Visions 2040

Results from the first year of Visions and Pathways 2040:

Glimpses of the future and critical uncertainties

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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University of New South Wales
Swinburne University
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Acknowlegement
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 www.lowcarbonlivingcrc.com.au

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Cover image credit: © Simon Cookes, VEIL, 2014

This report can be cited as:
Ryan, C., Twomey, P., Gaziulusoy, A. I., & McGrail, S. (2015). *Visions 2040 - Results from the first year of Visions and Pathways 2040: Glimses of the future and critical uncertainties*. Melbourne, Australia.

ISBN 978 0 7340 5108 0

Contents

1. What is Visions and Pathways 2040?

Visions and Pathways 2040 (VP2040) is a research and engagement program which seeks to explore and articulate visions and innovation pathways for thriving Australian cities that are low-carbon and resilient, adaptable in the context of change and robust under the physical and social challenges predicted with a changing climate. The program involves three universities (University of Melbourne, University of NSW and Swinburne) and nine government and industry partners. VP2040 has been funded as a four-year project by the Cooperative Research Centre for Low Carbon Living (CRC LCL) which is a seven-year, fifty-partner research institution with a broad and challenging charter to significantly reduce the contribution of the built environment to Australia's greenhouse gas production.

As with other CRC LCL projects, VP2040 is about understanding the trajectory of urban development and intervening to change it, focusing on city-scale change. The project seeks to envision some of the forms Australian cities and lifestyles might take in 2040 if they have achieved an 80% reduction in their greenhouse gas contribution and have addressed vulnerabilities that arise with changing climate and extreme weather events. These projections will be used to consider the policy, investment and further research that could bring them about.

VP2040 is not about predicting what ***will*** happen but rather creating visions of what ***could*** happen if we as a society work together to achieve change. For this reason, VP2040 is a coordinated research ***and*** engagement project aiming to produce visions and scenarios that describe plausible futures. VP2040 involves transdisciplinary, solutions-orientated research. The project uses a co-creation process intended to build commitment to the exploration of transformed cities that deviate from development-as-usual expectations. The communication of future visions is seen as an important part of stimulating an interest in innovation (technical and social) that could contribute to change. VP2040 brings research into a process of extensive engagement and open collaboration to address the multidisciplinary dimensions of cities and urban life and to build consensus about what kind of future cities we really want.

Cities as a nexus of change

It is not surprising that this flagship project of the CRC LCL has a focus on ***cities***. The city brings together the major strands of the CRC research agenda: buildings, precincts and communities. Cities involve complex and dynamic interactions between built and urban form, technology, social and cultural behaviour, and systems of provision (principally shelter, energy, water, food, transport, waste and information). These interactions can create vulnerabilities when environmental, climatic, economic or resource conditions deviate significantly from historical patterns.

Australian cities have complex embedded dependencies on very large flows of resources including oil and other fossil fuels. The cities' forms and metabolisms have been shaped by historical patterns of weather: prevailing summer and winter temperatures, rainfall, wind and storms. Most Australian cities lie close to the coast and are therefore vulnerable to sea-level rise and storm surges, particularly for buildings, roads and other transport systems and drainage (storm water). Transitioning to a low-carbon future (reducing energy consumption, switching to renewable energy ***and*** sequestering existing atmospheric CO_2) while reducing vulnerabilities to new weather patterns is a challenging task which will require continuous technological and social innovation.

In our urbanised world, cities play a critical role in the innovation system. Although occupying less than 2% of the world's landmass, cities have become the engines of the economy, at least in the industrial 'north'. In Australia, as in other nations, cities account for a disproportionate amount of GDP. For example, Melbourne and Sydney each generate around 75% of their state's economic output (SGS Economics and Planning 2014). Cities' contribution to innovation is increasingly understood to be a function of their liveability and the density and diversity of the social interactions that result from their built form and culture. The transformation of a city has to simultaneously improve its inhabitants' quality of life, amplify the conditions for social creativity and innovation, and enhance ecosystem services. The challenges facing us today require nothing less than a reconceptualisation of the city in all its dimensions. VP2040 aims to contribute to that reconceptualisation and to provide government, business and civil society with an understanding of possible pathways for policy, research, innovation, investment, technology, social organisation, professional and cultural practices and education. Much of our work will, of necessity, be directed to the transformation of the existing fabric – the retrofitting – of the city.

VP2040 also aims to identify productive areas for experimentation – labelled 'living laboratories' by the CRC LCL and the international research community – recognising that complex social interactions are best understood by testing new system arrangements in practice.

Project objectives

The VP2040 research team aims to:

- track current research, industry and policy intelligence, coordinate with other international foresight and backcasting projects
- identify emerging technological and social innovations, particularly those that are seen as having the potential to be disruptive forces
- collaboratively develop and refine a set of visions and scenarios for low-carbon resilient cities, to define a set of shared possible futures for four southern Australian cities
- translate those scenarios into communicable visions of future life that can be understood across all the CRC sectors including the general public
- backcast from the shared 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 CRC 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, providing an important additional knowledge stream to complement and enhance their existing processes of strategic intelligence
- 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, relevant to realising those futures
- to bring together the technical, economic and social aspects of low-carbon living to help build the network of CRC participants, uncover and explore key interrelationships and uncertainties across CRC 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
- to identify new socio-technical systems potentialities that could constitute the basis for so-called living laboratory experiments.

Collaborative research and engagement

Central to VP2040's methodology is a multi-stakeholder dialogue that brings together people from business, civil society, government and research to work collaboratively towards a better understanding of low-carbon living, resilience, sustainable cities, lifestyles and sustainable prosperity. To this end, the project follows the principles of participatory action-research, a methodology where ongoing steps in the project are shaped in response to findings of workshops and stakeholder/partner engagements.

An international scientific committee has been established consisting of globally prominent experts in fields relevant to the VP2040 project (see page 50). Interest in the structure and methodology of VP2040 led to the formation of a parallel project supported by some members of the VP2040 scientific committee, with support from Copenhagen, Malmo, Helsinki and Rotterdam. This project failed to gain final funding in 2014 but it is expected that a new application will emerge in 2015.

In Australia a recursive series of workshops is to be held over the first three years of the project, in Sydney, Melbourne, Adelaide and Perth. These workshops will involve the CRC partners, representatives of the research, business and government sectors, relevant professional bodies and the general public. They will use various approaches to public engagement, scenario generation and planning, visualisation, backcasting and roadmapping. Three workshops in Melbourne and Sydney were held early in 2014; they involved 103 people (see Appendix II). The scope of the community of engagement will be extended as the project continues. A series of expert workshops to refine the thinking about disruptive forces and the dynamics of change and, further, to review early scenario proposals, will inform future visioning workshops and the scenario formation process.

Project process to date

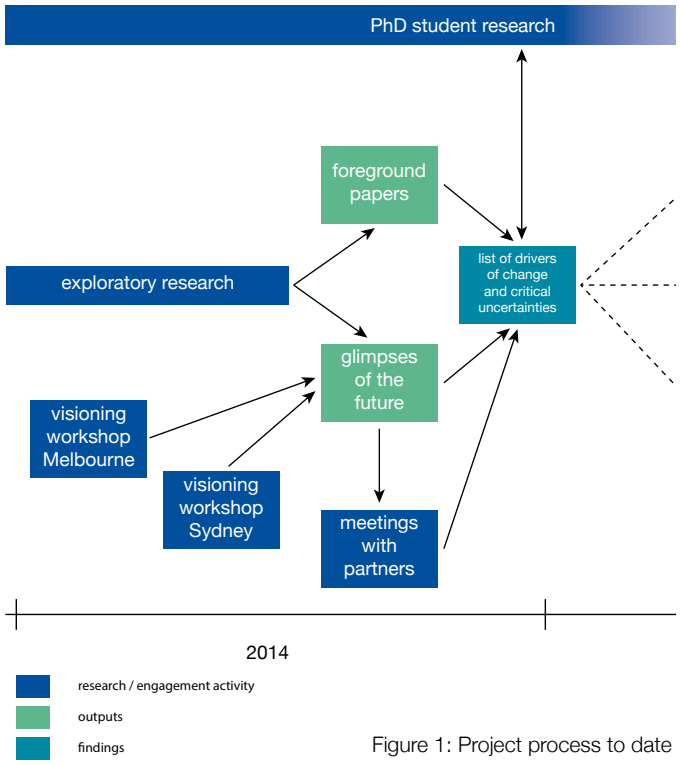


Figure 1: Project process to date

Visions and Pathways 2040 commenced with broad exploratory research relevant to the transformation of cities. Analysis and understanding of historical changes in socio-technical systems are well developed, and theories of significant transitions and the operation of innovation systems are well established. Much needs to be done on the application of those theories to the transformation of cities or the urban condition: this is a key research focus for the project. A parallel research issue is developing an understanding of the drivers for change relevant to the coming 25 years, and of their possible trajectories over those years. There is a continuing, wide-ranging review of potential changes across domains relevant to cities (in the context of climate change), including: social and technological developments; new energy technologies and systems; new governance and business models; the role of cities as agents of change; and existing process of planning (or roadmaps) for low-to-zero carbon economies. Research has also aimed to situate VP2040 in the global field of futures enquiry and other international projects exploring urban futures using similar methodologies (see Box 1). This exploratory research is presented in foreground papers published regularly on the VP2040 website and summarised in Section 2.

Three visioning workshops, two in Melbourne and one in Sydney, were conducted in parallel with the exploratory research. The deliberations (and debate) of these workshops became a brief for design charrettes, involving local designers who were present as listeners. Those charrettes produced images and narratives – 'glimpses' – of possible low-carbon and resilient (2040) futures, some as generic imaginaries and others strongly rooted in Melbourne or Sydney. The creation of these glimpses in parallel with the research, and ***before*** future scenarios are developed, expresses the project's commitment to engagement and to a participatory process. While the glimpses helped build a constituency of interest in non-business-as-usual futures, they have also been used to ground the research on drivers and trajectories for change. The complexity of the systems that support the the city and urban living – interconnected physical-technical-social-cultural systems – means that research has to be truly multidisciplinary and as open as possible to the lived experience and current social and cultural values of urban citizens.

The glimpses produced at the initial vision workshops have been used as dialogic objects in meetings with project partners and at other events. The partner meetings had three main purposes. First, as this is a partner-led project (within the CRC LCL), feedback from partners at this stage is of strategic importance in shaping the VP2040 research. Second, partners were invited to use the glimpses in their own strategic planning and with clients, to start conversations around innovations for low-carbon resilient futures. Third, circulating the glimpses to a wider audience is an opportunity to feature future innovations that may be of strategic importance to partners.

Three PhD students started their candidature in the three universities collaborating in this project. Their projects focus on enabling more distributed forms of low- and zero- carbon energy generation in cities; the role of open space in suburban areas; and new urban redevelopment models for achieving greater residential density (see Box 2).

The exploratory research, the visioning workshops and the partner meetings have led to a synthesis of important drivers of change and some preliminary scenario dimensions. These are presented in Section 4.

Box 1. International projects using visioning processes to explore urban futures

Around the world, increasing attention is being paid to possibilities for cracking open the transformation necessary for low-carbon and resilient urban living through co-developing future visions and pathways. A mix of projects emerging in the EU, Canada and the USA are using collaborative and creative 'visioning' processes to explore urban futures in a climate change constrained world. Examples are:

RETROFIT 2050 (http://www.retrofit2050.org.uk/)

The Retrofit 2050 project aimed to 'deliver a step change in current knowledge and capacity for urban sustainability' and identify ways to increase the scale and effectiveness of retrofitting. The project focused on UK city-regions. Retrofitting is defined as the process of re-engineering existing cities to enable societal responses to climate change and resource constraints. The project viewed a city as a 'complex adaptive system' and drew on critiques of traditional planning processes. The methodology included expert workshops to develop three 'generic' 2050 visions and concurrent 'foresight' activities focused on identifying potential disruptive and sustaining technologies in three domains – energy, water, and waste.

MUSIC (http://www.themusicproject.eu)

The MUSIC project aims to reduce carbon dioxide emissions in five cities by 50% by 2030. It is a collaborative project involving five cities (Aberdeen, Montreuil, Gent, Ludwigsburg, Rotterdam) and two research institutes in Northwest Europe. The project is using and testing transition management tools in urban contexts. Its methodology includes analysing the system, envisioning, analysis of future pathways, experiments (connected to societal challenge and longer-term vision), and assessment and monitoring. It draws on complex systems theory and models of reflexive governance.

VISIONS 2030 (http://www.visions2030.org.uk/)

The VISIONS 2030 project builds on a growing recognition that walking and cycling can make a considerable contribution to sustainable transport goals, public health and the sociability of communities. The project aims to assess the potential in four UK cities for achieving substantial increases in walking and cycling by 2030, and to generate pathways with input from a range of participatory tools and in consultation with local walking and cycling groups.

CRISP (http://crisp-futures.eu)

The CRISP project sought to identify potential pathways that will help in the transition to a sustainable, low-carbon Europe. The project used a transition-management theoretical framework and a visioning-backcasting methodological framework. The distinguishing characteristic of CRISP was the involvement and participation of school students, as well as experts and individuals, companies and governments.

SPREAD (http://www.sustainable-lifestyles.eu/)

The aim of the SPREAD Sustainable Lifestyles project was to engage societal stakeholders from business, research, policy and civil society in the development of a vision for sustainable lifestyles in 2050 and to produce a roadmap for strategic action for policy makers to enable sustainable lifestyles in Europe. Background research was carried out on critical lifestyle impacts and the barriers/drivers impeding and encouraging more sustainable lifestyles. Research findings were consolidated to create a shared vision for 2050, four scenarios to explore extreme prototypical futures supporting sustainable lifestyles, and pathways to overcome challenges and realise opportunities.

Post-Car(d) Urbanism (http://www.postcardurbanism.net)

Post-Car(d) Urbanism explores the future of mobility and transport in Swedish cities. The project is trialling online scenario planning systems. It is the first time large-scale crowd-sourcing platforms have been used in Sweden to explore future policy issues.

Box 2: VP2040 PhD Research

Three PhD students are conducting research that is funded by, and feeds into, the VP2040 project. One student is based at each partner university: Che T Biggs at University of Melbourne, Jennifer Witheridge at Swinburne University of Technology and David Bennett at University of NSW.

Disruptive Innovation from the Bottom-up: Institutional Entrepreneurs Enabling Distributed Energy (Che T Biggs):

A growing number of organisations are attempting to shape the economic and social landscape in which distributed energy can better diffuse. However, little is currently known about the strategies used by these institutional change agents or how these actors may affect the trajectory of innovation in the energy sector and within cities. This study examines Australian cases to explore the strategies of intervention that are used, the conditions shaping those strategies and the untapped opportunities for supporting distributed energy. It will identify:

- Which strategies are effective at addressing innovation system (IS) weaknesses and in what contexts
- Where institutional entrepreneurs or policymakers must address IS weaknesses and what may prevent this, and
- How strategies are aligned to different possible trajectories of innovation.

Contested Space: Future Challenges and Pathways for Open Space in Australian Suburbs (Jennifer Witheridge):

In addition to being a basic requirement of city living, high quality open space can also provide and support environmental benefits such as mitigating the urban heat island effect. However, regulation and management of these spaces is complex and often fragmented, which can lead to suboptimal developments of open space and the green infrastructure it supports. In order to better understand these issues and how they can be better addressed, this PhD will investigate: historical forces that have shaped the configuration, provision and management of open space in Melbourne; drivers and barriers to suburban open space provision in its use, quality, functionality, and management practices; and broader socio-technical/ecological factors that will need to underpin the institutional practices of future open space provision and management in Australian suburbs. Additionally, this research project will:

- Be future focused, identifying key ways open space can be managed, configured and optimised for higher density living
- Identify opportunities for collaborative open space management and development by identifying underutilised open space, and discussing flexible management practices to optimise their use
- Provide additional data to policy developers and built environment practitioners, and
- Contribute to research on Australian suburbs and open space.

Shaping Suburbia: The Form and Future of our Suburbs (David Bennett):

Currently in existing urban settlements increases in residential density are usually attempted via development bonuses. This approach typically results in either high-rise development (which often has associated issues of lower market acceptance, cultural issues and poor carbon performance) or no development at all. This PhD project aims to determine how our existing low-density suburbs can evolve via unconventional development models and thereby: play a more significant part in our cities' growth; increase citizens' incidental activity; reduce per-citizen ecological footprint; and create living communities with low carbon intensity. A core research objective is to empirically study and highlight the connections between 'settlement patterns' (i.e. the built environment) and 'behaviour patterns' (including the way we get around and walkability metrics). This research aims to provide data that helps to legitimise a new approach to city-making and walkable, low-carbon, connected communities.

