Parameters of our study

BRANZ

Introduction
Optimisation
Urban Energy
Next?

- **Lessons from international high-performance buildings**
- **'Optimised' building design:**
  - Tvis and Tsol , R-value of all components, shading, WWR and height of glazing, heat storage
- **Urban design options from CCP :**
  - Height limit 7 storeys
  - sloping South facades over 5 storeys;
  - permeability = lanes (4m / 10m) or courtyards

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Where to start?

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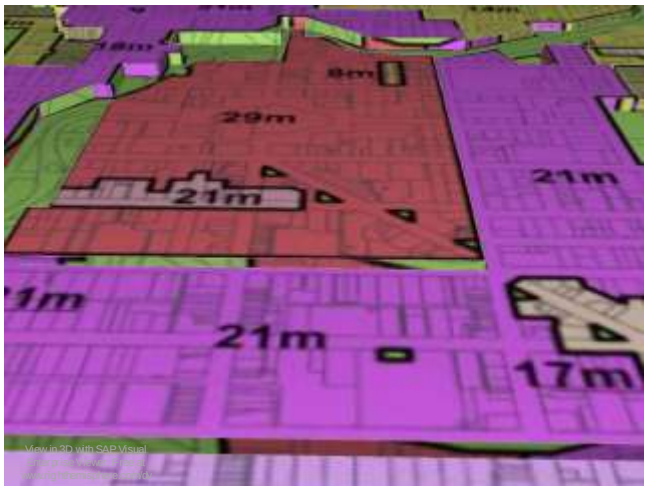

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Where to start?

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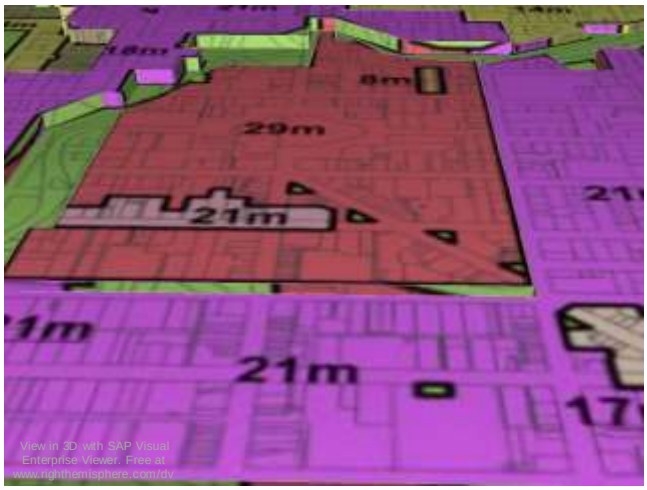

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7 Case Study Net ZEBs – Lessons

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Next?

- **30 IEA NetZEB Case Studies**
  - http://www.iea-shc.org/task40
- **7 of these Cases examined:**
  - IEA cases must have measured performance
  - Non-residential – Office and Education
  - 3 under 700m2 and 4 are 3000m2 or larger
  - 1 - 10 storeys
- **Interviewed design teams**

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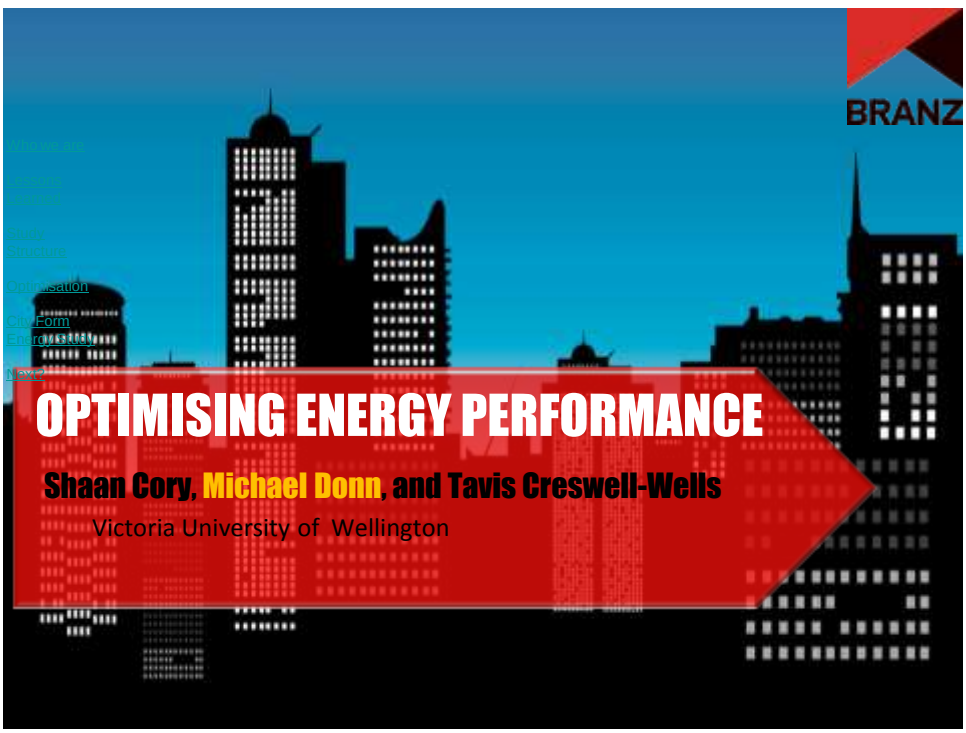

Simulation and Optimisation

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- **Simulation EnergyPlus: 8760hours.**
  - Genopt –optimiser for E+
  - Max and Min values.
  - Completes runs until optimum is established.
- **Base scenario code for Christchurch.**
  - Select Set of Energy Lowering Solutions to optimise.
  - Note: Parameters are only optimum for this scenario – but design principles still apply.

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Christchurch Base Building Model

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NZBC

- **Wall, Floor and Roof Insulation**
- **Single Glazing**
- **WWR 50%**
- **12W/m² LPD**
- **8.5W/m² EPD**
- **0.1person/m²**
- **10L/s.person Fresh Air**

BEES Schedules:

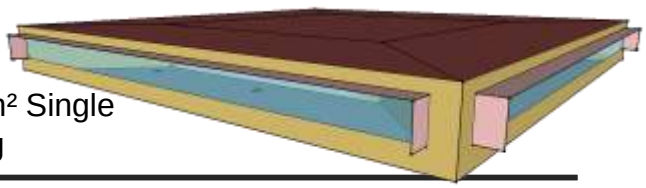
•8am to 5pm

Thermal Mass:

•Concrete Slab

IEA Task 40 Set Points:

•18-27˚C



5 Zone -1000m² Single Storey Building

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Set of Energy Lowering Solutions

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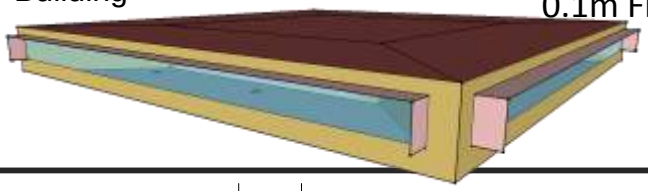
- **Design changes:**
  - Natural Ventilation
  - Electric Light Controls
- **Optimised parameters:**
  - Solar shading: 0-3m
  - Insulation: R0.1-R12
  - Window to Wall Ratio(WWR 10-90%)
  - Window Height 0.1m Floor/Roof

5 Zone -1000m² Single Storey Building



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Optimum Shading Parameters

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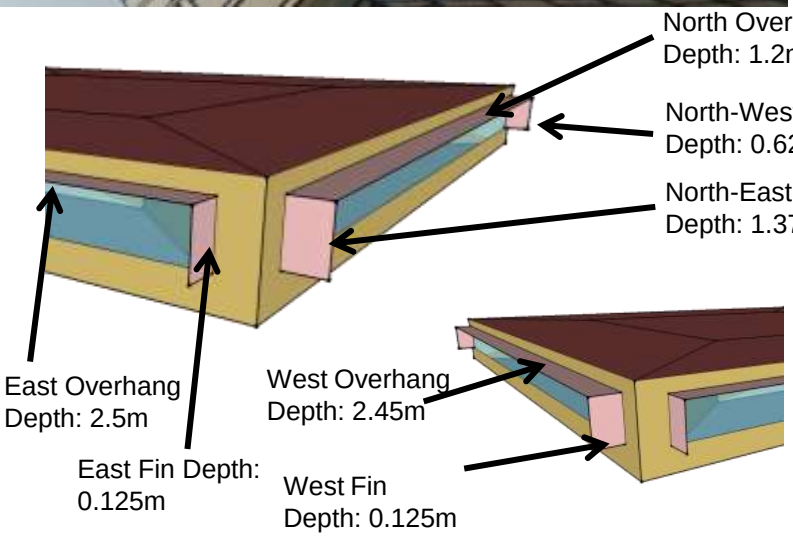

