Solar Farms in Maine

MBOIA Training

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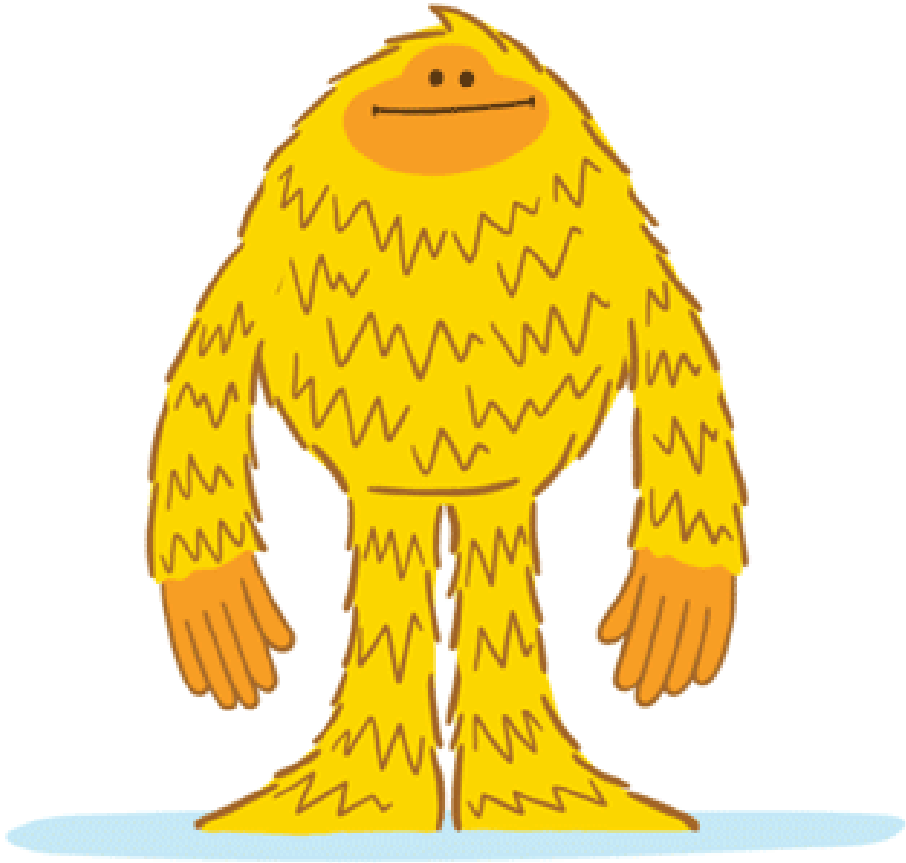
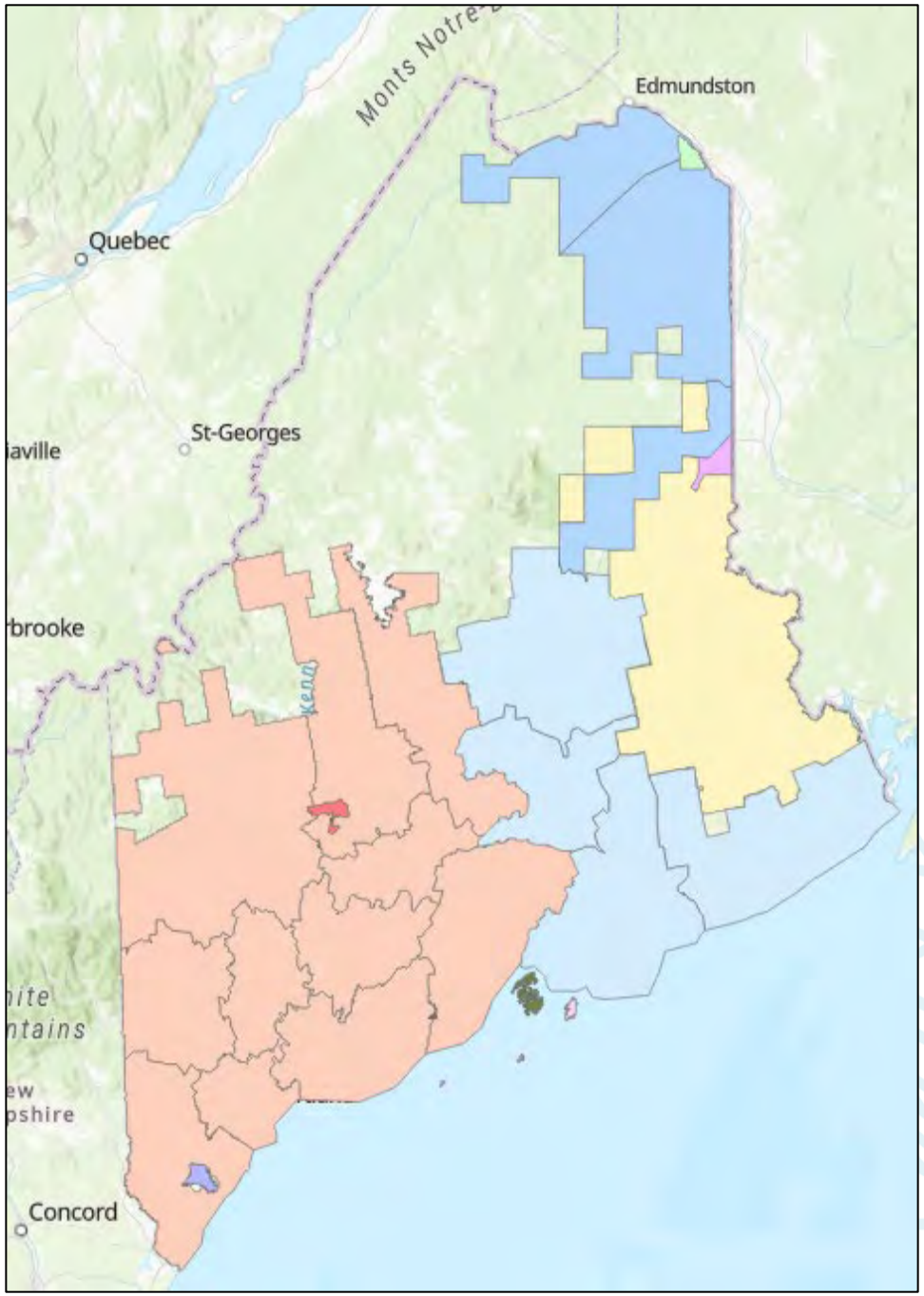
July 14, 2022



