Solar Research Test Bed

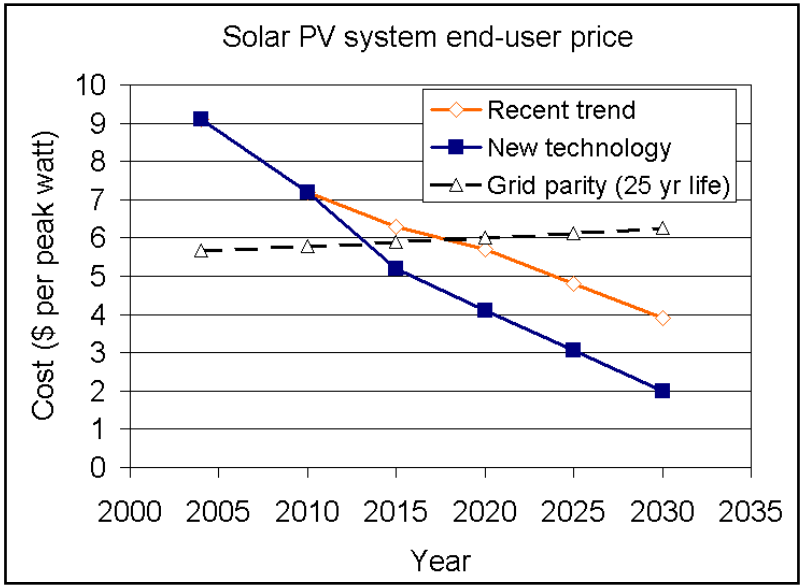
Illinois Center for a Smarter Electric Grid

University of Illinois
Building Research Laboratory #344

The Vision of Sustainability at UIUC

- "Environmentally sustainable construction is healthy, energy efficient and consistent with the missions and values of the U. of I. as a public research university,"
  - Stanley O. Ikenberry 12/9/09

- "We will build our campus' capacity to address the immense challenges by scoping and advancing Sustainability Laboratories. These real-world locations will address environmental, social, and economic aspects of sustainability through research, education, and outreach."
  - Robert A. Easter 2/10/10



- Photovoltaic panels are actually the *longest life* energy resource available today: 50 year life, 25 year warranties.
- They have the *lowest maintenance* costs of any energy technology.
- The technology is mature.
- Costs have reached parity with retail electricity, and continue to drop.

Value proposition

Solar Research Test Bed

Implementation of the Solar Research Test Bed is an important part of the research scope of the Illinois Center for a Smarter Electric Grid (ICSEG). ICSEG's research mission is to support the continuing development of the Smart Grid through research that tests and validates the trustworthiness (secure, reliable, private, resilient) of new components and systems that will be required to realize the full potential of the Smart Grid, and renewable energy systems such as wind and solar are critical to realizing this vision.

The Solar Research Test Bed will allow ICSEG researchers to study in a controlled environment certain solar components, devices, and systems that underpin the performance of solar generation but may also be vulnerable to both natural and man-made forces that can compromise the trustworthiness of those systems. ICSEG researchers will be able to identify those vulnerabilities and develop solutions to assure trustworthiness. The Solar Research Test Bed will provide the research platform to test and validate these solutions before real-world commercial deployment on the Smart Grid.

The research results from this work will comprise a body of intellectual property (IP) that can find practical application through licensing and new venture creation in emerging, fast-growing markets for Smart Grid products and services.

Research Objectives

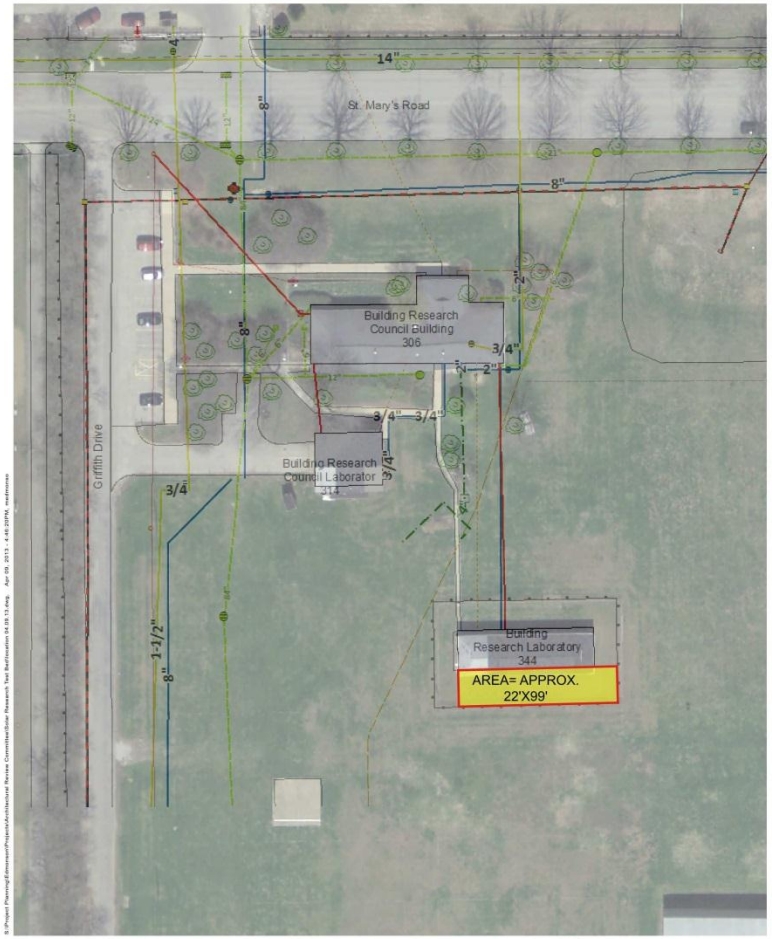
Illinois Center for a Smarter Electricity Grid (ICSEG)

- Promote the integration of solar energy into the grid through research that supports enhanced security, reliability, and trustworthiness of solar systems in general.

