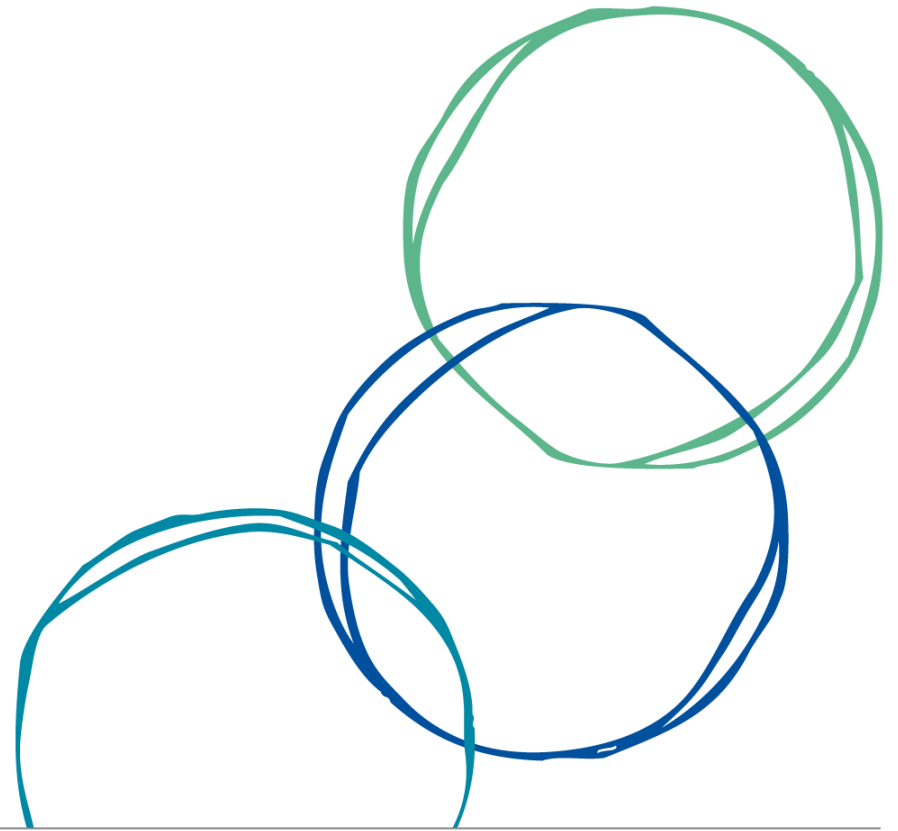


# Participants Annual Forum 2017

Melbourne Town Hall  
22 November 2017



# The CRCLCL at five years: maximizing impact

Scientia Professor Deo Prasad AO  
CEO: CRC for Low Carbon Living



# CITIES LEADING THE WAY IN TACKLING GHGs

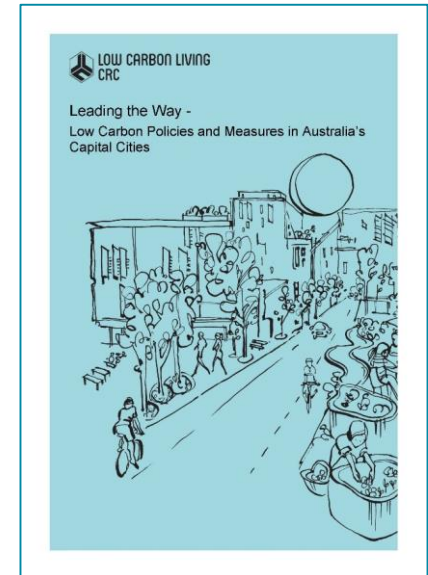
COP23 Bonn Germany 6-17 November 2017

7,494 cities (121 countries, 600M ) committed to the Global Covenant of Mayors for Climate & Energy to accelerate ambitious, measurable climate and energy actions

25 cities = carbon-neutral in 2050

Austin, Accra, Barcelona, Boston, Buenos Aires, Cape Town, Caracas, Copenhagen, Durban, London, Los Angeles, Melbourne, Mexico City, Milan, New York City, Oslo, Paris, Philadelphia, Portland, Quito, Rio de Janeiro, Salvador, Santiago, Stockholm & Vancouver

[The Global Alliance for Buildings and Construction (GRAC) is a member signed a statement to dramatically speed- and scale-up collaborative action]



LOW CARBON LIVING  
CRC

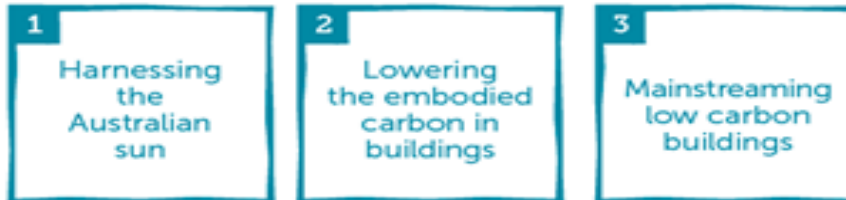
Page | 10

# WHAT WE DO

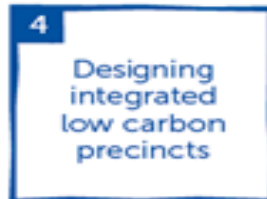
We are committed to three integrated research programs for our research activity and projects.

Our projects and activities translate across these eight impact pathways, a journey towards a low carbon economically viable built environment.

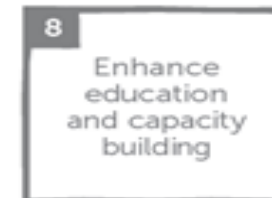
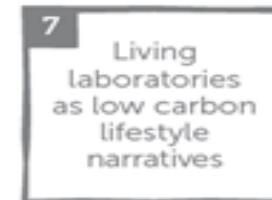
## Integrated Building Systems



## Low Carbon Precincts



## Engaged Communities





# How: Integrating end user response

## Government



*Evidence base for ~\$1billion/yr investment in government programs*

## Manufacturing



*Incubating next generation multi-purpose building products*

## Development



*Enabling world class low carbon property development*

## Professionals



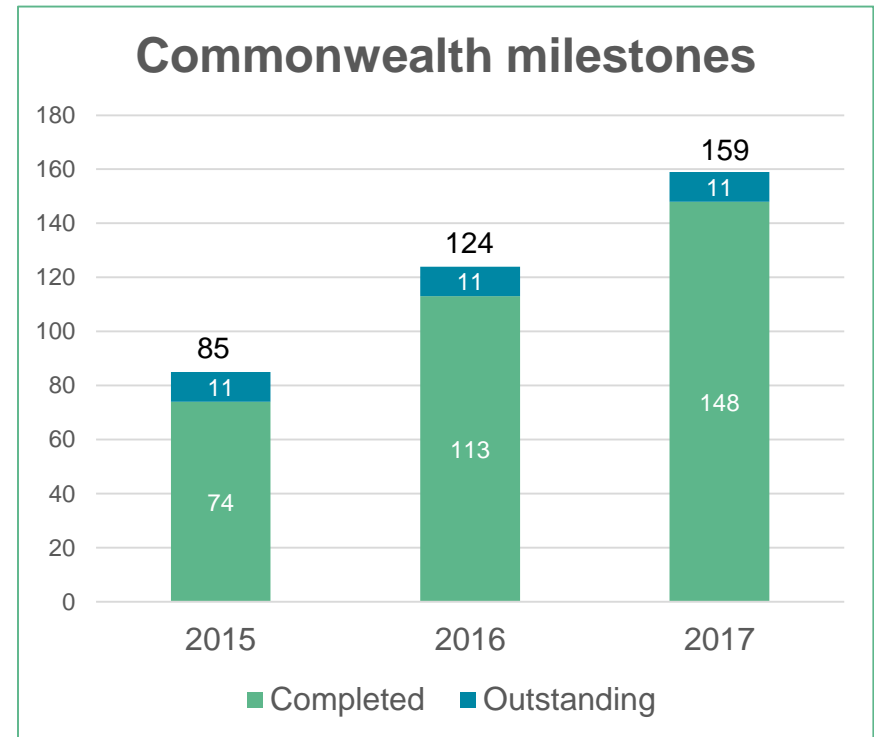
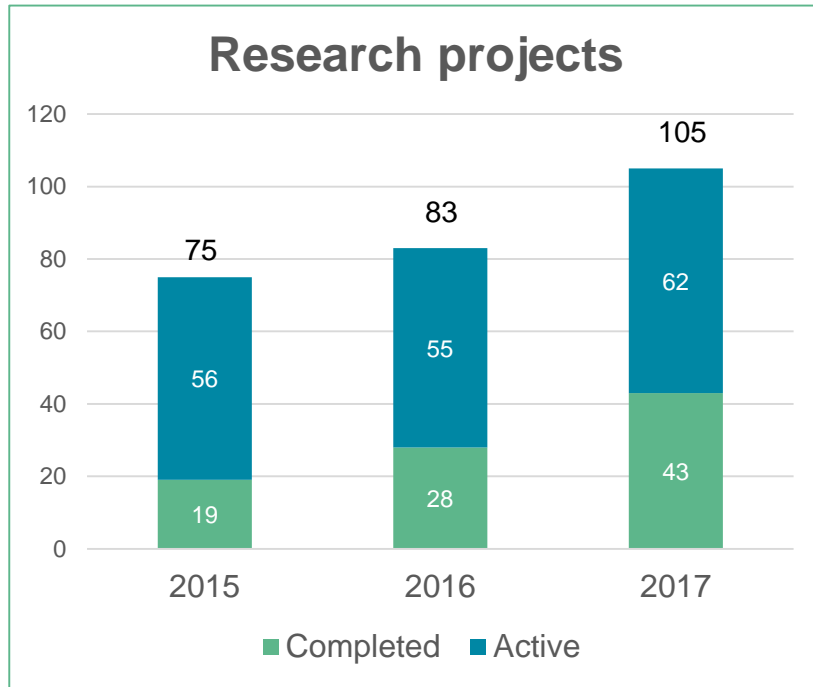
*Tools for Australia's building design services industry*

# A POWERFUL INDUSTRY NETWORK

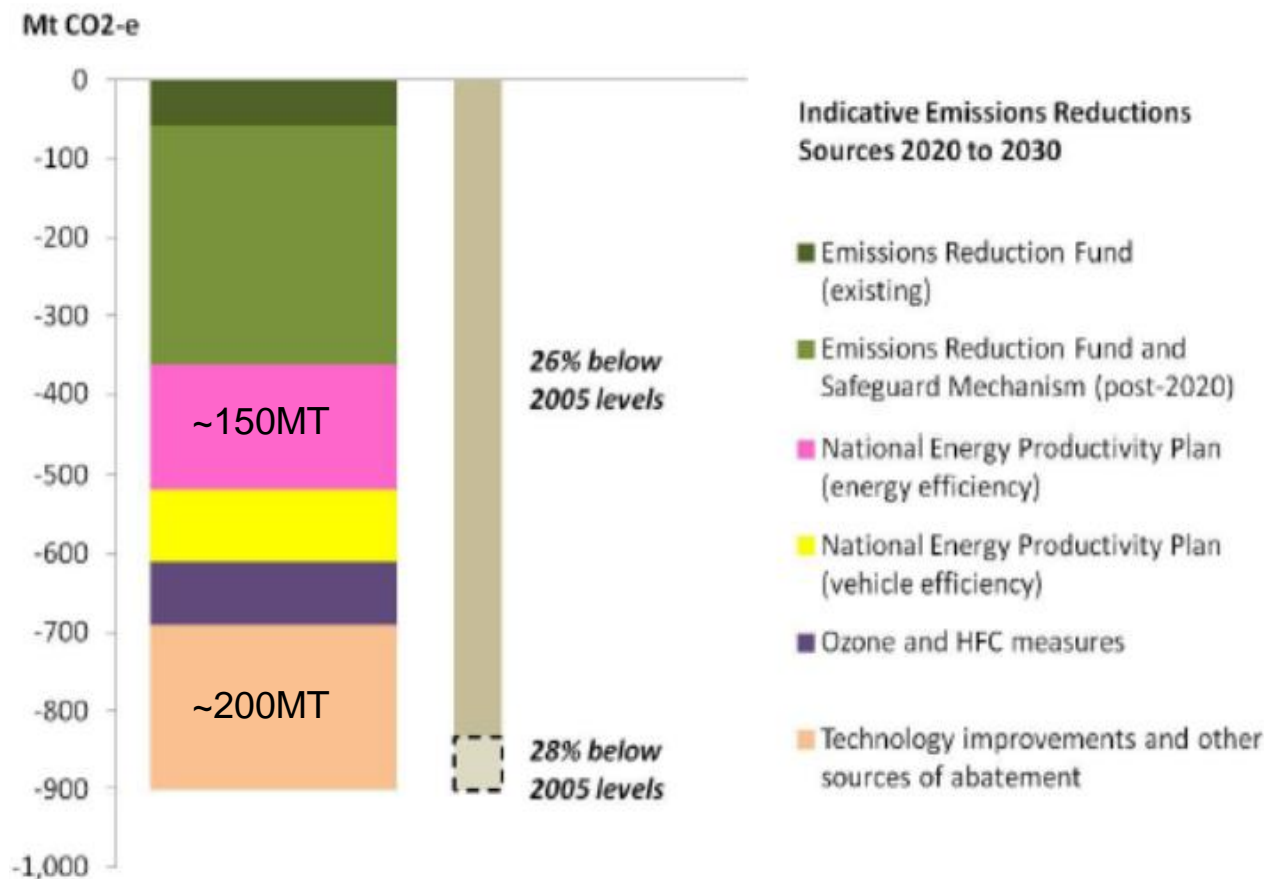


- ✓ CRC engages with many thousands of SMEs through industry bodies
- ✓ Two way communication: end user advice, vehicle for implementation
- ✓ Led by **Professor Ken Maher** – Gold Medal winning architect and Chair of ASBEC
- ✓ **Networks at each Node**

# Projects and Milestones



**CRCLCL projected estimates of 10 Mt cumulative reductions by 2020 – however recent estimates show 100 Mt of Carbon Emission Reductions potentially enabled by 2030 from our current research activities.**



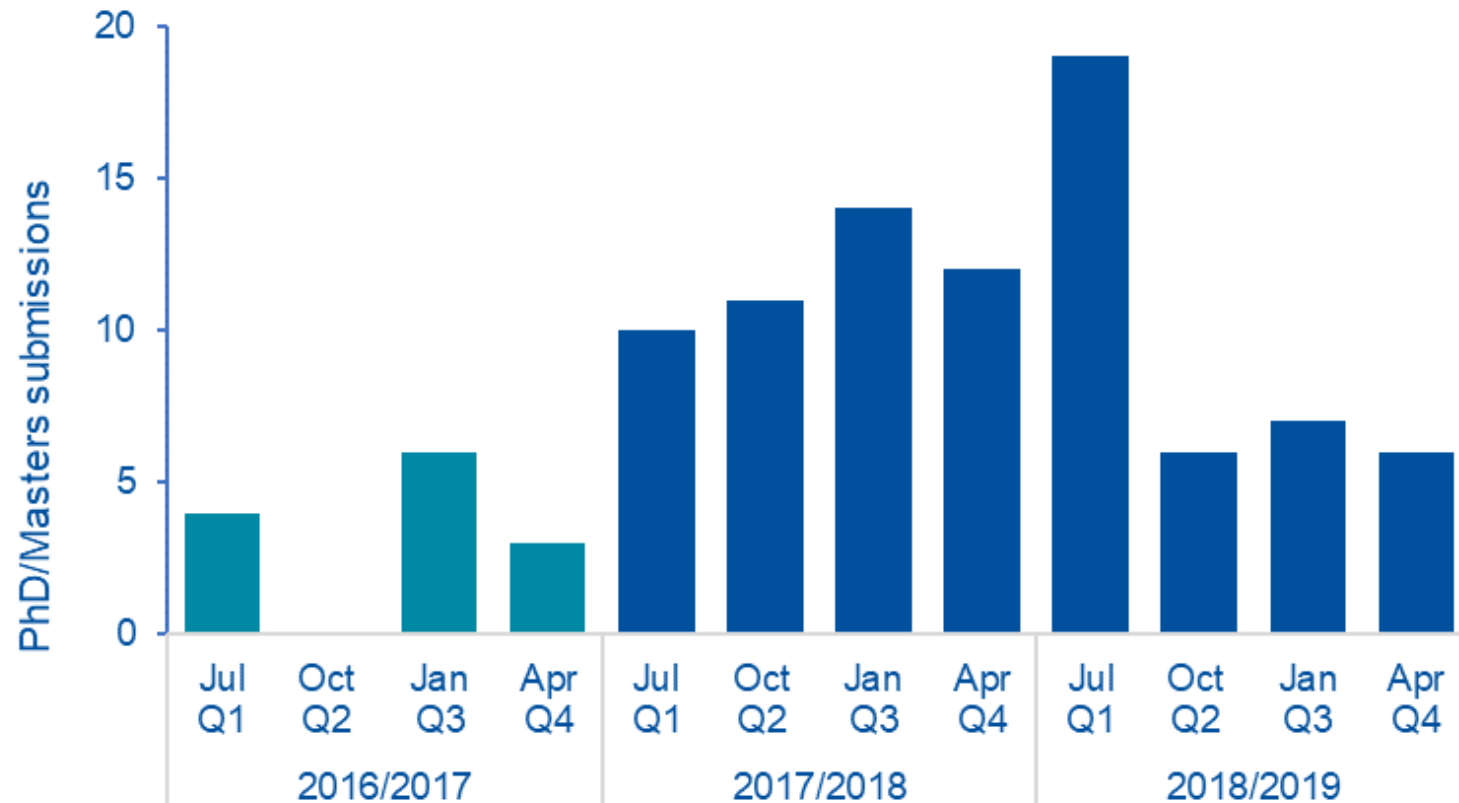
Source: Cwth 2030 Carbon Target presentation, 11 Aug 2015



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# ONCE IN A GENERATION CAPACITY BUILDING

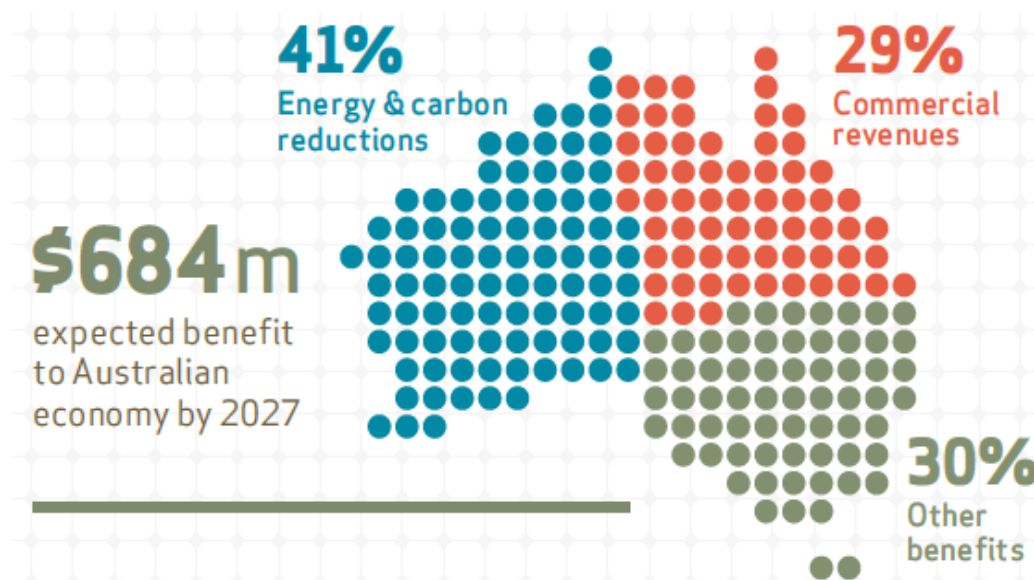
HDR enrolments	104
Thesis submissions	13 (13%)
Withdrawn	6 (5%)
Balance	85 (82%)



# *Projected Economic impact of \$684m by 2027.....*

## 2016 PwC Review:

On track to exceed **\$684m** (original estimate)



# Tracking progress

2012/13      2013/14      2014/15      2015/16      2016/17

Participants

45

44

45

44

44

Contributions

\$9.12M

\$13.13M

\$22.46M

\$14.34M

\$19.67M

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Publications  
to-date

Book/  
Chapters

6

Journal  
Articles

110

Conference  
Papers

116

Reports

143



LOW CARBON LIVING  
CRC

# RP1001 Air handling solutions, integration approaches and building design considerations for Photovoltaic Thermal (PV-T) roofing

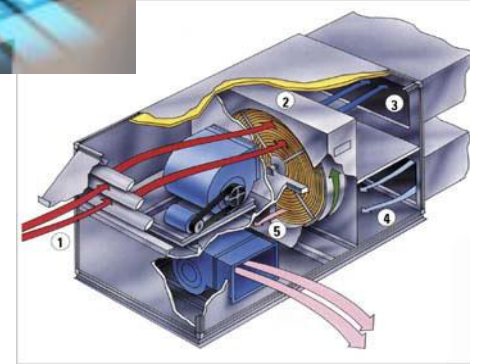
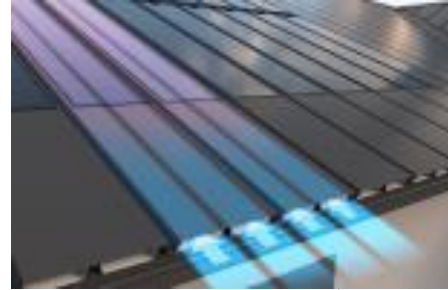
- Determination of appropriate cost-effective solutions for thermal integration.
- Trial the thermal integration of a PV-T system based on the optimised design, as part of a Living Laboratory.
- Development of a methodology to group the building typologies, operational (thermal supply and demand) situations, and macro- and micro- climates.





# RP1015 - Combining a building integrated PVT system with a low temperature desiccant cooler to drive affordable solar cooling

- As the price of PV continues to fall, rooftop PV becomes a very cost effective option.
- This project aims to integrate PVT roofing system with desiccant cooling systems.
- BIPV/T cannot produce temperatures high enough to drive an absorption cooling cycle.
- However BIPV/T in many Australian climates can potentially produce thermal energy at a temperature that can drive a low temperature desiccant cycle



# UNSW/Solar analytics

## PV & Building load prediction algorithms



Ausgrid<sup>2</sup> data from 8000 solar PV systems shows that approximately 51.8% are not performing to capacity

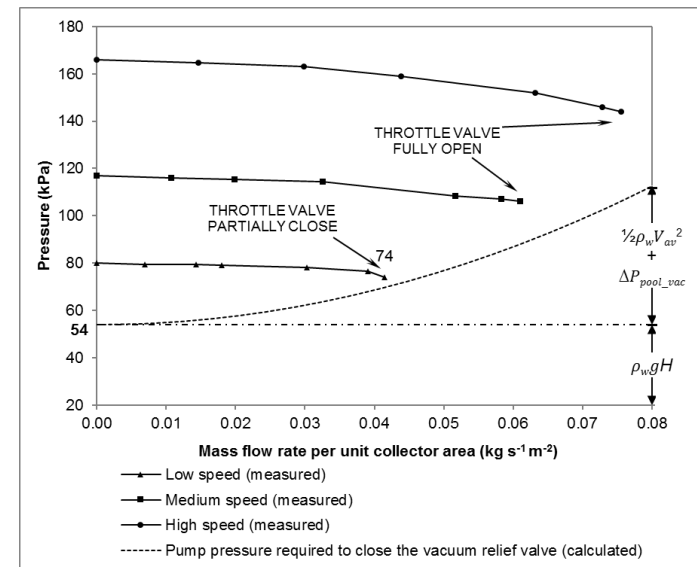
This project builds on a previous successful project.

Aim is to improve algorithms for predictions with a view for developing accurate storage models.



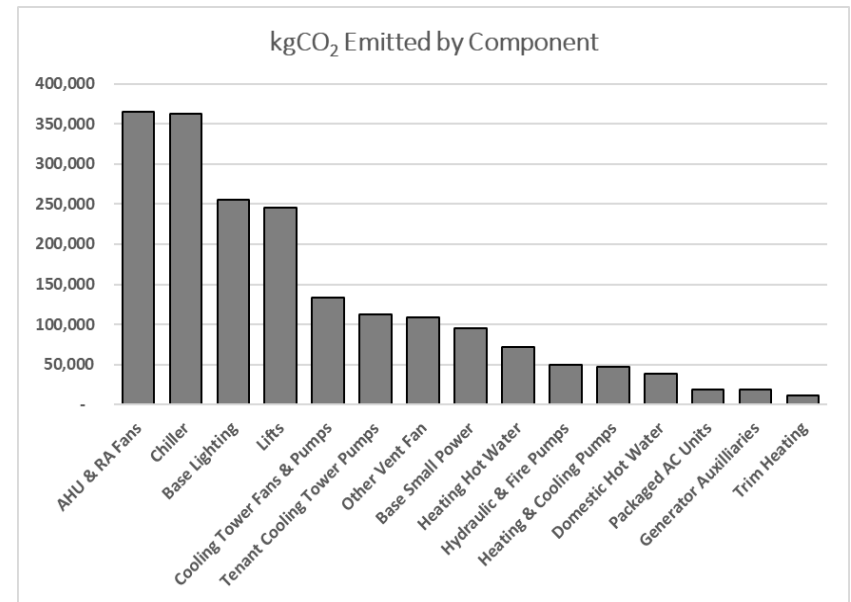
# R1014: IMPACT OF ENERGY EFFICIENCY POOL PUMPS ON PEAK DEMAND, ENERGY COSTS AND CARBON REDUCTION

- Variable speed pumping can drastically lower the energy, carbon emissions and peak demand of swimming pool filtering and solar pool heating.
- Experimental results have demonstrated that a solar pool heating system can be operated at lower flow rates and **deliver 70% reduction in electricity usage whilst maintaining acceptable pool temperatures.**
- Approximately 90% of the heated swimming pools in Australia are installed with solar pool heating.
- Project has made submission to Department of Energy and Environment – re MEPS for pools
- Running a pool filter at low speed saves ~70% of the pump energy. A PV system of 2 kWp can supply the energy required over 92% of the time, however a high speed pump, the PV would only supply the pump energy for about 45% of the time.



# R1033: Mainstreaming High Performance Commercial Building HVAC

- The overall aim of this project is to investigate how to mainstream high performance Heating Ventilation and Air Conditioning (HVAC) in commercial buildings.
- Currently investigating the current best practice of HVAC designs in Australian commercial buildings and communicate that to industry to raise standards.
- 5 star buildings still have significant energy in moving air and water around
- Graphic shows that for a 5 star commercial building in Sydney, Air Handling Units and Return air fans consume as much energy as the chiller.
- Project has also utilised outputs to make a submission to the ABCB with regards to revising the NCC for 2019.
- Submission provided evidence of ~15 - 50% reductions in energy metrics for fans and pump systems in commercial buildings based on best practice data from exemplar commercial buildings

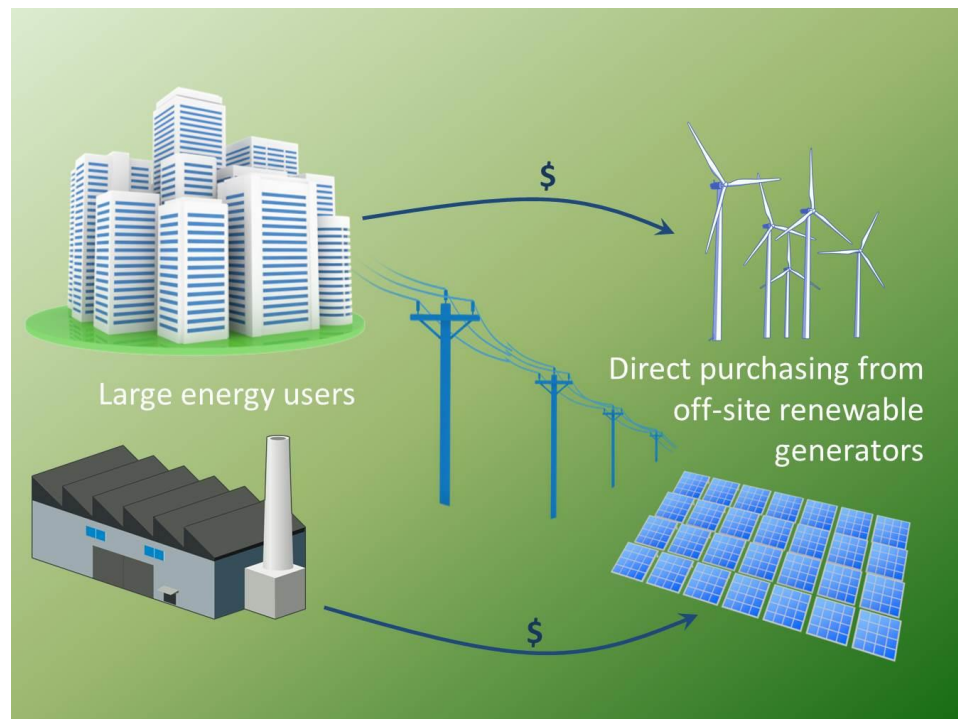


16

# RP1032 Facilitating large energy user deployment of off-site renewable generation

**Aim** to produce practical resources for market participants (End Users/Electricity Retailers/Project Developers) so as to reduce transaction costs

- Define and investigate the emerging market for renewable energy direct purchase in the Australian NEM context
- Decision support resource (decision tree)
- Descriptions of business and contractual structure options
- Implications and pros/cons analysis
- Summary of current market sector preferences



## Impact

- Market has accelerated – especially since wholesale electricity prices have recently increased substantially.
- Offsite PV and wind – significant opportunities - cost effective for many businesses

17



# The GHG Case for Geopolymer Concrete

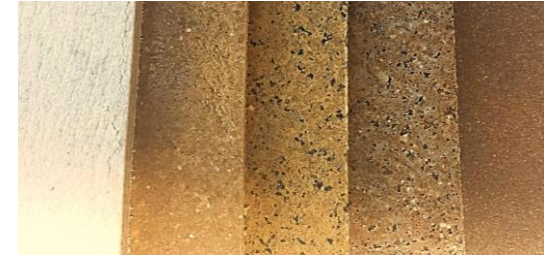
- CO<sub>2</sub> emissions generated by typical concrete mixes using Portland cement as the binder are between 0.29 and 0.32 tonnes of CO<sub>2</sub>-e per m<sup>3</sup>.
- According to the Australian Bureau of Statistics 2012-13, the current production of pre-mixed concrete is about 27 million m<sup>3</sup> per annum.
- Results in 8 million tonnes of CO<sub>2</sub>-e p.a. from the manufacture of pre-mixed concrete.
- Geopolymer alternatives can provide significant carbon reduction compared to OPC concrete.
- For an uptake of 10% geopolymer/concrete replacement, 640 thousand tonnes per annum less carbon will be emitted to the atmosphere per year from Australia alone.

## Annual carbon emission savings for various uptake of geopolymer concrete.

% adoption of geopolymer	Carbon emissions (tonnes) due to pre-mixed concrete manufacture	Carbon emission savings (tonnes) that can be achieved by geopolymer alternative
0%	8,000,000	0
10%	7,360,000	640,000
20%	6,720,000	1,280,000

# RP1022 – Investigation of innovative sustainable low carbon products from waste materials for built environments

- Transferring waste materials (wood, plastic and marine waste such as seaweed and seashell) into resources for the developing of a new generation of high performance non-toxic engineered wood-plastic bio-composite for building, furniture and architectural applications.
- This invention will enable re-using of these 85% of the urban wood wastes.
- These products have been specifically designed for disassembly and recycling and the end of their life.
- Also the materials have been designed for a consistent state of non-toxicity for end users regarding chemical and biological Volatile organic compounds (VOCs) for the whole product's lifespan.



## NP4007 – Glass recycling for waste reduction in built environment

- This study has successfully manufactured a high quality artificial construction slabs from waste glass powder filler with high flexural and compression strength as well as low water absorption and moderate density.
- Using these mixtures as raw materials and enhancing different performance of product using bio-wastes instead of synthesis raw materials is unprecedented until now.
- These products have been specifically designed for disassembly and recycling and the end of their life.



11/30/2017

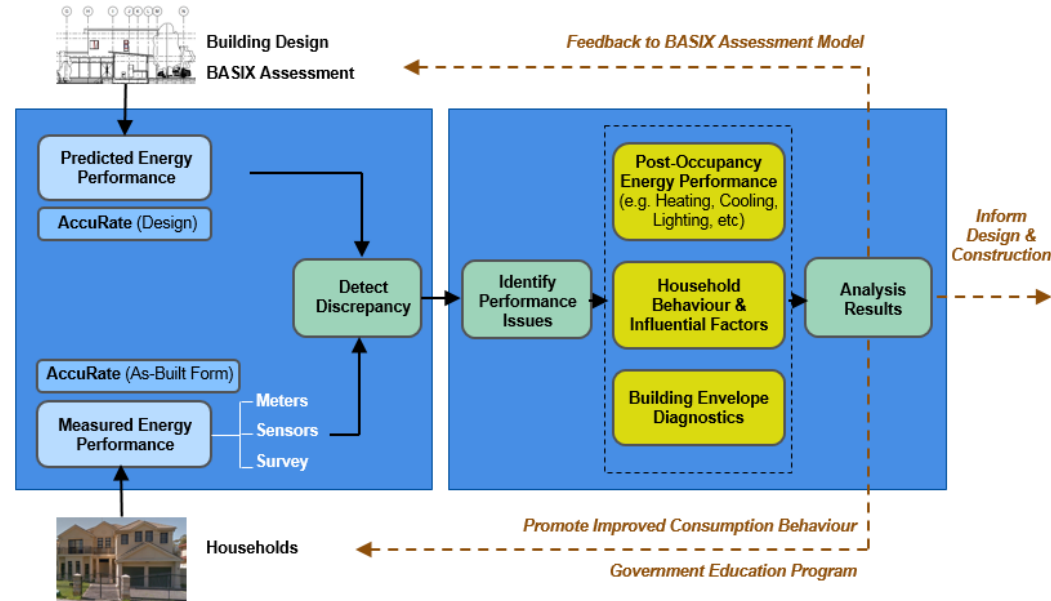
# RP1017 Validating and Improving the BASIX Energy Assessment Tool for Low-Carbon Dwellings

## PROJECT SUMMARY

This project investigates post-occupancy energy performance of dwellings in order to inform government policy and reduce greenhouse gas emissions (GHG) in the residential sector.

It compares BASIX estimations to actual energy consumption for each type of energy use in homes, and identifies performance issues in consumer behavior, energy efficiency of appliances and building conditions.

The outcomes will inform new GHG reduction targets for residential buildings, potential improvement of BASIX assessment models, government education programs, and carbon positive building design.



## FINDINGS

- Actual average GHG emission reduction was greater than BASIX estimation (which supports the change of BASIX targets).
- Actual average cooling and heating energy use was greater than BASIX estimation in Greater Sydney area.
- Actual average lighting and plug-in energy use was less than BASIX estimation in Greater Sydney area.

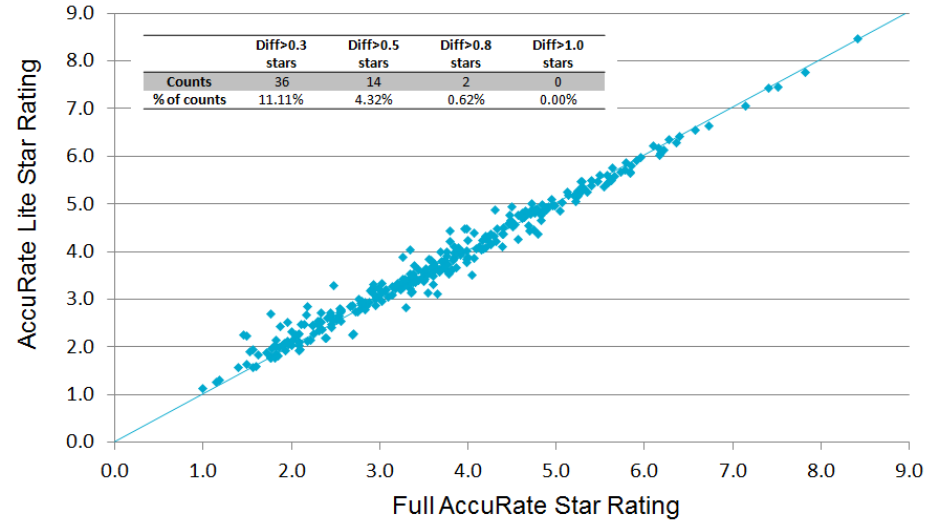




# Next generation whole of house tool

RP1024: Ref NEPP Measure 5

- Review of user assumptions in NatHERS
- Include appliances, generation and storage
- Simplify data entry
- Validate against measured data
- Investigate compliance



AusZEH Design  
(Lite & Heavy)

 Energy Inspection

 LOW CARBON LIVING  
CRC



Thermal



Embedded Carbon



Hot Water



Lighting



HVAC



Appliances



Occupancy



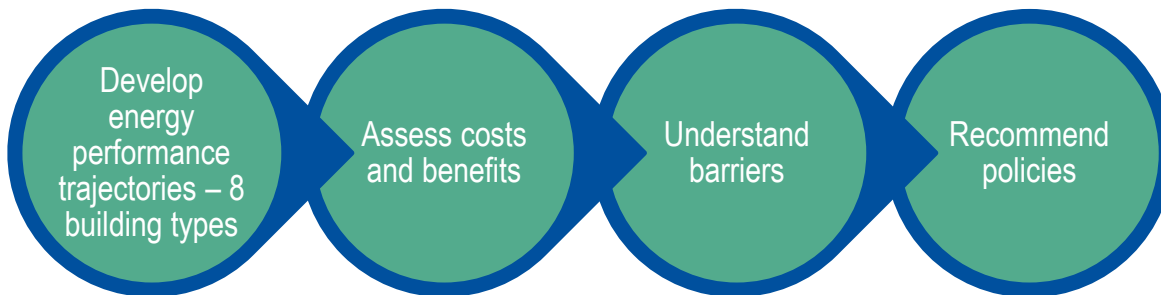
Generation

# SP16 Building Code Energy Performance Trajectory Project

Developing an industry-led evidence base for ambitious long-term trajectories and targets for improved energy performance for new buildings

## OUTCOMES

- Market transformation
- Higher performing buildings



### 5 policy solutions for a zero carbon built environment

- ① **National plan with strong governance to coordinate action**
- ② **Mandatory minimum standards with forward trajectory to provide a regulatory signal**
- ③ **Targeted programs and incentives to stimulate the market**
- ④ **Energy market reform to provide a level playing field**
- ⑤ **Data, research, information, education and training to enable effective action**

Source: ASBEC 2016, Low Carbon, High Performance

Project partners:



# RP2007: Integrated Carbon Metrics Project



## Project Objectives:

### Research Challenge:

One third of global GHG gas emissions are emitted from the building sector. While more work has been done on decreasing direct emissions from the operation of buildings, embodied emissions of construction materials and processes receive little consideration, even though they constitute a significant additional proportion of emissions. Estimating embodied emissions is complicated, and there are uncertainties as there is yet to be developed a universally accepted methodology.

