	JA Solar, JAM72S30-540/MR (1000V) (540W)	72 (38.9 kW)

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	-	2-17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Carport	Portrait (Vertical)	7°	185.36694°	0.0 ft	1x1	72	72	38.9 kW

Detailed Layout

Design 1 City of Ann Arbor - Allmendinger Park, 655 Pauline Blvd, Ann Arbor, MI 48103

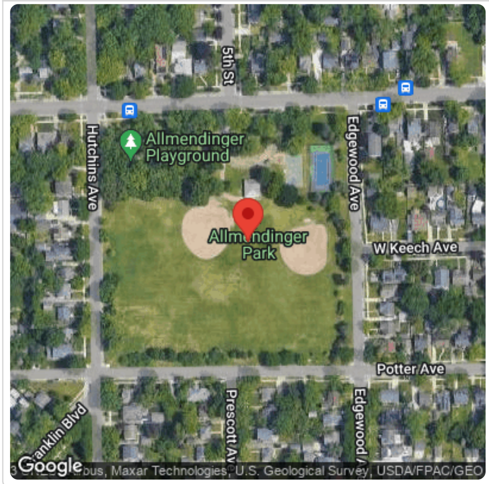
Report

Project Name	City of Ann Arbor - Allmendinger Park
Project Address	655 Pauline Blvd, Ann Arbor, MI 48103
Prepared By	Sachit Verma sachit.verma@novaconsultants.com

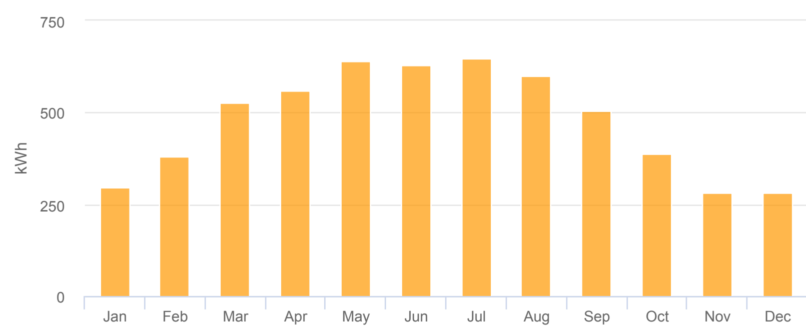
System Metrics

Design	Design 1
Module DC Nameplate	4.32 kW
Inverter AC Nameplate	3.80 kW Load Ratio: 1.14
Annual Production	5.729 MWh
Performance Ratio	80.4%
kWh/kWp	1,326.2
Weather Dataset	TMY, 10km grid (42.25,-83.75), NREL (prospector)
Simulator Version	06c4414b94-fb80585900-1d3828b8b5-c6b0074249

Project Location

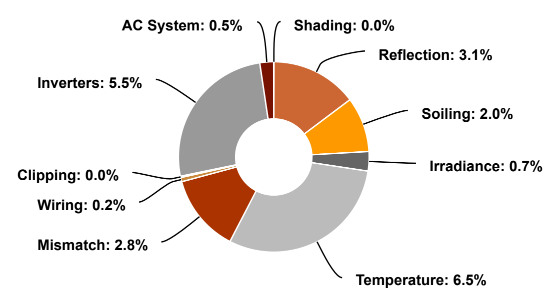


Monthly Production



Month	GHI (kWh/m^2)	POA (kWh/m^2)	Shaded (kWh/m^2)	Nameplate (kWh)	Grid (kWh)
January	51.5	78.7	78.6	321.0	295.0
February	72.7	101.7	101.7	416.5	379.3
March	118.7	145.0	145.0	595.1	527.5
April	145.3	159.6	159.6	655.9	558.7
May	182.0	186.2	186.2	764.4	639.2
June	188.1	187.6	187.6	769.8	627.5
July	193.7	194.7	194.7	798.4	647.0
August	168.0	180.7	180.7	742.6	599.0
September	126.1	150.6	150.6	619.6	504.9
October	85.5	111.2	111.2	456.1	389.5
November	53.3	77.7	77.6	317.9	280.0
December	47.0	75.6	75.6	308.9	281.8

Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,432.0	
	POA Irradiance	1,649.3	15.2%
	Shaded Irradiance	1,649.1	0.0%
	Irradiance after Reflection	1,597.4	-3.1%
	Irradiance after Soiling	1,565.4	-2.0%
	Total Collector Irradiance	**1,565.4**	**0.0%**
Energy (kWh)	Nameplate	6,766.0	
	Output at Irradiance Levels	6,718.6	-0.7%
	Output at Cell Temperature Derate	6,284.9	-6.5%
	Output After Mismatch	6,107.5	-2.8%
	Optimal DC Output	6,098.3	-0.2%

Condition Set

Description	Condition Set 1			
Weather Dataset	TMY, 10km grid (42.25,-83.75), NREL (prospector)			
Solar Angle Location	Meteo Lat/Lng			
Transposition Model	Perez Model			
Temperature Model	Sandia Model			
Temperature Model Parameters	Rack Type	a	b	Temperature Delta
	Fixed Tilt	-3.56	-0.075	3°C
	Flush Mount	-2.81	-0.0455	0°C
	East-West	-3.56	-0.075	3°C
	Carport	-3.56	-0.075	3°C

Soiling (%)	J	F	M	A	M	J	J	A	S	O	N	D

	Constrained DC Output	6,095.4	0.0%
	Inverter Output	5,758.2	-5.6%
	Energy to Grid	**5,729.4**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		11.1 °C
	Avg. Operating Cell Temp		27.6 °C
Simulation Metrics			
	Operating Hours		4641
	Solved Hours		4641

	2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5%		
Cell Temperature Spread	4° C		
Module Binning Range	-2.5% to 2.5%		
AC System Derate	0.50%		
Trackers	Maximum Angle	Backtracking	
	60°	Enabled	
Module Characterizations	Module	Uploaded By	Characterization
	JAM72S30-540/MR (1000V) (JA Solar)	HelioScope	Spec Sheet Characterization, PAN
Component Characterizations	Device	Uploaded By	Characterization
	Primo 3.8-1 / 240 (Fronius USA)	HelioScope	Default Characterization

Components

Component	Name	Count
Inverters	Primo 3.8-1 / 240 (Fronius USA)	1 (3.80 kW)
Strings	10 AWG (Copper)	1 (0.0 ft)
Module	JA Solar, JAM72S30-540/MR (1000V) (540W)	8 (4.32 kW)

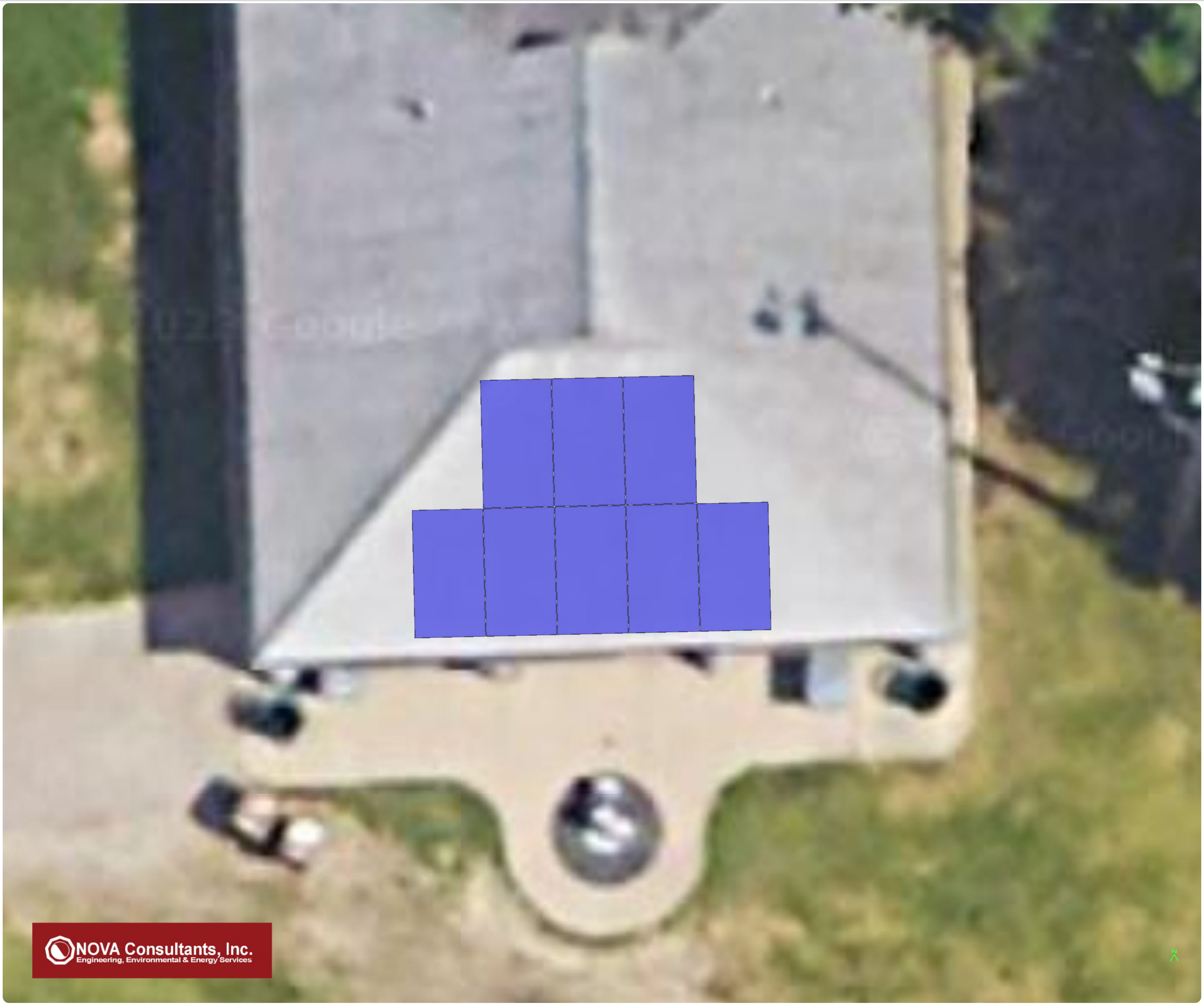
Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	-	2-17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Flush Mount	Portrait (Vertical)	26°	178.66397°	0.0 ft	1x1	8	8	4.32 kW

Detailed Layout



Design 1 City of Ann Arbor - Argo Canoe Livery, 1055 Longshore Dr, Ann Arbor, MI 48105

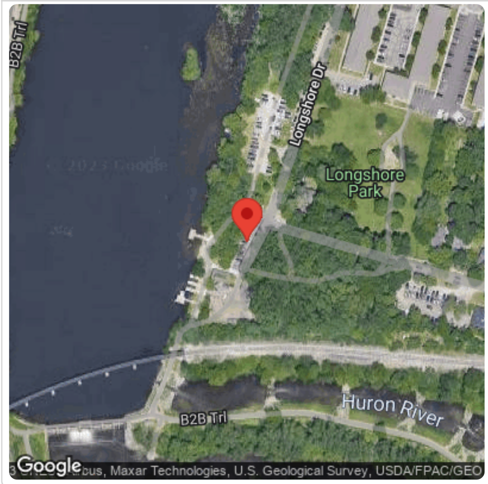
Report

Project Name	City of Ann Arbor - Argo Canoe Livery
Project Address	1055 Longshore Dr, Ann Arbor, MI 48105
Prepared By	Sachit Verma sachit.verma@novaconsultants.com

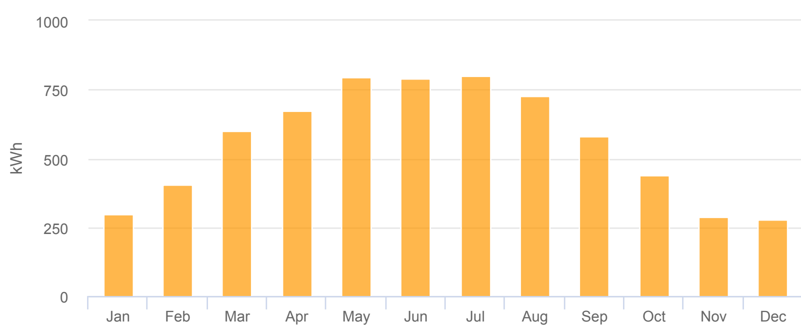
System Metrics

Design	Design 1
Module DC Nameplate	5.94 kW
Inverter AC Nameplate	5.00 kW Load Ratio: 1.19
Annual Production	6.665 MWh
Performance Ratio	71.8%
kWh/kWp	1,122.1
Weather Dataset	TMY, 10km grid (42.25,-83.75), NREL (prospector)
Simulator Version	06c4414b94-fb80585900-1d3828b8b5-c6b0074249

Project Location

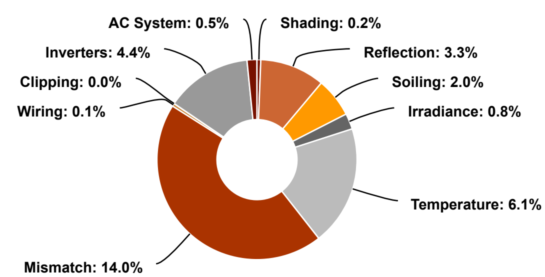


Monthly Production



Month	GHI (kWh/m²)	POA (kWh/m²)	Shaded (kWh/m²)	Nameplate (kWh)	Grid (kWh)
January	51.5	69.5	69.1	382.5	296.2
February	72.7	92.0	91.6	510.2	402.7
March	118.7	135.1	134.7	754.9	597.6
April	145.3	153.4	153.1	862.7	672.3
May	182.0	182.7	182.6	1,030.5	795.0
June	188.1	185.6	185.5	1,048.4	790.8
July	193.7	192.0	191.8	1,082.3	800.2
August	168.0	174.2	174.0	980.7	725.1
September	126.1	141.4	141.1	793.5	582.4
October	85.5	101.9	101.6	568.0	438.0
November	53.3	69.0	68.8	381.5	287.9
December	47.0	66.0	65.8	362.9	277.1

Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m²)	Annual Global Horizontal Irradiance	1,432.0	
	POA Irradiance	1,562.8	9.1%
	Shaded Irradiance	1,559.7	-0.2%
	Irradiance after Reflection	1,508.2	-3.3%
	Irradiance after Soiling	1,478.1	-2.0%
	Total Collector Irradiance	**1,474.5**	**-0.2%**
Energy (kWh)	Nameplate	8,758.1	
	Output at Irradiance Levels	8,688.1	-0.8%
	Output at Cell Temperature Derate	8,159.1	-6.1%
	Output After Mismatch	7,016.2	-14.0%
	Optimal DC Output	7,005.8	-0.1%

Condition Set

Description	Condition Set 1			
Weather Dataset	TMY, 10km grid (42.25,-83.75), NREL (prospector)			
Solar Angle Location	Meteo Lat/Lng			
Transposition Model	Perez Model			
Temperature Model	Sandia Model			
Temperature Model Parameters	Rack Type	a	b	Temperature Delta
	Fixed Tilt	-3.56	-0.075	3°C
	Flush Mount	-2.81	-0.0455	0°C
	East-West	-3.56	-0.075	3°C
	Carport	-3.56	-0.075	3°C

Soiling (%)	J	F	M	A	M	J	J	A	S	O	N	D

	Constrained DC Output	7,005.7	0.0%
	Inverter Output	6,698.8	-4.4%
	Energy to Grid	**6,665.3**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		11.1 °C
	Avg. Operating Cell Temp		26.6 °C
Simulation Metrics			
	Operating Hours		4641
	Solved Hours		4641

	2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5%		
Cell Temperature Spread	4° C		
Module Binning Range	-2.5% to 2.5%		
AC System Derate	0.50%		
Trackers	**Maximum Angle**	**Backtracking**	
	60°	Enabled	
Module Characterizations	**Module**	**Uploaded By**	**Characterization**
	JAM72S30-540/MR (1000V) (JA Solar)	HelioScope	Spec Sheet Characterization, PAN
Component Characterizations	**Device**	**Uploaded By**	**Characterization**
	Fronius Primo 5.0-1 (240V) (Fronius USA)	HelioScope	CEC 2014-08-16

Components

Component	Name	Count
Inverters	Fronius Primo 5.0-1 (240V) (Fronius USA)	1 (5.00 kW)
Strings	10 AWG (Copper)	1 (7.1 ft)
Module	JA Solar, JAM72S30-540/MR (1000V) (540W)	11 (5.94 kW)

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	-	6-17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Flush Mount	Portrait (Vertical)	30°	196.3777°	0.0 ft	1x1	6	6	3.24 kW
Field Segment 2	Flush Mount	Portrait (Vertical)	18.4°	105°	0.0 ft	1x1	5	5	2.70 kW

Detailed Layout

Design 1 City of Ann Arbor - Gallup Park Maas Shelter, Gallup Park Pathway, Ann Arbor, MI 48105

Report

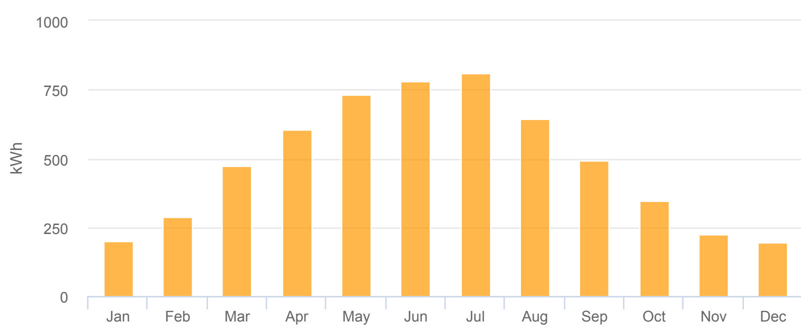
Project Name	City of Ann Arbor - Gallup Park Maas Shelter
Project Address	Gallup Park Pathway, Ann Arbor, MI 48105
Prepared By	Sachit Verma sachit.verma@novaconsultants.com

System Metrics

Design	Design 1
Module DC Nameplate	6.48 kW
Inverter AC Nameplate	5.00 kW Load Ratio: 1.30
Annual Production	5.792 MWh
Performance Ratio	60.5%
kWh/kWp	893.8
Weather Dataset	TMY, 10km grid (42.25,-83.65), NREL (prospector)
Simulator Version	91b698d9a1-cf5e19739c-2a70cc6e51-8338d5f2d3

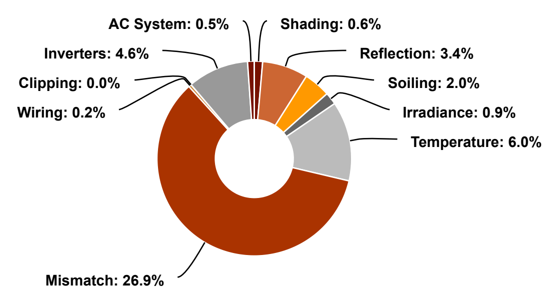
Project Location

Monthly Production



Month	GHI (kWh/m²)	POA (kWh/m²)	Shaded (kWh/m²)	Nameplate (kWh)	Grid (kWh)
January	51.1	64.1	63.3	380.6	198.8
February	72.5	86.0	84.8	513.5	287.1
March	115.7	125.8	124.0	755.7	471.3
April	142.8	146.3	145.6	891.5	607.0
May	167.4	165.0	165.0	1,011.8	733.8
June	185.4	180.3	180.3	1,108.0	782.7
July	196.4	192.3	192.3	1,181.1	808.4
August	159.1	160.8	160.4	984.2	643.2
September	127.5	136.9	135.0	824.6	490.7
October	84.4	94.8	93.9	569.9	347.2
November	53.1	63.8	63.2	380.6	224.5
December	47.9	62.0	61.2	367.0	197.3

Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m²)	Annual Global Horizontal Irradiance	1,403.3	
	POA Irradiance	1,478.1	5.3%
	Shaded Irradiance	1,468.8	-0.6%
	Irradiance after Reflection	1,418.6	-3.4%
	Irradiance after Soiling	1,390.2	-2.0%
	Total Collector Irradiance	**1,384.3**	**-0.4%**
Energy (kWh)	Nameplate	8,968.5	
	Output at Irradiance Levels	8,886.4	-0.9%
	Output at Cell Temperature Derate	8,356.5	-6.0%
	Output After Mismatch	6,112.5	-26.9%
	Optimal DC Output	6,100.4	-0.2%

Condition Set

Description	Condition Set 1			
Weather Dataset	TMY, 10km grid (42.25,-83.65), NREL (prospector)			
Solar Angle Location	Meteo Lat/Lng			
Transposition Model	Perez Model			
Temperature Model	Sandia Model			
Temperature Model Parameters	Rack Type	a	b	Temperature Delta
	Fixed Tilt	-3.56	-0.075	3°C
	Flush Mount	-2.81	-0.0455	0°C
	East-West	-3.56	-0.075	3°C
	Carport	-3.56	-0.075	3°C

Soiling (%)	J	F	M	A	M	J	J	A	S	O	N	D

	Constrained DC Output	6,100.1	0.0%
	Inverter Output	5,821.0	-4.6%
	Energy to Grid	**5,791.9**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		11.6 °C
	Avg. Operating Cell Temp		26.3 °C
Simulation Metrics			
	Operating Hours		4629
	Solved Hours		4629

	2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5%		
Cell Temperature Spread	4° C		
Module Binning Range	-2.5% to 2.5%		
AC System Derate	0.50%		
Trackers	Maximum Angle	Backtracking	
	60°	Enabled	
Module Characterizations	Module	Uploaded By	Characterization
	JAM72S30-540/MR (1000V) (JA Solar)	HelioScope	Spec Sheet Characterization, PAN
Component Characterizations	Device	Uploaded By	Characterization
	Fronius Primo 5.0-1 (240V) (Fronius USA)	HelioScope	CEC 2014-08-16

Components

Component	Name	Count
Inverters	Fronius Primo 5.0-1 (240V) (Fronius USA)	1 (5.00 kW)
Strings	10 AWG (Copper)	1 (7.4 ft)
Module	JA Solar, JAM72S30-540/MR (1000V) (540W)	12 (6.48 kW)

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	-	6-17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Flush Mount	Portrait (Vertical)	26°	169.64095°	0.0 ft	1x1	6	6	3.24 kW
Field Segment 2	Flush Mount	Portrait (Vertical)	26°	260.50314°	0.0 ft	1x1	3	3	1.62 kW
Field Segment 3	Flush Mount	Portrait (Vertical)	26°	79°	0.0 ft	1x1	3	3	1.62 kW

Detailed Layout

Design 1 City of Ann Arbor - Gallup Park Fast Shelter, Gallup Park Pathway, Ann Arbor, MI

Report

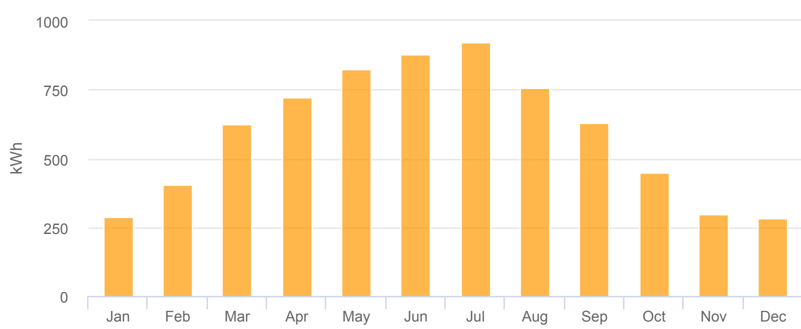
Project Name	City of Ann Arbor - Gallup Park Fast Shelter
Project Address	Gallup Park Pathway, Ann Arbor, MI
Prepared By	Sachit Verma sachit.verma@novaconsultants.com

System Metrics

Design	Design 1
Module DC Nameplate	6.48 kW
Inverter AC Nameplate	5.00 kW Load Ratio: 1.30
Annual Production	7.071 MWh
Performance Ratio	73.1%
kWh/kWp	1,091.1
Weather Dataset	TMY, 10km grid (42.25,-83.65), NREL (prospector)
Simulator Version	06c4414b94-fb80585900-1d3828b8b5-c6b0074249

