

Solar Radiation and Meteorological Data Support for the Long Island Solar Farm and NSERC

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a passion for discovery



LISF Solar Radiation and Meteorological Sensor Network

- **Technology Needs:**
 - Characterize the solar resource potential for feasibility assessment of centralized PV solar generating facilities in the Northeast
 - Expansion of the national PV solar data base operated by NREL to include Northeast regional data
 - Developing now-casting capabilities to mitigate power variability on the grid based on intermittent source of solar radiation

LISF Solar Radiation and Meteorological Sensor Network

- **Objectives:** Develop a comprehensive, site-specific, high frequency (1 s) data set of the available solar energy and meteorological conditions at LISF in real time and develop capabilities for near-term forecasting
- In collaboration with NREL, BNL will:
 - Design, implement, operate and maintain the sensor network
 - Collect and archive data for analysis and evaluation of long-term performance of the array
 - Provide data for evaluating variability of solar radiation in NE
 - Facilitate forecasting and modeling techniques
- **Challenges:**
 - Large array footprint (~200 acres) requires a broad sensor network for accurate coverage
 - Large volume of data requires fast response communications

LISF Solar Radiation and Meteorological Sensor Network



Kipp & Zonen SP Lite

Network of individual radiometer sensors to be strategically installed across the array:

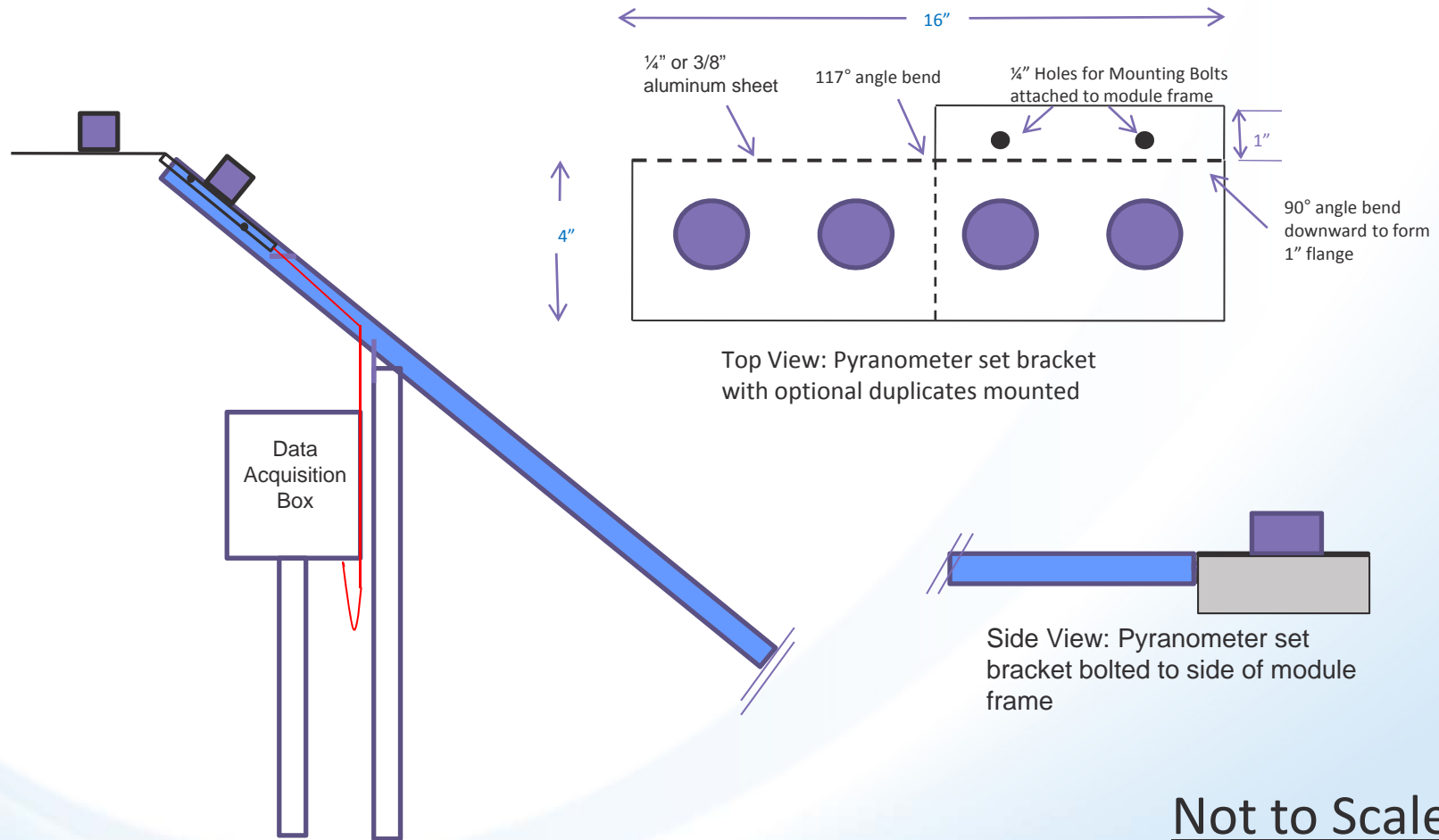
- (1) pair at each of 25 inverter power boxes
 - (1) in plane of array (27 deg)
 - (1) perpendicular to zenith
- (1) duplicate pair at each of 7 inverter boxes
- Total of 64 sensors

