115 kV / 34.5 kV Solar Power Plant/Substation

Problem Statement

Due to increasing renewable energy standards set by RES, Black & Veatch is sponsoring a design project to design a 60 MW grid tied solar power plant with an attached 115/34.5 kV substation. The team will design both parts of the project including the solar layout, substation layout, and associated deliverables.

Project Overview

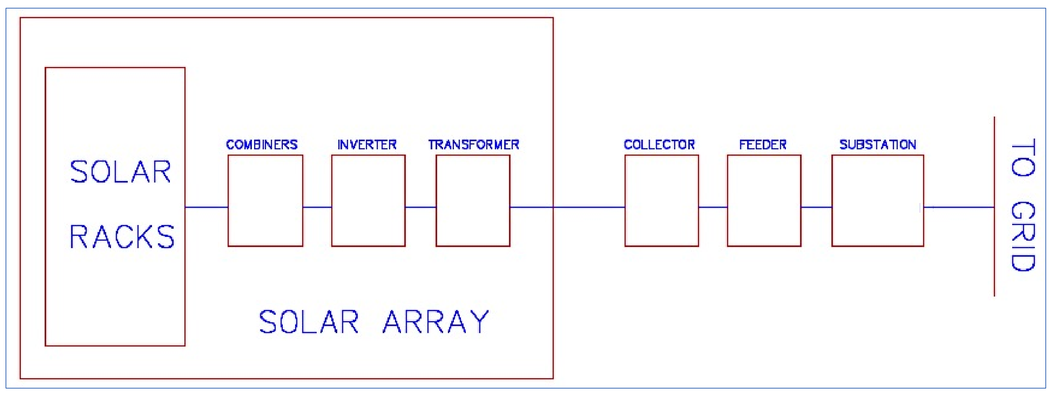
- Plant Location
  - Iowa
  - Used Iowa energy center solar calculator tools to determine best location in Iowa
- 60 MW Solar Power Plant
  - Plant/component sizing
  - Plant layout
  - Production and efficiency simulations
- Attached 115 kV/34.5 kV Substation
  - Substation one-line drawings
  - Substation three-line drawings

Specifications

- Solar plant required input parameters
  - Location: Iowa
  - Fixed Rack 325 W Hanwha Q Cells solar modules
  - 1670 kW Eaton Xpert inverter
  - 1500 VDC string voltage
  - ≈1.30 Inverter Load Ratio (ILR)
- Substation required input parameters
  - Substation specification document
  - Arcadia single line diagram

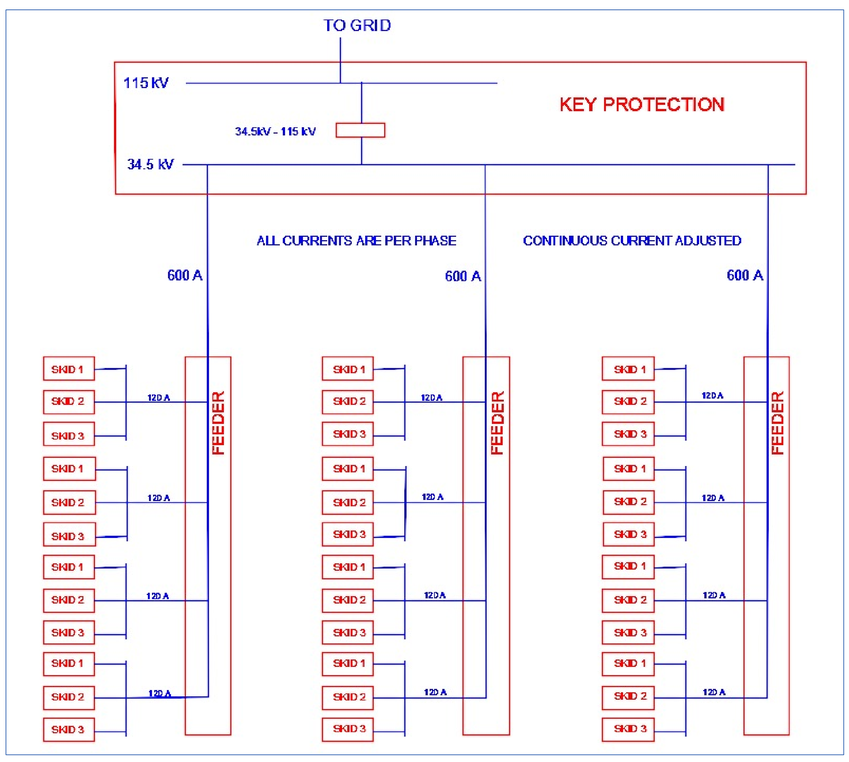
Overall System Block Diagram

Image below shows each major component and the power flow from the plant to the grid.



Substation System Block Diagram

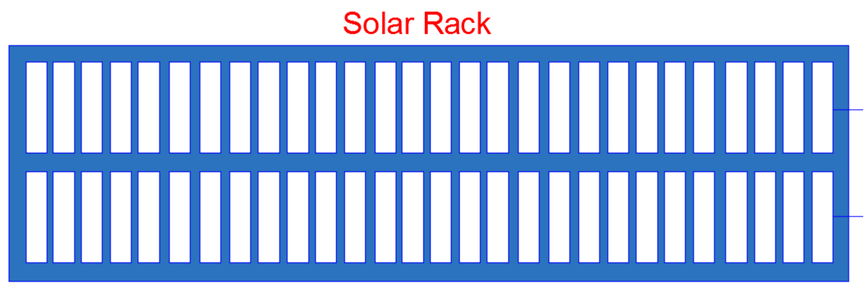
Image below shows power flow from solar arrays to the substation. Each “skid” represents one solar array.