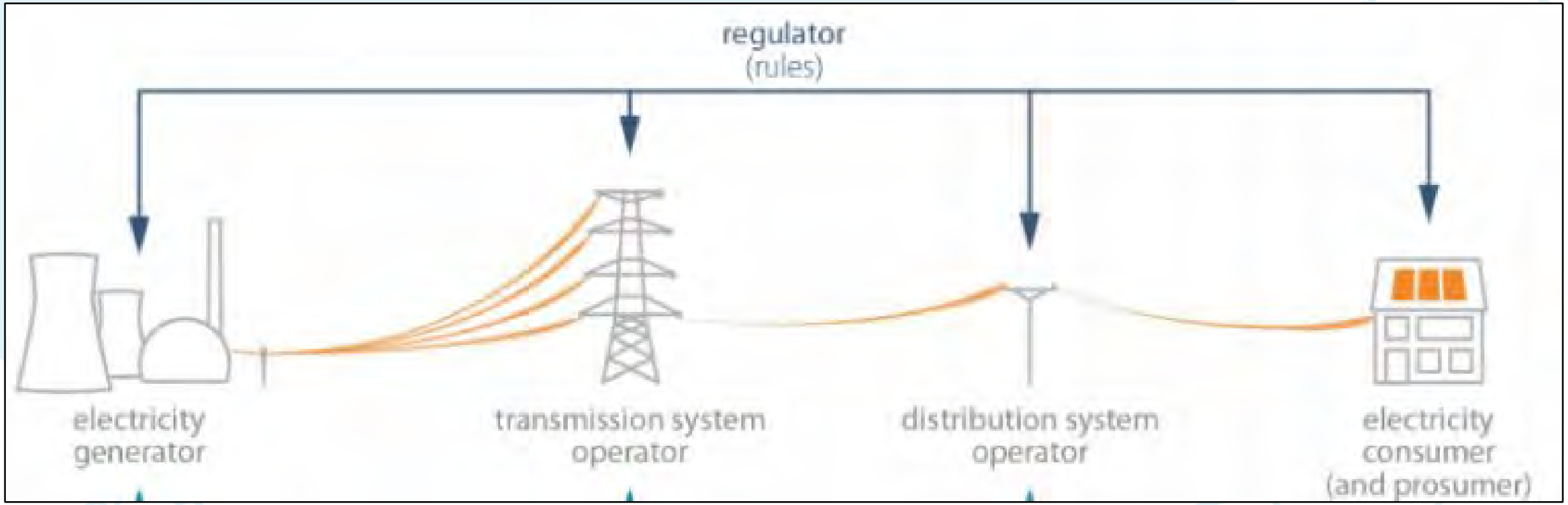
Pre-Construction

Site Selection – Utility Landscape

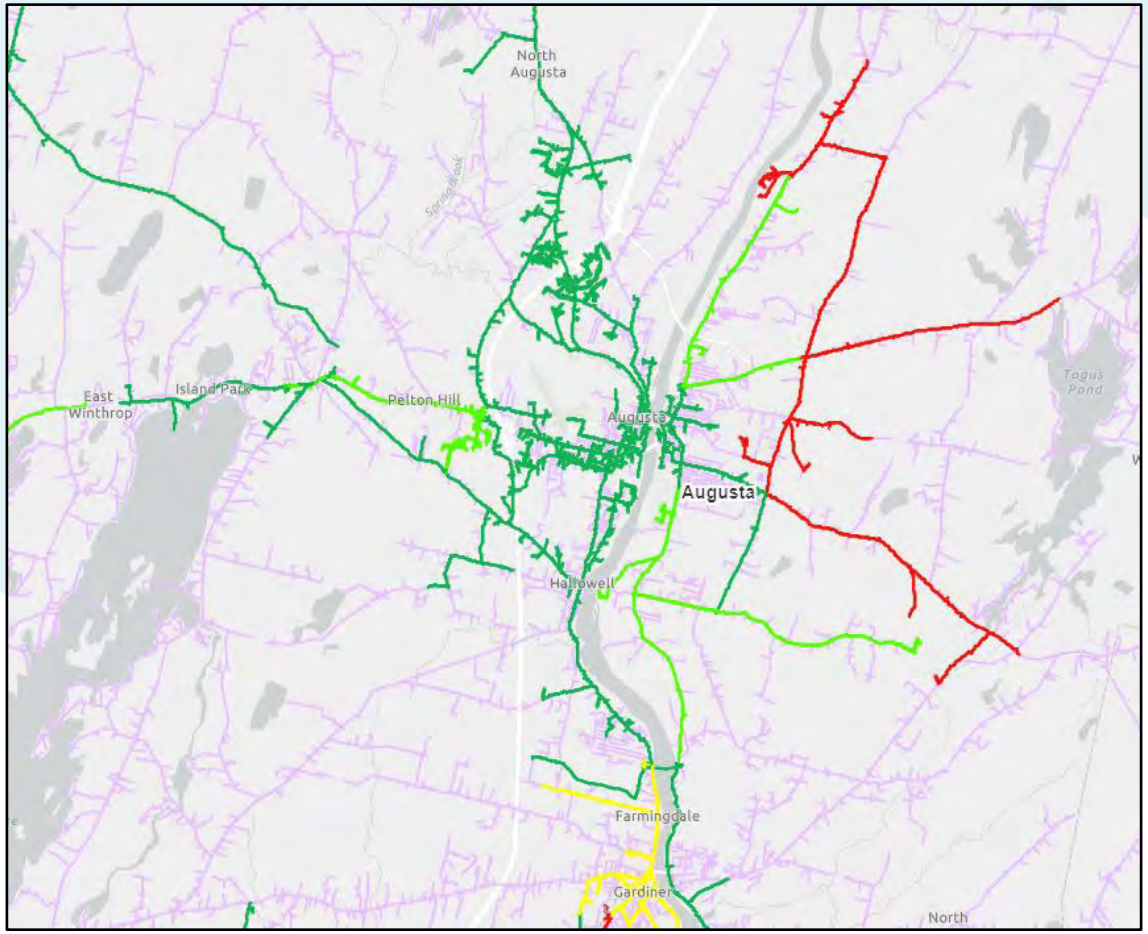
- Central Maine Power (60%)
- Versant – Bangor Hydro (13%)
- Versant – Maine Public (4%)
- Nine municipal/co-op utilities (4%)

