



LOW CARBON LIVING  
CRC

RP- 2015 Carbon Reductions and Co-benefits:  
Final Report – Part I, Literature and practice review  
of Australian policies relating urban planning and  
public health



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Date	June 2015
Title	RP- 2015 Carbon Reductions and Co-benefits: Final Report – Part I, Literature and practice review of Australian policies relating urban planning and public health
ISBN	
Format	
Keywords	
Editor	
Publisher	CRC for Low Carbon Living
Series	
ISSN	
Preferred citation	



Australian Government  
Department of Industry and Science

**Business**  
Cooperative Research  
Centres Programme

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## ACRONYMS

ASCC	Australian Safety and Compensation Council
BIM	Building Information Model
BITRE	Commonwealth Bureau of Infrastructure, Transport and Regional Economics
BTRE	Commonwealth Bureau of Transport and Regional Economics, now known as BITRE
CBD	Central Business District
CRC	Cooperative Research Centre
CRCLCL	Cooperative Research Centre for Low Carbon Living
CRC-LL	Living Laboratories in CRCLCL
DALY	Disability Adjusted Life Years
DCCEE	Department of Climate Change and Energy Efficiency
DTEI(SA)	South Australian Department for Transport, Energy and Infrastructure, now known as the Department of Planning, Transport and Infrastructure (DPTI)
FHWA	Federal Highway Administration
GHG	Greenhouse Gas
GIS	Geographic Information Systems
GPS	Global Positioning System
HBEP	Healthy Built Environment Program at the University of New South Wales
HEAT	Health Economic Assessment Tool, developed by WHO
HGV	Heavy Goods Vehicle
HiAP	Health in All Policies
HTS	Household Travel Survey
LCM	Low Carbon Mobility
LCV	Light Commercial Vehicle
LESS	Local-area Envisioning and Sustainability-scoring System
LL	Living Laboratory
MPPH	Municipal Public Health and wellbeing Plan
MSS	Municipal Strategic Statement
Mt	Million tonnes
NGGI	National Greenhouse Gas Inventory

NSW	New South Wales
NZTA	New Zealand Transport Agency
OECD	Organisation for Economic Cooperation and Development
PC	Passenger Car
PCAL	NSW Premier's Council for Active Living
PIM	Precinct Information Model
PT	Public Transport
RP2013	Research code identifier given by CRCLCL to its research project on co-benefits calculators
SSIM	Sustainable Systems Integration Model
TLFD	Trip Length Frequency Distribution
TLIAP	The Logistics Institute-Asia Pacific
UniSA	University of South Australia
UNSW	The University of New South Wales, Australia
UNU	United Nations University
VKT	Vehicle-Kilometres of Travel
VSL	Value of a Statistical Life
VTBC	Voluntary Travel Behaviour Change
WHO	World Health Organization

## EXECUTIVE SUMMARY

Project RP2015 was a scoping study designed to inform the CRC on the needs for R&D on the potential health and productivity co-benefits of low carbon planning and design for precincts. This Part I report provides a review of international research on co-benefits, examining and discussing current Australian policies in this area. The report meets the Cooperative Research Centre for Low Carbon Living's (CRC LCL) milestones R2.4.1 'Audit of current Australian policies (national, state, metropolitan and regional urban planning and health policies)' and U2.4.1 'Policies (national, state and local) where the co-benefits calculator can be used identified', and provides directions for the CRC's research on co-benefits. Co-benefits are defined to be ancillary benefits – such as community health and productivity gains – that result from intentional decisions to address low carbon living through energy demand and greenhouse gas emission reductions, with a focus on low carbon precincts.

The report describes current planning and policy interventions in place in Australia to encourage low carbon active transport forms such as walking, cycling and public transport. It describes the importance of research on co-benefits and the need for the CRC to support a major research initiative in this field. Such a project will identify and quantify co-benefits for public health and productivity from the planning and evaluation of low carbon urban precincts – the core activity of the CRC's *Low Carbon Precincts* research program.

The review found clear and growing interest in co-benefits, but also indicates that while there are some significant programs in the health sector, these interests are largely uncoordinated, especially from an urban planning perspective.

In addition, there is a need for quantitative tools to allow the co-benefits to be included in the economic evaluation process of precinct assessment. The review found three relevant existing tools: the Health Economic Assessment Tool (HEAT) developed by the World Health Organization (WHO), the New Zealand Transport Agency (NZTA) transport project evaluation tool and the United Nations University (UNU) co-benefits evaluation framework. Contrary to some expectations at the start of the study, there are few, if any, 'co-benefits calculators' suitable for use by planners, government agencies and developers. None of the precinct assessment tools such as Local Area Envisioning and Sustainability Scoring System (LESS) and Sustainable Systems Integration Model (SSIM), Precinx and Mutoxia (see Newton et al, 2013) include co-benefits calculations, although there is a clear desire to include these in evaluations. Further, none of the existing tools (HEAT, UNU and NZTA) are explicitly designed for use in precinct assessment. While each of the existing tools has useful aspects for inclusion in co-benefits analysis for precinct assessment, none of them provide a stand-alone capability.

The CRC's research on co-benefits should thus seek to provide urban planners and designers with a scenario-based method that allows health and productivity co-benefits from alternative, low carbon design scenarios to

be used in precinct design assessment. A capability for co-benefits analysis should be possible by modifying and extending existing tools making the need to develop a new tool unlikely. Accordingly, the following recommendations are made:

1. A full research project be undertaken to investigate the design of a co-benefits analysis tool for inclusion in the precinct assessment method being developed in the *Low Carbon Precincts* research program
2. The project should involve trials of the HEAT tool in different case studies as a first priority
3. The project should also investigate and apply the NZTA tool as a project add-on, perhaps with the development of a precinct-based version of the spreadsheet
4. The project should use the modified UNU framework, with Australian National Greenhouse Gas Inventory (NGGI) type models and available multimodal travel demand models, to estimate mode shares and usage by vehicle type under different land use scenarios as inputs to the HEAT and NZTA tools
5. The project should seek the inclusion of CRC partners such as Hassell, Urban Growth NSW, Renewal SA and other owners/users of precinct assessment tools to test opportunities to include co-benefit calculations in the precinct assessment tools, or for use with those tools.



## OVERVIEW

The Cooperative Research Centre for Low Carbon Living (CRCLCL) is a national research and innovation hub that seeks to enable a globally competitive low carbon built environment sector.

With a focus on collaborative innovation, CRCLCL brings together property, planning, engineering and policy organisations with leading Australian researchers. CRCLCL develops new social, technological and policy tools for facilitating the development of low carbon products and services to reduce greenhouse gas emissions in the built environment. A key aim of the CRCLCL is to help cut Australia's residential and commercial carbon emissions by 10 mega tonnes by 2020, which is the environmental equivalent of taking 2.3 million cars off the road each year. This will be achieved through developing low carbon building construction materials and increasing the evidence base for government policy and planning, among other measures. Australia has set greenhouse gas emissions reduction targets of 25 per cent by 2020 and 80 per cent by 2050 compared with 2000 levels.

To achieve the goals of the CRCLCL, it aims to deliver:

- opportunities for lower-carbon manufacturing
- a more efficient and productive built environment sector as a whole
- engaged communities participating in low carbon living
- an evidence base for good planning and policy
- large-scale national capability development
- tools, technologies and techniques that will ensure the sector remains globally competitive.

When the 2020 carbon reduction targets are met, the CRCLCL will have delivered a direct benefit of \$250 million per year to the economy, while reducing risk to the \$150 billion per year construction industry as it adjusts to a carbon-constrained economy.

Ultimately the CRCLCL will help unlock barriers to cost-effective carbon reduction opportunities, empower communities and facilitate the widespread adoption of integrated renewable energy. This will enable the sector to transition and contribute to Australia's greenhouse gas (GHG) emissions targets while maintaining industry competitiveness and improving quality of life.

The CRCLCL has three research programs, reflecting the three pivotal "bridges" that must be crossed in order to deliver a low carbon built environment.

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

### Program 2: Low Carbon Precincts Overview

The Low Carbon Precincts Program focuses on reducing the carbon footprint of our urban systems, with key consideration being given to integrating the interlinked

aspects of energy, water, waste, transport and buildings – all of which have significant carbon signatures as well as human health impacts.

The challenge is to reduce the carbon footprint of precinct infrastructure through the development of better tools and planning techniques. As a result, low carbon precincts will become highly desirable lifestyle options. Improved planning of precincts will allow carbon footprint to be reduced to zero in the longer term, at the same time as quality of life continues to grow.

Delivering low carbon precincts, the building blocks of our urban areas, is a prime example of direct action in climate change and a key research objective of the CRC. The evaluation and assessment of carbon performance of precincts is the fundamental area of interest in – and the main thrust of – Research Program 2. This requires modelling and analysis leading to quantitative assessment of carbon performance and comparisons between alternative policies, plans, designs and scenarios. The principal objective of Research Program 2's research is the development of a world class precinct design and assessment method, with associated tools and supported by scientifically verified data.

The development of this method is encapsulated in CRCLCL Pathway 4 'Designing integrated low carbon precincts' shown in Figure 1 below. This pathway applies and integrates the research undertaken in the four activity areas of:

- Activity 2.1 – Digital information platform for informed precinct design
  - establish a world-first spatial database platform in an open standard format able to integrate with proprietary databases in both the Geographic Information Systems (GIS) and Building Information Model (BIM) domains
- Activity 2.2 – Integrated assessment of eco-efficiency during precinct design
  - develop and test assessment models for precinct design, embodied in automated software applications based on Precinct Information Model (PIM) technology
- Activity 2.3 – Precinct-level demand forecasting for distributed infrastructure networks
  - develop a comprehensive, integrated tool set that enables measurement and assessment of precinct performance based on PIM technology and which forecasts demand at precinct level in terms of low carbon living
- Activity 2.4 – Health and productivity co-benefits
  - develop a suite of co-benefit calculators suitable for different stakeholders (government regulators, developers, precinct planners and designers and community end users) based on rigorous research to identify measurable metrics.

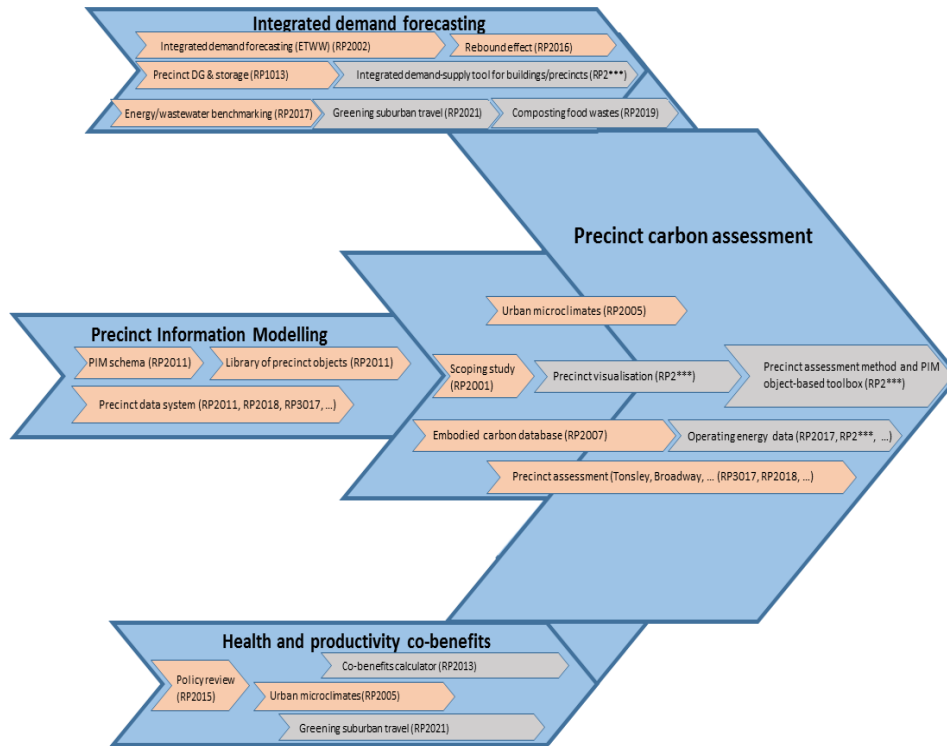


Figure 1: CRCLCL Pathway 4 'Designing integrated low carbon precincts' – the principal thrust of Research Program 2

Note: current at 20/02/15; Projects with grey backgrounds have yet to be approved

For more information regarding CRCLCL and its research programs, see [www.lowcarbonlivingcrc.com.au](http://www.lowcarbonlivingcrc.com.au).

Travel and transport activity and resultant carbon emissions are of interest to CRCLCL, especially for its low carbon precincts and engaged communities research. The CRC has sought guidance on what research it could support and pursue in this field. To this end on 29-30 October 2013 the CRC conducted a national workshop on Low Carbon Mobility (LCM) to debate the issues and to develop a research agenda. Workshop participants included CRC researchers and industry partners, as well as other interested parties.

