AMERICAN UNIVERSITY OF BEIRUT

Schedule-Based Automatic HVAC System Control

EECE 502 PRESENTATION

OPTISCHEDULE

ADVISED BY MR MOHAMMAD KHALED JOUJOU

Project #89

Meet our team

ABED KARIM NASREDDINE

CCE (Software Focus)

ELIE MINA

CCE (Software Focus)

KARL AL SKAFF

CCE (Software Focus)

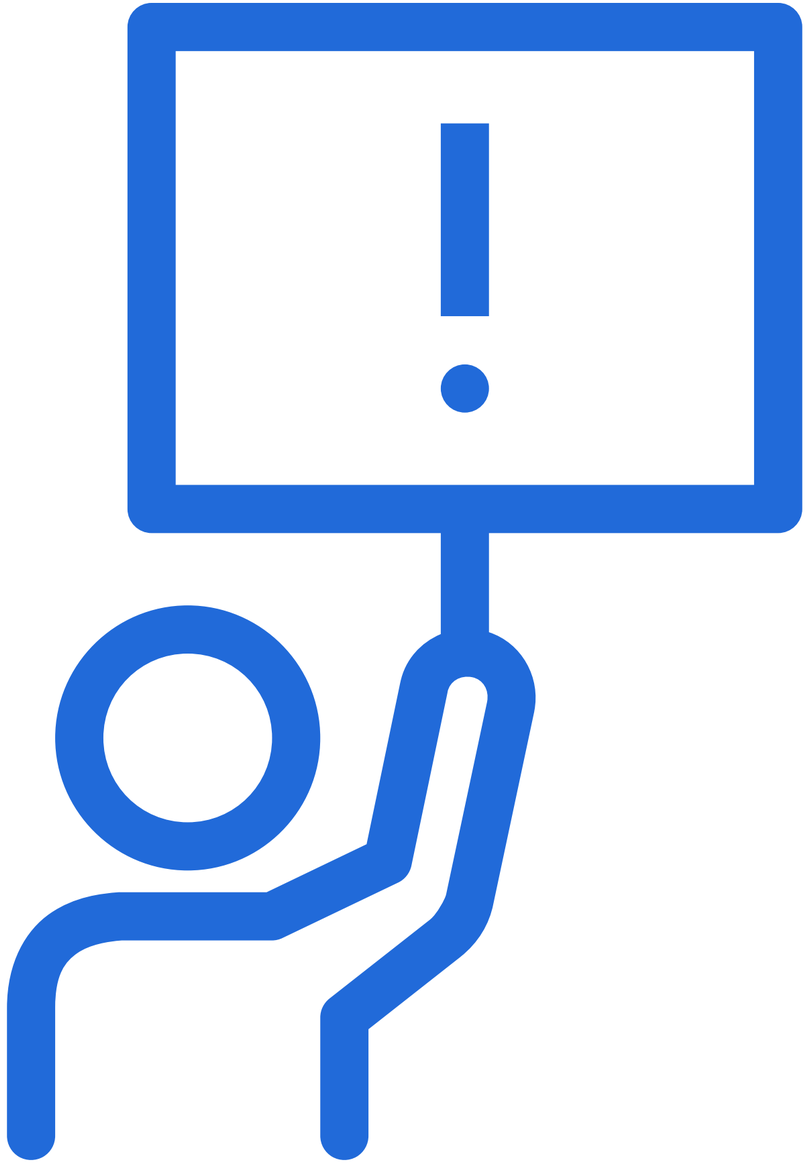
FADI ABDALLAH

CCE (Software Focus)

