ILLINOIS

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

NORTH CAMPUS PARKING DECK –
INSTALL SOLAR ARRAY CONCEPTUALIZATION U13038

October 3, 2013

POSITIVENERGY
PRACTICE

TEAM

POSITIVENERGY PRACTICE – Prime Consultant

HANNO WEBER & ASSOCIATES – Architect

RUBINOS & MESIA ENGINEERS – Structural Engineer

CONSTRUCTION COST SYSTEMS – Cost Estimating

WHY?

- Net-zero energy goal for new Electrical Engineering & Computer Science Building
- UIUC campus wide energy reduction objectives
- UIUC ‘Climate Action Plan’

THE CHALLENGE

PROJECT CRITERIA Mandatory Requirements

- Peak power output of 1.0 MW or greater.
- Energy production of 1,600 MWh/year or greater.
- Utilize top deck of existing North Campus Parking Garage.
- Code compliant installation.
- Structural integrity.
- Solar array must supply power requirements of existing parking operation.

PROJECT CRITERIA Design Influences

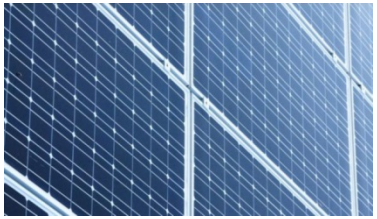
- Cost
- Aesthetics
- Ease of maintenance
- Storm Drainage
- Maximizing daylight
- Conformance with State procurement laws
- Maximizing power and energy production requirements
- Selection of most efficient structural solution
- Flexibility
- Project completion in Fall 2014

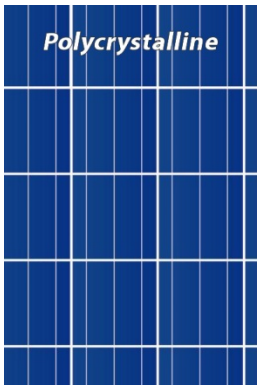
PARTS & ASSEMBLY

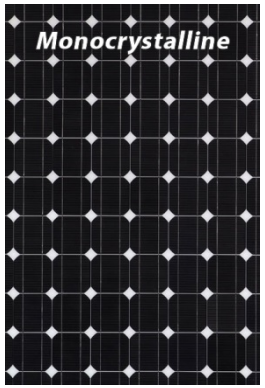
SOLAR PANEL TECHNOLOGY Panel Characteristics

Thin Film

Crystalline







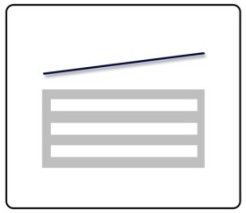
	Copper Indium Gallium Selenide (CIGS)	Cadmium Telluride (CdTe)	Polycrystalline	Monocrystalline
Eff %/panel	~ 11-13%	~ 11-14%	~ 14-16%	~ 16-19%
Area/panel	~ 1.25 m x 0.98 m	~ 1.25 m x 0.98 m	~ 1.68 m x 1.0 m	~ 1.68 m x 1.0 m
Weight/panel	~ 44 lb	~ 44 lb	~ 47 lb	~ 47 lb

SOLAR PANEL INSTALLATION Site Considerations

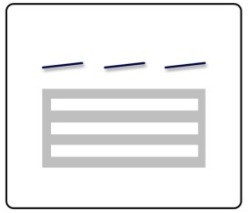
Criteria affecting the power generation capabilities of any solar technology or system include:

- Latitude
- Longitude
- Elevation
- Available Solar Radiation – Diffuse, Direct
- Air Temperature
- Wind Direction and Speed

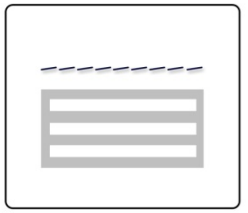
SOLAR PANEL INSTALLATION Panel Layout Options



Carpet



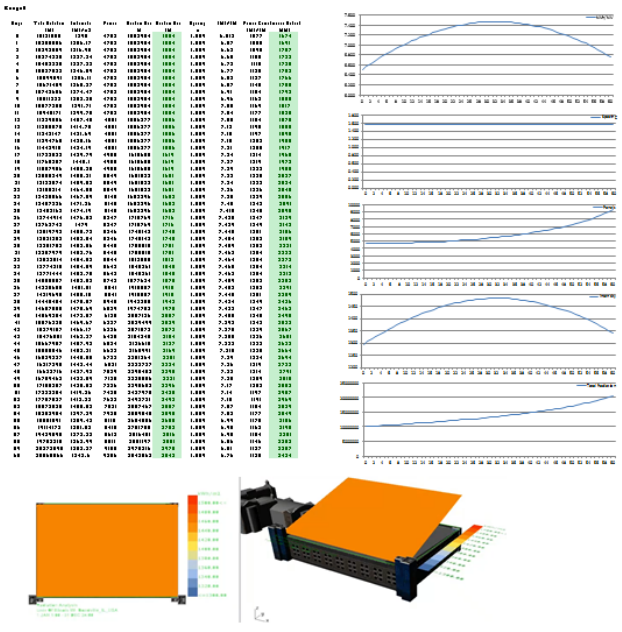
Carport



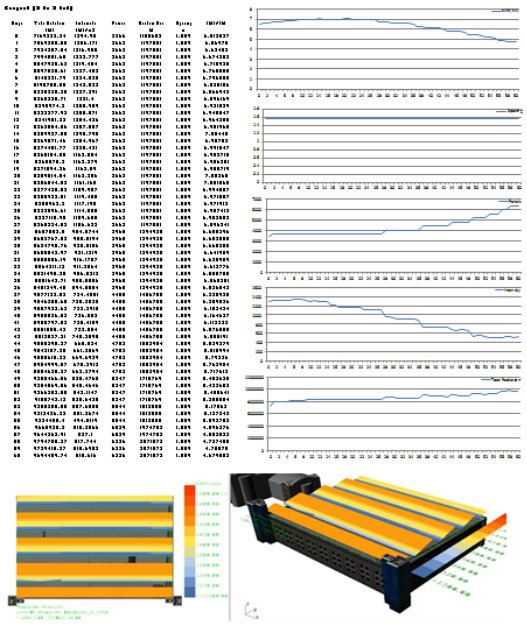
Trellis

RADIATION ANALYSIS Results Summary

Generation (kWh/yr) target met?



