Pathways 2040

Results from Visions and Pathways 2040:

Scenarios and Pathways to Low Carbon Living

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

This report can be cited as:
Candy, S., Larsen, K., Twomey, P., McGrail, S., & Ryan, C. (2017). Pathways 2040. Results from Visions and Pathways 2040: Scenarios and Pathways to Low Carbon Living. Melbourne, Australia

ISBN 978-0-7340-5484-5

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Executive Summary

Achieving zero net carbon by 2050 will require steep rates of reductions in our national emissions and increases in carbon sequestration in the intervening years.

Cities contribute disproportionate amounts to national emissions, have significant influence on national economies and progressing change, and are demonstrating strong climate leadership globally and in Australia.

An absolute emissions reduction target of 80% by 2040 is on a strong trajectory to carbon neutrality by 2050 and therefore in line with these recommended global targets to avoid catastrophic climate change. The VP2040 project explored the following emissions reductions targets:

- 80% reduction in carbon footprint on 2012/13 i.e. consumption emissions per capita (Section 5); and
- 80% absolute reduction on 2012/13 consumption emissions by 2040 (Section 6).

Our cities are also at the forefront of climate vulnerability and transformation must make them more resilient.

Visions allow us to 'dream' about future possibilities for resilient, low-carbon cities. Pathways allow us to explore how we might get there—both things that might happen to us (that we respond to) and actions we could take.

Section 5 of this report presents four provocative and exploratory 'vision and pathway' scenarios of how Australian cities could be transformed. These exploratory scenarios were developed in conversation with a wide range of partners, including through ten workshops across the partner cities, to get expert input across the project. More detail is available in the second year report—Scenarios 2040.[1]

Carbon footprint analysis of these four scenarios revealed that significant emissions reductions can be achieved, but that major structural changes to the economy will be required. This modelling was conducted using Integrated Carbon Metrics program. The modelling in Section 5 did not achieve the 80% per capita emissions reductions.

At the time of writing, Australia is not on track to achieve even its stated emissions reductions target. Partner feedback on the four exploratory scenarios emphasised tensions and questions undermining the perceived 'plausibility' of the scenario pathways—the "how do we get there?"

The scenarios were streamlined into two Action Pathways for cities, focusing on the forces of change that might be required to actually achieve the drastic greenhouse gas emissions reductions that we seek. The Action Pathways are explorations of the choices and actions for our cities that go beyond the technological and social innovations explored in the earlier four scenarios. They are described in detail in Section 6.

The Green Growth Action Pathway explores how political changes of the required magnitude might be triggered by action in cities, within the current economic and political framework. It invites partners and readers to consider their own potential power in progressing these. It particularly highlights possibilities to:

- Remove the social license to operate for entities that are not explicitly and proactively decarbonising;
- De-legitimise all forms of tacit acceptance and corruption that inhibit rapid reductions in the development and use of fossil fuels; and
- Strengthen alliances and active organisation of actors in leading cities to drive political change and shape state and national policy.

The Commons Transition scenario paints a new narrative with re-empowered citizens at the vanguard of sweeping social changes already underway in cities around the world. It draws on leading innovations in: sharing and shareable cities; P2P; Open Design Distributed Manufacturing (ODDM), cooperatives and platform cooperative movements; and new more radical narratives of cultural, political and economic transformation. These new narratives are already gaining momentum and starting to be explicitly 'named' and 'described' in the public discourse.[2,3] For example, citizen movements in Spain, Iceland, Taiwan, Korea, Italy and elsewhere have forged new political contracts that place citizens at the centre of city decision-making.

Modelling of the two Action Pathways was done using the Australian Stocks and Flows Framework. An 80% absolute reduction of consumption emissions attributable to city populations was achieved. The analysis demonstrated that emissions reductions of this scale can be achieved, but will require—and drive—massive transformation of our cities and perhaps our societies, economies and politics.

To believe that these exploratory scenarios and action pathways are possible, any of them—let alone ones we actually want—requires a leap of imagination. To make them possible requires a corresponding leap of determination. We invite readers and project partners to read and reflect on both the exploratory scenarios and the action pathways, to consider the key questions they ask and to explore the tools we have provided, to shape the vision and pathway that you—and your organisation—are ready to travel.

1 Ryan, C., Twomey, P., Gaziulusoy, A. I., McGrail, S., Chandler P. (2016). *Scenarios 2040 - Results from the second year of Visions and Pathways 2040: Scenarios of Low Carbon Living*. Melbourne, Australia. Available at http://www.visionsandpathways.com/wp-content/uploads/2016/05/VP-2040_second_year_report1.pdf

2 Monbiot, G, (2017). *Don't let the rich get even richer on the assets we all share.* The Guardian. Available https://www.theguardian.com/commentisfree/2017/sep/27/rich-assets-resources-prosperity-commons-george-monbiot

3 Hickel, J., (2007). *Want to avert the apocalypse? Take lessons from Costa Rica.* The Guardian. Available https://www.theguardian.com/working-in-development/2017/oct/07/how-to-avert-the-apocalypse-take-lessons-from-costa-rica

1. Introduction

We are in the final years of the critical decade,[4] the period in which our actions to reduce carbon emissions will determine whether we succeed globally to limit temperature rise to less than 2 degrees. At the same time, more than 50% of the global population now live in urban areas, which is expected to rise to 60% by 2050.

Over the coming decades cities will be engaged in a significant and rapid process of transformation as they decarbonise their economies and adapt to climatic changes that are already becoming evident. This transformation will involve both existing urban infrastructure and established patterns of urban living. This process of transformation will be hugely challenging for Australian cities, particularly if necessary targets for greenhouse gas emissions reductions are to be achieved.

The transformation of a city has opportunities to simultaneously improve its inhabitants' quality of life, amplify the conditions for social creativity and innovation, create livelihoods and opportunities for all, and regenerate ecological diversity and vitality. The challenges facing us today require nothing less than a reconceptualisation of the city in all its dimensions.

The Visions and Pathways 2040 (VP2040) Project is an exploration and investigation of what that means for Australian Cities. Informed by a review of leading global and Australian cities, as well as global and national emissions reductions targets required to avoid catastrophic climate change, the project has explored greenhouse gas emissions reductions targets of 80% by 2040—a solid trajectory towards carbon neutrality by 2050.

Over the three years of the project, many dimensions of the transformation of Australian cities have been explored. This final report presents the outcomes of this work. It suggests that the changes we need are possible, and plausible—but that the decarbonised and resilient future cities we seek could happen in many ways and will be shaped by the actions we take now.

4 Steffen, W., Hughes, L. (2013). *The Critical Decade 2013: climate change science, risks and responses.* Climate Commission Secretariat (Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education), Commonwealth of Australia.

1.1. What is Visions and Pathways 2040?

Visions and Pathways 2040 (VP2040) is a research and engagement project to develop, analyse and communicate visions and pathways for transforming Australian cities to achieve rapid decarbonisation and increased resilience in the face of climate change. The core focus of the project is the major southern Australian cities: Sydney, Melbourne, Adelaide and Perth. The project is funded by the Australian Cooperative Research Centre for Low Carbon Living (CRCLCL) and has involved three universities (University of Melbourne, University of NSW and Swinburne University of Technology) and a range of government and industry partners.

VP2040 has a focus on city-scale change—considering the the city's larger-scale systems (physical, technological, social and cultural)—beginning with the exploration of longer-term possibilities for transformation in response to the challenges of climate change. The project views 'dreaming' about the future as a critical and necessary facet of action for urban, low-carbon transitions: "supporting people to let go of commitments to where we are now and where we seem to be heading, and to simply think about what we desire for the future."[5] Visioning, scenario exploration and pathways analysis have been used as tools for considering such change and for analysing the identified future possibilities (e.g. examining their decarbonisation potential).

This analysis has concentrated on decarbonisation, envisioning possibilities for the physical form and urban lifestyles of Australian cities in 2040 with a target of reducing greenhouse gas emissions by 80%. Since this program commenced (and particularly following the Paris COP 21 in late 2015), the issue of appropriate Australian CO_2 targets has become a significant area for policy debate, with past 'aspirational' commitments looking increasingly at odds with international thinking. The selection and definition of the 80% target is discussed more fully in Sections 5 and 6.

VP2040 also considers vulnerabilities that arise with changes in climate and extreme weather events; viable scenarios must increase resilience at the same time as reducing $C0_2$. VP2040 uses research, engagement and open collaboration to build plausible visions of future cities that have the necessary decarbonisation and increased resilience. The aim of these visions is not to predict but to explore and inspire. The VP2040 visions have been developed into a set of scenarios for the future and plausible pathways through which such futures could unfold. These scenarios and pathways involve both narratives of change and quantitative exploration of their viability; they can be used to consider choices about policies, innovations, investment and research towards low carbon and resilient urban futures.

This flagship project of the CRCLCL, with its focus on cities, bridges the three programs of the CRC—buildings, precincts and engaged communities. It brings Australia into a domain of research and action that is well-established in other countries.

1.2. VP2040 project objectives

The VP2040 research aims to:

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

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

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

5 Ryan, C.J., McCormick, K., Gaziulusoy, I., Twomey, P., McGrail, S. (2014). Decarbonization of Cities: You're Dreaming! *The Solutions Journal* 5(6), 12-15..

1.3. This Report

Throughout VP2040, strong emphasis has been placed on the communication of future visions, scenarios and pathways for change. This is viewed as an important part of stimulating engagement and an interest in innovation (technical and social) and framing broader dialogue about potential change.[6]

A core goal of VP2040 has been to not only determine what desirable and plausible low carbon future cities may look like, but also to build enthusiasm for those outcomes, particularly within the built environment industry and amongst policy-makers. This report draws together the project's strands which are most likely to be of interest to these groups, and delivers a range of options for how this project's work can be used to stimulate conversations and policy change, and guide internal discussions and planning for governments and built environment industries and organisations. It provides deeper understanding of the interactions between physical and technological changes to lower carbon emissions, exposing the interplay between environmental, social and economic outcomes in the complex systems that underpin the functioning of a city. Collaborative processes have been developed that have allowed organisations and individuals to engage with the question of what future they want, what tradeoffs they are willing to accept, and what changes they need to make to steer towards a desirable future.

This report draws together and discusses findings from across the four years of the Visions & Pathways 2040 project, presenting an overview and providing links and references to earlier, more detailed work. It:

- updates and re-articulates the case for a focus on cities and bold, ambitious targets—clarifying the selection of the 80% target and taking this further in the last phase of modelling;
- outlines the methodology of the whole project, including the pathways analysis and the quantitative modelling which are presented for the first time in this report;
- presents the four Exploratory scenario visions (outlined in the second year report), along with further development presented here for the first time, including:
  - Pathway narratives;
  - Quantitative carbon-modelling settings and results;
  - Case studies of indicative activities and policies, signals of scaling and actors required to do so;
  - Discussion of the scenario plausibility, including issues raised by participants.

Section 6 of this report describes the refinement of the four exploratory scenarios into two challenging and contrasting 'Action Pathways'. The report links to resources that have been developed to support organisations to use the scenarios (both the four Exploratory Scenarios and the two Action Pathways) to challenge their own thinking and shape their own actions.

This work can help reframe how we think about the choices being made, and can make us alert to opportunities to shift the development trajectory onto a lower emissions path. It can be used to guide decision-makers towards development and implementation of policies that will bring about the best outcomes in terms of environment, with an understanding of the social and economic outcomes tied to those changes. Importantly, it can be used for inspiration and to provide hope: *the cuts to carbon emissions needed to avoid catastrophic climate change can be achieved, and can be achieved in multiple ways from top-down and grassroots-up, and through government, business and community input.*

6 Ryan et al. 2014, see above.

2. Why Cities

Cities are at the intersection of urbanisation and climate change. We are in the final years of the critical decade,[7] the period in which our actions to reduce carbon emissions will determine whether we succeed globally to limit temperature rise to less than 2 degrees. At the same time, more than 50% of the global population now live in urban areas, which is expected to rise to 60% by 2050.[8]

Cities are critical to our climate mitigation and adaptation response because:

- Cities are a major source of emissions. The structures and processes that support current configurations of urban life result in a disproportionate contribution to carbon emissions and vulnerability to climate change impacts
- Cities have the economic and cultural power to drive change
- Cities are taking the lead in emissions reduction

Urban areas face—and exacerbate—complex global environmental changes[9] that will continue to cause massive disruption, and require rapid and fundamental transformation. These points are discussed further below.

2.1. Cities are a major source of emissions

Although cities occupy just 2% of the global land area, their contribution to global greenhouse gas production is estimated at between 53%-87%, in terms of CO_2 emissions (depending on boundary assumptions and accounting methods—see further discussion in Section 3.4),[10] with the World Energy Outlook putting the figure at 71%.[11,12]

Australian cities have complex embedded dependencies on very large flows of resources including oil and other fossil fuels. Significant urban populations and carbon intensive urban lifestyles drive up the proportion of emissions attributable to cities. The per capita emissions for Sydney and Melbourne have been calculated at 24.7 and 29.1 tCO_2eq respectively,[13] which are 7-27% higher than the national per capita emissions[14] and around triple global per capita emissions.

2.2. Cities are increasingly vulnerable to climate change impacts

Nearly half of the world's cities are already experiencing the effects of a changing climate.[15] At the time of writing unprecedented extreme weather events have caused the displacement of over 5 million people in the USA as storms hit the cities of Houston and Miami, and over 40 million people have been affected by flooding across South Asia—India, Nepal and Bangladesh.

All cities' forms and metabolisms are shaped by historical patterns of weather: prevailing summer and winter temperatures, rainfall, wind and storms. Shifting climate patterns can threaten the resilience of those systems. 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).

There are also many stressors that occur more gradually over the longer term, for example as infrastructure or services have less and less surplus capacity and become brittle. This can be seen in the more frequent failure of electricity networks and train services during heatwaves.[16]

2.3. Cities have economic and cultural power

Cities also contribute significantly to national economies, both in Australia and in other countries. They account for a disproportionate amount of GDP and, consequently, major cities and residents' decisions can have large indirect economic impacts. For example, Melbourne and Sydney each generate around 75% of their state's economic output.[17] This also means that decisions made by city residents can have large broader impacts outside of the city boundaries and points to the potential macro significance of urban change in Australia.