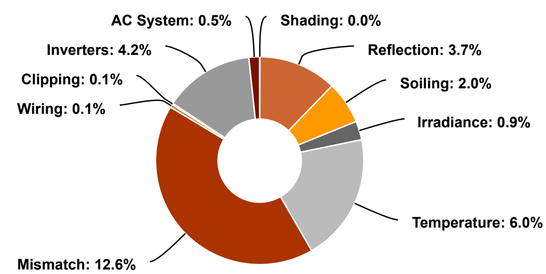
Project Location

Monthly Production



Month	GHI (kWh/m^2)	POA (kWh/m^2)	Shaded (kWh/m^2)	Nameplate (kWh)	Grid (kWh)
January	51.1	61.4	61.4	369.3	289.0
February	72.5	83.2	83.1	504.4	402.7
March	115.7	126.8	126.8	774.9	622.6
April	142.8	148.6	148.6	912.6	721.2
May	167.4	170.0	169.9	1,044.2	825.1
June	185.4	185.5	185.5	1,142.7	876.7
July	196.4	198.2	198.2	1,220.2	920.0
August	159.1	165.2	165.2	1,016.5	756.0
September	127.5	137.4	137.3	842.6	629.4
October	84.4	94.2	94.2	573.1	447.0
November	53.1	62.6	62.6	378.2	298.8
December	47.9	59.3	59.3	356.7	281.9

Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,403.3	
	POA Irradiance	1,492.4	6.3%
	Shaded Irradiance	1,492.2	0.0%
	Irradiance after Reflection	1,437.4	-3.7%
	Irradiance after Soiling	1,408.6	-2.0%
	Total Collector Irradiance	**1,409.1**	**0.0%**
Energy (kWh)	Nameplate	9,135.5	
	Output at Irradiance Levels	9,055.2	-0.9%
	Output at Cell Temperature Derate	8,511.6	-6.0%
	Output After Mismatch	7,435.7	-12.6%
	Optimal DC Output	7,424.7	-0.1%

Condition Set

Description	Condition Set 1
Weather Dataset	TMY, 10km grid (42.25,-83.65), NREL (prospector)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters	Rack Type	a	b	Temperature Delta
	Fixed Tilt	-3.56	-0.075	3°C
	Flush Mount	-2.81	-0.0455	0°C
	East-West	-3.56	-0.075	3°C
	Carport	-3.56	-0.075	3°C

Soiling (%)	J	F	M	A	M	J	J	A	S	O	N	D

	Constrained DC Output	7,420.4	-0.1%
	Inverter Output	7,106.2	-4.3%
	Energy to Grid	**7,070.6**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		11.6 °C
	Avg. Operating Cell Temp		26.5 °C
Simulation Metrics			
	Operating Hours		4629
	Solved Hours		4629

	2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5%		
Cell Temperature Spread	4° C		
Module Binning Range	-2.5% to 2.5%		
AC System Derate	0.50%		
Trackers	**Maximum Angle**		**Backtracking**
	60°		Enabled
Module Characterizations	**Module**	**Uploaded By**	**Characterization**
	JAM72S30-540/MR (1000V) (JA Solar)	HelioScope	Spec Sheet Characterization, PAN
Component Characterizations	**Device**	**Uploaded By**	**Characterization**
	Primo 5.0-1 / 240 (Fronius USA)	HelioScope	Default Characterization

Components

Component	Name	Count
Inverters	Primo 5.0-1 / 240 (Fronius USA)	1 (5.00 kW)
Module	JA Solar, JAM72S30-540/MR (1000V) (540W)	12 (6.48 kW)

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	-	2-17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Flush Mount	Portrait (Vertical)	15°	241.01118°	0.0 ft	1x1	6	6	3.24 kW
Field Segment 2	Flush Mount	Portrait (Vertical)	15°	182°	0.0 ft	1x1	3	3	1.62 kW
Field Segment 3	Flush Mount	Portrait (Vertical)	15°	121.77872°	0.0 ft	1x1	3	3	1.62 kW

Detailed Layout

Design 1 City of Ann Arbor - Gallup Park Parking, 3000 Fuller Rd, Ann Arbor, MI 48105

Report

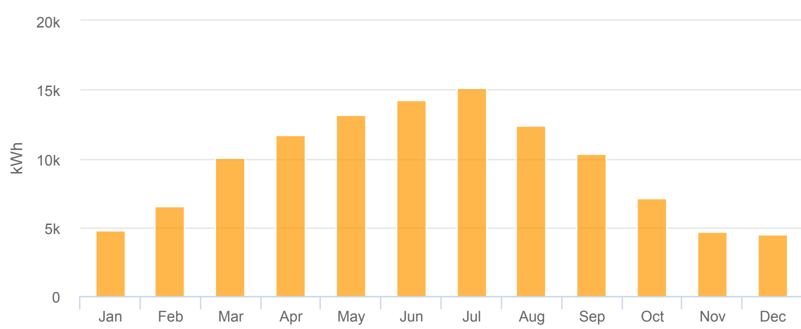
Project Name	City of Ann Arbor - Gallup Park Parking
Project Address	3000 Fuller Rd, Ann Arbor, MI 48105
Prepared By	Sachit Verma sachit.verma@novaconsultants.com

System Metrics

Design	Design 1
Module DC Nameplate	90.7 kW
Inverter AC Nameplate	75.0 kW Load Ratio: 1.21
Annual Production	114.6 MWh
Performance Ratio	85.6%
kWh/kWp	1,262.8
Weather Dataset	TMY, 10km grid (42.25,-83.65), NREL (prospector)
Simulator Version	3f06082235-dbb59b10a7-3d838af5f5-ec3db6ed90

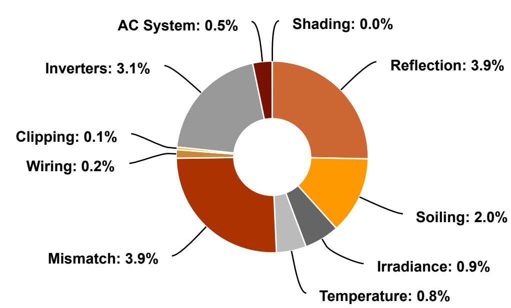
Project Location

Monthly Production



Month	GHI (kWh/m^2)	POA (kWh/m^2)	Shaded (kWh/m^2)	Nameplate (kWh)	Grid (kWh)
January	51.1	58.3	58.3	4,871.4	4,735.9
February	72.5	80.0	80.0	6,748.4	6,548.7
March	115.7	124.3	124.3	10,602.9	10,048.8
April	142.8	147.8	147.8	12,683.7	11,681.0
May	167.4	170.5	170.5	14,648.5	13,185.8
June	185.4	187.1	187.1	16,104.3	14,256.0
July	196.4	199.3	199.3	17,157.5	15,088.9
August	159.1	164.8	164.8	14,182.2	12,349.1
September	127.5	135.1	135.1	11,568.0	10,306.1
October	84.4	91.7	91.7	7,780.4	7,146.0
November	53.1	60.0	60.0	5,047.6	4,727.2
December	47.9	56.0	56.0	4,670.6	4,484.0

Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,403.3	
	POA Irradiance	1,474.9	5.1%
	Shaded Irradiance	1,474.8	0.0%
	Irradiance after Reflection	1,417.7	-3.9%
	Irradiance after Soiling	1,389.4	-2.0%
	Total Collector Irradiance	**1,389.4**	**0.0%**
Energy (kWh)	Nameplate	126,065.6	
	Output at Irradiance Levels	124,927.3	-0.9%
	Output at Cell Temperature Derate	123,963.9	-0.8%
	Output After Mismatch	119,124.0	-3.9%
	Optimal DC Output	118,861.7	-0.2%

Condition Set

Description	Condition Set 1
Weather Dataset	TMY, 10km grid (42.25,-83.65), NREL (prospector)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters	Rack Type	a	b	Temperature Delta
	Fixed Tilt	-3.56	-0.075	3°C
	Flush Mount	-2.81	-0.0455	0°C
	East-West	-3.56	-0.075	3°C
	Carport	-3.56	-0.075	3°C

Soiling (%)	J	F	M	A	M	J	J	A	S	O	N	D

	Constrained DC Output	118,782.6	-0.1%
	Inverter Output	115,133.1	-3.1%
	Energy to Grid	**114,557.4**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		11.6 °C
	Avg. Operating Cell Temp		18.6 °C
Simulation Metrics			
	Operating Hours		4629
	Solved Hours		4629

	2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5%		
Cell Temperature Spread	4° C		
Module Binning Range	-2.5% to 2.5%		
AC System Derate	0.50%		
Trackers	Maximum Angle	Backtracking	
	60°	Enabled	
Module Characterizations	Module	Uploaded By	Characterization
	JAM72S30-540/MR (1000V) (JA Solar)	HelioScope	Spec Sheet Characterization, PAN
Component Characterizations	Device	Uploaded By	Characterization
	Primo 15.0-1 / 240_OND (Fronius USA)	HelioScope	Default Characterization

Components

Component	Name	Count
Inverters	Primo 15.0-1 / 240_OND (Fronius USA)	5 (75.0 kW)
Strings	10 AWG (Copper)	10 (827.5 ft)
Module	JA Solar, JAM72S30-540/MR (1000V) (540W)	168 (90.7 kW)

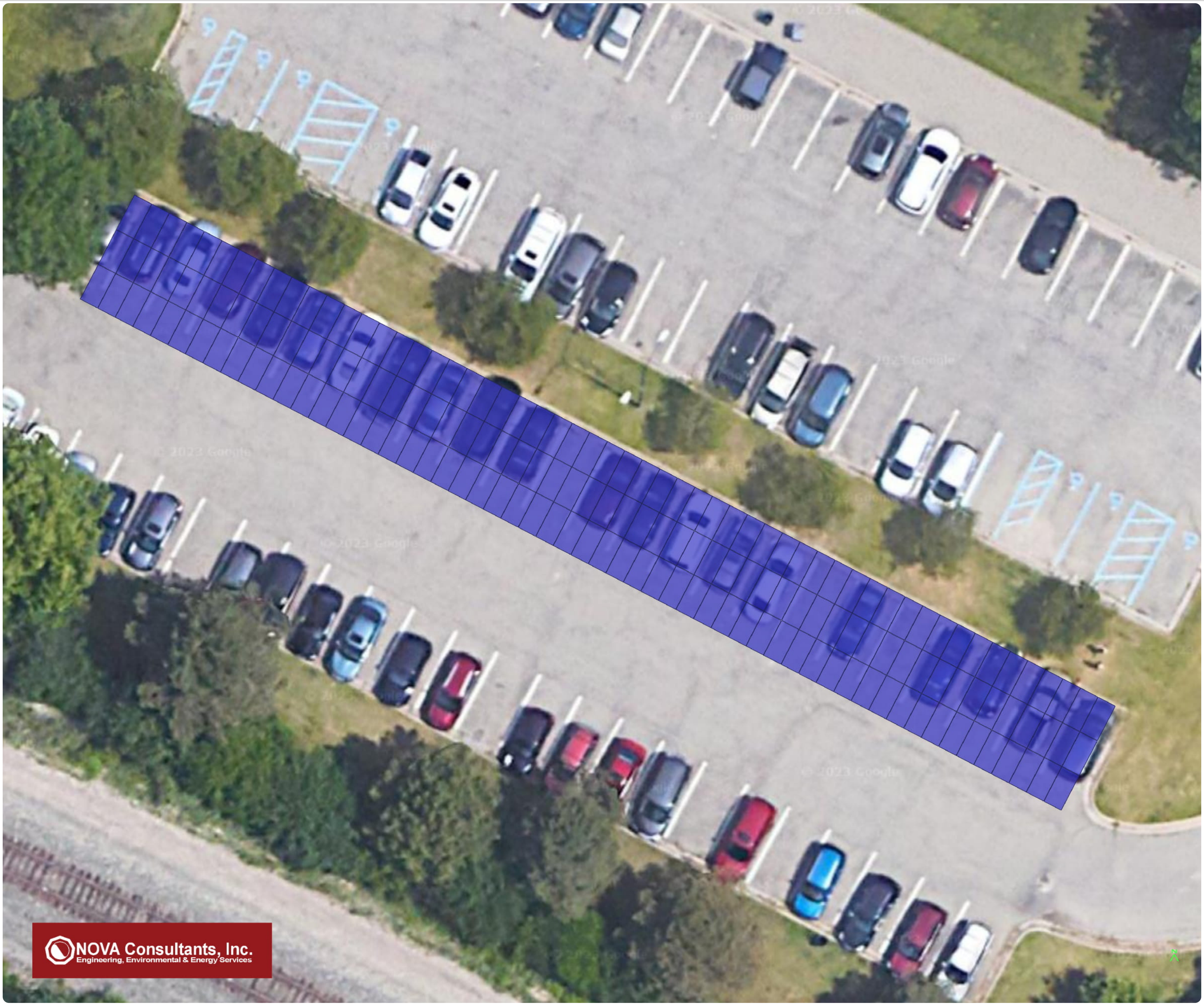
Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	-	2-17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Carport	Portrait (Vertical)	7°	207.5°	0.0 ft	1x1	168	168	90.7 kW

Detailed Layout



Design 1 City of Ann Arbor - Wheeler Service Center, 4251 Stone School Rd, Ann Arbor, Mi 48108

Report

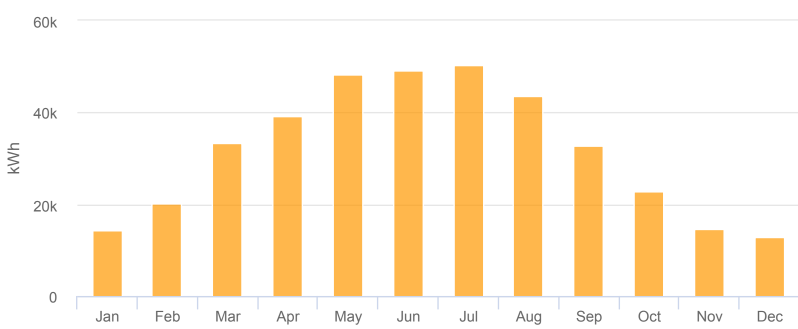
Project Name	City of Ann Arbor - Wheeler Service Center
Project Address	4251 Stone School Rd, Ann Arbor, Mi 48108
Prepared By	Sachit Verma sachit.verma@novaconsultants.com

System Metrics

Design	Design 1
Module DC Nameplate	311.0 kW
Inverter AC Nameplate	254.9 kW Load Ratio: 1.22
Annual Production	382.0 MWh
Performance Ratio	85.8%
kWh/kWp	1,228.0
Weather Dataset	TMY, 10km grid (42.25,-83.75), NREL (prospector)
Simulator Version	06c4414b94-fb80585900-1d3828b8b5-c6b0074249

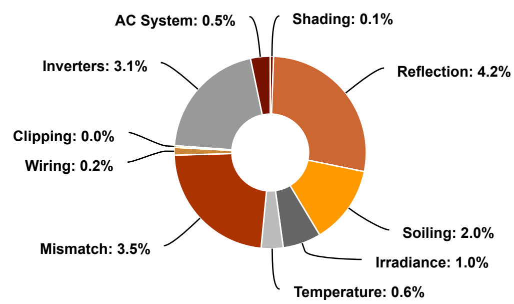
Project Location

Monthly Production



Month	GHI (kWh/m^2)	POA (kWh/m^2)	Shaded (kWh/m^2)	Nameplate (kWh)	Grid (kWh)
January	51.5	51.9	51.8	14,676.3	14,253.1
February	72.7	72.4	72.3	20,740.3	20,178.0
March	118.7	119.4	119.3	34,711.6	33,324.4
April	145.3	144.6	144.5	42,407.7	39,362.3
May	182.0	180.9	180.8	53,229.7	48,369.1
June	188.1	187.0	186.9	55,119.1	49,091.9
July	193.7	193.4	193.3	56,955.8	50,406.5
August	168.0	168.5	168.4	49,535.7	43,753.1
September	126.1	125.9	125.8	36,780.6	32,925.3
October	85.5	86.0	85.9	24,860.5	22,883.9
November	53.3	54.5	54.4	15,544.8	14,566.5
December	47.0	47.5	47.4	13,373.0	12,842.7

Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,432.0	
	POA Irradiance	1,432.0	0.0%
	Shaded Irradiance	1,430.8	-0.1%
	Irradiance after Reflection	1,370.9	-4.2%
	Irradiance after Soiling	1,343.5	-2.0%
	Total Collector Irradiance	**1,343.5**	**0.0%**
Energy (kWh)	Nameplate	417,935.2	
	Output at Irradiance Levels	413,868.3	-1.0%
	Output at Cell Temperature Derate	411,535.2	-0.6%
	Output After Mismatch	397,177.9	-3.5%
	Optimal DC Output	396,400.1	-0.2%

Condition Set

Description	Condition Set 1
Weather Dataset	TMY, 10km grid (42.25,-83.75), NREL (prospector)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters	Rack Type	a	b	Temperature Delta
	Fixed Tilt	-3.56	-0.075	3°C
	Flush Mount	-2.81	-0.0455	0°C
	East-West	-3.56	-0.075	3°C
	Carport	-3.56	-0.075	3°C

Soiling (%)	J	F	M	A	M	J	J	A	S	O	N	D

	Constrained DC Output	396,213.3	0.0%
	Inverter Output	383,876.3	-3.1%
	Energy to Grid	**381,956.9**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		11.1 °C
	Avg. Operating Cell Temp		17.9 °C
Simulation Metrics			
	Operating Hours		4641
	Solved Hours		4641

	2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5%		
Cell Temperature Spread	4° C		
Module Binning Range	-2.5% to 2.5%		
AC System Derate	0.50%		
Trackers	Maximum Angle	Backtracking	
	60°	Enabled	
Module Characterizations	Module	Uploaded By	Characterization
	JAM72S30-540/MR (1000V) (JA Solar)	HelioScope	Spec Sheet Characterization, PAN
Component Characterizations	Device	Uploaded By	Characterization
	Fronius Symo 15.0-3 (480V) (Fronius USA)	HelioScope	CEC 2014-08-16

Components

Component	Name	Count
Inverters	Fronius Symo 15.0-3 (480V) (Fronius USA)	17 (254.9 kW)
Strings	10 AWG (Copper)	38 (2,881.1 ft)
Module	JA Solar, JAM72S30-540/MR (1000V) (540W)	576 (311.0 kW)

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
E canopy	-	9-17	Along Racking
W canopy	-	9-17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
N canopy	Carport	Portrait (Vertical)	7°	267.48767°	0.0 ft	1x1	198	198	106.9 kW
S canopy	Carport	Portrait (Vertical)	7°	267.48767°	0.0 ft	1x1	180	180	97.2 kW
E canopy	Carport	Portrait (Vertical)	7°	267.48767°	0.0 ft	1x1	198	198	106.9 kW

Detailed Layout

100 kW City of Ann Arbor - Water Recovery Plant, 49 S Dixboro Rd, Ann Arbor, MI 48105

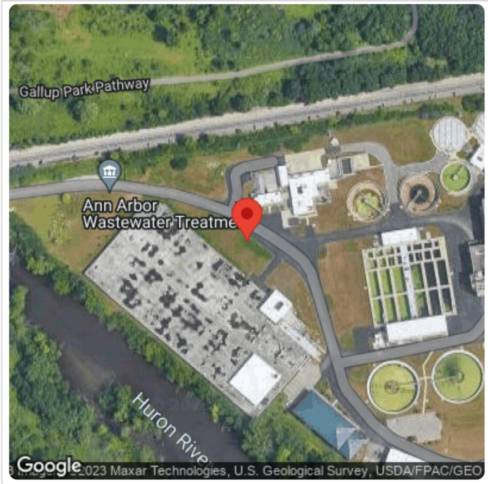
Report

Project Name	City of Ann Arbor - Water Recovery Plant
Project Address	49 S Dixboro Rd, Ann Arbor, MI 48105
Prepared By	Sachit Verma sachit.verma@novaconsultants.com

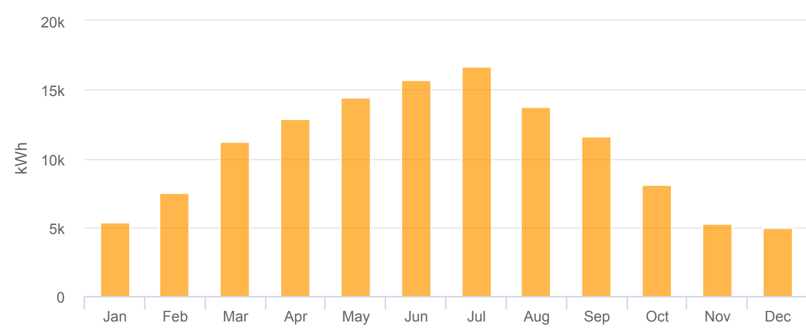
System Metrics

Design	100 kW
Module DC Nameplate	101.0 kW
Inverter AC Nameplate	75.0 kW Load Ratio: 1.35
Annual Production	127.5 MWh
Performance Ratio	84.8%
kWh/kWp	1,262.5
Weather Dataset	TMY, 10km grid (42.25,-83.65), NREL (prospector)
Simulator Version	0d27a6099b-50519a2d82-0789180870-6b85b19541

Project Location

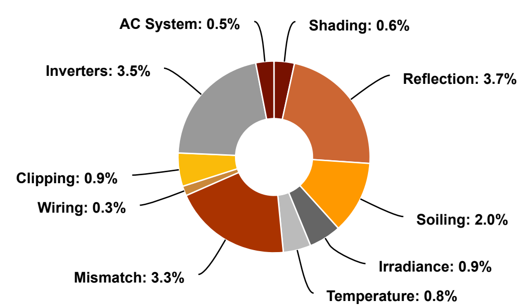


Monthly Production



Month	GHI (kWh/m^2)	POA (kWh/m^2)	Shaded (kWh/m^2)	Nameplate (kWh)	Grid (kWh)
January	51.1	60.0	58.7	5,484.5	5,333.9
February	72.5	82.6	81.9	7,715.9	7,501.1
March	115.7	124.8	124.3	11,823.7	11,170.9
April	142.8	149.4	148.9	14,246.2	12,911.4
May	167.4	170.9	170.3	16,299.0	14,475.1
June	185.4	188.4	187.8	18,024.7	15,718.5
July	196.4	200.1	199.5	19,140.2	16,669.3
August	159.1	165.1	164.5	15,776.3	13,722.4
September	127.5	137.0	136.6	13,034.3	11,629.8
October	84.4	92.9	92.5	8,760.4	8,064.5
November	53.1	60.6	60.0	5,630.5	5,276.6
December	47.9	57.5	56.0	5,222.9	5,010.1

Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,403.3	
	POA Irradiance	1,489.3	6.1%
	Shaded Irradiance	1,480.9	-0.6%
	Irradiance after Reflection	1,426.2	-3.7%
	Irradiance after Soiling	1,397.7	-2.0%
	Total Collector Irradiance	**1,397.7**	**0.0%**
Energy (kWh)	Nameplate	141,158.5	
	Output at Irradiance Levels	139,902.7	-0.9%
	Output at Cell Temperature Derate	138,837.4	-0.8%
	Output After Mismatch	134,315.9	-3.3%
	Optimal DC Output	133,955.8	-0.3%

Condition Set

Description	Condition Set 1
Weather Dataset	TMY, 10km grid (42.25,-83.65), NREL (prospector)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.075	3°C
Flush Mount	-2.81	-0.0455	0°C
East-West	-3.56	-0.075	3°C
Carport	-3.56	-0.075	3°C

Soiling (%)	J	F	M	A	M	J	J	A	S	O	N	D

	Constrained DC Output	132,727.4	-0.9%
	Inverter Output	128,124.4	-3.5%
	Energy to Grid	**127,483.7**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		11.6 °C
	Avg. Operating Cell Temp		18.7 °C
Simulation Metrics			
	Operating Hours		4629
	Solved Hours		4629

	2	2	2	2	2	2	2	2	2	2	2	2
Irradiation Variance	5%											
Cell Temperature Spread	4° C											
Module Binning Range	-2.5% to 2.5%											
AC System Derate	0.50%											

Trackers	**Maximum Angle**	**Backtracking**
	60°	Enabled

Module Characterizations	**Module**	**Uploaded By**	**Characterization**
	JAM72S30-540/MR (1000V) (JA Solar)	HelioScope	Spec Sheet Characterization, PAN
Component Characterizations	**Device**	**Uploaded By**	**Characterization**
	Symo Advanced 15.0-3 / 480_OND (Fronius USA)	HelioScope	Default Characterization

Components

Component	Name	Count
Inverters	Symo Advanced 15.0-3 / 480_OND (Fronius USA)	5 (75.0 kW)
Strings	10 AWG (Copper)	15 (690.9 ft)
Module	JA Solar, JAM72S30-540/MR (1000V) (540W)	187 (101.0 kW)