Carpet



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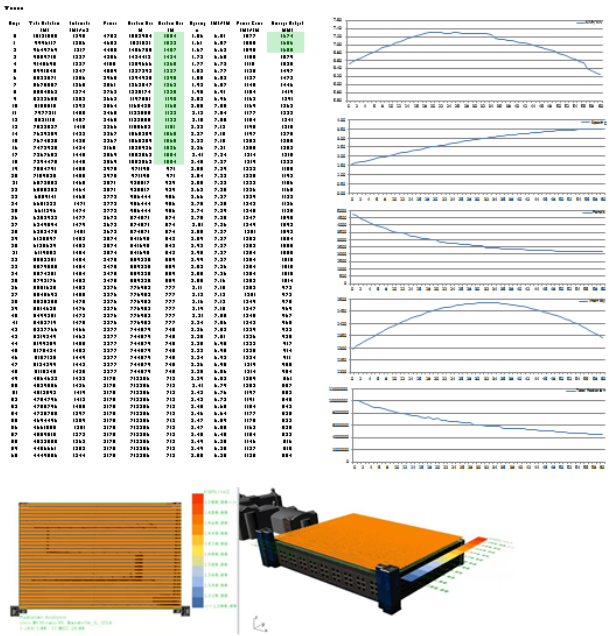


Trellis

RADIATION ANALYSIS Results Summary

System Advisor Model Report

Photovoltaic System		1.2 DC MW Nameplate	SPRINGFIELD, IL
Commercial		$0.00/W Installed Cost	39.83 N, -89.67 E GMT -6

Performance Model

Modules	
SunPower SPR-X21-345-COM	
Cell material	c-Si
Module area	1.6 m^2
Module capacity	344.9 DC Watts
Quantity	3,600
Total capacity	1.2 DC MW
Total area	5,871 m^2

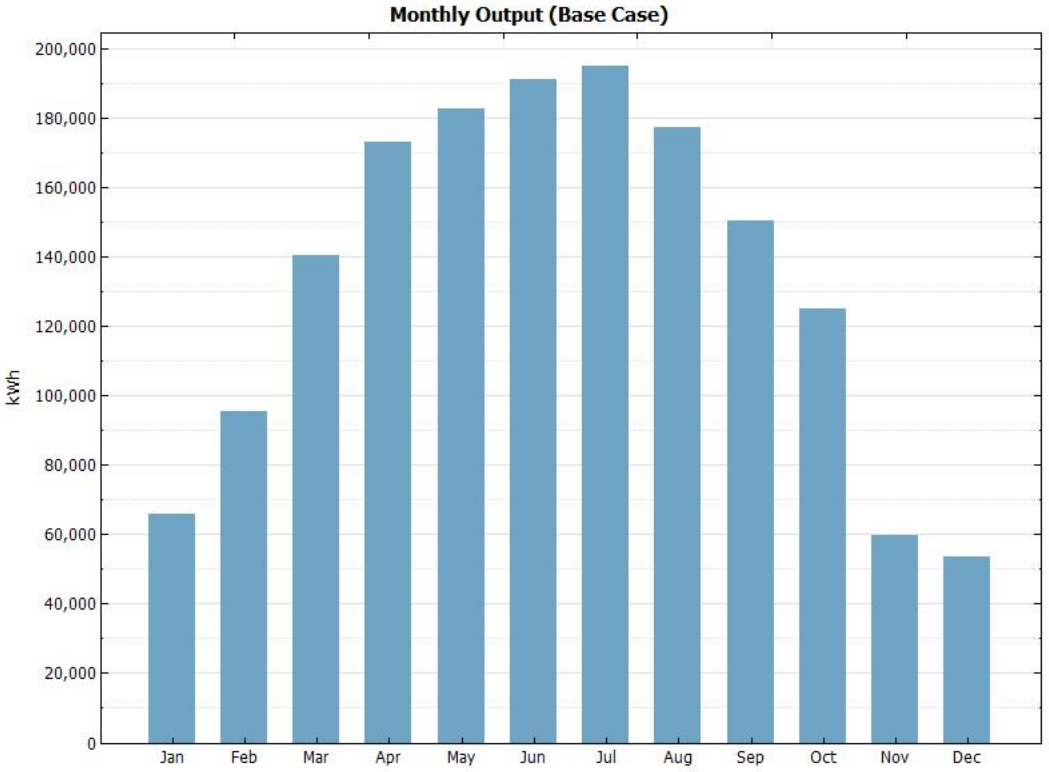
Inverters	
Advanced Energy: 3159000-110 480V	
Unit capacity	335 AC kW
Input voltage	330 - 600 VDC
Quantity	4
Total capacity	1.3 AC MW
AC derate factor	0.99

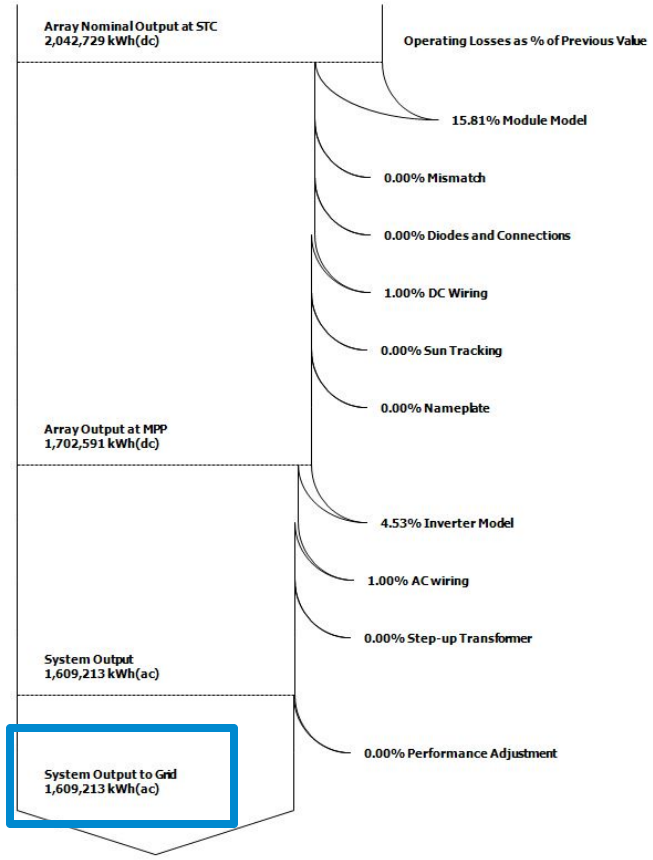
Array	
Strings	360
Modules per string	10
String DC voltage	573.0
Tilt (deg from horizontal)	20
Azimuth (deg E of N)	180
Tracking	fixed
Backtracking	-
Rotation limit (deg)	-
Shading	no
Soiling	yes
DC derate factor	0.99

Performance Adjustment	
Annual	none
Year-to-year decline	0.5%/yr
Hourly factors	no

Annual Results (in Year 1)	
Horizontal solar kW/m^2	1,543
Incident solar kW/m^2	1,644
DC kWh from array	1,719,000
Net to inverter	1,702,000 DC kWh
Gross from inverter	1,625,000 AC kWh
Net to grid	1,609,000 AC kWh
Capacity factor	14.8%
Performance factor	0.79

