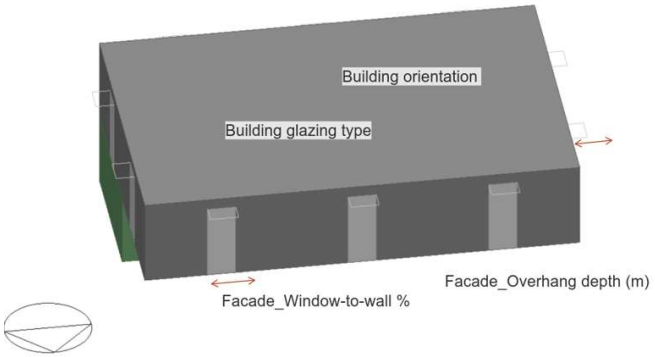
4 Façade optimisation

What is the ideal façade design for this building?

The concept design tool, 'Optimisation' (from DesignBuilder software) was used to efficiently search over many possible design variations to find an optimal design. The software makes use of a genetic algorithm to search in an 'intelligent' way amongst design options thereby greatly reducing simulation time.

A simplified model was created with the same floor area as the architectural concept design. The objective of the optimisation was to minimise cooling and heating electricity used to keep the building comfortable (between 19-25˚C).



Building model setting

Residential building:	low heat loads for occupancy, equipment, and lighting.
Construction	Wall R=1.2, Roof R=3.7, Floor R=0.5
Model infiltration	0.3 ach (very low)
Heating COP	3
Cooling COP	2.5
Temperature control	19-25 ˚C
Heating and cooling schedule	10h-22h every day

Optimisation variables

For each façade individually	N, S, W, E
Window-to-wall %	20-80%
Overhang depth (m)	0-2m
For the whole building	
Glazing type	4 single glazed, 2 double glazed *
Orientation	0-90˚

**Single (Clear, Tinted, Low E, Spectrally Selective) Double (Low E, Spec Selective)*

Figure 15: Building settings and Optimisation variables for the simplified model.

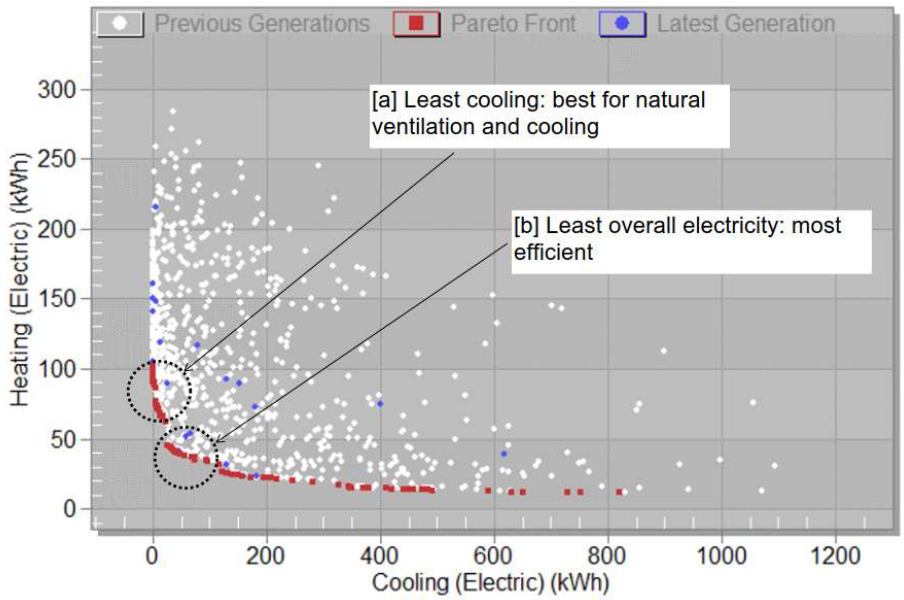


Figure 16: Optimisation result: The red dots represent optimal solutions from 1093 annual simulation in EnergyPlus (DesignBuilder). Groups of best solutions are shown as scenario [a] and [b].

The results were studied to reveal which design variables yielded the best results for case [a] and [b].