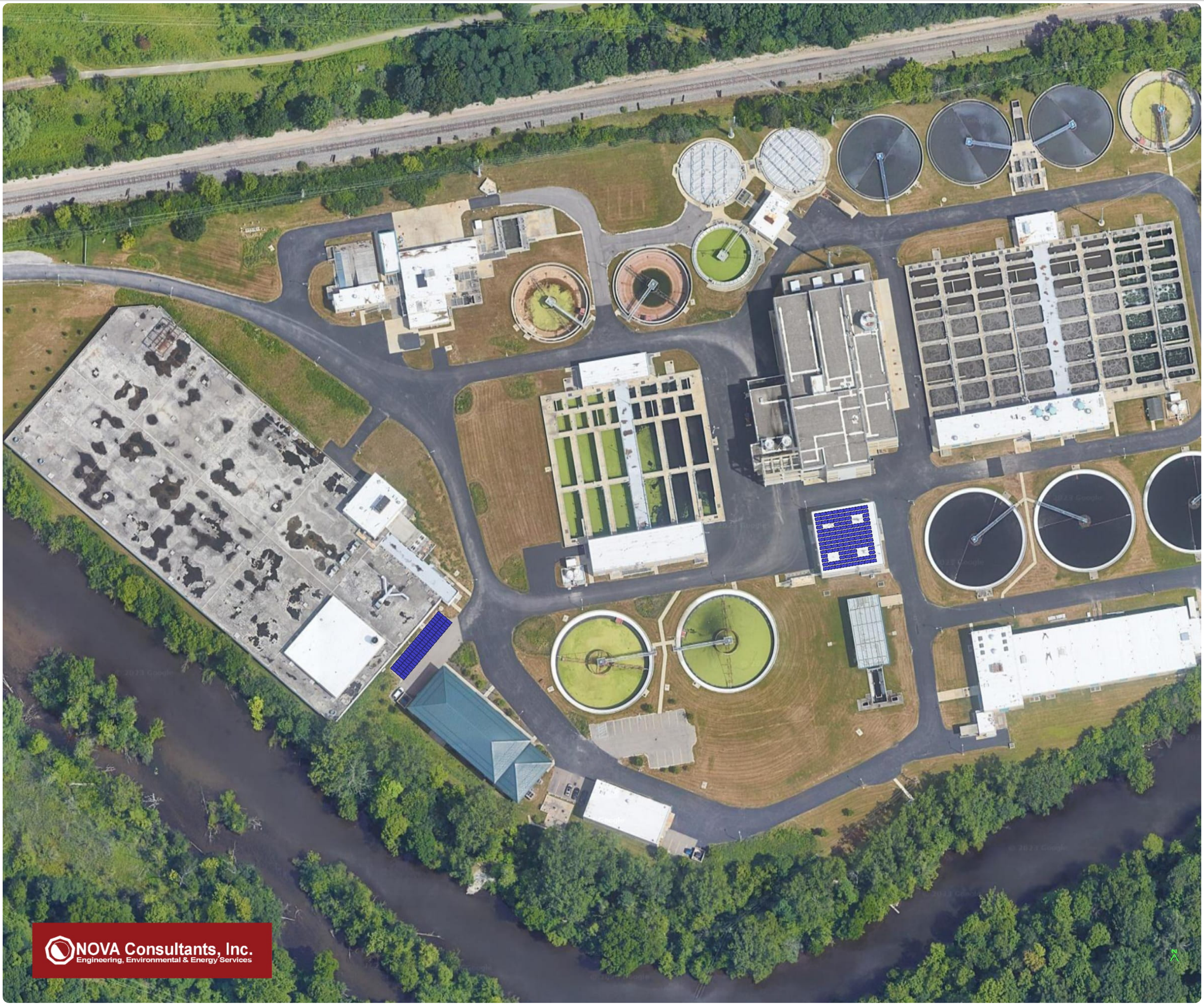
Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
East middle bldg	-	5-17	Along Racking
Canopy	-	5-17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Canopy	Carport	Portrait (Vertical)	7°	130.18846°	0.0 ft	1x1	75	75	40.5 kW
East middle bldg	Fixed Tilt	Landscape (Horizontal)	10°	170.55421°	1.6 ft	1x1	112	112	60.5 kW

Detailed Layout



Attachment 3 – Equipment Datasheets

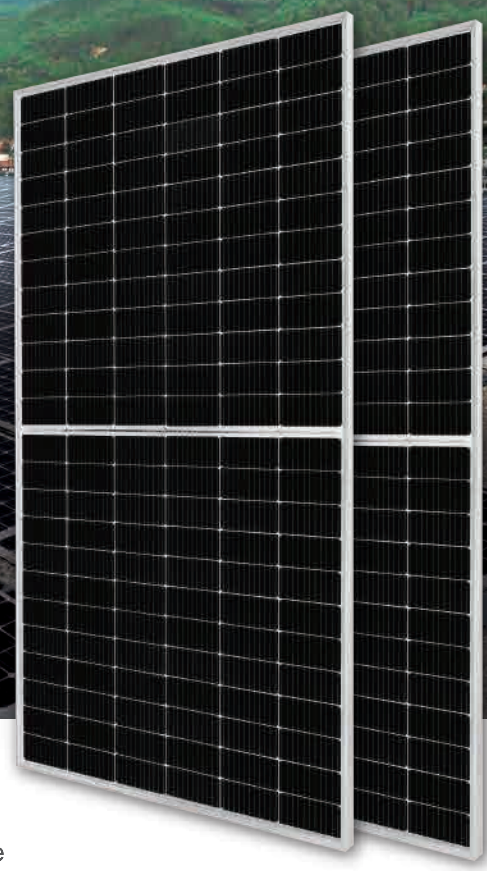
Harvest the Sunshine

DEEP BLUE 3.0

Mono

550W MBB Bifacial Mono PERC Half-cell Double Glass Module

JAM72D30 525-550/MB Series



Introduction

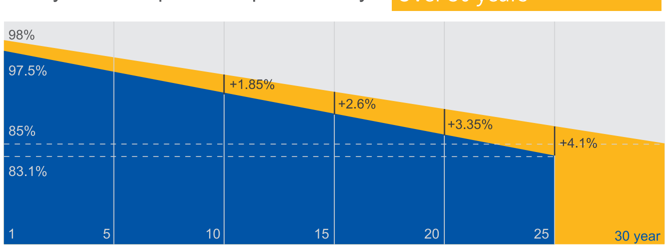
Assembled with 11BB bifacial PERCIUM cells and half-cell configuration, these double glass modules have the capability of converting the incident light from the rear side together with the front side into electricity, providing higher output power, lower temperature coefficient, less shading loss, as well as enhanced tolerance for mechanical loading.

- Higher output power
- More reliable, more stable power generation
- Less shading effect
- Lower temperature coefficient

Superior Warranty

- 12-year product warranty
- 30-year linear power output warranty

0.45% Annual Degradation Over 30 years



- Bifacial double glass module linear power warranty
- Standard module linear power warranty

Comprehensive Certificates

- IEC 61215, IEC 61730,UL 61215, UL 61730
- ISO 9001: 2015 Quality management systems
- ISO 14001: 2015 Environmental management systems
- ISO 45001: 2018 Occupational health and safety management systems
- IEC TS 62941: 2016 Terrestrial photovoltaic (PV) modules – Guidelines for increased confidence in PV module design qualification and type approval

JA SOLAR

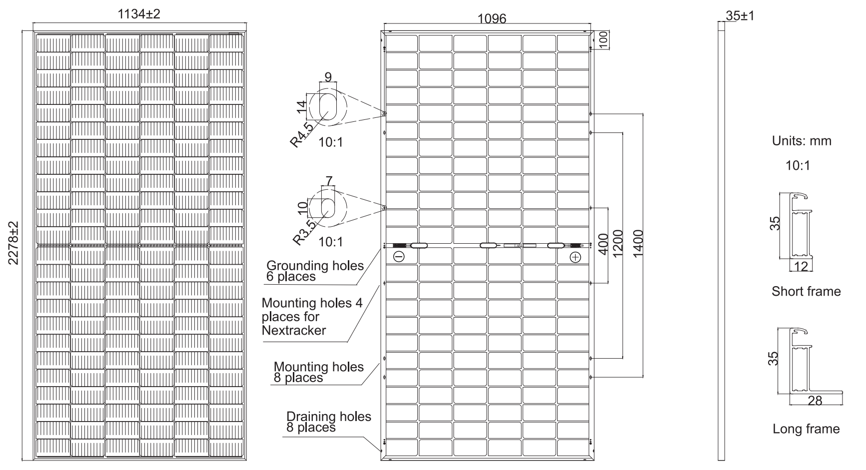
www.jasolar.com

Specifications subject to technical changes and tests.
JA Solar reserves the right of final interpretation.

JA SOLAR

JAM72D30 525-550/MB Series

MECHANICAL DIAGRAMS



Remark: customized frame color and cable length available upon request

SPECIFICATIONS

Cell	Mono
Weight	31.8kg±3%
Dimensions	2278±2mm×1134±2mm×35±1mm
Cable Cross Section Size	4mm² （IEC), 12 AWG(UL)
No. of cells	144(6×24）
Junction Box	IP68, 3 diodes
Connector	MC4-EVO2
Cable Length (Including Connector)	Portrait:300mm(+)/400mm(-); Landscape:1300mm(+)/1300mm(-)
Front Glass/Back Glass	2.0mm/2.0mm
Packaging Configuration	31pcs/Pallet 589pcs/40HQ Container

ELECTRICAL PARAMETERS AT STC

TYPE	JAM72D30 -525/MB	JAM72D30 -530/MB	JAM72D30 -535/MB	JAM72D30 -540/MB	JAM72D30 -545/MB	JAM72D30 -550/MB
Rated Maximum Power(Pmax) [W]	525	530	535	540	545	550
Open Circuit Voltage(Voc) [V]	49.15	49.30	49.45	49.60	49.75	49.90
Maximum Power Voltage(Vmp) [V]	41.15	41.31	41.47	41.64	41.80	41.96
Short Circuit Current(Isc) [A]	13.65	13.72	13.79	13.86	13.93	14.00
Maximum Power Current(Imp) [A]	12.76	12.83	12.90	12.97	13.04	13.11
Module Efficiency [%]	20.3	20.5	20.7	20.9	21.1	21.3
Power Tolerance	0~+5W					
Temperature Coefficient of Isc(α_Isc)	+0.045%/℃					
Temperature Coefficient of Voc(β_Voc)	-0.275%/℃					
Temperature Coefficient of Pmax(γ_Pmp)	-0.350%/℃					
STC	Irradiance 1000W/m², cell temperature 25℃, AM1.5G					

Remark: Electrical data in this catalog do not refer to a single module and they are not part of the offer.They only serve for comparison among different module types.

ELECTRICAL CHARACTERISTICS WITH 10% SOLAR IRRADIATION RATIO

TYPE	JAM72D30 -525/MB	JAM72D30 -530/MB	JAM72D30 -535/MB	JAM72D30 -540/MB	JAM72D30 -545/MB	JAM72D30 -550/MB
Rated Max Power(Pmax) [W]	562	567	572	578	583	589
Open Circuit Voltage(Voc) [V]	49.54	49.67	49.80	49.93	50.03	50.21
Max Power Voltage(Vmp) [V]	41.14	41.31	41.47	41.65	41.78	41.95
Short Circuit Current(Isc) [A]	14.61	14.68	14.76	14.83	14.91	14.98
Max Power Current(Imp) [A]	13.65	13.73	13.80	13.88	13.95	14.03
Irradiation Ratio(rear/front)	10%					

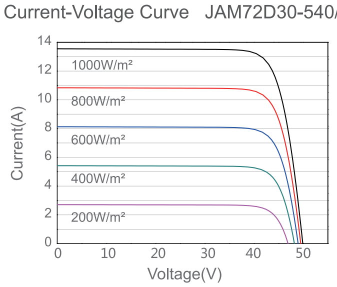
*For NexTracker installations, Maximum Static Load, Front is 2400Pa while Maximum Static Load, Back is 2400Pa.
**Bifaciality=Pmax,rear/Rated Pmax,front

OPERATING CONDITIONS

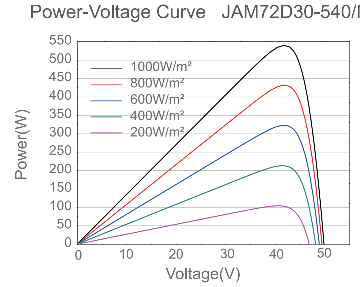
Maximum System Voltage	1500V DC
Operating Temperature	-40℃~+85℃
Maximum Series Fuse Rating	30A
Maximum Static Load,Front* Maximum Static Load,Back*	5400Pa(112 lb/ft²) 2400Pa(50 lb/ft²)
NOCT	45±2℃
Bifaciality**	70%±10%
Fire Performance	UL Type 29

CHARACTERISTICS

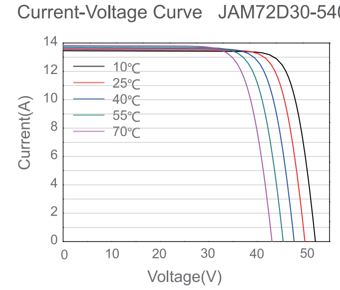
Current-Voltage Curve JAM72D30-540/MB



Power-Voltage Curve JAM72D30-540/MB



Current-Voltage Curve JAM72D30-540/MB



Premium Cells, Premium Modules

/ Perfect Welding / Solar Energy / Perfect Charging

FRONIUS SYMO ADVANCED

Powering three-phase projects that last -
now with integrated SunSpec PLC

PC board replacement concept

SnapINverter Technology

Integrated Data Communication

Smart Grid Ready

SuperFlex Design

Power Line Communication

Featuring ten models ranging from 10 kW to 24 kW, the Fronius Symo Advanced is the ideal inverter for commercial applications.

The new Advanced versions combine the benefits of the Fronius Symo with additional value for states with Module Level Shutdown requirements including integrated PLC transmitter for SunSpec Rapid Shutdown communication standard, compliance with NEC pre-2014, 2014 and 2017, zero tilt mounting, light weight and field serviceability.

TECHNICAL DATA FRONIUS SYMO ADVANCED (208-240 V VERSIONS)

INPUT DATA	SYMO 10.0-3 208-240		SYMO 12.0-3 208-240	
	208 V	240 V	208 V	240 V
Max. PV generator output ($P_{dc\ max}$)	15 kW_{peak}		18 kW_{peak}	
Max. input current ($I_{dc\ max1}$ / $I_{dc\ max2}$)	25 A / 16.5 A			
Max. array short circuit current (MPP1 / MPP2)	37.5 A / 24.8 A			
Nominal input voltage	350 V	370 V	350 V	370 V
DC input voltage range ($U_{dc\ min}$ + $U_{dc\ max}$)	200 - 600 V			
Feed-in start voltage ($U_{dc\ start}$)	200 V			
Usable MPP voltage range ($U_{mpp\ min}$ + $U_{mpp\ max}$)	300 - 500 V			
Max. input voltage	600 V			
Admissable conductor size DC	AWG 14-AWG 6 copper direct, AWG 6 aluminum direct, AWG 4-AWG 2 copper or aluminum with input combiner			
Number of MPP trackers	2			

OUTPUT DATA	SYMO 10.0-3 208-240		SYMO 12.0-3 208-240	
	208 V	240 V	208 V	240 V
AC nominal output ($P_{ac,r}$)	9,995 W		11,995 W	
Max. output power	9,995 VA		11,995 VA	
Output configuration	208 / 240 V			
Frequency range (f_{min} - f_{max})	45 - 60 Hz			
Admissable conductor size AC	AWG 14 - AWG 6			
Total harmonic distortion	< 1.5 %		< 1.75 %	
Power factor (cos $\phi_{ac,r}$)	0-1 ind. / cap.			
Max. continuous output current	27.7 A	24 A	33.3 A	28.9 A
OCPD/AC breaker size	35 A	30 A	45 A	40 A

EFFICIENCY	SYMO 10.0-3 208-240		SYMO 12.0-3 208-240	
	208 V	240 V	208 V	240 V
Max. Efficiency	97.0 %			
CEC Efficiency	96.5 %		96.5 %	

TECHNICAL DATA FRONIUS SYMO (208-240 V VERSIONS)

GENERAL DATA	SYMO 10.0-3 208-240	SYMO 12.0-3 208-240
Dimensions (height x width x depth)	510 x 725 x 225 mm (20.1 x 28.5 x 8.9 inches)	
Weight	41.7 kg (91.9 lbs)	
Protection Class	NEMA 4X	
Night time consumption	< 1 W	
Inverter topology	Transformerless	
Cooling	Regulated air cooling	
Installation	Indoor and outdoor installation, tilt from 0 - 90 degrees [1]	
DIN rail (length x width x depth)	max. 106 x 90 x 66 mm (max. 4.2 x 3.5 x 2.6 inches)	
Ambient operating temperature range	-40 - +60 °C (-40 - +140 °F)	
Permitted humidity	0 - 100 % (non-condensing)	
Elevation	max. input voltage of 600 V up to 3,400 m (11.155 ft)	
DC connection technology	6x DC+ and 6x DC- screw terminals for copper (solid / stranded / fine stranded) or aluminum (solid / stranded)	
AC connection technology	Screw terminals 14-6 AWG	
Certificates and compliance with standards	UL 1741-2010 Second Edition (incl. UL1741 Supplement SA 2016-09 for California Rule 21 and Hawaiian Electric Code Rule 14H), UL1998 (for functions: AFCI, RCMU and isolation monitoring), IEEE 1547-2003, IEEE 1547a-2014, IEEE 1547.1-2003, ANSI/IEEE C62.41, FCC Part 15 A & B, NEC 2017 Article 690, C22. 2 No. 107.1-16, UL1699B Issue 2 -2013, CSA TIL M-07 Issue 1 -2013	

[1] Fronius Shade Cover required for installation angles less than 15 degree

PROTECTIVE DEVICES	SYMO 10.0-3 208-240	SYMO 12.0-3 208-240
DC reverse polarity protection	Yes	
Anti islanding	Yes	
Over temperature protection	Output power derating /Active cooling	
AFCI	Yes	
Rapid shutdown compliant	Yes	
Ground Fault Protection with Isolation Monitor Interrupter	Yes	
DC disconnector	Yes	

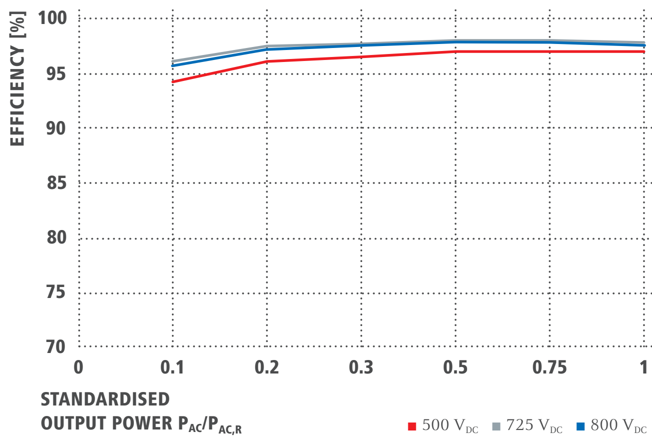
INTERFACES	SYMO 10.0-3 208-240	SYMO 12.0-3 208-240
USB (A socket)	Datalogging and inverter update possible via USB	
2x RS422 (RJ45 socket)	Fronius Solar Net, interface protocol	
Power Line Communication (PLC)	Yes – SunSpec Rapid Shutdown communication standard	
Wi-Fi/Ethernet/Serial/ Datalogger and webserver [2]	Wireless standard 802.11 b/g/n / Fronius Solar.web, SunSpec Modbus TCP, JSON / SunSpec Modbus RTU	
6 inputs and 4 digital I/Os [2]	Load management; signaling, multipurpose I/O	

[2] Available with the Fronius Datamanager 2.0 Card (only one card required for up to 100 inverters)

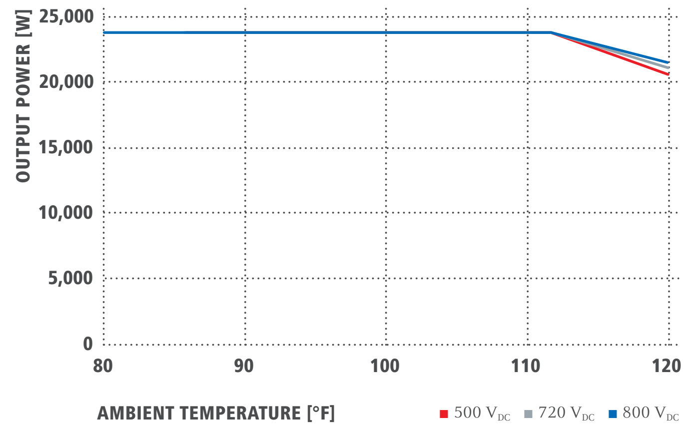
TECHNICAL DATA FRONIUS SYMO (480 V VERSIONS)

INPUT DATA	SYMO 15.0-3 480	SYMO 20.0-3 480	SYMO 22.7-3 480	SYMO 24.0-3 480
Max. PV generator output ($P_{dc\ max}$)	22.5 kW_{peak}	30 kW_{peak}	34 kW_{peak}	36 kW_{peak}
Max. input current ($I_{dc\ max1}$ / $I_{dc\ max2}$)	33 A / 25 A			
Max. array short circuit current (MPP1 / MPP2)	49.5 A / 37.5 A			
Nominal input voltage	685 V	710 V	720 V	
DC input voltage range ($U_{dc\ min}$ + $U_{dc\ max}$)	200 - 1,000 V			
DC startup voltage	200 V			
Usable MPP voltage range ($U_{mpp\ min}$ + $U_{mpp\ max}$)	350 - 800 V	450 - 800 V	500 - 800 V	
Max. input voltage	1,000 V			
Admissable conductor size DC	AWG 14 - AWG 6 copper direct, AWG 6 aluminum direct, AWG 4 - AWG 2 copper or aluminum with input combiner			
Number of MPP trackers	2			

FRONIUS SYMO 24.0-3 480 CEC EFFICIENCY CURVE



FRONIUS SYMO 24.0-3 480 TEMPERATURE DERATING CURVE



TECHNICAL DATA FRONIUS SYMO (480 V VERSIONS)

OUTPUT DATA	SYMO 15.0-3 480	SYMO 20.0-3 480	SYMO 22.7-3 480	SYMO 24.0-3 480
AC nominal Ouput ($P_{ac,r}$)	14,995 W	19,995 W	22,727 W	23,995 W
Max. ouput power	14,995 VA	19,995 VA	22,727 VA	23,995 VA
Grid connection	480 / 277 V WYE [3]			
Frequency (frequency range f_{min} - f_{max})	60 Hz (45 - 65 Hz)			
Admissable conductor size (AC)	AWG 14-AWG 6			
Total harmonic distortion	< 1.5 %	< 1 %	< 1.25 %	< 1 %
Power factor ($C_{os\ ac,r}$)	0-1 ind. / cap.			
Max. continuous output current	18 A	24 A	27.3 A	28.9 A
OCPD/AC breaker size	25 A	30 A	35 A	40 A

EFFICIENCY	SYMO 15.0-3 480	SYMO 20.0-3 480	SYMO 22.7-3 480	SYMO 24.0-3 480
Max. Efficiency	98 %			
CEC Efficiency	97 %	97.5 %		

GENERAL DATA	SYMO 15.0-3 480	SYMO 20.0-3 480	SYMO 22.7-3 480	SYMO 24.0-3 480
Dimensions (height x width x depth)	510 x 725 x 225 mm (20.1 x 28.5 x 8.9 inches)			
Weight	43.4 kg (95.7 lbs)			
Protection Class	NEMA 4X			
Night time consumption	< 1 W			
Inverter topology	Transformerless			
Cooling	Regulated air cooling			
Installation	Indoor and outdoor installation, tilt from 0 - 90 degree [4]			
DIN rail (length x width x depth)	max. 106 x 90 x 66 mm (max. 4.2 x 3.5 x 2.6 inches)			
Ambient operating temperature range	-40 - +60 °C (-40°F - + 140 °F)			
Permitted humidity	0 - 100 % (non-condensing)			
Elevation	2000 m (6562 ft) with a max. input voltage of 1000 V / 3400 m (11155 ft) with a max. input voltage of 850 V			
DC connection technology	6x DC+ and 6x DC- screw terminals for copper (solid / stranded / fine stranded) or aluminum (solid / stranded)			
AC connection technology	Screw terminals 14-6 AWG			
Certificates and compliance with standards	UL 1741-2010 Second Edition (incl. UL1741 Supplement SA 2016-09 for California Rule 21 and Hawaiian Electric Code Rule 14H), UL1998 (for functions: AFCI, RCMU and isolation monitoring), IEEE 1547-2003, IEEE 1547a-2014, IEEE 1547.1-2003, ANSI/IEEE C62.41, FCC Part 15 A & B, NEC 2017 Article 690, C22. 2 No. 107.1-16, UL1699B Issue 2 -2013, CSA TIL M-07 Issue 1 -2013			

[3] +N for sensing purposes - no current carrying conductor
[4] Fronius Shade Cover required for installation angles less than 15 degree

PROTECTIVE DEVICES	SYMO 15.0-3 480	SYMO 20.0-3 480	SYMO 22.7-3 480	SYMO 24.0-3 480
DC reverse polarity protection	Yes			
Anti islanding	Yes			
Over temperature protection	Ouput power derating / Active cooling			
AFCI	Yes			
Rapid shutdown compliant	Yes			
Ground Fault Protection with Isolation Monitor Interrupter	Yes			
DC disconnector	Yes			

INTERFACES	SYMO 15.0-3 480	SYMO 20.0-3 480	SYMO 22.7-3 480	SYMO 24.0-3 480
USB (A socket)	Datalogging and inverter update possible via USB			
2x RS422 (RJ45 socket)	Fronius Solar Net, interface protocol			
Power Line Communication (PLC)	Yes – SunSpec Rapid Shutdown communication standard			
Wi-Fi/Ethernet/Serial/ Datalogger and webserver [2]	Wireless standard 802.11 b/g/n / Fronius Solar.web, SunSpec Modbus TCP, JSON / SunSpec Modbus RTU			
6 inputs and 4 digital I/Os [2]	Load management; signaling, multipurpose I/O			

[2] Available with the Fronius Datamanager 2.0 Card (only one card required for up to 100 inverters)

/ Perfect Welding / Solar Energy / Perfect Charging

THREE BUSINESS UNITS, ONE GOAL: TO SET THE STANDARD THROUGH TECHNOLOGICAL ADVANCEMENT.

