Scenarios 2040

Results from the second year of Visions and Pathways 2040:

Scenarios of Low Carbon Living

V&P2040
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LOW CARBON LIVING CRC

Visions, Scenarios and Pathways for
Low-carbon Resilient Futures in Australian Cities

Project Funder
CRC for Low Carbon Living

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The CRC 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, we bring 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. The CRCLCL is supported by the Cooperative Research Centres (CRC) program, an Australian Government initiative. For more infomation go to:
http://www.lowcarbonlivingcrc.com.au

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Contents

1. What is Visions and Pathways 2040?

Visions and Pathways 2040 (VP2040) is a research and engagement program which develops visions and innovation and policy pathways for transforming Australian cities to achieve rapid decarbonisation and increased resilience in the face of climate change. The program involves three universities (University of Melbourne, University of NSW and Swinburne) and nine government and industry partners. VP2040 is funded as a four-year project by the Australian Cooperative Research Centre for Low Carbon Living (CRC LCL).

VP2040 seeks to envision possibilities for the physical form and urban lifestyles of Australian cities in 2040, on the assumption that they achieve at least an 80% reduction target in greenhouse gas emissions and have addressed vulnerabilities that arise with changes in climate and extreme weather events. Since this program commenced (and particularly following the Paris COP 21 in late 2015), the issue of appropriate Australian CO_2 targets has become a significant area for policy debate, with past 'aspirational' commitments looking increasingly at odds with international thinking. This program's target of an 80% reduction was set in 2014 after a review of targets set by other cities in OECD countries. The decision was to set a challenging target which was comparable with the upper-end of greenhouse gas emission reduction targets announced by some cities around the world (C40 Cities 2014).

VP2040 understands that there are likely to be many possible futures that achieve rapid decarbonisation, with different combinations of changes to technology and energy production, product and service design, methods of maximising assets utilisation, and styles of living patterns including lower levels of consumption. The program aims to define a set of plausible scenarios for city futures that can assist policy makers and the community generally in making choices about the future conditions that would lower CO_2 emissions. These projected futures will be used to facilitate debates about what policies, innovations, investment and research should be pursued to chart pathways to low carbon and resilient urban futures.

VP2040 is not about predicting what will happen but rather creating visions of what could happen. For this reason it is a coordinated research and engagement project that aims to co-create visions and scenarios with partners and the community. This transdisciplinary, solutions-oriented research aims to widen interest in the social and technical innovations that could help realise those futures.

Ultimately, VP2040 aims to use research, engagement and open collaboration to build plausible visions about what kinds of future cities we desire to inhabit. It brings Australia into a domain of research and action that is well-established in other countries. This flagship project of the CRC LCL, with its focus on cities, bridges the three programs of the CRC - buildings, precincts and engaged communities.

Background: Cities and the challenges of a low-carbon future

We are more than halfway through the critical decade (Hughes and Steffen, 2013), the period in which our actions on climate change will determine whether we succeed globally to limit temperature rise to less than 2 degrees. It is increasingly recognised that one of the primary focuses of global action in this decade will be cities. Over the coming decades cities will be engaged in a significant and rapid process of transformation as they decarbonise their economies and adapt to climatic changes that are already becoming evident. This transformation will involve both existing urban infrastructure and established urban patterns of living. It is clear that this process of transformation will be challenging for Australian cities, particularly with a target for greenhouse gas reductions of 80% by 2040.

The VP2040 focus on cities addresses an area of policy development that has emerged as a critical domain for governments at city, state and federal levels in Australia over the last year. Since the commencement of the project in 2013 the Australian government has formally recognised the important role of cities in shaping our future and appointed first a Minister for Cities and later an Assistant Minister to the Prime Minister for Cities and Digital Transformation. The City of Melbourne and the City of Sydney are partners in this program and have ambitious decarbonisation programs. As the South Australian Minister for Climate Change, the Hon Ian Hunter, made clear when he closed the VP2040 workshop in Adelaide, there is an emerging sense that the future economy will depend on how rapidly and creatively we can develop policies that stimulate the development of low-carbon goods and services. However, Australia lags behind other countries when it comes to investing in institutions that bring together research, business and communities to generate innovation for the post-carbon economy.

Engaging with the complexity of cities to chart pathways for transformation

As cities grow, their infrastructure, physical form and cultural characteristics become intertwined. These tightly interlinked structures and processes support urban life, giving each city its particular cultural and economic identity (or in more current parlance, its liveability). The VP2040 scenarios are being developed recognising that the following characteristics of cities need to be considered:

Cities as a major source of emissions

More than half the world's population now reside in cities and their contribution to global greenhouse gas production is

estimated at between 53%-87%, in terms of CO_2 emissions (depending on boundary assumptions and accounting methods) (SETO 2014), with the World Energy Outlook putting the figure at 71% (OECD/IEA 2008), even though they occupy approximately just 2% of the global land area. Nearly half of the world's cities are already experiencing the effects of a changing climate (UNEP 2011). The decarbonisation of the city means freeing cities from fossil fuel energy dependencies by reducing total energy consumption and switching to renewable energy sources. That will impact on many physical elements of the city such as buildings and transport, as well as infrastructures including energy, water, food, information, goods, services and waste disposal.

Cities and climate vulnerabilities

The form and infrastructure systems of the city are also shaped by its historical climate conditions. Shifting climate patterns and extreme weather events can threaten the resilience of those systems. Climate responses such as mitigation and adaptation have to be addressed in a coherent fashion as processes of decarbonisation need to build resilience over time.

Cities, nature and ecosystems services

Current systems of provision for Australian cities reflect a history of development that increasingly separates consumption from production. Most of the resources on which city life depends are produced beyond the city boundaries which isolates them from the lived experience of urban citizens. Cities are sometimes regarded as a refuge from nature, obscuring their dependence on natural ecosystems and the social processes that turn those ecosystems into goods and services.

Cities as economic and political agents

In the last decades, cities have become a focus for action on climate change because of their apparent agency - the willingness of their city authorities, businesses and citizens to make change. This was evident at the Copenhagen COP in 2009 and even more noticeable in Paris for COP 21. Globally, cities and networks of cities are active in adopting greenhouse reduction targets and investing in programs to reach them. Cities contribute significantly to national economies, both in Australia and in other countries. The same characteristics that have been shown to assist with generating innovation – supporting a culture of social connection and creativity – must be an essential feature of any city that successfully transitions to a low carbon future.

VP2040 project objectives

The VP2040 research aims to:

- track current research, industry and policy intelligence and coordinate with other international foresight and backcasting projects;
- identify emerging technological and social innovations with the potential to disrupt current trajectories of unsustainable development;
- collaboratively develop and refine a set of visions and scenarios for low-carbon resilient cities;
- to define a set of possible futures for four southern Australian cities - Sydney, Melbourne, Adelaide and Perth;
- translate those scenarios into communicable visions of future life to stimulate engagement across all the sectors of CRCLCL, including the general public; and
- backcast from those futures to develop potential pathways for their realisation, including niche innovations, research priorities, policy measures and governance structures.

As this is a project of the CRCLCL the project also has a set of utilisation objectives:

- to develop visions, scenarios and pathway analysis for strategic decision-making by the CRC and its partners;
- to provide a mechanism for the CRC to engage more widely with its various stakeholders, to establish and communicate new expectations about futures and directions for research, innovation and practice;
- to bring together the technical, economic and social aspects of the transition to low-carbon urban living to help the CRC explore key interrelationships and uncertainties across its projects;
- to provide a critical platform for the strategic planning and prioritisation of CRC research and for understanding the cross-disciplinary and cross-professional-practice implications of CRC research findings; and
- to identify new socio-technical systems that could constitute the basis for CRC living laboratory experiments.

2. The purpose and challenge of developing low carbon urban living scenarios

Scenario development is a core part of the research methodology being used in VP2040. Sets of scenarios and scenario visualisations can be developed to explore what low carbon lifestyles and associated city forms may emerge in the future. The VP2040 scenarios aim to provide distinct, consistent and plausible descriptions of how southern Australian cities in 2040 could support very low carbon and resilient ways of living. It is hoped that the analysis and subsequent scenario modelling can contribute to better understanding of what's required to achieve an 80% reduction in greenhouse gas emissions.

The development of modern scenario and futures thinking has sometimes been described as passing through three generations (List, 2005; Sondeijker, 2009). The first generation concentrated on predicting the future as accurately as possible, typically by extrapolating trends using quantitative or econometric methods. The second generation accepted that making point predictions of the future is often a foolish endeavour and shifted the focus from "will something happen?" to the question "what will we do if something happens?". Scenario planning, as pioneered by Shell in the 1970s (Wilkinson & Kupers 2013), is representative of this approach. The third generation focuses on longer time spans and preferred societal systems which are normative and explorative in nature and reflect the structural and societal changes required to pursue sustainability. This scenario process is intended to produce pictures of the future that we collectively may want. The question then becomes: "what do we actually want the future to look like?".

The VP2040 scenarios are located within the third generation of scenario thinking and are also influenced by the approach of Quist and Vergragt (2006) who employ participatory methods in developing the scenarios. However, this does not mean that the scenarios will be equally desirable for everyone. The normative element under which they have been constructed is that the city has achieved an 80% reduction in greenhouse gas emissions and greater resilience by 2040. The various structures and process that underlie these future cities may not be deemed as attractive to everyone.

Developing scenarios can be useful for a number of reasons. Scenarios can help us:

- Identify and examine assumptions;
- Consider a wider range of perspectives;
- Prepare for the future by considering the implications of possible futures;
- Consider the low carbon and resilience potential of different possibilities;
- Provoke debate and discussion;
- Communicate opportunities and risk in a more tangible way; and
- Examine the plausibility of different options and what's required to achieve them.

A number of challenges must be faced when developing low carbon urban scenarios, such as:

- There are hundreds of direct and indirect variables contributing to greenhouse gas emissions;
- The relationships between these variables is complex and changing;
- Australian cities are influenced by external factors such as larger socioeconomic or environmental changes which may influence their future development;
- Some variables are more significant than others, and scenario methods differ when it comes to isolating and prioritising variables;
- The development and use of future technologies is uncertain;
- Long-term scenarios are based on assumptions rather than fact, so are subjective in outlook; and
- Existing physical infrastructure in cities creates inertia when it comes to urban change.

The challenges above point to limitations in knowledge which must be recognised no matter what scenario methodology is used, and methodological challenges will be discussed in the next chapter. These limitations were one of the original motivations for doing scenario analysis - when these approaches were initially experimented with in the last century - following frequent forecasting failures. This led to new approaches which explicitly consider multiple possible futures. Some social scientists working with scenarios go one step further. For example, Rip and te Kulve (2008) argue that scenarios should be viewed as fictional. In their view 'good' scenarios are useful fictions. If a set of scenarios aid in strategy articulation, or encourage actors to reflect on their assumptions, then they are useful and worthwhile even if they don't accurately depict the future. Some practitioners of the 'intuitive logics' approach to scenarios similarly argue that in this scenario tradition the future is a fiction in the sense that the core assumption is that "the emerging future cannot be forecasted but [it] can be imagined and 'lived in'" (Wilkinson et al. 2013, p.700). Scenario practitioners in this school of thought view scenarios as "reframing devices" (Wilkinson et al. 2013, p.700).

Ultimately the credibility of any set of decarbonisation scenarios will depend on estimates of their likely success in delivering the reduction target and improving resilience. Quantifying the outcomes of the scenarios (in terms of CO_2 footprint was not directly a part of this funded research program. However there is a parallel Integrated Carbon Metrics research program within the CRC LCL which is developing a tool to quantify the carbon emissions from various processes in the urban environment. That project is using both top-down and bottom-up carbon modelling tools. Top down models begin with aggregated

information for a system (e.g. macroeconomic data) while bottom up models begin with detailed disaggregated information for product and service systems. VP2040 will be drawing upon their top down model which is an environmentally extended input-output model based on Australian input-output tables that are published by the Australian Bureau of Statistics (ABS) and data from the Australian Greenhouse Emissions Information System (AGEIS).

For illustrative purposes, Figure 1 shows baseline data for carbon emissions in Melbourne at a relatively high level of aggregation (10 sectors) across three greenhouse gas emissions scopes using the Carbon Metrics input-output model. The model, however, can be analysed at finer levels of emission source categories. The translation of the qualitative scenarios developed by VP2040 into this model may be relatively easy for some aspects of the scenarios (e.g. decarbonisation of electricity supply), however for other scenario elements, such as more efficient use of assets via the mainstreaming of a sharing economy, determining how to translate such changes into the (sub)sectors of these models is likely to be more difficult and requires making a wide range of assumptions.

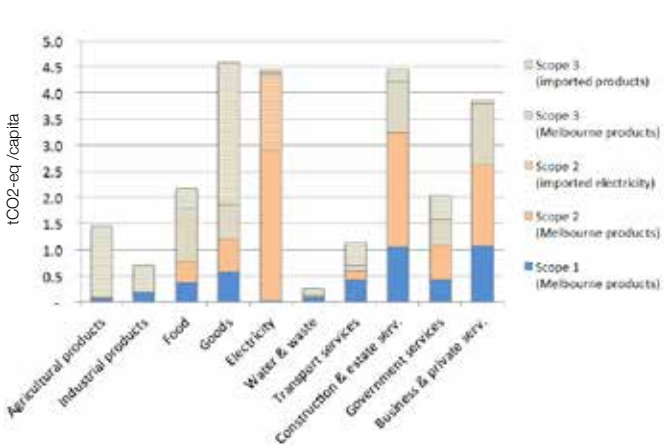


Figure 1. Per capita carbon footprint of Melbourne's total final demand by broad product category and scope Source: Wiedmann et al (2015)

Note:

Scope 1: Greenhouse gas emissions from sources located within the city boundary (e.g. emissions from heating or driving within the city)

Scope 2: Greenhouse gas emissions occurring as a consequence of the use of grid-supplied electricity, heating, and/or cooling within the city boundary

Scope 3: All other greenhouse gas emissions that occur outside the city boundary as a result of activities within the city boundary (e.g. emissions released in creating goods imported into the city)

3. VP2040 Scenario Methodology

The process used to develop the four scenarios is located within a broader research program which began in 2013. While the centrepiece of the scenario development was two participatory workshops conducted in 2015 in Adelaide and Perth, the scenarios were also informed by other activities conducted over the last two years, as documented in the previous VP2040 annual report. These included:

- Tracking current research, industry and policy intelligence to identify emerging technological and social innovations, particularly those that are seen as potentially disruptive (e.g. energy storage technologies, new peer-to-peer trading or sharing services, and autonomous electric vehicles).
- Learning from other national and international visioning, scenario and backcasting projects looking at sustainable and/or urban futures. Some particularly useful foresight material was found in SPREAD (http://www.sustainable-lifestyles.eu/), Retrofit 2050 (http://www.retrofit2050.org.uk), MUSIC (http://www.themusicproject.eu) and CRISP (http://crisp-futures.eu).
- Interviewing a selection of thinkers and practitioners in the realm of sustainability and city futures (see Box 1). A number of quotes from these interviews appear in Section 4.
- Conducting expert workshops on particular areas of relevance for potential disruptive change. These are described further below.
- Analysing glimpses from the two visioning workshops conducted in Melbourne and Sydney.
- Meetings and discussions with project partners on project findings, implications and emerging issues.

