Vacation Work Report

Bushveld Energy

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SPRCAI002

Electrical & Computer: Department of Electrical Engineering

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Internship Position: Engineer in Training
Internship Duration: 20 November 2023 to 8 December 2023
Employer: Bushveld Energy
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1 Introduction

This consolidated report encapsulates the diverse tasks and projects undertaken during the internship, demonstrating a comprehensive exploration of renewable energy technologies, project management, and engineering principles in real-world applications.

2 The Objective:

During the internship, the primary objective was to contribute to the Vametco Project Phase 2, focusing on designing a 200MW solar PV + Battery Energy Storage System (BESS) for the Vametco Mine. The specific goal was to create an efficient solar PV system tailored to meet Vametco's energy needs, with a key emphasis on utilizing advanced technologies, such as Vanadium Redox Flow Batteries (VRFB) and tracking solar panels, for optimal performance as well as wheel additional energy into the Eskom network.

2.1 Description of Equipment and Principles

2.1.1 Vanadium Redox Flow Batteries (VRFB):

Objective: Understanding the principles and applications of VRFB technology
Description: Conducted extensive research on VRFB technology, investigating its theoretical foundations, practical implementations through case studies, and a comparative analysis with Lithium-based batteries. Explored the unique benefits of VRFB, such as longer lifespan cycles and deep charge capabilities.
Implementation: Applied engineering principles related to electrochemical reactions, energy storage, and material science. Emphasized the importance of redox reactions and ion exchange for energy storage in VRFB. Contributed insights to the Vametco Project's BESS component, aligning theoretical knowledge with practical applications.

2.1.2 Tracking Solar Panels and Battery Energy Storage System (BESS):

Objective: Optimizing the solar PV system design for Vametco's energy needs by incorporating cutting-edge technologies.

Description: Utilized tracking solar panels to enhance energy capture, adjusting panel angles dynamically to face the sun. Integrated a Battery Energy Storage System (BESS) to supplement energy supply during low solar irradiance, ensuring a resilient power supply.
Implementation: Applied engineering principles of solar tracking technology, considering the sun's path and optimizing panel orientation for increased energy yield. Implemented BESS principles, considering load following, peak demand reduction, and network congestion mitigation. Demonstrated how BESS contributes to energy resilience and sustainability.

2.1.3 AutoCAD for Project Mapping:

Objective: Contribute to the design process of Vametco Project Phase 2 by mapping out the solar PV + BESS system.
Description: Used AutoCAD to plan the placement of solar panels, substations, and batteries, focusing on optimal spatial configuration and logistical considerations.
Implementation: Applied engineering principles of spatial planning, electrical system design, and layout optimization. Translated theoretical knowledge of electrical infrastructure into practical design elements. Developed skills in AutoCAD to contribute effectively to the project's preparatory design phase.

2.1.4 HOMER Software for Economic Analysis:

Objective: Evaluate the economic viability of the solar PV + BESS system, also find the optimal solar PV + BESS sizing with the lowest Levelised Cost of Energy (LCOE).
Description: Leveraged HOMER software to perform economic analyses, exploring various system configurations and assessing financial implications. Integrated technical insights from design models into HOMER for a comprehensive economic evaluation.
Implementation: Applied economics principles, considering factors like capital costs, operational costs, and project lifetime. Analyzed the trade-offs between different design models to identify the most cost-effective solutions. Demonstrated how economic considerations influence design decisions in renewable energy projects.

2.1.5 PVCad and PVSyst for Solar PV Design:

Objective: Design an efficient solar PV system for Vametco's energy needs, considering factors like layout, panel types, energy simulation, and wheeling into the Eskom network.
Description: Utilized PVCad for designing solar panels and estimating power generation, focusing on optimal layout and string configurations. Used PVSyst for in-depth solar resource assessment, system design, and performance simulation.
Implementation: Applied engineering principles of solar panel efficiency, string configurations, and energy simulation. Integrated PVSyst outputs into the overall design process, ensuring alignment with real-world constraints and optimizing for maximum energy yield.

2.2 Results Obtained

Throughout the internship period, the culmination of various tasks and projects has yielded substantial results and valuable insights in the field of renewable energy and engineering. The research and analysis of Vanadium Redox Flow Batteries (VRFB) provided a comprehensive understanding of their theoretical foundations and practical applications. This knowledge was directly translated into the design of the Battery Energy Storage System (BESS) for the Vametco Project, contributing to the project's overall resilience and efficiency.

The integration of cutting-edge technologies, such as tracking solar panels and a Battery Energy Storage System (BESS), proved successful in optimizing the solar PV system for Vametco's energy needs. The dynamic adjustment of solar panel angles based on the sun's path significantly improved energy capture, enhancing the overall efficiency of the solar PV system. The BESS, with its load-following capabilities, ensured a continuous and resilient power supply, demonstrating the practical implementation of engineering principles for sustainable energy solutions.

The use of AutoCAD for spatial planning and layout optimization facilitated the creation of an efficient and well-organized configuration for the solar PV + BESS system. The precise placement of solar panels, substations, and batteries, aligned with spatial constraints and logistical intricacies, showcased the application of engineering principles in spatial design. This optimization not only maximized energy generation but also contributed to the project's overall sustainability.

Economic analyses conducted through HOMER software provided critical insights into the financial viability of different system configurations. The evaluation of levelized cost of energy (LCOE), capital costs, and operational costs for each design model allowed for informed decision-making, balancing engineering considerations with financial constraints. This interdisciplinary approach ensured that the designed solutions not only met technical requirements but were also economically feasible.

The use of PVCad and PVSyst for solar PV design contributed to the overall optimization of the system. PVCad outputs provided efficient solar panel layouts and string configurations, adhering to engineering principles of panel efficiency. PVSyst outputs facilitated in-depth solar resource assessment, system design, and performance simulation, ensuring the solar PV system's alignment with real-world constraints and maximizing energy yield. These results collectively form a comprehensive foundation for the further development and implementation of sustainable energy solutions at Vametco.

3 Conclusion

In conclusion, my internship at Bushveld Energy was a transformative experience, offering hands-on application of theoretical knowledge to real-world engineering challenges. The investigation into Vanadium Redox Flow Batteries (VRFB) highlighted the crucial role of sustainable energy solutions in addressing Eskom's load shedding and blackout issues for

industrial facilities. Implementation of cutting-edge technologies, including tracking solar panels and a BESS, demonstrated innovation in optimizing renewable energy systems. Spatial design using AutoCAD and economic analyses with HOMER ensured optimal layouts that were both technically sound and economically viable. The use of PVCad and PVSyst underscored the importance of precise design in maximizing energy yield, contributing to sustainable and efficient energy generation.