OPTISCHEDULE

Motivation and Desired Needs

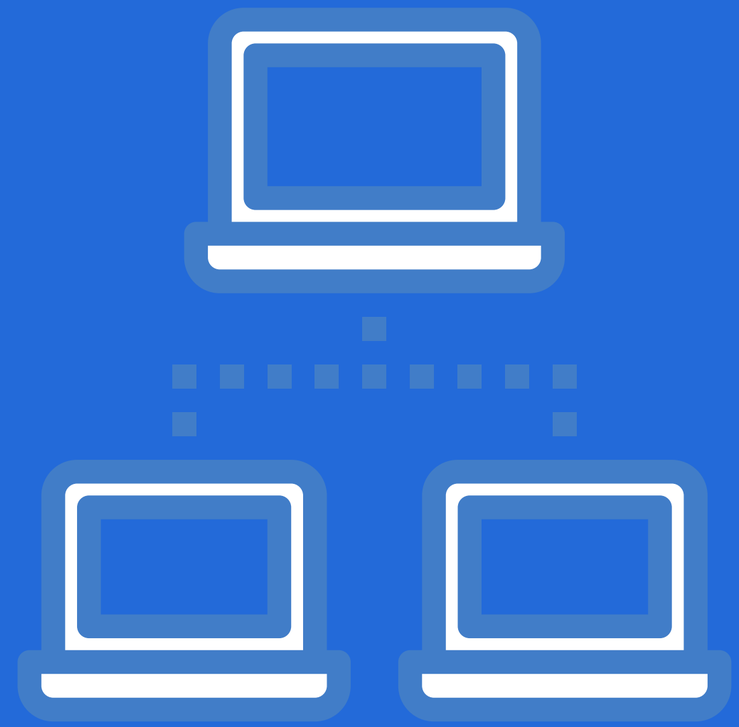
- Reduce energy waste in Bechtel building
- Reducing the operation cost of the American University of Beirut and provide additional financial support .
- Escape the rigidity of traditional building management systems with our app, which gives you dynamic control over your HVAC system.
- Reducing carbon footprint and contribute to a more sustainable future.



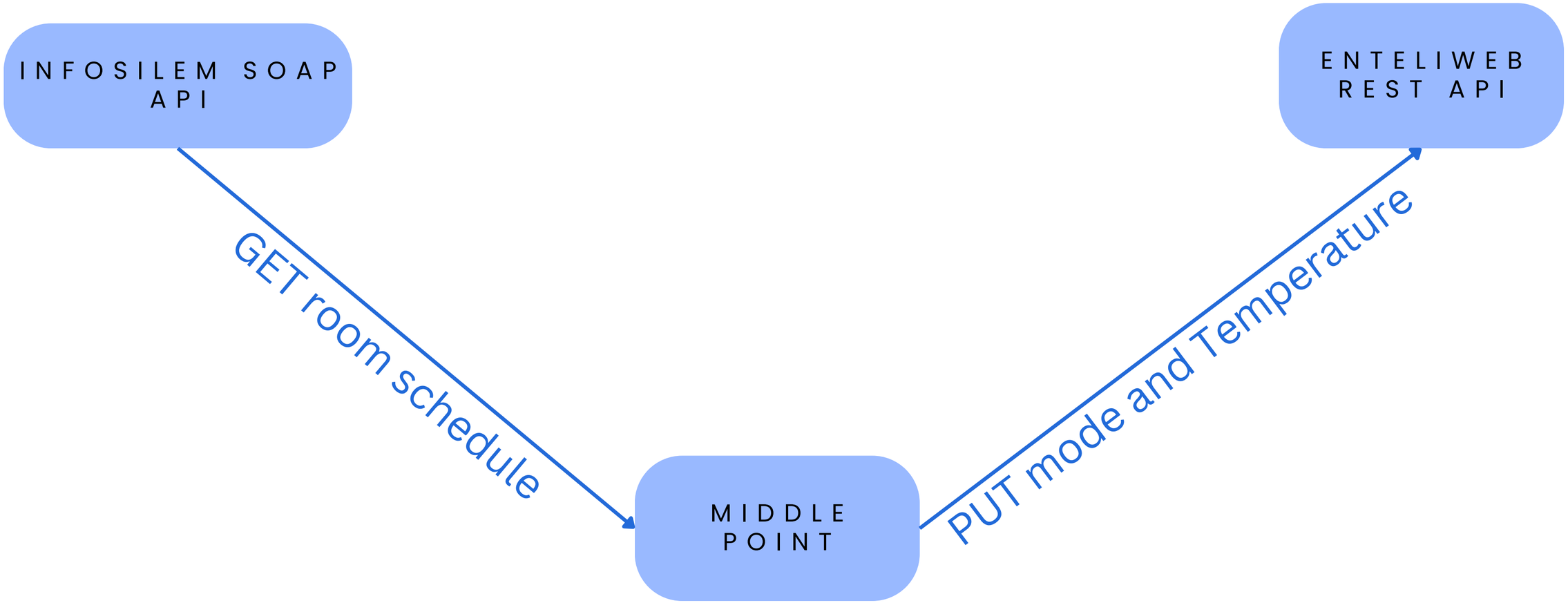
Deliverables

Our product is a web-based application that ensures coordination between two independent deployed tools at AUB:

- InfoSilem: room scheduling system
- EnteliWEB: Building Management System



Proposed Solution



Requirements and Specifications

- Capable of adjusting temperature and ventilation levels regularly based on room reservations
- Provide info about energy consumption and savings
- The system should be reliable and have a high level of uptime.
- The system should ensure the satisfaction and comfort of building occupants
- Compatible with the existing tools used at AUB
- User-friendly interface to adjust temperature and ventilation levels

