

## ***EE/CprE/SE 491 WEEKLY REPORT 7***

***10/25-10/31***

***Group number: sdmay25-02***

***Project title: Ames Microgrid Evaluation and Substation Consulting***

***Client &/Advisor: Adam Arnold (Burns & McDonnell) and Dr. Zhaoyu Wang***

### ***Team Members/Role:***

- Sean Carver - Transmission Team (Substation)
- Bethany Danley - Distribution Planning Team
- Thomas Edwards - Distribution Planning Team
- Nathan Kallal - Distribution Planning Team
- Mina Khalil - Transmission Team (Substation)
- MacKenzie Woods - Transmission Team (Substation)

### ***o Weekly Summary***

This past week, our team made substantial progress on both the microgrid and substation designs, creating foundational visuals and initial one-line diagrams to enhance system clarity. The Transmission Team refined the project scope after Sean and Emily's discussion with Seth, who suggested a shift in focus. Originally, we assumed limitations in the existing microgrid, but after analyzing its performance—particularly during the 2020 Derecho—we realized that Ames's substation, equipped with a redundant transformer, already offers reliable backup. During the Derecho, Ames attempted to shed load to maintain the microgrid, but the turbines didn't respond effectively, which pointed us toward a different solution. Rather than expanding the substation, we are considering establishing a battery system in the coal storage area that can shed load from non-essential buildings, allowing critical research facilities to remain operational if the Ames grid goes down. This shift means our project will focus more on battery storage than substation expansion, aiming to determine the capacity required to power essential loads temporarily while shedding non-essential ones. Our preliminary one-line diagram includes components such as transformers for voltage step-down, surge arrestors, capacitive voltage transformers for isolation, relay coils for monitoring, gas circuit breakers, load tap changers, and power fuses—currently simplified as boxes connected by lines, with plans to finalize the model in AutoCAD using industry-standard symbols. Though in the early stages, this new direction gives us a solid starting point to enhance the resilience of Ames's critical infrastructure. The Distribution team made strong progress with the finalization of the load profile of the ISU Campus, reaching a point to where the model is now in the development phase. There are still a few loose ends that are being dealt with in terms of the data specified in the load profile, as the client gave us further specifications that would be helpful in creating a realistic model. The contacts at ISU FP&M and the ISU Utilities will be contacted to obtain that

information.

o **Past week accomplishments**

- Transmission Team: This past week, our team made significant strides in developing the microgrid and substation designs, producing initial visuals and one-line diagrams to enhance system clarity. Following discussions with the client and additional input from Sean, we refined our project scope with a new focus. Originally centered on substation upgrades to improve redundancy, we recognized the existing system's strengths—specifically, the Ames substation's redundant transformer—and observed the microgrid's challenge in shedding load during the 2020 Derecho. Given this, our project is shifting toward a battery-based solution that can enhance resilience by supporting critical loads if the Ames grid fails. To align further with the client's updated needs, we've scheduled a meeting to discuss how best to implement this battery storage strategy, including the potential for a new yard in the coal storage area to house the system. While our one-line diagram serves as a foundational draft, it remains a work in progress. It highlights key components, such as one of the two transformers used for voltage step-down, surge arrestors for spike protection, capacitive voltage transformers for isolation, and relay coils for monitoring and safety. Additional elements, including gas circuit breakers, load tap changers, reactors, power fuses, fused disconnect switches, and a control enclosure, are outlined in simplified form, with final AutoCAD models to follow using industry-standard symbols. Though early in development, this one-line diagram now serves as a robust starting point for implementing a battery solution to improve reliability and resilience in Ames's critical infrastructure
- Distribution Planning Team: We met with Adam Arnold on Tuesday to discuss the load data obtained from ISU Utilities, covering topics such as data conversion and load profiling. Adam confirmed that our initial conversion from a yearly BTU total to a daily kWh load was accurate, but recommended obtaining more precise data to create a holistic load profile. Moving forward, the team will seek additional details, including power factor information, confirmation of campus system voltage, and an hourly breakdown of load data, which will help us capture peak loads for different seasons and transitional periods. The Distribution Team is coordinating with ISU contacts, aiming to gather this data before a follow-up meeting with Adam on November 6th. At that meeting, we plan to review the new information and analyze a preliminary model using OpenDSS to support more accurate load management and system planning.

o **Pending issues**

- Transmission Team: Finalizing the project scope remains a priority, especially as we consider a significant shift from substation upgrades to a battery-based resilience solution. We're collaborating closely with our client to ensure this potential change aligns with the project's objectives and remains feasible. A key challenge is determining which specific system upgrades, whether in substation components or a new battery system, will most effectively enhance redundancies and maintain reliable operation during failures. Additionally, our one-line diagram is still in its draft stages and requires further development to incorporate any scope changes. We're also coordinating an upcoming meeting with Jenalee to review and confirm these design elements, ensuring our approach meets both the technical and operational goals of the project as we refine our direction.
- Distribution Planning Team: Currently, we need to seek more data from ISU utilities. We

need to get the total BTU per hour per day in 2023 to actually build a load profile and find the true peaks at certain times. We also need to get the power factor that the ISU microgrid is running on in order to build our model.