The primary output from this Adelaide based workshop was a research synthesis report (Philp and Taylor 2014), outlining a plan for potential relevant research on LCL by the CRC over the period 2014-2019. The plan is based on a synthesis of the discussions in the workshop, informed by the keynote and background papers prepared for it, together with a review of the international literature. The outcome of the workshop was a well-designed research agenda for the CRC to pursue in the area of LCL, which should serve to inform and guide the CRC's research on low carbon precincts and engaged communities where transport dimensions are of critical importance. This includes precinct demand estimation and precinct design, technologies and systems for low carbon living, land use-transport interaction in urban design, and voluntary behaviour change programs. The research synthesis report is available for download at [www.lowcarbonlivingcrc.com.au](http://www.lowcarbonlivingcrc.com.au).

The analysis presented in Philp and Taylor (2014) indicated that many facets of LCM are appropriate areas

for CRC research that can contribute strongly to the attainment of the CRC's stated objectives for low carbon living. At the precinct level, the interplay between energy consumption in housing and transport, as identified by Newton and Newman (2013), is a key consideration. The most important research topics identified by Philp and Taylor (2014) are:

- potential health benefits and precinct evaluation and design evaluation methods
- methods for 'greening' suburban travel, given the current strong dependence on private car usage for suburban based travel
- provision and operation of infrastructure for electric vehicles
- experimentation and pilot testing of community options such as electric vehicle share scheme trials in the CRC-LLs.

Philp and Taylor (2014) provided a systematic overview of LCM research needs from the perspective of the CRC. Table 1, taken from the report, shows the research relevance and importance of the identified LCM research areas across the research programs of the CRC.

Thus the LCM research agenda clearly recognised the need for and importance of co-benefits research related to low carbon precinct planning and design.

Table 1: Systematic view of relevance and importance of areas for low carbon mobility (LCM) research as identified in Philp and Taylor (2014)

Research area	Urban design and LUTI	LCM policy and behaviour change	New technology and infrastructure	Analysis and tools for informed decision making
<b>Topic</b>				
<b>Data</b>				
<b>Integration</b>				
<b>Evaluation</b>				
<b>Urban planning and design</b>				
<b>Technology</b>				
<b>Safety</b>				

Key:



### RP2015 Carbon Reductions and Co-benefits Project Purpose

This scoping study aims to identify what planning and policy interventions are in place in Australia to encourage low carbon active transport forms such as walking, cycling and public transport. Further, the project aims to identify what co-benefits there are associated with this form of transport. Co-benefits are variously defined but for our purposes here, they are comprehensively seen as ‘those derived from the intentional decision to address air pollution, energy demand, and climate change in an integrated manner, but also considers the other unspecified benefits that may arise such as improved transport and urban planning, reduced health and agricultural impacts, improved economy or reduced overall policy implementation cost’ (Castillo et al 2007).

Thompson and Capon (2015) use the diagrammatic representation in Figure 2 to describe the co-benefit concept by considering human health impacts.

**“All human activities have potential direct positive and negative human health impacts. This is through pathways such as nutrition and levels of physical**

**activity, and indirect human health impacts through the health of the planet (for example, the climate system). It follows that there will be co-benefits for health from actions to tackle climate change. For clarity, the arrows are presented as uni-directional, however there are relationships in both directions.”**

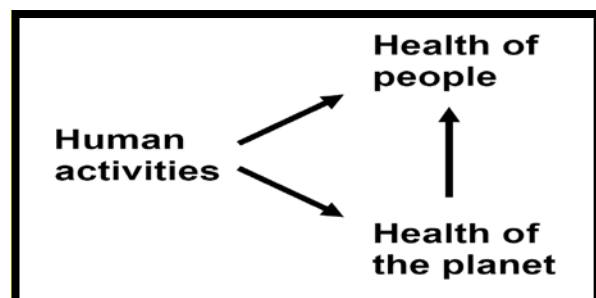


Figure 2: Concept of Co-Benefits for Health

Source: Thompson and Capon 2015 as adapted from Boyden 2013, p 153.

The current review includes programs, policies and practices where lowering carbon emissions is not necessarily the fundamental aim, but may appear as a

co-benefit in itself. Expected benefits from shifting to low carbon transport options are discussed in detail in Section 4, and fall under four descriptive categories:

- public health
- environmental
- quality of life/social, and
- economic.

This scoping project encompassed a desktop literature and practice review to meet CRC milestones:

- R2.4.1 – Audit of current Australian policies (national, state, metropolitan and regional urban planning and health policies)
- R2.4.2 - base line survey of current levels of active transport usage, including understanding of the environmental and human health benefits in the studied communities (Living Labs) plus constraints on the uptake of those practices completed
- U2.4.1 – Policies (national, state and local) where the co-benefits calculator can be used identified
- U2.2.4 – Communities to work with co-benefits calculator (living laboratories) identified.

This scoping study serves as a forerunner to the CRCLCL project RP2013 ('The Co-benefits Calculator') and identifies the research to be undertaken in that project. This scoping project further involves an analysis of active transport usage using data available from Household Travel Surveys (HTS) for Australian mainland capital cities plus ancillary databases to provide information on current baseline usage of the active travel modes. The milestones R2.4.1, R2.4.2, U2.4.1 and U2.4.2 are a core part of the research and development work in Program 2 'Low Carbon Precincts'. They are the first milestones in the research area R2.4 'Health and productivity co-benefits'. This milestone seeks to understand the potential usage and benefits of active transport, together with the development of a suite of co-benefit calculators suitable for different stakeholders – government regulators, developers, precinct planners, designers and community end users. The aim is to develop calculators based on rigorous research to identify measurable metrics derived from a PIM that provides a digital framework for design and assessment of planned precinct developments.

This document, the Part I scoping report, provides a review of previous research on co-benefits relating to public health and low carbon urban design, together with a review of current Australian policies in this area. As such it serves to explicitly meet CRC milestones R2.4.1 and U2.4.2, and to provide clear research directions for the CRC's research on co-benefits (principally RP2013).

A parallel study, described in Part II ('An analysis of current levels of active transport usage in Australia – towards a measure of baseline activity') of the final project report, determines baseline levels of active transport usage –walking, cycling and public transport – in metropolitan Australia. This was done through analysing available HTS databases to determine existing

levels of activity by the selected active transport modes. The baseline year is taken to be 2011, the last Census date. The main information gathered from the analysis of HTS data is as follows:

- total annual numbers of trip and person-km of travel by each of the active modes, by trip purpose
- modal split percentages for the active modes, in terms of numbers of trips and person-km of travel, by trip purpose
- overall trip length frequency distributions (TLFD), by distance and by travel time, for each of the active modes, by trip purpose
- TLFD for each of the active modes by demographic variables (gender and age groups).

The data analysis and its results are described in the RP2015 Final Report – Part II 'An analysis of current levels of active transport usage in Australia – towards a measure of baseline activity'. The Part II report provides a compendium of facts relating to low carbon transport usage in Australian metropolitan cities. The conclusions and recommendations provided in the Part I report have been drawn by taking account of both the review of literature and practice presented in it, and of the rich vein of statistical information in the Part II report.

## REDUCING CARBON THROUGH URBAN PLANNING AND POLICY

Over 80 per cent of carbon dioxide emissions originate in urban areas (Grubler 1994; O'Meara 1999), which occupy less than 2.4 per cent of the global land mass (Churkina 2008; Potere and Schneider 2007). The global rate of migration towards cities is three times greater than the rate of population growth (UN 2006). In 2007, for the first time in human history, more than half of the world's population was living in urban settings (UN 2007). Cities have been recognized as major contributors to global greenhouse gas emissions (International Energy Agency 2008; Grimm et al 2008), as well as a critical part of the solution in reducing these emissions (Chavez and Ramaswami 2011).

In the USA, studies have shown almost 40 per cent of total carbon dioxide emissions are associated with residences and cars, and that changing patterns of urban development and transportation can significantly impact emissions (Glaser and Kahn 2010).

In Australia we have one of the fastest growing populations for a developed country (Productivity Commission 2010) and one of the highest per capita carbon and ecological footprints in the world (Garnaut 2008; Global Footprint Network 2010).

Australian cities are typically composed of low density, dispersed suburbs, which are highly car dependent. This is resource and carbon emission intensive and therefore unsustainable in the long term (Rauland and Newman 2011). There is an immediate need for Australia to transition its cities to a low carbon alternative with more efficient form and function with respect to carbon

emissions. A low carbon city must improve the energy efficiency of its buildings and transport system (Chavez and Ramaswami 2011). A key aspect of this transition is transportation; the level and intensity of the demand for which depends greatly on the land use system and the land use planning instruments that have been applied.

Transportation systems guide our mobility, that is, our ability to move from one place to another in order to achieve our needs for participation in activities and utilisation of facilities, the locations of which depend on the distribution and intensity of land uses across a region. Transportation provides access to jobs, education and social interactions, for example, all of which are fundamental to human development (Donoso, Martinez and Zegras 2006). Public awareness and perception are two major barriers to the transition to low carbon transport options. Banister (2013) emphasises the need to understand the importance of time and how people want to use time in travel compared to other activities. Aditjandra, Mulley and Nelson (2013) suggest residents have to be well informed of the available opportunities for them to pursue sustainable travel choices.

Passenger car usage in Australian cities is thus a significant source of GHG emissions, and one that can be directly related to the shape and form of the built environment. The National Greenhouse Gas Inventory (NGGI) data indicates that 15.3% of Australia's total GHG emissions come from the transport sector. Analysis of the NGGI data indicates that the use of passenger cars in urban areas is responsible for 55.5% of the transport-based emissions, i.e. 8.5% of Australia's total GHG emissions (39.3 Mt out of 543.2 Mt CO<sub>2</sub>-e) is due to the use of passenger cars in our cities. See Figure 3.

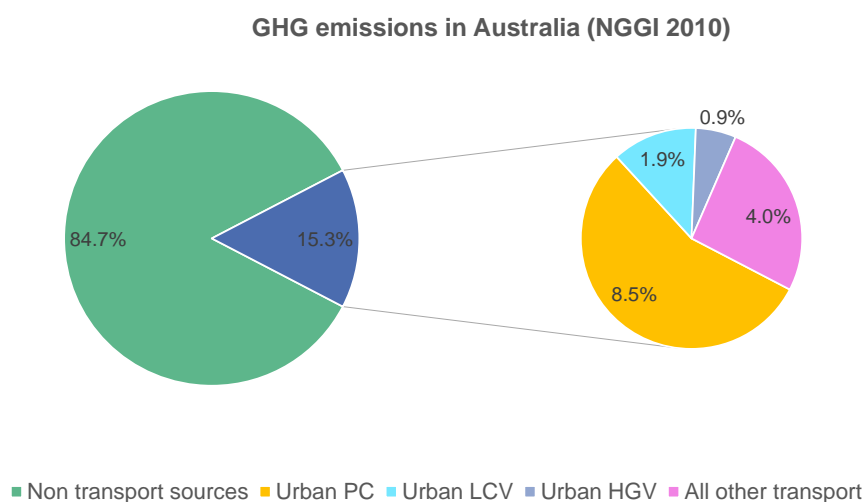


Figure 3: Contribution of passenger car usage in urban areas to Australia's total GHG emissions  
[derived from data in Department of Climate Change and Energy Efficiency (DCCEE) 2012]

The shape and form of our built environment, along with lifestyle choices, strongly influence the use of the private car in urban areas. Newton and Newman (2013) addressed this issue in their consideration of the carbon

benefits that can accrue from more compact urban forms where public and active transport modes are generally of most benefit. They considered the need for urban design innovation in Australia, largely focusing on energy

demands in housing and transport, and available alternative energy technologies and fuel types. The 'post war' suburbs, i.e. those areas of our cities first developed in the latter half of the twentieth century which are heavily car dependent, provide the most challenges in transitioning to a lower carbon future. The Newton-Newman framework for low carbon technology interventions is based around the consideration of appropriate low carbon technologies applied to housing and transport in suburban and inner urban areas. The framework identifies key differences in consideration between higher density urban regions and suburban developments. An extended version of the framework, explicitly identifying the active transport modes as key factors for both urban and suburban transport, is presented in Figure 4.

Given the known trade-off between housing type and location, with resulting impacts on demand for transport which are largely met at present by the private car in suburban locations, strategies to reduce urban carbon emissions need to be directed at providing substantial alternatives to that mode, based around greater use of the active modes and public transport. To make this direction feasible will require in depth consideration of built form, land use-transport interaction, land use mixes, the location and intensity for services and facilities and the supporting infrastructure, and precinct planning and design including the relationships between neighbouring precincts and between precincts and major activity centres such as the CBD.

