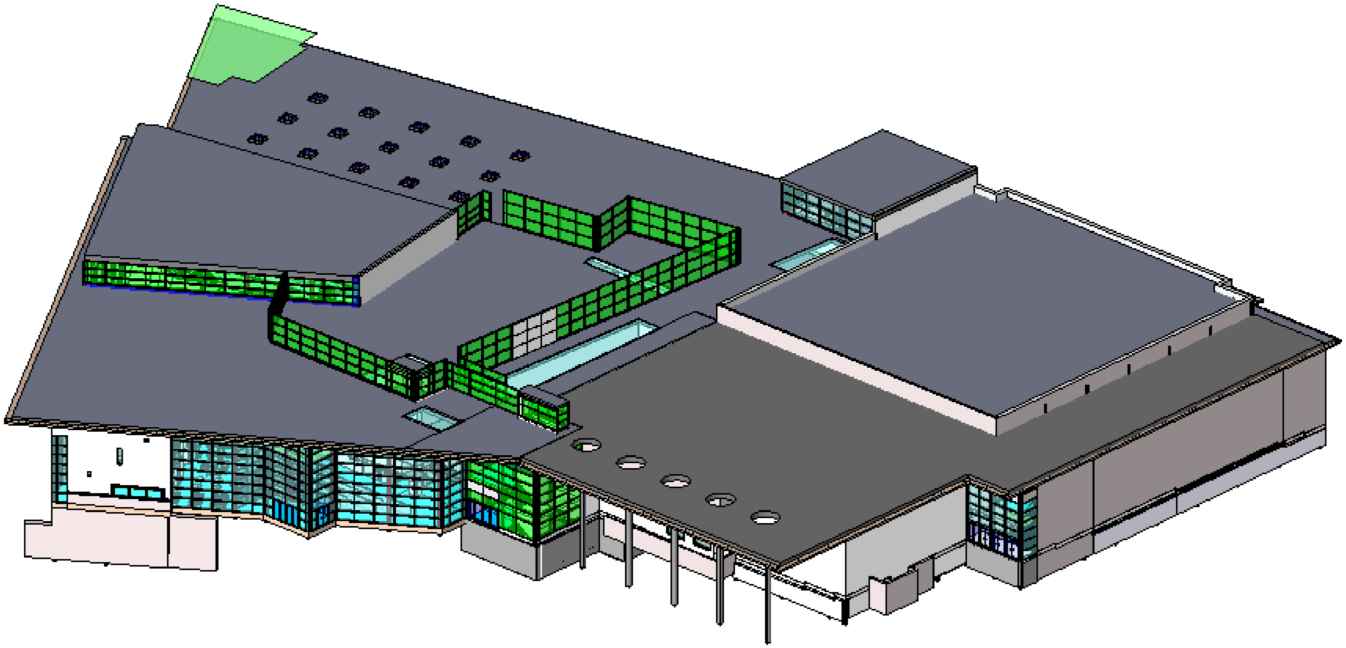
# Developing building simulation tools that balance rigor with efficient use

An insight into the Research and Development philosophy at EDSL Tas

The efficient integration of energy and daylight simulations into the quickly emerging BIM based workflow is a significant challenge.

The Key stage is the conversion of the architectural model to an analytical model.

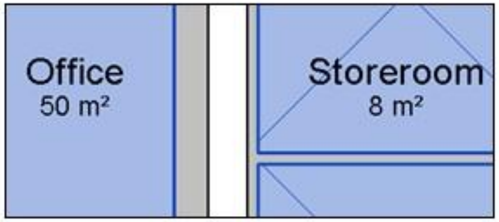


There are two key issues which hinder interoperability.

Architects are not aware of the simple rules for creating a model with good space definition.

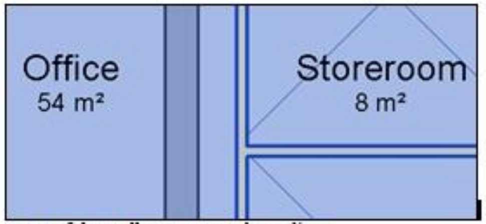
It takes 1 hour to make them aware of these simple rules

**1.3 Wall Voids and Walls made of Multiple Elements**



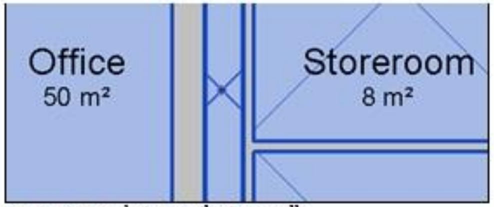

There can be no wall voids that do not contain rooms. As an example, see the picture above – two existing rooms are separated by two walls with a void between them. The geometry would be incorrect if a gbXML was made from this model; the two rooms would have no link and their walls would be marked as the wrong type.

Possible solutions:




1. Make one of the walls non-room-bounding.

This is one of the quickest solutions, and is best applied in cases where the wall void is very small or the wall separates off an area which logically belongs to the larger room (eg. a small storage area, or a thin wall hiding toilet cisterns). In the case above it wouldn't be a very good solution as the wall void is thick, as is the wall itself, and making the wall non-room-bounding has increased the floor area of the left-hand room significantly.



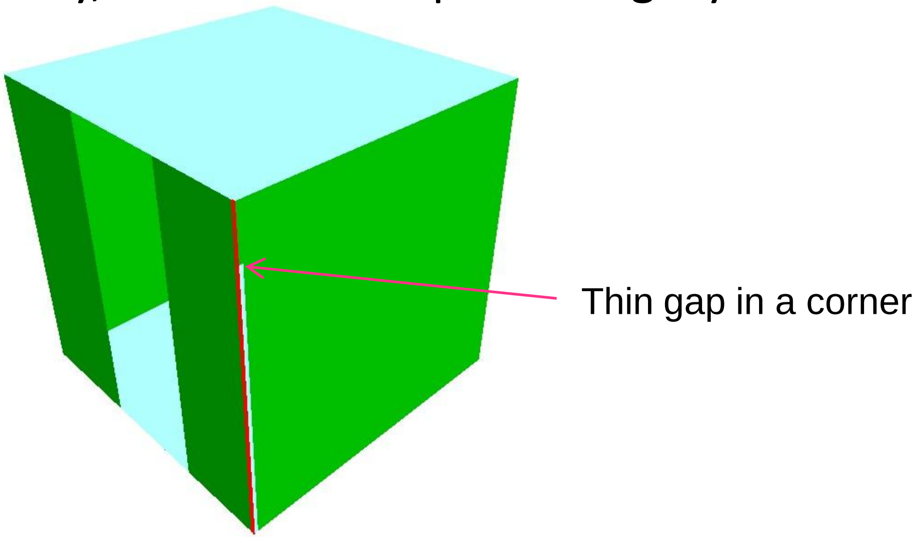

2. Place a new room between the two walls.

This is another quick solution, and is best applied in cases when the wall void is wide. For thinner voids (less than about 300mm) it should be avoided. In this case the wall void is quite wide and this solution would be reasonable.

Second, the geometry data in a gbxml file is an approximation of the architectural model .

advantage, fewer surfaces, hence faster simulations

Disadvantage, gaps in the geometry, hence loss of space integrity



KEY TECHNOLOGY

The Tas 3D model uses **solid modelling techniques** which are topologically robust.

-Space boundaries are always enclosed by surfaces.

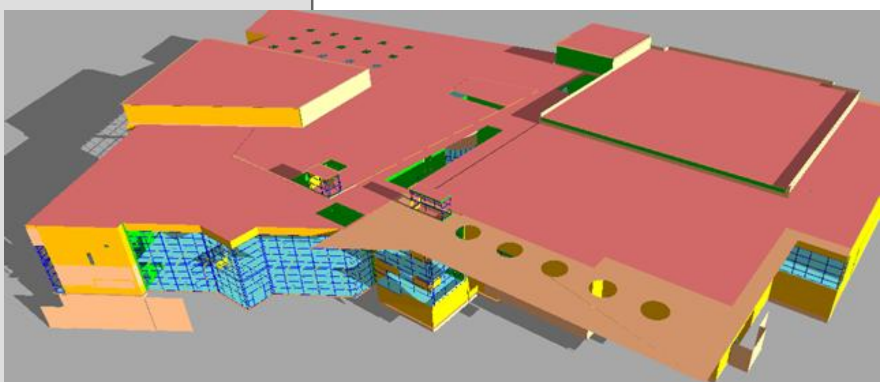
-The adjacency of rooms – surfaces and edges are explicitly represented in the data structure.

- *Integrity of the analysis model is guaranteed before simulation starts*

The Tas 3D model gbxml import creates an analytical model.

