RP3002 - Evaluating the impact of policies for promoting building energy efficiency retrofits

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Defining the Problem

Research Challenge

The low uptake of cost effective, energy efficient retrofits for commercial buildings suggests that economic considerations are not the sole determinant for their adoption. Socio-psychological segmentation studies provide additional determinants of consumption behaviour reflecting important lifestyle, attitudinal, risk, familiarity of technology, cultural and other forms of demographic preferences.

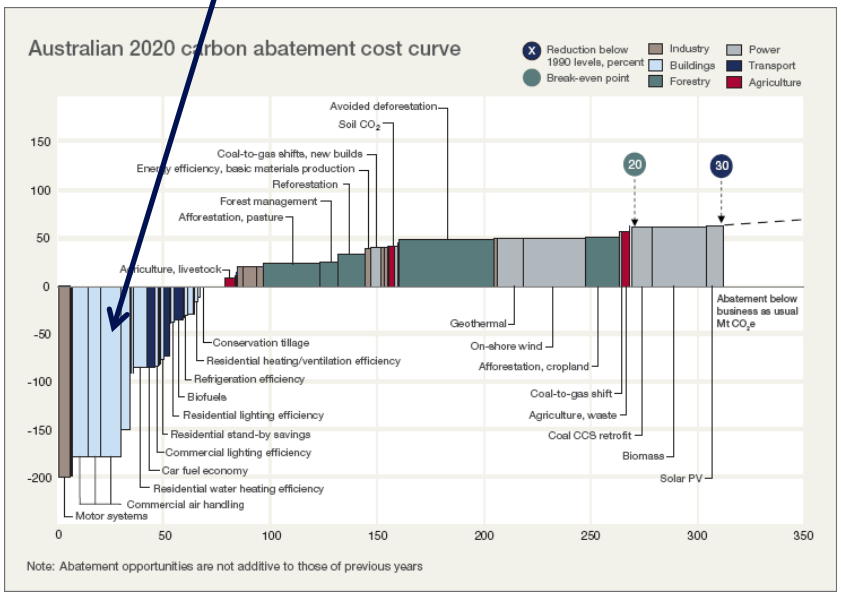
Project Objectives

This project set out to:

1. Develop an Agent-Based Modelling (ABM) framework to identify and understand the network relationships between building owners/tenants in different locations and their complex response to intervention options.

2. Develop a decision-support tool (DST) to help assess the impact of interventions/programs for promoting building energy efficiency retrofits.

How do we mobilise this carbon abatement potential? Low uptake suggests economic considerations are not the sole determinant for adoption.



Australian 2020 Carbon Abatement Cost Curve
Source – McKinsey Consulting

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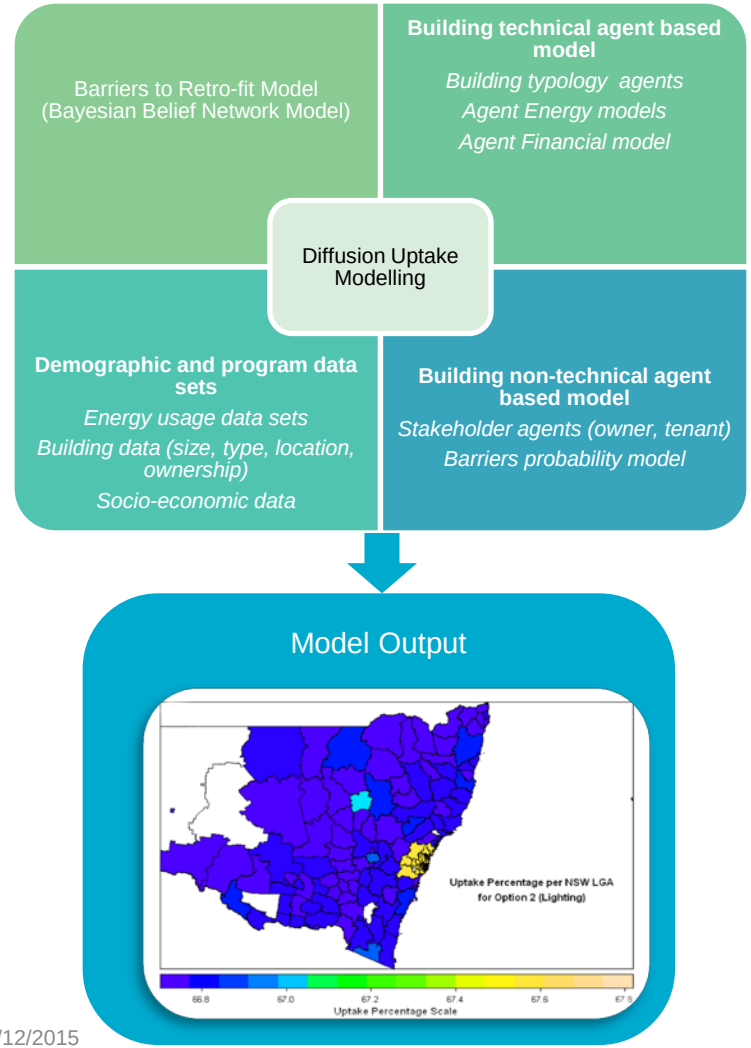
Commercial Building Policy Decision Support Tool