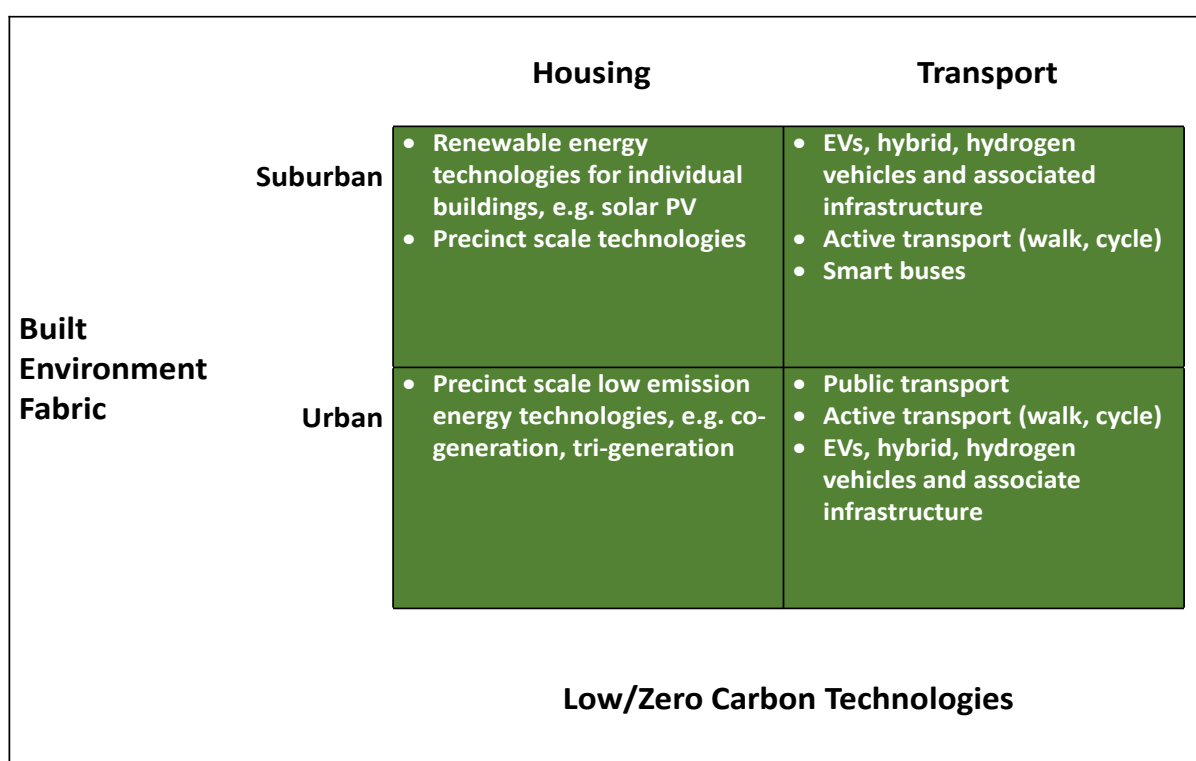


Figure 4: Modified Newton-Newman model framework for low carbon technology interventions in urban and suburban forms, including active transport as a key factor in both urban and suburban transport

[original source: Newton and Newman 2013]

Sensitivity test results, using the NGGI methods and data, show reducing person-km of travel by private car by 10% would reduce total GHG emissions by 2.74 Mt p.a. CRCLCL aims to contribute to a 10.0 Mt p.a. reduction by 2020, with Program 2 postulated to provide 4.2 Mt p.a. of that amount. These figures highlight the importance of investigating transport related components with respect to carbon reduction potentials.

### Planning Interventions Overview

Urban form can have a significant effect on the carbon intensity of travel, with some urban forms showing a

greater capacity than others to reduce the rate of carbon emissions per capita. Newton et al (2012) underscore the importance of integrated land use and transport planning for growing cities, providing examples where transport planning and development planning have happened independently resulting in reliance on private vehicles or excessive pressure on public transport services. A major transformation in the way transport planning is carried out is required with a new approach toward environmental and liveability aspects and a focus on achieving carbon efficiency in transport and urban precincts (Hickman and Banister 2007).

Beyond reducing carbon emissions, changing the way we undertake urban and transport planning offers the potential to generate other important long term benefits, such as open space preservation, improved air quality and public health, and reduced infrastructure investments, leading to improved quality-of-life in urban areas (Donoso, Martinez and Zegras 2006).

The travel decisions people make have been found to be significantly associated with built environment factors such as density, location, mix of land uses and precinct design (Hickman 2013). Changes are starting to occur in the structure of cities, as the cities are reaching a limit to car use growth and there are shifts away from traditional urban culture and economic paradigms (Newman, Kenworthy and Glazebrook 2013). As such there exists the potential for urban design and planning to play a major part in establishing a low carbon transport future.

Many theories exist regarding the ideal layout for low carbon cities, however there has been found to be a huge gap between theory and practice (Hickman 2013). The current understanding is that urban form and layout set the 'envelope of possibilities' for travel, and residential layout and supporting facilities have a complex relationship with resident attitudes, preferences and perceptions (Aditjandra, Mulley and Nelson 2013; Hickman 2013). The 'compact city' approach attempts to bring activities closer to residents so that they can fulfil their needs by using low carbon options such as active travel or public transport (Aditjandra, Mulley and Nelson 2013). The problem exists in maintaining quality of life and space in high population density environments, and what options for built environment interventions are available where high density living is not feasible. Aditjandra, Mulley and Nelson (2013) found that the specific layout of towns and cities in a low carbon world was as yet unclear.

As noted in the previous section, the shape and form of our built environment, together with lifestyle choices, strongly influences the use of the private car in urban areas. The Newton-Newman framework – see Figure 4 – identifies key differences in consideration between higher density urban regions and suburban developments. In a subsequent paper, Newton et al (2013) stressed the need for urban precinct design assessment tools and clearly defined benchmarks for low carbon urban developments. Further, he noted that variability in housing and transport attributes of different suburbs leads to variations in carbon emissions by as much as 50 per cent (see also Newton et al 2012).

Research is required to establish the combination of factors in the built environment that are supportive of low carbon transport modes, and the urban planning interventions that are capable of achieving this in future city structures (Philp and Taylor 2014).

## Policy Interventions Overview

Santos, Behrendt and Teytelboym (2010) considered a wide range of low carbon transport policy options, which they grouped into three categories:

- physical policies, concerning infrastructure and service provision,
- soft policies, aimed at bringing about behavioural change, and
- knowledge policies, emphasising the role of investment in research and development for future sustainable mobility.

They argued that policy integration was the key and that optimal blending of mutually reinforcing policies was essential. Banister (2011) discussed the concept of the sustainable mobility paradigm, which again required integrated, mutually supporting sets of policies. Banister et al (2011) then suggested a possible policy framework for LCM systems. However, this still required determination of relevant policy sets. A major question is just what policies should be considered and how can policy settings be optimised? Nakamura and Hayashi (2012) reviewed international developments on LCM policies and strategies. They concluded that the specific development processes of individual cities significantly affected the feasibility and effectiveness of different policies.

Policy interventions are required in order to achieve a LCM future. The complex nature of the interaction between transportation and other urban systems, and the life cycle of transport related infrastructure means that traditional static planning practices may not achieve the desired outcome for reducing carbon emissions. Ramjerdi and Fearnley (2013) highlight the importance of adaptive and flexible policy-making frameworks, favouring methods of dynamic planning where decisions are made continuously and based on a steady flow of new information. A widely popular and accepted trend found to increase the success of policy implementation is the formulation of integrated policy packages, rather than policy measures that are considered and deployed in isolation (May and Roberts 1995; Banister et al 2000; Feitelson 2003; OECD 2007; Justen et al 2013a; Justen et al 2013b; Givoni 2013; Taeihagh, Bañares-Alcántra and Givoni 2013). Justen et al (2013a) support the use of policy packaging where there is a lack of public acceptability. For example, they discuss how urban road pricing schemes may be theoretically effective in encouraging modal shift from private car travel to public transport, but generally receive significant opposition from motorists. Policy packaging options to reduce opposition to the scheme could include public transport improvements, or directing revenue from the scheme to other road improvements.

However, it is not always clear what the 'correct' option is and which of methods and tools can be used for which purpose and at what stage in the process of policymaking (Justen et al 2013b; Ramjerdi and Fearnley 2013). Whitehead (2013) discussed the case of Stockholm, Sweden where a congestion charging scheme was introduced with an exemption for low emission vehicles, in conjunction with the introduction of financial incentives for the purchase of low emission vehicles. As the number of low emission vehicles increased, the effectiveness of the congestion reduction charging was severely diminished. As such, the

exemption policy was phased out less than 18 months after being introduced. Ramjerdi and Fearnley (2013) raise several questions with respect to the uncertainties and risk with transportation policies, including:

- What are the 'correct' sets of policies?
- How should the policies be phased in and out?
- How should the government address the choice among technologies?
- What are the variables/factors that need to be taken into consideration for decision making?
- What is the right time to take a position on a necessary regulatory framework?

Taeihagh, Bañares-Alcántra and Givoni (2013) developed a virtual environment system for the exploration and analysis of different configurations of policy measures in order to build and assess alternative policy packages. Packages such as these and decision support systems are required to assist policy makers to develop effective policies with respect to low carbon mobility. Good planning practices will allow low carbon mobility to become a reality.

### Health Co-benefits from Low Carbon Built Environment

Potential health co-benefits from policies and plans to improve the built environment have been recognised for at least the last decade. Initial studies, such as BTRE (2005), were concerned with improvements in air quality (i.e. reductions in the concentrations of air pollutants such as carbon monoxide, hydrocarbons, particulates and oxides of nitrogen in the atmosphere). BTRE (2005) concluded that motor vehicle related ambient air pollution had a significant effect on cardio-vascular disease, respiratory disease, and bronchitis in the Australian community in terms of both morbidity (i.e. ill health in an individual and to levels of ill health in a population or group) and mortality, and the costs of which were estimated at about \$0.8Billion (morbidity) and \$1.8Billion (mortality) per annum. The potential of urban transport policies, planning and management strategies to improve air quality was thus identified.

Measures to improve air quality, through changes in transport technology, transport planning, transport systems management and urban planning, will also lead to reduced GHG emissions in urban areas, through reduced fuel consumption and reduced travel.

In recent years the potential co-benefits of low carbon urban development have come of interest. Haines and Dora (2012) reviewed the overall situation regarding the non-communicable disease epidemics (including cardiovascular disease, chronic pulmonary disease and obesity related conditions) and urban environments. They concluded that health and sustainability are closely related at a global level, on the basis that improvements in health can only be maintained by protecting the underlying systems on which human health and development depend. They identified a range of policies that can simultaneously improve health and promote sustainability, with particular focus on reducing GHG

emissions (as part of climate change mitigation). They further suggested that some of these policies could also have additional environmental benefits, such as addressing loss of biodiversity and land use change.

For Haines and Dora the health sector provides a unique contribution to make to climate policies by providing tools and expertise for health impact assessments and economic analyses, and by developing health monitoring and evaluation of mitigation policies. Health professionals can promote greater accountability, and generate the evidence to aid the selection of policies that will improve health and reduce greenhouse gas emissions.

Equally, urban planners and designers should be encouraged to take account of health expertise in the formulation of urban policy and development plans. This argument was further pursued by Bambrick et al (2011) for consideration in climate change adaptation strategies in Australasian cities. Given that the more vulnerable groups in the urban population, including the elderly, socioeconomically disadvantaged groups and the chronically ill are likely to be most affected by increased morbidity and mortality resulting from climate change, adaptation strategies should address this underlying burden of disease and inequity as well as implementing broad structural changes to building codes, urban design and infrastructure capacity. In this way co-benefits for health (e.g. from improved air quality and increased levels of physical activity) can be realised.

The capability for improved urban transport systems and reduced use of private motor vehicle transport in urban areas provides a strong focus for recent research on public health and economic productivity co-benefits. An overview of this research is provided in Rabl and De Nazelle (2012), who present estimates of the health impacts from a shift from car to walking and cycling. In particular, they identified and evaluated four major effects:

1. Change in exposure to ambient air pollution for those individuals who change their mode of travel
2. Health benefit to those individuals
3. Health benefit for the general population due to reduced pollution
4. Risk of accidents.

From their own work and reviews of other studies (e.g. Woodcock et al 2009; De Hartog et al 2010; and Rojas-Rueda et al 2011), Rabl and De Nazelle concluded that improved health outcomes, especially for mortality, can be used for benefit-cost analysis of policies, programs and projects aimed at increasing active transport, as long as the numbers of individuals making a mode shift can be identified.

Woodcock et al (2009) applied Comparative Risk Assessment methods to estimate the likely health effects of different urban transport scenarios for London and New Delhi. Their scenarios included 'business as usual' – without any policies for reduction of GHG emissions – along with alternative scenarios for lower carbon emitting vehicles, active travel, and a combination of these two.