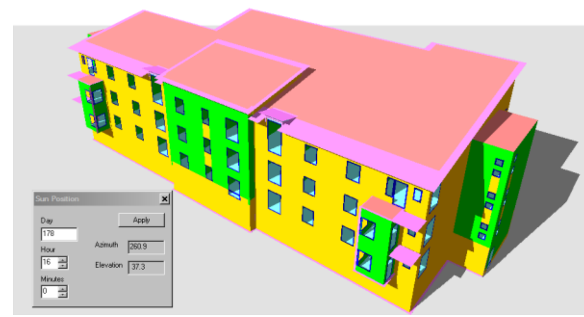
**Identifies gaps in the space boundaries, incorrectly orientated surface and adjacency problems and fixes them.**

218 complex spaces (43MB gbxml)



240 adjacency 118 small gaps and 117 orientation fixes

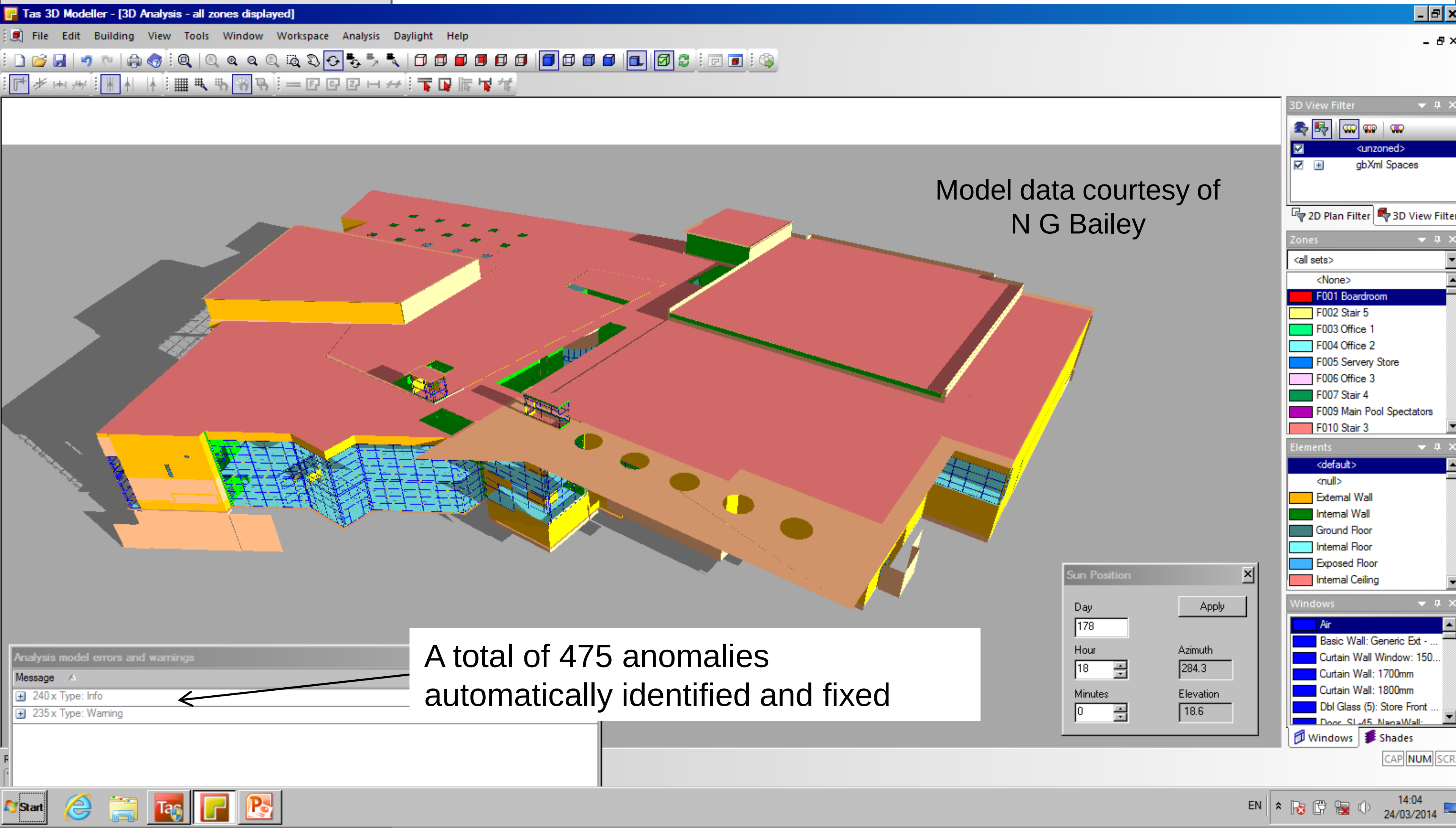
225 simple spaces (7MB gbxml)



