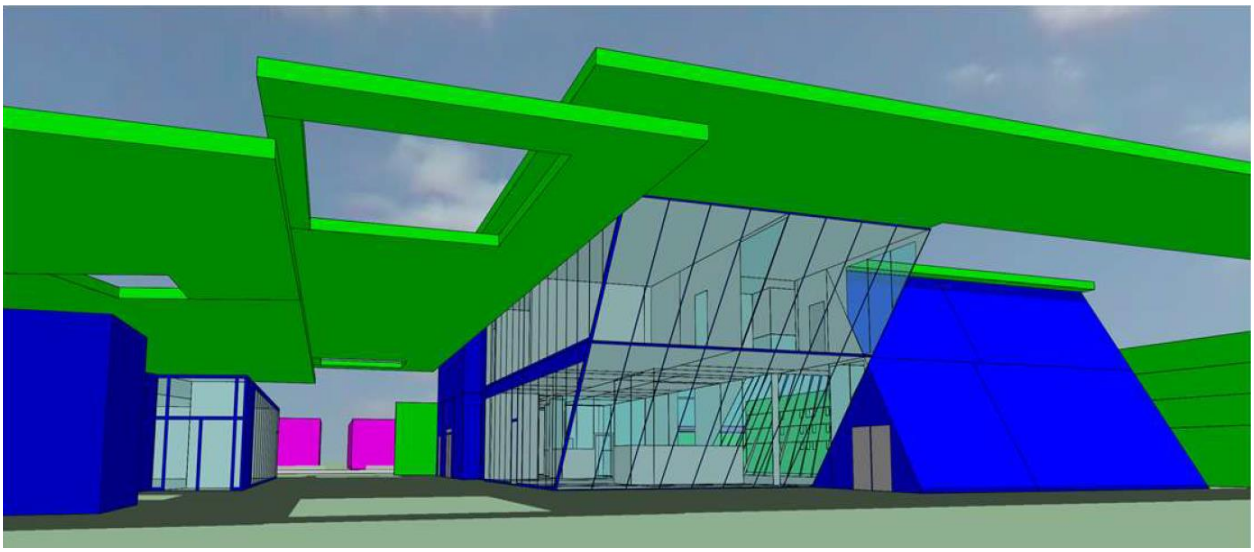
VE User of the Year Award 2020

Rare Document Storage and Archives Facility in Mumbai, India



Osama Hasan
Graduate Student in Energy Systems
San Francisco State University

As an academic project for the Energy Efficient Buildings graduate course, the objective was to perform a comprehensive energy simulation for a Rare Document Storage and Archives facility that will be constructed in Mumbai, India. Consisting of 3 floors, the building has an area of around 17,500 square feet and will be used to store and preserve historical documents, manuscripts, books, pictures, and audio recordings.

According to ASHRAE 90.1, the building site is considered under Climate Zone 1A (Very Hot-Humid), giving rise to significant year-round cooling loads. Input parameters such as the building's architectural layout, climate data, internal gain values, infiltration rates, building envelope, space zoning and setpoints were used to calculate cooling loads, ultimately leading to the design of an appropriate HVAC system.

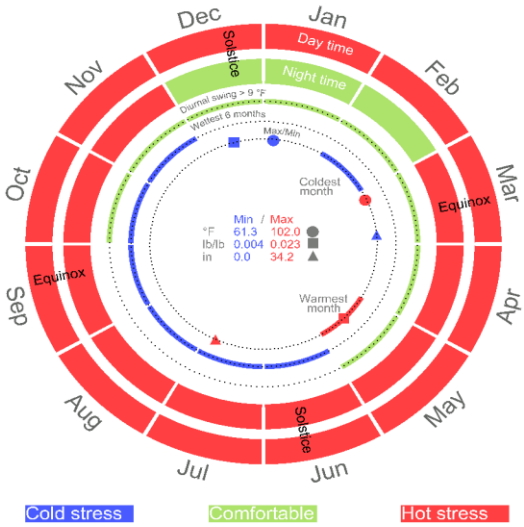


Figure 1 Climate Metrics for Mumbai

The overall arrangement consists of a VAV with reheat system, and cooling coils supplied by three sequenced chillers with a cooling tower.