Technical Constraints

01

S C A L A B I L I T Y

The system should be able to handle requests from more than 300 classrooms at the same time

02

R E D U N D A N C Y

The system should be able to operate in case of failure

03

I N P U T

The system should receive an XML file

Non-Technical Constraints

01

SUSTAINABILITY

The system should fulfill its task without compromising comfort of room occupants or energy savings

02

APPROVAL

The system should prove its efficiency, to get AUB's approval for deployment

03

USER FRIENDLY

The system should be easy to use and navigate

Literature Review - 1

Modeling user acceptance of building management systems

This paper examines the user acceptance of BMS

The concerns that the users have with BMS are:

- Efficiency
- Not easy to use

The paper concludes that BMS should require minimal human interaction by trying to achieve full automation of all tasks and should rely on simple control strategies

Literature Review - 2

Energy Savings from Temperature Setpoints and Dead band: Quantifying the Influence of Building and System Properties on Saving

The factors that influence the HVAC energy consumption:

1) Climate
2) Room size
3) Occupancy

Results are compared to a standard fixed setpoint of 22.5°C

Results showed that selecting the daily setpoint in the range of 1 °C to 3 °C above the baseline would result in an average savings of 7.5% to 16.4%.

DESIGN ALTERNATIVE 1

STATIC-TABLE APPROACH

SET POINTS TABLE

Static table that stores the optimal HVAC set temperatures according to different weather variables such a Temperature, Humidity.

WEATHER FORECAST

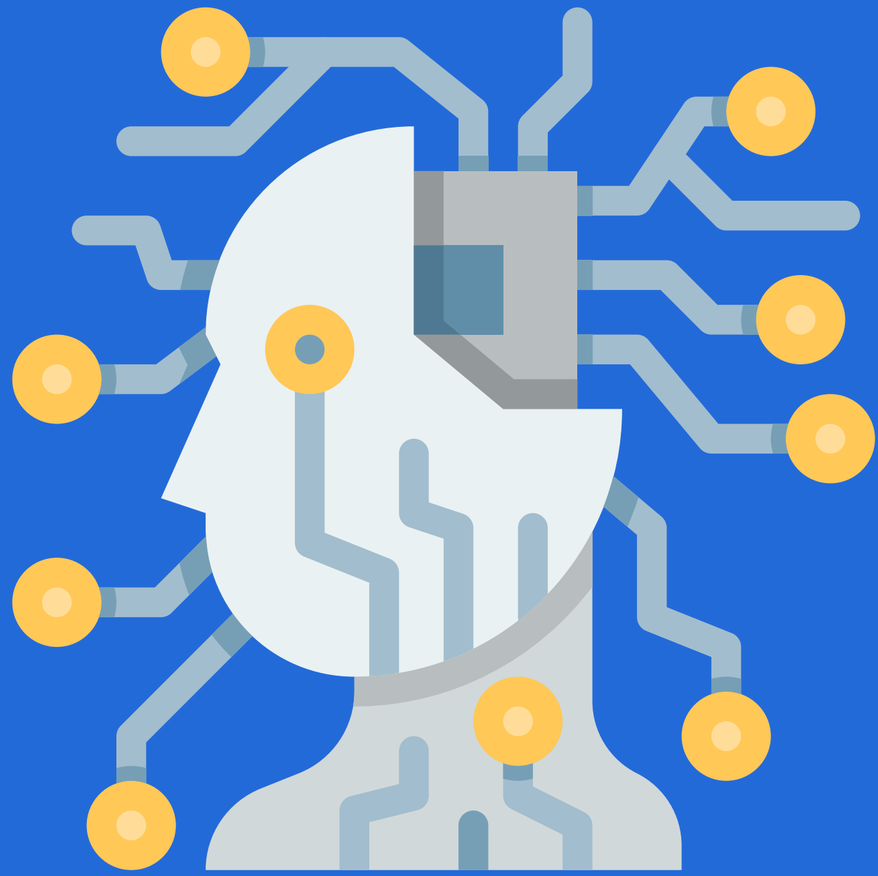
Third Party weather station to get specific weather data for AUB location

NODE JS

Ease of development , Axios Library , Support of REST API's and finally lightweight .

DESIGN ALTERNATIVE 2

Intelligent Model Approach



MACHINE LEARNING MODEL

Train a model to control HVAC temperatures not only based on forecast data weather but on user satisfaction .

PYTHON

The wide community, libraries and platform and the independence makes Python the right choice for such implementation.

