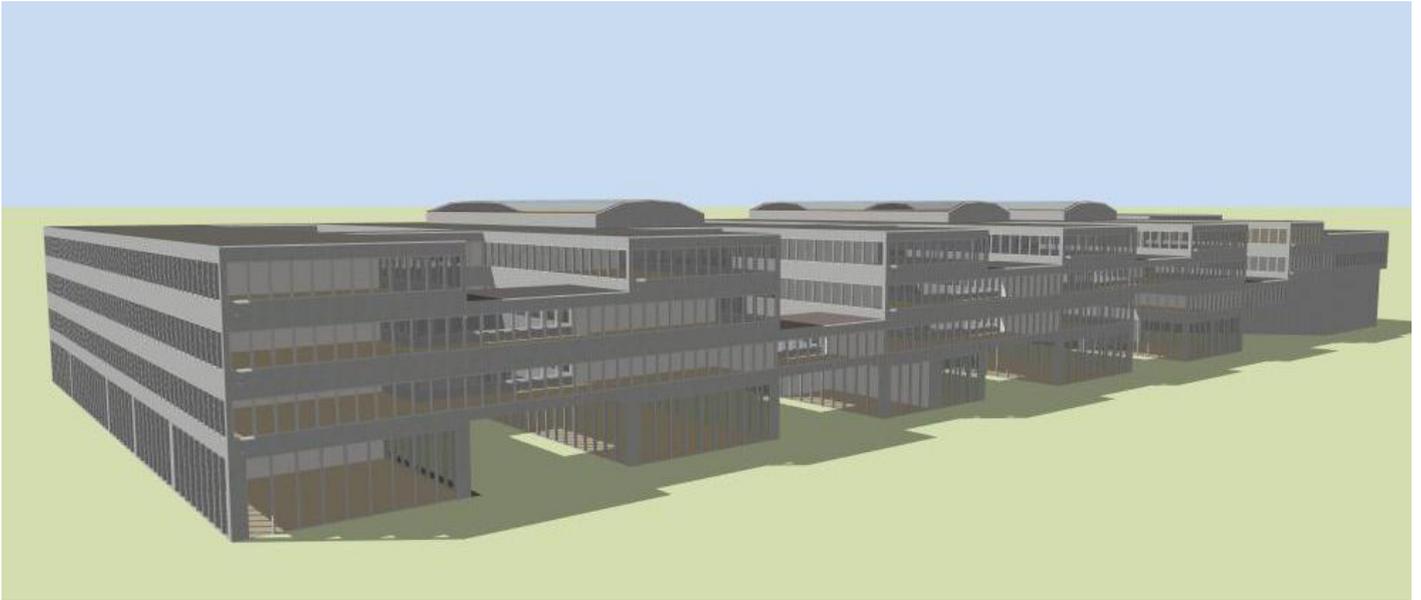


## Quantify Performance for a 20-Year Energy Performance Contract



CETTEG used DesignBuilder as part of an analysis for a 20 year private-public partnership tender focused on low energy building and comfort in France.

### At a glance

- Engineer school building under HQE environmental certification with 25% improvement on the RT2012 consumption objective.
- Both EnergyPlus simulation and RT2012 calculation run using a single base model to avoid double inputs and keep one consistent model throughout.
- Simultaneous evaluation of comfort and energy consumption for the building envelope and HVAC system operation.

### Project details

**Project description:** 25,000 m<sup>2</sup> science and technical university new-build for education, research and enterprise incubator.

**Performance criteria:** Aiming for high HQE certification level and France energy rule very low energy objective (-25% of maximum allowed).