- Enable the analysis of the **carbon fabric of the built environment**
- Build detailed, economy-wide **database** of embodied carbon flows
- Help assess the carbon performance of **precincts by delivering tailored PIM tools**
- Quantitatively evaluate low-carbon **scenarios at PIM and economy-wide level**
- Contribute to the process of defining universal carbon accounting **principles, guidelines and standards**  
(such as 'low-carbon', 'carbon-neutral', 'zero-carbon', etc.)



# Carbon Neutral Adelaide



C embodied in  
services

C embodied in  
electricity

C embodied in  
materials

Operational C

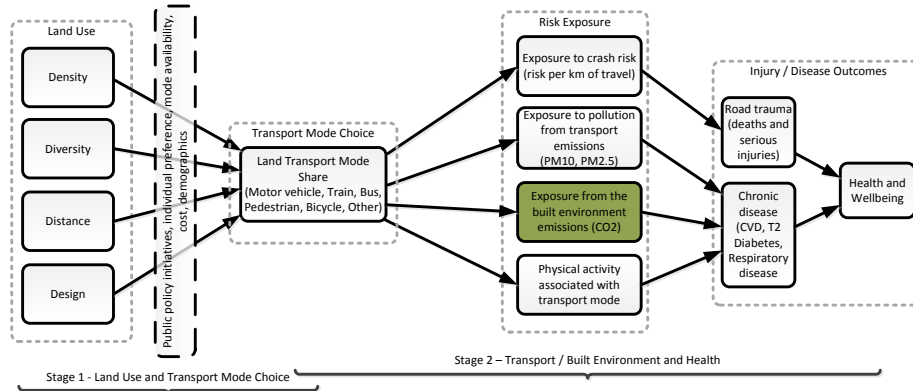
C embodied in  
equipment  
(capital goods)

C embodied in  
transport

# RP2028 Development and Trial of a Low-Carbon Living Co-Benefits Calculator

## Objective;

- Develop a co-benefits calculator suitable for various stakeholders involved in the planning process.(Regulators, Developers, Precinct planners, etc.)
- Linked to key aspects of the built environment
  - Residential density / diversity, Street networks, Green space, Traffic, mode share, etc.



## What are the Co – Benefits ?

- Reductions in injuries & deaths associated with transport accidents
- Reductions in chronic disease (CVD, asthma, respiratory disease) associated with built environment
- Reductions in chronic disease (CVD, overweight, diabetes) & increases in health associated with active transport modes (walking, cycling, etc.)
- Improvements in productivity (e.g., reduced travel time, more productive time use) associated with efficient urban land form design
- Overall health, wellbeing, productivity and economic benefit



# RP2023 Microclimate and Urban Heat Island Mitigation Decision-Support Tool

- Cities are vulnerable to temperature, and the task of cooling them has proved challenging.
- There is a strong need to link urban overheating issues with broad urban development and resilience issues to deliver an integrated and effective solution.
- What scenario analysis and decision-support tool are needed by governments and developers to mitigate urban heat?

This project aims to provide government and built environment industries with **a decision-support tool** to inform urban policy and development assessment related to cooling cities and reducing energy consumption.

Urban heat mitigation alternatives are explored under varying urban form, building materials scenarios, etc.

**CBD redevelopment:** Green Square, Parramatta City;

**Greenfield development:** Leppington, Macarthur Heights

## Green Square

### Past

- Urban heat in the historical context (industrial precinct)



### Present

- Impact of current redevelopment plans on urban heat

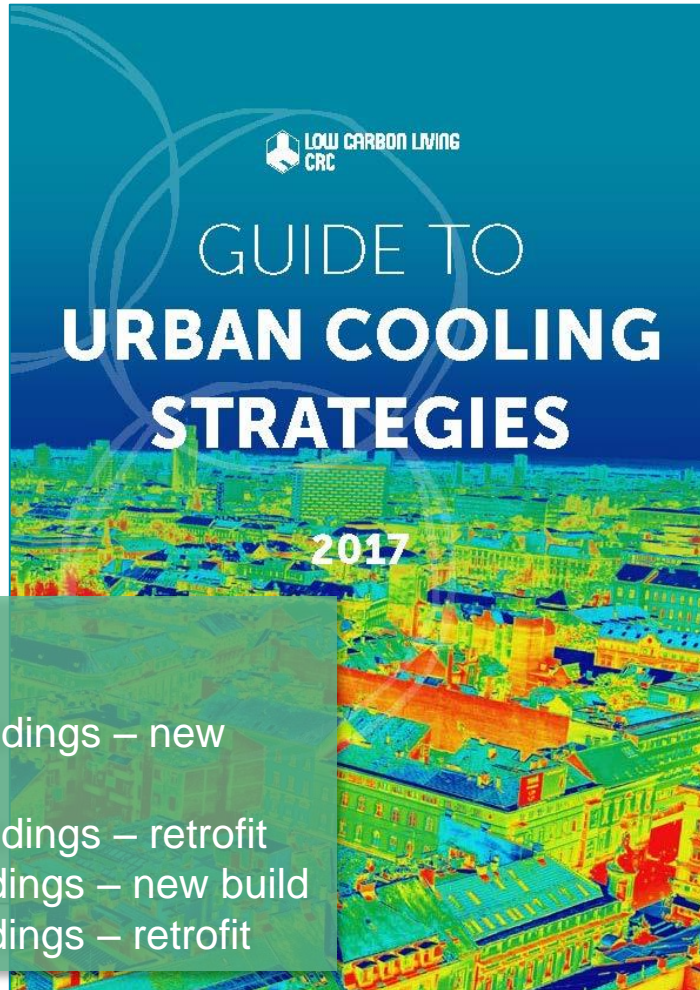


### Potential

- Impact of alternative mitigation options on urban heat



# Guide note series

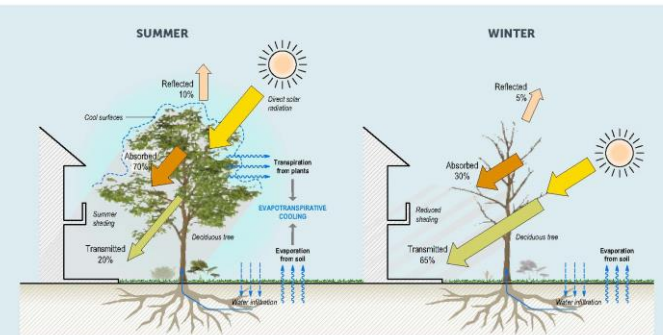


### Low carbon:

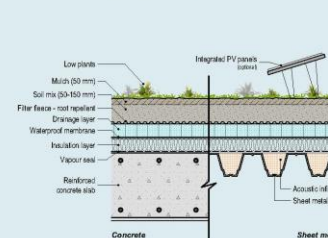
- Precincts
- Commercial buildings – new build
- Commercial buildings – retrofit
- Residential buildings – new build
- Residential buildings – retrofit

### GREEN ROOFS

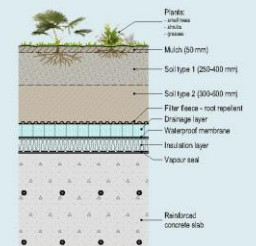
Cooling effect of a tree in a sunny day in summer and winter.



### Extensive green roofs



### Intensive green roofs



# RP2021: Greening Suburban Travel

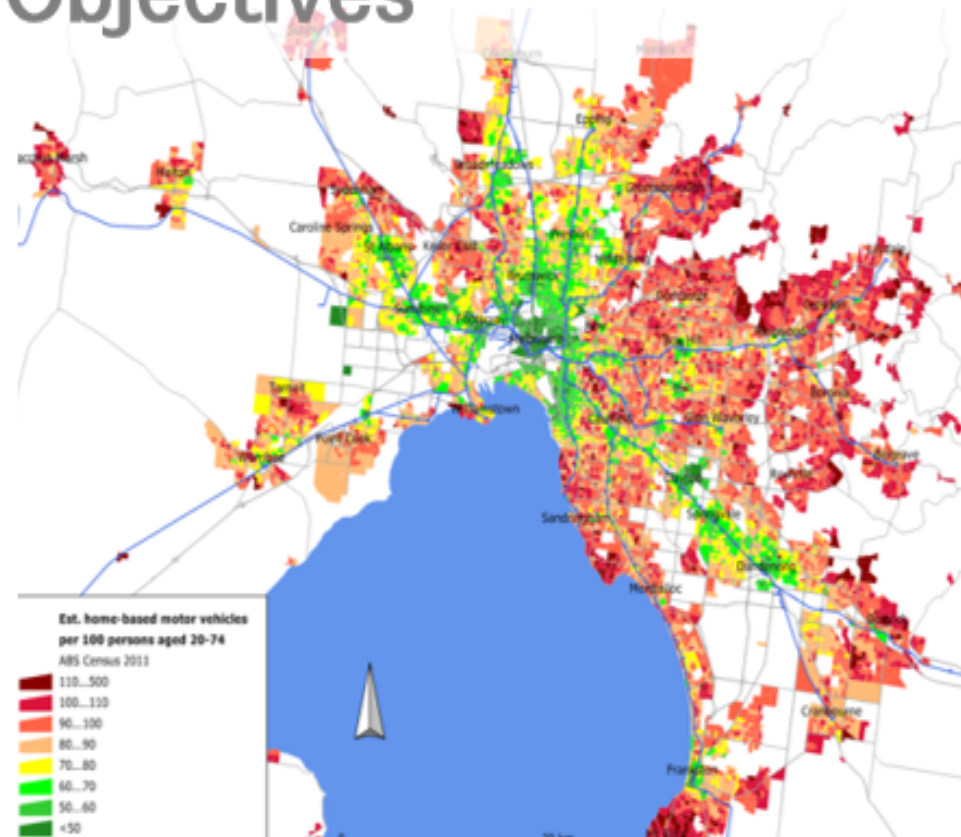
## Project Rationale and Objectives

Reduce GHG emissions from passenger car usage (8.5% net emissions or 39.7 Mt CO<sub>2</sub> in 2010)

Investigations of suburban mobility options that offer efficient, affordable and flexible trips while reducing reliance on private vehicle use

Framework and modelling tools for supporting effective investment decisions that increase the uptake of high priority low carbon transport interventions

Examples: on-demand public transport, shared mobility services, electric vehicles, smart buses, active transport initiatives and autonomous shared mobility



Switching 10% of person-km from cars to public transport would save 0.78 Mt GHG p.a.

Reducing average vehicle trip length by 10% would save 2.74 Mt GHG p.a.

Removing all car trips less than 2 km long would save 0.35 Mt p.a.





# SP0001: Brownfield Precinct Regeneration



## Government Strategic Planning Objectives

- 260ha site
- 40 year development
- 120,000+ population
- 60,000+ commercial jobs
- Multiple aspirational performance criteria...

## IDEAS FOR FISHERMANS BEND

A Research Synthesis project involving experts from 2 CRCs over 3 months



CRC LCL Building energy modelling identified opportunities for **70% reduction in operating energy** demand compared to BAU practices and regulations (10 star NatHERS, EE built-in appliances, rooftop solar PV)

Potable water: **62% reduction** in demand for imported potable water due to greywater harvesting and local treatment using 3<sup>rd</sup> pipe as a collection system;  
Sewerage: **70% reduction** in discharge to centralised treatment plant;  
Microclimate: **~ 2° centigrade mitigation** of urban heat island stress through irrigated green space and shaded urban environment

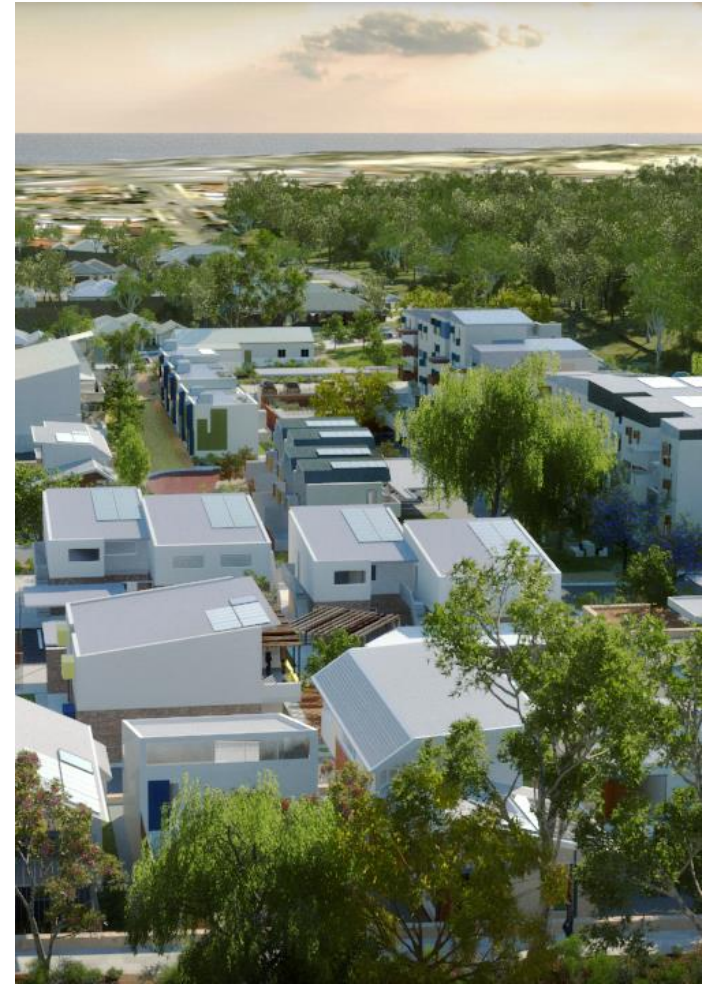


LOW CARBON LIVING  
CRC

# RP3033: Mainstreaming Low Carbon Housing Precincts – the WGV Living Laboratory & WGV2

## Project Objectives

- Demonstrate that significant reductions in BAU carbon emissions in mainstream precinct-scale residential developments are achievable.
- Identify where the carbon savings are made, including level of cost and complexity of the various strategies and mechanisms deployed.
- Evaluate market interest in the low carbon aspects of the development and how this relates to the level of resident participation with low carbon lifestyle actions.
- Understand the inter-relationships between stakeholders in regards to low carbon aspirations and how these can better align.



30



# Vision 2040: What LCL world do we want to live in?

Do the sum of the parts make a good whole?

RP3008: Ryan et al, 2016

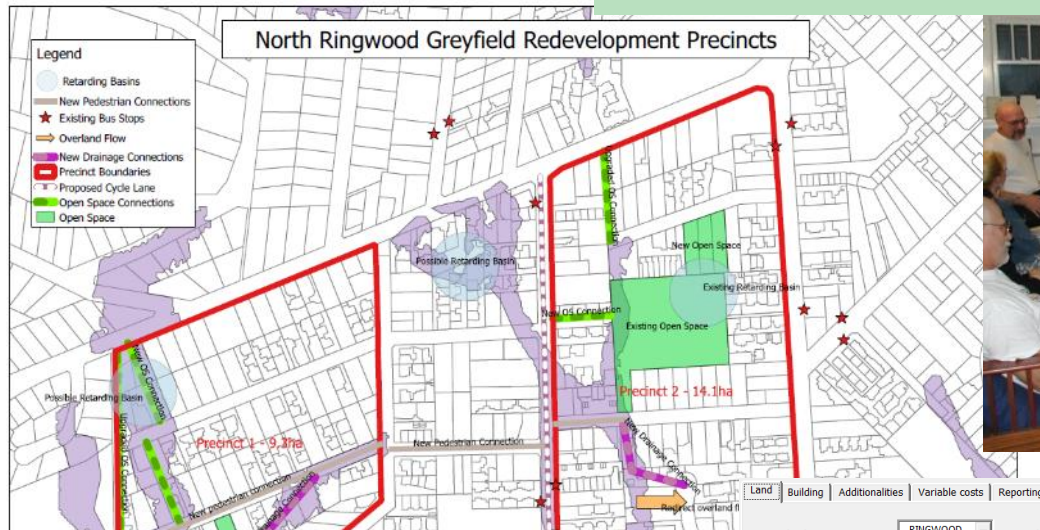




# RP3034: Community co-design of low carbon precincts for urban regeneration in established suburbs

A process and tools to get landowners to work together to redevelop suburbs for lower CO and better liveability

## Kitchen Table: Community champions



## Town Hall: Land use design



Land Building Additionalities Variable costs Reporting

suburb: RINGWOOD Median house: 800000 Median townhouse: 600000 Median unit: 519000

Average value (\$): 800000 Average lot size (sqm): 639.394

Number of initial lots: 1

Total area (sqm): 800 Cost of land (\$): 1040000 Land/sqm (\$): 1300

Land for additional features

Number of canopy trees: 0 0 sqm

Area of land of public space: 0 0 sqm

Clear all

Developable area: sqm

## Viability Tool

Blacktown City Council

NSW GOVERNMENT Planning & Environment

Maroondah City Council

State Government Victoria Department of Environment, Land, Water & Planning

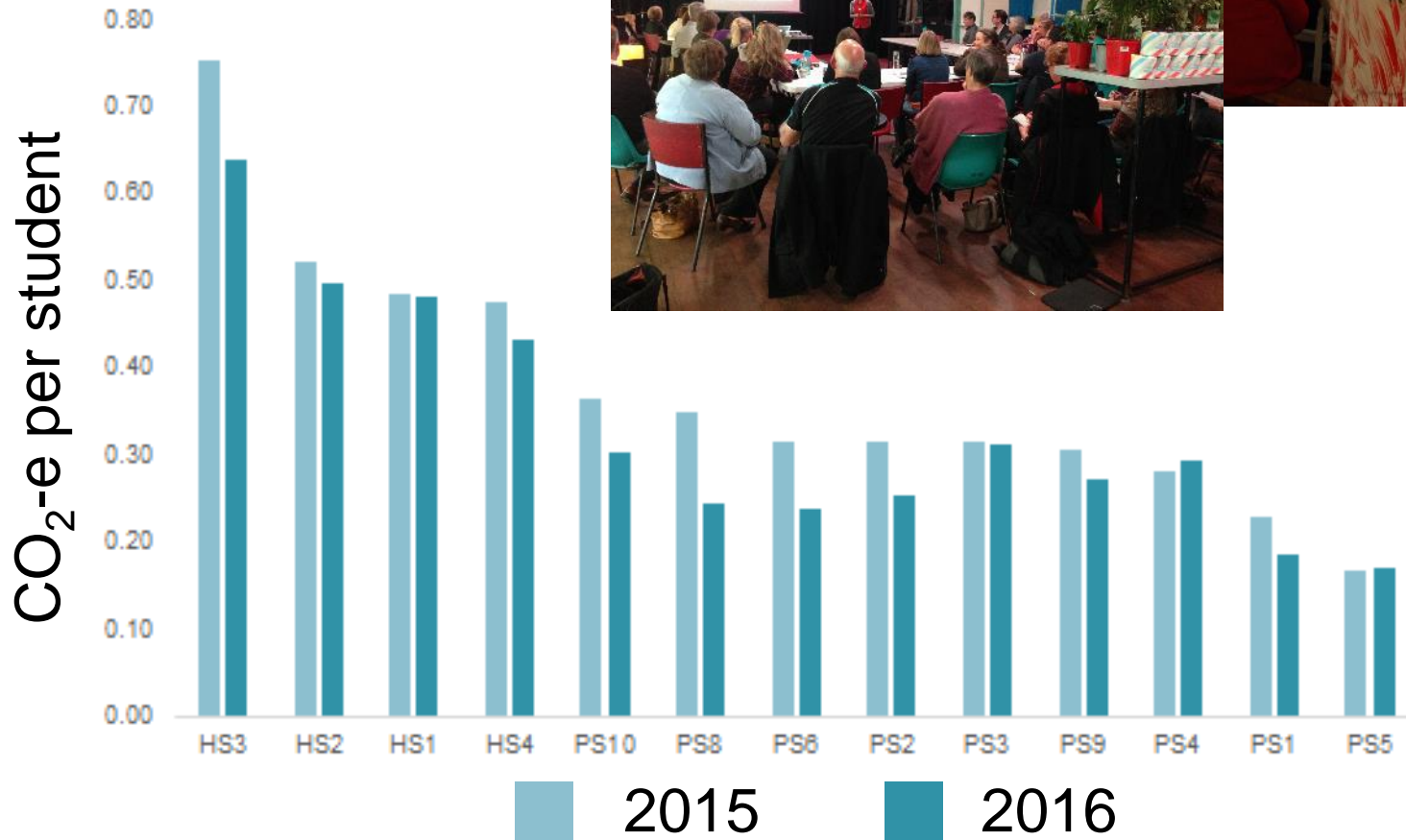


LOW CARBON LIVING CRC

crc•si

# RP3020: Climate Clever Schools

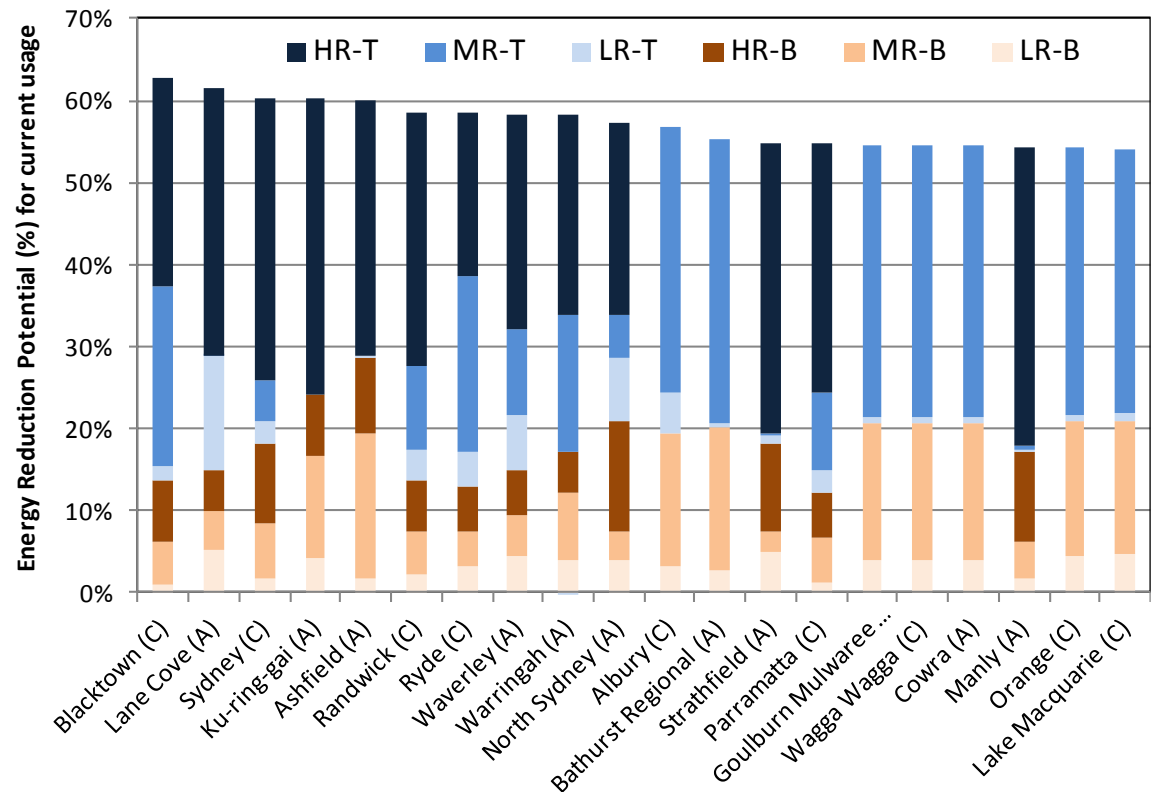
And how does this rub off into the community?



# Big datasets combined with agent based modelling to cover non financial barriers



- Building database
  - Age, location, type, floor area, ownership, NABERS rating
- Energy model
  - Technologies, savings opportunities
- Stakeholder interaction model
  - Financial, behaviour/ preferences, barriers
- Uptake model



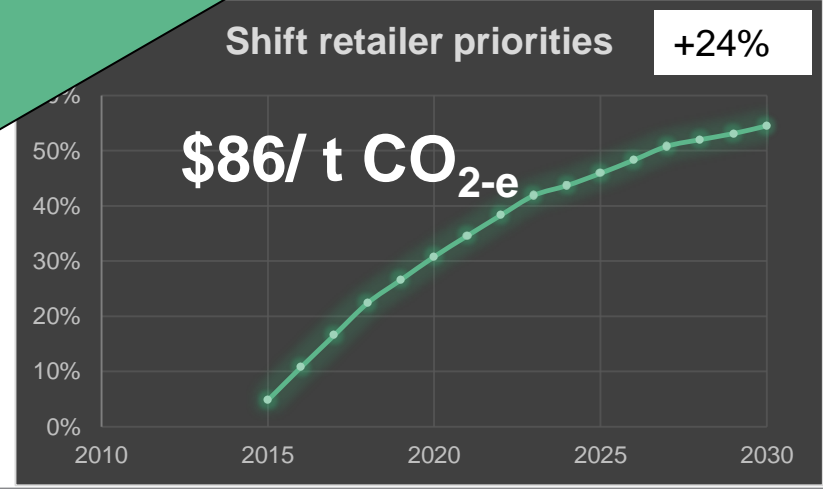
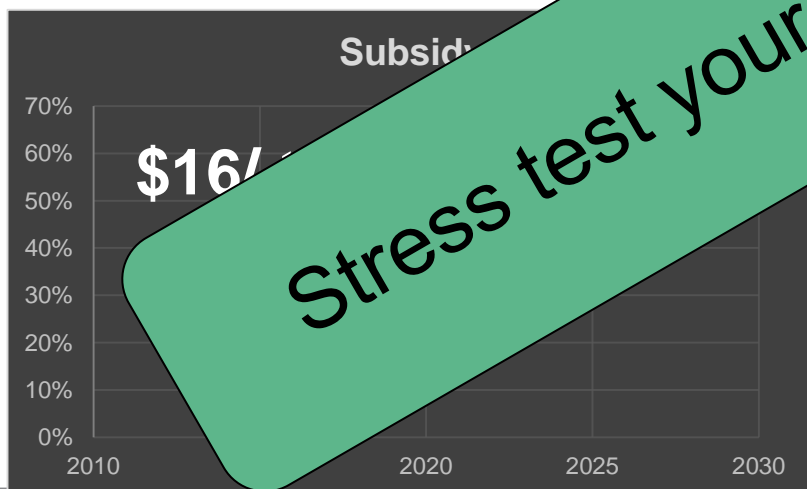
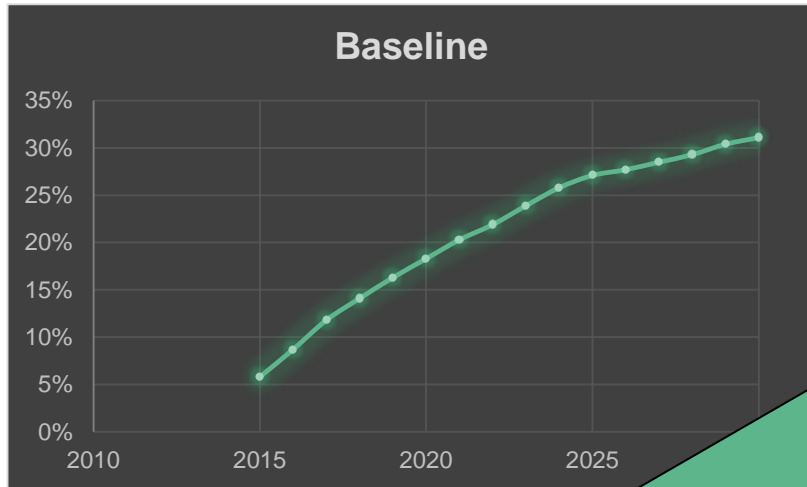
# Utilisation

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- Federal Government
  - Commercial building disclosure
- NSW OEH
  - Energy savings scheme
  - Environmental upgrade agency
- Sustainability Victoria
  - Energy auditing
- SA Government
- City of Melbourne
  - Energy efficiency opportunities

Stress test your policy ideas now!!!

# RP3028: Options for supporting low income Households in the NSW Energy Savings Scheme

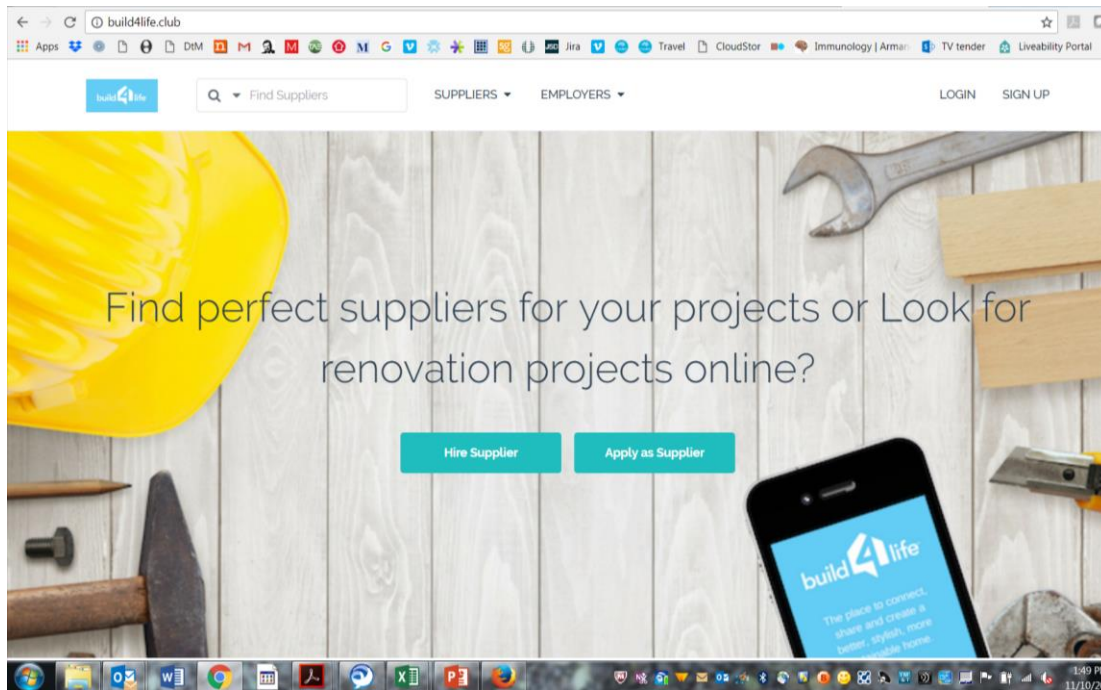


Stress test your policy ideas now!!!





# RP3029e1 The Build4Life Social Media Platform



- Online and face-to-face networks to promote sustainability information to people building or renovating their homes
- A combination of Facebook, TripAdvisor and Tupperware for building and renovation

Project Partners:



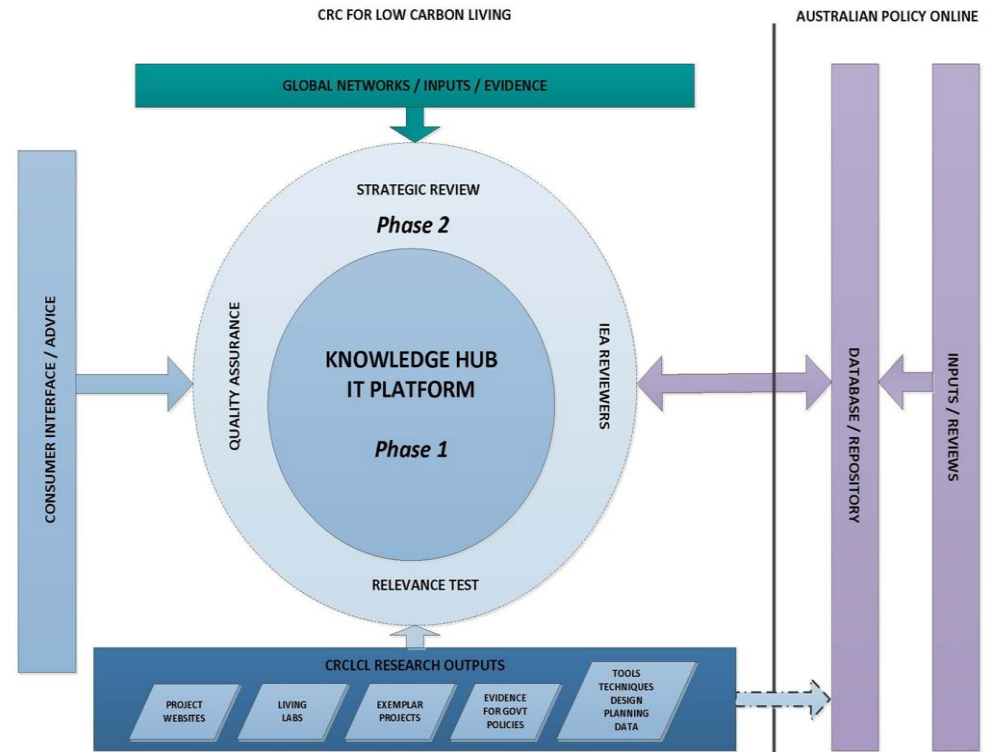
Office of  
Environment  
& Heritage

## Evidence-Based Decisions & Systematic Reviews (SRs)

- [Cochrane Collaboration](#): SRs on medical practice & healthcare, started 1993, large worldwide network of 'groups', provides training & support
- [Campbell Collaboration](#): SRs on social interventions, started 2000, partly modelled on Cochrane, smaller network of groups, looking to grow, provides support & training
- [Evidence Synthesis International \(ESI\)](#): worldwide umbrella body (incl. Cochrane and Campbell)

# SP0008 Low Carbon Built Environment Knowledge HUB

- Access to the outputs of the CRC
- Provides a collaborative platform for CRC Nodes, and
- Aligns the significant existing Australian and International resources for industry, policy makers, researchers and the public.
- Provides and maintains an evidence base for policy makers and practitioners promoting low carbon living



SP9 The role of regulation in driving low carbon outcomes in the built environment

SP11 Mapping CRCLCL projects against the Low Carbon, High Performance industry roadmap

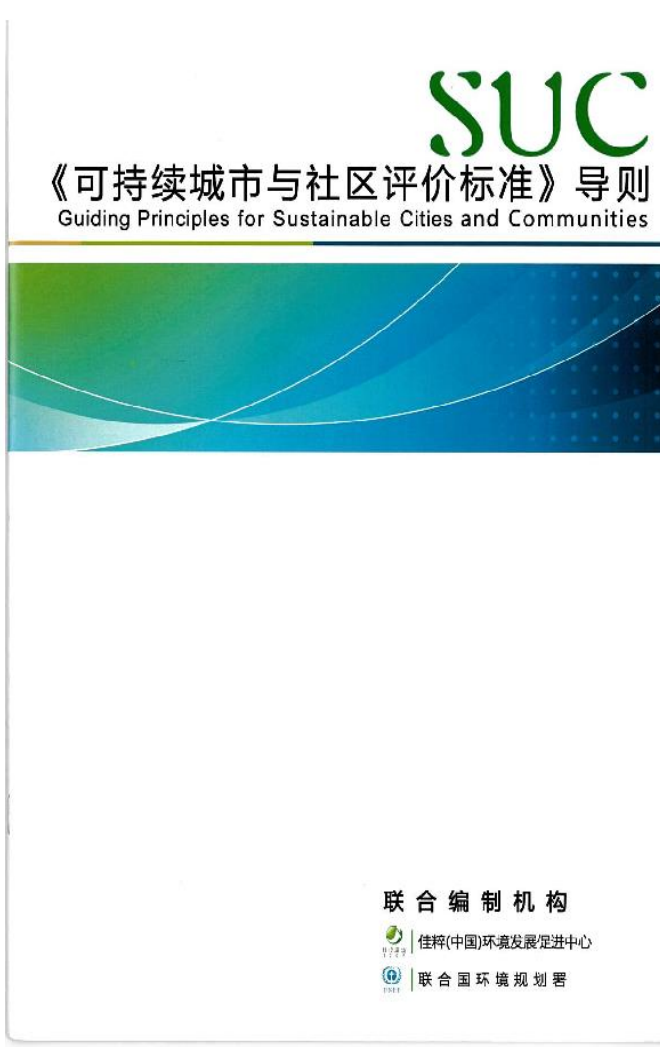
[illegible][illegible]

- Adding a market transformation program to the MEPS and learning program, with market transformation innovations undertaken in pilot and near-pilot areas to make the most efficient technology choices to be available to ACSI and Prosepio and to increase all contract line rates.

