

# **SOLAR POWER FOR A LOW ENERGY OFFICE**

Brian D Hughes - Environment Agency



Mark Cunniffe - Hoare Lea

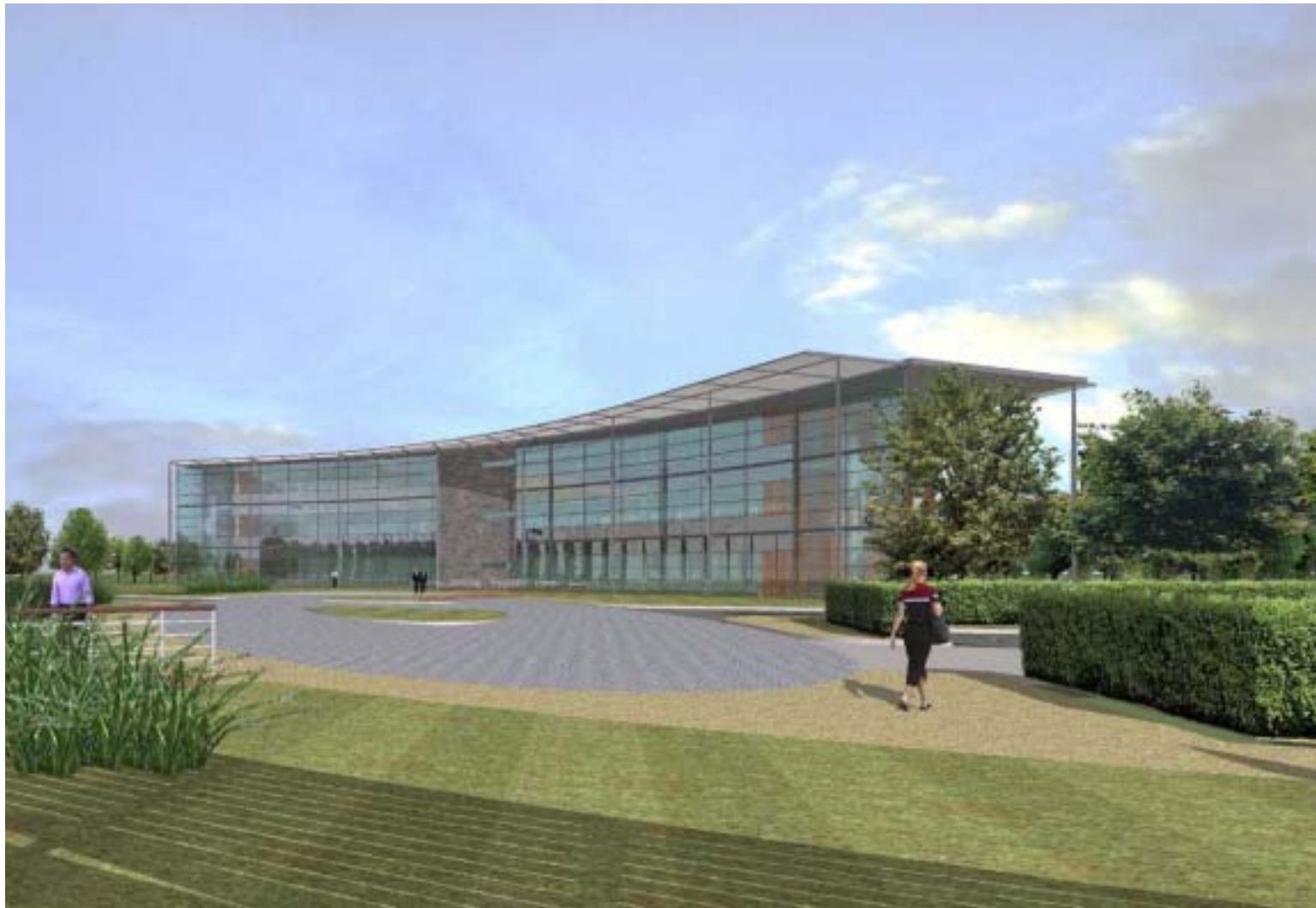


# Location of Wallingford



ENVIRONMENT  
AGENCY

# Artist's Impression



ENVIRONMENT  
AGENCY

# Facts and figures about the new office

- Floor area: approx. 26,000 sq.ft (2,500 sq.m)
- 3 floors
- 75% open plan and 25% cellular
- 250 staff based there but only expect approx. 185 at any one time
- Designed to achieve BREEAM “excellent” status



# Environmental features of the new office

- Energy efficient design and construction
- Optimum use of natural light
- Photovoltaic cells
- Solar thermal water heating
- Natural ventilation supported by wind turbines
- Rainwater harvesting
- Sustainable drainage from car park



# Environment Agency vision and targets re: energy saving

- We will reduce energy and resource consumption by promoting effective and efficient reduction methods consistent with best practice
- The Agency's own environmental performance will be as good as the best private and public sector organisations and we will use this position to influence others
- Reduce energy consumption in our buildings by 10% in the period 2000/1 - 2003/4
- Want to see a 60% cut in carbon dioxide emissions from the industries we regulate by 2050
- We will contribute to local initiatives and influence national policies to increase use and generation of renewable energy sources



# **SOLAR POWER FOR A LOW ENERGY OFFICE**

Mark Cunniffe



# Design Performance

- 25°C not to be exceeded for more than 5% of the annual occupied hours (“average” weather year)
- Natural cross ventilation (eliminate mechanical cooling)
- BREEAM “excellent”
- Energy efficiency substantially better than a Type 2 office (Econ 19 “Good Practice”)
- Future proofing – retrofit option for bore hole water cooled displacement ventilation static cooling and heating (DVSCH)

