

# Integrative Design of Hybrid Solar Technologies for Air Conditioning in Hot and Humid Environments

## Introduction

Air conditioning is one of the major energy consumption items in Dubai and countries with the same environmental conditions. Providing the majority of the air conditioning energy demand by renewable technologies will be a major step toward sustainable and green communities. The Sustainable City (TSC) in Dubai is currently under design, construction, and development by Diamond Developers Company (DD) with the most recent and innovative sustainable standards and technologies. This work is a solar design for the Center of Excellence Building at TSC. The American University of Beirut (AUB) participated in this research.

Social/Behavioral Study

Life Cycle Analysis

Integrative Design

Air Conditioning

Solar Technology

Thermal Energy

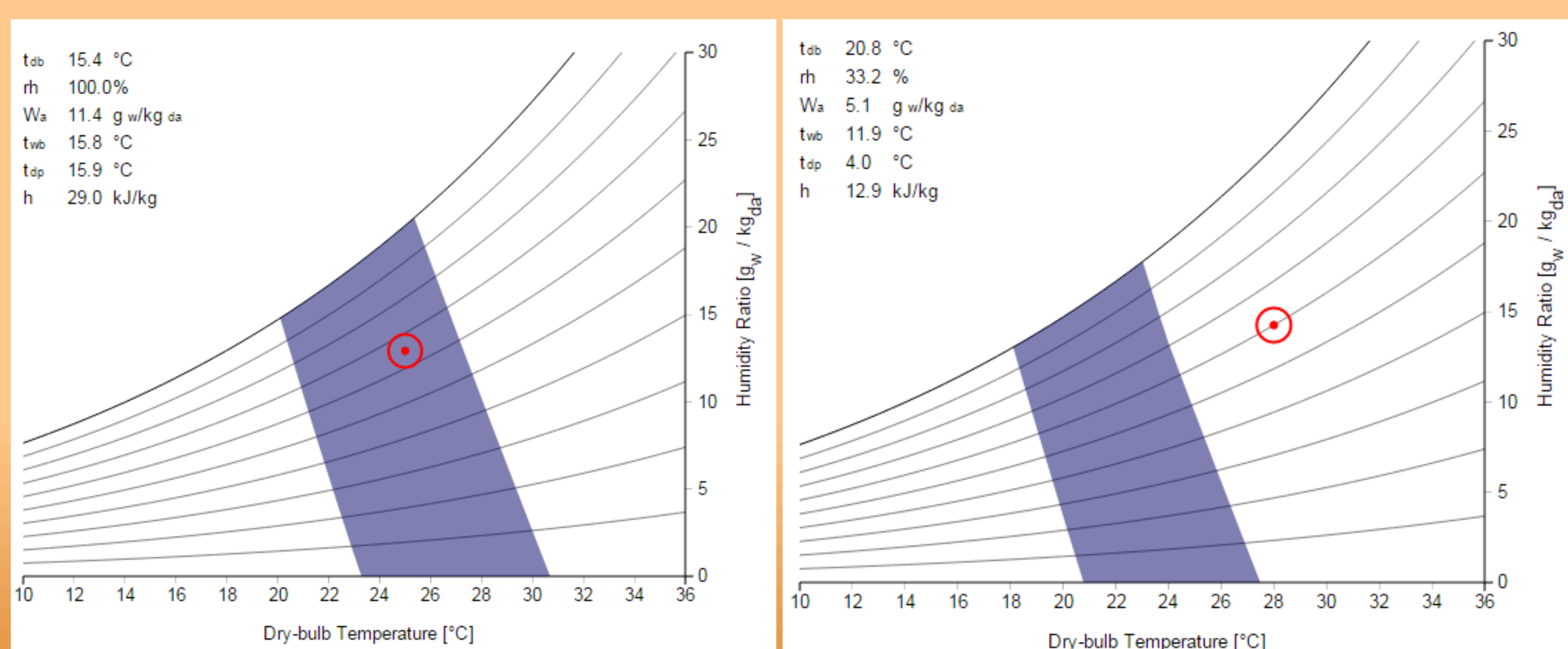
Electrical Energy

Thermal and Electrical Demand of the Building

Component	Max. Annual Energy Consumption with 40% overdesign (MWh/yr)	Peak Energy Demand <sup>2</sup> (kW)
Air Conditioning (HVAC)	0.2	21.6
Electricity Demand	975.1	83.3
Thermal Energy Demand for Air Conditioning	14,146	2,456

