115/34.5KV SOLAR PLANT & SUBSTATION

sdmay25-41

BLACK & VEATCH

Iowa State University
Department of Electrical and Computer Engineering

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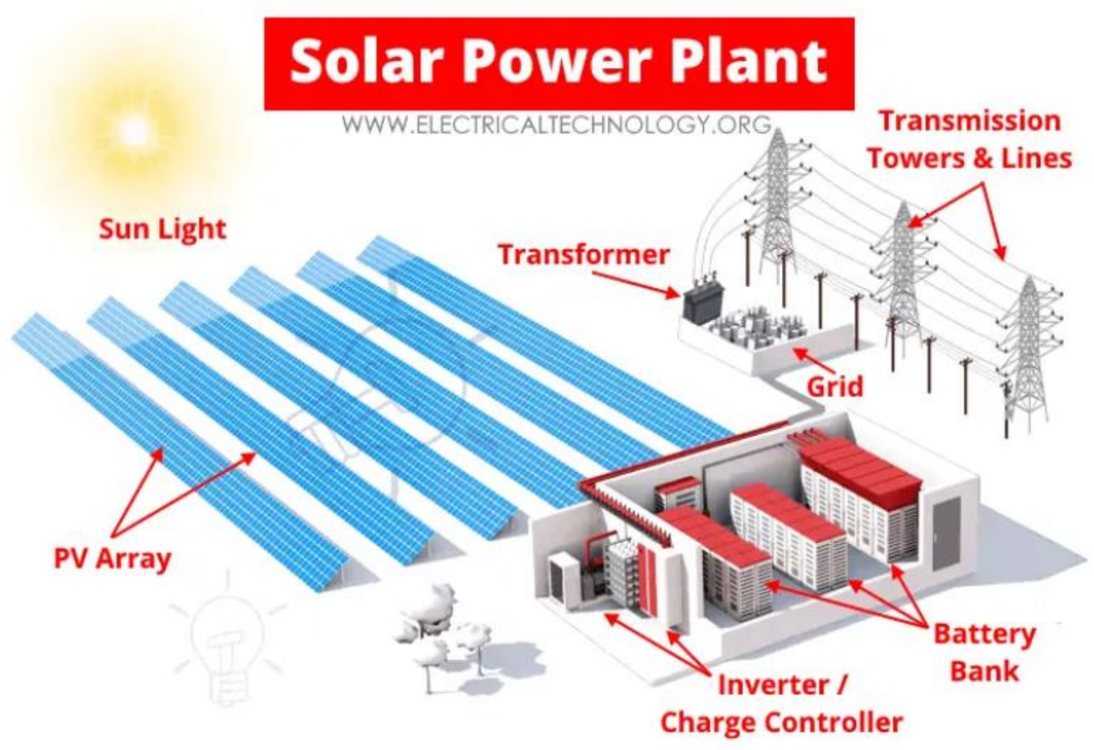
AGENDA

- **Project Overview**
- **Artifacts**
- **Human Suitability of Design**
- **Economic Suitability of Design**
- **Technical Suitability of Design**

PROJECT OVERVIEW

- Develop a solar plant in Luna County, NM and substation with 115 KV as the primary side of the transformer and 34.5 KV as the secondary side for end user.
- Photovoltaic (PV) Modules are used to convert solar energy into DC electricity.
- Inverters are used to convert DC to AC then connect to the low side of the transformer.

