UNSW Engineering
School of Photovoltaic and Renewable Energy Engineering

UNSW SYDNEY Australia's Global University

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Commercial Building Shape and Orientation: Impact on BIPV Energy Generation and HVAC Demand

Nicholas Bell

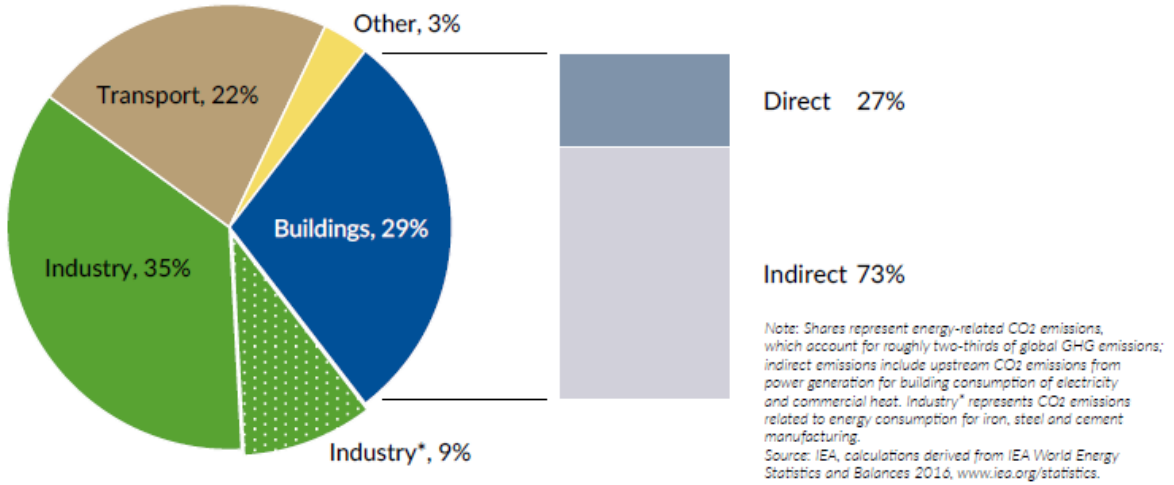
Problem Statement

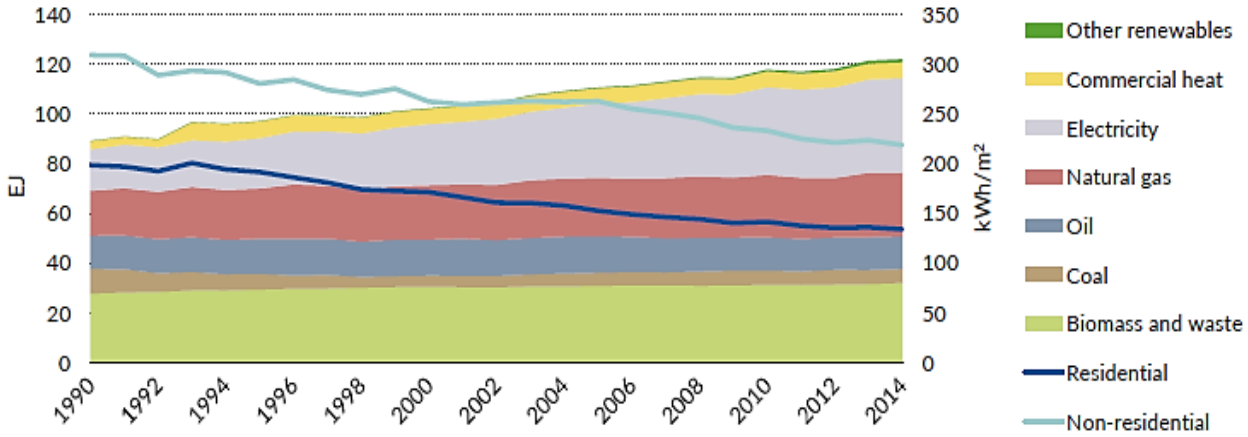
Buildings contribute almost 30% of global emissions (Ürge-Vorsatz, 2012)