For the process of creating scenarios, we initially considered common scenario building blocks. For example, underlying forces of change, often termed drivers of change (or driving forces), are commonly discussed in terms of the STEEP framework, which refers to social, technological, economic, environmental and political drivers. The team collected a long list of drivers of change based on desktop research and a survey of expert citizens. Extending the STEEP categories to six, we also explicitly incorporated demographic and geographic trends. Second, from all the above sources, we sought to identify emerging areas of disruptive innovation. Broadly, a disruption was defined as a change which significantly and rapidly disturbs the status quo.

From all of the above we identified an initial set of scenario dimensions. These are summarised in Table 1 below.

Dimensions	Major uncertainties
Centralised vs. distributed systems of provision (energy, water, food, transport, waste disposal)	• How centralised or distributed will our city systems of provision be? • Will this affect their resilience in response to changing climate and extreme weather events? • How greenhouse intensive are existing systems - will distributed systems assist in decarbonisation? • At what scales will this occur and to what extent?
The characteristics and use of urban space	• What will be the balance of public, private and shared spaces? • Will current preferences for private space shift towards greater sharing? • What will be our attitudes towards public spaces and private spaces and their possible trade-offs?
Urban form	• What will be the spatial form of future Australian cities? • Will density increase or will urban sprawl continue? • Will higher density housing only be achieved through high-rise residential towers or are other models available such as small-lot, low-rise housing? • Will urban form also be ‘distributed’ – such as a polycentric city of urban villages?

Table 1. Initial scenario dimentions

Embedding of new informational and 'smart' technologies in urban and household environments	• To what extent will cities be embedded with, and be dependent on, new information and communication technologies? • How will the 'internet of things' develop in the urban context? • Can such systems move beyond making current systems more efficient to assisting transformation? • How will privacy/surveillance concerns influence the development and use of these technologies?
Importance of production and consumption in emissions reduction	• Will emissions reductions come primarily through production efficiencies or through changes in consumption patterns and lifestyles? • Will consumption continue to grow or will there be a moderation or even decline? • To what extent might the sharing economy contribute to emissions reduction?
Ways of life within the city	• Will our values shift towards individualism or collectivism? • How will this influence other dimensions such as the use of urban space and forms of economic exchange? • Will there be an emphasis on individual freedom and private ownership or a more collective and communal approach? • How will these values influence the use of urban space and related systems of provision? • Could a sharing culture or a willingness to pay a premium for sustainability influence consumption patterns? • Will disparities in wealth/income become greater, or reduce?
Economic and political institutions	• Will economic and political institutions remain similar to the present liberal market economy or will these institutions evolve? • On what level(s) could such changes occur – local, state, national or beyond? • Will the VP2040 cities stay with multiple local governments or will there be some form of whole-city governance? • How could these changes influence low-carbon development and/or societal resilience (e.g. community-energy projects vs private sector energy projects etc.)?

Table 1. Initial scenario dimentions (continued)

Overview of the scenario development process

Methodologically, the scenario development process was mostly inductive and informed by participatory scenario workshops. Work progressed through three main phases:

1. Initial conceptualisation/debate, leading to initial 'proto-scenarios';
2. Scenario elaboration and visualisation; and
3. Scenario refinement.

The process of scenario development is summarised in figure 2.

Initial proto-scenario formation

Based on research conducted in 2014, research team members initially proposed and debated a range of possible scenarios that would be challenging, divergent and plausible characterisations of possible futures. Additionally, the research team attempted to combine multiple elements – ranging from concepts depicted in the 'glimpses' of possible low carbon urban futures (see Ryan et al 2015) to trend data – into coherent description of plausible futures of sustainable and resilient Australian cities. This approach is different to deductive scenario-building approaches that choose a pair of critical uncertainties and populate a matrix (van der Heijden, 1996). The multidimensional nature of cities meant that the common 2x2 scenario-matrix approach was considered inappropriate.

An initial set of four 'proto-scenarios' were based on social, political and economic conditions (broadly the last two dimensions in Table 1). This approach was judged to be more aligned with the project's emphasis on low carbon living which is broader than technological change or shifts in urban infrastructure. This approach was informed by other sustainability-related scenarios work which emphasises similar social, political and economic scenarios such as the Global Scenarios Group (2002), EPSRC Urban Futures project (Lombardi et al 2012) and the EPSRC Realising Transition Pathways (Foxon, 2013). Scenario elaboration and refinement processes then followed.

Scenario elaboration and visualisation

The Adelaide scenario workshop interrogated and elaborated the 'proto-scenarios'. This workshop aimed to more deeply consider different regions of major Australian cities, ranging from low density to high density. The potential uptake of social and technological innovations in each scenario was considered according to the core scenario 'logic' (see the process outline in Appendix I). Participants were asked to imagine what Adelaide would look like in 2040 in each scenario for three density levels (low density, medium density and high density). After the workshop, the research team drew on the workshop discussions when developing the scenarios, in particular when considering major sectors like energy, transport, buildings, food, information, water and waste.

A designer was hired to develop scenario visualisations based on the Adelaide workshop. The visualisation work was undertaken iteratively, starting with a broad design brief which was refined as the research team analysed workshop discussions and provided feedback to the designer by responding to the visualisation drafts.

Experts were also interviewed in order to better understand aspects of the scenarios. See the outline of interviewees in Box 1 and the summary of consultations in Box 2.

Scenario refinement

The scenarios were further interrogated at a workshop in Perth which focussed on plausibility (see outline of process in Appendix II) both generally, and in relation to the Perth context. See the Appendix for an outline of this process, and for examples. Pathways related issues were a strong theme and are discussed further below. The research team is currently considering this feedback. Further feedback in response to this project report is also welcomed.

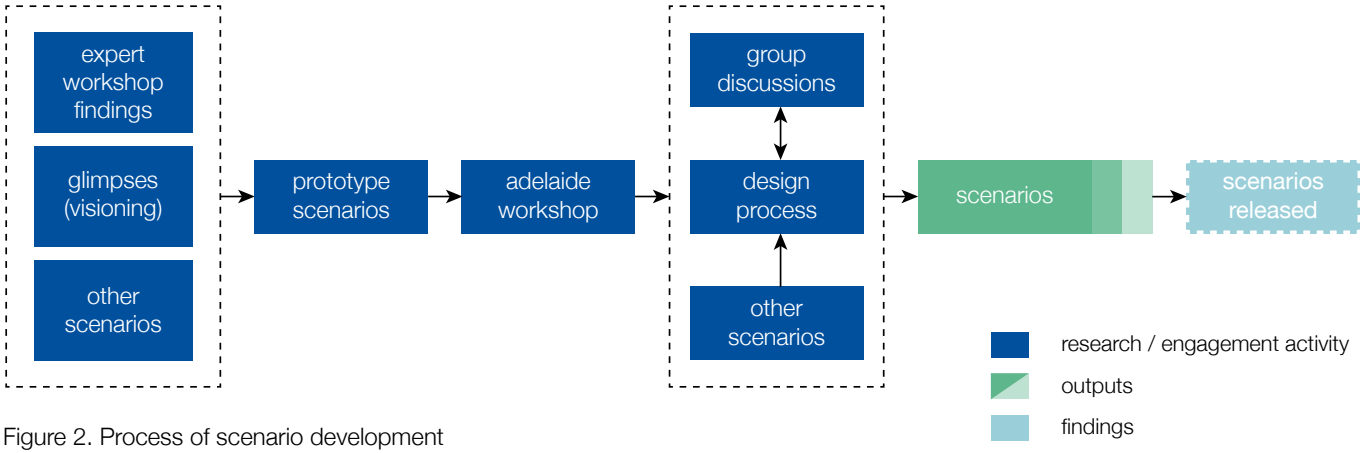


Figure 2. Process of scenario development

BOX 1: Expert interviews

In the second year of the project, the research team conducted interviews with 10 prominent thinkers and innovators who are working on urban futures. Each interviewee was asked a series of questions intended to explore their vision of a low-carbon and resilient urban future and how such a vision could be realised over the coming decades. Each interview lasted approximately 30 minutes and was conducted between February and July 2015. Selected quotes from these interviews have been included throughout this report, in order to illustrate aspects of the four scenarios. The interviews are available on the project website and a brief outline of each interviewee is provided below:

Andrew Maher is 'Chief Digital Officer' at Aurecon. When he was interviewed for this project, he was based at Arup where he lead their corporate R&D function in the region focusing on development of innovation strategy and foresight. Previously he established Digital Innovation at Arup and developed new ways of working, delivering and communicating services using the latest technological capabilities.

Professor Bill Randolph is the Professor and Director of the City Futures Research Centre in the Faculty of Built Environment at the University of New South Wales. He is also Deputy Director of the UNSW/UWS AHURI Research Centre and leads a research team specialising in housing policy, urban development and metropolitan planning policy issues.

Professor Brendan Gleeson is Professor of Urban Policy Studies and the director of Melbourne Sustainable Society Institute at the University of Melbourne. He is a Fellow of the Australian Academy of Social Sciences, author and editor of twelve books.

Professor Gail Whiteman is the Director of the Pentland Centre for Sustainability in Business at Lancaster University. She is also the Professor-in-Residence at the World Business Council for Sustainable Development and an Executive Board member of the international Resilience Alliance. She is a member of the VP2040 scientific committee.

Professor Geoff Smith is Emeritus Professor in Applied Physics at the University of Technology Sydney (UTS). His work over the past four decades has spanned solar energy, material science and green nanotechnology. Professor Smith works on the Urban Micro Climates research project as part of the CRC for Low Carbon Living, which aims to identify cost-effective strategies for mitigation of urban heat islands in Australian cities.

Professor Kate Auty is a Vice Chancellor's Fellow at the University of Melbourne. She is a lawyer with experience in natural resource management and environmental policy, Indigenous justice issues, native title, community consultation and curriculum. She was the Victorian Government Commissioner for Environmental Sustainability.

Ross Harding is a creative sustainability professional with an academic background in engineering and finance. He has most recently advised the Yarra Energy Foundation on its roadmap for creating a zero carbon City of Yarra by 2020, and has provided sustainability advice and cost/benefit analysis to leading architectural firms. "Finding Infinity" is Ross' most recent project, focusing on bridging the gap between communications and implementation of sustainability.

S**tephen Yarwood** is the founder of city2050; a consultancy specialising in long term strategic plans that recognise the social, environmental, economic and technological issues that are redefining the operating system of cities. From 2010 to 2014 Stephen was the Lord Mayor of Adelaide; the youngest person to ever hold this title.

Professor Tim Flannery is one of Australia's best-known scientists and environmental activists. He is renowned for his work on population levels and carbon emissions, and was nominated for Australian of the Year in 2007.

Tim Horton is the Registrar of Architects Registration Board, New South Wales. He is an award winning architect, was the founding CEO of the Committee for Adelaide and held positions as state President and National Director of the Australian Institute of Architects, and advised the Australian Government as a member of the editorial board for the Australian Urban Design Protocol and the Built Environment Industry Innovation Council

Box 2: Expert Consultations

VP2040 researchers undertook two expert consultations in 2015. Each consultation is briefly outlined below.

Consultation on emerging business models and new finance mechanisms

This consultation explored a number of emerging innovations and trends such as B-corps, social enterprises, revitalisation of cooperatives and business models based on collaborative consumption and the sharing economy. Hand-in-hand with emerging business models, experts suggested that new finance mechanisms can provide important sources of capital to help enable decarbonisation and resilience. These 'mechanisms' include socially responsible investment funds and banking (e.g. publicly disclosing the carbon footprint of investment portfolios), certified climate bonds and green bonds to fund both large scale and small scale green projects and initiatives, solar-leasing, environmental upgrade agreements and other innovative financing instruments which reduce upfront costs when installing new technologies or doing retrofits. Crowdfunding was also identified as an alternative source of funds for those innovations which cannot attract more traditional forms of financing such as angel investment. Finally, the consultation explored obstacles to the proliferation of these business models and utilisation of new financing approaches. Based on these findings we identified several policy and research priorities, which are detailed in a report published on the project website: 1) Developing shared visions, showcasing Australian success stories and telling compelling, positive stories; 2) Building forums and networks to foster greater interaction, collaboration and innovation; 3) Changing and clarifying inhibiting laws and regulations; 4) Creating better transparency and standards of responsibility for investment funds and businesses (e.g. accreditation standards for investment portfolio disclosure, embedding climate change risk into fiduciary duties); and 5) Incubating and transplanting new solutions across Australia.

Consultation on the digital economy as a disruptive force

This expert consultation scrutinised the direct and indirect social and environmental implications of the two competing value models in the digital economy: a peer-to-peer exchange economy and a peer-to-peer commons economy. Experts consulted by VP2040 argued that the direct social and environmental impacts of the two value models are similar but the indirect and structural implications of the models are different. These differences stem from the implications for business model development, product and service design and the structure of wage-labour relationships. Participants were concerned about a hypothetical future digital economy in which a set of companies own or control city-related data (such as transport data being collected and controlled by a private company through an online platform that is developed and owned by that company) as it may result in forms of 'data feudalism' and incentives for business models that undermine sustainability and resilience objectives. During the expert consultation it was understood that there are different options for how digital technologies can be deployed in the cities depending on which technologies and business models are implemented, yet it remains uncertain which options will yield the highest sustainability and resilience outcomes. Policy priorities and associated research questions were identified by the research team, with a focus on supporting innovation and entrepreneurship under the peer-to-peer commons economy, enabling sharing in cities, maintaining resilience in the face of changes which are expected as a result of greater automation, and governing the 'digital urban commons'.The 'digital urban commons' consists of informational resources and technologies regarding a city which can be used and contributed to by citizens such as online platforms used for mapping and locating fruit trees available for urban foraging, or smartphone applications designed for citizens to report infrastructural problems to the local authorities.

4. Scenarios of Low Carbon Living

The four end-state scenarios set out in this chapter describe distinctive long term possibilities of what low carbon living might 'look and feel' like in the future in southern Australian cities. As previously mentioned, these scenarios are not predictions. Rather, in VP2040 scenarios are primarily viewed as thinking aids and dialogic tools for exploring alternative plausible futures. Scenarios can help us to identify and challenge assumptions (e.g. about what underlies a low carbon resilient city), provide provocations to open up our attention to a wider range of perspectives, and can be used to assist with preparing for the future by considering the implications of such scenarios for current practices and policies.