100 adjacency
53 small gaps and
16 orientation fixes

***gbxml files from revised architectural models may be MERGED into existing Tas models***

# 3D view of Tas model generated from gbxml data

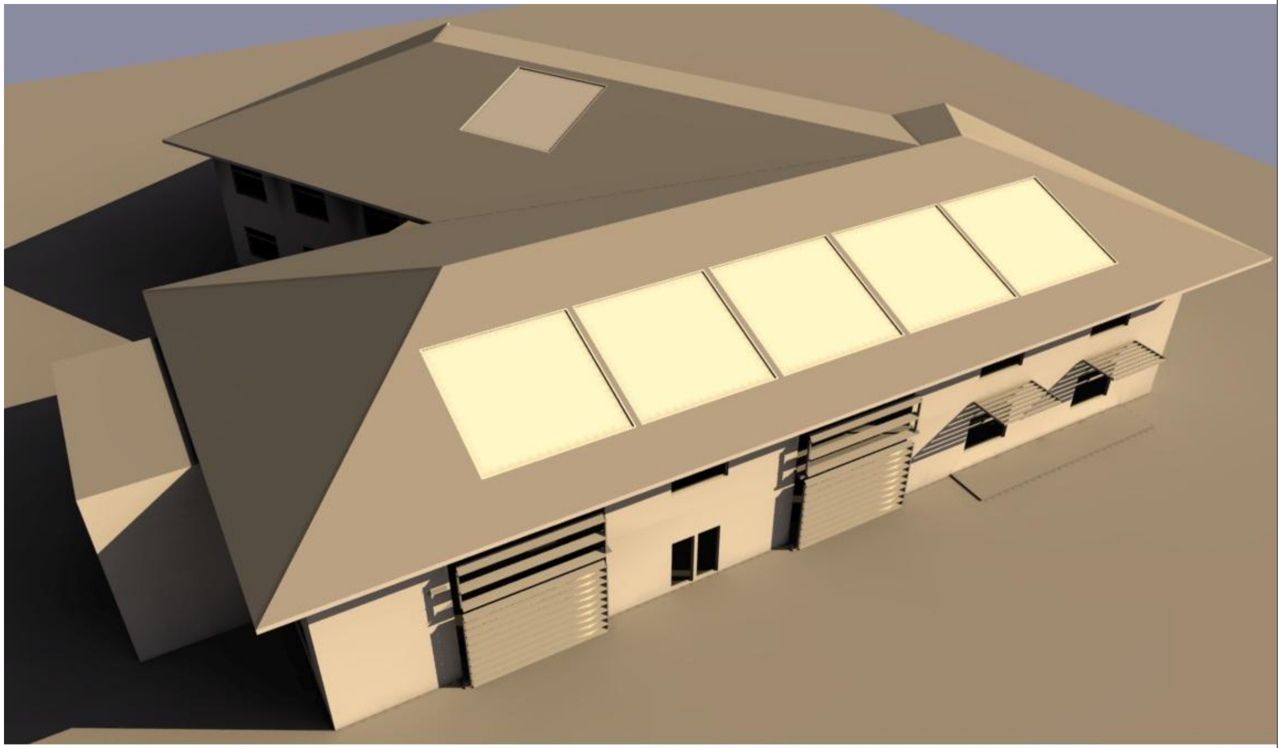


KEY TECHNOLOGY

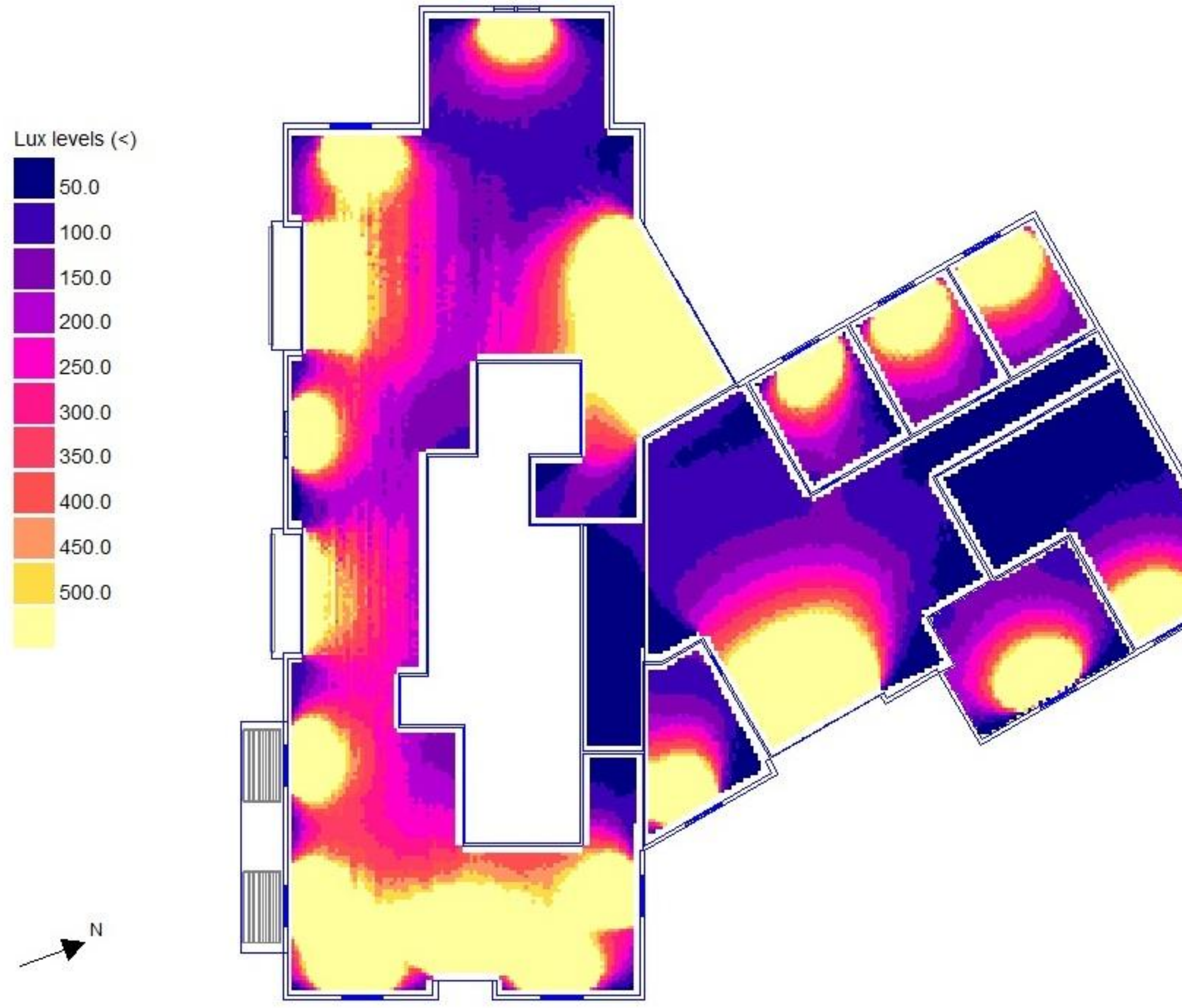
daylight render

Tas daylight is based on adaptive radiosity

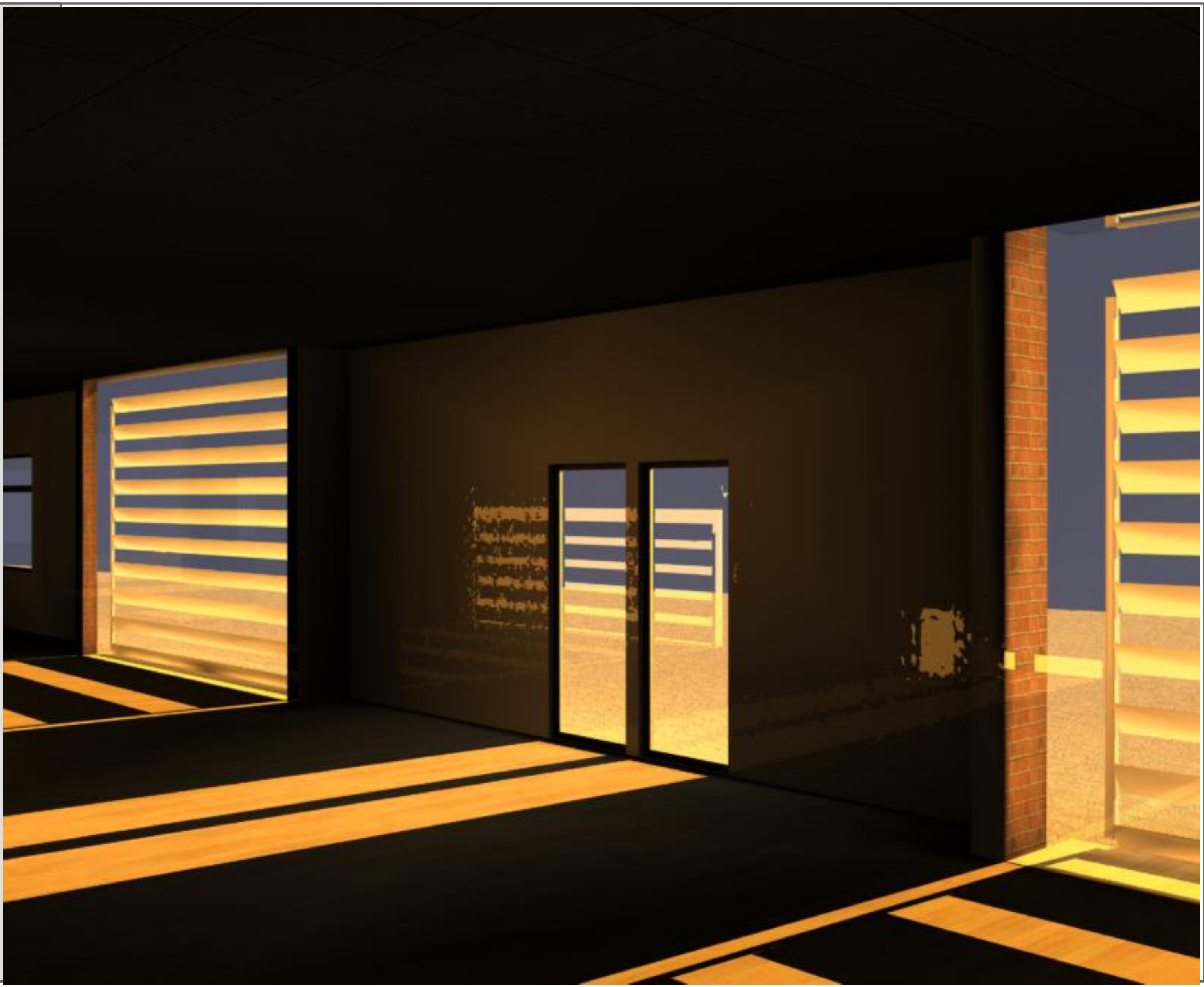
CIE 171,2006 compliant



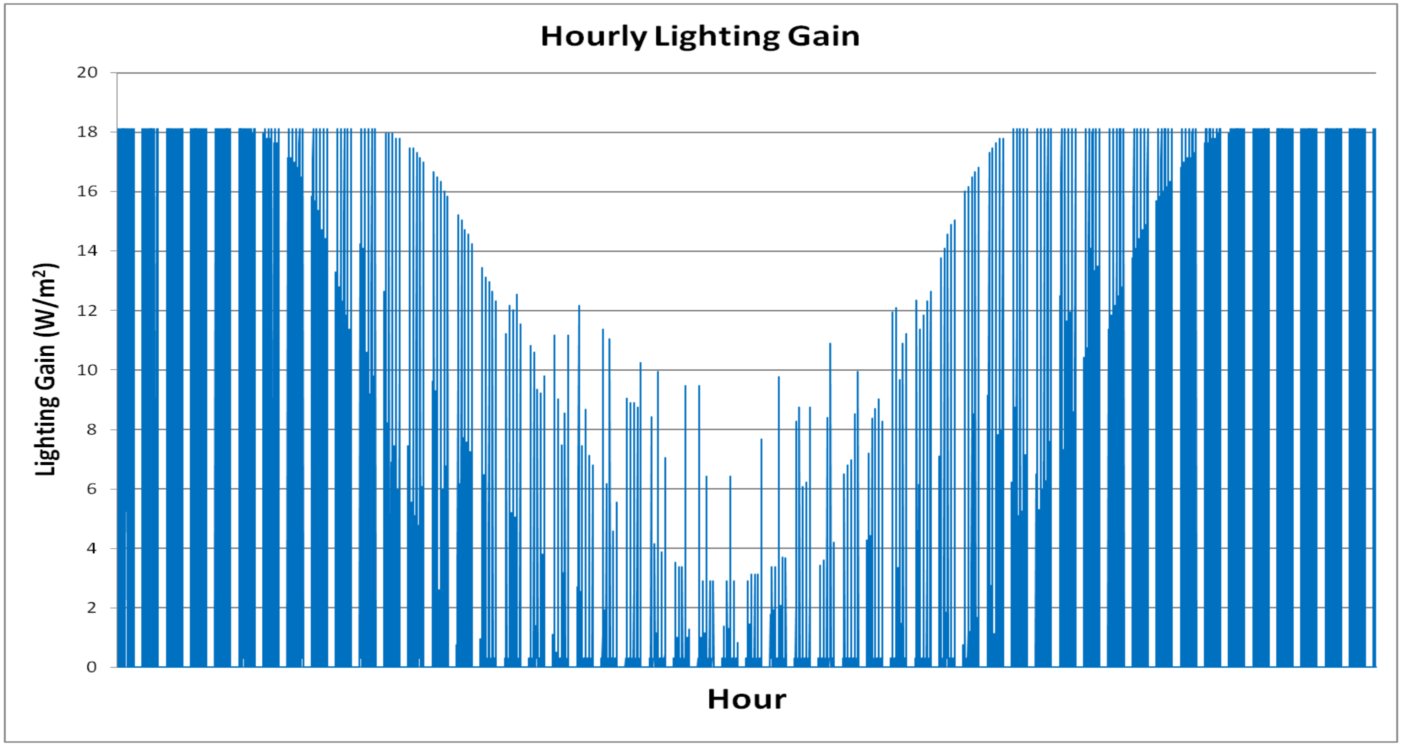
Fast multi zone daylight simulations



Inside and outside specular reflection analysis using ray tracing over the radiosity results