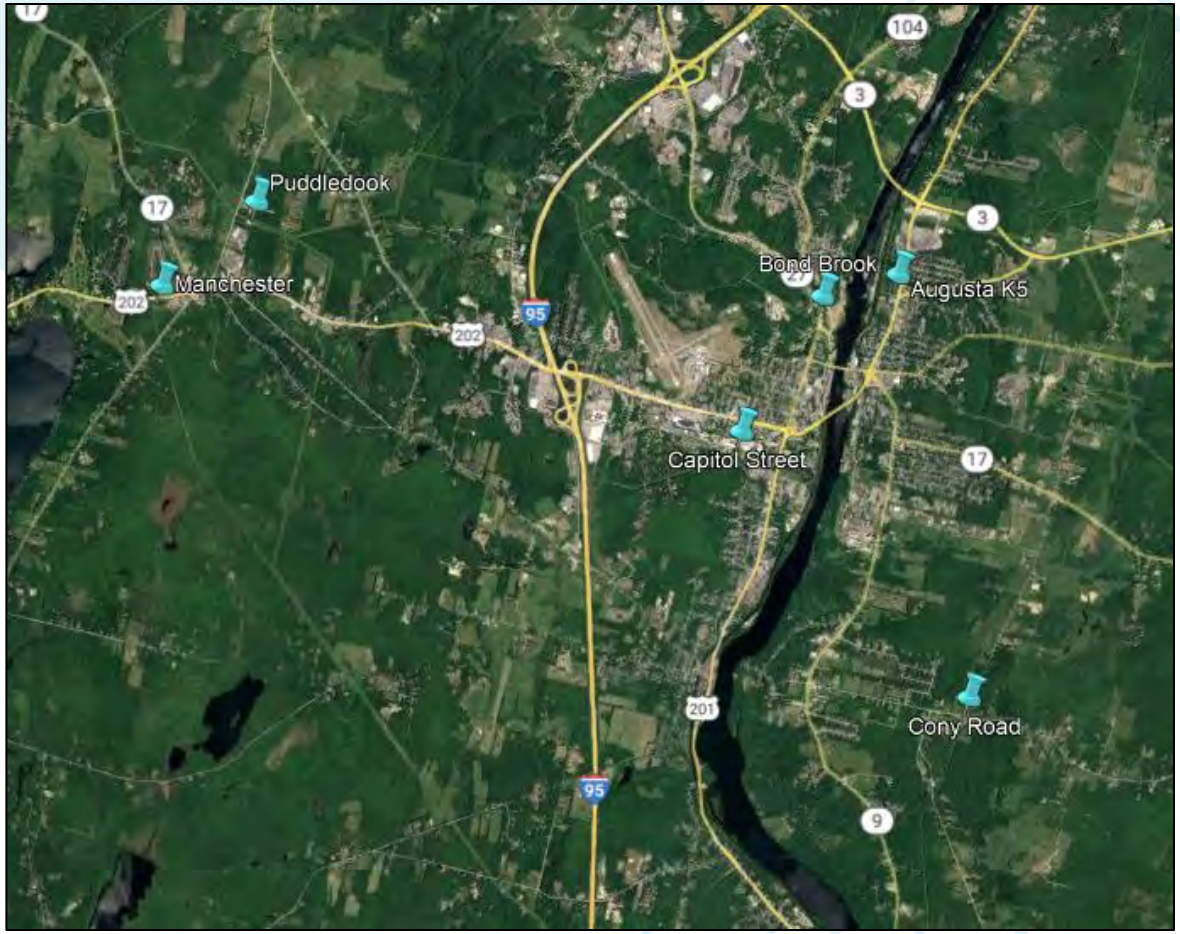


Site Selection – Transmission vs Distribution



Site Selection – Grid Information

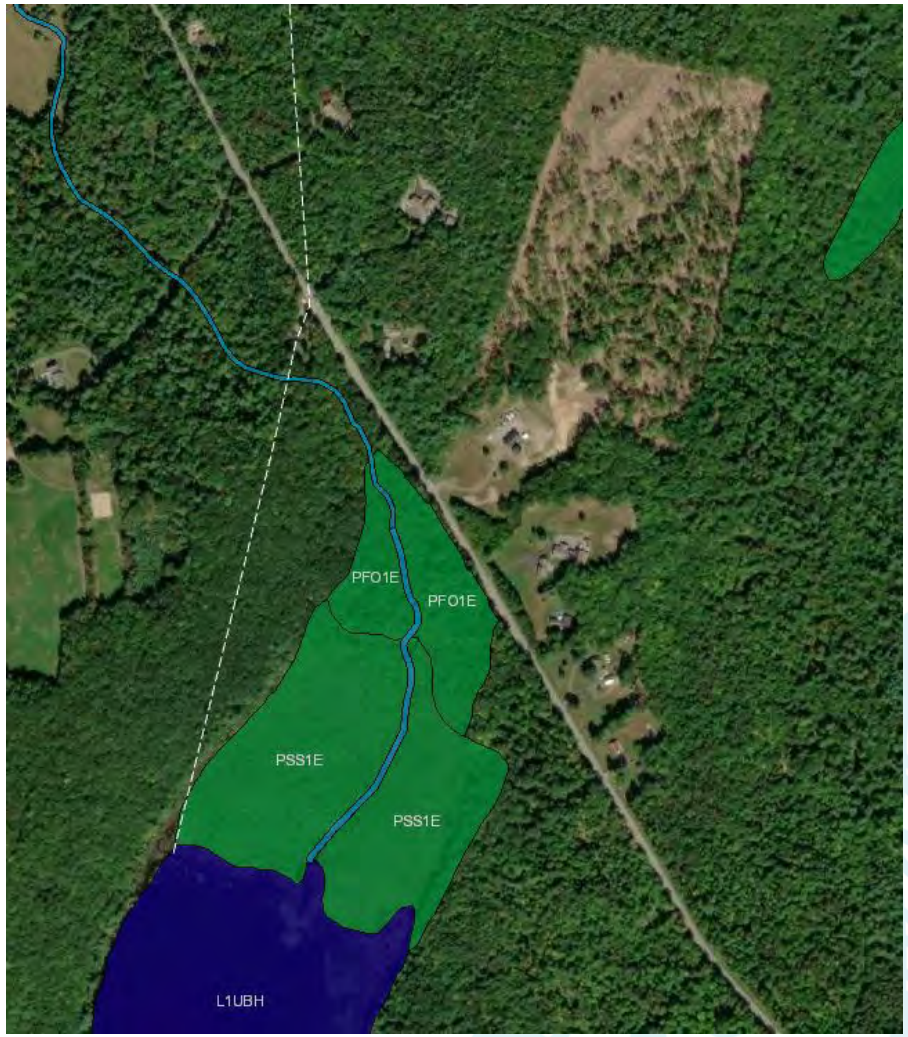




Site Selection – 3-Phase Power

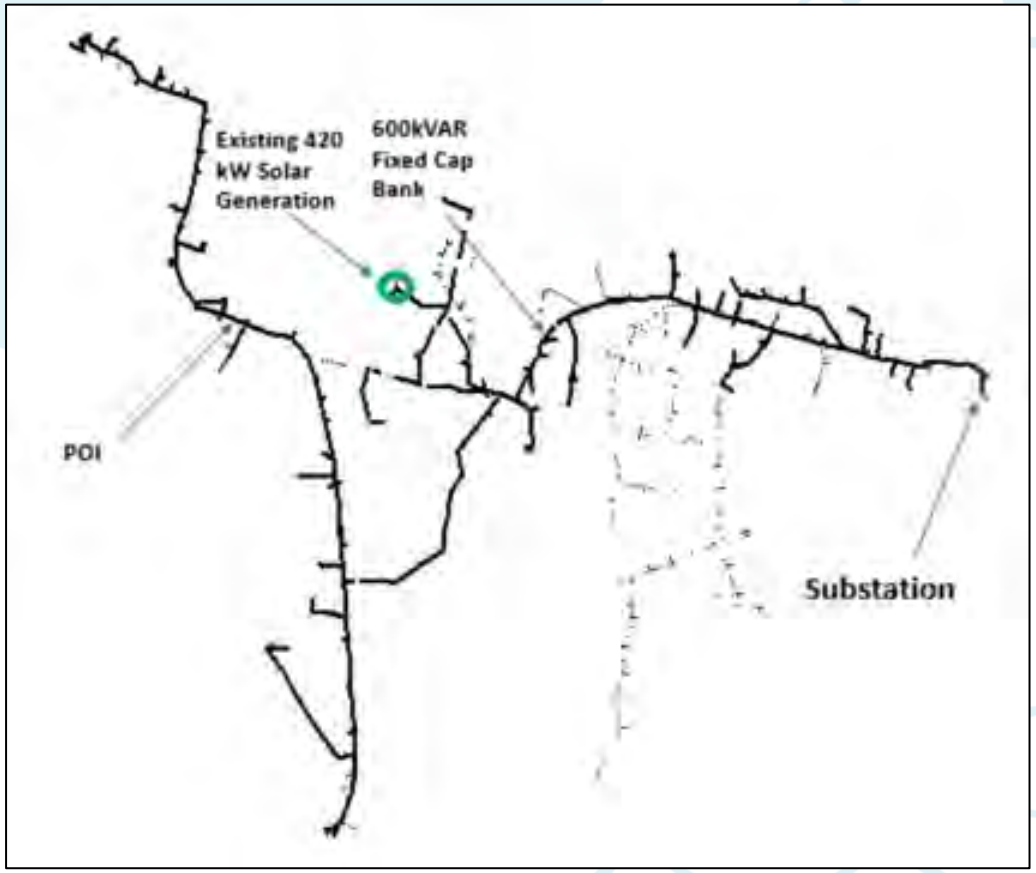
Site Selection – Desktop Screenings & Site Walks

- Parcel size
- Site Access
- Ownership, encumbrances
- Wetlands
- Topography
- Substrate
- Vegetation



Interconnection Process

- Technical screens
- Impact study
- Upgrade scope and cost
- Regional jurisdiction (ISO-NE)
- Interconnection Agreement



Permitting

- Zoning
- Change of use
- Impacts
  - Natural resources
  - Tree clearing & grading
  - Impervious area
- Stormwater
- Road access
- Decommissioning
- Building & electrical