- Create a solar research test bed for data collection and testing at full scale:
  - Evaluation of various inverter and microinverter approaches
  - Experimentation with partial shading and degraded panel performance
  - Evaluation of intelligent, heterogeneous loads
  - Interface to AMI test bed, including bidirectional capability
  - Experimentation with load-generation control
  - Experimentation with dynamic control strategies with locally variable cloud cover.

- Provide instrumentation to allow visualization of performance data in real time:
  - The visualization portal would be accessible over a secure web connection

Location of site



Proposed Location Plan (2011 photo)
SOLAR RESEARCH TEST BED
F&S, 04/09/13

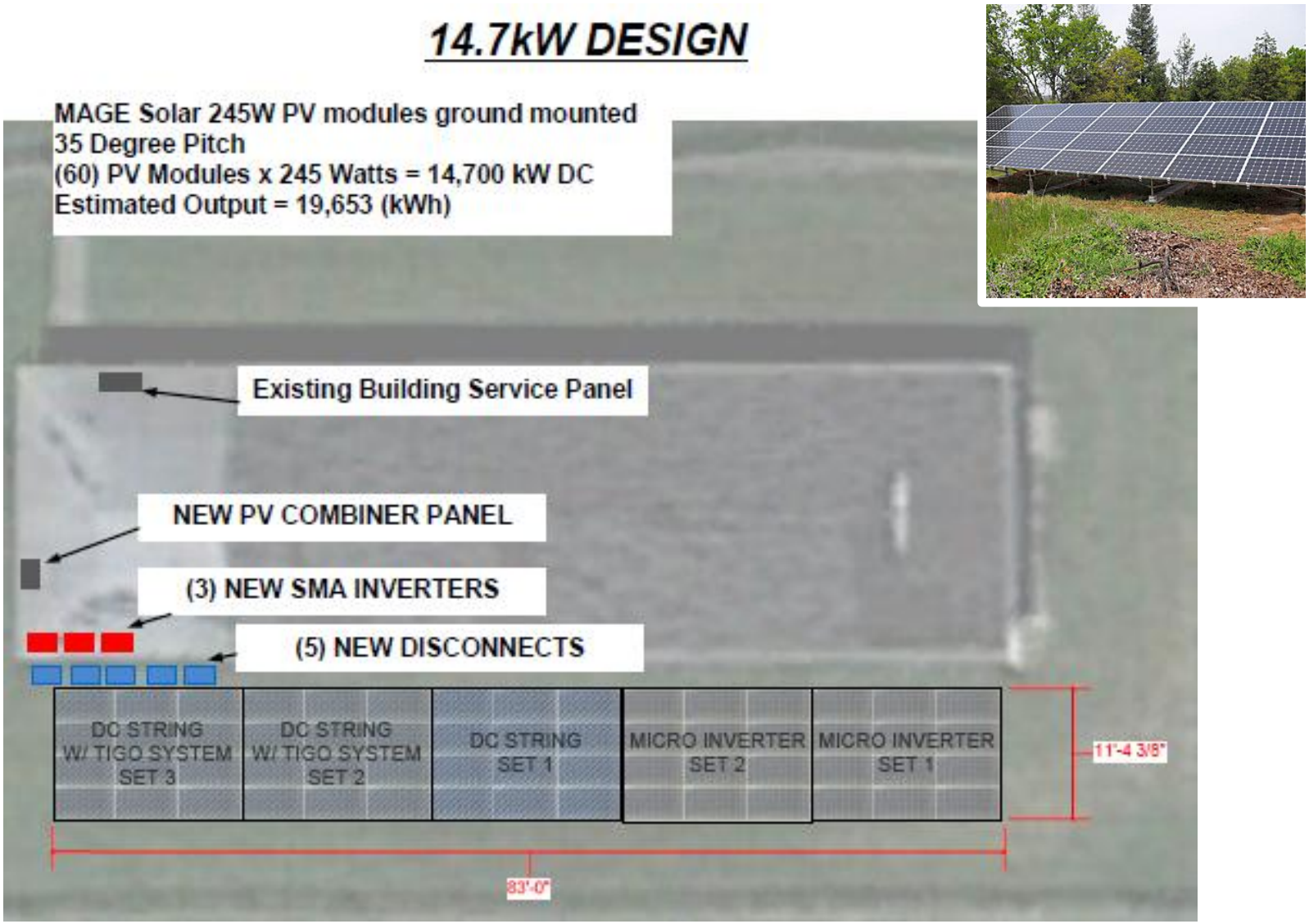
View of Building 344 from SW

View of Building 344 from SW

Footprint looking west

slopes down from east to west

Layout of 60 solar panels



MAGE Solar Panels

MAGE POWERTEC® PLUS

240 / 6 PL US AC PHOTOVOLTAIC MODULE

AC ELECTRICAL CHARACTERISTICS

AC Output (Min/Nom/Max)	211V / 240V / 264V
Oper Freq Hz (Min/Nom/Max)	59.3 / 60.0 / 60.5
Output Power Factor	0.99 min
AC Max Cont Output Current	0.992A
AC Max Cont Output Power	238W
Max Units Per Branch Circuit	16
Max Overcurrent Protection	20 A
Total Harmonic Distortion	< 5%