- Potential for significant energy and emissions reductions

Building Form - Balance

- Energy Consumption
- Energy Generation
- Function





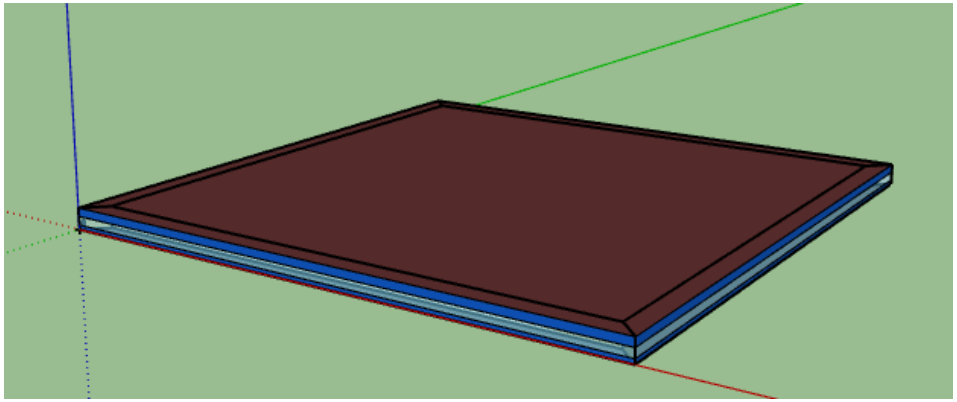
Source: Global Alliance for Buildings and Construction, 2016

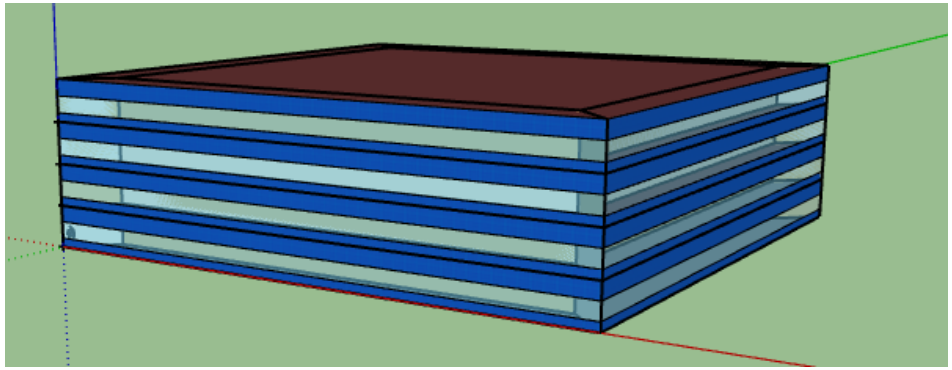
Aims

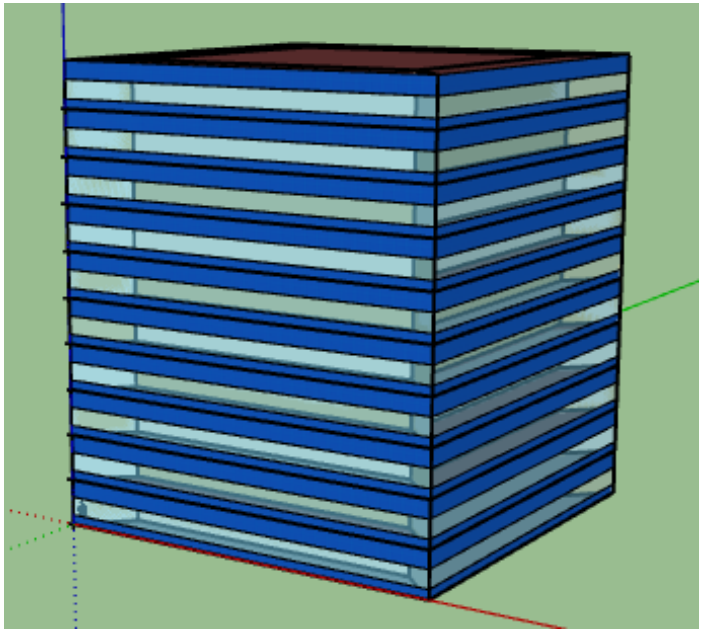
Investigate the impact of changes in building form upon energy use intensity and energy generation intensity

Compare energy use and generation intensity results from Building Performance Simulation in OpenStudio

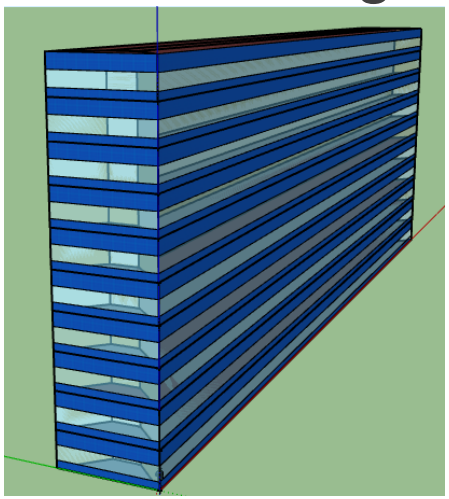
Simulation 1: Constant total floorspace (10,000 m^2), square floorplan. Changing the number of floors

