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Energy Efficiency and Passive Building Technologies: A Case Study

Llewellyn van Wyk
Principal Researcher CSIR
lvwyk@csir.co.za

Presentation Structure

Building Resilient Human Settlements

- Building Regulations & Standards: Part X
- SA climate change projections
- Way Forward SANS 204
- Technology options
- Conclusion

SANS 10400

Building Regulations and Standards

- Chief amendment is the creation of an **Environmental sustainability** section into the NBR

- Part XA is "Energy Usage in Buildings"

- Part XB, XC, etc. to follow

SANS 10400

Building Regulations and Standards

- Hot water supply
- Energy Usage
- Design assumptions
- Building envelope requirements

SANS 10400

Building Regulations and Standards

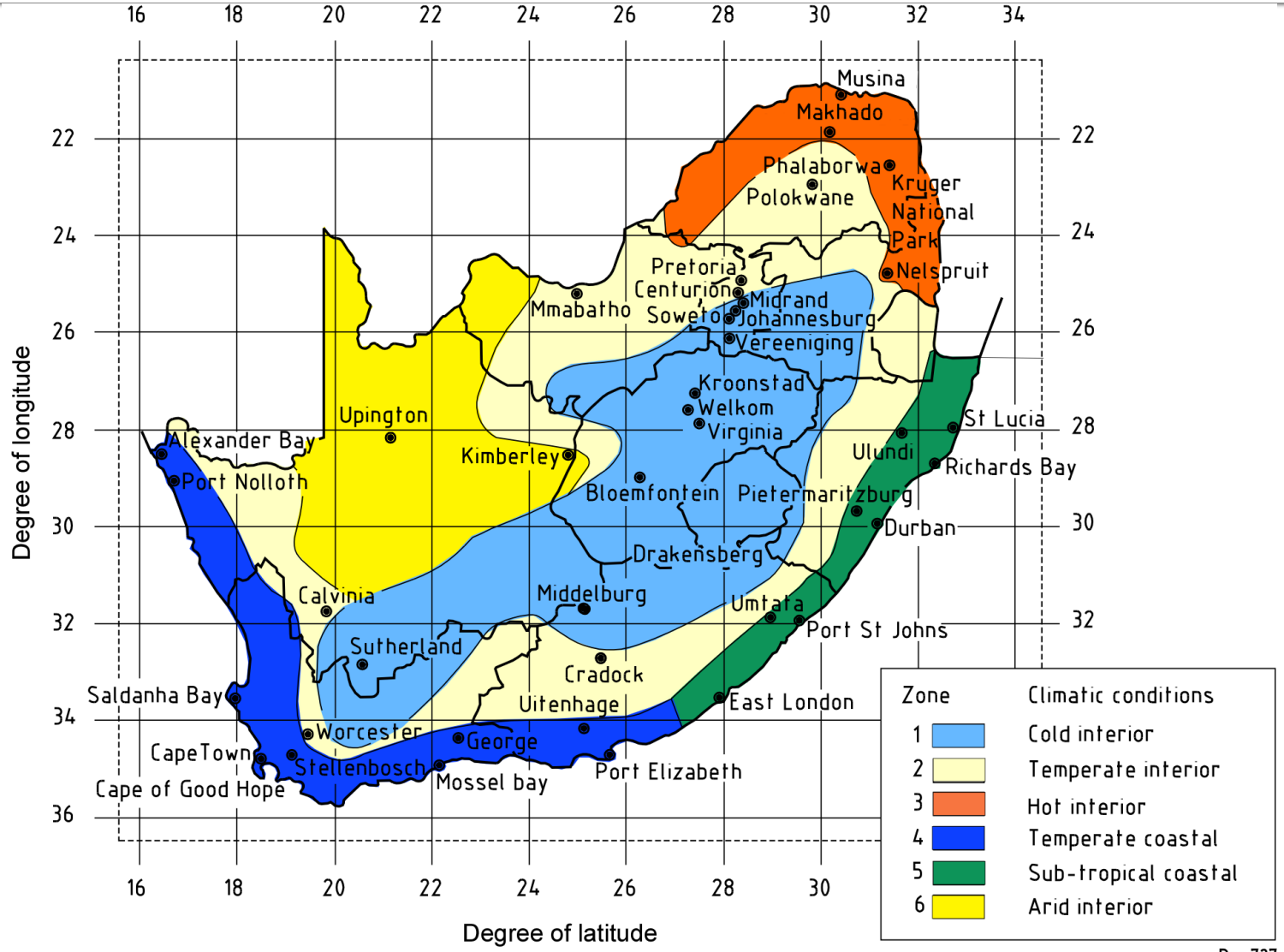
- Sets maximum energy demand for certain buildings per **climatic zone**

- Sets maximum annual energy consumption for same range of buildings (excludes houses) per **climatic zone**

- "Climate data for the certification of UK based projects
- The use of appropriate climate data is essential to accurately designing a *Passivhaus* as climate files used in PHPP define the boundary conditions upon which all of the thermal modeling calculations are based. BRE has produced **22 regional UK climate data sets that have been checked and ratified by the *Passivhaus Institut***.
- These dataset provides *Passivhaus* designers with data suitable for certification across the UK."