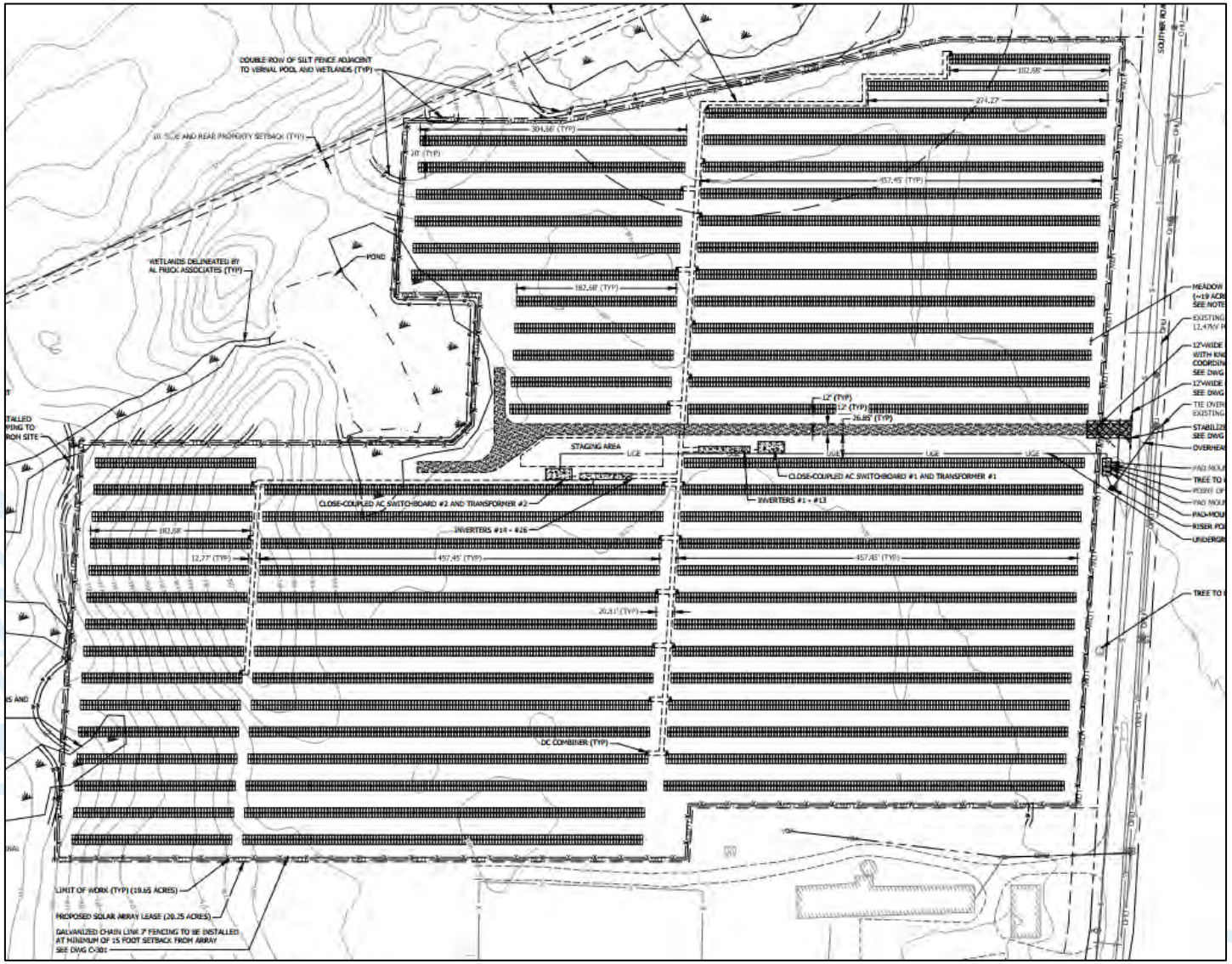
Engineering & Planning – Survey

- Boundaries
- Existing conditions
- Topography
- Tree heights

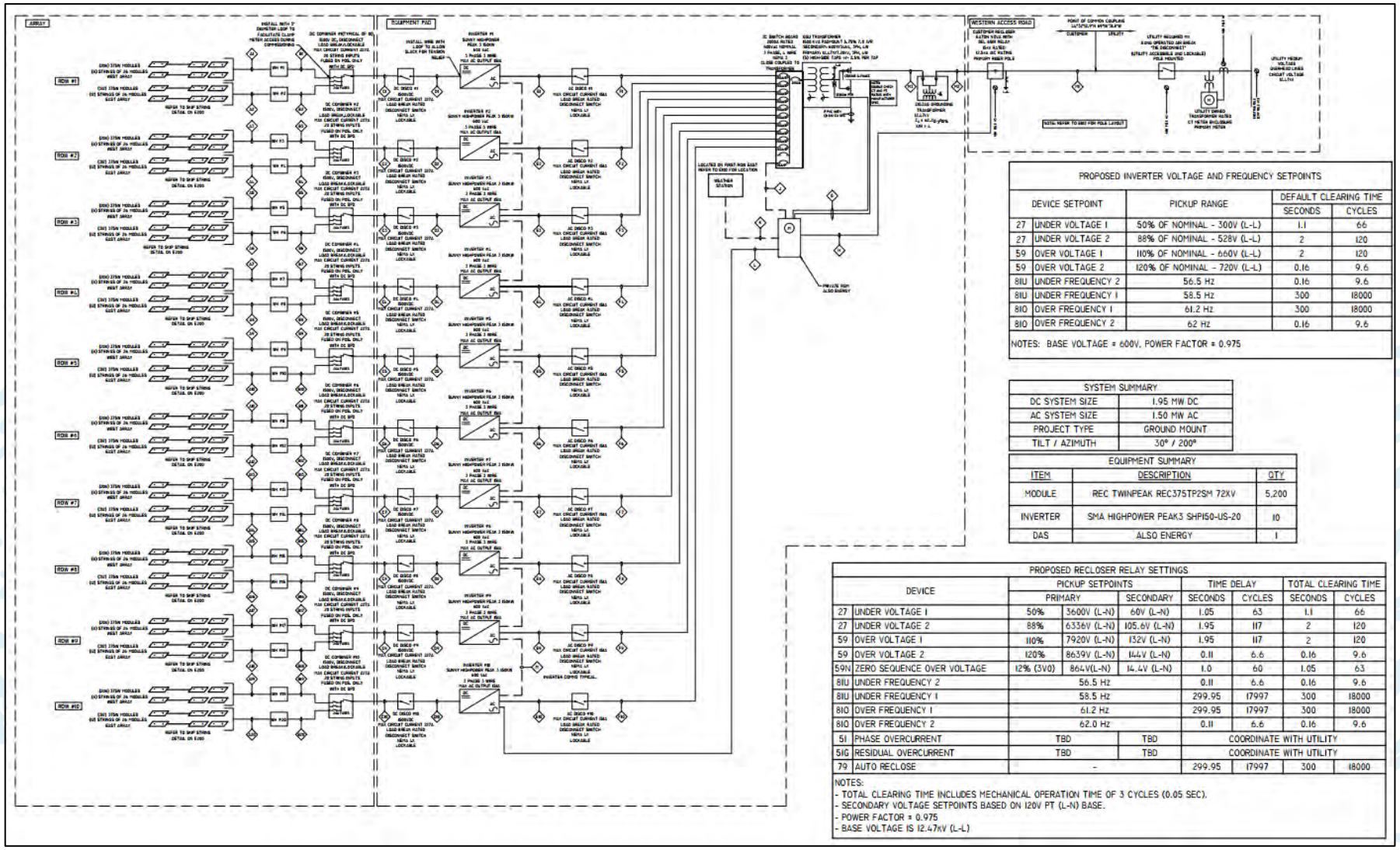
Engineering & Planning – Subsurface investigations

- "Pull test"
- Structural & electrical geotech
- Soil classification

Engineering & Planning – Civil



Engineering & Planning – Electrical



PROPOSED INVERTER VOLTAGE AND FREQUENCY SETPOINTS				
DEVICE SETPOINT		PICKUP RANGE	DEFAULT CLEARING TIME	
			SECONDS	CYCLES
27	UNDER VOLTAGE 1	50% OF NOMINAL - 300V (L-L)	1.1	66
27	UNDER VOLTAGE 2	88% OF NOMINAL - 528V (L-L)	2	120
59	OVER VOLTAGE 1	110% OF NOMINAL - 660V (L-L)	2	120
59	OVER VOLTAGE 2	120% OF NOMINAL - 720V (L-L)	0.16	9.6
81U	UNDER FREQUENCY 2	56.5 Hz	0.16	9.6
81U	UNDER FREQUENCY 1	58.5 Hz	300	18000
81O	OVER FREQUENCY 1	61.2 Hz	300	18000
81O	OVER FREQUENCY 2	62 Hz	0.16	9.6
NOTES: BASE VOLTAGE = 600V, POWER FACTOR = 0.975				