Large cities support the creation of environments which influence whether novel and cutting-edge innovations are generated. For instance, Richard Florida has observed that large cities with

7 Steffen, W., Hughes, L. (2013). *The Critical Decade 2013: climate change science, risks and responses.* Climate Commission Secretariat (Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education), Commonwealth of Australia.

8 UN. (2014). *World urbanization prospects: the 2014 revision : highlights.* United Nations, Department of Economic and Social Affairs, Population Division.

9 Sanchez-Rodriguez, R., Seto, K., Simon, D., Solecki, W., Kraas, F., Laumann, G. (2005). *Science plan: urbanization and global environmental change* (No. 15). International Human Dimensions Programme on Global Environmental Change, Bonn, Germany.

10 Seto, K. C., Dhakal, S., Bigio, A., Blanco, H., Delgado, G. C., Dewar, D., … Ramaswami, A. (2014). *Human Settlements, Infrastructure and Spatial Planning. In Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Edenhofer, O., Pichs-Madruga, R., Sokona, Y et al (Eds.). Cambridge, United Kingdom and New York, NY, USA, Cambridge University Press.

11 OECD/IEA. (2008). *World Energy Outlook*. Paris, International Energy Agency.

12 Webb, R., Bai, X., Smith, M. S., Costanza, R., Griggs, D., Moglia, M., ... & Ryan, C. (2017). Sustainable urban systems: Co-design and framing for transformation. *Ambio*, 1-21. DOI 10.1007/s13280-017-0934-6

13 Chen, G., Hadjikakou, M., Wiedmann, T. (2016) *Urban carbon transformations: unravelling spatial and inter-sectoral linkages for key city industries based on multi-region input–output analysis.* Journal of Cleaner Production. DOI:10.1016/j.jclepro.2016.04.046

14 Australian Government. (2015a). *Australia's emissions projections 2014-2015.* Department of the Environment, Canberra, Australia.

15 UNEP. (2011). *Towards a GREEN economy: Pathways to Sustainable Development and Poverty Eradication*. Paris, United Nations Environment Program.

16 Steffen, W.L., Hughes, L., Perkins, S. (2014). *Heatwaves: hotter, longer, more often.* Climate Council of Australia.

17 SGS Economics and Planning 2014, *Australian Cities Accounts 2012–13.* Available at http://www.sgsep.com.au/assets/GDP-by-Major-Capital-City-1213-.pdf

greater population density "not only have deep pools of talent and a critical mass of specialists, they also have the density to forge connections between people and firms with diverse bases of knowledge."[18] Many urban theorists point to importance of other forms of urban diversity for innovation such as "the diversity of the ethnic, cultural and social fabric" in a city.[19,20] Research has highlighted related trends in post-industrial cities and their socio-economic implications.[21,22,23,24]

Cities have other characteristics which can contribute to fostering new innovations and industries and point to their important roles in 'innovation ecosystems'.[17,19] For example, large, comparatively wealthy, urban populations provide a context that can support new market development, aiding commercialisation and adoption of relevant technologies (e.g. solar panels). Similarly, the higher population density in cities and other urban characteristics can contribute to the viability of other innovations such as carsharing services—though this may not be the case for peer-to-peer carsharing[25] — and the provision of public transport.

Concern about climate change is more prevalent in Australia's capital cities and the political power of these urban populations is a potential driver of change. A greater proportion of people living in Australia's major capital cities report concern about climate change (than people living outside major cities) and concern about climate change is highest among younger Australians, particularly young adults (aged 18-34), whom are a larger proportion of the population in major urban areas.[26,27,28,29] Related to this, the recent success of the Greens Party in inner urban areas in federal elections—particularly in Melbourne—may be indicative of the growing political importance of urban environmentalists, as evidenced by the election of the Greens Party's first Federal MP and related voting trends in other inner urban electorates in Melbourne.

18 Florida, R. (2017). *The geography of innovation.* www.citylab.com. available at https://www.citylab.com/life/2017/08/the-geography-of-innovation/530349/

19 Shearmur, S. (2012). Are cities the font of innovation? A critical review of the literature on cities and innovation. *Cities*, 29, Supplement 2, S9-S18.

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23 Bettencourt, L. (2013a). *The kind of problem a city is.* Working paper no. 2013-03-008. Santa Fe Institute, Santa Fe, USA.

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25 Hampshire, R.C., & Gaites, C. (2011). *Peer-to-peer carsharing: market analysis and potential growth.* Transportation Research Record: Journal of the Transportation Research Board, 2217, 119–126.

26 ABS. (2012). *Environmental views and behaviour,* 2011-12 (4626.0.55.001), Australian Bureau of Statistics.

27 ABS. (2013). *Australian social trends,* April 2013 (4102.0), Australian Bureau of Statistics.

28 The Climate Institute. (2016). *Climate of the Nation 2016: Australian attitudes on climate change.* The Climate Institute, Sydney NSW.

29 The Climate Institute. (2017). *Climate of the Nation 2017: Australia attitudes on climate change.* The Climate Institute, Sydney NSW.

2.4. Cities are taking the lead

In the last decades, cities have become a focus for action on climate change because of their apparent agency—the willingness of their city authorities, businesses and citizens to make change. This was evident at the Copenhagen COP in 2009 and even more noticeable in Paris for COP 21. A current high profile example is the 377 'climate mayors' across the US who pledged to uphold the Paris agreement after the national government formally withdrew their support in August 2017.[30] Also demonstrating the growing influence of cities are various networks and alliances supporting curbing emissions within municipal boundaries. These include C40 Cities Climate Leadership Group, ICLEI – Local Governments for Sustainability, Global & EU Covenant of Mayors for Climate and Energy, Under2 Coalition and Carbon Neutral Cities Alliance. The recently established Cities Power Partnership program of the Climate Council accelerates emission reductions in Australian cities and councils. This leadership appears to, in part, reflect frustration with action at the national and global level and therefore a need to shift the focus to local and State levels, as international and national stalemate drives the search for new political opportunities for low-carbon transition.

30 As of 8 September. Climate Mayors. (2017). 377 *US Climate Mayors commit to adopt, honor and uphold Paris Climate Agreement goals.* Available at https://medium.com/@ClimateMayors/climate-mayors-commit-to-adopt-honor-and-uphold-paris-climate-agreement-goals-ba566e260097

Global Municipal Leaders

Globally, cities and networks of cities are active in adopting greenhouse reduction targets and investing in programs to reach them. Table 1 summarises the climate commitments and actions already taken and planned by some of the world's leading cities in climate change action.[31] The main selection criteria for these cities were their ambitious community-wide GHG emission reduction targets and relevance to Australia as metropolitan cities. Targets and plans were considered ambitious if they proposed rapid decarbonisation over the next few decades, provided long-term strategies and addressed integration of policies across different sectors. The cities are presented in Table 1 in the order of target ambition, but not carefully ranked as the complexity of doing so would require deeper analysis.

Of these 10 cities, carbon/climate neutrality is the aim of Copenhagen (2025), Oslo (2030), Berlin (2050) and Seattle (2050). Berlin's goal appears to be the only legally binding climate target among these cities. Carbon neutrality signifies zero net emissions, which often includes offsetting remaining emissions that cannot be reduced by local measures. Oslo, Berlin and Stockholm state that they investigate offsetting and/or carbon sinks or that they are recommending them to meet their ambitious targets (Copenhagen's goal is claimed to be based 63% on carbon credits).[32] Stockholm's objective is to become fossil fuel free by 2040. Some of them have also set renewable energy targets to assist meeting their goals (at least San Francisco, Vancouver and Amsterdam). Six of the ten cities cities have selected CO_2 equivalent as their emission inventory unit, meaning that also other GHGs are included in addition to CO_2.

Consumption of goods as well as non-road transport are some of the commonly excluded sectors from the scope of emission reduction.

According to the C40 data, the strongest levels of mayoral power in the selected cities—of which populations range between 0.6 and 8.6 million—are held in terms of city roads, water, urban land use and public buildings. Local government powers are the weakest in terms of energy supply as well as private buildings and public transport.[33]

Common focus areas of action are energy use (buildings), energy production, transport, urban development, waste/resource utilisation and city administration. Energy use in buildings and transport constitute the largest sources of GHG emissions, followed by emissions from waste treatment. When the share of city administration emissions is reported, it is usually of the magnitude of 5-10% of the total emissions.

Nine out of these ten cities report emission reductions, often despite population growth. In addition to Oslo (where GHG emissions per capita have fallen but in absolute terms have increased), four other cities are reported being behind or lagging in their progress meeting their long-term targets (Copenhagen, Seattle, Toronto, London) though they present additional actions or policies to boost the pace of emission cuts. Half of the cities have updated their climate change planning document and/or framework last or this year, defining new short– and long-term actions to scale up the rate of GHG reductions.

Actions or measures that have been influential in cutting emissions include converting fossil fuels to renewables in combined heat and power production/district heating, improvements in buildings' energy performance, replacing fossil-based vehicles to clean vehicles, switching fossil fuels to renewable fuels in transport, congestion charge/restricted vehicle zones, increasing active transport, reducing waste sent to landfills and capturing landfill gas. Cleaner supply of electricity in the state/country and warmer weather leading to lower heating demands were also reported to play a role in a few cities. In the short-/mid-term (by 2020/30), new actions focus on bringing about further emission reductions e.g. by establishing partnerships with building sector stakeholders (Copenhagen, Toronto), public transport to use only renewable fuels (Oslo), reaching zero waste status (San Francisco) and climate-neutral new-build development (Amsterdam, Vancouver). Long-term actions (by 2040/50) include for instance fossil-free shipping (Stockholm), low-carbon neighbourhoods (Toronto) and introducing 200,000 electric cars (Amsterdam).

Cities also present a number of factors that enable or drive the city to meet their climate goals. At least half of them state to have a long tradition of environmental action and/or consider themselves leaders in addressing climate change. Favourable national/state policies and green energy production play a role (e.g. in Oslo and San Francisco). Co-benefits of low-carbon actions (e.g. employment, economic growth) are clearly stated to be driving 5/10 cities (Copenhagen, Berlin, Toronto, Amsterdam and London). Established status as a bike-friendly city (Copenhagen) or electric vehicle leader (Oslo) further drive the city to retain that reputation. Circular/cycle-based waste management is adopted in the case of Oslo and Amsterdam; the latter has launched the world's first circular city framework. Other clear enablers can be considered to be city networks (Copenhagen), building bylaws (Vancouver), committed citizens with many skills (Amsterdam) and culture of innovation (Seattle).

However, there are major challenges facing the emission cuts—these include population growth (6/10 mentioning this explicitly), tackling emissions especially in the transport sector (5/10), reducing the amount of plastic waste (2/10) and significant investment needed to implement actions (2/10).

31 It is a snapshot examination rather than an exhaustive review and based mostly on a desktop study of the city policy documents and other information available on the city websites. These 10 cities were selected to this snapshot as part of an earlier piece of work of the project (in early 2014 and May 2017) that made a broader scan of city-level climate change target action around the world. More detailed table is available at www.visionsandpathways.com.

32 Berger, J.J. (2017). Copenhagen, *Striving To Be Carbon-Neutral: Part 1, The Economic Payoffs*. Available at http://www.huffingtonpost.com/entry/copenhagen-striving-to-be-carbon-neutral-part-1-the_us_589ba337e4b061551b3e0737

33 This is based on relative comparison of cities' powers in relation to a range of assets and functions (across nine different city sectors and four dimensions: own and operate, set and enforce policies, budgetary and revenue control, and set vision) of the 10 selected cities indicated in the C40 city database (http://www.c40.org/cities/). Limited power does not necessarily mean limited action. While the strongest levels of cities' powers are related to owning and operating city assets, cities can use alternative pathways such as partnerships with non-government actors. More details see C40 Cities, ARUP (2015). *Powering Climate Action: Cities as Global Changemakers.* V1.0. Available at: https://issuu.com/c40cities/docs/powering_climate_action_full_report.