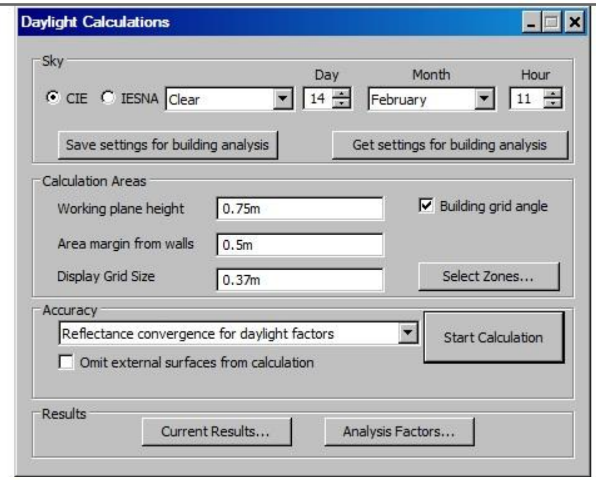
Space daylight data automatically used in energy simulation to calculate daylight savings

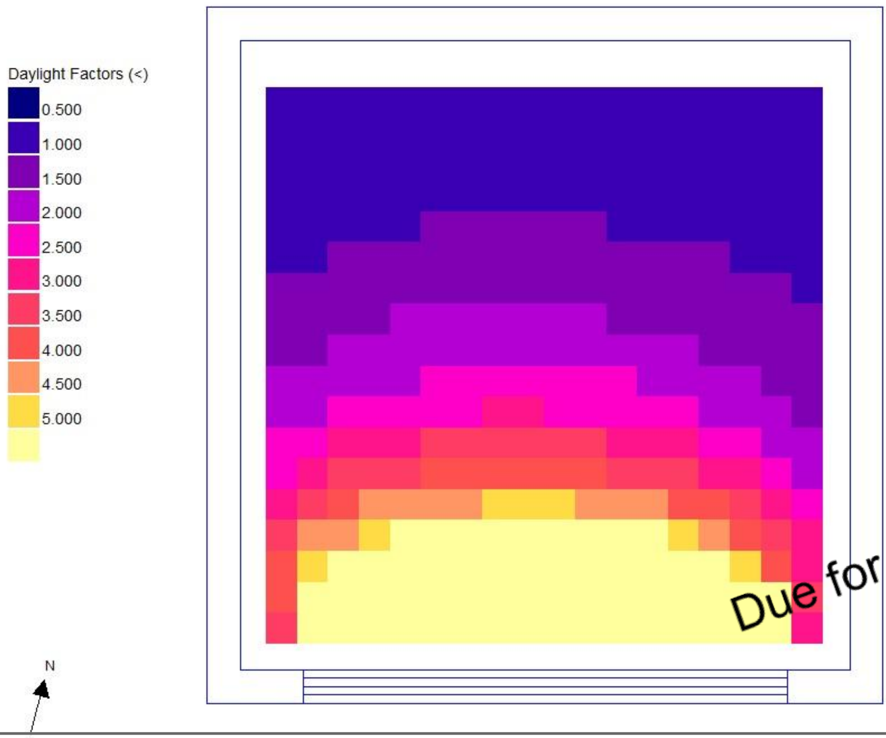


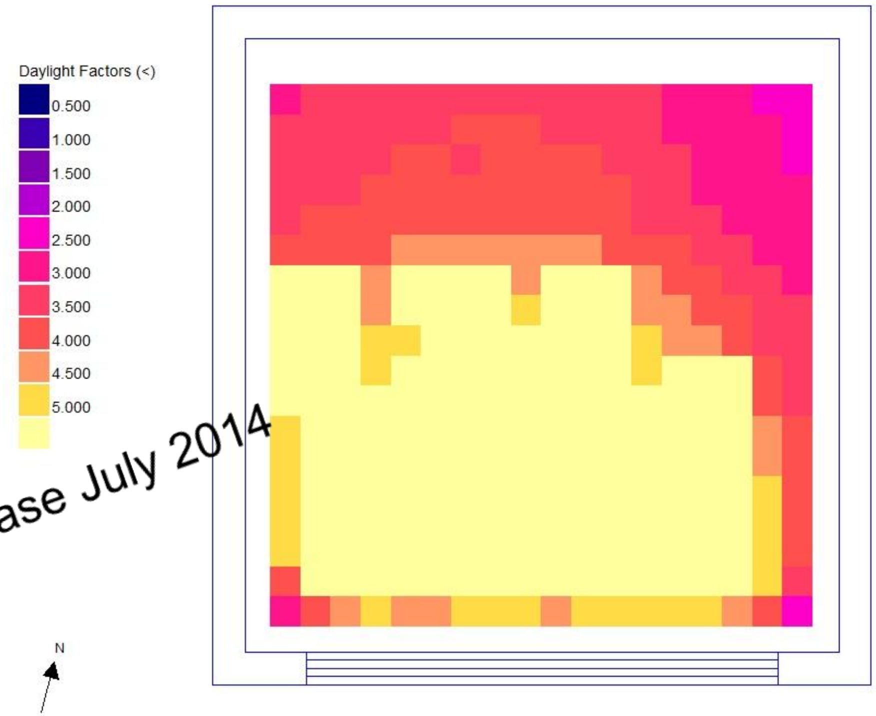
CBDM

Calibrate sampled beam and diffuse daylight analysis against equivalent solar gains from thermal simulations.

Calculate daylight levels from hourly solar gain over a year to produce UDI, DA and daylight distribution

