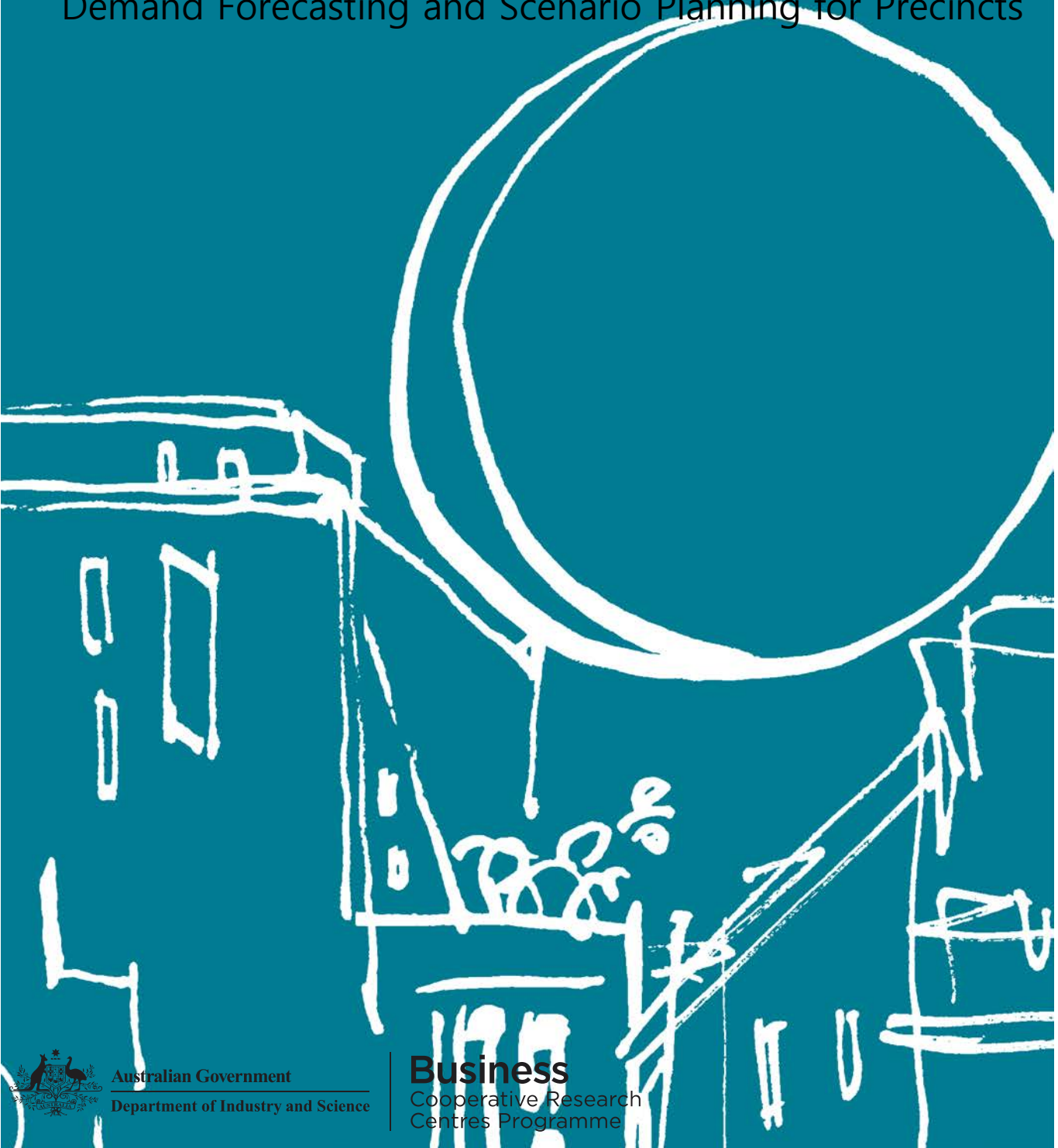




LOW CARBON LIVING
CRC

PROJECT WORKSHOP NO.1 Initial Workshop Summary Report

Integrated Energy, Transport, Waste and Water (ETWW)
Demand Forecasting and Scenario Planning for Precincts



Australian Government
Department of Industry and Science

Business
Cooperative Research
Centres Programme

Authors	Beatty, Kate; Berry, Adam; Delvin, John; Donaldson, Phil; Holyoak, Nick; Iankov, Ivan; Lehmann, Steffen; Newton, Peter; Oxlad, Lindsay; Philp, Michelle; Parasad, Deo; Taylor, Michael; Thomas, Nick; Ting, Jason Wiedmann, Tommy; Zaman, Atiq; Zito, Rocco
Title	Integrated Energy, Transport, Waste and Water (ETWW) Demand Forecasting and Scenario Planning for Precincts
ISBN	
Format	
Keywords	
Editor	
Publisher	CRC for Low Carbon Living
Series	
ISSN	
Preferred citation	

CONTENTS

CONTENTS	2
LIST OF FIGURES.....	3
INTRODUCTION.....	4
PRESENTATIONS.....	5
CRC for Low Carbon Living Overview – A presentation by Prof. Deo Prasad.....	5
Program 2: Low Carbon Precincts Overview – A presentation by Prof P.W. Newton	5
ETWW Project Overview – A presentation by Prof. M.A.P. Taylor.....	7
Energy Demand Forecasting – A presentation by Dr. Adam Berry, (CSIRO)	9
Transport Demand Forecasting - A presentation by Dr. Nicholas Holyoak, (UniSA).....	9
Economy-Wide Life-Cycle Accounting and Water Demand Forecasting - A presentation by A/Prof Tommy Wiedmann, (UNSW)	9
Waste Demand Forecasting - A presentation by Prof Steffen Lehmann, (UniSA)	10
The Practitioner's View - A presentation by Mr Phil Donaldson, (Renewal SA)	11
WORKGROUP DISCUSSIONS	12
Discussion topic 1: What definitions need to be considered?	12
Discussion topic 2: What are the main synergies that you can see from today?	12
Discussion topic 3: What are the main gaps that need addressing?	13
Discussion topic 4: Creating an integrated model – what alternative approaches can you think of [to those you currently work with]?	13
Discussion topic 5: List potential interactions between areas (e.g. if i reduce car use by staying at home, there'll be additional energy used and different use of water and considerations of waste).	14
Discussion topic 6: How will we retain interest/enthusiasm amongst the group?.....	14
Additional discussions.....	14
WHAT'S NEXT?.....	16
APPENDIX A: ENERGY DEMAND FORECASTING PRESENTATION.....	17
APPENDIX B: TRANSPORT DEMAND FORECASTING PRESENTATION.....	19
APPENDIX C: ECONOMY-WIDE LIFE-CYCLE ACCOUNTING AND WATER DEMAND FORECASTING PRESENTATION	20
APPENDIX D: WASTE DEMAND FORECASTING PRESENTATION.....	23
APPENDIX E: A PRACTITIONERS VIEW PRESENTATION	30

LIST OF FIGURES

Figure 1: Research Program 2 Structure.....	5
Figure 2: Considerations for interfacing existing Precinct Tools with PIM	6
Figure 3: The arena of precinct design assessment.....	6
Figure 4: Time horizons of the CRC Studies of Socio-Technical Innovation in Program 2.....	7
Figure 5: Expected tasks and milestones for the duration of the project	8

INTRODUCTION

The following is a summary of the workshop presentations, discussions and of the workgroup sessions for the CRC-LCL's project on ETWW conducted Friday 1st February 2013, 10:00 – 16:30 at Room C4-16 at the University of South Australia's City East Campus, chaired by Liz Ampt.

This project for the CRC for Low Carbon Living is designed to develop a shared platform for integrated ETWW (energy, transport, waste and water) demand forecasting and scenario planning for ETWW under low carbon futures, focusing on gaps, synergies, alternative approaches and required research directions. It will include a series of facilitated national workshops on demand forecasting for ETWW utilities and services and on scenario generation and appraisal. The aim is to seek the development of integrated tools for demand forecasting and scenario evaluation covering ETWW with identified commonalities in data requirements and model formulation. It will first (Phase 1) develop an integrated framework for demand forecasting that will then be fully developed and implemented in Phase 2. A method for including the impacts of household behaviour change in demand forecasting will be a major component of the framework. In this way overall carbon impacts of urban developments or redevelopments can be assessed effectively and efficiently.

The first of these facilitated national workshops on demand forecasting was hosted by The University of South Australia at their City East campus on Friday 1st February 2013. Running from 10:00am to 4:30pm, the workshop invited representatives from the project partner organisations with presentations from a selection of these as well as CRC-LCL and project leaders. Attendees also contributed to workgroup sessions with a range of topics and issues relative to the project discussed and presented. The following report is a summary and synthesis of this workshop containing the following elements:

- Introductory ETWW project information

- Presentations on CRC-LCL and the ETWW project
- Presentations by key researchers and industry
- Workgroup discussions and synthesis of outcomes
- What's next?

PRESENTATIONS

CRC for Low Carbon Living Overview – A presentation by Prof. Deo Prasad

The CRC-LCL builds upon expertise in sustainable urban design, solar energy, energy efficiency, built environment, decision support software tools and community engagement. It is dedicated to engaging multidisciplinary expertise, existing technology development, social research and national benchmark software tools. Three research programs reflect the three key research areas related to delivering a low carbon built environment. Programs areas are:

- Program 1: Integrated Building Systems
- Program 2: Low Carbon Precincts
- Program 3: Engaged Communities

Program areas look to making low carbon buildings affordable, low carbon infrastructure desirable and

informing and empowering decision makers. A multidisciplinary approach will enable sustainability with a low-carbon metric as well as sustained change, developing policies based on evidence. Programs are end-user driven allowing for tools that are widely and publicly available to drive policy and design.

More information on the CRC for Low Carbon Living is available from their website:

<http://www.lowcarbonlivingcrc.com.au/>

Program 2: Low Carbon Precincts Overview – A presentation by Prof P.W. Newton

Research Program 2 of the CRC will develop new knowledge and tools that enable the design of, and stimulate the market for, low carbon infrastructure at the precinct scale. This will facilitate property developers and local government partners providing low carbon infrastructure development as well as redevelopment and retrofitting at the planning point of delivery. The structure for the program is indicated below.

