COMMUNITY APPROPRIATE SUSTAINABLE ENERGY SECURITY (CASES) PARTNERSHIP

Final Report

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Introduction

Alaska cannot be easily described or succinctly depicted; the immense size of the state harbors a multitude of climatological, environmental, and cultural niches exhibiting many similarities and also significant differences. From towering mountains with raging rivers to expansive valleys speckled with lakes, Alaska's ecology is diverse and wild. As a result, the indigenous communities of Alaska that dot the landscape are numerous and unique, each having adapted to thrive in and coexist with their local environment. Even with their disparities, all such communities face a common threat: climate change. With rising sea levels, accelerated coastal erosion, and changing behaviors of animal populations, anthropogenic climate change has the most direct effect on rural areas. The paradox is that these communities most affected are also the most reliant on fossil fuels, an outdated and unsustainable source of energy in such remote towns. While infrastructural improvements in the energy grid must be promoted to facilitate self-sufficiency, solving the issues of climate change one community at a time is not efficient. It is for this reason that knowledge-sharing and cooperation are key to understanding specific, local needs while also providing a broad platform from which to initiate the implementation and management of sustainable energy solutions.

Purpose

The Community Appropriate Sustainable Energy Security (CASES) Partnership is an international research initiative hosted by the University of Saskatchewan and involves Alaska, Canada, Norway, and Sweden. It is focused on understanding and sharing local experiences to broker the knowledge and capacity for the design, implementation, and management of renewable energy systems. With 15 indigenous and northern communities involved in the project, the goal is to eliminate redundancies so those experiencing similar challenges have a template from which to extract solutions. The multiyear project is split into phases; the summer of 2020 is focused on Phase 1, which involves building community energy profiles through hard data searches coupled with community member interviews. The focus of the Alaska Center for Energy and Power (ACEP) internship was the town of Galena. Phase 2 will (start next year? happen in other communities?)

Methodology

Phase 1 of the CASES initiative is structured around a data collection template and an interview questionnaire, both of which were provided by the University of Saskatchewan. The first few weeks of the internship were spent searching for data; this involved uncovering the sources as well as the necessary methodology for extracting the required information. As the initiative involves a plethora of communities, it became clear that a centralized tool must be built to streamline data collection, simplify data processing, and create useful visualizations for end users, who can be researchers, energy planners, or community members.

As the summer progressed, the tool took on two forms: a Microsoft Excel document and a website. The large Excel file, along with a detailed how-to document, outlines the necessary steps to collect and store energy data for an Alaskan community of choice. Contained within the file are automated functions that process and visualize the data, as well as auto-populate the original CASES template. The website is being developed specifically for end users who may be uncomfortable or unfamiliar with the Excel interface.

With Galena being the primary town of interest, I have been in extensive contact with Tim Kalke of Sustainable Energy for Galena, Alaska (SEGA), who has been a partner of ACEP and CASES, and has helped tremendously with data collection and the interview process. The focus of the partnership has been the biomass project for the Galena Interior Learning Academy (GILA); as part of the internship I built an Excel tool to analyze and visualize GILA heat data from raw BTU meter readings and have assisted with coordinate mapping for the regeneration harvest surveys. The initial plan for the internship involved the intern spending time in Galena to obtain firsthand experience with the biomass installation and personally assist with community projects; due to the coronavirus pandemic, all such plans were cancelled, and internship format was restructured to be entirely online based.

Results and Discussion

The CASES project required eclectic community data to build a profile: general community characteristics, socio-demographics, climate, energy cost, fuel storage, fuel use, as well as electric and heating consumption/generation. For information on Alaska communities, specifically Galena, public sources were sufficient to obtain most community information (Table 1). Combined heat and power (CHP) and detailed housing information were the only parameters unavailable in public sources and are subsequently the most difficult to obtain. In general, CHP data would need to be requested from the utility; in the case of Galena, the utility did not record CHP information.

From these data a community profile for Galena was formed; within the template, all that is required of the end user is to paste the information from the source, with the data process and visualizations being created automatically. Figures 1-4 serve as examples of the plots produced in the Excel template. The benefits of such a tool are numerous: specifically for CASES, the Excel file streamlines and simplifies the creation of a community profile; for members of a community, it provides an easy-to-use structure for obtaining and summarizing energy data, which can be used for kickstarting sustainable energy projects or energy efficiency measures; and for the general energy research community, such profiles supplement existing datasets on energy use in northern and indigenous communities.