[illegible]

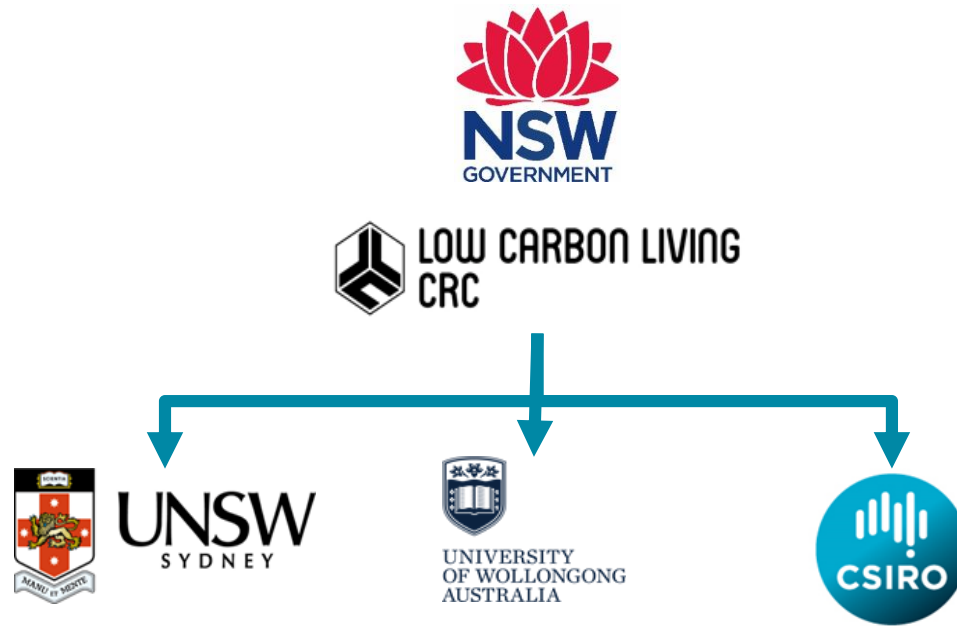


# International Forum on Sustainable Cities and Communities & Press Conference on SUC Guidelines, Beijing, 2015-17

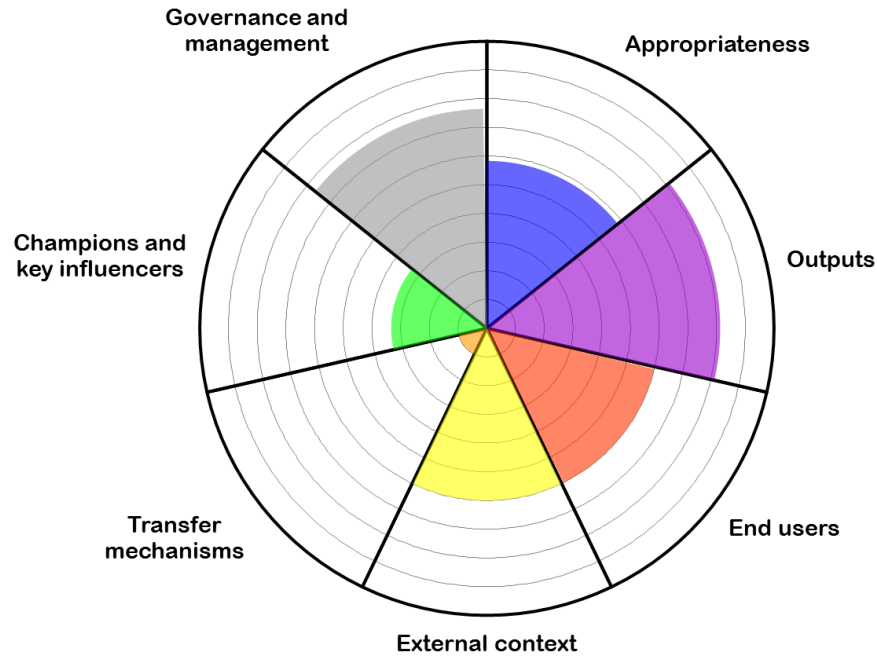


LOW CARBON LIVING  
CRC

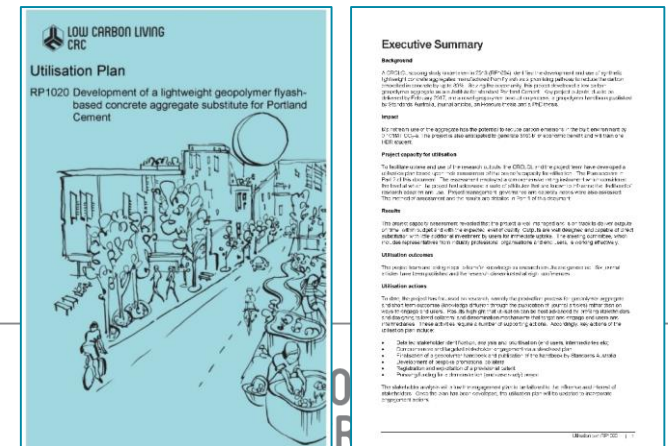
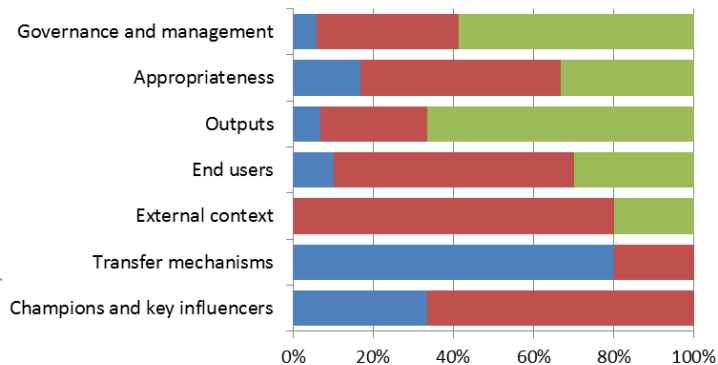
# Energy Efficiency Decision Making Node



# Utilisation planning



■ Low ■ Medium ■ High





# Catalogues



## Project Catalogue

Version 3, September 2017



## Part 1

#	Title	Purpose	Method	Literature review / Project report	Guideline / Plan / manual / standard / specification	Thesis	Conference paper / poster / presentation	Refined publication e.g. journal article	Case study	Other publications e.g. online article, submission	Tool model / framework	Training	Other
PROGRAM 1 INTEGRATED BUILDING SYSTEMS													
RP1001	Optimising HVAC and PV/T systems for different building typologies	Optimise the efficiency of PV/T and HVAC systems by matching them to building characteristics, building thermal demand and climate regimes	<ul style="list-style-type: none"> <li>Literature review</li> <li>Develop PV/T building model</li> <li>Test in two case studies (living laboratories)</li> </ul>	1	1	1	1	1			2		
RP1002	Heating and cooling buildings using a solar thermal collector	Overcome heat generation limitations of current solar thermal collectors by designing and testing a building heating and cooling system driven by a roof-top mounted concentrating collector	<ul style="list-style-type: none"> <li>TRNSYS modelling of solar inputs and building energy demands to select the optimum absorption cooling system components and operation conditions</li> <li>Validate model</li> </ul>		1		4	7			1		
RP1003	Risk and opportunities of incorporating photovoltaics into buildings	Identify the near- and long-term architectural, technical and regulatory risks and opportunities for building integrated photovoltaics (BIPV) and develop a roadmap for short- and long-term deployment	<ul style="list-style-type: none"> <li>PV building integration scoping study</li> <li>Develop value chain and costs analysis</li> <li>Functional analysis of BIPV</li> </ul>	2	2								
RP1004	Investigating heat generation standards for geopolymer concrete using flyash and slag	Reduce the use of Portland Cement by developing performance criteria for low carbon (geopolymer) concrete made using flyash and slag byproducts	<ul style="list-style-type: none"> <li>Establish industry working group</li> <li>Literature review on flyash and slag based concrete</li> <li>Identify barriers to use</li> <li>Develop performance standards</li> </ul>	1	1	4		1					
RP1006	Cost effective and socially acceptable net zero carbon homes	Develop an evidence-based rating tool that integrates housing design with new low carbon materials and technologies to identify the most economically viable low carbon combinations	<ul style="list-style-type: none"> <li>Literature review</li> <li>Investigate new designs, materials and technologies for energy reduction</li> <li>Monitoring 60 low carbon houses at Lichfield Park</li> <li>Stakeholder consultation</li> <li>Develop, validate and trial an integrated</li> </ul>	1	2	1							



## Tools Catalogue

Version 2, August 2017



## Intellectual Property Register

Version 3, October 2017



## Living Labs Catalogue

Version 1, October 2017



### Living Labs

We have established 15 Living Labs which are detailed in this catalogue.

Living Labs are real-life environments that promote innovation in services or technology by facilitating co-creation between multiple stakeholders including business, academia, government and users. They function as innovation accelerators, where new ideas emerge, are prototyped and tested in collaboration with users in real life settings.

Our Living Labs are categorised according to a typology of five categories (Fig 1):

Embedded:	Based in existing places, where users can be observed interacting with existing technologies or prototypes
Urban:	Similar to Embedded but at a larger scale
Purpose built:	Specifically built to become a place for prototyping and testing new materials and technologies
Community based:	Established for social innovation; may not possess a physical boundary
Virtual:	Activities are conducted entirely through virtual platforms

Our Living Labs are distributed throughout Australia (Fig 2).

The CRC for Low Carbon Living

We are an end user driven not-for-profit research and innovation hub whose core purpose is to transform the built environment to a low carbon future. Our mission is providing industry and government with co-creative research, which includes co-creating, validating and testing opportunities for low carbon technologies, materials, design and playing innovations. These social and technology solutions, and policy evidence will facilitate the transition to a low carbon built environment.

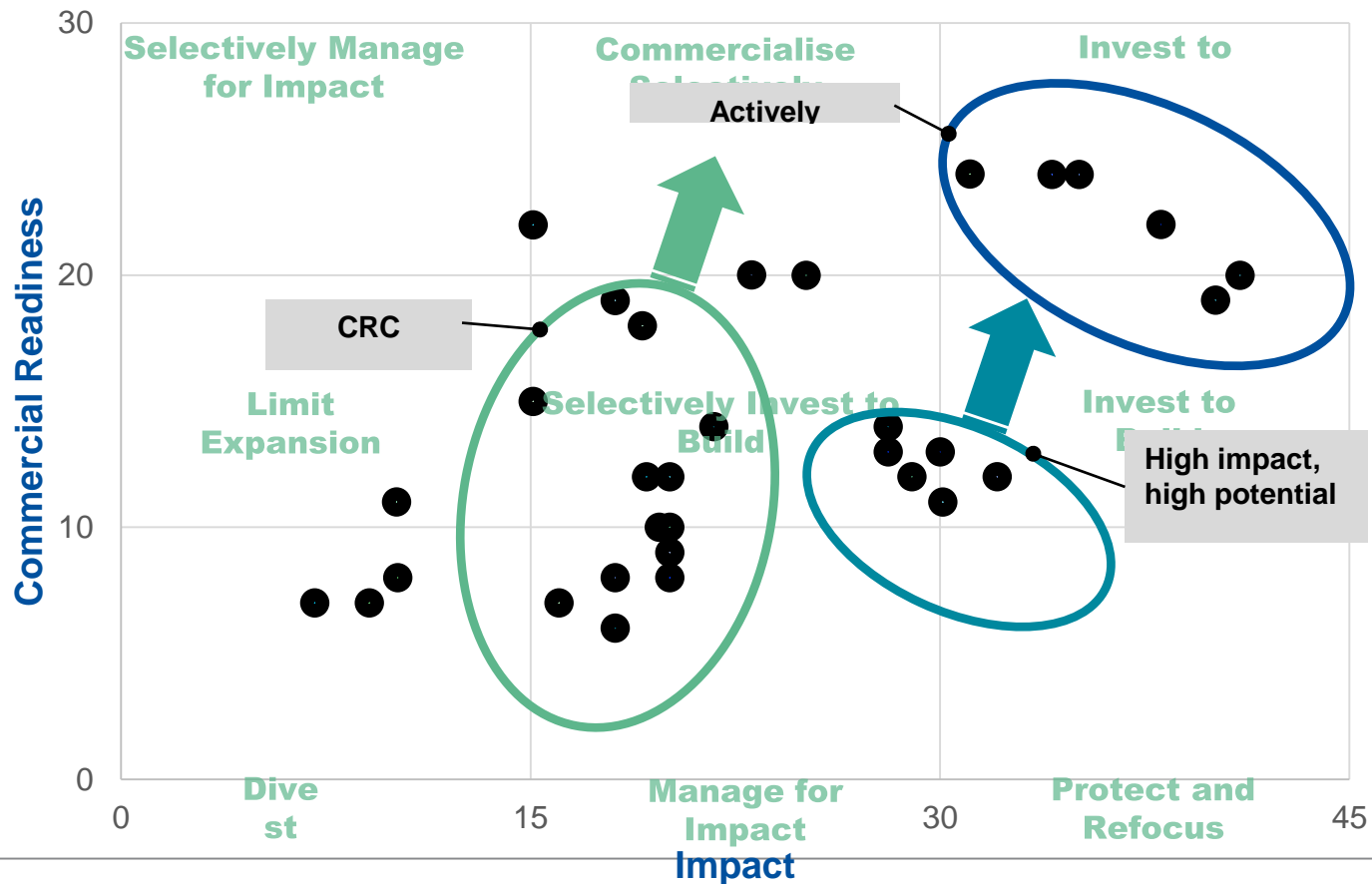
Guided by:

To find out more about any of our research, please contact us:  
 CRC for Low Carbon Living Ltd  
 Level 5, 100 Pitt Street  
 Sydney NSW 2000 Australia  
 Tel: +61 (0)2 9250 2000  
 Email: info@lowcarbonliving.crc.org.au





# IP mapping



# Researcher development

## USING BEHAVIOUR CHANGE INSIGHTS TO TRANSLATE RESEARCH INTO POLICY & PRACTICE

### Guide Note for CRCLCL researchers

#### PURPOSE

This guide note has been provided to assist our researchers in using behaviour change and other research supporting insights from social and environmental psychology.

#### THE RESEARCH CHALLENGE

Our research projects aim to effect change. They advance new and innovative ways of doing things, bringing forward new ideas to the mainstream. Change can be exciting but also daunting because it often involves new and unproven ideas and other resources doing things differently. These resources are not to be taken for granted but need to be used wisely. That's why our research comes with risks.

#### THE RESEARCH OPPORTUNITY

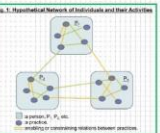
For our research to make a difference, we need to manage and support change that can be sustained over time. However, managing change can be risky and can lead to failure for many reasons. It is a complex task, and it is difficult to get it right. Our research is a chance to learn from others and to share our own experiences. It is a chance to learn from others and to share our own experiences. It is a chance to learn from others and to share our own experiences.

#### WHY CHANGE CAN BE DIFFICULT

Our research is filled with many different activities, or practices, that we want to change. It is a complex task, and it is difficult to get it right. Our research is a chance to learn from others and to share our own experiences. It is a chance to learn from others and to share our own experiences. It is a chance to learn from others and to share our own experiences.

Behaviour Insights Research (BIR) 2020

July 17



It is a chance to learn from others and to share our own experiences. It is a chance to learn from others and to share our own experiences. It is a chance to learn from others and to share our own experiences.

Behaviour Insights Research (BIR) 2020

July 17

#### REFERENCES

1. Behaviour Insights Research (BIR) 2020. <https://www.behaviourinsights.ac.uk/>

#### FURTHER INFORMATION

See our [website](https://www.behaviourinsights.ac.uk/) for more information.

Behaviour Insights Research (BIR) 2020

July 17

CRCLCL Annual Researcher Outcomes Survey

SUMMARY DESIGN SURVEY PREVIEW AND SCORE COLLECT RESPONSES ANALYZE RESULTS

QUESTION BANK

Search for questions

Recommended Questions

Previously Used Questions

All Categories

Community

Customer Feedback

BUILDER

THEMES

LOGIC

OPTIONS

PRINT

DELETED QUESTIONS (10)

LOW CARBON LIVING CRC

CRCLCL Annual Researcher Outcomes Survey

YOUR RESEARCH

10. What was/were your main reason(s) for doing the research?

☐ To get a job

☐ To develop or start my own business

☐ To try for a different career

☐ To get a better job or promotion

☐ To obtain extra skills for my job

☐ To get into a course of study

☐ To get into other research

☐ To improve my knowledge and education

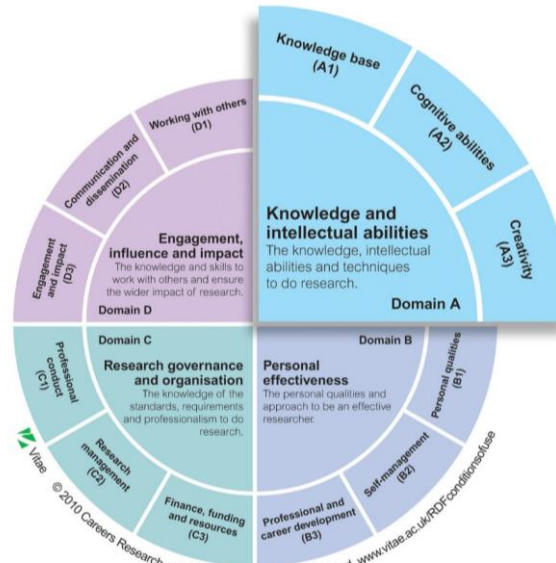
☐ To get skills for community/voluntary work

☐ To increase my self-esteem

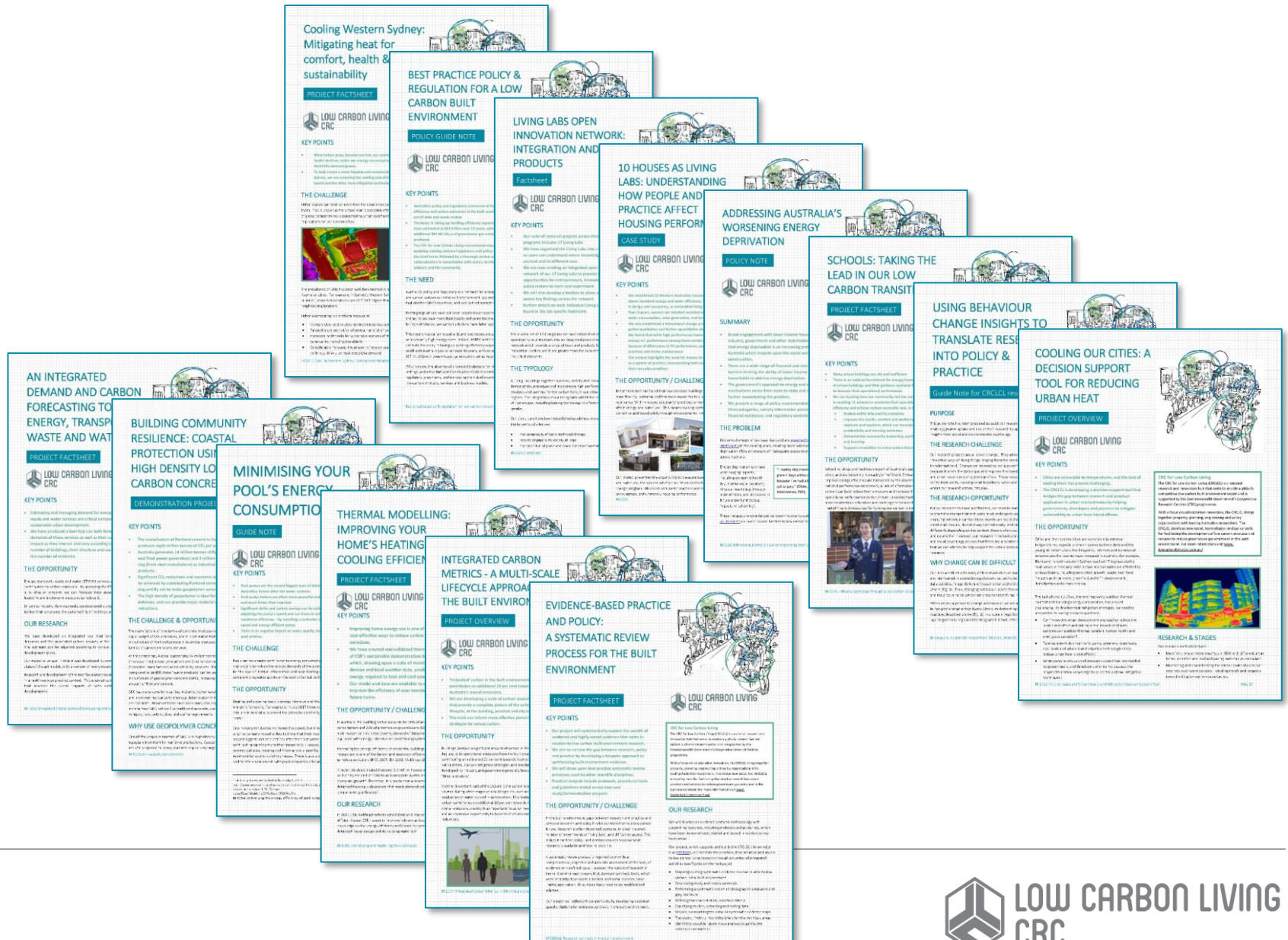
☐ To build relationships and networks

☐ Other (please specify)

"Tell us what you think!"



# Factsheets, guide notes, policy notes...



**LOW CARBON LIVING**  
CRC



# National forums





# Roadshows



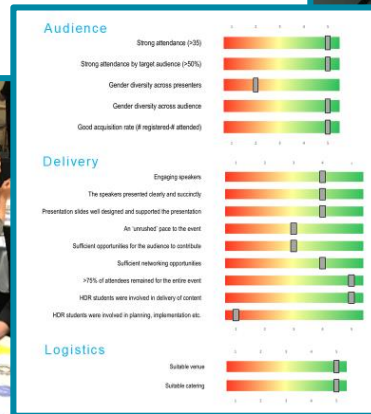
AILA



Local Government



PIM



PIM

Thank you

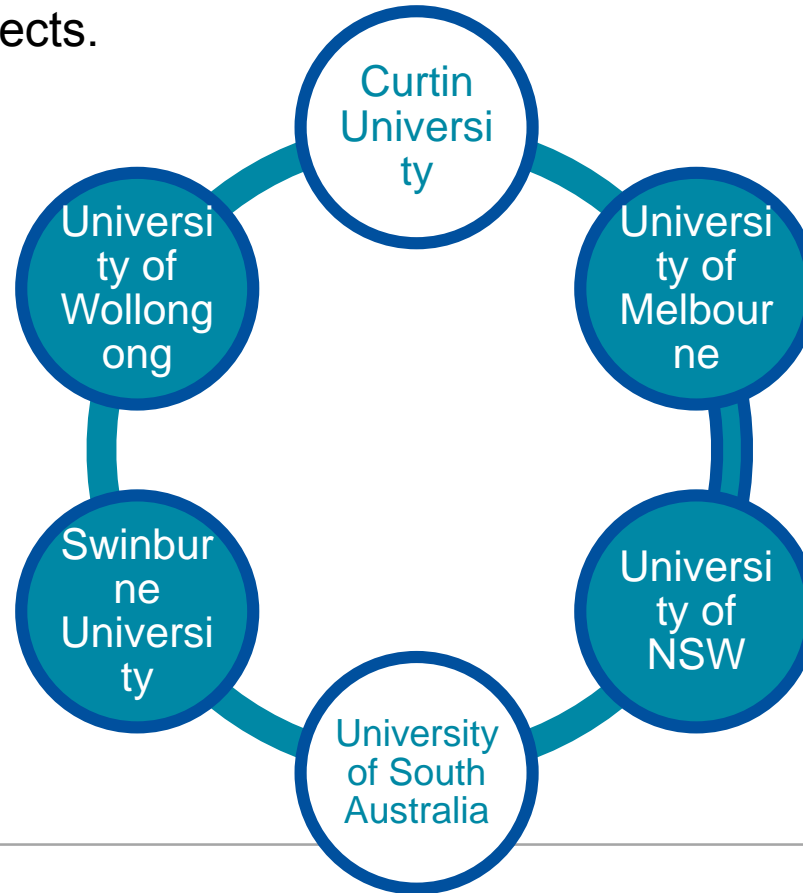
Information Modelling at a Project Scale to Manage the Carbon Load of the Built Environment

by Prof. David Woodhead, with Mike Hall

oureco

## ***Nodes of Excellence – national capacity for research***

- CRCLCL's five Nodes of Excellence established. The Nodes exemplify strong collaboration between researchers, industry and governments at local level and will form a legacy of the CRCLCL beyond 2020. The extension of the CRCLCL's work to the Nodes has the potential to engage a wide range of partners through increased outreach, and continue the collaborations established during the life of the CRCLCL's projects.



## PARTICIPANTS



The CRC for Low Carbon Living also works with an extensive range of government and industry third parties at a project level

## CONTACT US

CRC for Low Carbon Living Ltd  
[www.lowcarbonlivingcrc.com.au](http://www.lowcarbonlivingcrc.com.au)  
[info@lowcarbonlivingcrc.com.au](mailto:info@lowcarbonlivingcrc.com.au)

Twitter: @CRC\_LCL  
 P: +61 2 9385 5402  
 F: +61 2 9385 5530



Australian Government  
 Department of Industry,  
 Innovation and Science

Business  
 Cooperative Research  
 Centres Programme



# LOW CARBON LIVING CRC

# 3rd-party partnerships

...extending the CRC's reach...

## Program 1 - Integrated Building Systems

Energy efficient swimming pools:

*Randwick Council*

Geopolymer Concrete for coastal protection:

*NSW Ports; Independent Cement & Lime Pty Ltd; Australian Steel Mill Services Ltd*

## Program 2 - Low Carbon Precincts

UHI Mitigation DS tool:

*Greater Sydney Commission; EICU; SSROC; SSROC; Stockland; Inner West Council; Parramatta Council; Campbelltown Council; Waverley Council; NSW Government Special Services*

Urban Micro Climates:

*City of Adelaide; Nursery & Garden Industry Aust*

Mainstreaming low-cost & carbon housing:

*WA Housing Authority; The Next Practice Ltd*

Reuse of solids from Wastewater:

*Prospect Water Partnership; Degremont Pty Ltd Hunter Water Corporation; Suez Environment*

Retrofitting precincts for LC communities:

*UTS*

## Program 3 - Engaged Communities

Building Low Carbon Communities:

*Blue Mountains World Heritage Institute; Blue Mountains; Lithgow & Oberon Tourism; Gridstone Pty Ltd; Blue Mountains City Council*

Enhancing the market for low-carbon homes:

*AGL; Clean Energy Council; Knauf Insulation Australia; Fletcher Insulation Pty Ltd; Stockland Corporation Limited; Australasian Liveability Real Estate Institute; Energy Efficiency Council; Low Energy Supplies & Services Pty Ltd*

Media and communication strategies for carbon reduction:

*Sustainability Victoria*

National Building Code trajectory:

*ASBEC; Energy Action (Australia) Pty Ltd*



LOW CARBON LIVING  
CRC



# Thank you

To find out more, contact:

[CRC for Low Carbon Living Ltd](#)  
[www.lowcarbonlivingcrc.com.au](http://www.lowcarbonlivingcrc.com.au)

Room 202-207, Level 2  
Tyree Energy Technologies Building  
UNSW Sydney NSW 2052 Australia

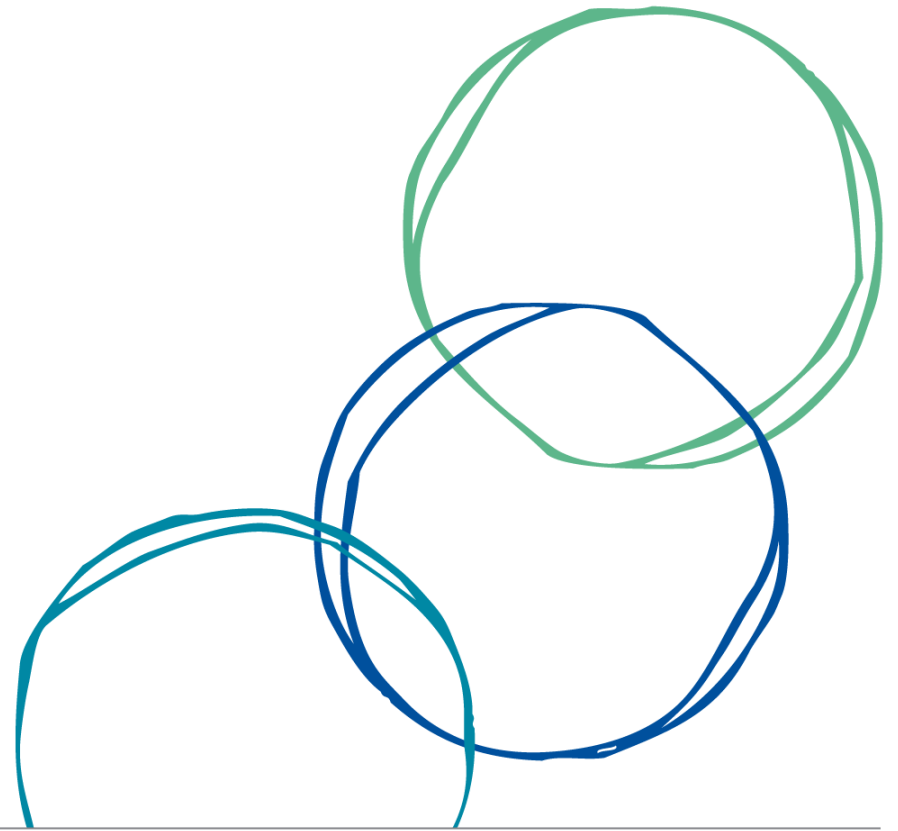
Twitter: @CRC\_LCL  
[info@lowcarbonlivingcrc.com.au](mailto:info@lowcarbonlivingcrc.com.au)  
P: +61 2 9385 5402  
F: +61 2 9385 5530

Deo Prasad  
[d.prasad@unsw.ed.au](mailto:d.prasad@unsw.ed.au)



# Keynote

Peter Madden OBE  
Ecovivid (UK)



# SMART AND LOW-CARBON CITIES?

Peter Madden, OBE  
@thepmadden

eco&vivid

Three million people  
move to cities every  
week





# AN URBAN WORLD

2.52bn



746m

1950

33% of total population

7bn

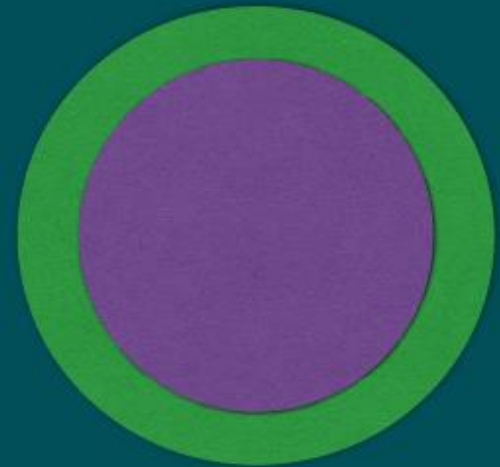


3.8bn

TODAY

54% of total population


9.55bn



6.3bn

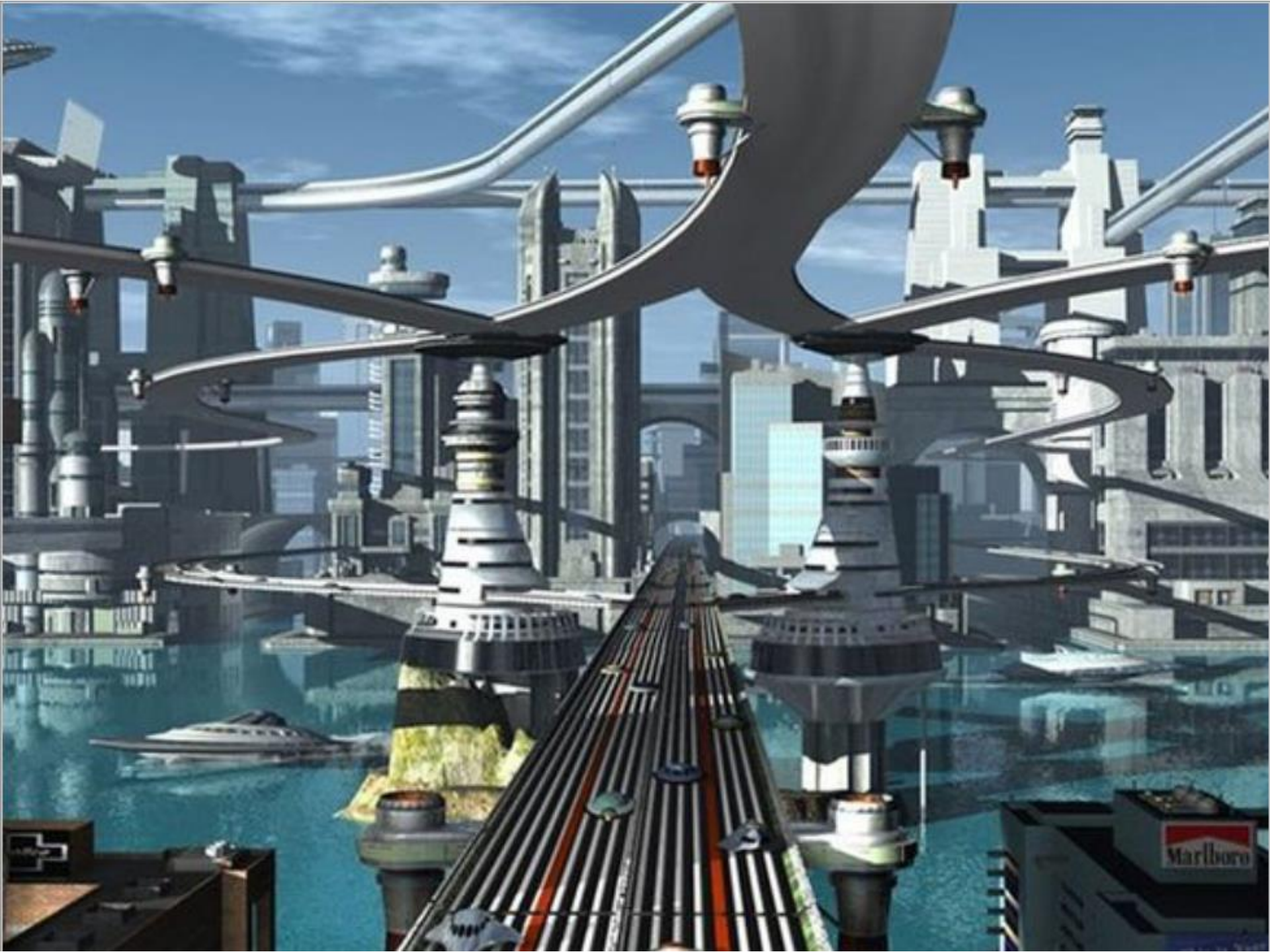
2050

66% of total population



**More data will be created  
in 2017 than the previous  
5,000 years of humanity**











**On Singles Day in China  
this November, Alibaba  
recorded \$25 billion of  
sales within 24 hours, 80%  
on mobile phones**

An aerial night view of a city skyline with numerous skyscrapers and illuminated streets. Overlaid on the city is a network of glowing white lines that connect various points across the urban landscape, symbolizing a digital or energy network. The text is centered over the image in a large, white, sans-serif font.

