Thermal performance of light steel residential buildings: Numerical simulations and experimental validation

Paulo Santos
(pfsantos@dec.uc.pt)

Brussels, 16th Mars 2009

FCTUC FACULDADE DE CIÊNCIAS E TECNOLOGIA
UNIVERSIDADE DE COIMBRA

TABLE OF CONTENTS

- Case Study: Single Family Residential Building
- Experimental Measurements
- Numerical Simulations
- Comparative Analysis of Results
- Parametric study:
  - Natural Ventilation
  - Internal Gains
  - Overhangs Shading
  - Windows Glazing Types
  - Windows Shade Devices

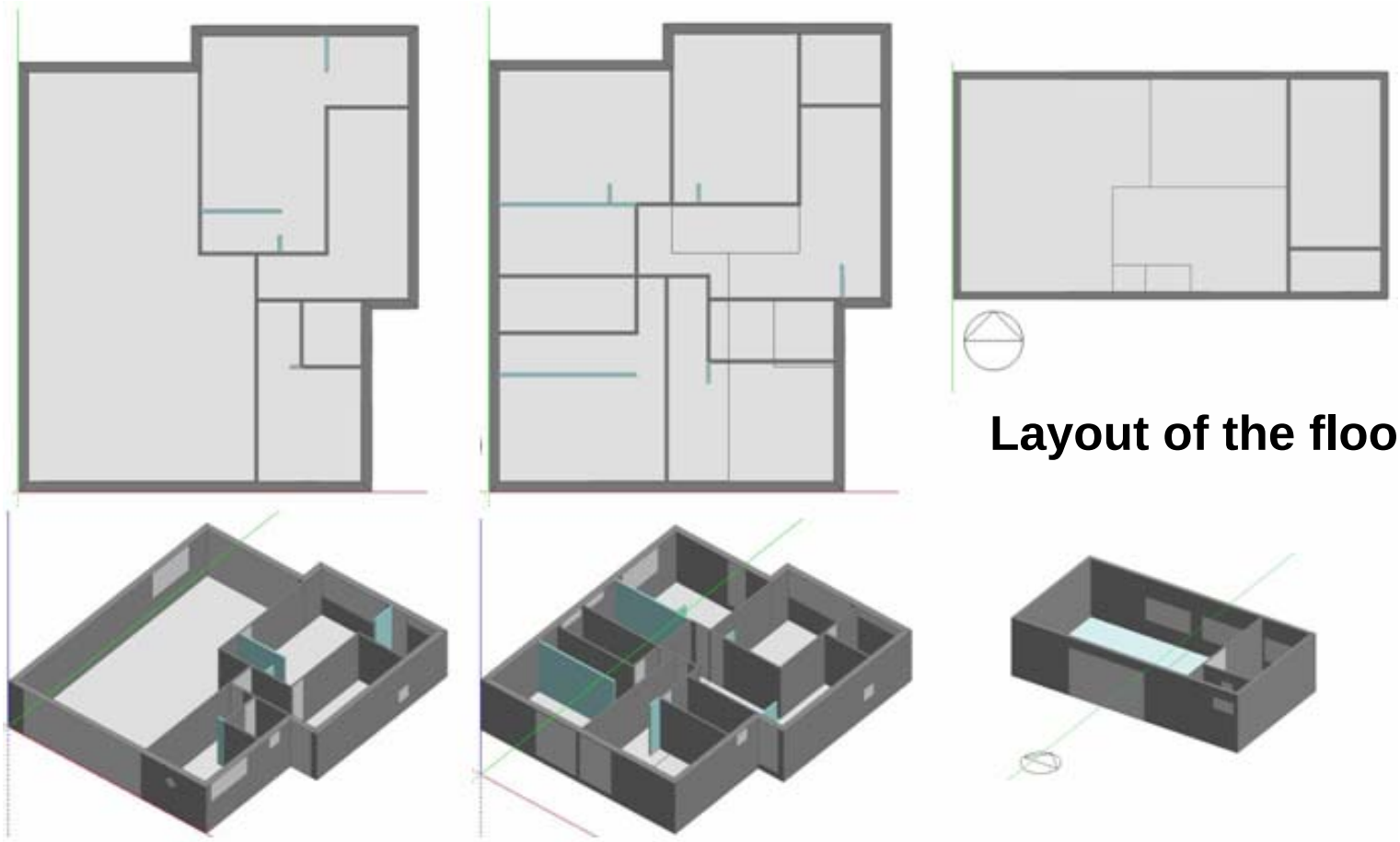
CASE STUDY

Single family residential building

Rear view

Front view

CASE STUDY: Single family residential building



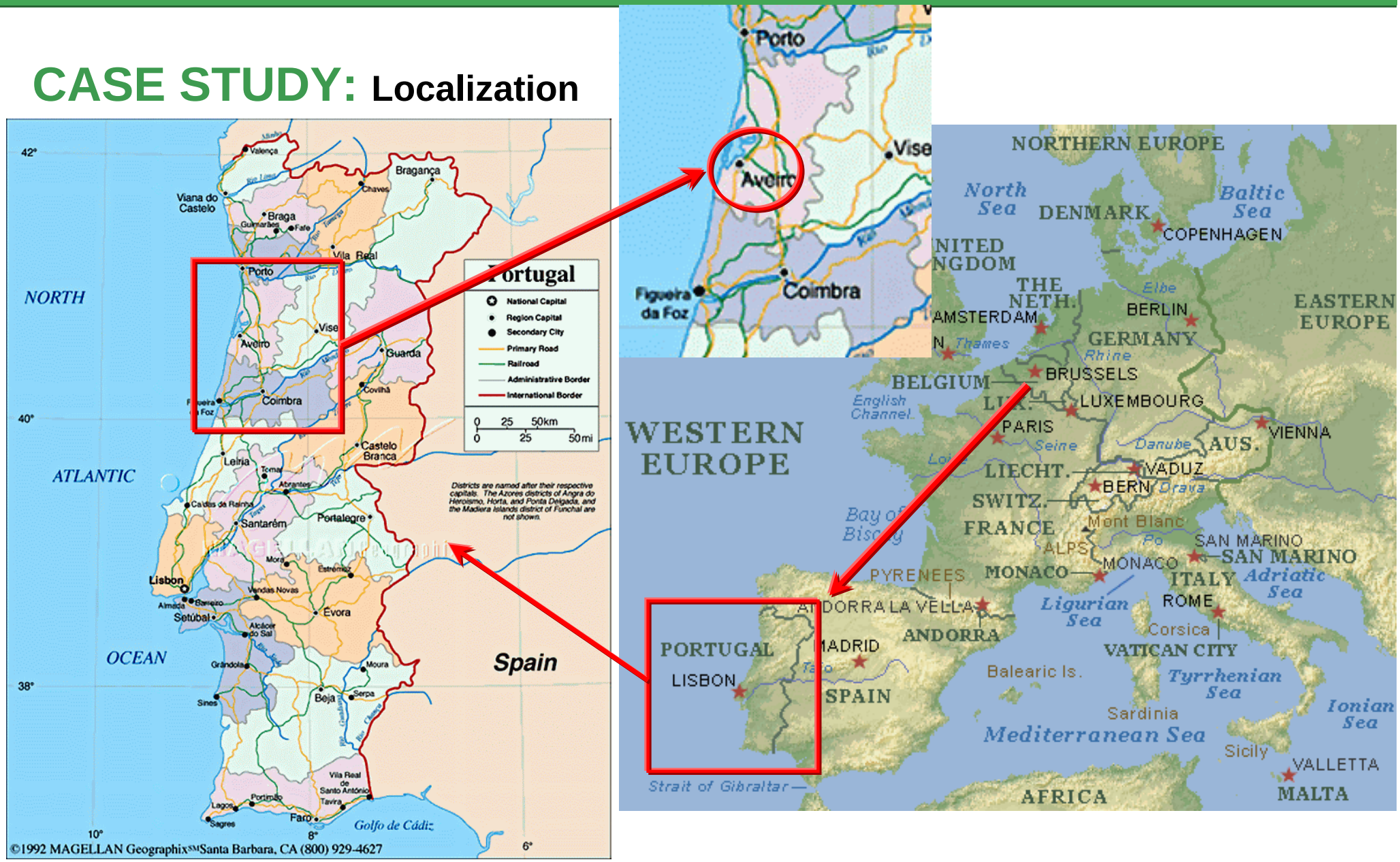
Layout of the floors

1st Floor – 183 m²

2nd Floor – 183 m²

3rd Floor – 68 m²

CASE STUDY: Localization



EXPERIMENTAL MEASUREMENTS