DC ELECTRICAL CHARACTERISTICS*

Maximum Power Rating	P_{mp} (W)	240
Tolerance of P_{mp}	(W)	-0/+5

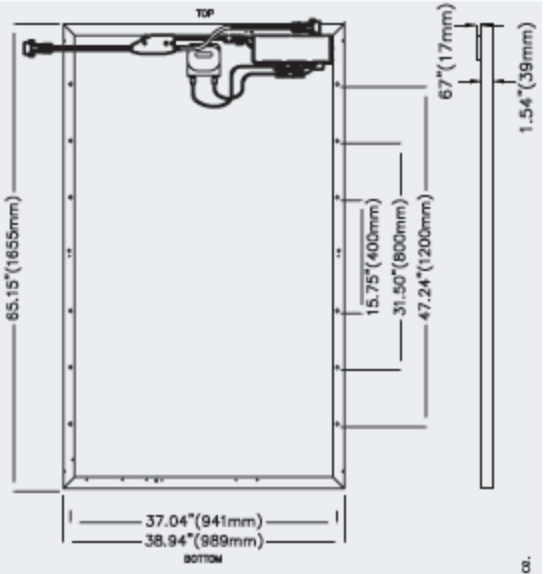
* STC @ 25° C, 1000 W/m², AM 1.5

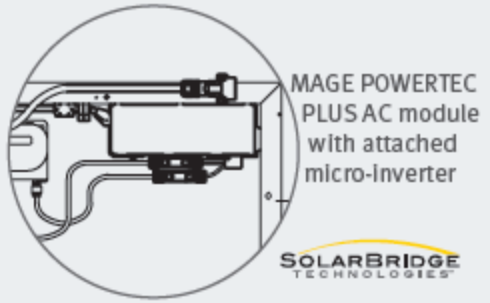
TECHNICAL FACTS

Number of Cells (Matrix)	60 (6 x 10)
Solar Cell Type	polycrystalline
Solar Cell Size (mm)	156 x 156
Solar Cell Size (in)	6 x 6
Dimensions (L x W x H mm)	1655 x 989 x 39
Dimensions (L x W x H in)	65.15 x 38.94 x 1.54
Weight (kg)	21.3
Weight (lbs)	47.0
Module Efficiency (%)	14.7

THERMAL CHARACTERISTICS

NOCT	(°C)	+ 46 ±2
Temperature Coefficient	I_{sc} (%/°C)	+ 0.05
Temperature Coefficient	V_{oc} (%/°C)	- 0.32
Temperature Coefficient	P_{mp} (%/°C)	- 0.43