**Sharing Cities: improve lives  
of residents through low  
carbon and local energy,  
sustainable buildings, electric  
mobility and platforms for  
citizen engagement.**



**PLACE**

**PEOPLE**



**Citizen  
engagement**

**Energy  
management**



**Building  
retrofit**



**e-mobility**

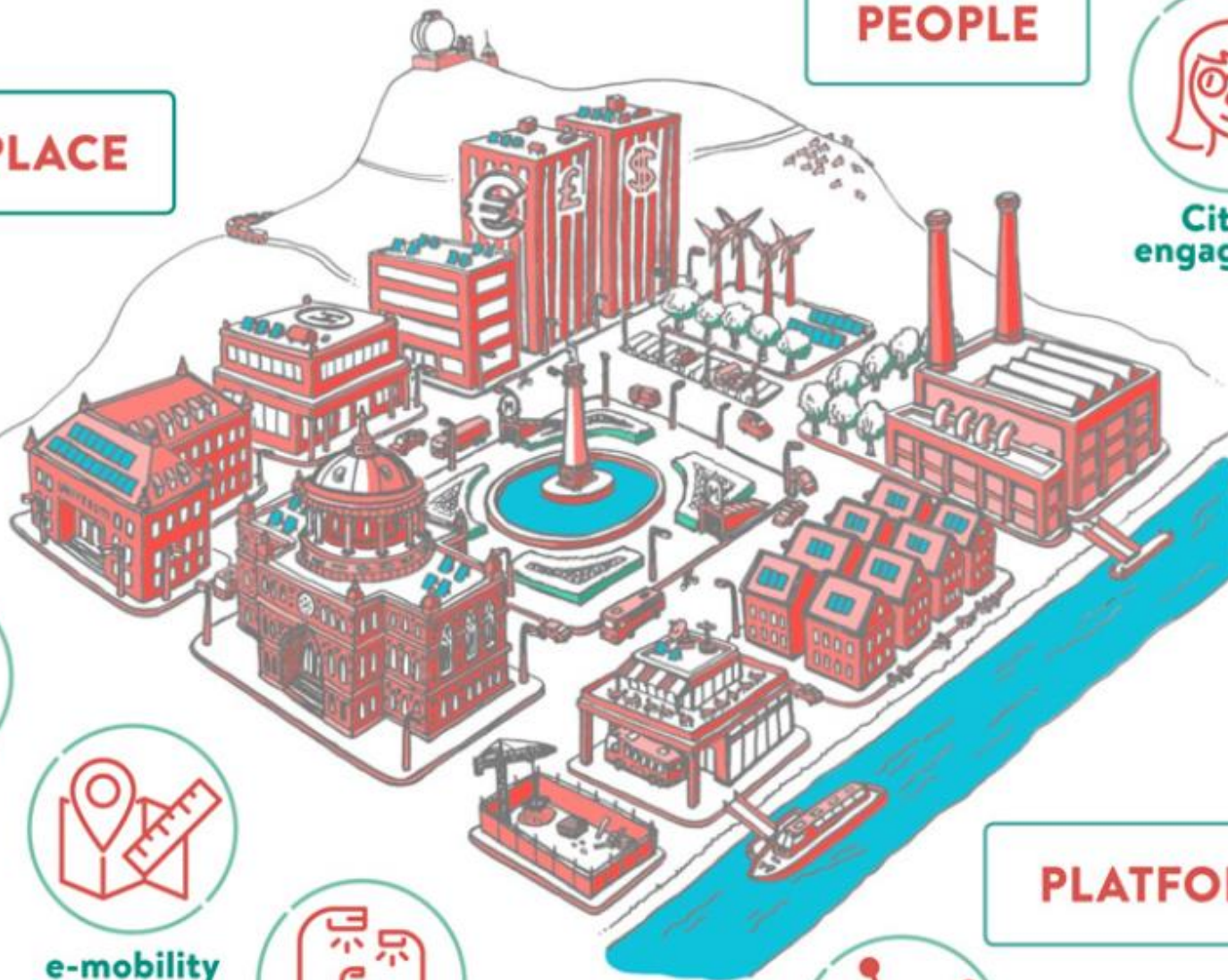


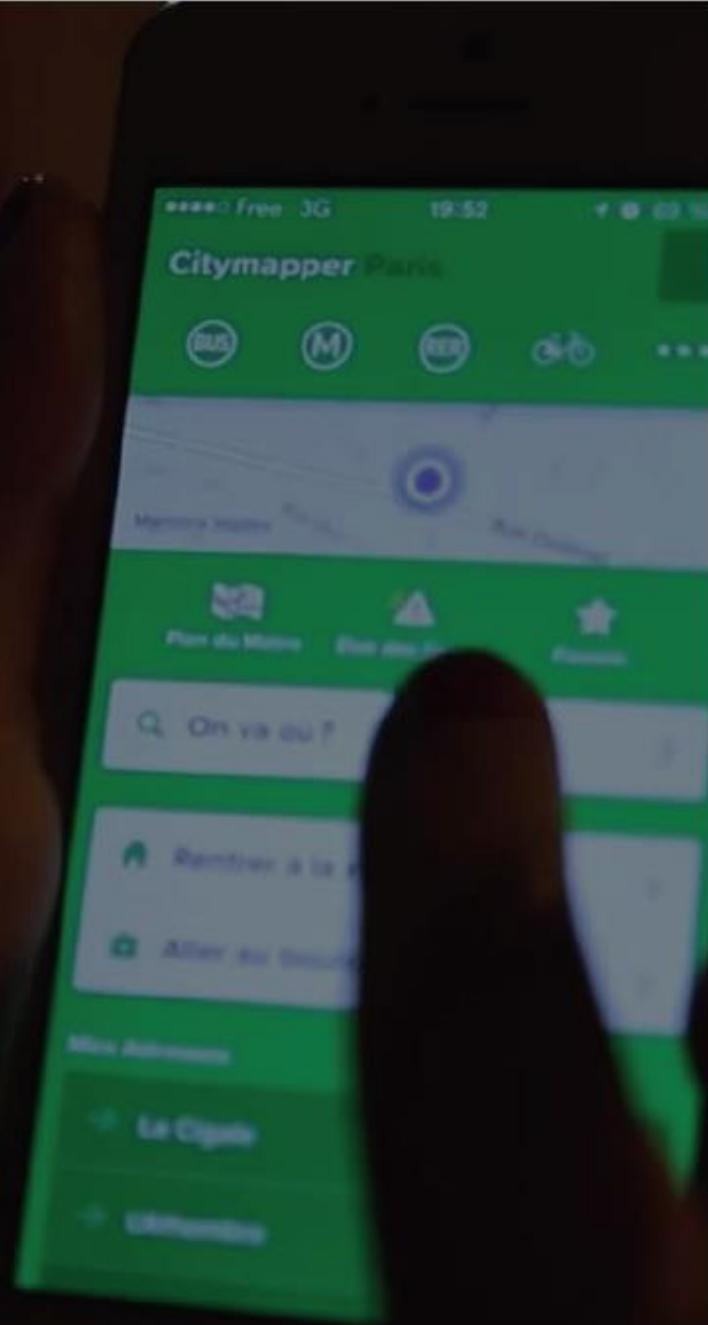
**Smart lamp posts**



**PLATFORM**

**Urban sharing  
platform**





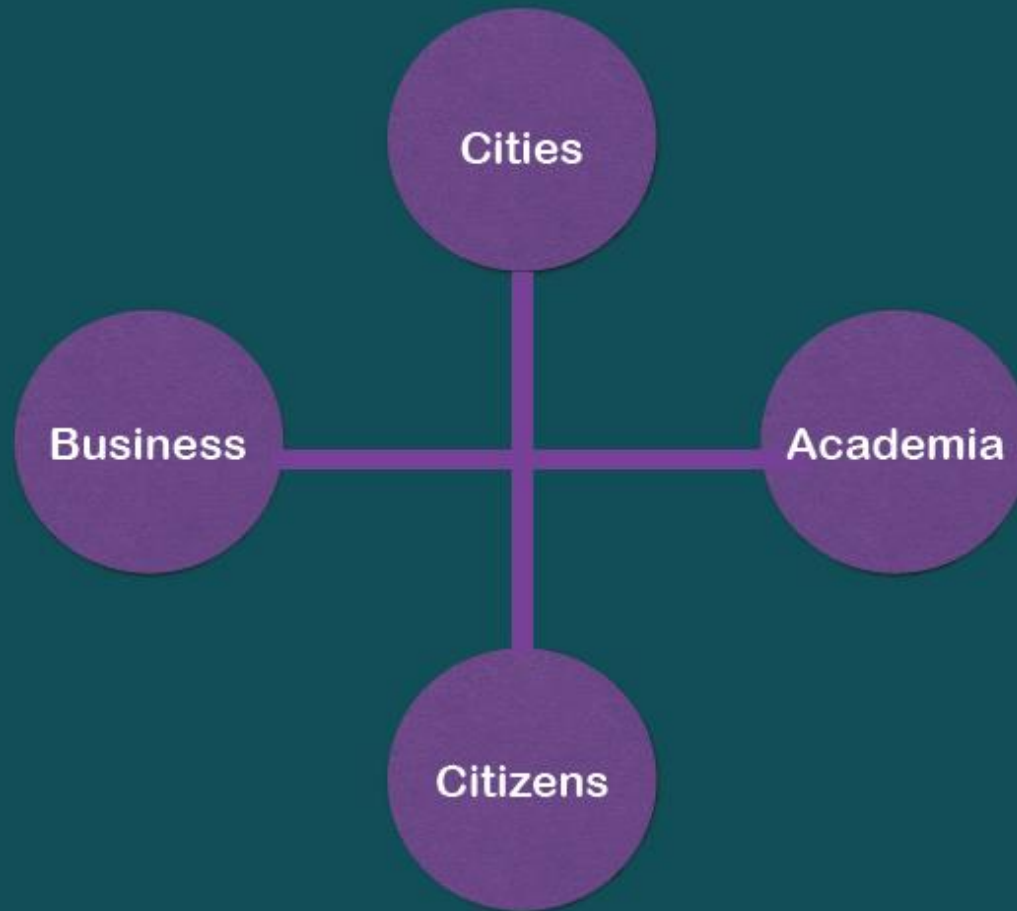


An aerial photograph of a city at night, showing a dense grid of streets and buildings illuminated by various lights, creating a complex pattern of colors and shapes. The text is overlaid on the center of the image.

Cities are complex:  
the challenge is not  
invention, but  
application

Smart cities need smart  
skills: where is the  
intelligent client?

# COLLABORATION








# CATAPULT

Future Cities





The global smart cities market will pass the \$1 trillion mark in 2019 and grow to \$3.48 trillion by 2026

**Cities occupy 0.5% of the world's land, consume 75% of its natural resources, and account for 80% of global greenhouse gas emissions**



An aerial night photograph of a city, likely San Francisco, showing a dense grid of lights reflecting on the water. The city lights are a mix of warm orange and yellow, with some cooler blue and purple lights visible. The background shows dark hills under a twilight sky.

**A triple win: growing  
business, lower  
carbon, better cities**

# THANK YOU!

For further information:  
[www.ecovivid.com](http://www.ecovivid.com)  
[@thepmadden](https://twitter.com/thepmadden)



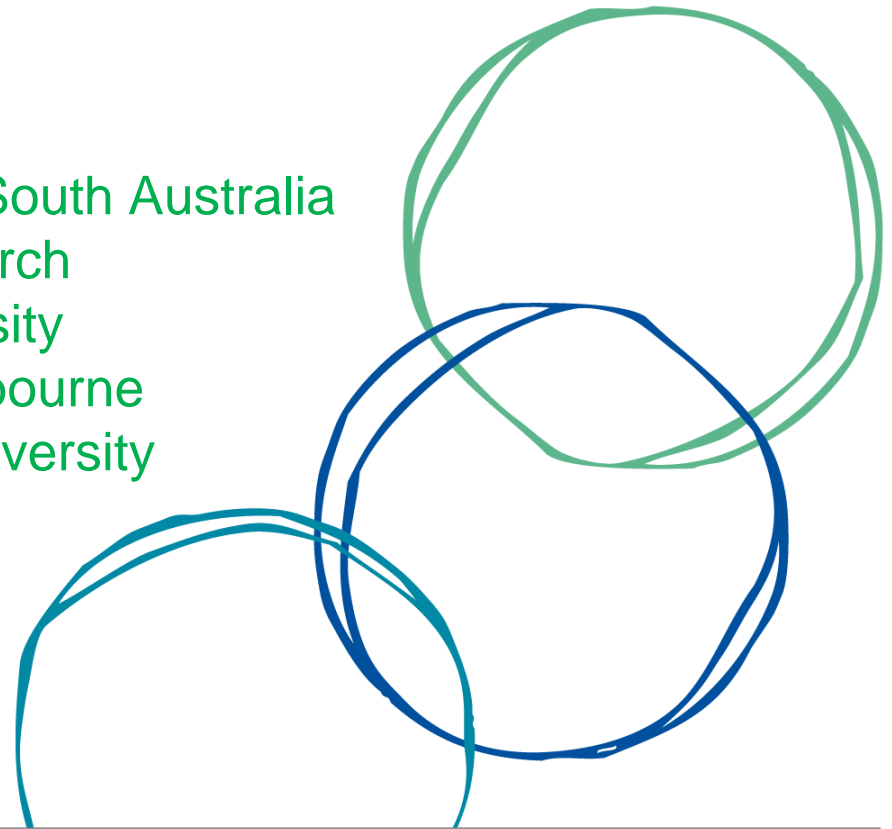


LOW CARBON LIVING  
CRC

# Leading the debate: Highlights from the CRCLCL National Forums

Dr Lan Ding, University of NSW  
Professor Wasim Saman, University of South Australia  
Philip Harrington, Strategy.Policy.Research  
Professor Peter Newman, Curtin University  
Professor Chris Ryan, University of Melbourne  
Professor Peter Graham, Swinburne University

Facilitator: Tanya Ha



# CRCLCL UNSW NODE

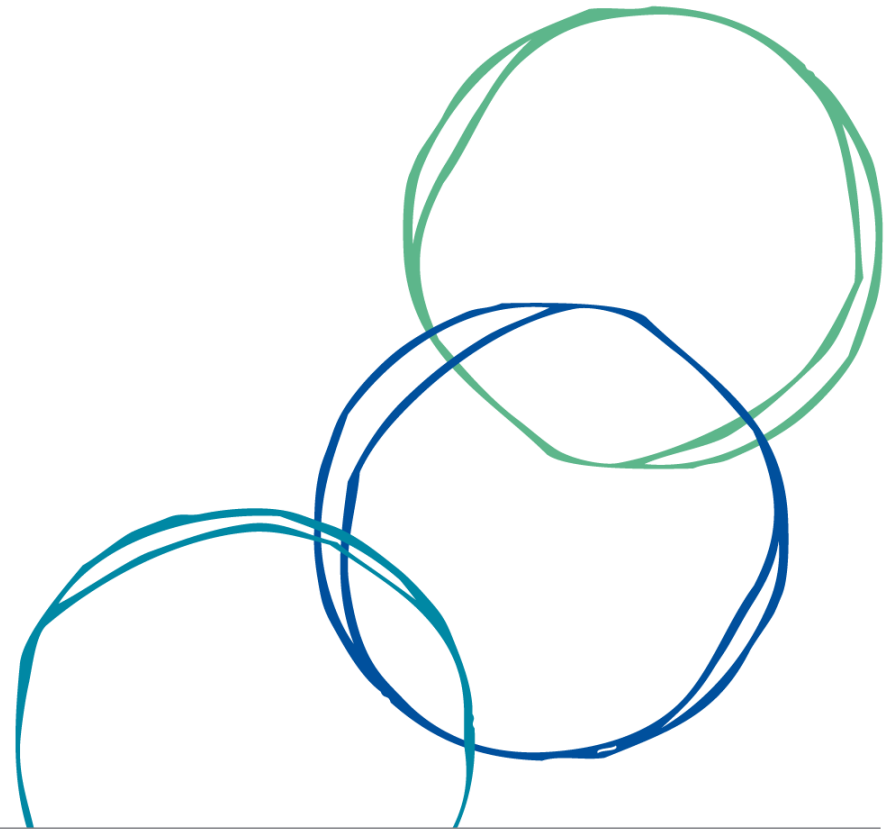


## Highlights from Cooling Cities National Forum

Dr Lan Ding, UNSW Australia

CRCLCL UNSW Node Leader

22 November 2017



# Cooling Cities National Forum

**Date:** 4 August 2017

**Host:** UNSW Node of Excellence: High Performance Architecture and CRCLCL

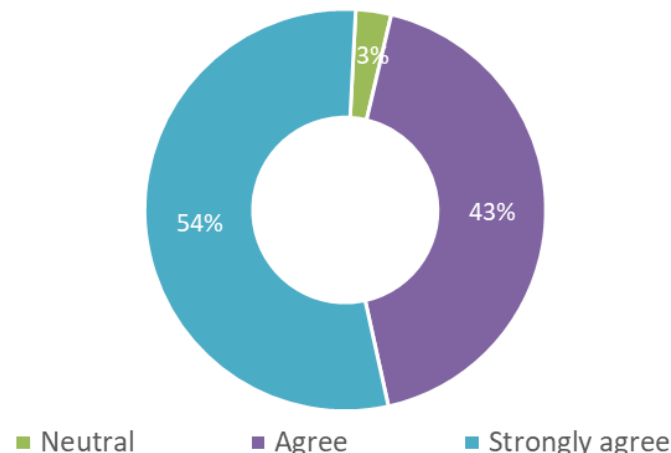
## Objectives

- Address the urgent issues related to urban heat islands and extreme heat events in Australia.
- Foster discussion on evidence-based decision-making in urban microclimate mitigation.
- Provide recommendations on mitigation strategies and technologies.
- Establish networks that facilitate collaborative efforts across academia, governments and the built environment industry.

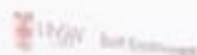
**Participants:** senior government managements, industry executives, academics

**Outcomes:** it was very well received.

Overall, I was happy with the event



- **1,889 visitors** to the CRCLCL website between 4 August and 11 August 2017, vs usual weekly average of 300-500 visitors
- Live-tweeting the Forum resulted in broad engagement on Twitter (**13,225** organic impressions on Friday 4 August 2017 vs usual daily range of 995 – 1,500 organic impressions)



UNSW Node of Excellence: High Performance Architecture  
**National Forum: Cooling Cities**

## Opening Address

Hon. Robert Hill AC  
Chair, CRC for Low Carbon Living

- 1. Introduction
- 2. The Role of the CRC
- 3. The Role of the Node
- 4. The Role of the Forum
- 5. The Role of the Node
- 6. The Role of the Forum
- 7. The Role of the Node
- 8. The Role of the Forum



## What did you like most about the event?

The quality and diversity of contributors, including bringing together research and practice (across government and industry) stood out as what participants liked best about the event.

*“Bringing the full spectrum of stakeholders (researchers, governments, business and practitioners) all together - very powerful”*

## Do you have any comments you would like to share?

*“it was a great refresher and great to see all the like-minded people sharing information and collaborating”*

# City of Melbourne

## Mitigating Urban Heat

National Forum: Cooling Cities 4.8.17

Ian Shears  
Manager, Urban Sustainability



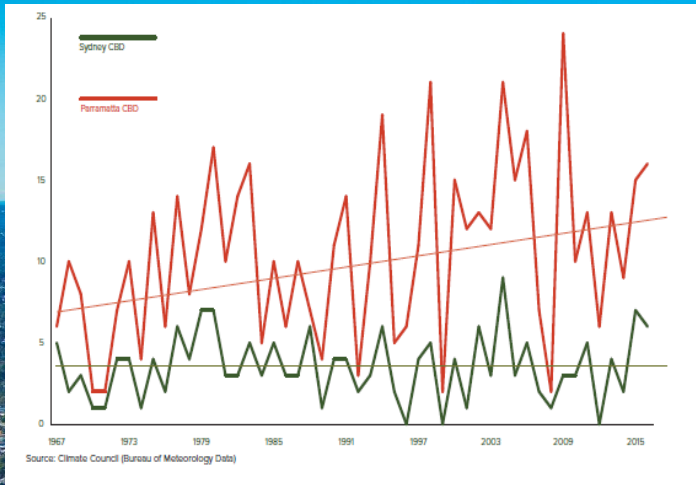
# Urban heat island

- Chris Derksema
- City of Sydney



LOW CARBON LIVING  
CRC





# LCLCRC: COOLING CITIES FORUM

Helen Papathanasiou  
City of Parramatta Council



LOW CARBON LIVING  
CRC



*Professor Mat Santamouris  
(Project Leader)*

01

Western Sydney presents 6- 10 C higher temperature during the summer period compared to the eastern suburbs



02

Energy Consumption for Cooling Purposes in Western Sydney is up to 100 % higher than in the eastern zones of the city

03

Heat related mortality can be up to 300 % higher in Penrith than in the Observatory Hill during the heat waves period

04

Peak Electricity Demand increases by almost 100 % when temperature increase from 20 C to 40 C

**THE PROBLEM**

*Professor Mat Santamouris  
(Project Leader)*

01

Mitigation techniques based on the use of water, greenery, and cool materials can reduce the average peak ambient temperature up to 2,5 C

02

Mitigation techniques can reduce the cooling needs of a residential and office building up to 39 % and 32 % respectively. The energy conservation potential is up to 1726 GWh for the Western Sydney area

03

Application of mitigation technologies can reduce the heat related mortality up to 90 % in Western Sydney. Mortality may reduce from 14 deaths per 100000 inhabitants to 7,5.

04

Application of Mitigation Techniques can reduce the peak electricity demand up to 5 % The total electricity demand over the summer period may be reduced by 0.8-0.9 TWh This corresponds to 0.8-0.9 million tons of avoided CO2 emissions

**THE IMPACT OF MITIGATION**

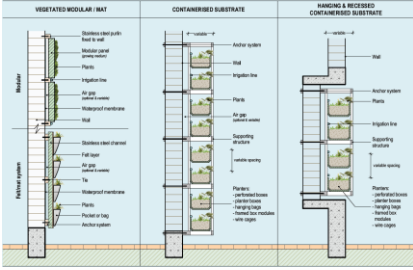


An aerial photograph of a city, likely London, with a heat map overlay. The colors range from blue (cooler) to red (warmer), indicating urban heat islands. The text is overlaid on the image.

*Dr Paul Osmond  
(Project Leader)*

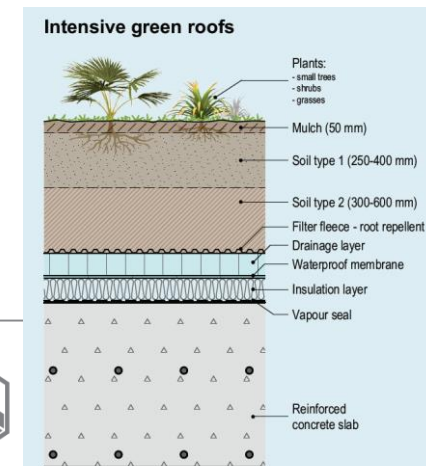
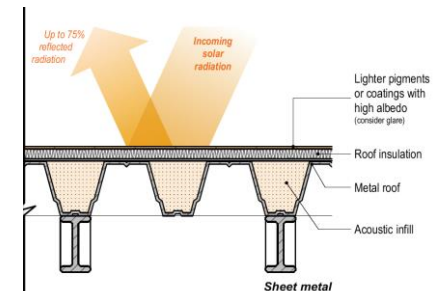
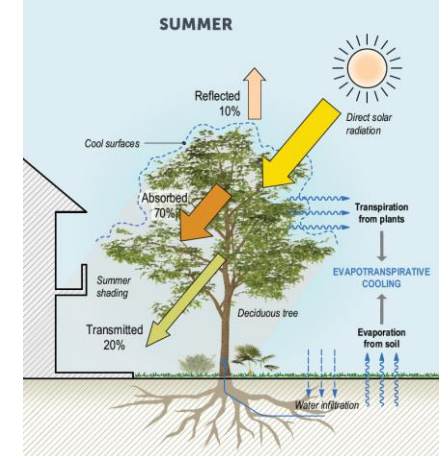
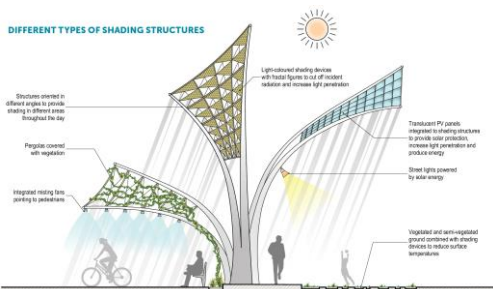
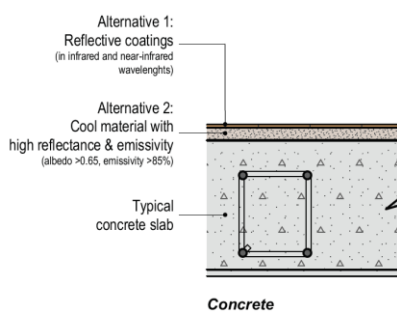
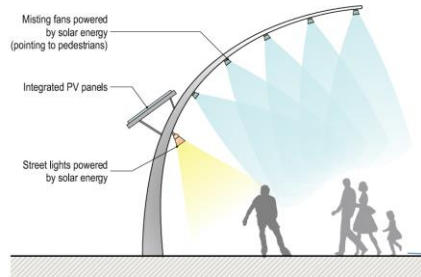
# **CRC-LCL Guide to Urban Cooling Strategies**





Dr Paul Osmond  
(Project Leader)

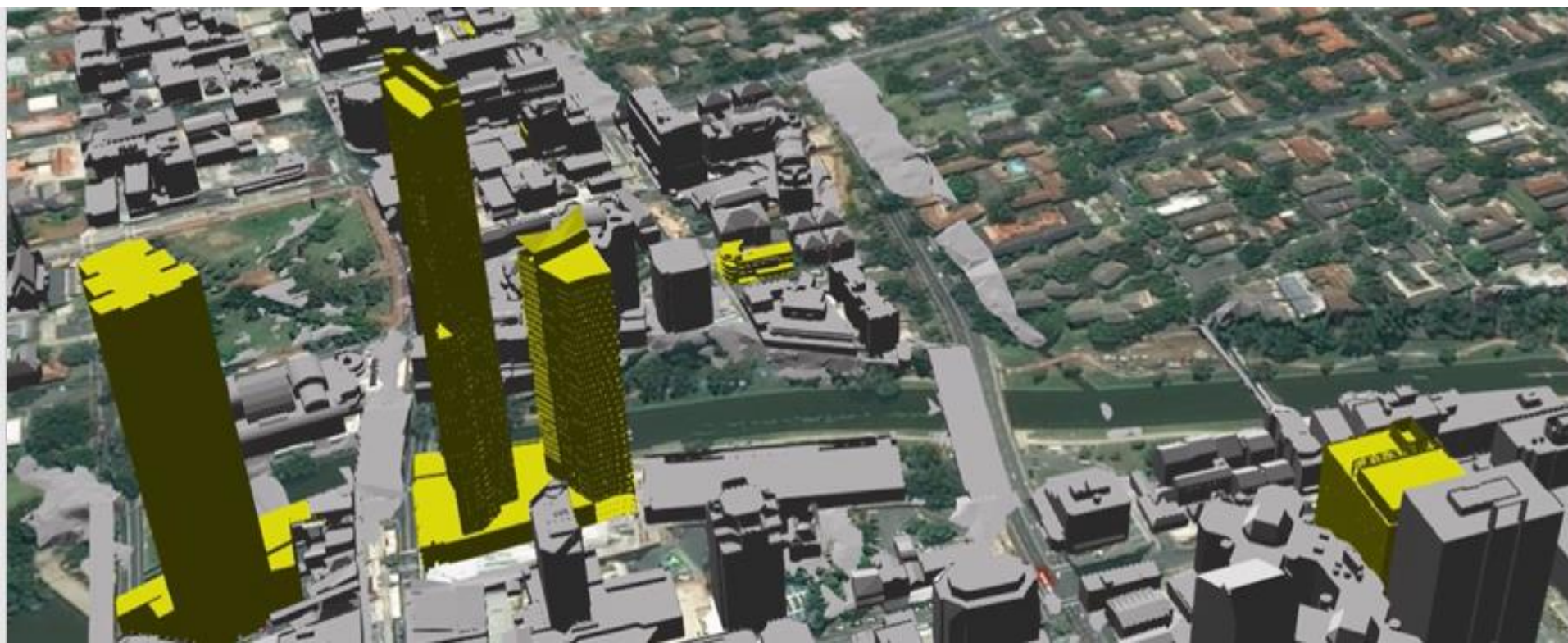
“This document provides practical guidance for built environment professionals and regulatory agencies seeking to optimise development projects to moderate urban microclimates and mitigate urban heat island effects in major urban centres across a range of climates in Australia”





## Microclimate and Urban Heat Island Decision-Support Tool

What-if scenario analysis of urban development, web-based 3D interactive platform



30/11/2017

85







### Exemplar Precincts

Parramatta CBD Redevelopment

Green Square Town Centre Redevelopment

Leppington Greenfield Development

Macarthur Heights Greenfield Development



### Key Urban Heat Performance Indicators

- Cooling Degree Days
- Annual Peak Temperature
- Outdoor Thermal Comfort
- Peak Electricity Demand



# Acknowledgement



## **Organising Committee of Cooling Cities National Forum**

CRCLCL UNSW Node: Lan Ding, Mat Santamouris, Paul Osmond, Komali Yenneti, Henry Petersen

CRCLCL: Deo Prasad, Stephen Summerhayes, Sara Fagir

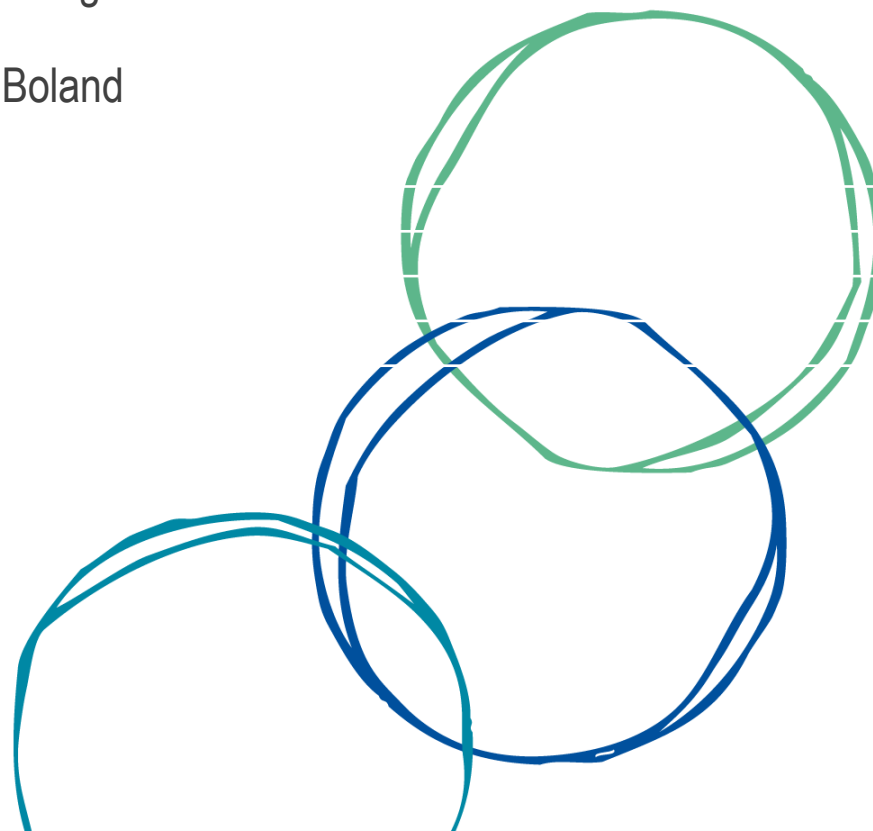
**Involvement of Other Nodes:** Peter Newton, John Boland

Contact: Dr Lan Ding  
CRCLCL UNSW Node Leader  
UNSW Sydney  
[Lan.Ding@unsw.edu.au](mailto:Lan.Ding@unsw.edu.au)

To find out more, contact:

CRC for Low Carbon Living Ltd  
[www.lowcarbonlivingcrc.com.au](http://www.lowcarbonlivingcrc.com.au)

Room 202-207, Level 2  
Tyree Energy Technologies Building  
UNSW Sydney NSW 2052 Australia



# National Forums by CRC Node in Regenerative Cities Curtin University

By

Professor Peter Newman AO

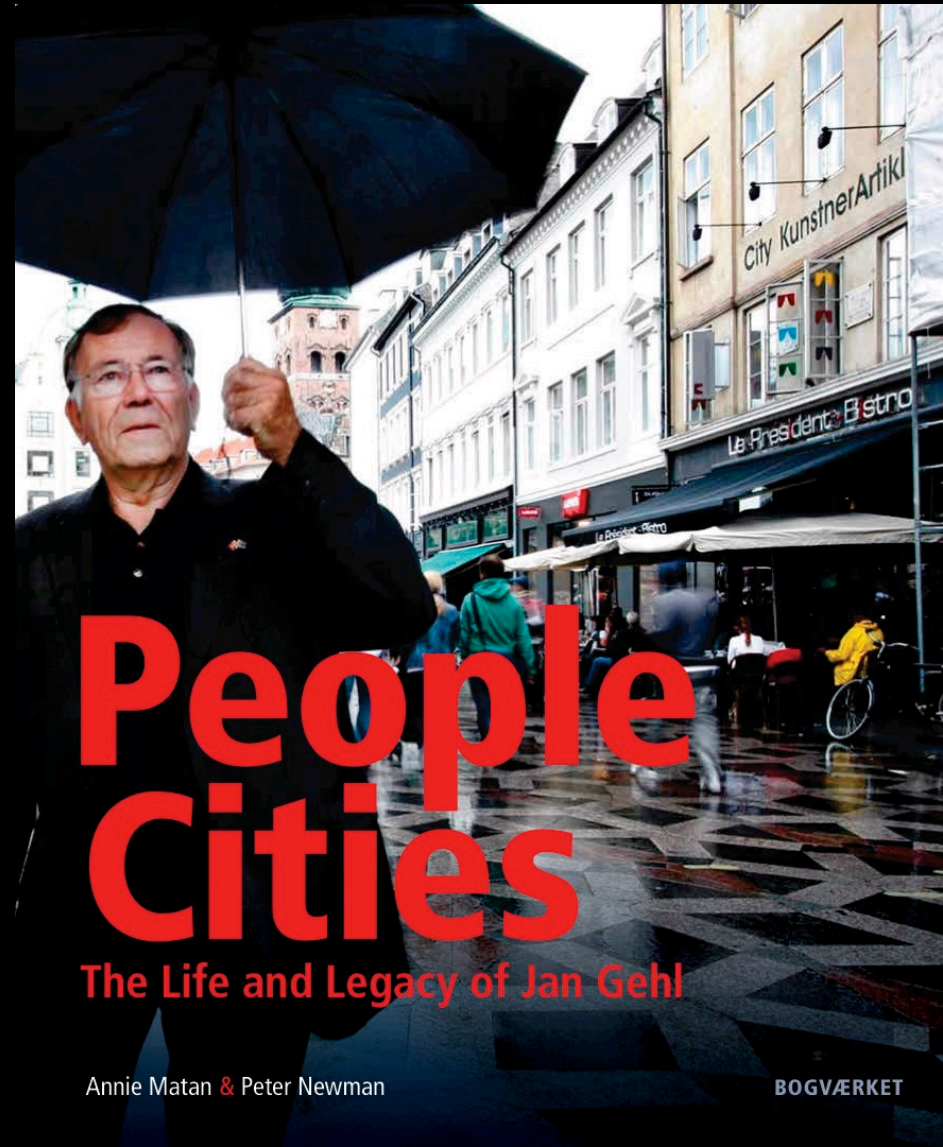
# Forum 1: People Cities and Low Carbon Living, 13 February



# Highlights....

- Professor Jan Gehl gave keynote.
- Book on Gehl's life launched by Danish Consul
- Researcher's all presented on Josh's House and WGV
- Professor Holger Walbaum from Climate KIC Europe spoke.
- 500 people came!

# The attractions of dense urbanism in walkable areas



# Economic and social attractions of walkable urban design...





Josh's House...affordable and zero carbon.





# WGV solar-storage, social housing, electric vehicles and 'Citizen Utilities'...scaling up.

WGV You Tube Film



# Forum 2: Regenerative Cities and Low Carbon Living, 23 May



# Highlights...

- Coincided with Board meeting in Perth so many Board members featured...Robert, Meg, Sandy...
- Professor Herbert Girardet wrote paper and spoke on Regenerative Cities
- PN launched his book...
- PhDs did Peka Kucha, brilliantly...
- Industry partners responded.
- New Government member and Giles closed with great energy!
- 150 came – more select.



LOW CARBON LIVING  
CRC

## Regenerative Cities

Making Cities work for people and planet

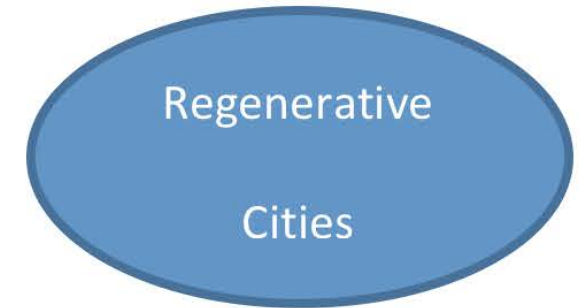
Background Paper



Herbert Girardet

Film... 'Regenerative Cities:  
making cities work for  
people and planet...'  
CUSP website

Also Peka Kucha...



Wealth associated with  
ever increasing  
ecological footprint

Wealth associated with reducing  
ecological footprint

Wealth associated with  
regeneration of ecological  
footprint



# RESILIENT CITIES

SECOND EDITION

**Overcoming Fossil-Fuel  
Dependence**



## Moved to:

- Energy – making more renewable energy than it consumes.
- Water – making more water than is extracted from the bioregion.
- Biodiversity – making more habitat than has been consumed.
- Food – making more food locally (hard to more than consumed)
- Waste – not just recycling but extracting waste from the past. Eg accumulated greenhouse gases.
- Social and economic – whilst making better community and economic opportunities.





Regenerative  
design  
started with  
regenerating  
nature in the  
city...