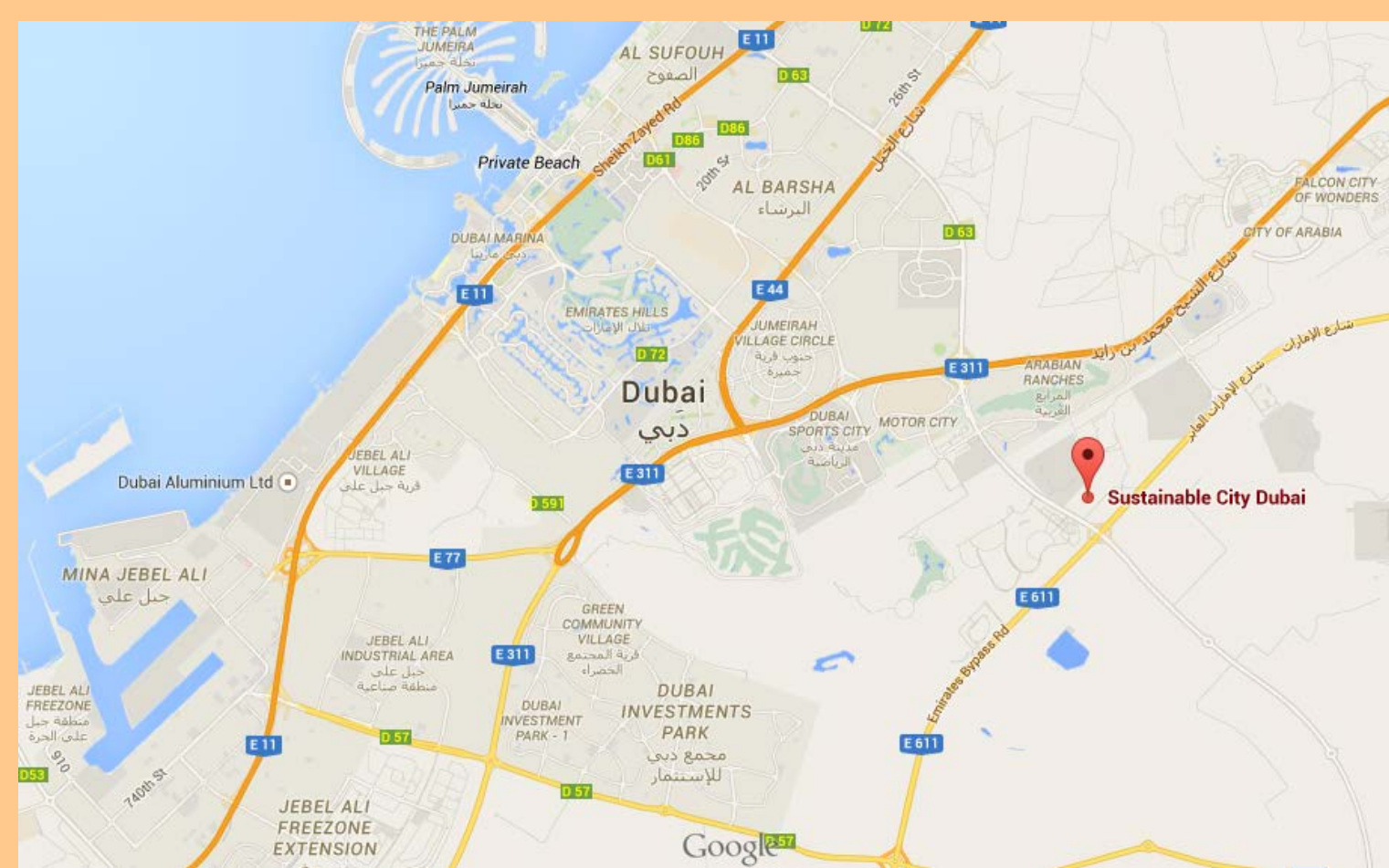
## Thermal Comfort

Thermal comfort is a subjective evaluation of one's satisfaction with the thermal environment. Comfort roughly equates to thermal neutrality, whereby occupants are neither losing nor gaining heat from their environment, but instead, are able to maintain equilibrium with the ambient conditions.