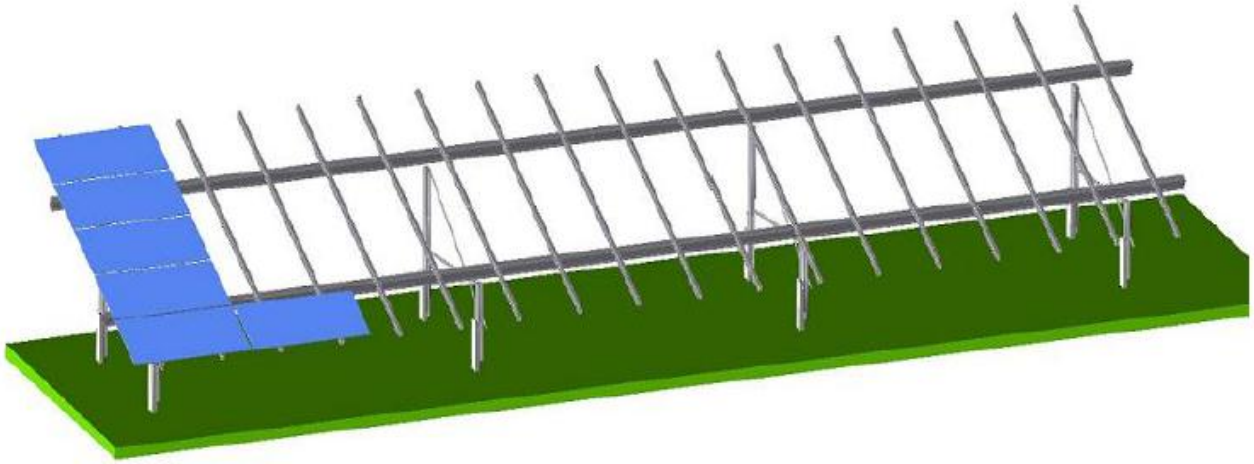


MAGE POWERTEC PLUS AC module with attached micro-inverter

SOLARBRIDGE TECHNOLOGIES

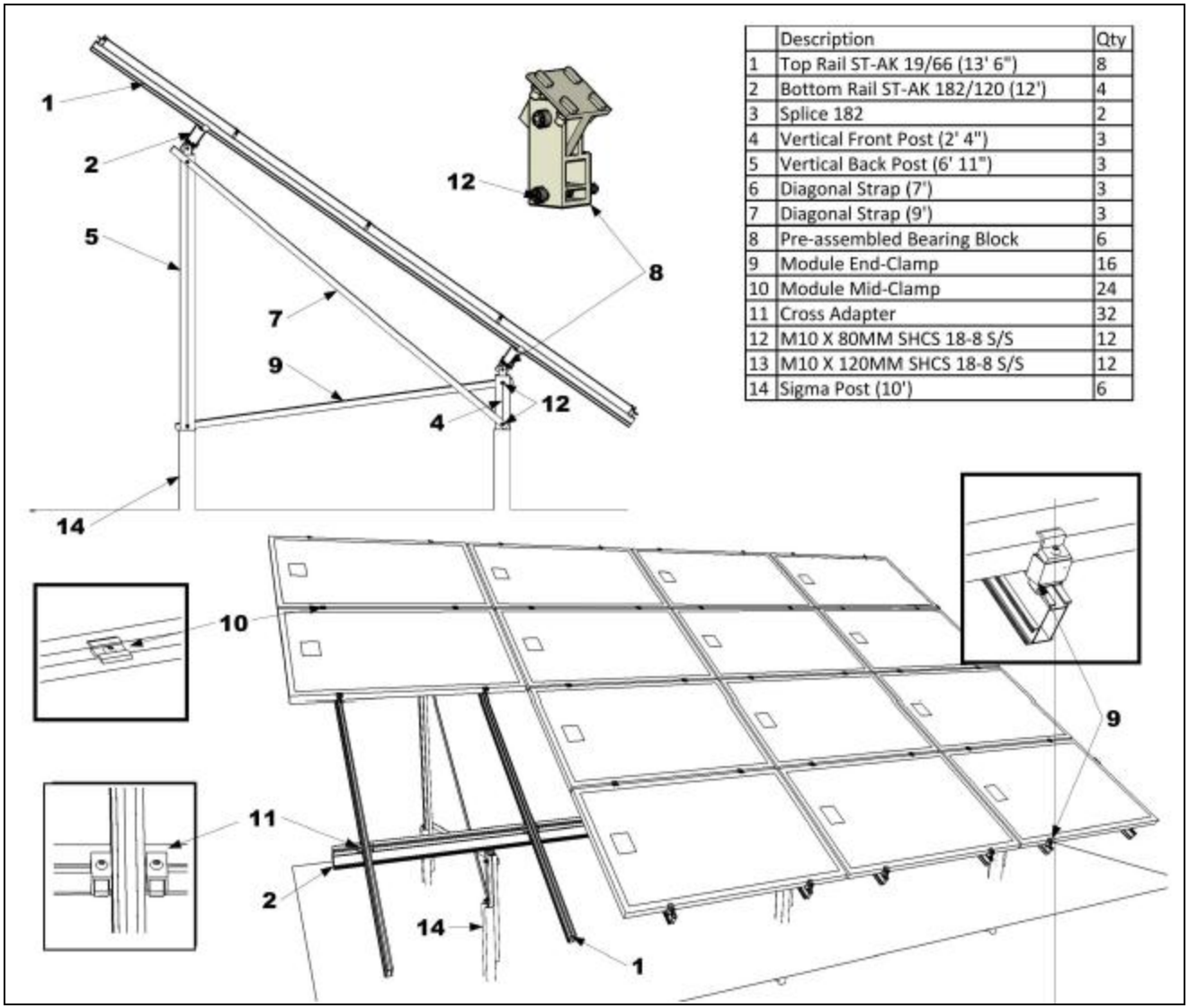
...din this datasheet are subject to change without notice.