2. Exploring the VP2040 research territory: Disruptive innovation and system change

Cities, systems and targets for transformation

The scale and timeframe for the decarbonisation of global economies is in an almost constant state of flux, though many national and city plans have binding (not aspirational) targets for reductions in greenhouse gases in the order of 80% over the next 25 years. Australian targets beyond 2020 are still to be negotiated and there is currently no national plan for cuts of the scale proposed by leading countries and cities elsewhere. VP2040 explores the possibilities for Australian cities to meet targets in line with international practice. Research carried out for the project has surveyed 60 cities to gauge their commitments to decarbonisation. This data has been used in setting the VP2040 targets.

There is a slowly emerging recognition in Australia of the need to address the vulnerabilities of urban settlements and conurbations to changes in the climate, to shifting weather patterns and extreme events. Planning for climate resilience is not far advanced in Australia, having been treated as less critical than disaster management (Biggs, Ryan et al 2014; Biggs, Ryan & Wiseman 2010). However, both Melbourne and Sydney have been chosen as members of the Rockefeller Foundation's 100 Resilient Cities program. VP2040 places great importance on the reconfiguration of cities and urban living to build adaptive capacity or resilience.

Creswick Resilince Centre (future vision) © Diana Pardo, VEIL, 2013

Cities have a number of interconnected ***systems of provision*** essential to their functioning. Following previous VEIL projects, the VP2040 project identifies eight systems:

- buildings and open space
- products and services
- energy
- water
- food
- transport
- information
- waste.

In every city, these systems develop patterns of production and consumption appropriate to local conditions (including climate) and available resources (including energy sources); they evolve with the city's social, political and judicial structures and forms of governance and they help shape the urban form of the city. In this way material and resource commitments become embedded in the physical infrastructure of the urban realm. However, cities are also cultural and social artefacts. Behaviours, social practices, values, lifestyles, notions of prosperity and ideas of progress are entwined with, and reproduced through, the built structures and form of the city.

In developing visions and scenarios for transformative change, the project has considered the inertia or 'lock-in' of the existing urban domain as having ***socio-cultural-physical-technical*** dimensions (Ryan 2013).

Disruptive systems change

To meet VP2040's challenging target of 80% reduction in emissions by 2040, it will be necessary to look for processes of transformation that are disruptive, that is to say processes capable of shifting the trajectory of development in rapid, nonlinear ways. In common with other CRC LCL projects, VP2040 aims to understand social, technical and behavioural changes that could have really significant impacts on cities' greenhouse gas emissions. Given the complex nature of the city, and the systemic challenges implied by decarbonisation and building resilience, it is important to look for disruptive forces that could have ***systems-wide*** effects, that is, 'innovations that are directed to redesigning entire systems of practices and provision, instead of individual products or processes' (Sterrenberg et al. 2013, p. 9). Focusing on the design of the entire system potentially leads to much greater sustainability gains than can be achieved from single product or process innovations such as have been the focus of traditional eco-design (Brezet & van Hemel 1997; Ryan 2003, 2004).

To understand these potential systems-changing forces, the VP2040 research program will regularly publish foreground papers and reports commissioned to explore different domains of disruptive change. These will form the basis for the research, scenario-formation and engagement processes to consider how different systems of provision may be radically reconfigured between now and 2040. Recognising the importance of the institutions, regulations, social norms, networks and physical infrastructures that enable and constrain our (un)sustainable behaviours, these papers and reports will examine technological innovations, social and (infra)structural innovations, organisational shifts in business, changes in community values, culture and individual behaviour. Learning from social practices theory, the project will avoid reliance on simple, linear, rational and individualised conceptions of human attitudes, behaviours and actions, as employed in some behavioural economics approaches to sustainability (Doyle & Davies 2013).

The first six foreground papers have been completed and published on the project web-site, with more soon to be completed.

Understanding processes of transformation and transition

VP2040 research is framed by an understanding of real-world processes of transformative change. Along with the research papers on potential disruptive forces the project has published *Review of Systems Innovation and Transition Theory* (Twomey & Gaziulusoy 2014), which considers the relevance to urban/city transitions of socio-technical transition theory and transition management and innovations theory.

The power of visualised futures

In both its research and its engagement processes the project builds on other Australian and European projects that seek to envision future urban conditions and to ***backcast*** from some consensus of future possibilities (see Box 1). The lead institution for VP2040, the Victorian Eco-Innovation Lab (VEIL) at the University of Melbourne has a long record of envisaging future urban conditions and modelling changes to systems of provision that can contribute to decarbonisation and resilience. VEIL has refined processes for engagement based on the visualisation of possible future conditions and has developed international connections with other ***designing the future*** projects, including a number of the projects listed in Box 1 (DESIS 2013; Ryan 2013; Vergragt & Quist 2011). With an emphasis on visions of non-business-as-usual futures VEIL , in common with its international collaborators, uses visions (often just glimpses of future possibilities) to widen engagement with relevant sections of the community. The process of generating visions – and the visions themselves – can be considered as a feedback loop within the multi-level ***transitions theory*** model, highlighting tensions at the socio-technical landscape level, portraying alternative (future) regimes in operation and defining potential new areas for innovation at the niche level (Ryan 2013).

Visions of possible futures are a way of opening up alternative discourses on the nature, culture and dynamics of city development and planning, to break from existing institutionalised discourses that underpin regimes of planning and urban design (Hajer 1995; Hajer & Dassen, 2014).

Potential disruptive forces and the transformation of cities: Summaries from VP2040 foreground papers

VP2040 foreground papers serve a number of functions in the project:

1. They provide an overview of important emerging disruptive forces which will be explored in later stages of the project and which are relevant to project partners
2. They identify important gaps in knowledge and related built environment issues that the VP2040 project can help to address in order to advance decarbonisation of the built environment in Australia
3. They identify a range of transition strategies, plans, and related frameworks which will inform the ***pathways*** component of the VP2040 project.

Emerging approaches in business model innovation relevant to sustainability and low-carbon transitions (Gaziulusoy & Twomey 2014): Businesses are critical actors in transitions to low-carbon and resilient cities. They can be a powerful source of innovative ideas, not only for reducing pollution and improving the efficiency of products and services, but also in shaping fundamental structural changes in markets and systems of production and consumption. In this foreground paper the authors review new and emerging business models that might play a critical role in the transition to sustainability and low-carbon futures. These include ideas such as: product service systems where the consumer pays for the services provided by a product rather than buying the product itself; open innovation where a company cooperates with other organisations or people to generate new ideas and commercialise them; peer-to-peer innovations based on cooperation among loosely connected, widely distributed networks of individuals through sharing open-source resources and distributed production capabilities. They also look at the interesting potential of crowd-funding, the sharing economy, and social enterprises and new technological models such as 3D manufacturing. We expect the latter sphere of innovation in new 'distributed' manufacturing systems to be the subject of a later paper.

Disruptive social innovation for a low-carbon world (Alexander 2014): Another source of disruptive change derives from innovations in the socio-cultural domain. Cities are a socio-cultural invention and the dynamics of social and cultural values, rituals, practices, aspirations and desires play roles in making urban life and urban identity as well as in shaping built structures and urban forms. Socio-cultural changes may have special disruptive potential. Changes in other spheres of innovation can be disruptive as tools or means; socio-cultural changes can be disruptive as goals or ends. When cultural and social shifts in values and practices, connected to goals and ends consistent with low-carbon living, take place, then innovations in tools or means (in technology, legislation, policy and so on) may follow. The paper reviews a number of emerging movements and social innovations that could profoundly influence trajectories of development toward a low-carbon – and resilient – world. These include: community-based transition movements (such as Transition Towns) directed at building an alternative low energy non fossil-fuel society; fossil fuel divestment campaigns that already have tangible impacts on various institutional investment portfolios; collaborative consumption and sharing, with the use of online forums and technologies to offer or acquire access to things by sharing, hiring, or gifting them in more or less informal ways; innovative approaches to renewable energy based on crowd-funding and socially directed finance instruments; reconstructing food systems from localised action; the 'voluntary simplicity' movement; re-imagining the good life by redefining 'progress' through alternative indicators to GDP.

Using futures inquiry to create low-carbon, resilient urban futures (McGrail & Gaziulusoy 2014): This paper reviews recent trends in futures inquiry and advances in related theory, and five projects similar to VP2040. These projects all support the development of visioning and backcasting approaches developed to address value-laden, complex and uncertain sustainability issues and ways in which 'experiential' futures activities can deepen stakeholder and public engagement. Overall, the major findings of this review support many of the methodological choices made in the VP2040 project. The paper also points to further opportunities for using scenario and other techniques in urban and organisational planning to help enable resilient urban futures.

A review of roadmaps for transitioning to a zero carbon built environment in Australia (McGrail 2014): This paper critically reviews and maps 13 roadmaps that have been produced by peak industry bodies, academic research groups, private consultancies, and non-profit research groups. The review demonstrates that existing roadmaps fail to adequately consider the interaction of changes in: urban form and design; technical innovation (and related use of new urban technologies); and individual attitudes and behaviours. Typically, only one aspect is the focus (e.g. adoption of new technologies for localised renewable energy production). Additionally, roadmaps often inadequately recognise that decarbonisation of the built environment will involve multiple sectors (including energy, construction, design, transport and telecommunications) and the interaction of developments in these sectors. Most roadmaps focus on a single sector or consider the sectors separately. The review points to the need to better answer the question 'How can we get there?' (along with the other two key roadmap questions, 'Where do we want to go?' and 'Where are we now?'). The pathways component of the VP2040 project will help to fill this significant gap. Additionally, VP2040 research will further examine the complex connections between urban forms, technologies and behavioural patterns.

Pathways to a zero-carbon economy (Wiseman 2014): This paper discusses VP2040 in the context of national strategies elsewhere, with an overview of key features of the most promising and innovative large-scale low-carbon economy transition plans and strategies. It draws on Melbourne Sustainable Society Institute's *Post Carbon Pathways* project which has reviewed a range of ambitious large-scale decarbonisation strategies, augmented by in-depth interviews with leading climate and energy transition researchers and policy makers. The paper discusses strategies authored by governments, including those of the EU, UK, Wales, Scotland, Denmark, California and Germany, designed to achieve 2050 emissions reduction targets of between 80 and 100%. It also discusses strategies developed by non-government research organisations in the UK, Germany, Norway, Australia and the US that demonstrate the technological feasibility of achieving close to 100% emissions reduction in the period 2020–2050.

Cities as agents and catalysts of action on climate change (Kautto & Ryan 2015): The role of cities in the transition to a low-carbon economy is increasingly recognised around the world. The Intergovernmental Panel on Climate Change has called for an 80% reduction in GHGs by 2050 to limit the warming to 2ºC degrees. While international climate change negotiations on this 2ºC target have appeared to stall, leaders of local governments and city communities around the world have been taking action. This is demonstrated, amongst other things, by a number of city-level networks, alliances and initiatives that have committed to voluntarily curb emissions within municipal boundaries. Examples include C40 Cities Climate Leadership Group, ICLEI – Local Governments for Sustainability, World Mayors Council on Climate Change and the Covenant of Mayors. A review of targets and action for a range of cities around the world provides the basis for setting the target adopted for VP2040. That review also suggests that, even though cities (and towns) typically lack the necessary geopolitical or legal status to be recognised in global negotiations on climate change, they are nevertheless taking a (sometimes significant) role in planning and implementing programs of carbon reduction and resilience. Cities are achieving de-facto recognition as agents of change. Given the disproportionate contribution of cities to the problem of climate change on the one hand and to the generation of innovation and GDP on the other, there is increasing attention to their disruptive role and potential to shape the transition to a post-carbon economy.

New energy systems and markets: Energy technology and storage, energy efficiency and distributed production (Dargaville 2015): The world's energy system is in the early stages of a revolution. Penetration of renewable technologies such as wind and solar PV have gone from tiny 10 years ago to substantial today, and growth rates are increasing. Initiatives are bringing forward deployment of renewables, and in some cases renewables are cost effective against incumbent fossil-fuel technologies without any subsidies. The costs, especially of PV, have come down dramatically, faster than many people expected, and the concept of grid parity – where it is cheaper to generate your own power than to purchase it from the grid – is beginning to be seriously discussed and has even occurred in some locations. Projecting or predicting which way the energy system will go is extremely difficult. Distributed technologies and storage, carbon capture , large-scale concentrating solar thermal or PV arrays; the choices depend on both the cost pathways of the technologies and policy landscapes which may favour some technologies over others. Much of the electricity generation mix in Australia is getting very old. The weighted average age of the black coal fleet is 29 years, and for the brown coal fleet the average is 34 years. Demand has been decreasing since 2009 at a rate of around 2% per year. There is little incentive (beyond the Renewable Energy Target) to build new generation. The path that is taken will have very significant impacts on the urban landscape.

Potential forthcoming and anticipated papers: Distributed manufacturing innovations (3D printing or additive manufacturing); Smart or sensate cities – the extension of data streams towards the city as an internet of things; The dynamics of urban density and form; Changing cultures of open and public space; The greening of cities and its contribution to physical and cultural ecosystem services; Transport and mobility systems; Water and cities; Waste and the circular economy.

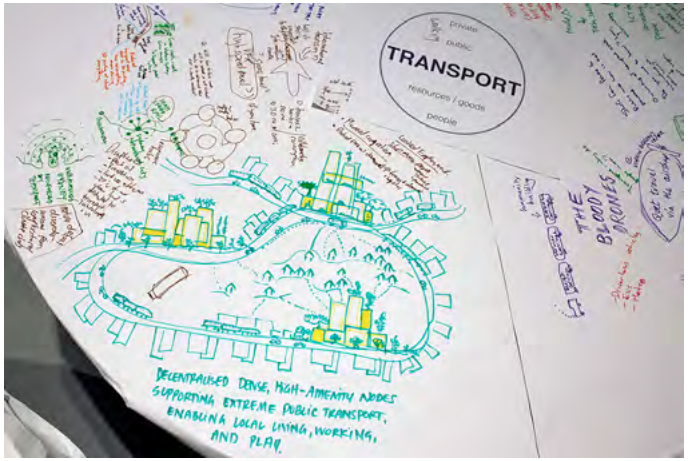
3. Early VP2040 visions of low-carbon resilient futures

The two foundation workshops for VP2040, conducted in Melbourne and Sydney, aimed to generate initial glimpses of the shape and life of future cities in Australia – glimpses that deviate significantly from the current curve of development. Participants were encouraged to approach the future accepting uncertainty, valuing novel and radical ideas, and giving rein to intuition, creativity, emotional experience and tacit and explicit knowledge.

At the workshops 103 individuals representing industry, government, civil society and research institutions were invited to imagine daily life in a 2040 city, assuming deep emissions cuts had been successfully achieved. They were asked to go into some detail regarding businesses, communications systems, social and cultural activities, buildings and public spaces, transport and mobility. Some of their thinking is caught in a short film, which is available at: http://www.visionsandpathways.com/about/vp2040-video/ . These glimpses, the discussions and feedback in the vision workshops and the exploratory research carried out in the early phases of the project, have enabled us to more clearly define some of the emerging disruptive innovations that could assist a transition to low-carbon resilient futures and have helped to identify drivers of change and critical uncertainties associated with those innovations.

The resulting round table discussions were observed by designers appointed by VP2040, who took the table ideas as working briefs for a set of 'glimpses' of low-carbon urban environments in 2040. These glimpses were to be fleshed out at three scales: life as experienced by a resident; the nature and form of a community/precinct/suburb; and city-wide infrastructure and connections to regional, state and national systems. Participants returned for a second workshop around a week later to see and hear what the designers had produced. This second workshop was structured as a focus group session, where the designed concepts were interrogated and debated in small groups. The aim was to consider what futures were possible and plausible rather than probable, as plausibility invites further inquiry, especially of discontinuities which can challenge the status quo, whereas probability narrows attention down to a focus on what is perceived as a potential outcome of already unfolding events.

On the following pages are some of the glimpses that resulted from these visioning workshops.