Separate models linking the transport scenarios to physical activity, air pollution and risk of traffic injury were developed. They found that reduced GHG emissions through increases in active travel and reduced use of private motor vehicles had larger health benefits than from the increased use of lower emission vehicles. Consequently they recommended the consideration of policies to increase the acceptability, appeal and safety of active urban travel and discourage urban travel by private car.

De Hartog et al (2010) and Rojas-Rueda et al (2011) considered the potential health benefits of cycling, the former in The Netherlands, the latter in Spain. Both studies concluded that the expected health benefits of cycling were substantially greater than the risks relative to car driving for individuals who took up cycling as a means of transport. Rojas-Rueda et al also considered the potential reductions in GHG emissions from a shift to bicycle transport, based on the community bicycle-share system available in Barcelona. Crawford and Whyte (2014) confirmed these results in their study of the potential health benefits of increased bicycle usage in Glasgow.

Creutzig and He (2009) identified significant environmental co-benefits, including reductions in GHG emissions, from traffic congestion mitigation policies in Beijing. Subsequently Creutzig, Mühlhoff and Römer (2012) examined the opportunity for cities to become agents of climate change mitigation, while simultaneously seeking other objectives such as improved accessibility and air quality. They considered alternative scenarios for reduced GHG emissions in four European cities (Barcelona, Freiburg, Malmö and Sofia). Their analysis indicated that active travel modes could take high modal shares in smaller cities (those with populations less than 500 000), while significant co-benefits for air quality, health, traffic congestion and monetary fuel savings would result.

In terms of economic productivity co-benefits, improved land use-transport integration can greatly improve the operation of urban freight transport and realise environmental improvements such as reduced GHG emissions. The research area of 'City Logistics' is devoted to this end. Taylor (2005) provides an overview of city logistics, the productivity and environmental problems it addresses, and the urban planning and transport planning solutions it offers. The Logistics Institute-Asia Pacific (TLIAP 2013) describes a major research project fund by the Singapore Government to develop the required planning tools for successful implementation of city logistics methods and the realisation of the potential productivity co-benefits through improved freight deliveries, reduced congestion around freight terminals and reduced fleet management and labour costs.

Thus there is mounting evidence that substantial co-benefits, especially for public health but also for economic productivity in urban areas, can result from urban policies and planning initiatives aimed at reducing GHG emissions. Yet this situation still requires substantial research and investigation. The recent systematic review by Shaw et al (2014) highlighted the lack of rigorous (reported) research based on proper experimental design and the use of control groups. Both the quantity and quality of the available evidence needs to be improved – the work of Stopher et al (2009) and Zhang, et al (2013) provides one avenue to accomplishing this requirement.

In addition, Shaw et al (2014) provides a conceptual model of the pathways from transport-land use interventions to GHG and health changes which could serve to guide decisions about which outcomes to measure in studies of potential co-benefits. This model is shown in Figure 5 below.

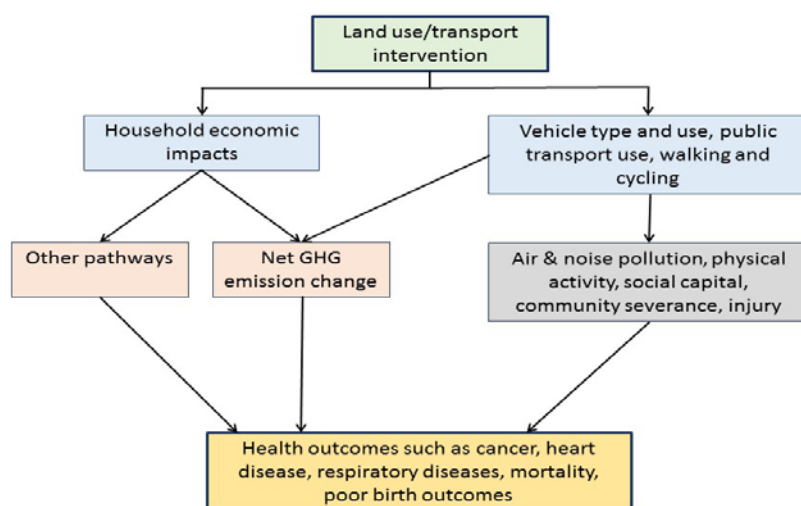


Figure 5: Adapted version of the conceptual model of pathways from land use and transport planning interventions to GHG emission and health changes

[original source: Shaw et al 2014]

## REVIEW OF CURRENT AUSTRALIAN POLICY AND PRACTICE

The review now considers a range of Australian policy and practice initiatives that can result in the reduction of carbon emissions. It is interesting to note that many of the significant initiatives originated in public health related agencies and do not have GHG reduction as a primary nor secondary aim – indeed, in many cases, there is no mention of environmental sustainability related outcomes. An understanding of the co-benefits framework can initiate an awareness of the multiple benefits possible from one policy initiative designed to do something else. Another important awareness raising outcome is interdisciplinary appreciation as different professional groups are exposed to a very different policy environment which can have benefits for them. This is manifest for those working, researching and studying in the low carbon arena who are not aware of what is being done in public health. The co-benefits framework can facilitate cross-disciplinary exchange and knowledge.

We now discuss key national, state and local policies that result in co-benefits, even if these are not acknowledged or understood. Our report presents significant initiatives, as well as ongoing research which is uncovering more policies and actions that have co-benefits.

### National Scale

#### **National Heart Foundation**

The Heart Foundation (2015) is a major stakeholder contributing to our knowledge about the role that the built environment plays in supporting good health – particularly active living (see <http://www.heartfoundation.org.au/active-living/Pages/active-living-resources.aspx>). In 2004, the Foundation published a seminal guide to shaping built environments so that they facilitate active living and good health more broadly (downloadable from: <http://www.heartfoundation.org.au/SiteCollectionDocuments/Healthy-by-Design.pdf>). The Guide aims to support the broad range of public and private sector professionals who have a role in the planning, design, development and maintenance of the public realm and make it easier to incorporate design considerations that will have a positive impact on health and wellbeing. This publication achieved a Planning Institute of Australia Excellence Award demonstrating its level of applicability to the planning professions and their work. The contribution of the Guide to sustainability was acknowledged in the Award citation.

The Guide has a set of design considerations set within the context of the important role that local government and planning professionals play in creating health supportive environments. The design considerations relate to the following:

- walking and cycling routes

- streets
- local destinations
- open space
- public transport
- seating, signage, lighting, fencing and walls
- fostering community spirit

A matrix entitled 'Like Design Considerations' concludes the Guide. This is an attempt to integrate the different requirements that planners need to take into account. While not specifically termed as such, the notion of co-benefits is entrenched in the matrix showing that design for active living, for example, has benefits across other areas at no extra cost.

Since that time, different states have published their own 'Healthy by Design' Guidelines with associated matrices. These encompass the general principles embedded in the Heart Foundation's 2004 document, putting them within the relevant state's legislative and policy context, as well as showcasing local case studies and stakeholder information. The State-based Guides have also augmented the original principles and matrix. For example, the South Australian Guide (2012; <http://www.heartfoundation.org.au/SiteCollectionDocuments/Healthy-by-Design-SA.pdf>) lists the following seven key objectives:

- *Walking, cycling and public transport* – provide an integrated, accessible network of walking and cycling routes and footpaths for safe, convenient and pleasant connection to open space, public transport, shops, local destinations and points of interest
- *Streets* – create functional and attractive street networks that prioritise safe and convenient travel for pedestrians and cyclists, and maximise opportunities to engage in planned and incidental activities
- *Local destinations* – provide local destinations to support lively, walkable and cycle friendly neighbourhoods
- *Open space* – provide a range of quality public open spaces within walking and cycling distance from dwellings. Open spaces should be accessible to a wide range of people with diverse needs and should foster community spirit
- *Supporting infrastructure* – install supporting infrastructure that provides for comfort, amenity, social interaction, safety and convenience
- *Urban food* – plan and design cities, towns and suburbs to ensure a more secure, resilient, healthy and sustainable food supply, and
- *Density* – encourage well designed residential areas with higher density and mixed uses.

The 'Healthy by Design SA' includes a comprehensive matrix which takes the original one further. According to the website, the matrix 'highlights the synergies between healthy by design and a range of other key design agendas in order to support an integrated approach to

urban design' in turn reinforcing the notion of different benefits across a range of considerations from one design intervention. The following are included:

- shade
- crime prevention through environmental design
- access design
- road user safety
- age friendly
- child/youth friendly
- pet friendly
- water sensitive urban design

Other state-based documents – Healthy by Design Victoria (2012); Healthy by Design Tasmania (2009) and the ACT's Active-Living-Impact Checklist (2012) – are all available from the Heart Foundation's Active Living Resources web page:

<http://www.heartfoundation.org.au/active-living/Pages/active-living-resources.aspx>.

A slightly different take on the Healthy by Design Guidelines is the Western Australian HABD (Healthy Active by Design) web tool (<http://www.healthyactivebydesign.com.au/>). This was prepared by the Heart Foundation in collaboration with the WA Departments of Health, Planning, Sport and Recreation and Transport, together with the Metropolitan Redevelopment Authority and the Planning Institute of Australia. CRCLCL industry partner Hassell was involved in the project. The resource covers the following topics showing how they need to be treated to enhance health:

- town centre/main street
- mixed use
- movement network
- public open space
- housing diversity
- sense of place
- shared facilities
- schools
- buildings

For each topic there is a library of research evidence for the suggested interventions, as well as design guidelines and related state policies – many of which encompass other non-health benefits. A Master Checklist with specific design guidance accompanies the web resource:

[http://www.healthyactivebydesign.com.au/sites/default/files/master\\_checklist/habd\\_master\\_checklist\\_140224\\_0.pdf](http://www.healthyactivebydesign.com.au/sites/default/files/master_checklist/habd_master_checklist_140224_0.pdf)

The Heart Foundation has also undertaken work on residential and commercial density, examining how different density levels create varying types of neighbourhoods with a range of characteristics that

influence whether an environment is supportive of, or hinders, an active lifestyle. Research is presented in three documents which examine the health benefits of denser neighbourhoods (all downloadable from: <http://www.heartfoundation.org.au/active-living/built-environment/Pages/Density-and-Health.aspx>):

- *Does Density Matter?* The role of density in creating walkable neighbourhoods (2014)
- *Low Density Development*. Impacts on physical activity and associated health outcomes (2014)
- *Increasing Density in Australia*: Maximising the health benefits and minimising harm (2012)

Not surprisingly, these reports present research evidence which suggests that higher densities encourage greater physical activity. Nevertheless, the reports caution that density has to be implemented carefully so that neighbourhood amenity is enhanced – the provision of green open space, quality public realm, good design and proximity of destinations and public transport are all critical. Busy, heavily trafficked and highly polluted roads are not conducive to health and should not be the location for high density development, a message that will be difficult for decision makers currently putting medium and high rise residential buildings along heavily trafficked and polluted transport corridors.

As well, walkability (including a practical audit for community members to understand just how walkable their local areas are and lobby for change where this is needed) makes a further contribution to understanding healthy built environments. The productivity benefits are covered in the Heart Foundation's 'Good for Business' (2011) which draws together research on the benefits of active transport for the economic viability of local businesses: <http://www.heartfoundation.org.au/active-living/Documents/Good-for-business.pdf>

Finally, it is worth mentioning the 'Streets for People Compendium for South Australian Practice' (2012; [https://www.healthybydesignsa.com.au/wp-content/uploads/16649%20StreetforPeopleCompendium\\_full.pdf](https://www.healthybydesignsa.com.au/wp-content/uploads/16649%20StreetforPeopleCompendium_full.pdf)) which examines the co-benefits of streets that are designed with people as the first priority. The report unpacks the impact of current car based travel patterns for chronic disease risk, illustrating the health benefits of being more active, together with the economic benefits (such as fewer road casualties) and the environmental benefits including reduced greenhouse gas emissions.

### Walk21

Walk21 (<http://www.walk21.com/>) is an international movement which 'exists to champion the development of healthy, sustainable and efficient communities where people choose to walk' (Walk21 Website). Annual conferences are held and in 2014, the NSW State Government and City of Sydney hosted Walk21 in Sydney (<http://www.walk21sydney.net/>). This put the spotlight on what is happening across the Australian nation to support walking for health and environmental

sustainability. An impressive array of speakers presented research, policy and practice initiatives to help Australian planning and public health advocates better understand what motivates and encourages walking. The decision to host Walk21 was made shortly after the December 2013 release of [Sydney's Walking Future](#) by Transport for NSW. Recognising the resulting social and economic benefits, the report's proposals aim to '**make walking the transport choice for quick trips under two kilometres**'. Walk21 showcased a wealth of research evidence, practice initiatives and inspiration to do this.