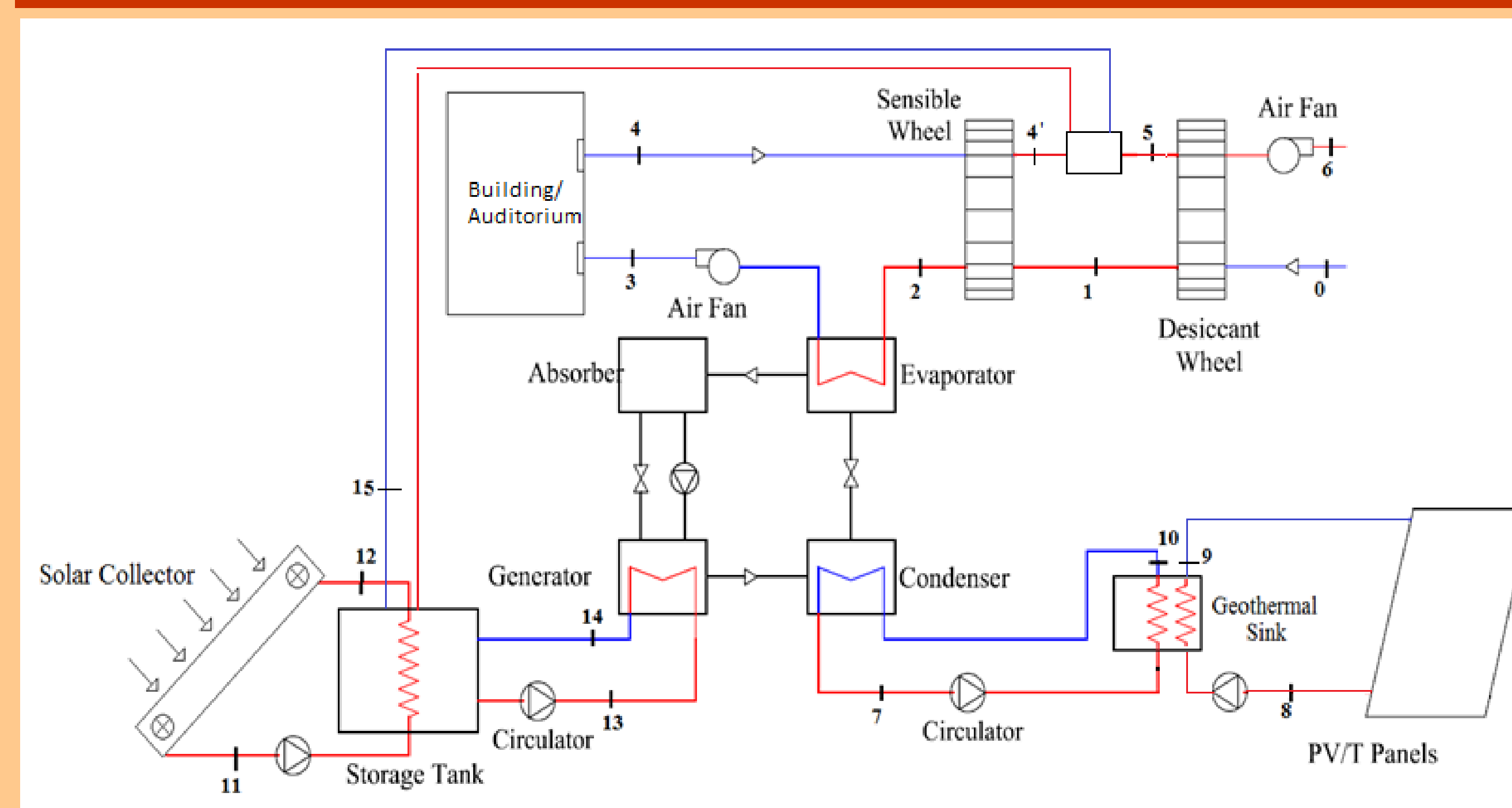
The thermal comfort modeling for February (left) and March (right) using the comfort tool and ASHRAE-55-2010 standard.