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Optimum Window Parameters

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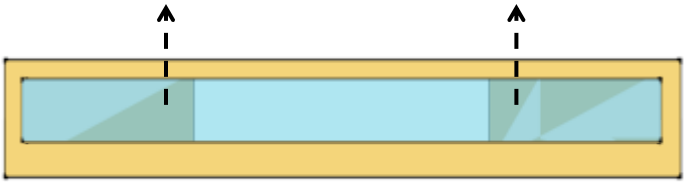

WWR: 50% Window Height: Moves Up 200mm

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'Optimum' Construction Parameters

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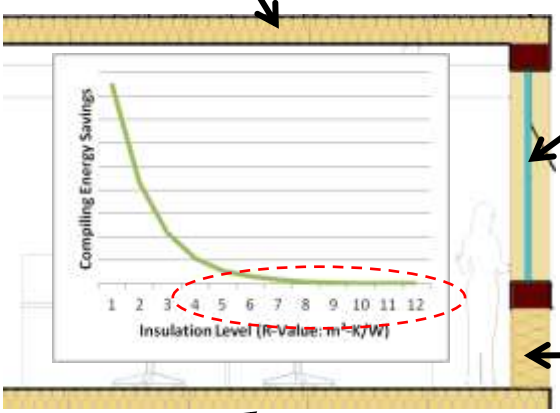
Roof Insulation:
- 12 m²-K/W



Glazing Insulation:
- 0.77 m²-K/W

Glazing T_{vis}/T_{sol}:
- 0.8

Wall Insulation:
- 12 m²-K/W

Floor Insulation:
- 1.5 m²-K/W

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Energy End-use Breakdown & Savings

Introduction
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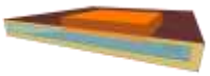
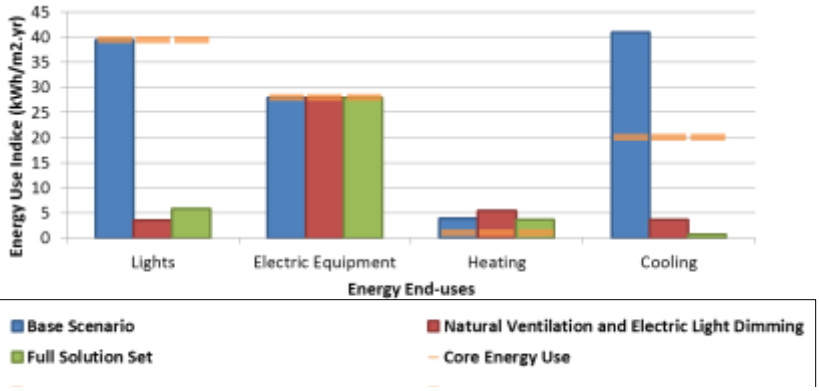
- **Largest Savings: Cooling and Lighting**
  - Achieved with Natural Ventilation/Free cooling and Electric Light Controls.
- **Natural Ventilation and Solar Shading**
  - Elimination of Cooling needs in perimeter
- **Base Scenario**
  - Perimeter Zones use more than Core Zone.





Deep Plan vs Shallow Plan

Introduction
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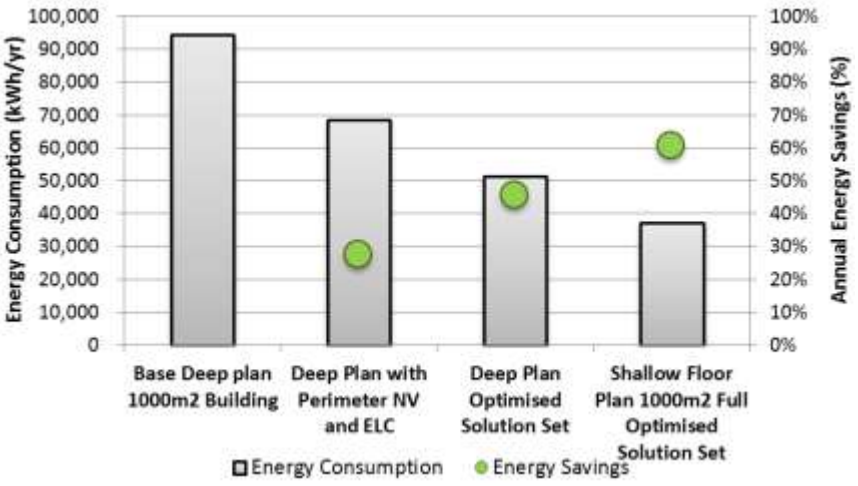
Next?



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Narrow plan building

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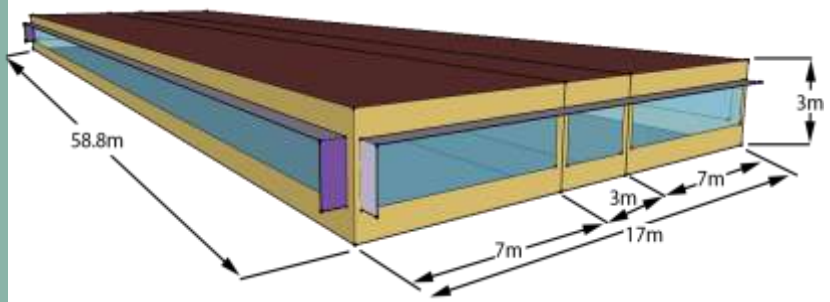
Next?



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Summary

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Next?

- **Cooling almost eliminated in Perimeter.**
- **Office Equipment very dominant.**
- **Design Principles:**
  - Free cooling and daylight design is crucial – if form is kept narrow for whole building design - almost eliminates mechanical cooling.
  - Insulate well – especially the roof AND glazing!
  - WWR not too much bigger than NZBC of 50% **NB NOT smaller!**
  - Have high window placement

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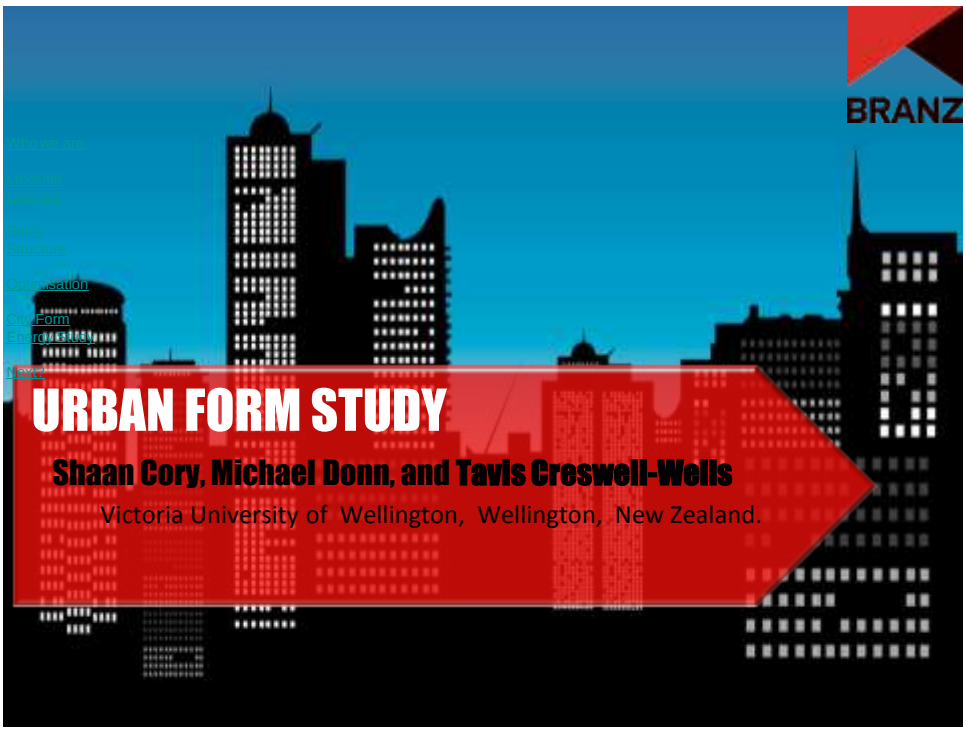
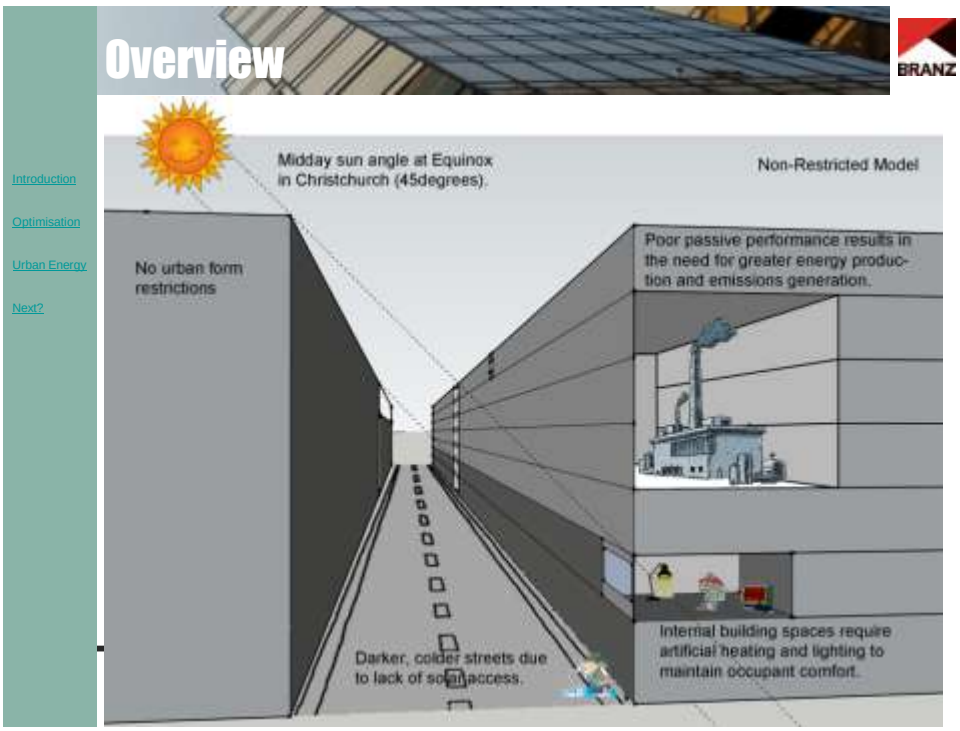

