Tidal Variation: A Unique Challenge for Ferry Electrification in Alaska

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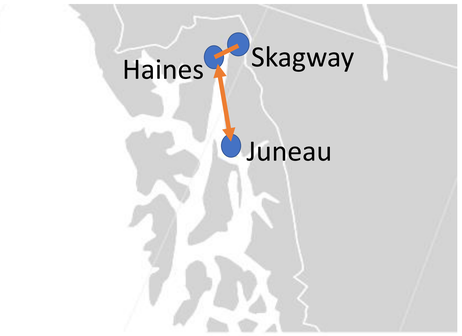

Figure 1: Considered routes in Southeast Alaska.

Project Goals

- Identify charging infrastructure options to accommodate Alaskan tidal variation
- Consider possible effects of electric ferry infastructure on the grid.
- Create connections and help establish a dialogue around electric ferries in Southeast Alaska

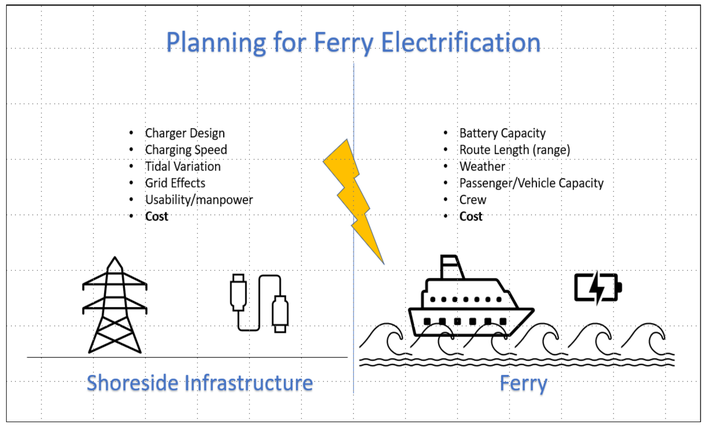

Figure 2: The variables behind electric ferries.

Background

Due to the size, population density, and geographical layout of Alaska, many small island-based communities rely on the ferry system to connect them to regional hubs and the mainland. These ferries will continue to provide essential services for the foreseeable future. Therefore, innovation and modernization within the fleet is critical to keeping coastal communities stable. This project was born out of an interest in marine electrification and the unprecedented political and financial support for electrifying ferries in Southeast Alaska. For years, countries and states around the world have worked to electrify ferry routes to reduce costs and emissions within the industry. With federal money allotted to bring this technology to Alaska, this project aims to provide a basic assessment of the unique challenges in the state, and to expand communication around this opportunity.

High Tides Require Custom Chargers

My first step was to consider which routes were the most accessible to electrification. After some research, I decided to use the Juneau to Haines to Skagway route as shown in figure 1 as the baseline for my studies, because the route includes one of the shortest routes (Haines to Skagway) and a critical connection to a regional hub (Haines to Juneau) for the two smaller communities. The port of Seattle was used as a benchmark for where electric ferries already operate in the United States. With my target route in mind, I consulted Alaska Marine Highways Service (AMHS) employee Dan Askins about what he thought was one of the biggest unknowns in Alaskan electric ferry development. He thought that our state's unique tidal range and effects on the ferries' charging system may be one of the largest and least-studied hurdles to ferry electrification. Thus, the first portion of the project was based on reading and using python software to analyze tidal data from NOAA. Eventually, I was also able to meet with companies that design electric ferry charging stations and discuss parameters including tidal range.

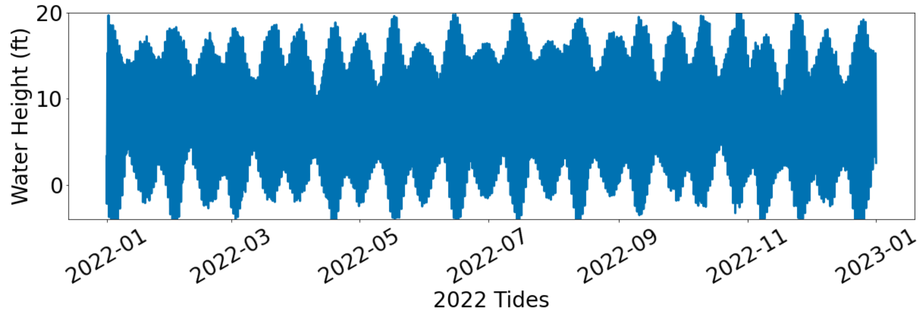

Figure 3: 2022 NOAA tidal data from Taiya Inlet Station (Skagway).

