Integrating Built Heritage and Sustainable Development

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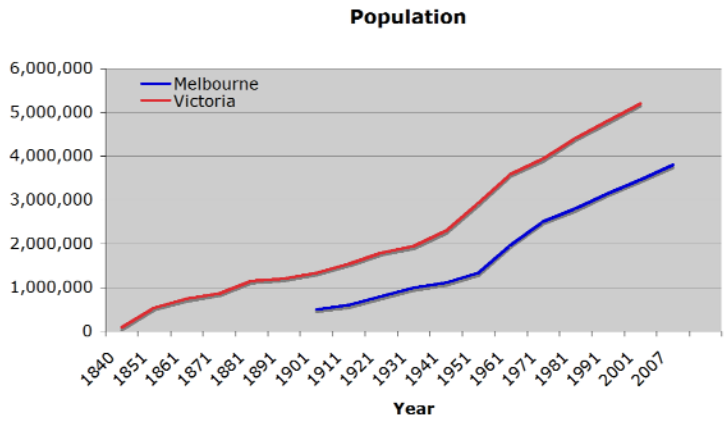
Outline

- Background
- Operational energy
- Embodied energy
- Life Cycle Energy
- Case studies
- Analysis of energy performance
- Summary

Existing dwellings

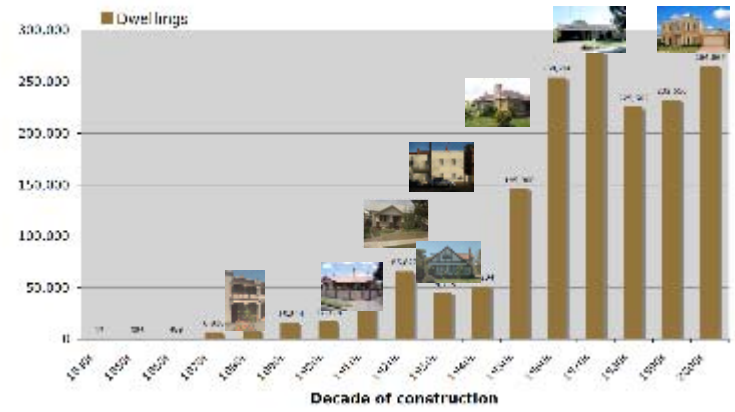
- 2.1 million dwellings in Victoria
- Existing dwellings account for 95% of the residential stock in Victoria
- Dwellings over 20 years old - constructed prior to the introduction of regulations to improve energy efficiency and without consideration of their environmental impact.
- The role of the existing built stock with regard to environmental sustainability cannot be ignored.

Historical growth



Source: Australian Bureau of Statistics

Historical development



Source: Valuer General Statewide Dataset, Victoria 2009

Historic heritage places in Victoria

- 1 World Heritage Site
- 16 historic heritage places on the National Heritage List
- + 2000 places on the Victorian Heritage Register
- + 100,000 places on Heritage Overlays -either individually registered or within designated area

Building Code of Australia

- Energy efficiency provisions introduced through the Building Code of Australia (BCA)
- Minimum energy performance standards
- All residential and commercial buildings
- New buildings
- Refurbishment, alteration or extension to existing buildings

Aims of research

- Inform how retention and adaptation of heritage buildings contributes to environmental sustainability
- Identify embodied energy in typical domestic buildings
- Provide information for building designers to make better decisions
- Provide evidence for building surveyors on Alternative Solutions under the BCA
- To test industry standard modelling methodology on heritage buildings
- Encourage innovative design solutions

Operational energy

- Space heating & cooling
- Water heating
- Lighting
- Appliances*
- Behaviour*

Embodied energy

- Embodied energy is the energy used for constructing buildings and associated maintenance over a period of time
- Includes energy used in production of construction materials and components, and transport
- Significant part of lifecycle energy - likely to increase as operational energy is reduced