BRANZ
URBAN FORM STUDY
Shaan Cory, Michael Donn, and Tavis Creswell-Wells
Victoria University of Wellington, Wellington, New Zealand.


Overview
BRANZ
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Next?
Midday sun angle at Equinox in Christchurch (45degrees).
Non-Restricted Model
No urban form restrictions
Poor passive performance results in the need for greater energy production and emissions generation.
Darker, colder streets due to lack of solar access.
Internal building spaces require artificial heating and lighting to maintain occupant comfort.

Overview

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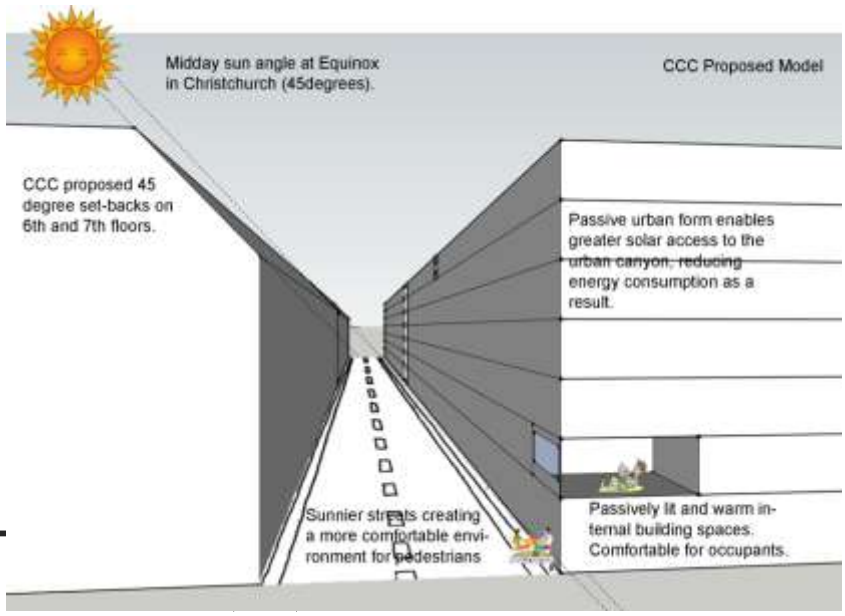
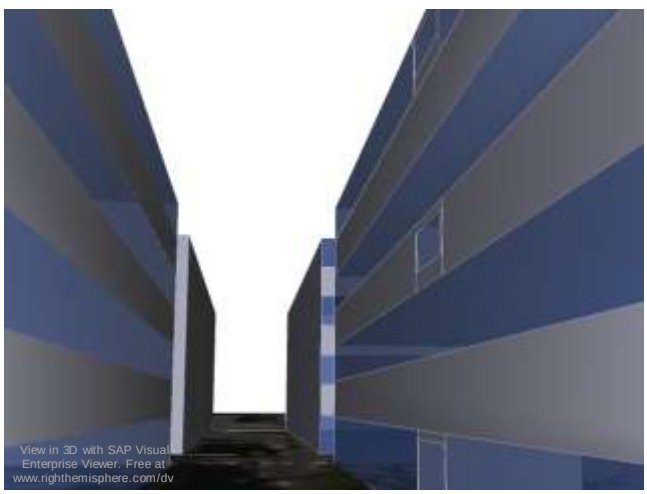
Urban Energy
Next?



Establishing the baseline

Introduction
Optimisation
Urban Energy
Next?



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Scenarios

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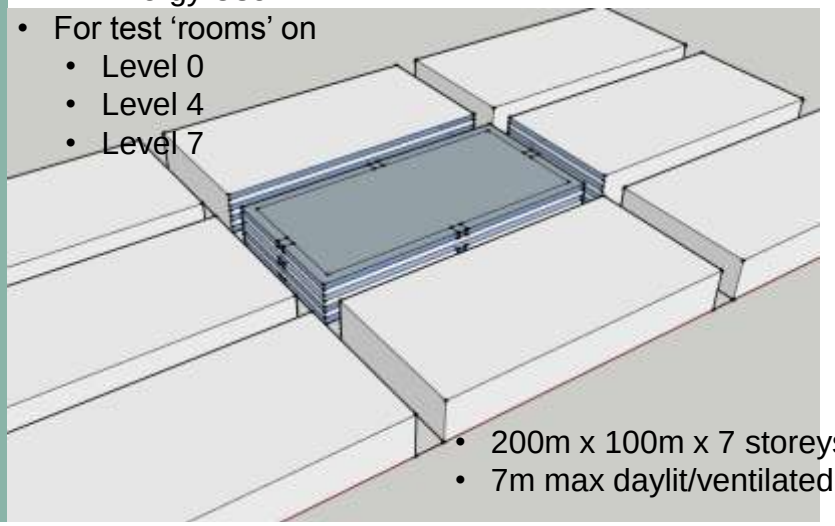
Next?

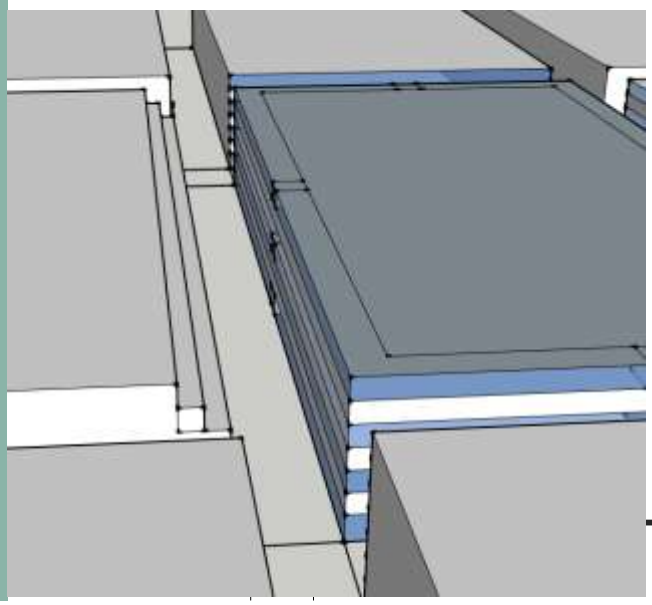
- Effect of Urban form on
  - Daylight
  - Energy Use
- For test ‘rooms’ on
  - Level 0
  - Level 4
  - Level 7



- 200m x 100m x 7 storeys
- 7m max daylit/ventilated

Step-backs?