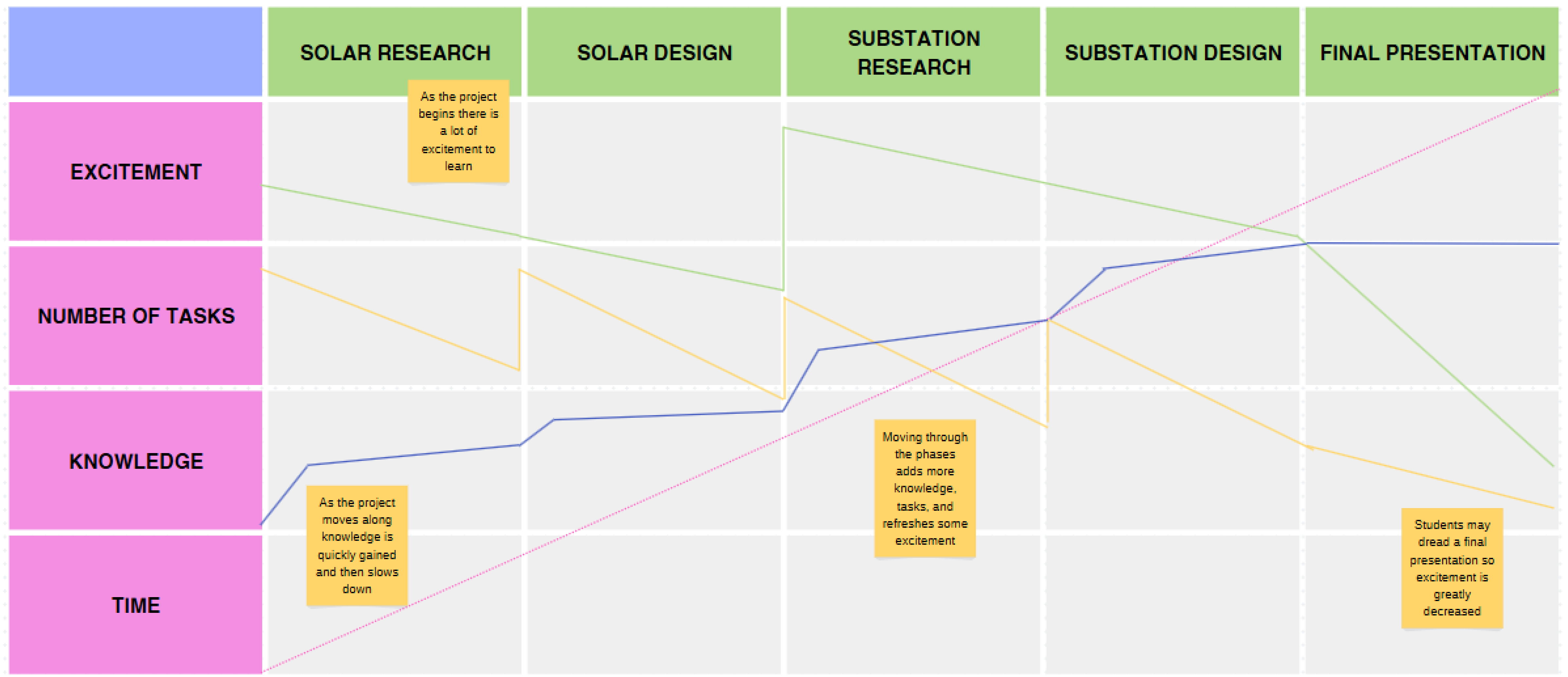


Project Information

Because of increasing utility renewable energy requirements, Iowa State University has been involved in the development of a 115/34.5kV Distribution Substation and a 60 MW Solar Plant. Our team will manage the whole design process, from the solar layout, electrical layout through all associated construction deliverables. The reliability and safety of the substation will be ensured with critical calculations such as load-flow analysis, short-circuit studies, system protection, and grounding. Our team will then develop an original tool that will be utilized for the optimization of elements of conceptual design. In this process, creative problem-solving is encouraged. Black & Veatch will give the conceptual design information and standards that shall guide our team throughout the project.

ARTIFACTS

JOURNEY MAP



SOLAR RESEARCH
SOLAR DESIGN
SUBSTATION RESEARCH
SUBSTATION DESIGN
FINAL PRESENTATION
EXCITEMENT
NUMBER OF TASKS
KNOWLEDGE
TIME
As the project begins there is a lot of excitement to learn
As the project moves along knowledge is quickly gained and then slows down
Moving through the phases adds more knowledge, tasks, and refreshes some excitement
Students may dread a final presentation so excitement is greatly decreased

PROS AND CONS TABLE

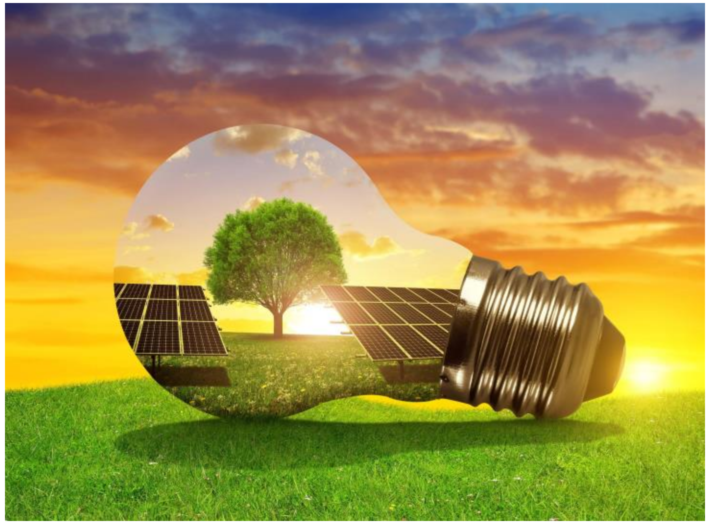
	Cheap Panels	Expensive Panels
Pros	• Lower cost per panel	• Longer Lasting • More efficient • Newer Technology • Takes up less land
Cons	• Inefficient • Need more land because of inefficiency • Wont last as long	• Higher upfront cost