# Design Response

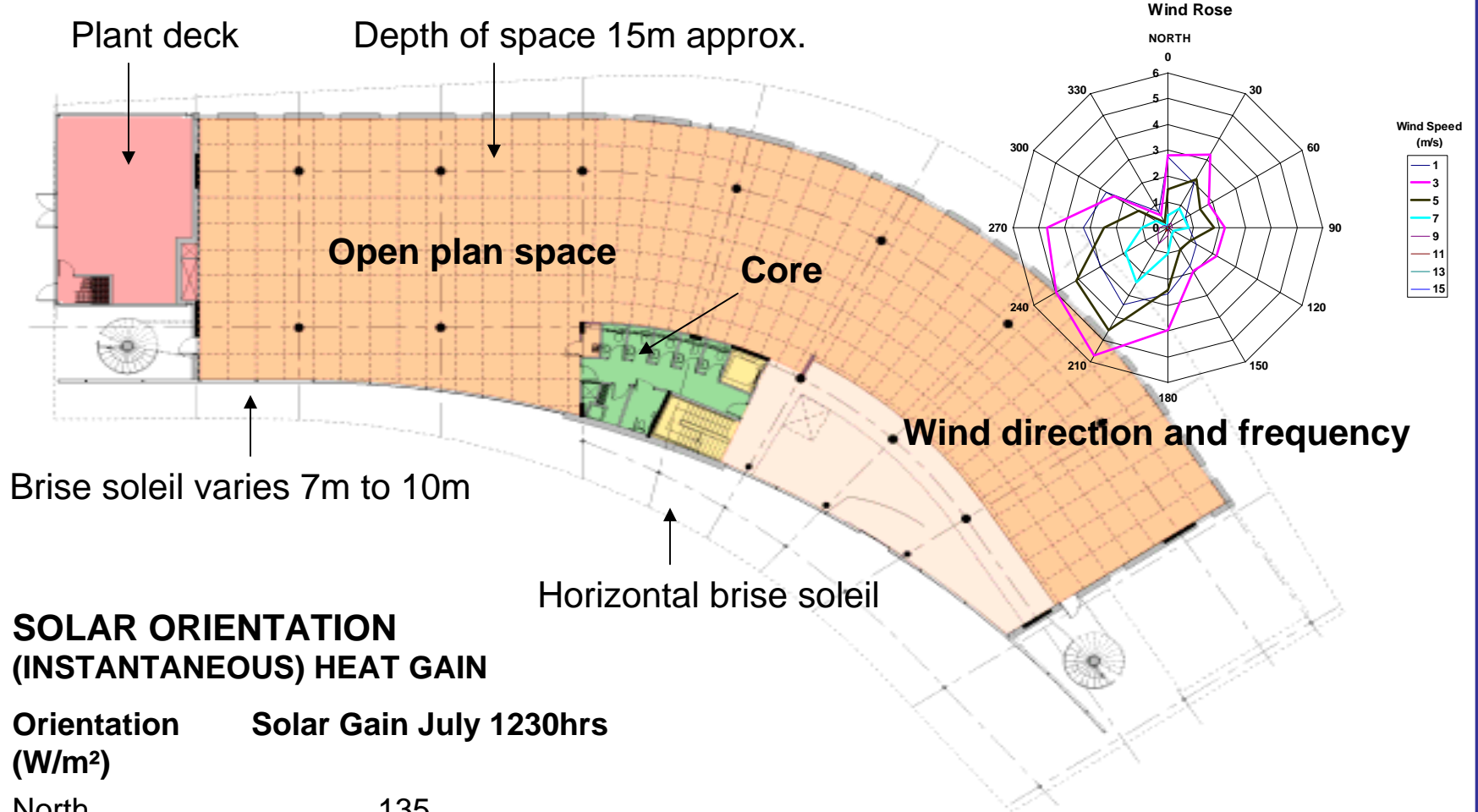
- **Internal Heat Gains**

- Occupancy: 1 person/12.5m<sup>2</sup> (9am – 6pm, Mon-Fri)
- Artificial lighting: 8W/m<sup>2</sup> (300 lux on the working place)
- Small power: 8W/m<sup>2</sup> (requires flat screens)

- **Building Design**

- Exposed concrete soffit (to absorb heat)
- Nocturnal cooling (motorised clerestory windows)
- External shading
  - Brise soleil to the South (with louvre mounted PV cells)
  - Plant deck/escape stairs to the East/West elevations
- Solar control glazing - Saint Gobain KN 155 (Neutral)
- Second floor thermal performance enhanced using wind turbine driven ventilation

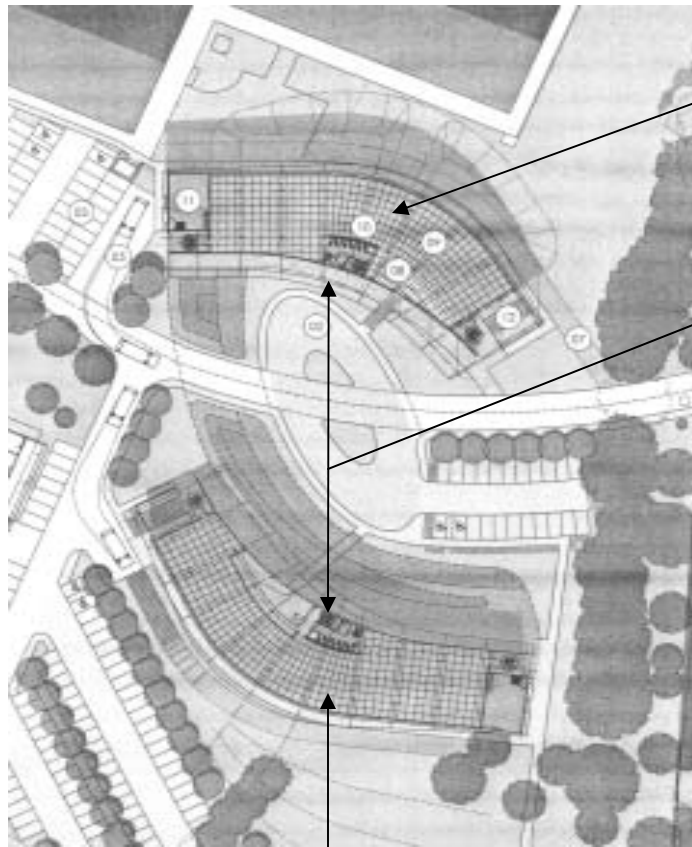
# Building Orientation Optimisation



## SOLAR ORIENTATION (INSTANTANEOUS) HEAT GAIN

Orientation	Solar Gain July 1230hrs (W/m <sup>2</sup> )
North	135
South	238
East	165
West	142