Ground-Mount Racking System



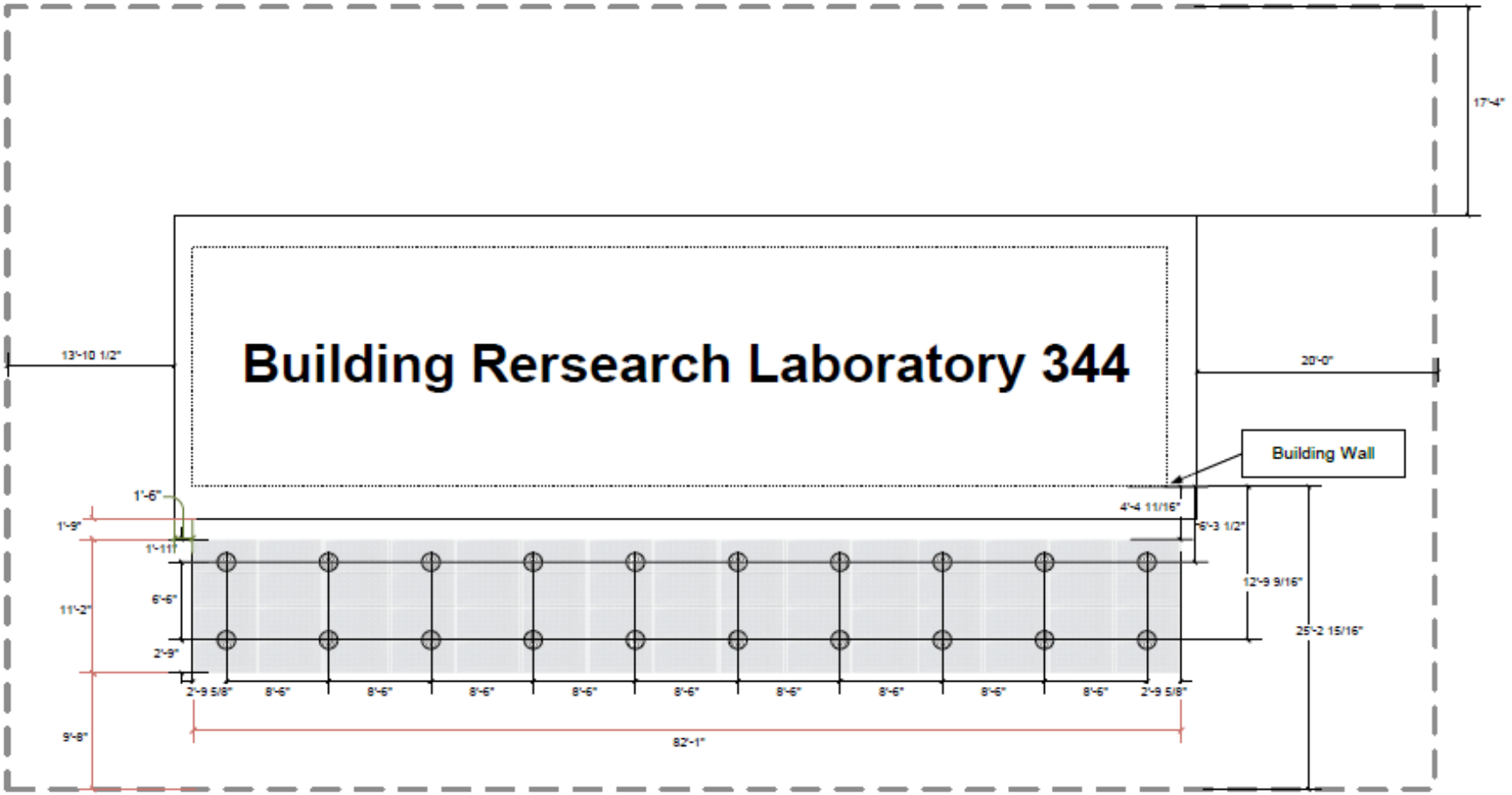
Technical Data	
Application	Ground mount
Load-bearing capacity	The mounting structure will be designed in accordance with the 2006 International Building Code including wind, snow and seismic loading.
PV module	Framed
Arrangement of modules	In rows or columns
Orientation of modules	Portrait (vertical) or landscape (horizontal)
Mounting angle	15 to 35 degrees in North-South direction
Slope of terrain	Maximum of 6 degrees in East-West direction
Design standards	MAGE SYSTEMTEC mounting systems and component parts are designed in accordance with the 2006 International Building Code.
Supporting structure	Extruded aluminum 6063-T6
Fasteners & small parts	Stainless steel
Foundation posts	Galvanized steel
Color	Aluminum
Warranty	10-year material warranty

Ground-Mount Racking System

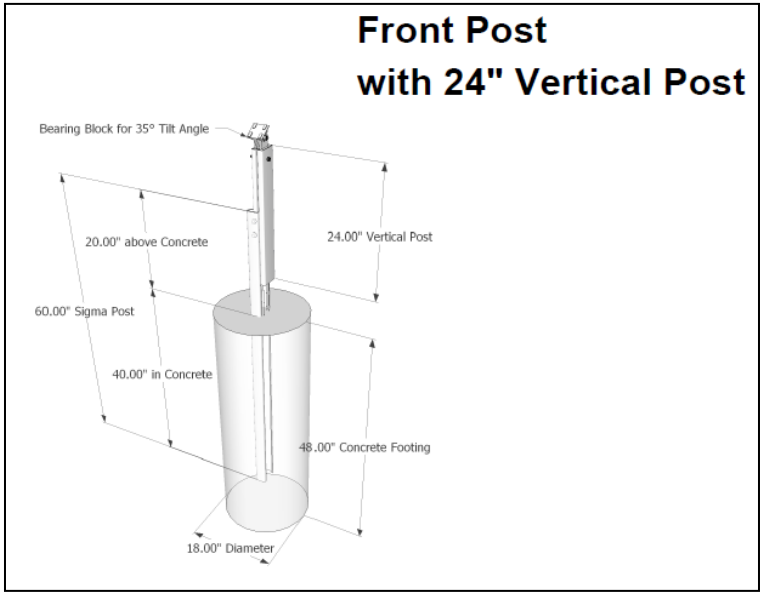


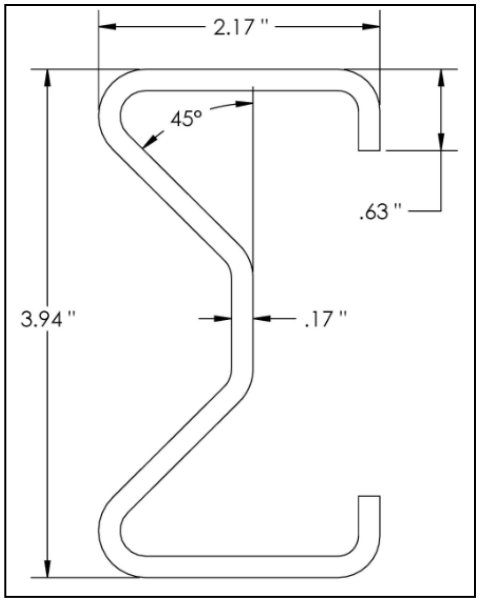
	Description	Qty
1	Top Rail ST-AK 19/66 (13' 6")	8
2	Bottom Rail ST-AK 182/120 (12')	4
3	Splice 182	2
4	Vertical Front Post (2' 4")	3
5	Vertical Back Post (6' 11")	3
6	Diagonal Strap (7')	3
7	Diagonal Strap (9')	3
8	Pre-assembled Bearing Block	6
9	Module End-Clamp	16
10	Module Mid-Clamp	24
11	Cross Adapter	32
12	M10 X 80MM SHCS 18-8 S/S	12
13	M10 X 120MM SHCS 18-8 S/S	12
14	Sigma Post (10')	6