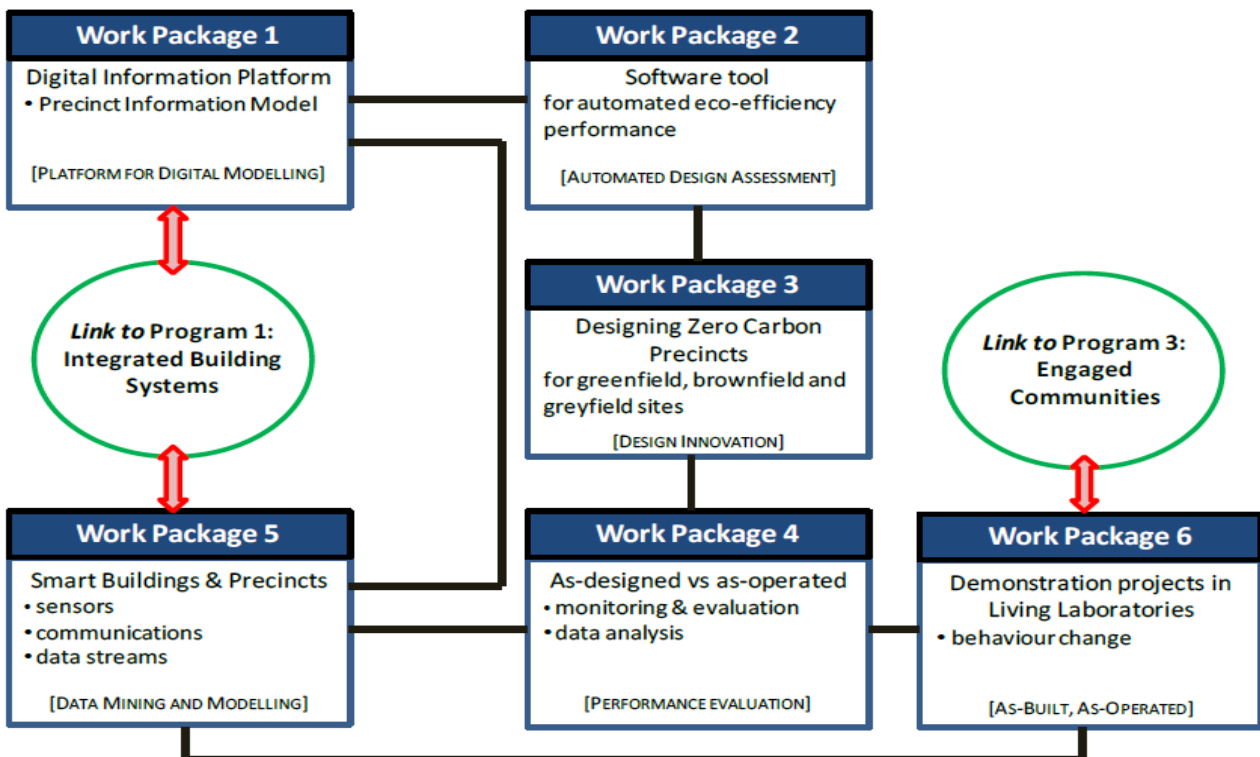


Figure 1: Research Program 2 Structure

The program 2 structure is based on six connected work packages, which also link to the other programs in the CRC. Activity areas included in Program 2 (and projects within these) consist of the following:

Activity 1: Digital Information Platform:

- Project: Scoping study for precinct design assessment tools (Module 1: PIM)

The following illustration of the Scale of 'Things' (Source: UrbanIT, after Andreas Kohlhaas) is used to demonstrate the location of precinct scale design assessment relative to other scales of assessment.

Considerations for interfacing existing Precinct Tools (such as PrecinX, MUtopia and others) with PIM is represented in Figure 2.

Activity 2: Performance Assessment & Demand Forecasting for Precincts

- Project: Scoping study for precinct design assessment tools (Module 2,3: Assessment methods, databases)
- Project: Integrated energy, transport, waste and water demand forecasting and scenario planning for precincts

The arena of precinct design assessment including relationships between framework, assessment and rating is illustrated in Figure 3.



Figure 2: Considerations for interfacing existing Precinct Tools with PIM

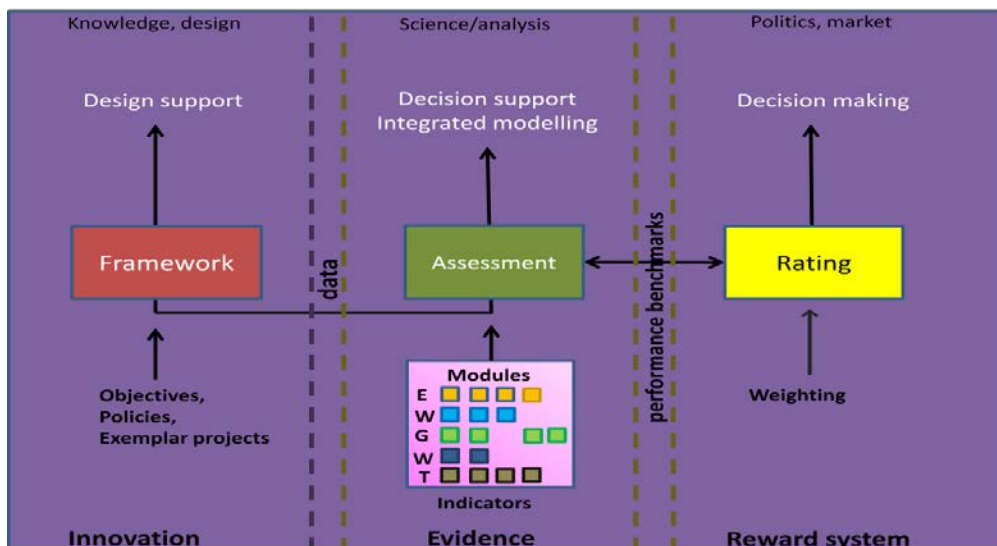


Figure 3: The arena of precinct design assessment

Activity 3: Design Innovation

- Project: Low carbon precincts – international review of best practice policy and practice
- Project: Design interventions for urban heat islands
- Project: Visions and Pathways 2050: Scenarios, Visions and Pathways for a Low Carbon Built Environment (Joint with program 3)

Activity 4: Performance Evaluation (precincts as operated)

- [Living laboratories/ Joint with program 3]

Activity 5: Data Mining and Modelling

- Project: Joint CRC/AURIN project on integrated energy/water database for Sydney (+ consumption models; Jevons effect

- Project: Health co-benefits calculator
- Project: Carbon metrics for the built environment (cross program)

The CRC Studies of Socio-Technical Innovation in Program 2 contains 3 time horizons as illustrated in the Figure 4.

Precinct demand forecasting largely within horizon 2: implementable over the next 3-10 years.

Discussions that arose from this presentation posed the question is the 'Program Framework' appropriate and what other 'precinct' issues/topics are not covered yet?

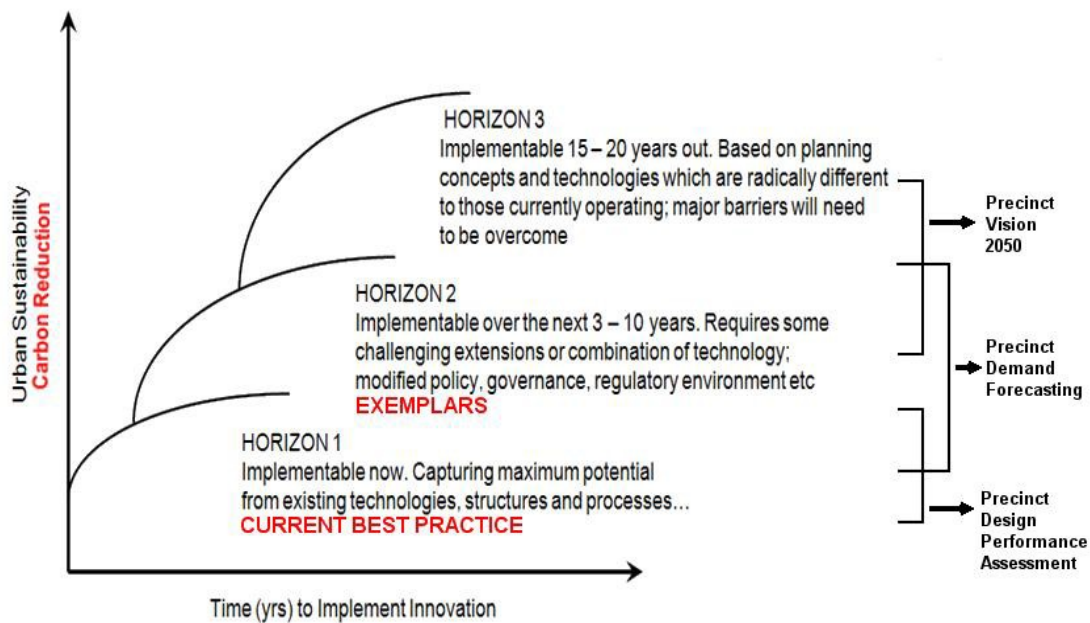


Figure 4: Time horizons of the CRC Studies of Socio-Technical Innovation in Program 2

ETWW Project Overview – A presentation by Prof. M.A.P. Taylor

The ETWW project exists in work package 2 of the CRC program 2 and has the following project partners:

- UniSA
- CSIRO
- UNSW
- SA DPTI
- Renewal SA
- SA Water
- Sydney Water
- AECOM

Project objectives are:

- Develop a method for the simultaneous estimation of the demands for energy, travel, water and waste
 - (initially) at residential household level
 - including carbon impacts
- Include the impacts of voluntary behaviour change by households
- Implement a tool for planners and developers
 - to estimate demands in the planning, design and evaluation of residential developments

It is anticipated that this will present challenges to develop a tool for use by practitioners (industry and community).

The project is to extend over 3 years with 2 project phases (1 year + 2 years) and a \$0.962M cash budget (+ \$1.266M in kind). The core team consists of:

- 1 project leader (Prof. Michael Taylor)
- 4 key researchers (Prof. Steffen Lehmann, Dr. Adam Berry, Dr. Rocco Zito, A/Prof Tommy Wiedmann)

- 1 postdoctoral fellow (Dr Nicholas Holyoak)
- 4 PhD students (TBA)
- project steering committee (partner and other organisation representatives)

Project outputs include an integrated framework for demand forecasting, to be developed, tested and implemented. This will result in an integrated demand estimation tool designed for use by practitioners and tested by them, which estimates carbon performance, accounts for behaviour change programs, includes different forecasting time horizons and includes interaction effects between demands.

Figure 5 shows a timeline of the expected tasks and milestones for the duration of the project.

Project steering committee meetings are to be held every 6 months. After the initial workshop, others will be held to consider the ETWW forecasting research synthesis, framework and specification. Finally, a national symposium will be held close to the conclusion of the project.

Phase	Year	Task/milestone	J	F	M	A	M	J	J	A	S	O	N	D		
1	1	1.1 Domain exploration	█	█	█	█	█									
		PSC meeting #1		█												
		Initial workshop			█											
		1.2 Workshop summary report				█	█									
		1.3 Synthesis of demand estimation					█	█	█	█	█	█				
		Synthesis workshop										█				
		1.4 Integrated model framework										█	█	█	█	
		PSC meeting #2											█			
		Researchers workshop (framework)												█		
		1.5 Framework synthesis report												█	█	
2	2	2.1 Model specification, ...	█	█	█	█	█									
		PSC meeting #3				█										
		Researchers workshop (specification)					█									
		2.2 Specification-integration report						█								
		2.3 Model implementation, ...							█	█	█	█	█	█	█	
		2.4 Model implementation report											█			
	3	3	PSC meeting #4											█		
			2.5 Model testing and integration	█	█	█	█									
			2.6 Assembly of prototype tool			█	█									
			PSC meeting #5				█									
3	3	2.7 Testing and application of tool				█	█	█	█	█	█	█	█	█		
		2.8 Tool implementation report						█								
		PSC meeting #6											█			
		2.9 National symposium												█		
		2.10 Final report												█		
															█	

Figure 5: Expected tasks and milestones for the duration of the project

Energy Demand Forecasting – A presentation by Dr. Adam Berry, (CSIRO)

A copy of the full presentation is available in Appendix A and in summary:

- Modelling and forecasting energy is becoming rapidly more complicated due to the rise of intermittent renewables, the growth of demand-side provisions, bi-directional power-flow and the likely arrival of EVs and other distributed storage.
- There is very little public data available that accurately captures the topology, impedance and behaviour of Australia's electricity and distribution low-voltage networks, nor is there much in the way of detailed analysis of demand-side load management/behaviour change initiatives.
- CSIRO is looking to improve the quality and availability of data with the National Feeder Taxonomy Study, Solar Cities and Solar Intermittency programmes, which mine data about the electricity distribution network, demand-side intervention initiatives and solar energy variability
- CSIRO has solar and load forecasting technologies that are suitable for short-term (<hours) forecasting of demand and tools for optimising the layout of networks and estimating EV & solar uptake.