The four scenarios are:

1. Clean-Tech Corporate Living: a city of clean and efficient production driven by a corporate market economy that has focused innovation on triple bottom line success and adopted circular economy production and product design practices.
2. Planned Regulated Living: a city of planned order where a democratic consensus has concluded that the challenges posed by a carbon and resource constrained world are best addressed through public planning, public investment in green infrastructures and tighter regulations that limit behaviour and practices to an acceptable environmental norm.
3. Networked Entrepreneurial Living: a city where large corporations and government are less influential but where the economy has developed around nimble, self organised entrepreneurial activity, particularly for the sharing and exploitation of excess capacities of various assets. It is a future characterised by a dynamically changing economy, experimentation and innovation and the development of networked platforms that are open source and open data.
4. Community Balanced Living: a city of low consumption, that promotes a socially and environmentally meaningful life including shared wellbeing, liveability and (face to face) social interaction and where there are a diverse set of alternative forms of enterprises, including cooperatives and B-corps.

As previous sections have noted, the scenarios were not explicitly deduced based on two critical uncertainties or drivers of change, as this could not account for the complexity of transitions in cities. However, to aid the comprehension of the scenarios, they can still be positioned within 'possibility spaces' based on some key dimensions.

Figure 3 locates the scenarios along two key dimensions: (i) top-down, centralised decision making and/or ownership (large hierarchical corporations or government) vs. bottom-up, decentralised decision making and/or ownership (e.g. small businesses or grassroots movements), and (ii) for-profit orientation vs. for-social-benefit orientation. These two dimensions also roughly correlate another set of dimensions: (i) 'Do it for me' vs. 'Do it yourself / ourselves' (i.e. - will people take the lead in creating low carbon living or will they expect corporations and governments to do it for them?) and meritocracy vs egalitarianism.

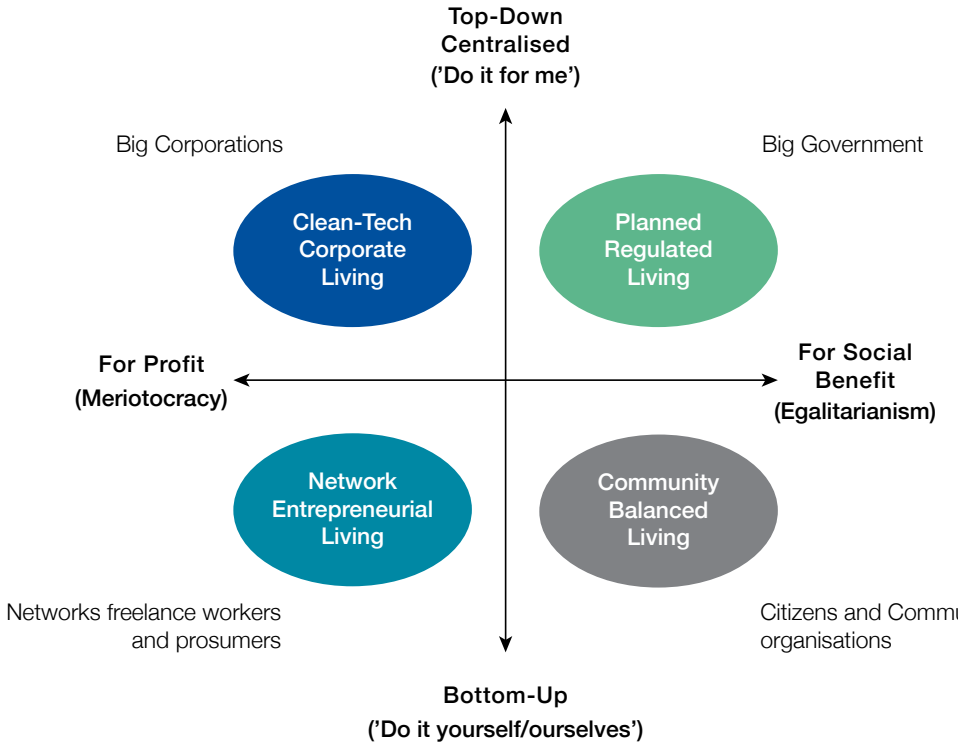


Figure 3. Characterisation of four scenarios along two dimensions

The scenarios also differ in that they focus on different types of emissions reductions such as consumption-side changes (e.g. reducing consumption) vs. production side changes. Three broad types of greenhouse gas emissions reductions were considered when conceptualising the scenarios:

- **Production and product based emission reductions:** This type of emissions reduction results from the decarbonisation of energy sources - particularly substitution by renewable electricity - along with investments in production efficiency and clean product design. This means that outputs such as goods and services are produced efficiently, with a minimal input of energy, and operate efficiently. Production efficiencies would include the development of circular economy production techniques to minimise and reuse waste products as well as designs for maximum product efficiency by minimising energy wastage. In this case, the low-carbon character of consumption depends primarily on the supply side and is usually underpinned by technological innovation and product design (Crul et al 2009). This is essentially the "eco-efficiency" or "ecological modernisation" approach that has been the main centre of attention from policymakers (Jackson, 2005). This has been called "weak sustainable consumption" by Fuchs and Lorek (2005) as it may not involve any change in existing patterns of consumption, aside from those required by energy substitution – e.g. a change from petroleum energy cars to electric vehicles and public transport. This form of reduction would include changes to the materials and design of the built environment to reduce recurrent energy consumption and embodied energy.
- **Usage-based or service-based emission reductions:** Emissions can be reduced by using existing products more efficiently or by better integrating products and services (Tischner et al 2009). For example, sharing schemes facilitate the sharing of durable yet often idle goods such as cars and lawnmowers. These schemes can be non-profit or for-profit. By distributing the use of goods across a wider set of users, there is less need for everyone to own their own version and thus reduces the strain on resource use while maintaining a similar level of consumption. New types of business models where business provide services rather than products (e.g. providing carpeting as a service on a leasing basing rather than selling carpets) are an important part of this approach where assets are used more efficiently. In many cases, these efficiency gains may entail significant changes in lifestyles and attitudes, such as those towards ownership and private property. New forms of consumption may require significant structural changes and changes to consumer motivations, behaviours and routines. This is what Fuchs and Lorek (2005) have called "strong sustainable consumption" and covers both some types of usage-based sustainable consumption and the category that follows.
- **Reducing absolute consumption:** This option involves changes to lifestyles that reduce absolute consumption levels and thus also associated greenhouse gas emissions. Examples include walking or cycling rather than driving, wearing jumpers inside rather than using heaters, eating less meat and more seasonal foods, the sharing of resources, and repairing goods to increase product longevity.

Different potential sources of emissions reduction were emphasised in different scenarios. For example, the Community Balanced Living scenario emphasises dramatic reductions in consumption. This scenario envisages a reduction in general consumerism, greater sharing of resources and more localised ways of life with lower energy and material demands. In other scenarios such as Clean-Tech Corporate Living, new technological and business models reduce the carbon intensity of urban living without necessitating significant lifestyle changes. This is shown below in Figure 4.

While the aim in generating these scenarios has been to make them as divergent as possible, it is important to acknowledge that they are not mutually exclusive. Low carbon resilient futures for major southern Australian cities may well combine elements from each of the scenarios, and the scenarios could emerge spatially between or within different cities. In this way, a city could become a mosaic of communities that take on a local economic character reflecting different scenarios.

We now present a fuller description of the scenarios including how they can be expressed in different density zones of the city.

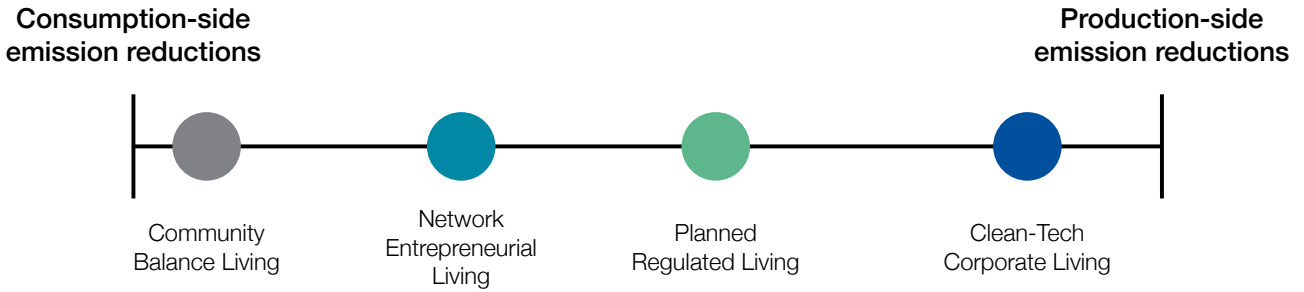


Figure 4. Scenarios ranked by type of emissions reduction

End-state scenario descriptions

Scenario 1: Clean-Tech Corporate Living

Keywords: Ecological modernisation; price-driven efficiency; circular economy; service economy; clean technology.

Key emission reductions: Product and production-process energy efficiency and carbon-intensity improvements.

This is a city of clean and efficient production, a model for the application of circular economy principles and clean-tech innovation. International agreements on limits to greenhouse gases quickly redirected market competition towards innovation for triple bottom line success, particularly for the shift from fossil fuel to renewable forms of energy. Large, for-profit companies with the resources to invest in innovation have become the primary actors in the economy. Significant decarbonisation of the city has been achieved principally through a focus on changing production systems and product design and the adoption of low-carbon clean technologies, with only minimal changes in consumption patterns (where necessary) to accommodate the new production and product systems. The private sector owns and manages most of the city infrastructure from energy supply to transport and building technologies to water. Even biodiversity and green spaces are privately owned, deriving revenue from charging for access along with government payments for ecosystem services delivered.

> ***"By 2040 autonomous vehicles should be prevalent. So the way that we occupy our road systems and the way that we use our transport networks will radically change and that will have a major impact on what we use the spaces within our cities for"***
> ***- Andrew Maher, ex-Arup now at Aurecon***

The 80% reduction in greenhouse emissions has been achieved through decarbonisation of the electricity system, substitution of electricity for other forms of renewable energy (e.g. wind, solar PV), high energy efficient products and a substantial increase in the service sector. Electricity is now more than 95% renewable even though consumption of electricity has grown. Renewable energy generation involves rooftop PV and surface PV cladding of buildings (with a high proportion provided by corporate companies as a leasing arrangement) and the adoption of bladeless wind generation in the lower density suburbs; however most electricity still comes from large-scale wind, solar and geothermal plants beyond the city boundaries.

> ***"Hopefully roofs will all be 'cool roofs' by then [2040], which stops heat getting into the building by reflecting more sun and also has feedback effects like reducing air conditioning load and making ventilated air a lot cooler. I expect there'll be a proliferation of whiter roofs, those technologies will become essential. The ultra cool roofs I'm working on do that in the extreme, and any heat that comes from anywhere else they also pump out. The albedo is close to 100 per cent, which is possible through the design of the materials"***
> ***- Professor Geoff Smith***

Technology is focused on delivering highly energy efficient products and related services. The services sector is large including, for example, a diverse range of products for the efficient management of buildings, energy, food, water, transport and waste from a carbon emissions perspective. Transport involves a mix of private vehicles, privately owned and run public transport (trams, buses and trains) and competing smart driverless taxi pods; the majority of all transport is electric powered, with some use of biofuels. High bandwidth communication has seen the creation of small business hubs for information based service businesses across the suburbs as well as local telework centres.

Information technology has helped to create a city that is smart and efficient. Competing investment in the 'internet of things' has been significant with the sale of privately held data now a significant contribution to GDP. Corporate competition in smart city technologies is a feature of life for citizens as multiple services from different companies compete to build their exclusive customer base. Robots and automation have reduced labour costs in many areas of production and service provision.

Within the mix of products and services, the economic identity of the city is strongly consumerist, profit oriented and individualistic, with wealth, status and economic growth as a societal priority. However, there is a continued shift towards casualised labour with decreasing job security and the proportion of citizens in full-time work. Inequality of income, wealth and power is large, tempered only by the need to suppress social unrest. Government provides essential infrastructure for corporate activity and works with business to target a light level of regulation to ensure that yearly emission reduction targets are achieved.

> ***"Some people in Arup have been talking about the systems within buildings and the possibility of manufacturers putting the components they supply on lease agreements. Would you get a different set of behaviours if the systems in buildings were retrofitted and owned by a company and they would be monitoring and maintaining them all the time?"***
> ***- Andrew Maher, ex-Arup now at Aurecon***

Clean-Tech Corporate Living - High Density

Features in this scenario snapshot include:

- a predominance of privately-owned autonomous vehicles (including taxis)
- multiple proprietary car-charging banks
- an inner-city metro
- robotic services including a car valet
- high-tech building facades and envelopes
- a pervasiveness of major brands
- access cards being required to enter a park
- private security services
- minimal social interaction and indicators of significant wealth inequality

Clean-Tech Corporate Living - Medium Density

Features of this snapshot include:

- a corporatisation of the entire shopping precinct including the construction of a high-tech dome
- the prevalence of consumerist lifestyles and various brands
- high tech personal devices and services including cheap digital newspapers
- multi-level car-parks, commensurate with the high use of privately owned vehicles, continue to occupy significant amounts of space

Clean-Tech Corporate Living - Low Density

Features of this scenario snapshot include:

- commercially-owned bladeless vertical wind turbines
- large, private homes
- significant home solar PV systems
- privately-owned vehicles are the main form of transport with relatively busy and wide roads
- little sense of a local community interaction
- the existence of poverty and homeless people

My life: Tamsin, 30.

Hi, my name is Tamsin and I'm 30 years old. I live in a flat in Sydney with two friends. It is pretty small, but it is low-maintenance because of all the smart tech that our landlord installed. Like, the lights and heating just happen! None of my friends have driving licenses. Why bother? It's way easier to book a self-driving car and get some work done en route. I work for Australia's only large-scale solar technologies company, SolarINC, as a communications adviser. I work from home most days and only go to the headquarters to meet with potential new clients in person from time to time. My flatmate and I have an annual membership to a nearby park, so we sometimes take our laptops there to use the park's wifi. Before we go, we check the 'alerts' in case the park is too full. My flatmate is a freelance engineer. She currently works as a contractor for Avi-Eth, which is a massive company that makes low carbon aeroplane fuel out of waste. As a freelancer she doesn't have paid sick or annual leave but earns double my rate in an hour. She generally works for a few days in a week then travels for a couple of months in countries where life is much cheaper for her holidays. Looking at my and my flatmate's life, I think we are lucky as life is not fair for a lot of people. I feel bad seeing homeless and poor people in Sydney. They can't afford park fees plus so many streets are private now - so they don't have anywhere to go. I worry about the effect of automation on my future work opportunities. My laptop died today, so I've got to go swap it for a new one.

Scenario 2: Planned Regulated Living

Keywords: Strong government; sustainable urbanism; egalitarianism; public investment; public service; acceptance of behavioral and consumption freedoms as trade-off for environmental and social security.

Key emission reductions: Public investment in sustainable urbanism; well designed, integrated and operated buildings, precincts and cities; public information-communication on environmental performance to boost adherence to behavioural norms.