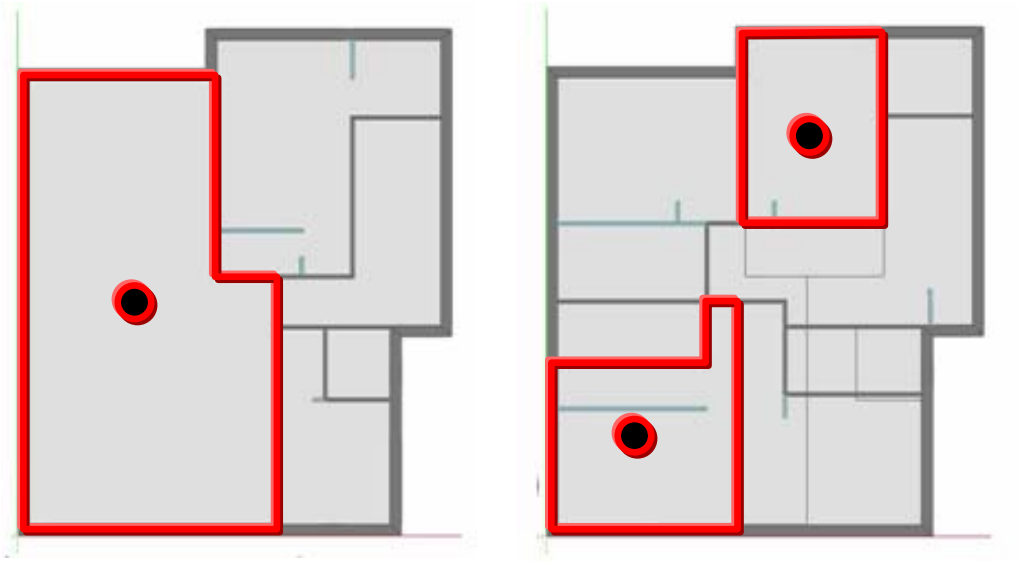
Indoor

Period: July 25 – October 25

Equipment

Temperature and humidity loggers

Measurement points



1st Floor:
- Living Room

2nd Floor:
- Bedroom NE
- Bedroom SW

3rd Floor:
- Office Studio

EXPERIMENTAL MEASUREMENTS

Outdoor – Climatic Data

Aveiro University meteorological station

universidade de aveiro

NUMERICAL SIMULATIONS

DesignBuilder SOFTWARE is an user interface for EnergyPlus

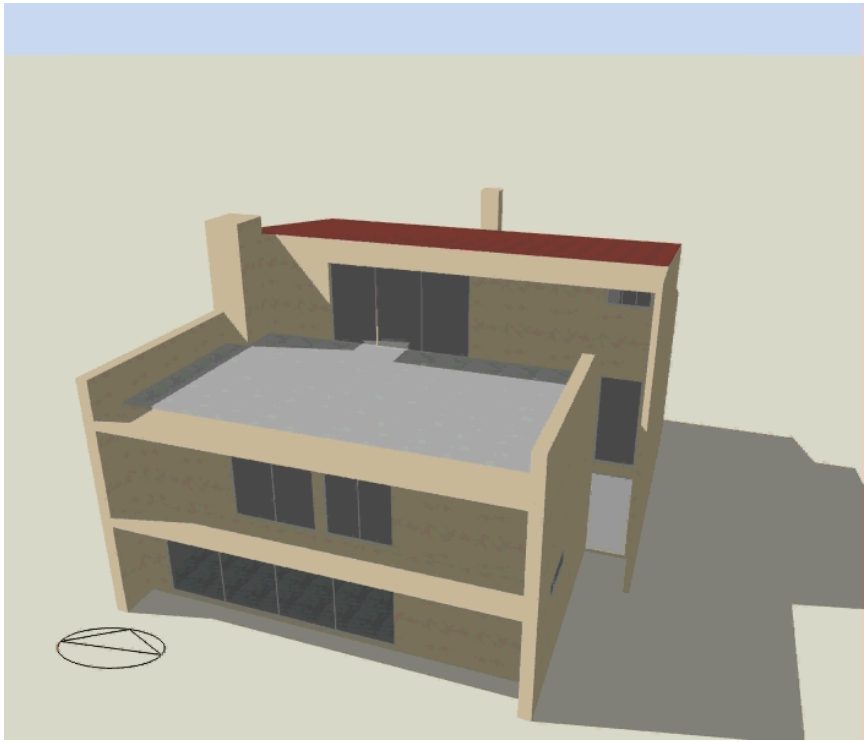
EnergyPlus

U.S. Department of Energy
Energy Efficiency and Renewable Energy

EnergyPlus is the United States Department of Energy building energy simulation program for modelling building heating, cooling, lighting, ventilating, and other energy flows.

NUMERICAL SIMULATIONS

DesignBuilder SOFTWARE **Model**



Orbit view of the DsB model

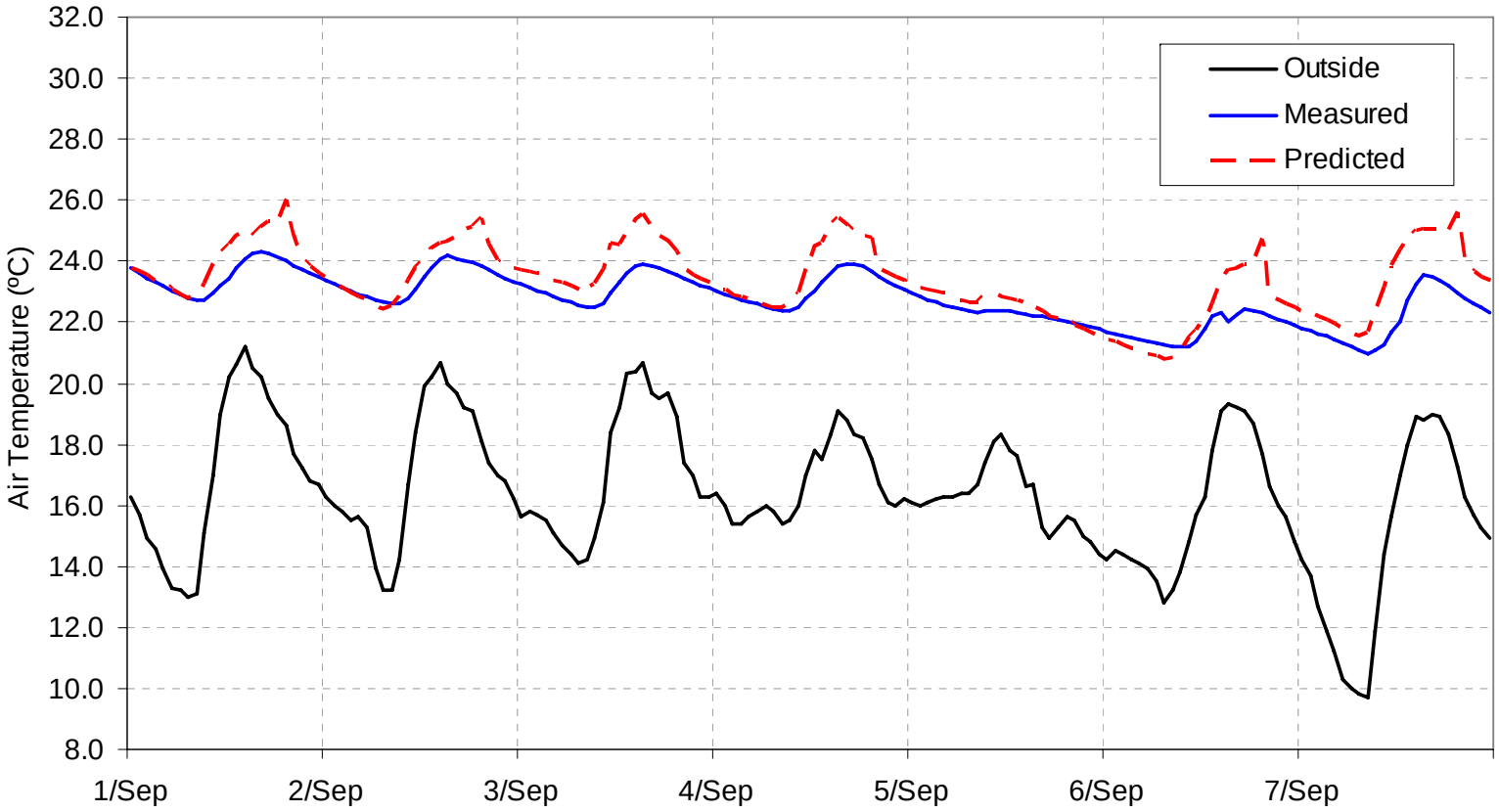
Shading evolution at 10 Aug.

