

# CS486C – Senior Capstone Design in Computer Science

## Project Description

<b>Project Title:</b> NAU building energy dashboard and analytics platform	
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### Project Overview:

Current developments and technologies in data science have led to numerous useful applications in energy, healthcare, business, and many other domains. For the last several years, NAU has been collecting a trove of raw data related to its buildings, which can help NAU analyze the operation and energy performance of the buildings, potentially leading to significant improvements in energy usage, cost saving, waste minimization, and the sustainability of the campus. The data is also being used for research and teaching at NAU.

Recently, NAU formed several Environmental Caucus Action Teams with the missions to promote sustainable solutions and work to reduce waste and climate impact at NAU (<https://nau.edu/environmental-caucus/action-teams>). The Energy Action Team (EAT) works closely with the university, in particular NAU Facility Services, and faculty, staff, and students to improve the energy efficiency and reduce the emissions of our campus. The collected data on NAU buildings will play a crucial role in achieving the sustainability goals of the EAT and the university.



However, the full potential of the data has not been realized yet, due to two major shortcomings:

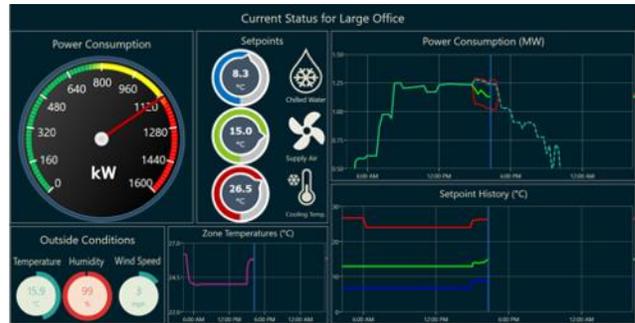
1. Lack of an intuitive and useful energy dashboard: though NAU currently has an energy dashboard for the residence halls, the dashboard interface is not intuitive nor appealing to users and has functionality issues. Furthermore, data querying and visualization are limited. These restrict the usefulness of the dashboard for everyday operation of the campus buildings.
2. Lack of predictive analytics capability: data is only useful if one can extract valuable information from it and analyze it to deduce useful conclusions. This requires the capability to perform data-driven predictive analyses and present the results in an intuitive and useful way to users.

### Objectives

The goal of this project is to overcome these challenges by developing an *NAU building energy dashboard and analytics platform*. We envision that the software platform will have the following key features and components:

- Backend: the backend will need the following functions:

- Pull in raw data seamlessly from the NAU building data server or directly from the meters.
  - Pre-process raw data to remove / replace missing data points and outliers, fix inconsistencies in time stamps, etc. The results are clean and valid data, stored in databases.
  - Perform several (statistical) calculations and analyses on the data.
  - Train machine learning models of certain features of the building data, and use these models for predictive analyses. Examples of models are: linear/nonlinear regression models, neural networks, gaussian processes.
  - Send notifications based on data analysis.
- Frontend for energy dashboard and analytics: a web-based frontend with the following features:
- User-friendly search, query and download of the building data.
  - Modern and intuitive visualization of data: interactive graphs and tables.
  - Intuitive presentation of predictive analytics.



The software will be used by NAU Facility Services (including building operators, campus planning personnel) and NAU faculty and students working on projects that can benefit from the building data.

### Impacts

If successful, the software will have a big impact on the operation of the campus buildings to improve our energy efficiency, reduce our emissions, save our energy cost, and ultimately achieve our sustainability goals. Not only will it make the existing NAU building data more useful, it will also aid NAU Facility Services in monitoring the buildings, understanding the campus' energy performance and characteristics, and making well-informed decisions regarding our energy efficiency, cost, and emissions.

### Knowledge, skills, and expertise required for this project:

- Programming and software development skills for modern web interfaces and databases.
- Basic knowledge of data processing and statistics. Knowledge of or willingness to learn programming tools for data processing and statistical computation. The programming language(s) and tool(s) will be determined by the student team.
- Knowledge of or willingness to learn basic machine learning and programming tools for machine learning. Expertise and good programming skills in this area are big pluses.

### Equipment Requirements:

- There should be no special equipment or software required other than a development platform and software/tools freely available online.
- Access to the NAU building data and servers, as well as the existing building management software at NAU, will be provided by the sponsors and NAU IT services.

### Software and other Deliverables:

- The software applications as described above, deployed and tested successfully with real data. Must include a complete and clear User Manual for configuring and operating the software.
- A strong as-built report detailing the design and implementation of the product in a complete, clear and professional manner. This document should provide a strong basis for future development of the product.
- Complete professionally-documented codebase, delivered both as a repository in GitHub, BitBucket, or some other version control repository; and as a physical archive on a USB drive.