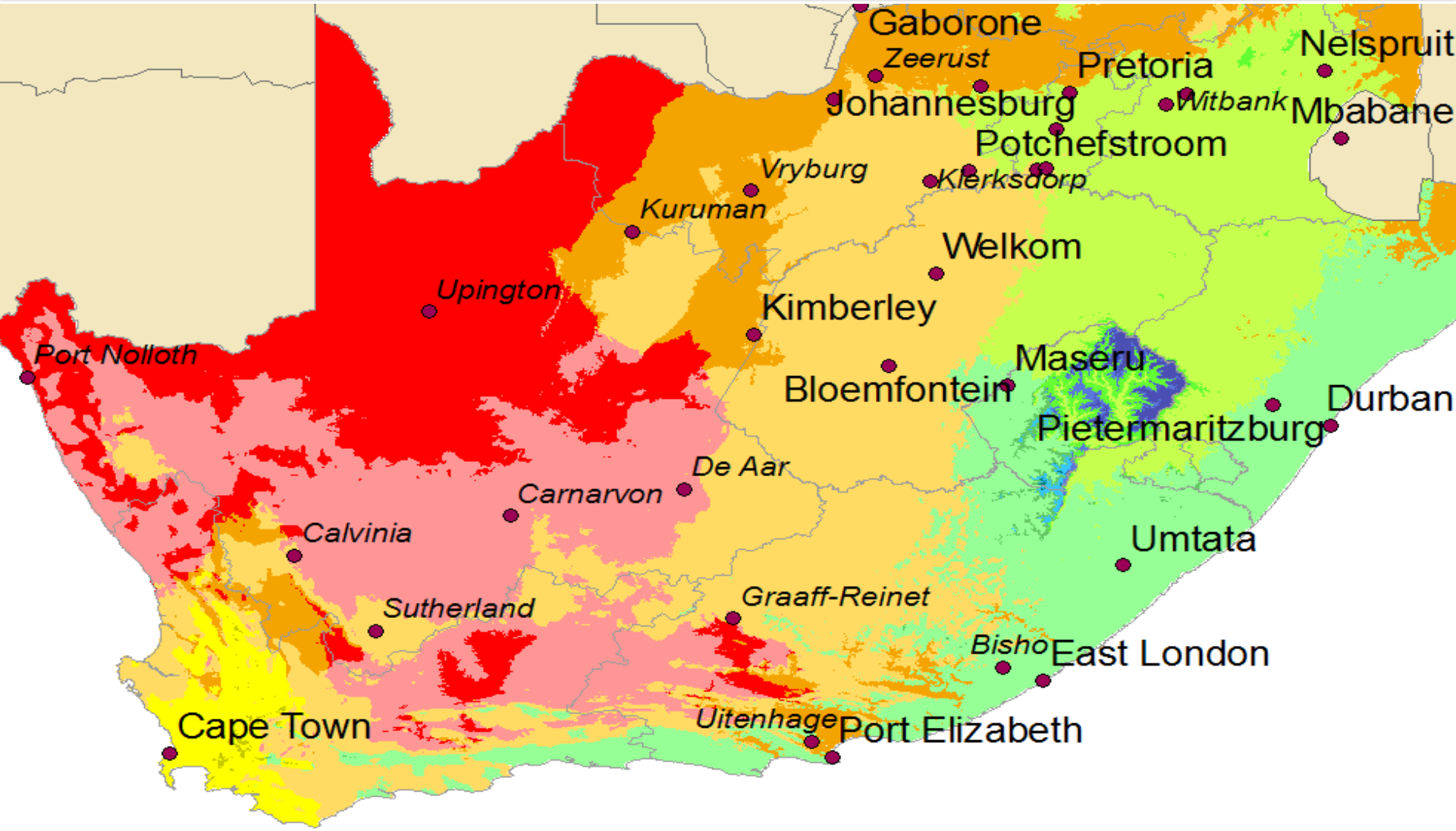
SANS 10400

Climate Zones in Regulations

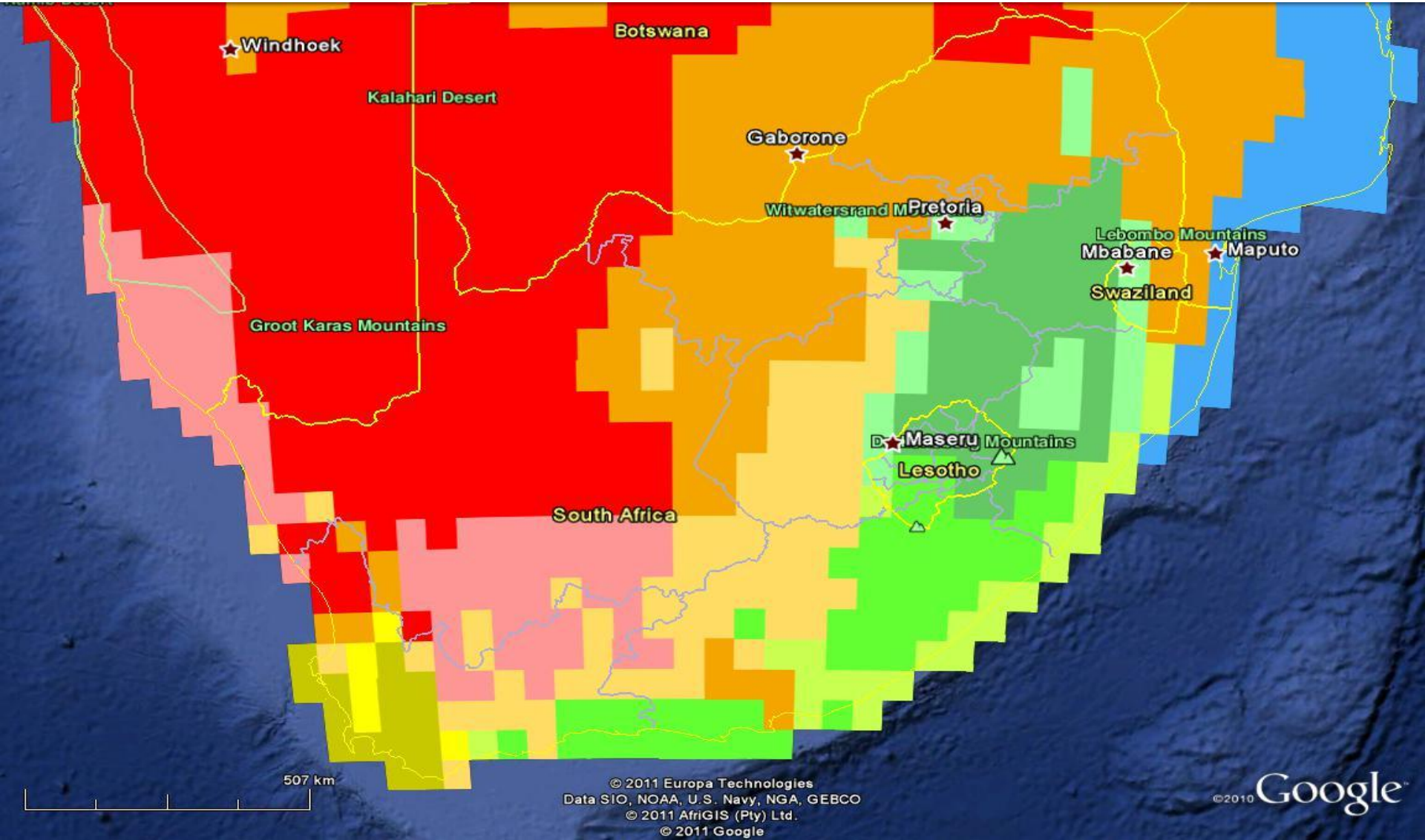


South African Climate Zones

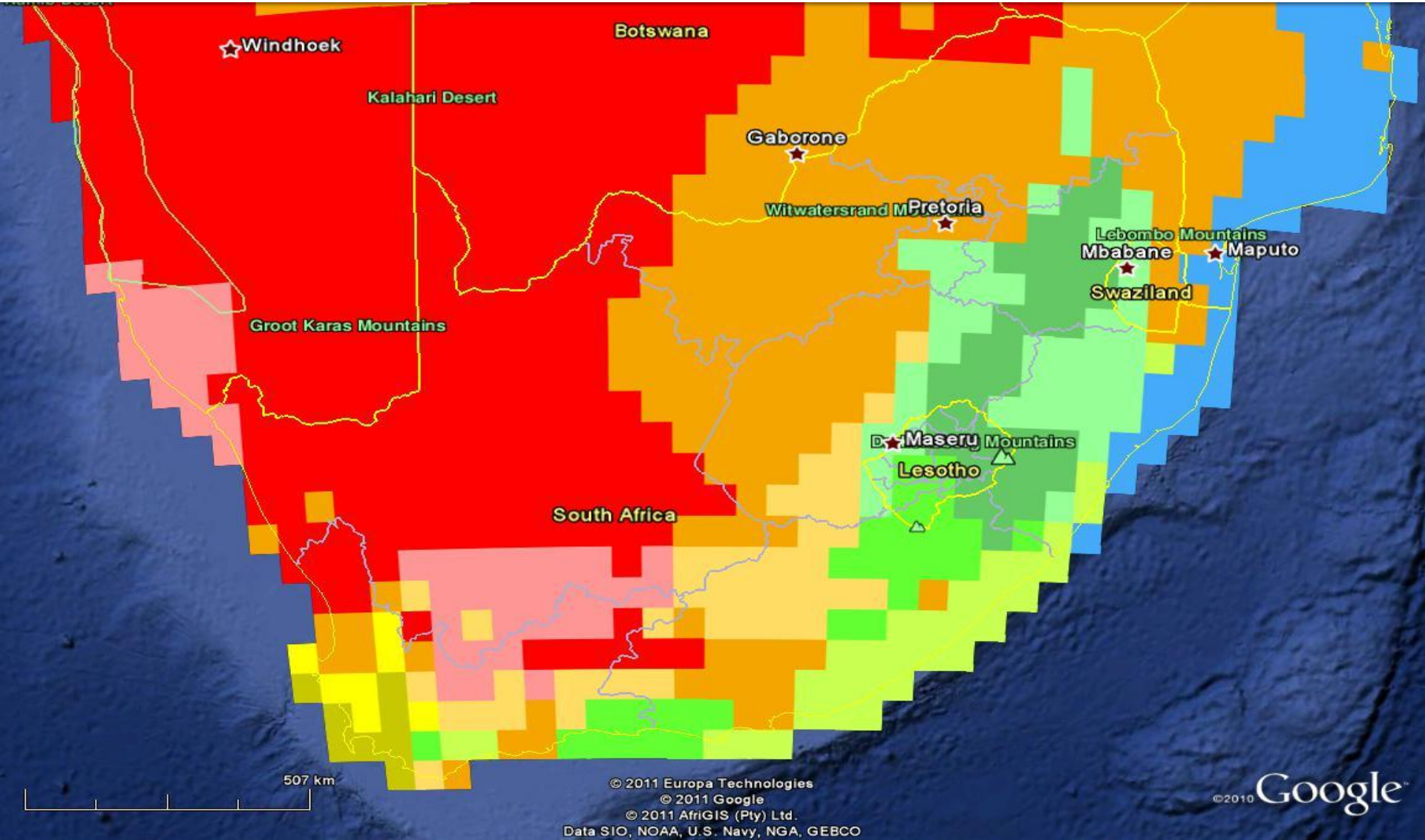
Koppen Map



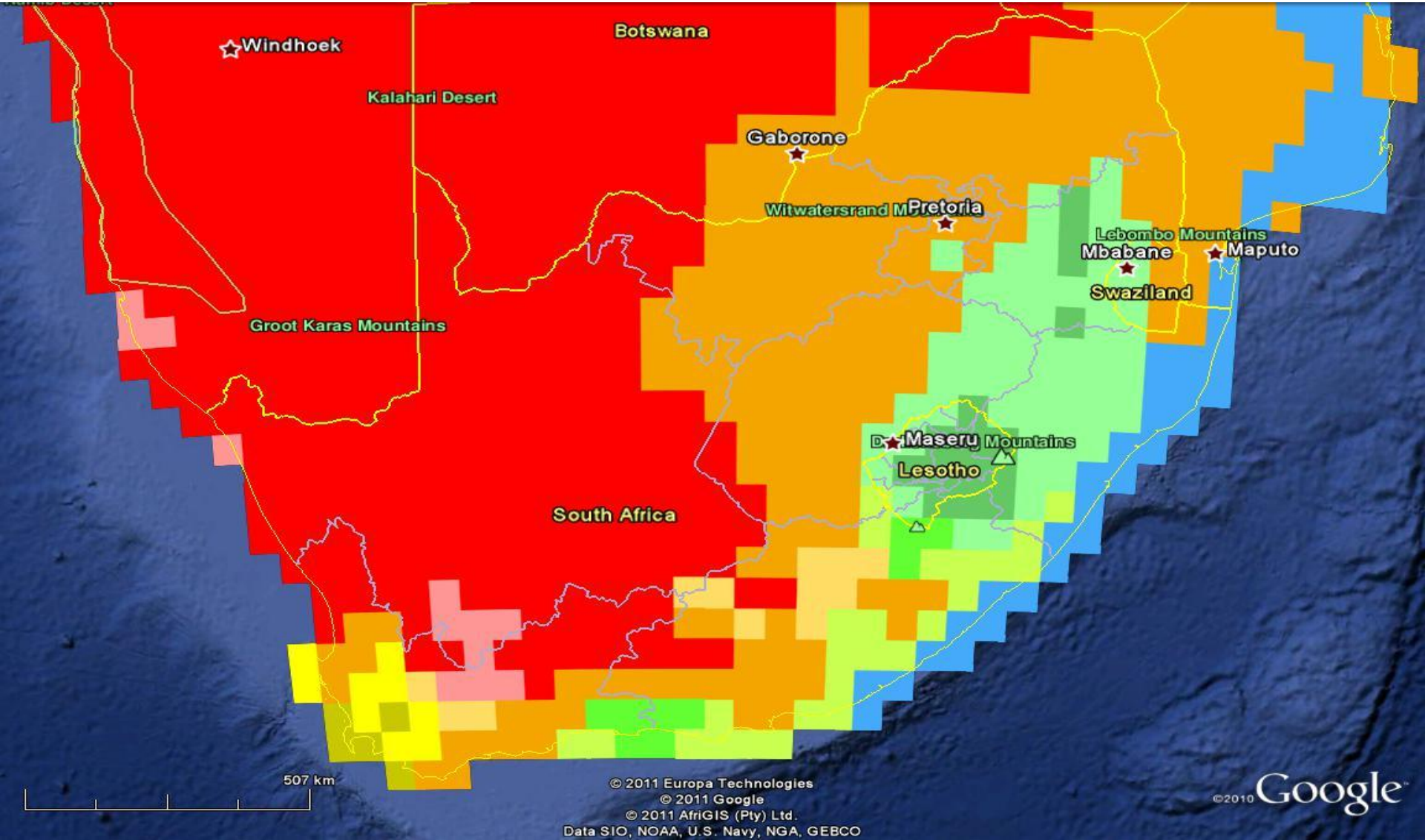
Climate change projections 2001



Climate change projections 2026



Climate change projections 2076



Climate change projections

Way Forward
SANS 204

2015…2020…2025…

1	2	3	4	5	6	7	8
Classification of occupancy of building	Description of building	Maximum energy consumption kWh/(m².a)					
		Zone					
		1	2	3	4	5	6
A1	Entertainment…	420	400	440	390	400	420
A2	Theatrical…	420	400	440	390	400	420
A3	Places of instruction	420	400	440	390	400	420
A4	Worship	120	115	125	110	115	120
F1	Large shop	240	245	260	240	260	255
G1	Offices	200	190	210	185	190	200
H1	Hotel	650	600	585	600	620	630