# Replacing concrete with...

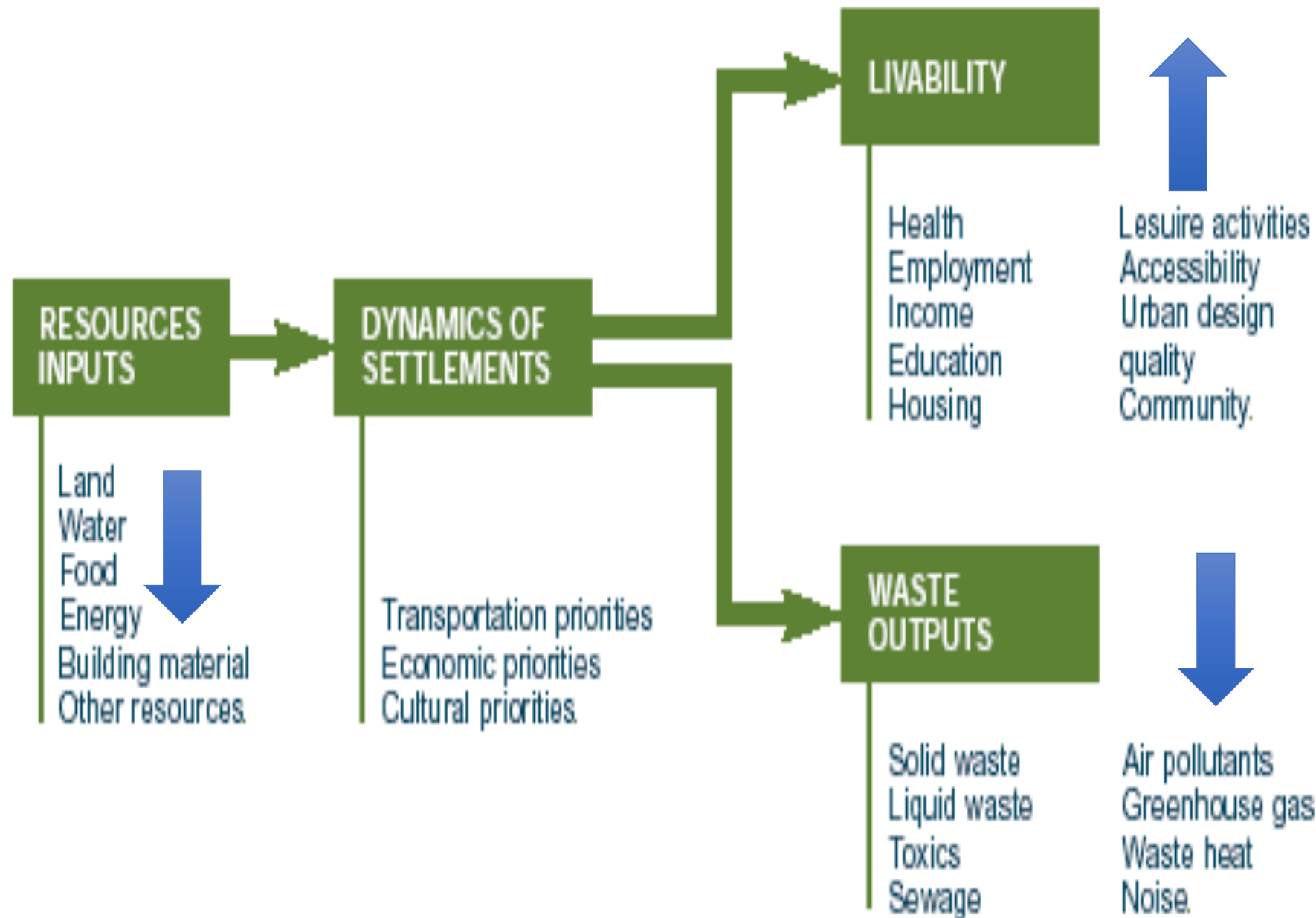




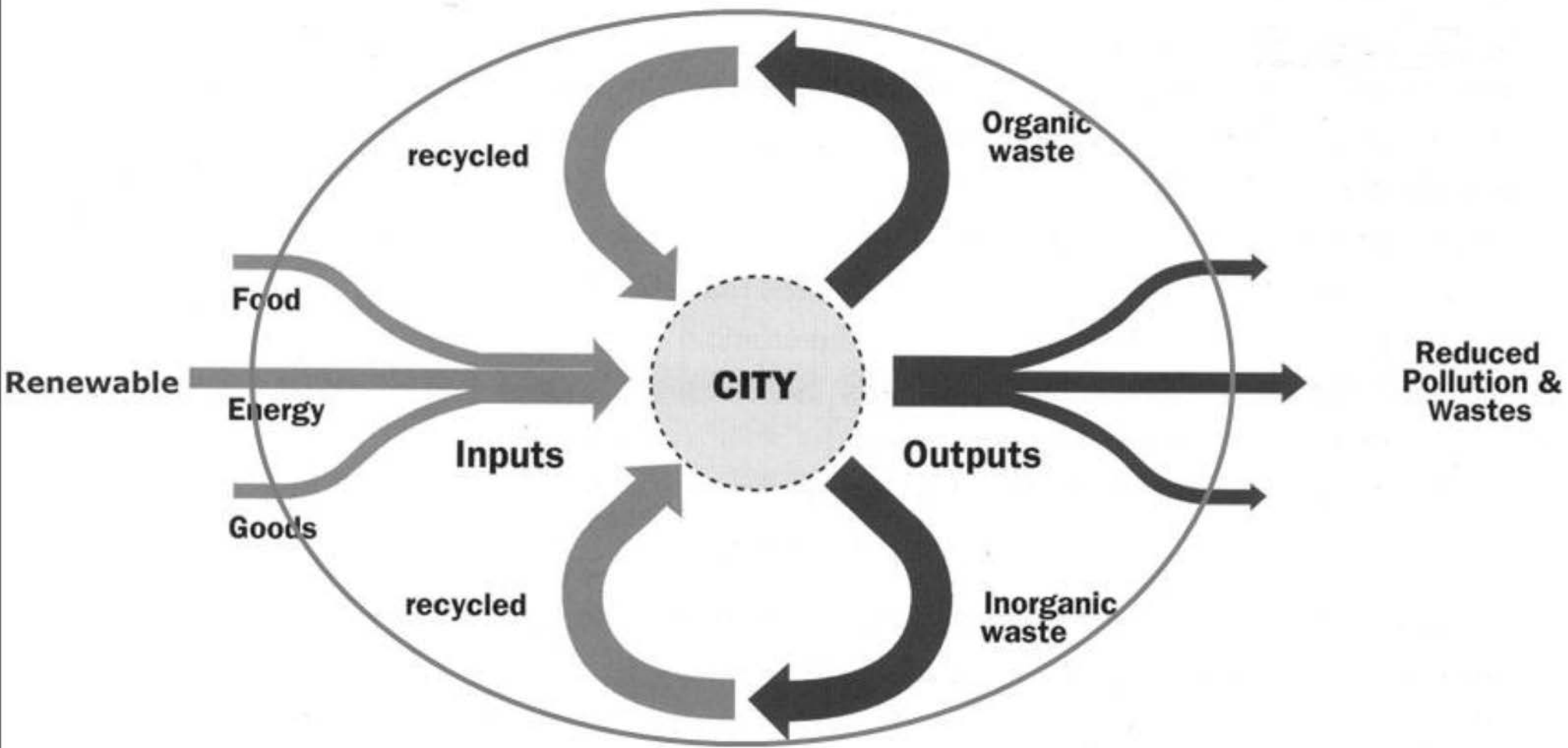
# Green infrastructure



Figure 5. Extended metabolism model of human settlements.



***Regen  
Cities  
can do  
better than  
reducing  
impact...***

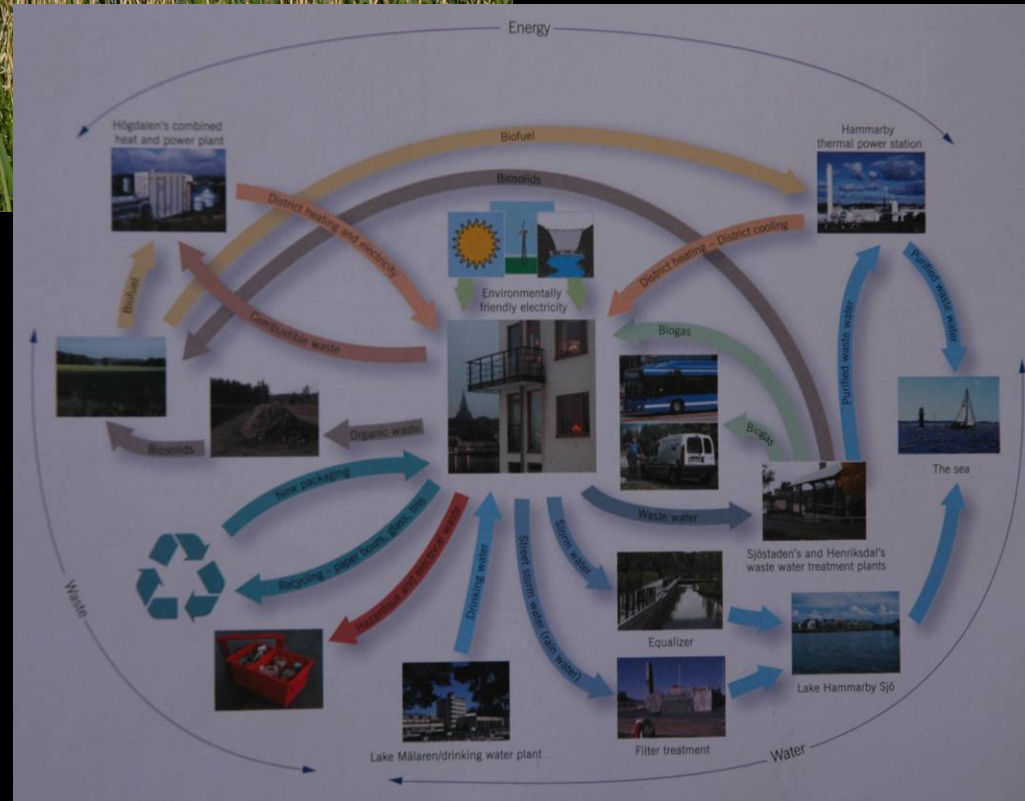


Circular  
metabolism



## Hammarby Sjöstad, Stockholm

Getting close...



# RE-GEN Village Almere, Amsterdam

<http://www.fastcoexist.com/3060167/this-new-neighborhood-will-grow-its-own-food-power-itself-and-handle-its-own-waste/1>









WGV - making more renewables than it consumes.  
Next phase Beyond WGV, 10 times bigger...

WGV You Tube Film

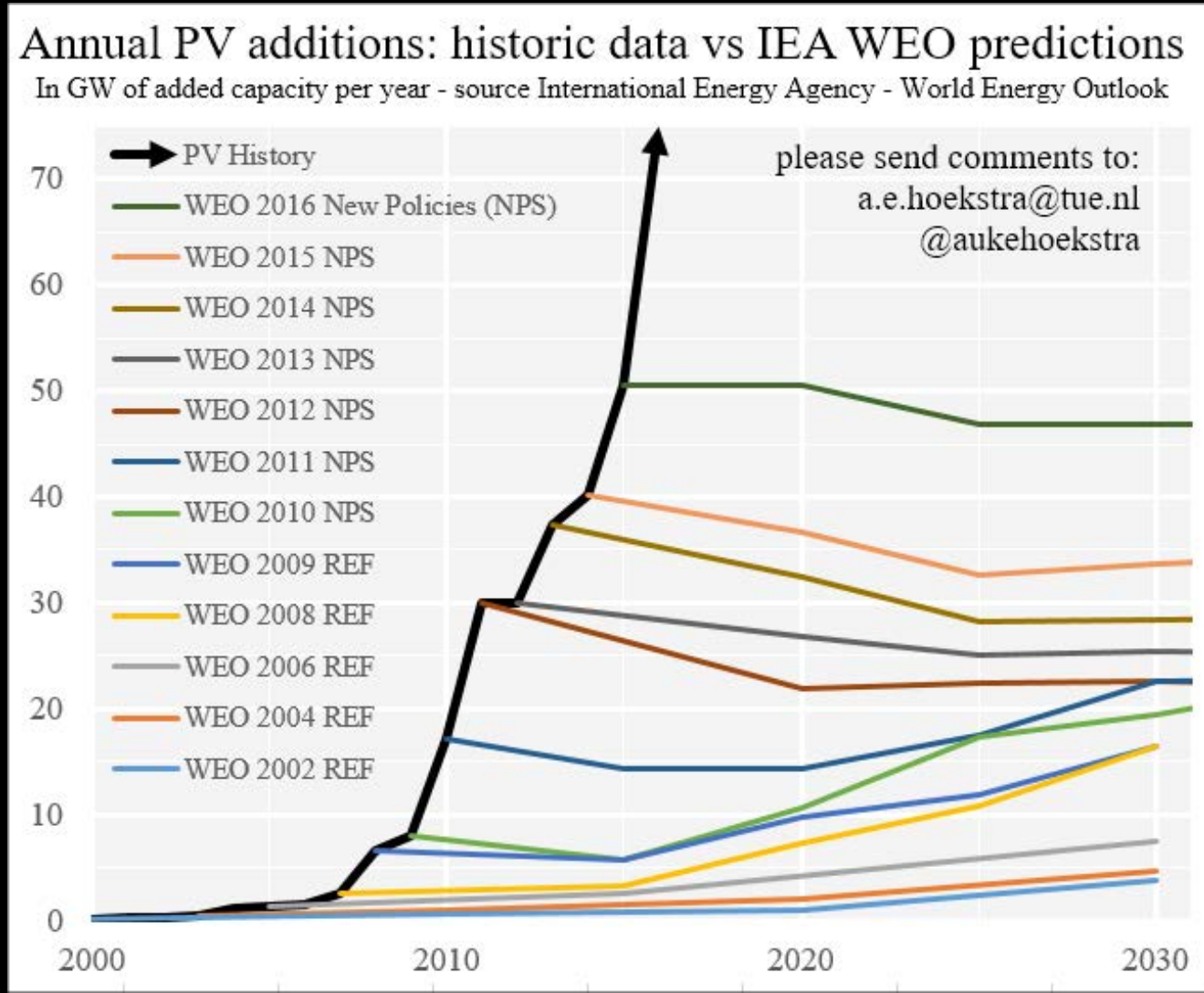


New Lord Mayor, wins Smart Cities Grant for \$8.5 m  
to pursue disruptive innovations in energy and water  
at Beyond WGV....using 'blockchain' to create  
community-based markets



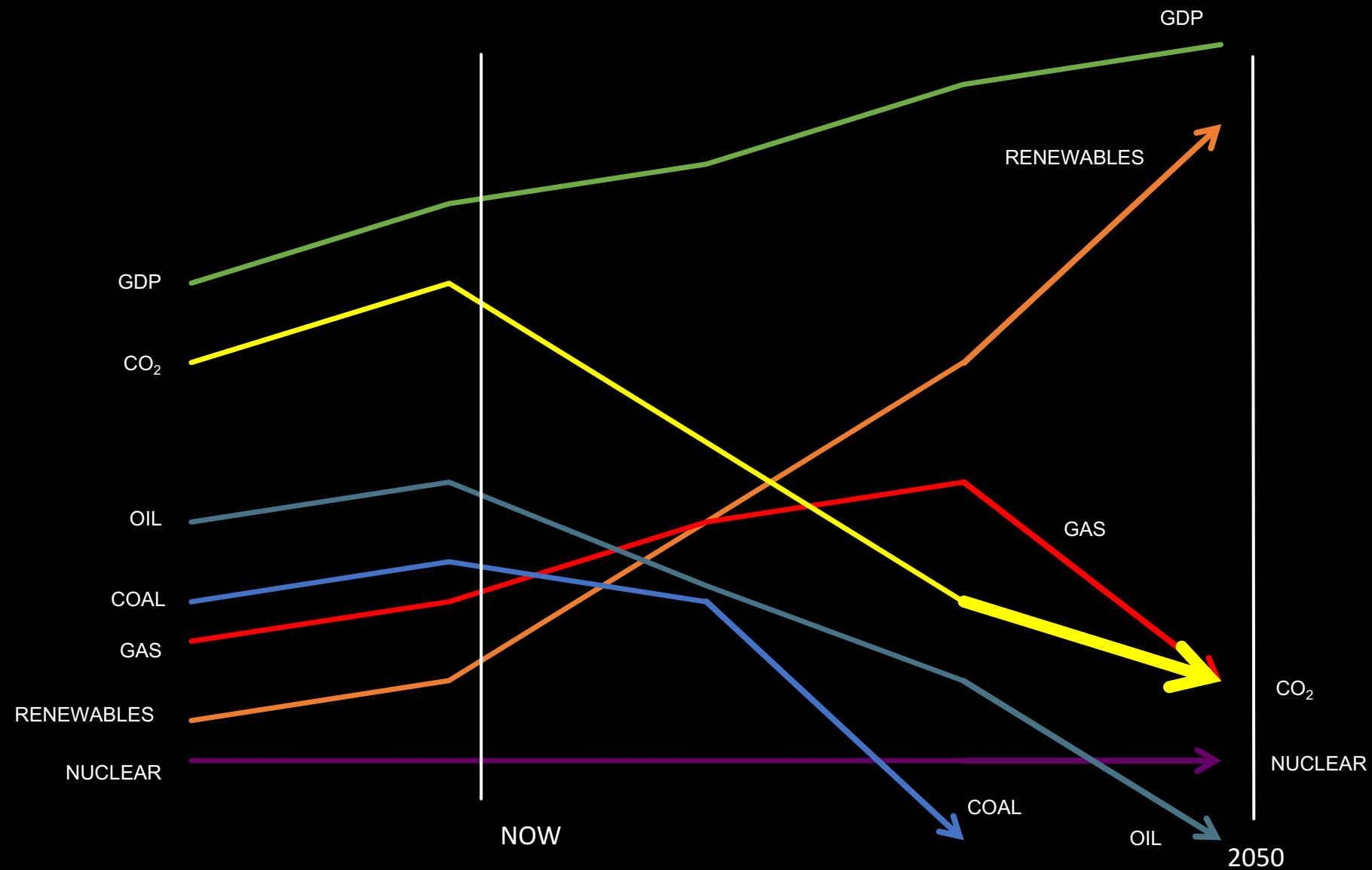


Why PV is  
disruptive  
and defies  
projection  
modelling...





# Predictions – **After the Peak**



But the goal posts are moving...  
we have to do much more...eg 1.5 degrees now.

Some are saying we must GEO-ENGINEER the planet

Can cities do *urban geoengineering*?





# Geo-engineering the planet through cities...

- Ecological impacts from pouring iron filings in the ocean or firing sulphur into the upper atmosphere, are unacceptably risky.
- Cities can start small scale and build up to substantial regeneration of all the planetary boundaries. For example:
- Making more renewable energy than it consumes as well as sucking CO<sub>2</sub> from the atmosphere. 3<sup>rd</sup> way technologies...Flannery.
- Recharging aquifers and rivers.
- Restoring soils and N/P balance in bioregion.
- Regenerating biodiversity through biophilic habitats on buildings.
- All the while regenerating community and the economy...

# 3rd Way Technologies...regenerating the atmosphere

*Carbon negative construction using :*

- Carbon-absorbing cement,
- Carbon negative plastics, which capture CO<sub>2</sub> from the air,
- EnergyPlus buildings, which generate more electricity than they consume,
- Prefabricated low-carbon housing made from biogenic materials (e.g., cross-laminated timber, straw composite).

*Carbon negative landscaping* using serpentine rock, which when crushed absorbs CO<sub>2</sub> from the air.

*Carbon negative industrial products* such as carbon nanofibers and carbon fiber replacing steel.

Its always going to be more than  
technology....design, consumer behaviour and  
governance....



# Conclusions: Growing Regeneratively

- Growing cities are needed to create opportunities - global and local.
- Can we go beyond 'reducing impact' to 'regenerating impact'?
- Shifting the agenda towards regenerative outcomes makes growth attractive. Eg WGV – from NIMBY to PIMBY
- We have started the journey...



# Facilitating the Transition to Low Carbon Housing

CRCCLCL National Forum  
Adelaide 4 July 2016



LOW CARBON LIVING  
CRC

asbec

AUSTRALIAN SUSTAINABLE  
BUILT ENVIRONMENT COUNCIL



University of  
South Australia

# What Do People Want?



A comfortable home to live in

A property with low running costs

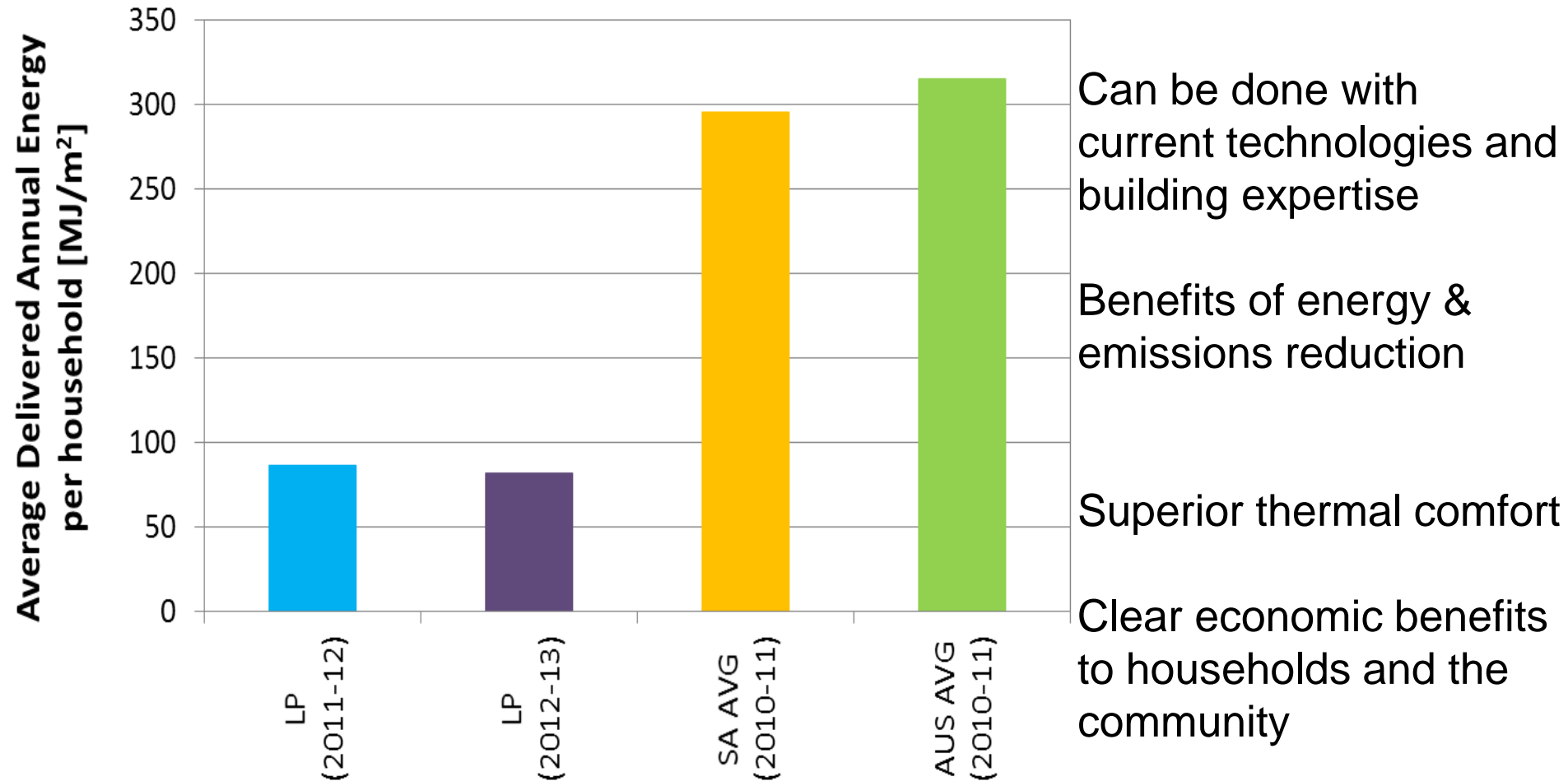
Has an efficient and effective air conditioning

Has solar panels



# What Does the Research Evidence Say?

## Lochiel Park Green Village



## Recommendations:

- Strong industry desire to facilitate change
- Housing
- Plenty of energy cost reduction opportunities through high performance housing
- Housing sector is significant in achieving our Paris targets
- Nationally consistent regulatory framework is necessary
- We need to move beyond the new home market, focus on rental properties
- Disclosure is a first significant step
- Higher level of community engagement and industry sectors education are necessary
- We need to sell the many co-benefits of high performance housing

## Current National Activities:

Department of Environment and Energy:

- National energy productivity plan
- National energy efficiency project: course development for professionals

ASBEC: Building Code Energy Performance Trajectory

ABCB: Energy Efficiency Project in preparation for the  
NCC revision in 2019

Victorian Government: Victorian Residential Efficiency  
Scorecard



## Current Messages

- **Using available evidence base will improve rating tools and add further credibility**
- **Improving standards can reduce household energy bills, improve comfort and health**
- **Domestic energy demand management is important in ensuring grid reliability**
- **Updating codes will contribute to the Paris emissions targets**
- **Good regulations can drive industry innovation**
- **Whole of house energy regulation is the preferred option for users and emissions reduction**
- **Poorly enforced regulation rewards non-compliance and consumers lose out**
- **We need to provide more information for stakeholders to make better use of assessment tools**

## PARTICIPANTS



The CRC for Low Carbon Living also works with an extensive range of government and industry third parties at a project level

## CONTACT US

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F: +61 2 9385 5530



Australian Government  
Department of Industry,  
Innovation and Science

Business  
Cooperative Research  
Centres Programme

# Thank you

[wasim.saman@unisa.edu.au](mailto:wasim.saman@unisa.edu.au)

To find out more, contact

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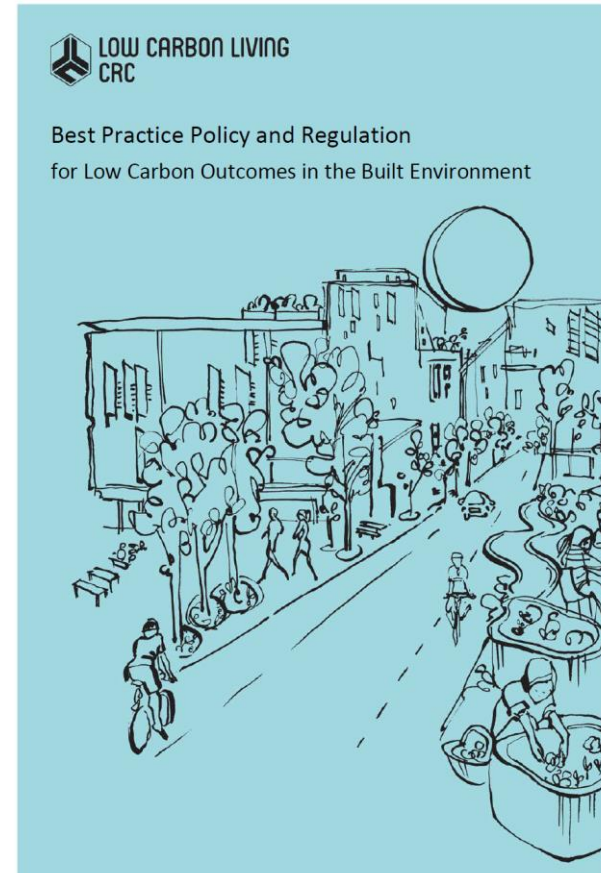
# Best Practice Policy and Regulation for Low Carbon Outcomes in the Built Environment – National Forum

Canberra, 21 April 2017



# Aims:

1. Identify the different ways in which policy and regulation affect carbon outcomes in the built environment
2. Describe the policy and regulatory landscape in Australia
3. Describe the policy and regulatory landscape in a range of comparable countries
4. Draw out the similarities and differences in how policies and regulations are being used to pursue the objective of low carbon in the built environment in Australia and in comparable countries
5. As a basis for debate and possible further research, draw conclusions and identify an idealised suite of policy and regulations, considering all three levels of government in Australia.



# Best practice elements:

- Targets are ambitious and tuned to emissions abatement commitments
  - Increasing trend towards net zero buildings targets (eg, UK, Netherlands, Belgium)
- Over-achievement/higher standards are encouraged and incentivised
  - Long term trajectories for Codes set, eg, Denmark – 75% lift in requirements but over 15 years and signalled in advance
- Rules-based and evidence-based processes are used for standard-setting and review by independent and expert bodies
- Post-construction verification of energy performance
- Comprehensive policy packages provide support, advice, incentives, tools and standards
- Mandatory, continuous disclosure of all building performance (EU, Singapore)
- Access to incentives/innovative financing is provided, but strictly performance- and outcome-based using ratings tools
- Strong focus on retrofit of existing buildings
- Incentives underpinned by white carbon pricing



# Australian best practices:

- NABERS – ‘as built’ metrics, strong training and accreditation framework, transparency, supports CBD, Commitment Agreement process
  - But...take-up mainly limited to offices, disclosure limited to larger offices via CBD, base building/tenant split
- CBD – market-enabling regulation, performing very well for larger offices
  - Very limited building coverage, base building focus
    - Was intended to be universal in coverage (2004)
- City/council leadership
  - SDS/SDAPP – using planning schemes to encourage above-minimum performance
    - Largely a response to low minimum standards
    - IGA between Australian Govt and states/territories aims to discourage this
  - Carbon, energy efficiency, renewable energy targets in 70% of LGAs
- Govt procurement – has helped transform upper end of office market
  - But standards infrequently updated, enforcement is questionable, impact on ‘mid tier’ limited
- Industry-led initiatives – GreenStar, Better Buildings Partnership
  - Top-end of the market, and mainly offices
- Embedded retailer/distributor model working well in commercial sector to encourage renewable energy take-up

# Australian worst practices:

- Low energy performance standards
  - NCC: if updated in 2019, it will be almost a decade since the last update
    - Despite ~doubling of energy prices over this time, and stronger evidence of accelerating climate change
    - Opportunity cost? ClimateWorks valued 10 year delay @ \$43 billion in unnecessary energy costs + 397 Mt CO<sub>2</sub>-e
  - MEPS, labelling stalled for many years
- Lack of clear and rules-based processes; excessive discretion
  - No forward trajectory to send signals for investment and innovation
  - No independent, expert institutions involved in policy review/setting
- Code/policy not linked to ghg outcomes
  - Based on 'minimum necessary' construct
- Code enforcement is essentially non-existent
  - NEEBP project (2014) revealed a widespread culture of non-compliance
  - Significant quality assurance gaps in NatHERS assessors, professional accreditation, training
- Lack of national consistency
  - BASIX, state variations under-rather than over-achieving agreed standards
    - And not subject to RIS processes
- Piecemeal policy coverage
  - Eg, CBD, NABERS, MEPS/labelling
- Lack of carbon price signal
- *"The lack of a national project management approach to policy and regulatory development and implementation"*.



# Where are we in the policy reform process?

- Some positives:
  - New Code standards for non-residential buildings likely from 2019 (but no political commitment at this stage)
    - ~40% lift proposed; ~5 star; should have been higher on economic grounds
  - SA is considering lifting standards for apartments from 2019
  - Commercial Building Disclosure threshold has dropped to 1,000 sqm tenancies
- But:
  - No national movement on residential standards, or in states other than SA (unclear whether others will come on board)
  - Primary focus is still on policy research (eg, NEPP work plan), with no political commitment to action
  - Ongoing concerns regarding Code compliance not being addressed systematically (Vic understood to be taking some action)
  - No national plan for achieving abatement; no sense of urgency
  - Opportunity costs of inaction continue to mount – unnecessary energy costs for households and businesses; unnecessary emissions



# Thank you

To find out more, contact:

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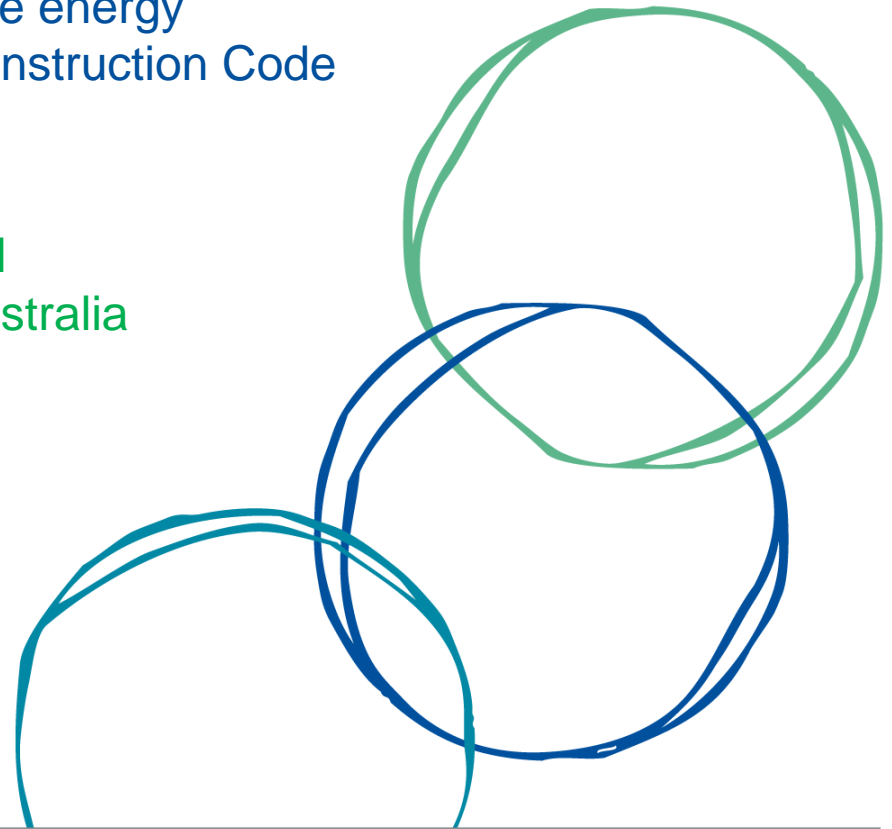


# Panel discussion

Providing certainty for industry investment in innovation:  
Making the case for a long term targets for the energy  
performance requirements in the National Construction Code

Eli Court, ClimateWorks Australia  
Neil Savery, Australian Building Codes Board  
Nicole Sullivan, Green Building Council of Australia  
Suzanne Toumbourou, ASBEC  
Chris Nunn, AMP Capital

Facilitator: Tony Arnel  
Energy Efficiency Council  
Norman Disney & Young



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# Building Code Energy Performance Trajectory

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Eli Court, Implementation Manager  
ClimateWorks Australia

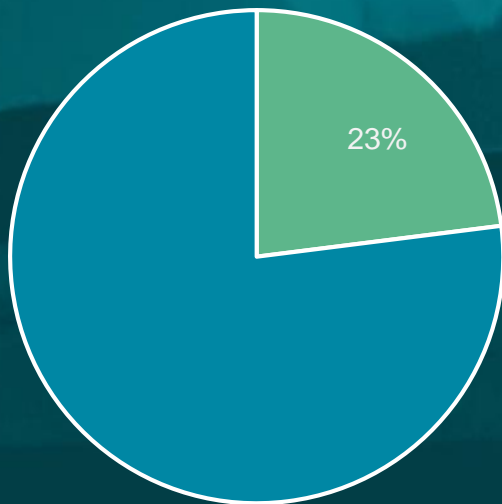
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22 November 2017

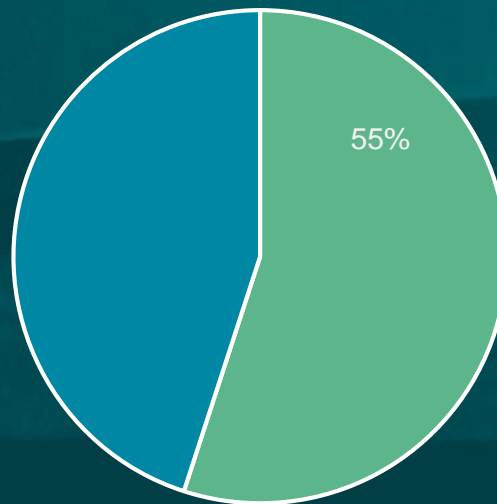


## Buildings: contribution to emissions and electricity consumption in Australia

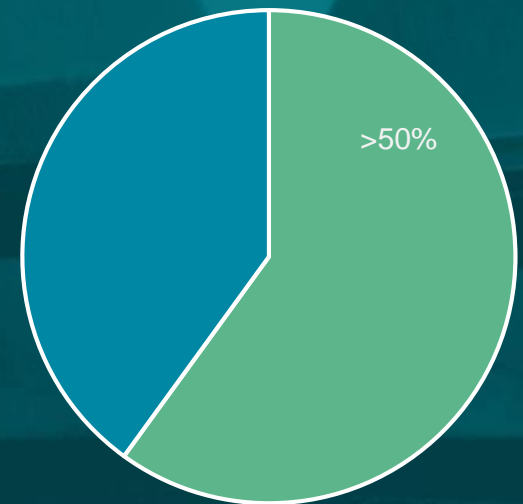
Emissions



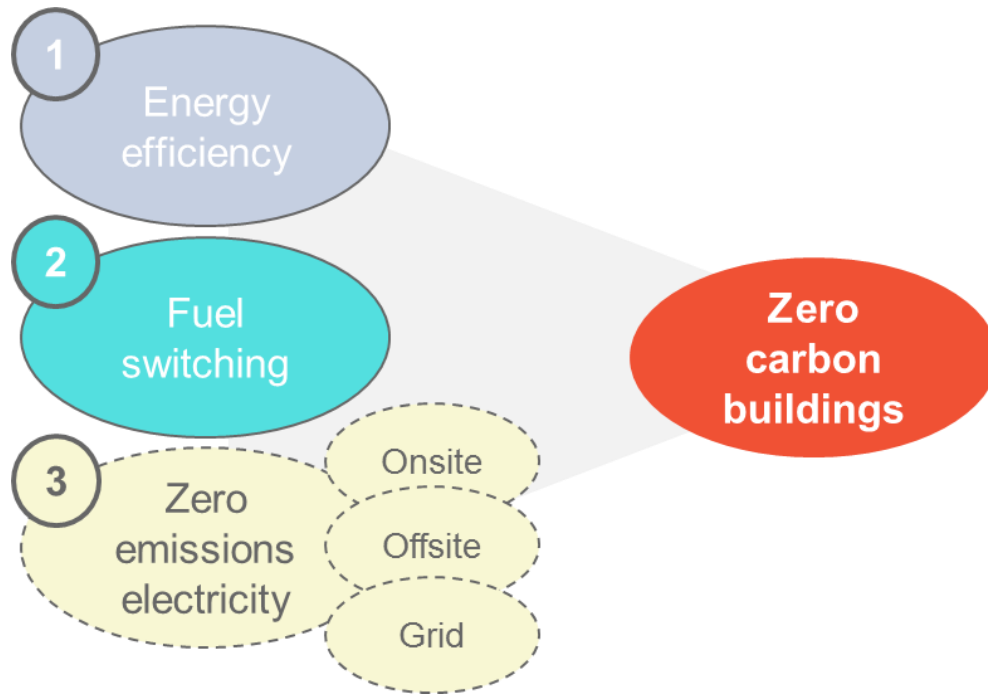
Electricity



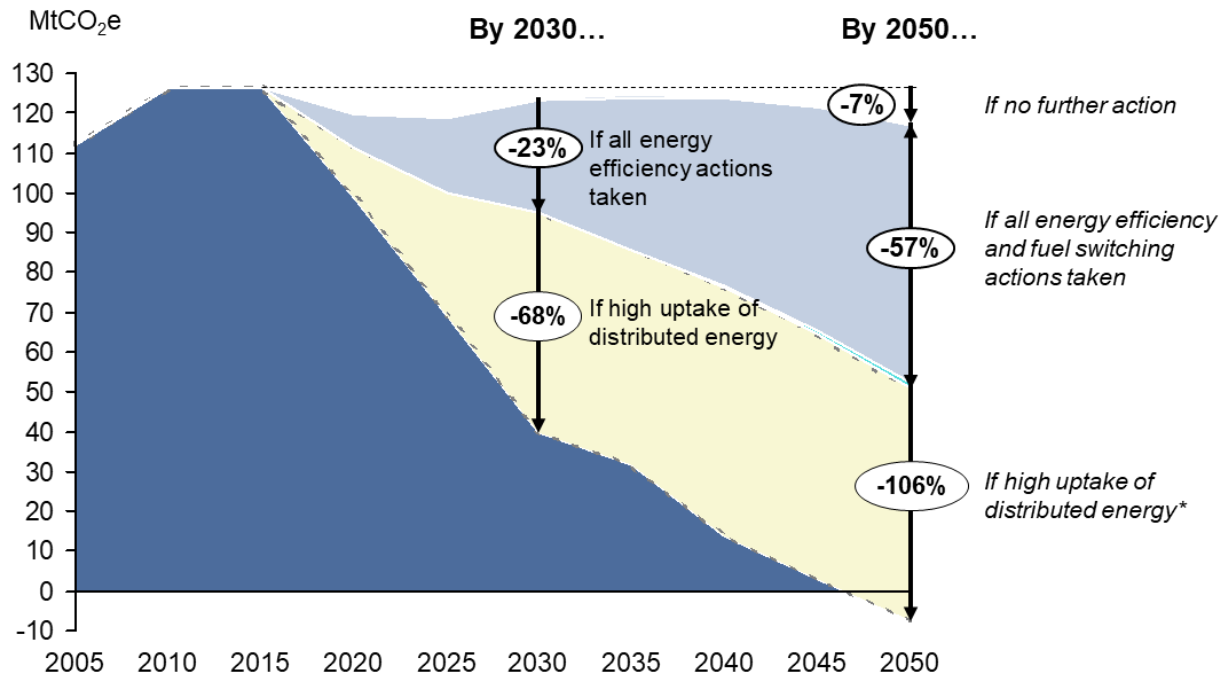
New as % of total in 2050



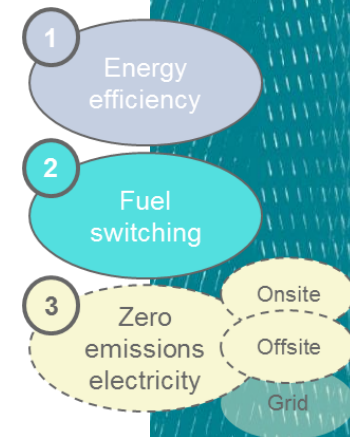
# Buildings can reach zero carbon through three key measures



# Net zero by 2050 via distributed energy

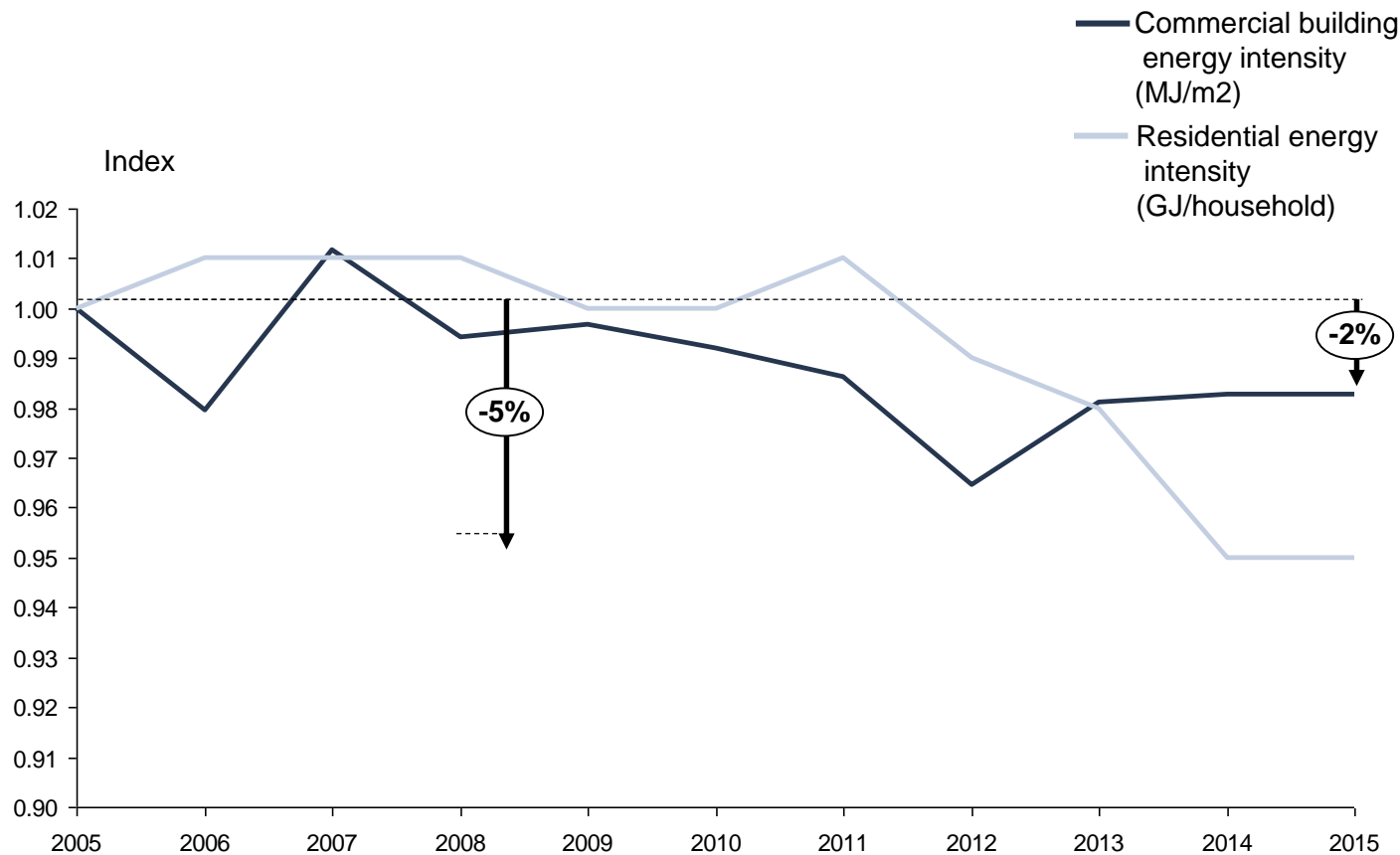


\* Distributed energy potential presented in this chart is based on the modelled potential uptake of distributed solar PV from the Future Grid Forum *Rise of the Prosumer* scenario (Graham et al, 2015).





