Week 3 Meeting

9/17/18
Team Leader: Katayi
Other Team Members: Nur, Chufu, Tam, Ahmed, YJ
Advisor: Dr. Ajjarapu

Topics

- Team Member Roles
- Deliverables
- Solar Plant / Substation Location
- Solar Power Plant/Substation Specifications
- Single Line Diagram
- ILR = 1.30
- Inverter: Eaton 1666kW
- Panel: Hanwha 325W
- Fixed Rack System

Team Member Roles

- Katayi (Team Leader)
  - Assign tasks to members, rotate on the 11th of every month
  - Responsibilities: Meeting minutes, research, communication in team
- Nur (Meeting Scribe)
  - Responsibilities: Reserve rooms for weekly meetings, and take notes during meetings and distribute them
- Ahmed (Research Manager)
  - Responsibilities: divide the research accordingly
- Tam (Report Manager)
  - Responsibilities: Weekly reports and agenda
- YJ (Website Manager)
  - Upload weekly reports, project plan, and design document to the website
- Chufu (Website Manager/Layout Designer)
  - Design the website and layout of project

Project Deliverables

This Semester:-

- Substation one-line drawings
- Solar plant array layout/drawings
- Engineering man-hour budget (Gantt Chart)
- Project plan (final)
- Design document
- Team website

Next Semester:-

- Substation three-line drawings
- Revise/improve last semester's drawings
- Engineering man-hour budget (Gantt Chart)
- Design document (final)
- Team website (final)

Location of Solar Power Plant/Substation

- California would be best location to establish solar power plant.
  - High sun radiation most of the year around.
  - Less rain and less cloudy.
  - Abundance of land.

$$Number\ of\ Panels\ Needed = \frac{60\ MW}{325\ W}(1.30) = 240000\ panels$$

$$Panel\ Area = 21.45\ ft^2$$

$$Total\ Area\ of\ Panels = 240000 * (21.45\ ft^2) = 5147990\ ft^2$$

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)
January	4.47	6,482,419
February	5.04	6,494,313
March	6.25	8,685,591
April	6.89	9,268,753
May	7.15	9,879,668
June	6.99	9,157,235
July	7.51	10,158,427
August	7.55	10,119,092
September	6.81	8,843,875
October	5.77	7,857,386
November	5.03	6,810,807
December	4.07	5,917,852
Annual	6.13	99,675,418

Requested Location	LOS ANGELOS
Weather Data Source	Lat, Lon: 34.05, -118.26 1.0 mi
Latitude	34.05° N
Longitude	118.26° W
PV System Specifications *(Commercial)*	
DC System Size	60000 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	20°
Array Azimuth	180°
System Losses	14.08%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2
Economics	
Average Retail Electricity Rate	0.127 $/kWh
Performance Metrics	
Capacity Factor	19.0%

Solar Power Plant /Substation Specifications

Solar Power Plant

- Output: 60MW
- DC Voltage: 1500V
- Panel: Hanwha 325W
- Inverter: Eaton 1666kW
- Inverter Load Ratio (ILR): 1.30
- Fixed Rack System

Substation

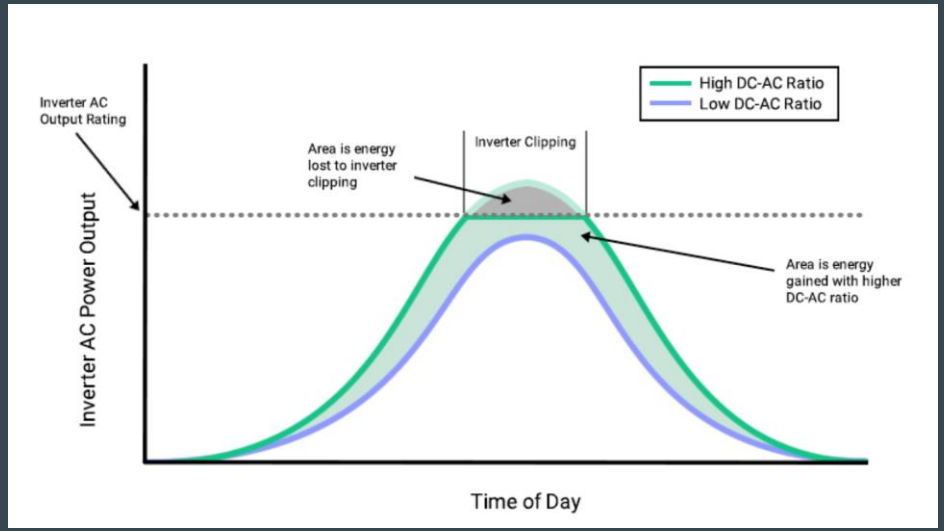
- Transmission Level Voltage: 115 kV
- Distribution Level Voltage: 34.5 kV

