EPSASA HOUSE: CSIR INNOVATION SITE: PRETORIA

ENERGY SIMULATION FINDINGS

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1 Project Background

The CSIR was contracted by the Danish Embassy in South Africa to inspect, evaluate and recommend innovative and appropriate housing technologies in Denmark that could be used to improve the quality and performance of low-income and affordable housing in South Africa. The visits were set up by the Danish Technological Institute (DTI) in Denmark.

1.1 Project description

The study encompasses the following:

- The construction of a demonstration house on the CSIR Innovation Site in Pretoria;
- The capturing of the as built house in the software;
- The identification and loading of the material properties;
- Running the simulation model.

2 Assessment Methodology

The following research methodology was used.

2.1 Technical Documentation

Drawing number 59C1043/House5/D, produced by Llewellyn van Wyk and Andre de Villiers was only used for the design inputs into the energy model, except where correspondence from EPSASA representatives contradicted content in the drawing, in such instances such information from the correspondence was used.

2.2 Simulation Software

EnergyPlus version 5.0.0.031 was used for this energy modelling simulation.

2.3 Energy Simulation and Operational Parameters

A ‘purchased air analysis was used in order to determine the energy performance of this building, that is, the amount of energy required in order to maintain a comfortable environment within the building was calculated, in terms of heat injected or rejected from the building, in a realistic scenario this would be represented by the operation of heaters and air-conditioning systems.

2.3.1 Definition of Comfortable Environment

If the temperature inside the building is within the bounds dictated within the table below, then the thermal environment is deemed comfortable. If the temperature is about to exceed such bounds, heat is injected or rejected from the building in order to maintain comfort, such heat is summed over the course of a year and is a representation of the energy efficiency of the building.

Time	Minimum Temperature (°C)	Maximum Temperature (°C)
00:00 – 08:00	16	26
08:00 – 18:00	21	26
18:00 – 00:00	16	26

2.3.2 Internal Heat Gains

Internal heat gains for the building from people and electrical equipment is dictated from the table below.

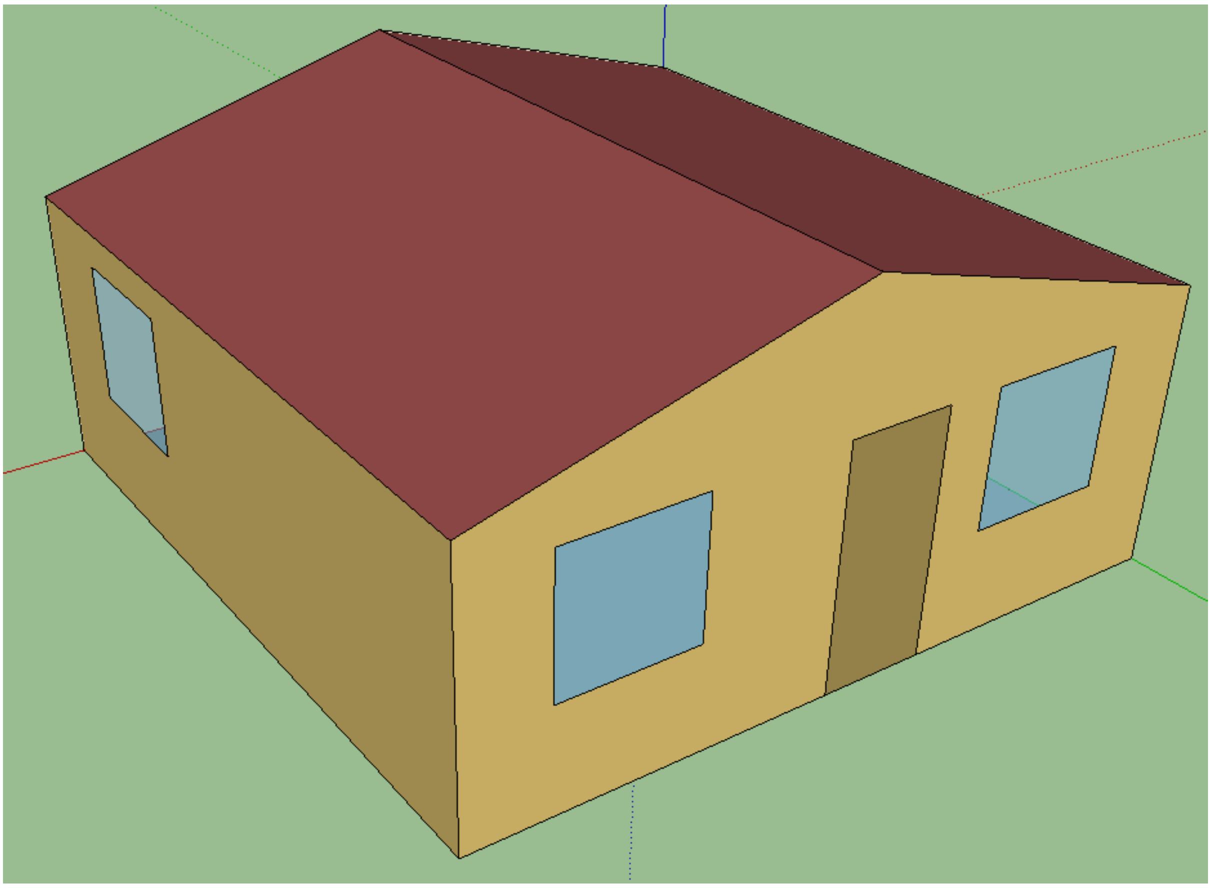
Time	Electrical Equipment (Watts)	People (Watts)
00:00 – 06:00	0	400
06:00 – 08:00	180	400
08:00 – 18:00	0	0
18:00 – 22:00	180	400
22:00 – 00:00	0	400