# But it isn't happening...

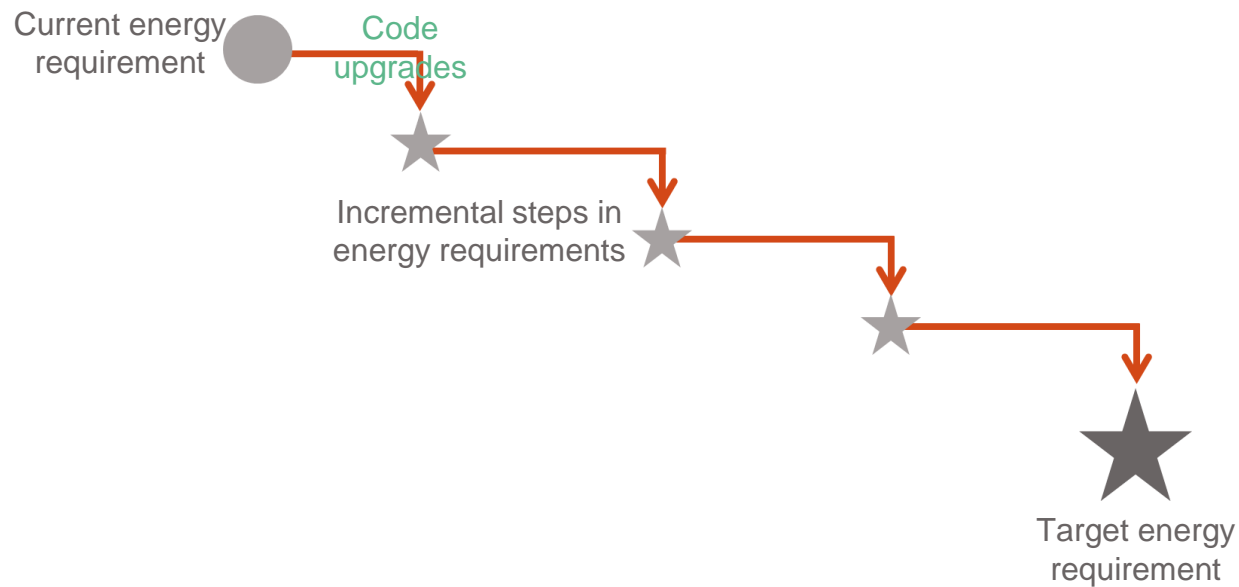


# Five key policy solutions

- 1 **National plan** with strong governance to coordinate action
- 2 **Mandatory minimum standards with forward trajectory** to provide a regulatory signal
- 3 **Targeted programs and incentives** to stimulate the market
- 4 **Energy market reform** to provide a level playing field
- 5 **Data, research, information, education and training** to enable effective action



# Mapping a forward trajectory





# Insights from phase 1 residential analysis

- Smart design v the regulated minimum
- Even with a conservative approach, opportunities are there
  - Energy efficiency
  - Solar PV
- More opportunity could exist with:
  - Less conservative assumptions
  - Smart design approaches
  - Quantification of broader benefits
- Short-term changes would require State/Territory action
- Compliance/enforcement must be improved at the same time



## Contact us

---

Eli Court | Implementation Manager

(03) 9903 8032

[Eli.Court@climateworksaustralia.org](mailto:Eli.Court@climateworksaustralia.org)

# Panel discussion



Finding, using and providing credible evidence: CRCLCL  
Knowledge Hub

Professor Peter Graham, Swinburne University  
Peter Madden OBE, Ecovivid  
Helen Bell, Green Building Council of Australia  
Kriston Symons, AECOM  
Ian Shears, City of Melbourne  
Warren Overton, Director, Sustainability Victoria

Facilitator: Scientia Professor Deo Prasad AO





# Low Carbon Built Environment Knowledge Hub project

SP0008



Participants Forum Nov 2017

## Knowledge Hub demonstration &

### Panel discussion:

***Finding, using and providing evidence –  
overcoming the barriers***

Project manager: Michelle Zwagerman

Project leads: Amanda Lawrence &  
Professor Peter Graham

**Centre of Urban Transitions**

Swinburne University of Technology



# Agenda

- Background
- Demo
- Panel discussion
- Questions



# What are the challenges?

Range of issues in evidence-based decision-making for both policy makers and practitioners in the built environment.

- Challenges in *finding* evidence
- Challenges in *using* evidence
- Challenges in *providing* evidence



# Today, where do people get new information?

	How important	Government	Industry	University
Asking colleagues or experts	Very	71%	64%	
	Somewhat			43%
Colleagues sharing information, in person, by email, etc	Very	57%	67%	
	Somewhat			43%
Websites of key organisations	Very	42%		
	Important		45%	
	Somewhat			71%
News reports and articles including print, online, radio, etc	Very	38%	50%	
	Somewhat			67%
Social media eg. Twitter, LinkedIn, Facebook, etc	Important	39%	42%	
	Somewhat			50%
Journal subscriptions	Very			57%
	Important		50%	
	Somewhat	38%		
Blogs	Important		45%	
	Somewhat	48%		67%
Libraries	Important			57%
	Not	65%	50%	
Institutional repositories	Important			33%
	Not	55%	44%	
Alerts/RSS from databases and information services	Somewhat		78%	43%
	Not	40%		
Subject databases and clearing houses	Not	61%	40%	29%



# Today, what do they use, and what would they use, if possible?



# Where to add value?



- ✓ **Collect** & curate for improved discoverability
- ✓ **Translate** for improved accessibility
- ✓ **Review** for improved confidence in the quality of evidence
- ✓ **Connect** people to people & people to content for improved collaboration in new research

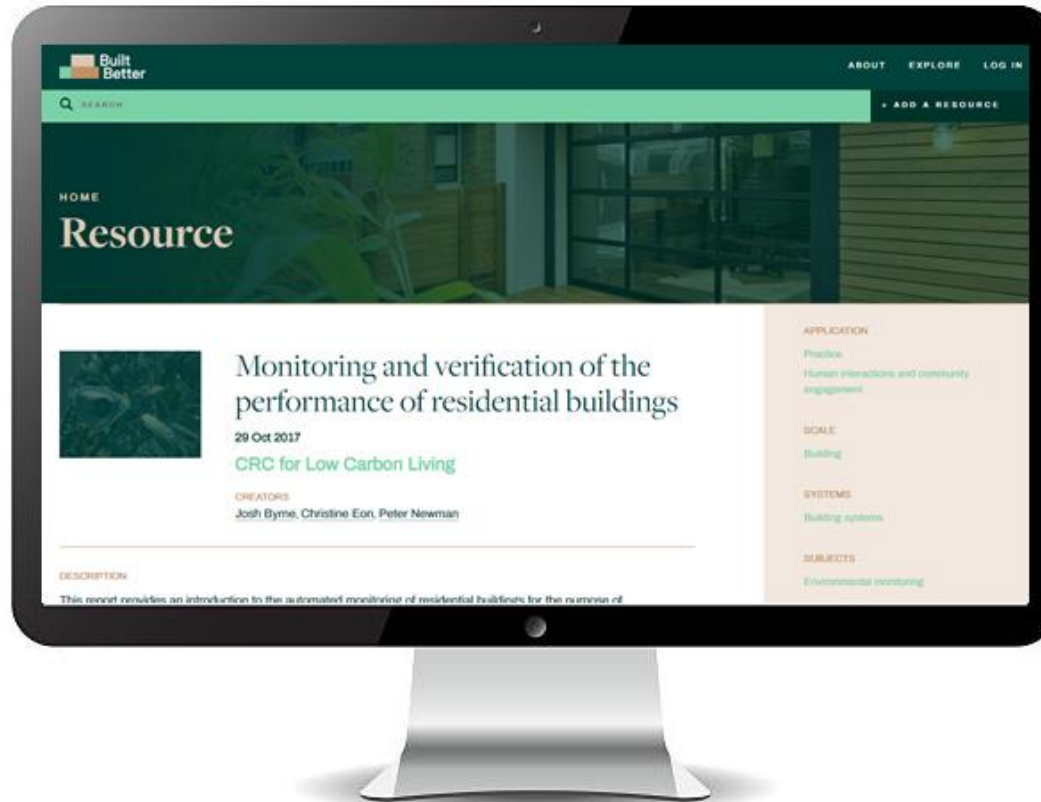


# The BuiltBetter Knowledge Hub solution

**BuiltBetter**



# Demonstration



11/30/2017

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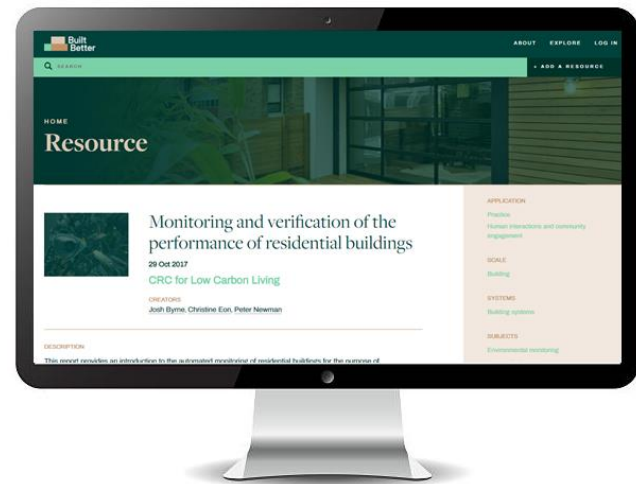
<http://builtbetter.org/>



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# Thank you

Please check out the new  
BuiltBetter.org website



<http://builtbetter.org>



# Panel presentation: Research Into Action



Dr Jemma Green, Curtin University (video)

Professor Alistair Sproul, University of NSW

*Beating the heat: PVT desiccant cooling*

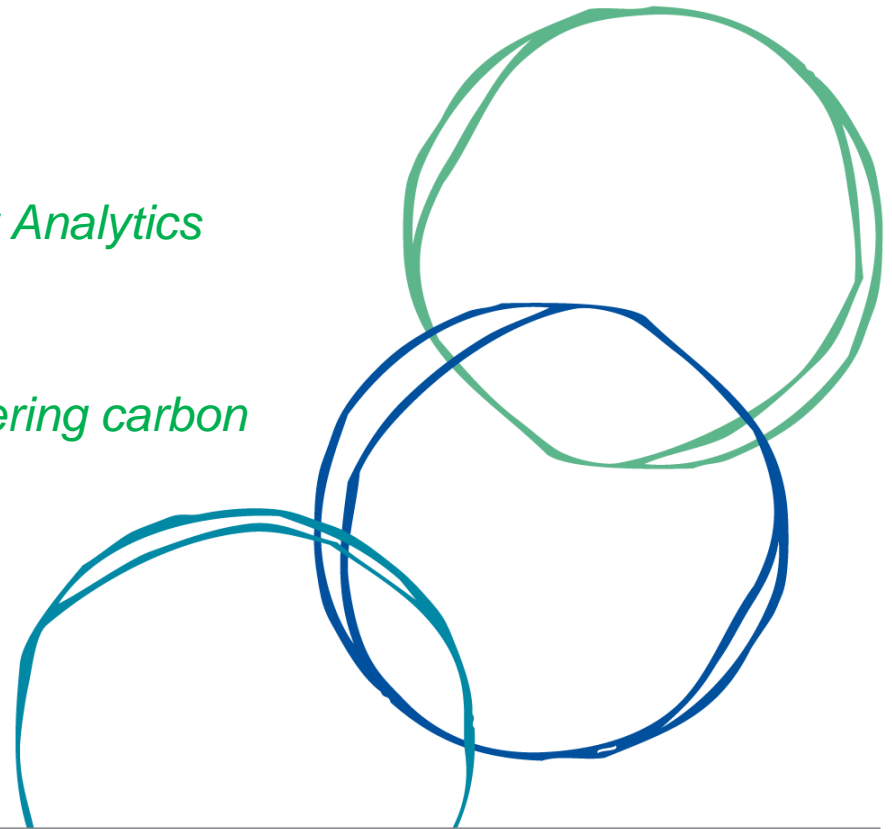
*Monitoring home energy performance: Solar Analytics*

Dr Vanessa Rauland, Curtin University

*Community buy-in: engaging schools in lowering carbon*

Dr Farshid Pahlavani, University of NSW

*Transforming waste: recycling glass into benchtops*



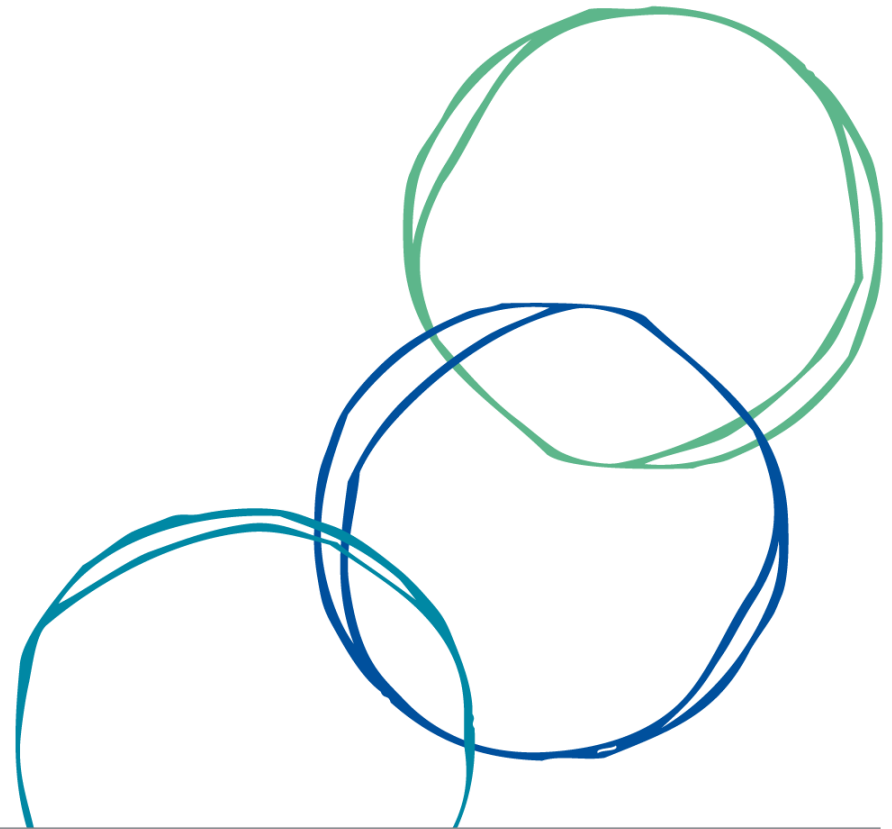
# 2017 Participants Annual Forum



## Beating the heat – PVT desiccant cooling

Associate Professor Alistair Sproul  
School of PV & RE Engineering

Wednesday 22<sup>nd</sup> November 2017



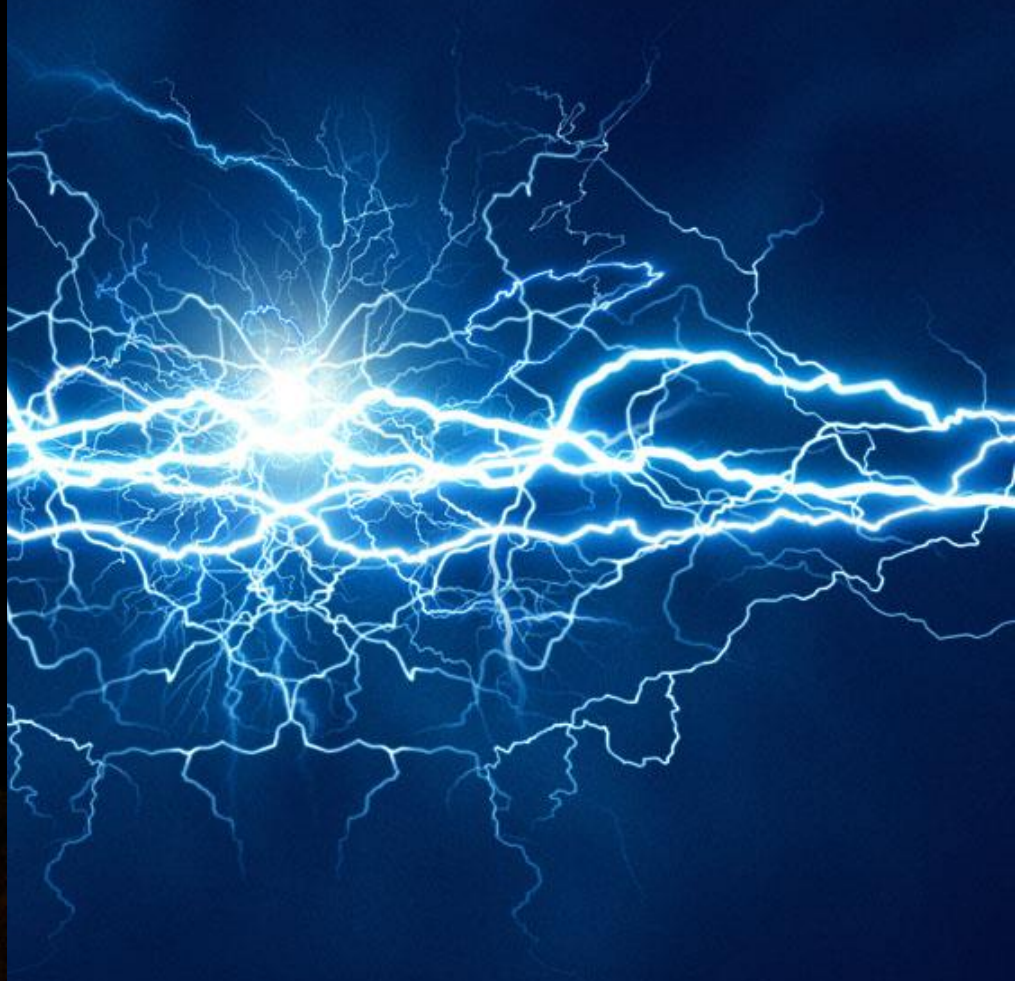
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*National Innovation Hub for a Sustainable Built Environment*

fire & humans  
~ 1 million  
years



electricity and  
humans ~ 150 years



the future is electric



photovoltaics is the present and the future





# PV/thermal collectors?

- PV/T ?
- Combined PV and thermal collector
- Our systems are based on air
- Can provide warm, low temperature air in winter – providing some heating and plenty of fresh air to homes.
- Australian climates that require heating – can make a significant contribution to a well insulated, well sealed home, that **does not** have significant winter direct solar gain through windows!
- Also can provide night cooling in hotter climates.
- COP – capable of  $> 20$  ( compression  $\sim 3 - 6$ )

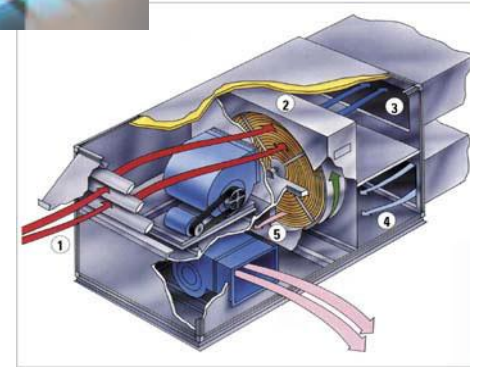
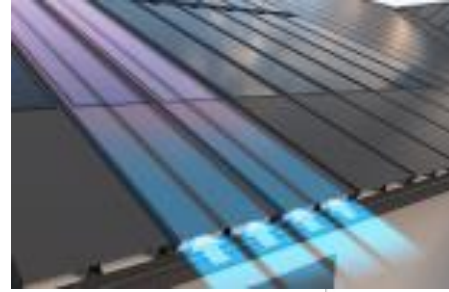


PV/T system Glebe, Sydney

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# What about cooling?

- As the price of PV continues to fall, rooftop PV becomes a very cost effective option.
- This project integrates PVT roofing system with a desiccant cooling systems.
- BIPV/T cannot produce temperatures high enough to drive an absorption cooling cycle.
- However BIPV/T in many Australian climates can potentially produce thermal energy at a temperature that can drive a low temperature desiccant cycle



# PV/T channels

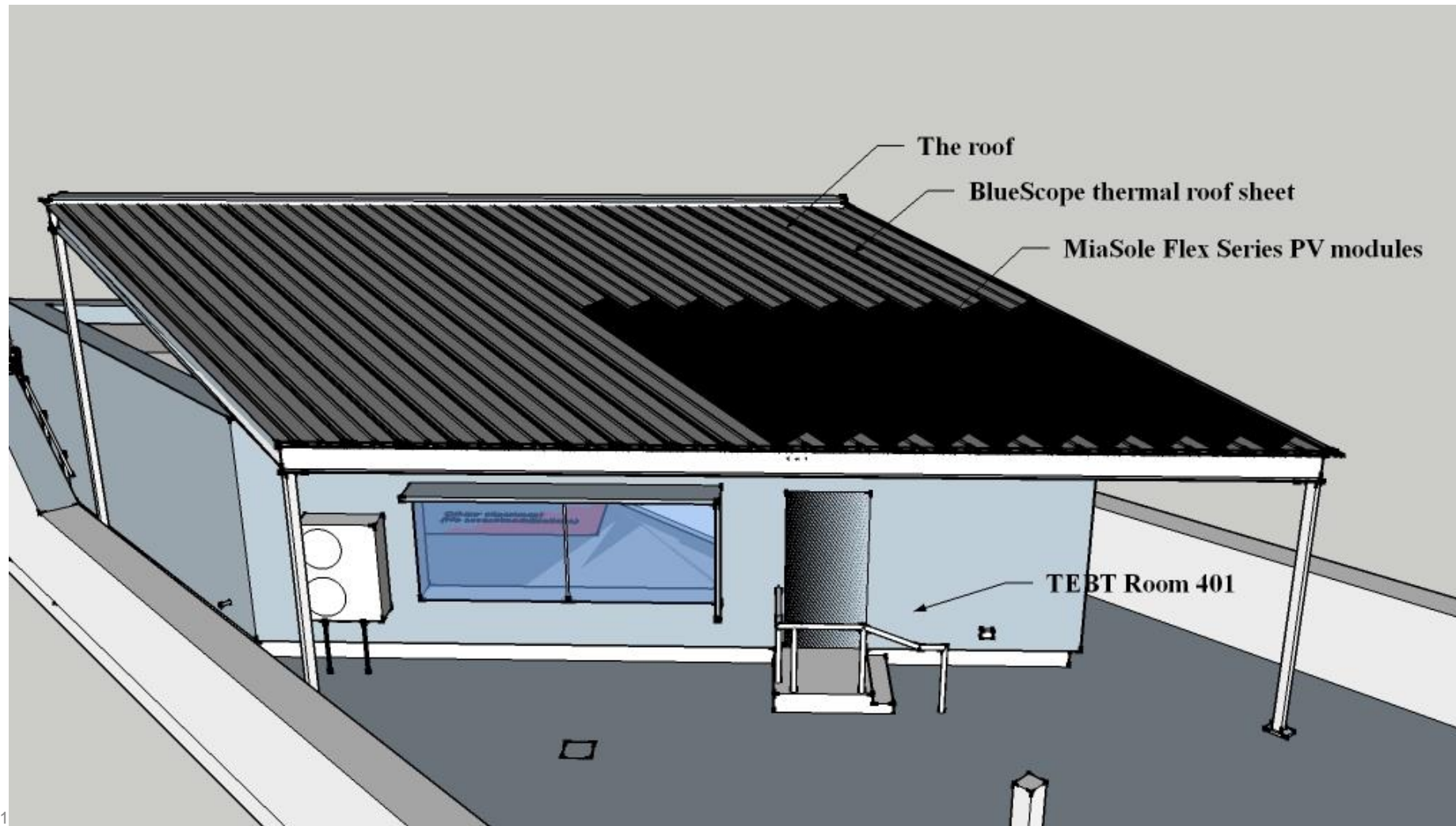


11/30/2017

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# Roof top PV/T - UNSW



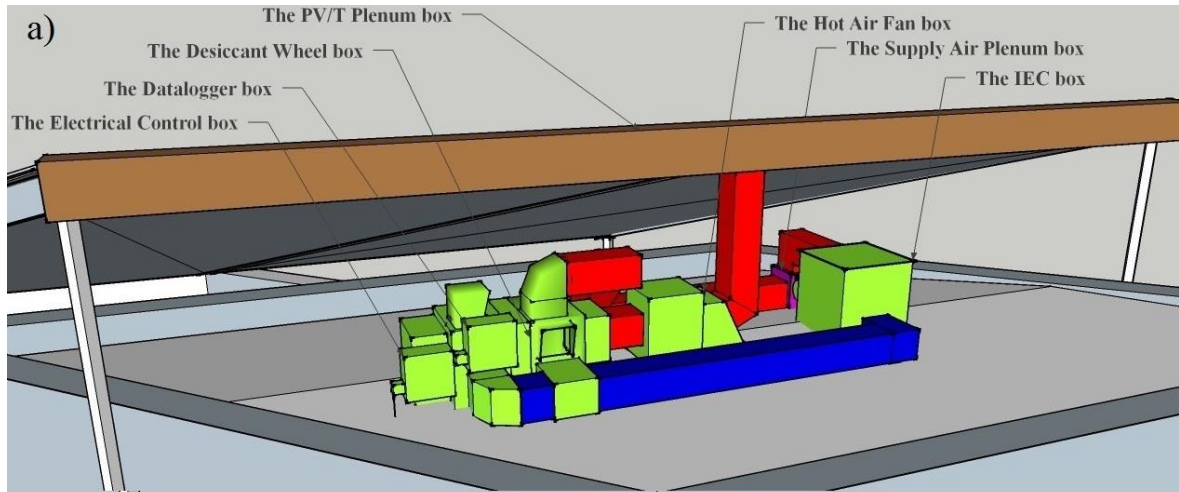
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# PV/T – desiccant system located at UNSW



## Colour Legend

	Uninsulated duct		Insulated duct		PV/T plenum box
	Supply air plenum box		Components supplied by UNSW/CSIRO include: the Desiccant Wheel box, the Hot Air Fan box, the IEC box, the Electrical Control box & the Data Logger box		

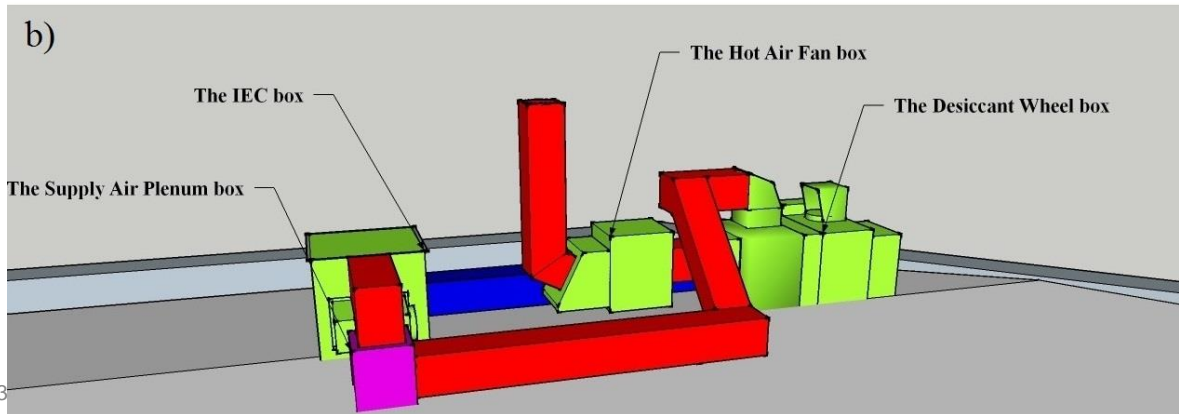


Diagram of the Desiccant Air Conditioning system a) view from the front with the PV/T air plenum box and b) view from the back without the PV/T air plenum box

# PV/T – desiccant – ground coupled

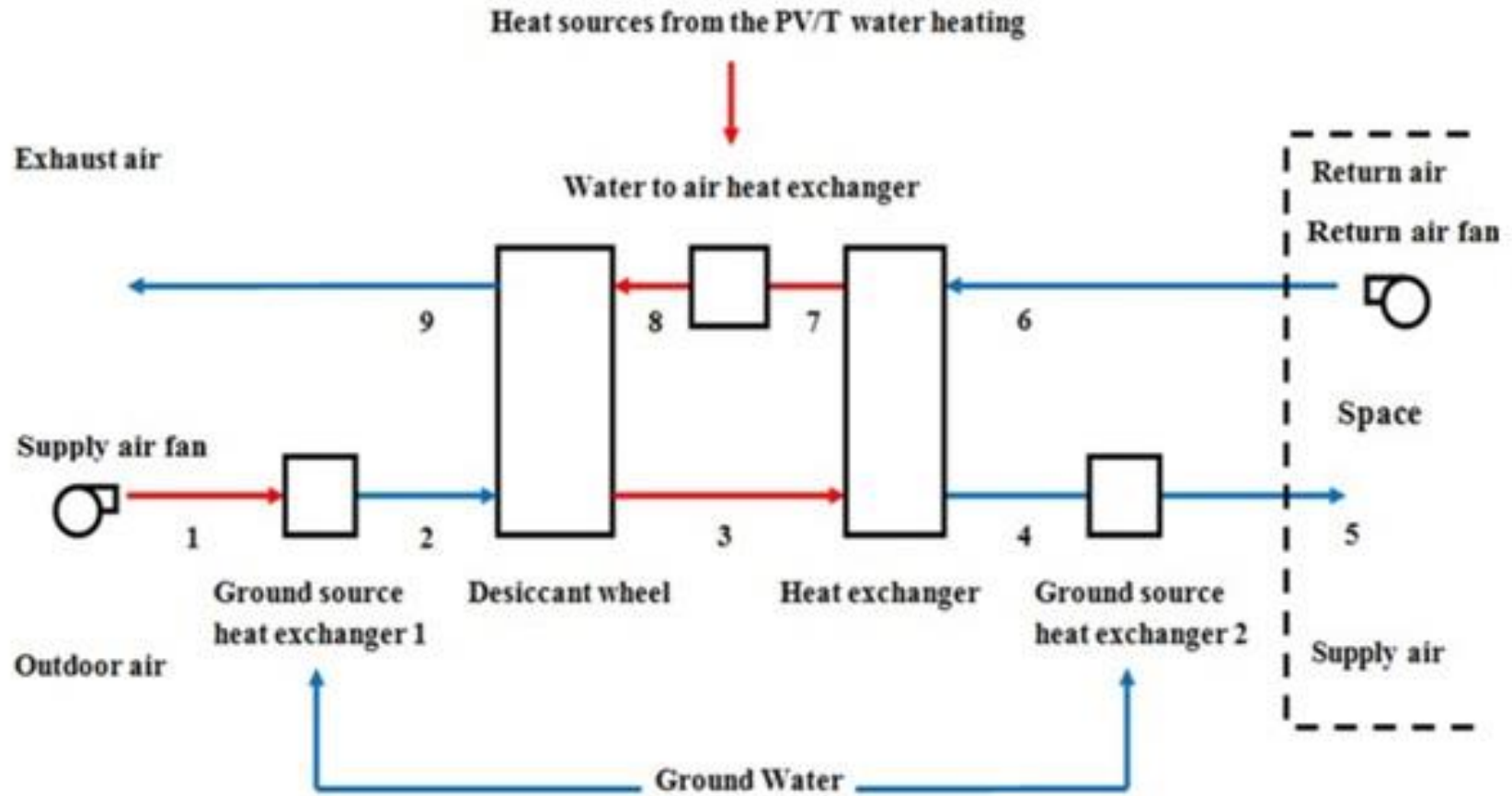
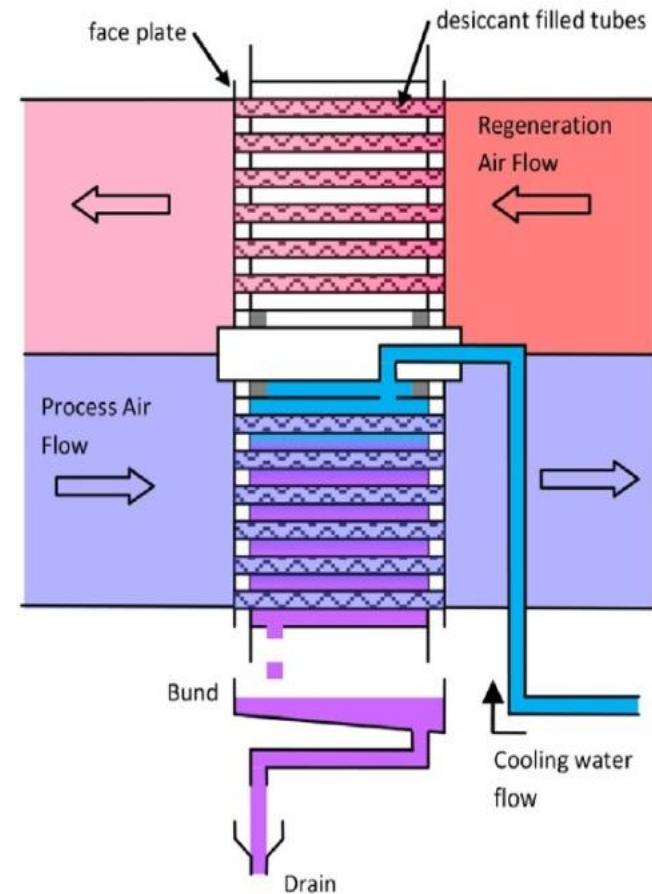
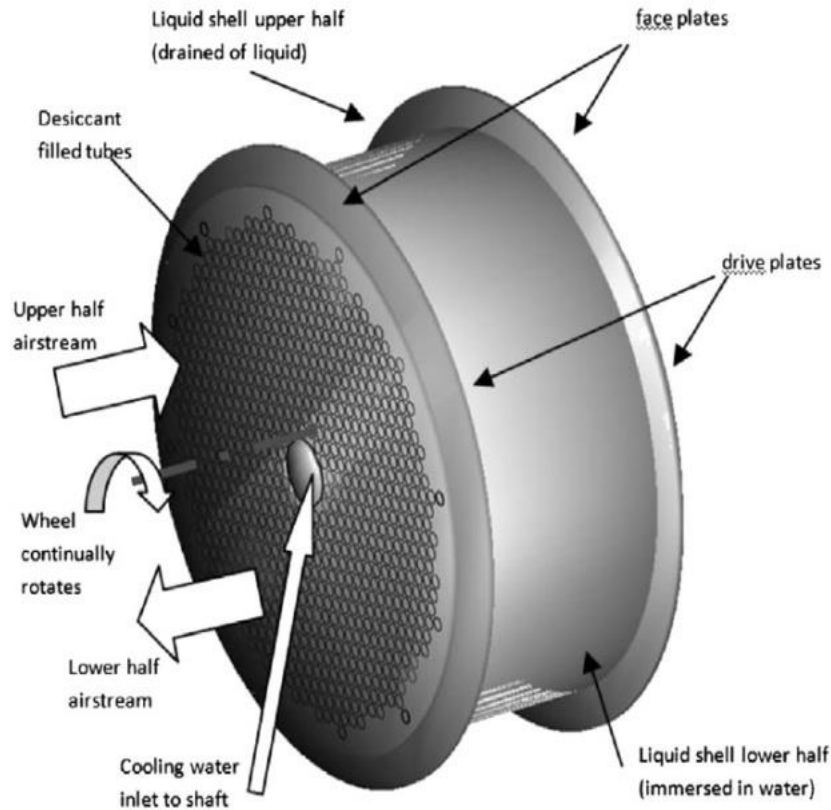


Figure 22 - The schematic diagram (top) and the psychrometric process (bottom) of a pre-cooled desiccant air dehumidification and cooling process



# CSIRO – water cooled desiccant wheel



# Conclusions

- PV prices are falling fast
- Potential for PV/T to do that as well IF scale can be achieved.
- Desiccant cooling – particularly with some form of water based or ground coupled pre-cooling or “inter”-cooling – offers lowest temperature regeneration. Cost reductions again needs scale.
- Can we compete with low cost PV and high efficiency compression?
- Acknowledgements: Jamie Adams, Lloyd Niccol, Mark Eckermann (BlueScope), Dr Stephen White, Dr Mark Goldsworthy, Marl Peristy, Roger Reece (CSIRO), Dr Jose Bilbao, Jinyi Guo, Xingchao Zhao and Simao Lin (UNSW)



*Solar Analytics*  
*Behind the Meter Energy Data*  
*And other fun stuff*

Renate Egan,  
Solar Analytics  
[renate@solaranalytics.com.au](mailto:renate@solaranalytics.com.au)

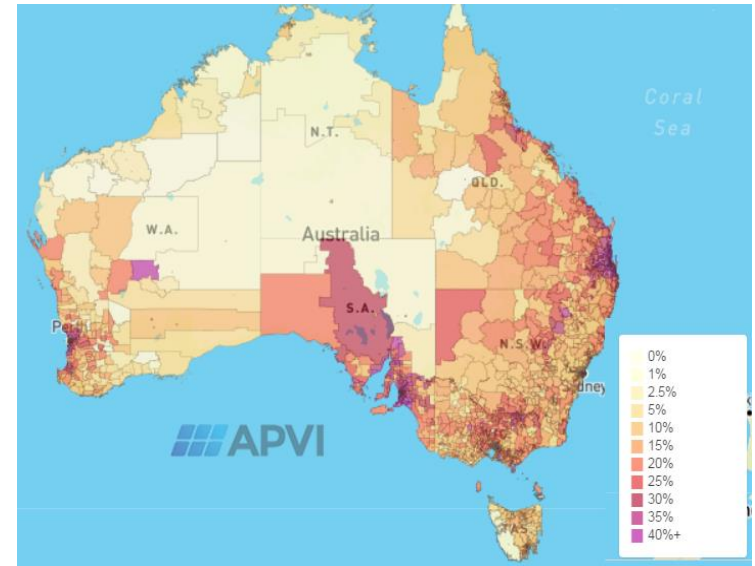
solar  analytics

# Australian Market

Unlike anywhere else in the world ...