Following the presentation, discussion was on:

- The ability of energy models to forecast precinct demographic changes eg. double in house numbers? This was considered unlikely at this stage due to data restrictions and very little known about voltage distribution.
- Caution must be taken with assuming transferability of models between locations.
- Models need to provide multiple and diverse products such as and other energy uses beyond electricity (eg. gas) and consider non-residential users in a precinct.

Transport Demand Forecasting - A presentation by Dr. Nicholas Holyoak, (UniSA)

A copy of the full presentation is available in Appendix B and in summary:

- Presentation summarised approaches to forecasting transport behaviour patterns for present and future years using modelling approaches.
- Overall, travel demands for a population are estimated from socio-demographic and land use data and assigned to the transport network supply.
- Modelling commonly occurs at macro (national/state), meso (metropolitan) or micro (intersection) scales with meso suggested as potentially most appropriate for this project.
- Transport forecasting is well researched and utilised in practice with much scope for including behavioural components.
- Key input data includes population and household profile info, employment and education data and transport system operation data.
- Key outputs include network travel patterns, emission and energy consumption estimates
- GIS data representation is heavily utilised for this and potentially other modelling realms.

Following the presentation, discussion was on:

- It was noted that transport modelling tools used are sophisticated and based on many years of developments.
- Although a 'meso' level model was suggested for being most appropriate at this stage, more micro-level models may also have an application.

Economy-Wide Life-Cycle Accounting and Water Demand Forecasting - A presentation by A/Prof Tommy Wiedmann, (UNSW)

A copy of the full presentation is available in Appendix C and in summary:

- Economy-wide life-cycle accounting based on environmental input-output analysis provides a comprehensive modelling framework for economy-environment interactions.
- Energy, transport, water and waste are represented in such a framework in the form of economic sectors, (annual) environmental flows
- Overall carbon outcomes can be quantified from a production (direct) and consumption (embodied / footprint) perspective
- Trade-offs and nexuses can be evaluated quantitatively and in the context of the Australian economy
- The current Industrial Ecology Virtual Laboratory (IE Lab) project is currently building up an environmental input-output framework for Australia with a sector resolution of ~1300 and spatial resolution of ~2000 (suburb level)
- Key input data for water demand scenarios include population growth, demographic changes, consumption patterns / lifestyles, uptake of water efficiency measures and water recycling initiatives and climate change. The rebound effect should be taken into account.
- The water supply side also has important implications for the overall carbon outcome of future water demand scenarios
- Quantified scenario variables from water demand model (and other models) can be used to project full IE Lab framework to future years, allowing the calculation of economy-wide carbon outcomes.
- Using the waste hierarchy, a focus must be on reducing/avoiding the creation of waste
- Circular material flows (looping material cycle) include maximised reuse and recycling; but recycling alone will not be enough
- Organic waste offers particular opportunities for composting, biomass and fertiliser production
- Samples were given for landfill/incineration/recycling and recovery/composting figures of a series of countries and for Adelaide
- A typical process of forecasting (future capacity requirements) was presented, comparing three methods of demand forecasting
- A list of existing tools and their foci was presented; Adelaide waste facts were presented
- It was obvious that the waste domain has its particular challenges and demand forecasting must go beyond weight, volume and diversion rate
- Future consumption and behaviour change patterns will have a significant impact
- Lifecycle approaches and embodied energy are significant
- Different types of waste streams and linkages to other domains (e.g. waste water) need to be integrated
- New waste types, such as e-waste or new construction components, create new challenges
- Each city will need to define its particular solutions, this means: the tool will need to be calibrated and fine-tuned

Waste Demand Forecasting - A presentation by Prof Steffen Lehmann, (UniSA)

A copy of the full presentation is available in Appendix D and in summary:

- Presentation summarised approaches to forecasting waste demand and estimation methods

Following the presentation, discussion was on:

- This project component has two PhD students that will be involved and seeking 1 more
- What about waste water and waste energy? There will be important aspects to each project element that will cross the boundaries.

The Practitioner's View - A presentation by Mr Phil Donaldson, (Renewal SA)

A copy of the full presentation is available in Appendix E and in summary:

- Why the need for ETWW demand forecasting– driving affordable outcomes, consistent metrics, policy, combined approach
- What we do now – range of current software tools including PrecinX
- Lochiel Park - ecological footprint calculations
- Tonsley Park redevelopment – integrated energy, water and waste management, requires tri-gen plant and energy transfer stations, renewable energy and storage, retic system, smart building control integration
- PrecinX: software tool integrating onsite energy, embodied CO2, potable water, transport, housing diversity and stormwater modules. Outputs KPI's of greenhouse gases, potable water, total affordability and vehicle hours travelled. Applied to infill and fringe case studies and presents a comparative analysis of development scenario planning using key metrics.
- Tools: needs include common metrics, to take note of industry needs, present scenario sensitivity, incorporate benchmarks with links to existing databases and assessment processes. Also behaviour change capabilities, be easy to use, understand the market and avoid re-inventing the wheel.

Following the presentation, discussion was on:

- Will developers see the benefits? Will they use the tool that gives them their most preferred/best answer? Developers attitudes are changing over time and decisions are made based on conversations based on initiatives
- It will be useful to identify the stakeholder and end-user need with respect to the modelling tools – therefore a need to contact them exists.

WORKGROUP DISCUSSIONS

Following on from the presentations and discussions, the workshop participants were divided into 3 workgroups (of approx 6 members each) and given approximately 1 hour to discuss 6 topics associated with the ETWW project. Following this workgroup session, representatives presented their respective group's outcomes. Groups were structured as follows:

Table 1: Workshop group members

Group 'A'	Group 'B'	Group 'C'
Phil Donaldson	Nick Thomas	Michelle Philip
Rocco Zito	Nick Holyoak	Michael Taylor
Kate Beatty	Adam Berry	Tommy Wiedmann
John Devlin	Ivan Iankov	Jason Ting
Steffen Lehmann	Peter Newton	Atiq Zaman

During this session, discussions were to centre around six core questions. These questions and the combined outcomes from all groups are presented in the following sections.

Discussion topic 1: What definitions need to be considered?

Considerations that were identified by the workshop groups had much common ground with some topics identified by more than one group. Where this occurs, the number of groups that have identified this issue is provided in brackets. The definitions that need consideration were identified as:

- Precinct (3): 'Green Star Communities', link to PIM project, aggregation flexibility, scale can vary but covers a mix of users/building types, landmark that links surrounding land uses, boundaries can be physical eg. major roads or social
- Time frames/horizons (2): dependant of client base and their requirements, closely linked to forecasting,

providing and managing/operating infrastructure and services

- Forecasting scenarios (2): what and how, scenario analysis and policy drivers, succinct detail, how receptive and how dynamic eg. policy, climate, technology
- Low carbon living (2): low carbon, metrics of definition, lifestyle – personal - behaviours
- End user (2): government, developer, policy, utilities (Stakeholders), Community, builder, consumer, developer, tool benefits, users, open source, regulators
- Waste: water, energy, nutrient, time
- Base-unit of analysis
- Demand: specific/different definitions for ETWW, Waste in particular is different - more likely a supply, seasonal variations
- Behaviour change: voluntary, compulsory, incentives – relationship of all to industry transformation – personal / precinct development
- Incremental change versus transformational change
- Forecasting parameters: is mean enough or range/distribution (and consequence of system failure)

There is a need to define what is meant by a 'precinct', not only in terms of the physical aspects and spatial scale but also consider data needs associated with modelling, the low carbon living elements within it and who will be involved in the assessment of these. At this stage the required definitions relate to establishing the broad forecast model parameters such as base units and behavioural inclusions.

Discussion topic 2: What are the main synergies that you can see from today?

Workgroups were held after the presentations and discussions from CRC and partner organisations, providing participants with an insight into the dimensions

of the forecasting issues related to energy, transport waste and water. As workgroups they then had the opportunity to identify general common ground and interactions of model forecasting. The identified issues extend beyond the forecast model development itself.

- Data (2): level of data consistent – household data, climate data; Data bases, storage and recall, operational scale – opportunity for “platform widget”, demographic base of models – everyone uses ABS
- PrecinX (2): ETWW
- Expense: Commercial – Affordability
- Energy: Across all areas
- Complexity: simple resilience
- Adaptable: regenerative opportunities
- Pollution/Hazard/Safety
- Localisation: Reduce all domains

This discussion topic also gave rise to some additional questions posed by the groups relating to the level of relationships between ETWW and the modelling approach. Network based modelling across areas – network based approach is a common element? Or is this a supply chain approach?

Possible synergies seen in the data used in the modelling processes with the PrecinX model viewed as a tool that should be recognised and investigated further.

Discussion topic 3: What are the main gaps that need addressing?

To complement the previous discussion topic, workgroup members had the opportunity to note areas that need addressing in terms of gaps and shortfalls. This topic received more attention than the previous in terms of provided answers with some common to the previous (eg. the issue of data). Again, the issues extend beyond the forecast model itself.

- Data (3): Getting the data – ‘Design Data Protocol’, consistency of input data, how ETWW uses data – is ABS data inputs the same as transport energy, cross elasticity between the ‘silos’, measurement of performance – data capture, what and from where?
- Time (2): Time/resources/people allocated in project – eg. energy experts, time frame –model scale, how fine/coarse, need to identify reach
- Waste informatics (modelling)
- Evaluation
- Retrofitting – Access? and invisibility and scale
- Prioritise demand scenarios – future
- Pricing and sensitivity analysis – capability
- Impact analysis (intended consequences)
- Life cycle boundaries
- Energy – includes all types eg. gas

The importance of data emphasised as groups identify aspects that will need to be addressed relating to availability, types and applicability. Identifying modelling and analysis capabilities and establishing research timeframes and resources is also needed.

Discussion topic 4: Creating an integrated model – what alternative approaches can you think of [to those you currently work with]?

Due to time constraints, only 2 groups suggested alternative approaches and other considerations.

- Trust modelling of industry: get the first cut - look
- Don’t re-invent the world
- Outputs: test, valuable, reliability of tests
- Activity based model of personal scale
- Distills down to a common carbon metric: Consider 1. Focus is a precinct performance. 2. What is the most suitable way to present forecast results eg. transport – is it probability distribution of trip length?

- Also: Elasticities (economic) of the demands and cross-elasticities between the demands

Discussion topic 5: List potential interactions between areas (e.g. if i reduce car use by staying at home, there'll be additional energy used and different use of water and considerations of waste).

This topic was addressed in different ways by the groups, who have suggested specific interactions, and other considerations beyond these. Rather than provide detail on potential interactions between areas, one group noted that it is very important to identify and clearly define interactions and interaction boundaries while asking which are 'important' and to prioritise these.