In addition to the CASES work, heating information was obtained from visualizations of GILA building BTU data (Figures 5-6). Energy audits have been done on a few of the buildings within the campus that were known to be improperly insulated, but as data is collected on all GILA buildings, having a centralized data entry and visualization platform will be useful for monitoring energy efficiency measures that plan to be implemented in the future. As these facilities are partly heated with biomass during the winter months, it will become especially important to apply energy efficiency projects to allow the yearly harvest of biomass to not exceed the regenerative capacity of the local forest.

The final project of the internship involved mapping coordinates for sampling regeneration rate within the harvest boundaries in QGIS (Figure 7). First, the harvest areas were identified and traced, after which a point grid was layered within each boundary, with specifications of having a minimum 200 ft. distance between points. These points will serve as the sampling locations, with the goal of eliminating the need for field employees to calculate the minimum required distance between samples.

The most technologically challenging aspect of the internship was the development of the website, which is still ongoing. The purpose of the website is to allow individuals with limited technical ability to be able to obtain and comprehend energy data for their community. The web development framework used to create the website was Django and the visualizations were done using a Bokeh library. While individually, Bokeh is an intuitive and simple tool for visualizing data in a web browser, converting high-level Python objects (such as plots and widgets) into JSON for viewing, it does so through a separate Bokeh server. The most difficult and error-inducing aspect of the project was incorporating dynamic Bokeh plots into a Django server without use of the Bokeh server, which required converting Python code into JavaScript. Through long, arduous searches in help forums and the help of Tawna Morgan, a PSI programmer with ACEP, many of the issues have been resolved and the functionality of the site continues to grow.

Conclusion

The goal of the ACEP internship was two-fold: provide the University of Saskatchewan with a CASES community profile for the city of Galena, and to assist Tim Kalke with projects relating to the biomass initiative and the GILA campus. The general Excel template and website that I created serve the first purpose: they allow for simple, streamlined data collection and visualization for any Alaskan community of interest to the CASES initiative and simultaneously can serve to encourage any community interested in sustainable energy projects to gather the necessary data and understand their own energy consumption and needs. The next step with regards to the template would be to configure the file to be useful for non-Alaskan communities.

I will be in contact with Vikas Menghwani, a postdoctoral researcher at the University of Saskatchewan, who plans to further the work I have done to include Canadian participant communities. The analysis of GILA heat data and creation of a regeneration harvest survey map fall within the scope of Galena-specific tasks for Tim Kalke. Now that the raw BTU data for GILA buildings is centralized and readable, the next steps involve accurate data collection on the amount of biomass currently necessary to supplement the diesel boiler in the winter. Next, it would be beneficial to brainstorm energy-efficiency measures, specifically in facilities with poor insulation, to minimize wasteful usage of harvested species.

Acknowledgements

I would like to thank ACEP, and especially Heike Merkel, for the wonderful opportunity to pursue an internship in renewable energy while having a background in biology. The connections I formed and experience I gained during the summer are incalculable in their value and will serve as an important precursor to my master's program in Sustainable Energy Systems in the fall.

I would also like to express my gratitude to Heike Merkel, Patty Eagan, and Eric Goddard for the extremely difficult task of transforming the internship into an entirely online endeavor. With the onset of the COVID-19 pandemic, it took incredible creativity and resilience to adjust to the circumstances, maintain the integrity of the internship, and provide guidance and assistance to all interns throughout the summer.

I am extremely grateful to the Office of Naval Research for funding the project. I would also like to acknowledge my project team: Diane Hirshberg, Tim Kalke, and George Roe, whose weekly guidance, assistance, and task management were paramount to the success of the internship. Finally, I would like to extend my gratitude to Tawna Morgan, whose coding prowess and error analysis were indispensable during the initial production of the website.

References

Alaska Energy Authority. (2012). *Alaska Energy Authority End-Use Study: 2012*.

Colt, S., Goldsmith, S., Wiita, A. (2003). *Sustainable Utilities in Rural Alaska: Effective Management, Maintenance and Operation of Electric, Water, Sewer, Bulk Fuel, Solid Waste.* Final Report. Institute of Social and Economic Research.