CSIR Built Environment Innovation Site, Pretoria

Building Technology

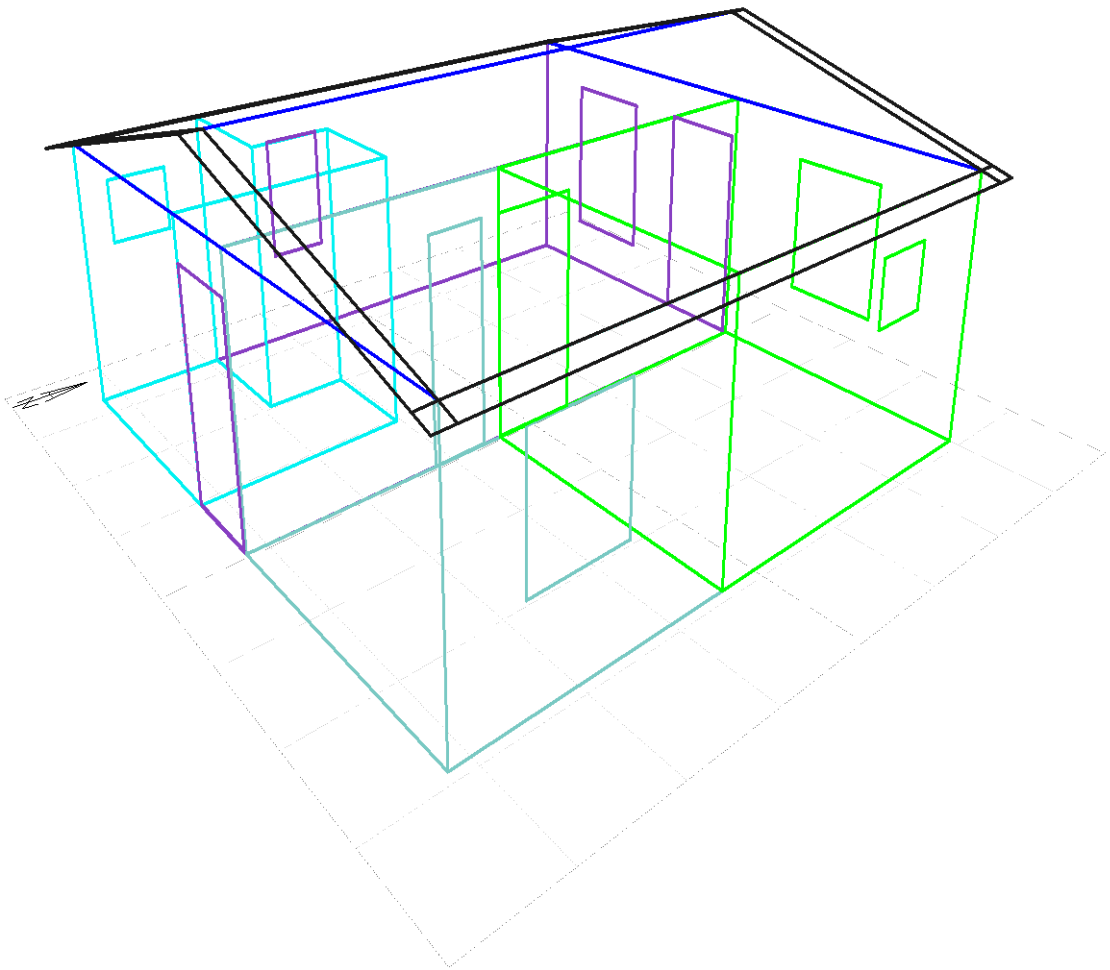
❖Imison System

Concrete floor slab
Galv light steel frame
Expanded polystyrene panels
Galv steel mesh or woven fabric mat cladding to both sides
Fibre reinforced plaster both sides