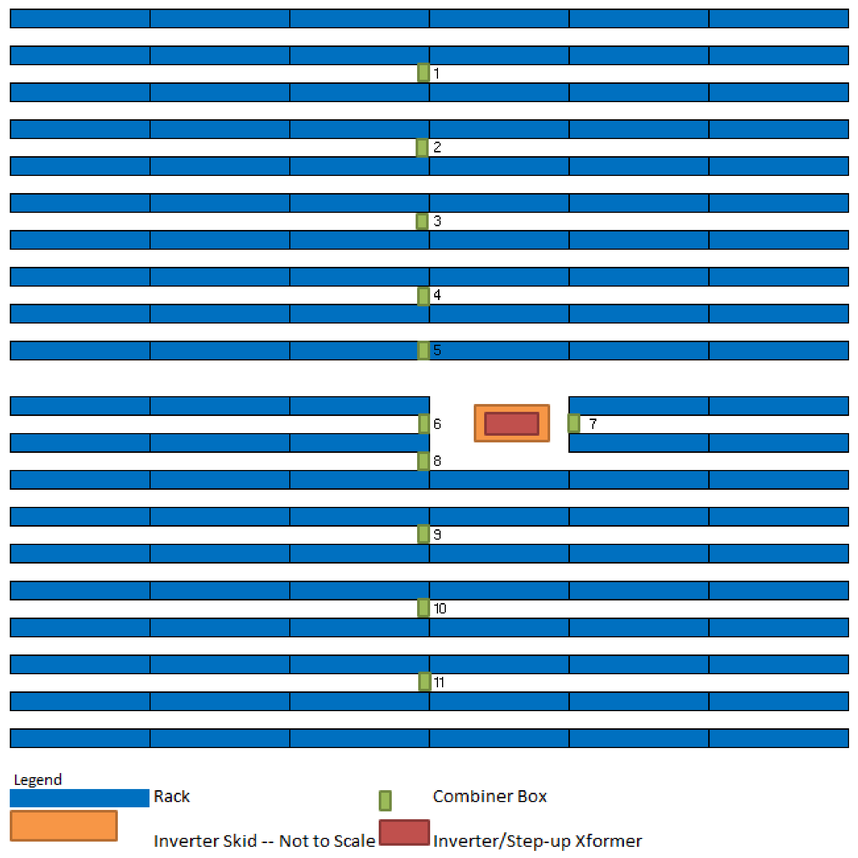
Solar Power Plant Design

- 36 total arrays
- Number of component -- per array
  - 118 racks per inverter
  - 11 combiners per inverter
  - 12 racks per combiner*
  - 2 strings per rack
  - 28 modules per string
  - 6608 modules per array
- Spacing – per array
  - 12 ft between racks, this distance gives us the least amount of losses due to shading.
  - 16 ft inverter access road in the middle

The image below shows two strings connected to make a rack:



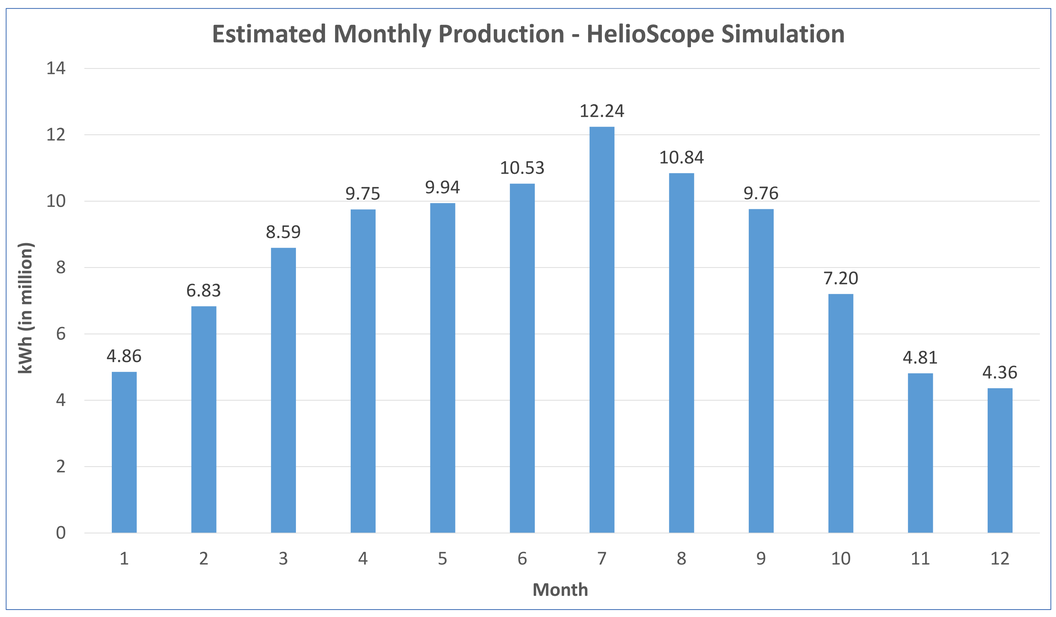
Below is a depiction of a one solar array showing racks, combiners and inverter placement:



*An additional combiner is added to the right of the inverter skid because conductors from the racks to the right of the inverter cannot cross over the inverter skid.

Production Simulation

The graph below is a Helioscope simulation that shows the projected month to month power production.



Total production: Approximately 99.73 million kWh/year

INDUSTRY CLIENT: Black & Veatch
CLIENT CONTACTS: Adam Literski, Rahul Ramanan
ADVISORS: Venkataramana Ajjarapu, Anne Kimber
TEAM EMAIL: may1602@iastate.edu
TEAM: Chase Benton, Senko Dizdarevic, Arif Ibrahim, Makoko Mukumbilwa