This is a city of planned order. Everywhere in the city there is evidence of significant past challenges and crises and of the evolving democratic consensus that the challenges posed by a carbon and resource constrained world are best addressed through tighter regulations and laws that limit behaviour and practices to an acceptable environmental and social norm.

Rational and technocratic approaches guide all areas of development and the use of public assets and capital. Private sector activity is strongly regulated and there is great public trust that the balance between corporate profits and public needs is well managed by government. Environmental and social ethics is expected to guide all decision making for maximum societal benefits.

An 80% reduction in greenhouse gas emissions has been achieved through: public investment in renewable energy supplies and grid-connected storage; public production of (non-food based) biofuels; reducing per capita energy and material consumption through technological efficiencies , changes in social behaviour and large scale public investment in improving existing building stock; the planning and the evolution of a more compact 'twenty minute city', with comprehensive and integrated public transport systems, including bicycling, walking and driverless electric taxis and small community shuttles. Building codes and standards are strong and regularly tightened. Business premises are more dispersed away from the city centre and teleworking from distributed hubs across the city accounts for almost half of working hours.

> *"I believe that through government's leadership, strategic planning, a good vision and ability to implement you can actually achieve quite significant change in cities. [...] We can't make cities work effectively unless there's a single governance body around an urban conurbation like the mayor of London, that actually probably really drives the show when it comes to urban management...urban management [can] be real time. Data will be … available instantaneously. City leaders will be able to make real time management decisions, to improve the efficiencies of their cities and make them more productive, more liveable and more sustainable"*
> ***- Stephen Yarwood.***

New behaviours and practices (and limitations on consumption generally) align with the imposed conditions as citizens accept the social value of such acquiescence; culturally this is much more significant than individuals who proactively seek more sustainable lifestyles. City information systems are ubiquitous and publicly owned; they provide feedback on consumption levels, for individuals and for communities. Systems of provision of food, water, energy, transport and waste are based on a distributed model (more localised and networked) and emphasise diversity and redundancy to contribute to increasing resilience in the face of a changing climate and more frequent extreme events.

The progressive retrofit of existing built infrastructure to meet stringent environmental performance standards has been achieved through government programs and public investment; this has helped keep employment high even as automation has increased in most areas of production. This is one example of the growth of public services that help the community to maintain environmental standards.

Economic identity is defined by: a market where real full costs of all commodities are recognised and priced (internalised costs); consumers and producers who strongly focus on the public good; consumers accepting careful, moderated consumption for social and environmental well-being; businesses that accept they have a responsibility beyond shareholders; wide social agreement on directions for research and innovation and for high government expenditure on this area; the provision of public infrastructure that makes living a very low-carbon existence easy; valuing of collective, community needs over individual interests and greater equity; and growth measured in various forms of social prosperity as well as GDP.

> *"Each of us has our own vision about what the sort of city that we'd like to live in is like. Those sorts of things will only come out of a consensual discussion around what the city should be like. That's why I mentioned deliberative democracy, where we need to get some handle on what we want into the future in a way that's beyond government policy, or whatever Lend Lease thinks is the best thing, all the banks think are the best thing."* ***- Tim Flannery***

Planned Regulated Living - High Density

Features of this scenario snapshot include:

- vertical wind generation
- solar generating bike paths
- a bicycle and walking friendly environment
- no cars or private vehicles
- modern trams
- plants being grown for biofuels
- bicycle sharing services
- well-maintained and clean public infrastructure
- new green spaces from utilisation of previous car spaces
- green facades on high rise buildings
- urban agriculture for local consumption
- public displays celebrating the city's success in becoming carbon neutral

Planned Regulated Living - Medium Density

Features of this scenario snapshot include:

- increased density through vertical build
- solar-energy generating roads and bike-paths
- no overhead powerlines
- mandatory PV or green skins on buildings
- well-maintained public transport
- driverless taxis (particularly for last-mile services complementing public transport) and few privately owned vehicles
- significant urban agriculture including green facades to also cool buildings
- a civic spirit and social interactions on the street

Planned Regulated Living - Low Density

Features of this scenario snapshot include:

- vertical wind turbines
- solar-energy generating bike paths
- last-mile taxi services (complementing public transport)
- a digital city information display on neighbourhood emissions
- local water towers for pumped energy storage
- hydroponics systems
- rain gardens
- a walking and cycling friendly environment

My life: Will, 75.

My name is Will and I'm a biophillic scientist. I research the interaction between living systems and non-living systems for living and working spaces. I'm proud to have helped develop Melbourne's network of green laneways during 2020s. Now that I'm 75, I only work part-time so I've got more time for my grandchildren, sport and holidays. Most people my age play sport - it is paid for by the government and keeps us healthy, so why not? As slow travel is subsidised, I'm planning to take six months off for a rail holiday next year. My wife and I live in an old 1990s apartment that we renovated with public interest-free loans to meet today's water and energy efficiency standards. When the government gave out urban agriculture grants I helped establish the hydroponic farm in our apartment block that now supplies us and our neighbours with a lot of our vegetable needs. Because public transport is free for people of retirement age and very convenient and fast, we've stopped driving altogether.

Sometimes I realise how much life has changed over the last 25 years - that it now seems so natural and reasonable to focus less on 'retail therapy', to eat only high quality foodstuff and seasonal produce, to accept that what is good for my community is more important than my needs and that life is well organised so that we all benefit socially and environmentally.

Scenario 3: Networked Entrepreneurial Living

Keywords: Peer-to-peer; collaborative economy; micro-businesses; innovation, freelance workers; prosumers; diversity and creativity.

Key emission reductions: Efficient use of assets; decentralised renewable electricity trading; a culture of innovation and collaboration finding novel sustainability solutions

This is a city that has become highly self-organised in the sharing and exploitation of excess capacities of various assets (e.g. vehicles, spaces, consumer goods, time and skills). It is a nimble and dynamically changing economy, where there is a great diversity of experimentation and innovation through open source, open data and open platforms. Many workers are freelancers. There has been a rapid growth in agile micro-businesses that produce innovative technologies, products and services to exploit renewable energy and to increase resource and material efficiencies.

All new businesses are supported by informal, digitally connected networks. Individuals have also taken up such technologies to become 'prosumers' and actively engage with businesses in the design of products. In this new market context the value of information is rising rapidly compared to materials. Many material products are now manufactured within a distributed system involving open source design studios and an extensive network of local 3D printing fabrication workshops.

Whilst non-profit social entrepreneurialism is strong, small business is still primarily profit oriented. Big business and government have significantly less influence in this city where citizens take pride in an entrepreneurial do-it-yourself approach to making life fulfilling and sustainable.

"...in 2040 parts of the city are doing very well, parts of the city are self-reliant, increasingly having shifted to distributed or autonomous systems that allow them to regulate their own consumption and supply of things like food but also energy and water. And the risk is that 2040 has these almost breakaway communities that have shaken loose of the old and aging central infrastructure that we can no longer afford to upgrade. So, it's effectively been a process of transitioning out of central to these autonomous types of systems. It's now easy to treat our own water and our waste and that's able to be recycled into our urban agriculture, but not everywhere. So, the biggest problem in 2040 is the idea that the desirable aspects of it are not distributed evenly." -Tim Horton, Registrar of Architects Registration Board, New South Wales

The 80% reduction on greenhouse emissions have arisen from various forms of collaborative production and consumption, including: renewable energy (particularly electricity), diverse shared transport systems; inventive use of and reuse of spaces; a vibrant repair sector; and local manufacturing. Production and storage of electricity from a wide range of technologies form the basis of many small enterprises, so that this is now highly decentralised; there is also peer-to-peer energy trading through local micro-grids. Information systems for managing energy, water, food, waste and transport systems are highly advanced. Citizens are energy and resource savvy, relying on various digital monitoring and feedback technologies and online information sharing to make better consumption choices. Travel has also been reduced due to the increased use of online digital interactivity; local small businesses and freelance workers operate from home and public spaces.

Economic identity is defined by: agile, entrepreneurial micro-businesses; freelancers collaborating on a project basis; value is generated through manipulation of information and creation of information rich products and services. City governance is evolving around ideas of open source democracy.

Networked Entrepreneurial Living - High Density

Features of this scenario snapshot include:

- a dynamic environment of various commercial activities including street vendors repairing goods, goods exchange services and drones delivering parcels
- diverse transport modes including autonomous vehicles, bicycles and electric bikes, and basic tram services
- a virtual travel arcade
- a 3D printing hub
- digital newspapers
- exchanges using alternative currencies

Networked Entrepreneurial Living - Medium Density

Features of this scenario snapshot include:

- various forms of mobility including unofficial public transport and autonomous vehicles (including many rented-out)
- digital newspaper
- drones delivering goods
- renting out of home spaces for office use during the day
- bitcoin payments
- a DIY 3D factory for local manufacturers

Networked Entrepreneurial Living - Low Density

Features of this scenario snapshot include:

- an electricity spot price billboard (for local peer-to-peer electricity trading)
- digital water use indicator
- solar PV panels
- bladeless vertical wind turbines
- electric vehicle charging spots with price advertisements
- various forms of mobility including autonomous vehicles
- drones delivering goods
- exchanges using alternative currencies
- a garage start-up company

My Life: Jai, 28.

I'm a solentrepreneur - a solutions-oriented entrepreneur and a solo-entrepreneur - and I've got a few different start-up businesses. The most profitable right now is 'GrubsUp' - healthy fast food delivery, specialising in insects. Because they're low carbon and high in protein customers can't get enough.

I rent a great 3-bed apartment and sublet two of the rooms to friends who are also entrepreneurs. When we're out during the day we rent the lounge room out as office space and sublet our WiFi. Because we live in the city's Innovation Precinct, the rules are pretty relaxed. We installed PV facade panels all over the outside of the apartment, so now we sell energy in the local micro-grid.

One of my flat mates is an energy trader so we have an inside track on that. Carla the other flatmate is a RRR - a repair/rebuild/re-engineer - so If anything goes wrong with our hardware or software, or we need new tools, she can help. When we all come together we act like a micro business. All these things keep our overheads down and free up some cash for start-ups.

When we're not working my flatmates and I are into virtual-reality gaming. I find it a good way to meet people, without having to go out.

Scenario 4: Community Balanced Living

Keywords: Localisation; well-being; balanced living; alternative enterprises and exchange; caring for commons.

Key emission reductions: Reduced consumption, local living and sharing economy

This is a city of low consumption, strongly reflecting values to do with the creation of a socially and environmentally meaningful life. In this community, shared wellbeing, liveability and face-to-face social interaction are more highly prized than material possessions.

There is still a market economy, however there is a thriving and diverse set of alternative forms of enterprises that are not profit oriented, including cooperatives, B-corps and other types of social enterprises.

> *"As soon as you start to create a local community again, you start to ask your neighbour if you can borrow something and it all requires interaction and it's all about bringing back the whole concept of the community in some way. I see local community centres, there being a nice mix between community, energy, even art, there being hubs where people hang out. It might be a public space like a park but it will have a solar field. We're going to have to create these hubs"* ***- Ross Harding***

This is a strong collaborative economy, with exchanges that are driven by a shared sense of social responsibility and altruism, operating on a non-profit basis. There is also a strong local community dimension to these exchanges, with an emphasis of local production and trading systems. A high proportion of the population works only part-time in the mainstream economy, with time freed for other pursuits that range from creative activity to cooperative work contributing to building community resources. Some community work is supported through local currencies. Communities generally have much greater responsibilities for the creation, improvement and maintenance of commons spaces or essential resources, including food production, renewable energy generation, rainwater collection, storage and distribution, the maintenance of built infrastructure, urban forestation, education and training, aged care and so on. Recycling and repair of most goods is an important service for small businesses and cooperatives. A high proportion of new building and building refurbishment depends on the contribution of cooperative, community labour. While this description fits the city as a whole, there is a great diversity of social and community cultures across the city - communities are diverse with some degree of specialisation in their contributions to the creation of goods and services and patterns of consumption.

The 80% reduction on greenhouse emissions has been achieved through the significant reduction in consumption of energy and materials, the sharing of resources and a highly diverse system of small scale, renewable electricity generation. Transport energy consumption has reduced greatly with more localised living. With less circulating capital from lower participation in the money economy there has been less investment in new public transport. Financial and community resources have been focused more on the maintenance of critical existing transport infrastructure, improving bicycle and walking conditions and the conversion of older vehicles to electricity and bio-gas for local use.

> *"[I can envisage a] transition to an economy of care so that we put a lot more human labour power and work and a larger segment of our economy is directed to providing human services. It could be everything from childcare to supporting aged people, [in an] aging society"* ***- Professor Brendan Gleeson.***

The economic identity of the city is characterised by: measures of prosperity that are not related to growth in GDP or material/resource consumption, with a cultural focus on more complex and nuanced measures of human flourishing (with these measures being a regular topic for community debate). People and social relationships are valued more than material possessions. A high proportion of overall economic value is derived from creative activities. Working is not seen as critical to identity and the average weekly hours in salaried employment is almost half of what it was twenty-five years ago. Governance is distributed or polycentric.

> *"A radical low carbon resilient Melbourne would be an inclusive place … and would have everybody pulling together to live in a place that looks after people. A place of sociality where our culture is one of sharing, low waste, walkability, and of making sure that we're using technology so that we're not being used by it."*
> ***- Kate Auty***

Community Balanced Living - High Density

Features of this scenario snapshot include:

- extensive use of green walls on building exteriors for urban cooling and food production
- public markets for sales of local produce
- significant social interaction in the street
- substantial urban farming including low-tech vegetables patches, fruit trees and vertical farming
- busses operating on biofuel, electric rickshaw services and few privately owned vehicles
- co-operatives
- a recycling and repair expo
- use of local currency

Community Balanced Living - Medium Density

Features of this scenario snapshot include:

- extensive DIY vegetable patches, fruit trees and gardens
- slow living and substantial social interactions
- notice signs for sharing and bartering of food
- cycling lanes and narrow roads for minimal car traffic
- refurbished historic tram
- vertical wind turbines
- voluntary child care services by elderly citizens
- shared kitchens

Community Balanced Living - Low Density

Features of this scenario snapshot include:

- evidences of 'slowness' in lifestyle – not everyone is trying to 'get somewhere'
- significant social interaction in the street including a strong intergenerational mix – the elderly are an integral part of the community
- pervasive local food production and sharing
- citizens helping to build a local community centre
- repair and recycling activities
- community owned vertical wind turbines
- solar roofs
- a refurbished historic tram
- local non-commercial car sharing and a dominance of cycling lanes for roads

Photo by TownePost Network via Flickr CC BY 2.0

My Life: Martina, 55.

Now that my kids have left home, I'm living in a co-house with several other 'empty nesters'. I have a private en-suite bedroom and living room but we share the kitchen, laundry and garden. It's fun - we share the cooking and get most of our produce from our shared garden or the community garden by the town hall.