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Roe, G. *Estimating Alaska Community Heat and Power Requirements*. Unpublished.

Appendix: Tables and Figures

Table 1 A summary of the information gathered for the CASES profile and the corresponding data source.

Parameter	Data Source	URL
Community characteristics	DCRA Open Data	https://dcra-cdo-dcced.opendata.arcgis.com/#data
Socio-demographics	ACS Estimates	https://data.census.gov/cedsci/
Climate	1) NOAA Local Climatological Data 2) xmACIS2 Climate	1)https://www.ncdc.noaa.gov/cdo-web/datatools/lcd 2) https://xmacis.rcc-acis.org/
Energy cost	1) AK Energy Data Gateway (PCE) 2) Alaska Affordable Energy Model	1) https://akenergygateway.alaska.edu/guided_search/#1 2) http://model-results.akenergyinventory.org/current/index.html
Fuel storage	DCRA Open Data	https://dcra-cdo-dcced.opendata.arcgis.com/#data
Fuel use	AK Energy Data Gateway (PCE)	https://akenergygateway.alaska.edu/guided_search/#1
Electrical consumption	AK Energy Data Gateway (PCE)	https://akenergygateway.alaska.edu/guided_search/#1
Electrical generation	AK Energy Data Gateway (PCE)	https://akenergygateway.alaska.edu/guided_search/#1
Heating consumption	Alaska Affordable Energy Model	http://model-results.akenergyinventory.org/current/index.html
Combined heat and power	N/A	N/A

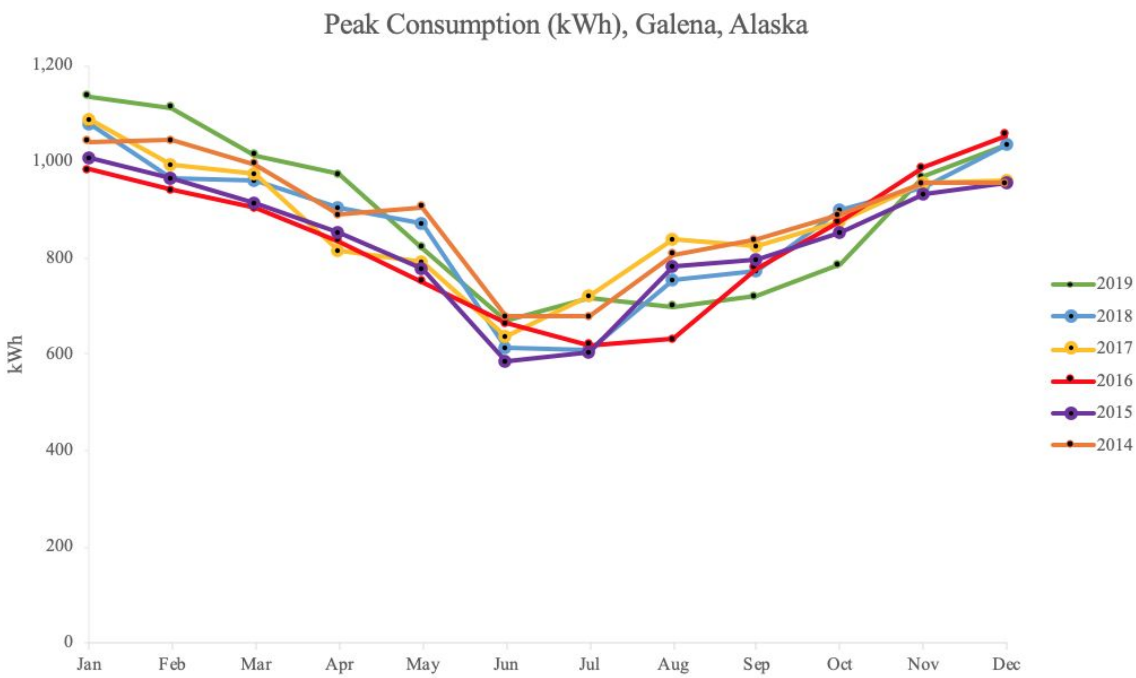

Figure 1. Peak electrical consumption (kWh) by month in Galena, as reported by the utility.