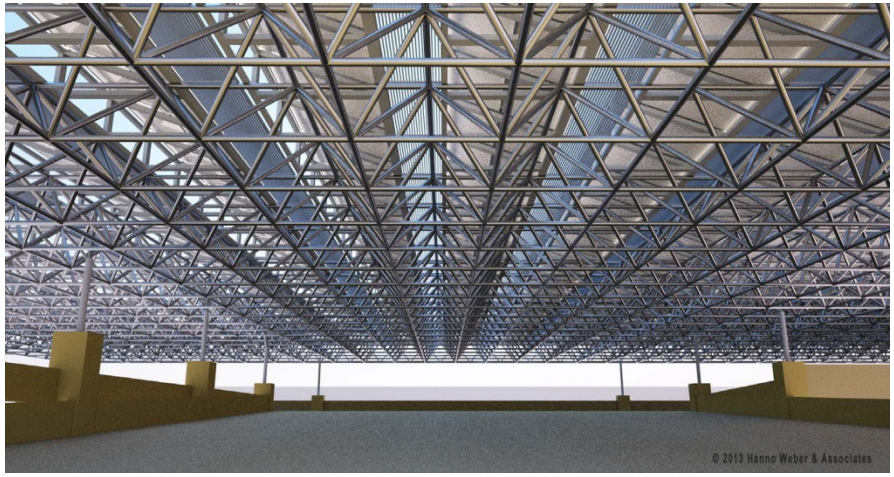
RADIATION ANALYSIS Results Summary





Including self shadings

ARCHITECTURAL ISSUES Panel Installation Flexibility

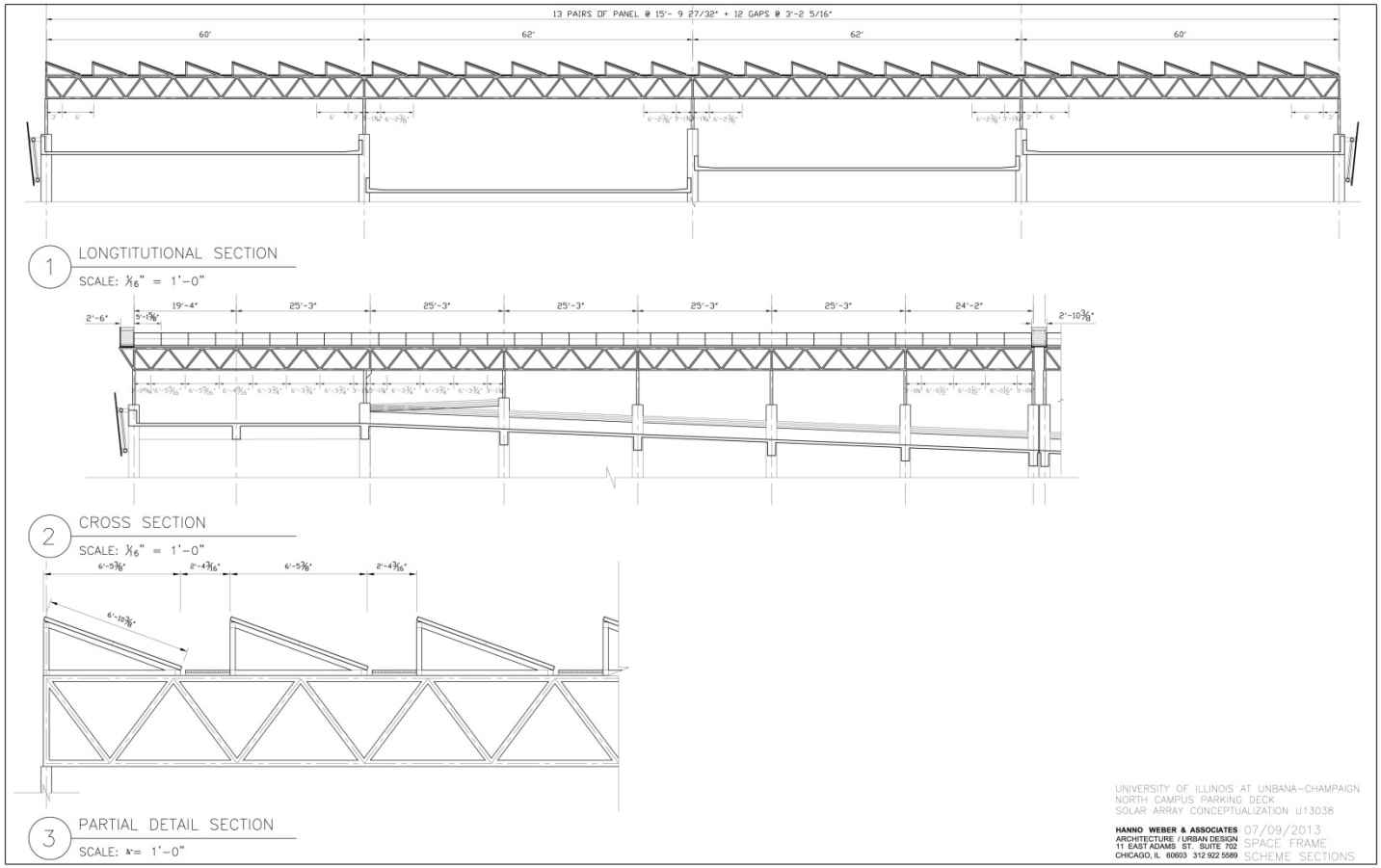


Space Frame Scheme

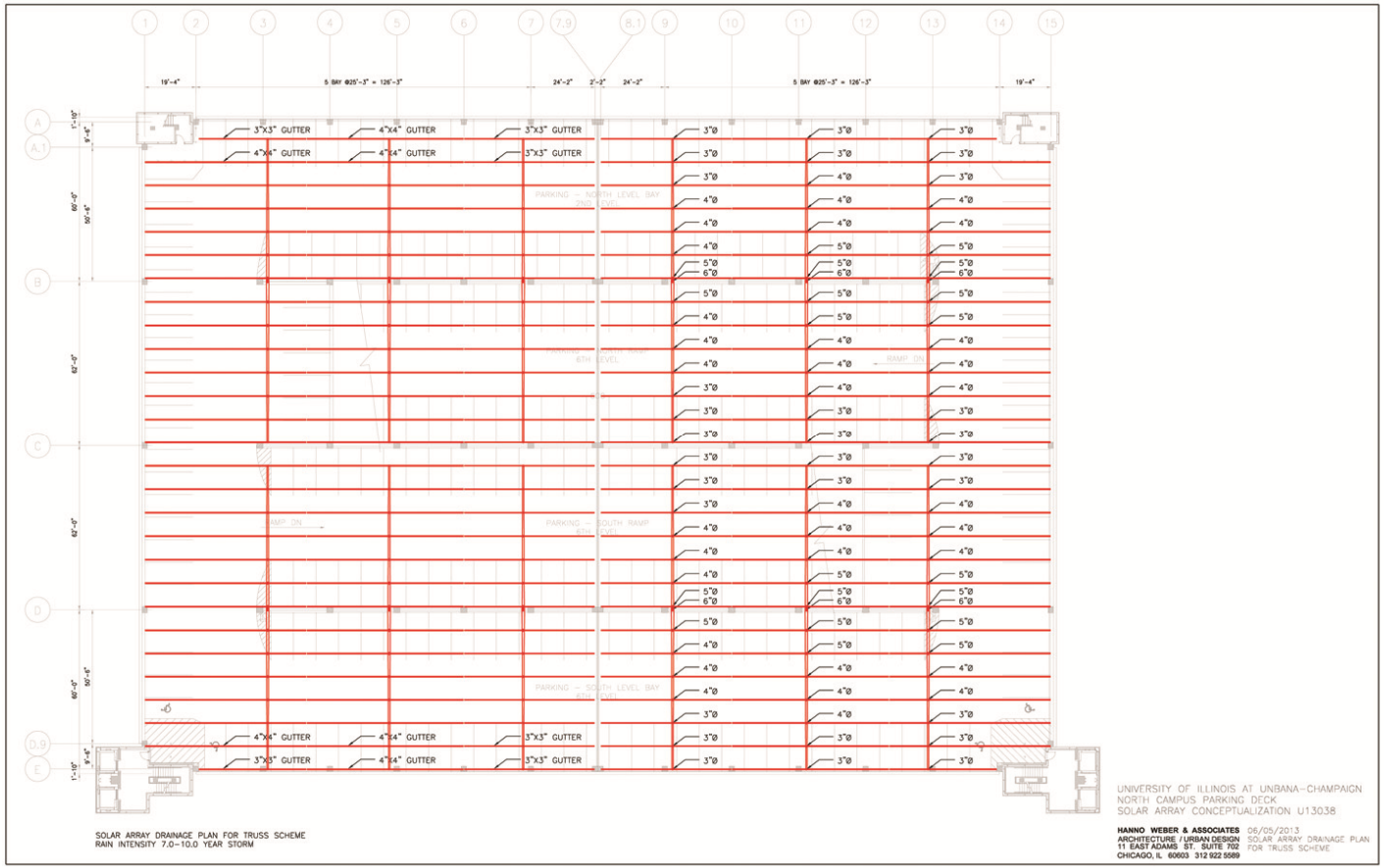
Truss Scheme