2.3.3 Air Changes per Hour

It is assumed that the air changes per hour for the dwelling over the course of the year is 0.5.

2.3.4 Graphical Representation

A graphical representation of the house that was modelled is displayed below, it was produced using Google Sketchup, using the openstudio plugin which used the energyplus input data file which was the exact same file that was used for the energy model.



Figure

2.4 Material Properties

Efforts were made to obtain the material properties required for the modelling from EPSASA, where such information was not provided, generic values were assumed.

Property	Expanded Polystyrene
Conductivity, k-value, W/mK	0.038
Density, kg/m^3	20/16*
Specific heat capacity, J/kgK	1500

Note: In some instances a density of 16 was given, in others it was given as 20, the polystyrene was used in the roof, walls and slab, the density given specific to the application of the polystyrene consequently a density of 20 was used in the walls and 16 for the roof and slab.

2.4.1 Assumed values

Property	Slab	Wall Concrete	Wall Plaster	Chromadek	Meranti	Glass
Conductivityk-value, W/mK	1.7	1.7	1.73	61	0.17	1.046
Density, kg/m^3	2500	2500	2200	7310	300	N/A
Specific heat capacity, J/kgK	1165	1165	1165	225	2000	N/A

2.5 Weather File

Due to the limited availability of weather files, a file for Pretoria is not available; consequently a Johannesburg weather file was used, provided by the US DOE and produced by ASHRAE, Johannesburg 683680, IWEC (International Weather for Energy Calculation). This weather file was however applied consistently to all the simulations.

3 Results

The following section records the visits made and describes the technologies seen.

EPSASA House	Heating Load (GJ)	Cooling Load (GJ)	Total Load (GJ)
	0.73	1.00	1.73

These results can be compared those presented at the *Domestic Use of Energy* conference in Cape Town, 2010 by Luke Osburn (Osburn, 2010) and which are presented below. The results presented at the Cape Town conference were achieved using an earlier version of EnergyPlus, namely, version 3.0.0.028. Thus in order to allow for a fair comparison the simulations were rerun with the later version used for the EPSASA analysis.

House	Heating Load (V3)	Cooling Load (V3)	Heating Load (V5)	Cooling Load (V5)
Conventional RDP House (House 1)	12.32	6.78	12.28	6.75
RDP with a ceiling	8.95	0.00	8.96	0.00
CSIR House 3	8.66	0.00		
SANS 204 house with carpet	2.88	0.00	2.89	0.00

The conventional RDP house is based on House 1 located on the CSIR test site. The second entry in the table is that RDP house fitted with a ceiling compliant with the requirements of SANS204 for a ceiling and the final model is of a fully compliant SANS204 house with a carpet installed. Variations within the results for the different versions of software are expected.

4 References

Osburn, L., 2010. “Energy Performance Evaluation of Formal Low Income Housing Within South Africa”, *Domestic Use of Energy Conference*, April 15-16, 2010, Cape Town.