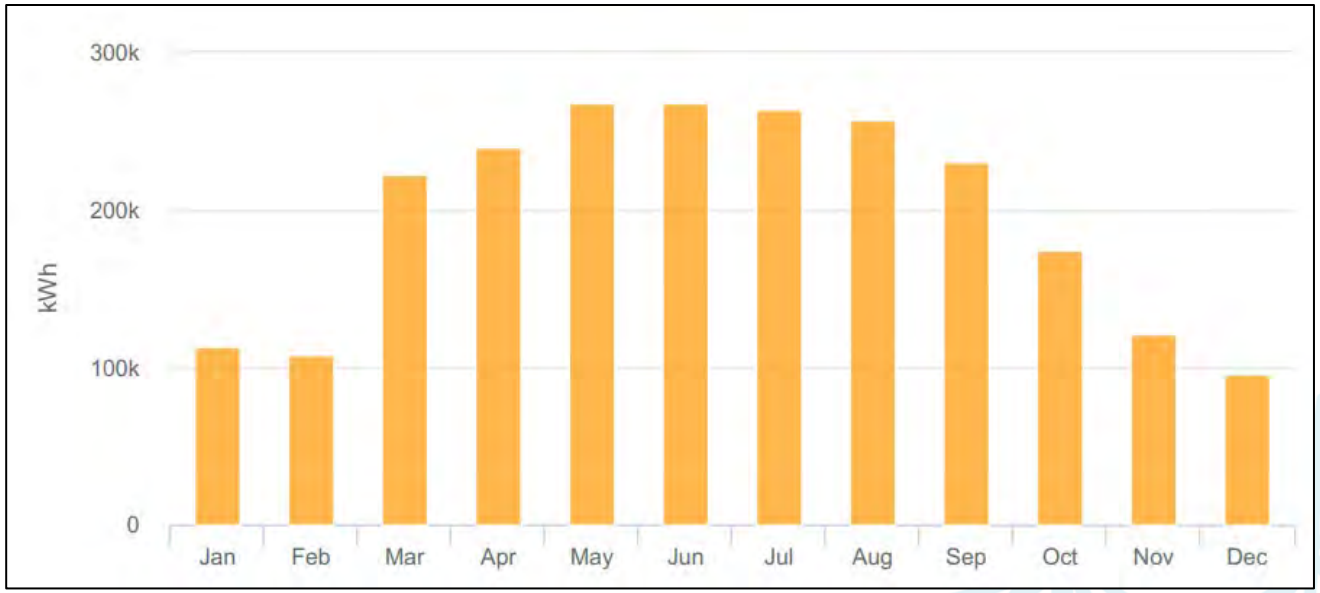
SYSTEM SUMMARY	
DC SYSTEM SIZE	1.95 MW DC
AC SYSTEM SIZE	1.50 MW AC
PROJECT TYPE	GROUND MOUNT
TILT / AZIMUTH	30° / 200°

EQUIPMENT SUMMARY		
ITEM	DESCRIPTION	QTY
MODULE	REC TWINPEAK REC375TP2SM 72XV	5,200
INVERTER	SMA HIGHPOWER PEAK3 SHP150-US-20	10
DAS	ALSO ENERGY	1

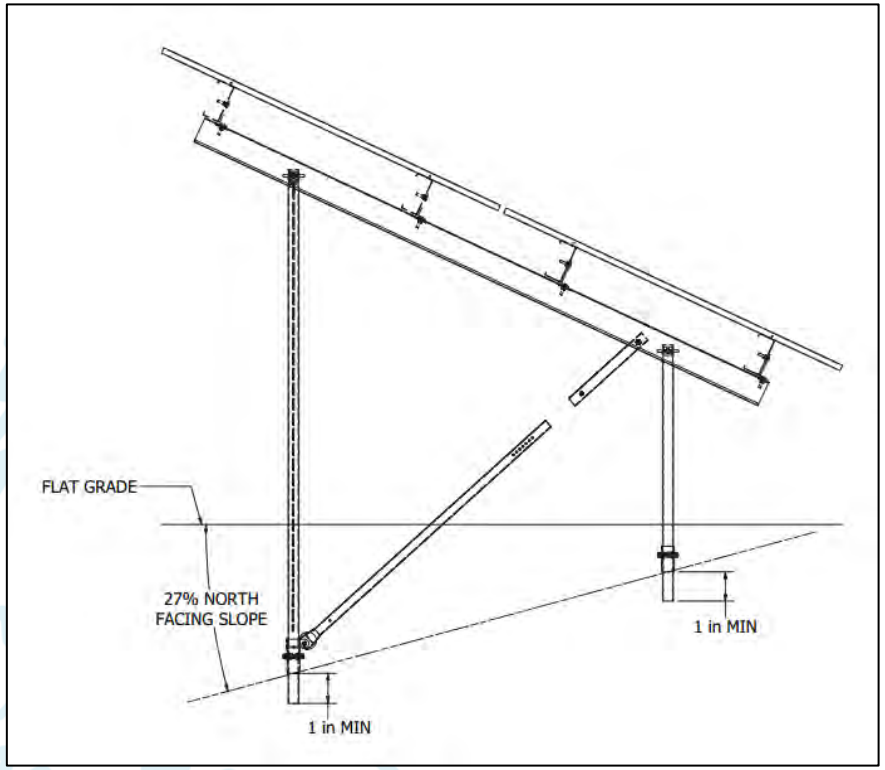
PROPOSED RECLOSER RELAY SETTINGS							
DEVICE		PICKUP SETPOINTS			TIME DELAY		TOTAL CLEARING TIME	
		PRIMARY		SECONDARY	SECONDS	CYCLES	SECONDS	CYCLES
27	UNDER VOLTAGE 1	50%	3600V (L-N)	60V (L-N)	1.05	63	1.1	66
27	UNDER VOLTAGE 2	88%	6336V (L-N)	105.6V (L-N)	1.95	117	2	120
59	OVER VOLTAGE 1	110%	7920V (L-N)	132V (L-N)	1.95	117	2	120
59	OVER VOLTAGE 2	120%	8639V (L-N)	144V (L-N)	0.11	6.6	0.16	9.6
59N	ZERO SEQUENCE OVER VOLTAGE	12% (3V0)	864V(L-N)	14.4V (L-N)	1.0	60	1.05	63
81U	UNDER FREQUENCY 2	56.5 Hz			0.11	6.6	0.16	9.6
81U	UNDER FREQUENCY 1	58.5 Hz			299.95	17997	300	18000
81O	OVER FREQUENCY 1	61.2 Hz			299.95	17997	300	18000
81O	OVER FREQUENCY 2	62.0 Hz			0.11	6.6	0.16	9.6
51	PHASE OVERCURRENT	TBD		TBD	COORDINATE WITH UTILITY			
51G	RESIDUAL OVERCURRENT	TBD		TBD	COORDINATE WITH UTILITY			
79	AUTO RECLOSE	-			299.95	17997	300	18000

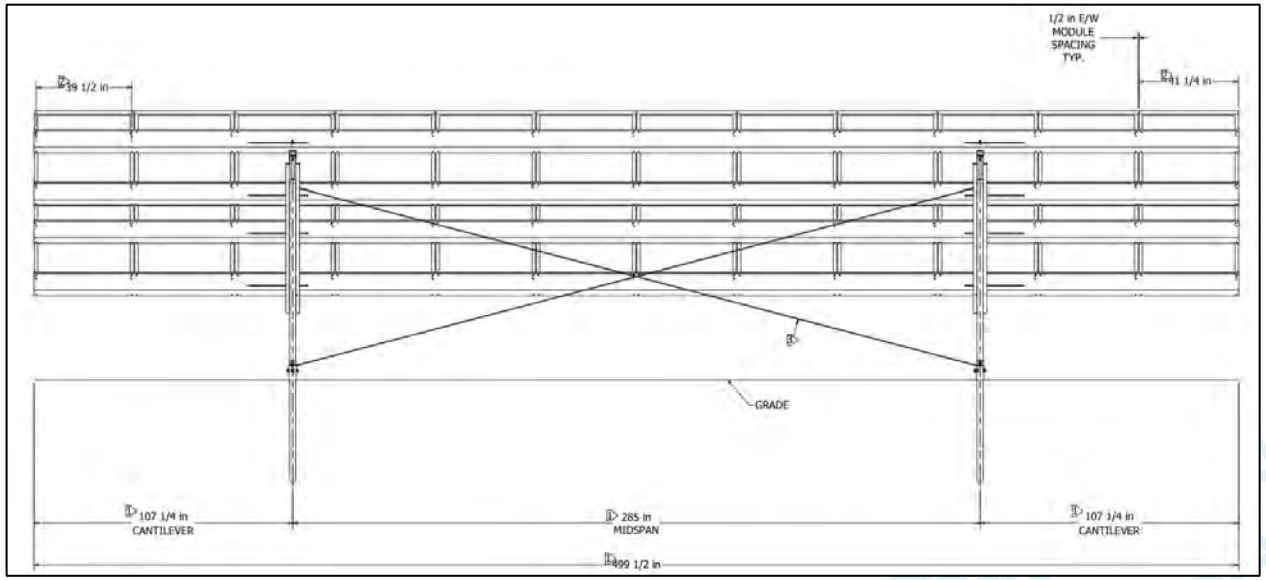
NOTES:
- TOTAL CLEARING TIME INCLUDES MECHANICAL OPERATION TIME OF 3 CYCLES (0.05 SEC).
- SECONDARY VOLTAGE SETPOINTS BASED ON 120V PT (L-N) BASE.
- POWER FACTOR = 0.975
- BASE VOLTAGE IS 12.47kV (L-L)