Table 1: Global Cities

Target and Scope[a,b]	*City Jurisdiction*	*Climate change policy framework and planned actions/ goals*	*Progress since baseline and influential policies / actions*
Copenhagen (DK) *Target: world's first carbon neutral capital city by 2025 (2005)* *Scope: CO_2, no consumption*	*Pop. 0.6 M* *Area: 86 km2*	*CPH 2025 Climate Plan* (2012, roadmap update 2016)—2017-2020 focus: • Energy consumption: partnerships with building sector stakeholders, targeting buildings with the highest energy consumption and poorest energy-label ratings • Energy production: more renewables, flexible energy system • Mobility: bicycle network, mobility as a service, carbon neutral buses • City administration: procurement, retrofitting municipal-owned buildings	The city has cut emissions by 38%. Highlights: • Increased biomass in combined heat and power (CHP) and wind power production • 64% of municipal fleet replaced with electric or hydrogen vehicles, garbage trucks converted to biogas and missing links (e.g. bridges) in city's bicycle infrastructure are being built
Oslo (NO) *Target: 50% by 2020 and 95%, i.e. carbon neutral by 2030 (1990)* *Scope: CO_2, no consumption*	*Pop. 0.66 M* *Area: 454 km2*	*Climate and Energy Strategy for Oslo* (2016) actions include: • Transport: public transport to use only renewable fuels by 2020; daily travels by bike to be increased to 16% by 2020, 25% by 2025; heavy-duty vehicles & construction machinery able to use renewable fuels by 2030 • Buildings: fossil fuels for heating phased out by 2020; energy consumption reduced by 1.5 TWh by 2020; carbon capture and storage at the largest waste-to-energy plant Klemetsrud by 2020 • City of Oslo: integrate climate budgets in municipal budget process	Emissions have increased by 25% (national emissions have risen by 4% due to oil and gas industry) but per capita emissions are falling. Highlights: • Over 30% of all new cars sold in Oslo in 2015 and 2016 were electric vehicles (EVs) or plug-in hybrids; there are 35,000 EVs in the Oslo region • 2,000 charging points for electric vehicles in the city established • EV incentives include no tax purchase, no VAT, free parking, free passing through the toll ring, access to bus lane, free charging
Stockholm (SE) *Target: fossil fuel free city by 2040 (city administration by 2030) (1990), 2.3 tCO_2eq / capita by 2020 (2012)* *Scope: CO_2e, no consumption*	*Pop. 0.9 M* *Area: 216 km2*	*Strategy for a fossil-fuel free Stockholm* 2040 (2016) focuses by 2020 on: • Energy: district heating system, 10% solar power of city organisation's use • Transport: reduce road traffic, reduce fossil fuels in road traffic (e.g. 500 public electric charging units on-street) • Resource efficient recycling: increase biogas production • By 2040: phase out coal, replace fossil oils with renewable fuels, investigate prohibiting sale of fossil fuels, reduce fossil plastic in incinerated waste	Emissions have fallen by a third and initial goal of fossil fuel free by 2050 was brought forward to 2040. Largest reductions in 1990-2010 from: • Conversion of oil-fired heating to district heating and heat pumps, biofuels in district heating • Replacing fossil-based vehicles and fuels with clean vehicles (e.g. > 20 biogas refueling stations), from diesel to renewable fuel in public transport • Congestion charge since 2006, dropped inner city traffic by 20%
Berlin (DE) *Target: 40% by 2020, 60% by 2030, 85% i.e. climate-neutral by 2050 (1990)* *Scope: CO_2, consumption*	*Pop. 3.56 M* *Area: 892 km2*	*Berlin Energy and Climate Protection Programme* (BEK) (2016/2017) actions: Energy: phase out coal, significantly reduce oil use & increase solar power • Buildings: increase renovation rate to 2%/year by 2030, reduce per capita consumption of living space, strengthen urban CO_2 sinks • Traffic: ecomobility alliance, > one-third of vehicles non-fossil fuel by 2030 • Private households: increase appliance efficiency, climate education	CO_2 emissions have been cut by one-third. Highlights: • Increase of highly efficient local CHP generation (extension of district heating grids and replacing coal and oil to natural gas and biomass) • Public energy utility (Berliner Stadtwerke) plans, builds and operates decentralised renewable energy systems and sells electricity & heat
Seattle (US) *Target: 58% by 2030, carbon neutral by 2050 (2008)* *Scope: CO_2eq, consumption*	*Pop. 0.66 M* *Area: 3692 km2*	*Seattle Climate Action Plan* (2013) actions by 2030 and new initiatives include: • Road transport & land use: citywide network of neighbourhood greenways prioritising walking & bicycling; from fossil fuels to carbon-neutral electricity • Buildings: low- to no-carbon energy through district energy and on-site renewable energy systems, public transparency of building energy performance, tune-ups in large commercial buildings • Waste: support capacity building for composting organics	'Peak emissions' reached as the community GHG emissions have been on a downward trend since 2008. Total emissions have decreased by 6%. The emission reductions have come from: • Lower passenger vehicle travel and more efficient cars • Improvements in building energy performance and more residents living in multi-family (and less energy-intensive) dwellings • Warmer weather led to lower heating demands in 2014 compared to 2008
London (UK) *Target: 60% by 2025, 80% by 2050; supply 25% of London's energy from local sources by 2025 (1990)* *Scope: CO_2eq, no consumption*	*Pop. 8.6 M* *Area: 1595 km2 (Greater London)*	*Delivering London's Energy Future, Mayor's Climate Change Mitigation and Energy Strategy* (2011) set four objectives (example actions/goals): • Reduce London's CO_2 emissions: retrofitting homes and public sector buildings, all new buildings zero carbon by 2025, ten low carbon zones • Maximise economic opportunities from the transition to a low carbon capital: Green Enterprise District, Low Carbon Employment and Skills Programme • Ensure secure and reliable energy supply for London: London Heat Map to help identify decentralised energy opportunities	In 2014, there was a 16 % reduction in emissions on 1990 levels and a 25 % reduction since the peak of emissions in 2000. Highlights: • Mayor's Decentralised Energy Project Delivery Unit overcame market barriers to investment in large-scale decentralised energy projects • By the end of 2013-14, over 100,000 homes were visited and over 400 public sector buildings were retrofitted through retrofit programmes • Two city-wide schemes aim to replace aging boilers, reduce fuel poverty, and improve air quality in London – saving 6,5 kt CO_2/year

Target and Scope[a,b]	*City Jurisdiction*	Climate change policy framework and planned actions/ goals	*Progress since baseline and influential policies / actions*
San Francisco (US) *Target: 25% by 2017, 40% by 2025, 80% by 2050; 100% renewable electricity supply by 2030 (1990)* *Scope: CO_2eq, no consumption*	*Pop. 0.87* *Area: 121 km2*	San Francisco Climate Action Strategy (2013 update; Zero-50-100-Roots framework supports the strategy): • Buildings: power 100% of residential and 80% of commercial buildings with renewables – coupled with energy efficiency measures • Transport: make half of the trips outside of personal vehicles by 2017, 80% by 2030 • Waste: reach zero waste status by 2020 • Others: increase urban canopy by 25%	28% GHG reduction achieved since 1990, thus exceeds the 2017 milestone 2 years early. Emissions reductions have resulted from: • Cleaner supply of electricity (two of the state's most inefficient fossil fuel plants closed) • Reduced consumption of natural gas and electricity in the commercial sector • Less waste sent to landfills due to zero waste program
Vancouver (CA) *Target: 33% by 2020, 80% by 2050; derive 100% of city energy use from renewables by 2050 (2007)* *Scope: CO_2eq, no consumption*	*Pop. 0.6 M* *Area: 115 km2*	Greenest City 2020 Action Plan (2012, 2015 update) has three overarching areas of focus: zero carbon, zero waste and healthy ecosystems. Plan is supported by the Renewable City Strategy 2015-2050 (2015): • Buildings: new buildings to be zero emission by 2030, retrofit buildings to perform like new construction • Transport: transition light-duty vehicles to electric, plug-in hybrid or sustainable biofuel powered; develop car-sharing & regional mobility pricing • City operations: comprehensive approach to pricing carbon emissions	15% reduction in community emissions. In 2014, 31% of energy use was renewable. Recent successes include: • Almost 50,000 new trees have been planted since 2010 • Capturing 71% of the landfill gas at Vancouver Landfill thanks to upgrades • Expanding district energy networks • Introducing metric for low-carbon new building and approving the Building Retrofit Innovation Fund • Introducing a bike share program
Toronto (CA) *Target: 30% by 2020, 80% by 2050 (1990)* *Scope: CO_2eq, no consumption*	*Pop. 2.81 M* *Area: 634 km2*	TransformTO supports the Climate Change and Clean Air Action Plan (2007). Short-Term Strategies (2016): • Buildings & energy: enhance Better Building Partnership, energy efficiency in social housing, elevate energy efficiency standards for new construction • Transport: explore road pricing, enable electric vehicles • City operations: expand energy retrofits, improve fleet fuel efficiency • 2050 Pathway to a Low-Carbon Toronto (2017) roadmap: low-carbon neighbourhoods, electric mobility, workforce for high-performance buildings	City-wide emissions have dropped by about 24%. Partly attributed to: • State-level efforts to phase out coal in electricity generation • Improved technologies at the city's five landfill sites to capture methane emissions Highlight: • The Toronto Atmospheric Fund (TAF) is a council-created agency to finance local initiatives to reduce emissions and improve air quality in the city
Amsterdam (NL) *Target: 40% in 2025, 75% by 2040 (1990); 20% more renewable energy/capita by 2020 (2013)* *Scope: CO_2, no consumption*	*Pop. 0.8 M* *Area: 219 km2*	2040 Energy Strategy (2010) links to the Amsterdam Climate Programme (2008): • Buildings: climate-neutral new-build development from 2015 • Transport: 40,000 electric vehicles by 2025, 200,000 electric cars by 2040 • Energy: more efficient wind turbines replace the old wind turbines by 2040 • Sustainable Amsterdam Agenda (2015) focuses on: • Energy, clean air: solar energy to 160MW, emission free public bus transport in 2026, 1000 properties without energy bills • Circular economy: 65% household waste separated by 2020 • City operations: implement roadmap 'Municipality CO_2 Neutral'	CO_2 emissions have decreased by around 7% 2008-2015. Renewable energy increased by 3% 2013-2015. Highlights: • 13/14 major new construction project plans energy neutral or better • 'Clean kms' increased in 2016 to nearly 3,000,000 a month • In addition to the environmental zone of freight traffic (since 2009), the environmental zone vans started in the beginning of 2017 • Circular Amsterdam framework first in the world, uses circularity as a criterion for the issue of new building plots

a Target: All cities have community-wide emission reduction targets, and some also have adopted additional city administration and/ or renewable energy targets (not all additional targets are presented here). Baseline year is indicated in brackets.

b Scope: Refers to emission inventory unit and whether the city includes any consumption-based (Scope 3) emissions in their core emissions that the target relates to. Note that if there was no data available to show their inclusion (in city planning or inventory documents), it was assumed that they were excluded. It is, however, recognised that community GHG inventories are often not reported by scope and that sector-based data is useful for comparative benchmarking (Blackhurst et al. 2011). Berlin uses consumption-based accounting; while emissions embodied in products and infrastructure are apparently not yet included in the inventory, they are reported to be accounted for in the target value of emissions in 2050 (4.4 Mt CO_2). Seattle in turn presents a hybrid of a production-based and consumption-based approach in their emission inventory; their 'core emissions' include e.g. half of the vehicle trips that either begin or end in the city and waste management outside the city boundaries but exclude e.g. air travel that is examined in the 'expanded view' of the city's emissions.

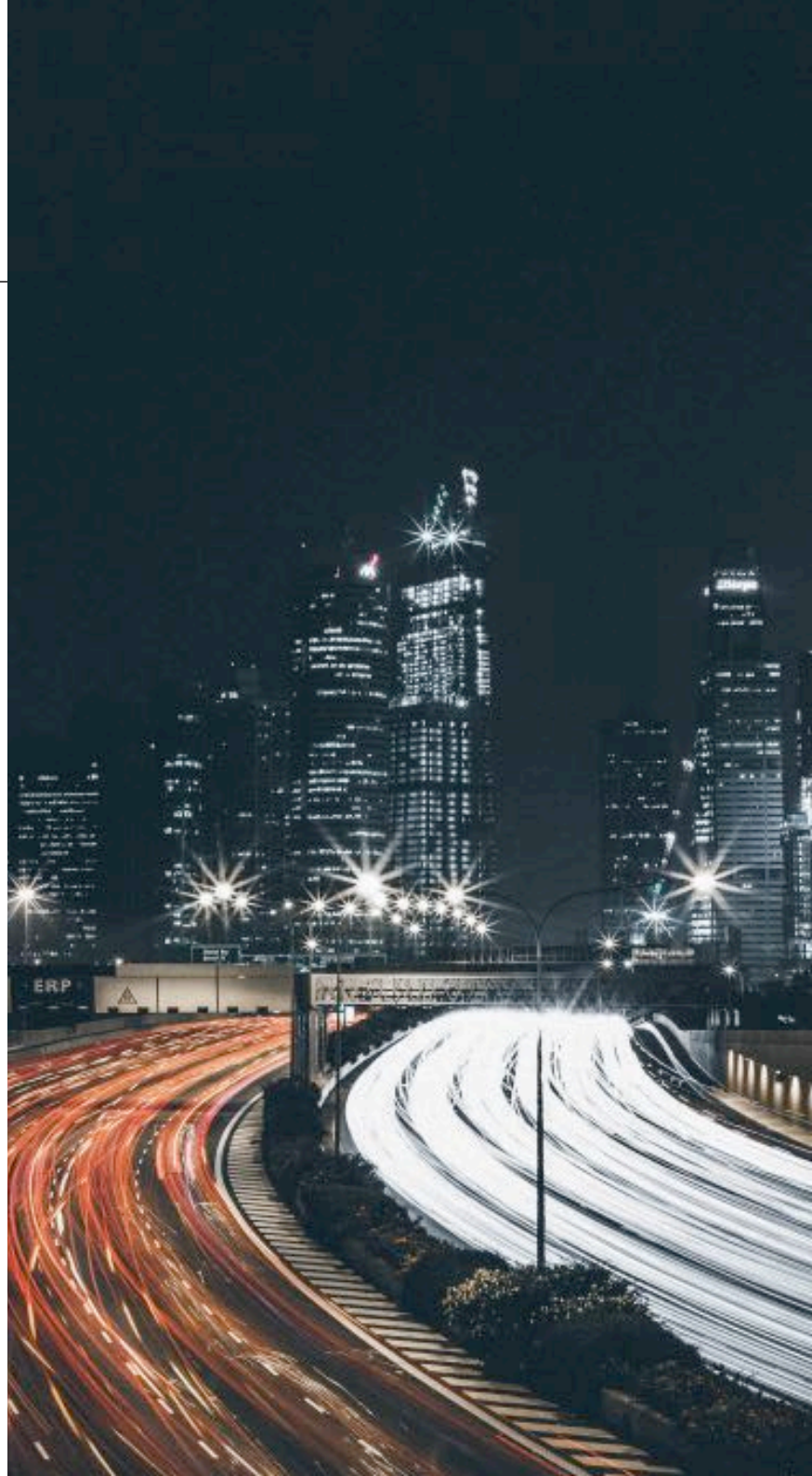
Australian Municipal Leaders

Australian cities do not have a single municipal authority with jurisdiction over the majority of the city area. While the cities themselves are comparably large (or larger) than many of the global cities above, the municipal authorities are much smaller and there are many of them covering the area of the city. For example, metropolitan Melbourne has a population of 4.3 million and an area of 10,000 km2, but this is made up of 32 independent local councils.[34] The central City of Melbourne only encompasses a population of approx. 137, 500 in 2016 people in 36.2 km2.[35] This means that any comparison with the global cities above needs to take the major differences in municipal governance arrangements into account.

