Iowa State University
Department of Electrical and Computer Engineering

115/34.5kV Solar Plant & Substation

Client: BLACK & VEATCH

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Introductions & Agenda

- Project overview
- Detailed Design and Visuals
- Functionality
- Technology Considerations
- Areas of Concern and Development
- Conclusions

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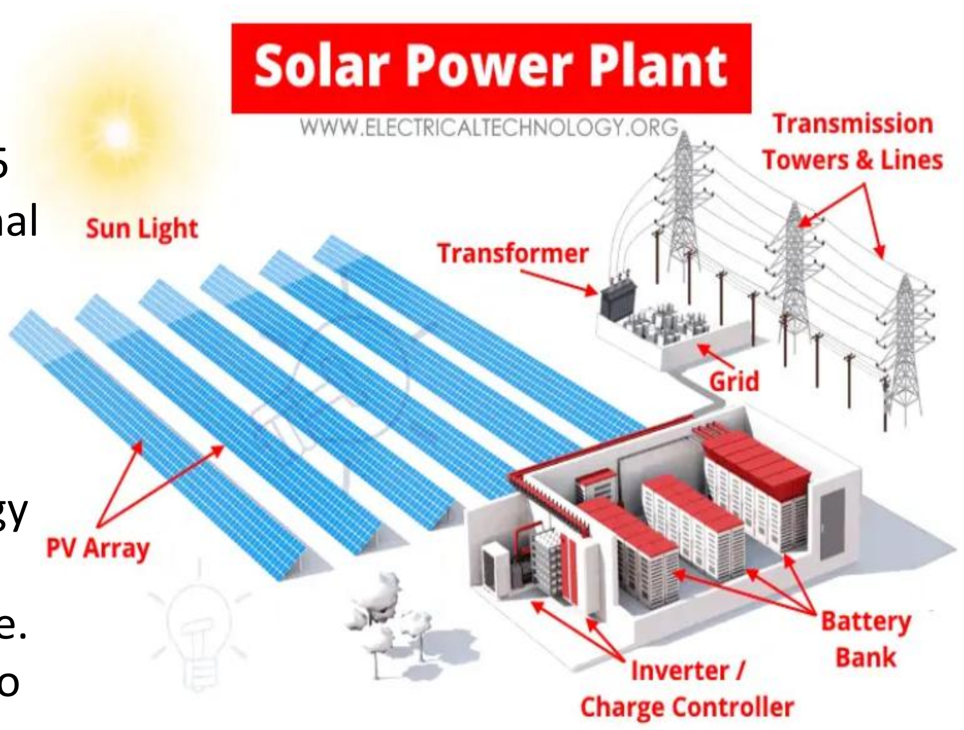
Project Overview

- **Project Scope:** Develop a solar plant integrated with a 115/34.5 kV substation to provide reliable, renewable energy transmission and distribution.

- **Objective:** Step down voltage from 115 kV to 34.5 kV, enabling efficient power distribution to regional grids and reducing reliance on traditional energy sources.
- **Key Components**:

- **Photovoltaic (PV) Modules** to convert solar energy into DC electricity.
- **Inverters** to convert DC to AC, suitable for grid use.
- **Transformers** to step down voltage from 115 kV to 34.5 kV for safe distribution.

- **System Reliability**: Incorporates switchgear and protection systems to handle faults, ensure safety, and maintain stability, supporting a resilient and flexible power grid.