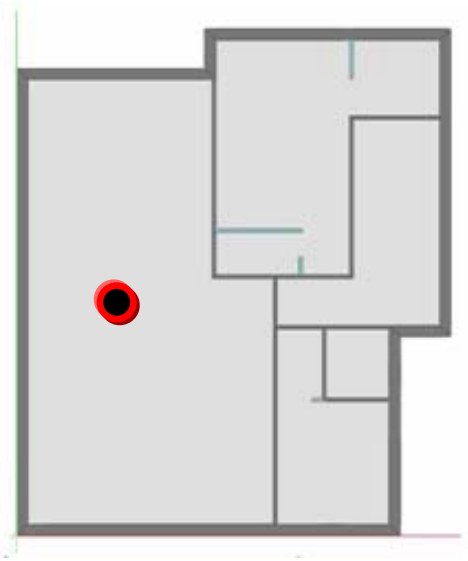
The model was assembled using 15 thermal zones

COMPARATIVE ANALYSIS OF RESULTS

Passive thermal cond.
Unoccupied period
No internal gains,
No ventilation

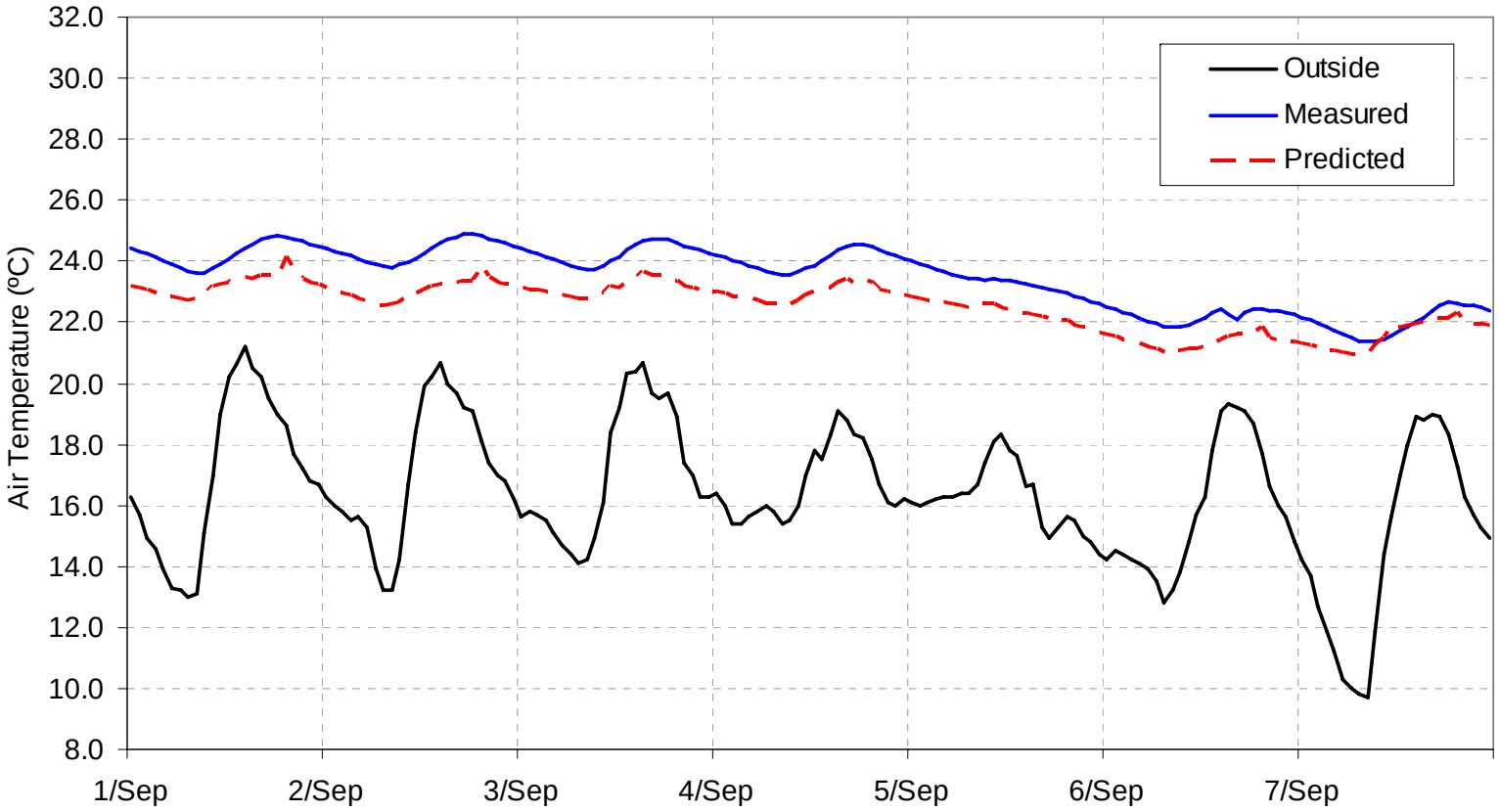
Living Room (1st Floor)