USERS INPUT

We tend to collect users satisfaction data through Professors input on each session given

DESIGN DECISION

ALTERNATIVE 3

WEB INTERFACE

Admin is capable of controlling the desired set temparature of the HVAC system from a web app .

WEATHER PREDICTION

TThe software solution retrieves weather prediction data from an open source api in order to set the convenient set temperature

LOCAL DEPLOYEMENT

The application is hosted on a server allocated by the IT department being behind the main university firewall satisfying our security concerns

IMPLEMENTATION

1) REQUEST

- Provide valid user credentials to access the InfoSilem API.
- Request access token.
- Request/Response is done using "axios" library.

2) RESPONSE

- Schedule is received in XML format.
- Parse data from XML to JSON using "xml2js" library.
- Clean up the parsed code.

3) ITERRATIONS

- Reservations are looped over.
- In each iterration, a reservation is inspected after saving its:
  - Start and End Time
  - Room Number
  - Day of the Week
  - Reservation Start and End Date

IMPLEMENTATION

4) COMPARISONS

- Current Date is compared to Reservation Start and End Date.
- Current Day of the Week is compared with numDay array.
- Current Time is compared to Reservation Start Time and End Time.

5) LAST RESERVATION

- Before the last comparison mentioned previously, populate an object called "lastReservationOfTheDay" holding room numbers as keys and each key value is set to the last reservation of the day for that room.

6) HVAC SYSTEM CONTROL

- Once all comparisons match, HVAC system is turned ON.
- After 15 min of reservation end, the HVAC system is put into STANDBY MODE
- Loop through the "lastReservationOfTheDay" array to turn OFF rooms listed in this array after 15 min of reservation end.

IMPLEMENTATION

7) FUNCTION CALL

- All code concerned with HVAC system time scheduling is placed inside an async function called optiScheduleCaller().
- This function is called every 5 minutes using a useEffect react hook.

8) CHANGING VALUES

- All values of interest can be changed and are stored in a useState.
- After the form is submitted, these values are sent to a serverless API which includes all the logic mentioned previously with the extra options of calling PUT requests to the InteliWEB server.

9) OTHER FEAUTRES

- The UI was implemented using Flowbite based on Tailwind CSS.
- The smart weather prediction gets its value from api.nrel.gov
- All other features will be presented in our demo website.

Experimental Setup

RETRIEVING ROOM SCHEDULE

Tested the connection with InfoSilem and retrieved room schedule using SOAP API in the form of an XML file

CONNECTION WITH THE BMS

Tested the connection with EnteliWeb and modified the variables related to the Set Temperature and operating mode using REST API

AUTOMATING BOTH FUNCTIONALITIES

Tested the application as a whole, the work at this point is automated. The system is now automatically retrieving the room schedule and communicating the necessary information with the BMS

Experimental Results

ACCURATE BEHVIOR

The application was able to set the HVAC system into the correct mode and temperature based on the room reservations