The more complex challenges facing Australian city municipalities in directly reducing greenhouse gas emissions have not stopped many of them taking very strong leadership positions. The targets, strategies and some key actions of the four central municipalities of four of Australia's major cities—Melbourne, Sydney, Adelaide and Perth—are summarised in Table 2. Two other inner city municipalities in 'Melbourne' have been included as an indication of the leadership positions also being taken by 'non-central' authorities. These are the City of Darebin and Moreland City Council, both of which have greater populations and areas than the central City of Melbourne.[36]

Climate change remains a more partisan political issue at all levels of politics in Australia than in many of the countries or states of the leading global cities. This means that commitments to particular targets or ongoing actions at a state or national level have been slow to emerge and often disrupted by election cycles, meaning that they can disappear not long after they do. This has left many councils who are keen to take action frustrated by the lack of clarity or consistency in the state and national policy that affects their decisions and operations. As the City of Melbourne commented in their 2014 update of the *Zero Net Emissions by 2020 Plan* "collective progress in certain areas has been slow, such as reducing Victoria's reliance on brown coal, our most emissions intensive electricity source. *Zero Net Emissions—Update* 2008 was written with the assumption that Australia would put a price on carbon and international policy would be in place to drive significant emissions reductions" —which has not happened. Single municipal authorities, on their own, have little ability to shape the main electricity supplies to their constituents.

However, as there is no single authority responsible for the planning or infrastructure of an entire metropolitan area, local councils who are willing to push ahead of their states on targets and actions have formed their own alliances. In Melbourne councils like City of Melbourne, City of Darebin and Moreland (among others) are involved in initiatives like Resilient Melbourne or the Northern Alliance for Greenhouse Action to help individual councils engage in systemic climate planning. Adelaide is one state where the city council and the State government have been working together on their carbon neutral Adelaide initiative. At the other end of the spectrum, Western Australia has declared that it will not even consider any state-wide emissions targets leaving the City of Perth relatively isolated in its climate change action.



34 Resilient Melbourne. (2016). *Resilient Melbourne Strategy.* Available at https://resilientmelbourne.com.au/strategy. p12.

35 City of Melbourne. (2017). *City of Melbourne's Forecast Population*. Available at http://melbournepopulation.geografia.com.au/

36 See Climate Council. (2017). Local Leadership: *Tracking Local Government Progress on Climate Change* p30-31 for other examples. Available at http://www.climatecouncil.org.au/cpp-report

Table 2: Australian Cities

Target and Scope[a,b]	*City Jurisdiction*	*Climate change policy framework and planned actions/ goals*	*Progress since baseline and influential policies / actions*
City of Melbourne *Target: zero net emissions by 2020, 25% renewable electricity by 2018; 4.5%/year council emissions (2011/12)* *Scope: CO_2e, cons.*	*Pop. 128K* *Area: 36 km2*	*Zero Net Emissions by 2020* (2002, update 2008 and 2014) actions include: • Council operations: Queen Victoria Market renewal, Urban Forest Strategy • Buildings & industry: commercial building retrofits (1200 Buildings Program) • Energy: Collaborate with CitiPower on energy management & supply system • Transport & freight: implement Bicycle Plan, develop walking plan • Waste: trial precinct solutions that improve resource recovery	Overall emissions increased by 18% since 2008/9. Target of 10% reduction in council operation compared to 2010/11 achieved. Highlights since 2003: • Queen Victoria Market solar array installed (25,000 kW capacity) in 2003 • NCOS Certified Carbon Neutral status for council operations in 2012 • Swanston Street redevelopment increased public transport & cycling access • Melbourne Renewable Energy Purchasing Group with 3 other councils
City of Darebin *Target: zero net emissions by 2020; zero net emissions council by 2022 (2006/7)* *Scope: CO_2e, cons.*	*Pop. 147K* *Area: 53 km2*	*Darebin Climate Emergency Plan* (2017) actions focus on 2017-2022: • Energy: expanded Solar $aver Program to install 11,000kW, Solar Bulk Buy • Buildings: new buildings high ESD standard, streetlights to energy-efficient LEDs • Transport: Darebin Cycling Strategy, explore electric vehicles for council fleet • Consumption and waste: Investigate food waste service options to residents • Other: Climate Emergency campaign, invest with fossil-free financial institutions	Council emissions reduced by 45% from 2006/7 levels. Successful actions: • Solar systems installed for app. 500 pensioners & low-income households • 142 businesses had their lights upgraded to energy-efficient LEDs • Energy efficiency information in several languages • Increased comfort & reduced energy costs in 482 vulnerable households
City of Adelaide *Target: Carbon neutral, i.e. 65% by 2025 (2007); carbon neutral council by 2020* *Scope: CO_2e, cons.*	*Pop. 22K* *Area: 16 km2*	*Carbon Neutral Adelaide Action Plan 2016-2021* (2016) action highlights: • Buildings: support adaptive reuse of commercial buildings, Green City Plan • Transport: encourage 100% renewable energy for all electric vehicle recharging • Energy: increase investment in large scale renewables, battery storage • Waste & water: reduce emissions from solid and liquid waste	Community emissions have reduced by 20% in 2007-2013. Highlights: • City office emissions cut by 23% e.g. through green building design • $2.6 billion invested to extend tram network & electrify the train network • Cycling journeys in and through the city have doubled since 2003 • 43% of State's grid electricity sourced from renewable energy
City of Sydney *Target: 70% by 2030, zero net emissions by 2050; 50% of renewable electricity by 2030; council 44% by 2021 (2006)* *Scope: CO_2e, cons.*	*Pop. 208K* *Area: 25 km2*	*Environmental Action 2016-2021 Strategy and Action Plan* (2017) actions: • Buildings: net zero carbon buildings challenge, non-residential tune-up program • Energy: trigen system at Town Hall House, invest up to $10M in renewables • Transport: update car sharing policy, 10 high-priority regional cycling routes • Waste: review & update waste treatment contracts to avoid landfilled waste • Other: plant 700 street trees each year until 2021	Community emissions reduced by 17% in 2006-2015. Highlights: • Better Buildings Partnership collectively reduced annual emissions by 45% • Over 6,600 LED street lights installed across the local area since 2011 • 650 on-street parking spaces dedicated to car share vehicles • 69% of household waste diverted from landfill each year
Moreland City Council *Target: 22% by 2020 (in line with zero net emissions by 2045, 2011)* *Scope: CO_2e, cons.*	*Pop. 163K* *Area: 51 km2*	*Zero Carbon Evolution Strategy* (2014) actions by 2020: • Energy: low-interest finance for solar PV systems, Community Solar Cooperative • Buildings: energy efficiency retrofits on 36k homes, Green Tradies program • Transport: Improve north-south and east-west bike networks, 500 car share bays • Other: Urban Heat Island Action Plan, minimise food waste	Council operation emissions reduced by 4% in 2011/12-2013/14. Highlights: • 2nd in VIC certified as carbon neutral for its corporate operations in 2012 • Over 1000 low income homes retrofitted in 2012 • Significant energy efficiency improvements of key city buildings since 2009 • 6 public electric vehicle charging stations installed in 2013
City of Perth *Target: 30% by 2030, (BAU baseline), 20% renewable/ low carbon energy by 2030; council 30% by 2030* *Scope: CO_2e, no cons.*	*Pop. 21K* *Area: 20 km2*	*Environment Strategy* (2016) highlights: • Energy: generate renewable energy from city properties • Buildings: retrofitting and improved energy performance initiatives • Transport: work with community to increase the use of public transport • Waste: improved residential & commercial waste, recycling,green waste services • Water: implement and promote water sensitive urban design	Highlights: • 380,000 trees planted in the City's carbon offset tree planting program • Penny Lane Green Star affordable housing project completed in 2013 • $500k invested into the City of Perth Cycle Plan 2029 adopted in 2012

a Target: All cities have community-wide emission reduction targets, and many also have adopted additional city administration and/or renewable energy targets (not all additional targets are presented here). Baseline year is indicated in brackets.

b Scope: Refers to GHG emission inventory unit and whether the city includes any consumption-based (Scope 3) emissions in their core emissions that the target relates to. Note that if there was no data available to show their inclusion (in city planning or inventory documents), it was assumed that they were excluded. It is, however, recognised that community GHG inventories are often not reported by scope and that sector-based data is useful for comparative benchmarking (Blackhurst et al. 2011). Melbourne and Moreland include at least some Scope 3 emissions in their city operation related GHG inventories; Darebin, Sydney and Adelaide in terms of community-wide emissions.

Critical influences for the VP2040 project from this global and Australian analysis include:

- Leading cities are aiming for carbon neutrality by 2050 or earlier, often with an acknowledged or anticipated use of offsets to achieve this;
- While the scope of included emissions varies significantly, all of them ***include*** 'community-wide' emissions i.e. beyond the scope of the city administration's direct emissions but mostly ***exclude*** consumption related emissions (see Section 4.4. for details on accounting methods);
- As seen in Tables 1 and 2, Australian cities refer to 2006-2012 baselines whereas global cities refer mostly to reduction from 1990 levels and a few from 2005-2008 levels. Some global cities report progress since baseline and when the emissions peaked (which can be different years). Choosing a later year may also be because of lack of data to compile an emission inventory for earlier years. This is significant in relation to the speed of change and when accelerated reduction occurs, but significance reduces if/when zero net emissions are achieved.
- The tension between emissions reductions and population growth is a challenge for many cities, but their commitment is to absolute, not per capita, emissions reductions.

The VP2040 project has therefore explored targets at two levels:

- 80% reduction in carbon footprint on 2012/13 e.g. consumption emissions per capita—to include the more challenging and ambitious goal of accounting for all emissions related to consumption of city inhabitants (used for analysis of the four exploratory scenarios—see Modelling tables in Section 5)[37]
- 80% absolute reduction on 2012/13 consumption emissions by 2040—combining the ambitious consumption accounting with absolute emissions reductions for the city (used for analysis of the two Action Pathways—see Section 6).
- A more detailed justification of these very ambitious targets, and the carbon accounting and modelling methods used in this project, is at Section 4.4.

37 Per capita emissions targets have been used by other Australian decarbonisation work, such as the ClimateWorks' Deep Decarbonisation Pathways Project analysis, which presented an illustrative deep decarbonisation pathway by which energy-related emissions are reduced by over 80% per capita nationally by 2050.

3. Challenges and Opportunities of Visions and Pathway Scenarios

This Section discusses the rationale, and some of the challenges, of using Visions and Pathway scenarios to explore and motivate action towards sustainable futures. It also discusses the benefits and challenges of accompanying qualitative scenario analysis with quantitative modelling of emissions reductions.

3.1. Visualised futures can change what is possible

Visions of possible futures can open up new conversations on the nature, culture and dynamics of city development and planning, breaking from the existing institutional perceptions of possibilities that underpin planning and urban design decisions.[38,39] The process of generating visions – and the visions themselves – can be considered as a feedback loop. They highlight tensions at the socio-technical landscape level, portray alternative (future) regimes in operation and make potential new areas for innovation visible.[40,41,42]

The development of modern scenario and futures thinking has passed through three generations,[43] [44] summarised as:

- Predicting the future as accurately as possible, through quantitative or econometric methods to extrapolating trends —"what will happen?".
- Considering possibilities to inform preparation and response strategies—"what will we do if something happens?" e.g. the scenario planning pioneered by Shell in the 1970s[45]
- Exploring necessary or desired structural and societal changes required to pursue a goal e.g. sustainability. Normative and explorative scenario processes produce pictures of the future that we collectively may want. The question then becomes: "what do we actually want the future to look like?"

The development of the VP2040 Visions is located within this third generation. The normative element under which these scenarios have been constructed is that the city has achieved an 80% reduction in greenhouse gas emissions and greater resilience by 2040. VP2040 is also strongly committed to participatory methods that develop scenarios with people and communities who are affected by them.This does not mean that the structures and process that underlie these future cities are attractive to all those who have contributed to their development.

Around the world, increasing attention is being paid to co-developing future visions and pathways to crack open the transformation necessary for low-carbon and resilient urban living. 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. Descriptions of these projects are summarised in the first year report from this project.[46]

There are significant challenges in scenario work and envisioning low carbon urban futures, including:

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

'Good' scenarios are useful fictions. All of the challenges above are important, but they do not undermine the validity of the 'stories' that are told in visioning scenarios. If a set of scenarios aid in strategy articulation, or encourage actors to reflect on their assumptions and dominant worldviews, then they are useful and worthwhile—they do not need to 'accurately' depict a future.[47]

38 Hajer, M. A., & Dassen, T. (2014). *Smart about cities: visualizing the challenge for 21st century urbanism.* NAI PBL Books Rotterdam.

39 Hajer, M. (1995). *The Politics of Environmental Discourse.* Oxford University Press.

40 Ryan, C. (2013). *Eco-Acupuncture: designing and facilitating pathways for urban transformation, for a resilient low-carbon future.* Journal of Cleaner Production, 50, 189–199.

41 Ryan, C., Gaziulusoy, I., McCormick, K., & Trudgeon, M. (2016). *Virtual city experimentation: A critical role for design visioning.* Evans, J., Karvonen, A., & Raven, R. (Eds.). (2016). The Experimental City. Routledge.

42 Gaziulusoy, A. I., & Ryan, C. (2017). Roles of design in sustainability transitions projects: A case study of Visions and Pathways 2040 project from Australia. *Journal of Cleaner Production*, 162, 1297-1307.

43 List, D. (2005). *Scenario Network Mapping The Development of a Methodology for Social Inquiry.* (PhD thesis) Division of Business and Enterprise, University of South Australia. Available at http://www.audiencedialogue.net/Scenario%20network%20mapping%20.pdf.