- The model combines a number of agent based models to predict the change in BAU for energy efficiency upgrades in commercial building due to policy interventions.
- Key model components include
  - Building technical ABM – used to understand the energy and financial performance of commercial buildings due to various technology options
  - Building non-technical ABM – used to model the complex interaction between various barriers to retrofit to represent behaviour of key stakeholders (tenant, owner) to determine likelihood of upgrade being implemented.
- Employs CSIRO existing methods in mathematical diffusion, multi-criteria analysis and choice modelling, to accommodate the multiple financial, non-financial variables and barriers associated with diffusion of retrofit technologies or behaviour change to their usage. This will allow complex policy and behavioural change programs to be tested and better targeted to owners and tenants, to maximise impacts in reducing carbon emissions in existing building stock.
- Model output provides predicted uptake (sqm of office space) of energy efficiency options by LGA by time interval ie where will upgrades occur and when.

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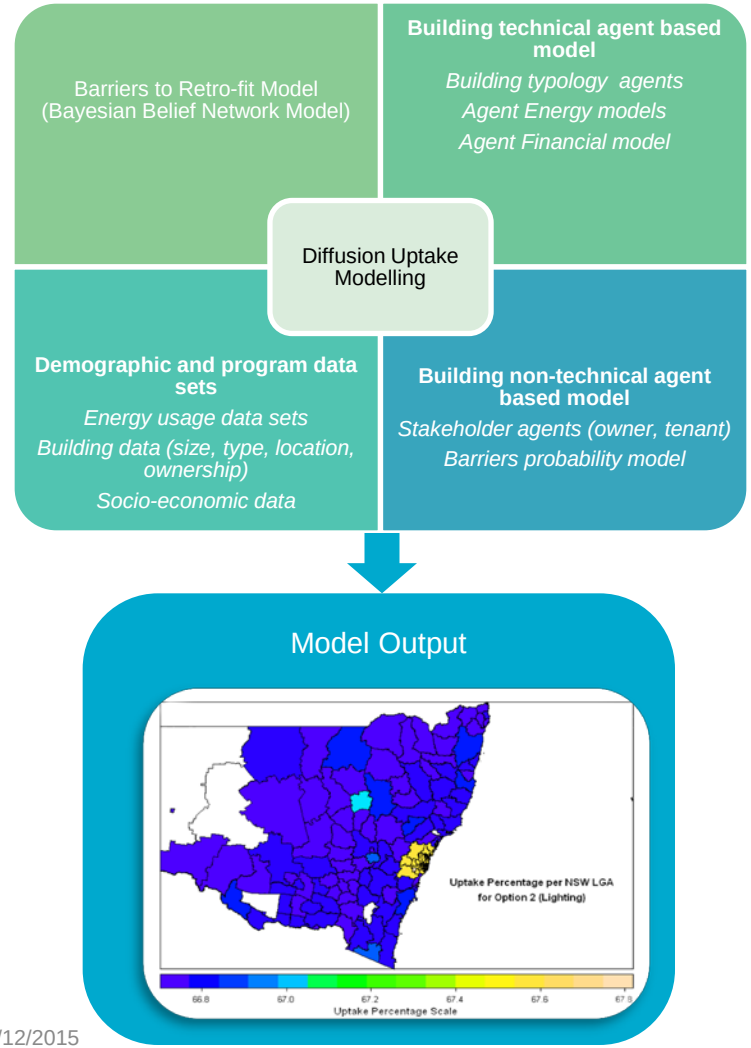
How the tool works – Building Technical ABM