# Building Locations

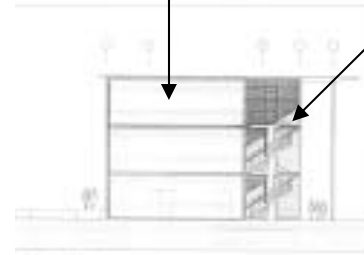


Environment Agency Building

Façade designs – a common theme

Plantroom

Escape staircase



West Elevation

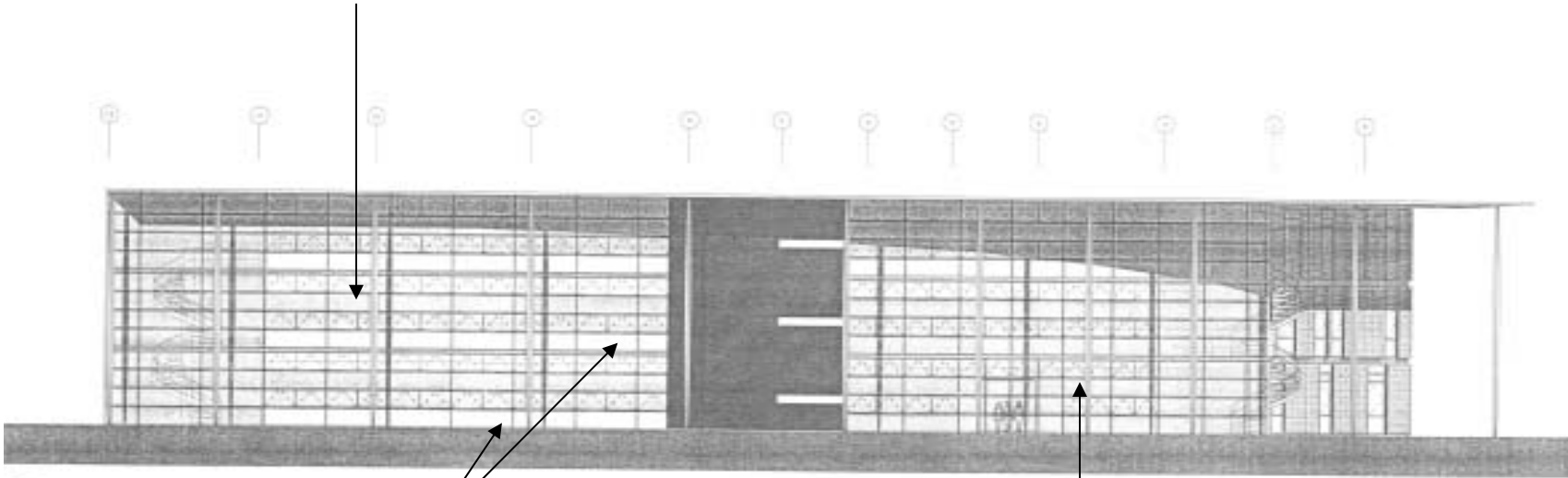
East Elevation

NORTH

HR Wallingford Building

# South Elevation

Top hung motorised clerestory windows

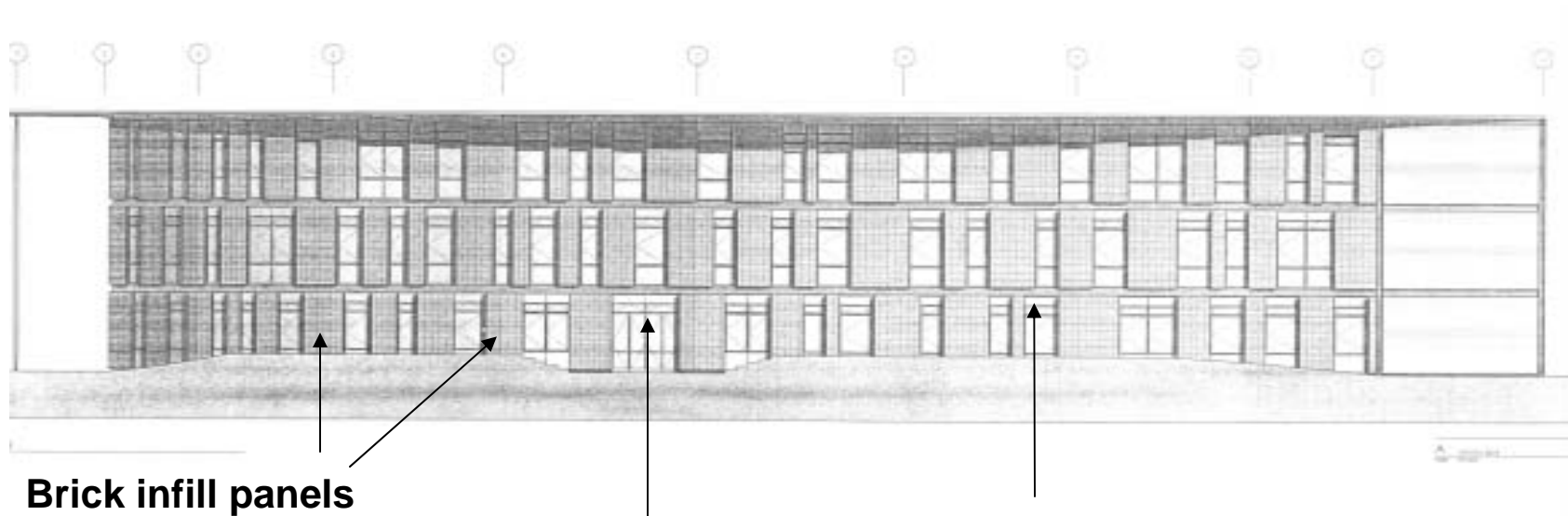


Opaque cladding panels

Top hung manual opening windows with interstitial blinds

Solar control glazing Saint Gobain KN 155 “neutral”

# North Elevation



**Brick infill panels**

**Top hung motorised clerestory windows**

**Manual opening windows with internal blinds.**

**Solar control glass. Saint Gobain KN 155 “neutral”**

# South and North Façade

## South Facing



Solar control glazed elements with opaque cladding panels reflecting the architectural style of the HR Wallingford building.