- Reducing car use – work from home, increase in energy use
- Car fleets – reduce carbon – newer cars, fleet change over – wasting embedded energy
- Energy used in providing water at point of consumption
- For precinct, energy and water use in precinct (household?) by time of day given travel by household members (therefore times individuals are in the precinct – activity modelling etc.)
- Waste disposal has transport component and an energy component
- Waste water
- Opportunity analysis –
- Connections to outside the precinct
- Multiplier effects of solutions - opportunities
- Employment/productivity/food – supply chain, lifestyle, community connections

As there are many specific examples of interactions, this is a topic that will need further consideration in terms of what interactions are to be recognised and how these will be represented in the forecast modelling process.

This is especially important to deliver an integrated ETWW modelling approach.

Discussion topic 6: How will we retain interest/enthusiasm amongst the group?

Groups offered a range of suggestions to this last topic, largely focussed around structured communication with opportunities for non-structured interaction. It was largely seen as the responsibility of the research leaders to initiate with the opportunity for all involved organisations (and beyond) to participate.

- Digital
- Shared data store
- Email updates
- Online forum/discussion board for researchers
- Newsletter on project updates – key researchers
- User forums to get feedback and inform stakeholders
- Opportunity for research forums – PhD's
- Regular exchange of progress and events, outcomes – key researchers
- Non-CRC participants – board, team leaders
- Joint papers
- Common areas for interaction,
- Wine and beer – program leaders
- Encourage external and practitioner inputs

Responses to this topic indicate that it is an important aspect that can be achieved through various interaction methods at varying levels of complexity and resources. The use of electronic means is encouraged to increase the ease of the communication process.

Additional discussions...

In addition to the topic-led issues, the workgroups also identified other research items considered worthy of mention, which included:

- Peer review outside CRC
- CRC journey over the coming years – what is the narrative? Can we make it exciting, colourful and artistic?
- Raising the profile of this project and project group – articles (eg. based on the first workshop, birth of CRC) should be distributed to networks
- Capacity building of industry and PhD's – upskilling multi-dimensional analysis of developing ecological engineers
- Celebrate!



WHAT'S NEXT?

The next stage of the research is to develop a synthesis of demand estimation, a process that will (in the first instance) require researchers and other relevant parties provide comment and suggestions based on this report. This report (and other developed materials) should be communicated beyond the CRC participants, a process that will be assisted by the use of the CRC LCL website.

In terms of defining a forecast model framework, a literature review can summarise the key content relevant to the ETWW fields. It will therefore be essential to identify a collection of core or foundation literature on demand forecasting approaches for all parties to review.

At this stage of the research it is also important to raising the profile of this project, not only to inform but to promote interaction with potential contributors within the existing research organisations and beyond. This process will be helped by activities such as the development of communication channels and electronic resources or 'common areas' for literature, data sources and updates.

APPENDIX A: ENERGY DEMAND FORECASTING PRESENTATION

Slide 1

Energy Demand Forecasting

Adam Berry
1 February 2023

ENERGY TRANSFORMED FINDER

CSIRO

Slide 2

Why is Energy Demand Forecasting so Demanding?

- The way we generate, deliver and use our power has changed dramatically!
- We know surprisingly little about our energy distribution networks, the way we use power and the way that distributed renewables behave
- There is an absolute sparsity of data

CSIRO

Slide 3

Trying to Ease the Burden

- Our research in this space has three aims:
 - Develop a deeper understanding of the current state of play for energy networks and energy users
 - Develop approaches to understand where we will go from this current state of play
 - Provide experimental facilities to test the technologies that are relevant for today and tomorrow

CSIRO

Slide 4

Understanding the State-of-Play

CSIRO

Slide 5

Understanding the Australian Electricity Distribution Network

850,000km
(about forty laps around the earth)

We are building the first Australian Feeder Taxonomy

CSIRO

Slide 6

Understanding Energy Use

What is the impact of interventions, initiatives and opportunity on real-world residential energy users?

We are analysing energy data from the Australian Solar Cities trial and NSW aggregate energy data

We are developing residential building energy models based on data from Housing NSW and the NSW Department of Planning

CSIRO

Slide 7

Understanding Renewables

What is the nature of solar variability in Australia?

The solar intermittency report provides detailed statistical analysis of real-world solar output data, discovers some scary ramp-rates and looks at the impact on Australia's unique electricity network

CSIRO

Slide 8

Understanding Renewables


What is the nature of solar variability in Australia?

The solar intermittency report provides detailed statistical analysis of real-world solar output data, discovers some scary ramp-rates and looks at the impact on Australia's unique electricity network

CSIRO

Slide 9

Getting Ready for What is Next



Slide 13

Real-World Analysis



Slide 10

Solar and Load Forecasting

Fine-grained and local forecasting is difficult



We are building adaptive, forecasting for multiple time-frames



Slide 14

Experimental Facilities

How do distributed generation, microgrids, renewables, solar cooling and HVAC actually perform in the wild?



The Renewable Energy Integration Facility and Australian HVAC Performance Test Facility provide us with an opportunity to find out



Slide 11

Optimal Planning and Operation

Selection, sizing, placement and operation of distributed generators is complex



We are developing a suite of DG planning tools



Slide 15

Thank you

Advisory
Energy Transformation
CSIRO

1 +61 3 8360 6123
e Adam.Berry@csiro.au

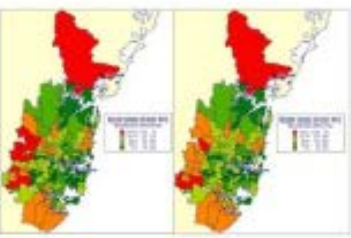
ENERGY TRANSFORMED FACILITY
www.csiro.au




Slide 12

Forecasting Uptake

To what degree will people embrace electric vehicles and solar PV?



We have developed uptake models that consider demographics, attitudes, housing stock and technology costs



APPENDIX B: TRANSPORT DEMAND FORECASTING PRESENTATION

Slide 1



Transport Demand Forecasting


Slide 2



In General...

- Departments of Transport – biggest users of these types of models...
 - Transport network owners, administrators and managers (in general)
 - Nationally and internationally
- Future year transport infrastructure requirements,
 - eg, new roads, bridges,
- Development of policy and planning strategies,
 - Minimising environmental impact,
 - Maximising transport efficiency


Slide 3



In General...

- Transport forecasting is... forecasting present and future year transport behavior patterns using models.
- Travel demands for a population are estimated from **socio-demographic** and **land use** data and assigned to the transport network supply.
- A range of software packages are available to assist in this process.
- Predominantly private vehicle travel on the urban road network... but also public transport demand, non-motorised modes, freight modes...


Slide 4



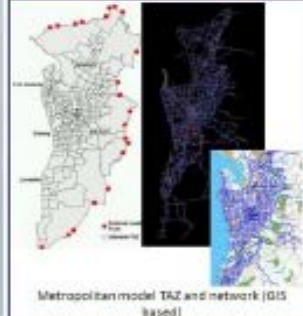
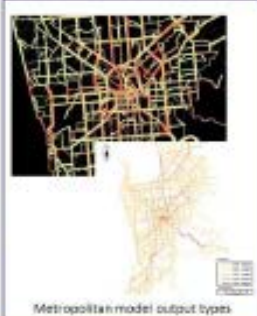
Modelling Scope

Dimension	MACRO scale	MESO scale	MICRO scale
Spatial	National or State-wide	Large regions... such as entire metropolitan area	Localised... such as a series of intersections
Temporal	<u>Static</u> Long time periods such as annual patterns	<u>Static</u> Longer time periods such as typical weekday, AM or PM peak period	<u>Dynamic</u> Continuous and typically shorter periods
Operational Data Requirements	Aggregate over a very large region (National or Inter-State)	Low detail over a large region (TAZ definition)	Higher detail over a smaller region (road geometry)
ETWW?	Less appropriate	Most appropriate	Less appropriate

Slide 5




Modelling Scope – Metropolitan

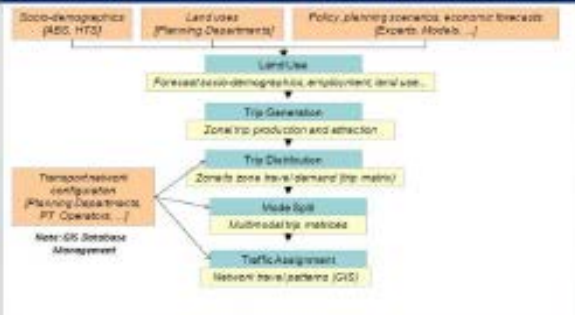
Metropolitan model TAZ and network (GIS based)

Metropolitan model output types

Slide 6



Metropolitan Modelling




Flowchart illustrating the Metropolitan Modelling process:

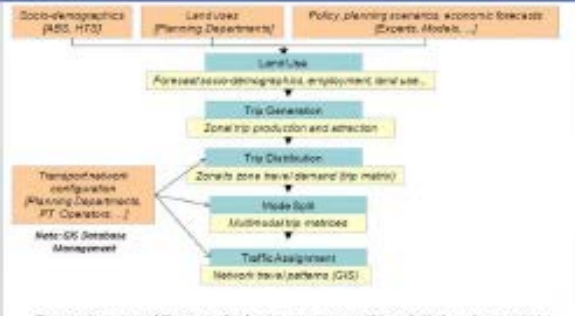
- Inputs: Socio-demographics (ABS, HFS), Land uses (Planning Departments), Policy, planning scenarios, economic forecasts (Experts, Models...)
- Process: Land Use (Assess socio-demographics, employment and use) → Trip Generation (Zonal trip production and attraction) → Trip Distribution (Zonal zone travel demand (trip matrix)) → Mode Split (Multimodal trip matrices) → Traffic Assignment (Network travel patterns (GIS))
- Support: Transport network configuration (Planning Data, traffic, PT Operators...), Metro-GIS Database Management

There are alternative modelling approaches, but this process is most widely applied in Australian capital cities.

Slide 7



Metropolitan Modelling




Flowchart illustrating the Metropolitan Modelling process:

- Inputs: Socio-demographics (ABS, HFS), Land uses (Planning Departments), Policy, planning scenarios, economic forecasts (Experts, Models...)
- Process: Land Use (Assess socio-demographics, employment and use) → Trip Generation (Zonal trip production and attraction) → Trip Distribution (Zonal zone travel demand (trip matrix)) → Mode Split (Multimodal trip matrices) → Traffic Assignment (Network travel patterns (GIS))
- Support: Transport network configuration (Planning Data, traffic, PT Operators...), Metro-GIS Database Management


There are alternative modelling approaches, but this process is most widely applied in Australian capital cities.