Individuals, households, buildings, products and services

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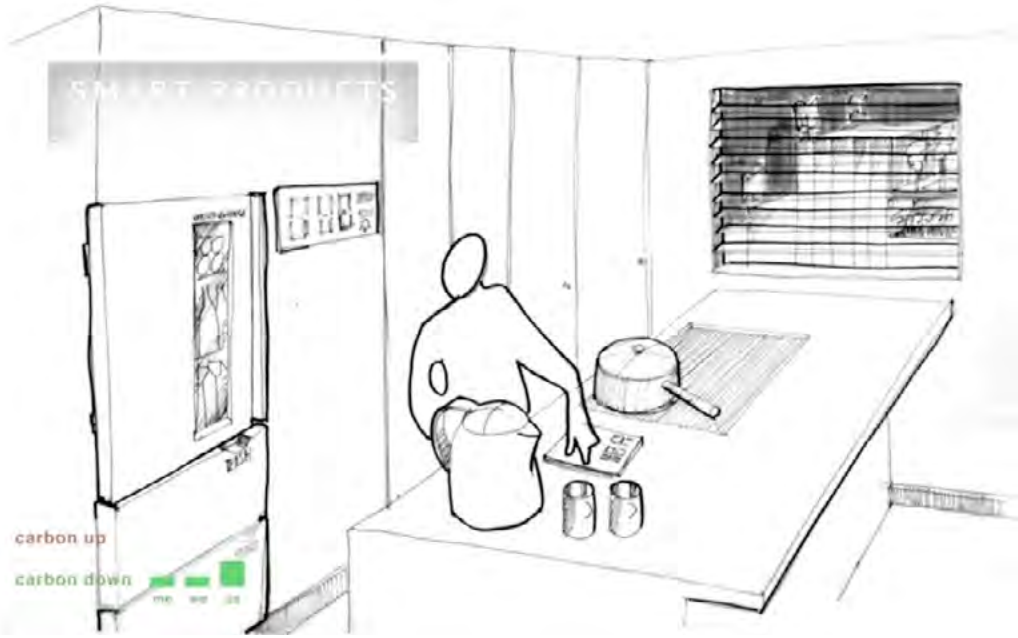
Smart household appliances have become mainstream by 2040. This kettle knows that as only one person requires a beverage it should only heat 250ml of water, resulting in reduced energy consumption.



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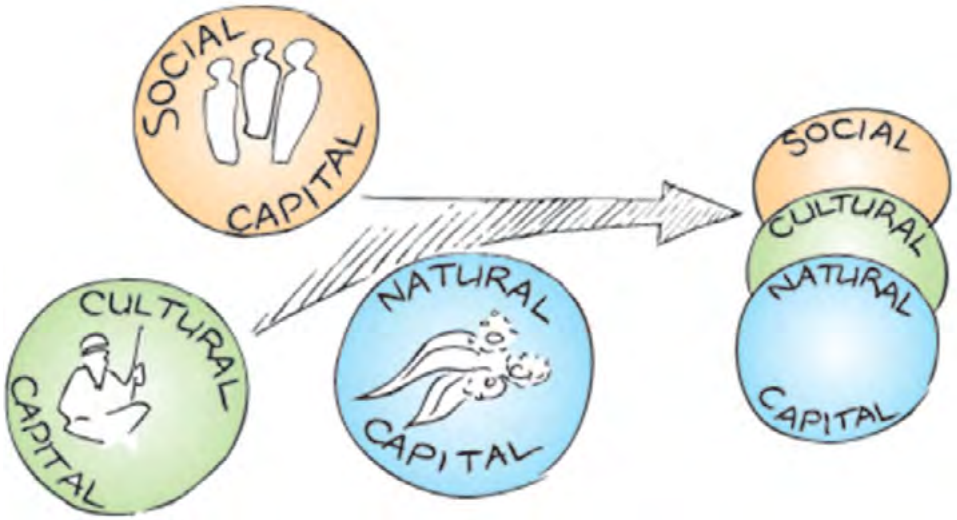
Smart kitchen products are energy efficient, provide on-demand hot water, grey water capture and reuse, bio-degradable packaging, and manufacturers are accountable for the end-of-life of all products.



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In 2040, Australian society's focus is broadened from a sole emphasis on 'economic capital' to seeing social, cultural and natural capitals as equally important.

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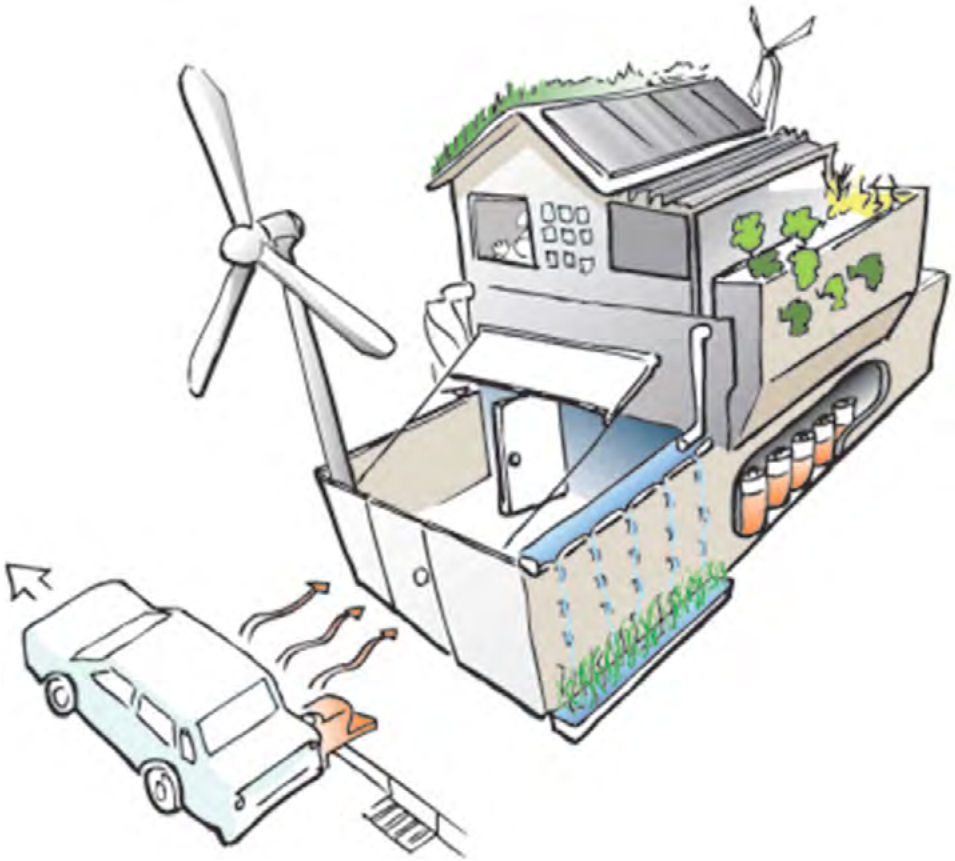
In 2040, a Melbourne resident checks her and her community's 'contribution index' using her smart wrist-band. As currently existing wrist-bands monitor the wearers' fitness, the 'contribution index' wrist-band gives the woman an up-to-date reading of her personal contribution to the city as well as that of her community. Contributions could be measured in terms of energy generation, water consumption, participation in recycling or perhaps contribution to caring for other community members. Her community could be a social network or the residents of her neighbourhood.



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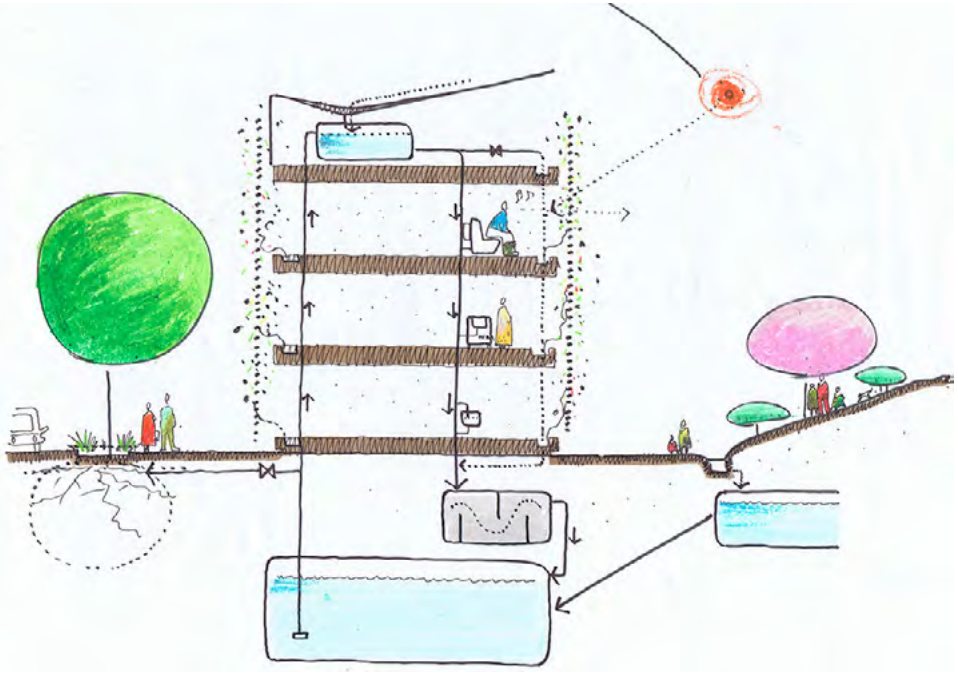
This residential home in 2040 generates its own energy from wind and solar. The house harvests rainwater and uses blinds and a 'green roof' to regulate its temperature. The residential vehicle is electric.



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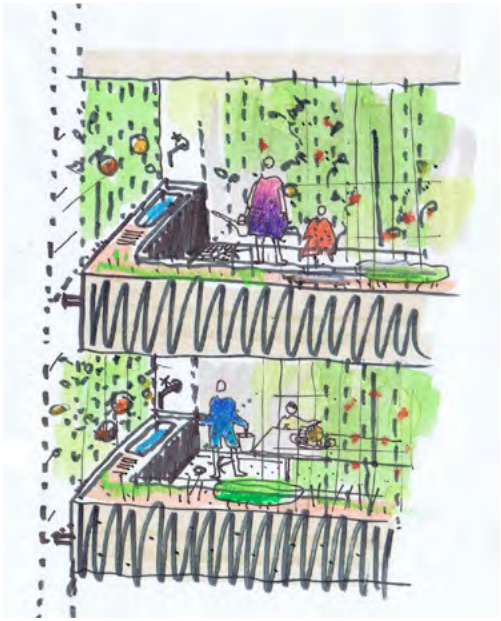
In 2040, buildings are parts of highly efficient cyclic systems. Stormwater is collected and stored under buildings, parks and kerbs. Stored water is used as thermal storage. The top of the building captures water, light and energy. Nutrients are reclaimed from human waste with high-tech composting toilets.



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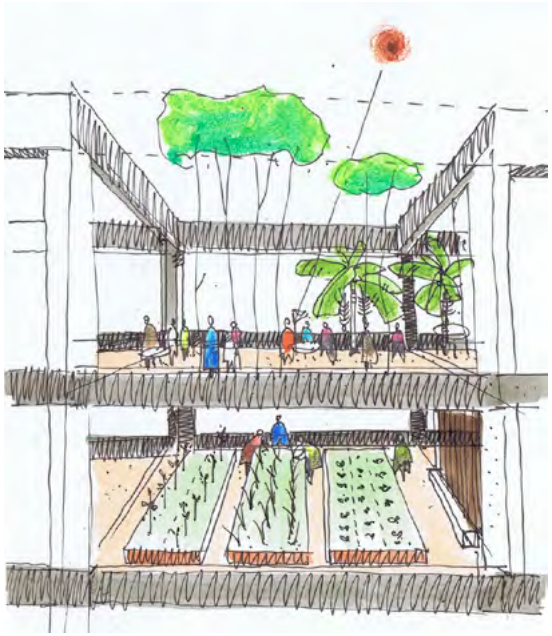
In 2040, living and manufactured elements are effectively combined to make buildings self-sustaining systems. This building is a shade structure with a vegetation 'skin' which reduces energy consumption and heat-island effect. Buildings are used as gardens and for producing food.



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By 2040, some buildings in Melbourne have been abandoned due to heat and their excessive running costs during climate extremes. These buildings are being repurposed as urban greenhouses.

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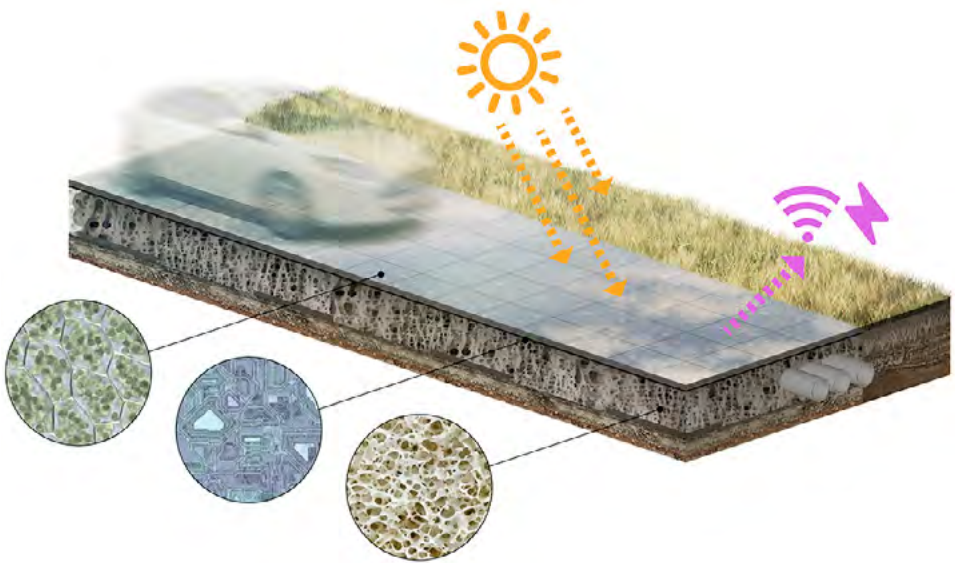
The radical concept of 'burrowing' and building houses underground is becoming mainstream in 2040 to escape extremes of heat and bushfires on the urban fringe. The entrance of this Melbourne house is a stairwell going underground. The backyard is now the 'top yard', and is used for recreation, food production and natural habitats. This provides protection, a decrease in energy costs and a greater connection with the natural environment.



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The nation-wide Living Roads project which was initiated in 2030 has invested in building smart Living Roads in our cities. By 2040, most suburban roads have been upgraded from asphalt to Living Road. At its simplest level, a Living Road takes in sunlight and uses the energy to power a hi-speed Wi-Fi network and provide electricity for homes. The Living Road comprises a number of different layers and is a hybridization of biological and technological systems. Once it is 'grown', the Living Road is handed over to the community who maintain and look after it.

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In 2040, the sharing economy and maker culture have become mainstream. With the help of smart technologies, redundant postboxes have been converted to book and toy exchange hubs. Each community shares a 3D printer. Members of communities can monitor individual and community carbon footprint at any time through any screen that is connected to the Internet.

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Cycling takes priority in this streetscape of Melbourne 2040. Bicycle lanes are widened to encompass the road and, while cars still exist, they are considered a form of public transport. They are smaller, solar powered and communally used. Food is grown in garden beds to reduce 'food miles' and trams continues to be integral to the city's transport.

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In 2040 personal mobility needs in urban areas are mostly met by public transport and cycling. This image shows an elevated cycling highway next to a Melbourne train station. Drones play an important role in the mobility system by delivering and distributing post and other small goods with high energy and time efficiency.

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In 2040, suburbs of Sydney are no longer just a myriad of introverted cul-de-sacs. They are strongly inter-connected with pedestrian-oriented streets that promote a community-based culture. Streets and areas within our suburbs are differentiated with more shared ways for people, bicycles and shared-vehicles which are clearly differentiated from those for through-transport. This series of images display the evolution of these micro-communities which are all self-sufficient with regards to energy, food and water. The white lines depict those roads which are allocated exclusively to shared cars, bicycles and pedestrians and reconnect all cul-de-sacs. The red lines depict main roads and yellow dotted lines depict local hubs.

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Real-time energy usage and carbon footprint monitoring for each community is freely available to everyone. People can read their community's energy and carbon performance as well as that of their neighbours. Feedback and learning new ways to be more energy and carbon efficient, as well as having pride in the ecological performance of one's community, is a standard part of mainstream culture.