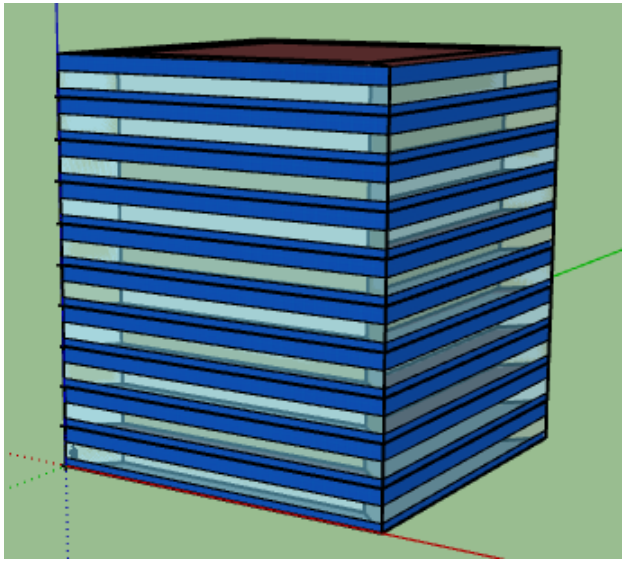


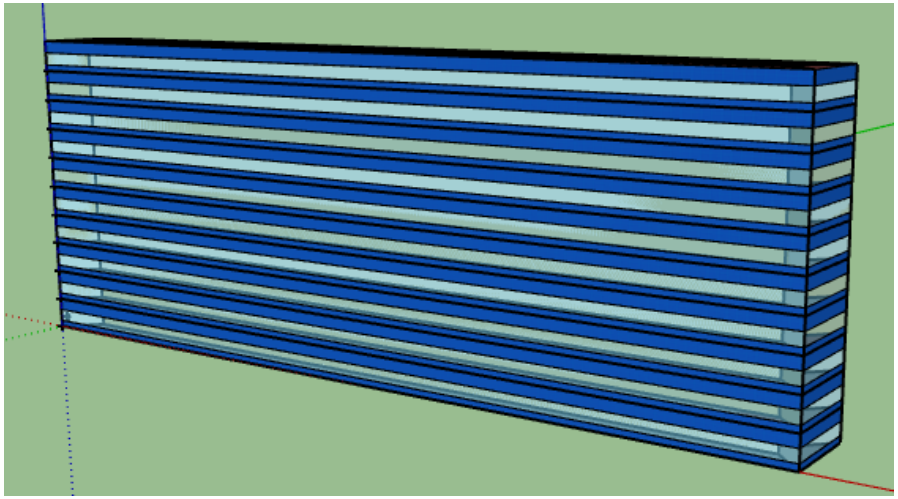




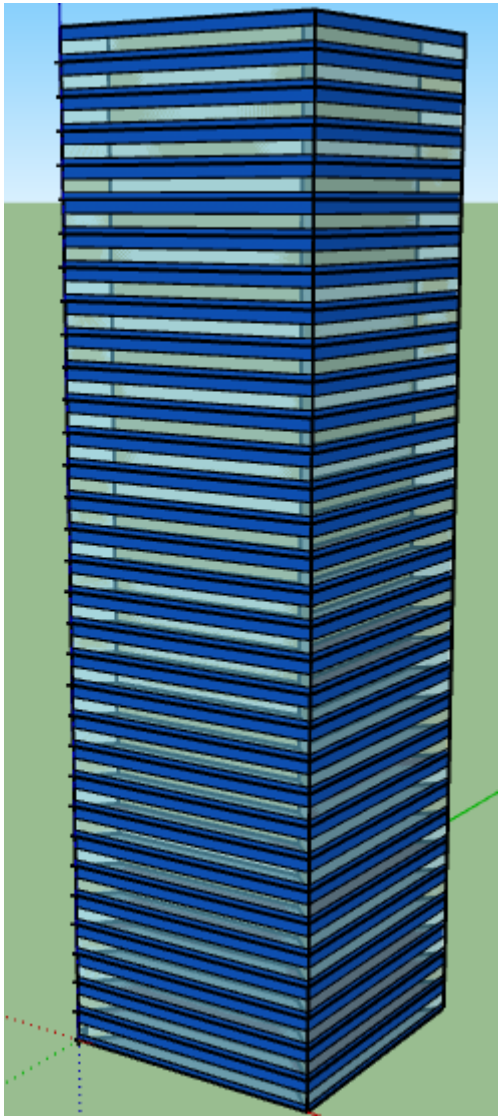
Simulation 2: Constant total floorspace (10,000 m^2) and 10 floors. Changing length to width ratio