### **Healthy Spaces and Places**

Healthy Spaces and Places (Planning Institute of Australia 2009) is a unique collaboration between the Australian Local Government Association, the National Heart Foundation of Australia and the Planning Institute of Australia. The program emphasises the consideration of people's physical and mental health from active or healthy living in the planning of sustainable communities. Healthy Spaces and Places highlights the importance of planning and designing communities for people movements, and provides training, information and case studies demonstrating how to do this. Resources and research evidence is provided on its website: <http://www.healthyplaces.org.au/site/>

Through the use of practical training, case studies and guidelines, the Healthy Spaces and Places program aims to:

- encourage the development of built environments that provide opportunities for physical activity and other health-related activities
- continue to improve health outcomes for all Australians through better-designed built environments
- raise awareness of the relationship between physical activity and the built environment, and
- contribute to a national policy setting.

Healthy Spaces and Places is aimed at everyone who can make a difference to the overall health and wellbeing of Australians in order to bring about positive community-level change including :

- planning and design professionals
- health professionals
- the property development industry
- governments, and
- community organisations

## State Level

### **Health in all policies South Australia**

South Australia's 'Health in All Policies' (HiAP) is an approach which emphasises the fact that health and wellbeing are largely influenced by measures that are often managed by government sectors other than health (SA Health 2014). HiAP seeks to highlight the connections and interactions between health and policies from other sectors. HiAP explores policy options that contribute to the goals of non-health sectors which will improve health outcomes. By considering health impacts across all policy domains such as agriculture, education, the environment, fiscal policies, housing and transport, population health can be improved and the growing economic burden of the health care system can be reduced. The health sector's role is to support other sectors to achieve their goals in a way which also improves health and wellbeing.

The link between transport and health is listed as a justification for this approach and used to highlight the need for policy makers in all sectors to be aware of the impact of their decisions on population health and to act to incorporate considerations of health into their policies.

The South Australian HiAP model includes two key elements:

- central governance and accountability, and
- a 'health lens' analysis process.

This is shown in Figure 6.

The model captures the interactive and fluid nature of the approach (Figure 6). Beginning with clear governance and accountability it moves through a flexible Health Lens analysis process, leading to improved policy or social determinants of health outcomes.

The governance structure provides a mandate for horizontal collaboration and joined-up policy making, which underpins the HiAP work. A number of critical elements have contributed to South Australia's early success in adopting a Health in All Policies approach (HiAP). These include:

- a cross government mandate,
- leadership from the centre, and
- a dedicated strategic Health in All Policies team within SA Health.

The model seeks agreement on the policy focus and utilises robust methods of assessment and analysis to explore the links between the policy area and health and wellbeing of the population.

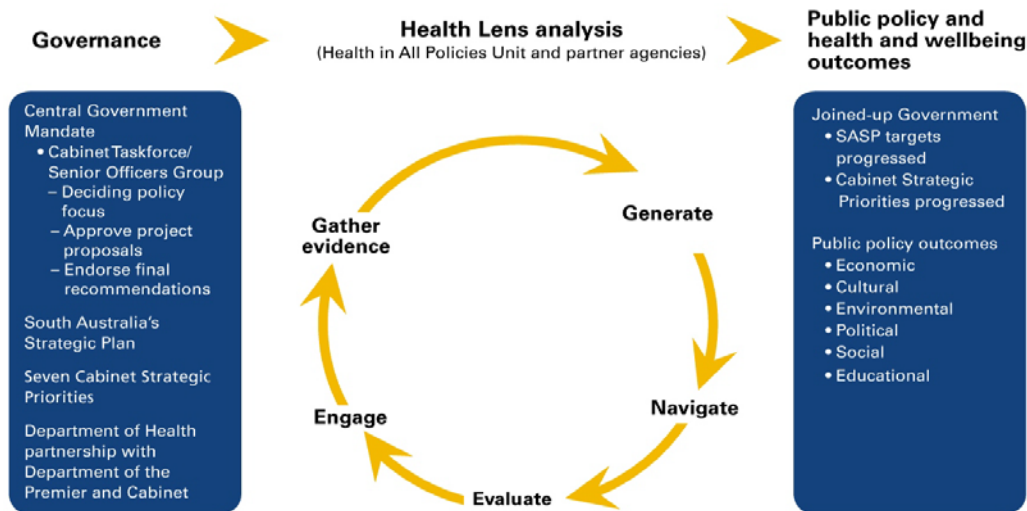


Figure 6: HiAP South Australia State Government Model

source: [www.sahealth.sa.gov.au](http://www.sahealth.sa.gov.au)

### Liveable Neighbourhoods Western Australia

Trialled first in 1998, Liveable Neighbourhoods (Western Australia Planning Commission 2009) has been adopted by the WA Planning Commission as operational policy. It is mandatory in the design and approval of urban development. Liveable Neighbourhoods applies to structure planning and subdivision for greenfield sites and for the redevelopment of large brownfield and urban infill sites. Liveable Neighbourhoods aims to implement the objectives of the State Planning Strategy which guides the sustainable development of Western Australia to 2029. Liveable Neighbourhoods operates as a development control policy, or code, to facilitate the development of sustainable communities. As a part of the planning approval process, applications to the WA Planning Commission must meet Liveable Neighbourhoods development conditions.

Principal aims of the policy include:

- to provide for an urban structure of walkable neighbourhoods clustering to form towns of compatible mixed uses in order to reduce car dependence for access to employment, retail and community facilities.
- to ensure that walkable neighbourhoods and access to services and facilities are designed for all users, including those with disabilities.
- to foster a sense of community and strong local identity and sense of place in neighbourhoods and towns.
- to provide for access generally by way of an interconnected network of streets which facilitate safe, efficient and pleasant walking, cycling and driving.

- to ensure active street-land use interfaces, with building frontages to streets to improve personal safety through increased surveillance and activity.
- to facilitate new development which supports the efficiency of public transport systems where available, and provides safe, direct access to the system for residents.
- to facilitate mixed-use urban development which provides for a wide range of living, employment and leisure opportunities, capable of adapting over time as the community changes and which reflects appropriate community standards of health, safety and amenity.
- to provide a variety of lot sizes and housing types to cater for the diverse housing needs of the community at a density that can ultimately support the provision of local services.
- to ensure the avoidance of key environmental areas and the incorporation of significant cultural and environmental features of a site in to the design of an area.
- to provide for a more integrated approach to the design of open space and urban water management.
- to ensure cost-effective and resource-efficient development to promote affordable housing.
- to maximise land efficiency wherever possible (Western Australia Planning Commission 2009).

### Healthy Urban Development Checklist New South Wales

The NSW Ministry of Health has recognised the need to develop its capacity to influence healthy urban design and development and to more actively participate in, and influence, urban planning and development processes. The Healthy Urban Development Checklist is one of the

measures now being used to do this (NSW Department of Health 2009).

The purpose of the checklist is to assist health professionals to provide advice on urban development policies, plans and proposals. It is intended to ensure that the advice provided is both comprehensive and consistent. The checklist focuses on helping health professionals to answer the questions:

- What are the health effects of the urban development policy, plan or proposal?
- How can it be improved to provide better health outcomes?

There are ten characteristics of healthy urban development in the checklist. Each one has detailed information about its importance in supporting human health and how it can be incorporated into the built environment (both in terms of policies and land use decisions).

The topics are:

- healthy food
- physical activity
- housing
- transport and physical connectivity
- quality employment
- community safety and security
- public open space
- social infrastructure
- social cohesion and social connectivity
- environment and health

The checklist is a tool for reviewing and commenting on development application plans and providing input and advice on health related issues at an early stage of the urban planning and policy process. Although not exclusively, the primary users of the checklist were initially intended to be Area Health Service (now Local Health District) professionals. They can use the checklist to:

- provide a standardised tool to guide and inform feedback and advice to, for instance, local government and developers on urban development policies and plans in NSW
- evaluate the health aspects of urban developments
- support engagement between urban planners and developers and health professionals
- inform others (planners, developers, policy makers) about the range of factors that need to be considered in creating healthy urban developments

Most recently, and of particular interest for this review, is an additional chapter entitled 'Environmental Sustainability and Climate Change'. While it has not

been formally incorporated into the original checklist, it is available on the Sydney West Local Health District website:

<http://www.sswahs.nsw.gov.au/populationhealth/hud/>.

This chapter presents the co-benefits concept through example environmental and health co-benefits of climate change mitigation and adaptation strategies. This is shown in Table 2. With this update, the Healthy Urban Development Checklist embraces the notion of co-benefits and puts an understanding of the inter-relationships between action on climate change and improvements in human health firmly on the agenda of health professionals.

### **NSW Premier's Council for Active Living (PCAL)**

Established in 2004, PCAL is an inter-agency forum based in NSW which aims to 'build and strengthen the physical and social environments in which communities engage in active living' (PCAL website:

[www.pcal.nsw.gov.au](http://www.pcal.nsw.gov.au)).

Its remit now includes healthy eating. PCAL is charged with building strategic partnerships across government, NGOs, private sector and the community to promote physical activity and healthy eating. Membership of PCAL includes senior representatives from the NSW Government, business and the non-government sector. The Council reports to the Premier. PCAL's focus has been on initiating policy change through the provision of strategic advice and advocacy. It has different areas of work but of particular importance are active travel (walking, cycling and use of public transport), health promoting urban environments and the liveability of NSW cities and towns. PCAL has an excellent website with lots of really important resources for healthy planning: [www.pcal.nsw.gov.au](http://www.pcal.nsw.gov.au)

While not exclusively an outcome of PCAL's work, but very much to do with its strategic partnership work in active travel, the 2014 'NSW Active Travel Charter for Children'

([http://www.preventivehealth.net.au/uploads/2/3/5/3/23537344/nsw\\_active\\_travel\\_charter\\_for\\_children\\_2.pdf](http://www.preventivehealth.net.au/uploads/2/3/5/3/23537344/nsw_active_travel_charter_for_children_2.pdf)) was launched at the Walk21 Congress (of which PCAL was a key partner). The Charter recognises co-benefits of active travel, stating that this can have 'considerable health, social and environmental benefits for children, parents and the community'.

### **Health Objective in the NSW Planning Bill 2013**

During 2011-13 NSW underwent a major review of the NSW planning system. This was the first comprehensive evaluation of the State's Planning System in over 30 years. The Review process was launched in 2011 with extensive consultations held across the state. The second phase focused on an Issues Paper covering the ideas and feedback received during the first round of consultations. A Green Paper entitled 'A New Planning System for NSW' was published by the NSW Government in July 2012 which was followed by a White Paper and draft legislation in April 2013 which was tabled in the State Parliament.

Table 2: Example environmental and health co-benefits of climate change mitigation and adaptation strategies

Mitigation strategies	Environmental co-benefits	Health co-benefits
Decreased fossil fuel combustion	Cleaner, pollution-free air	Lower rates of respiratory and cardio-respiratory disease
Improved public transport and mass transit systems	Reduced consumption of a range of non-renewable resources, including oil and metals	More people walking and cycling to and from stations promotes health and fitness and reduces overweight and obesity
	Reduced pollution from fossil fuel combustion	Lower rates of respiratory and cardio-respiratory disease
Increased fruit and vegetable consumption	Reduced ecological footprint	Promotes good health and nutrition and lowers rates of cancer and several chronic diseases
Adaptation Strategies	Environmental co-benefits	Health co-benefits
Early warning systems for weather extremes and disease outbreaks	Prevention or minimisation of environmental damage	Reduced death and disease following natural disasters and better control of infectious diseases
Improved programs to adapt rural economies to a changing climate	Prevention or minimisation of land degradation	Strengthened social capital and beneficial effects on mental health

(Supplementary Environmental Sustainability and Climate Change Chapter, p.4)

Lobbying for the inclusion of health in planning decision making was an important component of this review, bringing a greater appreciation of the inter-related nature of planning, environmental protection and human health. While not termed, 'co-benefits', the inclusion of an objective to protect and support human health in the NSW Planning Bill 2013 was a significant achievement of key health and built environment stakeholders working in close and strategic collaboration. Led by PCAL and the Healthy Built Environments Program (HBEP) at UNSW (<http://www.be.unsw.edu.au/programmes/healthy-built-environments-program/about>), a consistent and clear message on the importance of health in planning decision-making was delivered to the NSW Government at every stage of the review process (Thompson and McCue, 2015). The inclusion of a human health related objective in planning legislation (albeit yet to pass into NSW law) is internationally and nationally significant and augurs well for the continued development of the health-built environment relationship in planning policy and action. It is interesting to note that the stakeholder group, which worked together during the review, called itself the 'Healthy Planning Expert Working Group' has now been named in the Sydney Metro Strategy as part of devising healthy built environment guidelines with the State Department of Planning and Environment (see page 25 below).

## Local Level

### **Cycle2City Brisbane**

Cycle2City ([www.cycle2city.com.au](http://www.cycle2city.com.au)) opened in June 2008 and is operated by a private company. Cycle2City

is a bicycle sharing system along the lines of those operating in many European and North American cities, in which bicycles are located at a number of bike stations around the city and are available for hire. The bicycle can be left at any one of the stations after use. The system is designed to support people who want to ride, walk or run to work but suffer inadequate workplace facilities. Construction of the main CBD facility King George Square Cycle Centre was jointly funded by the Brisbane City Council and the Queensland State Government. Users must pay a membership fee to access the facilities located around Brisbane. Membership provides daily access to:

- secure bike parking
- towels
- air conditioned locker rooms, and
- showers

The Cycle2City website also provides comprehensive information to help plan routes to work for cyclists, walkers and runners.