**Location:** Plateau de Saclay, Gif-sur-Yvette - France

**Project status:** First place in tender analysis, best notation for technical topic.

### Introduction

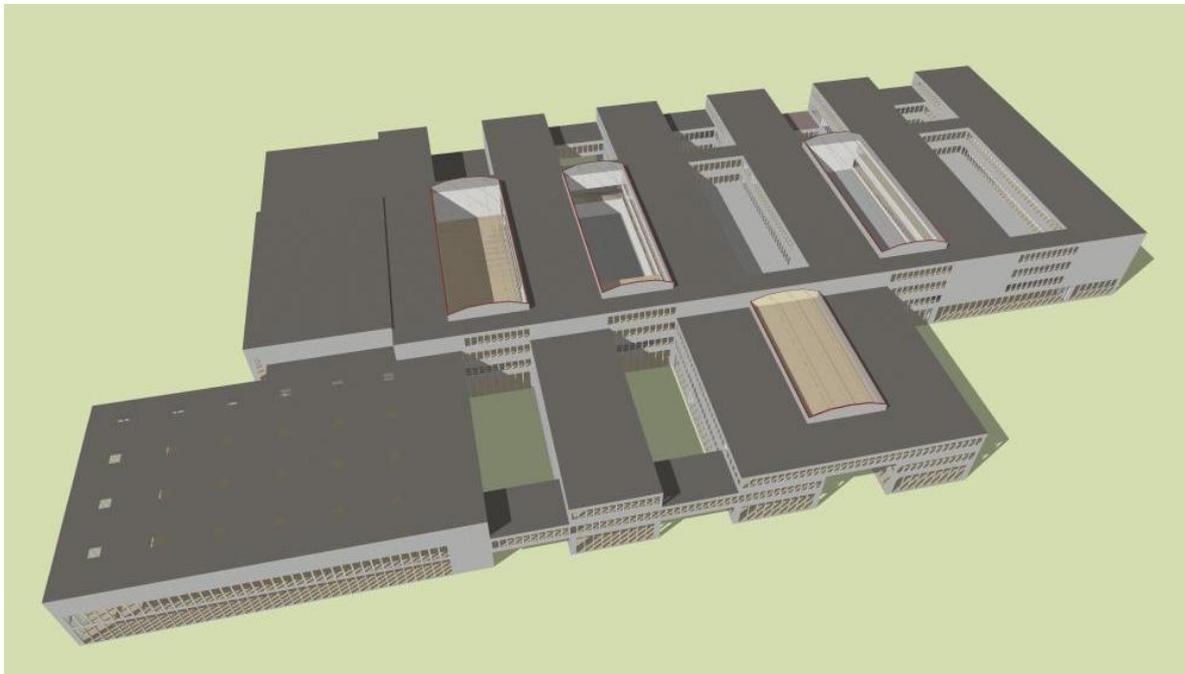
The Plateau de Saclay, near Paris, is becoming a large campus with renowned university and engineer schools. A new building project with stringent environmental and energy targets was tendered as a 20

year public-private partnership. Extensive studies were required to reach the high comfort and low energy consumption targets.

The building will accommodate students, researchers, enterprises and events to create an environment of innovative stimulation. The architect created a simple shape with open spaces allowing mainly natural lighting. Insulation, glazing solar properties and selectivity (high visible transmission for low thermal transmission) were chosen and validated with simulations.

Two main challenges were identified in this project:

- Reducing heating and cooling needs, knowing that the occupancy is difficult to estimate for so many activities in a large building.
- Select HVAC systems to minimise energy consumption and ensure the best control and settings for the partner committed to annual energy consumption targets.



## Reducing loads

Glazing represents an important part of the envelope for energy reduction and meeting thermal comfort and daylight factor requirements. To avoid too many heat losses in winter and too many solar gains in summer a number of options were validated:

- Low emissivity pane ( $U_g = 1 \text{ W/m}^2\cdot\text{K}$ ), efficient frame, solar factor around 0.4 and less on some facades
- Sun shades for critical orientations
- High reflective internal blinds automatically controlled on daylight levels and time of day

Natural ventilation has been used to help cool the building and minimise the need for mechanical cooling:

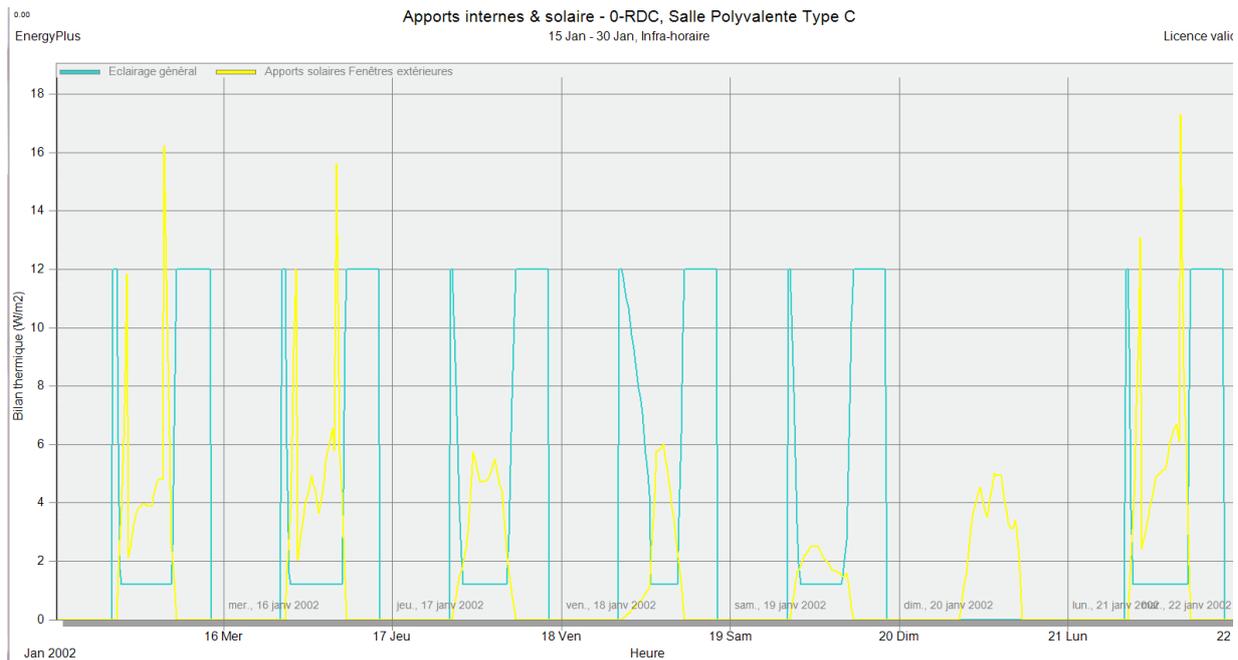
- 30% of external glazing area is openable to allow natural ventilation to flow through the zones