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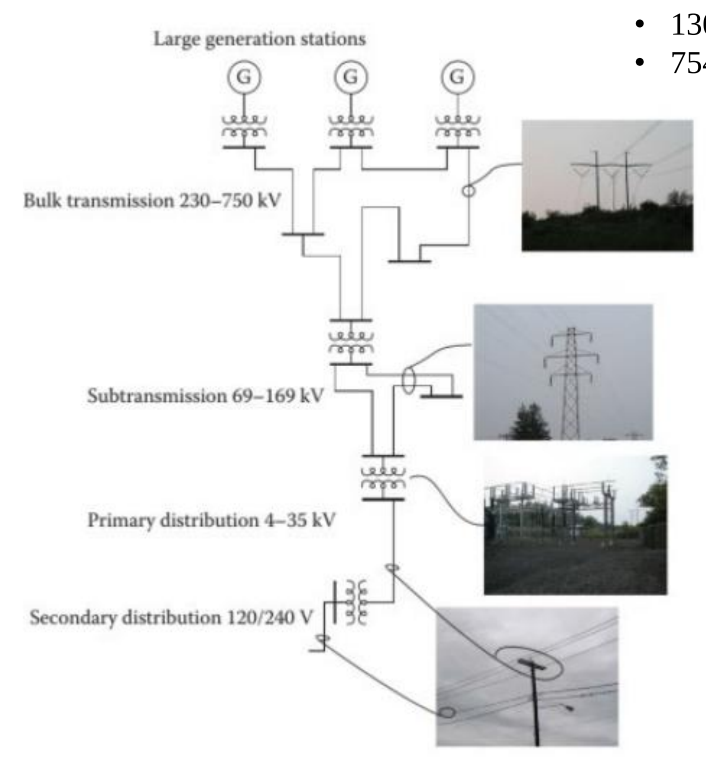
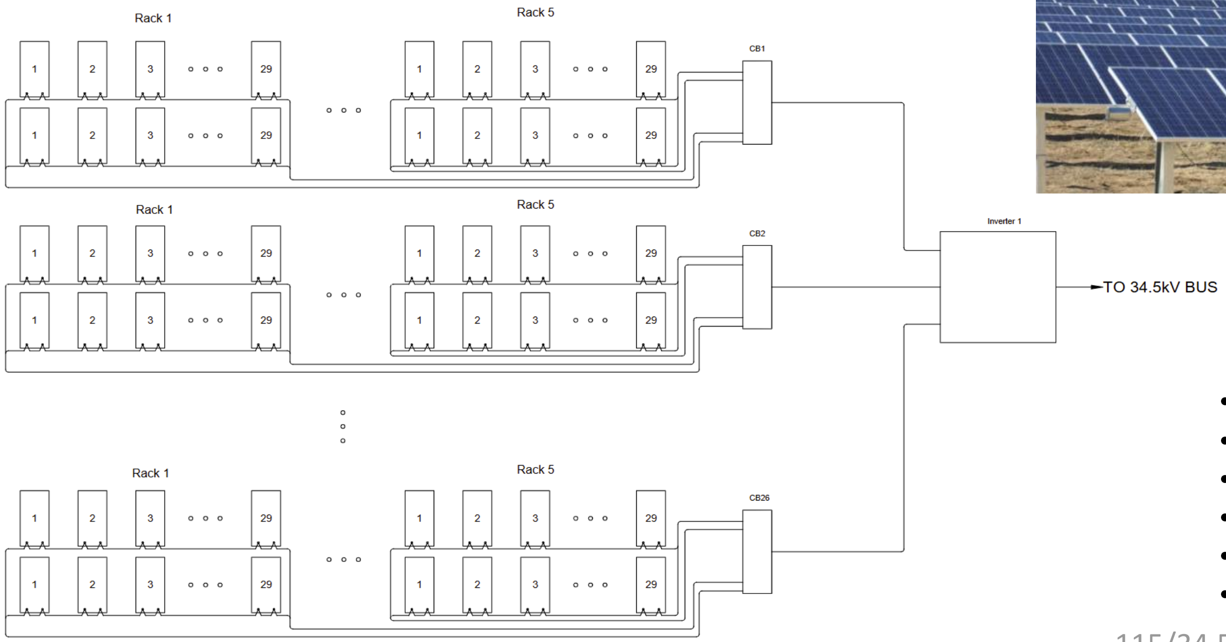
Detailed Design and Visuals

Solar Farm overview

- Solar Farms are usually interconnected to the grid at either the sub-transmission voltage or primary distribution level.
  - 5 racks/row
  - 26 rows/array
  - 130 racks/array
  - 7540 modules

Solar Plant		
Arrays in Plant	15	
Panels in Plant	113,100	
Inverters in Plant	15	
CBs in Plant	390	
DC Plant Output	77.33	MW
AC Plant Output	60	MW





- 30-degree tilt
- Table Height Projection: 7.4 ft
- Row Space: 9 ft
- Pitch: 16.4
- Array dimensions
- GCR

Solar Panels → Combiner Box → Inverters → Transformers → Substation → Transmission lines → Grid