## North Facing

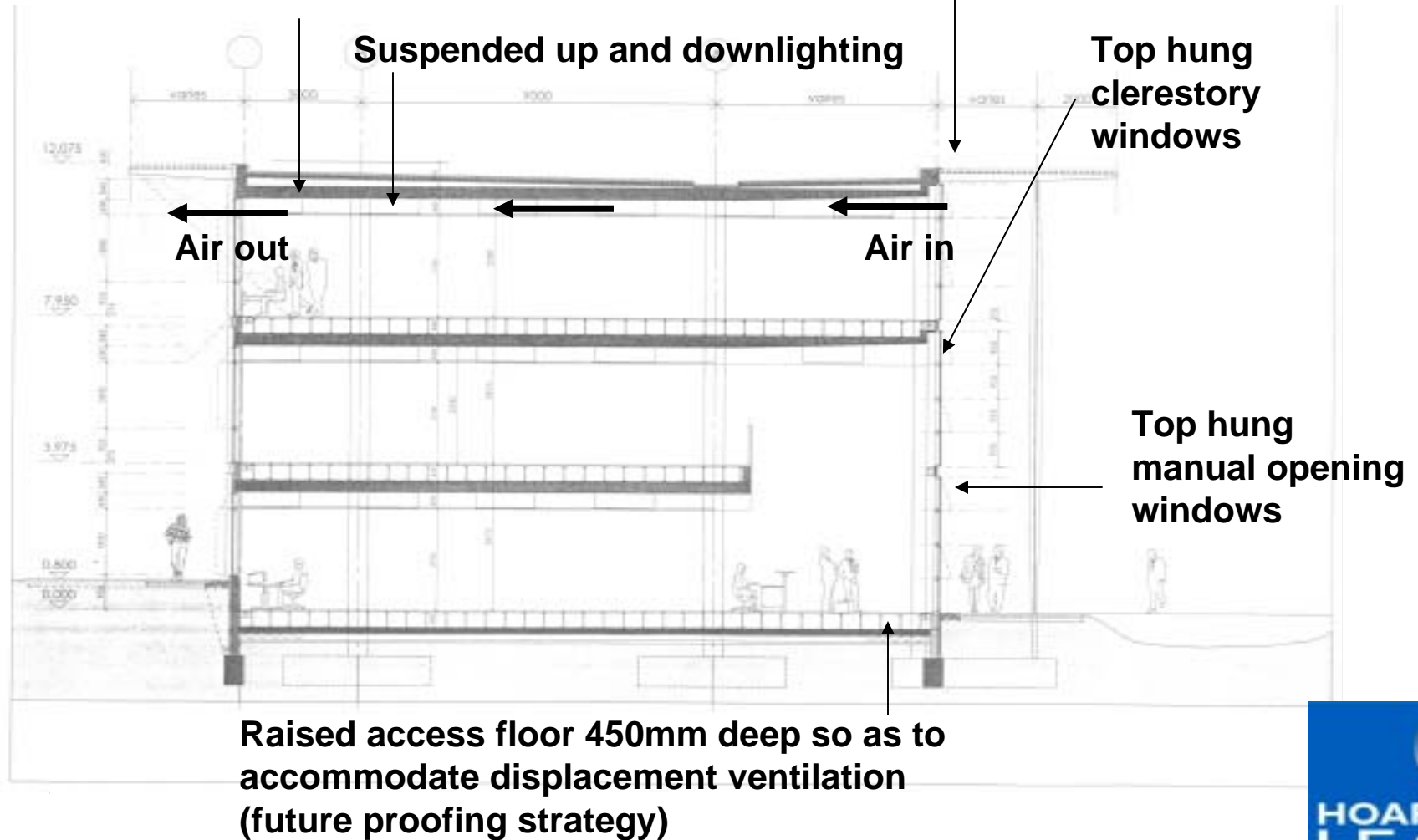


Solar control glazed elements with brick intermediate panels.

# Section Through the Building

Flat slab construction  
attenuating heat gain

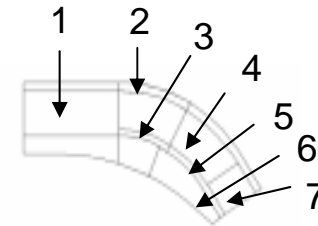
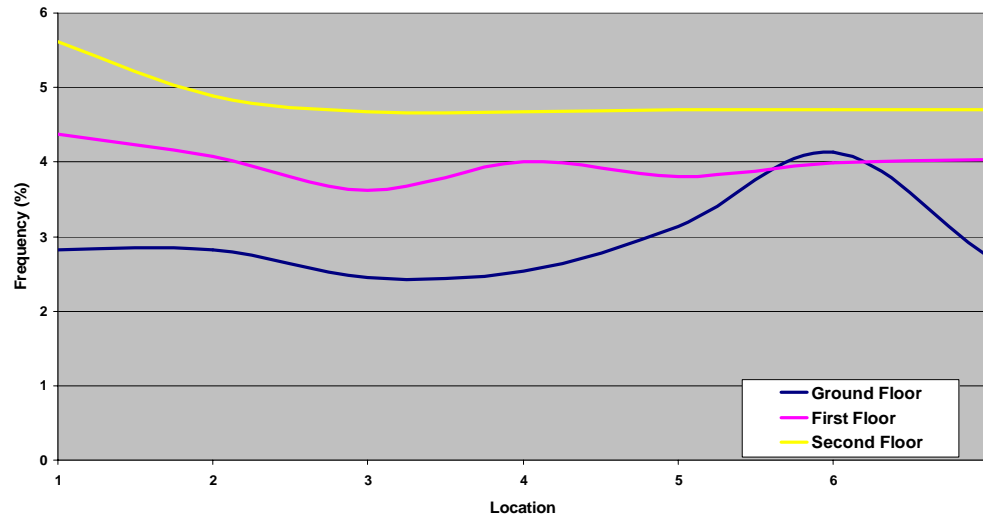
South façade brise soleil with PVs  
mounted in louvre sections