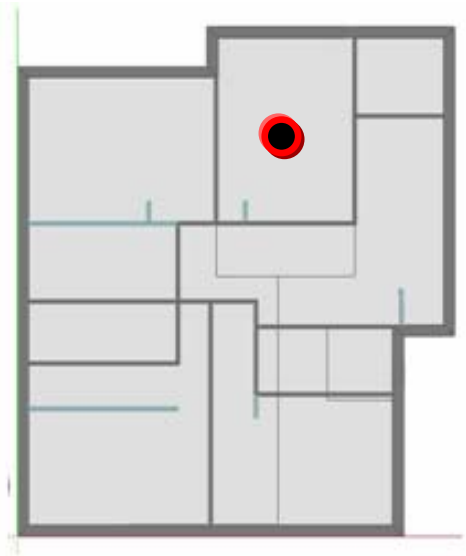




COMPARATIVE ANALYSIS OF RESULTS

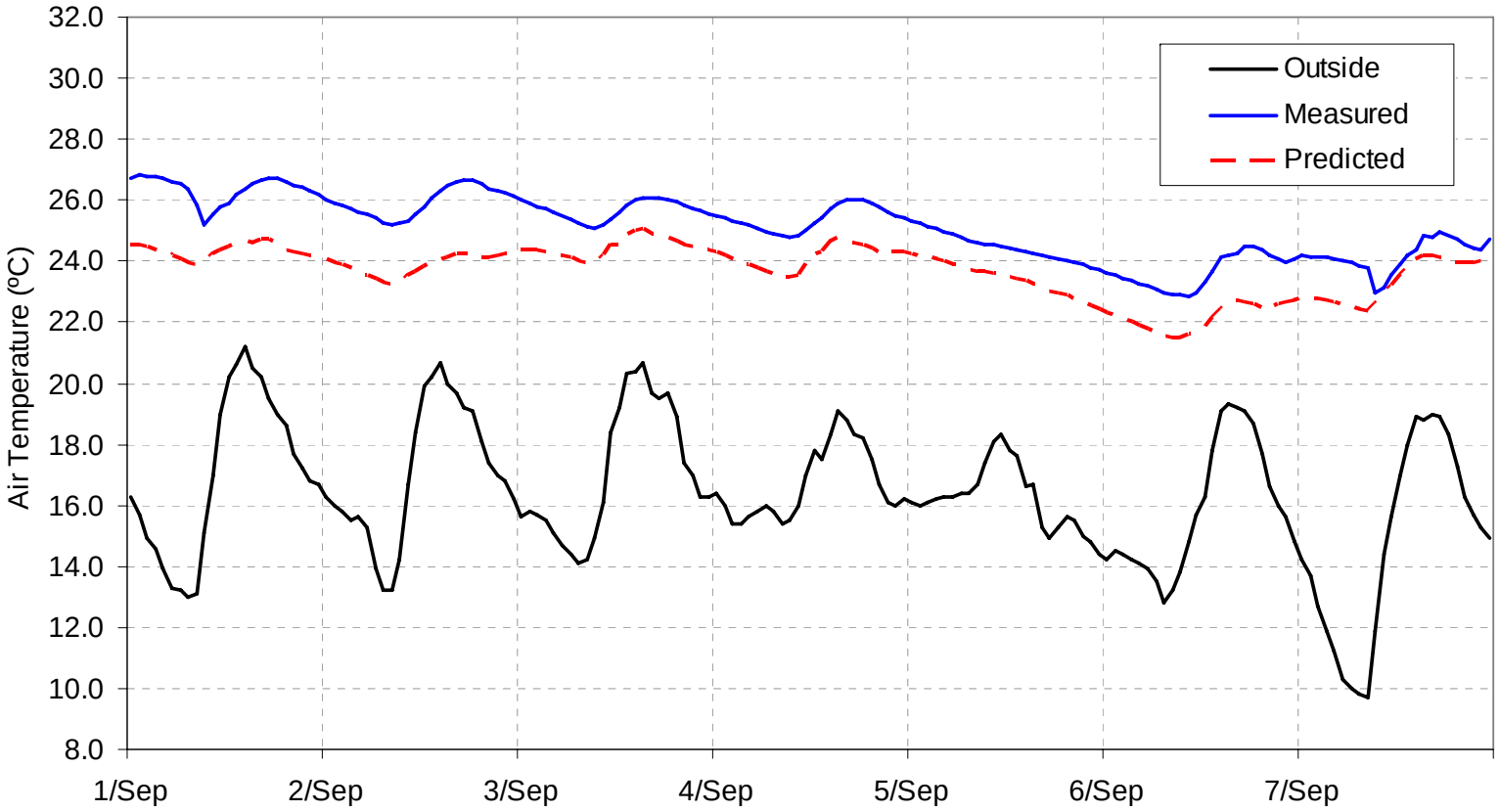
Bedroom NE (2nd Floor)

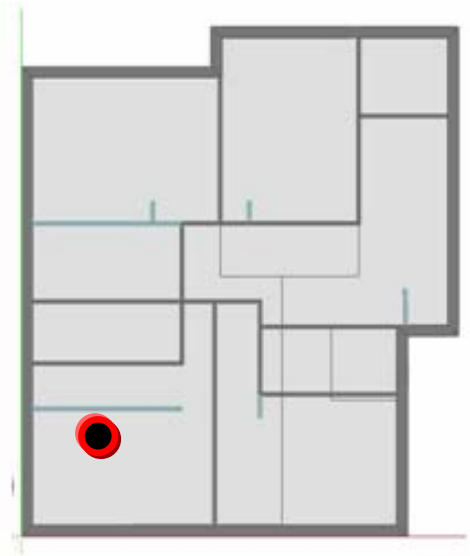




COMPARATIVE ANALYSIS OF RESULTS

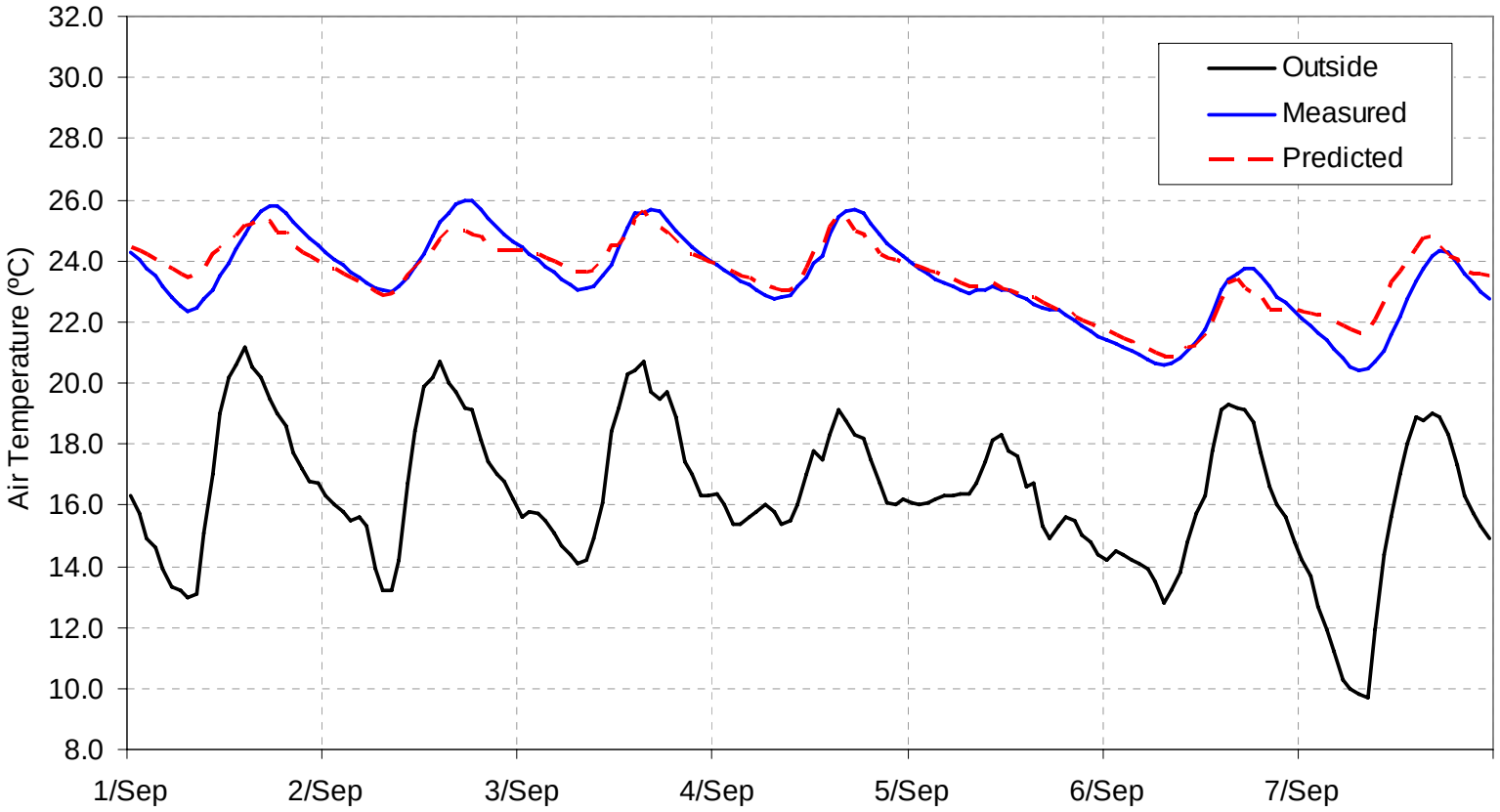
Bedroom SW (2nd Floor)