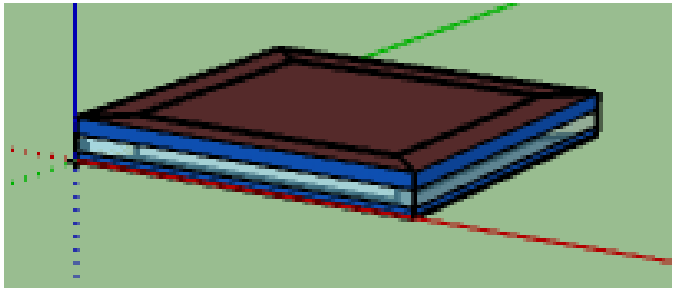


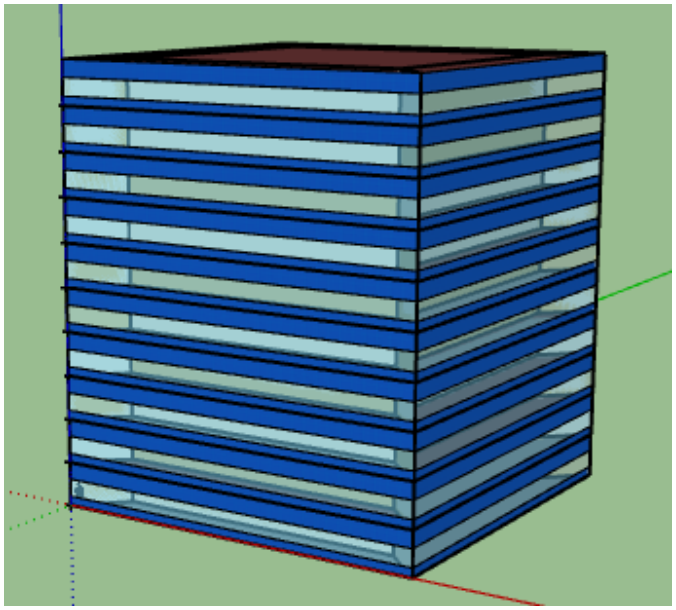




Simulation 3: Changing number of 1,000m^2 square floors



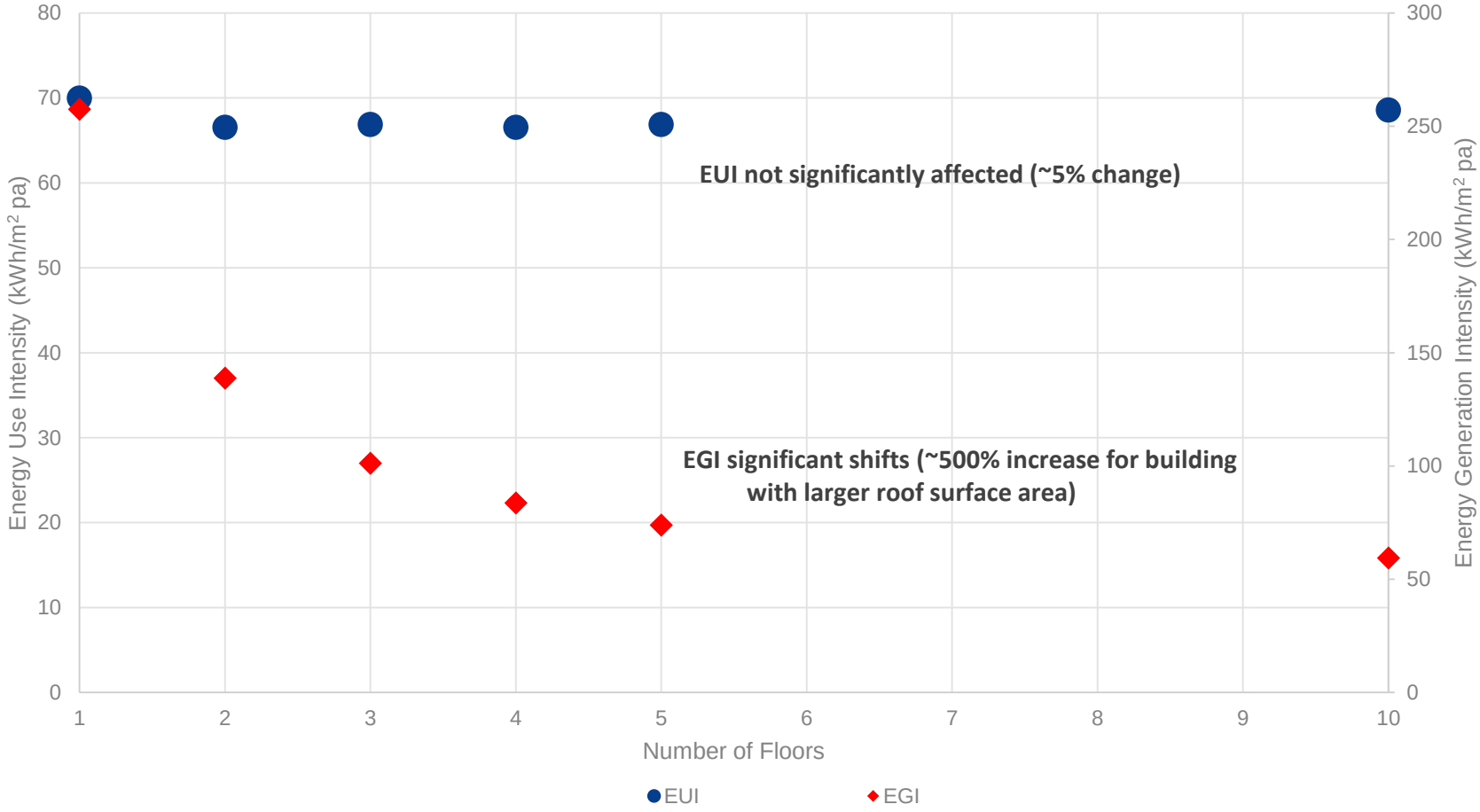




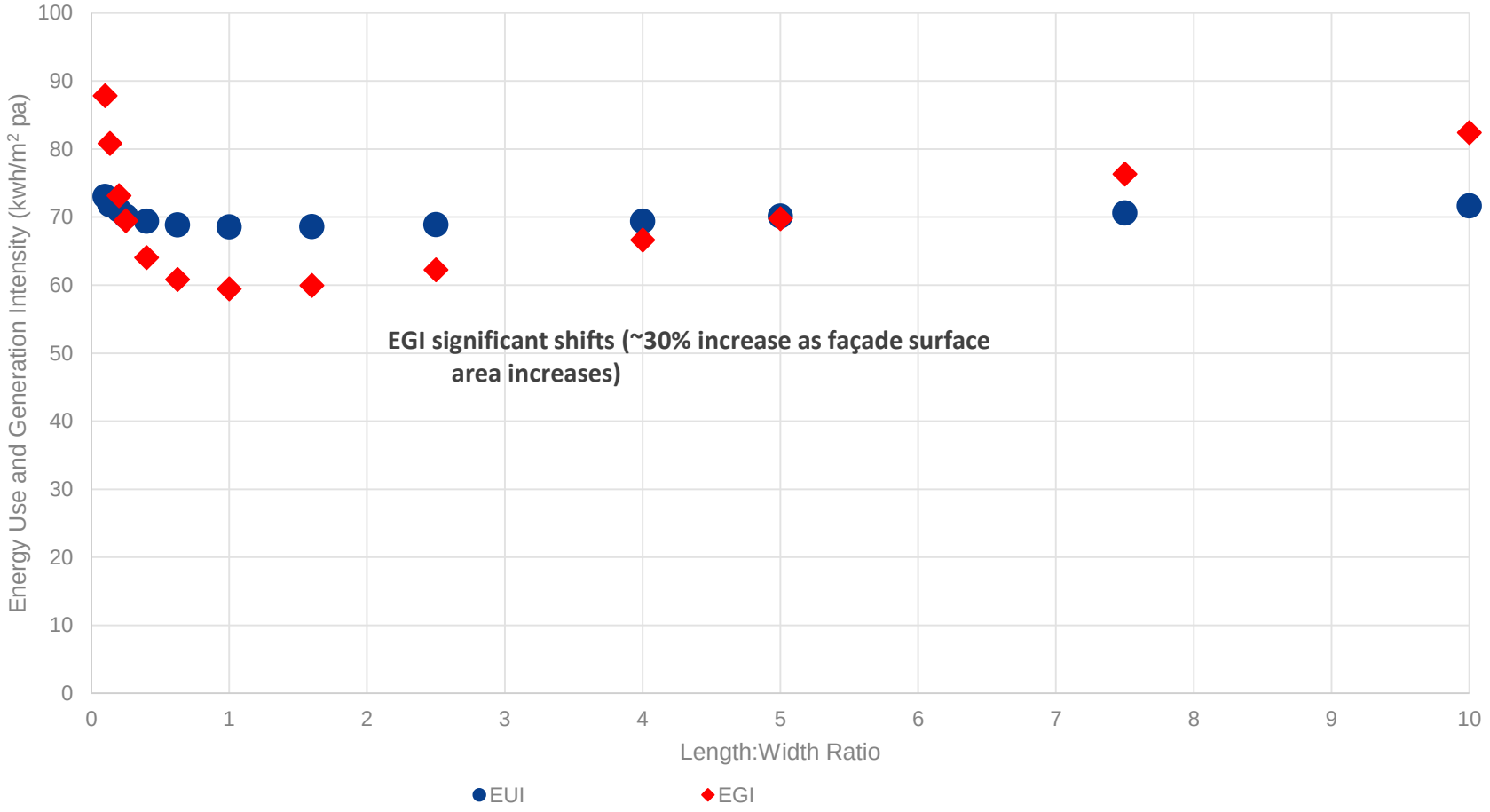