What began in 1945 as a one-man operation now sets technological standards in the fields of welding technology, photovoltaics and battery charging. Today, the company has around 4,760 employees worldwide and 1,253 patents for product development show the innovative spirit within the company. Sustainable development means for us to implement environmentally relevant and social aspects equally with economic factors. Our goal has remained constant throughout: to be the innovation leader.

Further information about all Fronius products and our global sales partners and representatives can be found at **www.fronius.com**

Rapid Shutdown CERTIFIED

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pv-sales@fronius.com
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as17

EN v01 Feb 2020

/ Perfect Welding / Solar Energy / Perfect Charging

FRONIUS PRIMO

/ Solutions for a brighter tomorrow.

/ PC board replacement process

/ SnapINverter mounting system

/ Wi-Fi®* interface

/ Design Flexibility

/ Smart Grid Ready

/ Arc Fault Circuit Interruption

/ With power categories ranging from 3.8 kW to 15.0 kW, the transformerless Fronius Primo is the ideal compact single-phase inverter for residential applications. The sleek design is equipped with the SnapINverter hinge mounting system which allows for lightweight, secure and convenient installation. The Fronius Primo has several integrated features that set it apart from competitors including dual powerpoint trackers, high system voltage, a wide input voltage range, Wi-Fi* and SunSpec Modbus interface, and Fronius' online and mobile monitoring platform Fronius Solar.web. The Fronius Primo also works seamlessly with the Fronius Rapid Shutdown Box as a reliable rapid shutdown solution outside the PV Array boundary.

TECHNICAL DATA FRONIUS PRIMO

GENERAL DATA	FRONIUS PRIMO 3.8 - 8.2	FRONIUS PRIMO 10.0-15.0
Dimensions (width x height x depth)	16.9 x 24.7 x 8.1 in.	20.1 x 28.5 x 8.9 in.
Weight	47.29 lb.	82.5 lbs.
Protection Class	NEMA 4X	
Night time consumption	< 1 W	
Inverter topology	Transformerless	
Cooling	Variable speed fan	
Installation	Indoor and outdoor installation	
Ambient operating temperature range	-40 - 131°F (-40 - 55°C)	-40 - 140°F (-40 - 60°C)
Permitted humidity	0 - 100 %	
Elevation	4000m (13123 ft)	
DC connection terminals	4x DC+ and 4x DC- screw terminals for copper (solid / stranded / fine stranded) or aluminum (solid / stranded)	4x DC+1, 2x DC+2 and 6x DC- screw terminals for copper (solid / stranded / fine stranded) or aluminum (solid / stranded)
AC connection terminals	Screw terminals 12 - 6 AWG	
Revenue Grade Metering	Optional (ANSI C12.1 accuracy)	
Certificates and compliance with standards	UL 1741-2010 Second Edition (incl. UL1741 Supplement SA 2016-09 for California Rule 21 and Hawaiian Electric Code Rule 14H), UL1998 (for functions: AFCI, RCMU and isolation monitoring), IEEE 1547-2003, IEEE 1547.1-2003, ANSI/IEEE C62.41, FCC Part 15 A & B, NEC 2017 Article 690, C22. 2 No. 107.1-16, UL1699B Issue 2 -2013, CSA TIL M-07 Issue 1 – 2013	UL 1741-2010 Second Edition (incl. UL1741 Supplement SA 2016-09 for California Rule 21 and Hawaiian Electric Code Rule 14H), UL1998 (for functions: AFCI, RCMU and isolation monitoring), IEEE 1547-2003, IEEE 1547.1-2003, ANSI/IEEE C62.41, FCC Part 15 A & B, NEC 2017 Article 690, C22. 2 No. 107.1-16, UL1699B Issue 2 -2013, CSA TIL M-07 Issue 1 -2013

PROTECTIVE DEVICES	STANDARD WITH ALL PRIMO MODELS
DC reverse polarity protection	Yes
Anti Islanding	Internal; in accordance with UL 1741-2016-09, IEEE 1547-2003 and NEC 2017
Over temperature protection	Output power derating/ Active cooling
AFCI	Yes
Rapid shutdown compliant	Per Sect. 690.12 of 2014 (of NEC 2017 prior to Jan 2019)
Ground Fault Protection with Isolation Monitor Interrupter	Yes
DC disconnect	Yes

INTERFACES	STANDARD WITH ALL PRIMO MODELS
USB (A socket)	Datalogging and inverter update possible via USB
2x RS422 (RJ45 socket)	Fronius Solar Net, interface protocol
Wi-fi*/Ethernet LAN	Wireless standard 802.1 1 b/g/n/Fronius Solar.web, SunSpec Modbus TCP, JSON
Datalogger and Webserver	Included
Serial RS485	SunSpec Modbus RTU or meter connection
6 inputs or 4 digital inputs/outputs	Load management; signaling, multipurpose I/O

*The term Wi-Fi® is a registered trademark of the Wi-Fi Alliance.

TECHNICAL DATA FRONIUS PRIMO

INPUT DATA	PRIMO 3.8-1	PRIMO 5.0-1	PRIMO 6.0-1	PRIMO 7.6-1	PRIMO 8.2-1
Recommended PV power (kWp)	3.0 - 6.0 kW	4.0 - 7.8 kW	4.8 - 9.3 kW	6.1 - 11.7 kW	6.6 - 12.7 kW
Max. usable input current (MPPT 1/MPPT 2)	18 A / 18 A				
Max. usable input current (MPPT 1+MPPT 2)	36 A				
Max. array short circuit current (1.5* lmax) (MPPT1/MPPT2)	27 A / 27 A				
Nominal input voltage	410 V	420 V	420 V	420V	420 V
Operating voltage range	80 V - 600 V				
DC startup voltage	80 V				
MPP Voltage Range	200-480 V	200-400 V	240-480 V	250-480 V	270-480 V
Max. input voltage	600 V (1000 V optional[1])				
Admissible conductor size DC	AWG 14 - AWG 6 copper (solid / stranded / fine stranded)(AWG 10 copper or AWG 8 aluminium for overcurrent protective devices up to 60A, from 61 to 100A minimum AWG 8 for copper or AWG 6 aluminium has to be used) , AWG 6 - AWG 2 copper(solid / stranded) MultiContactWiringable with AWG 12				
Number of MPPT	2				

OUTPUT DATA		PRIMO 3.8-1	PRIMO 5.0-1	PRIMO 6.0-1	PRIMO 7.6-1	PRIMO 8.2-1
Max. output power	208 V/240 V	3800 VA/3800 VA	5000 VA/5000 VA	6000 VA/6000 VA	7600 VA/7600 VA	7900 VA/8200 VA
Output configuration		208/240 V				
Frequency range (adjustable)		45.0 - 55.0 Hz / 50 - 66 Hz				
Operating frequency range default for CAL setups		–/ 58.5 - 60.5 Hz				
Operating frequency range default for HI setups		–/ 57.0 - 63.0 Hz				
Nominal operating frequency		60 Hz				
Admissable conductor size AC		AWG 14 - AWG 6				
Total harmonic distortion		< 5.0 %				
Power factor range		0.85-1 ind./cap				
Max. continuous output current	208 V	18.3 A	24.0 A	28.8 A	36.5 A	38.0 A
	240 V	15.8 A	20.8 A	25.0 A	31.7 A	34.2 A
OCPD/AC breaker size	208V	25 A	30 A	40 A	50 A	50 A
	240 V	20 A	30 A	35 A	40 A	45 A
Max. Efficiency		96.7 %	96.9 %	96.9 %	96.9 %	97.0 %
CEC Efficiency		95.0 %	95.5 %	96.0 %	96.0 %	96.5 %

INPUT DATA	PRIMO 10.0-1	PRIMO 11.4-1	PRIMO 12.5-1	PRIMO 15.0-1
Recommended PV power (kWp)	8.0 - 12.0 kW	9.1 - 13.7 kW	10.0 - 15.0 kW	12.0 - 18.0 kW
Max. usable input current (MPPT 1/MPPT 2)	33.0 / 18.0 A			
Max. usable input current (MPPT 1+MPPT 2)	51 A			
Max. array short circuit current (1.5 * Imax)	49.5 A/ 27.0			
Nominal input voltage	655 V	660 V	665 V	680 V
Operating voltage range	80 V - 1,000 V			
DC startup voltage	80 V			
MPP Voltage Range	220-800 V	240-800 V	260-800 V	320-800 V
Max. input voltage	1000 V			
Admissible conductor size DC	AWG 14 - AWG 6 copper direct, AWG 6 aluminum direct (AWG 10 copper or AWG 8 aluminium for overcurrent protective devices up to 60A, from 61 to 100A minimum AWG 8 for copper or AWG 6 aluminium has to be used), AWG 4 - AWG 2 copper or alu-minum with optional input combiner			
Number of MPPT	2			
Integrated DC string fuse holders	4- and 4+ for MPPT 1 / no fusing required on MPPT 2			

OUTPUT DATA		PRIMO 10.0-1	PRIMO 11.4-1	PRIMO 12.5-1	PRIMO 15.0-1
Max. output power	208 V/240 V	9995 VA/9995 VA	11400 VA/11400 VA	12500 VA/12500 VA	13750 VA/15000 VA
Output configuration		1-NPE 208/240 V			
Frequency range (adjustable)		45-55 Hz / 50-66 Hz			
Operating frequency range default for CAL setups		–/ 58.5 - 60.5 Hz			
Operating frequency range default for HI setups		–/ 57.0 - 63.0 Hz			
Nominal operating frequency		60 Hz			
Admissible conductor size AC		AWG 10- AWG 2 copper (solid/stranded/fine stranded)(AWG 10 copper or AWG 8 aluminum for overcurrent protective devices up to 60 A, from 61 to 100A minimum AWG 6 aluminum has to be used), AWG 6-AWG 2 copper (solid/stranded) Multi Contact Wiring able with AWG 12			
Total harmonic distortion		< 2.5 %			
Power factor range		0-1 ind./cap.			
Max. continuous output current	208 V	48.1 A	54.8 A	60.1 A	66.1 A
	240 V	41.6 A	47.5 A	52.1 A	62.5 A
OCPD/AC breaker size	208 V	70 A	70 A	80 A	90 A
	240 V	60 A	60 A	70 A	80 A
Max. Efficiency		96.7 %			
CEC Efficiency 600 V/ 1000 V	240 V	96.0 % / 96.5 %			96.5 % / 97.0 %

[1] inverter rated for up to 1000 V open-circuit. Nominal, Operating, and MPP voltages based on 600 V system design. Actual DC system voltage is dependent on PV string-sizing, not inverter input capacity.

/ Perfect Welding / Solar Energy / Perfect Charging

THREE BUSINESS UNITS, ONE GOAL: TO SET THE STANDARD THROUGH TECHNOLOGICAL ADVANCEMENT.

What began in 1945 as a one-man operation now sets technological standards in the fields of welding technology, photovoltaics and battery charging. Today, the company has around 3,800 employees worldwide and 1,242 patents for product development show the innovative spirit within the company. Sustainable development means for us to implement environmentally relevant and social aspects equally with economic factors. Our goal has remained constant throughout: to be the innovation leader.

Further information about all Fronius products and our global sales partners and representatives can be found at **www.fronius.com**

v08 Aug 2017 EN

Fronius USA LLC
6797 Fronius Drive
Portage, IN 46368 USA
pv-support-usa@fronius.com
www.fronius-usa.com

SUNSPEC ALLIANCE

C US

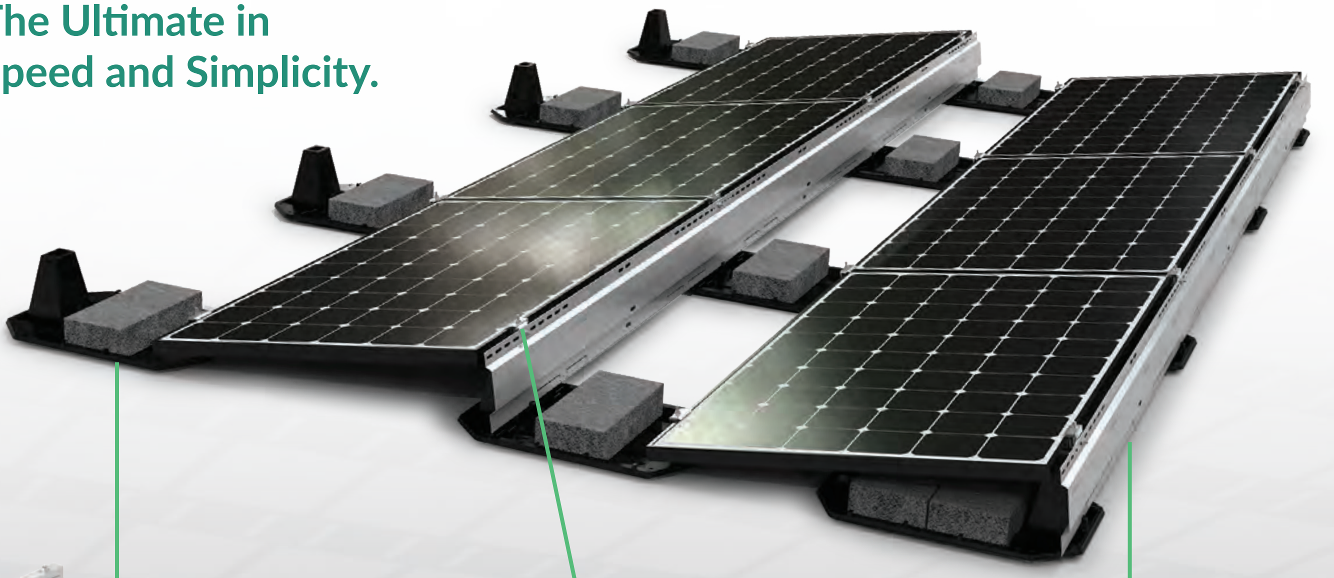
EcoFoot2+®

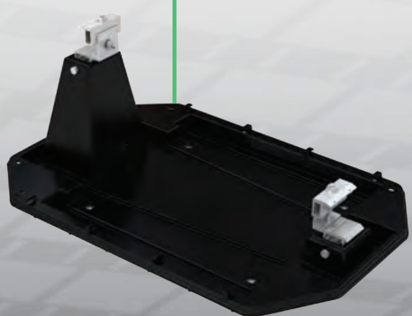
Ballasted Racking System

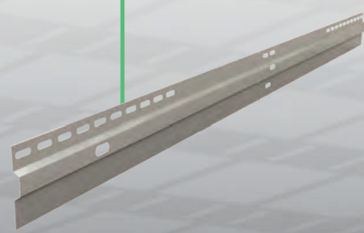
Installer-Preferred for Low-Slope Roofs

Three Main Components.

The Ultimate in Speed and Simplicity.







Base
UL-Listed ASA based resin is a durable material commonly used for automotive and construction products. Wire Clips are built-in for easy wire management. Class A fire rated and UL2703 Certified.

Universal Clamp
The preassembled Universal Clamp is ready to go right out of the box. Simply drop the Clamp into the Base. Integrated Bond Pin achieves integrated grounding without the use of grounding washers. Fits 30-50mm module frames with a single component.

Wind Deflector
Corrosion-resistant wind deflector on every module helps minimize uplift, reduce ballast requirements and carries UL2703 validated ground path from modules and racking components.

EcolibriumSolar

Contact: 740.249.1877 | sales@ecolibriumsolar.com | www.ecolibriumsolar.com

Pure Performance

Unbeatable, Right Out of the Box.

No other racking products install flat roof arrays better than EcoFoot2+ Racking Solution. Installers prefer EcoFoot2+ because it's fast, simple, and durable. The line-up is unbeatable:

- Ready-to-go, preassembled components and simple installation
- No PV panel prep required: bases self-align
- Low-effort roof layout, just two chalk lines required
- No training required, 5-minute learning curve

Master the Most Challenging Rooftop

Stackable Bases fit up to 50kW of Bases delivered on a standard pallet.

System Benefits

- Low part count
- Rapid system deployment
- Preassembled Universal Clamp
- Increased design flexibility
- More ballast capacity
- Simplified logistics
- Ship up to 50kW per pallet

Validation Summary

- Certified to UL2703 Fire Class A for Type I and II modules
- Certified to UL2703
- Grounding and Bonding
- Wind tunnel tested to 150mph
- SEAOC seismic compliant
- CFD and structurally tested
- DNV GL rated at 13.5 panels per installer-hour

Technical Specifications

Dimensions: 26.5"L x 18.25"W x 8.3"H
Typical System Weight: 3.5–6 lbs. per sq. ft.
Module orientation: Landscape/Portrait
Tilt angle: Landscape 10°/Portrait 5°
Module inter-row spacing: 18.9"
Roof pitch: 0° to 7°
Clamping range: 30-50mm
Ballast requirements: 4" x 8" x 16"
Warranty: 25 years
Slip sheets: not required by Ecolibrium Solar.
If required by roofer, use 20"x29" under Base.

Commercial

Residential

Design Flexibility

Wire Management Built-In

EcolibriumSolar

740-249-1877 | www.ecolibriumsolar.com
507 Richland Avenue, Athens, OH 45701

SDE

GENMOUNTS
SOLAR RACKING SYSTEMS

1.2 Megawatt Carport Array
Lawrence Township, NJ 08648

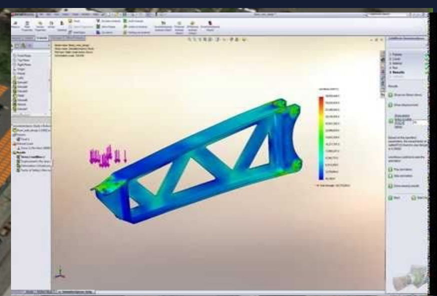
Solar Carport Systems

Engineering Services

Every carport project is unique, as multiple factors can impact the PV layout and structural design.

- ***Parking lot orientation and space***
- ***City/County/State Regulations***
- ***ASCE Hazard & Structural Guidelines***

No matter what variables arise, our executive engineering team will design a system that offers you the most cost effective solution for your project.



PV Production vs Aesthetics

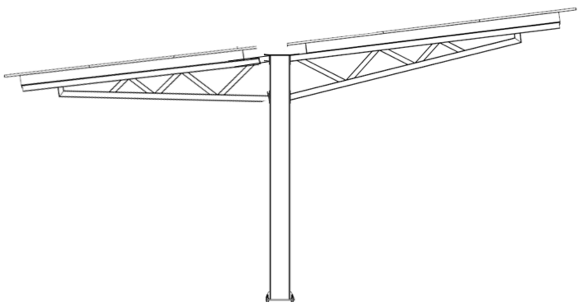
After our NABCEP PV designers finalize the layout that meets your energy production requirements, our structural and civil engineers will provide all of the certified drawings and calculations for permit approval.

SDE Product Standards

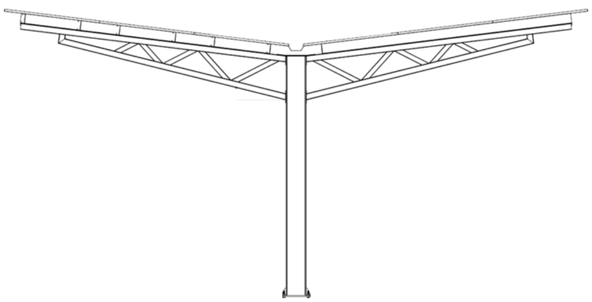
All structural components are in strict compliance with the standards set forth by the American Iron and Steel Institute's Specifications for Formed Steel Structural Members. SDE has invested in an ISO-9001 Quality certification (currently in progress).

ENGINEERING MANUFACTURING INSTALLATION

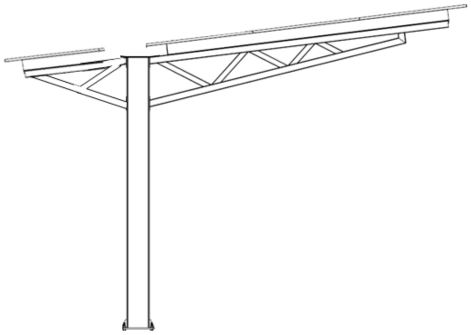
T-FRAME DESIGN (36x 72 Cell Modules/Section)



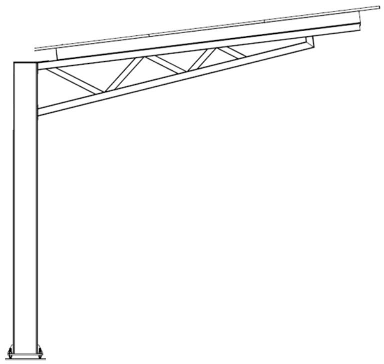
Y-FRAME DESIGN (36x 72 Cell Modules/Section)



L-FRAME DESIGN (24x 72 Cell Modules/Section)



L-FRAME DESIGN (18x 72 Cell Modules/Section)



Application	Parking Area & Sidewalks		
Tilt Angle	7 Degrees	Modules Per Section	36
Module Orientation	Portrait	Ground Clearance	Site Specific
Wind Load	125 MPH	Foundation	Reinforced Concrete
Snow Load	50 PSF	Purlin Length	236 Inches
Post Spacing	236 Inches	Manufacturing	Made in Michigan, USA

PRODUCT SPECIFICATIONS

All product specifications have been verified through third party engineering firms. For areas with higher wind/snow requirements, additional options are available.
20 - 34 foot section spans are available.

PRICING OVERVIEW

SDE calculated our average cost/watt prices, using 350 - 370 Watt Modules. Prices outlined below includes foundation cages, all required racking components, hardware, and freight.

36 PANEL Y or T FRAME CANOPIES: 30 - 35 CENTS/WATT

24 PANEL L FRAME CANOPIES: 40 - 45 CENTS/WATT

18 PANEL L FRAME CANOPIES: 45 - 50 CENTS/WATT

ENGINEERING **MANUFACTURING** INSTALLATION

SDE "owns" the manufacturing facility.... Why is this important?