Embodied energy - UK

=

200,000 km

Embodied energy - UK

=

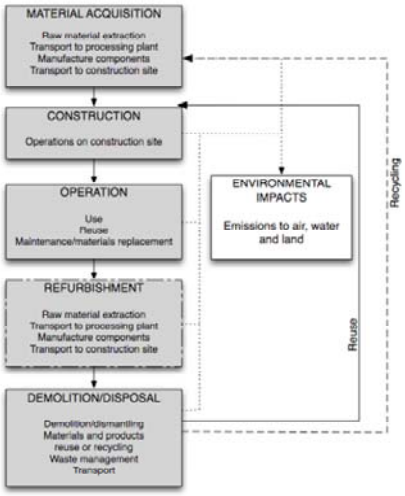
35 tonnes CO_2

Over 50 years to recover the embodied energy through lower operational CO_2

Life Cycle Assessment

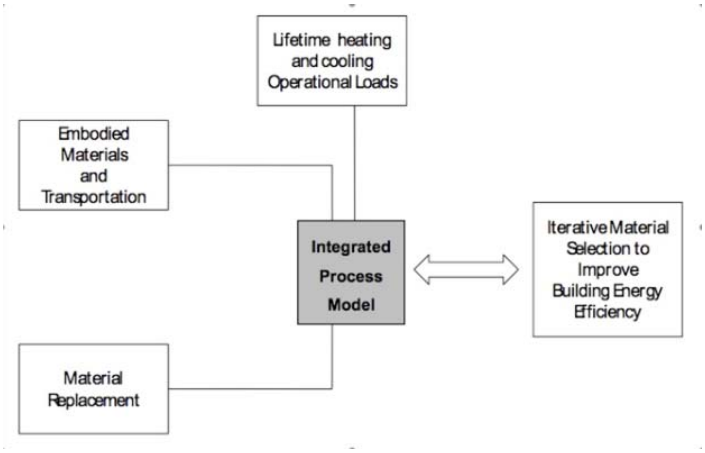
- Life cycle assessment (LCA) is a methodology used to assess the environmental effects of buildings in terms of material use, energy consumption and environmental impacts 'from cradle to grave'
- Life cycle energy assessment comprises the operational and embodied energy attributable to buildings over their life time, and therefore provides a complete means of analysing the energy requirement and environmental impact of buildings
- The methodology is used to support decision-making in environmental sustainability

Life Cycle Energy Assessment - Stages



Source: Adapted from Bragança *et al*, 2008

Integrated process model



Selection of case studies

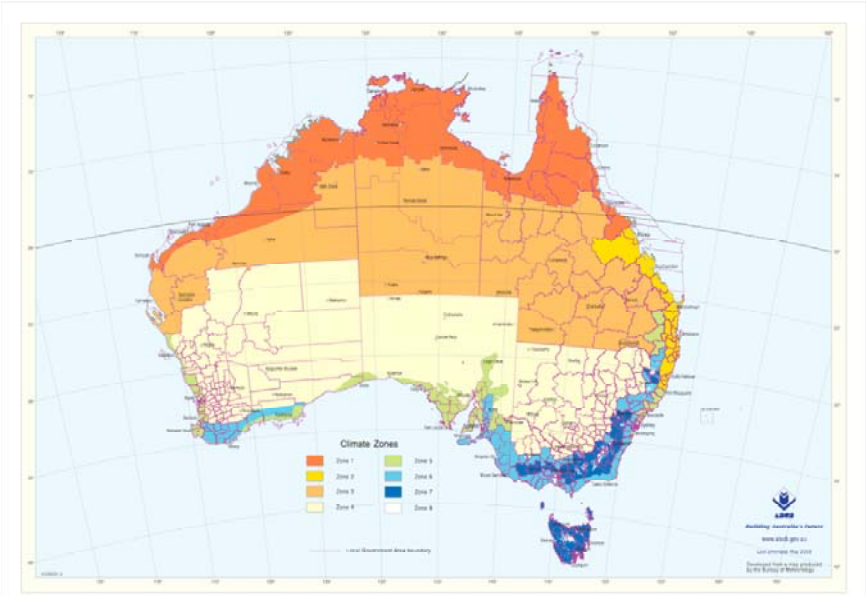
Consideration given to the following:

- Range of building archetypes
- Representative of the housing stock
- Heritage significance
- Condition
- Integrity
- Climatic zones