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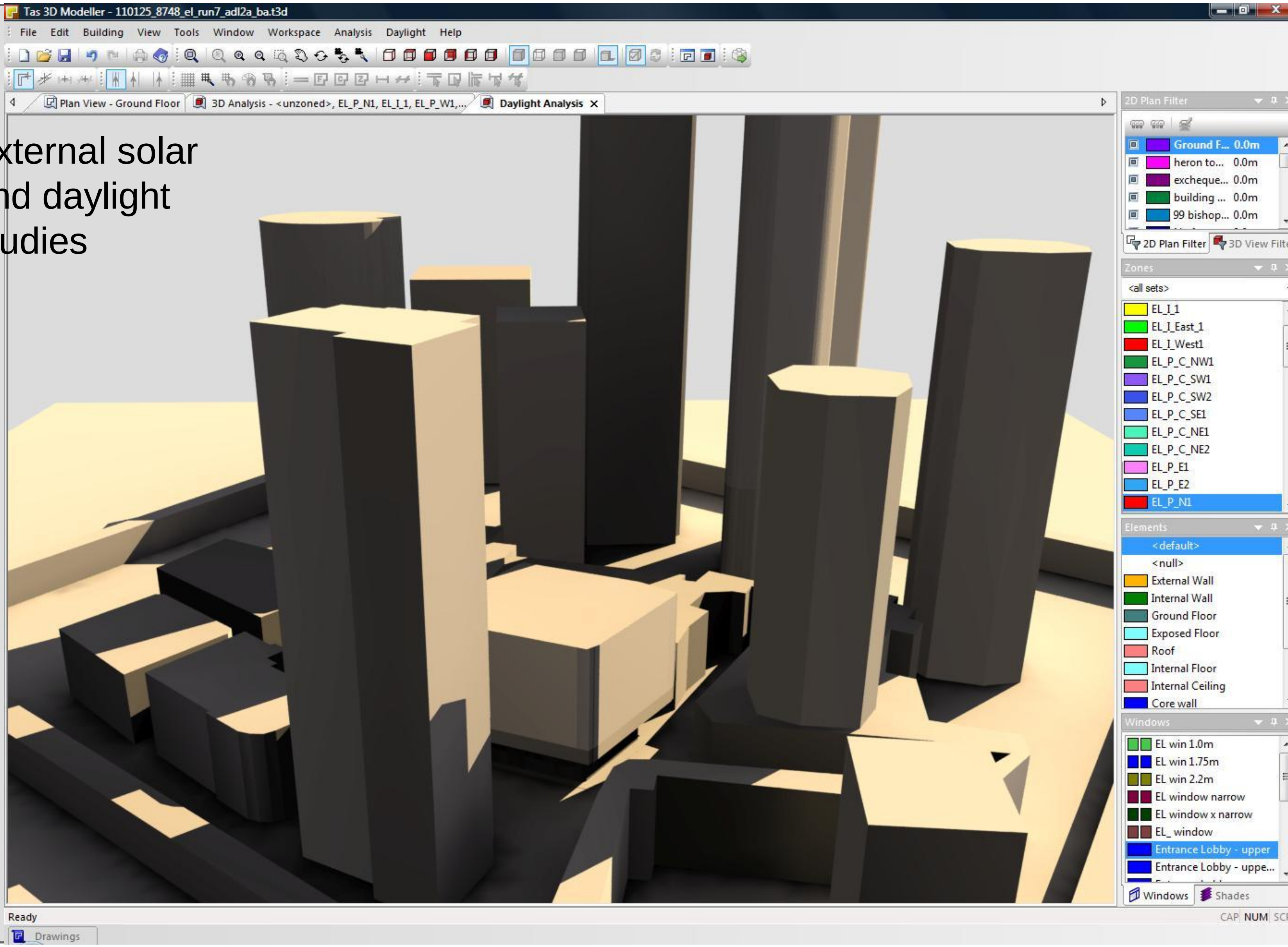
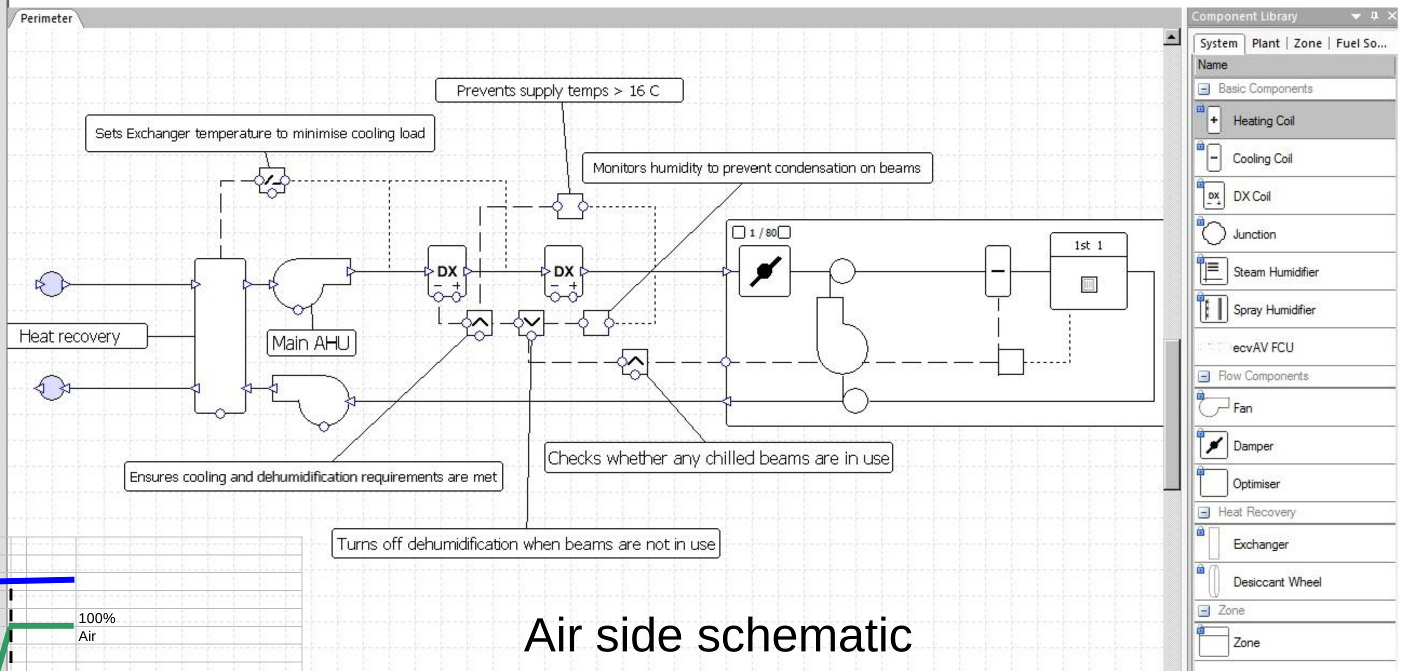
External solar and daylight studies

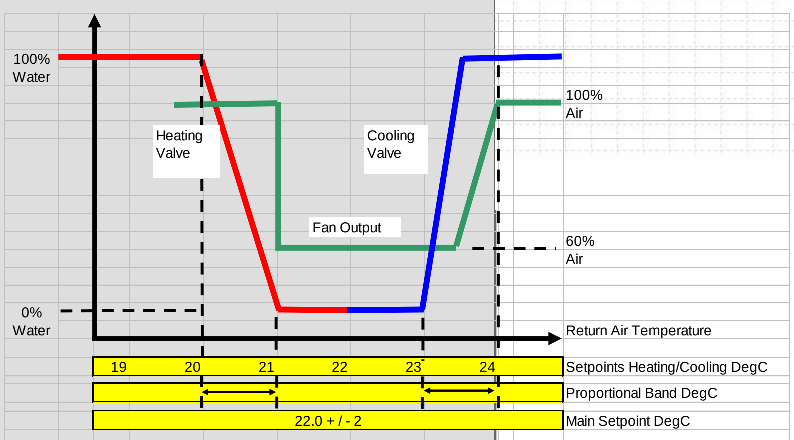


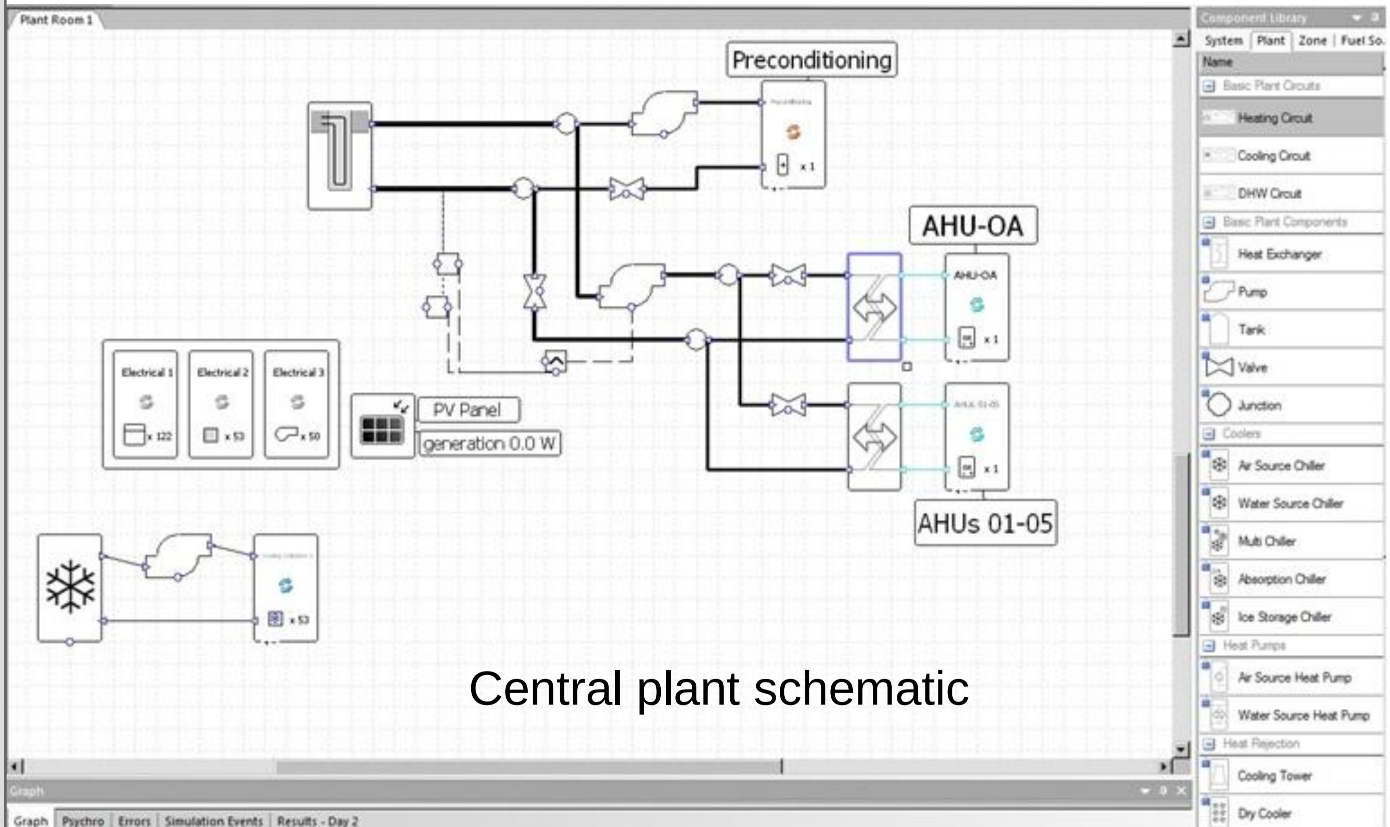
# Component based plant and control modelling coupled to building simulation