Slide 8



ETWW Data

- Common ground for the ETWW project...
 - Data with a spatial component
 - GIS database management and representation



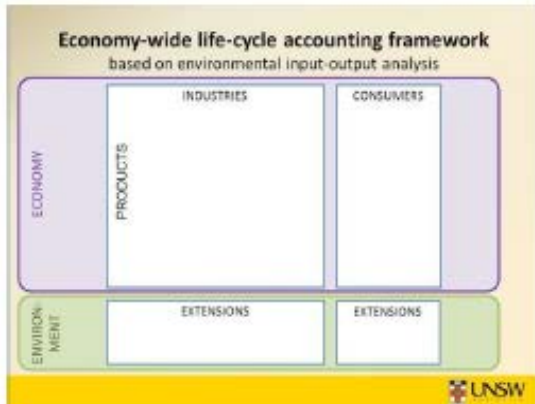
Energy Transport Water Waste

LCL ETWW Project

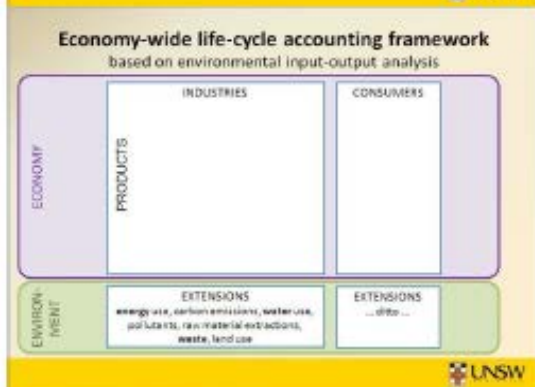
APPENDIX C: ECONOMY-WIDE LIFE-CYCLE ACCOUNTING AND WATER DEMAND FORECASTING PRESENTATION

Slide 1

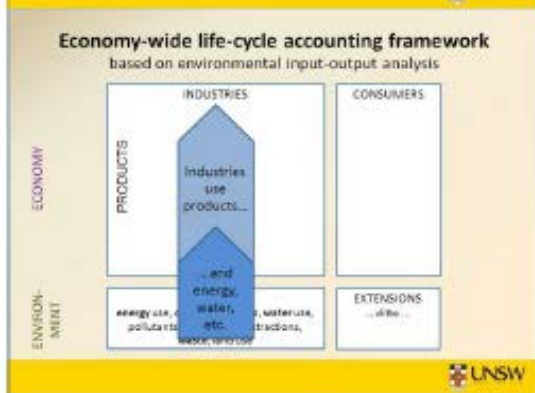
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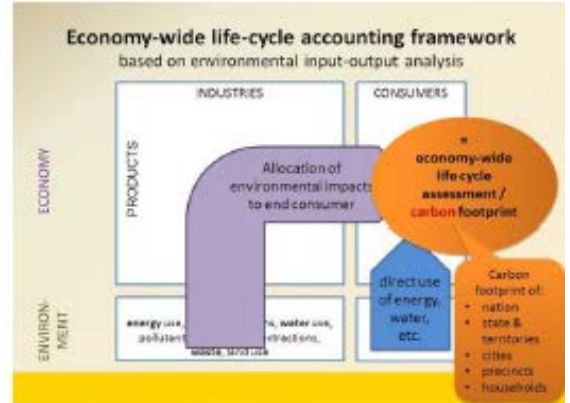
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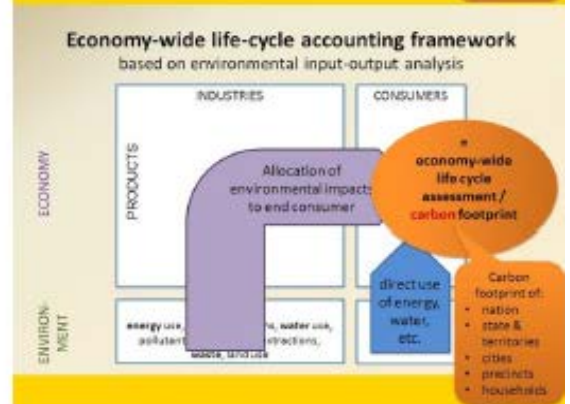
Slide 4



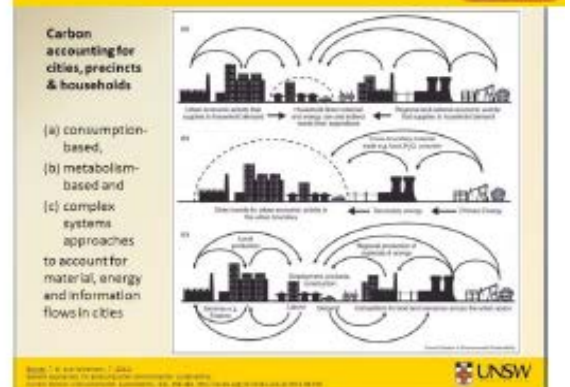
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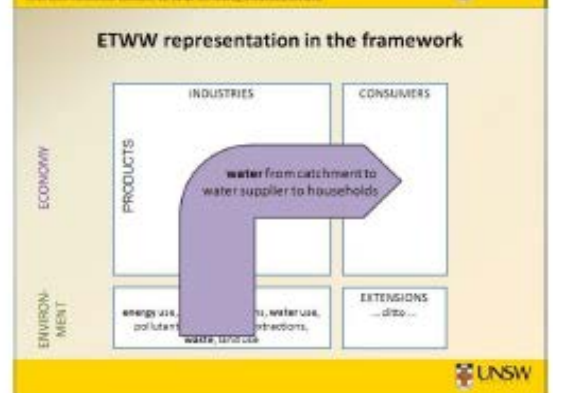
Slide 6



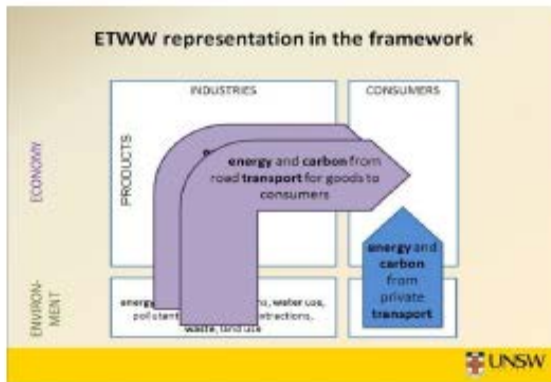
Slide 7



Slide 8



Slide 9



Slide 13

Water demand forecasting

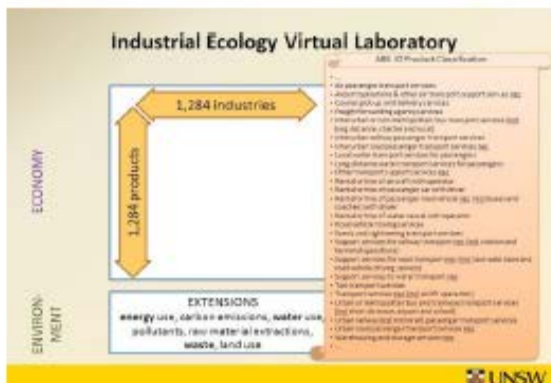
Scenario-based estimation of:

- population growth
- demographic changes
- consumption patterns / lifestyles
- uptake of water efficiency measures (e.g. leak-reduction, residential and non-residential programs and regulatory initiatives)
- water recycling initiatives
- climate change

Also: rebound effect

Thomas, B. A. and Alessio, I. L. (2018) Estimating direct and indirect rebound effects for U.S. households with input-output analysis Part I: Theoretical framework. Part 2: Simulation. Ecological Economics, in press.

Slide 10



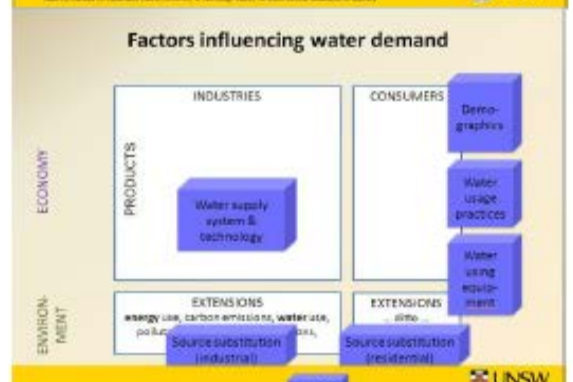
Slide 14



Slide 11



Slide 15



Slide 12



Slide 16



Slide 17

Water - Energy Nexus Needs More Study

There is a pressing need to understand the reliance of water systems on energy and the water-dependence of energy systems in a water and energy constrained future. More research is needed to understand the connections between water, energy and other related materials in the built environment. (UNSW)

All rights reserved

Energy growth for urban water use in Australia

Source: (UNSW) at 21/10/2010

(UNSW) L. J. Franklin, A. Tappin, S. Day, S. G. Grant, S. Tolson & S. Williams (2010).
 'Implications of the projected environmental effects of water supply on the energy sector'.
 Report for Precinct Energy Research Institute (PEI), 2010. 44 pages.

Slide 19

Conclusions

Economy-wide life-cycle accounting is useful to capture

- water supply and demand
- direct and indirect water use (water footprint)
- the water-energy nexus
- the water-energy-carbon nexus
- the water-energy-waste-transport-carbon nexus

IE Lab allows for economy-wide life-cycle accounting at precinct level (timeframe: annually)

> use IE Lab to calculate carbon outcomes of ETWW scenarios

Slide 18

Embodied energy of water supply and consumption is not negligible...

Embedded energy (EE)	Total energy consumption (GJ)	Total GHG emissions (t CO ₂ e)
Building	3,778	264.5
Roads	708	21.0
Water supply network	112	8.8
Wastewater system	265	20.2
Road vehicle fuel	1,417	30.4
Total	6,380	445.9
Average EE (or CO ₂ e) per capita	22	1.8
Average EE (or CO ₂ e) per household	39	2.7

} ca. 0%

(UNSW) L. J. Franklin, A. Tappin, S. Day, S. G. Grant, S. Tolson & S. Williams (2010).
 'Implications of the projected environmental effects of water supply on the energy sector'.
 Report for Precinct Energy Research Institute (PEI), 2010. 44 pages.

APPENDIX D: WASTE DEMAND FORECASTING PRESENTATION

Slide 1

Integrated ETWW demand forecasting and scenario planning for precincts (ETWW: energy, transport, waste and water)

Program 2: Low Carbon Precincts, 2013-2015

Project Workshop 01 Feb 2015, Adelaide
Prof. Steffen Lehmann, Aliq Zaman, John Devlin

Slide 5



Slide 2

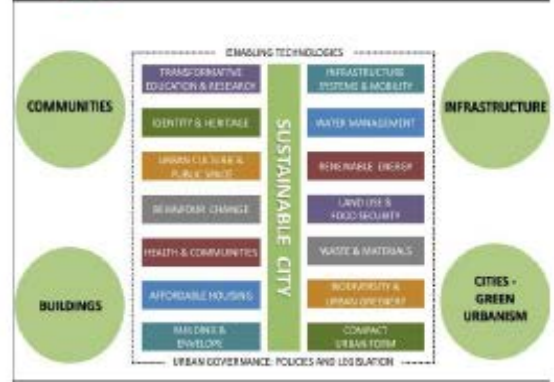
Domain 'Waste': the waste scenario

Purpose of Workshop

The purpose of the workshop is to explore the different **methods for demand estimation** in the different ETWW domains, and to work towards a synthesis of possible approaches for integrating demand estimation and forecasting.

A first step in this process is to find out about the **approaches, methodologies and models** employed in the different domains.

Slide 6

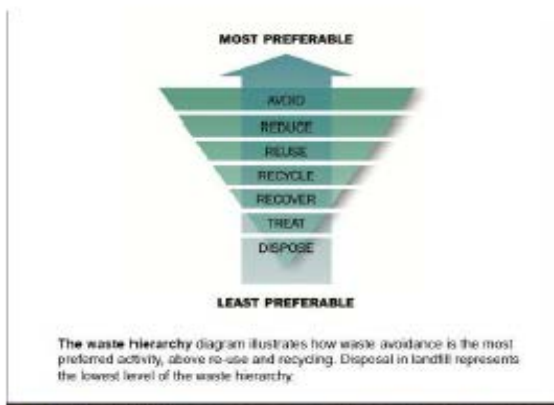


Slide 3

- Uses photosynthesis, harnessing solar power
- Provides energy, food
- Collects, stores rain water
- Absorbs air pollution
- Oxygen supply, creates a microclimate
- Produces no waste
- Carbon sequestration, absorbs CO₂

Could buildings be like a tree and cities like forests?