## Project



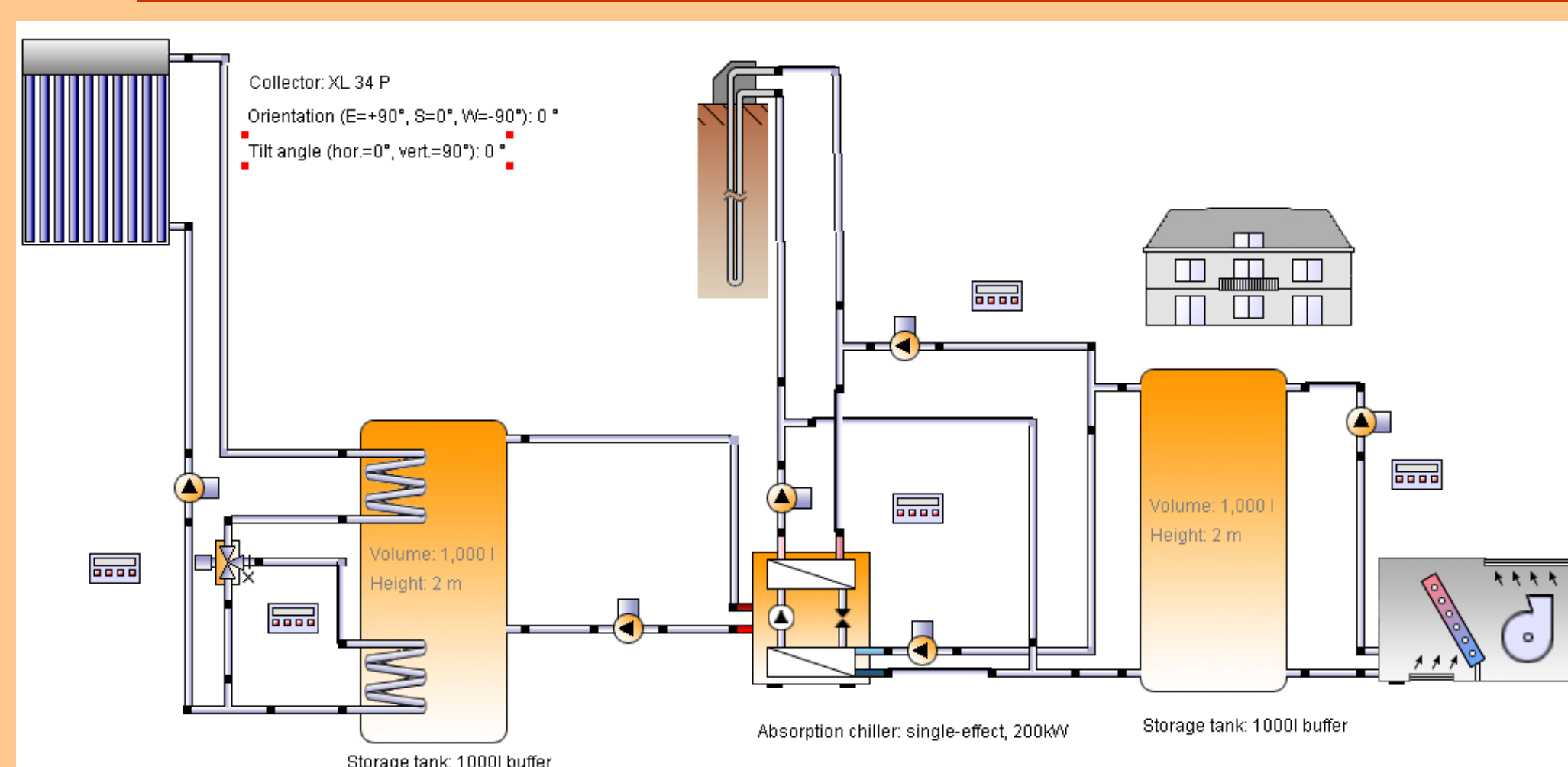
Center of Excellence Building located in TSC in Dubai (marked in red). The ground floor size is 4300 m<sup>2</sup> and contains three floors. It has an auditorium with around 600 people capacity.