- Commercial office building stock model for different area and types
  - Agent Types: low, medium & high rise commercial office buildings
  - Stock data (m2 of floor area, building number)
  - Forecasting 2010 to 2021 with different age group (More than 30 years and Less than 30 years)
- Spatial boundary:
  - by LGA to State levels and by Metro and non-metropolitan areas
- Commercial building stock ownership (%) for capital cities (Sydney, Melbourne, Brisbane)

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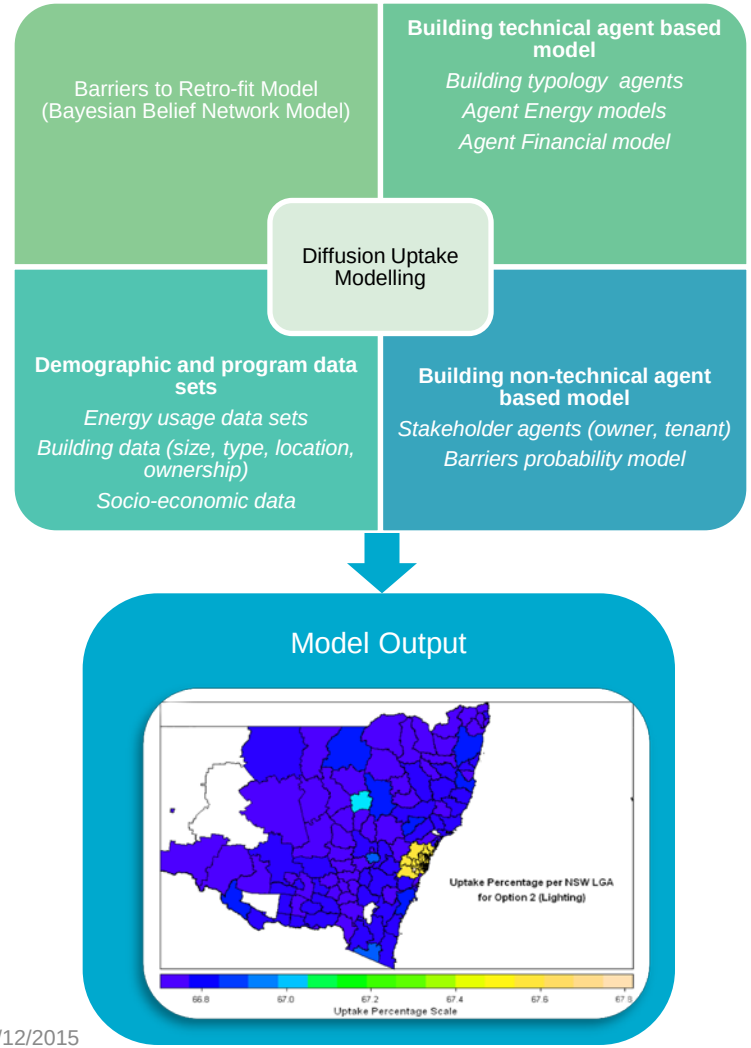
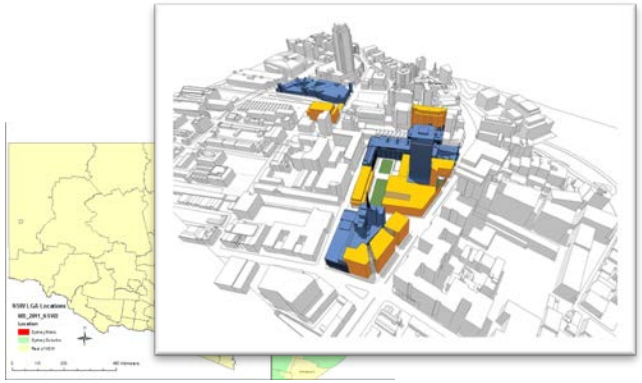
How the tool works – Building Technical ABM





- Commercial office building energy models for different climate zones and types
  - Agent Types: low, medium & high rise commercial office buildings
  - Energy data (MJ/m2/year, kWh/m2/year):
  - Six different energy end use (HVAC, lighting, Lift, Electric equipment, Hot water, External use)
  - Two type of energy use by responsibility (Base building & tenant)
- Spatial boundary:
  - Two spatial level: by State & LGA levels (or SA2: Statistical area level 2)
- Application
  - Allows for quantification of impact of retrofit options on energy usage for stock