- *No third party contracts*
- *No additional distributor profit margins*
- *No outsourced fabrication and steel processing*
- *We control 100% of your project time-line, which results in superior quality, quick response times, and faster product deployment.*

All structural components fabricated In-House

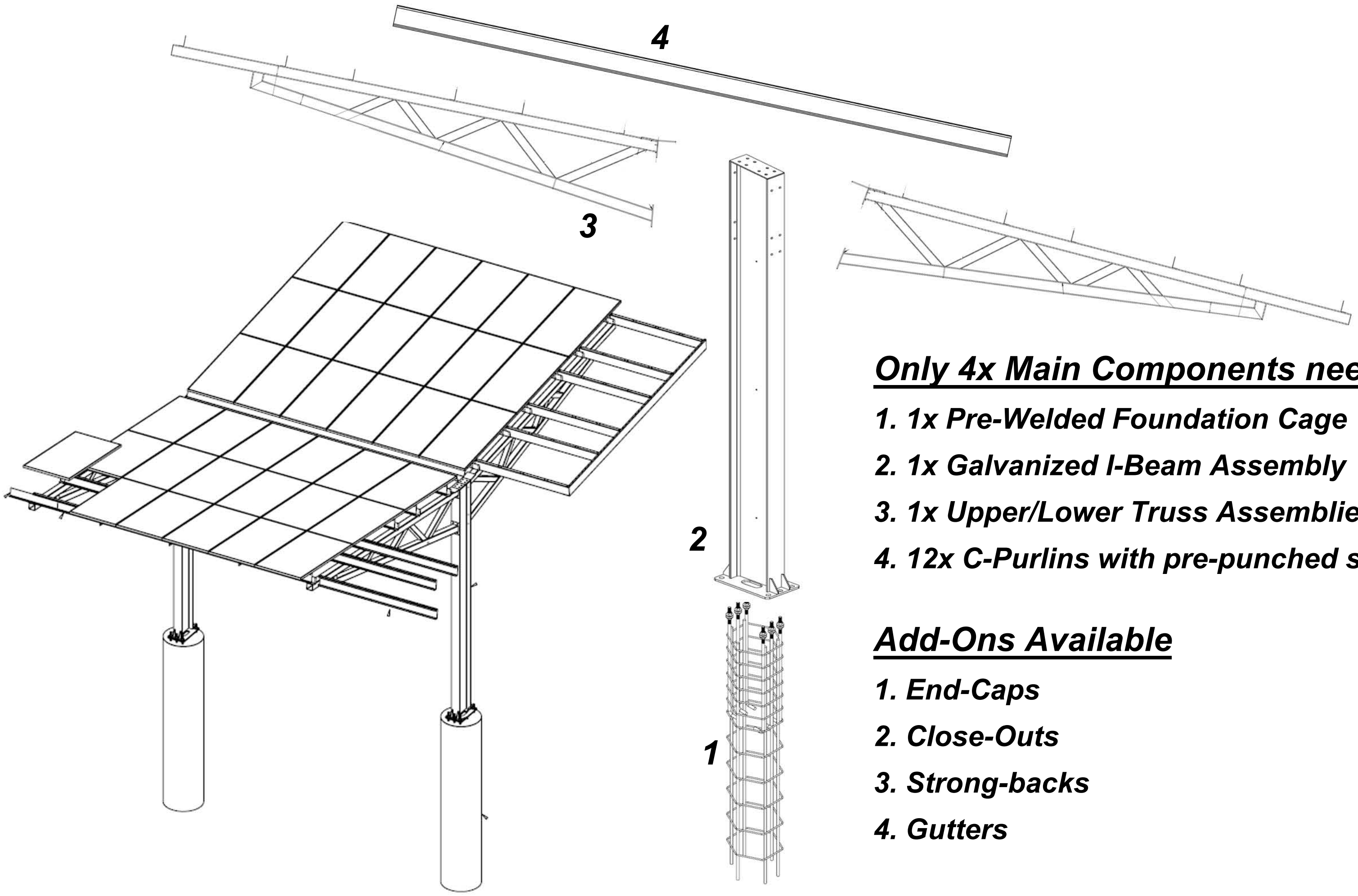
ENGINEERING MANUFACTURING **INSTALLATION**

Designed for Rapid Assembly

SLR-TRUSS: *All trusses are custom designed for your 60 or 72 cell module choice. Only 2 attachment points from I-Beam to Truss with minimal hardware.*

C-PURLIN: *No expensive clamps required* *The C-Purlins are processed through a high speed stamping/roll forming line. The slots are precision punched to align with your module frame holes, which results in faster installation times.*

EASE OF INSTALLATION - DESIGNED FOR MINIMAL EFFORT



Only 4x Main Components needed

1. 1x Pre-Welded Foundation Cage
2. 1x Galvanized I-Beam Assembly
3. 1x Upper/Lower Truss Assemblies
4. 12x C-Purlins with pre-punched slots

Add-Ons Available

1. End-Caps
2. Close-Outs
3. Strong-backs
4. Gutters

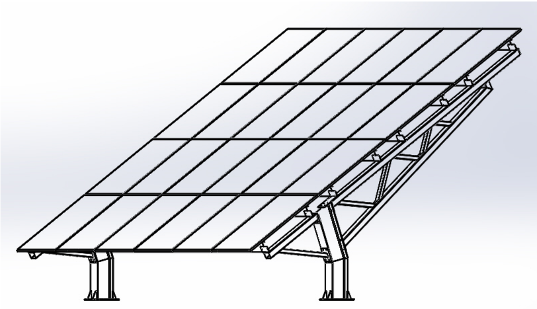
WE ALSO OFFER THE FOLLOWING:

BALLASTED COMMERCIAL ROOF MOUNTS

12 - 24 PANEL POLE MOUNTS SEASON ADJUST & DUAL AXIS TRACKING

SKY-RACK 2.0 GROUND MOUNTS

4x HIGH PORTRAIT GROUND MOUNTS



COMPANY OVERVIEW

SDE is a family-owned business established in 2007. Headquartered in Albion Michigan, we have grown to become an international manufacturer of Solar and SATCOM products. We currently employ between 25-30 personnel to support Engineering, Manufacturing, Installation, and Project Management.
We are committed to customer satisfaction through continuous improvement.

VISION

Our vision is to become a "one-stop-shop" for your solar project requirements. From preliminary designs to full installation support, we will be there for you!

Contact us today to get your project started.

CONTACT US

1104 Industrial Avenue
Albion Michigan
49224

phone +1 877 517 0311
email: kyle@sinclair-designs.net
www.sinclair-designs.com

MIDCOUR
YOUR EV CHARGING SOLUTION

MC-AX Series

48A-11kW Single Phase Wall-mount EV AC Charger

- Ideal for commercial EV charging
- LAN-Wi-Fi or LAN-Wi-Fi-4G options for connection for Central Management System
- Supports RFID card & QR code for user authentication and management
- Input: 200Vac~240Vac
- Modern, ergonomic and customizable design
- Optional 5 inch LCD display
- IP protection class for outdoors: NEMA4
- Supports Over the Air Technology
- Charging interface: SAE J1772 (Type 1)
- Supports OCPP 1.6 JSON (Upgradeable to 2.0)
- Supports RS232/485 external communication interface (Optional)
- Supports ISO 15118 protocol
- Supports dynamic output load distribution, making the field power configuration planning of charging stations more flexible

Applications

- Parking garages, hospitality & retail
- Commercial fleet operators
- EV infrastructure operators and service providers
- EV dealer workshops

Model Name		AXLU111
Safety		UL/Cul (North America)
Product Photo		
Power Specification		
AC Input	Input Rating	Single-phase: 200~240Vac
	AC Input Connection	L1/L2/GND or L/N/PE
	Input Current	48A
	Frequency	50Hz/60Hz
AC Output	Output Current	48A
	Output Power	11kW
User Interface & Control		
Display		LED pilot lamp (standard), 5-inch LCD (Optional)
User Authentication		RFID (ISO/IEC 14443A/B, ISO/IEC 15693, FeliCa™, Mifare), ISO 15118
Meter		Meter IC(1% Accuracy)
Communication		
External		LAN+WiFi (standard) or LAN+4G+WiFi (Optional)
Internal		OCPP 1.6 JSON (Upgradeable to 2.0) EEBUS (support in 2022)
Environmental		
Operating Temperature		-30C to +50 ℃ (standard) or -20 ℃ to +50 ℃ (with payment system)
Humidity		< 85% (RH) @ 50 ℃
Altitude		≦ 2000m
Enclosure Protection (IK/IP Level)		NEMA TYPE 4
Cooling Method		Natural Cooling
Mechanical		
Dimension(WxDxH)		Approx. 295 x 158 x 505mm
Weight		<7kg (with socket); <10kg (with plug)
Cable Length		5m / 7.5m (Option and need to use cable management)
Protection		
RCD/CCID		CCID 20
Input Side		UVP, OVP, Surge protection, Ground fault
Output Side		OCP, Control pilot fault, Residual current protection
Protocol		OTP, Relay welding detection, CCID self-test, MCU function fault detection
Regulation		
Certificate		UL2594, UL2231-1/-2, CTEP Energy Star
Wireless Certificate		FCC/IC
Charging Interface		SAEJ1772 Type 1 Plug

Attachment 4 – Personnel Resumes

Sunil K. Agrawal, Ph.D., P.E., Diplomate - AAEE
Project Manager/Senior Engineer

EXPERIENCE:
Dr. Agrawal is a Project Manager and Senior engineer for NOVA Consultants, Inc. He has more than 25 years of project management, environmental due diligence, environmental auditing, ISO 14000, engineering design and management experience. His specialties include project management, senior review, ISO 14000, brownfields redevelopment, asbestos and lead based paint, environmental audits, Phase II investigations, remedial investigations/feasibility studies (RI/FS), treatment of contaminated soils and ground water, industrial and municipal wastewater, treatment of hydrocarbon and heavy metals contaminated soils and sludge, treatment of hydrocarbon contaminated vapors, site assessments, NPDES and RCRA permitting.

EDUCATION:
Ph.D. Civil/Environmental Engineering, University of Windsor
M.S. Environmental Engineering, Asian Institute of Technology
B.S. Civil Engineering, University of Jabalpur

CERTIFICATIONS:
Registered Professional Engineer - State of Michigan
Diplomate - American Academy of Env. Engineers (Listed in Who's Who in Env. Engineering)
Certified Storm Water Manager – Michigan Department of Environmental Quality
Certified Underground Storage Tank Professional
RBCA Training by ASTM
HAZWOPER – 40 Hour Training and Annual Refreshers

MEMBERSHIPS:
American Academy of Environmental Engineers
Member - Water Environmental Federation (WEF)
Member - Michigan Water Pollution Control Association

WORK EXPERIENCE:

Project Director/Senior Engineer, NOVA Consultants, Inc., Novi, Michigan
Responsibilities include: supervision of a staff of 25 full-time and 5 part-time professionals. Technical review of all the projects, reports and correspondence before they are delivered to the clients. Supervision of several projects related to automotive plants, former MGP, commercial, industrial and institutional sites. These projects include construction management, ISO 14000, environmental audits, Phase I, Phase II and Phase III site

assessments, hydrogeological study, remedial investigations, remedial system design, construction package, review of system operation and maintenance data.

<u>Senior Engineer, Delta Environmental Consultants, Inc., Farmington Hills, Michigan</u>
Responsibilities included: Senior review of all the technical documents, development of Standard Operating Job Procedures (SOJP) for several field and office related tasks, client development, negotiations with the regulatory agencies, project management of several LUST and Act 307 sites, preparation of work plans, review of Phase I, Phase II and Phase III site assessment reports.

<u>Senior Project Engineer, NTH Consultants, Inc., Farmington Hills, Michigan</u>
Responsibilities included: Project management and supervision of several projects related to the design and field implementation of remediation activities. Supervision of geological and hydrogeological investigations and remedial design at CERCLA, RCRA and Act 307 sites. Preparation of Work Plans, Quality Assurance Project Plan (QAPP), Remedial Action Plan (RAP), Health and Safety Plans, Field Monitoring Plans.

<u>Project Manager/Engineer, Rama Rao & Alfred, Inc., Detroit, Michigan</u>
Responsibilities included: Project management and project engineering of several projects related to the design of water and wastewater treatment plants, sewer system and pumping station designs. Participated in several Value Engineering workshops as a member of the technical team to evaluate the designs of other consultants. Designed water mains, water treatment plans and booster stations. Installation of underground storage tanks and groundwater collection piping at a hazardous waste site.

Sachit Verma, MS, EIT
Program Manager - Solar

EXPERIENCE

Mr. Verma is a Program Manager and Solar engineer with NOVA Consultants, Inc. He has over 16 years of solar, energy, environmental, project management, resident engineering, environmental cost estimation, instrumentation & controls and process design engineering, environmental investigation and remediation experience. His expertise includes modeling, cost estimation, industrial wastewater treatment, design of remediation systems, hydrogeologic investigation, optimization of cooling towers, energy management systems, instrumentation and controls, chemical, and environmental engineering projects. He has extensive experience in subsurface contaminant transport, wastewater treatment, experimental design and installation of environmental systems, and sampling & analysis.

EDUCATION

M.S., Chemical Engineering, Louisiana State University, Baton Rouge, LA
B.S., Chemical Engineering, I.I.T.

PROFESSIONAL AFFILIATIONS

Engineer - In - Training (EIT)
Member - American Institute of Chemical Engineers (AIChE)

REPRESENTATIVE PROJECT EXPERIENCE

Currently working on about 20 solar projects in various states in United States and Ontario, Canada. Responsible for the project planning to feasibility, array sizing, technical evaluation, technology selection, quality assurance and quality control all solar projects.

Performed troubleshooting procedures for a PCB remediation system for wastewater at a major automotive facility, and implemented changes to the PLC based control system to successfully address the situation.

Performed troubleshooting procedures for the control system for a groundwater remediation system at a major automotive facility, and implemented changes to the sensors, relays, and the ladder logic for the PLC based control system to successfully solve the problem.

Designed and implemented the control system for air-sparging and soil vapor extraction systems to control the valve operating cycles, and ensure system shutoff if explosive vapors were detected.

Provided cost estimation services for numerous large and small projects. These projects included waste disposal, remediation, asbestos survey and abatement, environmental investigation, energy conservation projects etc.

Conducted design modifications and process troubleshooting procedures for a mobile DNAPL treatment system at a major automotive facility in Ohio, and successfully managed the project till contract closeout.

Performed several air sparging and soil vapor extraction pilot tests to determine remediation system design parameters, perform data interpretation and report preparation.

Designed and supervised construction of pump and treat systems, air sparge systems, and combined air sparging and soil vapor extraction systems for the treatment of soils and groundwater.

Assisted in the management of a $200 million expansion and renovation project for research complex at major automotive facility, until the project was temporarily halted by the client. Designed an extensive distribution system for ultra-pure gases using state-of-the-art safety and control systems, prepared meeting notes, and guided the non-technical managers towards sound technical decisions.

Performed risk assessment and managed the remediation of a PCB impacted site for future use in the beverage industry. The project was completed on time and within budget to the satisfaction of the client.

Managed the UST assessment and upgrade activities for five USTs involving non-destructive testing and cathodic protection systems. Coordinated activities among eight independent sub-contractors, attorneys, and the MDEQ with minimal disruption to ongoing site activities.

Managed the revision of several complex SPCC plans for a major gas and electrical utility company to reflect revised EPA regulations.

Successfully solved a 12-year old environmental problem related wastewater discharge at a school district bus garage using an innovative process strategy for waste management, treatment, and disposal, while maintaining compliance with applicable environmental rules and regulations.

Coordinated site investigation and remediation activities at a major utility company field office to address the issue of unknown source releases, including access agreements from adjacent property owners and liaison with the MDEQ.

Jeffrey M. Eckhout, EIT
Project Manager

Mr. Eckhout is a Project Manager with NOVA Consultants, Inc. He has over 13 years of experience in civil/environmental engineering. Mr. Eckhout has considerable experience in areas of Remedial Investigations, Due Diligence, Phase I and II Environmental Assessments, Baseline Environmental Assessments, Environmental Auditing, ISO 14000, SPCCs, Compliance, Asbestos and Lead Based Paint Surveys, and Design of Remediation Systems. He has worked extensively on number of General Motors, Delphi, and American Axle and Manufacturing facilities.

EDUCATION

B.S. Environmental Engineering, University of Michigan, Ann Arbor, 1995

PROFESSIONAL AFFILIATIONS

Engineer-In-Training (EIT), 1996
40 Hour HAZWOPER
8 Hour Annual Refresher for HAZWOPER

PROJECT EXPERIENCE

NOVA Consultants, Inc., Novi, Michigan
Project Manager

Project management, Project Supervision, Field Supervision, ISO 14000, Remedial Investigations, Design and engineering of remediation projects; numerous Phase II site assessments; Environmental auditing, Compliance, Asbestos and Lead Based Paint Survey and Abatement, Groundwater and soil sample collection; Free product recovery; Hydrogeologic Investigation; Delineation Study; Air Sparge and Soil Vapor Extraction. Supervised the installation of soil borings and monitoring wells. Performed various phases of environmental site assessments.

Mr. Eckhout has prepared many reports associated with environmental audits of manufacturing facilities, ISO 14000 certification, due diligence of manufacturing facilities, hydrologic investigations, feasibility studies, underground storage tank removal, closure reports, and site safety plans.

Jeff has managed and supervised numerous asbestos survey and abatement projects in Michigan and Indiana.

Supervision of Asbestos Survey, Abatement and Air Monitoring Project in Rolls Royce Engine Plant, Indianapolis, Indiana (formerly owned by General Motors Corporation – our contract was with General Motors)
Project Management and Supervision of Asbestos Survey, Abatement and Air Monitoring of Former Fisher Body Plant, Plymouth, Michigan. Ashley Corporation bought the property from General Motors and retained NOVA to complete all asbestos related activities in the main building (about 1.2 million sq. ft.).
Project Management and Supervision of Asbestos and Lead Based Paint Sampling at General Motors Technical Center, Warren, Michigan.
Supervision of asbestos sampling and air monitoring during abatement activities at Buick City Project, Flint, Michigan.
Supervision of numerous asbestos sampling and abatement projects of various buildings.

Assisting in the field activities and design of 800-gpm industrial wastewater treatment system for one of the GM manufacturing plant for the treatment of PCBs impacted water.

Involved in the field activities and design of cooling water optimization for the Willow Run Powertrain Plant, General Motors Corporation, Ypsilanti, Michigan pursuant to ISO 14001 certification efforts.

Implemented site assessment activities in several UST projects, including initial abatement measures such as soil, product, and water removal. Obtained right-of-way permits, and NPDES permits.

Completion of regulatory reporting for LUST sites, hydrologic investigations, delineation studies, closure reports, feasibility study analysis and reporting, and corrective action plan preparation for the excavation of soils.

Completion of several emergency response projects, which included the delineation and excavation of soils, and treatment of groundwater.

Assisted in developing several Environmental Management Systems (EMS) for several clients. The purpose of the subject EMS was different for different clients.

Assisted Ford Motor Company in developing an EMS system to manage Underground Storage Tanks located in Ford's Research and Engineering Center at Dearborn, Michigan.
Assisted on several projects for General Motors projects that involves various components of ISO 14001 certifications.
Assisted in setting-up of EMS for Ashley Corporation. Ashley owns properties all over the United States where numerous manufacturing facilities are located. Insurance companies required Ashley to set-up EMS to reduce the cost of the insurance. NOVA is also responsible for managing their EMS and internal auditing on a long-term basis.

Assisted with the field activities and report preparation for numerous environmental audits for Michigan Consolidated Gas Company facilities as part of ISO 14001.

Clayton Cox, P.E.

Mr. Cox is a Principal Electrical Consultant with NOVA Consultants, Inc. He has over three decades of experience in electrical power engineering. The majority of that time was spent in the Substation Design, Engineering and Operating areas of PPL Corp and DTE Energy. His graduate engineering concentration at Drexel University was Power Engineering.

EDUCATION

M.S. Engineering Management, Drexel University, Philadelphia, PA **1998**
M.S. Electrical Engineering, Drexel University, Philadelphia, PA **1991**
Thesis: Distribution Substation Protection – A Computer Aided Approach
B.S Electrical Engineering, University of Detroit, Detroit, MI **1981**

PROFESSIONAL AFFILIATIONS

Institute of Electrical & Electronic Engineers

SUBSTATION DESIGN EXPERIENCE

DTE Energy, Detroit, MI

Manager Central Design & Supervisor Substation Design 2001-2010

- Managed Substation Design, System Underground Design, Arch-Civil Design & Surveying groups.
- Responsible for upgrades and new substation designs for 4KV, 13.2KV, 24KV, 40KV, 120KV & 230KV voltage levels, and ranging in size from 10MVA - 80MVA. About 70% of efforts involved 13.2KV distribution class substations, which included two and three transformer substations with reductant capability, capacitor banks, and multiple distribution feeders. Augusta, Collins, and Drake 120/13.2KV are examples.
- Championed the use of lower cost substation options. The pad-mounted substation is an example - a substation with a small footprint that may be placed in areas where a small conventional substation may be unacceptable; providing equipment, property, design, and construction cost savings.

Substation Design Engineer & Lead Design Engineer 1997-2001

- Substation site review, project cost estimating, detailed design, and project design overview of distribution & sub-transmission substation projects done by technicians and outside engineering firms. Headed up effort to develop a modular substation.

PPL Corp, Allentown, PA

System Protection & Substation Project Engineer 1983-1997

- Provided relay system protection (12.47KV -230KV) for distribution, transmission & substations. Created designs for 138/69/12.47KV distribution substations. Developed project cost, scope, and schedule.

OTHER MANAGEMENT & ENGINEERING EXPERIENCE

DTE Energy, Detroit, MI

Engineering, Substation Technology, Audit Services 2010-2020

- Migrated Substation and T&D electrical equipment into Asset Management System - Maximo to aid preventive and predictive maintenance.
- Transitioned Substation Operations from a manual paper based to an electronic system, with field employees using mobile devices to perform work - giving leadership greater visibility into work status and productivity.
- Managed and performed Operational Audits involving Electric & Gas Operations to encourage continuous improvement.

Gerald A. Young, MBA, BEE, P.E.
Senior Electrical Engineer

A Professional Engineer with long-term success in the design of electrical systems for industrial, commercial, and government facilities. Expertise in all phases of PV Solar Array construction from concept through closeout. Expert skills in innovative problem solving and technical documentation. Known as the Subject Matter Expert in PV solar, lighting and wiring, and the go-to person in related construction issues. Reputation as a team player with strong interpersonal communication skills and the ability to handle multiple projects simultaneously.

Mr. Young has an extensive experience in evaluating, designing, troubleshooting PV solar, lighting and electrical issues. Currently he is working on several roof mounted solar power array in various parking structures including one for Blue Cross/Blue Shield building in downtown Detroit. He has also worked on several parking lots for General Motors in resolving electrical and lighting issues.

EDUCATION

MBA, General Business, Wayne State University, Detroit, MI
BEE, Electrical Engineering, University of Detroit, Detroit, MI

MEMBERSHIPS

Illuminating Engineering Society of North America, Member
Engineering Society of Detroit, Member

PROJECT EXPERIENCE

NOVA Consultants, Inc., Novi, MI
Senior Electrical Engineer

- Lead electrical engineer on number of roof mounted and ground mounted PV Solar Arrays
- Designed cost-effective and maintainable power, lighting, and control systems for municipal and township projects.
- Engineered grid-tied solar photovoltaic power systems for an electrical utility.
- Developed upgrades to roadway and parking lot lighting systems using LED technology.
- Designed lighting systems for roadways, roundabouts, parking lots, and a marina.

Electrical Engineer, Worldwide Facilities Group

- Designed electrical systems for new and renovated industrial facilities for GM.
- Designed a complete electrical system for a new 500,000 square foot heavy-duty transmission plant with a high degree of occupant satisfaction.
- Designed the complete electrical renovation of a 60-year-old aluminum foundry eliminating unneeded substations and saving energy and maintenance costs.

General Motors, Pontiac, MI
Electrical Engineer, Worldwide Facilities Group

- Directed Architect-Engineering firms in the design and construction phases of many types of industrial facilities for GM. Developed corporate electrical design, construction, and maintenance standards for improved efficiency and cost savings.
- Initiated and led development of a new system of facilities specifications, the GM OneSpec, which is now used as the common specifications system throughout GM.
- Chaired 30-person committee on the rewrite of GM Electrical Installation Standard EI-1.
- Directed the complete electrical design of a 5-story office building integrated into an existing industrial and office site.
- Conceived electrical plan and directed the electrical design of a brownfield conversion of an obsolete metal stamping plant into a state-of-the-art metal hydroforming facility.
- Developed standard electrical details which eliminated unnecessary costs, simplified installation, reduced design time and construction errors, and improved maintainability.
- Represented the organization in harmonization meetings with other corporate divisions, commonizing construction practices and establishing common purchasing databases, thereby reducing costs.
- Developed lighting guidelines for the Lighting Strategies Committee resulting in lower first cost, lower life cycle cost, reduced energy consumption, and improved maintainability.

Field Electrical Engineer, Plant Engineering and Construction

- Relocated to Shreveport, Louisiana to oversee the construction of a two million square foot truck assembly plant.
- Resolved numerous construction problems and contract issues in the field. Developed contract revisions when required.
- Witnessed electrical testing for quality control resulting in the facility meeting cost and quality standards.

Electrical Engineer, Argonaut Division

- Designed electrical systems for new and renovated industrial facilities.
- Designed complete renovation of medium voltage electrical system for a large 50-year-old parts plant, which required innovative solutions for undersized substation rooms.
- Designed the installation of facilities monitoring and control systems for 13 industrial plants.

City of Detroit, Public Lighting Commission, Detroit, MI
Electrical Engineer

- Designed both new and renovated street lighting systems for city main and residential streets and alleys. Designed lighting for athletic stadiums and floodlighted a downtown monument.
- Designed an innovative solution to relighting a major downtown roadway using existing series street lighting cables. Performed electrical and photometric testing of components and systems.