Engineering & Planning – Solar Production Modeling



Engineering & Planning – Racking





Site preparation

- Survey and phased stake out
- E&S control perimeter
- Vegetation clearing
- Grading
- Access road

Solar Construction

Terminology

PV: Photovoltaic. Converts solar energy to electrical energy.
Ground screws: Heavy metal screws drilled into the ground/rock to support the racking system.
Racking: The supporting structure for modules and other associated equipment.
Modules: Panels, Mods, Rectangles. A unit of solar cells designed to produce DC power.
Strings: A number of modules connected in series. The voltage is additive. If you connect 10-40 volt modules in series the voltage of that string will be 400 volts DC.
DC Combiner: A device including an enclosure that is used to connect 2 or more PV System DC circuits together in parallel
Inverters: Electronic equipment that converts DC to AC electricity.
AC Combiner: No definition in the code but is taken to mean a panelboard or switchboard used to combine 2 or more inverter output AC circuits in parallel
Array: A grouping of modules with support structure including any attached equipment such as inverters, optimizers, etc.

Installation Electrical Codes:

Along with the general codes in the NEC that apply to all wiring, PV installations are governed by Articles 690, 691 and 705.Article 690 deals with most of the PV system, and 705 applies to the interconnection between the premises wiring and the PV system wiring. Article 691 only applies to PV systems larger than 5 Megawatts, these systems must be engineered, and the installation must follow those stamped plans.

Licensing:

Installers of all PV system equipment and wiring must be licensed in the State of Maine. This includes installing modules. This does not include the racking system, anyone can install the racking

ENCUMBRANCES

Ground Screws or driven posts installed for module and equipment racking.

Note bonding/grounding wire

Trenching

Electrical Interconnection

Medium Voltage Solar Service

Service disconnect at MV Service

Recloser

Secret stuff inside recloser

“Close coupled” Transformer and Switchgear. Note bussed interconnection.