ARCHITECTURAL ISSUES Aesthetics

ARCHITECTURAL ISSUES Panel Spacing Studies

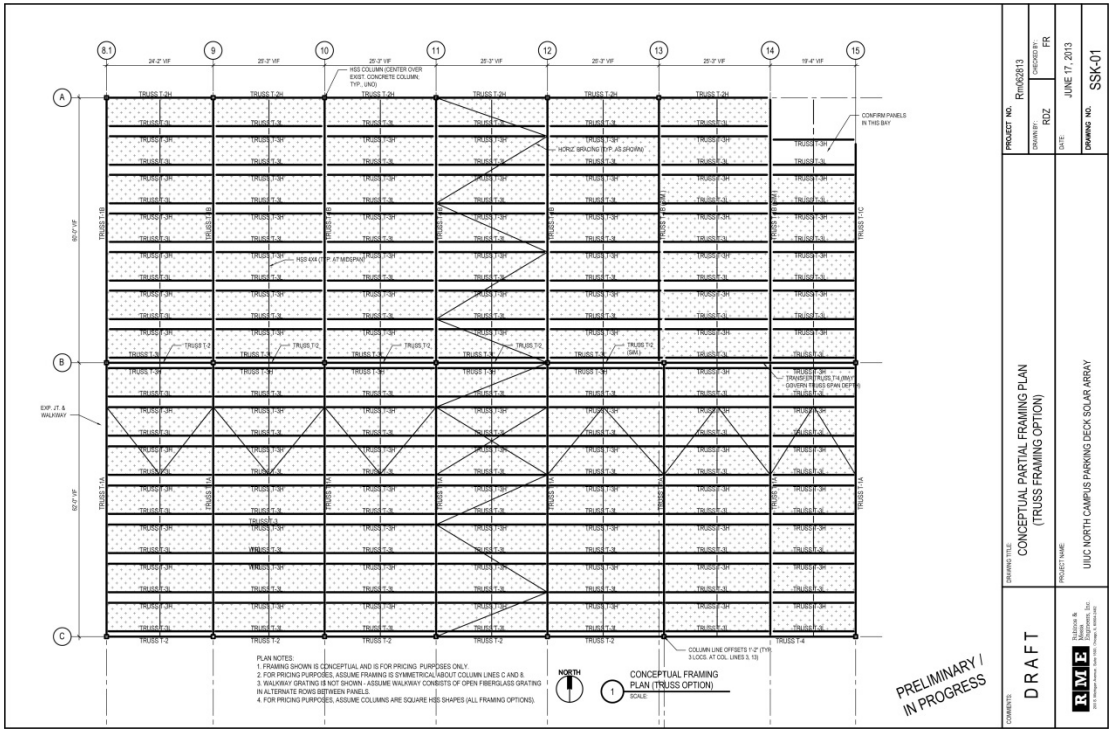


ARCHITECTURAL ISSUES Drainage

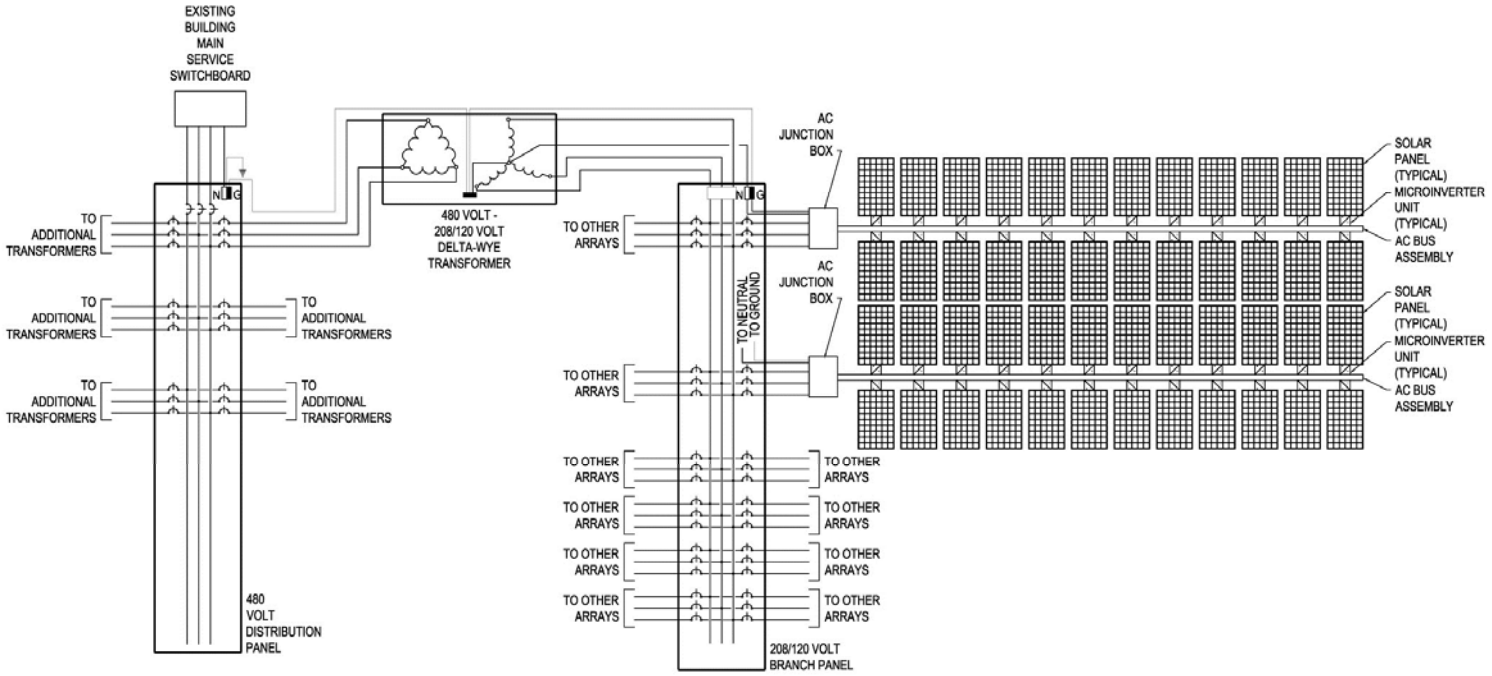


STRUCTURAL ISSUES

- Constraints of existing structure.
- Multiple framing options.