I work for a social enterprise called 'Community Energy Solutions' which hooks houses up to local micro-grids by securing finance from our co-operative bank and helping with sourcing of cheap rooftop PV cells from a network of national vendors. The office is at the neighbourhood work hub, so I normally just ride there. I work from 10am - 3pm each day then volunteer at the toy library of the local primary school.

My friends and I moderate the local news app - it's a great way to find out what's happening locally and keeps everyone connected. On weekends, I love scouring the local swap-markets, seeing my kids or having coffee with my book club.

Table 2. Scenario summaries – key socio-politico-economic features

	Clean-Tech Corporate Living	Planned Regulated Living	Networked Entrepreneurial Living	Community Balanced Living
Key economic relations	Liberal market economy/ Corporate capitalism	Coordinated market economy / Regulated mixed economy	Peer-to-Peer, 'prosumer' market economy	Commons-based, 'glocal' economy
Key actors	Multi-national and national corporations; National or supra-national government	State and metropolitan government; planning profession; corporations	Social entrepreneurs; micro-businesses; freelance workers; prosumers; network platform providers	Citizens; local government; community organisations; co-operatives and social enterprises;
Key values	Individualism	Mixed individualism and egalitarian values; a recognition of a need for a strong public sector	Mixed individualism and communitarian ('doing good' as well as 'doing well')	Communitarian / Egalitarian; strong concern for fairness, well-being, social connections and ecological consciousness.
Key lifestyle changes	Minimal. Materialist, 'do-it-for-me', consumerist lifestyle prevail; budget and prices are the primary drivers of behavioural change.	Moderate. People have adapted to new regulations (e.g. strict recycling; driving restrictions) and new enabling environments (e.g. upgraded public transport) but otherwise are not pro-active consumers (or producers)	Significant. Collaborate consumption is pervasive; people are pro-active consumers and have self-organised into formal and informal networks; 'Prosumers' create their own goods (3D printing)	Very significant. Major changes in the total level and patterns of consumption (e.g. meatless diet); sharing of goods, skills, and time; shorter formal working weeks; opening up of private spaces (e.g. backyards); participating in local activities including food production.
Key financing	Private investment (banks, institutional funds)	Public investment; Public-Private Partnerships	Crowdfunding; microfinance; peer-to-peer lending; venture capital	Credit Unions; local government; gifting; community support finance for local projects
Key advocates	Mainstream free-market economists, (progressive) businesses; technological optimists	Technocrats; urban planners; social democrats	Social entrepreneurs; makers and hackers; prosumers and consumer activists;	Transitionists; post-capitalists; downsizers; degrowthers;

Table 3. Scenario summaries – selected urban features

	Clean-Tech Corporate Living	Planned Regulated Living	Networked Entrepreneurial Living	Community Balanced Living
Electricity/ Energy	• Technological breakthroughs in large scale electricity (clean coal, solar thermal, geothermal), biofuels and some decentralised RE and storage • Smart buildings / home energy management for wealthy • Circular economy production reduces the demand for energy	• Pervasive building codes, regulations and subsidies for energy efficiency, renewable energy • Government investment in R&D • biofuels (from non-food sources) • Local public energy infrastructures (smart grids and energy generation hubs)	• Households prefer renewable energy autonomy, including storage, and trade excess on peer-to-peer trading networks • Small tech apps help energy-savvy users efficiently managed their energy consumption	• Community and household renewable energy systems • Less demand for electricity from simpler lifestyles, smaller homes and local living
Transport	• The city is dominated by personal vehicles for the wealthy, which are either electrified or highly fossil-fuel/bio-fuel efficient • Smart vehicles ensure that driving is safe and enables workers to be productive while travelling • The less affluent face poor transport infrastructure	• Massive shift to use of electrified, integrated, public transport systems, including small autonomous electric taxis (some as small, slow local transport from train/tram stops) • High vehicle registration costs, congestion charging, and car bans have reduced the incentive for car ownership • Denser cities have reduced the need for travel, as has investment in teleworking centres	• An efficient use of a diverse range of personal low-carbon transport (electric and biofuel vehicles), that are available for fare, rental and share, and whose use is coordinated via networking technology • Online interactions and working from home reduces the need for daily travel	• Living in 20-minute suburbs, where most goods and services are available, reduces the need for travel • Walking and cycling is embedded into healthy lifestyles • When longer-range travel is required, ride-sharing, bio-gas public buses and public trains are used
Food	• In-vitro meat and GM foods • Little urban agriculture but some high-tech large 'tower farms' (using hydroponics) within cities for vegetables and fish	• Regulations and nudging for behavioural change in diet (e.g. school menus, junk food advertising); reduced meat, increased seasonal food • Mandatory food labelling including emissions • Efficient freight systems	• Local food delivery to home or work via smart apps • Some food production in the city and p2p networks to exchange / sell produce	• Widespread growing of food within urban boundaries • 'Farming' is a mixture of commercial, community, school and individual gardens and also council-run horticulture for 'social food'

Table 3 continued. Scenario summaries – selected urban features

	Clean-Tech Corporate Living	Planned Regulated Living	Networked Entrepreneurial Living	Community Balanced Living
Urban Form	• Market driven • supports high efficient 'centralised' infrastructure for food, water, energy • CBD inner city densification for affluent knowledge economy workers and sprawling outer suburbs	• Planned increased density right across the city • Centres and corridors (polycentric city form) • Significant investment in green spaces and biophilic design. • Sacrificial public spaces (in parks and squares) design to absorb flooding	• A distributed city where localisation is not important • Less pressure on the CBD with teleworkers, work hubs and small businesses	• Mosaic of villages; distributed localised infrastructure; diverse village characteristics • Suburban form not changed but housing occupancy increased • Partial removal of back fences • Use of road and 'nature strip' for community purposes
Water	• Privatised water production - including high tech waste and storm-water recycling	• Public ownership of water infrastructure - use of recycled and storm water - multi pipe systems	• Distributed water trading as businesses	• Distributed, storage of rainwater extensive, local low-tech (vegetative) cleaning of wastewater
Waste	• High tech waste collection and transport (including vacuum systems) • Large scale automatic 'centralised' systems for recovery and recycling • Organic waste separated and sold as farm fertiliser	• High separation of waste categories pre-collection		• Highly distributed local collection and reuse • Organic waste used for city greening and food production • Aim is to effectively separate and minimise transport distances
Information	• Big corporate investment in urban internet of things • Urban data is valuable and corporate owned with few major companies • Competing systems platforms for use by citizens and city governance • Information mostly utilised for centralised control of city functions	• Big public and private investment in urban internet of things • Data is open source. Some data essential for system control also directed to public information systems for feedback about environmental and resilience performance - widespread use of public information screens and building/community scale information.	• Distributed and entrepreneurial production and trading of urban data; multi-enterprise, with diverse small scale private ownership • Important intersection with social media systems • Sales to individuals to track their performance (e.g on energy consumption) - to manage consumption and associated costs	• Data investment lower and more patchy • Where there is 'performance' data distribution it is more focused on community targets; a feature of interest in social media communities

Scenario plausibility and local applicability

Participants at the Perth scenario workshop (Dec 2015) and the digital economy expert workshop in Melbourne (Dec 2015) were asked to provide feedback on the scenarios. This feedback covered general scenario plausibility themes and more specific issues and opportunities related to the future digital economy. Additionally at the Perth workshop participants also considered the local applicability of each scenario (also see Appendix II). The selected discussion themes and issues reported below are particularly relevant to the upcoming pathways analysis, and may also inform future refinement of the VP2040 scenarios:

Scenario end-state framing and assumptions about low-carbon pathways

A common challenge when developing scenarios is identifying a divergent yet coherent set of futures. In the case of the VP2040 scenarios, in one scenario for example, transport is envisaged as primarily provided by privately-owned vehicles without significant mode shifts occurring as is the case in other scenarios; food consumption is envisaged to have changed more or less depending on the scenario. In these ways the scenarios portray extreme outcomes which some participants at the Perth workshop criticised. For example, some participants expect a major shift away from privately-owned vehicles to occur in all scenarios, and others questioned the assumptions about food consumption in each world. Such feedback can be considered in a few ways. The current conceptualisation can be defended as prompting thinking about particular outcomes such as considering how and why privately-owned vehicles might still be the dominant form of transport in 2040. Alternatively, the scenario end-states could be revised to portray less extreme outcomes. The aim however is to provide the project's partners (and governments more generally) with a sense of key decision points and the pathways that flow from them. So divergence and extreme projections can be valuable.

Some participants at the Perth workshop also questioned related assumptions which are embedded in the scenario conceptualisation such as the relationship between urban density and public transport and related investment and operational models. The "pigeon holing [of] some frameworks and issues" in particular scenarios was questioned by some participants who also argued that "some ideas can span all four scenarios". Related questions were asked included "why might good public transport not be privately owned?" (although other participants raised concerns about ensuring all people, rich and poor, have access to quality services) and "why might 'clean-tech corporates' not be vegetarian or vegan?". These comments can be interpreted as provocations and a suggestion to question common assumptions. Such questions will be central to the next phase of the work.

The role of government and new governance models

Questions regarding the role of government were raised for all four scenarios at both the Perth workshop and the digital economy workshop. For example, regarding Networked Entrepreneurial Living, a participant at the Perth workshop commented that it's "not clear [in this scenario] what role government plays". Other participants at this workshop argued that the changes envisaged by this scenario need a guiding framework from government (e.g. adequate regulatory frameworks) as well as government support. Participants at the digital economy workshop also argued that the role of the state in the Community Balanced Living scenario was unclear. Participants felt that this left questions on responsibilities of lawmaking and law-enforcing unanswered. Similarly, policy and planning issues related to achieving greater density, zoning (e.g. zoning implications of local food production) and more communal housing models were raised at the Perth workshop regarding Community Balanced Living. A related issue is identifying ways to aggregate private individually owned land in areas targeted for higher density, such as "providing incentives for ordinary people to sell their land jointly with neighbours". Finally, for Clean-tech Corporate Living, a range of policy-related barriers to change were also emphasised by participants such as the "need to take into account the political structure and laws that favour unsustainable practices". Participants at the digital economy workshop also queried the role of government in health care and education in this future.

At the Perth workshop some skepticism was voiced about state government leadership driving significant change (at least in Perth) regarding the Planned Regulated Living scenario; similar questions arose in the Melbourne workshop discussion. These questions centred around trust in government, bipartisanship and avoiding the negative perception that regulatory approaches to low carbon urban living are a shift towards a "nanny state". Some participants argued that deliberative democracy models should be considered more in the scenario analysis as they may increase trust and help to avoid a negative perception of regulatory approaches.

Other issues related to technology governance and incentives for innovation were also raised at the digital economy workshop. It was asked if privacy still existed in the Networked Entrepreneurial Living scenario and, if so, how it was established and maintained. For Community Balanced Living the main questions revolved around mechanisms to incentivise innovation, including intellectual property arrangements and terms of data ownership and use.

The issue of power was also raised at the digital economy workshop regarding many of the scenarios. For example, in regards to Clean-Tech Corporate Living, the participants of the digital economy expert workshop did not find the idea of a wholly market-driven world where the power is held by corporates convincing. Participants argued that there has to be a role for the state supporting mechanisms that allow power to be distributed in the way assumed in this scenario end-point.

Consideration of disruptive change

Some workshop participants asked questions about disruptive change as presumed in the scenarios and the types of potential disruption they felt should be incorporated into the scenario analysis. For example in the digital economy workshop questions were raised about the Networked Entrepreneurial Living scenario end-point. Participants asked: what was the pathway that led to a future in which big brands and big business did not exist (or only existed in a marginal way)? They pointed out that it was not clear whether they "went quietly" or "put up a fight". This also implies that potential forms of resistance to change and different types of systemic transformation need to be considered as sources of disruption. Many types of potential disruption were argued to need further consideration ranging from technological disruption, to economic (e.g. employment disruptions related to technological change) and environment-related change (e.g. due to the effects of climate change). Some issues specific to the Western Australian context (see below theme) were raised at the Perth workshop such as the potential for increased southern migration related to climate change. Research on the sources of disruptive change is ongoing in VP2040 and will be an important part of the upcoming pathways work.

Avoiding too narrow a focus on reducing greenhouse gas emissions

Some scenarios such as Networked Entrepreneurial Living were seen by some as being too narrowly conceived. The scenario was criticised for not considering all important aspects of urban life and/or having limited applicability across the community. This was judged to reduce the plausibility of the scenario. A related message of the Perth workshop was that adequate consideration of sufficiently wide range of issues - such as level of inequality and need to maintain food security - is required to ensure that potential scenarios are both desirable and plausible. A related question asked by one participant was "what are the impacts [of these futures/trajectories] on other sustainable development goals?"

Similarly, in an interview conducted for VP2040 Tim Flannery noted that:

> ***"I can also imagine a radically low carbon and resilient city that would be horrific to live in. Some cities around the world are pretty low carbon, and they're pretty resilient, but they are horrible to live in. Everything from Jaipur to Mumbai. It's getting more high carbon, but you could imagine, terrible dysfunctional cities that are just exactly low-carbon, resilient" (quote from Chandler, 2015).***

This theme is also linked to the previous issue of the potential for major disturbances or 'shocks' over the coming decades. Participants suggested these need simultaneous attention whilst considering options for reducing GHG emissions.

Of course it is a project objective to help our partners (and the wider community) understand ways in which meeting carbon targets and improving resilience may produce future conditions that might be judged unacceptable on various counts. This project is not aimed at eliminating futures where, for example, there is an increase in social and economic disparity; or to make judgments on the degree of technocratic control inherent in meeting climate-related targets.

Contextual/local suitability of the scenarios

A further discussion theme at the Perth workshop centred on how and if general scenario end-states would manifest in specific cities and under local conditions. Would this occur differently in different southern Australian cities? This points to the potential value of more city-specific analysis, whether it be further scenario analysis or pathways focussed analysis (see the next chapter). For example Perth has a number of unique dimensions such as its remoteness, isolated energy market (Western Australia is not connected to the national electricity market) and higher energy prices, local geography, and a unique state economy which presents different economic challenges and opportunities. These features and conditions may influence both which scenario end-states would manifest in Perth and what specific form they take in this context.

Spatial considerations

Similar to the above discussion theme, many participants at the Perth workshop raised spatial considerations such as whether the scenarios were a good fit with the current urban structure of Australian cities. For example, at the Perth workshop participants pointed to related assumptions central to Community Balanced Living, arguing it assumes that "Perth's hideous spatial structure and appalling housing stock could be retrofitted effectively" and emphasising the challenge of "retrofitting the existing urban form". A number of participants also argued that the densification of urban living is a significant challenge in Perth, pointing to cultural, financial

and political barriers. Similarly other scholars have warned of the dangers of a 'place-blind' approach to policy-making which is seeking to enable low carbon innovation (e.g. Uyarra et al. 2016). Additionally, many participants argued that the VP2040 scenarios are more or less relevant to different parts of Perth (e.g. inner/CBD region, outer suburbs). These considerations may be most relevant for pathways that involve shifts in the urban structure of Australian cities and need to consider the embedded nature of infrastructure and existing building stock. Such analysis can draw on other research on urban regeneration challenges and options (e.g. Newton et al., 2011; Newton & Glackin 2014).