Layout of concrete footings

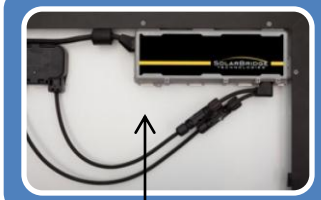


Concrete footing design details



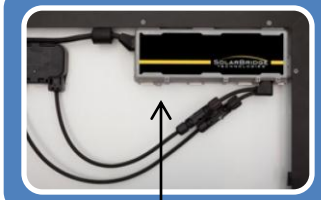


Five strings each with 12 solar panels



String A: 12 solar panels

- SolarBridge microinverter integrated on each panel (12)
- Power Line Carrier to SolarBridge Power Manager gateway (1)



String B: 12 solar panels

- SolarBridge micro-inverter integrated on each panel (12)
- Power Line Carrier to SolarBridge Power Manager gateway
- **Future firmware upgrade to each microinverter**

1 SolarBridge gateway box

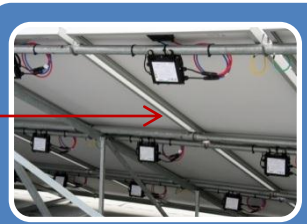
String C: 12 solar panels

- All panels connected in series
- Standard string-level inverter located in BRL #344 (1)

3 gateway boxes for C,D,E

String D: 12 solar panels

- All panels connected in series
- Standard string-level inverter located in BRL #344 (1)
- **DC optimizer on each panel** (12)



String E: 12 solar panels

- All panels connected in series
- Standard string-level inverter located in BRL #344 (1)
- **DC optimizer on each panel** (12); **future swap-out to custom device**