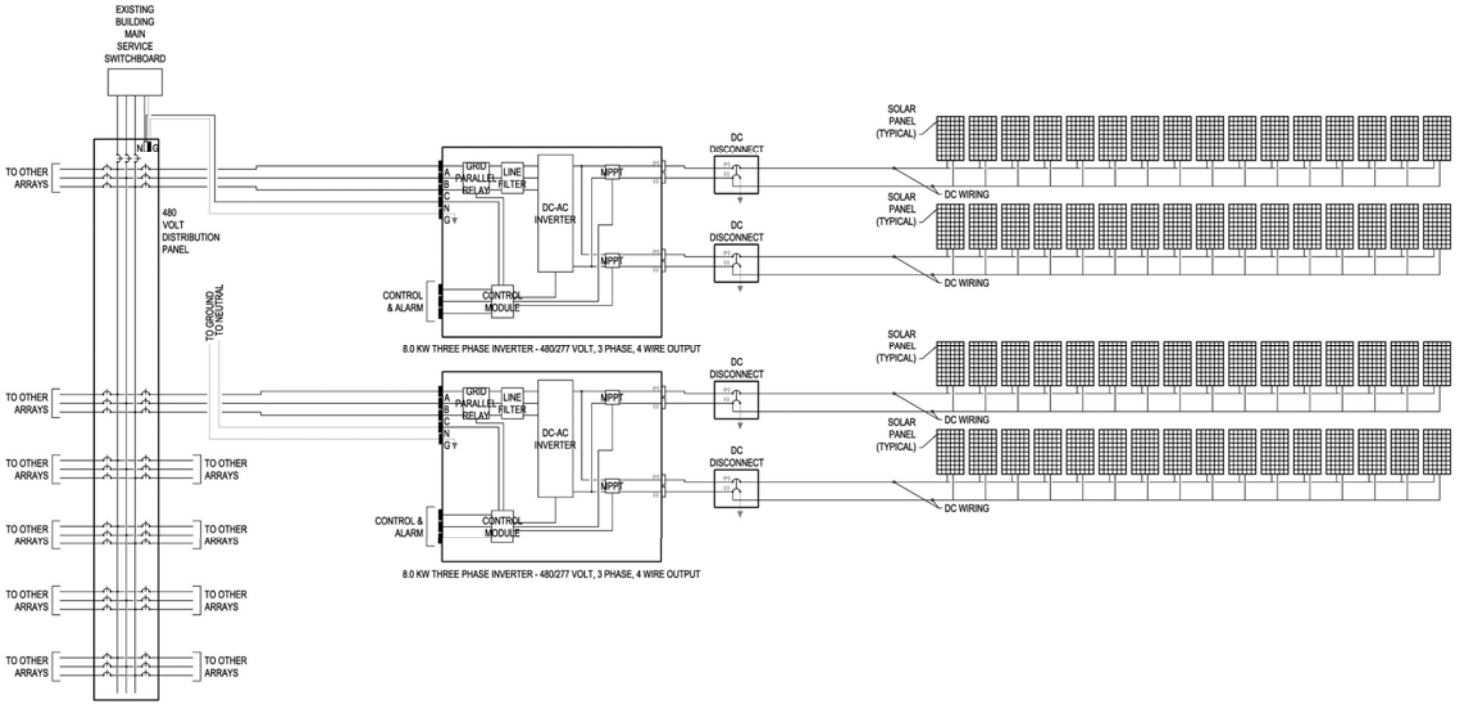


INVERTER TECHNOLOGIES Microinverters



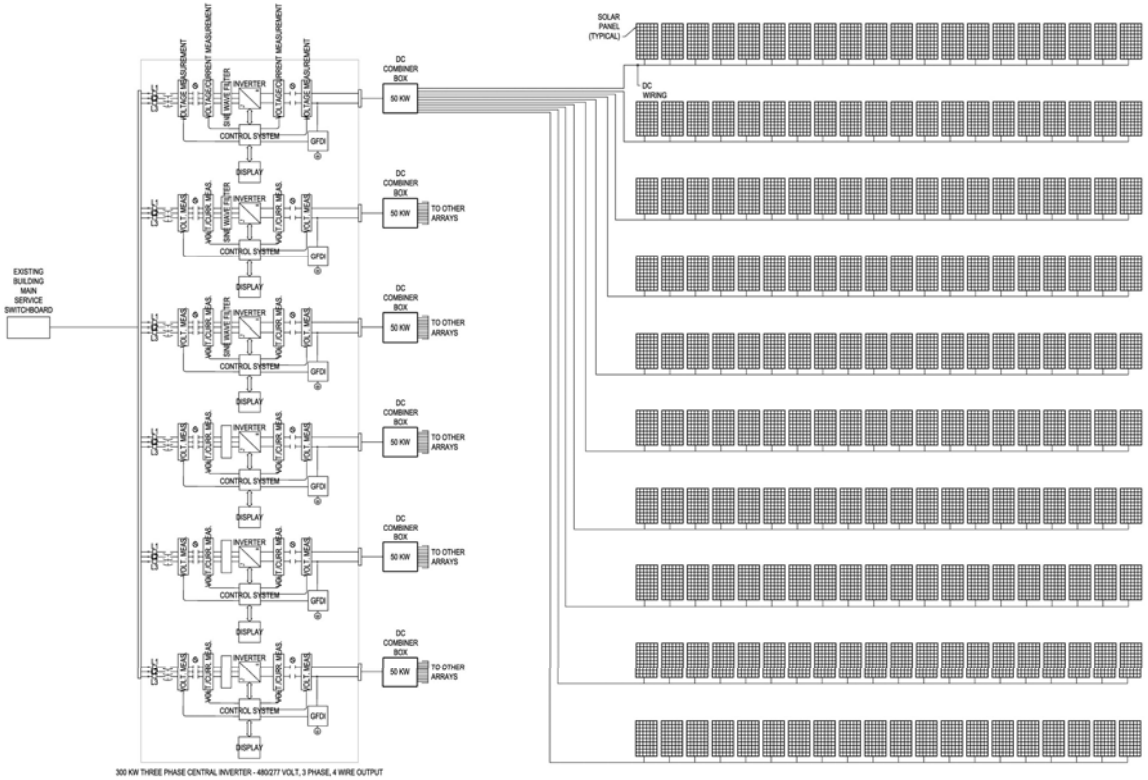
Microinverter Schematic Wiring Diagram

INVERTER TECHNOLOGIES String Inverters