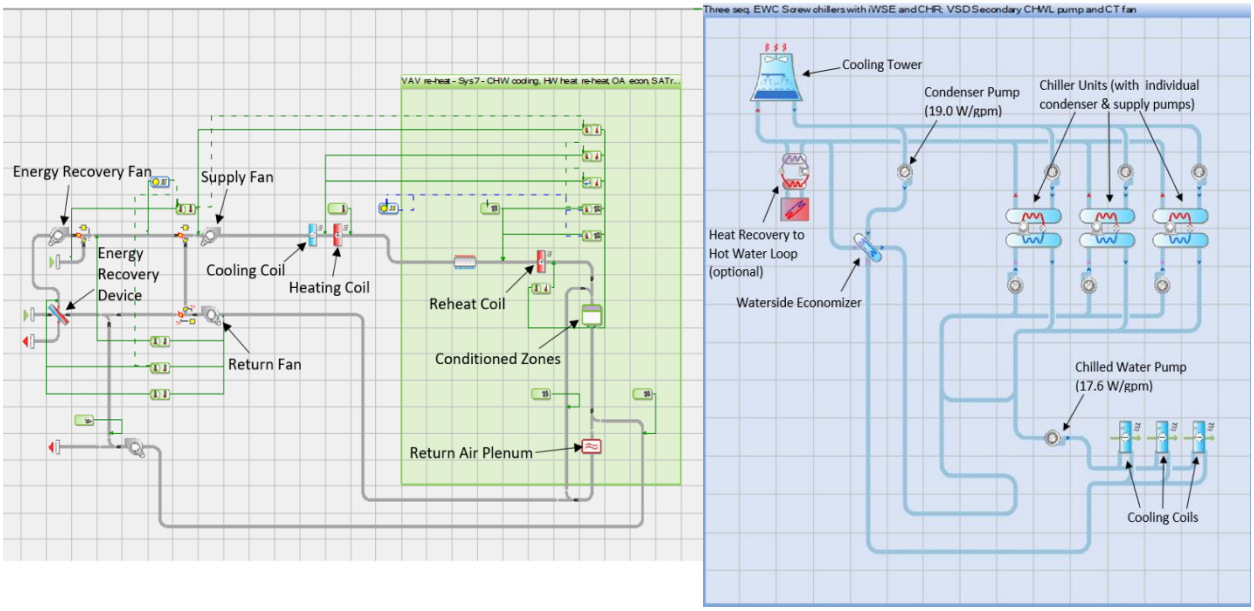


Figure 2 Air Side and Waterside diagrams of the Proposed Cooling System

Rooms were zoned according to their size, purpose, and proximity to one another, and zones were assigned different temperature and humidity setpoints throughout the building. Sensitive

materials are to be stored in document storage and archive rooms, which means they require constant cooling setpoints, including during off-hours and weekends. On the other hand, rooms intended for general use such as offices and lounges were setback during off-hours to reduce cooling loads.

Table 1 Space Setpoints

Area	Cooling Setpoint (°F)	Heating Setpoint (°F)	Humidity Control (RH)
Rare Book Collection & Archives	65	65	40% +/- 10%
Rare Book Librarian	65	65	50% +/- 10%
Rare Book Reading	70	70	50% +/- 10%
All Other Areas	75	70	< 60%
All Other Areas Setback	80	60	< 60%

Not everyone has the same comfort preferences due to their different clothing, metabolic rates, etc., therefore an occupant comfort analysis was performed using the software and ASHRAE 55 compliance was verified. In addition to cooling, the circulation of fresh air into occupied spaces is essential to maintain good air quality and occupancy comfort. ASHRAE 62.1 ventilation requirements were applied based on room occupancy and use, to ensure air quality for all personnel in the facility.

Two models were produced for this project: a baseline model that adheres to ASHRAE 90.1 standards, and a proposed model which includes energy conservation and on-site renewable energy measures. Energy conservation measures focused mainly on reducing cooling loads and optimizing the operating parameters of the cooling equipment. The ECMs integrated into the proposed model were:

1. Decreased heat gains using higher thermal resistance materials in the building envelope.
2. Reduced lighting density and gains through the use of more efficient lighting and daylight harvesting.
3. Installation of variable speed drives on circulation pumps, supply fans, and cooling tower fans associated with the HVAC system.
4. Reduced chiller compressor loads by increasing the chilled water supply temperature.
5. On-site renewable energy generation from a solar PV system on the building's roof and adjacent areas.