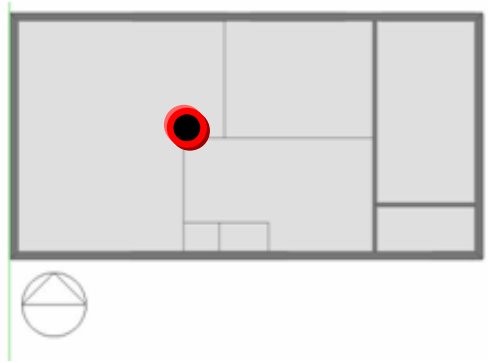




COMPARATIVE ANALYSIS OF RESULTS

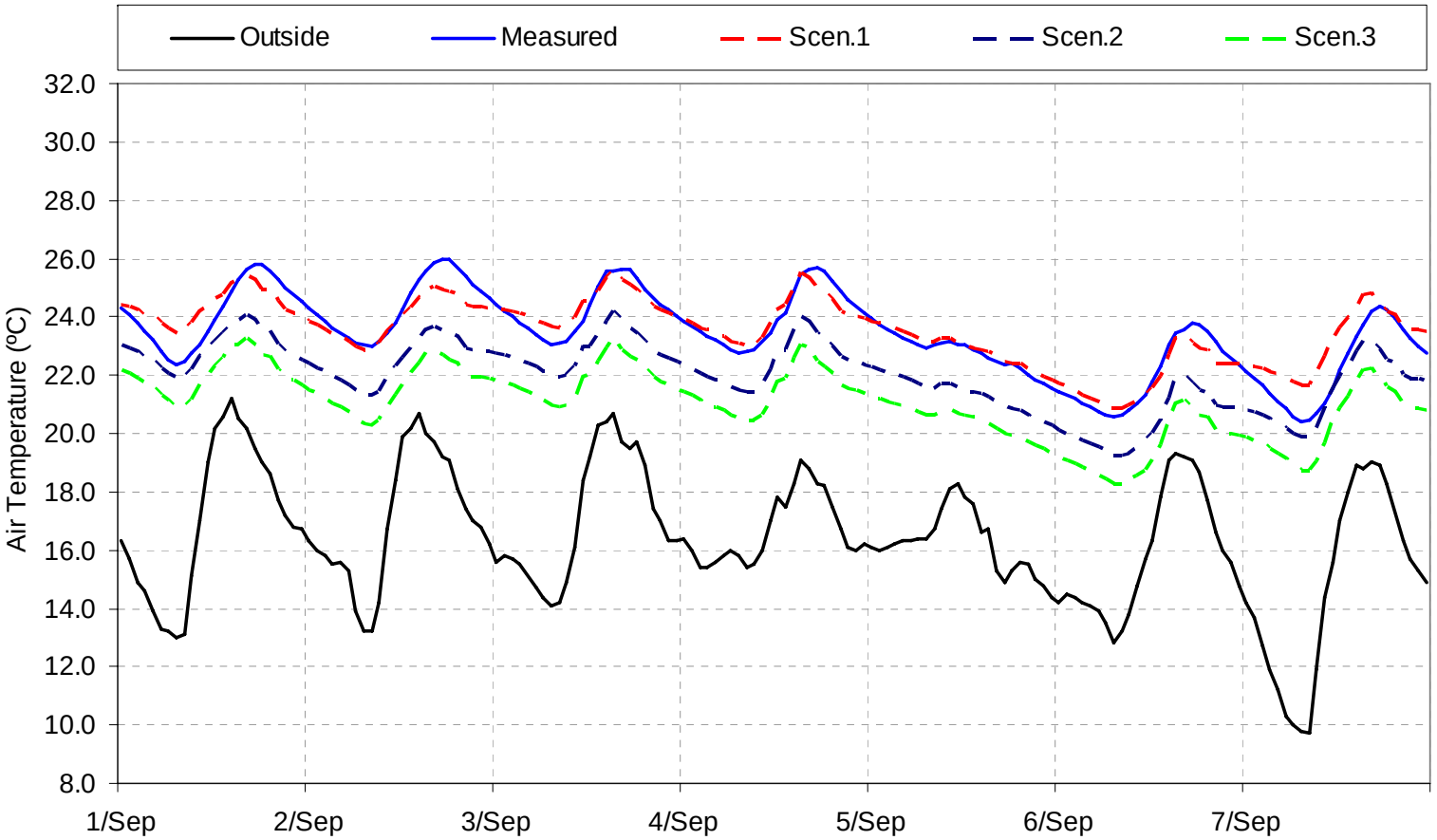
Office Studio (3rd Floor)





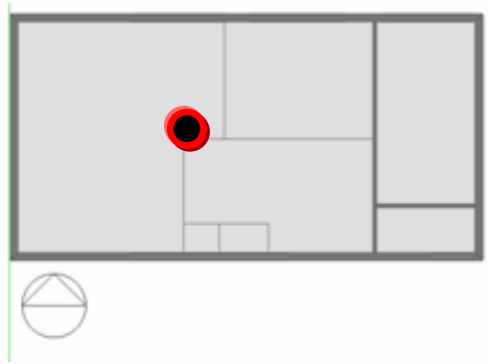
PARAMETRIC STUDY: Natural Ventilation

Office Studio (3rd Floor)



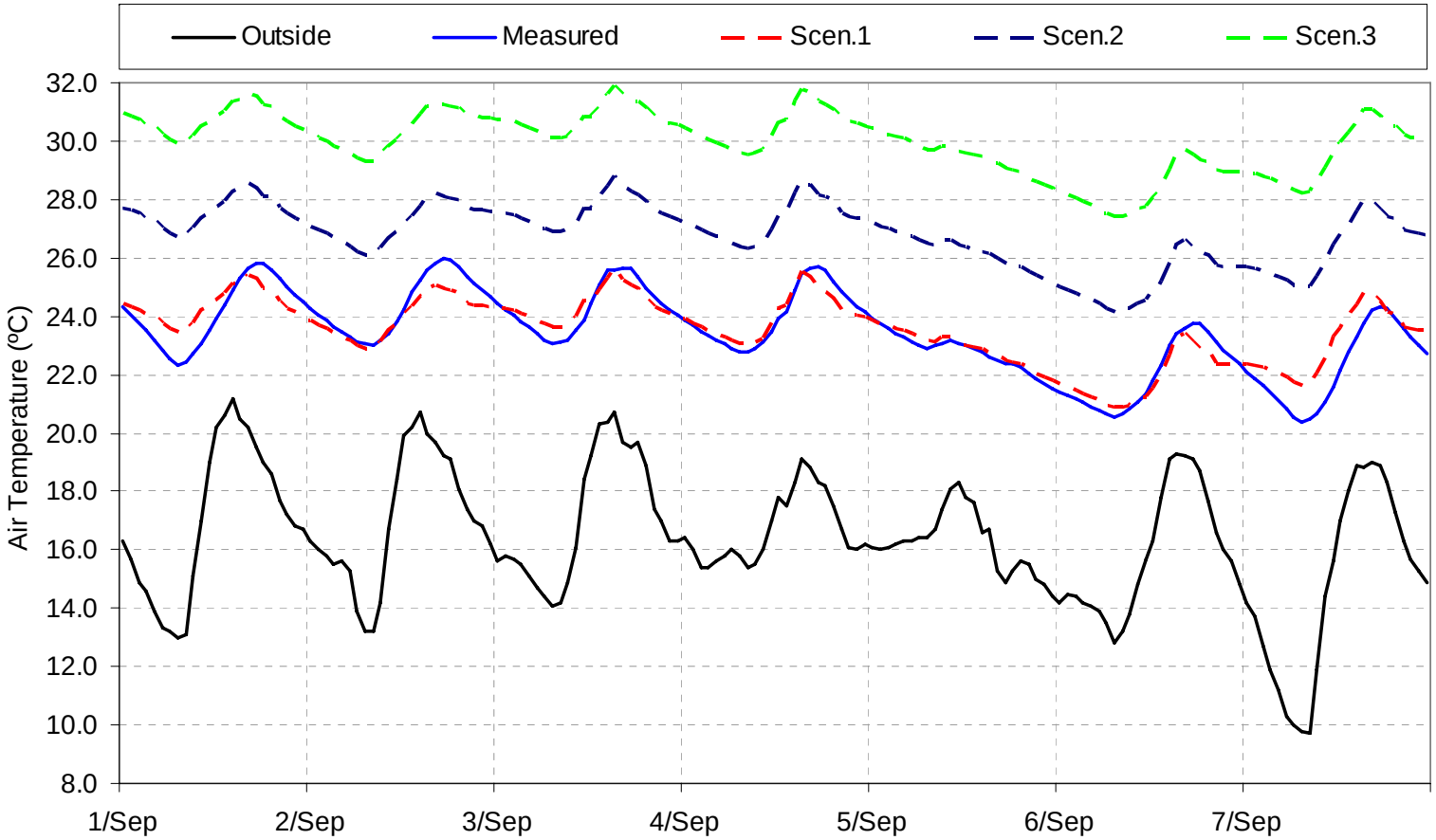
Three scenarios:

1 – No Vent.;
2 – 0.6 ac/h;
3 – 1.2 ac/h.