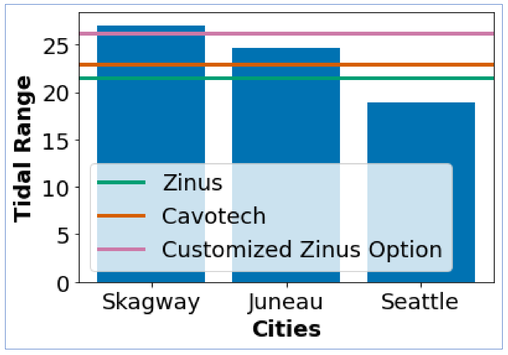

Figure 4: Tidal range in selected cities and manufacturer tidal adjustment standards.

Results

The tides in Juneau and Skagway ranged from -6.5 to +20.4 feet in 2022. This is a 26.9-foot range. Monthly analysis shows that the range stays uniform for all 12 months in both ports, and that the tidal range is similar at both locations (likely due to proximity). The Seattle port shows a tidal consistency like the Alaskan ports. However, the tidal range is smaller: -4 ft to +15 ft. Zinus and Cavotech were the two main resources I had for manufacturer data. As seen in figure 4, neither company currently has a system designed to meet Alaskan tidal ranges. However, the Zinus representative did mention that customizing systems is a possibility.

Modeling a Grid Friendly Solution

For the second phase of the project, I have begun studying the use of Power Factory models to look at possible shoreside impacts of charging an electric ferry. I am planning to use an IEEE 13 load feeder model to represent the shoreside grid, and to design an adjustable quasi-dynamic battery system. Then, I will adjust the parameters of the battery system to see how different sizes and charging speeds effect grid behavior.

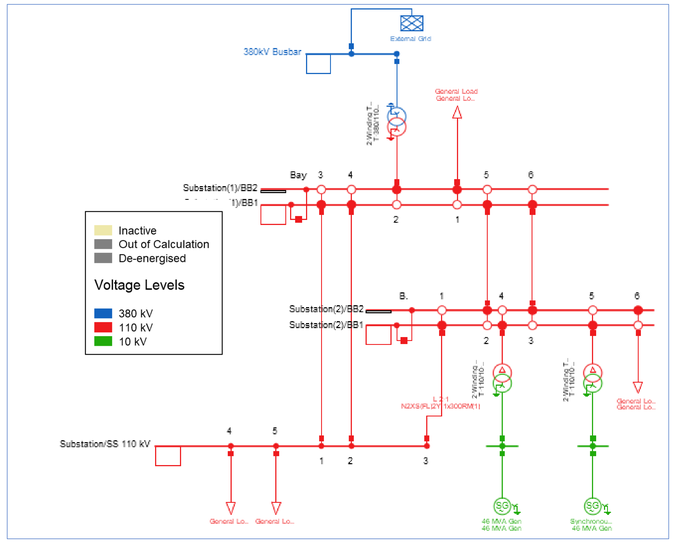

Figure 5: A sample model from PowerFactory software.

Conclusion

In general, tidal variation is accounted for in most forms of electric and hybrid ferry infrastructure. However, Juneau and Skagway have a much higher tidal variation than places where the infrastructure is currently in place. The two Alaskan ports of Juneau and Skagway both had tidal ranges more than 24 feet, while Seattle only has a range of about 19 feet. Similarly, the companies that supply the charging infrastructure both advertise a tidal adjustment of under 23 feet. A Zinus sales associate stated that they could accommodate a 26 ft tidal range with some modifications to their tower and customize the designs to meet more extreme specifications. Additionally, conversations with people around the project have led me to believe that the wheels are in motion for this conversion to take place. The Southeast Conference has recently received a finished feasibility study from the Elliot Bay Design Firm and is strongly positioned to consider the idea of electrification. In the end, my studies have shown that like many Alaskan projects, ferry electrification will pose unique challenges. However, it is also safe to say that the innovative power of Alaskan minds working together will allow us overcome these challenges to create a cleaner ferry system.

Acknowledgements

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