Conventional roof
Double glazed doors and windows
40mm polystyrene insulation to roof
100mm polystyrene insulation under slab

Way Forward
SANS 204

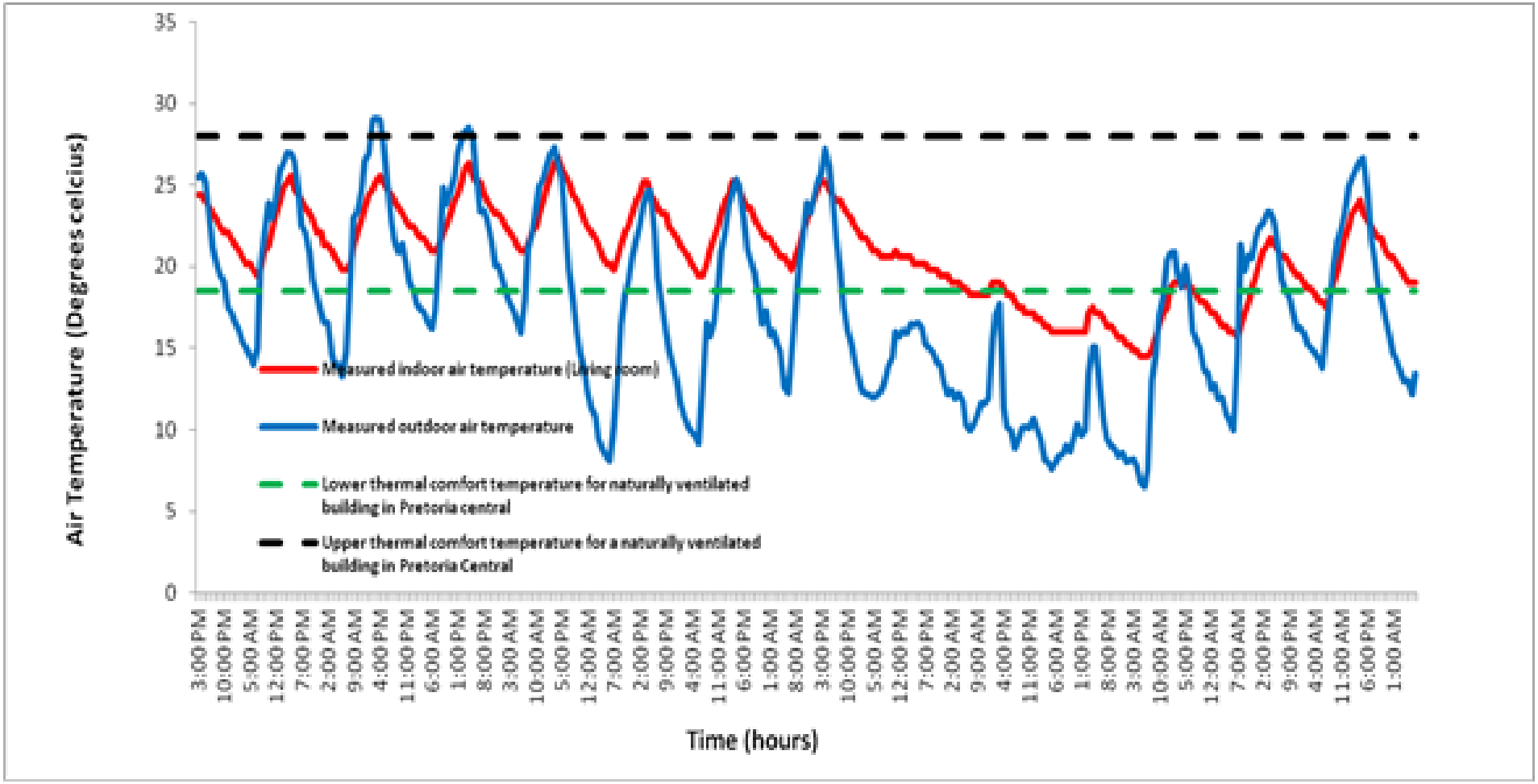
- External wall total R-value value range from 0.35 – 2.2 (?)
- Roof assemblies total R-value range from 2.17 – 3.7 (?)