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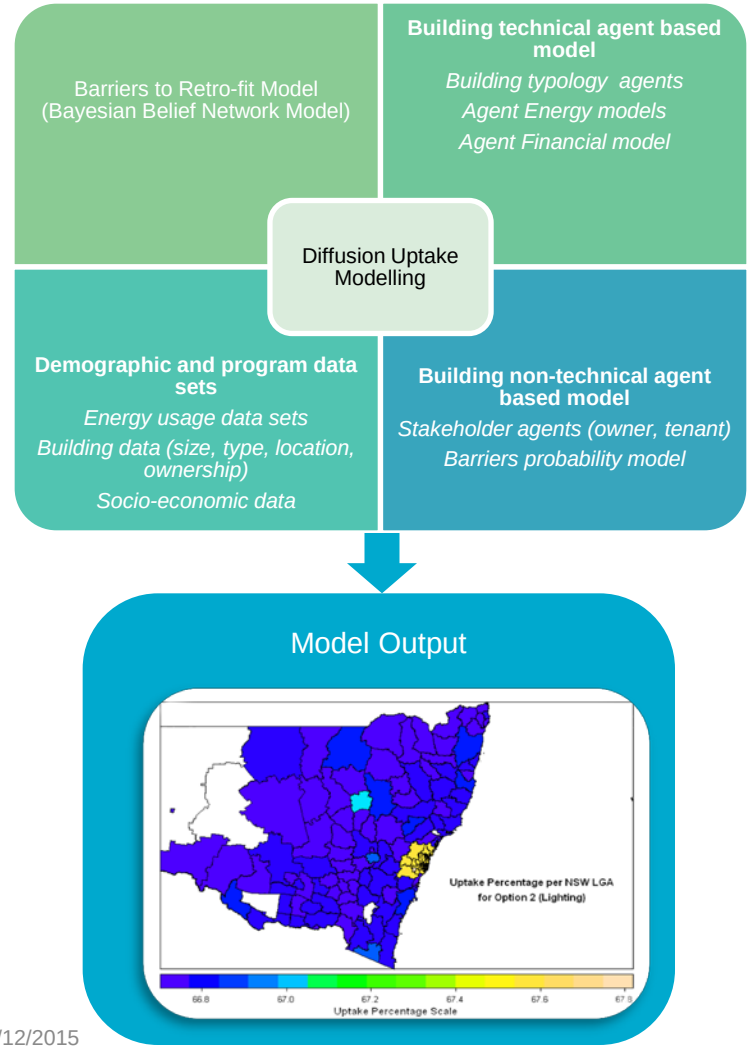
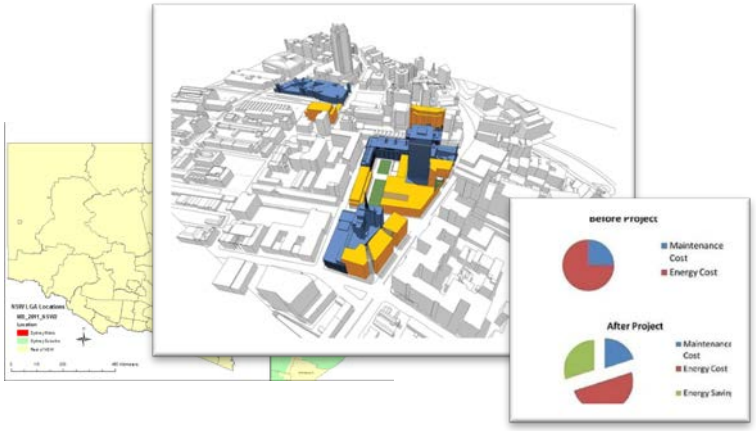
How the tool works – Building Technical ABM





- Financial data model (IRR) tables of different commercial office building having different energy performance (2 star to 4 star)
  - Agent Types: low, medium & high rise commercial office buildings
  - Six different upgrade packages from simple low cost building tuning to high cost options such as chiller replacements.
    - Age group: More than 30 years old and Less than 30 years old
- Spatial boundary:
  - by CBD and Non-CBD area
- Baseline: Various NABERS energy rating

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How the tool works – Building Non-Technical ABM

Barriers to Retro-fit Model
(Bayesian Belief Network Model)