Raised access floor 450mm deep so as to  
accommodate displacement ventilation  
(future proofing strategy)

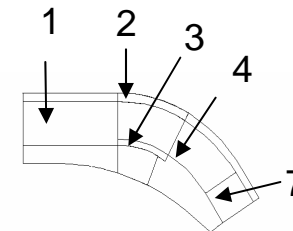
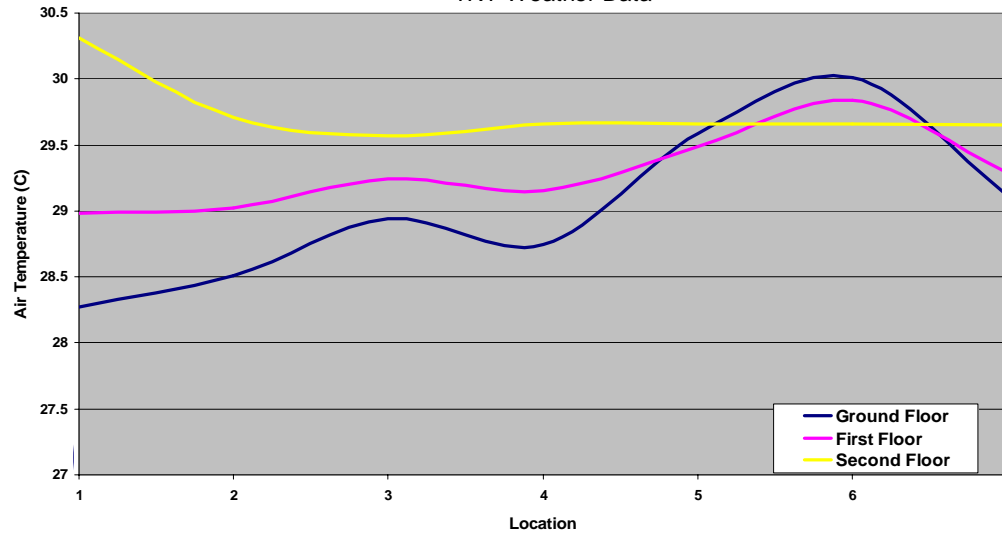
# Thermal Performance – TRY Weather Year

Percentage of the Annual Occupied Period - Air Temperature Above 25°C  
TRY Weather Data



Ground and First floor

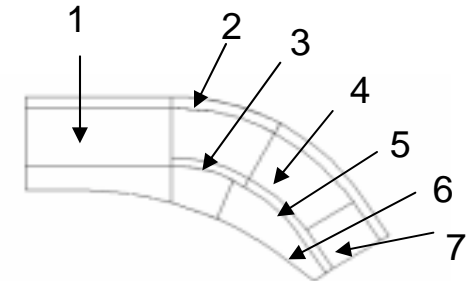
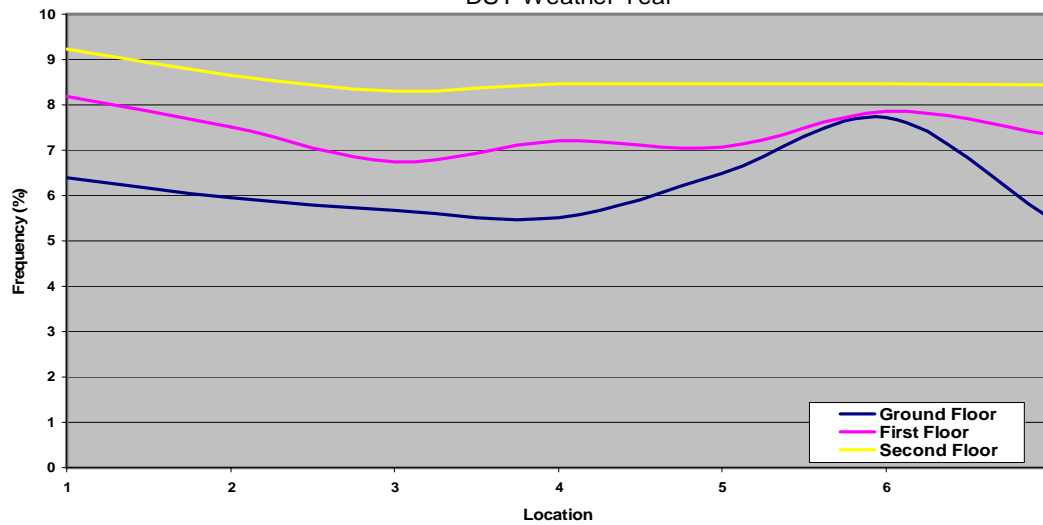
Peak Air Temperature (°C)  
TRY Weather Data