44 Sondeijker, S. (2009) *Imagining Sustainability: Methodological building blocks for transition scenarios* (PhD thesis) Erasmus University, Rotterdam.

45 Wilkinson, A. & Kupers, R. (2013). Living in the Futures. *Harvard Business Review*, May Issue.

46 Ryan, C., Twomey, P., Gaziulusoy, A. I., & McGrail, S. (2015). Visions 2040 - R*esults from the first year of Visions and Pathways 2040: Glimpses of the future and critical uncertainties.* Melbourne, Australia. ISBN 978 0 7340 5108 0

47 Gaziulusoy & Ryan 2017, see above.

3.2. Pathways help link the present with the future

Pathways attempt to answer the question "Yes that sounds good, but how do we get there?" Pathways are increasingly employed in the discussion of transitions to low carbon societies; they are important to the perceived plausibility of the Visions presented.

Developing low carbon transition pathways is inherently complex and fraught, as understanding and describing processes of change involving interacting technological, physical, economic, political, social and ecological systems is no easy task. In cities the complexities, uncertainties, and resistance associated with the sustainable provision of energy, food, mobility, shelter, water and waste removal are likely to be particularly difficult to unpack.

Key challenges of analysing sustainability transitions pathways include:

- identifying and defining appropriate spatial/geographic boundaries and time scales;
- the inherent unpredictability of disruptive social and technological innovation and system transformations;
- the existence of multiple agents and agendas, contested values and goals;
- inertia and path dependence.

These are briefly discussed below, along with implications and decisions taken in relation to them in this project.

The first challenge is of identifying and defining appropriate spatial /geographic boundaries and time scales. Broad temporal and spatial scales can provide more comprehensive coverage of the subject of interest (e.g. total carbon emissions) but can also oversimplify and miss cultural, behavioural or social dynamics. This challenge is significant for analysis of Australian cities. The city known as Melbourne can be variously defined as the central local government municipality (the City of Melbourne), extended to include the urban areas of Greater Melbourne and also its wider rural hinterland. The selected geographical boundaries have implications for potential impact and jurisdiction (who is actually in control of decisions with major impacts on emissions). Even once geographical boundaries are determined, representation of city emissions requires consideration of activities beyond the physical boundary of the city to include an accurate understanding of the role of cities in generating greenhouse gases (e.g. the emissions of electricity and food provided for the city). The approach VP2040 has taken to this is detailed in Section 3.3 where quantitative methodology is outlined.

The second challenge is the inherent unpredictability of disruptive social and technological innovation and system transformations. For example, some anticipated disruptive innovations fail to materialise in the time expected (e.g. heat pumps and electric cars). Some cycle through hype and disappointment cycles (e.g. hydrogen, biofuels) and others experience rapid and unforeseen rapid diffusion e.g. solar PV, meat-free Mondays.[48] The successful influence and continued strength of dominant incumbents is also hard to anticipate.[49]

The third challenge is the multiplicity of agents and agendas operating in the underlying system. A city is composed of numerous agents, organisations and networks operating in various loops of interaction that continuously reshape and, to some extent, redefine the urban landscape. Within and between these actors there is also likely to be a diversity of goals and values attached to any proposed sustainability pathway. This contestation on the desirability, appropriateness and effectiveness of any proposed pathway is a defining feature of 'wicked problems'. Cities are living environments in which people have personal, emotional, and social stakes, including socially embedded relations and a level of trust.[50]

Transformation in cities is countered by processes of inertia or path dependence (the self-reinforcing processes that guide the development of a system) and lock-in (the historically evolved system state and its physical embodiment that cannot be changed easily). For example, the case of carbon lock-in in energy systems described by Unruh[51] showed how this arises from the co-evolution of large interdependent technological networks, social institutions, cultural practices and incumbent businesses that support and benefit from system growth. In transition theory this is captured in the term 'regime'.

There are three main conceptions of pathways[52] in the literature on low-carbon transitions, summarised on page 17. These perspectives are not mutually exclusive and analysis of sustainability transitions can draw on the respective strengths of these different perspectives. There have been recent efforts to bridge these qualitative approaches with quantitative modelling (in the techno-economic traditions) such as the EU FP7 Pathways Project (2014-2016). VP2040 Pathways are most strongly aligned with the 'socio-technological' approach (see page 17), while also drawing on the 'techo-economic' approaches in quantitative modelling of technical change and emissions reduction, and through some high-level indications of policy or action directions for key actors.

48 Turnheim, B., Berkhout, F., Geels, F., Hof, A., McMeekin, A., Nykviste, B., van Vuuren, D. (2015). Evaluating sustainability transitions pathways: Bridging analytical approaches to address governance challenges. *Global Environmental Change* 35, 239–253.

49 Deetman, S., Hof, A.F., Girod, B., van Vuuren, D.P. (2015). Regional differences in mitigation strategies: an example for passenger transport. *Regulation of Environmental Change*, 15(6), 987–995.

50 Wittmayer, J. M., & Loorbach, D. (2016). Governing transitions in cities: fostering alternative ideas, practices, and social relations through transition management. In *Governance of Urban Sustainability Transitions* (pp. 13-32). Springer Japan.

51 Unruh, G. (2000). Understanding carbon lock-in. *Energy Policy,* 28(12), 817–830.

52 Rosenbloom, D. (2017). Pathways: An emerging concept for the theory and governance of low-carbon transitions. *Global Environmental Change*, 43, 37–50.

There are three main conceptions of pathways[53] in the literature on low-carbon transitions, briefly summarised as:

- Biophysical pathways are typically grounded within climate science research and understood as "long-term trajectories of GHG emissions linked to particular stabilization targets and derived from macro-level parameters describing human-climate interactions over time."[54] Their role is typically not to advocate specific pathways or provide specific policy advice but rather inform impact assessments and set the context for climate negotiations.
- Techno-economic pathways focus on forecasted changes in the technological and economic performance of specific sectors (e.g. electricity, transport, industry, or buildings) and links such changes to potential investment reconfiguration and/or changes to government policy. This approach typically emphasises rational economic decision making and how changes in relative cost and/or performance of key technologies and carbon pricing could affect investment and operational patterns. The Pathways to Deep Decarbonization Project[55] and the Beyond Zero Emissions project[56] are Australian examples of this research strand. In this approach, there is often a more explicit normative stance in regard to what are regarded as desirable goals, the criteria for assessing pathways and in providing policy recommendations. However, these criteria are often cast only in terms of efficiency and cost-minimisation (e.g. identifying the lowest cost option for achieving an emissions reduction target);
- Socio-technical pathways explore the interconnected nature of technological and social change. They do not oppose or ignore the biophysical and techno-economic dimensions of innovation and transitions, but the main focus is the "broader political, institutional, cultural, and behavioural dynamics relevant to long-term processes of societal change."[57] Socio-technical pathways analysis is usually qualitative, typically uses narratives, is averse to thinking in terms of simple causes or single factors, and often draws on historical studies to learn from past episodes of system changes to elucidate the complex interconnections between technological and social dynamics. There is also a tendency to engage more explicitly with the normative goals and implications of sustainability transitions. Thus preferred scenarios using multiple criteria including social dimensions (such as inclusion and inequality) appear more often.

53 Rosenbloom, D. (2017). Pathways: An emerging concept for the theory and governance of low-carbon transitions. *Global Environmental Change*, 43, 37–50.

54 Ibid p.39.

55 ClimateWorks Australia, ANU, CSIRO & CoPS. (2014). *Pathways to Deep Decarbonisation in 2050: How Australia can prosper in a low carbon world:* Technical report. ClimateWorks Australia.

56 BZE. (2017). Beyond Zero Emissions. http://bze.org.au/

57 Rosenbloom 2017 p.43, see above

3.3. Quantitative modelling for credibility

The shift in focus from national to sub-national climate action that has emerged in the past decade and recognition of the key role for cities in climate mitigation[58] has given rise to new challenges around measuring the success of local action. The quantification of greenhouse gas emissions in urban areas is seen by city governments as an essential aspect of developing and evaluating mitigation strategies to achieve reduction targets. The credibility of any decarbonisation scenarios will ultimately depend on a demonstration of their likely success in achieving those targets.

Quantitative modelling is a way to measure or estimate the impact of low-carbon interventions and help to identify the most promising sectors for future investment in the necessary urban transformation towards sustainability. To produce a credible estimation, quantification methods should be able to capture the changes in emissions generation from different low carbon policies and other strategies. Various methods have been developed for different purposes, such as monitoring, reporting, planning, decision-making, and analysis of land-atmosphere carbon exchange, and with different spatial and temporal system boundaries.[59]

Emissions accounting is often used to determine baseline emissions and their distribution across goods and services to identify key intervention points for mitigation. Dynamic modelling methods are typically employed to simulate the effects of low-carbon initiatives implemented over time according to the characteristics of each scenario to build emissions profiles for each of the end-states. These profiles can then be compared to the baseline and to each other to determine the efficacy of various low-carbon interventions.

Challenges arise however when determining the ranges for variables in the modelling process, capturing the dynamics and complexities inherently present in urban areas and quantifying interactions across multiple regions and sectors. Changes in the urban context are necessary across a number of different but interacting domains e.g. electricity, mobility, food. The potential non-linearity and non-continuity of change arising from these interactions can make quantitative modelling particularly difficult. Formal models can be limited in accommodating fundamental shifts in the structure and dynamics of systems because they are often fixed by the system definitions and structures in the model's equations. This challenge was faced in this project, as the first input-output modelling method used was limited to quantifying carbon emissions reductions from changes to demand and carbon intensities governed by linear equations and with no interaction with other domains. Although this method is effective for giving a snapshot of emissions impacts at certain points in time, it is not suitable for modelling feasible low-carbon pathways over time, leading to the use of ASFF for analysis of the Action Pathways. See discussion in Section 4.4 for more detail.

58 Betsill, M.M., Bulkeley, H. (2006). Cities and the multilevel governance of global climate change. *Global Governance* 12(2), 141–159.

59 Rojas-Arevalo, A.M., Aye, L., Candy, S. (2017). Quantifying greenhouse gas emissions: A review of models and tools at the precinct scale, Australia

4. VP2040 Methodology

The VP2040 methodology was informed by the theory, examples and considerations/complexities outlined in Section 3, and is discussed in more detail in earlier reports. Key points and links to more information are summarised below.

4.1. Four 'Visions'

Drivers of Change

An analysis of key drivers of change (or driving forces) extended the commonly used STEEP framework (which refers to social, technological, economic, environmental and political drivers) to explicitly incorporate demographic and geographic trends. There was also an explicit focus on identifying emerging areas of disruptive innovation—where changes might significantly and rapidly disturb the status quo.

These areas were explored through:[60]

- Tracking current research, industry and policy intelligence to identify emerging technological and social innovations, particularly those that are seen as potentially disruptive (e.g. renewable energy generation and storage technologies, new peer-to-peer trading or sharing services, and autonomous electric vehicles);
- Creating an international scientific committee of experts involved in projects similar or related to VP2040;
- Learning from other national and international visioning, scenario and backcasting projects looking at sustainable and/or urban futures. Some particularly useful foresight material was found in SPREAD,[61] Retrofit 2050,[62] MUSIC[63] and CRISP;[64]
- Interviewing a selection of thinkers and practitioners in the realm of sustainability and city futures;
- Conducting expert workshops on particular areas of relevance for potential disruptive change;
- Analysing glimpses from the two visioning workshops conducted in Melbourne and Sydney;
- Meetings and discussions with project partners and members of the international scientific committee on project findings, implications and emerging issues;
- Two participatory workshops conducted in 2015 in Adelaide and Perth.

The key scenario dimensions identified were:[65]

- Centralised vs. distributed systems of provision (energy, water, food, transport, waste disposal);
- Shifts in governance and emergence of new actors, particularly those underpinning the emergence of cities as an active player in global climate action;
- The characteristics and use of urban space and urban form;
- Embedding of new informational and 'smart' technologies in urban and household environments;
- Importance of production and consumption in emissions reduction;
- Ways of life within the city; new urban cultures;
- Economic and political institutions.

Developing Visions

The Vision development process was mostly inductive and informed by participatory scenario workshops through three main phases, summarised in Figure 1:

1. Initial conceptualisation/debate, leading to an initial set of 'proto-scenarios' based on social, political and economic conditions;
2. Scenario elaboration and visualisation—the 'proto-scenarios' were interrogated and elaborated through visioning workshops in the cities (with over 250 participants in total) for deeper consideration of 'localised' possibilities for transformation in the Australian cities. Design ateliers were run to develop scenario visualisations from the workshop outcomes;
3. Scenario refinement—further interrogation at workshops in Perth, Sydney and Melbourne on the plausibility of potential scenario pathways.

The Visions are presented in Section 5.

60 See detail in Ryan, C., Twomey, P., Gaziulusoy, A. I. @ McGrail, S. (2015). *Visions 2040 - Results from the first year of Visions and Pathways 2040: Glimpses of the future and critical uncertainties.* Melbourne Australia

61 http://www.sustainable-lifestyles.eu/

62 http://www.retrofit2050.org.uk

63 http:// www.themusicproject.eu

64 http://crisp-futures.eu

65 See detail in Ryan, C., Twomey, P., Gaziulusoy, A. I., McGrail, S., Chandler P. (2016). *Scenarios 2040 - Results from the second year of Visions and Pathways 2040: Scenarios of Low Carbon Living.* Melbourne, Australia.