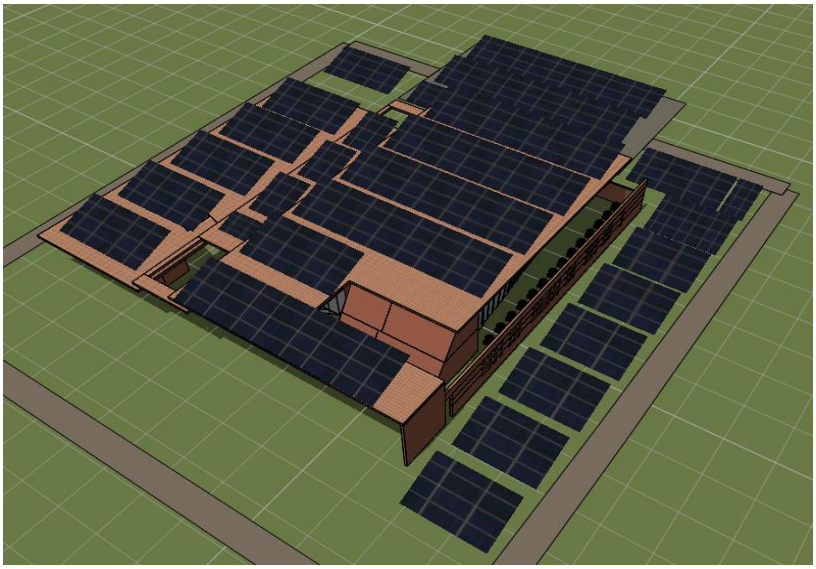


Figure 3 Arrangement of Solar Panel Arrays

Electricity and gas utility tariffs were assigned to compute annual energy costs and an overall comparison between the baseline and proposed models was performed. What makes this project unique and innovative is that through the application of the ECMs using the IESEVE software, a zero net energy building design was achieved despite the considerably high cooling loads.

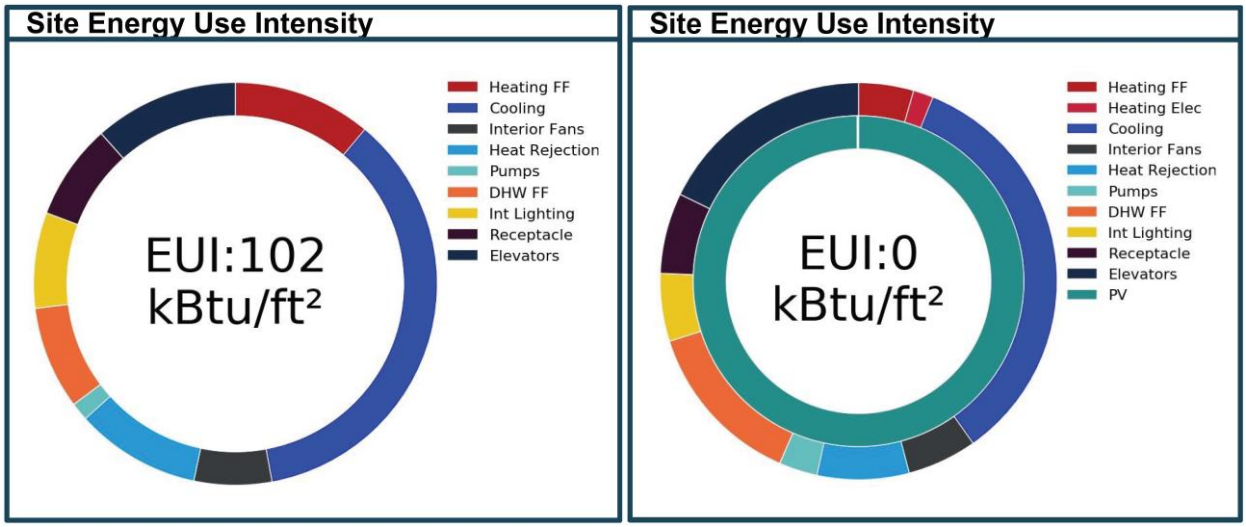


Figure 4 Baseline EUI (Left) vs Proposed EUI (Right)