Source: Australian Building Codes Board

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Case studies [1] Bundoora

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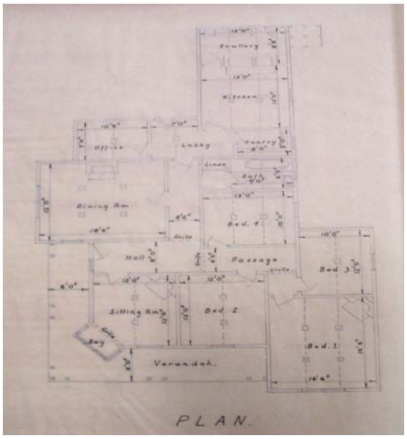
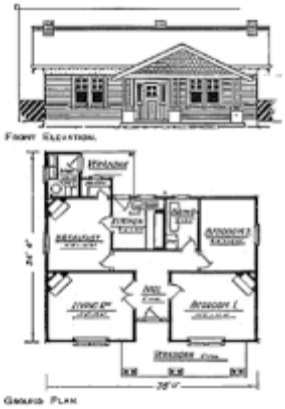
Case studies [2]
North Melbourne

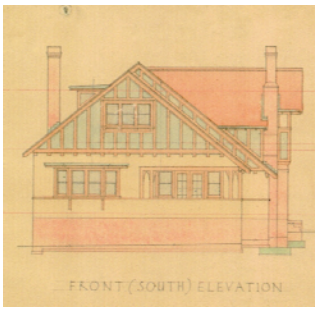
Case studies [3]
Drumcondra



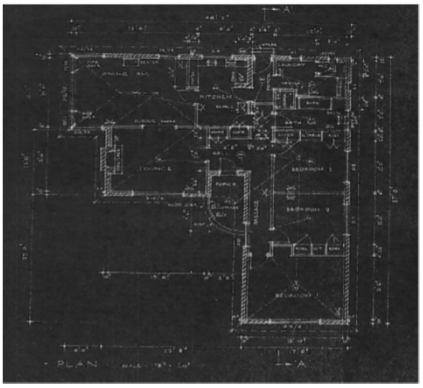
Case studies [4]
Manifold Heights



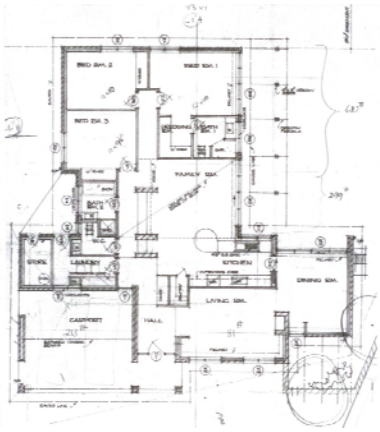
Case studies [5]
Newtown

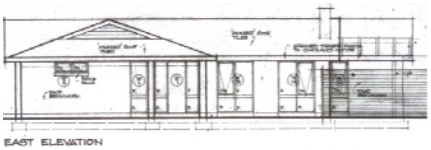


Case studies [6]
Newington



Case studies [7]
Keilor East





Case studies [8]
Parkville

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AccuRate Ratings

No	Building description	Orientation	Building Area in m^2	Heating $MJ/m^2.yr$	Cooling $MJ/m^2.yr$	Total Energy $MJ/m^2.yr$	Star Rating
1	Free standing 4 bedroom outer suburb house	East	218	117	45	162	5.1 Stars
2	Two storey single fronted mid-late Victorian period terraced house	West	125	296	18	314	2.6 Stars
3	Free standing single storey double fronted Edwardian period house	West	220	404	18	422	2.3 Stars
4	Free standing single storey house (State Savings Bank of Victoria)	North	114	655	46	701	0.9 Stars
5	Free standing double fronted Interwar period house	East	280	414	55	469	1.9 Stars
6	Free standing single storey triple fronted post war house	South	154	351	27	378	3.6 Stars
7	Free standing single storey 3 bedroom middle suburb house	East	171	257	36	293	3.4 Stars
8	Apartment in residential block	North-east	92	290	6	296	2.8 Stars

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Life cycle energy assessment (MJ)