## Solar Thermal Driven Air Conditioning

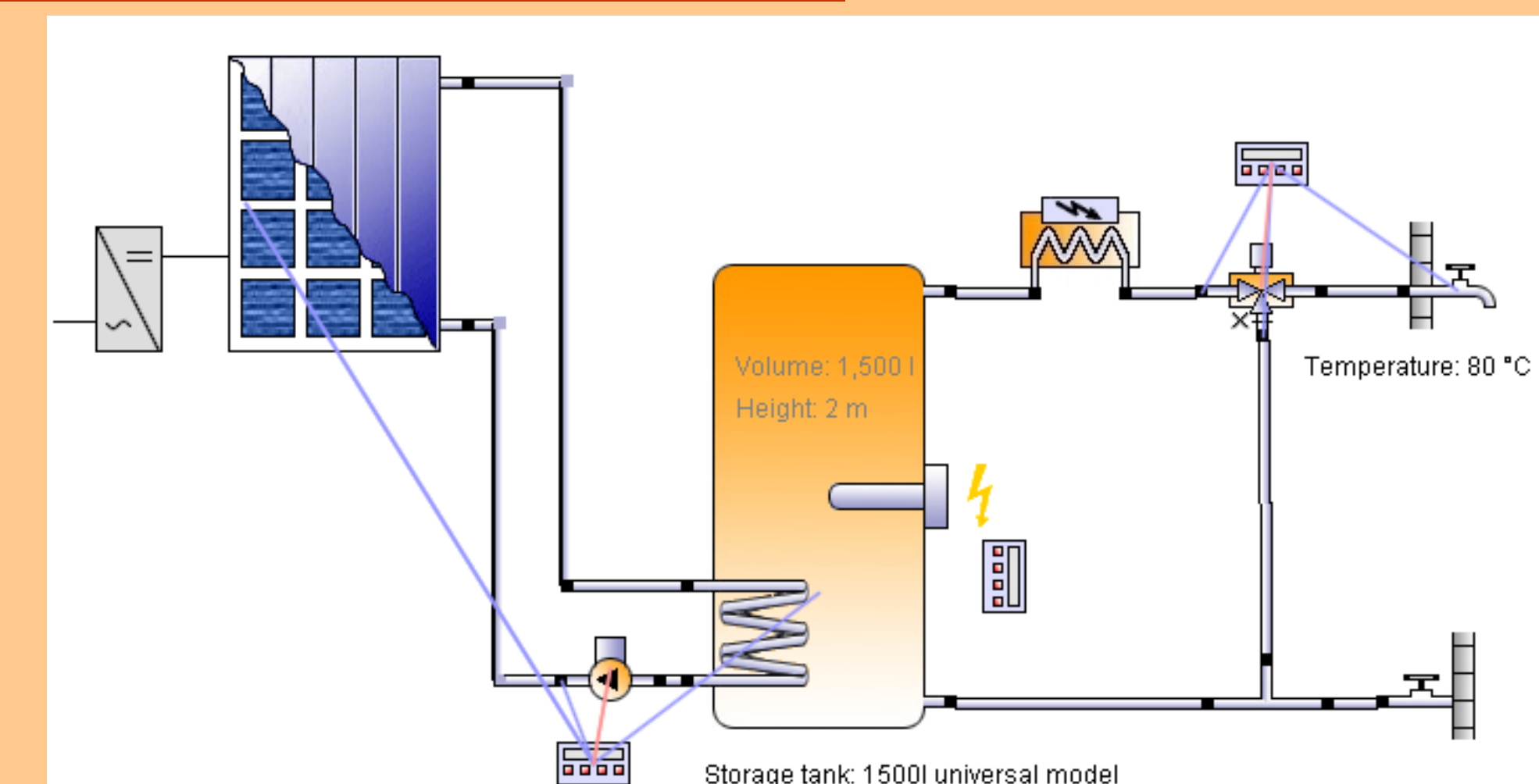


Thermal-driven single stage absorption chillers and dehumidification system will be used for air conditioning