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In the suburban micro-communities of Sydney in 2040, a sharing and exchange culture is enabled by information technology. It includes features such as online brokering services where people can list and exchange needs, skills and capacities. Sustainable options for any situation are available from 'Low Carbon' Broker Apps which help minimise community carbon use. People post requests, such as calls for help moving furniture across the city, to which other community members can respond.

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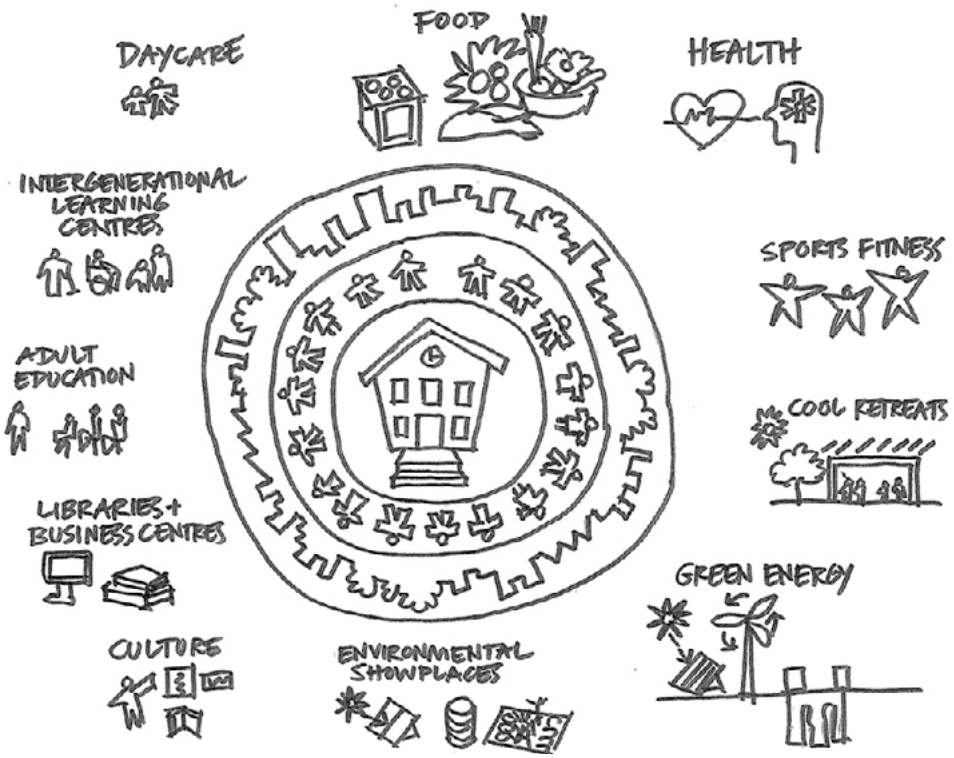
Sydney Harbour Bridge has been transformed from a highway allocated to cars to a bridge prioritising public transport and cycling. Across the bridge there is heavy rail connecting Sydney with other New South Wales districts, electric bus connecting central Sydney with suburbs, and a cycling super highway. The bridge is also a social hub with urban gardens on the side, most run as small businesses. People enjoy a walk across the bridge by the gardens with spectacular views of Sydney Harbour. The bridge is painted with photovoltaic paint collecting solar energy.



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Schools are important hubs for the community, providing services and space for all of its members. The use of the schools and the surrounding space and facilities varies with the time of day and the time of year. Activities and services include child daycare, adult education and intergenerational learning, libraries, business centres, environmental showplaces, green energy generation, sports and fitness, health centres, cafes and local food produce, and cool retreats.

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In Glebe, in the Inner West of Sydney, the Living Road, which was presented in an earlier glimpse, has helped revitalise a community that was lifeless and where much of the street space had been used for car parking. Now the street is a public plaza with many residents having converted their living spaces into offices, cafes and other small business. The street is a place of collective pride and play. People are comfortable having barbecues and social gatherings in the street.

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In Penrith in the Outer West, the construction of Living Roads has helped revitalise the community. With the old conventional 'dead' road, a typical Penrith street displayed little human activity, garages were closed off and there were unused green spaces. Today, the Living Road has encouraged greater community engagement and more people are comfortable with planting gardens on their front lawns. Walking and cycling are prevalent. The road has its own artificial intelligence which directs traffic, and traffic lights and power-lines have been removed. People occupy the street with complete comfort and safety because the road monitors and directs the minimal amount of vehicle traffic. Many people work from home and at lunch time people often tend to their gardens and crops.

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In Melbourne, the central north bank of the river is home to the renovated Flinders Street Station, the final design being an amalgam of the winning entry and the People's Choice winner. Efficient transport design is combined with a large green public garden space, creating an urban garden space in the heart of the city. Lawns, a swimming pool and shaded walking paths contribute to the public amenity. The Elizabeth Street river flows out underneath this park to create a decorative recreational waterfall at the Yarra River's edge. Adjacent to this are a series of pleasure docks housing boating and watersports equipment for hire. Southbank is one of the centres of urban agriculture.

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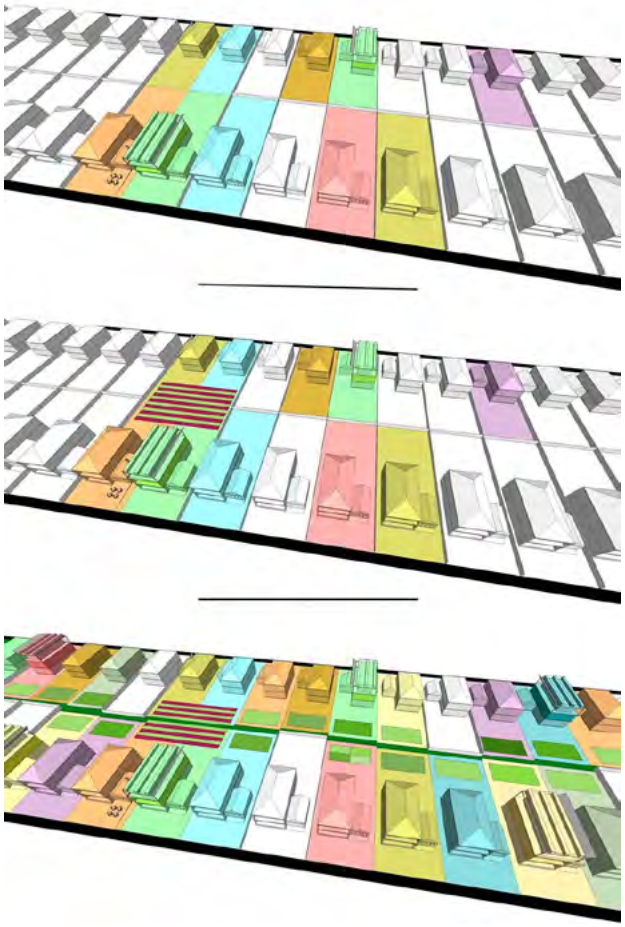
The South Bank district has been heavily planted to address the urban heat island effect. It has become a site for many different scales of urban agriculture, some commercial and some community run. Aquaponic farms are located on the river edge along with the introduction of terraced farming. The bridges crossing the river provide pedestrian connection and new ways to experience the city environment, passing between vertical gardens and through new green towers. River traffic has greatly increased and it is all electric or hybrid to prevent any pollution of the water. While the density of building around the river has greatly increased the net effect is of a more natural bucolic environment.



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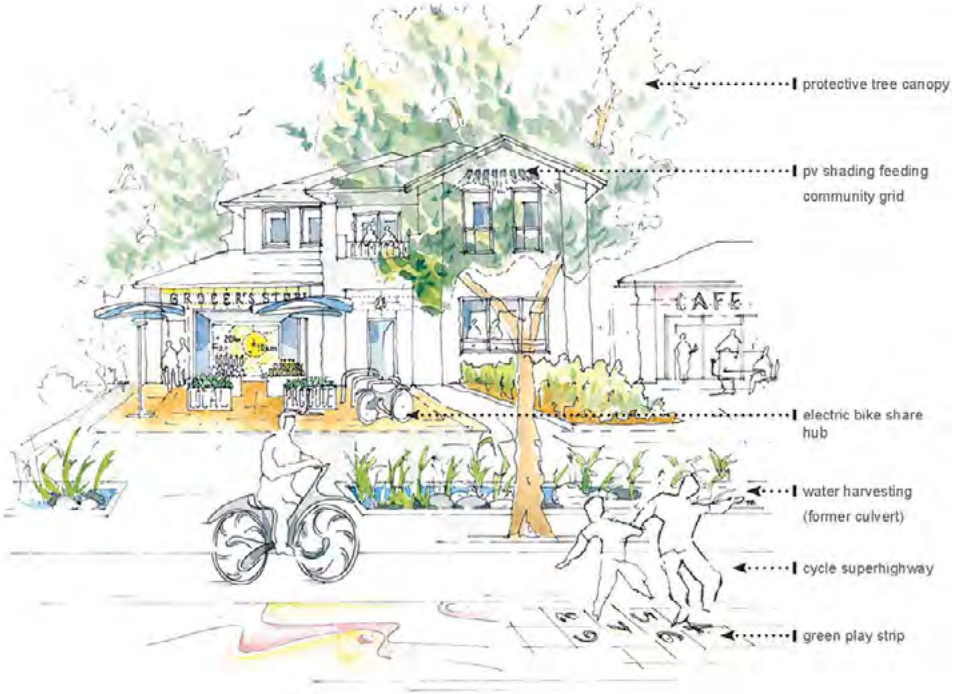
In 2040 there is a third type of space in addition to public and private space: the shared space. This emerged as people began to pull down the fences of their front yards and offered their neighbours access and use of their private property. The practice gradually spread across neighbourhoods. Shared spaces became the preferred areas for neighbours to socialise and people began to make more productive use of the shared land.



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As a result of the neighbourhood change that took place between 2014 and 2040, houses were transformed. Dwellings were extended (usually upwards) and converted to multi-occupancy. Front fences came down and front yards became shared spaces extending out to the edges of the cycle super-highway. Neighbours socialise in these shared spaces, especially in hot days. Some garages have been transformed into cafes or hubs for sharing tools etc. There is a great vibrancy on the street. Electric cars use the street only when necessary and children play together without safety concerns. Water is harvested by bioponds, trees form a protective canopy and photovoltaic units on every house feed power into the grid.

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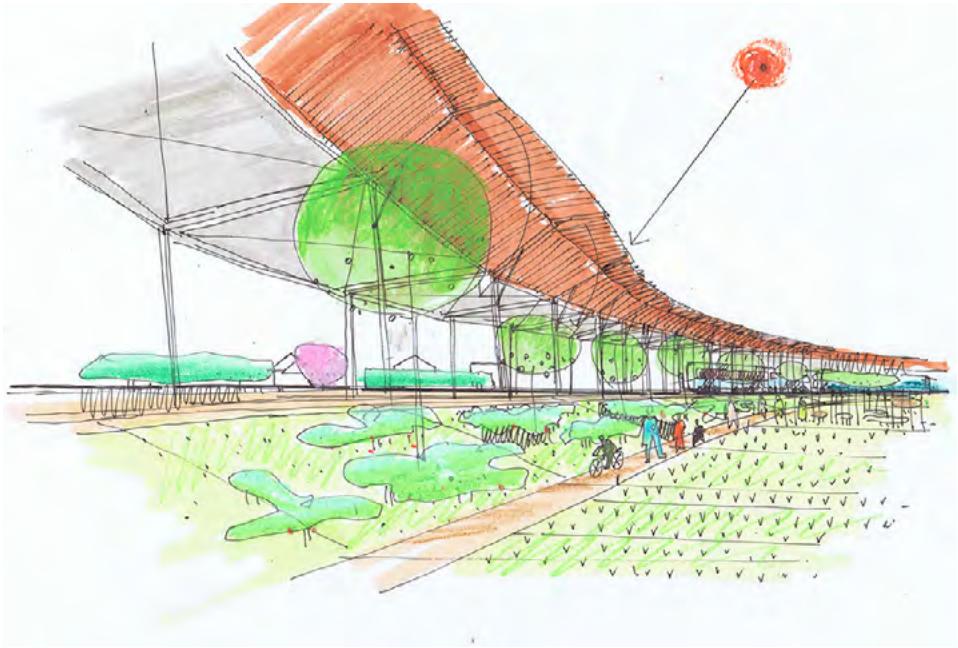
As a result of the neighbourhood change that took place between 2014 and 2040, the streets were transformed. Front fences came down, allowing for community gardens and shared spaces where neighbours socialise along the street. There are solar-powered barbecues in communal hubs for the enjoyment of all neighbours. The street is covered with a tree canopy as protection from heat and solar radiation.



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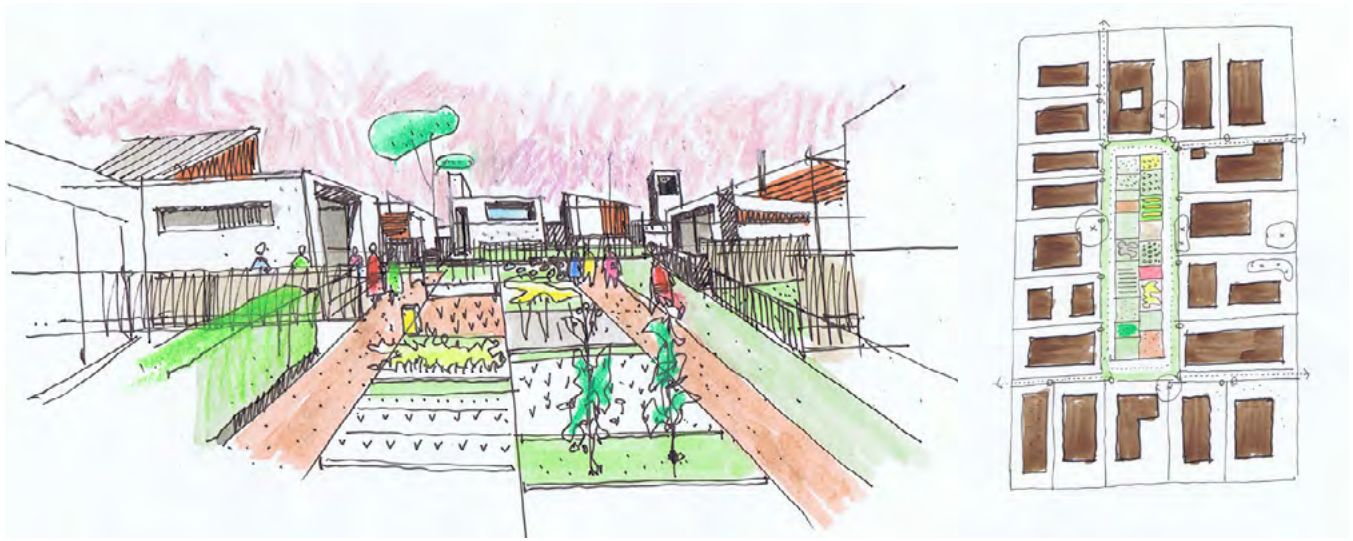
In 2040, railways are unable to cope with the heat so are shaded with massive canopies. The surrounding areas have become green spaces and are used for food production.



