Introduction
The goal of our senior design project was to create an energy efficient building by participating in a design optimization competition. The aim of the competition is to design an office building that reduces carbon emissions and the building’s dependence on fossil fuel while maintaining occupant comfort and construction affordability. The competition is organized by the UK-based DesignBuilder Software Ltd (DBS) and De Montfort University (DMU).

Competition specifications
• Site: South London Gatwick, Lat. 51.15, Long. -0.18
• Total floor area: 3000 m² (+/- 1%)
• Office area: ≥ 2400 m²
• Utility area: ≥ 420 m²
• Discomfort hours below 200
• Daylighting greater than 50% to qualify

Accomplishments
Simulations run using the software generated the following building performance results.
• Annual operational CO2 emissions: 75.35K kg
• Construction cost: £3.08M
• Discomfort: 155.88 hours
• Daylighting: 53.00%

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LED with linear control
• Reduces energy usage
• Low CO2 emissions
• Most sustainable light source
• Provides comfortable lighting for office personnel

Sun-path diagram
• Predicts the influence of direct sunlight and shadows
• Assists in building positioning
• Aids in optimising angle and position of photovoltaic panels.

A LTHW HVAC system chosen for energy efficiency and the use of low temperature water setting.
• Operates off gas, the primary energy source in London
• Due to the climate cooling is not as high a priority as heating, as the climate allows for natural ventilation in summers.
• Software simulations verified LTHW has the lowest CO2 emissions at reasonable cost.

Top left: Annual fuel breakdown of building.
Room electricity holds utilizes most fuel consumption followed by lighting and heating. The green bar represents electricity generated from the photovoltaic panels. The photovoltaic panels provide the building with approximately 40% of the annual energy usage.

Bottom left: Annual internal and solar gains.
The top graph shows the heat balance and the distribution among heating and cooling sources. Solar gain is the highest contributing factor. This shows the importance of avoiding direct sunlight for comfort during the day. Computer equipment is another important factor to consider, as it will generate a significant amount of heat, especially in the cellular offices. To balance the heat gains, cellular offices are placed in the northern part of the building.

Above: Daily CO2 production over one year.
The graph indicates that the output is higher during the winter due to heating required by the cold winter climate in London, England.

Team goals
• Obtain annual CO2 emissions below 100K kg
• Maintain construction costs below 3.5 Million GBP

Team members
• Jovana Poduje
• Maria Nygren
• Sofia Gomez
• Tony Nylander