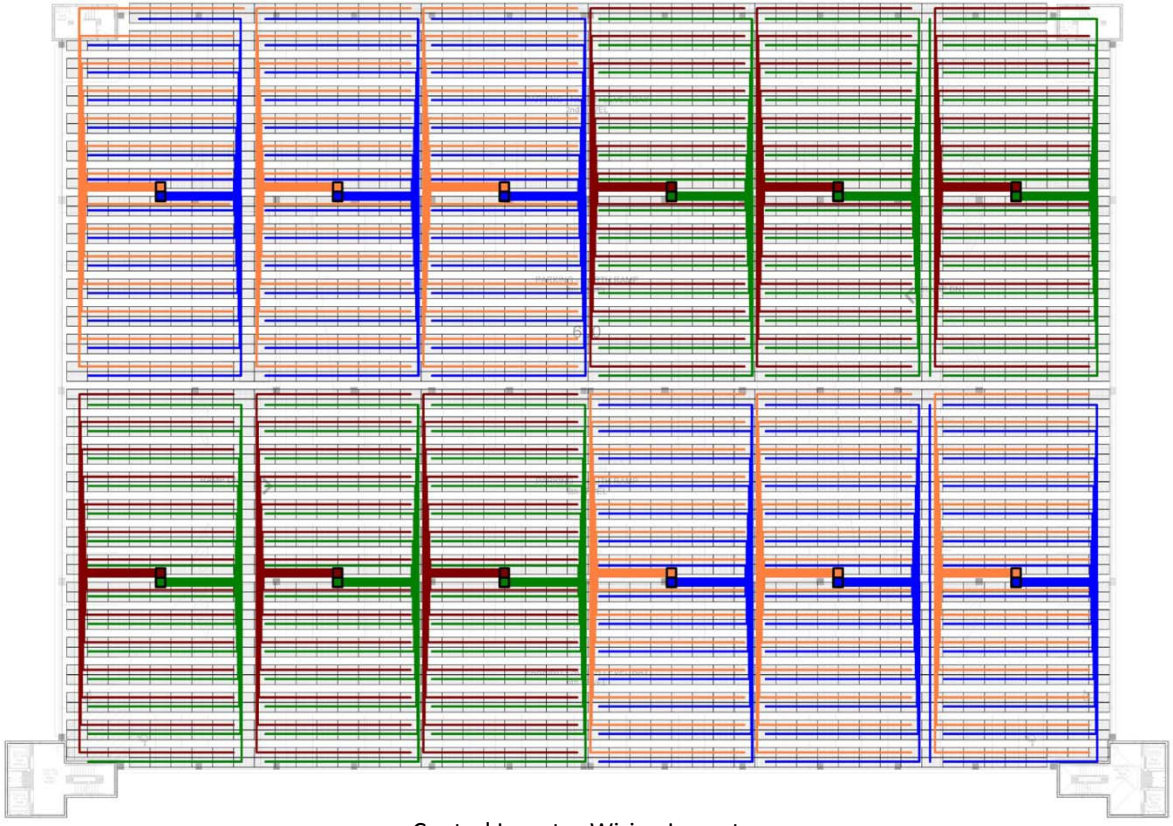
String Inverter Schematic Wiring Diagram

INVERTER TECHNOLOGIES Central Inverters



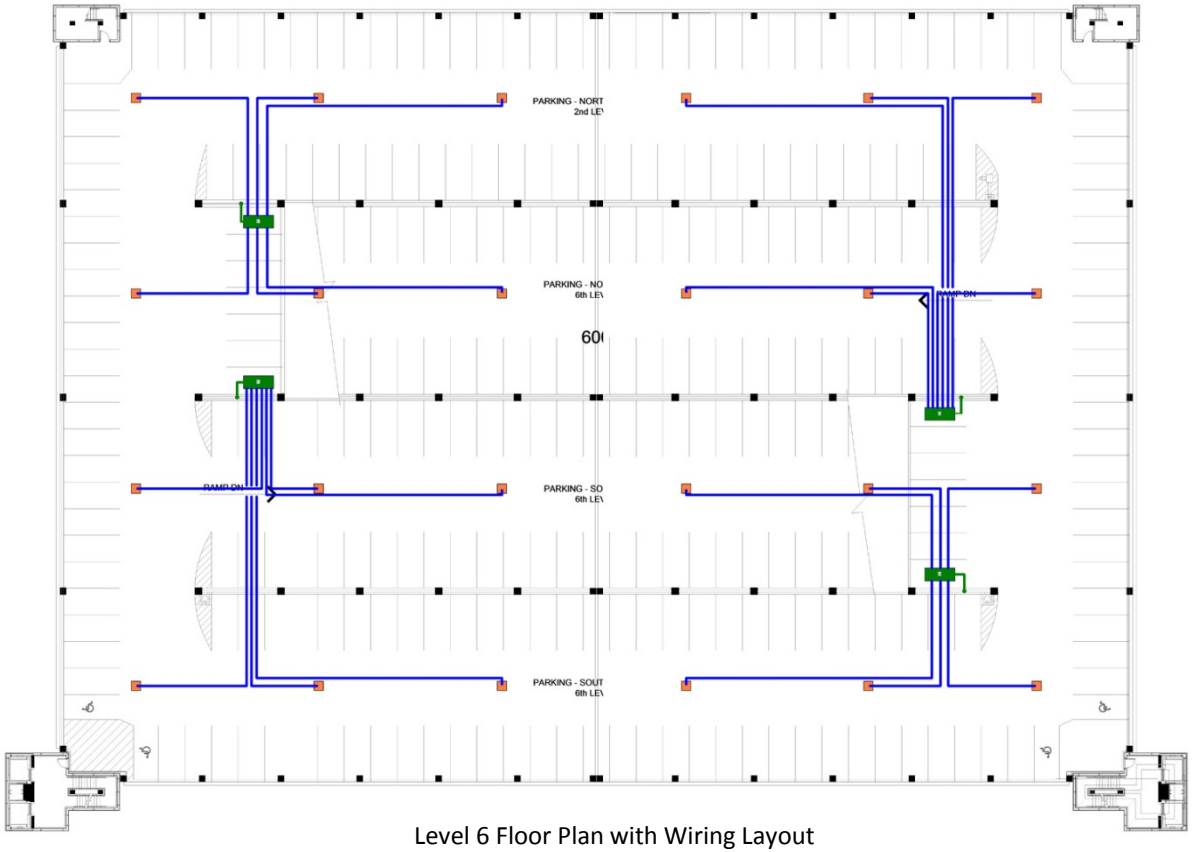
Central Inverter Schematic Wiring Diagram