- 15% of the Atrium internal glazing is openable
- 20% of the skydome is openable to exhaust hot air at high level

The window openings were evaluated based on temperature setpoint control.

Lighting gains must be minimized, and different strategies were modelled depending on the function of the different space types:

- Lighting is enabled during occupancy only and controlled automatically
- Occupant detection is installed in zones where occupancy is variable
- Daylight dimming is provided for perimeter zones



***Zone dimming validation. Lighting energy versus solar gains (window blind operation controlled according to solar radiation on façade).***

## HVAC systems and comfort

Except for laboratories, air quality requirements dictate air change rates. These have been designed to minimise the need for zone cooling via terminal units.

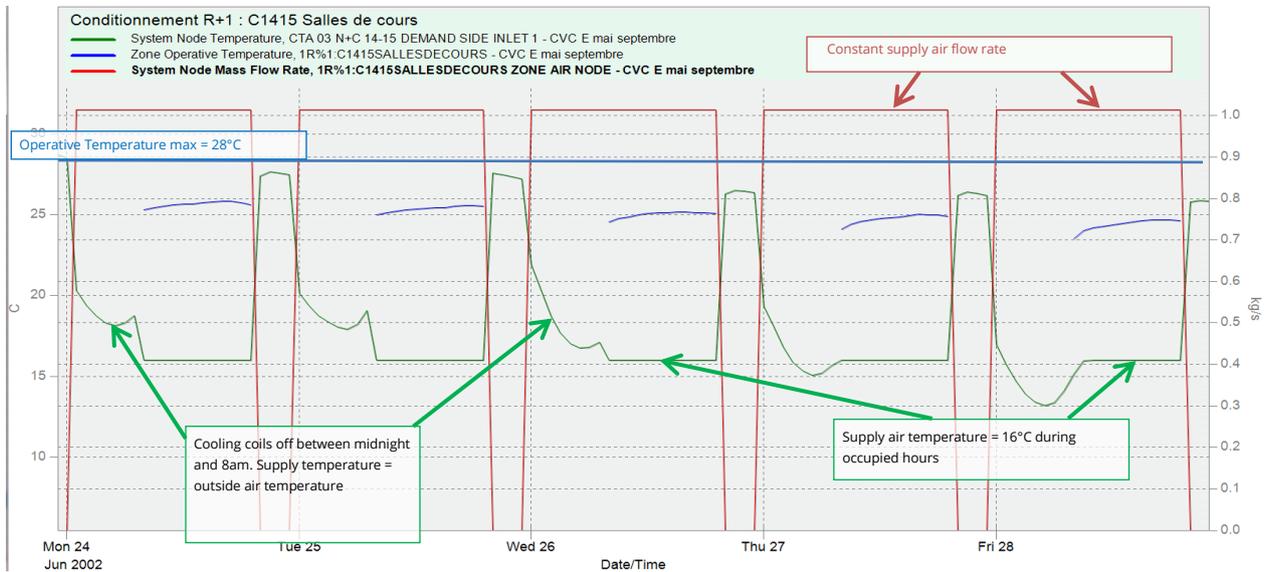
This air strategy has been validated with simulations to identify the number of hours where the zone temperature exceeds 28°C (program requirement is < 30 hours/year).