Concerns about the lack of the "outcast" and forms of crime

In the digital economy workshop participants raised concerns about and found unrealistic the lack of the underprivileged and the outcast. Questions were raised specifically about the Networked Entrepreneurial Living scenario end-state. One of these questions was about the privilege of digital literacy. Participants inquired if this scenario depicted adequate mechanisms and appropriate social structures with regards to bringing along those people who are not digitally literate or who choose not be. Or, alternatively, would they be left behind and become marginalised? Participants also asked questions about what a counter-culture would look like in this society and what the new forms of crime would be entailed.

These seven themes were not the only topics discussed at the Perth and digital economy workshops but they do provide a sense of the feedback provided to the research team and can help to focus upcoming pathways analysis. Many of them are not newly identified issues; rather they re-emphasise the importance of these issues and related key questions.

5. Pathways implications and future research

Frameworks for conceptualising and analysing pathways

One of the main objectives of the next stage of VP2040 is to illuminate and provide descriptions of the prospective pathways from the present to possible low-carbon and resilient urban futures in Australia, such as the scenario end-states outlined in earlier chapters. The insights and understandings from the pathways analysis will then be used to suggest, consider and select potential strategies, novel governance structures and policy mixes that can help to facilitate and support the dynamics that have been identified as potential drivers of structural change. In this chapter we briefly explain some of the considerations that will be part of the research ahead and provide some preliminary implications that we have identified through earlier workshops and other project research.

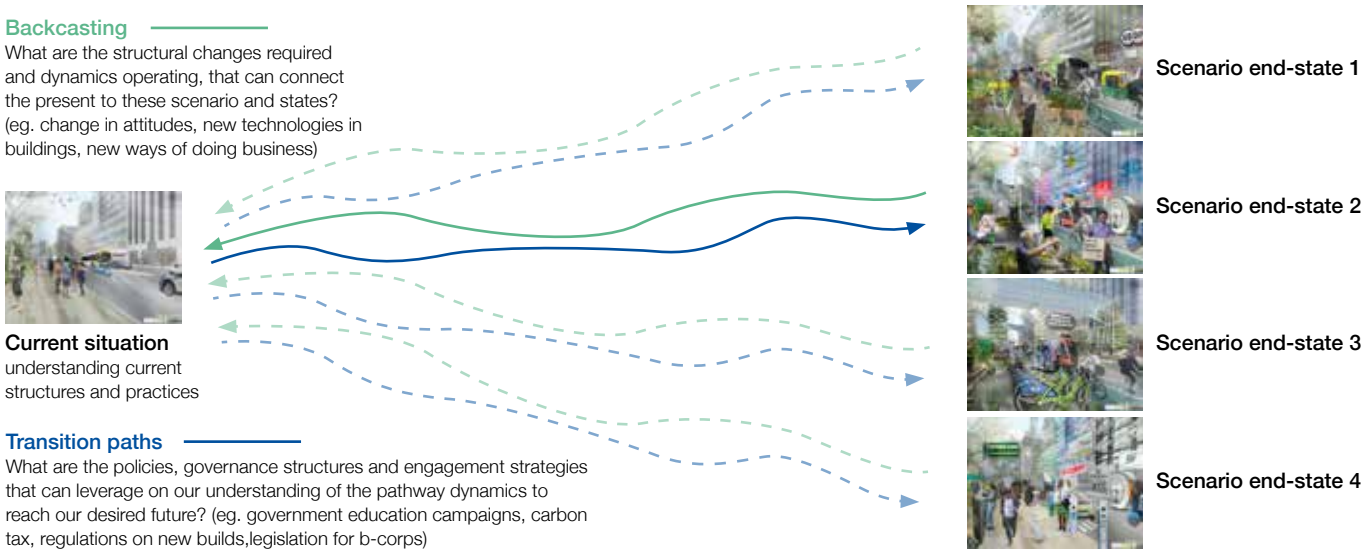
As previously emphasised in this and other VP2040 documents a systems perspective is utilised in this research. Two frameworks that will assist in specifying transition pathways have been described in a VP2040 foreground paper (Twomey and Gaziulusoy, 2014) are the Technological Innovation Systems theory and the Socio-Technical Transitions approach.

Technological innovation systems (TIS) theory is a useful heuristic framework for analysing the success or failure of a technology on the basis of the performance of the surrounding technological system. It includes identifying the key structural elements of a technological system (e.g. actors, institutions, interactions and infrastructures) and key functions of a TIS (e.g. entrepreneurial activity, knowledge development and diffusion, market formation, expectations and goal formation, resource mobilisation, and the formation of advocacy coalitions). The complexity and interconnectedness of physical, technological and cultural/social systems in cities presents challenges for the use of TIS approaches.

The Socio-Technical Transition approach, particularly the Multi-Level Perspective (MLP), is a framework that developed out of historical studies of transitions in areas such as energy and transport. The MLP is particularly powerful in understanding the complex interplay of different forces in creating disruptive change. The MLP approach posits three levels of change or analysis to aid understanding transitions: a landscape (macro) level that encompasses the dynamics of deep cultural, economic and political patterns; a regime (meso) level that refers to the current practices, routines and dominant rules that prevail in a socio-technical system; and a niche (micro) level which represents the space where actors experiment with radical innovations that may challenge and break through into the prevailing regime. Additionally, theories of framing processes and micromobilisation processes are also relevant to understanding potential transition pathways (see McGrail et al. 2015). Such theories are both relevant to understanding emerging urban change processes and potential future interventions. We also anticipate drawing on scholarship on green transformation processes (Scoones et al. 2015b).

One approach that will be used in the next round of workshops to explore how potential transformations may come about is a process called backcasting which is important in the sustainability arena. The objective is to connect desirable long term future scenarios to the present situation by means of a participatory process. The central question of this process is to ask "what do we need to do today to reach a given future (or scenario end-state)?" In other backcasting approaches which might be more applicable in this project the question is reversed "what has happened, what has been done, to reach this future state from the present?" This frames pathways as elucidated from a 'retrospective history' process. This can be

Figure 5. Backcasting approach. Source: draws upon CRISP 2012



linked to the MLP approach by seeking to identify existing niche developments that would from a present starting point develop into a pathway trajectory to a particular future scenario (Ryan 2008; Sondeijker 2009; Manzini 2011). Backcasting from scenarios can be described as solving a jigsaw puzzle, in which we have a shared picture of where we want to go and we put the pieces together to get there. Figure 5 illustrates the phases on the project within the context of the previous scenario end-state development.

Following Sondeijker (2009), an initial task in this backcasting approach is to identify the necessary changes in culture, structure and practices to bring about the possible futures. This includes identifying what structural changes need to be 'broken down' and what need to be 'built up'. For example, elements that may need to be broken down in the food sector could include areas such as negative attitudes towards hi-tech food (such as GMO or in-vitro meat) or the dominance of large corporation business models based on low-cost, high carbon foods. Examples of structural elements to be built up could be better testing and dissemination of information on the safety of new foods and new technologies that reduce waste in food production (CRISP, 2015).

The forces, drivers and barriers that will shape the path of transitions can occur at all three levels in the MLP framework. That is, these can have implications for how technologies/ innovations develop in niches, for the stability (or not) of the incumbent systems/regimes, and in the role of wider societal changes in accelerating structural transformation. Furthermore, interaction between the multiple levels (niche, regime, and landscape) potentially accelerates the build-up and break down of structures. Consequently understanding these dynamics of interactions can help in developing transition policies and strategies.

Pathways implications from work completed to-date

In addition to using more general frameworks for conceptualising and analysing pathways, the pathways phase of the project will also be informed by project findings that point towards specific focal areas relevant to potential pathways.

Three broad potential sources of greenhouse gas emissions reductions were considered when conceptualising the VP2040 scenarios. At a high level these sources provide options that can be further explored during the pathways phase (e.g. defining or assessing more specific possibilities in each category). A further orientation to help explore the scenario pathways are the different processes of change (or mechanisms) that would need to occur in order to achieve the envisaged outcomes, the different actor motivations that are posited or assumed, and whether more or less top-down or bottom-up change is envisaged. Additionally, the scenarios can be seen as varyingly market-centric, state-centric or civil society-centric. These pathway-oriented dimensions are summarised in the table below:

Table 4: Pathways orientation of the VP2040 scenarios

Scenario	Change processes	Main actor motivations	Emissions reduction orientation
Clean-Tech Corporate Living	Market-centric	Commercial opportunities and business risks/threats (i.e. profit-driven change)	Production and product based emission reductions
Planned Regulated Living	State-centric (e.g. regulations, planning driven change)	Emphasis on achieving social equality and socially responsible outcomes (e.g. regulating for social outcomes even if this impacts on private sector profitability in short-term)	Production and product based emission reductions Usage-based or service-based emission reductions Some reduction in absolute consumption
Networked Entrepreneurial Living	Both market-driven and civil society-centric	Mixture of motivations but for-profit business / enterprise orientation remains dominant	Usage-based or service-based emission reductions
Community Balanced Living	Civil society-centric (e.g. local community / civic initiatives)	Commons-oriented (community outcomes/value not individual profit motive)	Reducing absolute consumption levels

Identifying and examining pathways: approaches and preliminary thoughts

Scholars working on a similar project in Europe, Turnheim et al (2015, p. 242), recently noted that "actively-shaping transition dynamics is difficult" and that such challenges are "compounded by the diversity of opinion, scholarly and otherwise, that exists about governing and steering technology and structural changes in society". A further key challenge is linking knowledge (e.g. about possible pathways) with action and decision-making processes (Miller et al. 2014). The sorts of changes entailed by low carbon transitions may be best viewed as unfolding processes rather than having a clear or predictable end-state. This is the argument made by the editors of the recently published volume The Politics of Green Transformations:

"We understand 'greening', therefore, as a process rather than a measurable end-state. Just as it is impossible to conceive of the end-point of the unfolding low-carbon transition, so previous transformations did not start out with clear blueprints and plans that were then rolled out. Rather, they were the product of competition and interaction between a number of pathways, supported by diverse social actors with highly uneven political power" (Scoones et al. 2015a, p. 3)

During this phase of the project VP2040 will further explore how, and to what extent, transition dynamics in urban contexts may be proactively shaped and conceptualised. We recognise that similar work is being done both in the CRC for Low Carbon Living and in other contexts and will draw on this as is appropriate. Key approaches being considered are noted below:

Quantitative modeling

One main approach to understanding or assessing transition pathways is quantitative systems modelling (Turnheim et al. 2015). Here techniques such as techno-economic modelling and integrated assessment models are used to provide a forward-looking perspective and to consider the potential impact of various options (e.g. alternative public policies). For example, in VP2040 the identified qualitative scenarios can be modelled using quantitative approaches to better understand and assess their emissions reduction potential. This is currently being explored in collaboration with the Integrated Carbon Metrics project of the CRC for Low Carbon Living and through the VEIL Australian Stocks and Flows Framework.

Deliberative multi-stakeholder workshops

Engagement exercises attended by involved actors will also be conducted to identify or explore potential options and courses of action for achieving urban low-carbon transition and resilience goals. These engagement activities are closer to an action research approach which simultaneously pursues both action and research outcomes. Through participatory workshops and related participatory planning exercises such approaches aim to either stimulate creativity or to foster greater deliberation on potential pathways such as regarding perceived barriers and potential ways of addressing these barriers. In contrast to the 'big picture' nature of earlier project workshops it is expected that these workshops will explore a narrower set of key themes or focal options that are relevant to advancing specific potential pathways.

Partner engagement/workshops and CRC engagement

An important part of this phase of the project is expected to be meeting with project partners and the CRC for Low Carbon Living itself regarding the emerging findings of the VP2040 project and potential future courses of action related to achieving low carbon and resilient cities. Options to link the knowledge being produced with real-world action will be explored such as via related or concurrent decision-making or policy-making processes. In addition, VP2040 will engage with the CRC to consider potential areas and priorities for CRC for Low Carbon Living research (or similar research organisations).

Examination of current/emerging urban change processes and potential policies

During this phase VP2040 PhD students will continue to examine current and potential change processes in Australian cities relevant to creating low carbon and resilient cities in Australia. Specifically their research covers distributed energy generation (in particular on-site solar energy generation), urban design/healthy built environments, and the governance of open space (see Appendix IV). Additionally, during this project researchers will examine emerging policy and innovation trajectories in leading cities, i.e. those who are trialing new approaches to creating more low carbon and resilient cities. This research will aim to identify transferable lessons or insights relevant to Australian cities.

6. Where to next?

The next phases of the project will involve elaboration and refinement of scenarios including quantitative emissions comparisons, developing policy and innovation pathways and exploring governance implications. As part of this, the project will collaborate with the Integrated Carbon Metrics project of the CRC LCL and the Australian Stocks and Flows Framework project to develop estimations of the scenarios' potential to reduce emissions. This aims to examine whether these scenarios have the ability to reduce city emissions by 80% by 2040. Subsequent phases will also involve participatory workshops that use backcasting approaches. This involves considering potential pathways to low carbon resilient cities, asking what could help bring about these (or other) scenarios. Figure 5 illustrates the current and planned work over the next year.

Initial meetings with the project partners aimed both at updating them on the work and assessing their priorities in terms of the policy domains and choices that they see as significant for their activities related to rapid decarbonisation and resilience. There are some significant divergences in the scenarios that point to different societal outcomes from the way that particular policy domains are approached. An immediate example that is seen as very relevant for the 'city partners' is the way that urban data is utilised to effect social behaviour and resource efficiency (see the information section in table 3 (information). Interest in the potential value of 'big urban data' (including from the pursuit of an internet of things) is high as policymakers consider the potential of 'smart cities', which as the scenarios suggest could be configured in very different ways (depending on the ownership and structure and utilisation of data sources). An important value of the backcasting work will be to identify any key 'trajectory branching points' (to use a description that emerged from one of the partner meetings) where policy decisions will affect the evolution of a technological capacity, or the configuration of infrastructure, or the values of citizens, or politically acceptable consumption patterns, and so on. These considerations will influence the structure of the backcasting workshops.