(2) Thermistor sensors at each of 25 modules to monitor module and ambient air temperatures Campbell CR 3000 Data Logger

(25) Data loggers for radiometer, module temp, and environmental data
(1 at each inverter box)



Mounting of Field Pyranometers on Modules



Not to Scale

LISF Solar Radiation and Meteorological Base Station

- High quality research-grade base station instrumentation to enhance and correlate the broad field sensor network data
 - Broad spectral response longwave (4500 – 42000 nm) irradiance pyrgeometer



Kipp & Zonen CGR 4



Kipp & Zonen CMP-21/CV-3 Ventilator

- High performance shortwave (285 – 2800 nm) irradiance permeometer

LISF Solar Radiation and Meteorological Base Station

Measurement of direct beam short wave (200 to 4000 nm) solar irradiance with limited (5°) collimation by a tracking pyrheliometer



Kipp & Zonen CHP 1 Pyrheliometer



Kipp & Zonen SOLYS Sun Tracker

Sun tracker to obtain more accurate solar radiation data

LISF Solar Radiation and Meteorological Base Station



Yankee Environmental
Systems MFR-7

Multifilter Rotating Shadow Band Radiometer (MFR) simultaneously measures global, diffuse, and direct normal components of spectral solar irradiance for improved QA. Facilitates determination of optical depths of water vapor and aerosols.

LISF Sensor and Base Station Quality Assurance

- **BNL and NREL collaboration on QA:**
 - Planning and specification of sensor array
 - Sensor calibrations:
 - Conducted by NREL as part of their calibration campaign
 - Direct performance comparison testing at both facilities
 - Data management



Independent accreditation to ISO standards



Sensor calibration and testing at NREL

Meteorological Sensor Network

- New 10 m tower sited near LISF
 - Ambient temperature
 - Relative humidity
 - Wind speed and direction
 - Rain gauge



Leveraging Existing BNL Meteorological Services

- **85 meter tower***
 - Two heights – existing 85m and planned ~50m
 - RM Young 5106
 - Wind speed
 - Wind direction
 - Temperature – RM Young 41342
 - Campbell CR1000 data logger
 - Campbell Radio
- **10 meter tower***
 - RM Young 5106
 - Wind speed
 - Wind direction
 - Temperature – RM Young 41342
 - Campbell CR1000 data logger
 - Campbell Radio
- **2 meter***
 - Nova Lynx Rain Gauge 260-2500E
 - RM Young 41382LC Temp/Rh Sensor
 - Campbell CR1000 datalogger
 - Campbell Radio



BNL 85 m Met Services tower

* All instruments in duplicate at each location

Reducing Grid Variability by Now-Casting

- Develop capability to predict near-term (0 - 30 min) variability in array output due to the impacts of clouds
- Current predictive capabilities use satellite-based “top down” observations over time and are statistically based.
- Our approach is an optically-based “upward looking” technique using Total Sky Imagers (TSI) that, along with imaging software, will track location, speed, direction and light transmission of clouds
- Potential collaborations to optimize TSI techniques



Yankee Environmental
Systems TS-880



Raw (left) and processed
(right) TSI data

Collaborations to Enhance Predictive Capabilities

Scanning Cloud Radar:

Possible collaboration with ProSensing, Inc. to site new scanning cloud radar that can expand abilities to track clouds as they approach the array.



Scanning cloud radar installed at DOE ARM facility



BNL NY Blue Supercomputer

Longer Range Forecasting:

Collaboration with SBU to explore application of computational techniques to simulate/model meteorological conditions for longer-term predictive capabilities

Northeast Solar Energy Research Center

- Planned NSERC research array will leverage the solar and meteorological sensor network capabilities and database established for LISF
- Provide an independent unbiased baseline for comparison of new PV components and systems
- NSERC can serve as a platform for testing and evaluation of new sensors and monitoring equipment as well as forecasting and modeling systems