No	Buildings	Initial	Replacement	Construction	Embodied	Heating load	Cooling load	Operational
1	Bundoora	1.04E+06	7.75E+05	6.93E+04	1.88E+06	3.53E+06	3.92E+06	7.45E+06
2	North Melbourne	5.72E+05	2.63E+05	4.08E+04	8.78E+05	4.66E+06	8.32E+05	5.49E+06
3	Drumcondra	1.07E+06	2.25E+05	7.64E+04	1.37E+06	1.23E+07	1.58E+06	1.39E+07
4	Manifold Heights	5.35E+05	1.97E+05	4.24E+04	7.75E+05	9.42E+06	1.91E+06	1.13E+07
5	Newtown	1.58E+06	4.38E+05	1.18E+05	2.14E+06	1.49E+07	5.74E+06	2.06E+07
6	Newington	8.47E+05	6.18E+05	5.67E+04	1.52E+06	6.17E+06	1.36E+06	7.53E+06
7	Keilor East	1.10E+06	2.93E+05	7.12E+04	1.46E+06	6.85E+06	2.82E+06	9.67E+06
8	Parkville	4.02E+05	1.13E+05	3.19E+04	5.47E+05	2.92E+06	1.73E+05	3.08E+06

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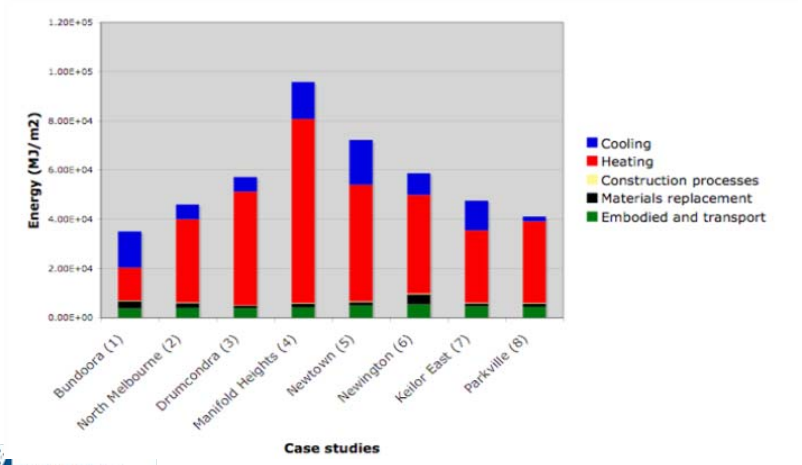
Life Cycle Energy Assessment



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Limitations of simulation tools

- Assessment of operational energy
- Standard pattern of occupation assumed
- Does not take into account occupants or behaviour
- Existing buildings - some information may not be known and assumptions have to be made
- Cannot model impact of minor changes
- Limited ability to model changes e.g. ventilation
- Unable to fully model the effect of thermal inertia associated with mass construction on performance

Analysis of performance

- Building [1] had lowest operational energy consumption
- Building [1] had low heating loads but high cooling loads
- Heritage buildings had initial lower embodied energy - apart from Building [6]
- Heritage buildings had lower recurring embodied energy than Building [1]
- Heritage buildings [3], [4] and [5] had highest heating loads
- Heritage buildings had lower cooling loads - apart from Building [5]
- Buildings [2] and [8] had lowest cooling loads

Summary of main points

- Building characteristics are a principal factor in energy consumption - both operational and embodied - over the lifetime
- Operational energy accounts for a major part of the life cycle energy consumption
- Embodied energy is an important consideration accounting for 6% - 20% of lifetime energy depending on the construction - this is likely to increase in importance as operational energy is reduced

Continued…

Summary of main points

- Heritage buildings often have lower initial and recurring embodied energy due to low energy-intensive materials
- Energy used to produce building products/ components is significant
- Energy for initial construction processes is a very small proportion of lifetime energy
- Energy for maintenance varies - depending on the materials and frequency of replacement
- Maintenance and repair is more efficient than demolition and replacement


Thank you for your attention
“An amazing amount can be done to get existing buildings up to scratch. These buildings have a past but they have a future too.”
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