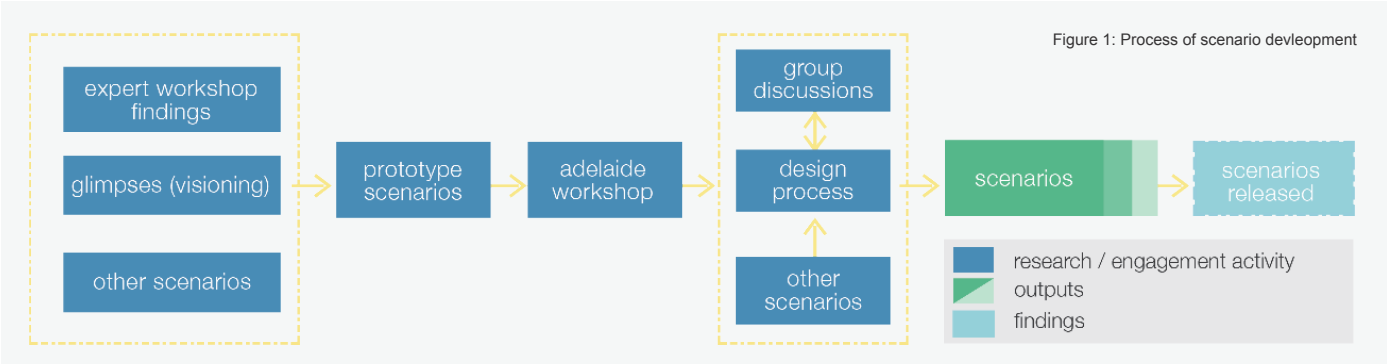


Figure 1: Process of scenario devleopment

4.2. Four Exploratory Pathways

Our approach to pathway development was inspired by participatory backcasting studies that involve stakeholders (or other relevant actors) in exploratory processes which look back from long-term futures to define related change pathways. Methods were developed by VEIL in its previous Melbourne 2032 project that were adapted for the VP2040 work.[66] This pathway-focussed inquiry differed from the earlier scenario-building activities with respect to its stronger emphasis on current and potential patterns of change and consideration of policy/action implications.

Activities to explore low-carbon pathways for Australian cities and consider their plausibility have included:

- **Participatory Backcasting** (defined primarily as low-carbon outcomes): engaging built environment sector actors and other experts in a process of reasoning back from scenario end-states to identify possible transformative changes consistent with such low-carbon outcomes, current seeds of such change, and potential 'branching points'. This was primarily undertaken at workshops in Sydney in 2015, and Melbourne in 2016 (see Appendices);
- **Narrative Development:** possible sequences of events through which low-carbon pathways may emerge (which were termed "pathway narratives") were explored through development of associated qualitative narratives (see *Section 4* of this report). This included multiple cycles of pathway conceptualisation, feedback, and desktop research (Figure 2). Experts and stakeholders provided feedback on these illustrative pathway narratives (see Appendices);
- **Quantification of scenario outcomes examining projected changes to the city carbon footprints in the year 2040** (see Section 4.4).

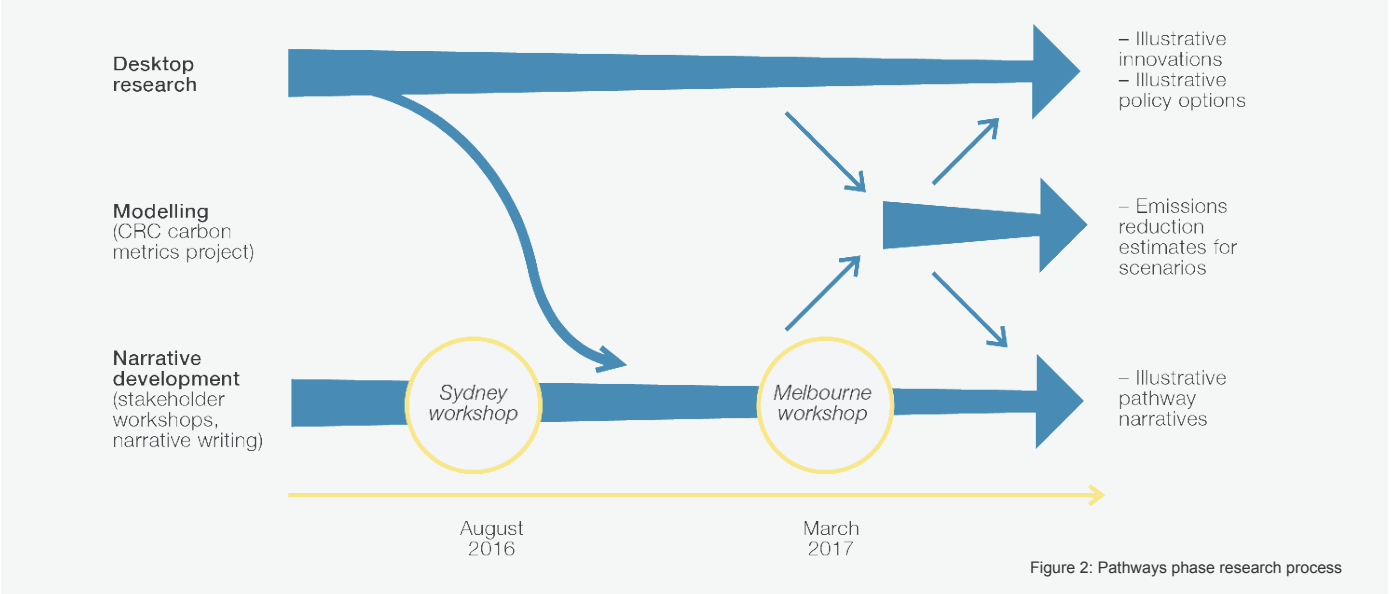


Figure 2: Pathways phase research process

The research team also identified activities and innovations relevant to each scenario, how they might scale as 'signals' that this scenario was unfolding and considered the policy implications and actions that could be undertaken to amplify or accelerate them.

4.3. Two Action Pathways

This project has worked in an iterative process, collaborating closely with industry and government partners. Throughout the project there have been ten workshops across the partner cities to get expert input broadly and on very specific elements within the project – such as on the sharing economy. We've also communicated findings back to industry and government to begin to inform practice.

Through this process partners have provided detailed feedback on the four exploratory scenarios (detailed in Section 5.5). These can be summarised as:

- Tensions and questions remain that undermine the perceived 'plausibility' of the scenario pathways—the "how do we get there?";
- Too complex to be used as guides for their own decision-making—need simpler (and 'more desirable' versions) as tools to determine their own pathway and actions.

To respond to the tensions and critiques raised in relation to the four original scenarios, we have streamlined the scenarios into two 'combined' scenarios that provide clearer Action Pathways for cities. These two new scenarios allow for more coherent and multifaceted activities and responses to drive climate response, more fully exploring the possibilities presented in the first four scenarios.

The two Action Pathways are detailed in Section 6.

66 Ryan et al. (2015) and and Ryan (2013), as above.

4.4. Accounting, Targets and Modelling—Quantitative Methods

The contribution of cities to global greenhouse gas emissions has been estimated at between 53-87%,[67] depending on boundary assumptions and accounting methods[68] (as discussed in Section 2). This Section discusses considerations around these boundary assumptions and accounting methods, and how they have informed the major decisions that have shaped the quantitative analysis. This includes:

- The use of consumption-based accounting of emissions attributable to cities;
- The initial use of an 80% reduction in carbon footprint per capita (on 2013 levels) target for analysis of the four exploratory scenarios, using the multi-region input-output model developed as part of the CRCLCL Integrated Carbon Metrics program;
- Feedback from the participants in the Pathways workshops that shaped the development of two Action Pathways, and the more ambitious target for analysis;
- The use of an 80% absolute reduction on 2013 city consumption emissions by 2040 for analysis of the two Action Pathways, using the Australian Stocks and Flows Framework model.

Accounting: Use Consumption-based emissions rather than Production-based

Production-based accounting estimates GHG emissions occurring within a geographically defined area. These are often referred to as direct or Scope 1 GHG emissions according to the GHG protocol.[69] They include all direct GHG emissions from production processes located within the geographical boundaries of the area, regardless of where the output is consumed.[70] Most city or municipal carbon accounting includes Scope 1 emissions and in many cases Scope 2 emissions—GHG emissions from the generation of purchased electricity. *Consumption-based accounting* allocates all upstream GHG emissions from production processes to the final consumer; a defined population (i.e a city or country) or a specific activity (i.e. the provision of urban services). These are commonly referred to as embodied emissions or Scope 3 emissions. Most of the cities reviewed in Section 2 included Scope 1 and 2 emissions in their accounting of emissions.

In a review of city carbon footprints across multiple countries, it was found that those calculated with *production* based methods resulted in lower per capita emissions for cities compared to national per capita emissions figures for their respective countries.[71] This would seem to indicate that city emissions are not 'significant' in comparison to emissions overall. However, that review also notes that the use of production-based emissions figures distorts the responsibility of different cities for generating greenhouse gases and divert attention and blame from the high consumption lifestyles that drive unsustainable levels of greenhouse gas emissions. In practice, they also fail to identify the areas in which interventions are required to reduce emissions, by focusing attention on only one part of multiple complex commodity chains. This failure is raised in a number of studies that have identified *consumption*, especially in the industrialised world, as the main driver of environmental pressure.[72,73,74]

In the Australian context, characterised by high consumption lifestyles, it would seem that a consumption-based approach would be necessary to accurately and fairly calculate our carbon footprint. It is particularly the case in our post-industrial cities because "...in service-oriented cities, consumption-related emissions are more important than those produced by production."[75] A recent consumption-based estimate of the carbon footprints of Australia's two largest cities, Melbourne and Sydney, found that per capita emissions were 29.1 and 24.7 tCO_2eq respectively, with more than 50% attributable to imported emissions from goods and services (excluding food and electricity).[76] If an average of these two figures were multiplied by the total number of people living in cities across Australia, city emissions would constitute 63% of national emissions, which is consistent with overall studies and with the disproportionate contribution of cities in Australia to the national GDP. The disadvantage of consumption-based approaches for the VP2040 project is that they may identify opportunities for emissions reductions that are outside the direct control of city governments.

The decisions was taken early in the project to do the analysis based on consumption based emissions (more ambitious), but to first consider per capita carbon footprints, rather than absolute emissions (less ambitious—allowing the problematic population growth to be excluded).

67 Seto *et al.* 2014, see above.

68 Webb *et al.* 2017, see above.

69 World Resources Institute, C40 Cities, ICLEI. (2014). *Global Protocol for Community-Scale Greenhouse Gas Emission Inventories. An Accounting and Reporting Standard for Cities.* Available at http://www.ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities

70 Larsen, H.N., Hertwich, E.G. (2009). The case for consumption-based accounting of greenhouse gas emissions to promote local climate action. *Environmental Science & Policy*, 12, 791–798. doi:10.1016/j.envsci.2009.07.010

71 Dodman, D. (2009). Blaming cities for climate change? An analysis of urban greenhouse gas emissions inventories. *Environment and Urbanization*, 21, 185–201. doi:10.1177/0956247809103016

72 Princen, T. (1999). Consumption and environment: some conceptual issues. *Ecological Economics,* 31(3), 347–363.

73 Lenzen, M., Murray, S.A. (2001). A modified ecological footprint method and its application to Australia. *Ecological Economics,* 37(2), 229–255.

74 Wier, M., Lenzen, M., Munksgaard, J., Smed, S. (2001). Effects of household consumption patterns on CO_2 requirements. *Economic Systems Research,* 13(3), 259–274.

75 Bai, X. (2007). Industrial ecology and the global impacts of cities. J*ournal of Industrial Ecology,* 11(2), 2.

76 Chen *et al* 2016, see above.

Modelling Four Exploratory Scenarios with Integrated Carbon Metrics

Greater Sydney was used as a case study to explore the impacts of low-carbon interventions in the four characteristically different low-carbon city scenarios, represented as changes in demand and carbon intensity over time. A consumption-based environmentally extended multi-region input-output (MRIO) model was used to determine the baseline 2013 emissions profile and the carbon footprints of each scenario end-state.[77] It was developed as part of the Integrated Carbon Metrics research program within the CRC LCL and based on Australian input-output tables that are published by the Australian Bureau of Statistics (ABS) and data from the Australian Greenhouse Emissions Information System (AGEIS). It includes data on inter-industry relationships for three regions—Greater Sydney, rest of Australia (RoA) and one region representing the rest of the world (RoW). Emissions are allocated from sectors to final demand of products using the standard Leontief demand-pull model.[78]

In addition to the indirect emissions calculated using MRIO analysis, the household direct emissions were also estimated on the basis of spending on energy derived from household survey data. The emissions included in private car use and household energy use are available in supplementary data. The emission factors are taken from National Greenhouse Accounts[79] while fuel prices have been sourced from Australian Institute of Petroleum.[80] The result of this process is a 'carbon map' of city emissions based on demand by sector and by region. Figure 3 shows what this looks like for the 2013 baseline emissions.

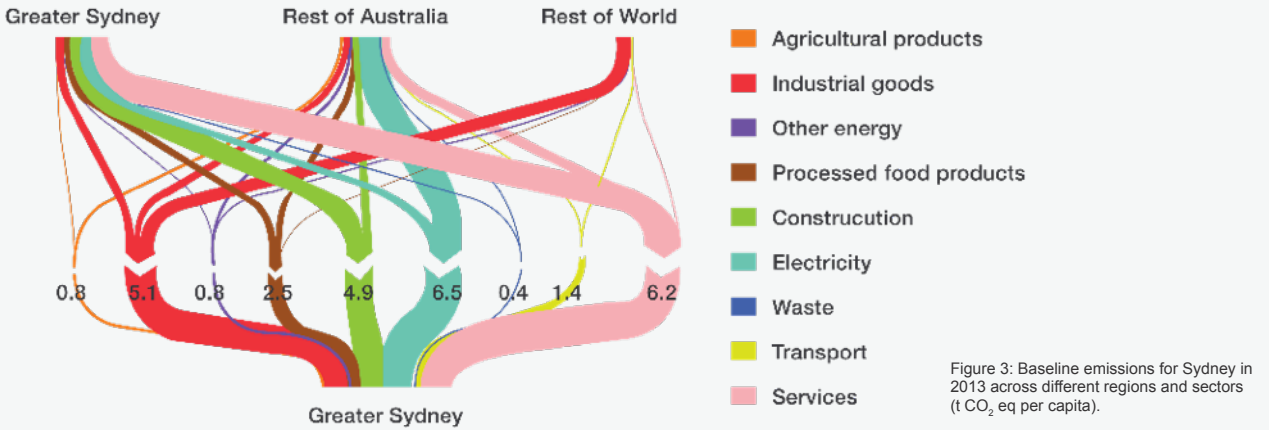


Figure 3: Baseline emissions for Sydney in 2013 across different regions and sectors (t CO_2 eq per capita).