**KEY TECHNOLOGY**




Air side schematic

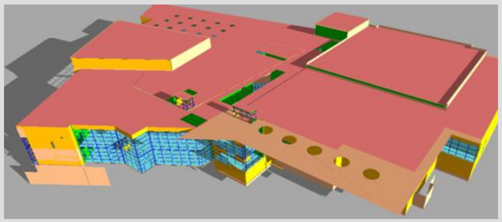




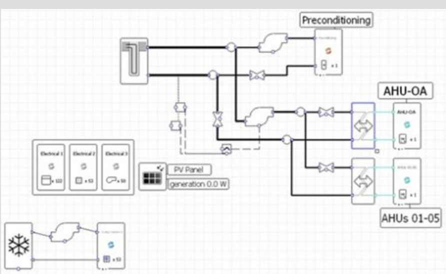

Central plant schematic

KEY TECHNOLOGY

Dynamic building thermal simulation uses a ‘Heat Balance Method’ as described in ASHRAE Fundamentals 2013 page 18.14



Annual building simulation completed in 80 sec.




Coupled space weighting factors and systems annual simulation 16 sec.

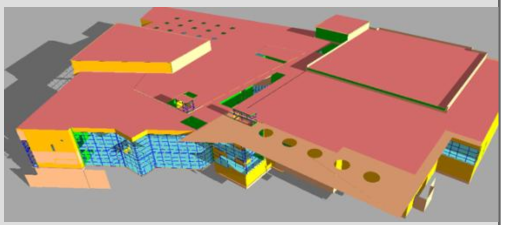
Smart coupling of building and plant simulation

Room ‘weighting factors’ can be calculated before plant simulation

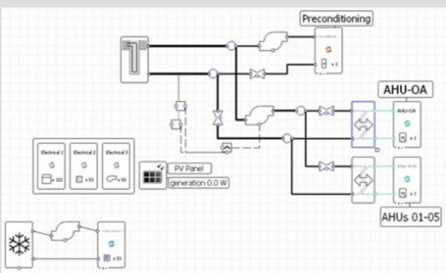
When plant operation alters the zone energy balance applying the time series weighting factor adjustments ‘corrects’ the result

Very accurate for simple adjustments, e.g. ventilation changes are typically within 1% of the exact solution

# Smart coupling of building and plant simulation

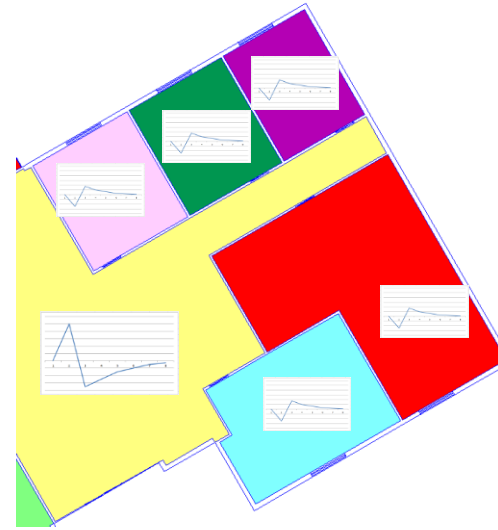


Annual building simulation completed in 80 sec.



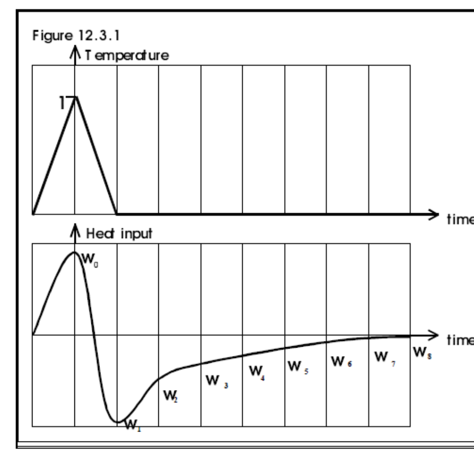

Coupled space weighting factors and systems annual simulation 16 sec.

As well as calculating the target zone's response, the effect of a temperature pulse on its neighbouring zones can be calculated and stored



When the plant simulation alters a zone's energy balance, the effect on neighbours is included and building heat balance is retained. Very important for underfloor systems and perimeter core zones in open plan

Convective and radiant weighting factors are calculated so systems with varying proportions of convective/radiant split may be modelled.



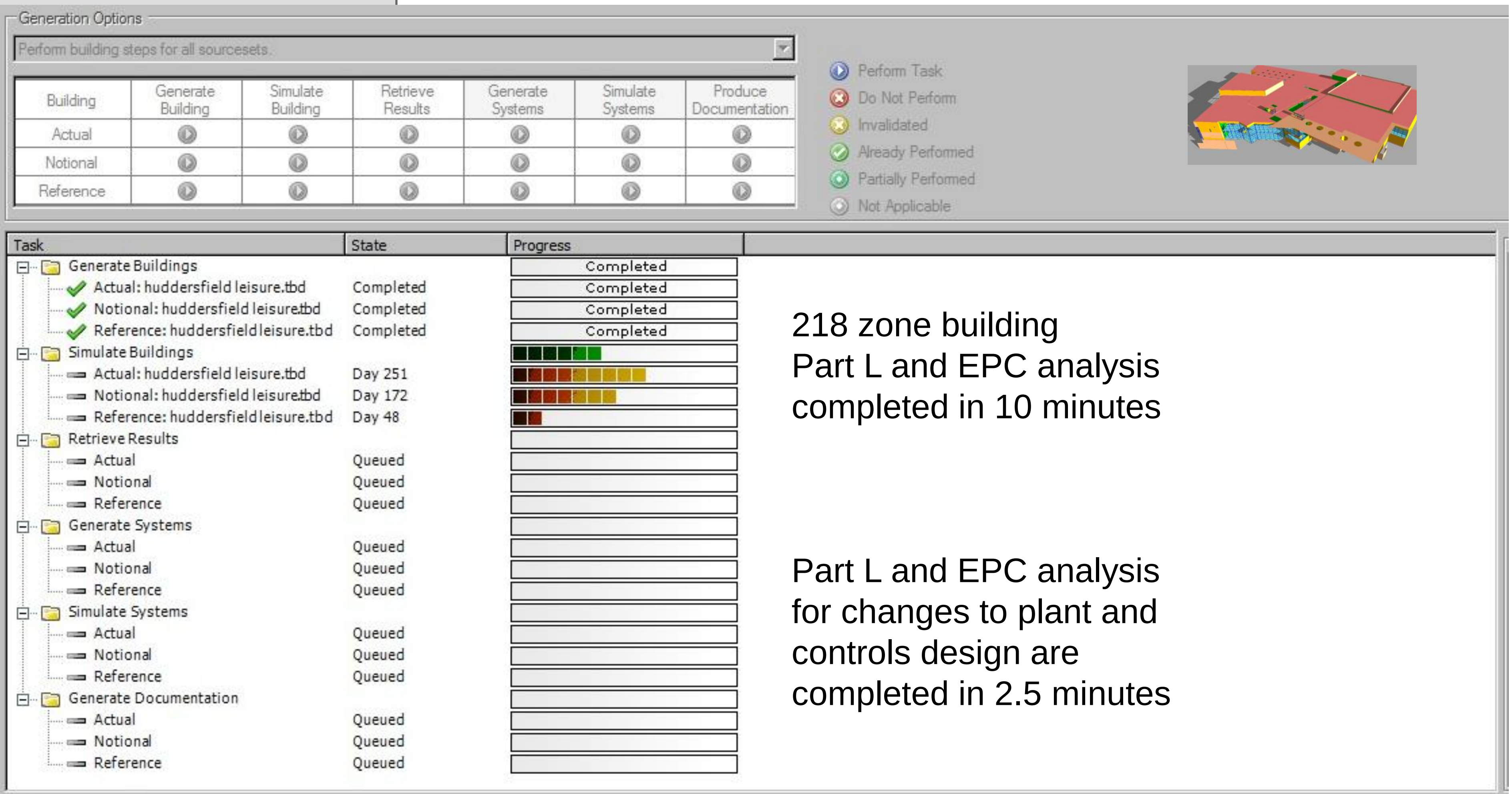
## Automation Interface

KEY TECHNOLOGY

UK Building Regs Studio 2013 automates the calculation procedure for Part L/EPC. It is multi-core enabled, simulating actual, notional and reference models simultaneously.