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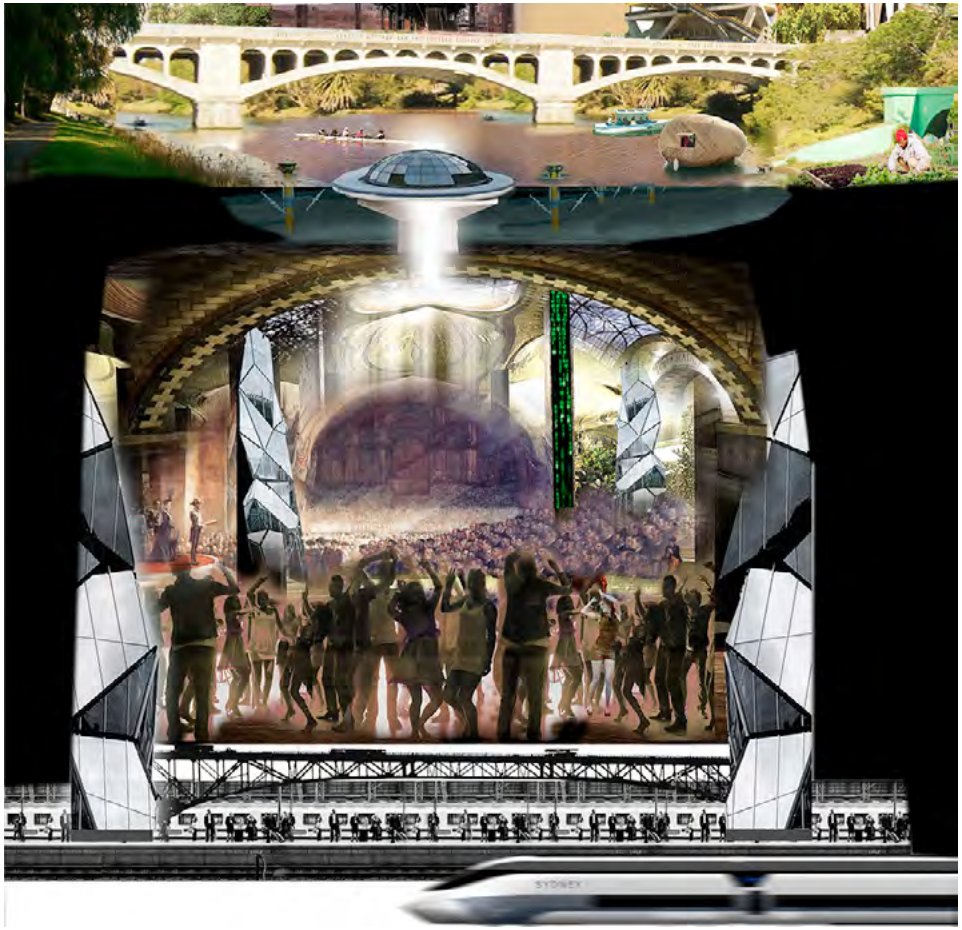
There is less emphasis on owning a private backyard in 2040, and Melbourne residents work together to maintain communal land. Private houses have decreased in size and a change in value systems means that residents are conscious of waste and believe in quality over quantity. New housing estates are designed to facilitate the sharing of food production, waste water, green spaces and household items (ie. a tool library). New types of employment have emerged, such as the 'urban agriculturalist' who maintains such communal spaces.



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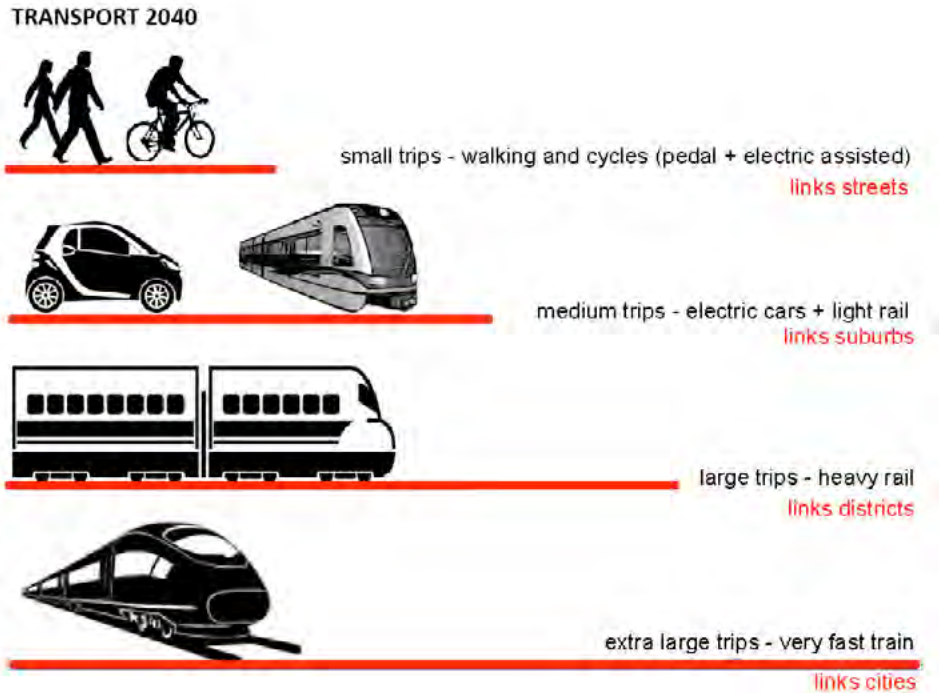
Melbourne's tennis precinct has a vast multi level 'Cool Zone' below the adjacent river – a repurposing of the old car tunnel under the Yarra. Above, the city is constantly monitored for the consumption and production of resources: water, food, energy, etc. The monitored information is available on big public screens and by way of apps on peoples smart phones and smart watches. Creating a dynamic information feedback network provides citizens with a sense of their collective achievement in maintaining a sustainable city and at the same time warns them of impending weather extremes and dangers.



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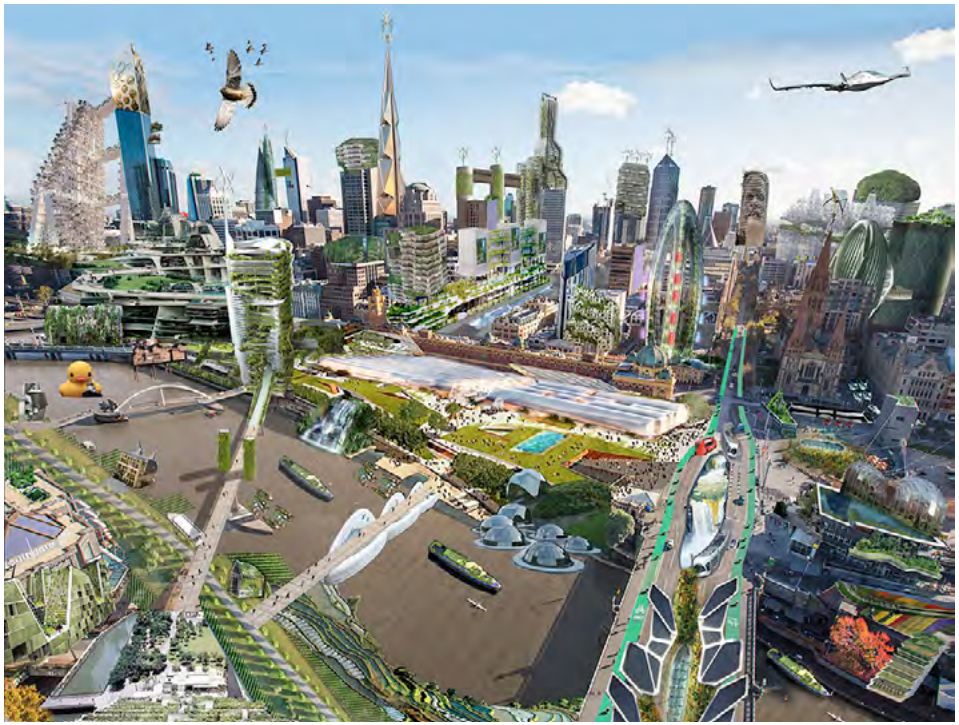
The transport system is multi-modal. People walk or cycle for short distances. Medium distance trips are done by shared electric cars and light rail. Heavy rail is for large trips among districts, and cities and states are connected with very fast train.



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Melbourne CBD operates as an integrated network of interconnected sustainable systems. The city has been extensively greened to reduce heat island effect and to create comfortable and attractive walking and cycling zones and paths. Principal urban connections are made through active transport. Additional bridges connecting the north and south banks of the Yarra River are all dedicated to walking and cycling. The Yarra River, now no longer subject to polluted water runoff has been returned to a pristine state and suitable for swimming, even though it still retains its characteristic brown colour.

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As Victoria's population grows so does the percentage of the population living in cities. Existing high rise towers have new external shading, particularly to the north and west. New skyscrapers abound and incorporate a diverse range of sustainable architectural design strategies. Green walls and green roofs are deployed to reduce heat island effect. Vertical productive landscapes are integrated into many of the buildings to supply locally grown food to the city. Wind turbines are deployed on the roofs of many buildings and wind capture and ventilation enhancement strategies now shape new buildings in sculptural but aerodynamically efficient ways.

4. Exploration of possible scenario elements and dimensions

VP2040 will develop a set of scenarios for the transformation of southern Australian cities. These scenarios will explore potential changes and trajectories over the next 25 years – ways in which significant reductions in greenhouse gas emissions and increased resilience might plausibly be achieved. The scenarios will be progressively elaborated and tested through a series of workshops over the next two years, held in Adelaide and Perth in 2015, and then in Melbourne and Sydney.

VP2040 will collaborate with the Integrated Carbon Metrics project of the CRC LCL and the Australian Stocks and Flows Framework project at the University of Melbourne to develop robust estimations of the scenarios' potentials to reduce emissions. Each of those projects is preparing a current state analysis that will quantify Melbourne's 2014 greenhouse gas contribution and analyse that contribution in terms of the city's *systems of provision*. That is, they will quantify Melbourne's greenhouse gas contributions from: construction materials; energy (electricity and other fuels); transport (mobility and goods); water; food; waste (organic, post-consumer and hard); and information.

During the first year of the project, the research team considered some building blocks for a set of scenarios. Common building blocks used in scenario-building include trend identification and descriptions (e.g. time series analysis and associated projections), identification of underlying drivers of changes and/or critical uncertainties, informed speculation about lower-probability high-impact events that could shape the future (e.g. so-called wildcard events and discontinuities), identification of weak signals of future change, and identification of core dimensions which may differentiate a set of scenarios. Urban/city scenarios are commonly differentiated according to core dimensions such as land use patterns, urban density, and transportation modes/ behaviours. In order to aggregate the effect of changes to *interconnected* systems of provision in the city, the VP2040 project will consider for its scenarios four core dimensions of change: shifts in ***production***, ***consumption***, ***organisation*** (including governance, business models, patterns of production and consumption and so on) and ***urban morphology*** (see Figure 2 below). Preliminary scenario dimensions will be reviewed and elaborated further in expert workshops and consultations.

Two additional crucial scenario building blocks are ***assumptions*** (e.g. regarding population changes, or technological changes / technology costs) and core ***hypotheses*** (e.g. pertaining to how and why patterns of production or consumption could change over the next 25 years) which inform the development of a scenario (de Brabandere & Iny 2013). A further ingredient is ***imagination*** (de Brabandere & Iny 2013).

In this section we detail some of the building blocks that have been considered and which will serve as important inputs into the next stage of the project. We also report the key findings of the deliberative workshops held in Melbourne and Sydney in which expert citizens discussed the glimpses. These workshops brought to the surface important issues and uncertainties which are central to the future of Australian cities.

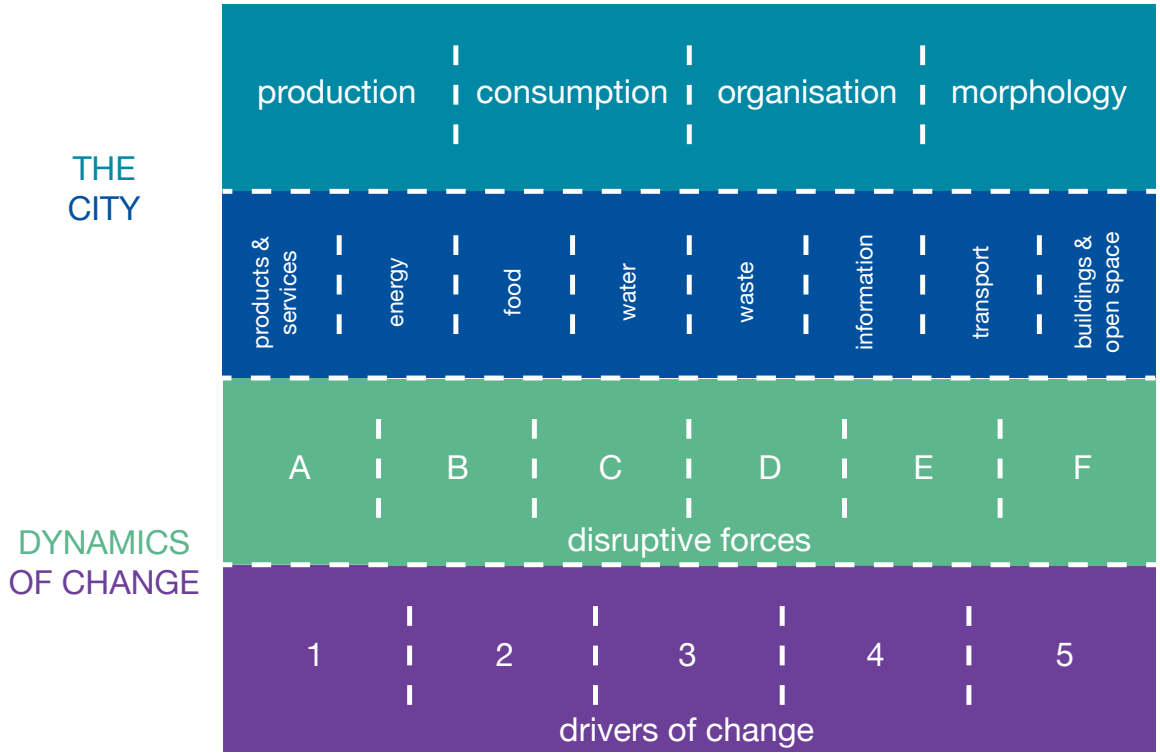

Figure 2: Draft high-level scenario framework

Drivers of change

Underlying forces of change, often termed drivers of change (or driving forces), are a useful starting point for building a set of scenarios. These are commonly discussed in terms of the STEEP framework, in which the key drivers are social, technological, economic, environmental and political drivers.

The project team has collected a long list of potential drivers of change for Australian cities (with a particular focus on the rate of emissions reduction and level of resilience), based on desktop research and a survey of expert citizens conducted in mid-2014. Extending the STEEP categories to six, to explicitly incorporate demographic and geographic trends, the drivers were categorised as:

- **Socio-cultural** drivers, which include the cultural environment and changes to it, and the (relatively) enduring social structures (e.g. socio-economic structures) which influence human behaviour
- **Geo-demographic** drivers, which include demographic changes (e.g. ageing of population) and changes in the use of our geography (e.g. urban sprawl)
- **Technological** drivers, which include technological advancements (i.e. technological change as a driver of change) and associated drivers such as learning rates in emerging technology development (e.g. which influences future technology costs and adoption)
- **Economic** drivers, which include changes in the macroeconomic situation and related economic cycles and policies (e.g. interest rates), changes in housing market confidence (which influences housing prices), and the rate of foreign investment (e.g. in the housing market)
- **Environmental** drivers, which include the level of climatic variability and change (e.g. changes in the frequency of extreme weather events), and the degree of natural resource availability/ competition (e.g. the level of water scarcity/abundance)
- **Political** drivers, which include relevant macro geopolitical forces/factors (e.g. related to oil supply and prices) and lower-level factors such as the level of federal government support for/opposition to new urban (re)development models.

These categories are interrelated and often overlap. For example, the advancement and uptake of new technologies is often considered a technological driver of change but is equally a social process which, furthermore, is often also influenced by multiple political drivers which shape the policy environment (e.g. policies that influence the uptake of renewable energy).