### **Melbourne Cycling Scheme**

Melbourne Bike Share (<http://www.melbournebikeshare.com.au/>) is a similar scheme. It is promoted as 'a great way to travel around Melbourne... a new form of public transport, designed for short trips across the city.' (Melbourne Bike Share Website). Bikes can be accessed from 50 stations throughout Melbourne city by residents or visitors. Helmets are free and attached to the bike.



Figure 7: Melbourne Bike Share (left); Brisbane Bike Share (right)

Source: Susan Thompson

### **TravelSmart Interventions (Example TravelSmart Households in the West)**

Voluntary behaviour change is defined as change that occurs when individuals make choices for personal reward without a top-down mechanism, regulation of any sort, or a feeling of external compulsion (Ampt 2004; Ker 2004). This principle can be applied to achieve more sustainable urban transport systems and reducing carbon related to travel. Voluntary Travel Behaviour Change (VTBC) schemes attempt to shift travel mode choices to more sustainable transport options. The schemes do this by providing appropriate information, assistance, motivation or incentives, so that people will voluntarily choose to travel in ways which can benefit themselves, the community and the environment (Stopher and Bullock 2003; Chatterjee and Bonsall 2009). VTBC encompasses a range of programs including personal travel planning, travel awareness campaigns, workplace travel plans, school travel plans and car sharing schemes (Chatterjee and Bonsall 2009). The general consensus is that VTBC programs lead to reductions in car use whilst increasing public transport use, walking and cycling (Ampt and Rooney 1998; James 1998; Ampt 1999; Rose and Ampt 2001; Marinelli and Roth 2002; Stopher and Bullock 2003; Ker 2004; Pramberg 2004; AGO 2005; Tideman et al 2006; Bonsall 2009; Brog et al 2009; Chatterjee 2009; DTEI(SA) 2009; Seethaler and Rose 2009). In order to motivate, target and develop behaviour change in individuals, VTBC schemes employ psychological principles at a community level application (TravelSmartVictoria 2002;

Seethaler and Rose 2003; Ampt 2004; Seethaler and Rose 2004, 2005).

The TravelSmart Households in the West project, as described in DTEI(SA) (2009), Stopher et al (2009) and Zhang et al (2013), provides comprehensive, readily available information on the methodologies employed in a highly successful VTBC intervention undertaken in Adelaide as part of the National Travel Behaviour Change Program. Whilst there have been many applications of VTBC programs across Australia, the methodologies used in the application and evaluation of this project represent a benchmark for VTBC schemes in Australia.

The project was undertaken over three local government areas comprising 4.5% of the total Adelaide metropolitan area and including 13% of its population with a diverse socio-economic representation. The project area was characterised by the fact it had not previously been exposed to a VTBC intervention, alternative transport was accessible, and there were several major entertainment and business centres. The project aimed to (Tideman et al 2006; DTEI(SA) 2009):

- reduce private car use through VTBC
- achieve ongoing change in travel behaviour
- directly engage people within their own settings and cultural context in an attempt to make the program accessible for the maximum number of socio-demographics
- provide simple, motivating tools and techniques addressing the most significant barriers to behavioural change
- develop partnerships with key stakeholders
- independently evaluate results with statistical confidence
- be effective and efficient on a broad scale

The application involved a combination of community development and individualised marketing approaches. 191 community groups were engaged in the project, helping to influence community opinions and offer support to individuals. 22,103 household were engaged at an individual level. Prior to the commencement of the project, a community perceptions survey on private car use and sustainable travel options was undertaken. A follow up survey was conducted after the project had concluded to determine changes in community attitude. The before-and-after surveys showed a significant shift in community perceptions about private car use and sustainable transport options.

The TravelSmart intervention was initiated using a letter of introduction mailed to over 65,000 households to introduce the project and pave the way for the next phase. The secondary phase involved a guided conversation (by phone or face-to-face) with a trained TravelSmart officer to discuss the household travel requirements and the negative aspects of car use. The third phase of the intervention used direct coaching of the household with a TravelSmart officer to devise a solution to reduce car use for the benefit of the



individual. This phase also included providing a series of tools designed to encourage people to change their travel behaviour.

The focus of the project then shifted to a 'legacy building' stage. A network of organisations and people were identified as TravelSmart Friends and were subsequently trained or mentored to continue support in the community to reduce car use. This approach fulfils a maintenance niche after the conclusion of the TravelSmart project in order to sustain changes through the community in a socially regulated manner.

Evaluation of the program was undertaken primarily to measure statistically significant changes in household travel behaviour with a focus on private car use, and to understand what caused VTBC. The blind evaluation was undertaken by an independent third party and conducted in a manner disassociated from the TravelSmart project to eliminate bias in the reporting of results (Stopher et al 2009).

The following statistically robust findings were taken from the TravelSmart Households in the West evaluation (DTEI(SA) 2009; Stopher et al 2009):

- Car travel was reduced by participants on weekdays and weekends by an average 10.4km per household per day, representing an 18% reduction. Non-participants showed a significant 6% increase in distance travelled. The total reduction of Vehicle-Kilometres of Travel (VKT) per day for participating households was 229,850 vehicle-km while non-participants increased daily VKT by 605,030 vehicle-km. The GPS device was unable to distinguish between car drivers and passengers. As such, ride sharing was not represented in these results, inferring a potentially larger decrease in VKT than reported
- Participants exceeded the greenhouse gas abatement target of the National Travel Behaviour Change Project, saving a total of 86 million VKT, equivalent to 28,000 tonnes of greenhouse gas emissions
- Participants learnt to make fewer trips, significantly reducing the number of journeys by 5%, while non-participants increased the number of trips made by 3.8%
- Participants learnt to travel more efficiently reducing travel time significantly on weekends and week days as opposed to non-participants who increased time travelling
- Significant household savings in fuel were an additional benefit totalling \$11.6 million based on average petrol prices over the evaluation period, equal to a \$525 saving per participating household
- Public transport patronage rates in the TravelSmart project area showed more than a 6% increase in 2005-6, and continued increase in 2006-7. This compared to a 1% increase in 2005-6 patronage and a 1% decrease in 2006-7 patronage in metropolitan areas outside of the project area.

This example has highlighted how a systematic and robust intervention can have significant impacts on travel behaviour for large scale applications of VTBC in metropolitan areas and at the same time contribute to informing and improving the field for future applications.

### ***Environments for Health - Municipal Victoria***

The Environments for Health: Municipal Public Health Planning Framework was designed to assist local governments in Victoria to plan for the impact of the natural, built, social and economic environments on health. Since its publication in 2001, this framework has provided the guiding principles for planning for public health and wellbeing. The principles, now embedded in the Public Health and Wellbeing Act 2008, hold that primary prevention is achieved by viewing health as the product of multiple factors. These factors extend from the individual to the environment in which one lives: the interaction and relationship between these factors have a major influence on health.

Under the Public Health and Wellbeing Act 2008, local government in Victoria is mandated to prepare a municipal public health and wellbeing plan (MPHP). The MPHP is a strategic plan that sits alongside and integrates with the corporate plan of the council, the council land use plan required by the Municipal Strategic Statement (MSS) and other local plans of community partners with an interest in local public health. The MPHP sets the broad mission, goals and priorities to promote municipal public health and wellbeing. In turn, these are intended to inform the operational processes of council and local organisations (Department of Human Services Victoria 2001).

### **Metropolitan Strategies Across Australia**

We are increasingly seeing reference to human health, climate change and environmental sustainability in metropolitan strategies for Australian capital cities. This is not however, necessarily linked to a formal co-benefits framework but the foundations are there for this to occur. The Melbourne Metropolitan Plan (<http://www.planmelbourne.vic.gov.au/>) includes an entire chapter entitled 'Liveable Communities and Neighbourhoods' with a Government commitment to 'create healthy and active neighbourhoods'. A key component of this is the creation of the '20 minute neighbourhood'. This is where residents can ideally access a range of local services within 20 minutes of their home. Active transport and access to quality green open space feature as important characteristic of the '20 minute neighbourhood'. The principles of healthy planning as espoused in 'Healthy Spaces and Places' (see page 21 of this report) are presented in the Melbourne Plan.

Similarly, the Adelaide Plan ([http://www.dpti.sa.gov.au/planning/30\\_year\\_plan](http://www.dpti.sa.gov.au/planning/30_year_plan)) embraces a liveability objective, which is interlinked with the Plan's other two objectives – sustainability and climate change resilience, and competitiveness. Principle 8 entitled 'Healthy, safe and connected communities' specifically relates to walkability, safe

design and high quality open space availability. While not set in a co-benefits framework, the Plan aims to deliver compact and carbon efficient city development, together with transit oriented developments which connect public and active transport modes.

Most recently, the Sydney Metropolitan Strategy –‘A Plan for Growing Sydney’, 2014 (<http://www.strategy.planning.nsw.gov.au/sydney/>) has embraced health as an important outcome of the state’s planning decisions. The Strategy’s Goal 3: ‘A great place to live with communities that are strong, healthy and well connected’ includes an entire section on health. Direction 3.3 ‘Create healthy built environments’ presents key ways that the built environment can support healthy communities. The Strategy makes a commitment that the Government will deliver guidelines for a healthy built environment (Action 3.3.1), working together with the NSW Healthy Planning Expert Working Group which was established during the NSW Planning Review (see page 26 of this report). In addition, the Sydney Plan includes reference to co-benefits (Direction 4.3) in relation to the development of ‘*Green Cover Design Principles*’ which are to ‘incorporate vegetated, permeable and reflective surfaces into urban settings, to address thermal loading in the built environment and provide co-benefits such as reduced energy costs for cooling, stormwater management, cleaner air and biodiversity habitat’ (p105). Of course there will also be co-benefits for human health but this is not referenced in the Plan.

### **NSW Local Government Policy**

Doctoral research is currently underway to investigate the adoption of co-benefits at the local government level in Australia. It is being supervised by Thompson (with colleague Williams) in the Built Environment at UNSW. Set within the broader Australian environmental and urban planning policy context, this research examines local council policies in relation to their adoption of a co-benefits framework in addressing climate change and related environmental issues. The project is particularly focused on the effective integration of a co-benefits framework in mitigating the impact of climate change and at the same time, achieving health, productivity and other gains for the community. The study will evolve a systematic understanding of Australian local government policy context in a way that will not only help to identify the conditions under which the co-benefits approach could be effective, but also to understand how to plan, generate and purposively promote co benefits in urban planning and the built environment at the local level.

This work is central to understanding local government policy responses to co-benefits. The PhD will deliver on CRC output milestone R2.4, most specifically, R2.4.1 (to which it has already contributed through the provision of information for this report) and R2.4.3, as well as contributing to achieving R2.5.4. Further, the PhD has assisted the realisation of utilisation milestone U2.4.1 and can deliver on U2.4.4.

## CO-BENEFITS GENERATED FROM CARBON REDUCTION ACTIONS

### Public health benefits

Active transportation modes such as walking and cycling are widely recognised for their zero carbon impact and the co-benefits associated with them with regard to public health. Many studies have investigated the impact of these transportation modes on public health (Giles-Corti and Donovan 2002; Sallis et al 2004; Wen and Rissel 2008; Woodcock et al 2009; and Hickman 2013).

The Alliance for Biking and Walking (2014) conducted a national benchmarking study for the USA that found interesting results related to public health. Providing opportunities for regular physical activity, such as walking and bicycling, can make a big impact on improving public health and life expectancy (Buehler et al 2011; Gordon-Larsen et al 2009; Hamer and Chida 2008; Oja et al 2011; Pucher et al 2010; Shephard 2008). In fact, the quantified health benefits of active transportation can outweigh any risks associated with these activities by as much as 77 to 1, and add more years to our lives than are lost from inhaled air pollution and traffic injuries (Rojas-Rueda et al 2011; Jacobsen and Rutter 2012). The Alliance found in their report that States with higher rates of bicycling and walking to work also have a higher percentage of the population meeting recommended levels of physical activity, and have lower rates of obesity, high blood pressure, and diabetes.

Specifically in relation to children's health, Mackett (2012) reviewed the impact of active travel on school children. Results showed that children who walk more than they use the car are more energetic in all activities over a greater proportion of the day, on average, than those who use the car more than they walk (Mackett 2012; Goodman et al 2011).

The task remains to find an effective way to evaluate these benefits. Shaw et al (2014) conducted a systematic review of the public health and carbon benefits from various international transport policies. This review generally found the quality of studies were poor, raising validity issues with respect to reported results, due to issues including:

- limited methodological detail
- poor or no justification for selection of controls
- no information about the validity of measurement instruments
- inadequate measurement of transport use and health outcomes
- poor statistical analysis
- short follow-up period, and
- failure to consider and manage confounding.