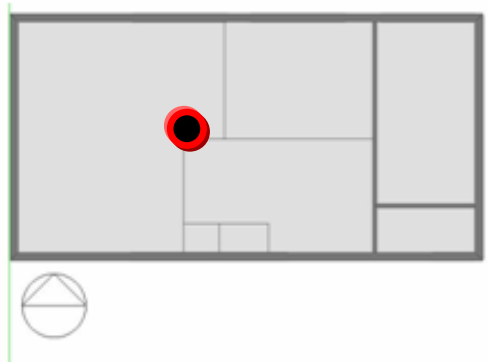
PARAMETRIC STUDY: Internal Gains

Office Studio (3rd Floor)



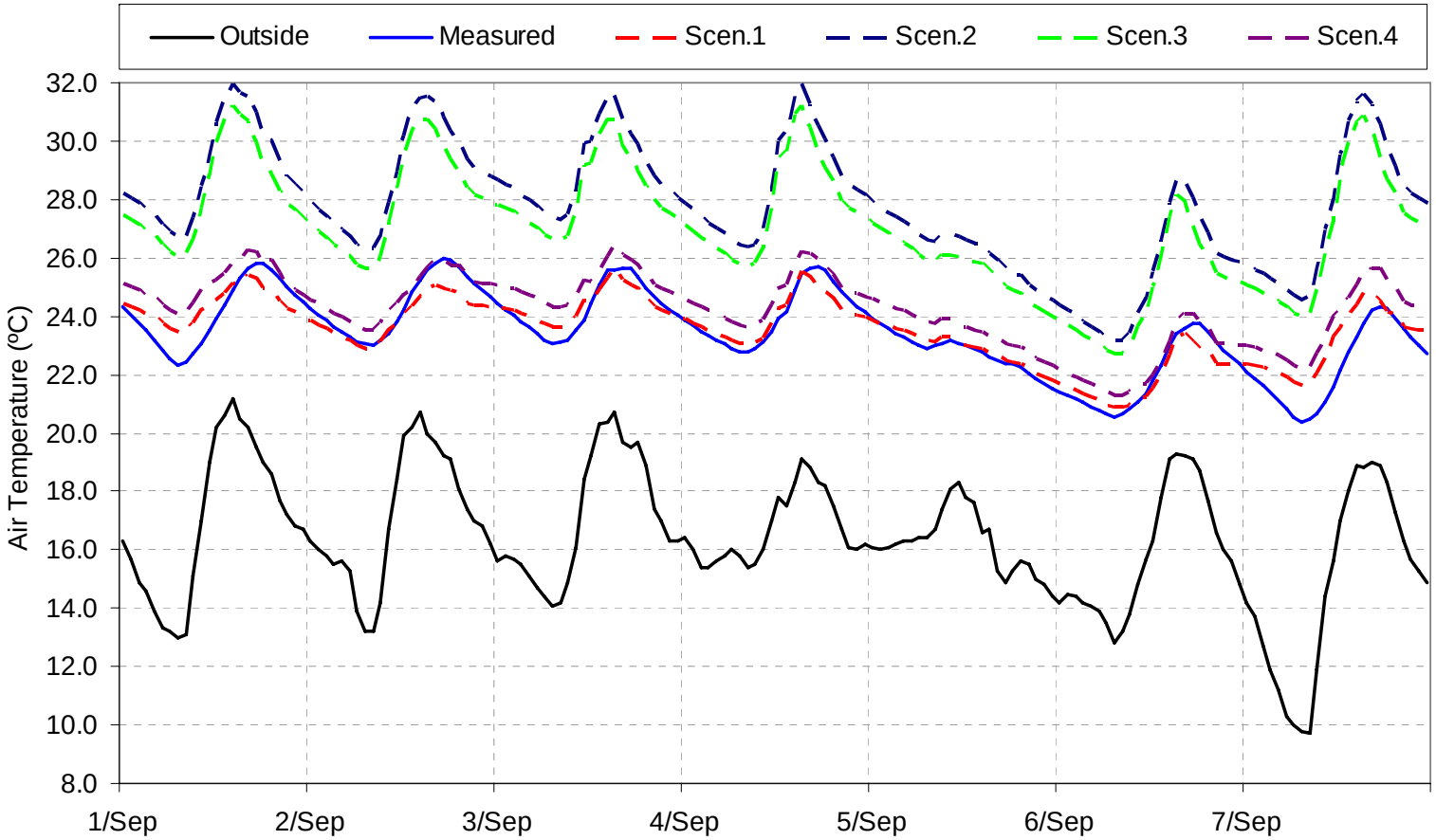
Three scenarios:

1 – No I.Gains;
2 – 5.0 W/m²;
3 – 10.0 W/m².



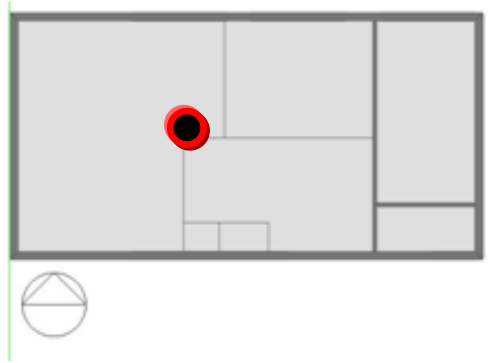
PARAMETRIC STUDY: Overhangs Shading

Office Studio (3rd Floor)



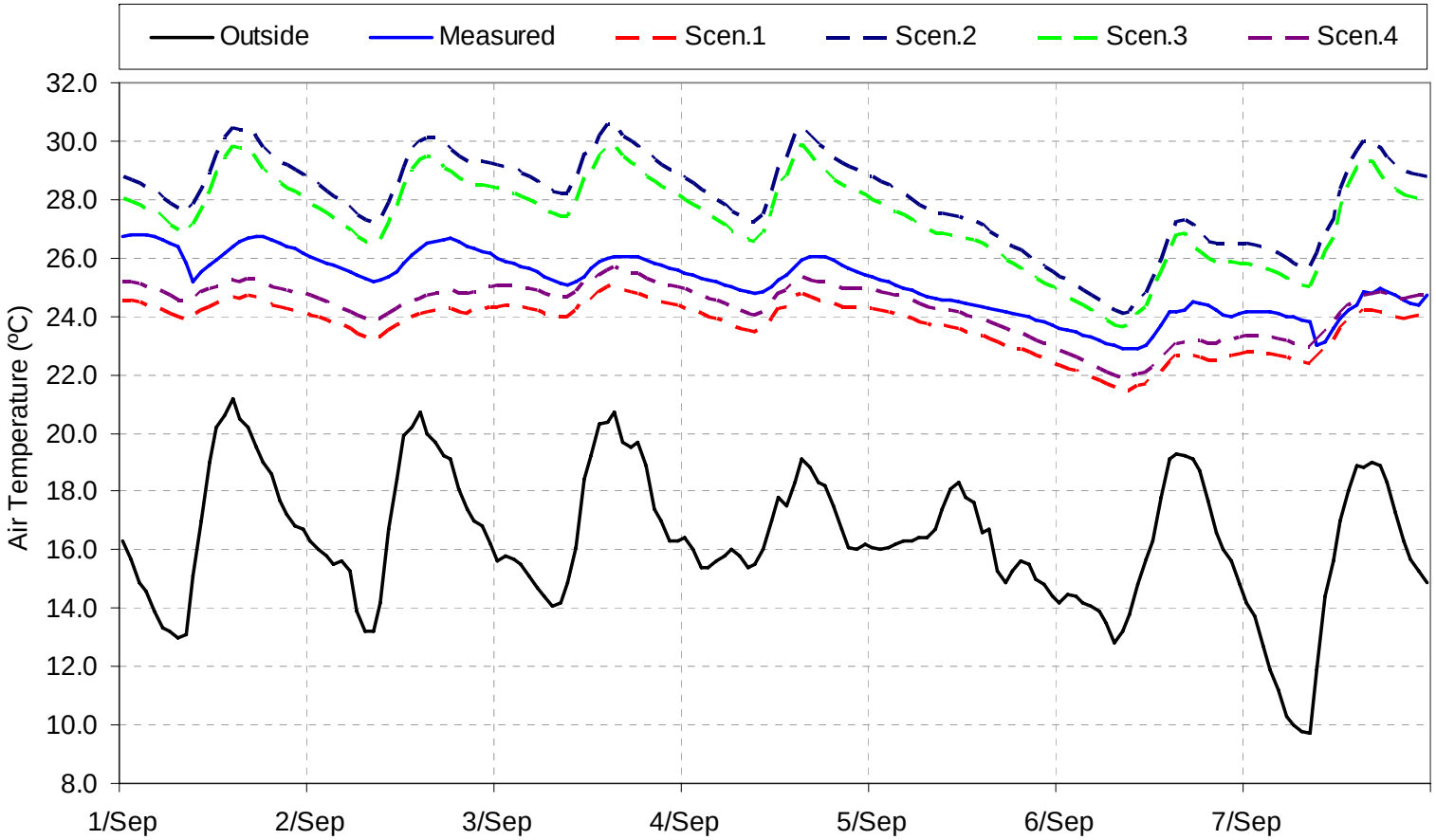
Four scenarios:

1 – All overhangs;
2 – No overhangs;
3 – No horiz. overh.;
4 – No vert. overh.



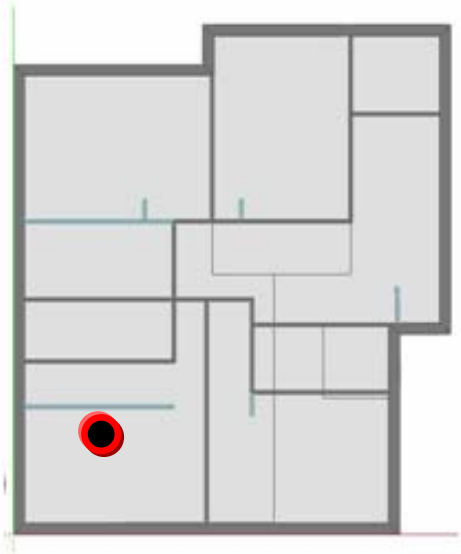
PARAMETRIC STUDY: Overhangs Shading

Bedroom SW (2nd Floor)



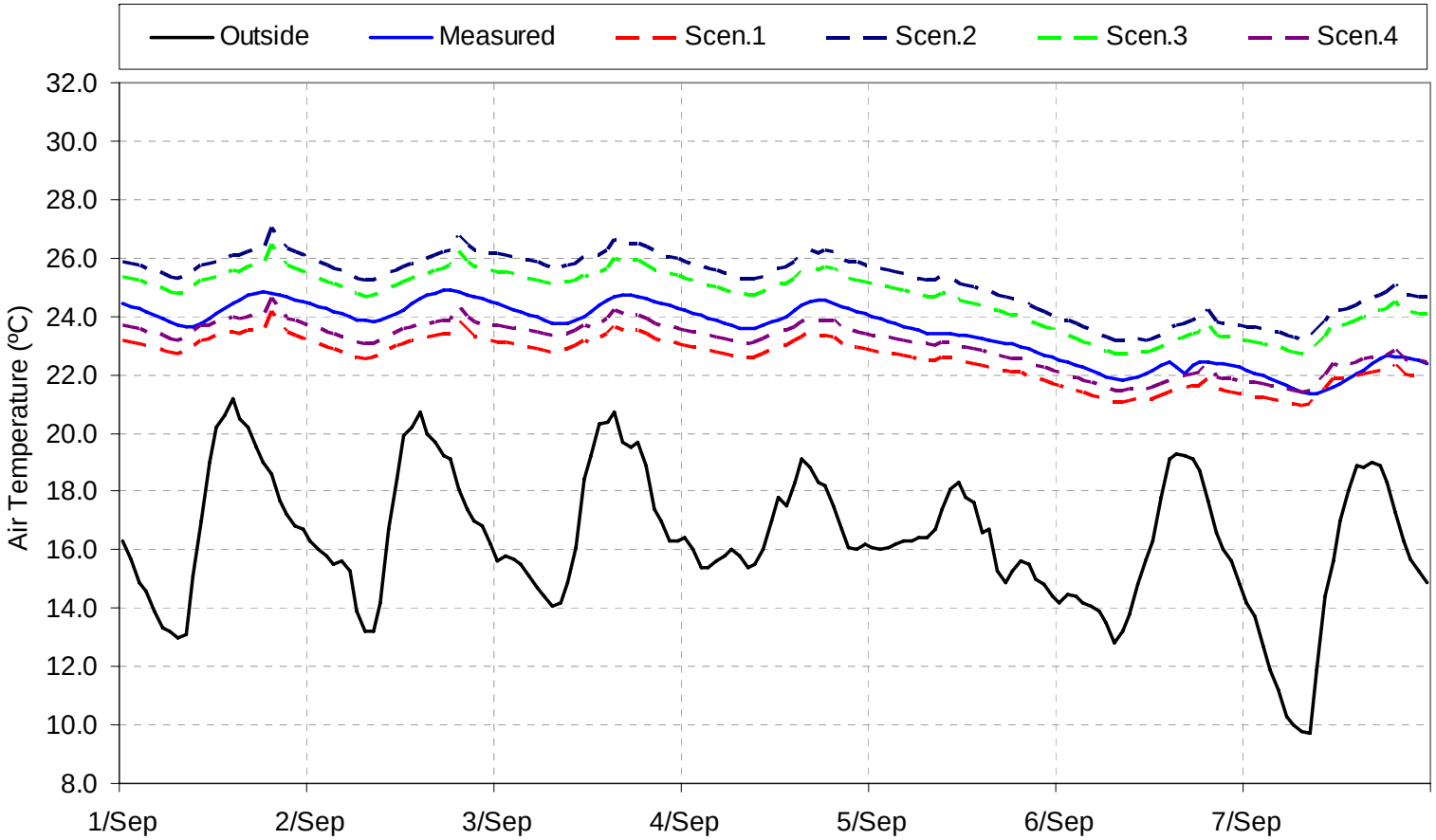
Four scenarios:

1 – All overhangs;
2 – No overhangs;
3 – No horiz. overh.;
4 – No vert. overh.



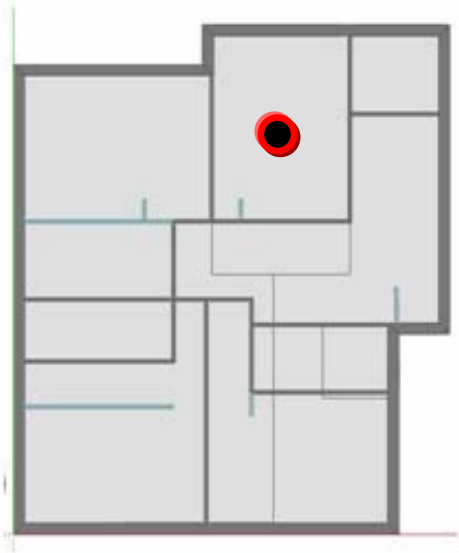
PARAMETRIC STUDY: Overhangs Shading

Bedroom NE (2nd Floor)