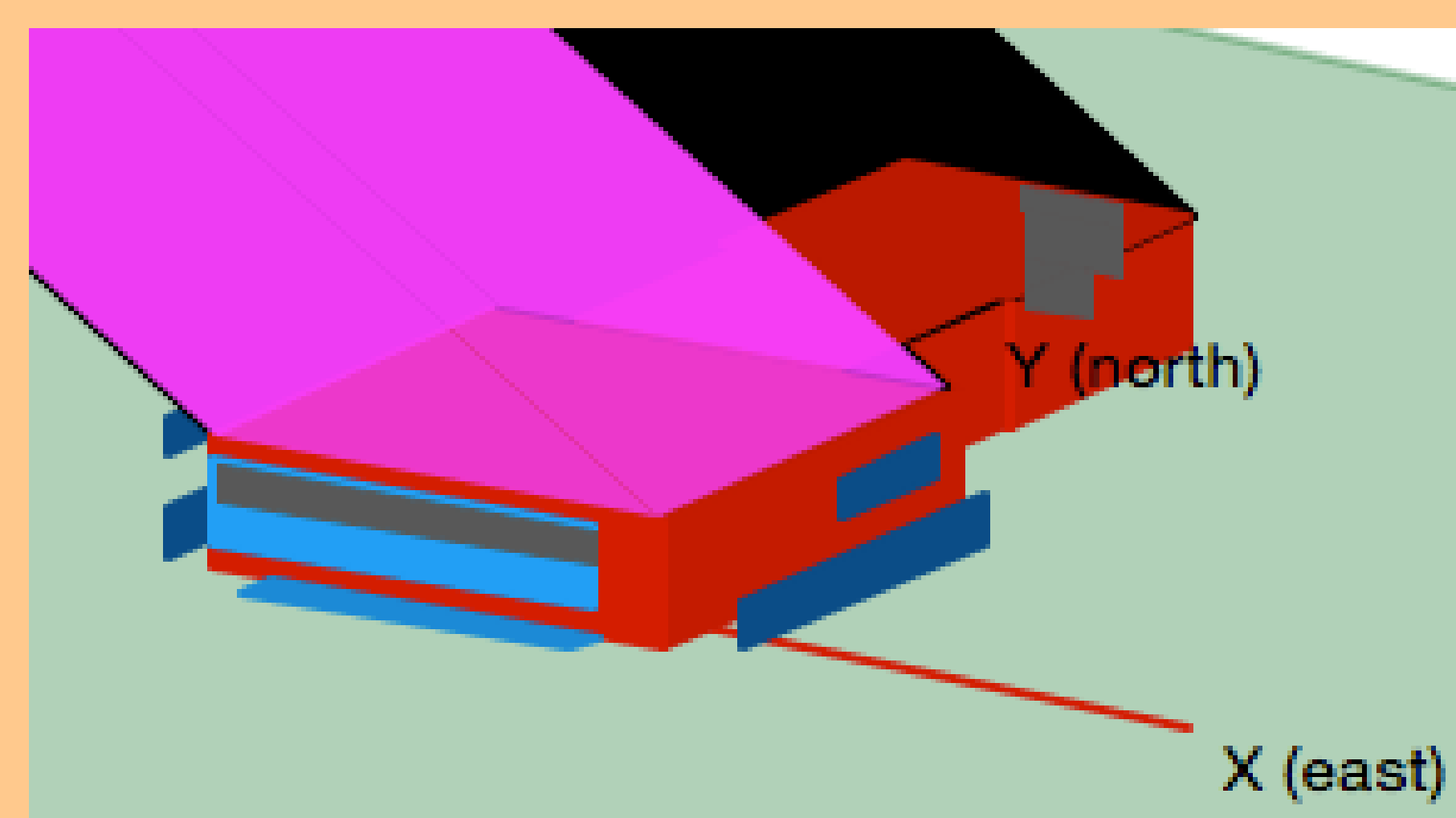
## Hybrid Solar Technologies



Evacuated tube solar collectors for integration with absorption chiller



PV and PV/T panels to provide electrical and hot water demand of the Center of Excellence Building



Building-Integrated Solar Technologies for windows and façade. Shad analysis was performed by System Advisor Model Software

## Life Cycle Analysis of Solar Technologies

Technology	Monocrystalline PV	Polycrystalline PV	CIGS PV	PVT	CSP	EVAC
CO <sub>2</sub> Emissions [kg]	1125	875	750	875	665	N/A
EPBT [yr]	6.00	5.70	3.83	2.94	7.98	7.31

## Summary

A combination of solar thermal, photovoltaic, and building integrated solar technologies can provide all of the electrical and cooling demand of the Center of Excellence Building. We recommend 1764 PV panels, 4120 evacuated tube solar collectors and two single stage absorption chillers with capacities of 230 and 270 refrigeration ton (RT).

## Acknowledgment

We would like to thank our collaborators at American University of Beirut, Prof. Ghaddar and Prof. Aboughali. We acknowledge the social and behavioral study by Dr. Sarah Outcult at UC Davis