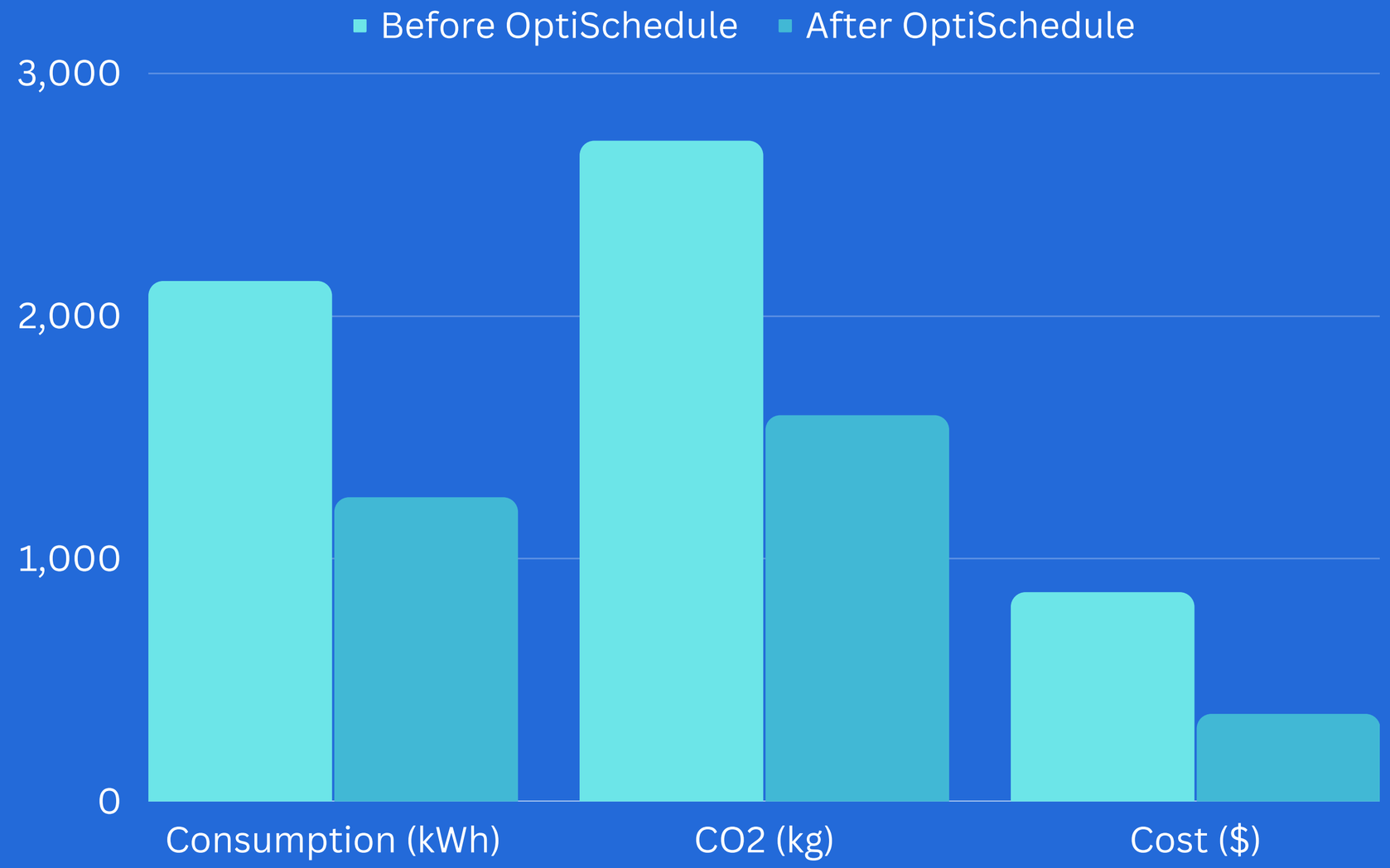
SAVINGS

The HVAC was switching to StandBy mode and Off mode when there was no need for it to be functional. This resulted in several hours of savings per day.

ECO FRIENDLY

The system helps reducing energy consumption, which also reduces the emissions of the polluting CO2 gas.

Impact of OptiSchedule: Before and After Comparison



OPTISCHEDULE


DEMO

OUR SOLUTION

SMART MIDDLEWARE APPLICATION THAT ENSURES COORDINATION BETWEEN ROOMSCHEDULING AND HVAC CONTROL

DEPLOYED ON BECHTEL BULDING

OPTISCHEDULE

THE KEY TO SUSTAINABLE BUILDING MANAGEMENT

IMPACT

Revolutionizing HVAC Control

OptiSchedule is a game-changer in the field of HVAC control. It utilizes precise technology to optimize the use of heating and cooling systems in university buildings. By turning off the HVAC system when it's not needed, OptiSchedule can help universities reduce their carbon footprint and contribute to a greener future in addition to significant energy savings.

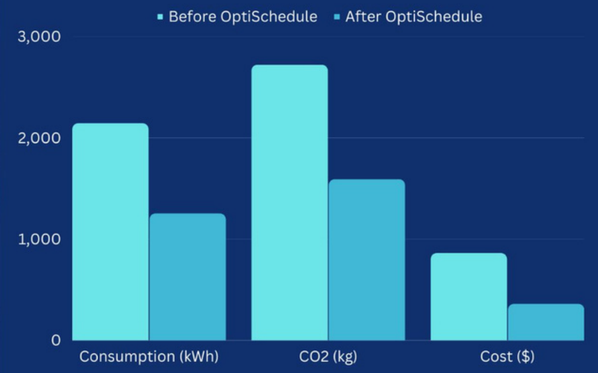
Smarter Heating and Cooling with OptiSchedule

OptiSchedule employs intelligent algorithms to determine the optimal times to turn on and off HVAC systems based on class schedules and weather forecasts. This ensures that the building is only heated or cooled when necessary, and that the temperature is always comfortable for the occupants.

FEATURES

- DASHBOARD CONTROL
- CUMULATIVE SAVINGS GRAPH
- STANDBYMODE IN BETWEEN RESERVATIONS
- TABLE VIEW OF ROOMS TEMPERATURE

MEASURED SAVINGS



A N Y

QUESTIONS?

OPTISCHEDULE

T H A N K

YOU!

OPTISCHEDULE