TECHNICAL COMPLEXITY ANALYSIS

Technical Complexity Analysis	
Aspect	**Description**
Interdependent Variables and System Complexity	Our project involves the integration of electrical, mechanical, and energy systems with high interdependency between subsystems. To make sure there is safe and reliable power for the community, there must be coordination required between solar panels, inverters, transformers, and the distribution system.
Technological Sophistication	Our project utilizes new and advanced technology. This includes the use of the latest high-efficiency solar panels and advanced grid integration systems. Our team will be learning and implementing these new technologies throughout the project for our client's needs.
Technical Interfaces	Many technical interfaces are present, such as connections between solar panels and inverters, inverters to transformers, and integration into the electrical grid. For real-time system monitoring and control, we will have data communication interfaces.
Engineering Principles Utilized	Our project utilizes many principles from an electrical engineering discipline. Some applications include power systems design, voltage drop calculations, conductor sizing, inverter & DC combiner box selection, as well as solar panel sizing.
Internal vs. External Complexity	Internal Complexity: Our design involves many subsystems and each relies on the other for optimal performance. Our solar panels, inverters, DC combiner boxes, transformers, and any grid connections all work together seamlessly and must be designed in a way to perform well together. Our design must go though testing to prevent failures and we must also follow IEEE guidelines. External Complexity: Our project strives to set as a good example of a highly efficient and modern solar farm using the latest technologies. Some challenges include making sure our system will be capable with existing local infrastructure, making sure we have enough room for future growth, and making sure we are integrating the latest and greatest technologies in the industry.

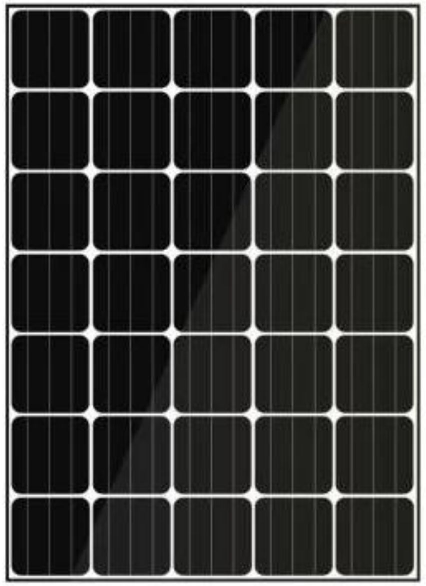
HUMAN SUITABILITY OF DESIGN

- We are giving them a clean, renewable source of power from the sun.
- The design follows most of the constraints or requirements that have been given, and more updates to the farm over time can give us the best chance at addressing all of the user's needs.
- Our team is currently coming up with more ways to make our solar farm more efficient through its layout and the components we selected.



ECONOMIC SUITABILITY OF DESIGN

- Our solar farm design has many significant advantages over existing solutions so far. We have strategically placed our solar panels and have optimized the solar farm layout, maximizing energy production per acre.
- Utilizing Monocrystalline panels
    - One of the highest-rated panels for their efficiency.
    - Although initially more expensive, we are reducing the total area needed for the farm, which translates to lower land acquisition and maintenance costs over time. Our design also minimizes long-term operational costs.
- One potential drawback is the higher upfront costs of purchasing high-efficiency monocrystalline solar panels.
    - To mitigate this, we explored various financing options & looked into the State of New Mexico’s assistance programs for large-scale solar installations.
- Our design also anticipates future expansions and technology upgrades to ensure that the initial infrastructure can support newer, more efficient technologies without significant changes. We have justified using monocrystalline panels both by discussing the needs of our client of long-term profitability and by performing a cost analysis where we have compared the price of land vs. the price of different types of solar panels.



Monocrystalline Solar Panel

TECHNICAL SUITABILITY OF DESIGN

Internal Complexity:

- Careful selection of Canadian Solar panels, ABB combiner boxes, and Siemens inverters based on their compatibility, specifications, and cost to ensure everything works together smoothly.
- AutoCAD drawings allowed us to check that all the equipment would fit properly on our land, ensuring optimal use of the space.
- Developed three array models to select the best substation design, reducing transmission losses and saving money.

External Complexity:

- Voltage drop calculations ensure the safety and reliable connection to the local power grid.
- Design choices complied with the necessary grid regulations.
- Location selection boosts performance and keeps costs low.
- The practical aspects ensured the choice was both technically and financially sound.

Expertise showcased:

- The project really showcases our ability to bring together different system components while keeping both technical and practical needs in mind.
- We've demonstrated a solid understanding of how to safely connect to the grid and meet all the necessary regulations.
- We also showed how effectively we can blend our technical expertise with real-world factors to create an efficient, cost-effective solution.

THANK YOU

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