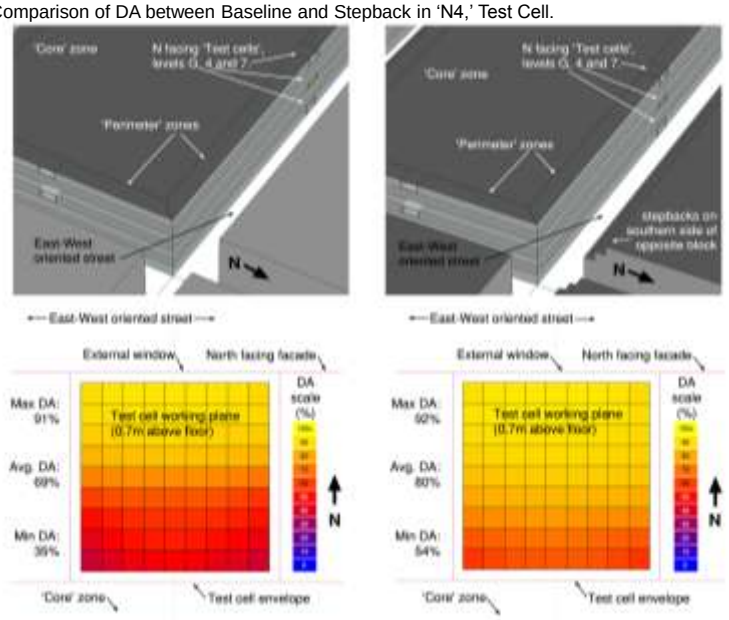
Introduction
Optimisation
Urban Energy
Next?



Daylight Autonomy (DA): North - Level 4

Introduction
Optimisation
Urban Energy
Next?

Comparison of DA between Baseline and Stepback in 'N4,' Test Cell.



Perimeter Energy change - setbacks

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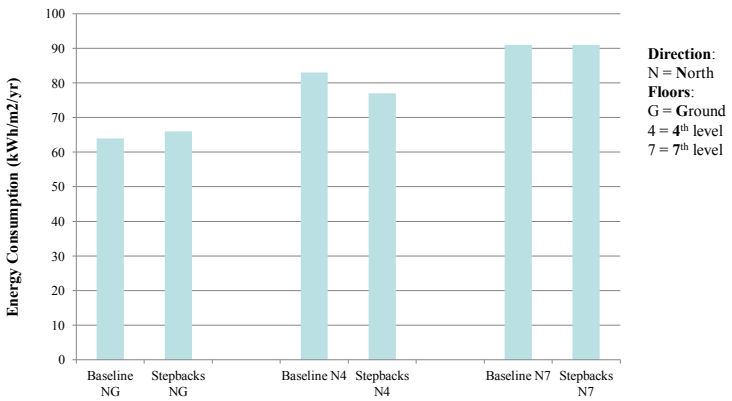
Optimisation
Urban Energy
Next?

EnergyPlus modelling of AEUI change for North Façade



- Step-backs make no difference to top floors.
- Biggest improvement apparent on mid-level floors.

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Effect of set-backs overall

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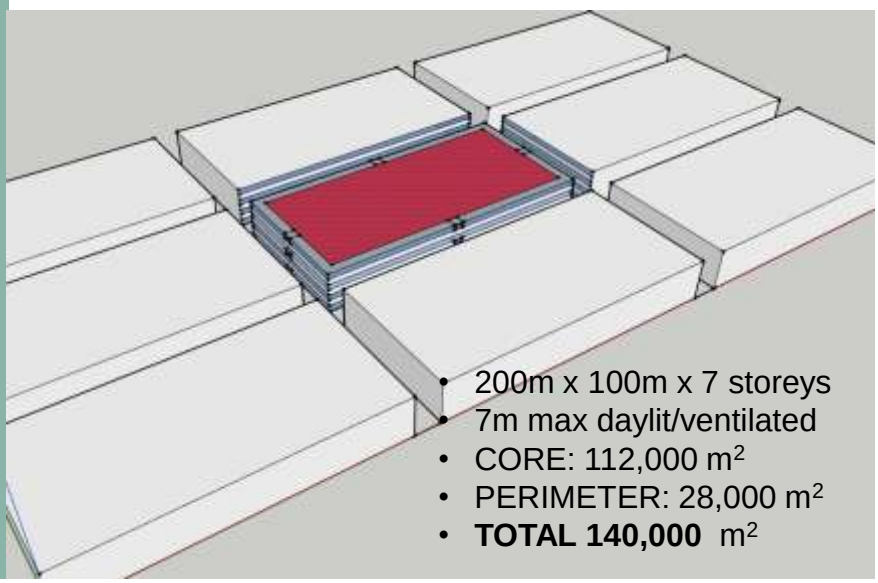

- 200m x 100m x 7 storeys
- 7m max daylit/ventilated
- CORE: 112,000 m^2
- PERIMETER: 28,000 m^2
- **TOTAL 140,000** m^2

Overall Energy Change: Step-backs

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Optimisation
Urban Energy
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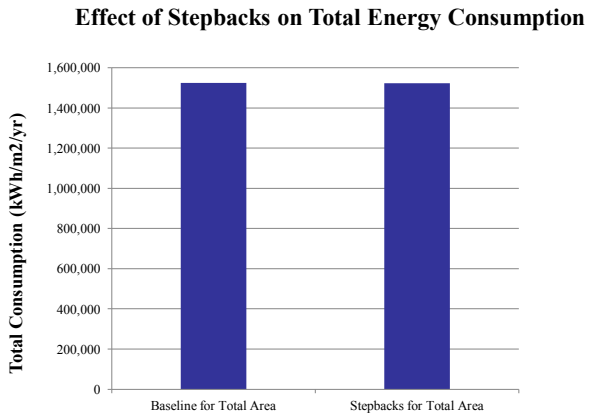

- Step-backs make negligible improvement to overall building energy consumption.

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Sunlight in Street: Effect of Stepbacks

- Annual, between 7am and 7pm (4,380 hours total)
- North-South oriented streets not affected (738 up to 778)

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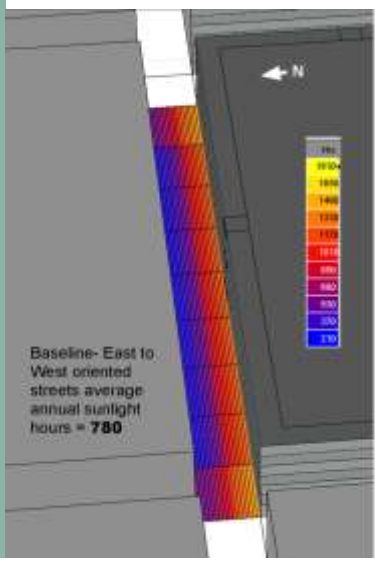

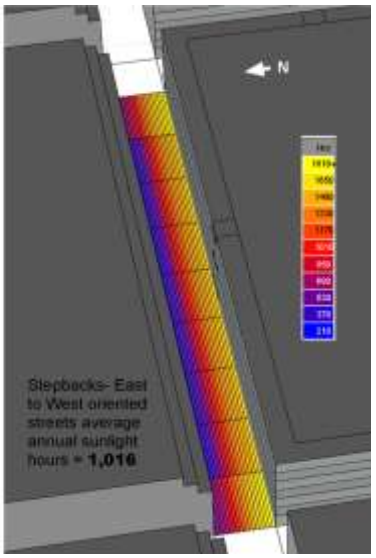

Baseline: All year

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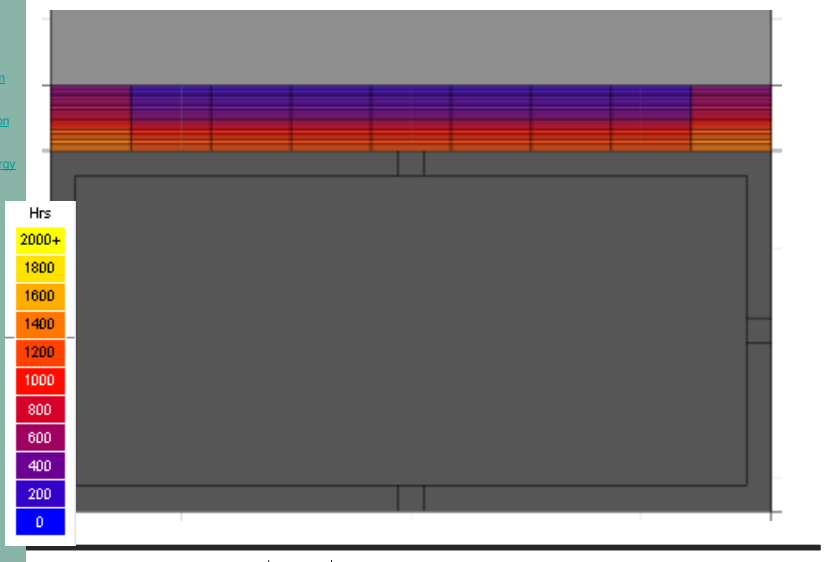

