

## **EE/CprE/SE 491 WEEKLY REPORT 5**

**10/11-10/17**

**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 week, we discussed key updates on ISU's energy system, including redundancy and the potential for future load growth tied to electric vehicle adoption. The substation team is refining the scope for potential upgrades, focusing on modeling theoretical power from wind and solar sources, integrating these into the ISU microgrid, and ensuring space availability for future substation expansions. We met with Jon Flemming, who provided insights on the campus power plant's operations, power reliability challenges, and renewable energy integration. Our next steps include finalizing substation details, generating new upgrade ideas, and preparing for a meeting with industry advisors to solidify our plans. The team remains focused on enhancing grid reliability, incorporating renewable energy, and ensuring long-term scalability and cost-effectiveness for the ISU campus power system.

### **o Past week accomplishments**

- **Transmission Team (Substation):** This past week, the transmission team made significant progress, with 2 out of 3 members attending the meeting with Jon Flemming. During the meeting, we gained valuable insights into ISU's power plant operations, redundancy systems, and the potential for future load growth, particularly with the integration of electric vehicles. We also learned which substation is connected to the Microgrid (Haber Rd.). The team also continued refining our project scope, focusing on understanding campus distribution and transmission challenges. We are now preparing to incorporate these insights into our designs and finalize the scope for future upgrades to improve grid reliability and scalability.
- **Distribution Planning Team:** As a team we have been working on building our load profile from the data we received last week. We're working on using real-time data to help

understand the 2023 historical data. The real-time data is helping us understand how much power each individual building is using, and what the power usage per hour looks like.

o **Pending issues**

- Transmission Team (Substation): The transmission (substation) team currently faces a few pending issues. We need to finalize the substation design scope, particularly concerning redundancy improvements, and assess potential upgrades despite the existing redundancy in the system. Additionally, we must gather more detailed fault current data and complete grounding studies for the microgrid tie-in to ensure reliability and safety. Scheduling a meeting with our Substation/T&D advisors is also a priority to address these concerns and finalize the substation upgrade strategy. Lastly, we need to generate new ideas for substation enhancements that align with future campus load growth and renewable integration.
- Distribution Planning Team: The distribution team currently has no pending issues.

o **Individual contributions**

<b><u>NAME</u></b>	<b><u>Individual Contributions</u></b>	<b><u>Hours this week</u></b>	<b><u>HOURS cumulative</u></b>
Sean	This week we met with Jon Fleming. He knows a lot about the campus microgrid. I led the meeting and took notes. I also consolidated the notes taken by MacKenzie with my notes. I am organizing a time to meet independently with our substation advisors to create a concrete roadmap for the rest of the semester.	5	14
Bethany	This week I've been working on building our load profile from the data we received last week. We received the 2023 daily total BTU for the entire campus. I've been going through and collecting information about the total BTU per square foot of each building on campus. From there, I'm using the square footage to find the total BTU usage of the building. All of this will help to provide the breakdown of how much power each building uses and how to model this with the 2023 historical data.	5	21
Thomas	Reviewed the notes that Sean and	4	20

	<p>MacKenzie took from the meeting with Jon Fleming. Took that information, looked at what would be useful for the distribution side, and then began researching how a ring configured distribution network functions and what separates it from the more typical radial systems.</p>		
Nathan	<p>I have attended all Senior Design meetings in the last week, including the one with Jon Fleming. From that meeting and Sean and Mackenzie's notes, I obtained a better understanding of how the campus microgrid operates and a better scope of what the distribution team will need to do. I have begun researching underground protection devices we can integrate into the university microgrid.</p>	5	18
Mina	<p>This week I have gone to all the meetings. I was not able to attend the Jon Fleming meeting since I was traveling to Ceder Rapids, but I read the meeting minutes. I have also done some research on my own time to get a better idea of the steps moving forward.</p>	5	18
MacKenzie	<p>I have been actively involved in the senior design project this week, attending all meetings, including the recent session with Jon Flemming. I have kept detailed minutes of each meeting, ensuring that they are promptly shared with both the project advisors and team members who were unable to attend. Additionally, I have contributed to discussions by asking insightful questions, helping to redefine the project scope, and ensuring that all necessary information is documented and circulated for continuous team alignment. I have also started on the one-line diagram for the Substation in ACADE.</p>	5	23