Slide 7



Slide 4

New book theme: low carbon precincts

The City District... as Power Station - Energy

The City District... as Water Catchment - Water

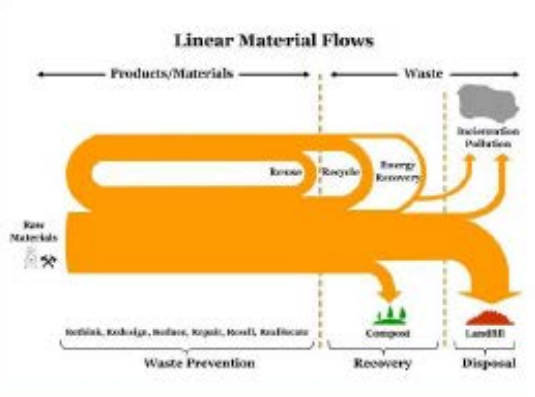
The City District... as Source of Food Supply - Material flows

Dec. 2013 2013 2012 2010

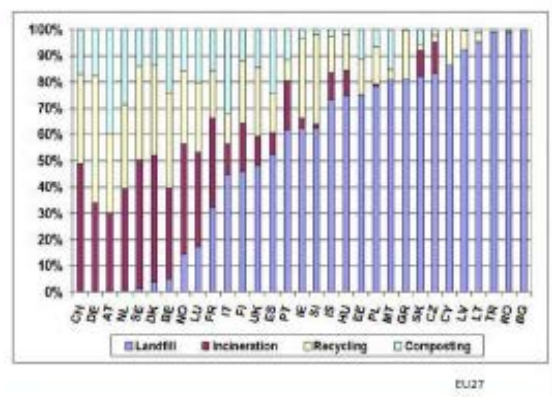
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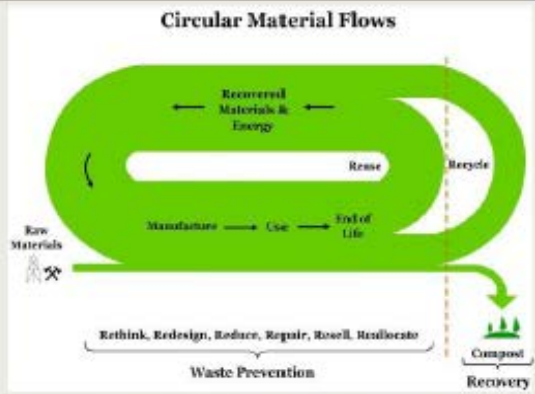
Slide 9



Slide 13



Slide 10



Slide 14

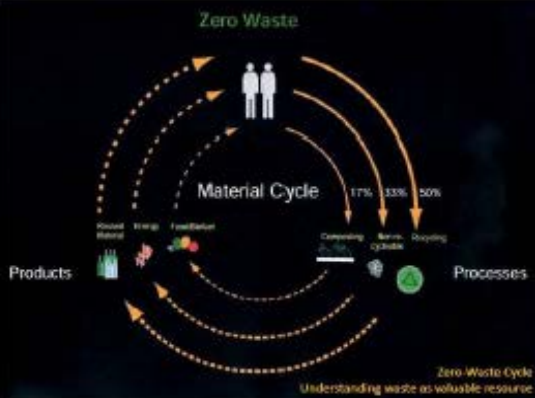
Definition: demand forecasting

Demand forecasting is a proven method in urban planning used for making planning and infrastructure design decisions based on **future capacity requirements**.

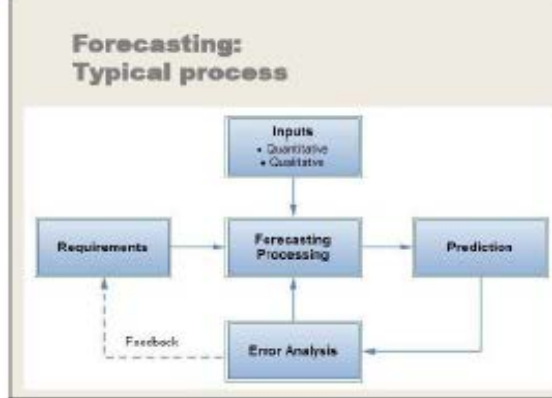
It is the activity of estimating the quantity of a service or product that future residents (consumers) will require.

Demand forecasting involves both informal methods, such as educated guesses, and quantitative methods, such as the use of historical or current data and statistics.

Slide 11



Slide 15



Slide 12

In the available literature, a recommended split for a city (here a typical developed city in Germany) can be found where no MSW waste goes to landfill:

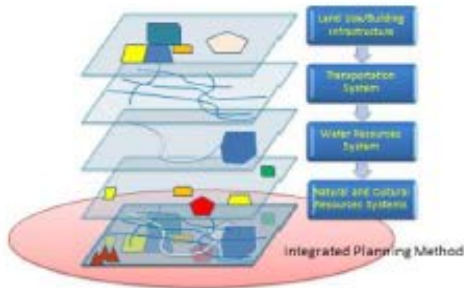
- Recycling and re-using waste: *min. 60 per cent and more recommendable (70-90 per cent recycling target).*
- Composting of organic waste (biomass): *around 30 per cent recommendable.*
- Incineration of residual waste (waste-to-energy): *generally to be avoided, maximum 10 per cent only for waste that cannot be recovered/recycled.*
- No landfill: *0 per cent.*

Slide 16

Demand Forecasting: methods

DEMAND FORECASTING METHODS		
Qualitative Method (Judgements)	Combined Method (Judgements and Statistics)	Quantitative Method (Algebraical and Statistical)
<ul style="list-style-type: none"> Survey Executive jury method Delphi 	<ul style="list-style-type: none"> Artificial Intelligence Methods - Expert/Group method of data handling - Support / believe vector machines System Dynamic (Causal loop system) 	<ul style="list-style-type: none"> Causal forecasting - Regression analysis - Econometric models - Input-Output models Time series - Trend/Pattern analysis - Regression analysis - Exploratory analysis

Slide 17



Typically, the three domains of transportation, water and energy infrastructure are well understood and are part of most existing tools, while the waste domain is less easily integrated and often not part of the approach.

Slide 18

Approaches	Scalability		
	Carbon Neutral Building	Carbon Neutral Community	Regional Sustainable Development
Data Analysis	X	X	X
Modeling and Simulation	X	X	X
Data Visualization	X	X	X
Spatial Decision Support	X	X	X
Geo-spatial Representation	X	X	X
Toolset	X	X	X
	Research Theme One	Research Theme Two	Research Theme Three

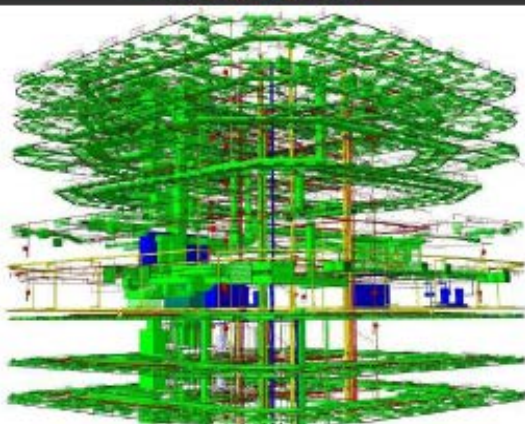
Diagram: Three interrelated research themes unified by a series of common or shared research approaches.

Slide 19

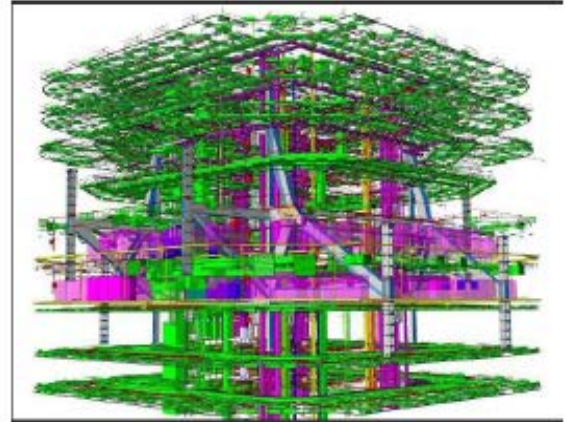
BIM and PIM: Systems Integration



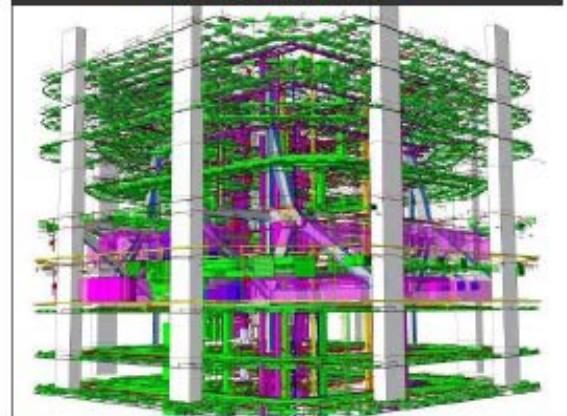
Slide 20



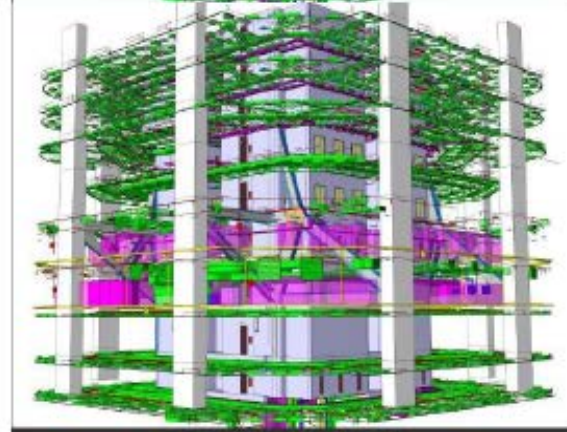
Slide 21



Slide 22



Slide 23



Slide 24

Available Rating Tools: built environment

1. National Australian Built Environmental Rating System - NABERS OFFICE Waste (Australia)
2. Urban Design Institute of Australia (UDIA) Qld - EnviroDevelopment (currently under development in WA, SA and Vic)
3. SMARTWaste (UK)
4. GreenStar - Communities Rating Tool (Australia)
5. Wrap Net Waste Tool (UK)
6. ReDi Index (USA)
7. Other tools

... but none deal with the full complexity of WASTE.

Slide 25

Existing tools and their use

Tool	Country	Users	Re-use plan	Comprehensive plan	Disposal plan	Compliance
SUSSES OFFICE assess	Australia	Office Buildings	X	X	4	X
EuroDevelopass (CCMA)	Australia	Multi-residential Developments	✓	✓	X	X
SMARTValue	USA	Developers for Waste Management	✓	✓	X	X
Green Star	Australia		✓	✓	X	X
Wap Net Waste Tool	UK	Building Users	X	✓	4	4
BaDi Data	USA	Managed Cold Waste	X	X	4	4

Slide 29



Slide 26

Performance metrics and parameters

Current methods of **quantitative waste and material flow estimation** use the weight of waste generated as a unit to quantify different scenarios.