Active transportation not only improves our physical health, but also our mental well-being and ability to focus

(Garrard et al 2012; Singh et al 2012; Chaddock et al 2010; Hillman et al 2005).

### Environmental benefits

The most harmful pollutants are emitted within minutes of starting a car (the 'cold start' phenomenon), meaning that short trips may pollute more by distance and have a bigger impact on our overall health than longer trips (FHWA 2012). These short trips are often ones that can be undertaken using a zero carbon option such as walking or cycling.

The cost of the health impact of outdoor air pollution in OECD countries, both deaths and illness, was about USD 1.7 trillion in 2010, with road transport accounting for about 50% of this cost, almost USD 1 trillion (OECD 2014).

Reduction in noise pollution would occur with decreased car use due to decreased car numbers and decreased congestion.

### Quality of Life improvements/ Social benefits

Social inclusion is also recognised as a major benefit from low carbon precinct design and encouraging the use of active transport modes. Taylor and Ampt (2003) found that areas where voluntary travel behaviour change interventions were undertaken experienced:

- increased activity and interaction in streets
- reduced reports of local crime
- increased social interaction and trust at a community level
- increase in recognition of local heritage and culture
- increase in cultural products in local shops
- decrease in number of 'complaints-without-solutions' to local councils
- increased community initiated projects.

### Economic and productivity benefits

Years of planning and building streets for cars has left many communities severely lacking in bicycle and pedestrian infrastructure. Building new facilities for bicycling and walking can be a boost for the economy via factors such as:

- new jobs
- rising property values
- increased business at local establishments
- reduced traffic congestion (Alliance for Biking and Walking 2014).

There is also a direct economic incentive to individuals. The costs of running a car far outweigh active transport options, and can result in significant household savings (Litman 1999).

Reduced income from carbon based fuel taxes may be recouped through increased public transport patronage (Taylor and Ampt 2003).

Improvements in productivity for urban freight operations are also possible under policies and plans for better integration of land use and transport, as discussed in Taylor (2005) and TLI-AP (2013).

The reduction of direct and indirect health benefits discussed above also has an economic impact through reduced burden on the health care system.

## CALCULATING THE CO-BENEFITS GENERATED FROM CARBON REDUCTION ACTIONS

This policy and practice review has outlined the possible co-benefits associated with a shift to low carbon active transportation modes. However, the review has also revealed that there is little direct policy action being undertaken to reduce our carbon outputs. Understanding the value of carbon reduction actions and the associated co-benefits would provide impetus for policy makers and practitioners to further the carbon reduction agenda. A streamlined method is required that will enable this important information to be quantified, so that it can be fed into low carbon living decision making. Four such methods, generally referred to as calculators, are reviewed in the following subsections.

## Health economic assessment tools (HEAT) for walking and for cycling (WHO, 2014)

The World Health Organisation (WHO) recognises that the promotion of active transport is an important approach to address the challenge of high levels of physical inactivity around the world, and achieving this requires support from the transport and urban planning sectors. Economic appraisal is an established practice in planning, however, health effects of transport interventions are often excluded from these analyses due to their complex nature.

In order to address this issue, WHO have developed the Health Economic Assessment Tool (HEAT) for walking and cycling. This tool provides guidance and a practical, web-based tool for economically assessing the health effects of walking and cycling. This tool is designed to assist in the economic assessment of the health benefits of walking or cycling by estimating the value of reduced mortality resulting from specified amounts of walking or cycling. The basic structure of HEAT is shown in Figure 8.

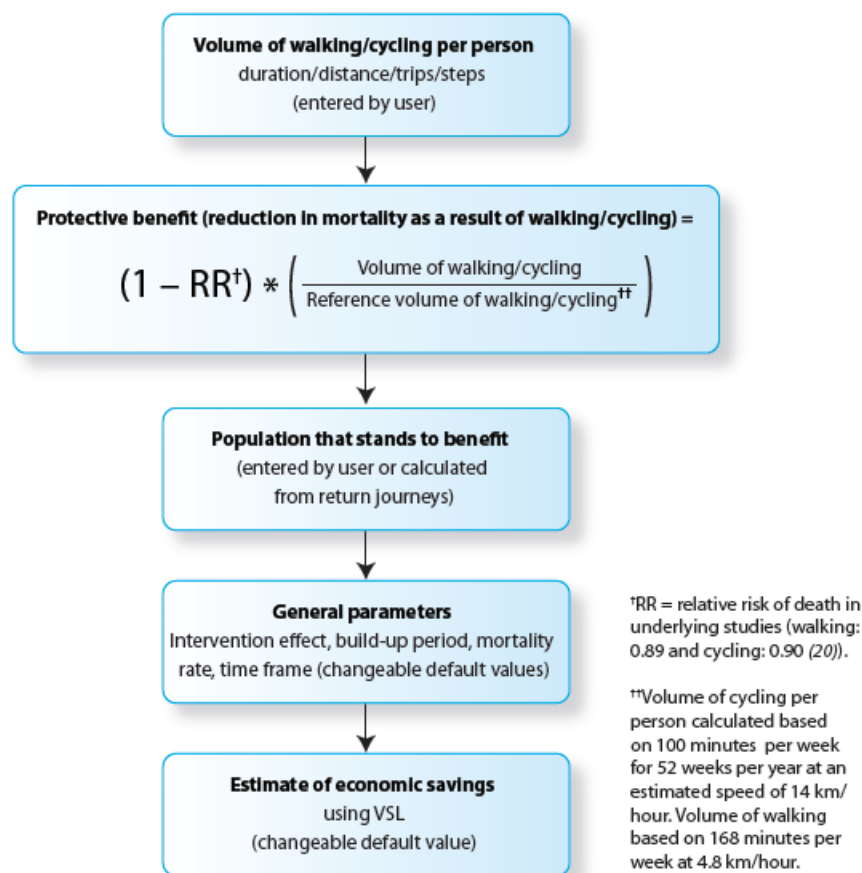


Figure 8: Basic functions of the HEAT Tool. (Source: WHO 2014)

Source: WHO 2014

HEAT was designed to be used by a wide variety of professionals and can be applied anywhere from a national to local level. Intended users include:

- transport planners
- traffic engineers, and

- special interest groups working on transport, walking, cycling or the environment.

The tool can be used in a number of different situations, including:

- planning a new piece of cycling or walking infrastructure
- evaluating the reduced mortality from past and/or current levels of cycling or walking, and can also be used to demonstrate the economic consequences of a potential future change in levels of cycling or walking, and
- as a starting point for more comprehensive economic appraisals or health impact assessments.

Assessments can be undertaken with two main types of data, either data from a single point in time, or before and after data. The following data is required for input:

- the number of people walking or cycling, and
- the average time spent walking or cycling in the study population, which can be formatted as either:
  - duration - average time walked or cycled per person
  - distance - average distance walked or cycled per person
  - trips - average per person or total observed across a population, or
  - steps - average number of steps taken per person.

In addition HEAT requires health-related statistical data, including parameters such as Disability Adjusted Life Years (DALY) and Value of a Statistical Life (VSL). Australian values for these and other related parameters are summarised in ASCC (2008).

Given these inputs HEAT can then estimate the following outputs:

- maximum annual benefit
- mean annual benefit, and
- net present value of mean annual benefit.

The maximum annual benefit is the total value of reduced mortality due to the level of walking or cycling entered by the user. This output assumes that the maximum possible benefits to health will have occurred. In reality, the health benefits are likely to accrue over time. As such, the mean annual benefit is therefore the key output of the tool. It adjusts the maximum annual benefit (total value of lives saved due to the level of walking or cycling entered by the user) by three main factors:

- an estimate of the time it takes for the health benefits from regular walking or cycling to occur
- a build-up period for uptake of walking or cycling, which allows the user to vary the projections in uptake if valuing a specific intervention such as for a new cycle path, and varies for full usage occurring between 1 and 50 years, and
- the net present value of mean annual benefit, which adjusts the above outputs to take the diminishing value of current savings over time into account (the

model suggests a discount rate of 5% but this can be varied).

WHO (2104) provides a number of case study examples of the use of HEAT in continental Europe, the UK and the USA.

Crawford and Whyte (2014) provided a separate case study application of HEAT to increased levels of cycling in Glasgow. They found significant economic benefits from reduced mortality as a result of increased cycling, and concluded that the tool could be used to provide more comprehensive and meaningful cost benefit analysis of plans and proposals for new infrastructure and transport service provision.

No case study applications for Australia or indeed the Asia-Pacific region have been found to date. The CRC for Low Carbon Living should seek to undertake such studies involving the application of HEAT in one or more Australian cities.

### NZTA evaluation tool (Wedderburn 2013)

The New Zealand Transport Agency recognised that there were interventions available to increase public transport access through walking and cycling. However, the cost-benefits of these interventions were not entirely clear. As such they have developed a cost-benefit analysis spreadsheet to assist in the assessment of various transport interventions.

Research was conducted by the agency to examine evidence on interventions that could improve the integration of public transport with walking and cycling, in order to provide decision makers with a robust basis for the appraisal of measures, using a cost-benefit analysis approach. The purpose of this research was to develop an analytical assessment framework to:

- understand how provision for walking and cycling at either end of a public transport trip affects the attractiveness of that mode,
- understand the wide range of initiatives and measures that can improve public transport integration with walking and cycling,
- forecast demand for public transport trips integrated with walking and cycling, and
- calculate the costs and benefits of alternative proposals to improve integration.

The results from this research was incorporated in the evaluation tool (available at [www.nzta.govt.nz/resources/research/reports/537/docs/evaluation-tool.xlsx](http://www.nzta.govt.nz/resources/research/reports/537/docs/evaluation-tool.xlsx)), which integrates the findings from studies of international and local travel behaviour in New Zealand, for estimating the benefit-cost ratio of improving walking and cycling access to public transport. The spreadsheet tool aims to:

- provide an easy-to-use tool to estimate the demand for walking and cycling as a public transport (PT) access mode, and

- calculate the monetary costs and benefits of alternative options to improve integration at individual stations and stops.

The spreadsheet evaluation tool is capable of estimating the dollar value of improvements to the integration of public transport, walking and cycling based on research which compared the monetary appraisal values from international business case guidance. The economic evaluation parameters follow the principles outlined in the NZ Transport Agency's Economic Evaluation Manual. It is recommended that the economic evaluation should be conducted over a specified evaluation period linked to the life of the asset.

The evaluation tool is designed to be used as one spreadsheet for each station or stop. It can be applied to a single bus stop or a major multimodal interchange. It has been designed to allow the evaluation of several alternative options for the station/stop.

The tool is intended to be flexible, in order to adapt to different levels of data availability. The minimum data requirements for use of the tool are:

- estimates of daily boarding/alighting at the station/stop
- an estimate of the number of passengers interchanging between public transport modes
- population and employment data for the surrounding area (e.g. from census data), and
- cost estimates of the measures proposed (some unit values are included in this report).

The evaluation tool is designed to estimate passenger impacts for a single year - either the proposed implementation year or a future-year scenario. If users want to test the impacts of integration measures combined with forecast population/employment growth, separate spreadsheets should be completed for the implementation year and any future-year scenario(s). In this way it is possible to disaggregate the impacts of the integration measures from the impacts of population/employment growth.

The main application of the evaluation tool is as an add-on to the NZTA economic evaluation method which is required to be applied to all transport systems projects in New Zealand.

An alternative application of the tool is for demonstrating the benefits, particularly the health benefits, of increased public transport use. For a given station and access mode profile, users can use the evaluation tool to estimate the change in total kilometres walked and cycled (as an access/egress mode) as a result of higher PT patronage. However, users currently need to calculate the health benefits of this increase outside of the evaluation tool spreadsheet.

Use of the NZTA tool as an additional component in benefit cost analysis as part of a precinct design assessment procedure is feasible, and should be considered in the CRC's co-benefits research.

## UNU Evaluation Tool

UNU (2014) describes an evaluation tool similar in nature to the NZTA tool but couched at a broader level of application. It combines a quantitative spreadsheet of a simplified representation of the transport sector with an institutional evaluation to evaluate not just the magnitude of emission reductions from local air pollution and carbon emissions but also to determine barriers to implementation of policies and projects. It uses the framework described by Schipper et al (2000), which is similar to that developed at the University of South Australia (see BTRE 2005; Taylor et al 2005) and adopted for use in the Australian National Greenhouse Gas Inventory (NGGI), see DCCEE (2012). Thus the tool has a firm basis and can be applied by using the conventional outputs from a regional travel demand model (traffic volumes (by mode and vehicle type) and speeds (or travel times) on the links of a transport network). Given these travel load data and appropriate fuel and emissions factors for the vehicle fleet, fuel consumption and emissions loads (GHG and air quality pollutants) can be calculated and estimated for future land use-transport scenarios.