Single Line Diagram

- Transformers: change voltage from one level to another
- Lightning arrestors: protect substation equipment and electric system from lightning strokes
- Circuit switcher: provides equipment protection of transformers, lines, cables, and capacitor banks
    - also used to energize/de-energize capacitor banks
- Disconnect switches: isolate lines and equipment for maintenance
- Circuit breakers: protection devices to detect fault (via current transformer) and interrupt current flow
    - allows the rest of the system to continue operating with minimal impact
- Ring bus, double bus, or breaker and a half: failure of a circuit breaker does not cause an outage
    - parts of the substation can be de-energized for maintenance and repairs

Inverter Load Ratio (ILR) = 1.30

- ILR is the DC/AC ratio or ratio of the solar arrays to the inverter.
- Even though most people think a rate of 1.1 is ideal, we will use 1.3 because:
  - Our system will rarely experience “full standard” conditions
  - Generally, when an inverter is in over-power mode, it sacrifices excess power as losses



Inverter: Eaton 1666kW

- Inverters convert DC power produced by the solar panel into AC power that can be sent to the grid
- We will be using the Eaton 1666kW inverter, largest utility scale class
- Boosts plant reliability, reduces maintenance cost

Panel: Hanwha 325W

- Designed specially for large power plant to reduce the BOS cost
- Up to 17.4% efficiency rate under any condition, minimum of 16.3%
- Normal max power 325 W
- Max system voltage 1500(IEC)/1500V (UL).

ELECTRICAL CHARACTERISTICS								
POWER CLASS				320	325	330	335	340
MINIMUM PERFORMANCE AT STANDARD TEST CONDITIONS, STC[1] (POWER TOLERANCE +5 W / -0 W)								
Minimum	Power at MPP[2]	P_{MPP}	[W]	320	325	330	335	340
	Short Circuit Current*	I_{SC}	[A]	9.39	9.44	9.49	9.54	9.59
	Open Circuit Voltage*	V_{OC}	[V]	46.17	46.43	46.68	46.94	47.20
	Current at MPP*	I_{MPP}	[A]	8.79	8.85	8.91	8.97	9.03
	Voltage at MPP*	V_{MPP}	[V]	36.39	36.70	37.02	37.33	37.63
	Efficiency[2]	η	[%]	≥16.0	≥16.3	≥16.5	≥16.8	≥17.1
MINIMUM PERFORMANCE AT NORMAL OPERATING CONDITIONS, NOC[3]								
Minimum	Power at MPP[2]	P_{MPP}	[W]	237.2	241.0	244.7	248.4	252.1
	Short Circuit Current*	I_{SC}	[A]	7.57	7.61	7.65	7.69	7.73
	Open Circuit Voltage*	V_{OC}	[V]	43.08	43.32	43.56	43.81	44.05
	Current at MPP*	I_{MPP}	[A]	6.89	6.94	6.99	7.04	7.09
	Voltage at MPP*	V_{MPP}	[V]	34.44	34.72	35.01	35.29	35.56

[1] 1000 W/m², 25°C, spectrum AM 1.5G [2] Measurement tolerances STC ±3%; NOC ±5% [3] 800 W/m², NOCT, spectrum AM 1.5G * typical values, actual values may differ

Fixed Rack System

- We will use this system because:
  - Easier to maintain
  - Cost effective

Questions That We Have

- How do we use the array parameter tool?
- Should we use 1666kW or 1670kW for our calculations?
- What are the differences between the given and standard drawings?
- What is the reason of using G4.1 solar panel instead of G4.2 model (considering G4.2 is the newer version)?