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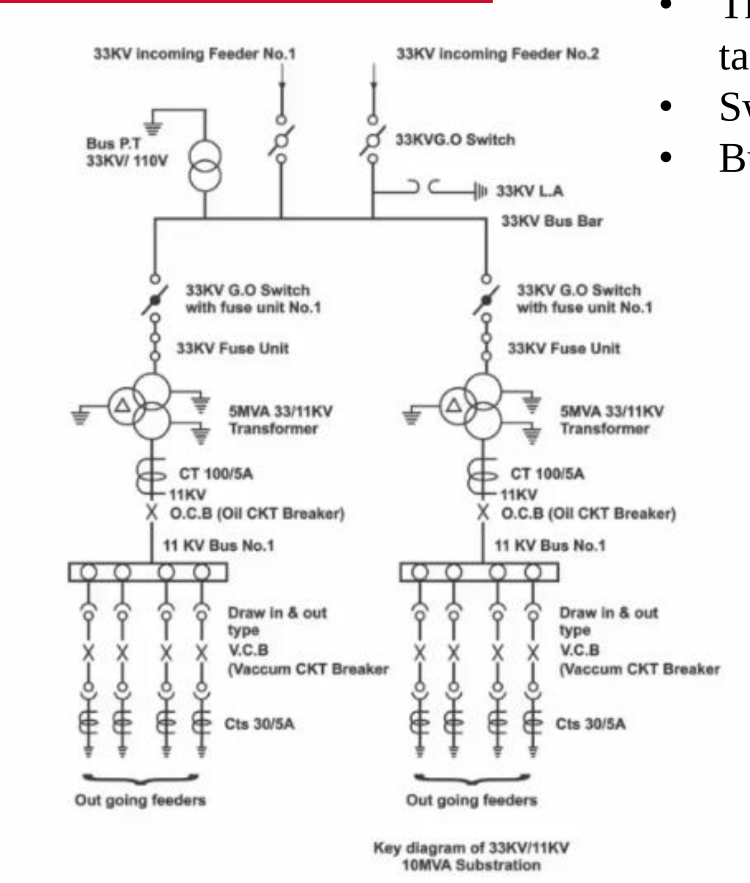
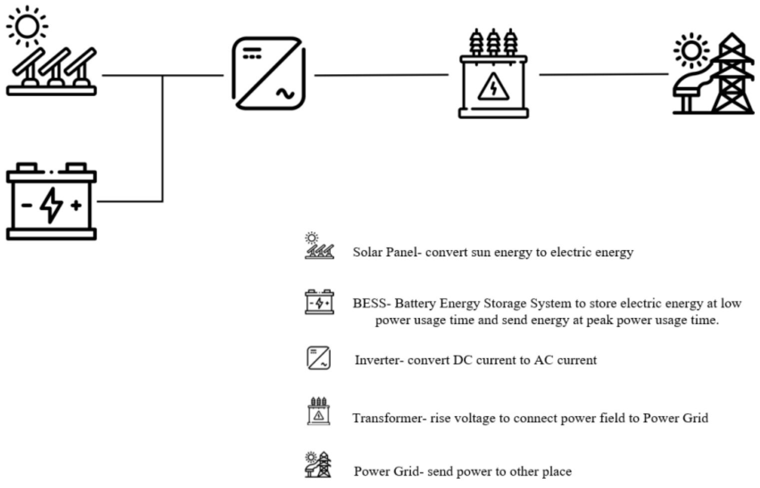
Detailed Design and Visuals

Substation overview

- Transmission lines come into substation at 115 kV.
- These lines step down into transformers which take the voltage from 115 kV to 34.5 kV.
- Switchgear: Faults/Emergencies.
- Bus bars: distribution.



Block diagram of power flow



- Circuit diagram.
- 33/11 kV system and transformer.
- Path power flow + safety components.