An overview of important drivers of change and disruptive forces shaping the future of Australian cities is provided in Figure 3 below:

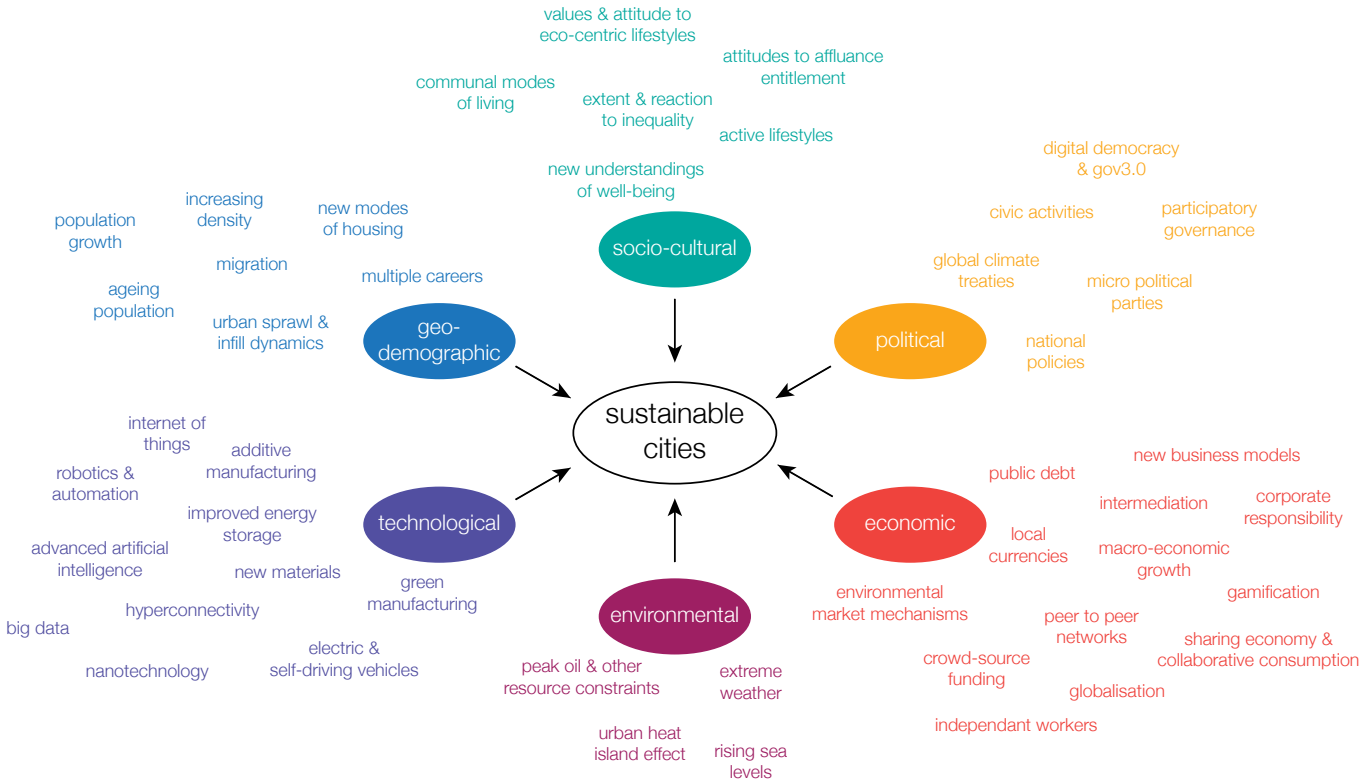

Figure 3: Drivers of change and disruptive forces shaping the future of Australian cities

Some trends that could prove disruptive for Australian cities

The research has uncovered some trends that are potentially disruptive for Australian cities.

Adoption and development of small-scale renewable energy technologies and reductions in electricity consumption: More than 1.2 million rooftop solar photovoltaic (PV) systems have now been installed in Australia, up from only 8000 in 2007 (Flannery & Sahajwalla 2013). About 2.6 million people, 11% of our population, now use the sun for their electricity needs, driven by falling production costs, supportive government policy such as feed-in tariffs and other financial incentives, and rapidly rising electricity prices encouraging the search for alternatives (Flannery & Sahajwalla 2013). In 2014, even though most subsidies for rooftop solar were in decline, around 700 MW of rooftop solar was installed (GEM 2014). Electricity consumption has dropped annually since 2008 to the evident surprise of the generation and network companies. It fell 1.1% in 2014. Greenhouse gas emissions, however, climbed by 1% in the same period after the carbon tax was abolished (GEM 2014). Rooftop solar generation reportedly accounts for 46% of the 2014 reduction in electricity consumption (solar and energy efficiency together accounting for 89%) (GEM 2014). Rooftop solar PV installations represent an investment of more than $4.5b in reshaping the Australian electricity market, an investment which has come from household capital rather than from the energy sector. (This could be considered a crowd funded transformation.) The continued fall in the cost of PV cells, development of lower-cost localised electricity storage systems, more active user/consumer engagement and new business models may contribute to further disruptive change over the coming decades (CSIRO 2013) – see Figure 4 below. Advances continue to be made in other building-scale and precinct-scale renewable energy technologies for harnessing the full-range of sources – sunlight, wind, water, tides, rain, geothermal heat, and organic waste – along with utility-scale technologies (City of Sydney 2013).

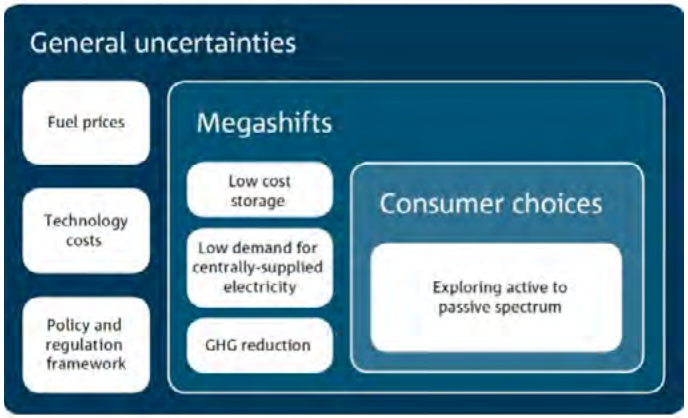

Figure 4: Future Grid Forum scenario development framework (see CSIRO 2013)

The sharing economy/sharing: The concept of the 'sharing economy' has become increasingly mainstream over the past few years. The related concept of sharing cities has recently been proposed (see for example the Sharing Cities Network). The VP2040 vision workshops generated animated discussion around the sharing of public open space (see Section 3). Information and communications technologies (ICTs) and new online platforms have enabled more people to share resources, skills and property in new ways and have led to access-based consumption models. These platforms can help to increase the use of underutilised assets (such as a second car or a spare room) and generate related efficiencies, reduce consumption (e.g. through tool- or car-sharing schemes, or other collaborative consumption schemes), and enable a range of new services. In the first place, this trend may lead to more efficient cities and reduce overall material consumption. Sharing enthusiasts believe it also has the potential to result in cultural change and address consumerism. Nevertheless, the business models of iconic sharing-economy implementations such as Uber and Airbnb are under scrutiny – and in places being actively opposed – because of their potential for transforming the economic system (ShareAdelaide 2013). Interest in and research on the 'collaborative economy' are growing (Botsman 2014).

New technological infrastructures/smart cities: A set of new information technologies and innovations has led to the prospect of: a) urban environments that are sensored/measured/monitored using communication technologies (forming a city-embedded internet of things); b) new urban management systems based on real-time analytics (i.e. smart cities); and c) new forms and modes of virtual interaction. Real-time monitoring of the condition of public infrastructure (roads, waste systems, buildings, water and energy and so on) is already taking place using new sensors along with analysis of data streams from existing infrastructure such as surveillance cameras, building systems and mobile phones. So-called 'big data' is expected to lead to new methods for analysing and shaping human behaviour (Rabari & Storper 2014). These technologies are predicted to enable a new era of management for the physical city (e.g. urban infrastructure and transport) and to make possible wider changes in the political and social interactions of people within cities, and between citizens and government (Rabari & Storper 2014). CSIRO has identified a megatrend that they termed ***virtually here*** which points to a future world 'of increased connectivity where individuals, communities, governments and businesses are immersed in the virtual world to a much greater extent than ever before' (Hajkowicz, Cook & Littleboy 2012). Current and emerging trends such as teleworking, smart work centres (and work hubs) and virtual travel may reduce travel and associated greenhouse gas emissions (see the Sustainable Digital Cities network: http://sustainabledigitalcities.net/). All these trends have implications

for the future management and governance of cities, for the interactions and experience of people who live in them, for reducing resource use and the urban footprint (Rabari & Storper 2014).

There is increasing debate, reflected in discussions at the VP2040 vision workshops (see Section 3), about the politics of big urban data. There are concerns that it entrenches technocratic governance, surveillance, corporate lock-in, and 'hackable', or brittle, infrastructure (Kitchen 2014). Much of the proposed environmental value of smart technologies seems directed to removing inefficiencies in current systems management, rather than enabling transformation. However, increased efficiency is not necessarily compatible with resilience (Biggs, Ryan & Wiseman 2010). Some countries are exploring more participative approaches to the design of systems that could change the dominant discourse about information-based city management (Hajer & Dassen 2014). More grassroots smart-city technologies and change movements are also being pioneered by innovative groups of 'civic hackers' (Townsend 2013).

Distributed systems and distributed manufacturing models: Earlier VEIL research identified a growing interest in distributed systems as an alternative model for the provision of socially critical resources such as energy and food. Distributed systems are defined as 'infrastructure and critical service systems (for water, food and energy etc.) positioned close to resources and points of demand' where 'individual systems may operate as separate, adaptive units but are also linked within ever-wider networks of exchange – at the local, regional or global level' (Biggs, Ryan & Wiseman 2010). The distributed system model is contrasted with existing centralised systems. Interest in distributed systems is linked to concerns about the vulnerability of existing urban infrastructure and more centralised systems, and the potential for localised and networked systems to provide additional social benefits (e.g. social and cultural connectedness, citizen engagement, building local economies) and increased infrastructure resilience.

A range of additional changes and disruptive innovations derive from the potential for new distributed manufacturing models. Some of these focus on the use of new or emerging technologies such as cheaper and more advanced 3D printing technologies and software systems, and the continued development of mass customisation approaches. Other lower-tech social innovations and changes that have developed include the 'maker' movement, DIY culture, and groups (re)learning related skills for greater localised self-reliance.

Infill objectives/development and associated challenges: There is general agreement among state agencies and other government bodies responsible for strategic planning in Australia's major cities that future development and redevelopment needs to be more compact and within established urban areas. Such development is termed 'infill' (Newton 2012). Targets range from 50 to 70% of net new housing as infill development. However, the actual rate of infill housing production has been well below the targets listed in metropolitan planning strategies (Newton 2012). If infill targets are not met, the net result will be further low-density urban sprawl (as in Melbourne and Perth) and potentially a larger environmental footprint. Urban infill is thus a major urban governance and innovation challenge.

Declining housing affordability and 'Generation Rent': A growing minority of lower-income Australians are not affordably housed, and home ownership is not the readily achievable goal it once was for an increasing number of people. Over the past decade house prices have risen far faster than average earnings, impacting affordability (Kelly, Harrison & Donegan 2013). Consequently, the rental market has grown rapidly over the past decade and an increasing number of families and individuals (sometimes termed 'Generation Rent') live in private rental housing. Given well-understood issues such as split incentives, the rapid growth of the private rental market marks a major trend in the Australian built environment with important policy implications for decarbonisation efforts.

Growing urban and national populations: Australia has one of the highest population growth rates in the OECD and some capital cities have recently grown around 50 per cent faster than the rest of the country (Department of Infrastructure and Transport 2013), with more rapid population growth in 2006–11 than 2001–06. For example, Melbourne's population grew from approximately 3.5 million in the year 2000 to approximately 4.35 million in mid-2013, and Perth grew from approximately 1.3 million in 2001 to almost 2 million in mid-2013. The most significant population growth in most of our major cities is happening on the edges, in the outer suburbs.

If current trends continue (for example, if fertility, net overseas migration and life expectancy rates continue in line with recent trends) Australia's population will grow to around 30 million in 2030, with approximately 20% of the population older than 65 (up from 14% today), and to around 40 million in 2060 (Australian Bureau of Statistics 2014). Higher birth rates, life expectancy and net overseas migration would result in an even bigger Australia, potentially reaching 50 million by 2060 (Australian Bureau of Statistics 2014). As the ABS note, these trends and associated projected population levels have implications for the need for amenities such as housing and infrastructure, and also have implications for the level of infill or low-density sprawl.

Disruptive corporate governance, financial and investment initiatives: A rapidly expanding range of innovative corporate governance and financial strategies are creating significant new opportunities for disruptive investment in low-carbon urban infrastructure, technologies and systems.

New corporate governance and business models such as Benefit Corporations (B Corps) and open source, peer to peer and not-for-profit social enterprises are building on earlier learning about corporate social responsibility (CSR), triple bottom line (TBL) accounting, and consumer and producer co-operatives to drive new approaches to setting and achieving corporate goals. Increased emphasis on longer-term social, environmental and economic costs and benefits is also being informed by growing recognition of the fiduciary duty implications of climatic and environmental risk factors such as stranded fossil fuel assets and extreme weather events.

Innovative corporate financing initiatives with the potential to drive low-carbon investment switching include ethical investment and superannuation products with explicit low-carbon and 'green' filters; climate bonds and green bonds; sustainable stock exchanges; and crowd-funding experiments facilitated by social media. Full realisation of the potential of these emerging corporate governance and finance opportunities will be strongly influenced by key metropolitan, national and international level decisions about corporate law and regulation, carbon tax and emissions trading regimes.

Findings from the foundation visioning workshops: glimpse deliberation themes and participant feedback

Another important source of perspectives for developing an initial set of scenario dimensions was the themes that emerged from discussions at the Melbourne and Sydney visioning workshops. The views and issues that were raised, and are briefly reported here, point to potential scenario dimensions and related uncertainties.

Preparedness for a changing climate

An important question is whether some aspects of social and economic life depicted in the glimpses are plausible (e.g. whether a much greener city with a high level of urban agriculture would be viable) in the event of an unprecedented shift in climate beyond historical analogues. The uncertainty inherent in climate projections for cities (temperatures, sea level rise and shifting rainfall patterns) along with the likelihood of growing extremes in heat and rainfall variability, present a challenge in designing for future resilience. An approach favoured by some workshop participants is to prepare for the worst and adopt extreme measures.

Localisation of production: to what extent, and what forms of production?

Workshop participants were generally enthusiastic about the potential for shifts towards more localised, distributed production within cities. However, concerns were raised about the plausibility of the implied shift towards total localised self-sufficiency, and equity of resources and/or differences in opportunity to introduce localised production (for example, for solar and wind power in high density vs low density built environments). There is some confusion about the difference between decentralised systems and distributed systems: the latter term usually implies the need for networking and resource sharing among localised systems to even out permanent or variable inequalities. There are also varying views about the appropriate (spatial) scales for new distributed systems and models.

New forms and uses of informational and 'smart' technologies: benefits and costs?

Workshop participants generally welcomed the envisaged uses of digital technology and new digital infrastructures (e.g. embedded sensors) for new networked mobility systems or more efficient urban systems. Responses were mixed to the idea of real-time tracking of personal consumption (as in, for example, the 'contribution index' in Section 3): some found the concept attractive, others disapproved of the implied shift towards personal data being made public. Some participants reacted negatively to the idea of carbon-footprint data (of precincts, for example) being made public to achieve behavioural changes through comparison and shaming strategies. Others questioned the expectation that smart technologies will deliver significant reductions in consumption and therefore emissions. All the concerns covered in the wider literature were evident. The notion of a 'hack me out' service providing a 'remove me from digital space' option for people is a potential glimpse into a different unexpected future.

Expansion of the public realm, private space and urban density

Many of the glimpses (echoing similar ideas from the literature and urban policy) see a future with increased residential density being accommodated by significant reductions in private space per person with a shift of social life towards public shared spaces. Increased amenity and social use of public space – often repurposed through changing transport / mobility solutions – were common to glimpses of transformed inner-city and suburban residential areas. However, some workshop participants raised concerns about the resulting lack of private spaces for individual residents. To what extent will people will accept a 'no fences' urban environment (in which, for example, households' front fences are removed to allow for shared urban agriculture spaces) or communal spaces rather than private backyards? Will there be cultural differences between the medium to high-density residential areas and the lower density suburban areas? There were arguments that private spaces for individuals should be maintained or increased.

An 'eco-communal' approach or more culturally diverse low-carbon, resilient solutions?

As in the public space discussions, there was some divergence on the extent of communal involvement in future city life, particularly in relation to production activities such as growing food, recycling water, 3D printing and generation of renewable energy, and in relation to communal practices that reduce consumption. Values and behavioural change depicted in many glimpses failed to resonate with all participants. For example, some participants in the Melbourne workshop reacted negatively to a more communal life being presented as 'the way to go'. The idea of a major shift from individualism to communalism made some participants question the plausibility of achieving rapid transformational shifts in values within 25 years.

Calls for whole city and 'multi-level' perspectives

The Melbourne workshops directed a lot of attention to life in the inner city and it was felt that there was insufficient consideration of how the metropolitan city would work as a whole. In contrast, the Sydney workshop produced more glimpses related to suburban life and there was some uncertainty as to what life in the inner city or the Sydney CBD would be like. It is important to work towards a whole city perspective. Participants also pointed to the importance of a city's regional and global connections as well as the spatial connectedness within the city. These connections can also be important drivers of change and sources of resilience.