To find the right solution, three parameters were investigated using DesignBuilder:

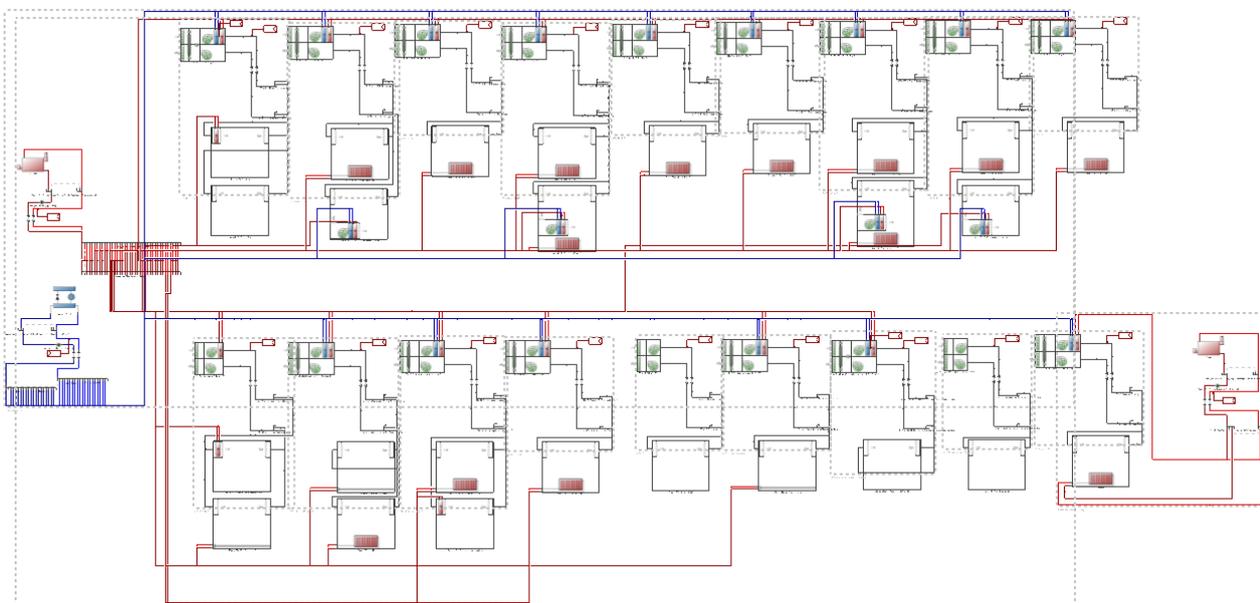
- Air supply temperature, 16°C offers a good compromise.
- Assessment of the mechanical air flow rate and shading requirements to meet the different zone cooling loads. DesignBuilder's fully integrated tools were ideal for this assessment to identify the best trade-off between daylighting and cooling loads.

- The summer operating times of the mechanical ventilation air handling units (AHUs) to help purge heat from the building. This enabled the AHUs to be switched off between midnight and 8 AM.

The AHUs have heat recovery and those supplying amphitheatres or meeting rooms are controlled to meet zone ventilation requirements based on occupancy.



**Zone analysis to optimise air flow for comfort conditions**



**HVAC system modelled in detail using DesignBuilder**

Both chilled and hot water are supplied from the Plateau de Saclay district heating and cooling system for its various buildings.

## Sensitivity study

The company winning the tender bid has to commit to the predicted yearly energy consumption which is based on the modelling results. The model was tested with variants to better understand its sensitivity to user changes and simulation input assumptions such as occupancy. This helped confirm the tolerance error to be added to the (binding) energy commitment in the tender.

Variants included:

- AHU heat recovery efficiency reduction from 70% to 60%
- Heating setpoint increase of 1°C
- Occupancy density, internal gains reduced by 10%

## RT2012 certification

In parallel, the building must pass the RT2012 French regulation requirements and demonstrate a 25% energy consumption reduction on the minimum requirement.

DesignBuilder, with its RT2012 module, allowed both the compliance analysis and detailed analysis to be completed using a single base model with minimal changes. Modelling the shading and overhangs in such a complex building with that amount of glazing would have been time consuming to input in another software. DesignBuilder's automation of the shading generation saved a lot of time and modelling effort.

The real work in this project was to study the way to beat the RT2012 requirement by 25% without losing the balanced solutions found with the EnergyPlus simulation. DesignBuilder's fully-integrated features for analysing energy, comfort and daylighting helped this to be done with the minimum effort.

## Conclusion

This project was completed to very tight timescales, requiring many parallel analyses to be undertaken to identify the optimum solutions and "sanity-check" the effects of the different variables. All of the tender's modelling requirements were completed successfully, with the submission being ranked 1<sup>st</sup> for technical content. DesignBuilder helped the designer produce a simple modular approach which was appreciated by the assessment team.

Modelling for Energy Performance Contracting, where the predicted performance is to be guaranteed over 20 years, is a serious undertaking. DesignBuilder's functionality allowed this to be undertaken efficiently and gave the whole team the confidence in the results needed to make the tender bid.



CETTEG provides consultancy on energy cost optimisation and simulation expertise for new or existing building projects. Cost optimisation applies from energy supply negotiation to meter reading and invoice checking. Our simulation projects are often large buildings targeting high environmental quality (LEED, BREEAM or HQE). More details on [www.cetteg.fr](http://www.cetteg.fr).