77 Wiedmann, T.O., Chen, G., Barrett, J. (2015). The Concept of City Carbon Maps: A Case Study of Melbourne, Australia. *Journal of Industrial Ecology,* 20(4), 676-691. DOI:10.1111/jiec.12346

78 Miller, R.E., Blair, P.D. (2009). *Input-output analysis: foundations and extensions.* Cambridge University Press

79 Australian Government. (2014). *National Greenhouse Accounts.* Department of the Environment, Canberra, Australia.

80 AIP. (2016). *Australian fuel prices reports.* A.I.P: Australian Institute of Petroleum. http://www.aip.com.au/pricing/

Scenario Settings

To simulate emissions reductions between a baseline level in 2013 and four different end states in 2040, each scenario narrative and summary table was translated into more specific modelling assumptions and settings across six focal sectors (electricity/energy, transport, food, goods, water and waste) and 11 core variables (proportion of renewable energy generation, energy consumption, transport mode distribution, number of vehicles, need to travel, diet profile, consumption of processed foods, amount of food waste, consumption of goods, changes in urban water infrastructure).

These settings were then translated into settings across the 12 main sectors in the Integrated Carbon Metrics (ICM) model, as well as some settings changes across 1284 sub-sectors where further nuance was needed. This work was led by the ICM project team (which is also funded by the CRC for Low Carbon Living) at the University of New South Wales.

Existing consumption levels of certain products and carbon intensities of industries were linearly increased or decreased over the intervening time period according to each scenario's target settings in 2040. Iterative review and modification of the scenario settings was undertaken where required to meet the 80% carbon footprint reduction target by 2040.

Limitations of MRIO method

This method can be classified as static in nature,[81] giving a snapshot of carbon emissions attributable to a city for a given year by sector and by region. Emission reduction measures can be explored by altering either the demand for products, the industry carbon emission intensities, or both. It allows rapid computation and identification of emissions across different sectors and regions, providing an indication as to which industries

81 Rojas *et al* 2017, see above.

are the most promising sectors for future investment in the necessary urban transformation towards sustainability

A key limitation is that the linear equations in MRIO model relating outputs of one industry to inputs of others are not necessarily representative of reality because increases or decreases in output do not always require proportional increases or decreases in inputs in complex systems. In addition to this, the inter-industry matrix that governs the flow of materials from one industry to another is determined from input-output tables and cannot be altered. This means that improvements in material use efficiencies or material and factor substitution (e.g. recycling, organic farming methods, sharing systems, transport mode shifts) cannot be explored in detail,[82] which have been identified as important in other decarbonisation pathways research.[83] While it would be possible to model the impacts on overall emissions of reducing either the carbon intensity or demand that might result from substitution or improved efficiencies, it is not possible to model specific actions that would actually cause those reductions.

Another limitation of this method for modelling pathways is that the temporal and natural resource constraints are not considered. The rate at which low-carbon interventions can be implemented depends on resource availability and the rate at which existing carbon-intensive products or services that we depend on can be replaced (for example, a certain amount of time is required to construct large scale renewable energy plants before the carbon intensive plants they replace can be de-commissioned). When exploring possible decarbonisation pathways, it is necessary to know not only the magnitude of the emissions savings of low-carbon interventions but how long they will take to be realised. This is essential to prioritise investment in interventions that will contribute to necessary rapid decarbonisation.

Finally, with this method it is not possible to explore carbon sequestration potential (or limitations). This may be necessary to achieve carbon neutrality by 2050, reflected in the fact that it has been included in other decarbonisation studies[84] and some forms of sequestration—like offsetting through tree-planting—are explored or implemented by some of the city emission reduction plans outlined in Tables 1 and 2.

82 Larsen *et al* 2009, see above.

83 ClimateWorks *et al* 2014 see above.

84 Ibid.

Modelling Two Action Pathways with Australian Stocks and Flows Framework

Absolute 80% reduction

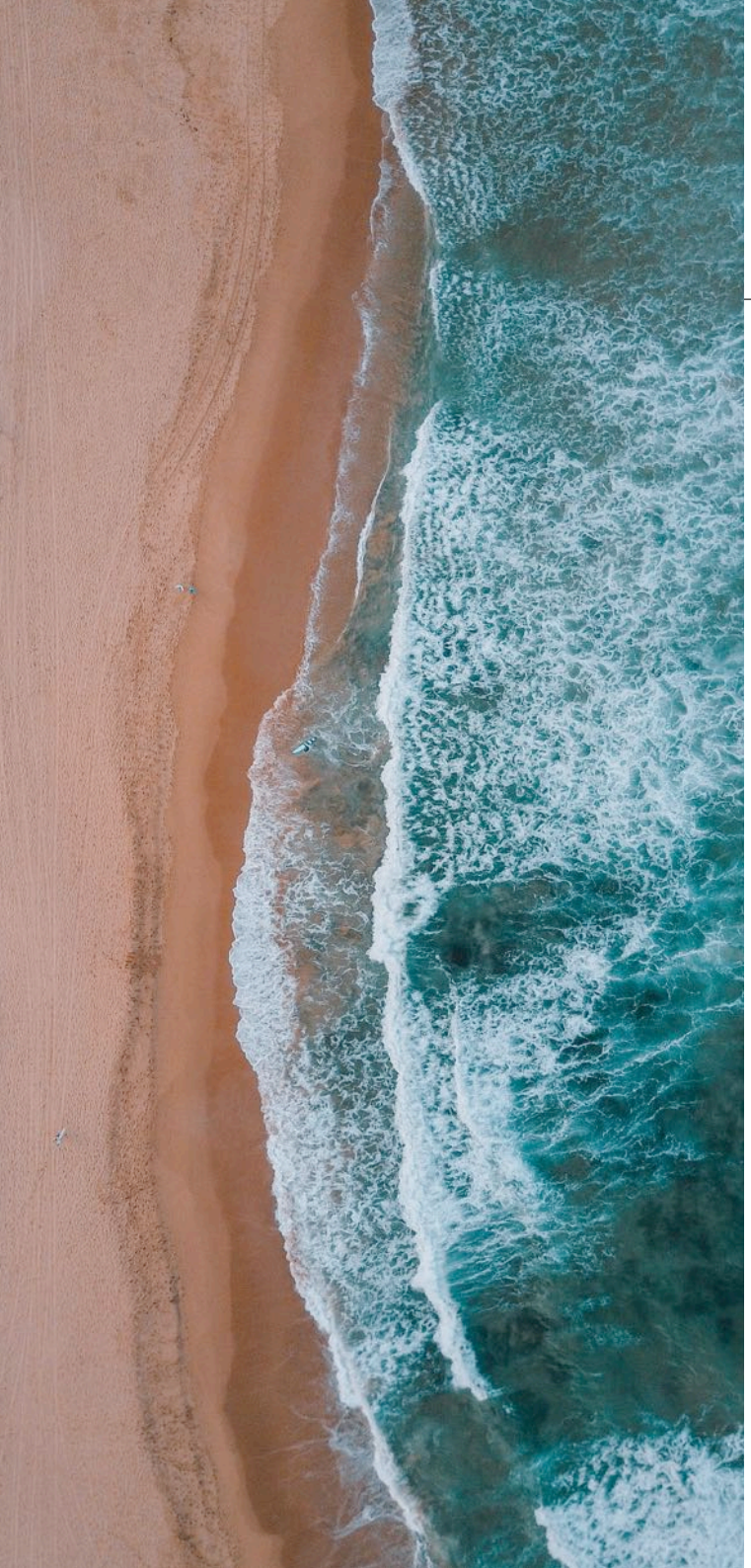
All nations signed up to the Paris Agreement, including Australia, have committed to limiting their greenhouse gas emissions and taking other actions to limit global temperature change. Specifically they have agreed to hold "the increase in the global average temperature to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels," and achieve carbon neutrality in the second half of this century. Australia's currently stated target is to reduce emissions to 26-28 per cent on 2005 levels by 2030.[85] The Paris Agreement target has been criticised as insufficient to stabilise climate and prevent catastrophic warming, with a stronger target of carbon neutrality by 2050 proposed and a focus on rapid decarbonisation.[86]

Achieving zero net carbon by 2050 will require steep rates of reductions in our national emissions and increases in carbon sequestration in the intervening years—more than 80% per capita and more like 80% absolutely. In 2015 the Climate Change Authority recommended that Australia reduce its emissions by 40-60% by 2030 based on 2000 levels.[87] An absolute emissions reduction target of 80% by 2040 is on a strong trajectory to carbon neutrality by 2050 and therefore in line with these recommended targets. Due to the fact that cities contribute disproportionate amounts to national emissions and have significant influence on national economies and progressing change, a strong 80% absolute emissions reduction for cities was considered a reasonable/necessary target for the Action Pathways.

85 Australian Government. (2015b). *Australia's 2030 climate change target - fact sheet.* Department of the Environment, Canberra, Australia. Available at http://www.environment.gov.au/climate-change/publications/factsheet-australias-2030-climate-change-target

86 Ramanathan, V., Molina, M.J., Zaelke, D., Borgford-Parnell, N.,Xu, Y., Alex, K. ... Victor, D. (2017). *Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change.* Institute of Governance and Sustainable Development, Washington DC.

87 Climate Change Authority. (2015). *Final Report on Australia's future emissions reduction targets*, Available at http://climatechangeauthority.gov.au/sites/prod.climatechangeauthority.gov.au/files/Final-report-Australias-future-emissions-reduction-targets.pdf



System dynamics modelling

After considering the limitations of the IO method discussed above for modelling low-carbon interventions in the context of this feedback, and given the complex nature of cities and the systemic challenges implied by decarbonisation, it was decided to model the pathways using the Australian Stocks and Flows Framework (ASFF). With this modelling platform it was possible to integrate resource use, temporal aspects and sequestration potential of low carbon interventions that are considered necessary to realistically explore urban transformation pathways.

The Australian Stocks and Flows Framework (ASFF) is a scenario modelling platform for integrated analysis of the physical economy of Australia.[88] It is a process-based simulation model of all sectors of the Australian economy, tracking the dynamics of major capital and resource pools, and the flows associated with these stocks such as productive output, resource inputs, changes in capital and carbon emissions. For each simulation, the model is first run over a calibrated historical period from 1946-2006, after which future scenarios can be calculated to 2100.

Within each scenario, population and consumption rates are set, along with the activity of primary industries and various technological parameters. The framework calculates the necessary physical activity, including the labour required, throughout the economy to provide for the population, infrastructure and underlying economic activity. Ultimately this may require imports of goods and commodities, or allow for exports if there is excess production. Additionally, emissions and wastes (allowing for recycling) are produced, and environmental resources are harvested. In the case of greenhouse gas (GHG) emissions, these are calculated for the three major gases (CO_2, CH_4 and NO_2) using process-based emission intensities[89] and combined with the major emission activities modelled in the ASFF in each sector, and then converted to CO_2 equivalents.[90]

Emissions calculated within the ASFF at a state or national level are attributed to cities based on previous methods developed for the Foodprint Melbourne project[91] that were then adapted for VP2040. In the previous work, city consumption factors for natural resources and emissions were calculated using the ratios between imports and exports, and city and national populations. For this project, city consumption factors were calculated based on data from household expenditure surveys, similar to the IO method. RoW emissions are addressed in the ASFF by equating the emissions from Australian export producing activities with the off-shore emissions (of our imports) and multiplying them by the same city consumption factors (the reasoning behind this method is discussed further in the 'Limitations' section). These are then both added to emission estimates calculated within ASFF for located sources within cities (i.e. building fuel use, and some transport) to get the overall carbon footprint.

This method is more transparent than other approaches, such as IO analysis, and therefore aids understanding. It also provides the ability to examine detailed mechanisms to reduce emissions in alternative scenarios, and to determine flow-on effects such as material implications or economic impacts. It has previously been used to investigate the long-term dematerialisation potential for Australia at a national scale to improve the current material, energy, and emission intensive pattern of Australia's production and consumption system.[92]

88 Turner, G.M., Hoffman, R., McInnis, B.C., Poldy, F., Foran, B. (2011). A tool for strategic biophysical assessment of a national economy – The Australian stocks and flows framework. *Environmental Modelling & Software*, 26, 1134–1149. DOI:10.1016/j.envsoft.2011.03.007

89 Australian.Government 2014, see above

90 Turner, G.M., Elliston, B., Diesendorf, M. (2013). Impacts on the biophysical economy and environment of a transition to 100% renewable electricity in Australia. *Energy Policy,* 54, 288–299. DOI:10.1016/j.enpol.2012.11.038

91 Sheridan, J., Carey, R., Candy, S. (2016). *Melbourne's foodprint: what it takes to feed a city*. Victorian Eco-Innovation Lab (VEIL), University of Melbourne, Melbourne, Australia.

92 Schandl, H., Turner, G.M. (2009). The Dematerialization Potential of the Australian Economy. *Journal of Industrial Ecology* 13, 863–880. DOI:10.1111/j.1530-9290.2009.00163.x

Scenario settings

The settings for the two action pathways build on previous work with the ASFF, including 'The Path We're On' (TPWO)—a background business-as-usual scenario at a national scale.[93] The two action pathways maintain the same population growth and a host of other settings of the background scenario but incorporate changes to parameters relevant to low carbon interventions within each narrative, as well as some key consumption or behavioral parameters.