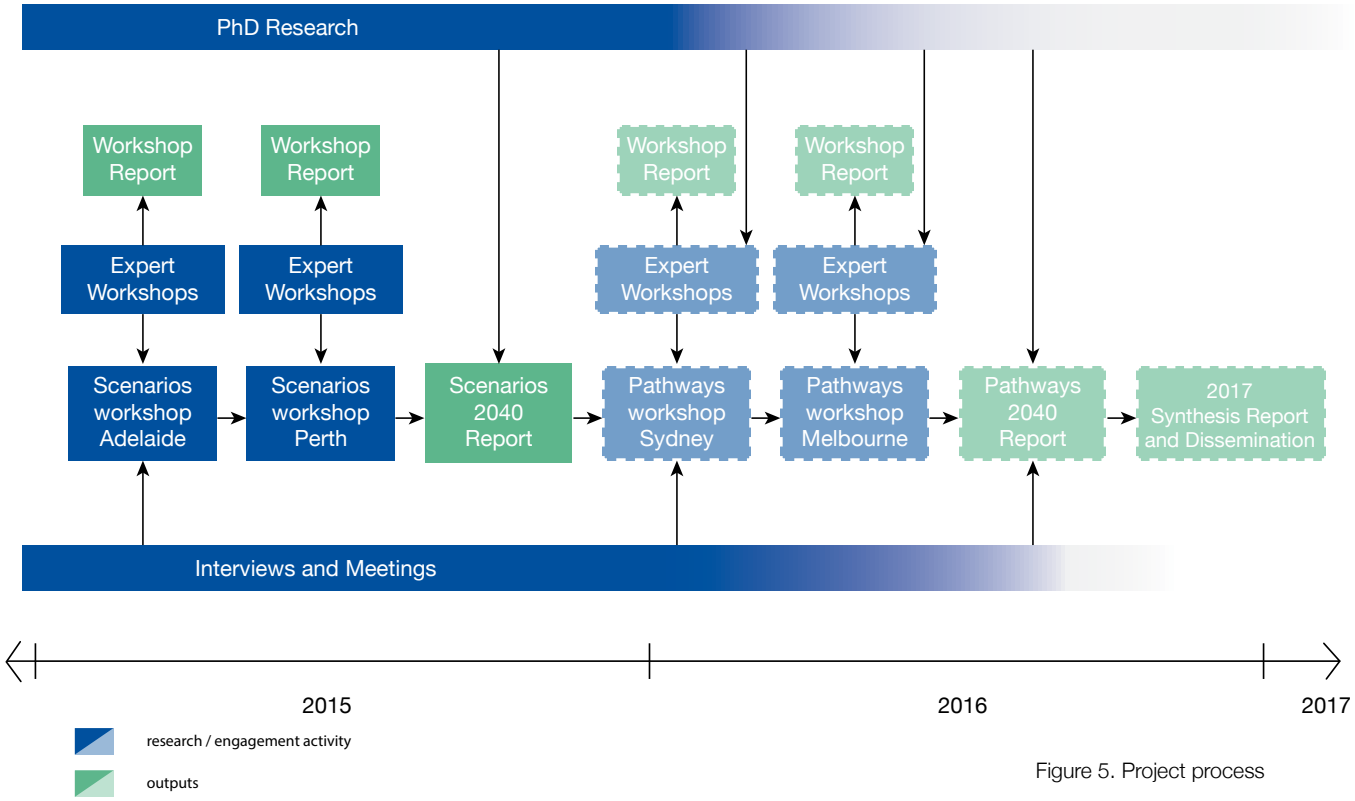


Figure 5. Project process

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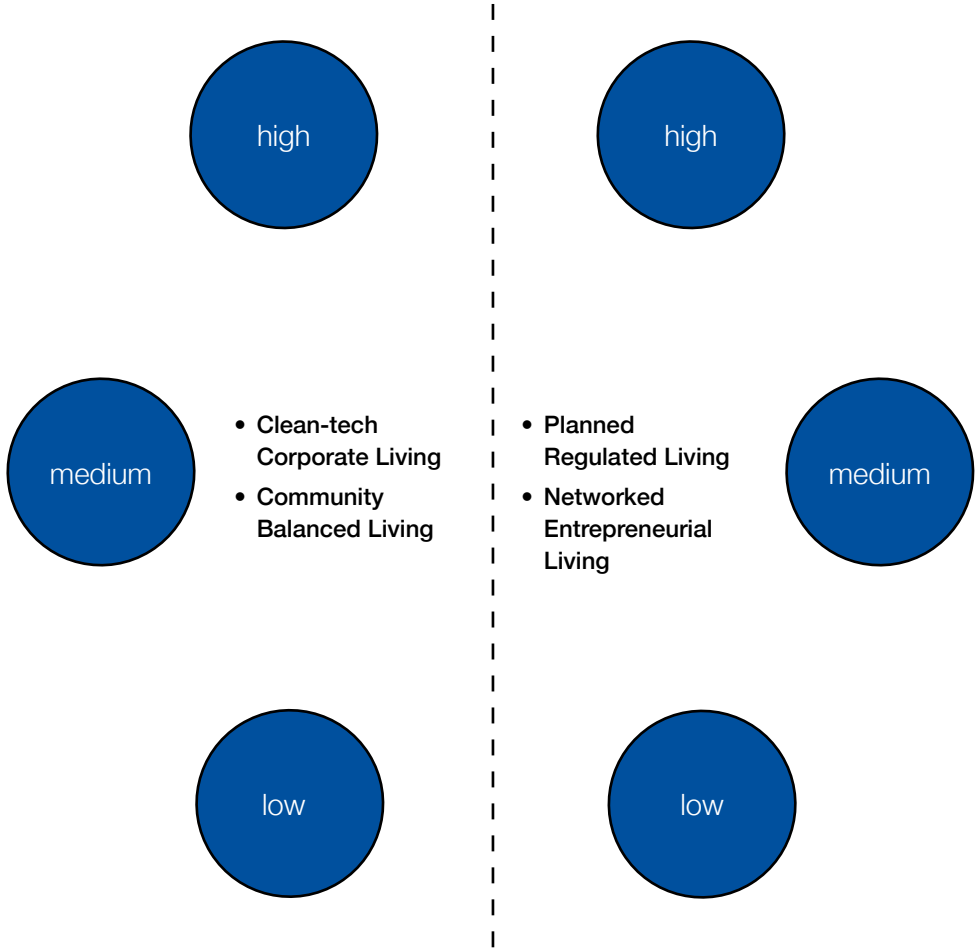
Appendix I - Adelaide Workshop Process Description

A half-day workshop was conducted in Adelaide to test and further develop the initial set of proto-scenarios. 43 participants from the state government, local governments, business and research institutions attended. The workshop consisted of two sessions; the first focused on the implications of the prototype scenarios on Adelaide across three generic density levels (high, medium, low) and the second aimed to investigate the prototype scenarios further by exploring how daily life would be like in each scenario.

In both of the sessions there were 6 tables with participants equally distributed around. In the first session each table was allocated a specific density level and two of the prototype scenarios. In the first session participants were asked to imagine and describe how Adelaide looked like under each scenario and density level allocated to their table. Towards the end of this session particular shocks and extreme events were introduced for groups to consider as a way of testing whether the resilience of Adelaide under each scenario. In the second session participants at each table were divided into two groups. Each group focused on one scenario and in pairs developed stories explaining one day of a hypothetical person in that scenario. Each pair worked with a different hypothetical person. At the end of this session one pair from each table acted out the story.

These two sessions were followed by a wrap-up session in which the participants shared their reflections and thoughts on what was exciting about the scenarios, what was concerning and what was missing.

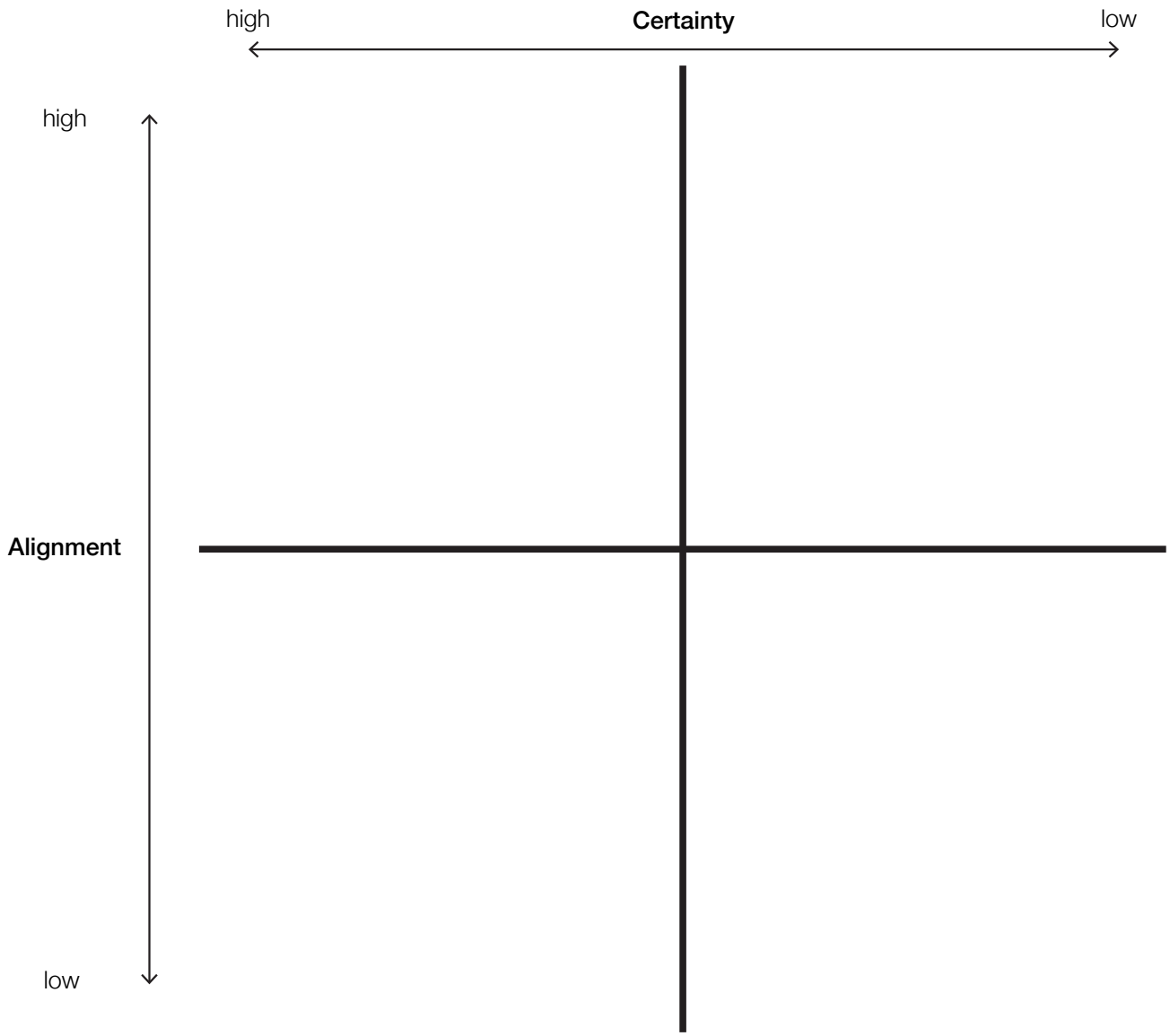


Appendix II - Perth Workshop Process Description

A half-day workshop was conducted in Perth to consider the plausibility of the draft set of proto-scenarios. The workshop was hosted by Aurecon and attended by local built environment professionals and sustainability experts as well as representatives from local and state government. Workshop participants were asked to provide a mixture of general feedback on the draft scenarios and more specific assessments of the plausibility of each scenario in Perth.

The workshop consisted of a short presentation on the scenarios and the urban low carbon challenge, individual and small group-based assessment of the scenarios, and more detailed evaluation of envisaged scenario elements (e.g. changes to urban form or transportation systems). During the initial assessment of each scenario participants were asked to provide four scenario-related assessments: 1) current changes that are perceived to be consistent with the scenario; 2) assumptions embedded in the scenario which are judged to require further consideration/analysis); 3) what, if anything, is missing from this scenario that leads you to question its plausibility; and 4) the overall plausibility of the scenario for Perth.

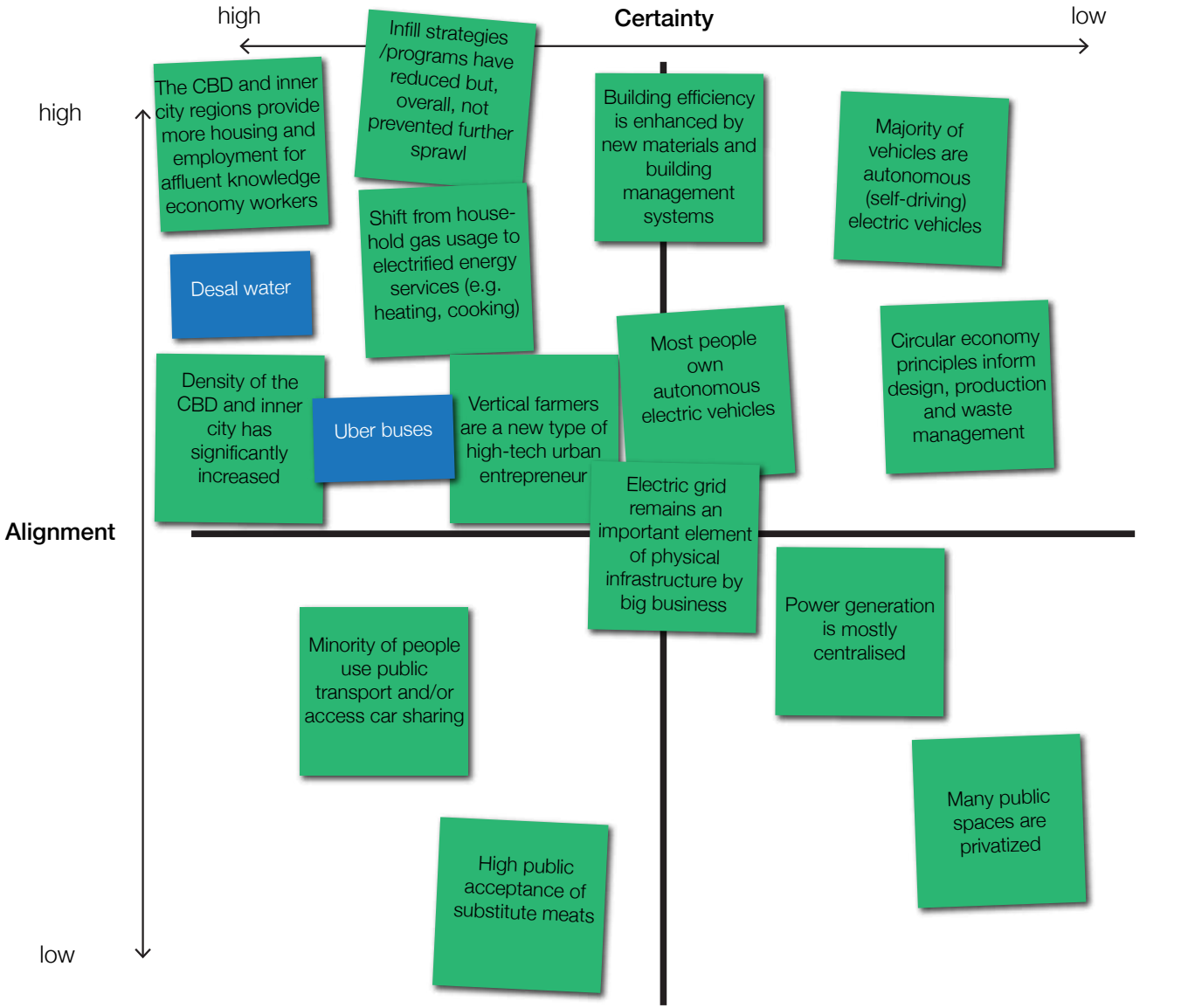
In the second small group exercise participants were asked to select the scenario they most wanted to explore in further detail. Each small group was given a list of potential scenario elements for the specific scenario that they were focussing on and then asked to assess each element – with reference to Perth – for the level of perceived certainty/uncertainty (which was termed the certainty level) and overall consistency of the element with the core 'spirit' of the scenario world (which was termed alignment). This small group process resulted in placement of each element on the following 2x2 matrix:



Two example scenario assessments are presented below which were completed for Clean-tech Corporate Living and Community Balanced Living. Each assessment is also discussed.