Social plausibility / feasibility

Participants raised other questions around the plausibility of the glimpses. An important theme was whether the glimpses incorporated enough diversity in lifestyle choices, preferences and values. Participants questioned the emphasis on cycling for short trips, which assumed a widespread or universal ability to cycle and the appropriateness of cycling during all seasons. Envisioned changes to work patterns such as shifting to a three-day work week led to debate about what changes in economic and political systems are plausible within 25 years. Are the glimpses 'visions of the privileged'? Is there a need to consider less prosperous futures where street life might be gritty and crowded?

Technical plausibility / feasibility

Some glimpses, although they met the goal of being provocative and allowing creative thinking, were questioned from a technical/scientific perspective. Is it plausible, for example, that roads might become a major source of energy or be 'living'? As the glimpses are for a twenty-five year horizon, it was argued, any technology central to the envisioned future needs to already be evident at least in the laboratory. Some debate about technical plausibility and feasibility come down to questions of possible paths to commercialisation.

Suggestions about additional issues and potential scenario dimensions (not conveyed by the glimpses)

Some participants in the feedback sessions were concerned about what wasn't mentioned or included in the glimpses, although sometimes implied. They mentioned elements from the economic sphere, including forms of work, occupations, changes to state and national economies; from the political sphere, including forms of governance and political systems; and from the broader social sphere, including interactions among the city, regional areas and the global economy. There was a call for more reflection on the homogeneity of the city – whether there will be greater diversity among city suburbs (a city as a mosaic of places) with different relative contributions of changes in production (e.g. for renewable energy) and changes in consumption. Finally, the glimpses also raised a number of how questions, although these weren't a focus in the initial visioning process, related to affordability, investment, and energy pathways.

The above themes point to important issues, potential scenario dimensions, and questions that will be explored in subsequent phases of the VP2040 project. More broadly the themes point to the importance of political and cultural processes as well as economic and technical processes.

Preliminary scenario dimensions

Drawing on all the above research, including the trend and desktop research, deliberative workshops and other ongoing research activities, the project team has identified a core set of seven preliminary scenario dimensions. Each dimension is an important characteristic of future cities which is relevant to emissions reduction and urban resilience.

1. **Centralised/distributed systems of provision**

How centralised or distributed will our city systems of provision be? Will energy systems become more distributed over the next 25 years? Will other systems of provision (for example, of food and water) also become more distributed? At what scales will this occur and to what extent?

There is much discussion in the literature, and a strong convergence in the future glimpses, that at least some of our systems of provision will become much more distributed. This is already a major trend in energy and in thinking about water. Will it occur in other systems (that is, in food, waste and transport)? How dependent will these systems be on networked load-sharing (distribution of excess, resolving shortages)? Will there be greater decentralisation, such as households moving completely off the grid?

2. 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 open, public spaces and private spaces and their possible trade-offs?

Many of the glimpses contained significant changes in the way our spaces are used and shared. However, the viability of such arrangements and the changes in values and attitudes that may be required to support these changes are open questions.

3. Urban form

What will be the spatial form of future Australian cities? Will density increase or will urban sprawl continue? What might be the relative benefits of medium- and high-density housing and suburban sprawl? 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' – polycentric villages?

There has been a trend in most metropolitan policy documents to direct development towards achieving greater (brown- and grey-field) infill and, overall, development of more compact cities (though implementation is falling short of these aims). Future cities could be more compact, polycentric, or complex mosaics of 'micro cities' with localisation, or have a higher degree of spatial differentiation.

4. Embedding of new informational and 'smart' technologies in urban and household environments

To what extent and degree will cities be embedded with, and 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? Will privacy/ surveillance concerns influence the development and use of these technologies?

Will the smart cities agenda take off and influence the design, management and resilience of urban systems? Will smart cities be radically more efficient cities? What is the trade-off between efficiency and resilience (with its emphasis on redundancy). How much might these systems achieve towards decarbonisation? What influence might they have on behaviour and consumption patterns?

5. Relative importance of production and consumption in emissions reduction

Will emissions reductions come primarily through production efficiencies and changes, or primarily through changes in consumption patterns and lifestyles? To what extent will the sharing economy contribute to emissions reduction (e.g. through avoided consumption)? Will consumption continue to grow or will there be a moderation or even decline? Could growth be significantly less material and energy intensive? How far can a service economy take us and how will the consumption of types of goods and services change?

There is often a cleavage in envisaged futures between (a) locating the bulk of carbon emission reductions on the supply-side, mostly through technological improvements (so 'sustainable consumption' is achieved by consumers adopting cleaner and more efficient products and services, but otherwise requires few changes to consumption patterns and lifestyles); and (b) emissions reductions coming from changes in lifestyles, often involving new patterns of social organisation. A related question: is 'dematerialisation' of the economy (an acceleration of the relative growth of services) the link between (a) and (b)?

6. Ways of life within the city (how lifestyles and norms may change)

Individualism vs collectivism: will our values shift in the direction of greater individualism or greater collectivism? How will this influence other dimensions such as the use of urban space and forms of economic exchange (market exchange, reciprocal exchange, and so on)?

Will there be an emphasis on individual freedom, private ownership and related ways of living or a more collective and communal approach? How will these values influence the use of urban space and related systems of provision? How will they influence consumption (by, for example, a culture of sharing or willingness to pay premiums for sustainable goods and services)?

7. 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? How could these changes influence low-carbon development and/or societal resilience (e.g. community-energy projects vs private sector energy projects, skills exchange programs, etc.)?

While it is unlikely that Australia will move significantly away from a market economy and liberal democracy (except perhaps in a collapse scenario) there is still room for significant variation in economic structures and governance. Will some communities having stronger local governance and a significance presence of cooperatives, not-for-profits, social enterprises and public ownership? Will large corporations continue to have a dominant role in the shaping of cities?

5. Where to next?

Bringing it all together

The scenario building blocks will be further elaborated, refined and explored in the next phase of the project. Quantitative estimates of current typical greenhouse gas contributions from Australia cities (taking Melbourne as the initial exemplar) will be available in February 2015. These estimates are important as they will give the baseline as well as the proportionate contribution from each of the six systems of provision defined for VP2040. For scenarios aimed at achieving an 80% reduction in emissions, different proportional changes in consumption and production will be required across those systems of provision. Those changes will derive from the potential trajectories of disruptive forces, considering the underlying drivers of change. This is schematically illustrated in the Figure 5 below.

Some critical variables such as population and climate projections will be defined for all scenarios based on the best current projections.

The next phase of the project will involve ongoing research, mapping of the domains of disruptive change, and consultation with relevant experts on possible, plausible trajectories of change. Expert workshops will provide a deeper 'dive' into particular areas of disruptive change with the aim of understanding how they might contribute to shifts in production and consumption. The experts will explore further issues related to the scenario dimensions, such as: the potential for systems of provision to become more distributed; the future characteristics and use of urban space; and the potential embedding and use of new informational and smart technologies in urban and household environments. These workshops will lead to 'first-pass' scenarios for southern Australian cities to 2040. Further elaboration and testing of these scenarios will lead in turn to a set of refined scenarios with high utility for planning and innovation. The refined scenarios will also examine changes needed in organisational structures (particularly relating to governance, the operation of the economy and business) and estimate any changes in urban form required to accommodate changes in the systems of provision (e.g. in transport and energy).

The scenarios will be workshopped to test their plausibility and further elaborated in the context of specific cities, at city-based workshops in Adelaide and Perth in 2015, and later in Melbourne and Sydney.

The quantitative carbon modelling should provide VP2040 with estimates of the reduction in emissions likely to result from each scenario. If those scenarios and 2040 conditions can be modelled in a dynamic way (possibly using the Australian Stocks and Flows Framework) then it will be possible to test for resilience by modelling the impact of shocks to the system (such as major climate events blocking supply of key resources, or major deviations from population projections). The project is not currently funded to do that work, so other methods of evaluating the resilience of projected future city conditions will be used, based on the rapidly converging set of resilience indicators for cities worldwide (including for example the Rockefeller Foundation's 100 Resilient Cities project).

The final stage of the project, in its final year, will involve backcasting and an analysis of the policy/research implications.

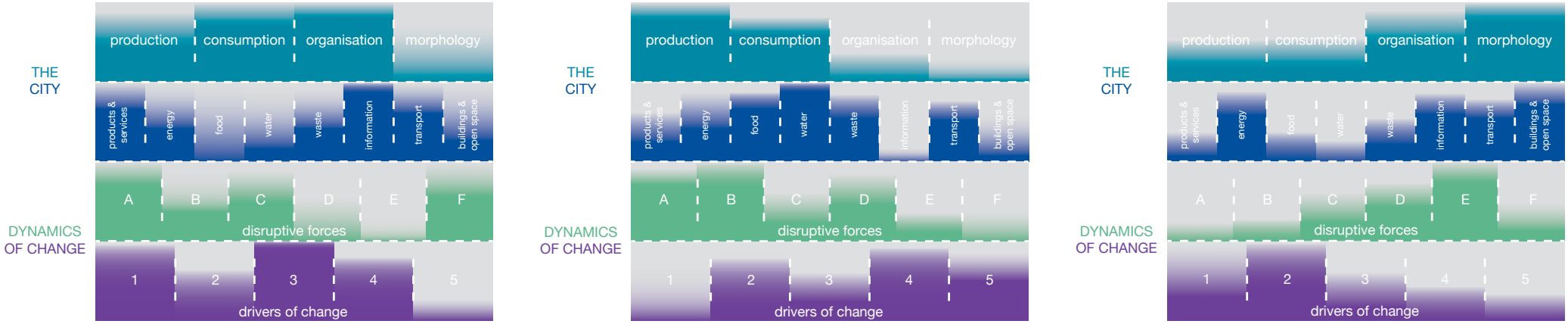

Figure 5: Three different (hypothetical) scenarios for future cities

Project process

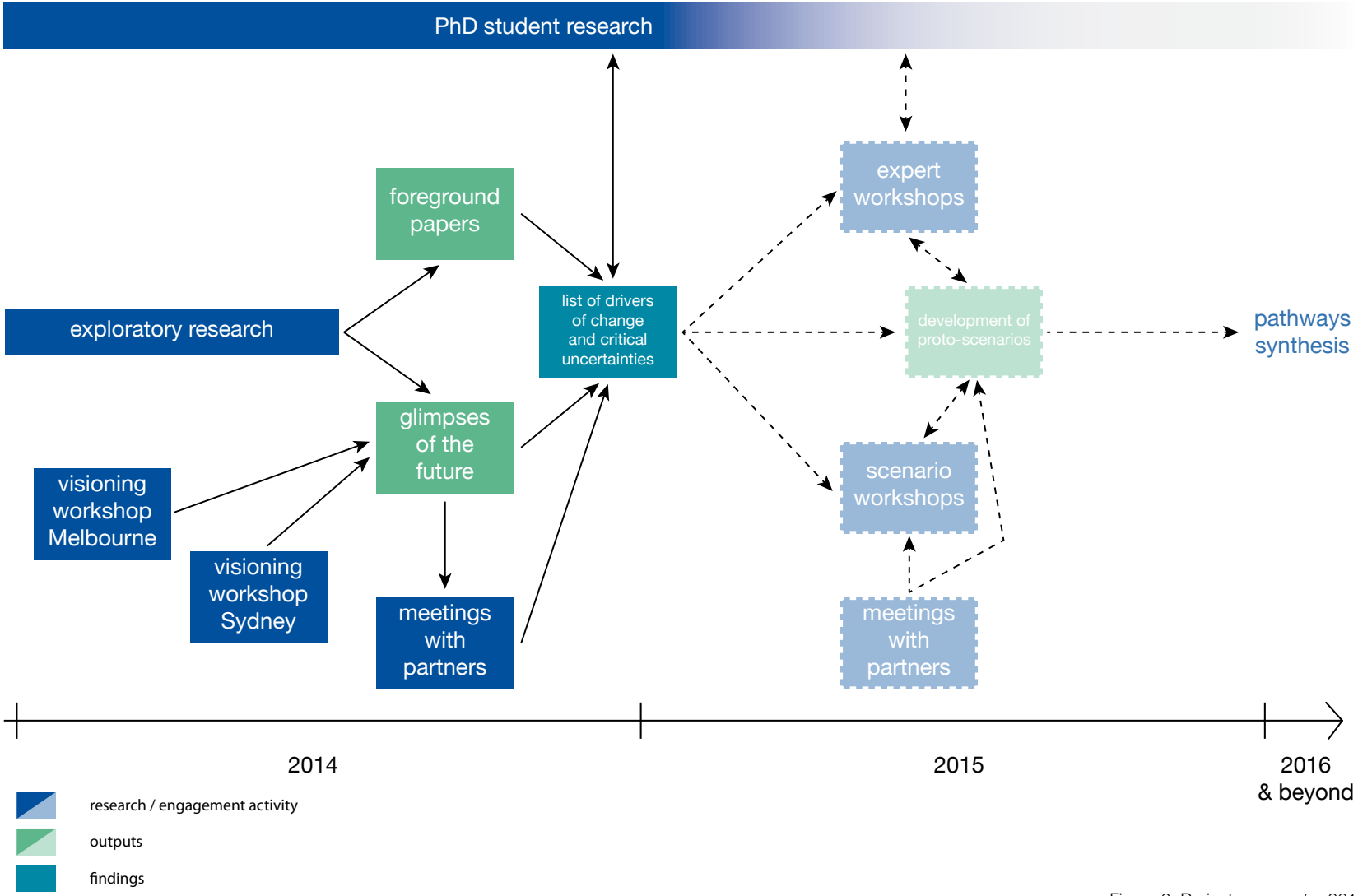

Figure 6: Project process for 2015.

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8. Appendices

Appendix I: Glossary

Term	Definition	Alternative term(s)	Related term(s)
Backcasting	A process conducted, typically in a participatory setting, to consider and strategise how a specific desirable future could be achieved. Participants plan back from future outcomes (hence, 'backcasting'), rather than forwards from the present. When used in sustainability-related contexts a backcasting process often has a number of core phases, such as: problem definition and orientation, future vision development, collaborative backcasting analysis, and development of action agenda(s). The end-product of this exercise could be an agreed roadmap or a preferred pathway (see below).		Pathway Roadmapping Roadmap
Complex adaptive systems	Systems that have a large numbers of components, sometimes referred to as agents (if the component/element has agency), which interact dynamically. In some cases, such as complex social systems, these interactions can evolve as agents adapt or learn over time. Complex adaptive systems have additional characteristics such as unpredictable and emergent behaviour, a high degree of sensitivity to initial conditions, and irreducible uncertainty.	Dynamical systems (chaos theory)	Nonlinearity Surprise
Discontinuity	A discontinuity is a major break in a previously relatively stable state in society, which sometimes happens unexpectedly and rapidly. It can have temporary or permanent implications, can be perceived as positive or negative and can take place abruptly or gradually. Transitions are discontinuities of gradual nature.	Disruptive change Structural change Break	Disruption Nonlinearity
Disruption	Change(s) which significantly disturb or interrupt an aspect of the status quo (e.g. an existing market). The term was originally used in the business and innovation literature to describe the processes by which incumbent firms get out-competed by new, less-resourced competitors typically displacing an existing market, industry, or technology (see Clayton Christensen's research). More recently, the term has been more widely used to refer to various types of change that is considered disruptive (e.g. climate disruption and technological disruption).	Disruptive change	Discontinuity Disruptive force Surprise
Disruptive force	An area of change or innovation that is capable of shifting the trajectory of development in nonlinear ways.		Discontinuity Disruption Nonlinearity
Driver of change	Fundamental social and environmental forces – typically concerning higher-level economic, technological, politico-legal and environmental changes, along with socio-cultural processes and factors – that bring about change, such as relevant trends. These drivers are often at the national, regional, or global level. For example, many exogenous processes drive change in Australian cities. Macro 'drivers' such as various geopolitical and technological forces influence international oil markets and therefore local transport (e.g. demand for public transport).	Driving forces	Scenario dimension