External wall assembly R- 3.7
Roof assembly R- 1.37



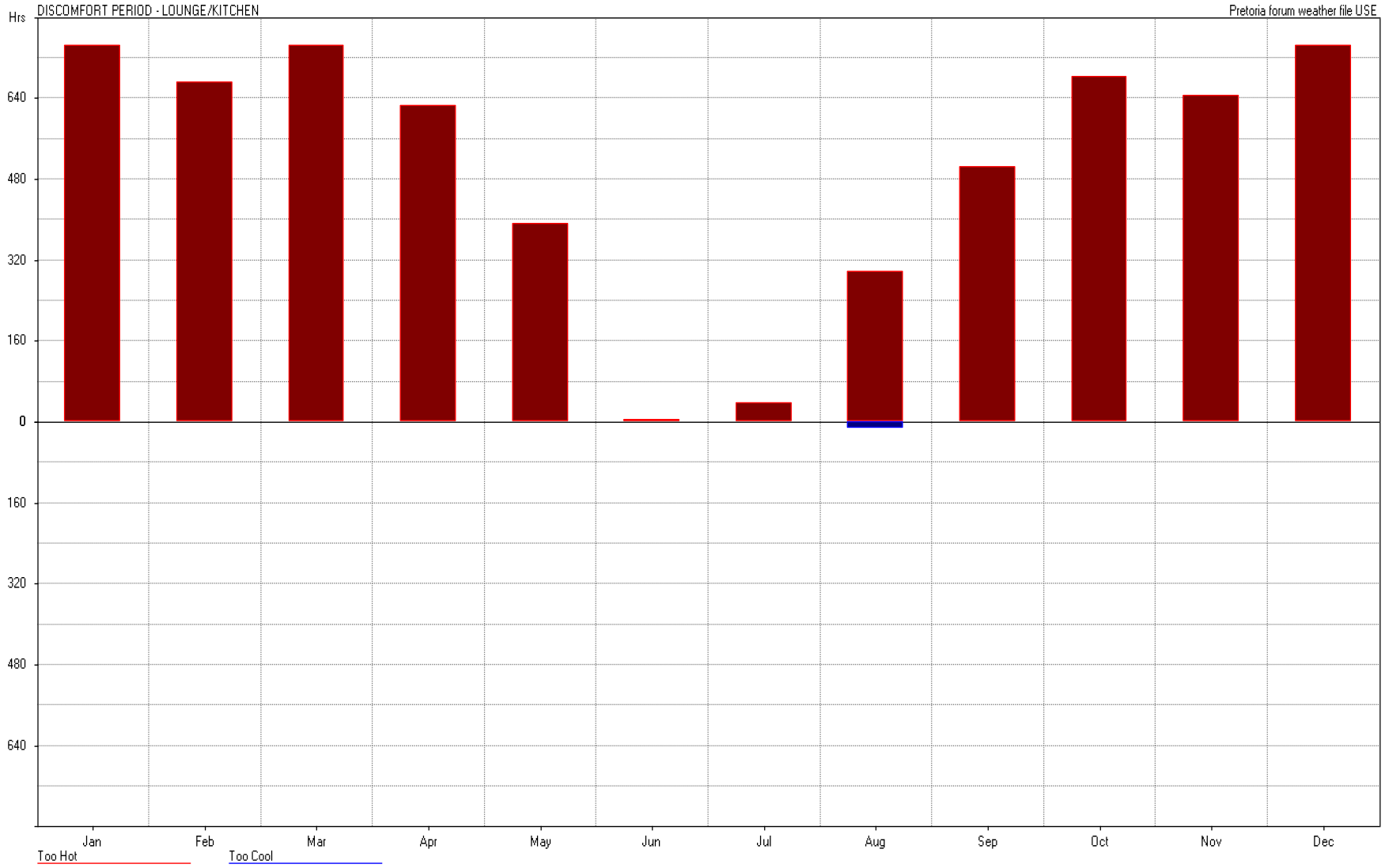
Technology Options

❖Influence of insulation on comfort levels



Technology Options

❖Influence of insulation on heating and cooling loads



Technology Options

❖Influence of insulation

744 hours in a month

8760 hours in the year

6091 hours too hot

Month	Hours too hot	Hours too cool
Jan	744	0
Feb	672	0
Mar	744	0
April	625	0
May	392	0
June	4	0
July	38	0
Aug	298	14
Sept	503	0
Oct	683	0
Nov	644	0
Dec	744	0
Total	6091	14

Technology Options

❖Influence of ventilation

ACH ventilation rate of 5 reduces total number of too hot hours from 6091 to 1501

Ventilation rate (ACH)	Too hot hours
5	1501
6	1215
7	994
8	873
9	806
10	743
15	582

Heating Load and Cost

- RDP House heating load of 3,401 kWh/annum at cost of R4081.87
- SANS 204 House heating load of 2,127 kWh/annum at cost of R2553.26
- BASF House heating load of 277.77 kWh/annum at cost of R566.66

Emissions from Energy Used

ESKOM 2011
.96 kg per kWh of electricity produced

Total area of residential building plans approved May 2013 = 584,237
For the year = 7,010,844 sq.m.