S. Paul Baluja, MS, P.E.
Senior Civil Engineer

EXPERIENCE

Mr. Baluja has over 35 years experience in site feasibility studies, land-use planning, civil engineering projects planning/ design, preparation of contract documents for procurement and construction, and providing construction assistance. He was involved in several projects from inception to completion including construction assistance and closeout. His broad experience includes commercial, industrial, institutional, municipal, transportation (traffic study, road and bridge assistance), and residential development projects. His expertise includes buildings/facilities layout, and design of roads and bridges, right of way, site utilities (storm, sanitary, water, gas, steam etc.), grading and paving, roadways and parking, truck docks, pavement marking and traffic signs, site water distribution and fire protection water system design, process piping, pumping stations, storm water management, preparation of engineering reports, project management, QA/ QC work, code compliance and obtaining permit approvals, review of shop drawings, overseeing construction work and project closeout.

EDUCATION

B.S. Civil Engineering, University of Nebraska
M.S. Structural Engineering, University of Nebraska
Continuing education courses and seminars on Construction Safety, Asbestos Abatement etc.

PROFESSIONAL LICENCES

Registered Professional Engineer - State of Michigan and State of Nebraska

REPRESENTATIVE PROJECT EXPERIENCE

NOVA Consultants, Inc.

Project Manager/ Senior Engineer. Current projects include project site design and construction assistance, site development for various Solar Array Projects. Recently completed jobs include: site civil/ structural design and construction management of a warehouse facility in Plymouth, Michigan; Civil site engineering design and construction assistance for Detroit Institute of Arts, several schools and churches improvements; Storm water management (analysis and design) of a phased development in Cleveland, OH; Part of a team for design of 52 miles of 72-inch water main from Lake Orion Township to Flint, Michigan; and third-party review and certification of Contractors and Suppliers invoices submitted for payment to Wayne County Airport Authority for all Capital Improvement Projects at Detroit Metropolitan Airport.

Project Manager-Construction at GM Tech Center, Warren, MI. The work included RFPS preparation, preliminary and final plans design reviews, construction management of multi-discipline (environmental – asbestos remediation, architectural, civil, structural, fire protection, mechanical, electrical) systems with emphasis on safety, evaluating bids, developing and processing change orders, budget control, reviewing pay applications, resolving discrepancies and recommending approvals, preparing reports and making project status presentations, maintaining project documents and project closeout.
$30M Lab Consolidation Facility construction and Equipment Relocation projects.

$25M Site Roads and Landscaping project (a design-build project).

Sigma Associates, Detroit, MI.
Project Manager/ Senior Civil Engineer. Projects designed included MDOT US-12 (Michigan Ave.) Rehabilitation and Sewer Separation in Dearborn with an outfall to Rouge River; US-24 (Telegraph Road) Crossovers design in Dearborn & Dearborn Heights, bridge over Au-Sable river in Roscommon County); Wayne County (Sibley Yard Maintenance Facility, Juvenile Detention Facility design, several road resurfacing/ road rehabilitation projects); City of Detroit Building Authority (Detroit Herman Kiefer Medical Facility Site Improvements, several public schools site improvements); City of River Rouge (Marion Industrial Highway improvements)**;** Water Pumping Station for City of Cleveland, OH; Detroit Water & Sewerage Department (design of replacement sanitary sewers and water mains in residential districts.

SmithGroup, Detroit, MI
Senior Civil Engineer on project planning and site engineering design work (site roads and si**te** utilities) for Chrysler Belvedere Assembly plant additions in Illinois, Bank One Data Processing Center site design in Van Buren Township including Haggerty Road widening, Jefferson Conner railroad design, BASF Headquarters building design in Southfield, Selfridge Air National Guard Base (runway rehabilitation) in Mt. Clemens, MI.
Team Award of Excellence from Chrysler for work on Chrysler Belvedere Assembly Plant, IL

Giffels Associates, Southfield, MI
Specialist/ Senior Civil Engineer for various site feasibility studies, site planning, master plans development, site designs (site roads and utilities) for several Caterpillar projects in Mapleton-IL, Peoria-IL and Morton-IL; IBM's several projects in Fishkill-NY; Ford Motor Company projects in Dearborn-MI, Tulsa-Oklahoma, Hermisillo-Mexico; Toyota Motors in Georgetown-KY; Eastman Kodak in Rochester-NY; Master Reviewer for Detroit Water & Sewerage Department's Segmented Facilities Plan; Parke-Davis piping and pumping system investigations; Navy projects site development work in Washington State; etc.

Madhukar (Mark) Mahajan, M.S, P.E
Senior Structural Engineer

Mr. Mark Mahajan is a very competent structural engineer with over 25 years of experience. He is knowledgeable of building codes, wind loads and many state specific requirements. He has designed solar array support systems in several states. He has designed carports in Michigan, Texas, California, New York, New Jersey and Maryland**.**

EDUCATION

Master of Science, Civil (Structural) Engineering December 1986
Wayne State University, Detroit, Michigan.

Master of Technology, Geotechnical Engineering, February 1985
Indian Institute of Technology, Bombay, India.

Bachelor of Science, Civil Engineering. November 1982
Victoria Jubilee Technical Institute, Bombay, India

REGISTRATIONS

Professional Engineer, Michigan
Professional Engineer, Ohio
Professional Engineer, Arizona
Certified Stormwater Operator, Michigan

PROJECT EXPERIENCE
Project manager
Managing all aspects of the engineering firm from preparing proposals to the final product delivery. Managing land development projects, geotechnical and structural projects. Preparing site plans and construction documents using LDD and Civil 3D for residential and commercial/industrial projects. Design of utilities including sanitary sewer, water main, and storm sewers. Design of stormwater detention/retention facilities. Coordination with subcontractors for surveying, wetland determination and MDEQ permitting. Assisting clients for obtaining flood plain fill permits and LOMAR applications.
Managing structural and geotechnical projects. Design of deep foundations including helical pier systems and wooden piles. Designing helical pier systems for restoration projects, including underpinning and tie backs. Structural design of residential and commercial buildings and renovation project. Structural design of segmental block retaining walls, concrete retaining walls, and sheet pile walls..
Project manager/engineer

Collecting preliminary data for site plan preparation. Preparing site plans for residential and industrial projects. Design of utilities including sanitary sewer, watermain, and storm sewers. Design of stormwater detention/retention facilities. Preparing construction drawings using Land Development Desktop (LDD). Preparation of as-built plans and condominium documents. Design of roads, grading and hydrological modeling using LDD. Earthwork volume computations. Managing design projects including client contacts and agency approvals. Preparing engineering cost estimates for various land development projects. Coordinating construction staking and geotechnical/environmental investigations with subcontractors. Managing small to medium size structural/foundation design projects. Structural analysis of structures for residential and small industrial sites using computer software. Designing deep and shallow foundation systems for residential and commercial projects. Designing helical pier system for various projects including building renovation.

Managing various environmental and civil engineering projects. Preparing construction drawings using CADD system and specifications for civil engineering projects. Preparing remediation system design package, engineering drawings, bid documents, engineering cost estimates for cleanup of contaminated sites. Estimating quantities and cost of remediation system installation. Evaluation of bids received from contractors. Preparing design drawings for surface impoundment closures, including slurry wall system design. Preparing geological profiles along a slurry wall alignment. Preparing design drawings and construction plans for landfill site remediation, cost estimating for landfill design. Utilizing various computer softwares such as word processing, spreadsheet, contouring programs for civil and environmental projects.

Geotechnical Engineer

Preparing design drawings for a major Balefill (landfill) project and for general civil engineering projects. Conducting various geotechnical analyses and design for landfill projects. Analyzing stability of slopes, preparing geologic cross-sections, isopach maps, and contour maps of geologic formations. Designing geosynthetics for landfill liners and covers. Volume computation for landfill project planning. Estimating various quantities for landfill construction and general civil engineering projects. Managing small to medium
size geotechnical investigation projects including reviewing laboratory test results and interpreting the data for recommendations.

Managing subsurface soil and groundwater investigation projects. Field logging of soil borings, preparing geologic cross-sections and formal geotechnical reports. Preparing schedule for field investigations and laboratory testing. Evaluation of field and laboratory data for recommendations. Groundwater monitoring well installation and determining the hydrogeologic conditions of aquifers. Analysis and design of foundations. Managing various construction testing projects including asphalt and concrete roads, waste water treatment plants, airport pavements.

John S. Witte
NABCEP Certified PV Installer

EDUCATION

BS Mechanical Engineering – University of Toledo; 1994
BS Construction Technology – Bowling Green State University; 1976

LICENSES / CERTIFICATIONS

NABCEP Certified PV Installation Professional
NABCEP Certified Solar Thermal Installer
GLREA Certified PV System Integrator
ISPQ Certified Instructor for Photovoltaic Courses

TEACHING EXPERIENCE

Owens Community College – NABCEP Certification	March 2009 – November 2011
GLREA Advanced PV Integrator Training Program	July 2007 – July 2009
GEO PV Apprentice Installer Training	June 2002 – November 2010
GLREA Apprentice PV Installer Training Program	January 2002 – March 2008

RELEVANT WORK EXPERIENCE

- NABCEP certified PV installation professional since 2006.
- 45 years of commercial construction experience including site engineering and construction supervision.
- 40 years of solar system design and construction including system testing, development of solar construction standards and system design & construction.
- 19 MW of grid connected solar since 2000.
- Experience in commissioning many types of inverters including single phase residential and 3-phase, medium voltage connections directly to the utility grid.

Union Electrical Contractor	2001 – onwards
Solar Design & Construction	1995 – onwards
Witte CM Services – Commercial and Industrial Construction	1984 – 1995
DSET Laboratories – Solar Testing and Quality Control Tech	1979 – 1984
Witte Construction – Residential Labor and Cost Estimating	1970 – 1979

John Gembarski
Site Supervisor

PROFESSIONAL SKILLS

- Licensed Electrician
- Experienced Supervisor
- Project management
- Troubleshooting
- Safety trained
- Arial Lift trained
- Electrical ARC/FLASH trained
- Solar installation supervisor

CERTIFICATIONS

- MUST Certified - Completed all modules and up to date
- CAM National Safety Council Certified in Basic Life Support & First Aid
- Save A Life Certified in AED, CPR, First Aid
- CAM Certified in Asbestos / Awareness
- Certified Operator on Arial lifts

EXPERIENCE

NOVA Consultants Inc **2011 - Present**

Supervised, managed and installed the electrical infrastructure on commercial and industrial building. Including on site project management, some of the duties included, attending owner/contactor meetings, receiving and implementing work orders, documenting paper work, preparing "as build" drawings, and scheduling sub contractors and inspections.

As the supervisor, some of the duties included assigning daily work to employees, recording payroll, ordering material, receiving new employee applications, verifying code compliance installations, providing a safe work environment, conducting safe to work and new employee orientations, recording daily safety and progress reports.

In addition as an installing Electrician, responsible for installing electrical systems and equipment that met all codes and standards. Example: Power distribution, emergency power, fire alarm, energy management, lighting systems, trouble shooting and controls. These are some of the responsibilities on a day to day basis.

ACHIEVEMENTS

Successfully supervised the electrical systems for Westland schools and remodel. This project was very demanding, fast pace, and a tremendous amount of coordinating and large work force. The experience and knowledge brought to this project is one of the key elements why it was completed on time, under budget, and injury free. Also involved in many other successful projects varying from Metro Airport, Public Schools, hospitals and other industrial, commercial, residential buildings.

COMPLETED PROJECTS

- Ann Arbors New Pre-School and remodeled middle school
- DTE Electric Company *SolarCurrents* Program
- Construction of Manchester’s New High School and Remodeled Middle School.
- Upgraded Metro Airports Security for 9-11 Commission
- Remodeled Schoolcraft College Bradner Library
- Construction of Dundee’s New High School and Remodeled Middle School.
- Public School Projects in Westland, Plymouth-Canton, Ferndale, Redford, Centerline, Troy, Others
- General Motors 500kW ground mount solar array.
- University of Michigan NCRC 430 kW ground mound solar array.
- Warren Consolidated 195 kW roof mounted solar array.
- DTE Energy 80.6Kw carport canopy solar array.
- Mercy High School 402kW roof mounted solar array.

Rick Marble
Schedule Tracking/AutoCAD Specialist

Mr. Marble has experience in PV Array Modeling and shade analysis, Report preparation, Schedule Tracking for Detroit Electric Company's Solar O&M Projects, Construction Documents

EDUCATION

Production Drafting degree

PROFESSIONAL LICENCES

Registered Professional Engineer - State of Michigan and State of Nebraska

PROJECT EXPERIENCE

Consumers Energy Grand Valley State University 3 MW Solar Array
Construction Documentation

DTE Domino's Farms 1,089 kW Solar Array
Glare analysis report and mitigation,
Performed glare modeling and analysis.

Consumers Energy Vevay township
Solar array design and shade analysis, Engineering Documentation, and Renderings for Township approval.

DTE Solar Fleet Operations and Maintenance
Project coordination, Scheduling, and Reporting.

Joe Ruffing, *BS*
Budget Tracking

Mr. Ruffing is responsible for tracking accounts payable and receivable, tracking project budget, maintaining project documentation and records, making payments to contractors, payroll processing etc.

EDUCATION

BS, Accounting

PROJECT EXPERIENCE

DTE Energy - GM Warren Transmission 898kW
Project Coordinator

- Tracked project budget and provided weekly and monthly reports to Project Manager
- Prepared purchase orders and processed invoices for subcontractors/materials
- Prepared and submitted invoices to customer
- Ensured project records and documents were maintained according to contract and NOVA policy

DTE Energy – Ford World Headquarters 1,038 kW

- Tracked project budget and provided weekly and monthly reports to Project Manager
- Prepared purchase orders and processed invoices for subcontractors/materials
- Prepared and submitted invoices to customer
- Ensured project records and documents were maintained according to contract and NOVA policy

Consumers Energy - GVSU Solar Garden 3MW

- Tracked project budget and provided weekly and monthly reports to Project Manager
- Prepared purchase orders and processed invoices for subcontractors/materials
- Prepared and submitted invoices to customer
- Ensured project records and documents were maintained according to contract and NOVA policy

Michigan Army National Guard (MIARNG) 330kW

- Tracked project budget and provided weekly and monthly reports to Project Manager
- Prepared purchase orders and processed invoices for subcontractors/materials
- Prepared and submitted invoices to customer
- Ensured project records and documents were maintained according to contract and NOVA policy

Gregory Wagner
Environmental Geologist/Site Safety Officer

Mr. Wagner is an Environmental Geologist and Site Safety Officer for NOVA Consultants, Inc. He has over 16 years experience in the fields of soil and groundwater sampling, asbestos and lead survey, environmental sampling, health & safety, industrial hygiene, environmental audit, due diligence, geology/hydrogeology, plant decommissioning, construction management/supervision, utility installation, and material testing.

His responsibilities include field supervision, asbestos and lead based paint survey, personal and area air monitoring, sampling of soils and groundwater, installation of borings and monitoring wells, geophysical survey etc. He has completed a number of asbestos and lead based paint survey and abatement projects for General Motors, Delphi Automotive, Ashley Capital and federal government projects.

Mr. Wagner has excellent computer and record-keeping skills. He is proficient in Microsoft Office and AutoCAD programs

EDUCATION
B.A. Earth Sciences, Adrian College, Adrian, Michigan

PROFESSIONAL CERTIFICATION AND TRAINING
Contractor/Supervisor for Asbestos, Michigan
Certified Asbestos Building Inspector, Michigan (A20617)
Certified Lead Inspector/Risk Assessor, Michigan (P-1615)
NITON XRF Trained
OSHA 40-Hour HAZWOPER
OSHA Confined Space Entry - Entrant/Attendant/Supervisor
Troxler Nuclear Moisture/Density Gauge

PROJECT EXPERIENCE
NOVA Consultants, Inc. Novi, Michigan **1999 - Present**
Environmental Geologist/Site Safety Officer
Responsible for sampling of soil, groundwater and air, asbestos and lead based paint survey, supervision of abatement activities, personal and area air sampling for asbestos and other industrial hygiene applications, clearance sampling, tabulation of data, preparation of reports, mercury monitoring and spill response, installation of soil borings and monitoring wells, collection of soils and groundwater samples, screening of soils with OVM/PID, and GPR surveys.

Mr. Wagner has also worked as health and safety officer for number of environmental projects that includes remediation and plant decommissioning. His responsibilities also include construction supervision, utility installation supervision, material testing, oversight of contractors, and facility decommissioning and remediation verification sampling.

Environmental Testing and Consulting Inc. Romulus, Michigan
Field Technician
Performed asbestos and lead based paint inspections, conducted personal and area wide air monitoring on asbestos and lead abatement projects.

Onsite Environmental Inc., Livonia, Michigan
Field Technician
Construction materials testing on various projects. Field supervision and oversight of contractors and air monitoring during asbestos abatement projects.

Imaging Subsurface, Inc., Detroit, Michigan
Staff Geologist
Assisted on many geophysical surveys such as magnetometer, and GPR surveys. Assisted in soil sampling projects using Geoprobe. Also performed laboratory testing of construction material and soils including Proctor and Atterberg Limits for construction projects.

Field Technician, CTI and Associates, Inc.
Performed in-place testing of soils using Troxler gauge on many construction sites. Supervised construction projects. Performed on-site concrete testing to determine if materials meet engineering specifications. Also worked as driller helper for both environmental and geotechnical drilling applications.

J. RANCK ELECTRIC, INC.

James Mann

J. Ranck Electric, Inc.

Project Manager

With over 20 years of working in electrical construction, James did not achieve this through traditional channels. He began as a teenager working under a journeyman as an apprentice logging his hours and reporting them to the proper state authority. Once he had the necessary hours he took the journeyman's test and received his license. During this process, he joined the IBEW as a licensed journeyman, and continued gaining the hours needed to obtain his master electrical license. Working in various roles of apprentice, journeyman, foreman, estimator, and project and quality manager, Mann brings a well-rounded perspective into the management of projects.

Over his career, James has proven his ability to understand, adapt, and excel at all aspects of construction management. His integrity, efficiency, and ability to communicate effectively while multi-tasking are some of his greatest attributes. To gain credibility and trust, James feels that 100 percent transparency with the owner and construction team is crucial to work through the challenging parts of a project.

His extensive experience is utilized in his current role of project manager. He oversees and coordinates all safety, quality and financial activities on his jobs to ensure all project goals are met. His attention to detail and dedication to customer needs are readily apparent when ensuring accurate document management, schedules and key milestones are met, while auditing, tracking and resolving issues and changes that present themselves.

Mann provides great value to all project stakeholders and is a tremendous asset to any project he is assigned. He fully embodies J. Ranck Electric's core values of Safety, Quality, Integrity, and Family.

EDUCATION

- ABC School
- Michigan Journeyman Electrical License (2007)
- Master Electrical License (2010)
- Michigan Electrical Contractors License (2019)

TRAINING & CERTIFICATIONS

- OSHA 10
- CPR and First Aid Training

PROJECT EXPERIENCE

MISOLAR PORTFOLIO SOLAR FARMS - MICHIGAN

JRE was contracted by the Geronimo Energy, a National Grid Company, for the engineering, procurement, and construction of two ground mounted solar arrays in Michigan. In total, The MiSolar Portfolio consists of 40 MW AC (60 MW DC) of solar power being generated at the two farms located in Clinton and Monroe Counties in central and southern Michigan.

Mann and his renewable energy team managed this EPC contact which included the engineering and construction of these two 120 acre arrays in the middle of the COVID-19 pandemic. Kicking off in May of 2020, Mann and his team implemented JRE's COVID-19 Operations Response Plan that included health screening, safety barriers, and disinfection policies while on-boarding and managing a labor force that exceeded 175 on-site crew members at this project's peak.

The scope of work included all AC and DC electrical work including the installation of inverters, transformers/AC combiners, equipment pads and racks, and collection systems. The installation also included the raceways and cabling for the NLS communication system for the array. Each site also included the engineering and construction of a 46 kV substation.

THE BUTTER SOLAR PORTFOLIO - WISCONSIN

Mann managed the electrical installation at three ground-mounted solar arrays in Wisconsin. In total, the Butter Solar Portfolio consists of 23 MW of solar power generated at 10 different solar sites located throughout Wisconsin, Iowa, and Minnesota. The multi-state power purchase agreement, and operated by BluEarth Renewables, is generating power which will be used locally by the Upper Midwest Municipal Energy Group and its customers.

This project included the installation of AC and DC electrical work for 10.5 MW at the Arcadia, Cumberland, and Fennimore arrays in Wisconsin. Mann and his team installed inverters, transformers/AC combiners, equipment pads, and racks, underground and above ground collection systems. He managed the installation of the raceways and cabling for the DAS/SCADA/Met Station for the arrays communications. All commissioning, start-up, synchronization, and performance testing on the electrical and communication systems installed was also conducted by Mann and his crews. At the time of completion in the fall of 2019, Arcadia was the largest array in the state of Wisconsin.

OTHER SOLAR ARRAY PROJECTS MANAGED

- Rooftop arrays for 9 Target stores, each site averaged 400kW – Michigan
- 2.75 MW DC array with battery storage/Vectren Energy – Evansville, IN
- 30 MW DC over three arrays/Consumers Energy – Grand Ledge, MI
- 60 MW DC Lapeer Array/DTE Energy – Lapeer, MI
- 1.4 MW DC solar array/Wolverine Power – Cadillac, MI
- 3.7 MW DC array at Grand Valley/Consumers Energy – Allendale, MI
- 1.2 MW DC array at Western Michigan University/Consumers Energy – Kalamazoo, MI

CONSUMERS ENERGY JH CAMPBELL

Mann managed a medium voltage and switchgear upgrade project at Consumers Energy's JH Campbell Power Plant in West Olive, Michigan. The work at Unit 2 consisted of the installation of new 5 kV bus duct from transformer to new switchgear, installation of new 5 kV feeder and cable tray from new switchgear to existing switchgear, and installation of new 5 kV feeder and cable tray from new switchgear to start up boiler feed pump. Mann also oversaw a second project to extend the facility's ground mat to the new dry fly ash system. Work included the installation of new copper ground wire and exothermic welding to join the conductors. Despite, financial and schedule issues that came up, Mann led this project with integrity, keeping this team focused on quality despite problems and pressure to cut corners.

J. RANCK ELECTRIC, INC.

Jason LeCureux

J. Ranck Electric, Inc.

Foreman

LeCureux has been employed by J. Ranck Electric, Inc (JRE). since September of 2010. With over 15 years of working in electrical construction in the roles of apprentice, journeyman and foreman, LeCureux has had extensive experience working on in the electrical field. Starting at JRE as a journeyman, LeCureux has worked his way up to becoming our premier solar foreman, highly trained and educated to handle any type of solar project he may be assigned to.

LeCureux is known for his multitasking abilities and success on high profile, complex, and multi-location projects. His solid work ethic inspires his crew to work at their utmost ability while working safely and efficiently. He has a record of keeping his jobs on schedule, utilizing his strong communication skills to coordinate between JRE's home office, the general contractor, subcontractors, engineering, and the owner, Jason is an integral part of the JRE team.

EDUCATION & REGISTRATION

- Muskegon Community College (1996-1997)
- Michigan State University (1997-1998)
- Michigan Journeyman Electrical License (2003)

TRAINING & QUALIFICATIONS

- CPR and First Aid
- Confined Space Training
- Silica Awareness
- Gold Shovel Certified
- OSHA 30
- Aerial Work Platform
- Crane Hand Signals
- Scissorlift Certification I - IV
- Industrial & Construction Forklift Training
- Lockout/Tagout Procedural Training
- DOT Fleet Compliance Training
- Medical Examiners Certificate (Med Card)
- ARC Flash Safety Training
- MISS DIG Procedure Training
- Excavators Damage Prevention Review
- Bucket Truck Training
- Boomlift Training
- Consumers Energy Underground 2016
- Michigan Truck Safety Training

PROJECT EXPERIENCE

FORD RESEARCH & ENGINEERING PARKING SOLAR AND BATTERY STORAGE – DEARBORN, MI

LeCureux was JRE's field leader for the EPC contract for this unique partnership between DTE Energy and The Ford Motor Company. This project consists of a rooftop array owned and operated by southeast Michigan power supplier DTE Energy on the top of a new six-story parking structures at the Ford Research & Engineering Center in Dearborn. LeCureux was critical in the coordination and management of tying in this 750 kilowatt array to Ford's 15kV campus loop that also includes a 125 kilowatt battery storage system that powers electric vehicle charging stations.