Feeders ➡ SG ➡ XMFR ➡ SG ➡ Circuit Breaker ➡ Busbar ➡ Outgoing Feeders

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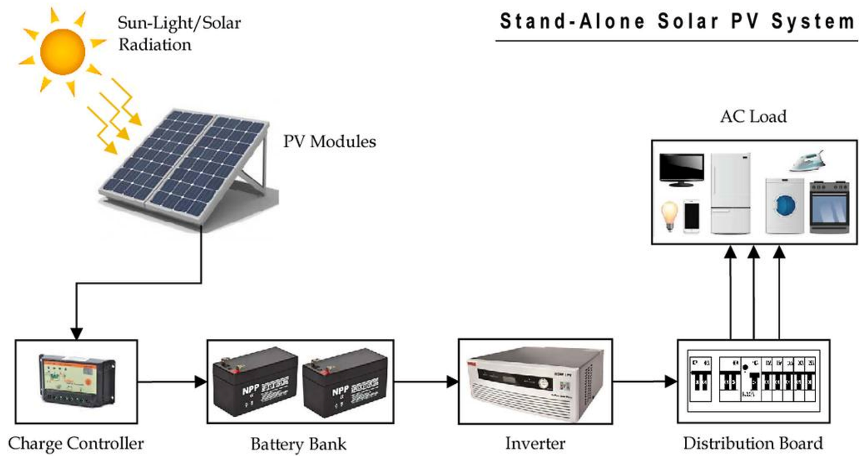
Functionality

- The solar farm's purpose is to generate power whenever the sun is out
- Most users would not be able to create a response from the solar farm.
- If the user is a utility company then they would be able to control whether the power is going into the grid or a battery
- If the farm is having a problem the utility company would dispatch maintenance and it would respond by being more efficient



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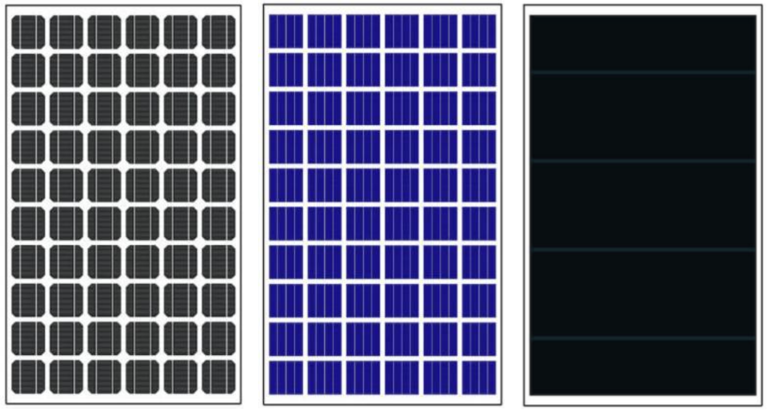
Technology Considerations



Solar Panel Type:

- Material: Monocrystalline, Polycrystalline, or Thin-Film
- Build: Bifacial or Monofacial Technology
- Selection: Monocrystalline & Bifacial for high efficiency and profitability long-term

	Monocrystalline	Polycrystalline	Thin-film
Efficiency	**Over 20%**	15% to 17%	7% to 13%
Cost (Per Watt)	**$1.00/Watt to $1.50/Watt**	$0.90/Watt to $1.00/Watt	$0.70/Watt to $1.00/Watt

Best Option

Inverter & Combiner Box

- Chosen based on: Efficiency rating, Reliability, Sizing, Lifespan

Design Software Comparison:

AUTODESK AutoCAD

- Drawings
- Models
- Documentation

BLUEBEAM

- Simple markups
- Document management
- Collaboration

etap POWERSTATION

- Design
- Analysis
- Optimization

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Areas of Concern and Development

- **Technical Specifications**
- Array Layout and Substation placement
- Too much voltage drop across cables
- Fuse rating in our selected combiner box
- **Cost**
- Getting costs for our selected Combiner Boxes and Inverters

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Conclusions

To conclude this presentation here are the key takeaways:

- **Project Goal**: Designing a solar plant and substation in New Mexico to deliver renewable energy to the grid.
- **Technological Choices**: Selected high efficiency panels along with reliable inverters and combiner boxes for optimized performance.
- **Design and Engineering Considerations**: We addressed crucial factors like array layout, substation placement, and voltage management to ensure minimal energy losses and efficient power transmission.
- **Current Challenges**: Working to resolve issues with voltage drops, and cost management.
- **Future Impact**: Aiming to set a foundation for future renewable projects and enhance grid stability.

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THANK YOU