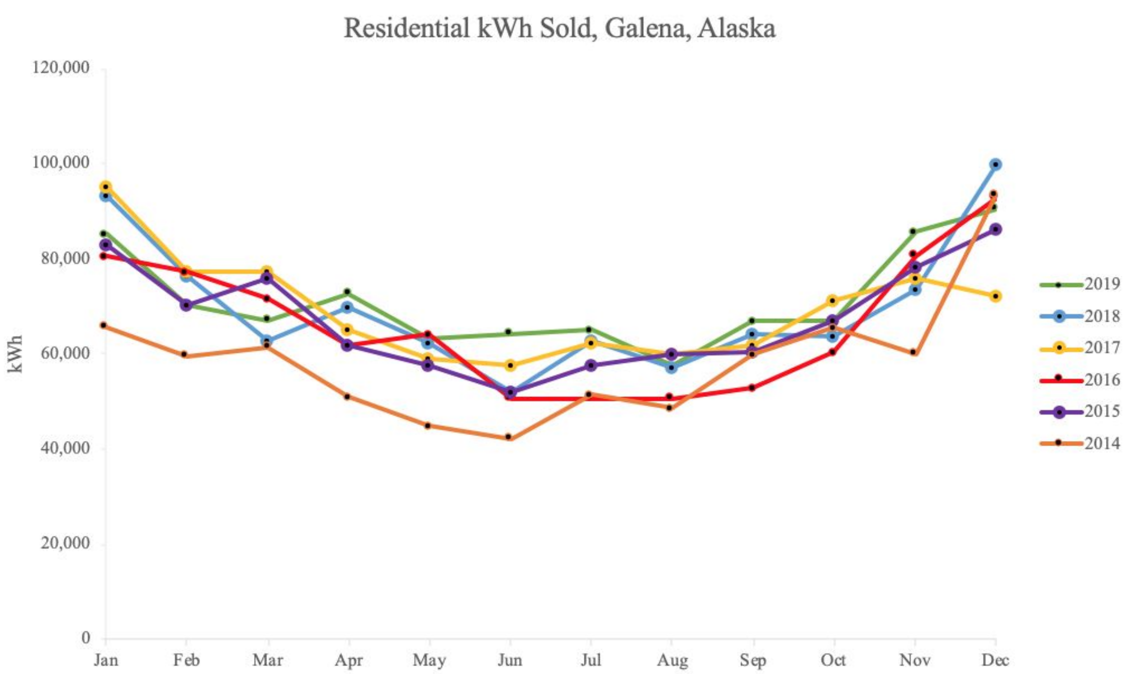

Figure 2. Monthly kWh sold to residential customers by the utility.