Forecasting this amount and its impact is largely based on the following indicators...

Slide 30



Slide 27

Performance metrics and parameters

- (1) **total amount/weight:** kilogram of MSW waste per capita, (e.g. 2kg p. cap. p. day).
- (2) **volume and weight per cubic metre of the particular mix (content type):** every substance will have a different weight to volume conversion factor. One cubic meter of water weighs 1000kg or 1 ton, but other materials will weigh different; e.g. wet food waste).
- (3) **diversion rate:** this is the current diversion from landfill rate and rate of resource recovery, current recycling and re-use rate in percentage terms, (e.g. 66% diversion rate).
- (4) **socio-economic context:** current and future consumption patterns, changes in affluence of residents and population growth (in \$/GDP per capita, driving the growth rate of waste generation, 3-year or 10-year time frame? E.g. \$40k pa in 2013, \$50k pa in 2015)

Slide 31

Demand estimation: waste domain

What is the situation in **Australia** in general and what are reasonable targets?

The total MSW waste generated by 20 mill. Australians was:

2007: 44 million tonnes, of which recycled: 52 per cent

2020 forecast: 80 million tonnes (this seems unavoidable, given the current growth rate), of which to be recycled: min. 80 per cent (recommended target).

Slide 28

Performance metrics and parameters

- (5) **behaviour change:** expected household behaviour change towards waste avoidance.
- (6) **infrastructure:** implications of policy/legislation, supply chain and waste disposal.
- (7) **treatment:** complexity of treatment / recovery.
- (8) **energy:** amount of embodied energy in KCal.
- (9) **environmental impact:** how hazardous it is.
- (10) **transport:** distance to treatment/recycling centre
- (11) **time horizon:** are we looking at 6 hours, 6 months or 6 years?

Slide 32

Australia: the waste facts

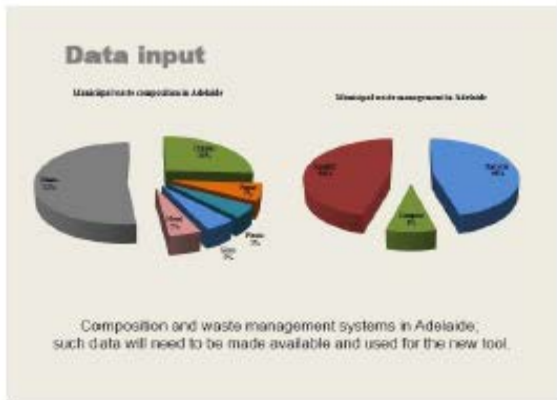
Per capita, **Australians** generated around **2.080 kg p. capita pa** (2.08 tonnes) of **total** waste (all waste streams together) in 2006-2007 (this includes around 750 kg MSW per capita p.a.).

This is around 5.7 kg per day, among the highest figures worldwide (Wilson et al, 2012).

The official waste generation per capita figure for **South Australia**, for 2006-2007, was **2.1 kilograms of MSW** per person p. day.

It's likely that the real figure is actually **higher** (getting reliable data is a constant challenge in the waste sector).

Slide 33



Slide 37



Slide 34

Adelaide: the waste facts

MSW Waste generation per person in Metropolitan Adelaide:

- 2002: 1.9 kg per day
- 2007: 2.1 kg per day
- 2012: 2.5 kg per day
- 2020 forecast: max. 1.6 kg per day or less (recommended target); this will be difficult to achieve.

Adelaide's recycling rate, diversion from landfill:

- 2002: around 50 per cent
- 2012: around 65 per cent
- 2020: to raise above 85 per cent diversion (recommended target, ZWSA)

Slide 38



Slide 35



Slide 39



Slide 36



Slide 40



Slide 41



Slide 42



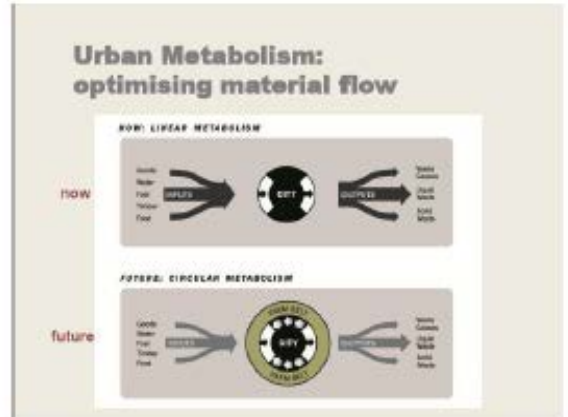
Slide 43



Slide 44



Slide 45



Slide 46

Low carbon construction systems: transforming industry

How will we build tomorrow?

- zero waste construction
- the manufacturing of materials requires the greatest amount of energy in the entire construction process
- modular prefabrication with BIM, mass customisation
- lifecycle assessment, material cycles, embodied and operational energy

Slide 47

Solutions: particular for each city

Each city must identify its unique set of principles and site-specific solutions to achieve a low-carbon, zero-waste urban transformation.

Recycling rates must be above 80% to be effective. But: recycling alone is not enough.

Slide 48

Question: urban planning and design

Should a new precinct be based on centralised or decentralised supply systems?

There is now a trend towards **smaller, decentralised systems** (e.g. decentralised recycling stations to avoid unnecessary waste transport; or district-scale biofuel generators, which run on waste cooking oil collected from local restaurants, operating at district level and supplying a district cooling system; or micro-waste-to-energy gasification plants using on-site waste for power generation as well as cooling and heating), and it looks like such systems can deliver a range of sustainability advantages.

To transport waste on trucks to distant landfill sites is very inefficient and damaging for the environment.

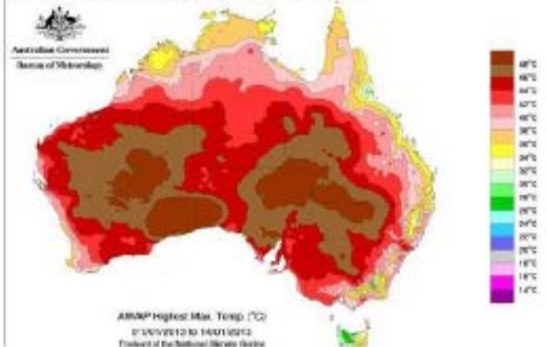
Slide 49

Methodology: practical considerations

- How often should the waste be measured?**
 - Daily, weekly, monthly, seasonally...
- Where should the waste be measured?**
 - At each bin, household bin, street level, precinct level...
- Within what boundaries should waste be considered?**
 - Impacts of commuting and remote consumption/pollution...
- How should the waste be measured?**
 - Self-assessed, on the trucks, at landfill, RFID tracking...
- Whose performance are we measuring?**
 - The building, the people, their lifestyles, the urban design, the city...
- What aspects of the waste are most important?**
 - Volume, weight, expense, hazardousness, complexity, scarcity...
- Why do we want to forecast the demand of waste services?**
 - Do we want to meet demand, or change the demand? **We want to move towards lower demand and a low carbon future...**

Slide 50

CRC Project in Program 2: Urban micro climate – Heat stress Mitigation strategies for urban heat islands



Slide 51





Slide 52

Discussion

APPENDIX E: A PRACTITIONERS VIEW PRESENTATION

Slide 1

Energy water waste and transport
A practitioners view a stimulus for discussion

Phil Donaldson
Director of Sustainability
Renewal SA

Slide 2

Renewal SA Context

The Urban Renewal Authority (URA), trading as 'Renewal SA', was established under the Housing and Development Act 1995

- to plan and deliver urban renewal and housing development opportunities across the state
- key focus on increasing the supply and diversity of affordable, desirable and sustainable housing and infrastructure,
- accelerating the renewal of social housing stock; and
- boosting economic investment.

- Contributing to meeting targets of the South Australian Strategic Plan;
- Delivering outcomes related to the 30 year plan for Greater Adelaide; and the regional volumes of the Planning Strategy
- Meeting the obligations of Renewal SA charter to deliver economic social and environmental benefits to SA through its business activities and project deliverables

Slide 3

A Practitioners View

- Why
- What
- Our experience
- Our results
- Our needs

Slide 5

A Practitioners View

What do we do now –Current Tools – solution focused

- Ecological footprint - Carbon
- Sustainability house rating tools
- PrecinX
- Economics

They cover

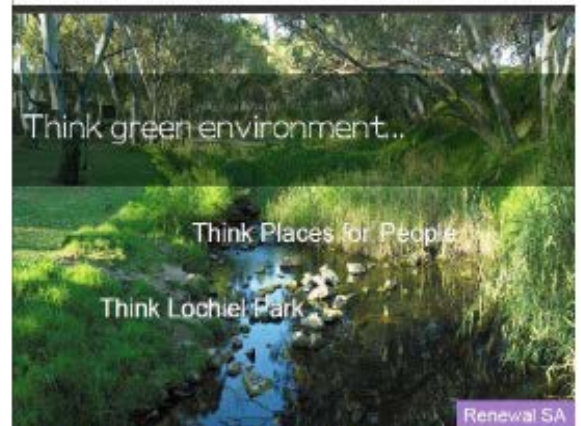
- Sensitivity triple bottom, line outcomes
- Commerciality of solution
- Efficiency of infrastructure
- Better than BAU and based on national and state data sets
- Defendable positions for funding
- Modeling performance for client outcomes

Slide 6

Think green environment...

Think Places for People

Think Lochiel Park



Slide 7

Lochiel Park Ecological Footprint

Targets
66% from BAU ?

Evaluation processes

50% improvement in housing component

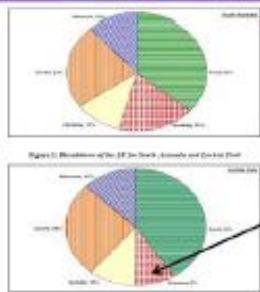


Figure 1: Breakdown of the EP for Lochiel Park, Adelaide and Greater Adelaide



Slide 9



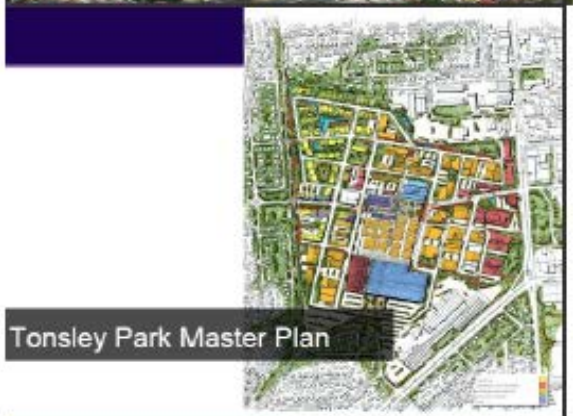
TONSLEY PARK REDEVELOPMENT

"...a platform to re-frame a future for sustainable advanced manufacturing and services in South Australia"


Slide 10



Slide 11



Slide 12

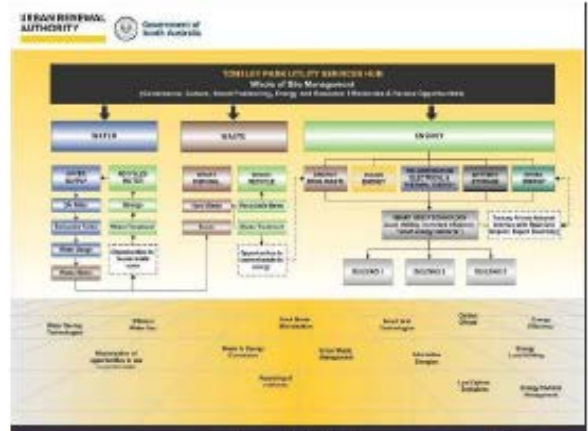


Integrated Energy, Water and Waste Management

EOT seeks a respondent who can design, supply, construct, install, own, operate (including by retolling of thermal energy products, gas and electricity, water and waste) and maintain a local energy, water and waste shared services smart grid solution throughout the development phase of the project.