Building technical agent based model

Building typology agents

Agent Energy models

Agent Financial model

Diffusion Uptake Modelling

Demographic and program data sets

Energy usage data sets

Building data (size, type, location, ownership)

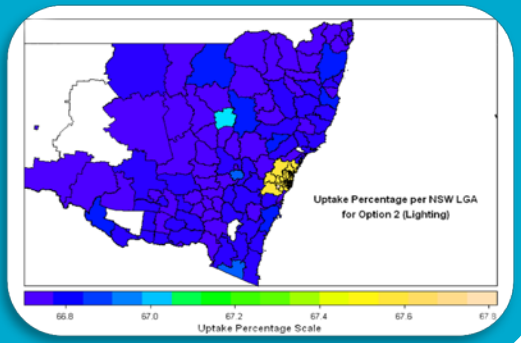
Socio-economic data

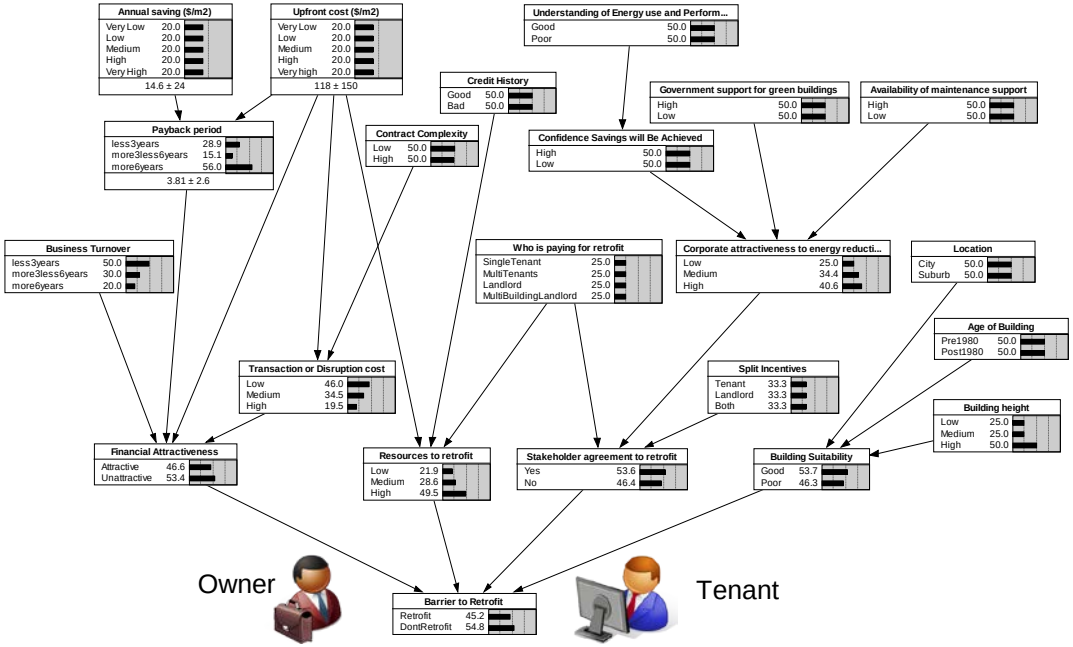
Building non-technical agent based model

Stakeholder agents (owner, tenant)

Barriers probability model

Model Output





- Non-technical factors impacting decisions to retrofit
  - Agent Types: Tenant and building owner (small eg family owned single building, medium multiple property owner, large owner/institutional investor)
  - Models complex interaction between various barriers to retrofit to represent behaviour of each agent as a probabilistic value to retrofit in each time interval
- Considers - credit history; who pays?; split incentives; upfront costs; payback period; ongoing support; government support; confidence on savings; business turnover; skills, corporate drivers