The UNU tool has three features which make it a flexible instrument for use in urban planning:

1. it is based on a scalable approach, so that it can be used to investigate the effects of different types of changes
2. the tool can be used in both ex-post (project data assessment) or ex-ante (scenario based assessment) with explicit consideration of environmental co-benefits as the intended benefit. As such decision makers can use it to decide on suitable options before selecting a specific policy or project, and
3. it may be used as a policy tool with implementation consideration, so that policy makers can use it to help identify suitable alternative development scenarios for a given city.

One important proviso to be noted for the UNU tool is that as implemented it defines co-benefits specifically as the simultaneous reduction of GHG and air quality pollutant emissions, and is not designed – as it stands – for consideration of health and productivity co-benefits, although UNU (2014) does indicate that health co-benefits are of importance. Thus there is a need to establish a method by which the outputs (in terms of GHG emission reductions) from a tool such as UNU or NGGI may be used in conjunction with a health-oriented tool (such as HEAT) to estimate potential co-benefits for alternative low carbon precinct design scenarios. This is recommended as the preferred direction for future CRC research on co-benefits in the 'Low Carbon Precincts' research program.

While the UNU tool of itself is not appropriate for direct application to low carbon precinct planning and design, its conceptual model is useful in this regard. The UNU conceptual model is presented in Figure 1, page 8 of UNU (2014). The original UNU model was primarily

aimed at assessment of co-benefits to health through reduced air quality pollution from traffic congestion management. A low carbon precinct specific version of this conceptual model has been developed as part of this scoping study, and this model is shown in Figure 9 below. The conceptual model is in six parts:

1. *intended benefits*, which cover the broad aims of the proposed plan or implementation
2. *policy instruments*, which describe the tools and policy measures available (or considered) for use
3. *targets*, which identify the specific objectives to be met
4. *indicators*, which provide metrics and benchmarks for the realisation of the targets
5. *modal focus*, which identifies and collects the individual contributions of different travel modes, vehicle types and technologies to the costs and benefits of the alternative scenario, and
6. *co-benefits*, which provides quantitative estimations of the performance of each tested scenario or alternative design in terms of the nominated benefits (taken as GHG emission reductions as the primary benefit, with health improvements and economic productivity improvements as the co-benefits).

The low carbon precincts version of the conceptual model, as shown in Figure 9, is specifically directed to the assessment of public health and economic productivity co-benefits from the development and implementation of low carbon precinct planning and design measures as an integral part of urban development or redevelopment. It is an output from the scoping study, expressly designed to enable use by the

CRC in its health and productivity co-benefits research. The conceptual model is complex, because of the inherent complexity of the interactions between the various factors to be considered, and so the diagrammatic representation of the model is also complex. Nevertheless, this model provides a blueprint for the development of a low carbon precincts co-benefits calculator. While it requires careful study to reveal all its features, it should provide a powerful base for further CRCLCL research on co-benefits.

### Precinct design and assessment tools

The CRC scoping report Newton et al (2013) identifies and describes four existing precinct design and assessment tools, which belong to, or are used by partners in the CRC for Low Carbon Living. These tools are:

- Precinx
- Mutoxia
- SSIM, and
- LESS

None of these tools explicitly include co-benefits calculators, and indeed do not cover potential health co-benefits from improved precinct design. Newton et al (2013) identify this omission in the existing tools as one that should be overcome through CRCLCL research, so that health and productivity co-benefits can be included in future versions of the precinct design and assessment tools.



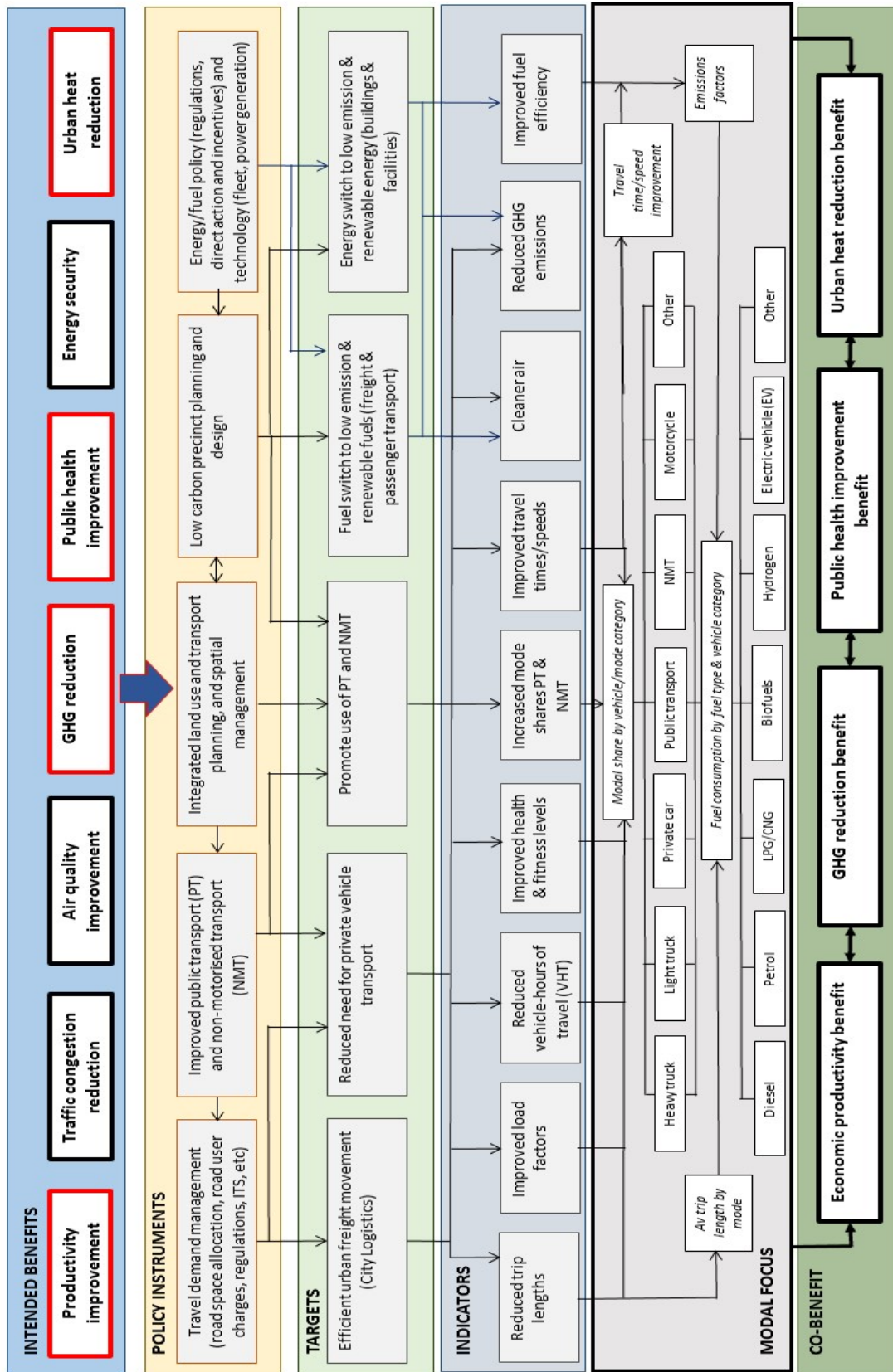


Figure 9: Conceptual framework for measuring co-benefits for urban precinct planning and design  
 [modified and adapted from the UNU (2014) conceptual framework for transport planning]

## CONCLUSIONS AND RECOMMENDATIONS – THE WAY FORWARD ON CO-BENEFITS RESEARCH

This scoping study has clearly indicated the importance of research on co-benefits to CRCLCL. It reinforces the need for the CRC to support a major research initiative in this field, to identify and quantify co-benefits for public health and productivity resulting from initiatives for the planning, design, implementation and evaluation of low carbon urban precincts – the core activity of the CRC's Low Carbon Precincts research program.

In its Final Report Part I (i.e. the present report) the scoping study provides a detailed summary of current planning and policy interventions in Australia to encourage low carbon active travel such as walking, cycling and public transport usage. It further identifies the potential co-benefits associated with this form of transport. For the purposes of the CRC's work, co-benefits are defined to be those other benefits (e.g. to health and productivity in the community) that result from intentional decisions to address low carbon living through energy demand and greenhouse gas emissions reductions, with a focus on low carbon precincts. The Part I report also meets the two CRCLCL milestones R2.4.1 and U2.4.1, as discussed in Chapters 2, 3 and 4.

The second part of this final report (Part II) describes baseline levels of active transport usage in Australian cities, and thus provides a platform from which future interventions in low carbon precinct planning and design can be assessed in terms of their capability to increase the levels of active transport. In doing so, the Part II report satisfies the CRC's milestone R2.4.2 'Base line survey of current levels of active transport usage, including understanding of the environmental and human health benefits in the studied communities (Living Labs) plus constraints on the uptake of those'. The results provided in the report can be used as indicators of current active transport activity in large Australian cities. The Part II report also identifies potential communities to work with the proposed co-benefits calculator, principally through the opportunity provided by the Adelaide Living Laboratory sites (Lochiel Park, Bowden and Tonsley). It thus also satisfies the CRC's utilisation milestone U2.4.2 'Communities to work with co-benefits calculator (living laboratories) identified'.

Thus this scoping study has enabled the CRC to meet the first four of its milestones in the R2.4 'Health and productivity co-benefits' research area, namely milestones R2.4.1, R2.4.2, U2.4.1 and U2.4.2.

The review of current research and policy development demonstrates clear interests in co-benefits but also indicates that while there are some significant national and state programs in the health sector, these interests are largely uncoordinated, especially from an urban planning perspective.

In addition, there is a need for quantification tools to allow health and productivity co-benefits to be included

in the economic evaluation processes that are part and parcel of the assessment of alternative precinct designs and scenarios. To have such capability has been identified as an important development for the CRC's Low Carbon Precincts research program.

This review found a handful of such tools, notable the HEAT tool developed by WHO, the UNU tool and the NZTA tool. Contrary to some expectations at the start of the scoping study, there are few if any 'co-benefits calculators', save these three tools, currently available and suitable for use by planners, government agencies and developers. None of the precinct assessment tools such as LESS, SSIM, Precinx and Mutoxia include co-benefits calculations (as also discussed in Newton et al 2013), although it is clear that there is a general desire to be able to add co-benefits to the evaluation analysis.

Further, none of the existing tools (HEAT, UNU and NZTA) are explicitly designed for use in precinct assessment. Thus there is a substantial opportunity if not necessity for the CRCLCL to undertake research to plug this gap. Each of the existing tools provides useful facets for inclusion in co-benefits analysis for precinct assessment, but none of them provide a stand-alone capability in this regard. There is also no evidence of the use of HEAT in Australia, and as this tool is the most relevant co-benefits analyser currently available, case studies involving its use, presumably in one or more of the suitable CRCLCL Living Laboratories, should be considered.

The UNU tool provides a potential framework for co-benefits identification and analysis. A revised version of this framework intended for low carbon precincts is provided in Figure 9 of this scoping report. The UNU tool is similar in application to the NGGI method for calculation of greenhouse gas emissions by the transport sector. This methodology and supporting databases are available to researchers within the CRCLCL, so that the required aspects of a precinct-based GHG estimator for changes in emissions due to changes in travel behaviour are in place.

The NZTA tool is an example of an add-on tool to provide co-benefits information to a broader benefit-cost analysis of individual projects (transport – but can be extended to infrastructure) and has potential for adaptation to precinct-level studies.

The main direction for the CRCLCL's research on co-benefits – a revamped RP2013 project – should thus be to provide urban planners and designers with a scenario-based method that allows estimations of health and productivity co-benefits from alternative precinct design scenarios to be used in the precinct design assessment tool. This is the expected major output of the Low Carbon Precincts research program.

The findings from the current review suggest that a capability for co-benefits analysis and its inclusion in precinct assessment can be developed through modification and extension of existing tools, and the need for development of a new tool from scratch is therefore unlikely.

Accordingly, the following recommendations are made:

1. A revised RP2013 project be undertaken, to research the design of a co-benefits analysis tool for inclusion in the precinct assessment method being developed in the Low Carbon Precincts research program.
2. The new RP2013 project should involve trials of the HEAT tool in different applications in Sydney, Melbourne and Adelaide as case studies (different precincts from Living Laboratories and different development scenarios) as a first priority.
3. The new RP2013 project should also investigate and apply the NZTA tool as a project add-on, perhaps with the development of a precinct-based version of the spreadsheet.
4. The project should use the UNU framework with Australian NGGI type models and available multimodal travel demand models under different land use scenarios to estimate mode shares and usage by vehicle type as inputs to the HEAT and NZTA calculators.
5. The new RP2013 project should seek the inclusion of CRCLCL partners such as Hassell, Urban Growth NSW, Renewal SA and other owners/users of precinct assessment tools to test opportunities to include co-benefit calculations in the precinct assessment tools, or for use with those tools.

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