**Accredited by CLG 1st May 2014**

# Studio automatic generation of notional & reference buildings, multi-core simulation and report generation.

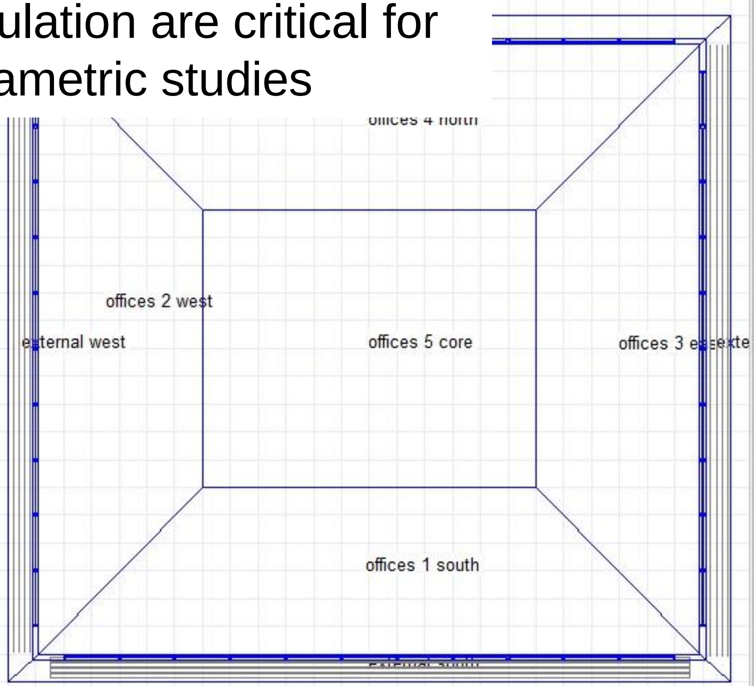



218 zone building
Part L and EPC analysis
completed in 10 minutes

Part L and EPC analysis
for changes to plant and
controls design are
completed in 2.5 minutes

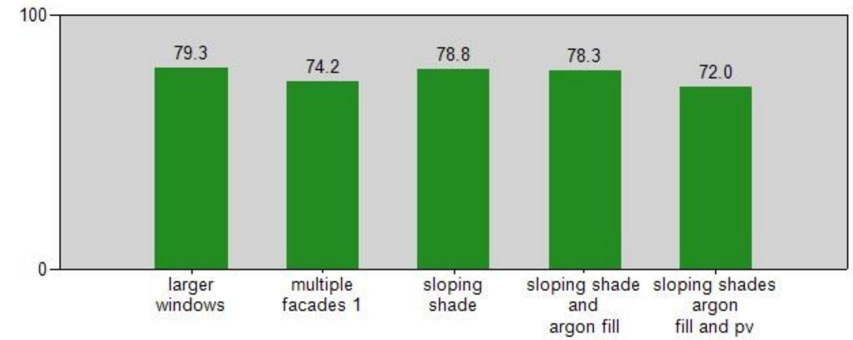
Tas 3D Modeller - sloping shade and argon fill