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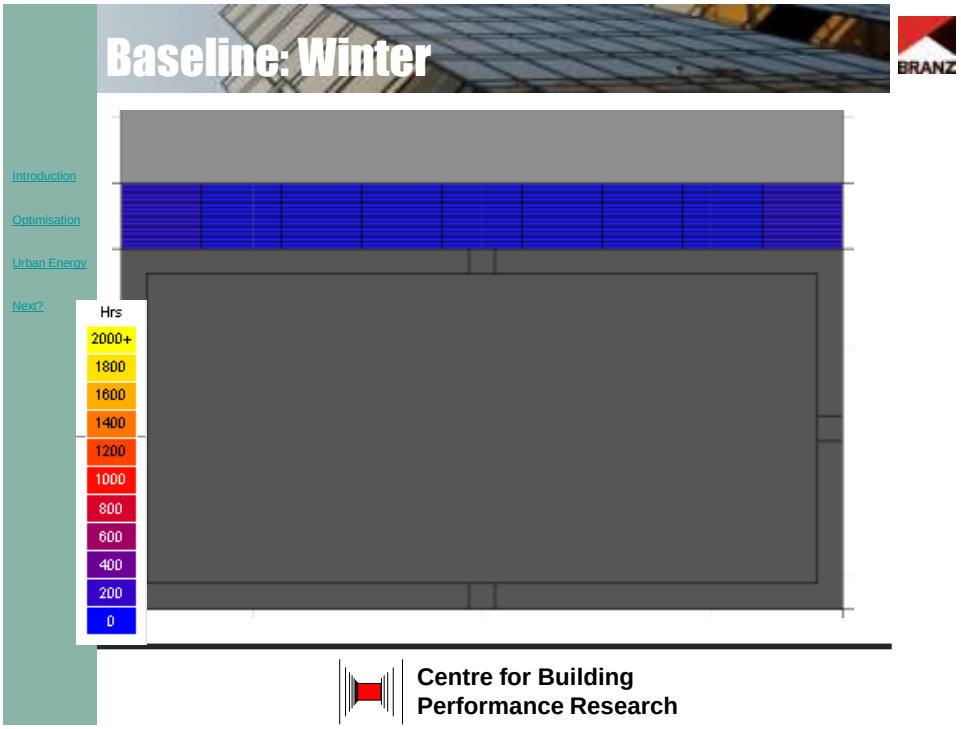
Baseline: Winter
BRANZ
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Next?
Hrs
2000+
1800
1600
1400
1200
1000
800
600
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200
0
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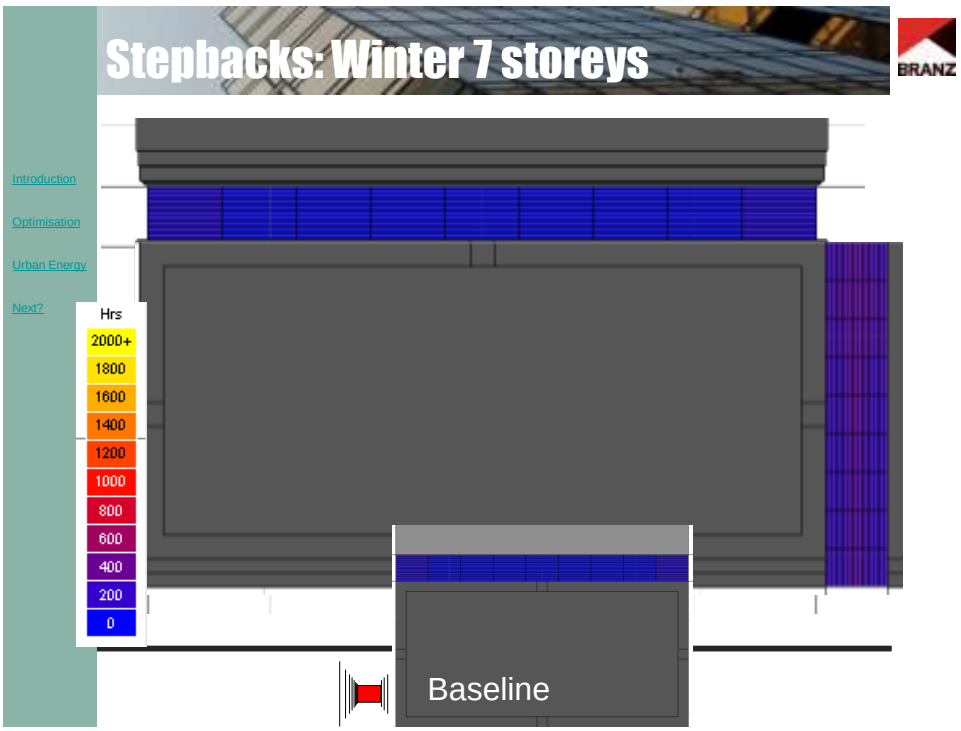
Performance Research


Stepbacks: Winter 7 storeys
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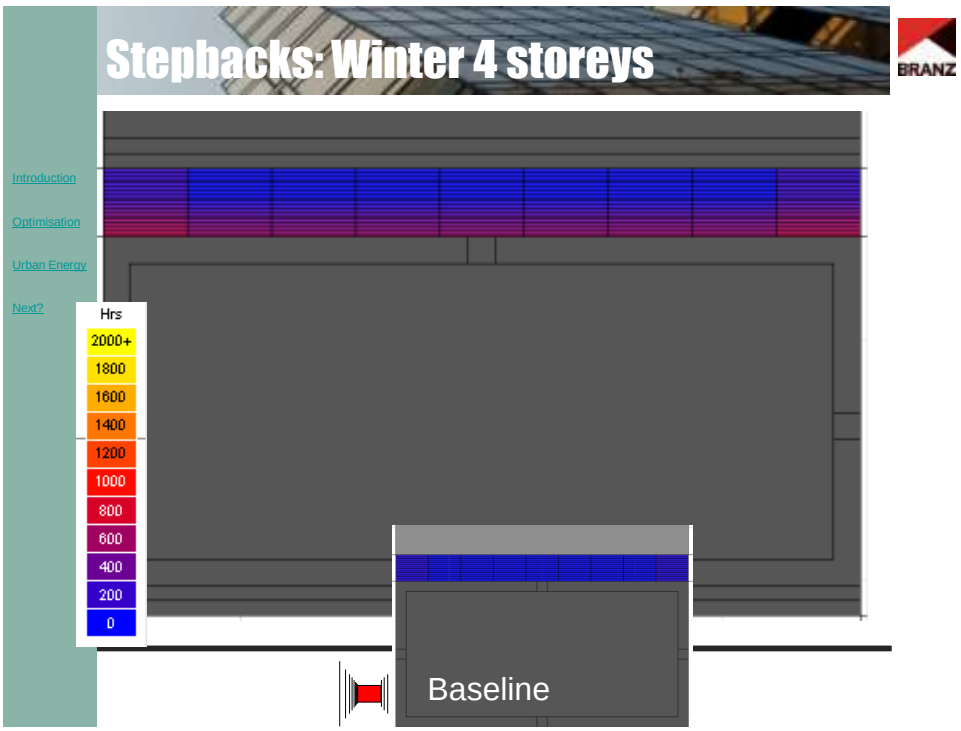
Baseline


Stepbacks: Winter 4 storeys
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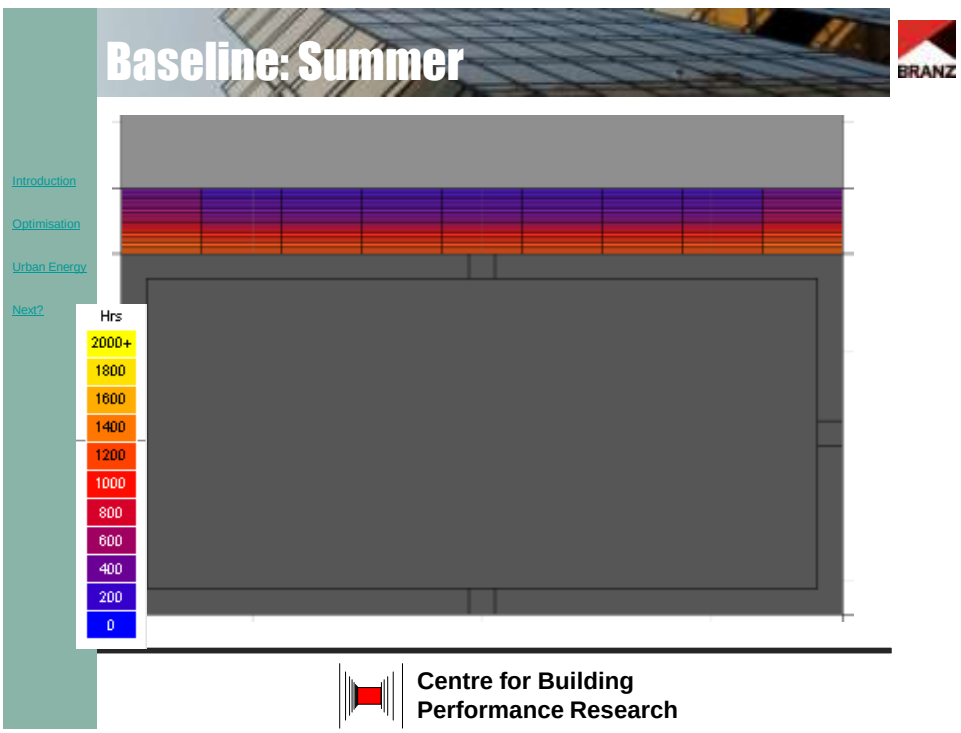
Baseline