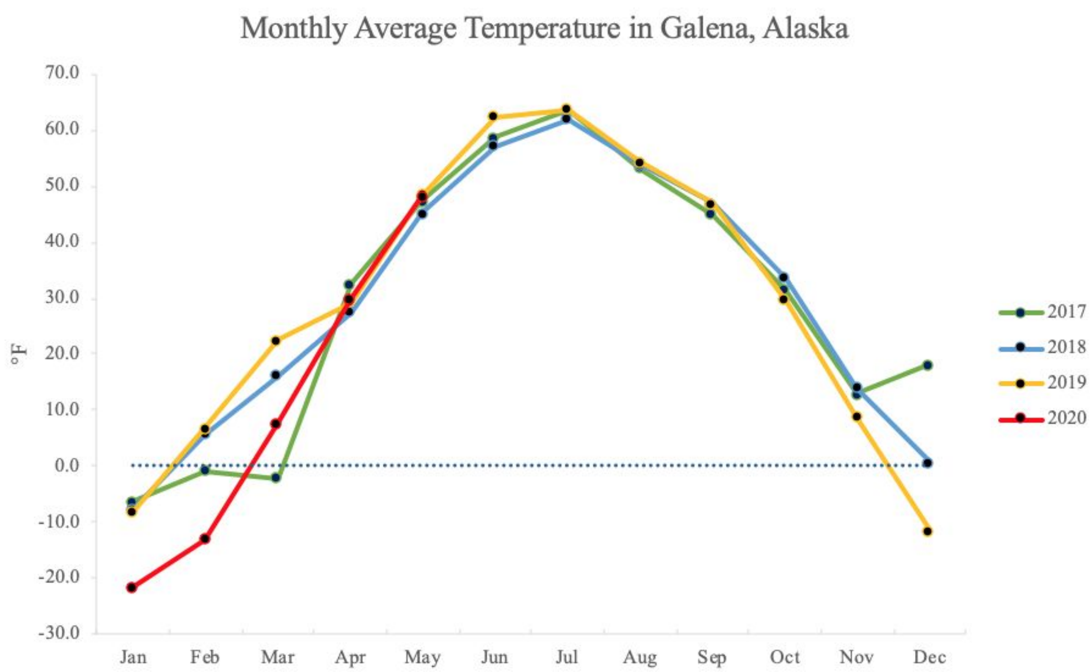

Figure 3. Average monthly air temperature in Galena for select years.

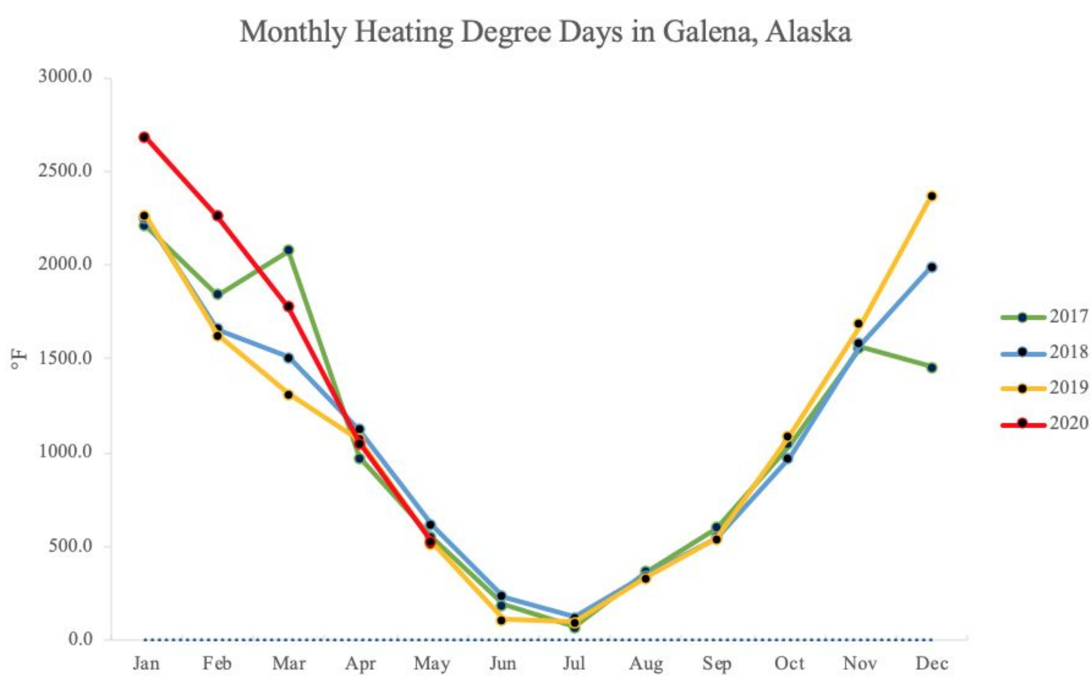

Figure 4. Total monthly heating degree days in Galena, formulated based on a 65 °F baseline.