ELECTRICAL SYSTEM INSTALLATION



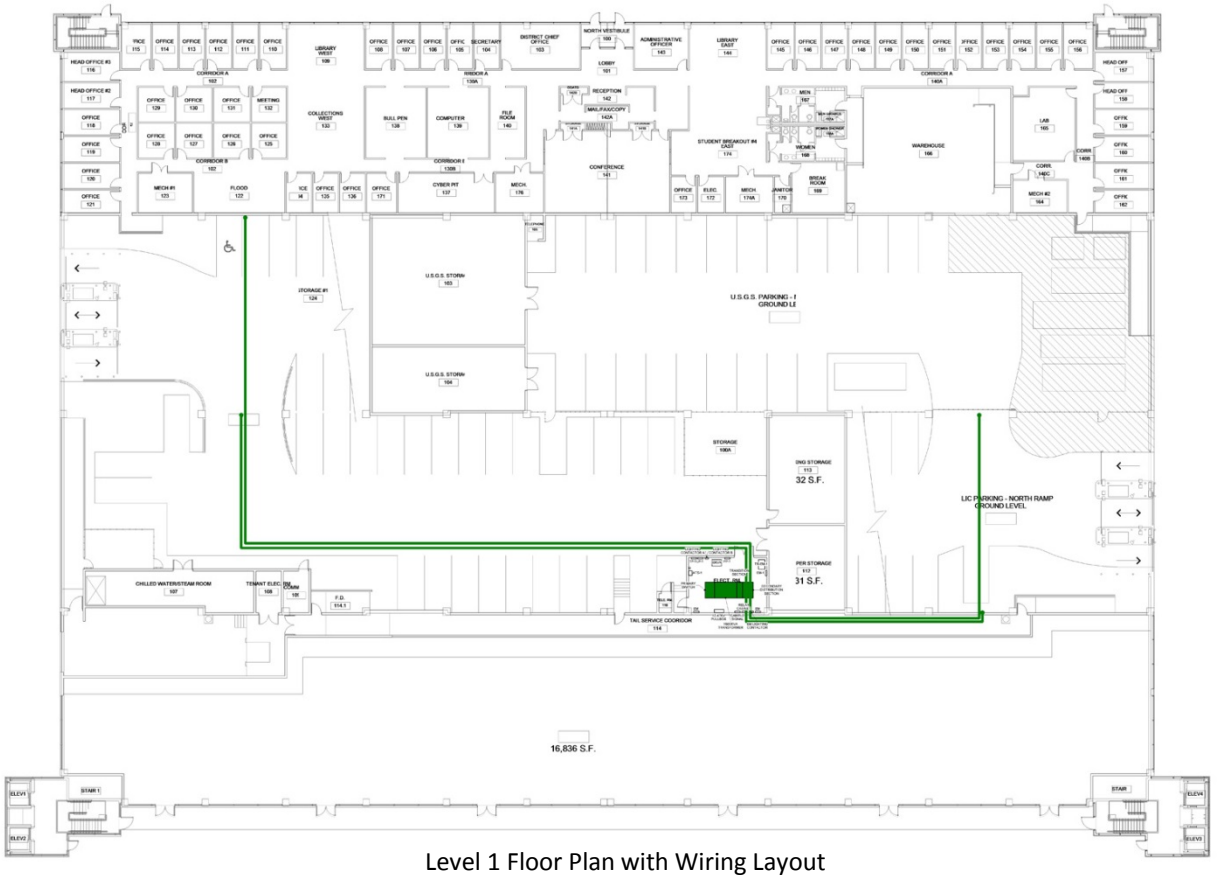
Central Inverter Wiring Layout

ELECTRICAL SYSTEM INSTALLATION



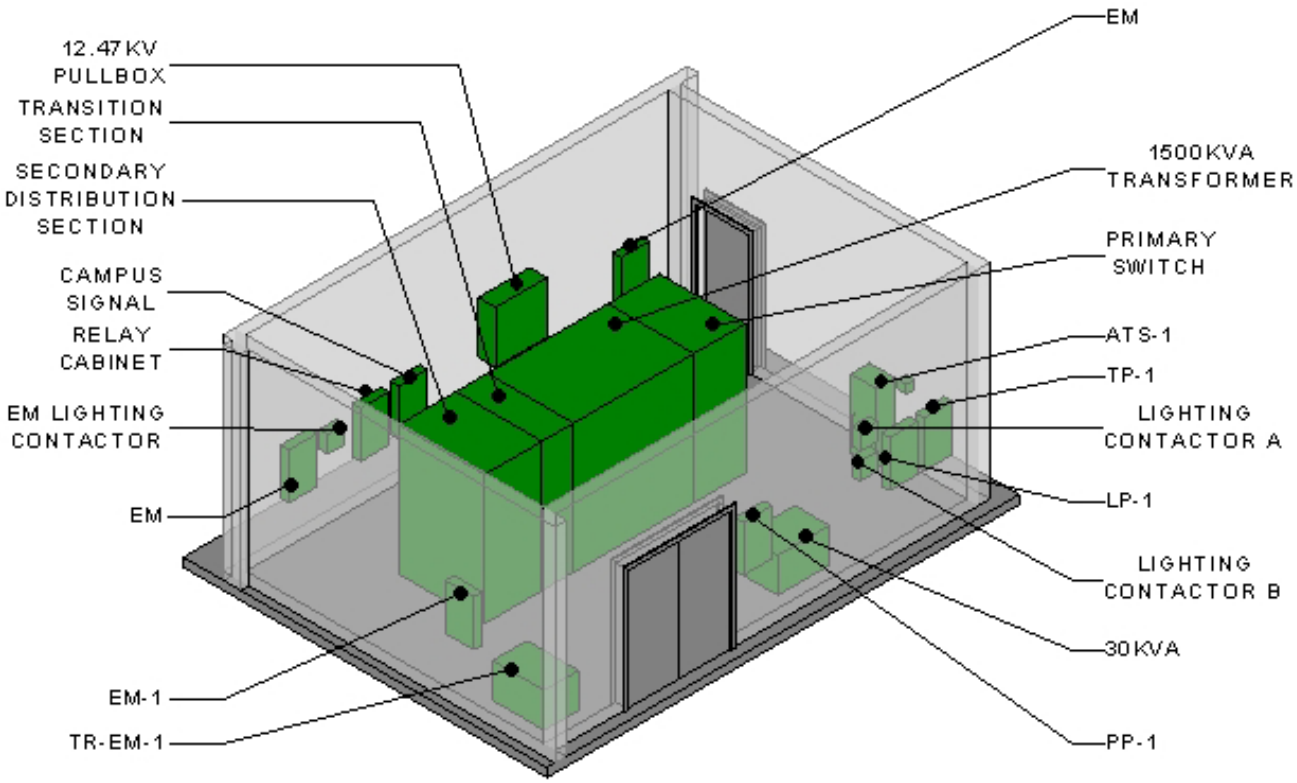
Level 6 Floor Plan with Wiring Layout

ELECTRICAL SYSTEM INSTALLATION



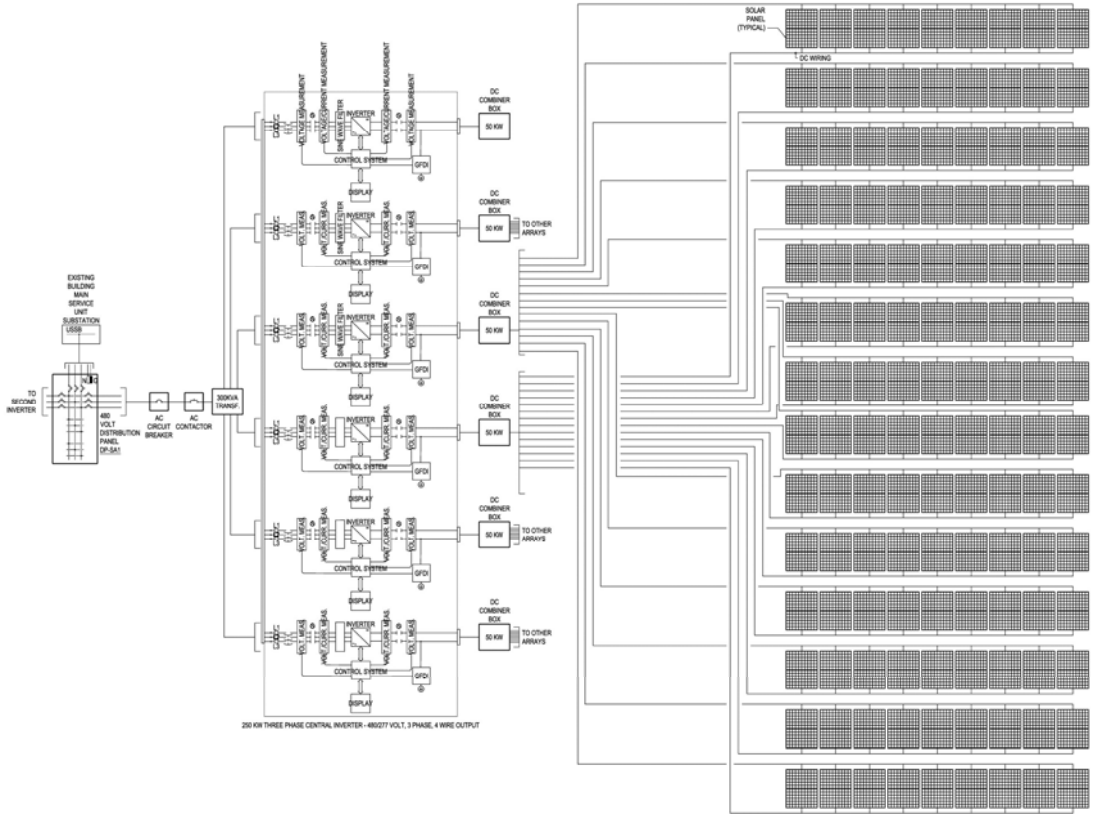
Level 1 Floor Plan with Wiring Layout

ELECTRICAL SYSTEM INSTALLATION



Electrical Closet

ELECTRICAL SYSTEM INSTALLATION



Central Inverter Schematic Diagram

SAFETY & PRACTICALITY

GENERAL INSTALLATION CONSIDERATIONS

- Panel Safety
- Lightning & Surge Protection
- Code & Life Safety
- Existing Equipment Relocation
- Stormwater Collection

MAKING IT HAPPEN

PROCUREMENT CONSIDERATIONS

- Contracting Methodology
- Solar Panel Procurement
- Domestic vs. Foreign
- Warranties
- Manufacturer Longevity
- Project Schedule

RECOMMENDATIONS

RECOMMENDATIONS

- Adopt project criteria as guiding principles for the project.
- ‘High-performance’ monocrystalline solar panels.
- Trellis configuration: Two parallel landscape-oriented panels per row; south-facing panels, angled at 20° from horizontal; 28 rows with 3,664 solar panels.
- Support structure: Factory manufactured, custom space frame assembly.
- Maintenance and access catwalks at each row of support structure; entrance points at both existing elevator/stair towers.
- Rain collection system at each row; horizontally piped to existing vertical sanitary risers.
- DC-AC inverter configuration: Four 250 kW central inverter units at existing roof deck level; AC inverter output to grid connected at garage main electrical service.
- Occupancy controlled, dimmed LED lighting to illuminate deck surface under array structure.
- Lightning protection and surge suppression to protect solar array installation.

WHAT WILL IT COST?

COST ESTIMATE

- Superstructure - $3,062,608
- Roof Drainage - $256,050
- Lighting - $184,009
- Electrical Distribution & PV - $5,067,537 ($4.05/Watt)
- Overhead & Mark-up - $2,305,042
- TOTAL: $10,875,247

WHAT’S NEXT?