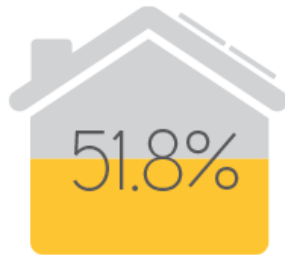
Leading in residential, lagging in utility scale solar

- High penetration distributed generation
  - Average 25% available households
  - 70-80% in some areas
- Isolated microgrids
- Diverse climate zones
- Engaged and informed market
- Lots of learning by doing
- Technology moving ahead of policy and regulation
- New markets, new services, new business opportunities



[www.apvi.org.au](http://www.apvi.org.au)

# So Much Generation... Behind the Meter



Ausgrid

Data from 8,000 Ausgrid solar energy systems shows that approximately 51.8% are not performing at capacity

‘Performance lessons from the real world’  
Sun



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# Solar Analytics

## More Power to You

We can tell if your  
solar energy system  
is working as expected  
and if it's not...  
we can tell you what's wrong  
and what to do about it.

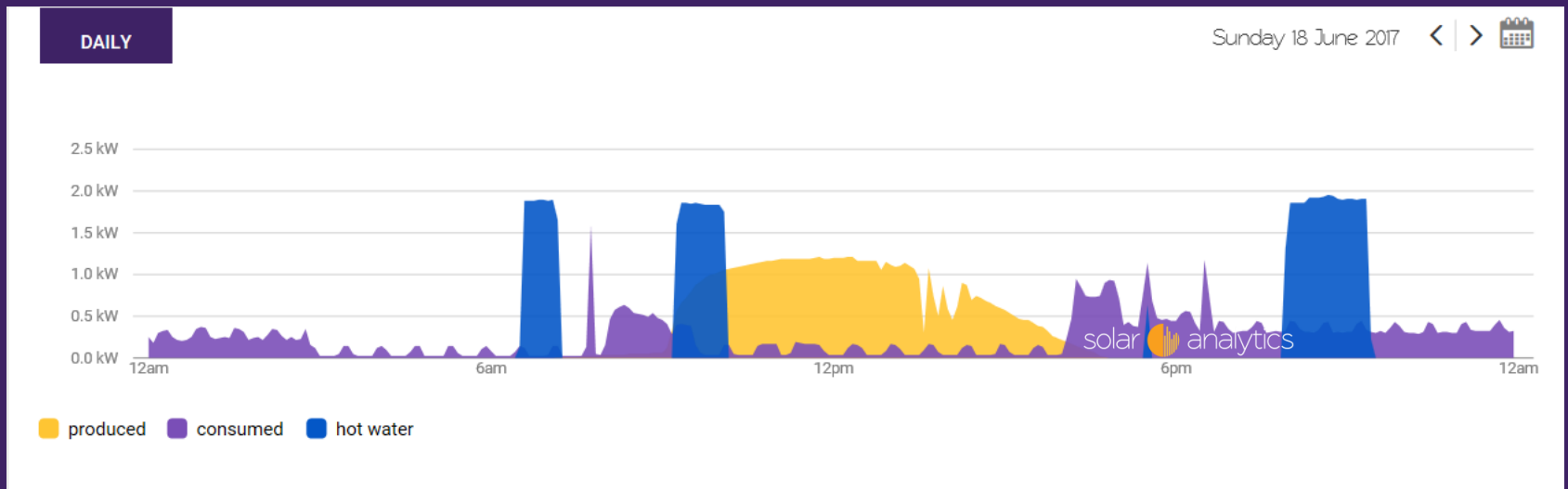


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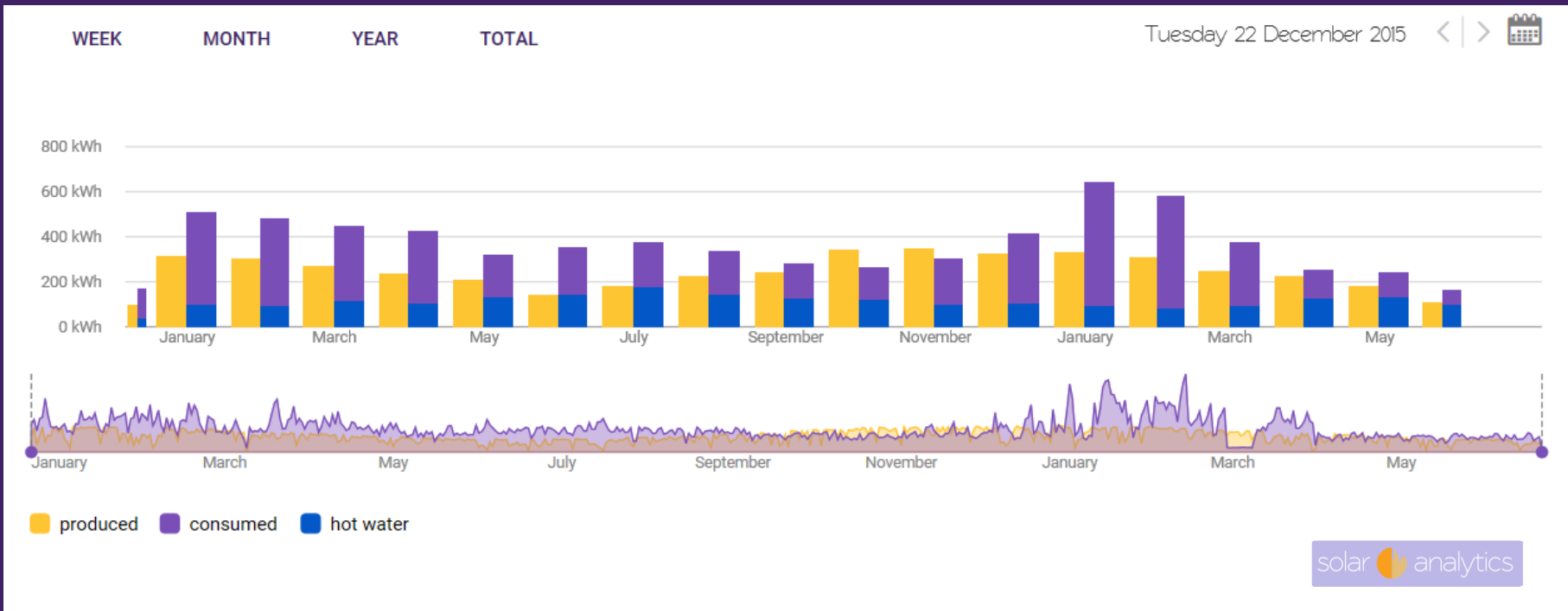


# Generation & Consumption





# By Week, by Month and All Year



# Site Specific Battery Estimator

NEW  
FEATURE



## THINKING ABOUT A BATTERY FOR YOUR HOME?

We can now tell you what size battery would be suitable for your home based on your power usage.

CALCULATE  
MY BATTERY

JARNASON ALEXANDRIA

Based on your production levels and consumption history, a battery size appropriate for you would be:

BETA 

BATTERY SIZE:

**7 kWh**

solar  analytics

GRID USAGE REDUCED BY:

**36.06 %**

COST OF BATTERY:

**\$9600\***

SAVINGS PER YEAR:

**\$437.82\*\***

solar  analytics



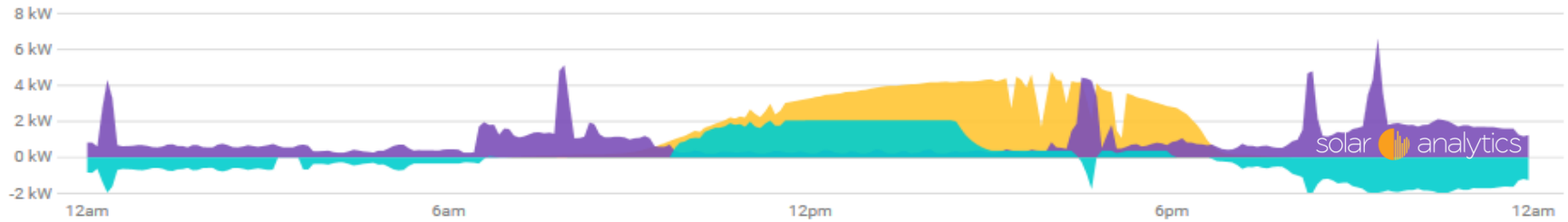
LOW CARBON LIVING  
CRC

# Energy Storage



DAILY

Thursday 16 February 2017



solar analytics





## PERFORMANCE

- Solar Focus
  - Engaged Customer
  - Retailer Benefit
  - Industry Benefit



January 2017

99.7%

Monthly average solar performance rate



# Solar Analytics

Empowering people to navigate the energy transition

in less than 3 years

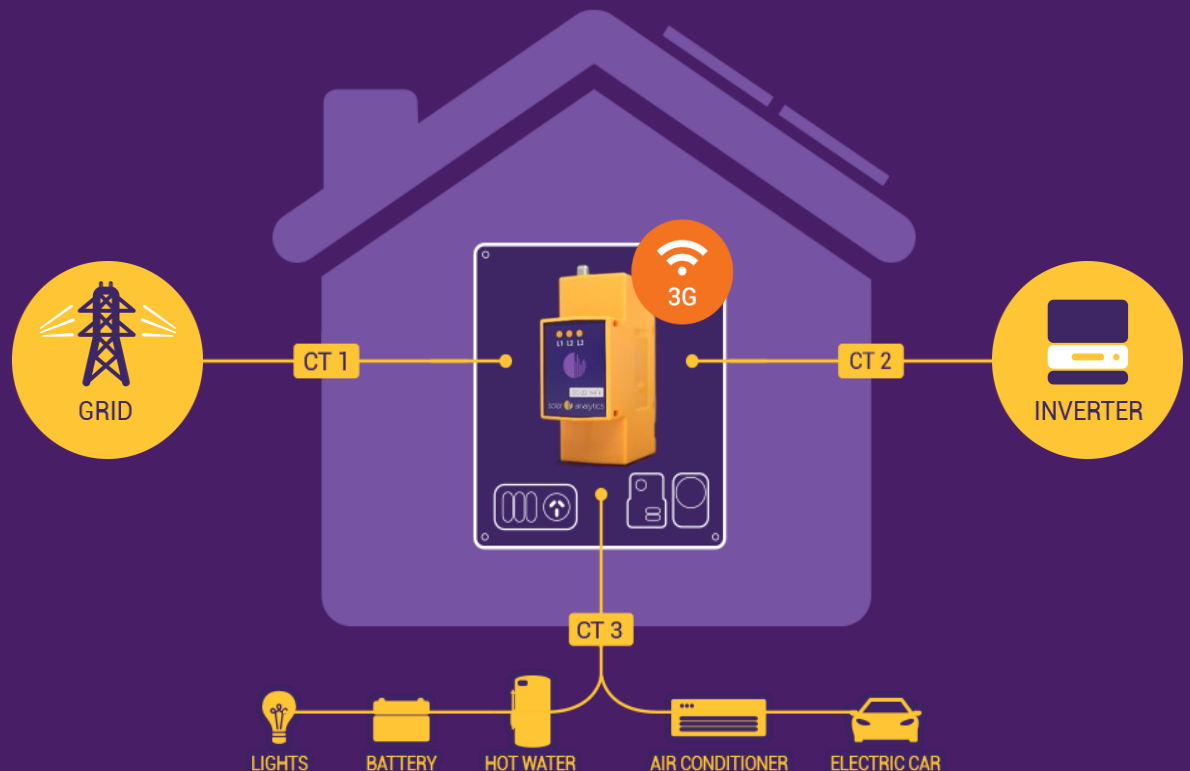
300-17,000 customers

2-350 solar resellers

0 to 5 energy retailers

5 countries

4 states in the US



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CRC



# Power in the Data



2016

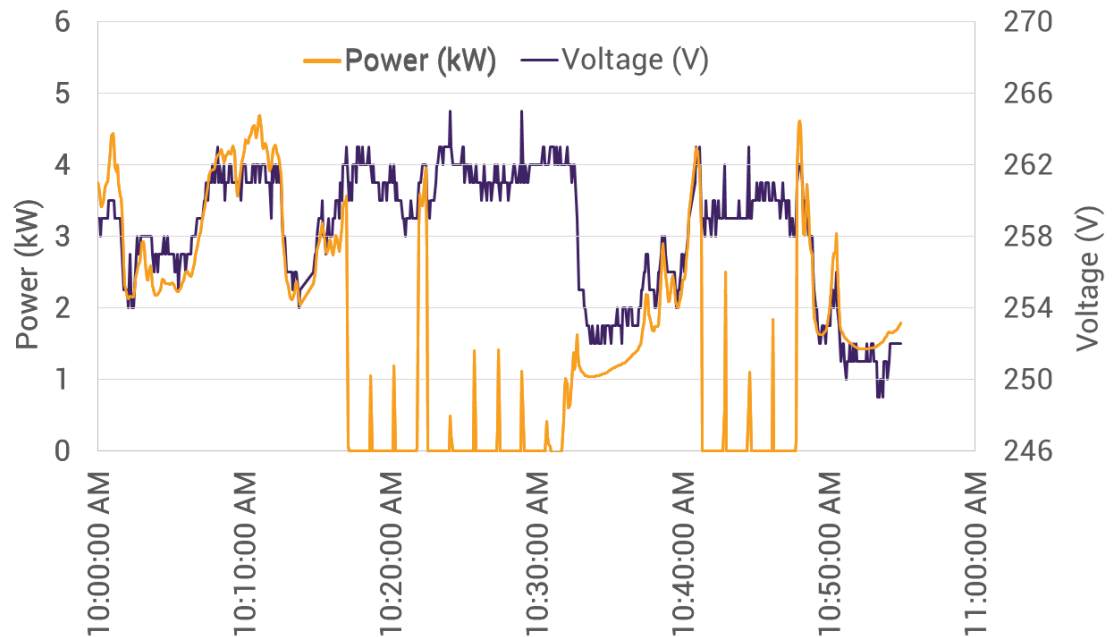
2017

2018

# Detailed Energy Insights

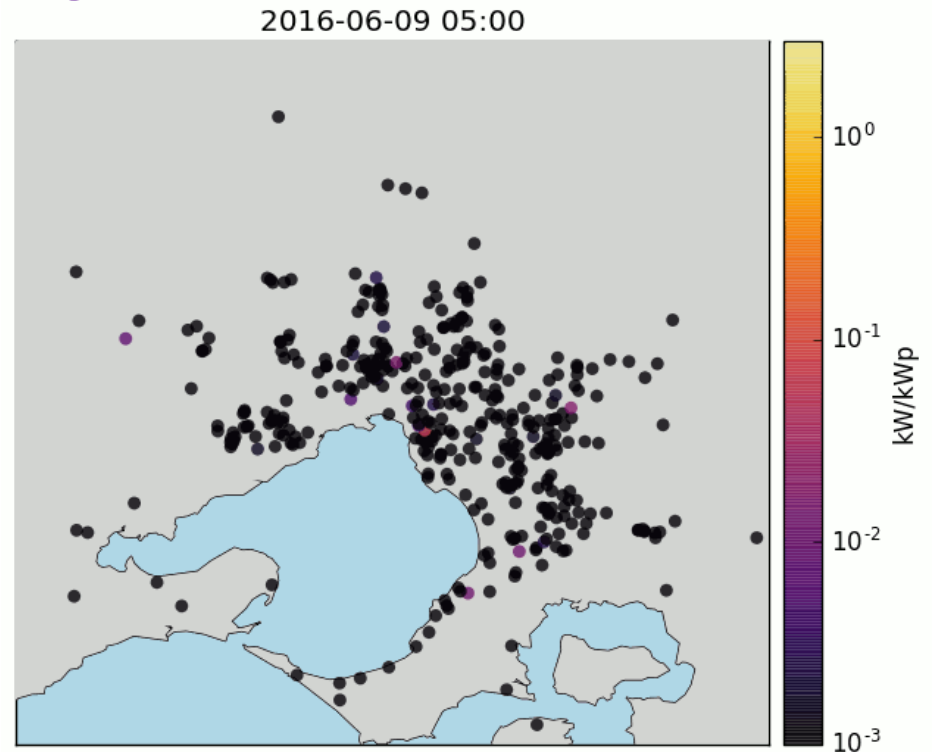
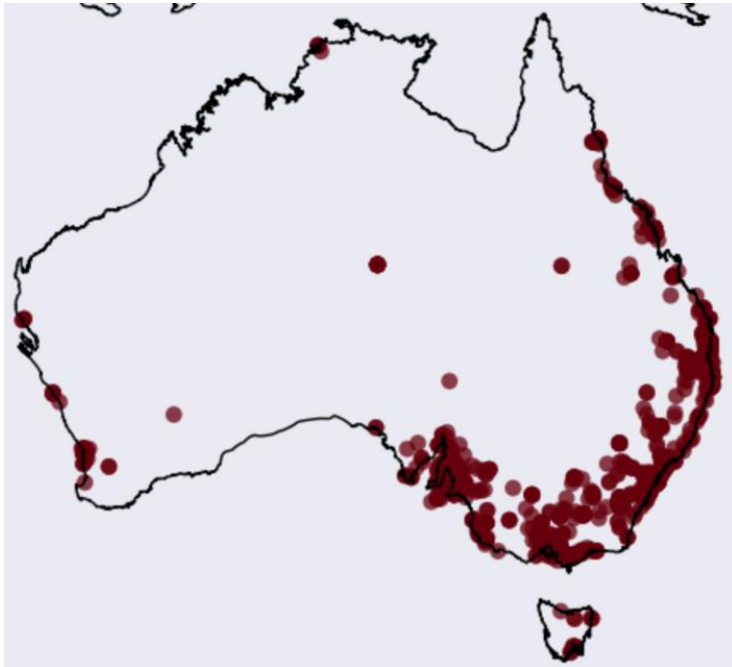
## Real Time Data Measurements

- Energy – generated
- Energy – exported
- Power - real
- Power - reactive
- Power factor
- Power, min, max
- Frequency, min, max
- Voltage min, max



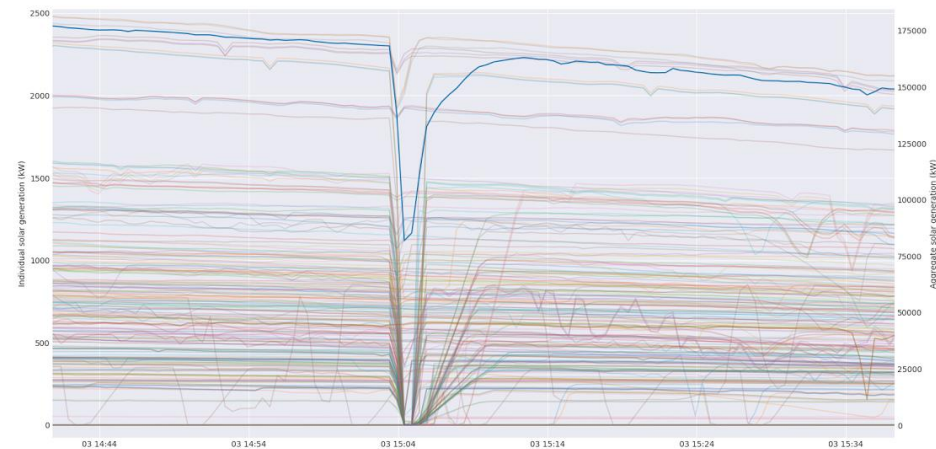
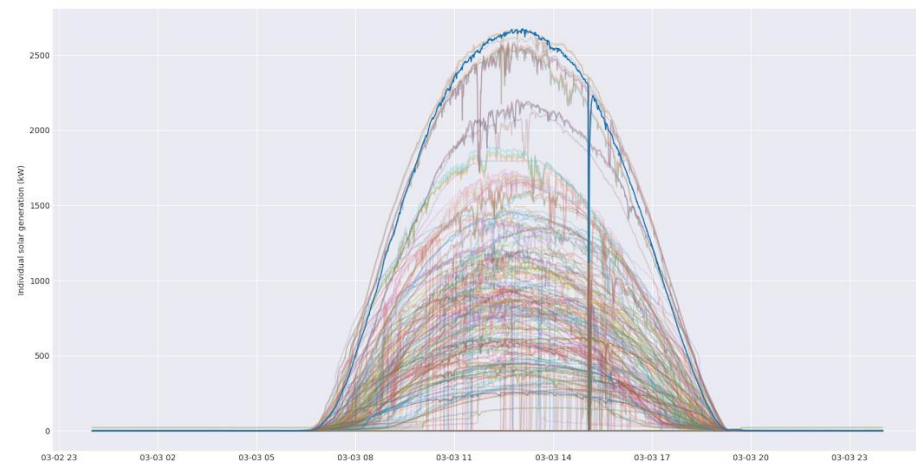


# Detailed Energy Insights



# Adelaide Voltage Event on 3 March 2017

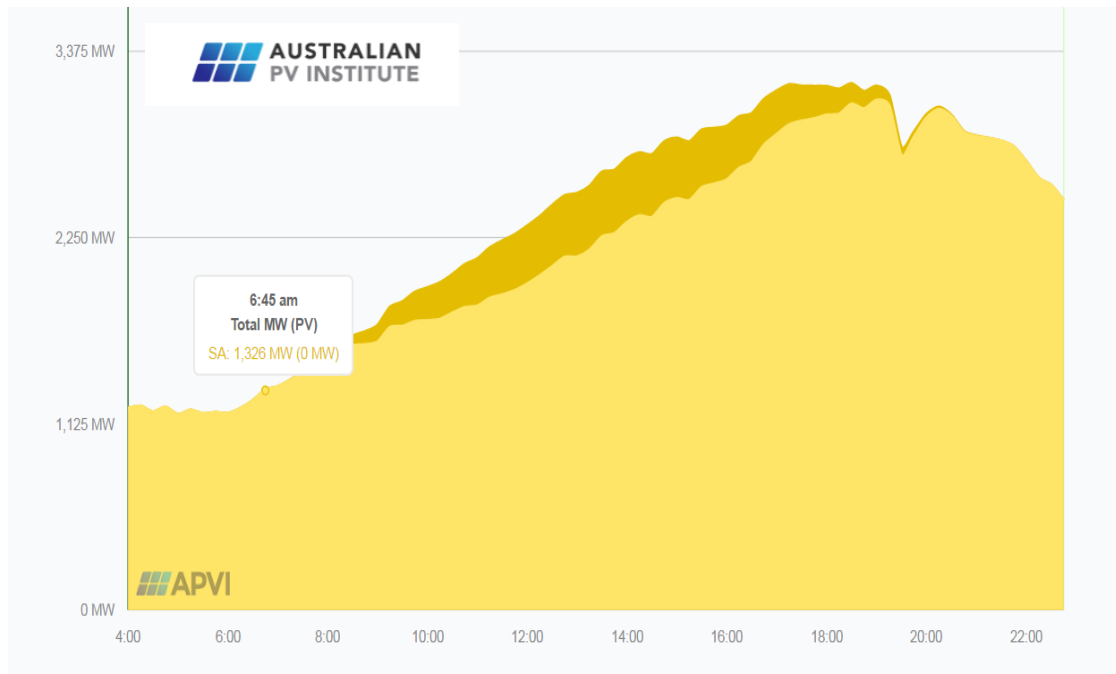
- AEMO report into the event is [here](#).



# Live Power Feed

South Australia

8 Feb 2017



solar  analytics

*The world's most intelligent solar monitoring*

*renate@solaranalytics.com*



LOW CARBON LIVING  
CRC



# Research into action

Community buy-in: engaging schools  
in lowering carbon



*Dr Vanessa Rauland*

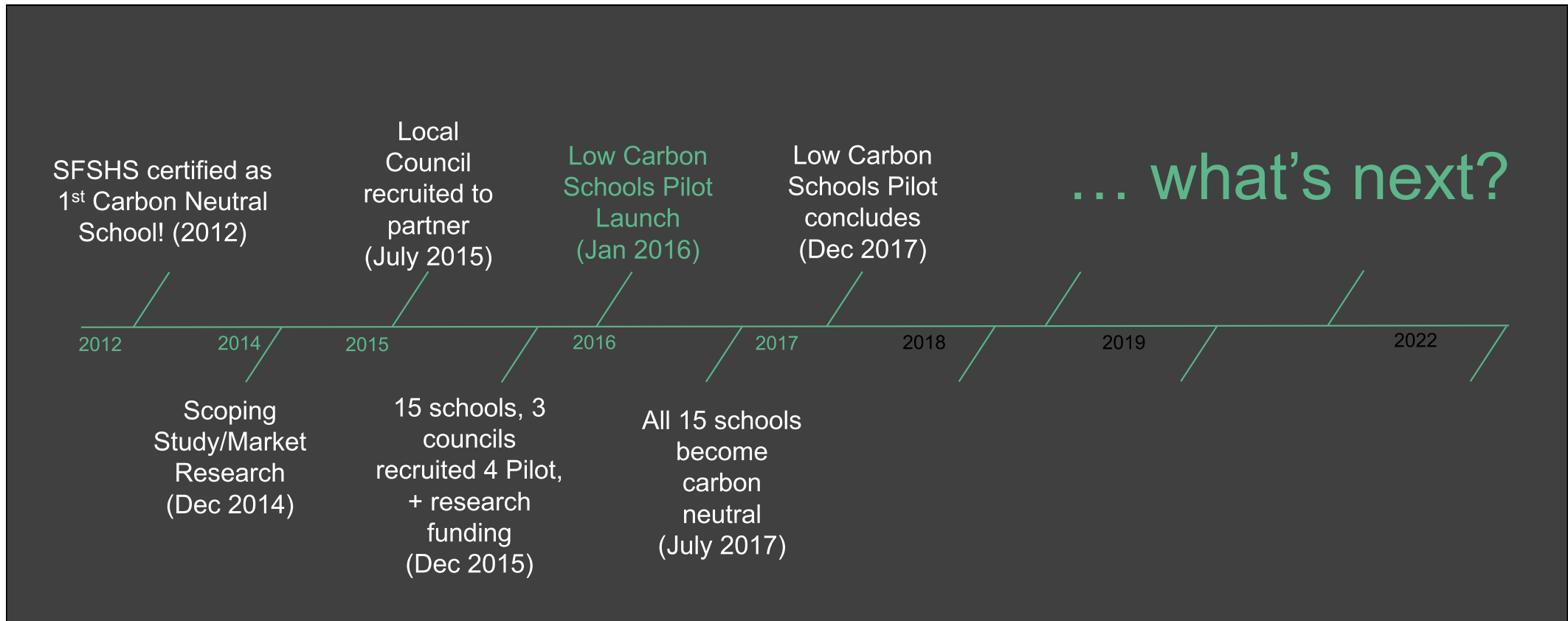


22 Nov 2017

# SOUTH FREMANTLE SENIOR HIGH SCHOOL

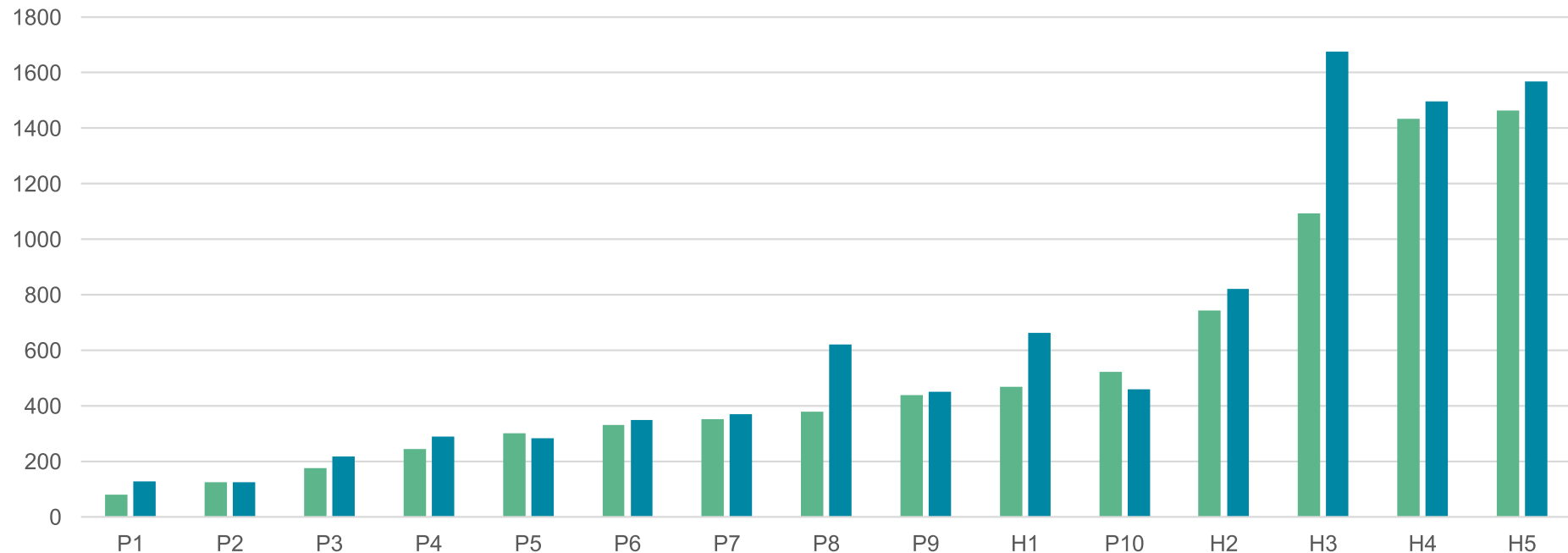


# TIMELINE



# PARTICIPATING SCHOOLS – METRO PERTH

Student Numbers 2015 & 2017



Local Councils	# Schools
City of Fremantle	6
City of Cockburn	2
City of Melville	1

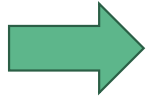
Level	# Schools
Primary	10
Secondary	5

Type	# Schools
Public	14
Private	1



# PROGRAM STRUCTURE

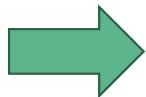
First 6  
months



5 Workshops



Next 18  
months



Meet-ups &  
Implementation



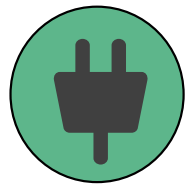
## Calculate & Plan



1. Emission Baseline
2. Carbon Reduction Action Plan
3. Low Carbon Policy

1. Share experiences
2. Accountability
3. Monitoring progress

# EARLY RESULTS...



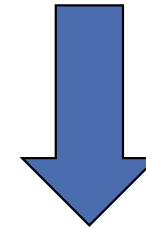
232 energy initiatives  
(electricity & gas)

126 water initiatives

163 waste initiatives

## INITIATIVES

521



65 %

338

# KEY INITIATIVES



Fridges

Security lights

Flow restrictors



Chilled water fountains



Fixture charges

Electronic white boards



Data loggers

Water leaks

Faulty urinals

Gas pilot lights

## Uncommissioned BMS...



Auto-shut down of computers



## Holiday switch off campaign

Solar



LED lights



# CARBON REDUCTION



**Carbon Neutral!**  
**3,700**<sub>tCO<sub>2</sub></sub>



climate  
clever

# The ClimateClever Initiative

*Creating low carbon, high performing  
schools & communities*



Curtin University



LOW CARBON LIVING  
CRC

# Problems facing schools:

- Inefficient school buildings
- Wasted \$\$ on utility bills
- Lack of comparison data
- Ad hoc sustainability initiatives - no systematic approach
- No process to integrate sustainability into curriculum
- Challenges on how to teach STEM?
- Tight budgets



# OUR SOLUTION





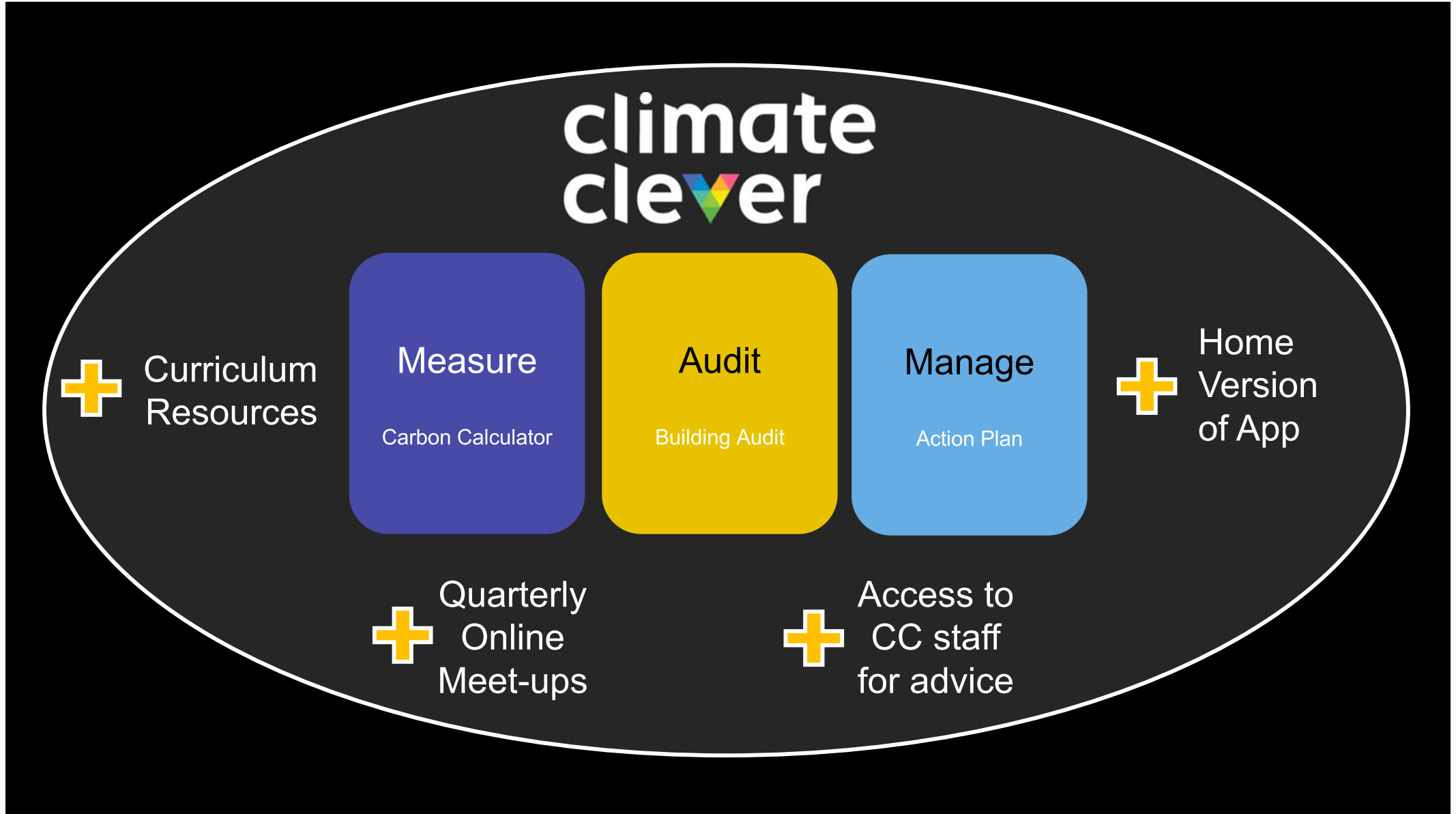
# WHAT IT DOES...