Template Building – Fixed Variables

Location	Sydney
Lighting Power Density	6.4 W/m^2
Equipment Power Density	10.6 W/m^2
% Solar Usable Surface Area	75%
Solar Efficiency	20%
Roof R-Value	3.2
Wall R-Value	2.8
Window U-Value	3.7
HVAC System	VAV with PFP Boxes and Electric Reheat (Chiller COP 5.5)
Window to Wall Ratio	40%
Floor-to-Ceiling Height	3.6 m

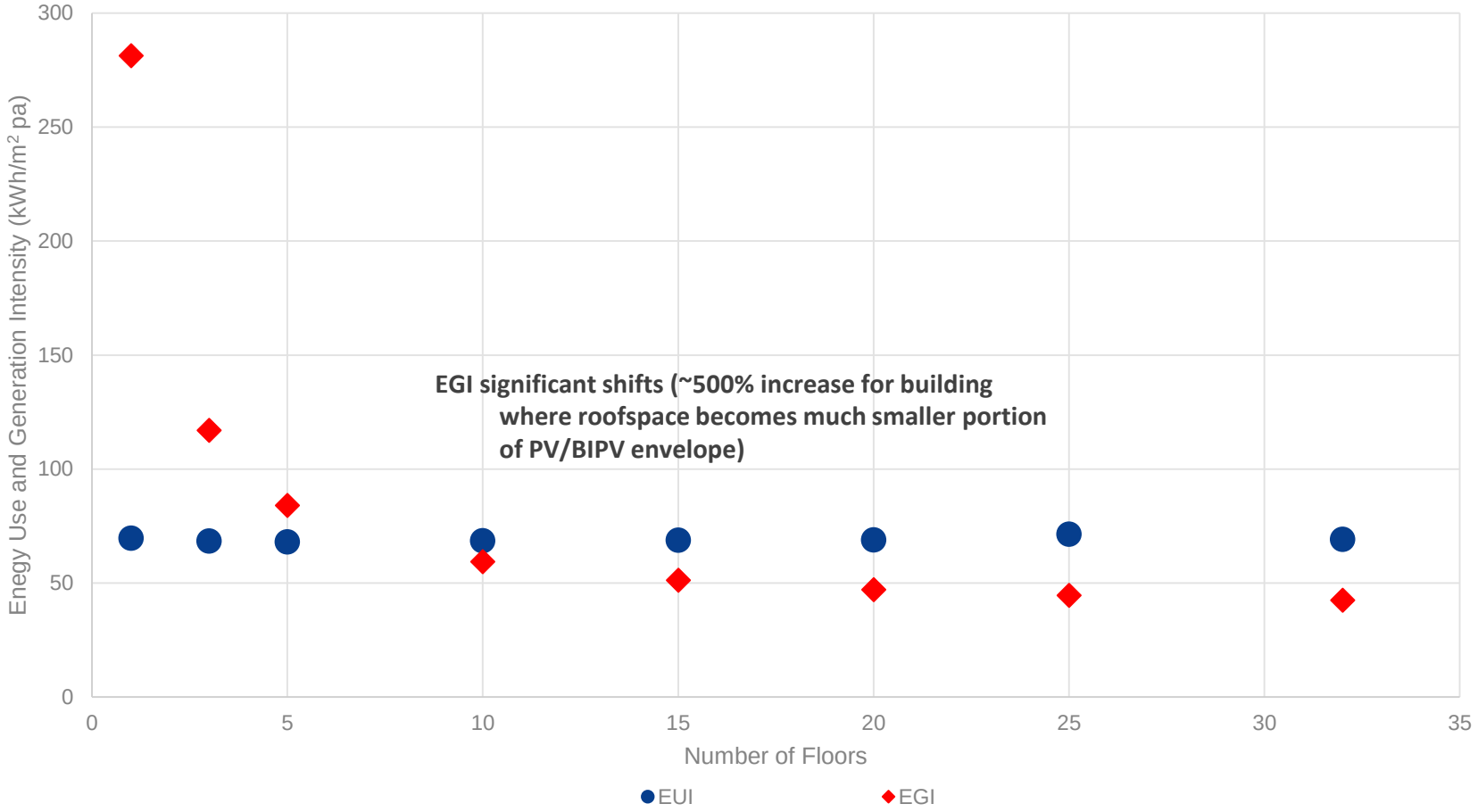
Simulation 1 – Energy Use Intensity/Energy Generation Intensity vs Number of Floors