Baseline: Summer
BRANZ
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Hrs
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0
Centre for Building
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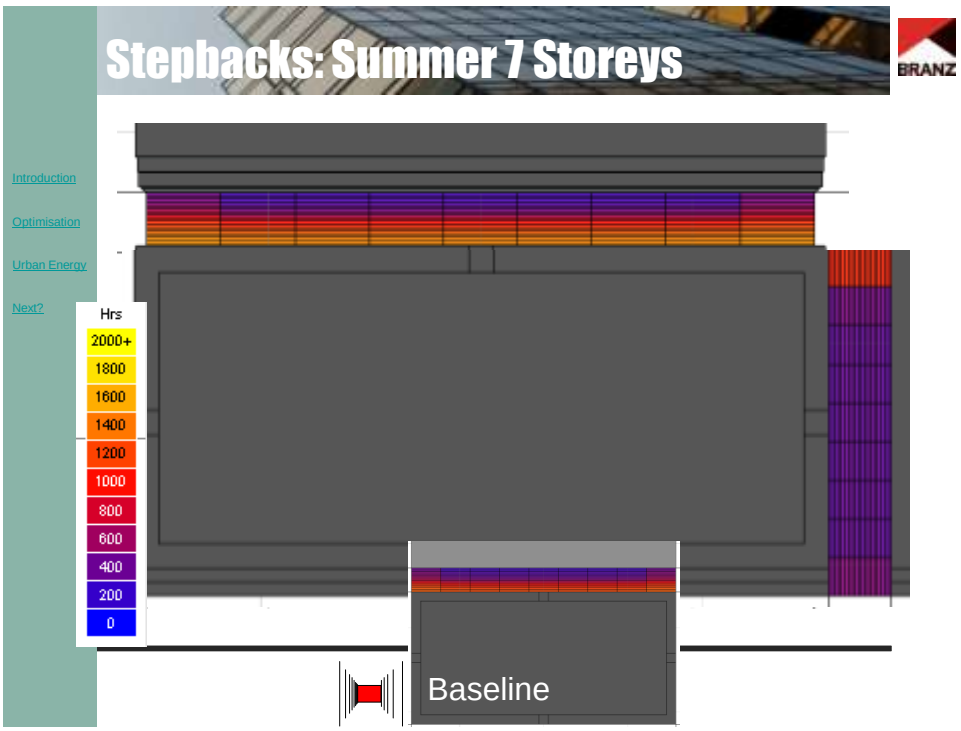
Stepbacks: Summer 7 Storeys
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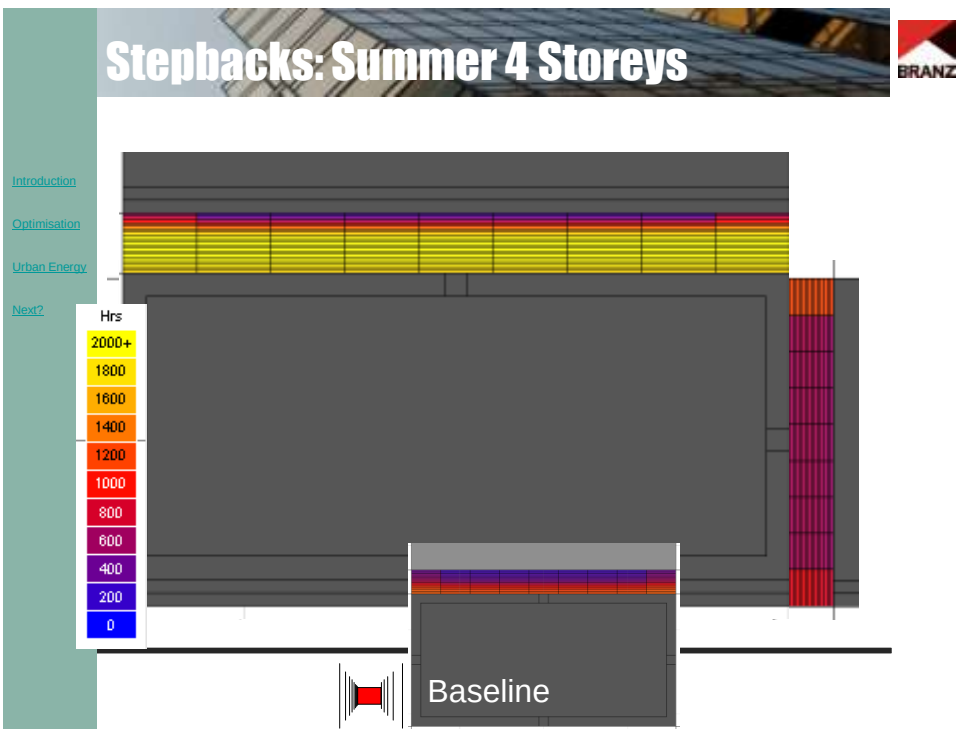
Baseline


Stepbacks: Summer 4 Storeys
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2000+
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0
Baseline

Deep plan buildings

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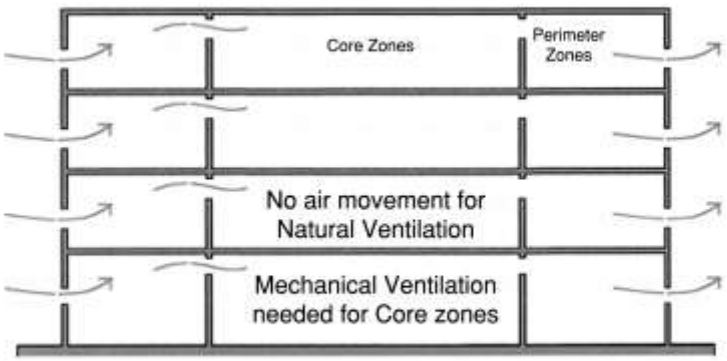

Typical Building Cannot Ventilate Naturally

Lanes?

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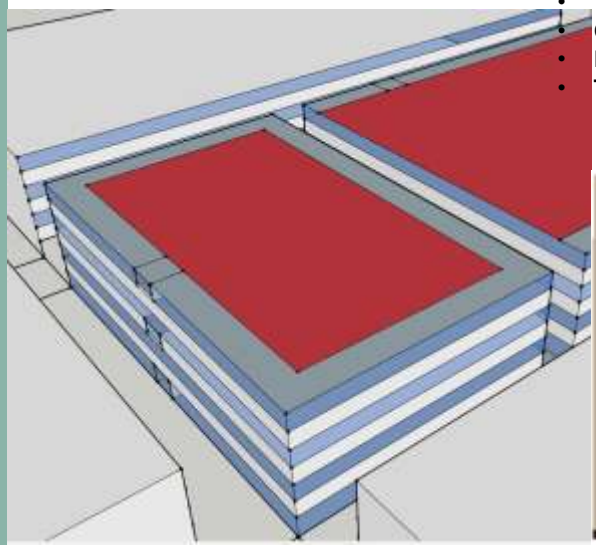
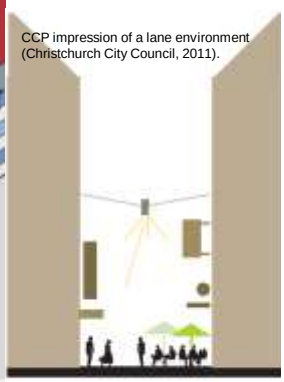
- 3 buildings in total:
- 65m x 100m x 7 storeys
- 7m max daylit/ventilated
- CORE: 93,000 m^2
- PERIMETER: 44,400 m^2
- **TOTAL 137,400** m^2





CCP impression of a lane environment (Christchurch City Council, 2011).