MV side of solar transformer

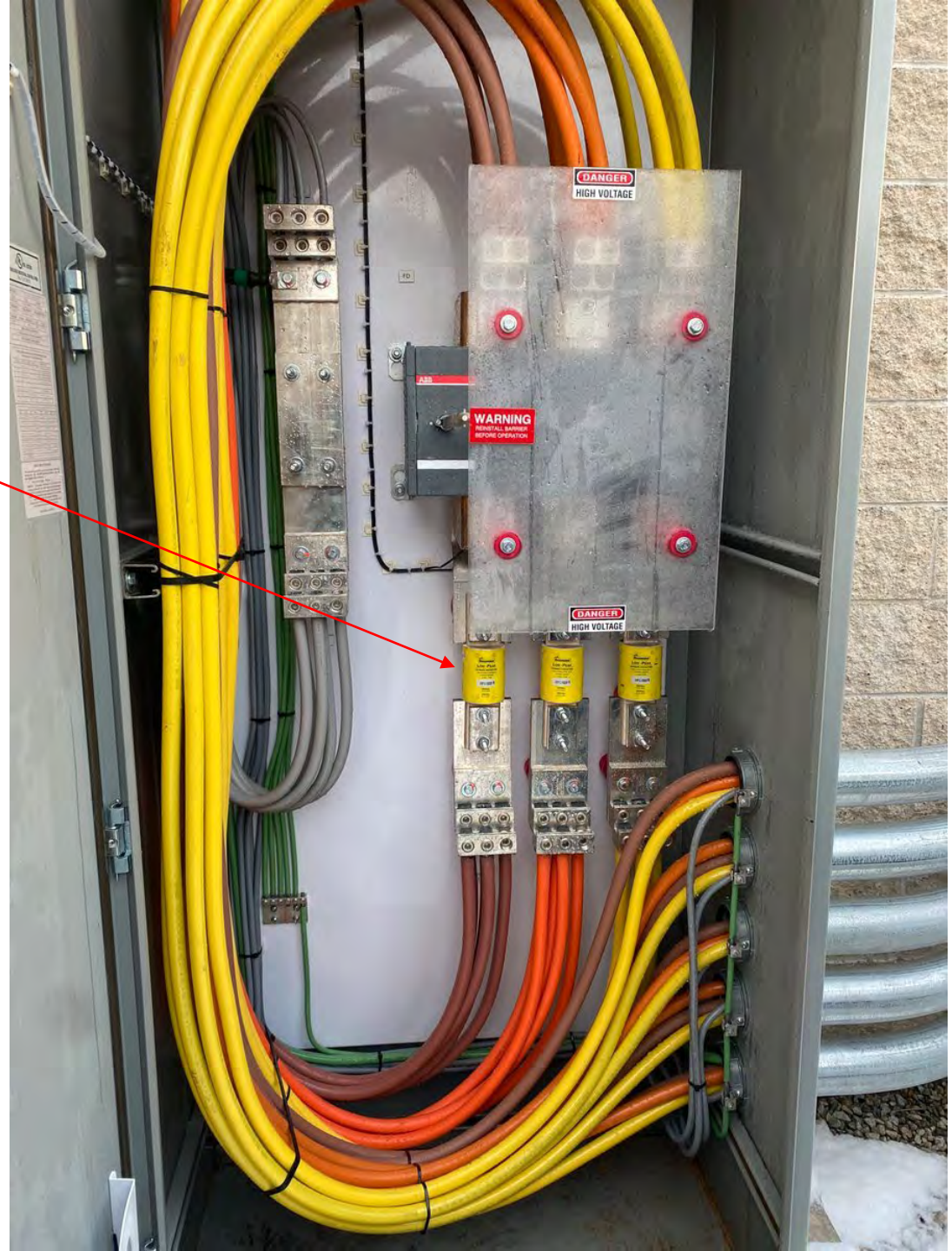
Low voltage side of solar transformer

AC Switchboard at Wastewater site

Outside PV System
Disconnect switch

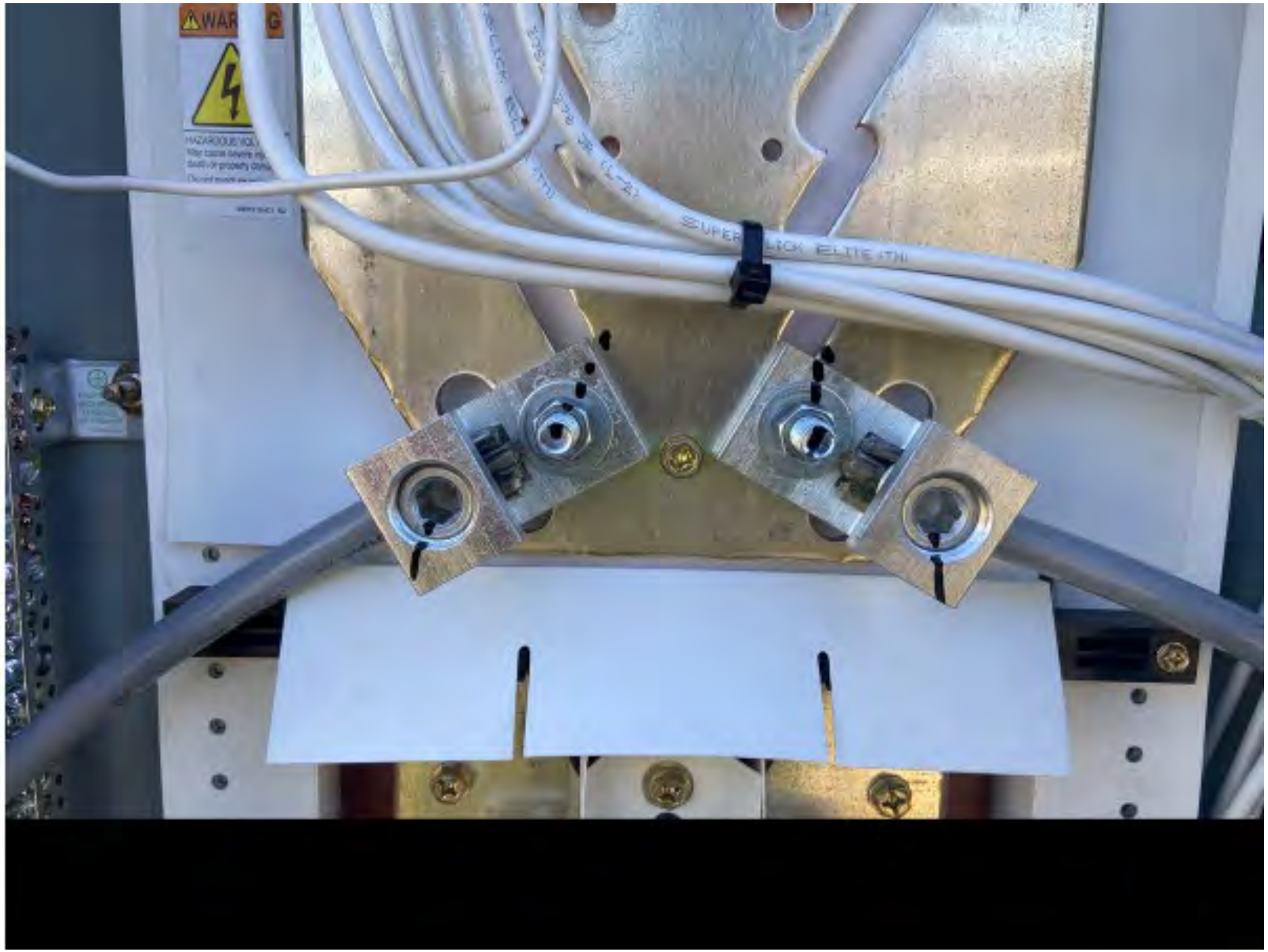
Main circuit breaker for low voltage solar service

We still use fuses sometimes.



"AC Combiner"

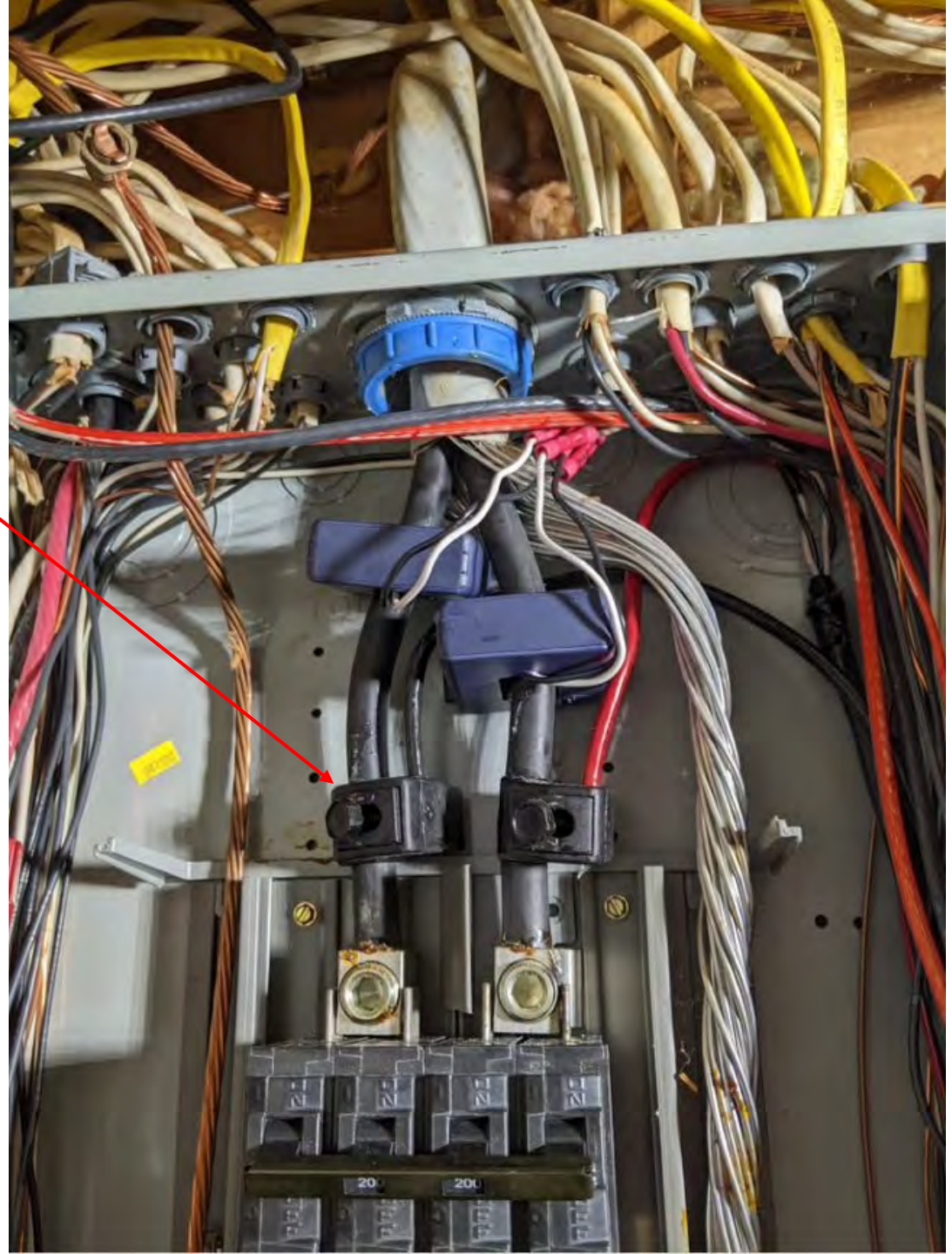
Note torque marks on all field tightened electrical connections



Inside of main breaker cabinet: note excellent workmanship!

Residential solar installation: basically the same components as the larger ground mount systems

Line side tap on 200 amp service



Concrete pads for large equipment: The solar transformer itself can weigh more than 12,000 pounds.