Accuracy and speed of simulation are critical for parametric studies




Tas Facade Designer

## Quick Energy Benchmark Results

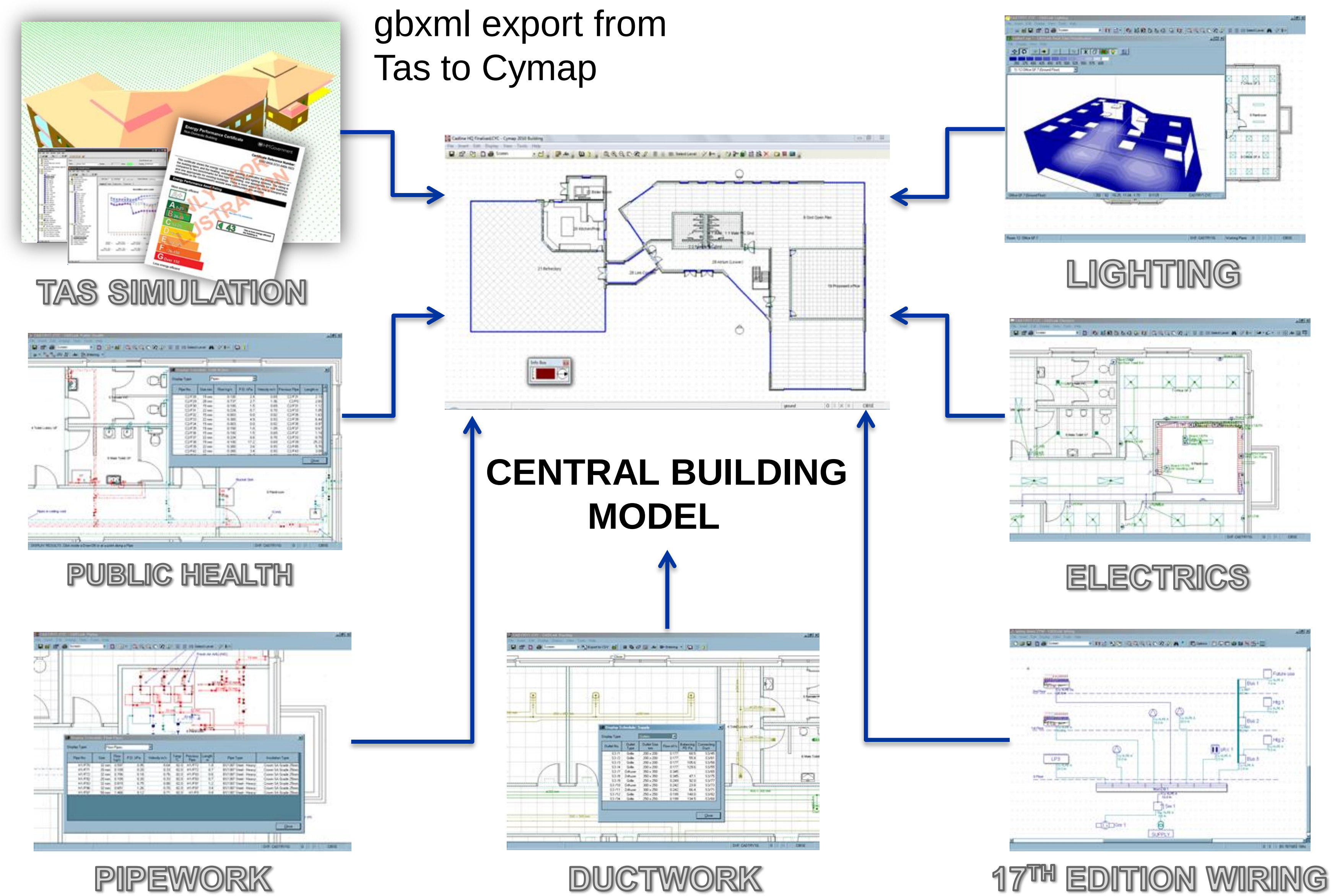


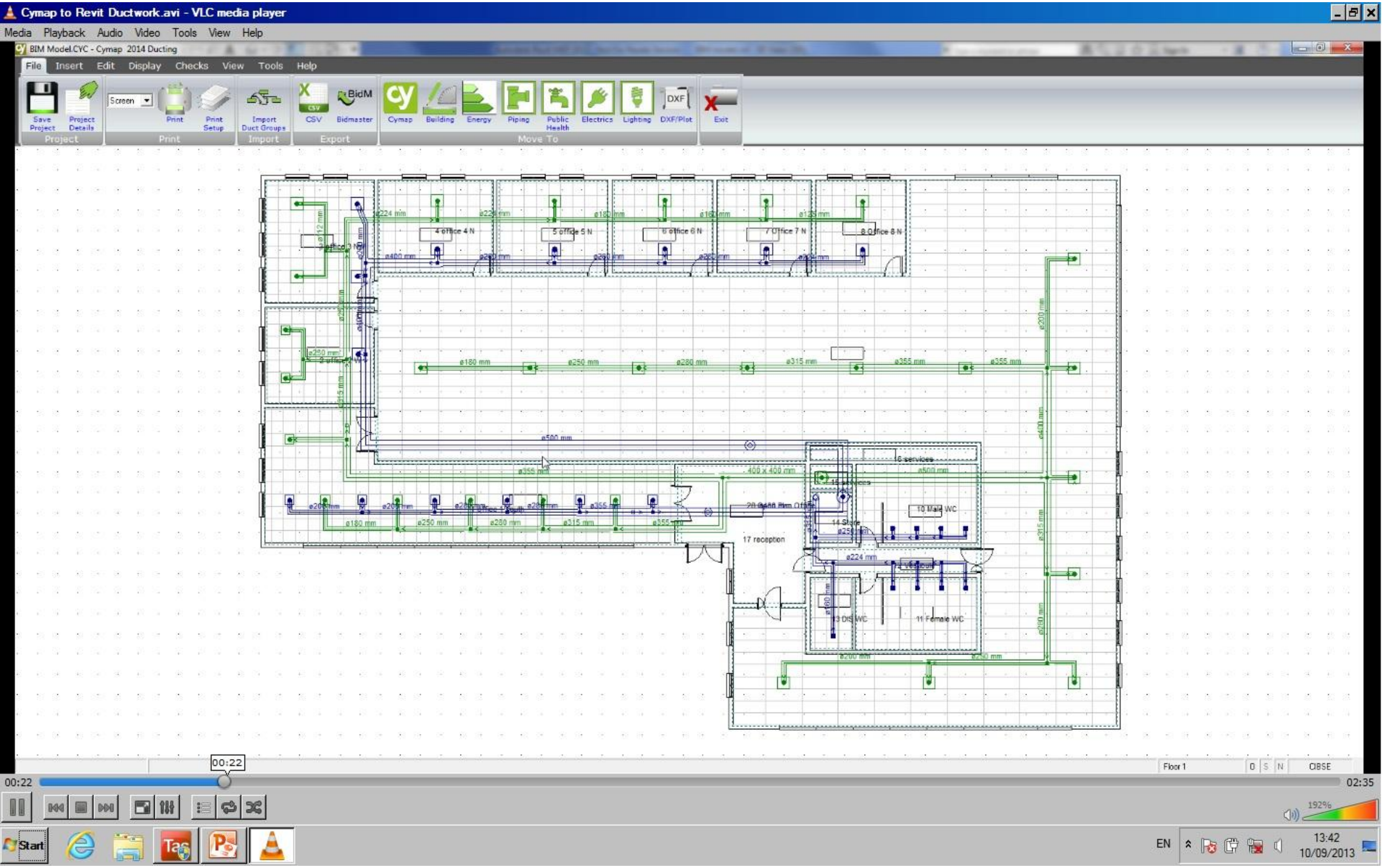

### offices 1 south

| Building Name | Floor Area (m2) | Daylight Factor (%) | Solar Exceedance (%) | Internal Blind |
|---|---|---|---|---|
| larger windows | 107.2299 | 7.92 | -27.46377 | False |
| multiple facades 1 | 107.2299 | 6.10 | -52.38129 | False |
| sloping shade | 107.2299 | 6.82 | -36.28601 | False |
| sloping shade and argon fill | 107.2299 | 6.82 | -36.44553 | False |
| sloping shades argon fill and pv | 107.2299 | 6.82 | -36.47341 | False |

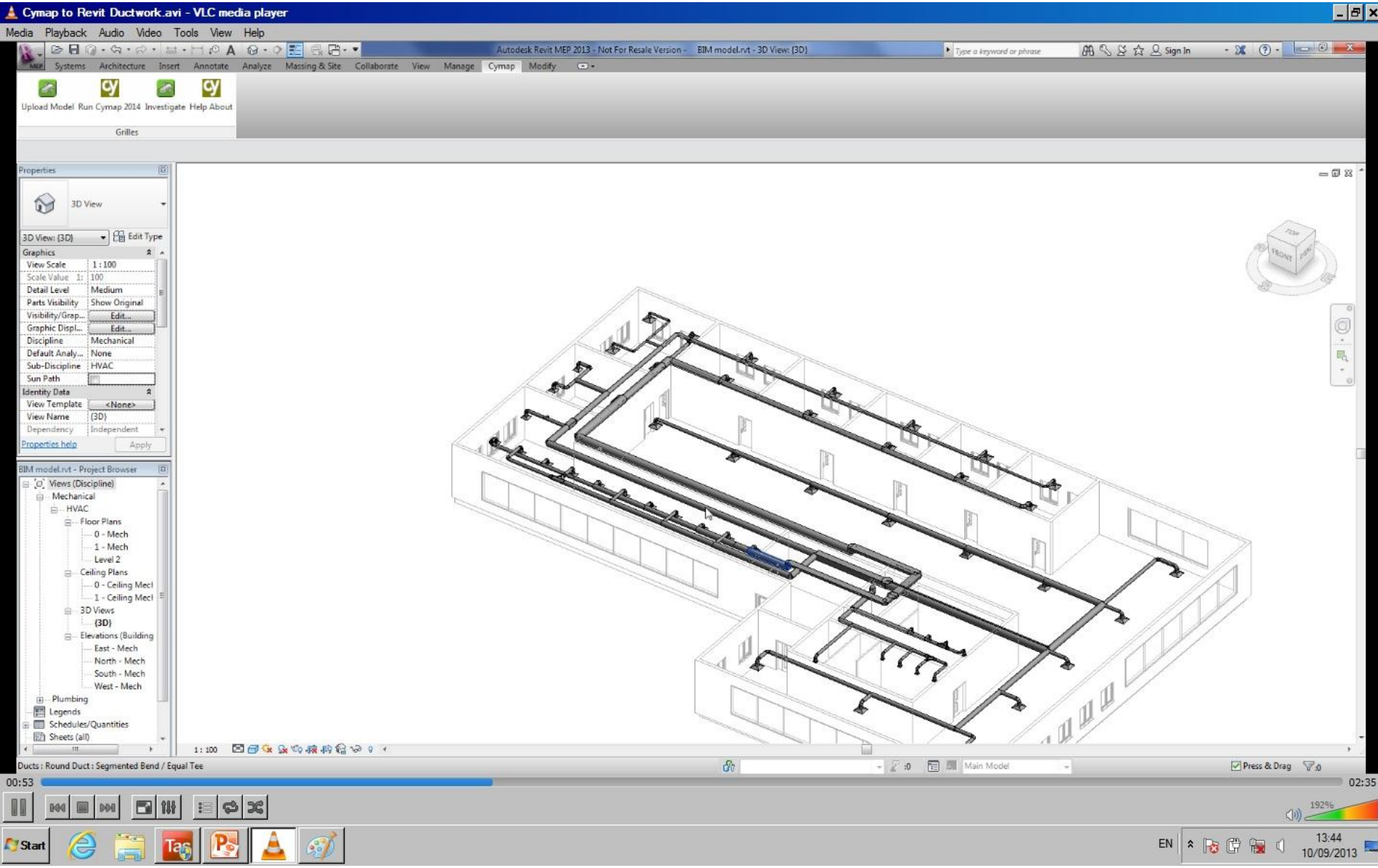
### offices 2 west

| Building Name | Floor Area (m2) | Daylight Factor (%) | Solar Exceedance (%) | Internal Blind |
|---|---|---|---|---|
| larger windows | 94.24611 | 8.03 | -29.78436 | False |
| multiple facades 1 | 94.24611 | 6.17 | -53.4896 | False |
| sloping shade | 94.24611 | 7.97 | -30.68942 | False |


gbxml export from
Tas to Cymap
TAS SIMULATION
LIGHTING
CENTRAL BUILDING MODEL
PUBLIC HEALTH
ELECTRICS
PIPEWORK
DUCTWORK
17TH EDITION WIRING


Cymap to Revit Ductwork.avi - VLC media player
Media Playback Audio Video Tools View Help
BIM Model.CYC - Cymap 2014 Ducting
File Insert Edit Display Checks View Tools Help
Save Project
Project Details
Print
Print Setup
Import Duct Groups
CSV
Bidmaster
Cymap
Building
Energy
Piping
Public Health
Electrics
Lighting
DXF/Plot
Exit
17 reception
11 Female WC
10 Male WC
Floor 1
CIBSE
00:22
02:35
Start
EN
13:42
10/09/2013

# INTEGRATED SERVICES DESIGN



Due for release July 2014

# Ecobim

An early concept sustainability design tool for architects

Compliant with UK Part L, CIBSE, ASHRAE and CEN standards

KEY TECHNOLOGY

# Technology Strategy Board Project:

Technology Strategy Board
Driving Innovation

London South Bank University

EDSL Tas

Verco

- Increased automated analysis
- IPMVP compliance
- Demand control
- Integration with Verco Carbon Desktop
- Integration with TAS:
    - Interface with weather station
    - Exchange data (Using BIM Protocols)
    - Compare model Vs actual
    - Identify the ‘Performance Gap’
    - Hone model
    - Use model to plan substantial refits

30 Month project
Value £822,500

Demand LOGIC

## KEY TECHNOLOGIES

Solid modelling 3D geometry

Radiosity and ray-trace daylight simulation

Dynamic building thermal simulation uses a Heat Balance Method – Reference ASHRAE

Component based plant and control modelling coupled to building simulation