Lane Daylight Autonomy (DA)

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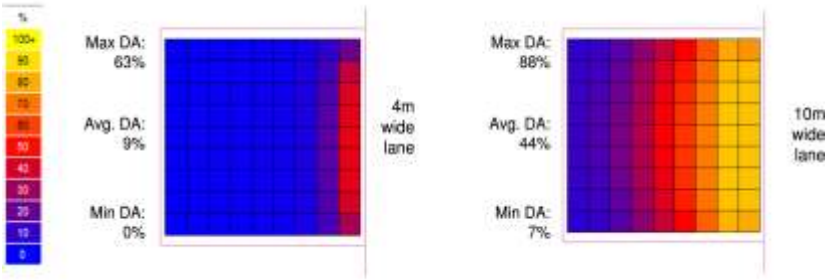
Level 4, East and West oriented zones adjacent to lanes



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Energy Consumption Change: Lanes

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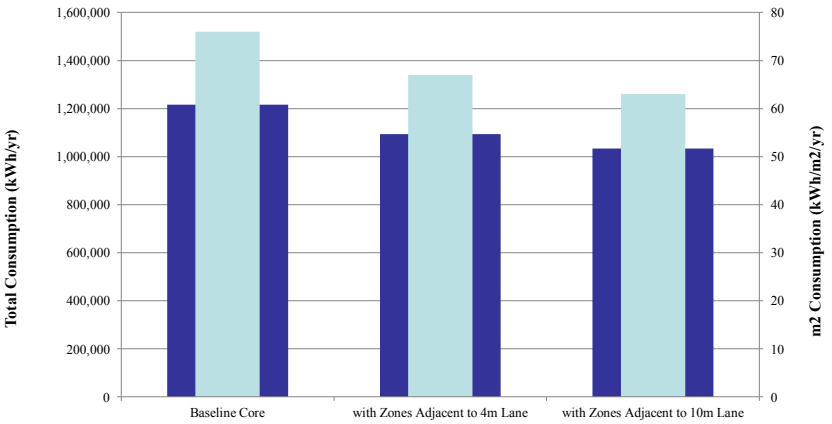

- Despite very poor daylighting, 4m lanes still reduce energy consumption

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Deep plan buildings

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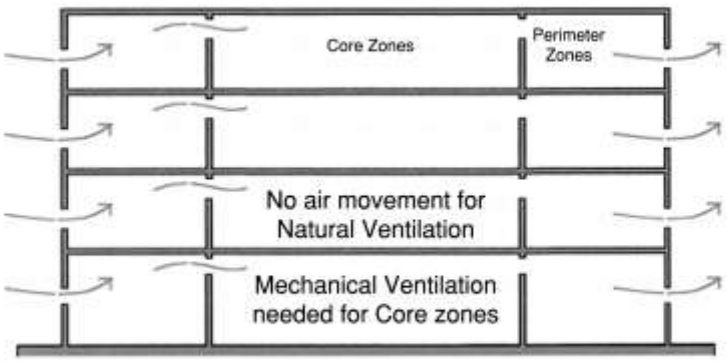

Typical Building Cannot Ventilate Naturally

Narrow plan buildings

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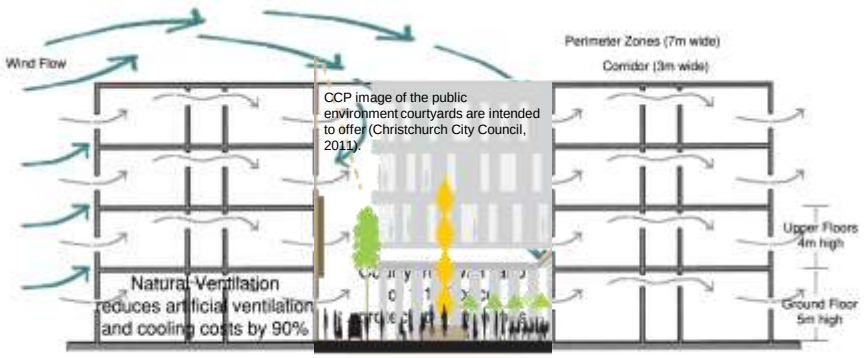
Where: $\frac{Area\ Courtyard}{(Av.\ Height\ Buildings)^2} < 10$ winds 50% reduced

7 storey courtyards: 2.4
4 storey courtyards: 7.1



CCP image of the public environment courtyards are intended to offer (Christchurch City Council, 2011).

Courtyards for Wind Protection and Natural Ventilation

Courtyards

Introduction
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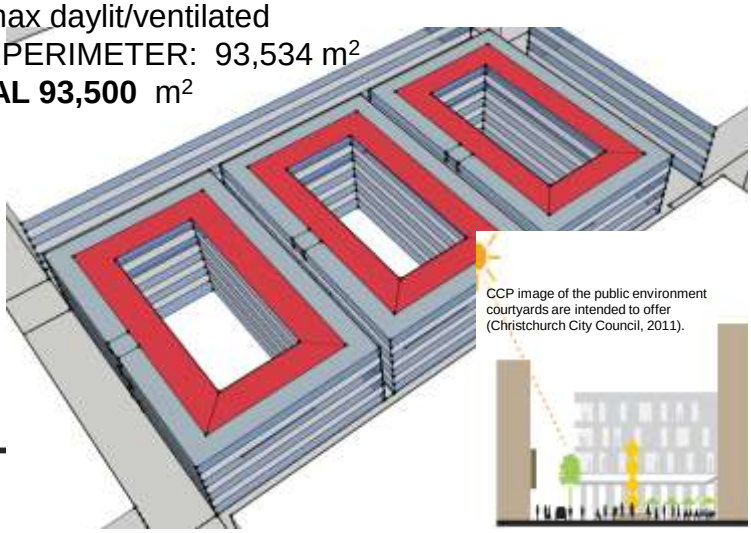
Next?

- 3 buildings
- 65m (62m) x 100m x 7 storeys
- 7m max daylit/ventilated
- Only PERIMETER: 93,534 m^2
- **TOTAL 93,500** m^2



CCP image of the public environment courtyards are intended to offer (Christchurch City Council, 2011).

Improved Daylight due to Courtyards

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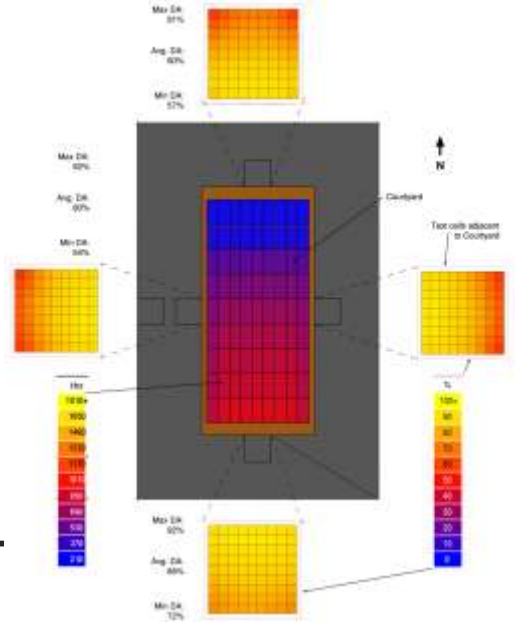

-Very good daylight to zones facing courtyard at mid-height

- Shading becomes an issue at Ground level

Daylight / Sunlight in streets

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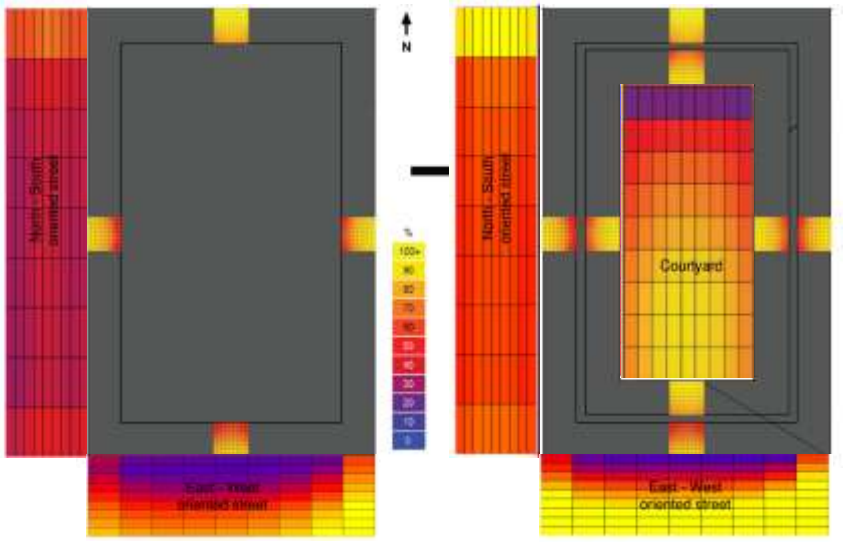