EOT was released in July 2012

Slide 13



Slide 14

Approved Master Plan

Indicative Electrical Loads

- >SIEC – >3 MW
- >Tier 5 >2.5 – 3.5 MW (EG)
- >Flinders University >8 MW

Overall Site by 2026 >20.4 MW



Slide 15

A Practitioners View

Individual Loads

Stage	Building - EOTW (kW)	Cooling (kW)	Electricity (kW)	Street Lighting (kW)
I 2012 - 2015	874	1,380	1,741	40
2P 2012 - 2015	2,148	6,120	4,184	-
E 2012 - 2020	11,998	35,512	21,402	89
I 2012 - 2020	8,698	11,507	4,269	47

Cumulative Loads

Stage	Building - EOTW (kW)	Cooling (kW)	Electricity (kW)	Street Lighting (kW)
I 2012 - 2015	874	1,380	1,741	40
2P 2012 - 2015	3,245	8,538	7,847	40
E 2012 - 2020	12,944	39,461	25,248	89
I 2012 - 2020	11,642	11,888	10,412	140

Slide 16

- Requirements**
- Part 1 works**
- > Design supply construct install own operate a smart grid energy system
 - > Minimum period of 20 years
 - > Retail energy
 - > Must deliver to Foundation Occupiers

Slide 17

Requirements

The systems

- Tri-gen plant and energy transfer stations
- Renewable energy and storage
- Solar arrays –1 Mw and 5 Kw systems
- Reticulation system
- Integrated solar , renewable energy and tri gen system
- Smart building control integration

Slide 18

Requirements

Part 2 works

- Extension of Smart Grid System to other tenants/ occupiers by 2017
- Design and construct site water , waste water and waste management infrastructure to proposed foundation occupiers, other tenants/ occupiers and retail tenants by 2017

Part 3 works

- Integration of the smart energy grid (Part 1 works) and Part 2 A extension works with the water and waste management services and infrastructure ASARP

Slide 19

Intelligent systems

The diagram shows a flow from 'Intelligent operations Factors' (including Energy, Water, and Air) through an 'Event and Information Gateway' to various control systems like 'Building Control System', 'Energy Management System', and 'Water Management System'. It also includes 'Operational Control Centre' and 'Operational Control System'.

Slide 20



Slide 21

Intelligent systems

The diagram is identical to the one on Slide 19, showing the integration of various systems into an intelligent operations framework.

Slide 22



Slide 23



Slide 24

Introducing
PRECINX™

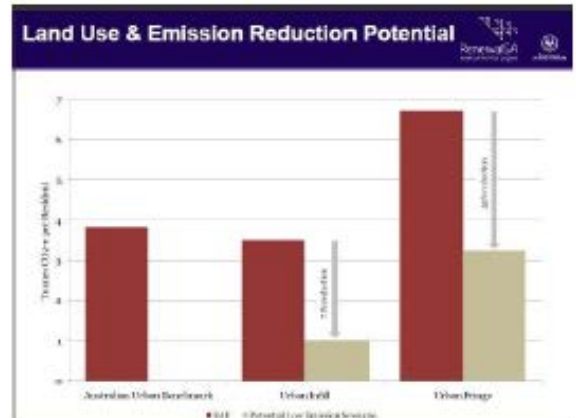
Landcom's new precinct sustainability tool to drive better design

URA TRAINING + HANDOVER
4th July 2012

Slide 25

What is PRECINX?

Slide 29



Slide 26

PRECINX - Development Rollback

Output	Modules	KPIs-reporting
<ul style="list-style-type: none"> Demand side measures/initiatives for precinct scale Supply side solutions for precinct Costs: capital and running, precinct and household GHG per dwelling Basis for discussion with suppliers Infrastructure planning implications 	<ul style="list-style-type: none"> on-site energy embedded CO2 water transport housing diversity stormwater 	<ul style="list-style-type: none"> greenhouse gases potable water total affordability vehicle hours travelled

Slide 30

LOCATIONAL SPECIFICATIONS

	Standard	Minimum
Location	• Suburban/Urban Growth Zone • Urban Fringe	• New Zone 3 or 4 - Best • Urban Fringe
Dwellings	• New apartments/medium density • New apartments/medium density • New townhouses/medium density	• New apartments/medium density • New townhouses/medium density
Public Transport	• Good transport frequency/coverage	• Good transport frequency/coverage
Lot Size/Character	• 150sqm/medium density • 150sqm/medium density	• 150sqm/medium density • 150sqm/medium density
Land Use Mix	• High mix of uses	• High mix of uses
Energy Services	• 100% gas heating	• 100% gas heating
Water Services	• Low flow shower heads for public facilities	• Low flow shower heads for public facilities

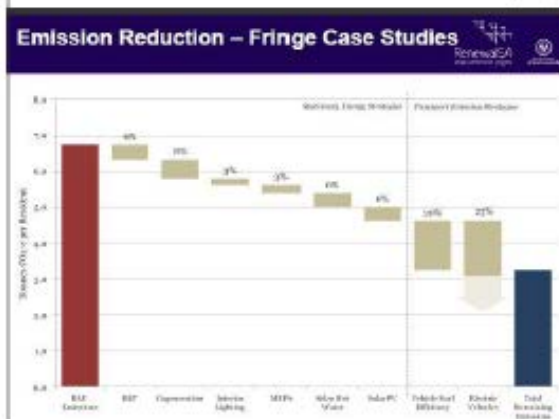
Slide 27



Slide 31

KEY RESULTS

Slide 28



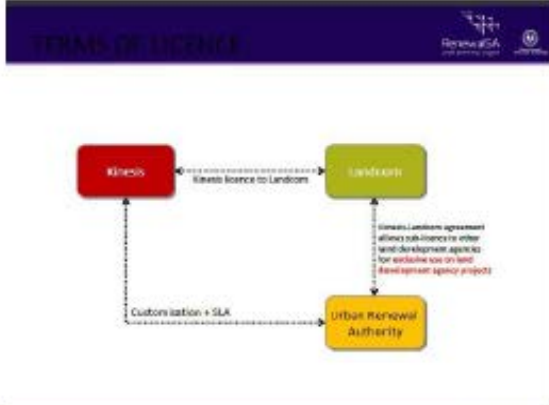
Slide 32

KEY RESULTS AFFORDABILITY

Slide 33



Slide 34



Slide 35



Slide 36

Metrics

Dwelling type	Current Market Scenario	High Density Scenario
Attached, 200 m2 lot (140 m2 GFA)	48 dwellings	11 dwellings
Attached, 100 m2 lot (135 m2 GFA)	89 dwellings	11 dwellings
Apartment (90 – 120 m2 GFA)	0 dwellings	411 dwellings
Total Dwellings	137 dwellings	433 dwellings
Total Population	141 occupants	674 occupants

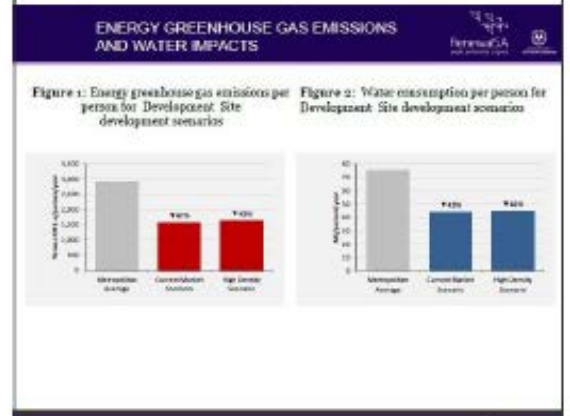
Slide 37

Technology	Both Scenarios
NatHER thermal rating	6-Star
Heating and cooling appliances	Standard
Hot water system	Gas-booster solar
Other appliances (fridge, washing machine, dishwasher)	Best Practice (4-5 star) in apartments only
Solar PV	1 kW on 50% of attached dwellings and 0.5 kW per apartment
Rainwater tanks (attached dwellings only)	1,000 litre tank for garden and toilet use

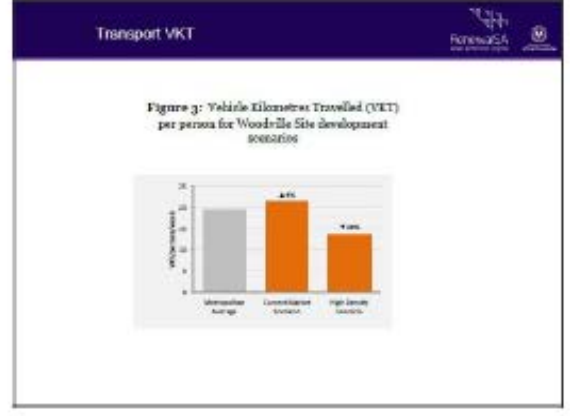
Slide 38

Use Stage	Current Market Scenario	High Density Scenario	% Multiple
Energy			
Total CO2 - GHG/year	881	5288	200%
Electricity demand - kWh/year	450	5280	137%
Peak electricity demand kW	275	700	180%
Gas demand - kWh/year	230	190	100%
Residential CO2 - GHG/year	1,100	3,600	94%
Residential peak electricity demand / kWh/night	1.8	1.8	100%
Water			
Total demand - ML/year	33	44	60%
Residential consumption - ML/dwelling/year	41	44	71%
Transport			
GHG emissions - tCO2e/year	58	1,040	304%
Vehicle Emissions (Residential) - tCO2e/year	11	19	16%
Abandonment			
Energy, water and transport - \$/dwelling/year	\$1,040	\$1,140	10%

Slide 39



Slide 40



Slide 41

Reconciling commercial and sustainability tensions for low carbon living

- Adopting a systems approach
 - Planning and designing at a precinct, neighbourhood and building scale, based on evidence – agreed metrics
- Assessing feasibility of projects and initiatives that includes triple bottom line assessment.
- Adopting whole of life cycle costing approaches.
- Assessing alternative and integrated sources of water, energy and waste infrastructure models (TRANSPORT)



A Practitioners View

Slide 42

Tool - Needs

- Able to provide common metrics that can inform multiple uses in other tools - collaboration not competition
- Must link and take note of industry needs re realities of planning and development
- Sensitivity to different scenarios and have scalability
- Must have benchmarks across a range of development and building types
- Must link to database and assessment processes that enable cumulative pre and post assessment i.e. ability to create evidence of value re GGE avoidance related to scenarios

Slide 43

A Practitioners View

Tool - Needs

- Behaviour change - industry issues - community
- Make it easy
 - Seamless –technology as an enabler
 - Instant feedback individual
 - Instant feedback Precinct scale
- Be clear about materiality issues - value for money options
- Understand market and the development industry - demonstrate pathway - forward

Slide 44

- Lets not re- invent the wheel
- Provide mechanisms for open sharing and collaboration
- Engage consultant industry
- Marketing benefits though industry partners




Ground truth across industry who are not necessarily partners