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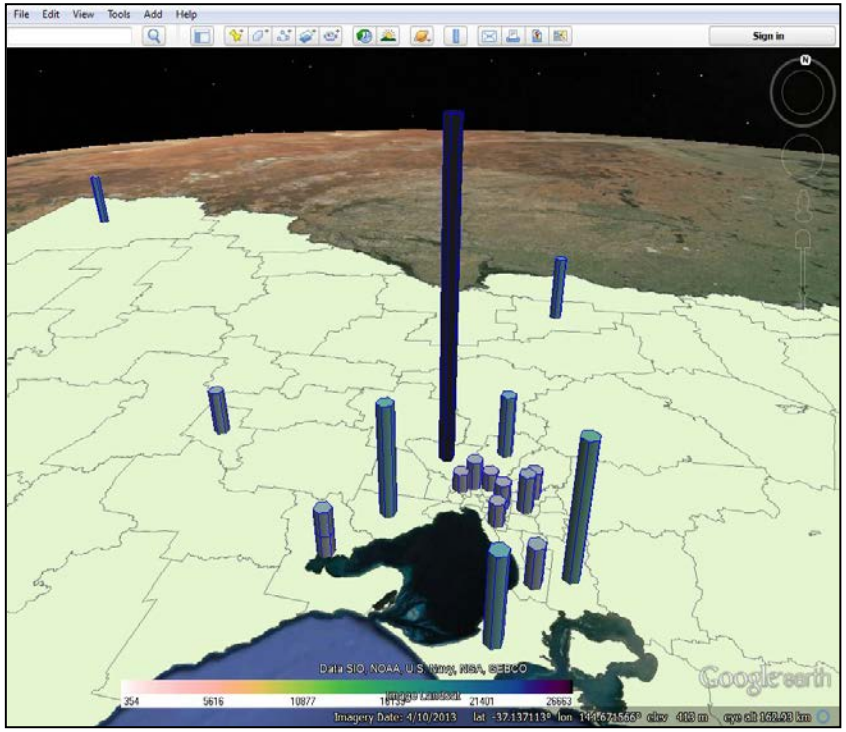
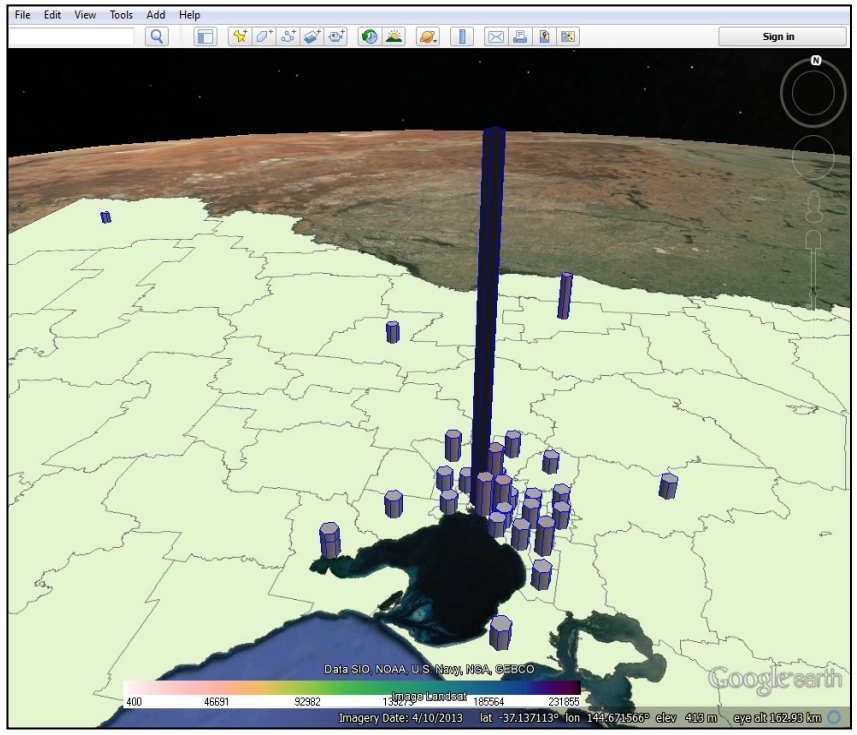
Example Policy Evaluation – Sustainability Victoria EEOB

Scenario 1 – Existing EEOB Program
Application – Building Tuning
Building Type – Small (C & D grade)
Policy cost – $ 1.79M
Uptake – 27 Buildings (actual 24)
Energy savings – 16,500MWh



Scenario 1 floorspace uptake (in sq.m) for tuning with incentives under WI_25 for period 20 (5 years) . The highest values were obtained for the LGAs of Hume, Casey, and Wyndham.

Scenario 4 – Existing EEOB Program
Application – Building Tuning
Building Type – All
Policy cost – $ 2.47M
Uptake – 58 buildings
Energy savings – 53,000MWh



Best value for Money Option - Scenario 4 floorspace uptake (in sq.m) for tuning with incentives under WI_25 for period 20 (5 years) . The highest values were obtained for the LGAs of Melbourne, Greater Shepparton, and Yarra.