- Completed: May 2021
- System Size: 865 kW DC / 750 kW AC
- Panels: 2,159 Canadian Solar 400 W modules
- Inverters: 12 SMA Inverters
- Storage: 125 kW/506 kWh Battery Storage System – ConEdison Battery Storage Systems
- Panel Claw ballasted racking system
- 13.2 kV Interconnect

DTE ENERGY'S SOLAR CURRENTS PROJECTS

LeCureux was instrumental in providing successful project outcomes for many projects associated with the DTE Solar Current Projects constructed by J. Ranck Electric, Inc. (JRE) from 2010 to 2017. LeCureux has been involved with every project constructed by JRE as a part of this program, first as a journeyman and later as a foreman. LeCureux has aided in the completion of 17 of the 26 arrays constructed in the DTE Solar Currents program, assisting DTE in moving towards attainment of it's early goal of 15 MW of energy provided through renewable resources. LeCureux successfully constructed ground mounted, roof mounted and tracking arrays as part of this program. LeCureux was the job site superintendent/foreman for the Domino's Farm 1.1 MW DTE project. When it was completed, this array was the largest array installed as part of DTE's collaborative program with large industrial companies (Solar Currents) but was the largest in the state of Michigan.

NINE TARGET STORE ROOFTOP SOLAR ARRAYS THROUGHOUT THE STATE OF MICHIGAN

Jason was selected as the foreman for nine separate Target store rooftop solar arrays throughout the State of Michigan. Several stores were completed simultaneously on this aggressively scheduled set of projects. Each store has a rooftop array constructed averaging 400 kW spanning across the state of Michigan. Projects are located in Fenton, Auburn Hills, Fort Gratiot, Macomb Township, Okemos, Muskegon, Grand Rapids, Traverse City and Novi, which required interaction with multiple jurisdictional authorities to complete the project in accordance with all governing regulations. LeCureux's ability to plan and execute multiple objective simultaneously was a great asset on this project where logistics were of utmost importance to maintain constant work flow from one project to the next.

OAKLAND SCHOOLS ALTERNATIVE ENERGY

LeCureux managed multiple crews handling both solar and wind turbine construction at four different locations for this project. This work was a small portion of a much larger construction project that required close monitoring and communication between other contractors and the general contractor. LeCureux excelled at providing all electrical work and cooperative scheduling between contractors to ensure that all JRE work was completed in a timely and effective manner while improving the overall project schedule whenever possible. His attention to detail and ability to multi-task was a great attribute and essential to the successful completion of this project.

Attachment 5 – JRanck Experience

J. RANCK ELECTRIC, INC.

QUALITY. SAFETY. INTEGRITY. FAMILY.

Since 1986, J. Ranck Electric has provided design-build and bid/spec construction services. A family business with roots in the Midwest, JRE has become a national presence in electrical and communications contracting. We strive to grant every customer the highest quality, safety, and professional experience with each construction project we perform. JRE keeps a close watch on our ever-changing industry while upholding our corporate values and remaining a financially sound, stable company with prudent growth.

Our team takes pride in our ability to self-perform a wide scope of work while supporting the customer's schedule and meeting deadlines. With extensive experience and a host of resources, our crews are prepared to address the unique aspects of each project from concept to completion. JRE specializes in transportation, heavy industrial, power, water, oil, gas, and renewable energy infrastructure. No matter the customer or type of work, the JRE Team adds value on every construction project, repair, and maintenance call.

From apprentices to senior management, we all have a strong understanding of the coordination required for a safe and successful installation. Current customers know that when JRE promises to deliver, we are true to our word. Trust is not something that we take lightly and we value each relationship, whether it is with a customer, subcontractor or vendor. We strive to develop long-term connections with our customers, in order to create relationships built on trust, anticipated needs, and responsive action.





DEFINING SUCCESS

We define success through the everyday interactions of our team, whether it is coordinating with contractors and customers or working through unique schedule and shutdown issues; the high level of quality that we deliver is unwavering. Communication is key to any strong relationship. Our team excels when presented with schedule and scope challenges and we know our customers rely on open communication, a timely response, and the highest level of professionalism every step of the way.

Concept to Completion

Nationwide service:

- Turnkey electrical and communications contracting services
- Design/Build and design/assist services
- Network cabling and fiber installations
- Tower construction and maintenance
- Highway and street lighting
- Traffic signal installation and maintenance
- Site development
- Signage and guardrail installation
- Excavation/trenching/directional boring/hydro vacuum
- Solar and wind turbine installation
- Energy efficiency solutions
- Equipment rental service
- Storm response
- Utilities

START WITH A CONCEPT:

Beyond our bid/spec electrical and communications contracting, we also offer design/build and design/assist services. Our multi-state licensed project teams collaborate to improve the upfront design quality, planning, communication, and speed of installation, which will in turn promote cost savings for our customers.

FULL SERVICE CONTRACTOR:

The confidence we have in our crews to meet every deadline while self-performing the majority of the work is proven. Our crews have extensive experience and a host of resources to pull from, specific to each unique aspect of your project. We are prepared to assist in new construction projects, repairs, maintenance, and exploratory excavation.

PROFESSIONAL EXECUTION:

Our teams will manage the installation process utilizing technology and expertise to track job cost, scheduling, completion status, and productivity information for each stage of the project. This approach gives us the ability to assess what is complete and what resources (labor, material, tools, equipment) will be required to finish the project on time and under budget.

J. RANCK ELECTRIC, INC.

[PROJECT EXPERIENCE]

GROUND MOUNT SOLAR

ENBRIDGE ENERGY - SOLAR EPC

SOLAR POWER GENERATING FACILITIES — WISCONSIN AND ILLINOIS

J. Ranck Electric Inc. (JRE) was contracted by Enbridge Energy, for the engineering, procurement, and construction of three ground mounted solar arrays in the mid-west United States. The projects are part of Enbridge's larger "self-power" initiative to build renewable power generating facilities in their pipeline right-of ways to help power their assets with clean electricity. In total, the projects consists of 39MW DC of solar generating capacity on 210 acres at three facilities Flanagan Solar in Pontiac, IL, Portage Solar near Portage, WI, and Adams Solar near Grand Marsh, WI.

JRE's contracts included the installation of AC and DC electrical work including the installation of inverters, transformers, equipment pads and racks, and collection systems. JRE also installed the raceways and cabling for the NLS communication system for the array. Each site also included a substation expansion and interconnection.

Flanagan Solar 81.72 acre site — Pontiac, IL

- Size – 13.24 MW DC/ 10.13 MW AC
- Modules installed – 31,512
- Racking – NEXTracker Tracking System - 498 rows
- 225kW Sungrow, Model No. - SG250HX-US Inverters
- Posts - 4140
- (5) 34.5kV transformers interconnecting to 34.5kV substation
- Tracking Motors and gear boxes – 498
- Linear Footage of MV Cable – 5950'
- Linear Footage of FO Cable – 5950'

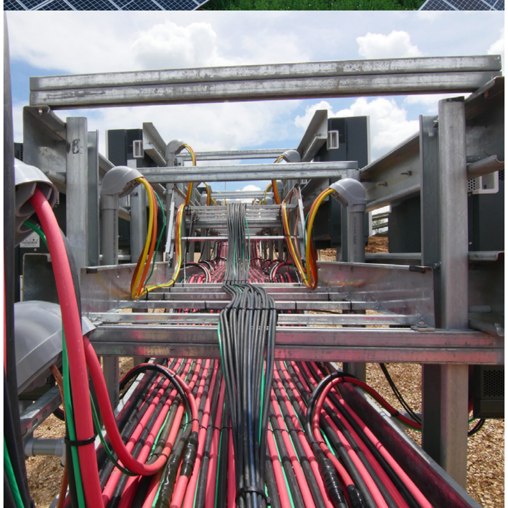
Adams Solar 53.56 acre site — Grand Marsh, WI

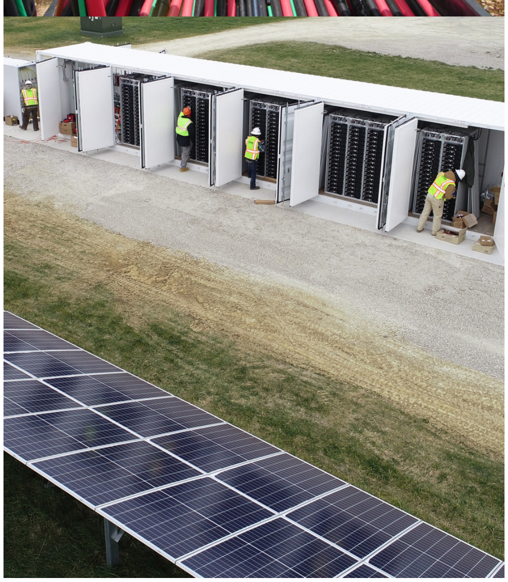
- Size – 10.59 MW DC/ 8.55 MW AC
- Modules installed – 25,220
- Racking – NEXTracker Tracking System - 347 rows
- Inverter – 225kW Sungrow, Model No. – SG250HX-US
- Posts - 3248
- (4) 34.5kV transformers interconnecting to 5kV substation
- Tracking Motors – 349
- Gear Boxes – 347
- Linear Footage of MV Cable – 3330'
- Linear Footage of FO Cable – 3330'

Portage Solar 74 acre site — Portage, WI

- Size – 15.24 MW DC/ 12.15 MW AC
- Modules – 36,218 installed
- Racking – NEXTracker Tracking System - 559
- Tracking Motors and gear boxes – 559
- Inverter – 225kW Sungrow, Model No. – SG250HX-US
- Posts - 4735
- (6) 34.5kV transformers interconnecting to 5kV substation
- Linear Footage of MV Cable – 6385'
- Linear Footage of FO Cable – 6385'

GROUND MOUNT SOLAR





DTE ENERGY /FORD MOTOR CO. EPC SOLAR

FORD RESEARCH AND ENGINEERING CENTER - PARKING STRUCTURE ARRAYS WITH BATTERY STORAGE – DEARBORN, MI

J. Ranck Electric, Inc. was selected as the EPC contractor for this unique partnership between DTE Energy and The Ford Motor Company. This system consists of a rooftop array owned and operated by southeast Michigan power supplier DTE Energy on the top of a new six-story parking structures at the Ford Research & Engineering Center in Dearborn. The 750 kilowatt array is connected to Ford's 15kV campus loop and includes a 125 kilowatt battery storage system that powers electric vehicle charging stations.

- Completed: May 2021
- System Size: 865 kW DC / 750 kW AC
- Panels: 2,159 Canadian Solar 400 W modules
- Inverters: 12 SMA Inverters
- Storage: 125 kW/506 kWh Battery Storage System – ConEdison Battery Storage Systems
- Panel Claw ballasted racking system
- 13.2 kV Interconnect

GERONIMO ENERGY - EPC

MISOLAR PORTFOLIO SOLAR FARMS – MICHIGAN

J. Ranck Electric (JRE) was contracted by the Geronimo Energy, a National Grid Company, for the engineering, procurement, and construction of two ground mounted solar arrays in Michigan. In total, The MiSolar Portfolio consists of 40 MW AC (60 MW DC) of solar power being generated at the two farms located in Clinton and Monroe Counties in central and southern Michigan. The power purchase agreement, being built by Geronimo Energy, will generate power and be locally used by Consumers Energy.

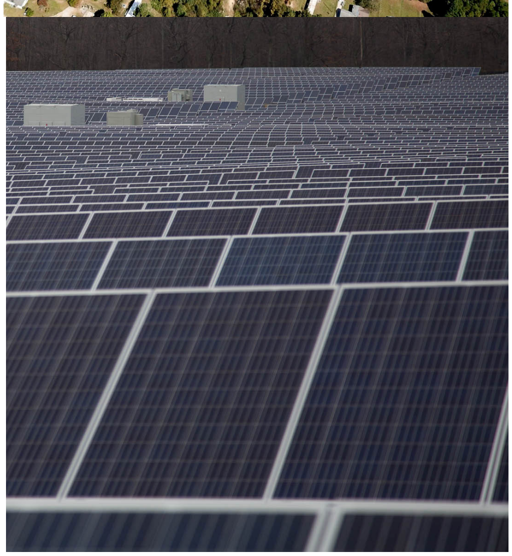
JRE's contract included the installation of AC and DC electrical work including the installation of inverters, transformers/AC combiners, equipment pads and racks, and collection systems. JRE also installed the raceways and cabling for the NLS communication system for the array. Each site also had a 46 kV substation.

- 320 combiner boxes installed and 21,255 posts installed
- (16) 35 kV transformers installed
- 79 tracking motors installed
- 18,839' of fiber optic cable installed
- 1,922 gear boxes installed
- 16,080 linear feet of medium voltage cable installed (each linear foot has three cables)

- Temperance – 123 acre site
- 30 MW DC / 20 MW AC
- 74,790 Trina Bifacial Modules (390,395, and 400W)
- Racking: Array Technology Tracking System
- 962 rows of tracker system capable of turning 32 rows at once to follow the sun
- (160) 125kW Yaskawa Solectria XGI Inverters

- Bingham – 121 acre site
- 30 MW DC/ 20 MW AC
- 73,440 Trina Bifacial Modules (400W)
- Racking: Array Technology Tracking System
- 960 rows of tracker system capable of turning 32 rows at once to follow the sun
- (160) 125kW Yaskawa Solectria XGI Inverters

Ground Mount Solar



PINE GATE RENEWABLES

MICHIGAN SOLAR FARM PORTFOLIO – MICHIGAN

JRE was contracted by national solar developer Pine Gate Renewables to construct eight arrays of their initial 14 solar farm development. The projects are part of a larger initiative to bring more than 500MW of renewable energy projects to Michigan through 20-year Power Purchase Agreements. In total, the 14-farm portfolio is expected to produce enough energy to power around 7,600 homes in the first year of operation. JRE constructed arrays in Branch, Genesee, Missaukee, Hillsdale, Montcalm and Saginaw counties.

- September to December 2020
- Contracts totaled over $10 million
- 22.7 MW DC / 16MW AC installed
- Game Change Genius Tracker racking installed 2P
- 128 Sungrow Inverters SG125HV
- 57,105 Canadian Solar Bifacial mixed wattage 390-405 panels
- 108,832 linear feet DC feeder cable installed
- Eight 2000KVA Transformers installed

THE BUTTER SOLAR PROJECT

THREE UPPER MIDWEST MUNICIPAL ENERGY SOLAR FARMS – WISCONSIN

J. Ranck Electric (JRE) was contracted by the RECON Corp. for the electric work at three ground mounted solar arrays in Wisconsin. In total, The Butter Solar Project, consists of 32 MW of solar power being generated at 10 different solar farm locations throughout Wisconsin, Iowa and Minnesota. The multi-state power purchase agreement, being built by Developer OneEnergy Renewables and operated by BluEarth Renewables, will generate power and be locally used by Upper Midwest Municipal Energy Group and their customers.

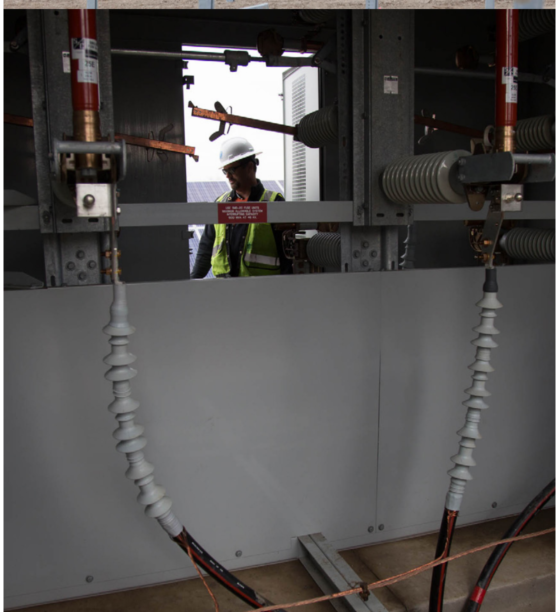
JRE's contract included the installation of AC and DC electrical work for 14.88 MW at the Arcadia, Cumberland and Fennimore arrays in Wisconsin. Work included the installation of inverters, transformers/AC combiners, equipment pads and racks, underground and above ground collection systems. JRE also installed the raceways and cabling for the DAS/SCADA/Met Station for the array communications. JRE conducted all commissioning, start-up, synchronization, and performance testing on the electrical and communication systems installed. At the time of completion in the summer of 2019, Arcadia was the largest array in the state of Wisconsin.

Arcadia – 21.18 acre site
- 7.449 MW DC/5 MW AC
- 19,604 Modules (REC TWINPEAK)
- RBI Fixed Tilt Racking
- 40 Sungrow Inverters

Cumberland – 13.24 acre site
- 3.325 MW DC/2.5 MW AC
- 9,048 Modules (REC375TPS272M)
- RBI Single Axis Tracker (839 Table, 1,678 Posts, 156 Field Equipment Posts)
- 20 Sungrow Inverters

Fennimore –15.7 acre site
- 4.11 MW DC/3 MW AC
- 10,816 Modules (REC TWINPEAK 380WATT)
- RBI Single Axis Tracker (987 Tables, 1,974 Posts. 125 Field Equipment Posts)
- 24 Sungrow Inverters

GROUND MOUNT SOLAR



VECTREN ENERGY SOLAR - EPC

EPC SOLAR ARRAY WITH BATTERY STORAGE – EVANSVILLE, IN

JRE was contracted for the design, engineering, procurement, and construction of the 2.75 MW DC solar array on 15 acres off US 41 in southern Indiana. This utility-owned array includes a 1 MW Lithium Ion Battery Storage System with 4.65 MWH of capacity.

- 7,784 REC 350W solar modules 1500V
- TMEIC 2.5MW AC Inverter skit at 1500 Volt DC
- 12 SolarBos 1500 Volt combiner boxes
- 139 Racks
- 1,056 Posts
- DAS system interfacing with the utility's existing SCADA
- Johnson Controls 1 MW/4MWH L2000 BU 5000-E Distributed Energy Storage System
- 53' L2000 BU 5000-E containerized system
- 18 racks, consisting of 17 battery modules per rack, of lithium ion energy storage
- Power Conversion System: Ingecon Storage Powermax 1170TL U B 450 Bi-Direction inverter
- 1500 kVA Step up transformer 450/12,470 V

DELTA TOWNSHIP SOLAR

PHASE I, II, AND II CONSUMERS ENERGY SOLAR FARM – GRAND LEDGE, MI

JRE was contracted to install the posts, racking and panels for Consumers Energy's largest solar array. Through a power purchase agreement the generating system will provide enough energy to power 3,300 homes for the Lansing Board of Water and Light. Constructed on 190 acres in Delta Township, near Grand Ledge, MI, the array was the second-largest in the state at the time of commissioning.

- System Size: 30 MW DC /24 MW AC
- Constructed from September 2017 to May 2018
- NEXTracker racking system - increasing generation efficiency by nearly 15 percent
- 35,602 man-hours worked

- Delta #1 - System Size: 10 MW DC
  - Panels: (29,160) 340W Trina modules
  - Racking: 405 racks and motors
  - Posts: 4,459
- Delta #2 - System Size: 15 MW DC
  - Panels: (43,200) 340W Trina modules
  - Racking: 600 racks and motors
  - Posts: 6,532
- Delta #3 - System Size: 5 MW DC
  - Panels: (14,040) 340W Trina modules
  - Racking: 195 racks and motors
  - Posts: 2,149

Ground Mount Solar

AMERICAN LEGION ROAD SOLAR - EPC

20 MW SOLAR ARRAY – ROANOKE RAPIDS, NC

- System Size: 20 MW
- Constructed from May – November 2017
- Panels: 59,090 Total Panels (28,424 Hanwha), (30,666 Trina) – 92 truck deliveries
- Racking: 1,555 racks (2X19 configuration)
- (9) TMEIC 1.83MW integrated inverter skids (inverter, DC Recombiner, transformer)
- 6,220 posts
- 612,596 ft. stringer wire connecting modules
- 70 acres of solar panels on a 124-acre farm

DTE ENERGY SOLAR

60 MW SOLAR FARM – LAPEER AND DETROIT, MI

In 2017, J. Ranck Electric, Inc. completed construction of what was, at the time of construction, the largest solar project in Michigan and largest utility-owned solar array east of the Mississippi River. Located in Lapeer, this system consists of two separate arrays owned and operated by southeast Michigan power supplier DTE Energy on land leased from the city of Lapeer. With crews exceeding 120 workers and a total of 160,000 man-hours worked with zero OSHA recordable incidents, JRE safely met the aggressive project schedule with completion in 2017. The solar farm will generate enough power for 9,000 homes.

- The arrays included over 188,000 solar panels on nearly 420 acres of land
- Constructed from January 2016 to April 2017
- All three arrays used Solar FlexRack racking systems
- 19,016 posts
- 488,000 ft. medium voltage cable
- 1.5 million ft. of stringer wire connecting modules
- 1.6 million ft. of underground conduit
- 46 kV switchgear (25) and transformers (25)

- Array #1 - Demille Array, Lapeer, MI
  - System Size: 34.57 MW DC/28.56 MW AC
  - Panels: 32,528 Canadian Solar CS6X 315W & 76,000 Canadian Solar CS6X 320W
  - Inverters: 42 Schneider XC 680 NA

- Array #2 - Turill Array, Lapeer, MI
  - System Size: 22.96 MW DC/19.72 MW AC
  - Panels: 34,998 Canadian Solar CS6X 315W & 37,126 Canadian Solar CS6X 320W
  - Inverters: (29) Schneider XC 680 NA

- Array #3 - O'Shea Array, Detroit, MI
  - System Size: 2.44 MW DC / 2.04 MW AC
  - Panels: (7,398) Suniva OPT335-72-4-100
  - Inverters: (68) SMA 30000TL-US

[PROJECT EXPERIENCE]

Rooftop Solar

TARGET STORES

3.7 MW ROOFTOP ARRAYS - MULTIPLE LOCATIONS, MI

- In 2016, J. Ranck Electric, Inc. began construction on multiple contracts totaling 3.7 MW for the installation of rooftop solar arrays on Target stores at various locations in Michigan. Ranging in size from 323 kW - 478 kW, these arrays are constructed in an aggressive overlapping scheduling sequence. JRE is currently constructing three arrays simultaneously and will begin to add additional arrays as final plans are approved. JRE is currently in negotiations for additional stores both in Michigan and several other states. Listing below details sizes and locations of arrays currently under contract:
- 444kW Fenton, Michigan
- 323kW Fort Gratiot, Michigan
- 343kW Okemos, Michigan
- 478kW Grand Rapids, Michigan
- 472kW Novi, Michigan
- 416kW Auburn Hills, Michigan
- 438kW Macomb, Michigan
- 397kW Muskegon, Michigan
- 422kW Traverse City, Michigan
- 402kW Saginaw, Michigan

DUKE REALTY

DISTRIBUTION WAREHOUSES - INDIANAPOLIS, IN

- Constructed in 2014
- Installation of 3 separate rooftop arrays totaling 10.5 MW
- Biggest rooftop solar array in Indiana at the time it was completed.
- Kanzo Ballasted Panel Claw Generation 3 racking system (to date, JRE has installed more of this type of racking than any other contractor in the world)
- Installed 39,500 280 watt Solar World Panels and Schneider 680 kW Inverters

SHEDD AQUARIUM

ROOF MOUNT CHICAGO, IL

- Constructed in 2013
- Installation of 265 kW roof mount solar array using 300 Watt modules provided by owner, Schneider Electric 250kW inverter , & Schletter racking system

METRO LINK

345.6 KW SOLAR ARRAY – MOLINE, IL

- Constructed in 2013
- Installation of 345.6 kW roof mount solar array using Motech 255 Watt modules provided by owner, SGI 300kW inverter & AET racking system

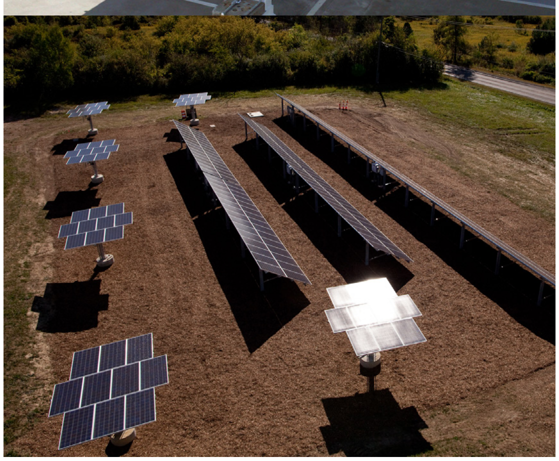
BLUE CROSS BLUE SHIELD

DTE – DETROIT, MI

- Constructed in 2011 as part of DTE's Solar Currents Program Project
- Installation of a 33,000 sft surface area 220 kW Rooftop Array using Schott 235 watt modules, 2 Satcon Inverters rated at 100 kW & AET racking

[PROJECT EXPERIENCE]

Specialty Solar



HOOSIER ENERGY

4MW SYSTEM – MULTIPLE LOCATIONS IN INDIANA

- In 2015, J. Ranck Electric constructed three separate solar arrays for Hoosier Energy in Indiana. Each site was identically designed both in layout and equipment generating 1.34 MW of power. The system totaling 4.02 MW connected directly to the Hoosier Energy utility grid.
- Each array consists of 4320 Canadian Solar 310 watt panels, 2 Schneider SC 540 Inverters and an ATI Single Axis Tracker 30% GCR Racking system
- Array names & locations:
    - < Green County , Crane, Indiana
    - < New Castle, New Castle, Indiana
    - < Harrison Array, Georgetown, Indiana
- JRE did the complete electrical installation as well including the installation of electrical components,wiring of the AC and DC applications, medium voltage interconnection, DC combiner boxes, and module interconnect wiring.