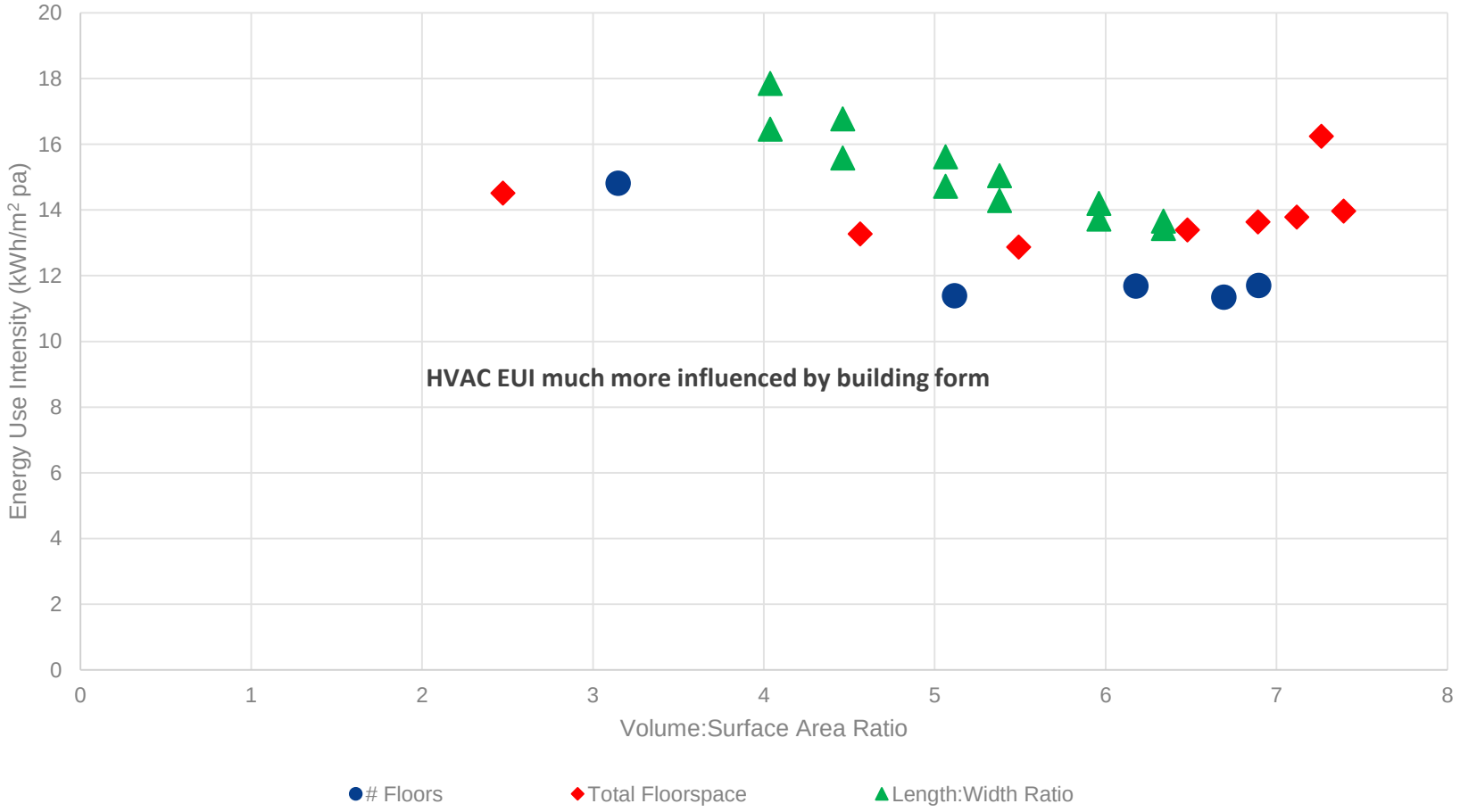
Simulation 2 - Energy Use Intensity/Energy Generation Intensity vs Length: Width Ratio