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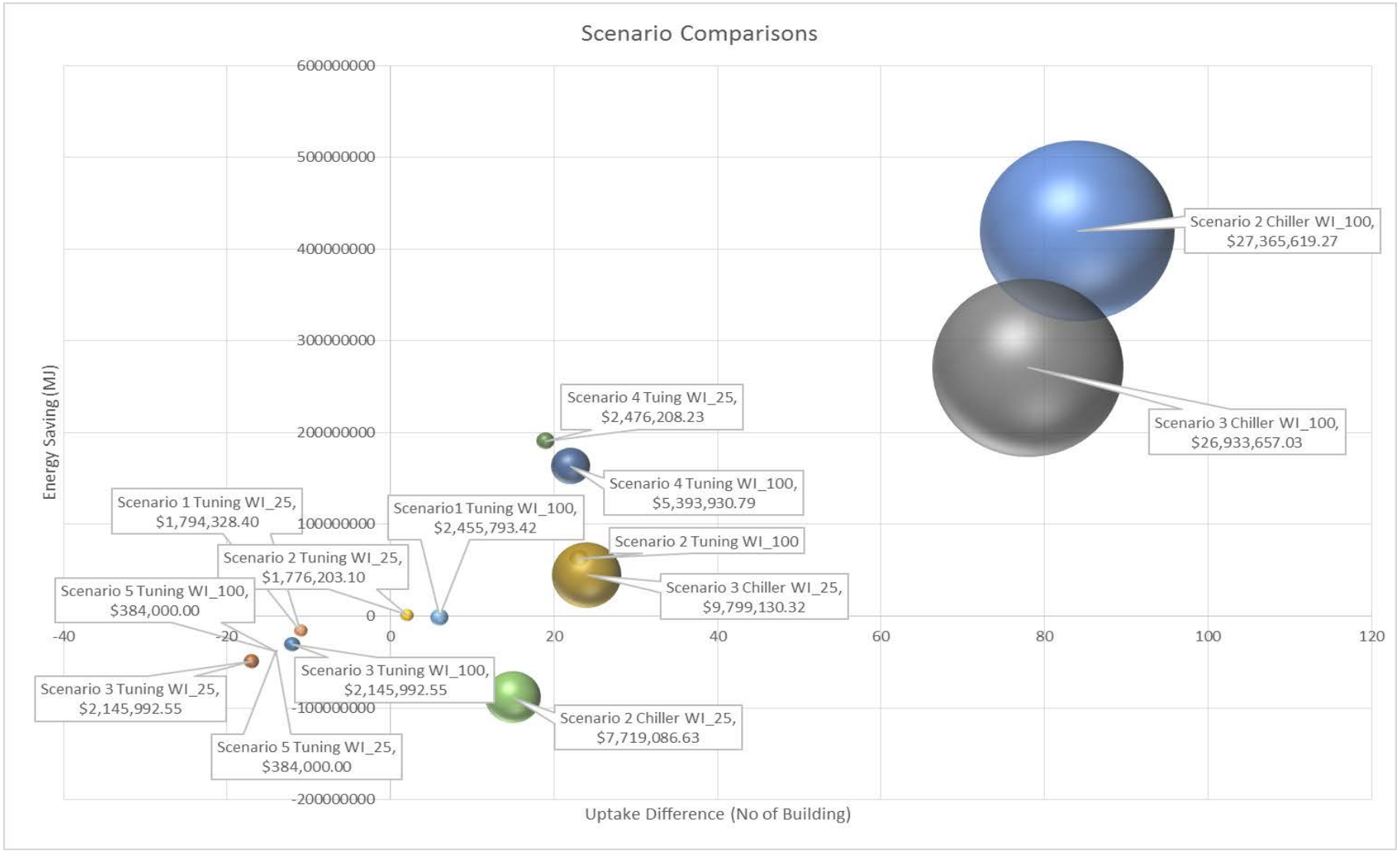
Example Policy Evaluation - Sustainability Victoria EEOB



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Conclusion

- The project has developed a unique modelling approach to allow key stakeholders to simulate various interventions to create incentives to improve the energy performance of the existing building stock.
- This tool could help to achieve substantial improvements in energy efficiency uptake to gain better value for public investment and help inform the planning of new and existing policies.

Thank you

To find out more, contact:

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