RDP house = 81,6 $kgCO_2$/sq.m.
SANS house = 26,77 $kgCO_2$/sq.m.
BASF House = 6,62 $kgCO_2$/sq.m.

- RDP House emissions = 3,264 $kgCO_2$/annum
- SANS 204 House emissions = 1,071 $kgCO_2$/annum
- BASF House emissions = 265 $kgCO_2$/annum
- All new residential building in SA built to this performance standard = 525,673t CO_2 saving

Water Usage from Energy Used

ESKOM
1.34l/kWh SO (sent out)

- RDP House water = 4,557 l/annum
- SANS 204 House water = 2,850 l/annum
- BASF House water = 371 l/annum

Energy and Water Savings for SA

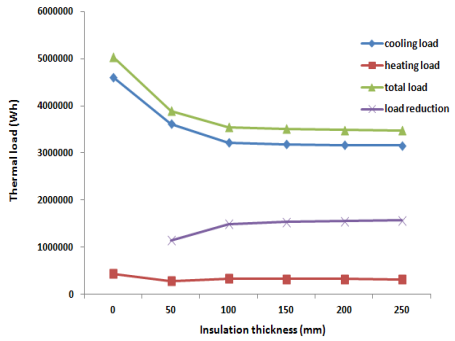
Total square meters of residential building approved for 2013 forecast: 7,010,844 (StatSA)

- Energy saving = 547 GWh/annum
- Carbon saving = 525,763 tCO_2/annum
- Water saving = 733 Ml/annum

Technology Options

- PG Study: Classroom
- Influence of Neopor ceiling insulation

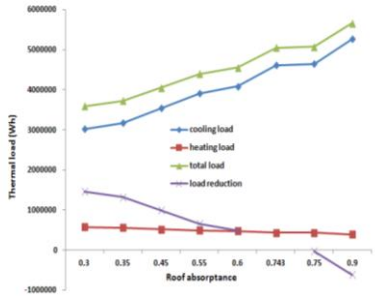
Insulation thickness (mm)	heating load (Wh)	cooling load (Wh)	total load (Wh)	load reduction (Wh)	% Reduction (+) or increase (I) (-)
0	430301	4609662	5039962		
50	275138	3616208	3891346	1148616	22.8
100	332802	3214089	3546890	1493072	29.6
150	325212	3181734	3506946	1533016	30.4
200	321731	3166330	3488060	1551902	30.8
250	317994	3155451	3473445	1566517	31.1



Technology Options

- PG Study: Classroom
- Influence of roof paint

Absorptance	heating load (Wh)	cooling load (Wh)	total load (Wh)	load reduction (Wh)	Reduction (+) or increase (-) (%)
0.3	568533	3014417	3582950	1457012	28.9
0.35	549927	3172363	3722290	1317672	26.1
0.45	515205	3533453	4048658	991304	19.7
0.55	484095	3903094	4387189	652773	13.0
0.6	469193	4080707	4549900	490062	9.7
0.743	430301	4609662	5039962		
0.75	428419	4642558	5070976	-31014	-0.6
0.9	390967	5265176	5656143	-616181	-12.2



Kleinmond Housing Project

Low Income Housing Potential

Innovative technology	Per house	National
Energy reduction (heating load)	11.12 GJ	23.3m GJ
Electricity (SWH)	5840 kWh/annum	12.76b kWh/annum
Electricity (PVP)	36 Kwh/annum	75.6m kWh/annum
Co2 reduction (SWH)	5,927 kg CO_2 eqt/annum	13b kg CO_2 eqt/annum
CO_2 reduction (PVP)	31 kg CO_2 eqt/annum	68m kg CO_2 eqt/annum

Conclusion

❖Potential for reducing thermal loads

- Results indicate that ceiling insulation has the greatest potential for reducing thermal loads by up to 31%.
- The second most effective measure is a combination of 40 mm wall insulation, 150 mm ceiling insulation and a 0.3 roof absorptance leading to a reduction of 30.4%.
- The third most effective measure is by painting the roof white (0.3 absorptance value) leading to a reduction of 28.9% (See Figure 12).
- The fourth method is to use a combination of 40 mm wall insulation and 150 mm ceiling insulation that realises a reduction of 28.1%.

Thank you