o Individual contributions

<u>NAME</u>	<u>Individual Contributions</u>	<u>Hours this week</u>	<u>HOURS cumulative</u>
Sean	I have contacted the client and gave my ideas on how to narrow our scope. They agreed with one of my solutions and are meeting to flesh out the idea and the specifics. I then met with the rest of my group mates to let them know of our new scope. We came up with a plan for emailing our utility contact to hopefully get more information before our next meeting.	4	23
Bethany	I attended the meeting with Adam over the load profile we have built. I emailed ISU utilities in order to gain the additional information that we need.	3	27
Thomas	This past week, I attended the meeting with Adam Arnold about the load profile data and next steps. I also started the official model in OpenDSS for the microgrid on campus, using the software and information we had so far to make a preliminary model.	4	27
Nathan	I attended the meeting with Adam over the load profile information and got feedback from him on our next steps. I sent an email out to a contact at ISU Utilities to ask some questions to confirm information for our open DSS Design	3	23
Mina	This past week, I have attended all the necessary meeting times and contributed to making sure we, as a transmission team, find a time to meet and schedule that time for the team.	3	24

MacKenzie	This past week, I focused on refining the initial one-line diagram for the substation design, ensuring that key components—such as transformers, surge arresters, relay coils, and gas circuit breakers—were accurately represented to enhance clarity. Additionally, I met with Sean and Mina, where Sean briefed me on the significant scope change, shifting our focus from traditional substation upgrades to a battery-based resilience solution. This update allowed us to revisit our design approach, ensuring it aligns with the new project direction. For our upcoming client meeting, I aim to further align our design decisions with the revised technical and operational goals of the project.	3	31
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o **Comments and extended discussion** *(Optional)*

Regarding non-technical concerns, there are currently no issues. Our team is collaborating effectively, and communication has been smooth across meetings and tasks. We feel confident in our ability to continue working together successfully as we move forward with the project.

o **Plans for the upcoming week**

- Sean: We have another meeting scheduled for tomorrow to discuss our scope. My plans for the week rely on what is discussed then and what information we get back from our utility contact. I am predicting that we will have to research battery packs and how to integrate them into our current system.
- Bethany: We have another meeting scheduled with Adam on the 6th of November, so my plan before that is to make sure we have all of the data that he requested.
- Thomas: Before Wednesday 11/6, I plan on creating a baseline functioning model of OpenDSS based on the Iowa State Campus. The model will have the bus layout of campus and distribution lines between each load (building on campus), although due to these being underground lines assumptions on the location and properties of these lines will need to be made. This model will ideally be ready to input the load profile data that Bethany and Nathan are looking for further clarification on and serve as a basis for the rest of the project.
- Nathan: Similar to Bethany I want to make sure that the distribution team has all the data we need by November 6th. I also plan on working with thomas when I have the chance to learn more about Open DSS and how we plan on using our model next semester. .
- Mina: For the upcoming week, we will have a meeting on Friday with Janalee so I will

prepare for that. I'm also planning to analyze the battery system that we will be upgrading and doing some research.

- MacKenzie: In the upcoming week, I plan to shift focus from substation upgrades to modeling and analyzing battery system upgrades to support the revised project scope. This will involve creating a detailed model in software like AutoCAD or Simulink, where I'll begin incorporating battery storage components and simulating their impact on system resilience. I'll also gather feedback from our advisor and client on this new direction to ensure our scope aligns with their expectations. Additionally, I'll prepare for our meeting with Jenalee by drafting an agenda and organizing questions around specific battery storage and system redundancy options to facilitate productive discussions. Finally, I'll review our current design approach to identify any gaps related to the battery solution, allowing us to address these and continue progressing toward our project's technical and operational goals.

#### o **Summary of weekly advisor meeting**

10/29 Distribution Team Meeting with Adam Arnold:

On Tuesday, the Distribution team met with Adam Arnold to discuss the load data acquired from both the ISU Utilities email and the public website. Adam told our team that the data we had compiled was a good start and the conversions that we had done to take the data from a yearly BTU total to a daily kWh load was correct, but also had a desire to gain more precise data in order to create a more holistic load profile. In order to move forward with identifying peak loads, he asked us to reach out to our contacts and obtain the following information:

- Power factor information for the system as a whole or at different metered points in the circuit
- Confirmation on the voltage that the campus system operates on
- Breakdown of the provided load data per hour, as opposed to the current model of just daily load amounts

With this information, a more accurate load shape will be able to be formed that represents the peak loads per season, as well as some shouldering times in the spring and fall where there may be a mismatch between the amount of energy produced by solar and the on-campus demand. The distribution team is reaching out to a contact from Jon Fleming and the [utilities@iastate.edu](mailto:utilities@iastate.edu) contacts for this information, and plan on meeting with Adam again on 11/6 at 5 PM if they can get this data. In that follow-up meeting, we will analyze the new information and look at a preliminary model of OpenDSS and the use of data in that system.

11/1 Substation Team Meeting with Jenalee, Seth, and Emily:

The substation team has scheduled a meeting with our Substation Client Team to discuss the substation scope for our senior design project for Friday, November 1st from 9:00 - 9:30AM.