Glimpse	Evocative design sketches that are based on participant input during visioning processes which embody a transformation of existing systems and require the active participation of the viewer in order to realise specific forms in which they might exist.		Vision
Lock-in	Systemic interactions among technologies, institutions and actors that lead to path dependency and prevent non-incremental change. The term 'carbon lock-in' has been proposed by Unruh to describe processes through which fossil fuel-based energy systems can be locked-in, in particular technological and institutional co-evolution processes driven by path-dependent increasing returns to scale.		System dynamics Technological lock-in
Metabolism (i.e. urban metabolism)	The interaction between an urban system and nature, particularly the exchanges of energy and matter. Four flows/ cycles are central to urban metabolism: water, energy, materials and nutrients.		
Narrative	A scenario narrative describes and shows – in a logical and internally consistent manner – what sequence of events and changes might lead from where we are today to a specific future state (as per a particular envisaged scenario). For example the narrative section of a transition scenario must describe how the specific sustainability transition could occur and 'unfold' over time. Unlike a 'roadmap' a scenario narrative is typically presented as a story in written form (with a plot) and/or through imagery such as pictures and films.	Qualitative scenario Scenario storyline	Pathway Scenario Scenario thinking
Nonlinearity	A system property describing how simple cause and effect relationships cannot explain the output generated from a given set of inputs. Thus, a nonlinear relationship is one in which the cause does not produce a proportional effect (in contrast to the superposition principle of linear systems). The future of nonlinear systems cannot be reliably predicted.	Nonlinear dynamics	Complex adaptive systems
Pathway	A pathway details a way in which a specified future outcome could be realised (e.g. a transition pathway to a low or zero carbon electricity system) and choices that are faced en route. Often there are many alternative 'pathways' that could lead to a future state. *A 'pathway' can be contrasted with a narrative and a scenario (see the definitions of these terms). Most importantly a narrative or scenario may incorporate a specific pathway but must also include other aspects, such as a story that describes in some detail how and why this pathway (and not another one) is enacted and its possible consequences.*		Backcasting Roadmap
Roadmap	A document that describes: a desired destination identified and agreed by a group of actors; agreed, actionable steps to move towards this destination; and the key interdependencies in these agreed steps. For example, a technology roadmap is typically jointly developed by involved and affected stakeholders to provide a basis for new technology development. They include common objectives, time-specific milestones, a consistent set of concrete agreed actions, and clearly defined roles for implementation.		Backcasting Pathways

Resilience	A characteristic of systems and individuals: the capacity to absorb disturbance and reorganise while undergoing change so as to retain the same function, structure, and identity. This is also described as the capacity to 'bounce back' from and absorb shocks.		Adaptive capacity Disruption Surprise
Scenario	A story which describes what could occur in the future and why, based on an explicit set of logically consistent assumptions and related inputs, and the expected outcomes of these changes / events. The story is based on an explicit understanding of the ways events and social processes could unfold, such as via causal reasoning and the application of relevant theories. A scenario may be exploratory or normative. *(In contrast to some typologies of scenario practices, in the VP2040 project predictive forms of analysis are referred to as forecasting).*		Narrative Scenario dimensions Scenario end-state
Scenario dimensions	The main variables, *drivers of change* (see above) or other important elements (such as identified 'critical uncertainties') that are used to develop a set of alternative scenarios. Scenario builders typically identify primary scenario dimensions through ranking or prioritisation processes, and concentrate on this relatively small number of dimensions as part of analytical processes used to define the overall 'logic' that underpins a set of scenarios.		Driver of change Driving forces
Scenario end state	The description of the outcomes, and the associated 'future world', of a particular scenario, such as the future city and its characteristics in the year 2040 in a VP2040 scenario. The future states of various aspects of this possible 'world' are defined (such as transportation, energy supply, consumption, or the level of inequality). A range of creative techniques are often used to describe to bring the outcomes to life (e.g. describing a 'day in the life' of a person living in the future world). *The scenario 'end state' can be contrasted with a scenario 'narrative': a scenario narrative describes the overall journey from the current state to the scenario end state.*	Future state Outcome	Scenario
Surprise	An unexpected change or event, often related to discontinuity and disruption (see above).		Discontinuity Disruption Wildcard
System dynamics	A branch of system theory and thinking which aims to understand the dynamic behaviour of complex systems and how systems change over time. Core concepts include feedback loops / processes (and nested feedback loops), system structure, delays, and flows.		Nonlinearity

System of provision	"All the processes and infrastructures through which goods and services are made available for consumption. A system of provision comprises: established industry processes and business practices, accumulated physical production and delivery infrastructure, and the corresponding social and cultural practices, which together define the ways in which lifestyles and particular sets of products and services become a mutually supporting structure. This includes not just all the processes involved in the design, production, distribution and disposal of products and services (along with the technical and organisational infrastructure), but also the shared set of expectations and established practices of consumption that affirm particular categories of products and services as 'necessary' for daily lifestyles to function." (Ryan, 2002)		System innovation Regime
System innovation	Large-scale structural change at the level of societal subsystems, involving nonlinear changes to socio-technical systems which meet societal functions such as housing, mobility, energy, and food.		Regime Transition
Transition	A long-term process of self-reinforcing change during which a society or a major subsystem of society fundamentally changes. A transition often involves interconnected changes in technology, the economy, institutions, ecology, culture and belief systems, and behaviour.	Regime shift	Discontinuity Regime System innovation
Transition scenario	A specific type of scenario (see above) which describes possible future long-term changes – in particular, structural changes – towards a desired, sustainable 'future state'. Transition scenarios are usually an output of a participatory scenario exercise.		Scenario Transition
Vision	A compelling image of the future, typically normative (i.e. an image of a preferred future), expressed in words and/or images, or another form. Visions are typically value-laden, expressing preferences and ideals. *The 'end state' of a normative scenario is similar to a vision. However, the term scenario implies a more pluralistic perspective. For example, a person may have vision of a shift to 100% zero-carbon energy system in Australia by 2030 and then explore in different normative scenarios (of which each has a different scenario 'end state') a wide range of ways this long-term vision could be attained or realised.*		Image of the future
Weak signal	An early indicator of a (potentially) important future change or phenomenon. A weak signal, once identified, may be interpreted as a signal of an important emerging trend.		
Wildcard event	A possible event that is low-likelihood but, if it occurred, it would be high-impact.		Surprise

Appendix II: Workshop participants

Representation at Visions & Pathways 2040 workshops Melbourne & Sydney 2014	Number of Participants
Business	**24**
AECOM	4
Arup	3
Aurecon	3
Brookfield Multiplex	1
Closed Loop	1
Cundall	1
e2 Design Lab	1
Fujitsu	1
GHD	1
Hassell	3
ICLEI	2
Material ConneXion Australia	1
Mirvac	1
SJB Urban	1
Consultancy	**4**
Freelance	1
KimMic	1
Maria Atkinson Consultancy	1
Planning Results	1

Representation at Visions & Pathways 2040 workshops Melbourne & Sydney 2014	Number of Participants
Finance	**2**
Clean Energy Finance Corporation	1
Green Energy Trading	1
Local Government	**15**
City of Melbourne	6
City of Stonnington	1
City of Sydney	3
Hume City Council	3
Manningham city council	1
Moreland City Council	1
Media & creative arts	**4**
ABC	1
Carbon Arts	1
CLIMARTE: Arts For a Safe Climate	1
The Future Makers	1
NGO	**11**
350.org	3
Beyond Zero Emissions	2
Climate Works	1
Creative Suburbs	1

Representation at Visions & Pathways 2040 workshops Melbourne & Sydney 2014	Number of Participants
GreenFleet	1
Moreland Energy Foundation	1
Net Balance Foundation	1
WWF	1
Peak body	**6**
ASBEC	1
Green Building Council of Australia	4
Institute of Architects	1
Research	**21**
Centre for Australian Foresight	1
Climate Energy College	1
La Trobe / Australian Centre of Excellence for Local Government	1
Monash: Centre for Water Sensitive Cities	1
RMIT	1
Swinburne	1
University of Illinois	1
University of Melbourne	9
University of Melbourne: Melbourne School of Design	1
UNSW	1

Representation at Visions & Pathways 2040 workshops Melbourne & Sydney 2014	Number of Participants
Research (continued)	
University of Melbourne Student Union	1
UTS – Institute of Sustainable Futures	2
UTS & freelance blogger	1
Utilities	**3**
AusGrid	1
Pacific Hydro	1
Sydney Water	1
Social Business	**2**
Open Food Foundation / Eaterprises	1
Shareable	1
State Government	**10**
Department of Human Services	1
Office of the Commissioner for Environmental Sustainability	1
Environment Victoria	1
NSW Energy Efficiency	1
Office of Environment and Heritage	2

Representation at Visions & Pathways 2040 workshops Melbourne & Sydney 2014	Number of Participants
Office of Living Victoria	1
Parks Victoria	1
State Government Victoria	1
Sydney Harbour Foreshore Authority	1
Grand Total	**103**

Appendix III: Workshop process

The visioning workshops were designed as two 3.5 hour sessions, held one week apart from each other. The aim of the first session was to facilitate the development of a complex 'multi-system' vision of desirable low-carbon and resilient futures for Australian cities. A team of designers were present in this session, each designer accompanying one of the five workshop groups. The visioning process acted as a design brief for designers to a 'creative whole-system' reconceptualisation of urban/ city life in 2040. Over the week between the first and second sessions, the designers and the research team worked to create glimpses of the futures envisioned by the workshop participants. The aim of the second session was to present these glimpses to the participants and receive feedback, identify points of divergence and critical uncertainties.

The following core question was put to the workshop participants:

What does 2040 look like for a (local) city that is well on the way to a post-carbon economy, with resilience to changed climate conditions / extreme weather events?

Physical layout and process constraints

There were 5 tables focusing respectively on shelter, energy, transport, food & water, lifestyle & behaviour as starting points. Each table accommodated 5–6 participants and one designer. These groups stayed together throughout the session. Each group rotated around the five tables in five rounds. Two wild-cards were introduced in the fourth and last rounds. This way, complexity was built gradually at each table and systemic visions were achieved.

The thoughts and visions were captured by writing/drawing/ notations on tables, notes and framing by table captains, observation and conceptual framing by designer /observers, and audio recording.

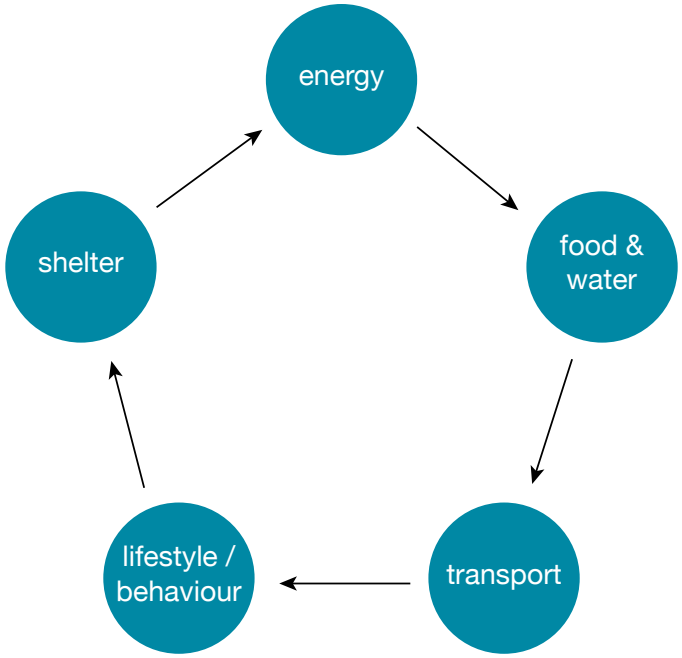

Figure 7. The five themed workshop tables.

The VP2040 team would like to thank the participants of Melbourne and Sydney visioning workshops for their expertise and creativity.

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Alison Rowe
Alvaro Maz
Ammon Beyerle
Andrew Feeney
Andrew Maher
Bernadette Thomas
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Blair Palese
Bridget Ryan
Brigid Stapleton
Caitlin McGee
Carmel Reyes
Carolyn Whitzman
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Celeste Morgan
Charlie Davie
Che Biggs
Chris Buntine
Chris Dereksema
Chris Riedy
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Joanne Jackovitch
Jodi Newcombe
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Kristen Wood
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Liam Ryan
Lingna Zhang
Lucy Sharman
Luke Farr
Maaike Gobel
Maria Atkinson
Martin Brennan
Martin Wainstein
Mary Haw
Maryella Hatfield
Matt Coetzee
Matt Wilson
Michaela Sheahan
Monica Hatcher
Monica Richter
Nicolette Boele
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Soumitri Varadarajan
Stephen Varady
Tim Browne

The VP2040 team would especially like to thank the following people for their contribution to the project and workshop processes.

Jeff Robinson - Aurecon
Chris Buntine - Aurecon
Brett Pollard - HASSELL
Victor Scorsis - HASSELL
Ken Maher - HASSELL
Rik McKenzie
Jimmy Liu
Kate Auty
Che Tarn Biggs
Jonathan Shaw
Margaret Trudgeon
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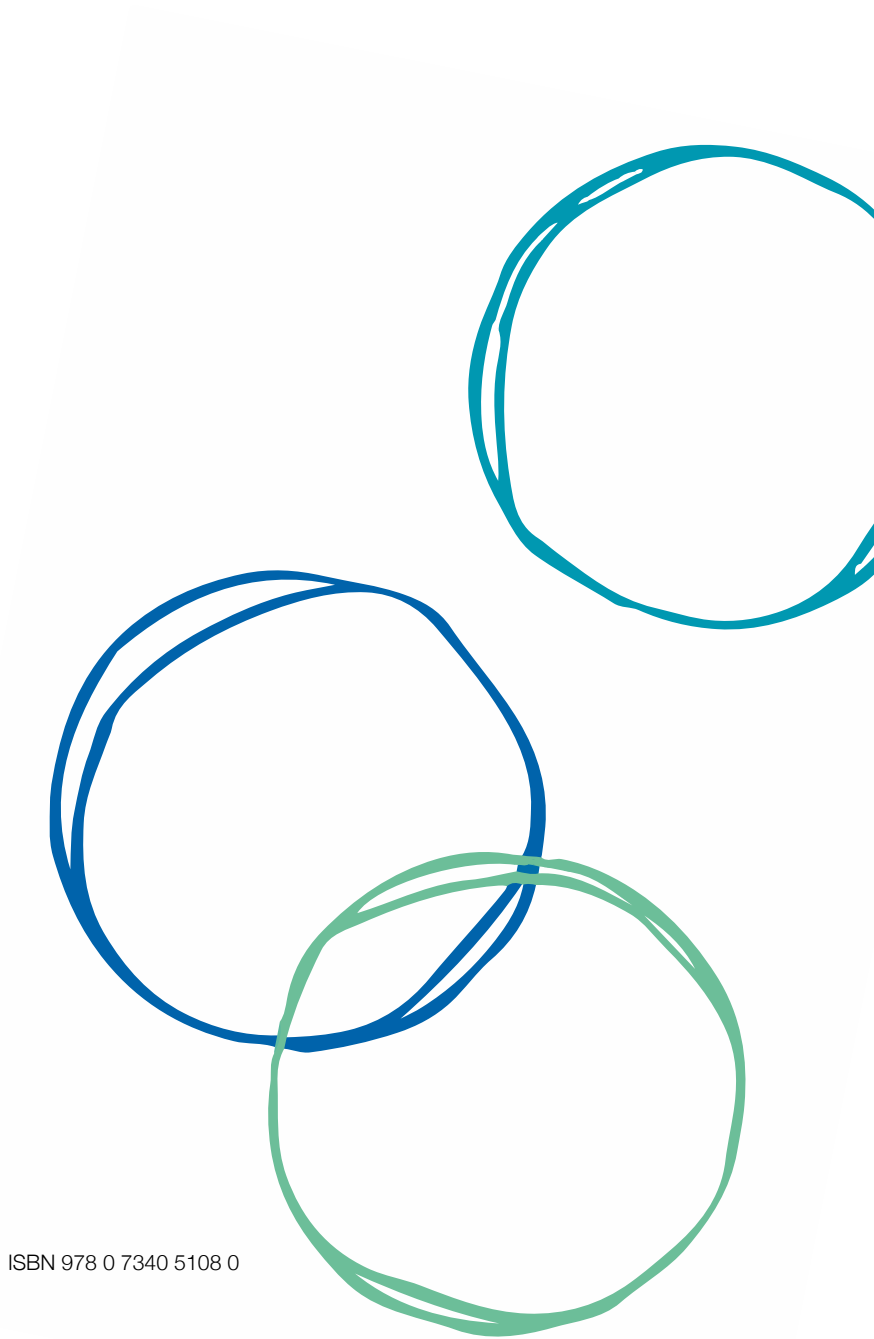

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Low-carbon Resilient Futures in Australian Cities

ISBN 978 0 7340 5108 0