- Affordable, online, data-driven student-led program
- Calculates & tracks carbon footprint
- Compare schools across Australia (& the world!)
- Identifies opportunities to reduce
- Systematic & interactive process
- Manages & tracks initiatives, shares success/learnings/progress using innovative technology
- Engages students, their families, school communities
- Saves schools \$\$ on operating costs



# THE PROGRAM



# MARKET VALIDATION

15



## Traction/success

- Carbon Neutral school 2012
- Market research in 2014
- Pilot 2016-2017
- National pilot 2018



100

## Funding to date

- \$97.5K – 2016/17 Pilot fees
- \$200K – research funding
- \$40K – AMP grant
- \$35K – 2018 Pilot fees



25

# MARKET SIZE

# 9,414

Schools in Australia

- 1,738 Catholic schools
- 1,042 Independent schools
- 6,634 Public schools

➤ 1,200 schools in WA

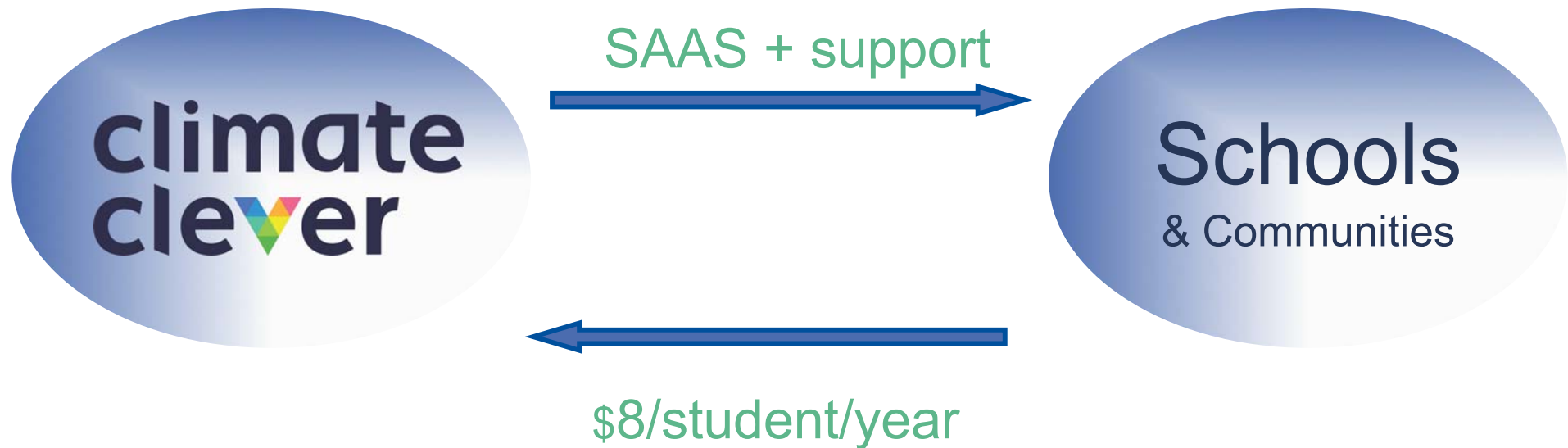


# 3,798,226

Students in Australia

# BUSINESS MODEL

Average of  
one year  
payback



International > Home > SME's > Orgs...



# TEAM



Dr Vanessa  
Rauland  
MD

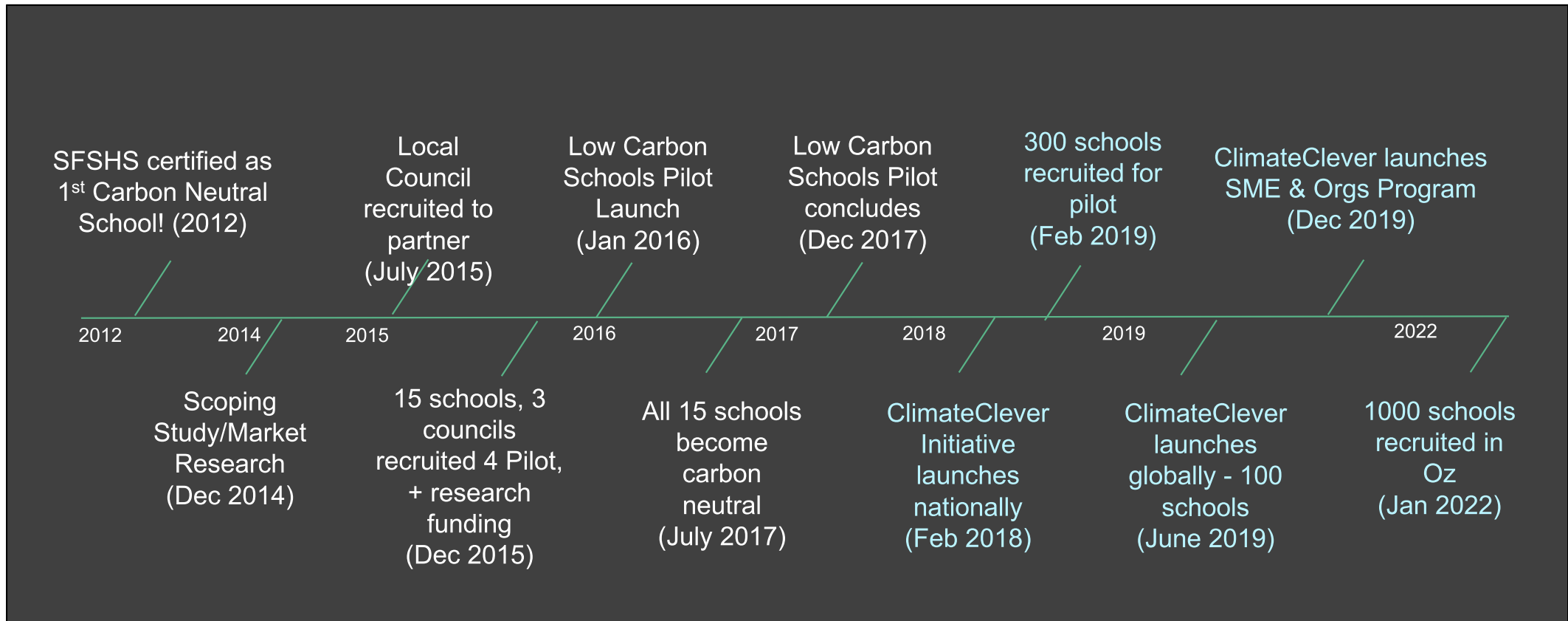
Portia Odell  
CRC Researcher  
Social Impact

Kathy Anketell  
Program  
Coordinator

Chantal Caruso  
Research  
Assistant

Fredy Bernal  
Carbon  
Accountant

# VISION & ROADMAP



# climate clever



**Dr Vanessa Rauland**  
**Ph: 08 9266 9025**  
**E: [v.rauland@curtin.edu.au](mailto:v.rauland@curtin.edu.au)**

**Thank you**



## PARTICIPANTS



The CRC for Low Carbon Living also works with an extensive range of government and industry third parties at a project level

## CONTACT US

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Australian Government  
Department of Industry,  
Innovation and Science

Business  
Cooperative Research  
Centres Programme



# Thank you

## To find out more, contact

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Tyree Energy Technologies Building  
UNSW Sydney NSW 2052 Australia

E: [info@lowcarbonlivingcrc.com.au](mailto:info@lowcarbonlivingcrc.com.au)

P: +61 2 9385 5402

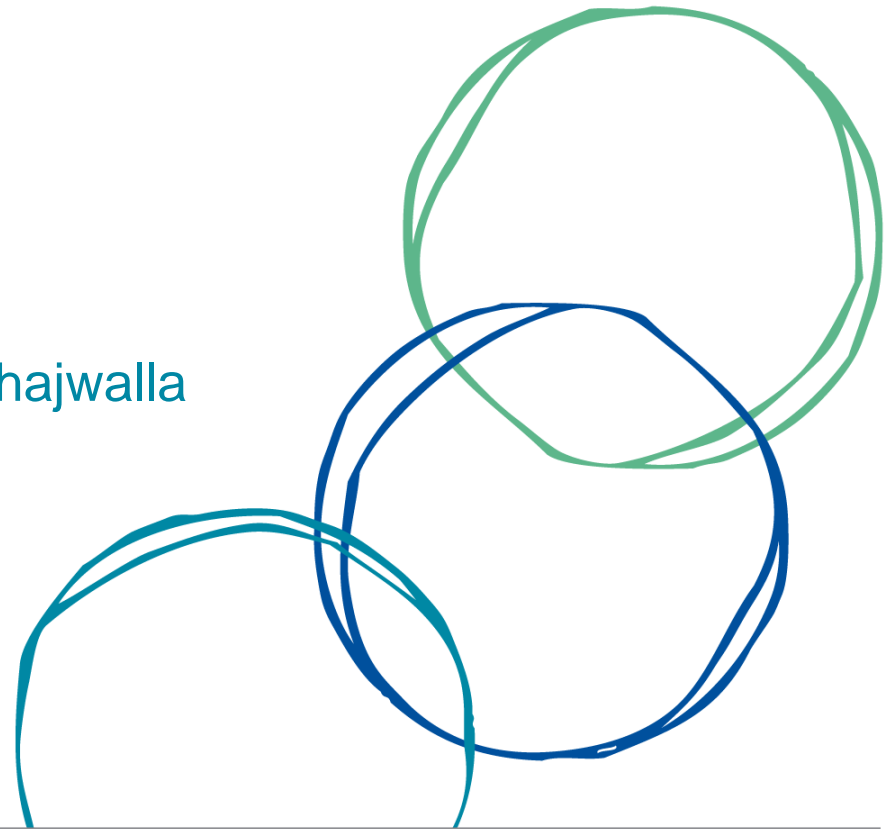
F: +61 2 9385 5530

Twitter: @CRC\_LCL

# Transforming waste: Recycling glass into benchtops

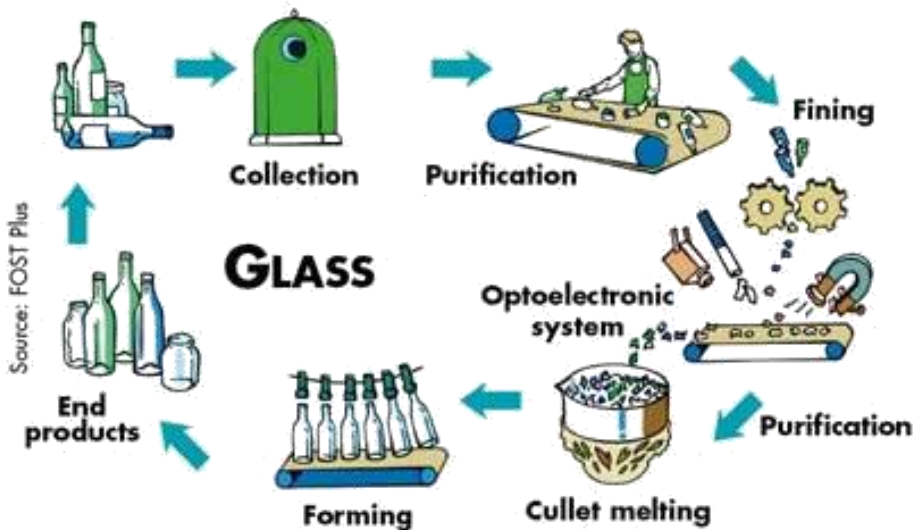
Heriyanto, [Farshid Pahlevani](#), Veena Sahajwalla

22 November 2017



# Glass Recycling

- Glass is very **durable** and **100% recyclable**.
- Recycle glass is substituted for up to 70% of raw materials
- Glass can be recycled endlessly without losing any purity, and is one of very few materials that can do so.
- Glass can take 4000+ years to decompose
- Lower energy consumption in producing new glass



# Different Types of Glasses

Types of glasses	Properties	Application	Softening point
Soda lime glass (most widely used glass)– contains $\text{Na}_2\text{O}_3$ , $\text{Al}_2\text{O}_3$ )	Inexpensive, easy to melt and shape	Windows, bottles, light bulbs, jars	724°C
Lead glass (contains 20-30% lead oxide ( $\text{PbO}$ ))	High density, very easy to melt, shape, cut and engrave.	Fine crystal radiation windows, TV tube parts, perfume bottles, crystal beads	600°C

Types of glasses	Properties	Application	Softening point
Borosilicate glass (contains 5-13% $\text{B}_2\text{O}_3$ )	Very good thermal shock resistance and chemical durability	Lab ware, kitchen ware, special light bulb, glass pipe	821°C
Aluminosilicate glass (contains 5-10% $\text{Al}_2\text{O}_3$ )	Excellent thermal resistance, durability	Combustion tube, high quality fibreglass	910°C
High silica glass (using 100% fused quartz)	Outstanding thermal resistance	Spacecraft windows, labware, fiber optics	1683°C



# Grenew® Products



Modern glass building



Building demolition



Broken window glasses

*From waste to novel **Grenew®** Products*



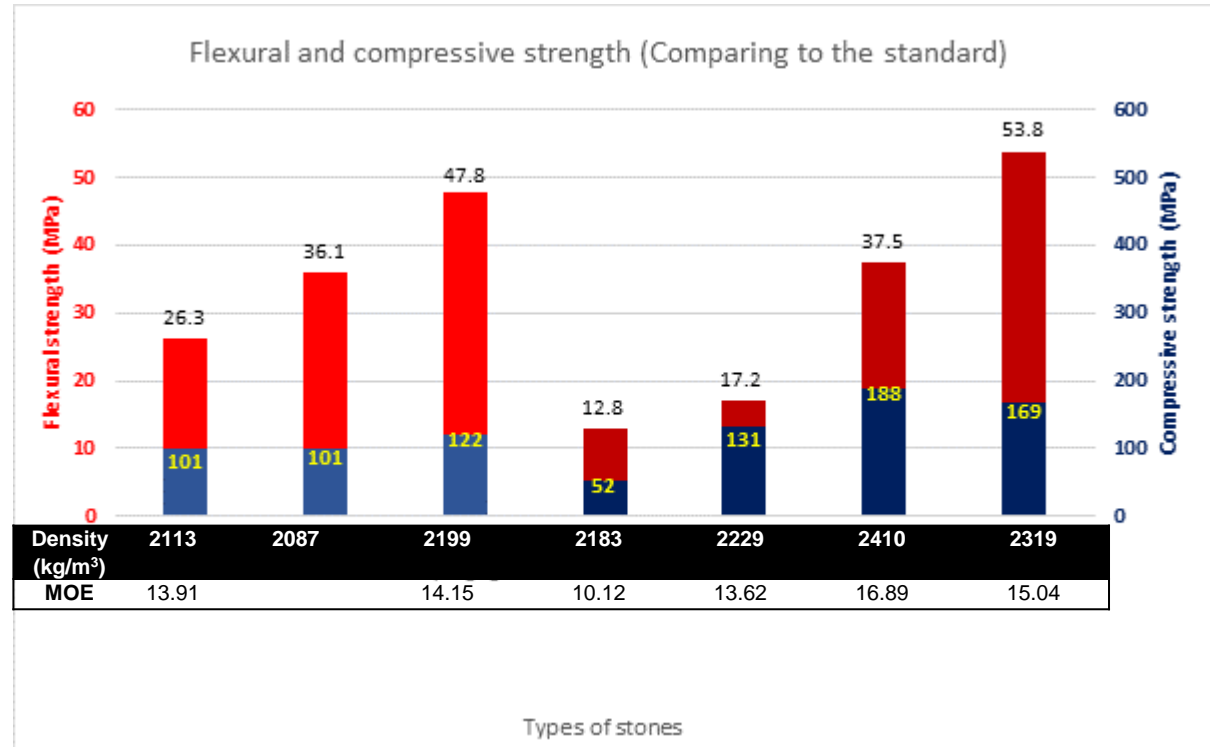
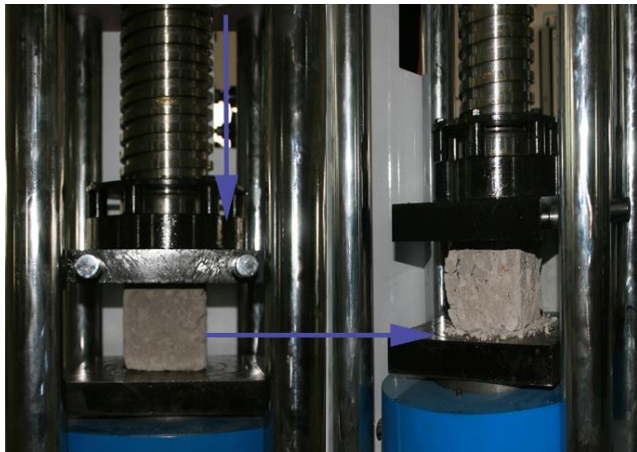
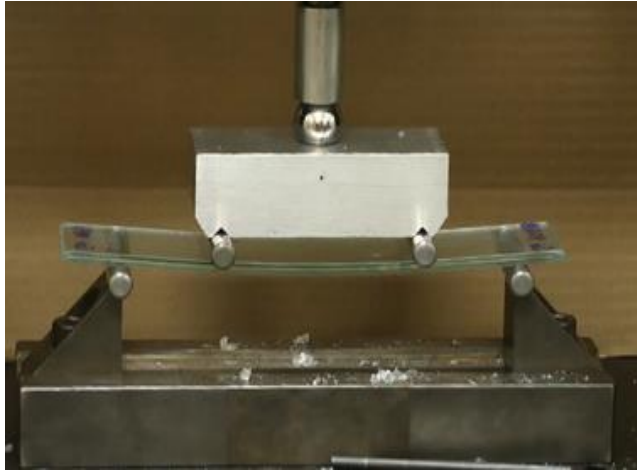
Products



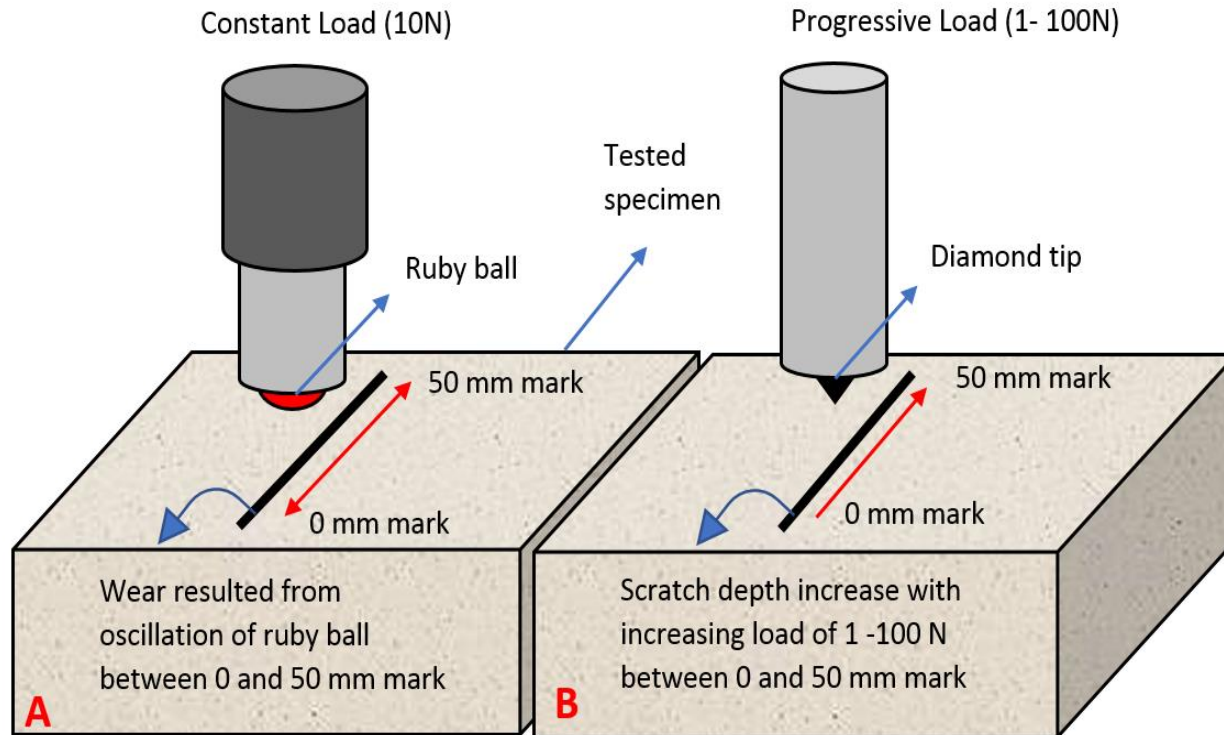
Analysis

# Grenew® Glass Panels

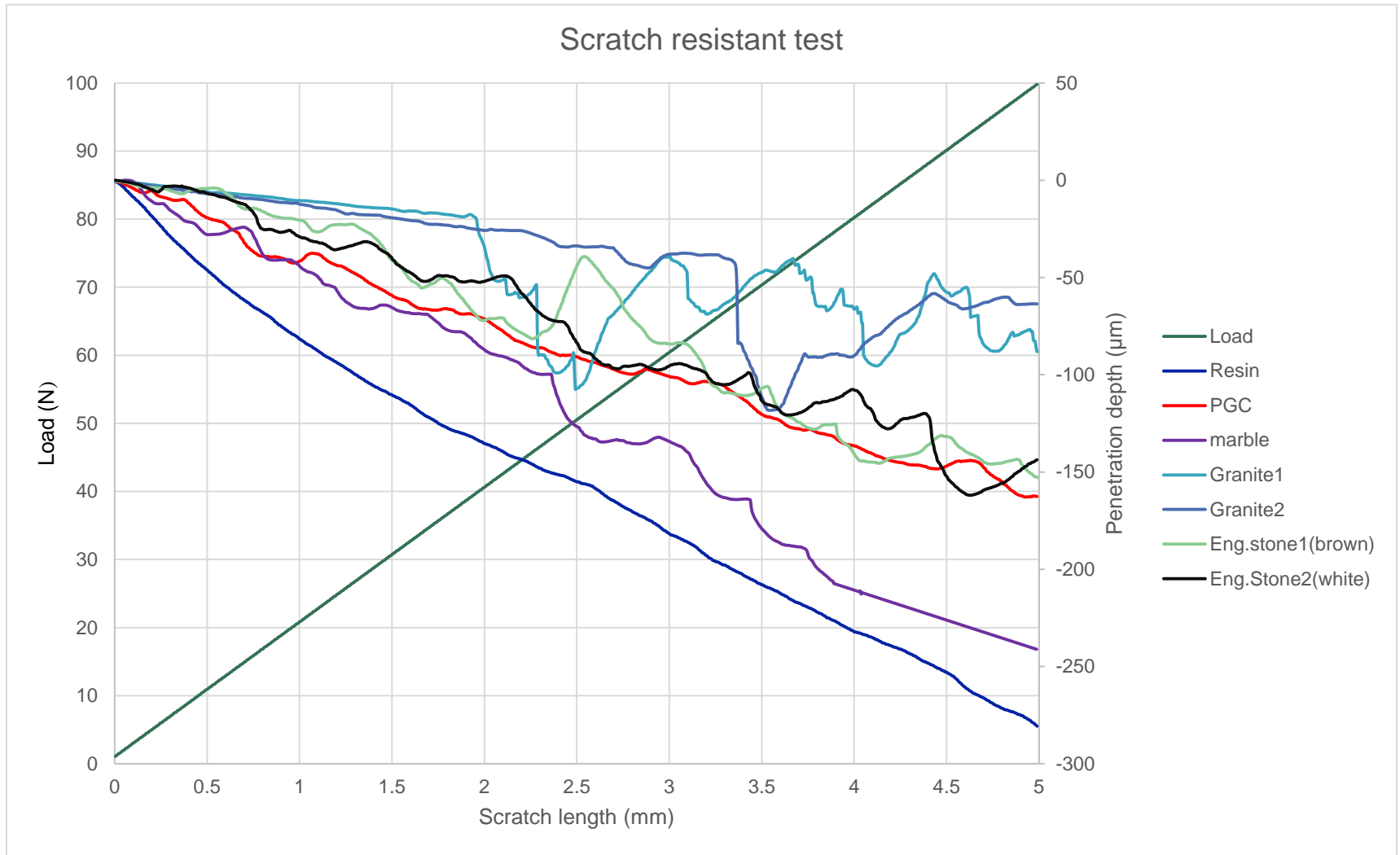
## Flexural Strength and Modulus of Elasticity



# Grenew® Glass Panels



# Grenew® Glass Panels

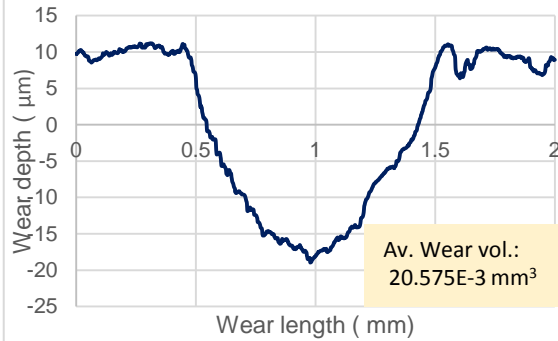




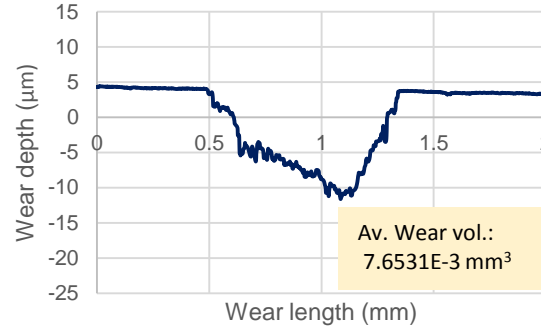
# Grenew® Glass Panels

Wear profile of tested samples and correlation of wear resistance with hardness

Wear (Resin)



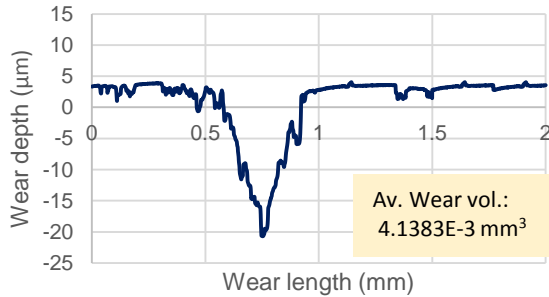
Granite



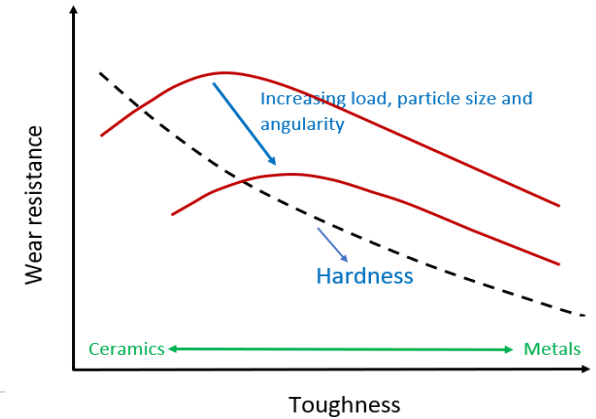
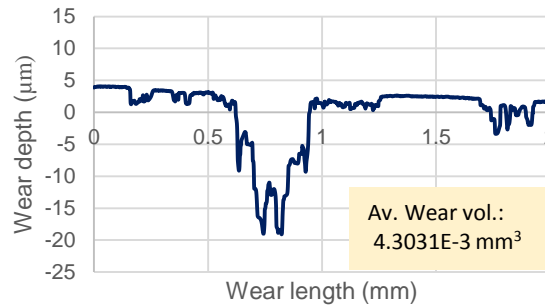
Wear (PGC)



Wear (engineering stone 1)

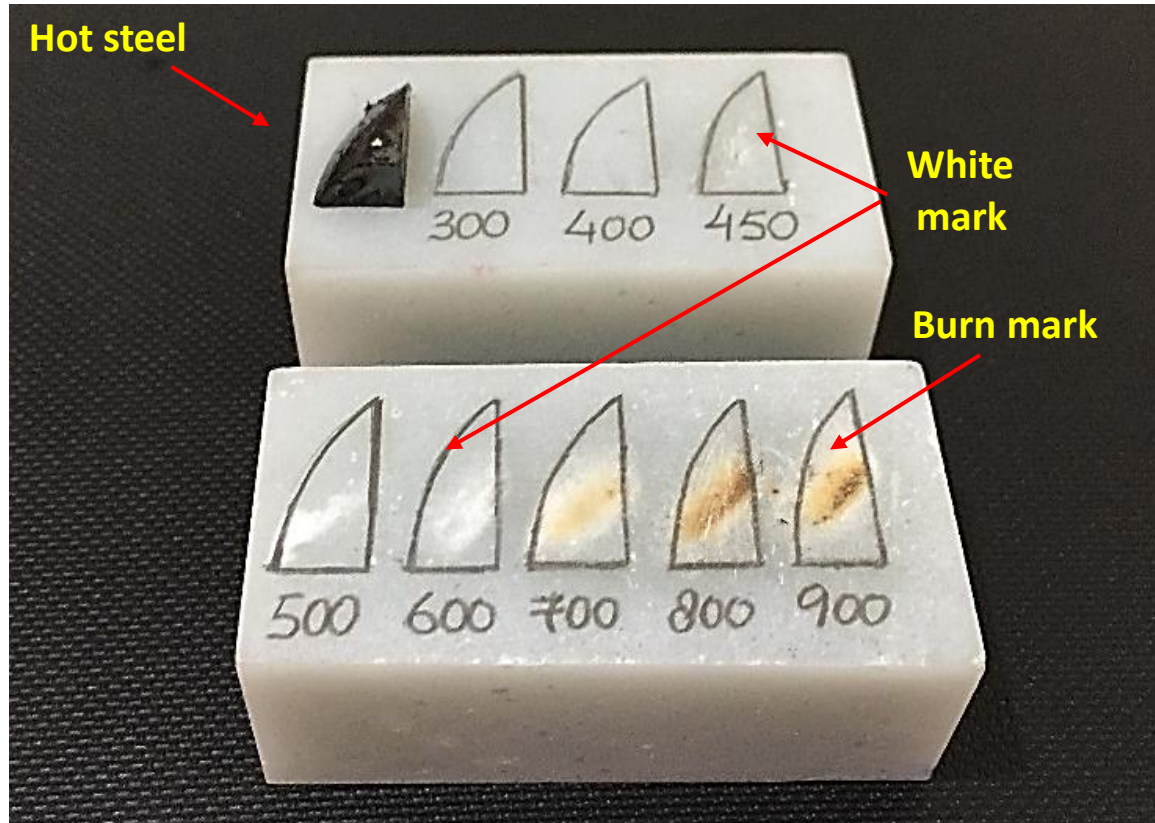


Wear (Engineering stone 2)





# Grenew® Glass Panels

Scorch test of PGC at 8 different temperature



# Grenew® Glass Panels

## Schematic and characteristic of horizontal and vertical burn for UL94 flame retardant test

	Horizontal burn (H-B)	Vertical burn
<b>Specimen setup</b>		
<b>Description</b>	First test (Least flame-retardant UL94 rating)	Second test after the specimen pass the H-B test
<b>Characteristics</b>	Slow burn	Self-extinguishing
<b>Pass requirement</b>	Pass the test if the specimen takes more than 3 min to burn 4 inches.	V-0: self-extinguish within 10 secs after five applications of 5 secs each flame (Best) (No flaming drips are allowed) V-1: self-extinguish within 60 secs (good) (no flaming drips are allowed) V-2: self-extinguish within 60 secs (flaming drips are allowed)

# Grenew® Glass Panels

## Flame retardant testing of different samples

Samples	Horizontal burn	Vertical burn ( Average total flaming combustion)
PGC	Pass (self-extinguish)	V1 (< 225 secs)
<b>Commercial samples</b>		
Marble	Natural stones do not contain polymer binder, therefore they passed all the required flame retardant test.	
Granite		
Quartz		
Engineering stone	Pass (self-extinguish)	V1 (< 210 secs)



# Grenew® Glass Panels

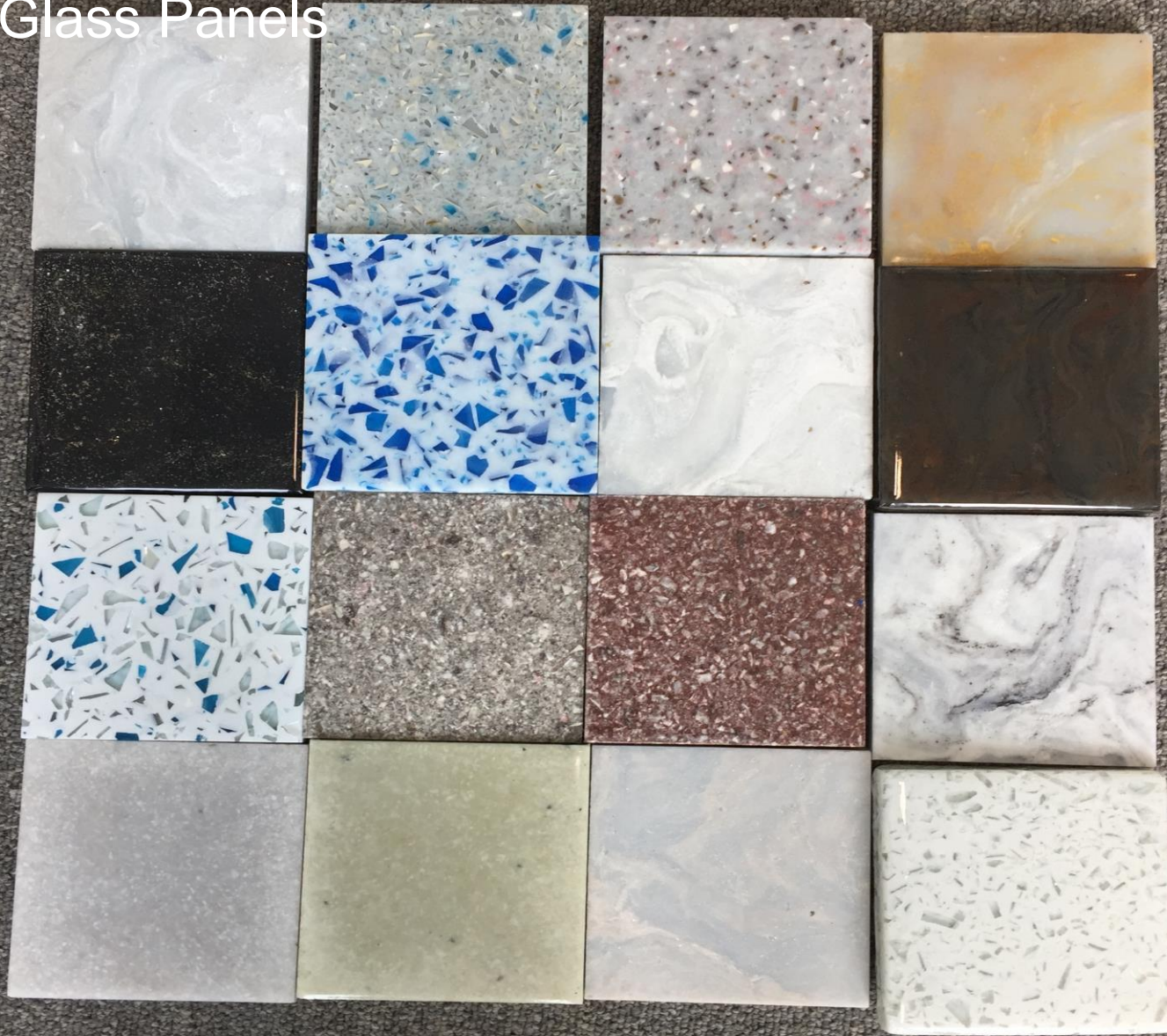


# Grenew® Glass Panels





# Renew® Glass Panels





# Grenew® Glass Panels





# Grenew® Glass Panels



## PARTICIPANTS



The CRC for Low Carbon Living also works with an extensive range of government and industry third parties at a project level

## CONTACT US

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Australian Government  
Department of Industry,  
Innovation and Science

Business  
Cooperative Research  
Centres Programme

# Thank you

## To find out more, contact

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