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: The substation team will meet with our advisors to finalize our deliverables. I would like to start on modeling the current state of the substation now that we know where it is and how it works.
- Bethany: I will continue to work on building our load profile information as well as schedule a meeting with Adam Arnold to go over all of this data.
- Thomas: I will with Bethany and Nathan to convert the load data from FPM into a per-building load estimation. Also, I plan to help schedule a meeting with Adam Arnold (Distribution team contact) to go over the load and talk about how to transition that data into a model.
- Nathan: Working with Bethany and Thomas, we will move building load data from the facilities planning website to another location to analyze the data. We will meet with one of our industry advisors to determine what we can accomplish once we get all the loading data finalized.
- Mina: For the next week, I will attend every meeting, including the internal meeting with the substation advisors. I will contribute as much as possible. I will also keep digging and gathering as much information so I can contribute as much as I can.
- MacKenzie: For the upcoming week, I plan to continue attending all senior design meetings and contribute to discussions on refining the substation and transmission team's project scope. I will work on organizing a meeting with the Substation/T&D advisors to address any outstanding issues and gather insights on potential upgrades. I will also continue to keep detailed minutes of each meeting and share them with our advisors and any team members who were unable to attend. Additionally, I will focus on further developing the one-line diagram, ensuring it accurately reflects our project updates and theoretical power integration. I plan to assist in generating new ideas for substation redundancy improvements and incorporating any feedback into our project strategy.

o **Summary of weekly advisor meeting**

10/16 Meeting with Client (Adam Arnold, Emily Straub, Jennalee Dickson):

At this meeting, we discussed the last two weeks of progress with the client. The main focus was the recap of the meeting with Jon Fleming, an Iowa State professor who has close ties with the campus utilities and knows how the system operates. We discussed the layout of the campus grid, how the system is in a ring alignment and mostly underground,

making that aspect of upgrades relatively slim since the underground systems tend to be stronger and less likely to fault. From a more specific substation side, the team talked about further defining the scope and meeting to ensure that any planned upgrades would be useful and not redundant from previous efforts. From the distribution side, the team discussed the viability of OpenDSS and determined it would be useful to use going forward. They also talked about the data received from ISU Facilities Planning and Management, and the goal of developing the daily data from 2023 into a per-building load to move forward with the OpenDSS model of the network.

Meeting w/ Jon Fleming - 10/11/2024

### **Campus Power Plant Overview:**

- Jon provided a quick run-down of the campus power plant, mentioning that we might not fully understand its workings based on the questions we asked.
- The plant operates with 5 boilers (previously coal, now burning natural gas), producing 400-pound steam, which is then sent to 3 turbine generators (around 40 MW combined output).
- ISU-generated power is 11.1 MW, and we currently purchase 8.6 MW from the grid.

### **Real-Time Data:**

- Real-time data on campus utility operations can be accessed via [Utilities Power Plant Data](#). This could be useful for the distribution team.

### **Power and Steam Distribution:**

- The plant extracts 90-pound steam for campus distribution (used for heating, research, water heaters, etc.), with additional steam driving both steam and electrical chillers.
- Peak campus power demand is around 19.8 MW, typically reaching into the mid-20 MW range during summer (max is in the lower 30s). The campus also has a contract to purchase wind power through the city (6 MW worth of wind generation).

### **Power Reliability and Redundancy:**

- ISU has reliable power as long as the city does, but campus turbines only provide about half of the needed power.
- There was a 10-hour power outage during the 2020 derecho when city power was lost, causing campus turbines to trip due to an inability to shed load fast enough. The plant does not have black start capabilities, requiring external power for restarting.

### **Power Outages and Contingency Plans:**

- In the event of an outage, ISU purchases electricity from the city at an industrial rate. Some

buildings have emergency diesel generators for critical systems.

- Power outages can be costly, mainly impacting research facilities that require continuous power, such as greenhouses or deep freezers.

#### **Microgrid and Distribution:**

- The campus operates on a ring system, allowing power redistribution if faults occur.
- Notably, Vet Med has its own steam and chilled water system and is not on the main campus microgrid. New Vet Med buildings are also independent.
- ISU cannot act as a utility to private contractors, so the CyTown project will be powered by the city grid.

#### **Renewable Energy Integration:**

- Jon mentioned that while ISU used to have a wind turbine on campus and has a small 20kW solar array, they don't significantly impact the microgrid. Solar power is not financially viable for ISU, as it would reduce purchased power from MISO, which is already obtained at low rates (3-4 cents/kWh).
- Small modular nuclear reactors were suggested as a future option for reducing carbon emissions, as they could integrate into the existing steam and electrical infrastructure.

#### **Future Projects and Potential Upgrades:**

- Jon was unsure of any proposed projects for upgrading the microgrid but mentioned past ideas like solar panel installations. He noted the difficulty of integrating solar due to voltage conversion and distribution challenges.