Power run to BRL #344

System components

Device Descriptions

PV Module
MAGE Solar
Power TEC Plus
245/ 6PL

INVERTER
Sunny Boy
5000HF-US

MICRO-INVERTER
SolarBridge
Pantheon II

DC OPTIMIZER
Tigo Energy
ES MM-2ES50

MOINTORING
SolarBridge
Power Manager

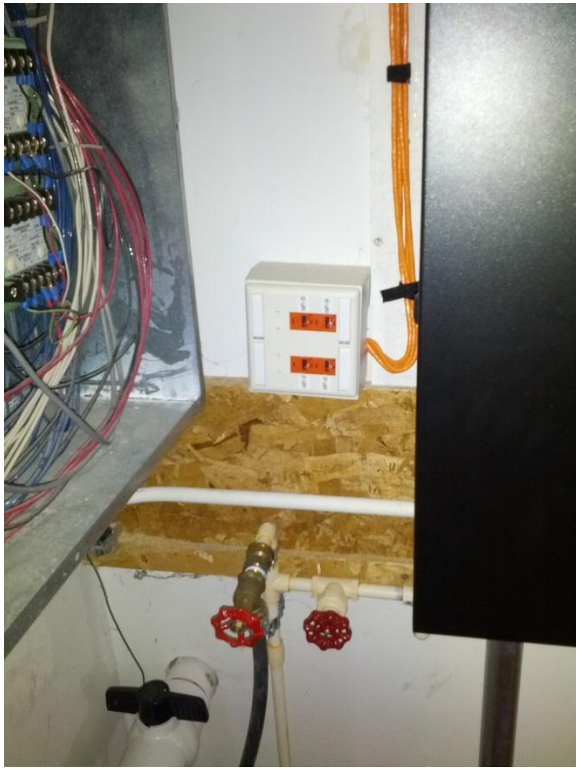
MOINTORING
SMA
Sunny Boy Web box

MOINTORING
Tigo Energy
Maximizer Management Unit

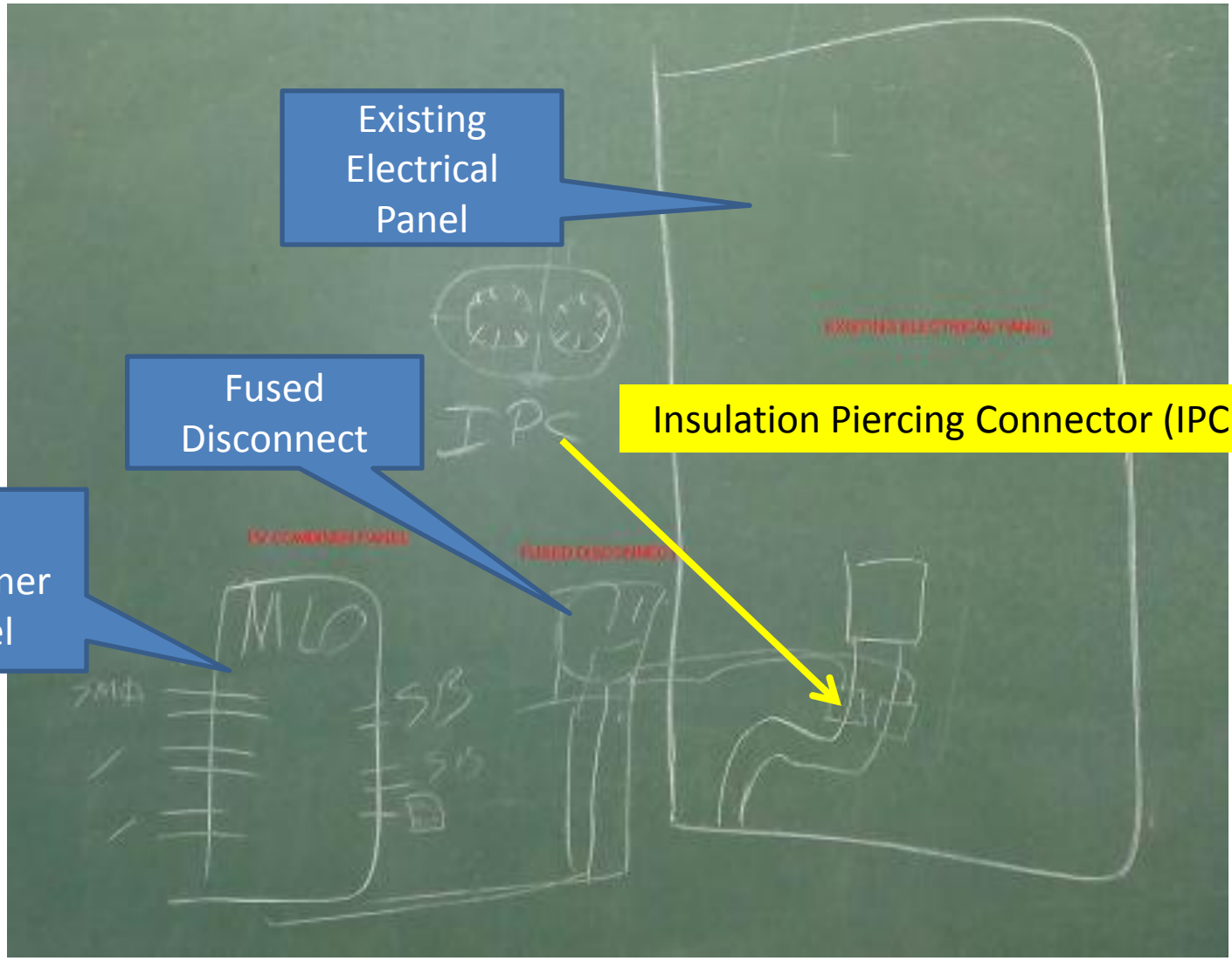
SYSTEM COMPNENT SPECIFICATION			
ITEMS	DESCRIPTION	MANUFACTURE	QUANITITY
1	PHOTOVOLTAIC MODULES	MAGE POWERTEC Plus 245/ 6 PL	60
2	INVERTER	SMA 3000HFUS 208/240	3
3	MICRO INVERTERS	Solar Bridge Pantheon II	24
4	DC OPTIMIZERS	TIGO MM-2ES50	24
5	MONITORING EQUIPMENT	Sunny Boy Web Box	1
6	MONITORING EQUIPMENT	TIGO MMU Monitoring Unit	1
7	MONITORING EQUIPMENT	Solar Bridge Management System	1
8	RACKING SYSTEM	MAGE System Tec ground mount	1