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Energy Performance: Courtyards

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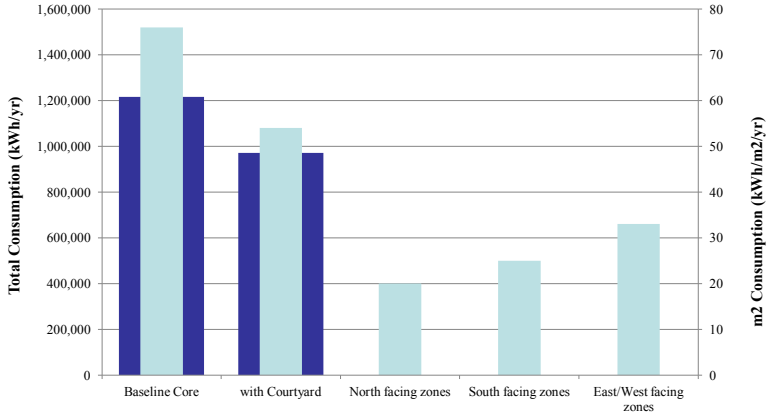

- All zones adjacent to the courtyard perform very well passively.
- Courtyard reduces total consumption by around 20%.

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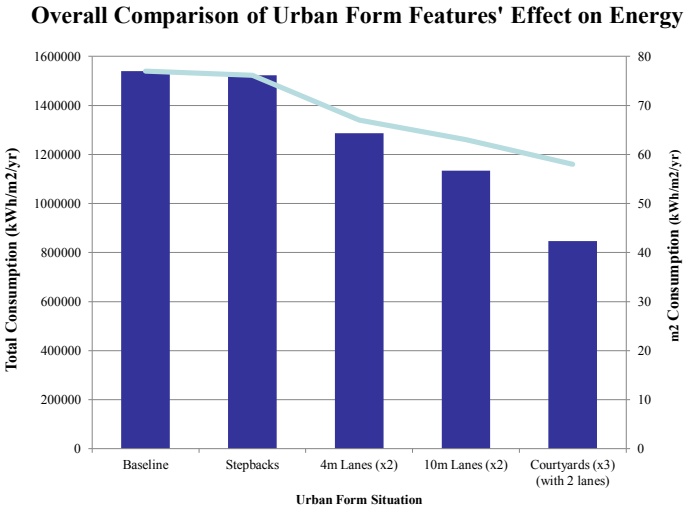
Summary



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Christchurch City Plan (CCP)

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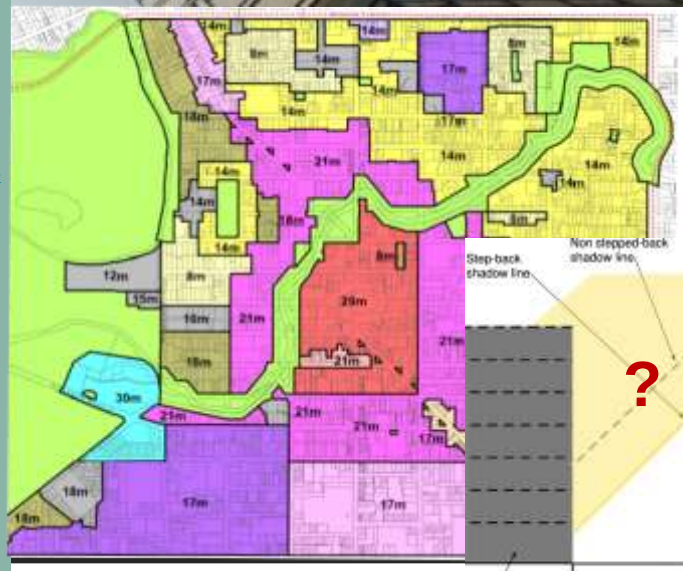

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Next Steps?

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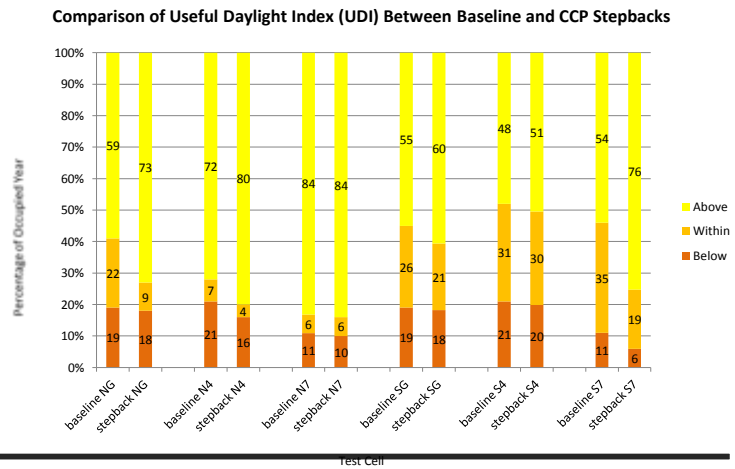
e.g. Good Daylight design looks at light between minimum 320 lux and maximum 2000lux (to avoid glare)



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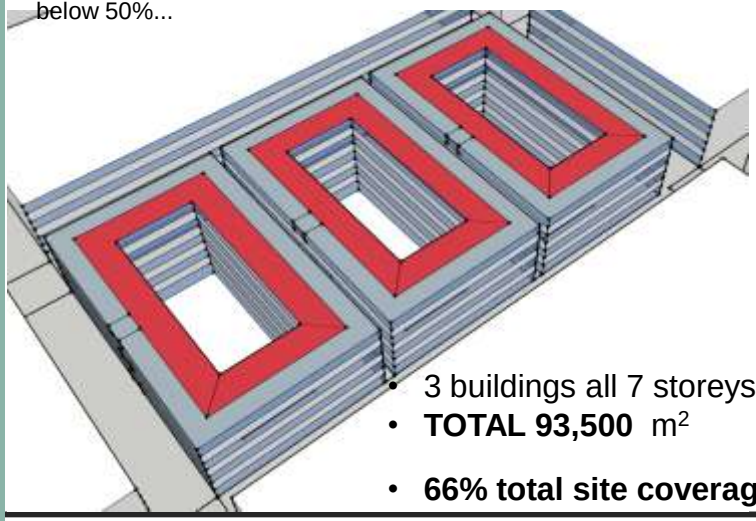
e.g. typical site coverage in a block in CBD before earthquakes was well below 50%...



- 3 buildings all 7 storeys
- **TOTAL 93,500** m^2
- **66% total site coverage**

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Next Steps?

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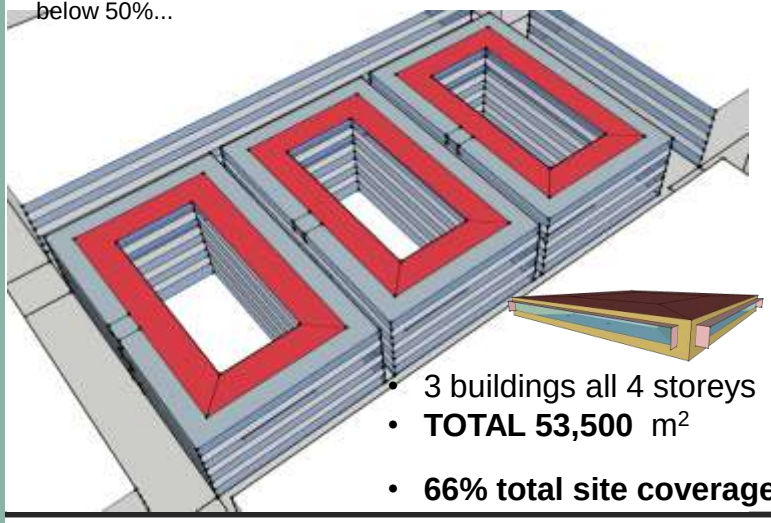
e.g. typical site coverage in a block in CBD before earthquakes was well below 50%...



- 3 buildings all 4 storeys ?
- **TOTAL 53,500** m^2
- **66% total site coverage**

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Next Steps?

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- **NZGBC grant to Shaan Cory, BEES Scholar at VUW**
  - Convert this to a guide
- **Your ideas HERE:**
  -
  -
  -
  -
  -

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Thank You

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- **To the BEES team for encouragement and assistance**
- **Tavis and Shaan (and Andrew)**
- **To you**

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