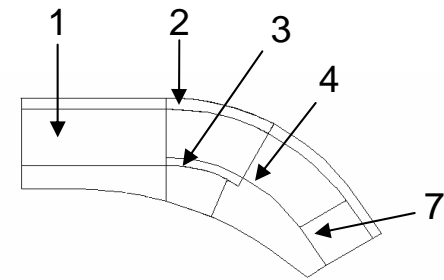
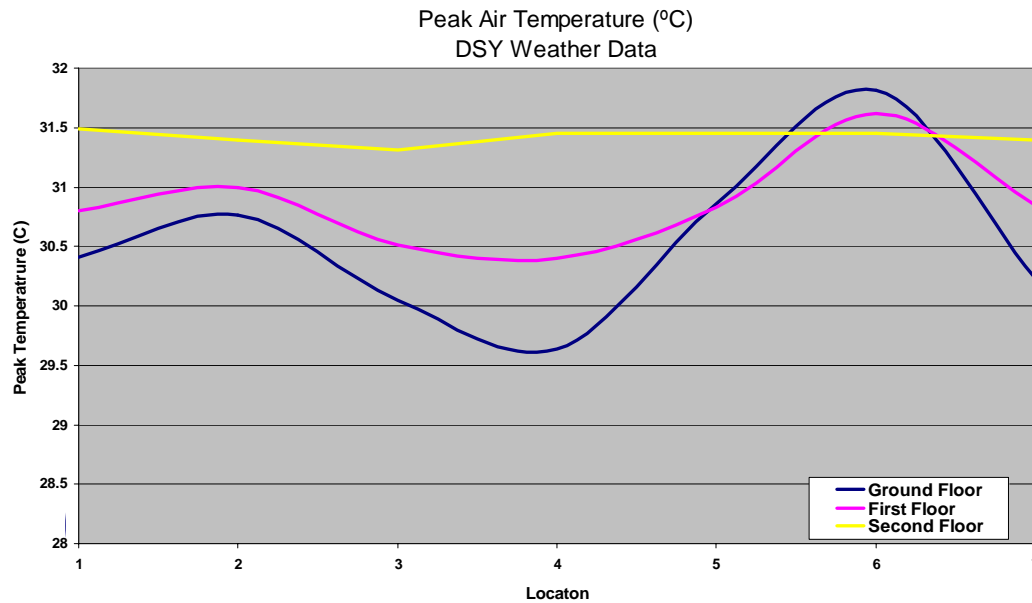
Second floor

# Thermal Performance – DSY Weather Year

Percentage of the Annual Occupied period - Air Temperature Above 25°C  
DSY Weather Year



Ground and First floor



Second floor

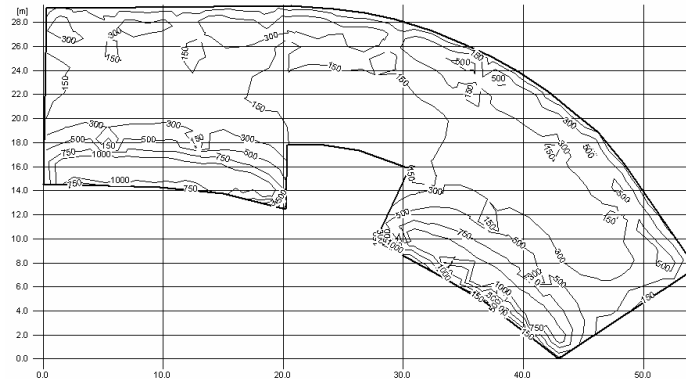
# Daylight and Artificial Lighting

- 8W/m<sup>2</sup> peak (undiversified) heat gain - 300 lux on the working plane
- Combined up and downlighting – compliance with CIBSE LG3 Guidance
- Intelligent luminaires – daylight and PIR occupancy sensing

Daylight simulations ground floor



Predicted illuminance levels



## Daylight Factor

0 – 2%

2 – 5%

> 5%

Artificial light required

Well daylight space, some artificial light

Well daylight space

Calculated average daylight factor

2.7%

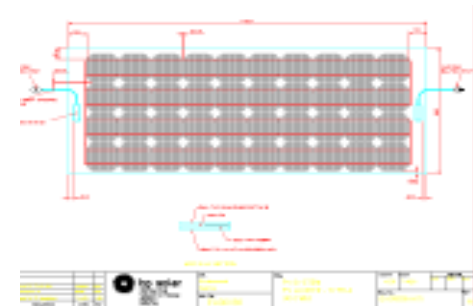
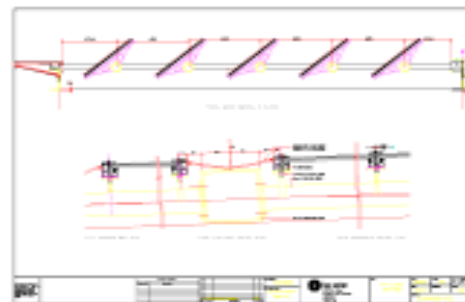
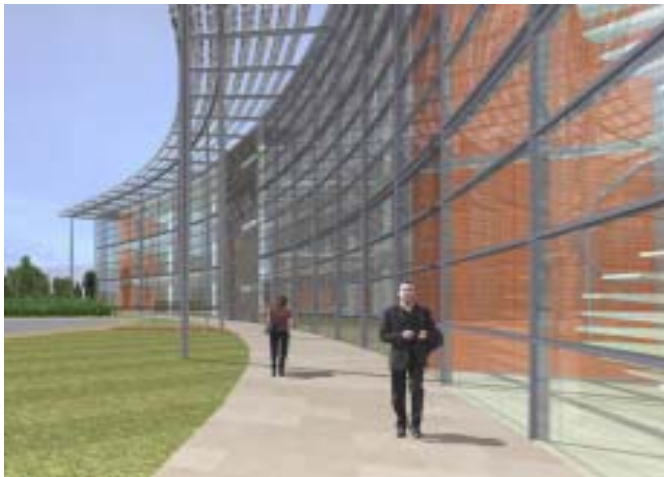
Calculated average daylight illuminance

361 lux

# Photovoltaics

- Built into the South facing brise soleil
- Dual function: reduce solar heat gain and displace mains electricity
- Type: monocrystalline
- Capital cost £280,000
- Savings: 23,000kWh/year
- £1,200/year @ 5p kWh
- 1,010kg CO<sub>2</sub> @ 0.43kg CO<sub>2</sub> kWh
- PV's displace 20% of "Good Practice" delivered electrical energy as defined in Econ 19 Type 2 building