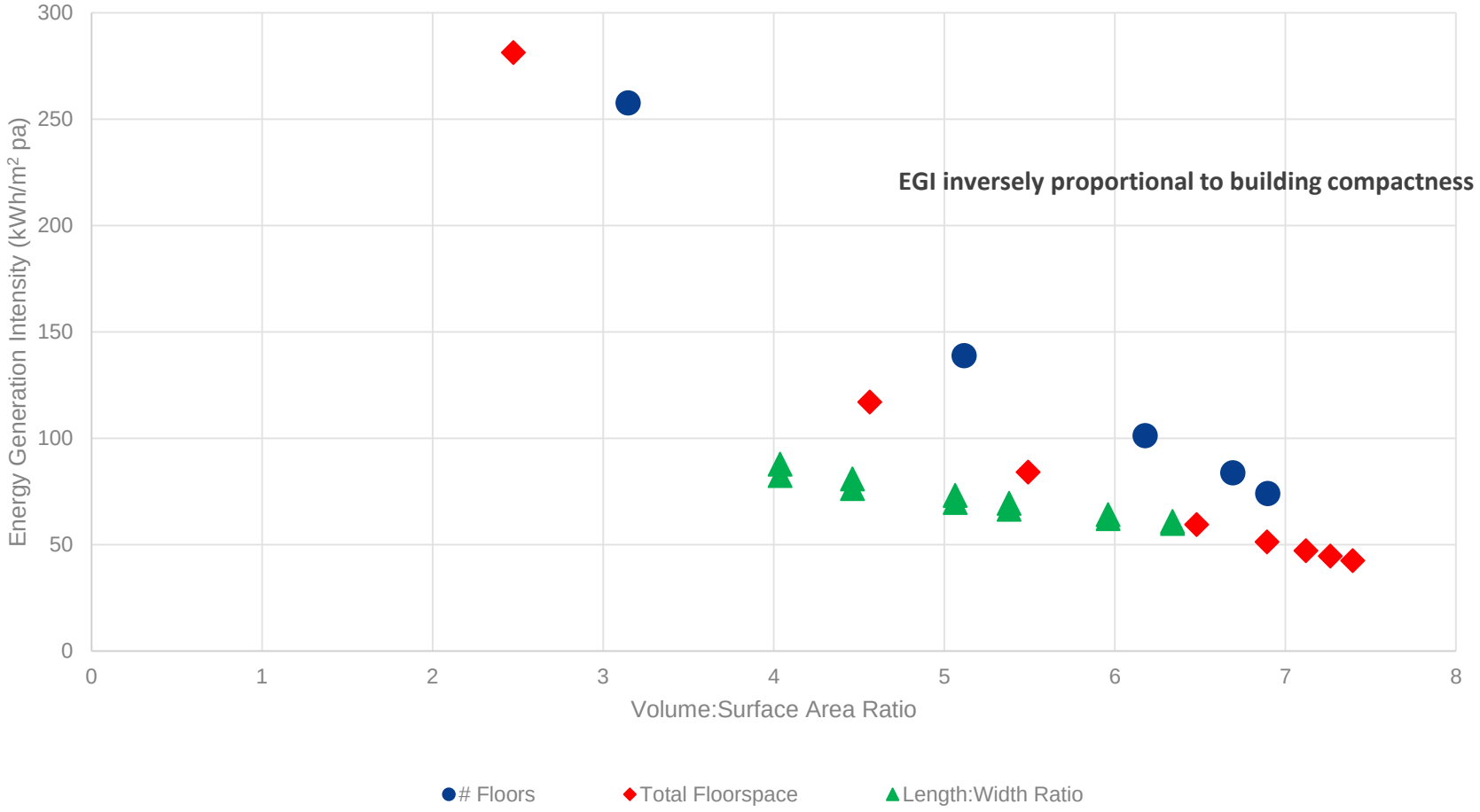
Simulation 3 - Energy Use Intensity/Energy Generation Intensity vs Total Floorspace



Results – HVAC Energy Use Intensity vs Compactness Factor (Volume: Surface Area)



Results – Generation Potential vs Compactness Factor (Volume: Surface Area)



Key Findings

BUILDING FORM IMPACTS HVAC EUI – 36% REDUCTIONS POSSIBLE

GENERATION POTENTIAL GREATLY INFLUENCED BY CHANGES IN BUILDING FORM FOR BIPV SURFACE AREA (FIVEFOLD INCREASE)

Implications and Future Work

Balancing generation potential against building form (keep HVAC EUI low) against functionality

Results do not account for surrounding buildings: tested required against more realistic shading scenarios

BIPV solutions not costed

References

- Global Alliance for Buildings and Construction, “Towards zero-emission efficient and resilient buildings – GLOBAL STATUS REPORT 2016”, 2016.
- pitt&sherry, “Baseline Energy Consumption and Greenhouse Gas Emissions in Commercial Buildings in Australia” Department of Climate Change and Energy Efficiency, 2012.
- NABERS, “NABERS Annual Report 2015-16”, 2016.
- Ürge-Vorsatz, D., N. Eyre, P. Graham, D. Harvey, E. Hertwich, Y. Jiang, C. Kornevall, M. Majumdar, J. E. McMahon, S. Mirasgedis, S. Murakami and A. Novikova, 2012: Chapter 10 - Energy End-Use: Building. In Global Energy Assessment - Toward a Sustainable Future, Cambridge University Press, Cambridge, UK and New York, NY, USA and the International Institute for Applied Systems Analysis, Laxenburg, Austria, pp. 649-760.