1-800-LAW-FIRM

MULTIPLE APPLICATIONS – SOUTHFIELD, MI

- Constructed in 2014
- Installation of 65.52 kW Roof Mount Array, 80.64 kW Carport, Electric Car Charging Stations and Roof top VAWT Wind Turbines

DOW EVENT CENTER AWNING

35 KW DOW – SAGINAW, MI

- Constructed in 2012
- 35 kW awning mounted solar array uses Suntech 275 watt modules, Solectria 15 kW inverters & a Schletter racking system

GE CAR CHARGING STATIONS

15 KW CANOPY WITH CHARGING STATION – GA

- Constructed in 2012, this 15 kW canopy involves the installation of an 8 parking space solar canopy with charging stations. Composed of GE modules, 1 GE electric car charging unit per 2 stalls and SMA Sunny Boy inverters.

SCIO TOWNSHIP

COMBINATION SOLAR ARRAY – SCIO, MI

- Constructed in 2010, this was the first DTE Solar Currents Program project installed in the State of Michigan
- Total system composed of two arrays, one fixed and one tracking as detailed below:
    - < 47 kW fixed array uses 224 watt Sharp Modules, 2-15 kW & 1-13 kW Solectria inverters
    - < 13 kW single access tracking array uses 60 panels rated at 224 Watt, 1-13 kW Solectria inverter forming 6 single access tracking arrays consisting of 10 panels, each allowing automatic adjustment with sun movement using a pyranometer
- Both arrays are connected to the central DTE web based monitoring system

CARPORTS / CHARGERS

VA HOSPITAL

493 KW ROOFTOPS/CARPORTS, MONTROSE, NY

- Constructed in 2015
- Installation of a total of 493 kW system consisting of a 413.10 kW carport, two small rooftop arrays and an additional small carport for the Veterans Administration in Montrose, NY

1-800-LAW-FIRM

MULTIPLE APPLICATIONS – SOUTHFIELD, MI

- Constructed in 2014
- Installation of 65.52 kW Roof Mount Array, 80.64 kW Carport, Electric Car Charging Stations and Roof top VAWT Wind Turbines

GE CAR CHARGING STATION

15 KW CANOPY WITH CHARGING STATION – GA

- Constructed in 2012,
- Installation of 15 kW canopy involves the installation of an 8 parking space solar canopy with charging stations. Composed of GE modules, 1 GE electric car charging unit per 2 stalls and SMA Sunny Boy inverters.

BOSCH CHARGING STATIONS

MULTIPLE LOCATIONS THROUGHOUT MICHIGAN

- Constructed from 2011 - 2014
- Installation of residential car charging stations throughout the State of Michigan
- Over 40 charging stations installed directly for the manufacturer

CHEVY VOLT SOLAR CARPORT CHARGING STATIONS

18 US LOCATIONS

- Constructed in 2011
- Installation of 11-32 kW solar arrays composed of canopies over 6-12 parking spaces with charging stations
- Average 6 stall canopy uses 96 modules, 12 stall canopy uses 192 modules,
- 1 GE Voltec electric car charging unit installed for every 2 stalls
- SMA Sunny Boy inverters with 3rd party monitoring system integration

TESLA

LOCATIONS THROUGHOUT THE EASTERN U.S.

- Constructed 2013 - 2015
- Installation of 4-10 parking space single unit supercharging stations for Tesla electric cars & first mobile supercharging unit installed in the US.
- 17 locations completed to date in 12 states
- Each location includes owner manufactured and provided equipment for the installation to include TESLA supercharging car units and all equipment to provide a complete charging system.

Solar Maintenance

J. Ranck Electric, Inc. (JRE) is currently contracted with several owner controlled solar arrays. JRE provides 24/7 on call service for emergency work, providing scheduling, troubleshooting, and repairs reported for non emergency work. In addition, these contracts cover scheduled yearly maintenance. Services include, but are not limited to the following items:

- Overall site conditions: Grounds, safety signage
  - Signs and labels checked - indicate if present and intact
  - Site appearance described
  - Any issues are reported to the owner, i.e. debris issues, etc.
- Solar Modules:
  - Check module condition
  - Report dust, film, etc., if present on modules
- Racking:
  - Check general condition of racking
  - Report any issues that need attention
  - Perform torque tests on racking
- Service Rack:
  - Perform torque test on equipment at the service rack
  - Check all wires for tightness
  - Perform IR Scans
- Inverters:
  - Check general condition of Inverters
  - Report any issues that need attention
  - Check field wires for tightness
  - Verify fuses are good
  - Perform IR scans
  - Replace filters as needed.
  - Complete performance testing
- Disconnects/Master Combiners:
  - Check condition of all disconnects and master combiners
  - Report any issues that need attention
  - Perform torque test on terminations
  - Perform IR scans

DTE ENERGY

O & M CONTRACT FOR ALL MICHIGAN SOLAR SITES

- 2010 - Present
- Maintain 26 sites with additional sites added as more projects are completed
- Annual contract that has been renewed for several years
- Site vegetation maintenance as needed added 2014

BOSCH

O & M CONTRACT FOR ALL MICHIGAN SOLAR SITES

- 2011 - Present
- Maintain 5 arrays at 3 locations with additional sites added as projects are completed
- Yearly contract that has been renewed for several years

Installed Projects

Job Name	City, State	Type of Installation	Completion Year	Project DC kW	Yearly Totals
2009 Summary of Projects Installed	Multiple Locations	Multiple Applications	2009	24.8	24.8
2010 Summary of Projects Installed	Multiple Locations	Multiple Applications	2010	211	211
2011 Summary of Projects Installed	Multiple Locations	Multiple Applications	2011	2732	2732
2012 Summary of Projects Installed	Multiple Locations	Multiple Applications	2012	1477.26	1477.26
2013 Summary of Projects Installed	Multiple Locations	Multiple Applications	2013	3474.8	3474.8
2014 Summary of Projects Installed	Multiple Locations	Multiple Applications	2014	14854.85	14854.85
2015 Summary of Projects Installed	Multiple Locations	Multiple Applications	2015	8852.56	8852.56
2016 Summary of Projects Installed	Multiple Locations	Multiple Applications	2016	137789.36	137789.36
2017 Summary of Projects Installed	Multiple Locations	Multiple Applications	2017	35613.2	35613.2
2018 Summary of Projects Installed	Multiple Locations	Multiple Applications	2018	58982.9	58982.9
Ellis North	Dryden, NY	Ground Mount	2019	13461.9	
DTE Ford PV and BESS (design)	Dearborn, MI	Roof Mount	NA	0	
Cumberland Solar	Cumberland, WI	Ground Mount	2019	3393	
Arcadia Solar	Arcadia, WI	Ground Mount	2019	7449.5	
Fennimore Solar	Fennimore, WI	Ground Mount	2019	4110	
DTE Gas Compressor Solar	Mt. Pleasant, MI	Ground Mount	2019	3.6	
ISI/Engie York Solar	Thomson, IL	Ground Mount	2019	2010.42	
ISI/Engie Madison Solar	Ridgeway, IA	Ground Mount	2019	2010.42	
Marshalltown Solar	Marshalltown, IA	Ground Mount	2019	3421.44	
ABI Virtue Cider Solar	Fennville, MI	Ground Mount	2019	78.3	
ITC Solar	Novi, MI	Ground Mount	2019	526.88	
Truman Solar	Wendell, NC	Ground Mount	2019	6593.3	
URE Shelby Solar	Shelby, OH	Ground Mount	2019	2547.45	
2019 Summary of Projects	Multiple Locations	Multiple Applications	2019	45606.21	43058.76
Ridge Farm Solar	Chrisman, IL	Ground Mount	2020	2547	0
Temperance Solar	Erie, MI	Ground Mount	2020	30000	0
Bingham Solar	St. Johns, MI	Ground Mount	2020	30000	0
Detroit Zoo Solar Shelter	Royal Oak, MI	Roof Mount	2020	7.29	0
DTE Ford PV and BESS	Dearborn, MI	Roof Mount	2021	750	0
Geddes 1	Saginaw, MI	Ground Mount	2020	2873	0
Geddes 2	Saginaw, MI	Ground Mount	2021	2873	0
Stonehart	Saginaw, MI	Ground Mount	2020	2881	0
Jack Francis	Mount Morris, MI	Ground Mount	2020	2873	0
May Shannon	Mount Morris, MI	Ground Mount	2020	2873	0
Workman	Lake City, MI	Ground Mount	2020	2784	0
Crescent Solar	Jonesville, MI	Ground Mount	2021	9.6	0
Bullhead	Jonesville, MI	Ground Mount	2021	2873	0
Angola	Coldwater, MI	Ground Mount	2021	2821	0
2020 Summary of Projects	Multiple Locations	Multiple Applications	2020	86084.89	83263.89
East Lansing Schools Carport & Ground M	East Lansing, MI	Carport and Ground Mount	●	629.1	0
Boyne Mtn. Solar	Boyne Falls, MI	Ground Mount	●	1768.56	0
●	0	0	●	0	0
●	0	0	●	0	0
●	0	0	●	0	0
2021 Summary of Projects	Multiple Locations	Multiple Applications	2019	0	0
		TOTAL TO DATE:	387880.83		387.880083MW

[PROJECT EXPERIENCE]

WIND

1-800-LAW-FIRM

MULTIPLE APPLICATIONS – SOUTHFIELD, MI

- Constructed in 2014
- Installation of 65.52 kW Roof Mount Array, 80.64 kW Carport, Electric Car Charging Stations and Roof top VAWT Wind Turbines (see picture on left)

MDOT REST AREA WIND TURBINE

3.5KW WIND TURBINE – ST. IGNACE MICHIGAN

- Completed in 2015
- Design Build project for engineering, procurement and installation of 3.5 kW Raum Energy Turbine complete with foundation and electrical work at the MDOT Rest Area on southbound I-75 in St. Ignace

SCIT TURBINE FOUNDATION

TURBINE FOUNDATION & ELECTRICAL -- MT. PLEASANT, MI

- Foundation and Electrical work completed in January & February of 2012. Project was then put on hold until July 2013 when the equipment was installed and the final electrical work was completed.
- Start up and integration by others.
- Work completed for Saginaw Chippewa Indian Tribe at the Water Treatment Plant in Mt. Pleasant, Michigan

MACKINAW CITY HARBOR

STATE HARBOR OF REFUGE WIND TURBINES PH III

- Completed in 2009
- Redevelopment of ferry docs for renewable energy usage. Project was the first “green” marina for the Department of Natural Resources,
- Complete installation of electrical and lighting improvements to accommodate the turbines, including the infrastructure for the Skystream turbines

J. RANCK ELECTRIC, INC.

Attachment 6 – Required Bid Forms

Form **W-9**
(Rev. October 2018)
Department of the Treasury
Internal Revenue Service

Request for Taxpayer Identification Number and Certification

▶ Go to *www.irs.gov/FormW9* for instructions and the latest information.

Give Form to the requester. Do not send to the IRS.

Print or type. See Specific Instructions on page 3.

1 Name (as shown on your income tax return). Name is required on this line; do not leave this line blank.
NOVA Consultants Inc.

2 Business name/disregarded entity name, if different from above

3 Check appropriate box for federal tax classification of the person whose name is entered on line 1. Check only **one** of the following seven boxes.

☐ Individual/sole proprietor or single-member LLC ☐ C Corporation ☑ S Corporation ☐ Partnership ☐ Trust/estate

☐ Limited liability company. Enter the tax classification (C=C corporation, S=S corporation, P=Partnership) ▶ ________

Note: Check the appropriate box in the line above for the tax classification of the single-member owner. Do not check LLC if the LLC is classified as a single-member LLC that is disregarded from the owner unless the owner of the LLC is another LLC that is **not** disregarded from the owner for U.S. federal tax purposes. Otherwise, a single-member LLC that is disregarded from the owner should check the appropriate box for the tax classification of its owner.

☐ Other (see instructions) ▶

4 Exemptions (codes apply only to certain entities, not individuals; see instructions on page 3):

Exempt payee code (if any) ________

Exemption from FATCA reporting code (if any) ________

(Applies to accounts maintained outside the U.S.)

5 Address (number, street, and apt. or suite no.) See instructions.
21580 Novi Rd, Suite 300

Requester's name and address (optional)

6 City, state, and ZIP code
Novi, MI 48375

7 List account number(s) here (optional)

Part I Taxpayer Identification Number (TIN)

Enter your TIN in the appropriate box. The TIN provided must match the name given on line 1 to avoid backup withholding. For individuals, this is generally your social security number (SSN). However, for a resident alien, sole proprietor, or disregarded entity, see the instructions for Part I, later. For other entities, it is your employer identification number (EIN). If you do not have a number, see *How to get a TIN,* later.

Note: If the account is in more than one name, see the instructions for line 1. Also see *What Name and Number To Give the Requester* for guidelines on whose number to enter.

Social security number
___ - __ - ____

or

Employer identification number
38 - 3073729

Part II Certification

Under penalties of perjury, I certify that:

1. The number shown on this form is my correct taxpayer identification number (or I am waiting for a number to be issued to me); and
2. I am not subject to backup withholding because: (a) I am exempt from backup withholding, or (b) I have not been notified by the Internal Revenue Service (IRS) that I am subject to backup withholding as a result of a failure to report all interest or dividends, or (c) the IRS has notified me that I am no longer subject to backup withholding; and
3. I am a U.S. citizen or other U.S. person (defined below); and
4. The FATCA code(s) entered on this form (if any) indicating that I am exempt from FATCA reporting is correct.

Certification instructions. You must cross out item 2 above if you have been notified by the IRS that you are currently subject to backup withholding because you have failed to report all interest and dividends on your tax return. For real estate transactions, item 2 does not apply. For mortgage interest paid, acquisition or abandonment of secured property, cancellation of debt, contributions to an individual retirement arrangement (IRA), and generally, payments other than interest and dividends, you are not required to sign the certification, but you must provide your correct TIN. See the instructions for Part II, later.

Sign Here Signature of U.S. person ▶ [signature] Date ▶ 4/12/23

General Instructions

Section references are to the Internal Revenue Code unless otherwise noted.

Future developments. For the latest information about developments related to Form W-9 and its instructions, such as legislation enacted after they were published, go to *www.irs.gov/FormW9.*

Purpose of Form

An individual or entity (Form W-9 requester) who is required to file an information return with the IRS must obtain your correct taxpayer identification number (TIN) which may be your social security number (SSN), individual taxpayer identification number (ITIN), adoption taxpayer identification number (ATIN), or employer identification number (EIN), to report on an information return the amount paid to you, or other amount reportable on an information return. Examples of information returns include, but are not limited to, the following.

- Form 1099-INT (interest earned or paid)
- Form 1099-DIV (dividends, including those from stocks or mutual funds)
- Form 1099-MISC (various types of income, prizes, awards, or gross proceeds)
- Form 1099-B (stock or mutual fund sales and certain other transactions by brokers)
- Form 1099-S (proceeds from real estate transactions)
- Form 1099-K (merchant card and third party network transactions)
- Form 1098 (home mortgage interest), 1098-E (student loan interest), 1098-T (tuition)
- Form 1099-C (canceled debt)
- Form 1099-A (acquisition or abandonment of secured property)

Use Form W-9 only if you are a U.S. person (including a resident alien), to provide your correct TIN.

If you do not return Form W-9 to the requester with a TIN, you might be subject to backup withholding. See What is backup withholding, *later.*

ATTACHMENT C
LEGAL STATUS OF PROPOSER

(The Respondent shall fill out the provision and strike out the remaining ones.)

The Respondent is:

- A corporation organized and doing business under the laws of the state of Michigan, for whom Sunil Agrawal bearing the office title of President, whose signature is affixed to this proposal, is authorized to execute contracts on behalf of respondent.*

  *If not incorporated in Michigan, please attach the corporation's Certificate of Authority

- A limited liability company doing business under the laws of the State of ________, whom ________________ bearing the title of ________________ whose signature is affixed to this proposal, is authorized to execute contract on behalf of the LLC.

- A partnership organized under the laws of the State of ____________ and filed with the County of ____________, whose members are (attach list including street and mailing address for each.)

- An individual, whose signature with address, is affixed to this RFP.

Respondent has examined the basic requirements of this RFP and its scope of services, including all Addendum (if applicable) and hereby agrees to offer the services as specified in the RFP.

Signature ________________________ Date: 4/16/13

(Print) Name Sunil Agrawal Title President

Firm: NOVA Consultants Inc.

Address: 21580 Novi Rd. Suite 300, Novi, MI 48375

Contact Phone 248-347-3512 Fax 248-347-4152

Email sunil.agrawal@novaconsultants.com

ATTACHMENT D
CITY OF ANN ARBOR DECLARATION OF COMPLIANCE

Non-Discrimination Ordinance

The "non discrimination by city contractors" provision of the City of Ann Arbor Non-Discrimination Ordinance (Ann Arbor City Code Chapter 112, Section 9:158) requires all contractors proposing to do business with the City to treat employees in a manner which provides equal employment opportunity and does not discriminate against any of their employees, any City employee working with them, or any applicant for employment on the basis of actual or perceived age, arrest record, color, disability, educational association, familial status, family responsibilities, gender expression, gender identity, genetic information, height, HIV status, marital status, national origin, political beliefs, race, religion, sex, sexual orientation, source of income, veteran status, victim of domestic violence or stalking, or weight. It also requires that the contractors include a similar provision in all subcontracts that they execute for City work or programs.

In addition the City Non-Discrimination Ordinance requires that all contractors proposing to do business with the City of Ann Arbor must satisfy the contract compliance administrative policy adopted by the City Administrator. A copy of that policy may be obtained from the Purchasing Manager

The Contractor agrees:

(a) To comply with the terms of the City of Ann Arbor's Non-Discrimination Ordinance and contract compliance administrative policy.

(b) To post the City of Ann Arbor's Non-Discrimination Ordinance Notice in every work place or other location in which employees or other persons are contracted to provide services under a contract with the City.

(c) To provide documentation within the specified time frame in connection with any workforce verification, compliance review or complaint investigation.

(d) To permit access to employees and work sites to City representatives for the purposes of monitoring compliance, or investigating complaints of non-compliance.

The undersigned states that he/she has the requisite authority to act on behalf of his/her employer in these matters and has offered to provide the services in accordance with the terms of the Ann Arbor Non-Discrimination Ordinance. The undersigned certifies that he/she has read and is familiar with the terms of the Non-Discrimination Ordinance, obligates the Contractor to those terms and acknowledges that if his/her employer is found to be in violation of Ordinance it may be subject to civil penalties and termination of the awarded contract.

NOVA Consultants Inc.
Company Name

[signature] 4/12/23
Signature of Authorized Representative Date

Sunil Agrawal, President
Print Name and Title

21580 Novi Rd. Suite 300, Novi, MI 48375
Address, City, State, Zip

248-347-3512 Sunil.agrawal@novaconsultants.com
Phone/Email address

Questions about the Notice or the City Administrative Policy, Please contact:
Procurement Office of the City of Ann Arbor
(734) 794-6500

ATTACHMENT E
CITY OF ANN ARBOR
LIVING WAGE ORDINANCE DECLARATION OF COMPLIANCE

The Ann Arbor Living Wage Ordinance (Section 1:811-1:821 of Chapter 23 of Title I of the Code) requires that an employer who is (a) a contractor providing services to or for the City for a value greater than $10,000 for any twelve-month contract term, or (b) a recipient of federal, state, or local grant funding administered by the City for a value greater than $10,000, or (c) a recipient of financial assistance awarded by the City for a value greater than $10,000, shall pay its employees a prescribed minimum level of compensation (i.e., Living Wage) for the time those employees perform work on the contract or in connection with the grant or financial assistance. The Living Wage must be paid to these employees for the length of the contract/program.

Companies employing fewer than 5 persons and non-profits employing fewer than 10 persons are exempt from compliance with the Living Wage Ordinance. If this exemption applies to your company/non-profit agency please check here [___] No. of employees__

The Contractor or Grantee agrees:

(a) To pay each of its employees whose wage level is not required to comply with federal, state or local prevailing wage law, for work covered or funded by a contract with or grant from the City, no less than the Living Wage. The current Living Wage is defined as $14.82/hour for those employers that provide employee health care (as defined in the Ordinance at Section 1:815 Sec. 1 (a)), or no less than $16.52/hour for those employers that do not provide health care. The Contractor or Grantor understands that the Living Wage is adjusted and established annually on April 30 in accordance with the Ordinance and covered employers shall be required to pay the adjusted amount thereafter to be in compliance with Section 1:815(3).

Check the applicable box below which applies to your workforce

[___] Employees who are assigned to any covered City contract/grant will be paid at or above the applicable living wage without health benefits

[___] Employees who are assigned to any covered City contract/grant will be paid at or above the applicable living wage with health benefits

(b) To post a notice approved by the City regarding the applicability of the Living Wage Ordinance in every work place or other location in which employees or other persons contracting for employment are working.

(c) To provide to the City payroll records or other documentation within ten (10) business days from the receipt of a request by the City.

(d) To permit access to work sites to City representatives for the purposes of monitoring compliance, and investigating complaints or non-compliance.

(e) To take no action that would reduce the compensation, wages, fringe benefits, or leave available to any employee covered by the Living Wage Ordinance or any person contracted for employment and covered by the Living Wage Ordinance in order to pay the living wage required by the Living Wage Ordinance.

The undersigned states that he/she has the requisite authority to act on behalf of his/her employer in these matters and has offered to provide the services or agrees to accept financial assistance in accordance with the terms of the Living Wage Ordinance. The undersigned certifies that he/she has read and is familiar with the terms of the Living Wage Ordinance, obligates the Employer/Grantee to those terms and acknowledges that if his/her employer is found to be in violation of Ordinance it may be subject to civil penalties and termination of the awarded contract or grant of financial assistance.

NOVA Consultants Inc.	21580 Novi Rd. Suite 300
Company Name	Street Address
	Novi, MI 48375
Signature of Authorized Representative Date	City, State, Zip
Sunil Agrawal, President	248-347-3512 sunil.agrawal@novaconsultants.com
Print Name and Title	Phone/Email address

ATTACHMENT F

VENDOR CONFLICT OF INTEREST DISCLOSURE FORM

All vendors interested in conducting business with the City of Ann Arbor must complete and return the Vendor Conflict of Interest Disclosure Form in order to be eligible to be awarded a contract. Please note that all vendors are subject to comply with the City of Ann Arbor's conflict of interest policies as stated within the certification section below.

If a vendor has a relationship with a City of Ann Arbor official or employee, an immediate family member of a City of Ann Arbor official or employee, the vendor shall disclose the information required below.

1. No City official or employee or City employee's immediate family member has an ownership interest in vendor's company or is deriving personal financial gain from this contract.
2. No retired or separated City official or employee who has been retired or separated from the City for less than one (1) year has an ownership interest in vendor's Company.
3. No City employee is contemporaneously employed or prospectively to be employed with the vendor.
4. Vendor hereby declares it has not and will not provide gifts or hospitality of any dollar value or any other gratuities to any City employee or elected official to obtain or maintain a contract.
5. Please note any exceptions below:

Conflict of Interest Disclosure*	
Name of City of Ann Arbor employees, elected officials or immediate family members with whom there may be a potential conflict of interest.	( ) Relationship to employee ( ) Interest in vendor's company ( ) Other (please describe in box below)

*Disclosing a potential conflict of interest does not disqualify vendors. In the event vendors do not disclose potential conflicts of interest and they are detected by the City, vendor will be exempt from doing business with the City.

I certify that this Conflict of Interest Disclosure has been examined by me and that its contents are true and correct to my knowledge and belief and I have the authority to so certify on behalf of the Vendor by my signature below:

NOVA Consultants Inc.	248-347-3512
Vendor Name	**Vendor Phone Number**

[signature]		Sunil Agrawal, President
Signature of Vendor Authorized Representative	**Date**	**Printed Name of Vendor Authorized Representative**