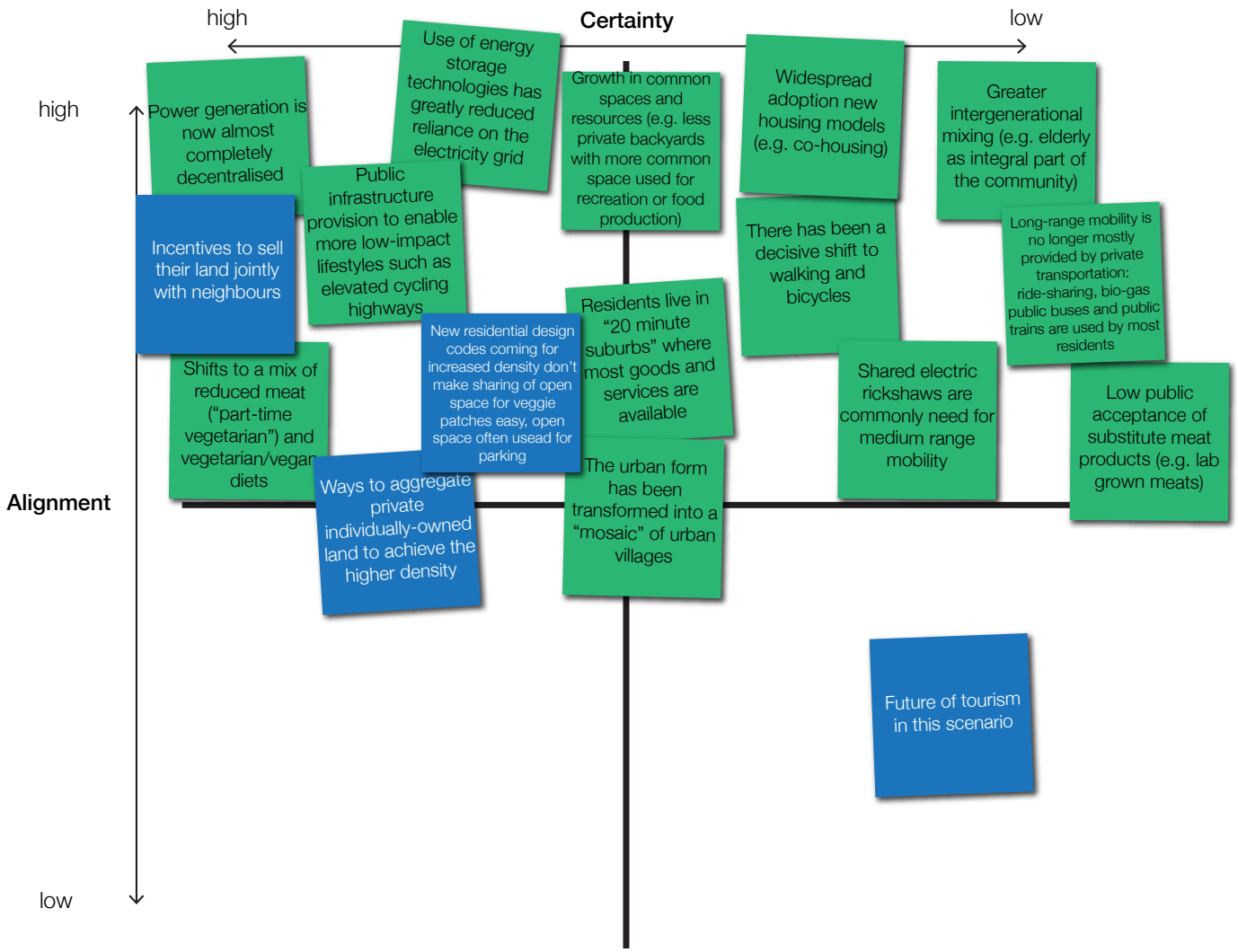
Clean-tech Corporate Living:

Some aspects of this scenario were judged to be highly plausible (quadrant 1 elements), however the majority of scenario elements were judged low alignment and/or low certainty indicating low overall perceived plausibility. Few reasons were stated for this assessment aside from the rise of decentralised solar and battery storage options with respect to the scenario element 'power generation is mostly centralised'. The participants also challenged some elements of the scenario such as 'many public spaces are privatised' and questioned whether the 'minority of people use public transport and/or access car sharing' in this future (also see the discussion in Chapter 4 of this report). The group placed the element 'the electricity grid remains an important element of physical infrastructure and is operated by large network business' in the centre of the matrix which may indicate a high level of uncertainty regarding whether this is expected to be an element of a Clean-tech Corporate Living future. Additional scenario elements particularly relevant to the Perth context were also proposed (see the blue 'post-its' for desalination plants for water supply, ferry transportation). This assessment could inform further refinement of the scenario and inform consideration of how it might manifest in different ways in specific southern Australian cities. Scenario elements which were judged to be high alignment but low-moderate certainty (e.g. 'building efficiency is enhanced by new materials and building management systems') may require additional policy attention to minimise or address related barriers to change.



Community Balanced Living:

Notably all proposed scenario elements were assessed to have high alignment, which is a strong contrast to other scenarios (e.g. Clean-Tech Corporate Living). However, the overall plausibility assessment for Perth appears to be moderate-to-low plausibility given the low and moderate certainty of participants regarding many of the scenario elements. Regarding quadrant 1 elements participants pointed to current trends such as new 'flexitarian' diets and ethical eating trends which are "not militant" and the rapid growth in solar PV systems. Plausibility was also related to urban form, urban policy and related factors in the Perth context: the group remarked, regarding a '"mosaic" of urban villages' and living 'in "20 minute suburbs" where most goods and services are available', that these changes are "more likely to happen in the suburbs; what about the CBD?". New housing models (e.g. co-housing) were described as a "poor fit with dwelling types we currently have". The group suggested - via blue post-its - that changes to planning policies for residential development and incentive structures need more consideration in this scenario, along with the future of tourism. The group also had low confidence in the major envisaged changes in transport. Use of public transport and ride sharing by most residents was seen to "need increased frequency, which is difficult with low density and low population size". Participants also argued that "people will want private mobility/transport e.g. electric car share schemes". An important consideration for further scenario refinement and pathways analysis is whether this scenario needs to be both 'top-down' and 'bottom-up' given the perceived importance of planning policies and incentive structures which were described as major barriers to this scenario occurring in Perth.



Appendix III - Workshop participant summary

Affiliation	Adelaide	Digital	Finance	Perth	Total
Business	**7**	**6**	**2**	**5**	**20**
AECOM	2			1	3
Arup		1			1
Ashurst			1		1
AURECON	1	2		2	5
Deloitte Digital		1			1
ETool				1	1
Grieve Gillett	1				1
Hassell	3			1	4
IBM			1		1
Siemens		1			1
Uber		1			1
Consultancy	**10**	**2**		**3**	**15**
Action Foresight		1			1
Balance Carbon Pty Ltd	1				1
Catalyst Energy	1				1
Centre for Australian Foresight				1	1
Cminus	1				1
Co-create Adelaide	1				1
Dsquared	1				1
EcoCity Design	2				2
Ecocreative	1				1
Ferart				1	1
Holos Group		1			1
Seed Consulting	2				2
Simply Carbon				1	1
Finance	**1**		**4**		**5**
Bank MECU			1		1
Clean Energy Finance Corporation	1				1
Impact Investment Group			1		1
Investor Group on Climate Change			1		1
NAB			1		1
Local government	**6**	**5**		**4**	**15**
Adelaide City Council	1				1
City of Canning				3	3
City of Fremantle				1	1
City of Marion	1				1
City of Melbourne		5			5
City of Onkaparinga	1				1
City of Port Adelaide Enfield	1				1
The City of Unley	1				1
Media & creative arts	**1**	**2**	**1**		**4**
ABC		1			1
Australian Science Media Centre	1				1
The Conversation		1			1
Transitions Film Festival			1		1
NGO	**4**	**1**	**2**		**6**
MEFL			1		1
Open Food Network		1			1

TACSI	2				2
Uniting Communities	1				1
Water Sensitive SA	1				1
Peak body	**1**		**3**		**4**
Carbon Markets Institute			2		2
Future Business Council			1		1
Planning Institute of Australia	1				1
Research	**7**	**4**	**4**	**10**	**25**
Carlton Connect Initiative		1			1
Carnegie Mellon University Australia	1				1
ClimateWorks Australia			1		1
CSIRO		1			1
Curtin University				3	3
CUSP				6	6
Murdoch University				1	1
University of South Australia	2				2
University of Adelaide	4				3
University of Melbourne		2	4		6
Social business		**1**	**4**	**2**	**7**
Doing Something Good			1		1
Earthworker			1		1
Enkel				2	2
Livewell Yarra			1		1
Shareable		1			1
Small Giants			1		1

State government	**5**	**1**	**2**	**1**	**9**
DEWNR	2				2
DPTI	1				1
Office of Green Industries SA		1			1
SA Government	1				1
Sustainability Victoria			2		2
Tonsley Redevelopment	1				1
WA Department of Transport				1	1
Utilities	**1**			**1**	**2**
Main Roads Western Australia				1	1
SA Water	1				1
Grand Total	**43**	**22**	**22**	**26**	**113**

Appendix IV - PhD Research

Below are abstracts of three the PhD projects associated with VP2040.

David Bennett - University of New South Wales

Shaping Suburbia - what's next for the suburbs?

Walking has been described as the single highest-return population-health intervention. There is good evidence that places with multiple destinations in close proximity of residents correlate with more walkability and increased physical activity. In the majority of cases this has been interpreted as a call for high density and specifically high-rise development. However, the majority of the Australian house-buying public shows a clear preference for single houses (Torrens Title) compared to apartments (Strata Title). Therefore the places we seek and choose to live work against the creation of walkable places and instead tend to deliver poor citizen physical activity outcomes.

There is undoubtedly a complex relationship between a physical built environment and its residents' likely behaviour. However if insights of how people will most likely travel can be probabilistically connected to place then the activity benefits and the range of other co-benefits can be supported through the creation of such places. This research seeks to provide insight into city-making for many post-war growth cities. In Australia single detached houses are by far the dominant housing typology (73%) and they occupy by a significant margin the physically largest areas.

Building on the possibility that incidental functional activity alone can provide sufficient physical movement to achieve the World Health Organisation's stated minimums for health, this project uses the concept of precinct proximity connected in a fine-grain place analysis. It allows the walkability and activity data to connect to the built environment in a novel way and suggests a number of practical and useable design insights that have implications for the evolution of currently low-rise built environments.

The application of these findings may allow low-rise suburban areas to transition to become places that support adequate physical activity while remaining aspirational places for the suburban home-buying public. In the process they can deliver a number of other key individual and city-wide co-benefits.

Che Biggs - University of Melbourne

Examining household solar adopters as agents of transformation in Australia's electricity sector

Recent studies suggest adoption of small-scale solar photovoltaic systems (SPVs) can distort the flows of financial and social resources underpinning fossil fuel based electricity systems. With 1.5m (and growing) SPV systems installed across Australia, it is arguable their collective impact on resources will influence how the nation's electricity sector evolves. However, little is known about how SPV adoption and associated behaviors (such as household battery adoption) re-directs electricity field resources at the household level. This research examines the role of SPV adopters as agents of transformation in the electricity field through a resource-based lens.

The study takes a critical realist approach and draws on surveys and interviews with electricity sector experts and SPV adopters to address three questions. It first asks whether and how PV adopters' shape the allocation of electricity sector resources. The significance of resource allocation is determined using a resource-based framework for transformative agency – developed in this thesis. Second, it asks what stated motivations and meaning SPV adopters associate with their own resource allocating behaviours. The focus on both motivation and meaning reflects the often-weak association found between stated motivations and behaviour in behavioural research and the importance of meaning and identity in explaining the alignment and institutionalisation of common behaviours. Thirdly, it asks whether there are patterns of behaviour, motivation and meaning among SPV adopters and how these patterns are related.

By seeking patterns of behaviour, this study aims to identify areas where SPV adoption might have its greatest impact on a changing electricity sector. Through exploring patterns of behaviour and motivation, this study seeks to identify what drivers underlie the transformative impact of SPV adopters. By exploring patterns of behaviour, motivation and meaning together, this study seeks to determine whether the transformative impact of SPV adoption reflects any sense of commonality or shared identity that might explain the future alignment of transformative agents in shaping Australia's electricity sector.

Jennifer Witheridge - Swinburne University

Contested space. Future challenges and pathways for open space in Australian suburbs

This PhD project examines the contestations about open space that occur as a result of increasing building density in the middle suburbs of Australian cities. Rapid household growth and the infrastructure and other costs of suburban sprawl has prompted public policy to embrace residential infill development to provide higher density housing closer to existing transport, employment and utilities. Now occurring at rates equal to greenfields developments, infill housing in inner and middle suburbs results in a loss of private open space through reducing and reconfiguring open spaces at a lot level. As a part of a broader

open space system, this shift changes the ecosystem service and recreation demands of public open space. Underlying these concerns is an appreciation that open space provides important ecosystem services and environmental comfort in the context of improved understanding of the effects of climate change, and the benefits of contact with nature, amenity and recreation, health and wellbeing, and aesthetic value.

This PhD project documents the changes in different suburban morphologies within Melbourne to investigate the efficacy of planning provisions in open space design, development and management in shaping and responding to infill development. Early findings suggest that changes to public and private open space as a result of greater infill development occur in isolation from each other whereas in combination they shape environmental health and benefits for city residents. It is also apparent that what constitutes adequate provisioning of private and public open space in Australia is contested, particularly as the significant changes occurring in the built form are not necessarily in accordance with state and local government strategies.

As well as adding to understanding of contestation over urban space, this research is also designed to be of practical value and future focused, providing additional data about suburban open space distribution, and detailing the multilevel requirements of future open space provision and management in Australian suburbs.

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