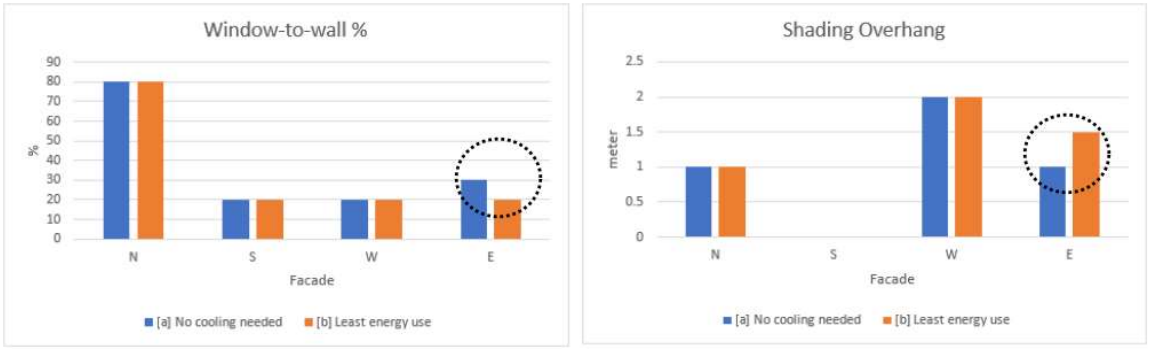


Figure 17: summary of façade variables of the two best performing scenarios [a] and [b]

Observation made:

- Scenarios [a] and [b] selected the same variables for: north orientation, window-to-wall ratio and shading on N, W, S.
- For [a] 'no cooling': spectrally selective double glazing and 30% window-to-wall ratio with 1m overhang on east was best.
- For [b] 'most efficient': double glazing and 20% window-to-wall ratio on east, with a 1.5m overhang was optimal.
- Glazing properties: [1] double glazing Low E spectrally selective: SHGC = 42%, VLT = 68%, U-value = 1.6. [2] double glazing Low E: SHGC = 69%, VLT = 74%, U-value = 2

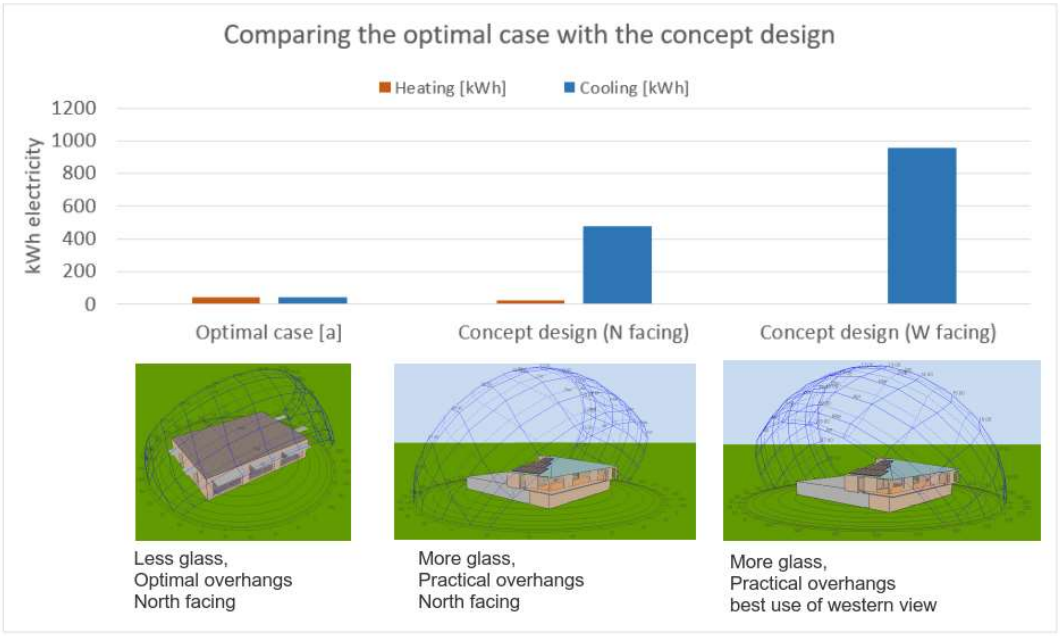


Figure 18: final comparison of optimal and concept designs and kWh annual electricity for heating and cooling

Figure 18 gives a good comparison of the energy consequences of the concept design at different orientations. The aesthetic concept design comes at a significant electricity cost[2] and using high glazing ratios doubles the energy cost. Optimised design is shown to almost eliminate heating and cooling in the Cape Town climate region.

[2] Assuming most cooling occurs during 4 hottest months, 1000 kWh/a = ~ 8kWh/day