Entrance at NW corner

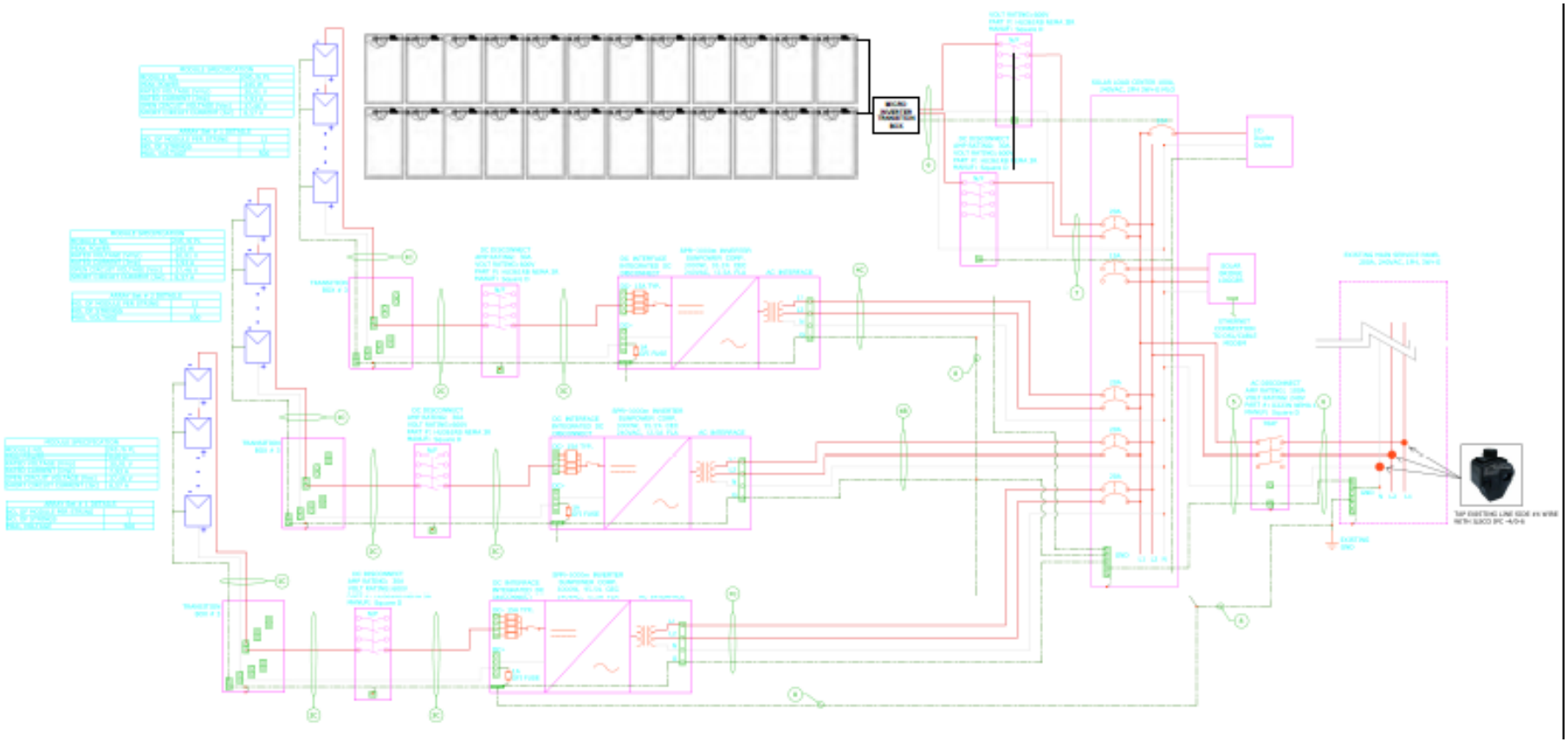
Electrical panel and Ethernet jacks



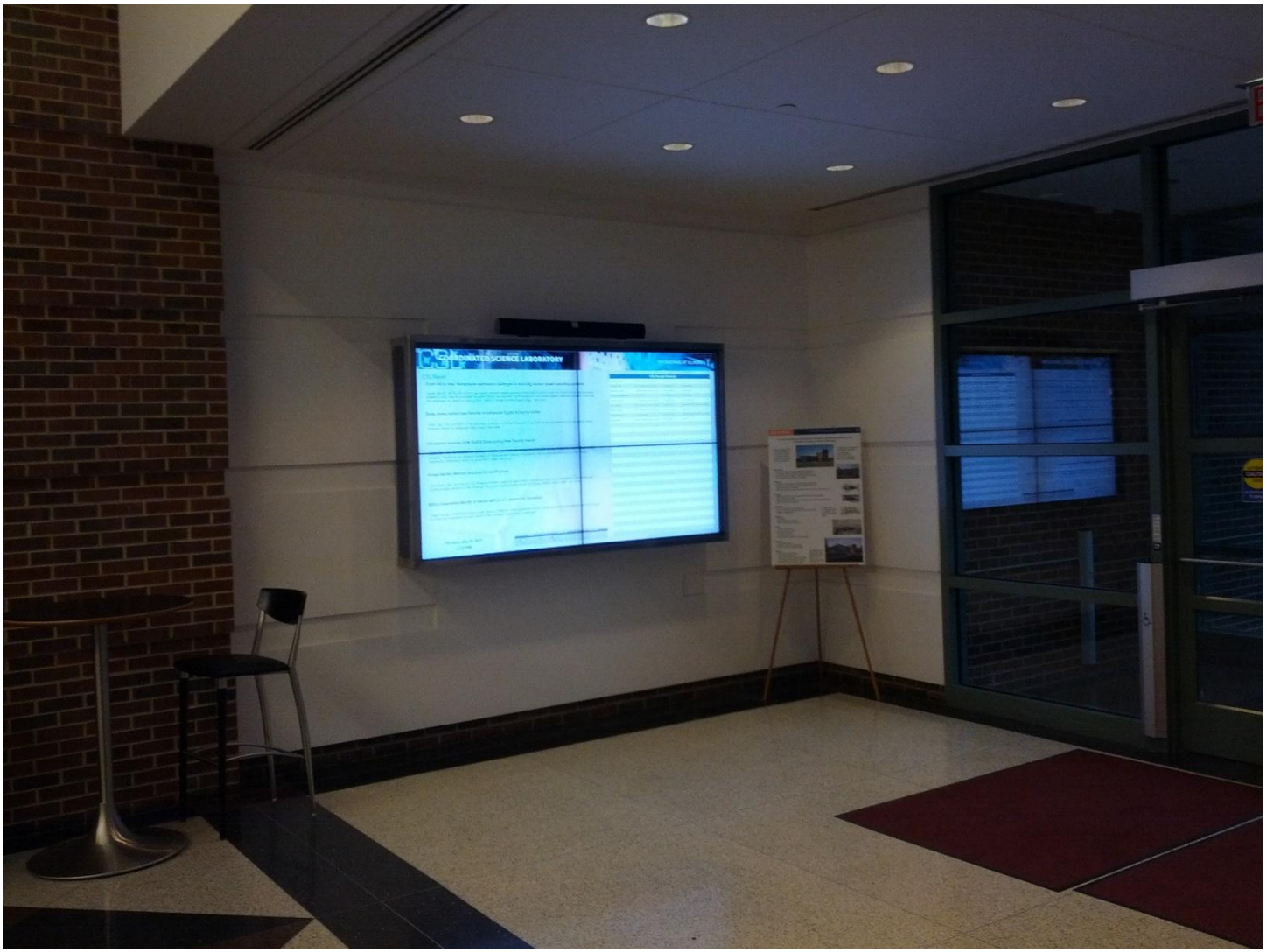
Combiner > Disconnect > Main Panel



Single line diagram



Solar dashboard in CSL lobby



Construction

May 15-31, 2013


GERDAU


GERDAU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MAGE SOLAR
MAGE POWERTEC PLUS
MAGE SOLAR
USA


MENU
ENTER
PV-SAFE
Tigo
energy


SMA
SUNNY BOY
SMA
SUNNY BOY
SUNNY BOY