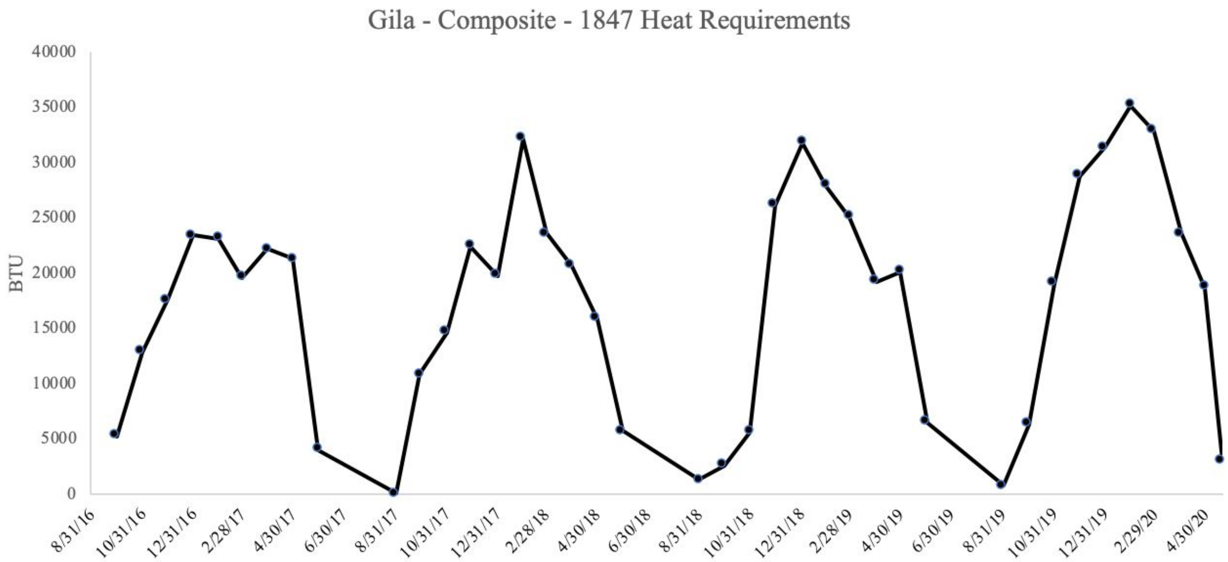

Figure 5. Heat data of the Composite building within the GILA campus. BTU readings span 2016-2020 and show a predictable seasonal heating profile.

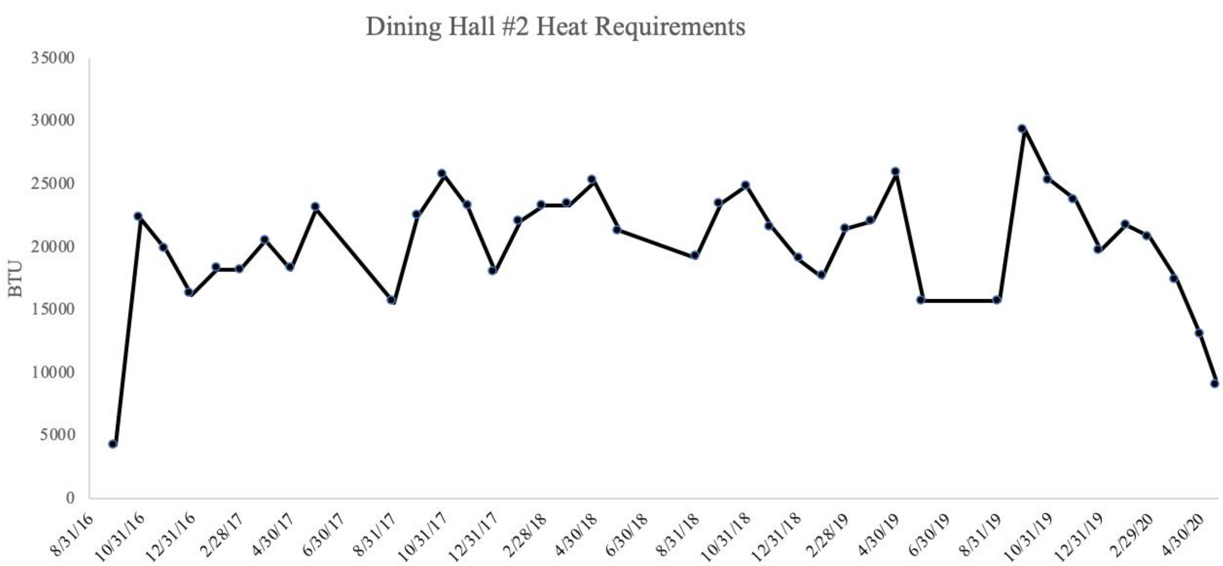

Figure 6. Heat data of Dining Hall #2 within the GILA campus. Compared to Figure 5, the heat profile does not vary significantly with season, indicating poor insulation and low energy efficiency.

Figure 7. QGIS map of harvest areas with sampling points identified within each boundary.