## South facing brise soleil with PV louvre sections



PV cells built into brise soleil

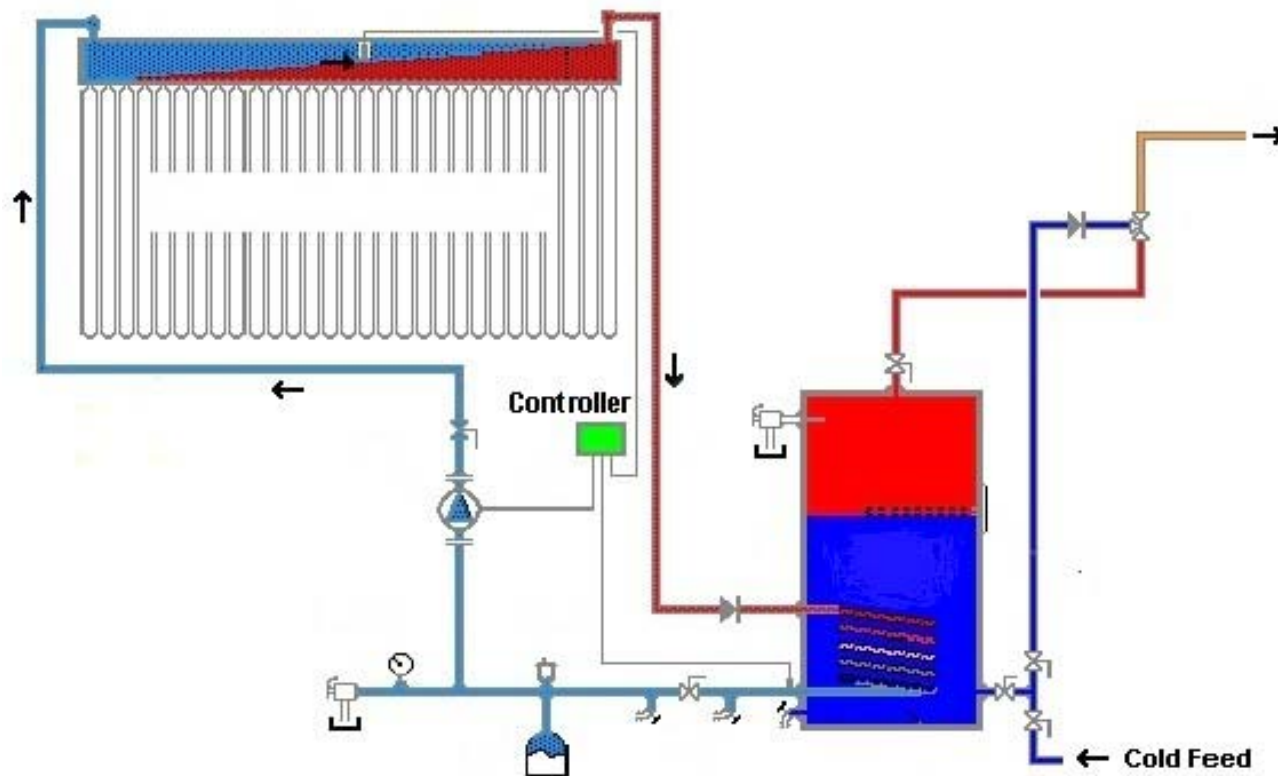
# Solar Water Heating

**Type:** Evacuated solar collector

**Capital cost:** £24,000

Annual predicted energy and carbon emissions saving: 341Kg/C/annum

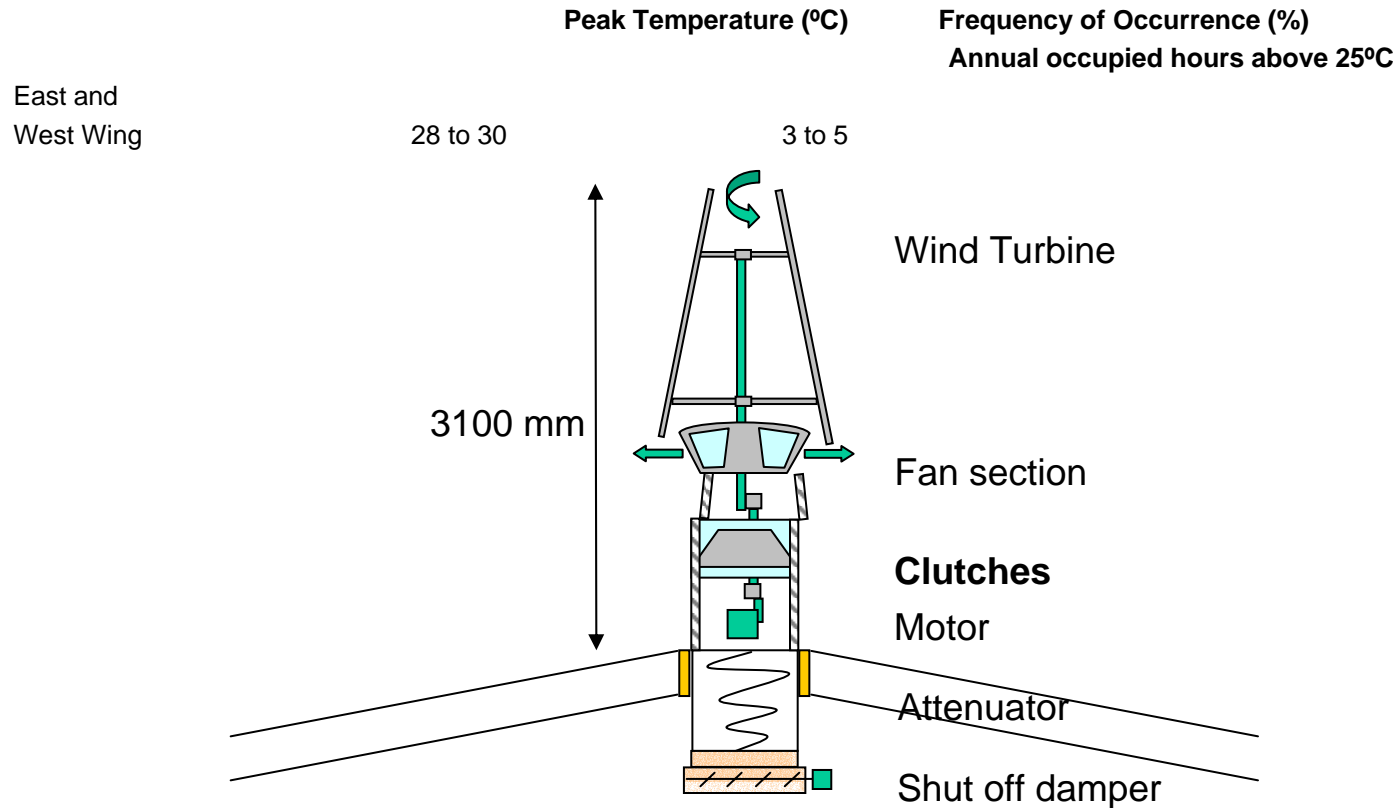
## Schematic drawing



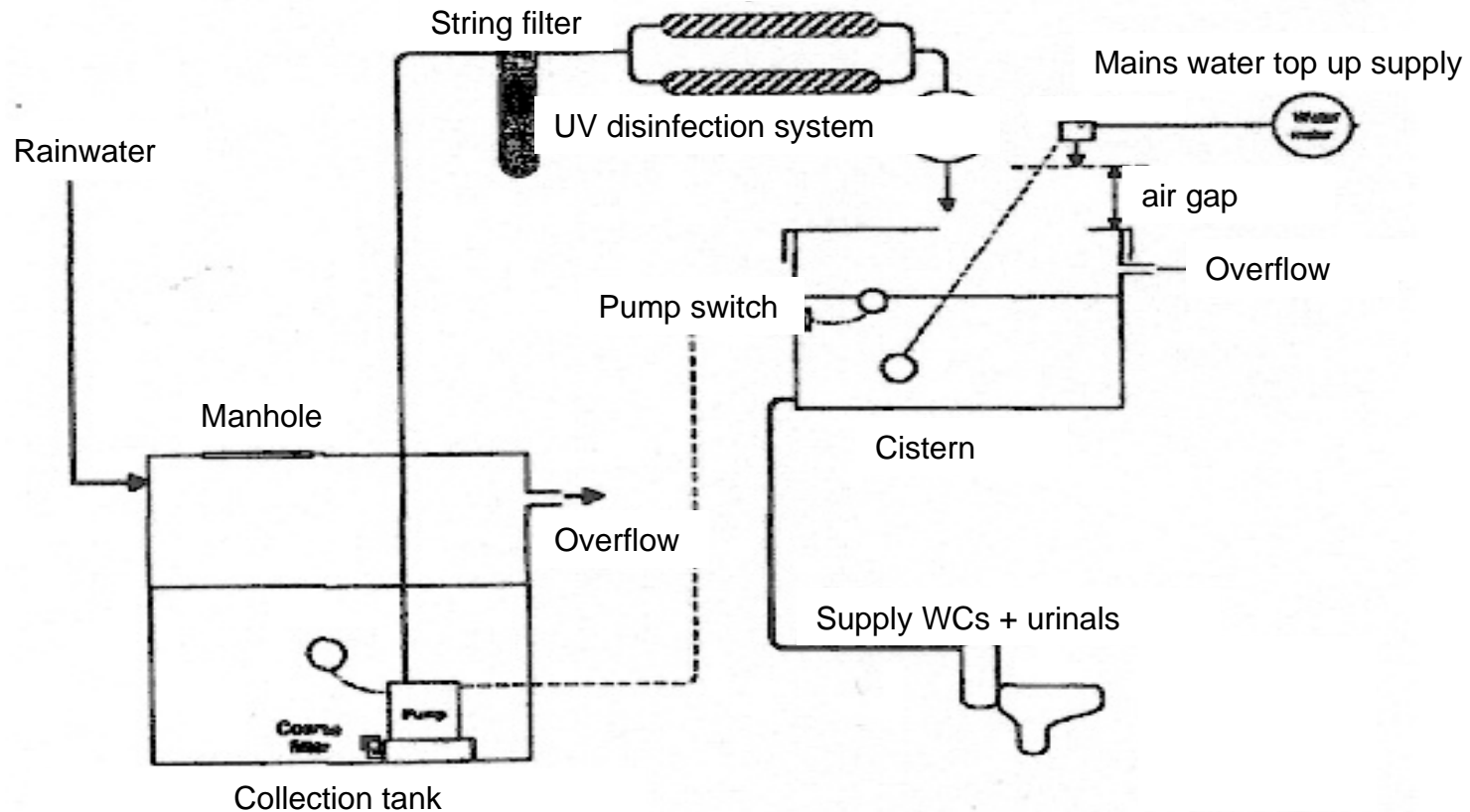
# Vertical Axis Wind Driven Ventilation

## Second floor thermal performance with turbines installed

Number of units	2 or 4
Design air flow rate	4 air changes per hour (motorised)
	Design air flow at a wind speed of 1.5 m/s 1.5 air changes
Capital cost	£50,000



# Rainwater Harvesting



Predicted annual water usage:	570m <sup>3</sup>
Predicted saving due to rainwater harvesting:	240m <sup>3</sup>
Tank size:	8000 litre
Capital cost:	£23,000

# Summary

- The EA building design responds to the Clients brief and in particular the thermal performance (comfort criteria)
- The building is an example of holistic, integrated environmental design, optimized in its use of:
  - Natural resources (sun, wind, daylight, solar gain and rainwater)
  - The building orientation and landscape
  - Building envelope and fabric
  - Internal heat gain
- **The result:**
  - A naturally ventilated optimised building of architectural merit
  - BREEAM excellent
  - Carbon emissions 26% below Econ 19 Type 2 office “Good” practice guidance