Installation of Support Structures, Racking

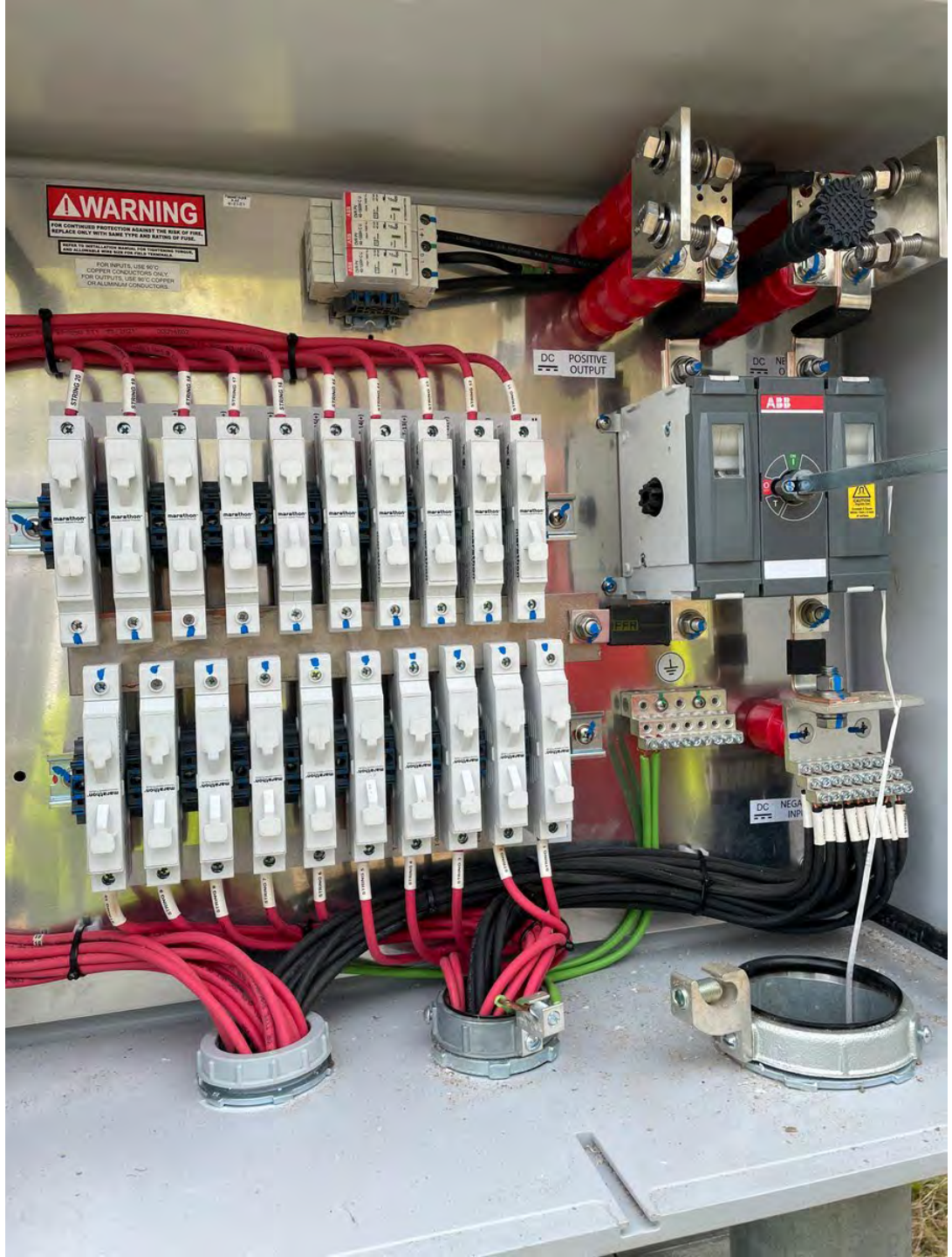
Installation of modules

Wiring of Modules

Note equipment ground jumper between “tables”.

DC Combiner

More secret stuff inside DC combiner



Inverter layouts and wiring: centralized or de-centralized

Centralized
Inverter
Installation

Decentralized
Inverter Rack

Note AC and DC Inverter Disconnects

Residential SFD inverter installation

Fencing or mesh: To fence or not to fence, that is the question

The conductors guarded by this mesh are below 8'.

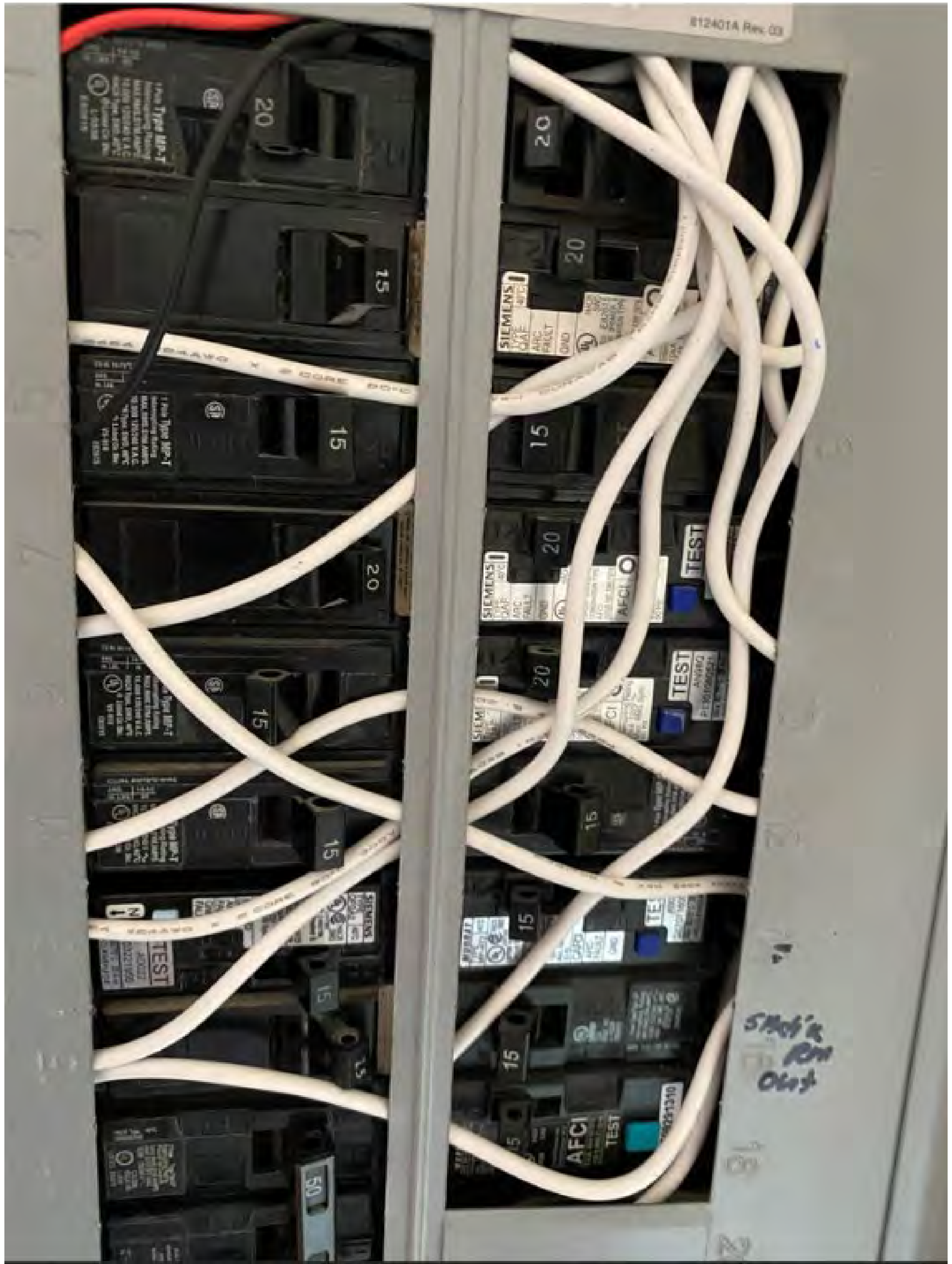
These conductors are above 8’ (not “readily accessible”) so they do not have to be “Guarded”

Commissioning and Testing

We love solar so much we use solar to test solar

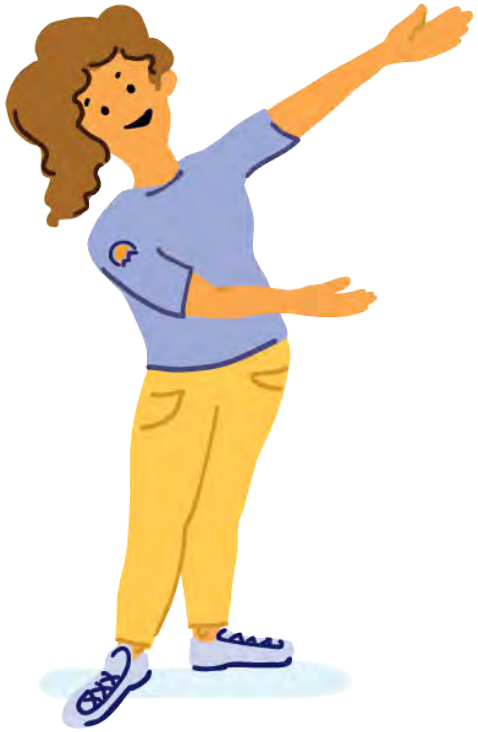
Maintenance:

Some issues that we find: existing non-code compliant wiring.


812401A Rev. 03


Lemon Peel
Green Pepper Corns
Pepper

Thank you all for all you do!



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