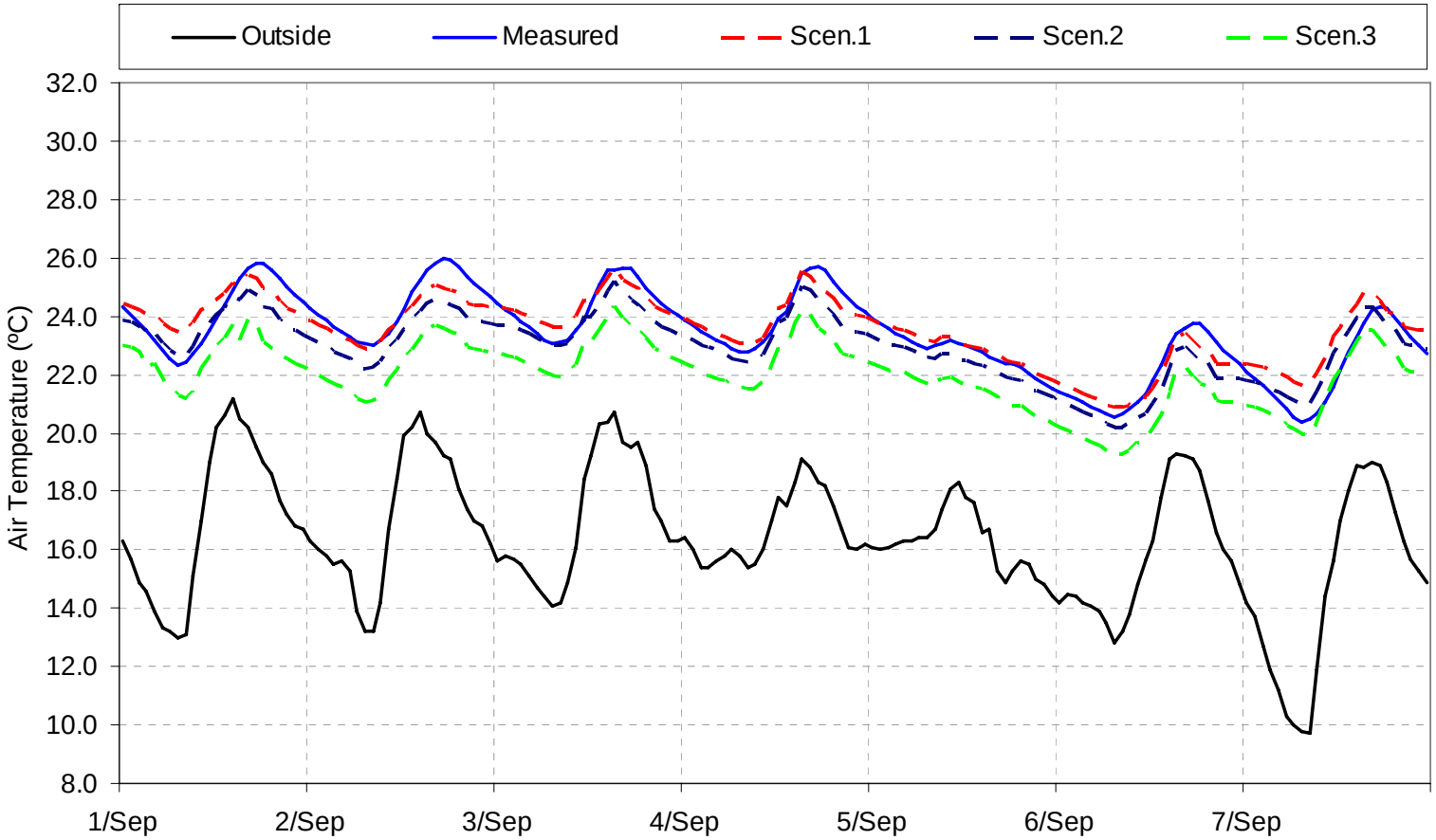
Four scenarios:

1 – All overhangs;
2 – No overhangs;
3 – No horiz. overh.;
4 – No vert. overh.



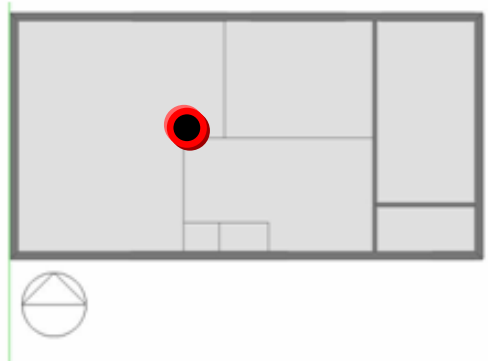
PARAMETRIC STUDY: Windows Glazing Types

Office Studio (3rd Floor)



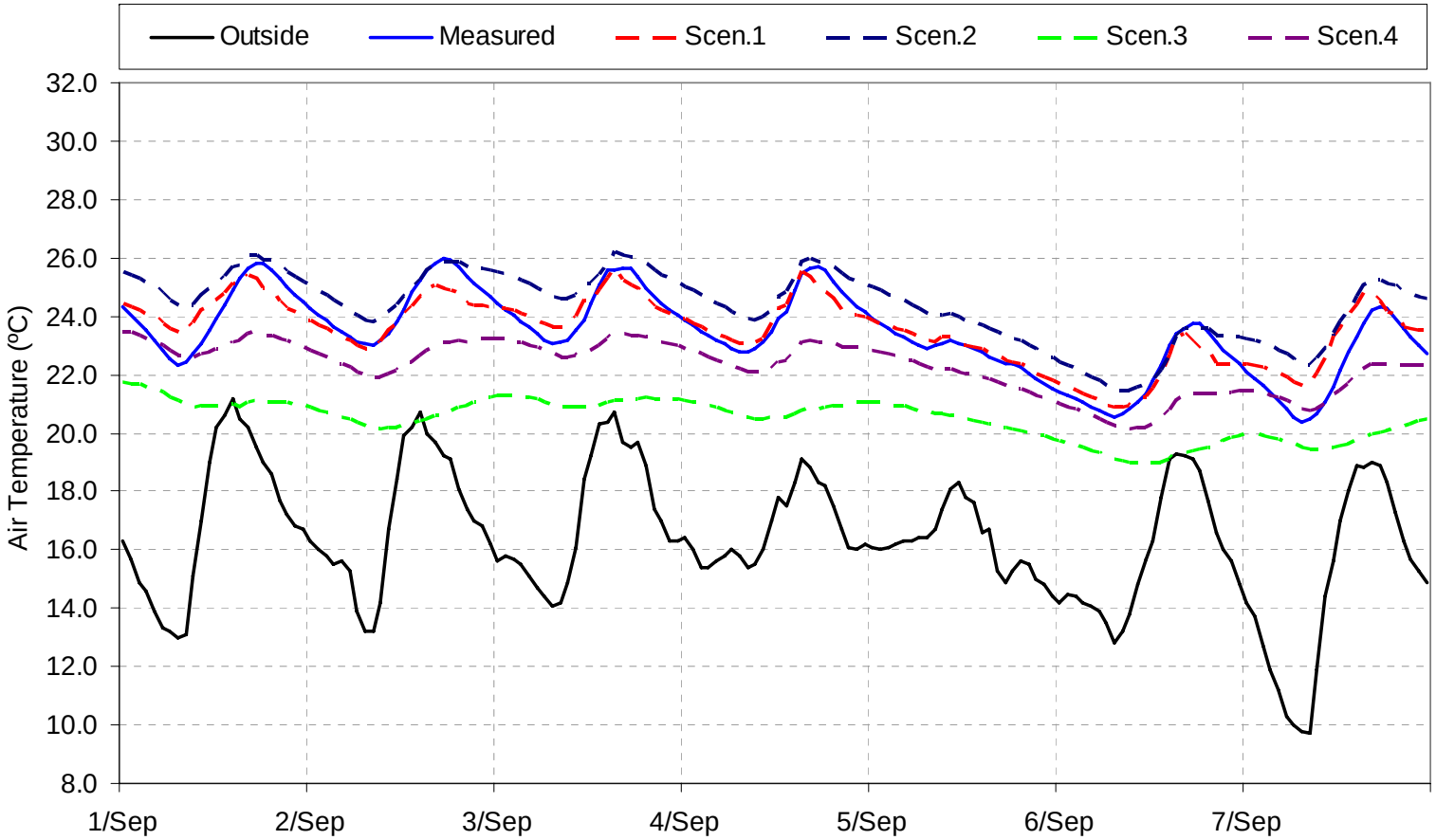
Three scenarios:

1 – Dbl LoE Clr 6/13/6 mm Arg;
2 – Dbl Clr 6/14/4 mm Air;
3 – Sgl Clr 6 mm.



PARAMETRIC STUDY: **Windows Shade Roll** (medium opaque)

Office Studio (3rd Floor)



Four scenarios:

1 – Interior;
2 – No shade roll;
3 – Exterior;
4 – Ext. light translucent.