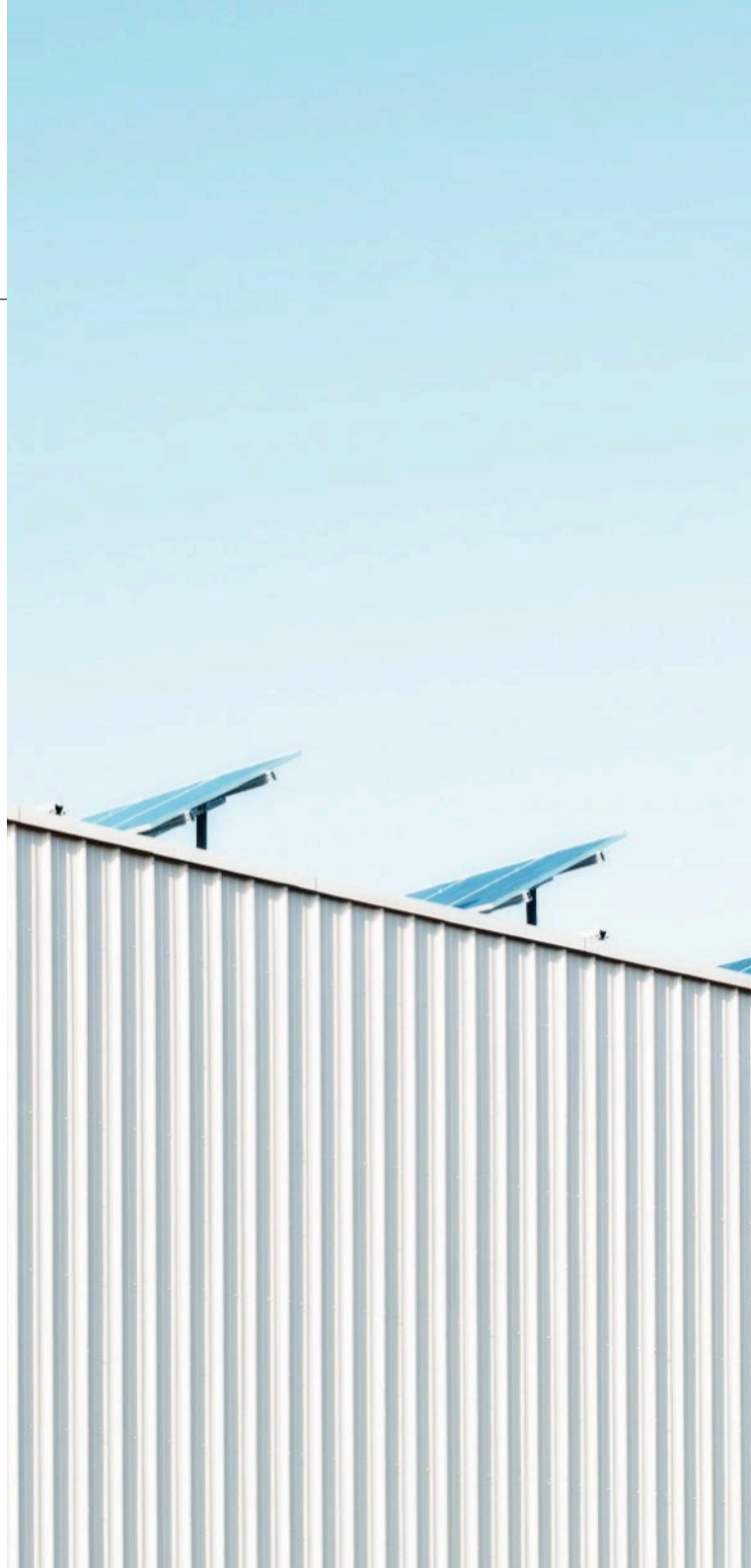
Similar to the carbon footprint modelling, scenario narratives were translated into settings across six focal sectors (electricity/energy, transport, food, goods, water and waste) and 11 core variables (proportion of renewable energy generation, energy consumption, transport mode distribution, number of vehicles, need to travel, diet profile, consumption of processed foods, amount of food waste, consumption of goods, changes in urban water infrastructure), however it was possible to incorporate more nuance into these variables. For example, changes in diet could also incorporate different agricultural production methods, changes in energy consumption become a specific result of urban form and density changes, and reduction in demand and carbon intensity for goods are linked to both behavioural change and recycling capacity. The rate at which low carbon technologies, such as electric and gas cars, can be implemented is restricted by the rate at which old technologies are discarded.

Limitations of ASFF model

The national scale of the model means that is is possible to incorporate embodied emissions, and other forms of embodied natural resource use, associated with urban consumption from the rest of Australia. However, due to the system boundary at the national level it is not possible to directly incorporate off-shore emissions from the acquisition of imported good and consumables. Although there are ways to estimate these emissions, either by using the emissions intensities of the producing country or domestic emissions intensities to estimate those associated with imported items, it could lead to significant data challenges or errors. Either way, activities in other nations are largely beyond domestic Australian control and therefore of limited use in considering ways to reduce city emissions.

As discussed above, this issue is instead addressed in the ASFF by equating the emissions from Australian export producing activities with the off-shore emissions (of our imports), since a reasonably close trade balance between exports and imports is required for this trade to continue. In this way, consumers of imported items are responsible for the domestic export activity and emissions; and higher income wealth of city populations may also enhance this emission estimate. This approach has the attraction that domestic policies affecting the structure of export industries (not to mention consumption behaviour) remain relevant.

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



93 Turner, G.M., Larsen, K.A., Candy, S., Ogilvy, S., Ananthapavan, J., Moodie, M., James, S., Friel, S., Ryan, C.J., Lawrence, M.A. (2017). Squandering Australia's Food Security— the Environmental and Economic Costs of our Unhealthy Diet and the Policy Path We're On. *Journal of Cleaner Production* (in press). DOI:10.1016/j.jclepro.2017.07.072

5. Four Visions and Pathways

The four exploratory scenarios can be summarised as:

1. Clean-Tech Corporate Living: a city of clean and efficient production driven by a corporate market economy that has focused innovation on triple bottom line success and adopted circular economy production and product design practices.

2. Planned Regulated Living: a city of planned order where a democratic consensus has concluded that the challenges posed by a carbon and resource constrained world are best addressed through public planning, public investment in green infrastructures and tighter regulations that limit behaviour and practices to an acceptable environmental norm.

3. Networked Entrepreneurial Living: a city where large corporations and government are less influential but where the economy has developed around nimble, self organised entrepreneurial activity, particularly for the sharing and exploitation of excess capacities of various assets. It is a future characterised by a dynamically changing economy, experimentation and innovation and the development of networked platforms that are open source and open data.

4. Community Balanced Living: a city of low consumption, that promotes a socially and environmentally meaningful life including shared wellbeing, liveability and (face to face) socialising.

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

Figure 4 locates the scenarios along two key dimensions: (i) top-down, centralised decision making and/or ownership (large hierarchical corporations or government) vs. bottom-up, decentralised decision making and/or ownership (e.g. small businesses or grassroots movements), and (ii) for-profit orientation vs. for-social-benefit orientation. These two dimensions also roughly correlate another set of dimensions: (i) 'Do it for me' vs. 'Do it yourself/ourselves' (i.e.—will people take the lead in creating low carbon living or will they expect corporations and governments to do it for them?) and meritocracy vs egalitarianism.

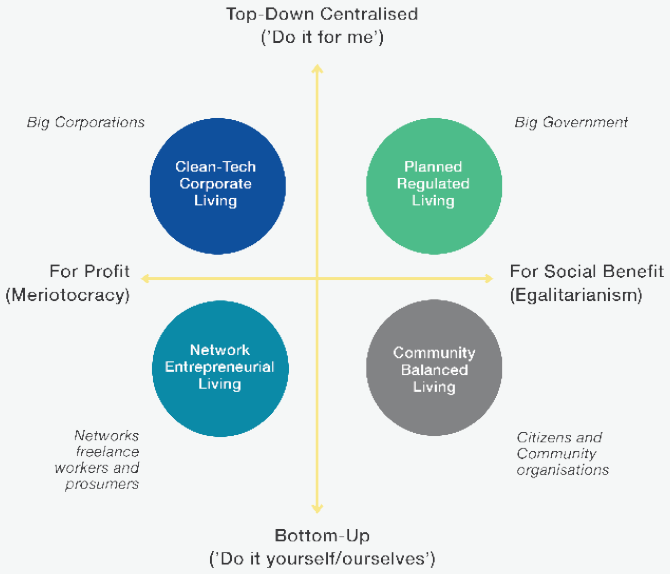
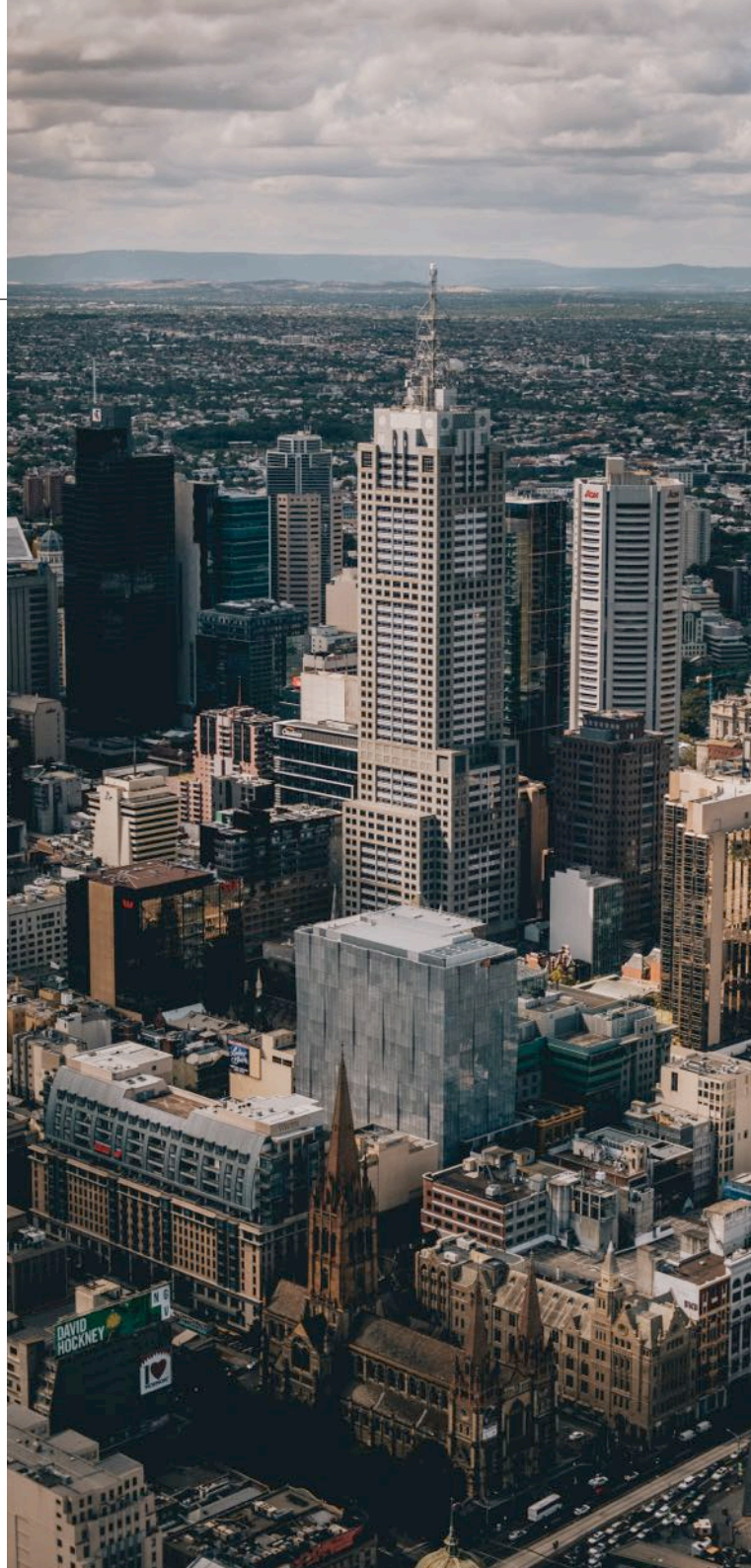


Figure 4. Characterisation of four scenarios along two dimensions



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

• **Production and product based emission reductions:** This type of emissions reduction results from the decarbonisation of energy sources—particularly substitution by renewable electricity—along with investments in production efficiency and clean product design. This means that outputs such as goods and services are produced efficiently, with a minimal input of energy, and operate efficiently. Production efficiencies would include the development of circular economy production techniques to minimise and reuse waste products as well;

• **Usage-based or service-based emission reductions:** Emissions can be reduced by using existing products more efficiently or by better integrating products and services. For example, sharing schemes facilitate the sharing of durable yet often idle goods such as cars and lawnmowers. These schemes can be non-profit or for-profit;

• **Reducing absolute consumption:** This option involves changes to lifestyles that reduce absolute consumption levels and thus also associated greenhouse gas emissions. Examples include walking or cycling rather than driving, wearing jumpers inside rather than using heaters, eating less meat and more seasonal foods, the sharing of resources, and repairing goods to increase product longevity.

Different potential sources of emissions reduction were emphasised in different scenarios. For example, the Community Balanced Living scenario emphasises dramatic reductions in consumption. This scenario envisages a reduction in general consumerism, greater sharing of resources and more localised ways of life with lower energy and material demands. In other scenarios such as Clean-Tech Corporate Living, new technological and business models reduce the carbon intensity of urban living without necessitating significant lifestyle changes. This is shown below in Figure 5.

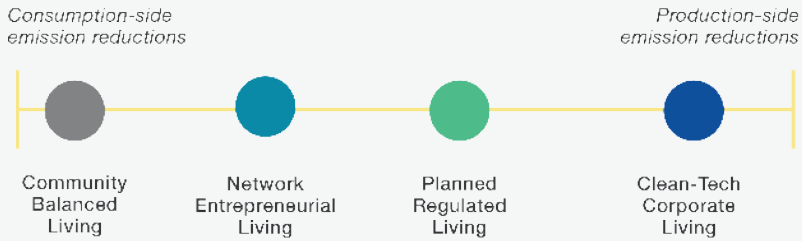
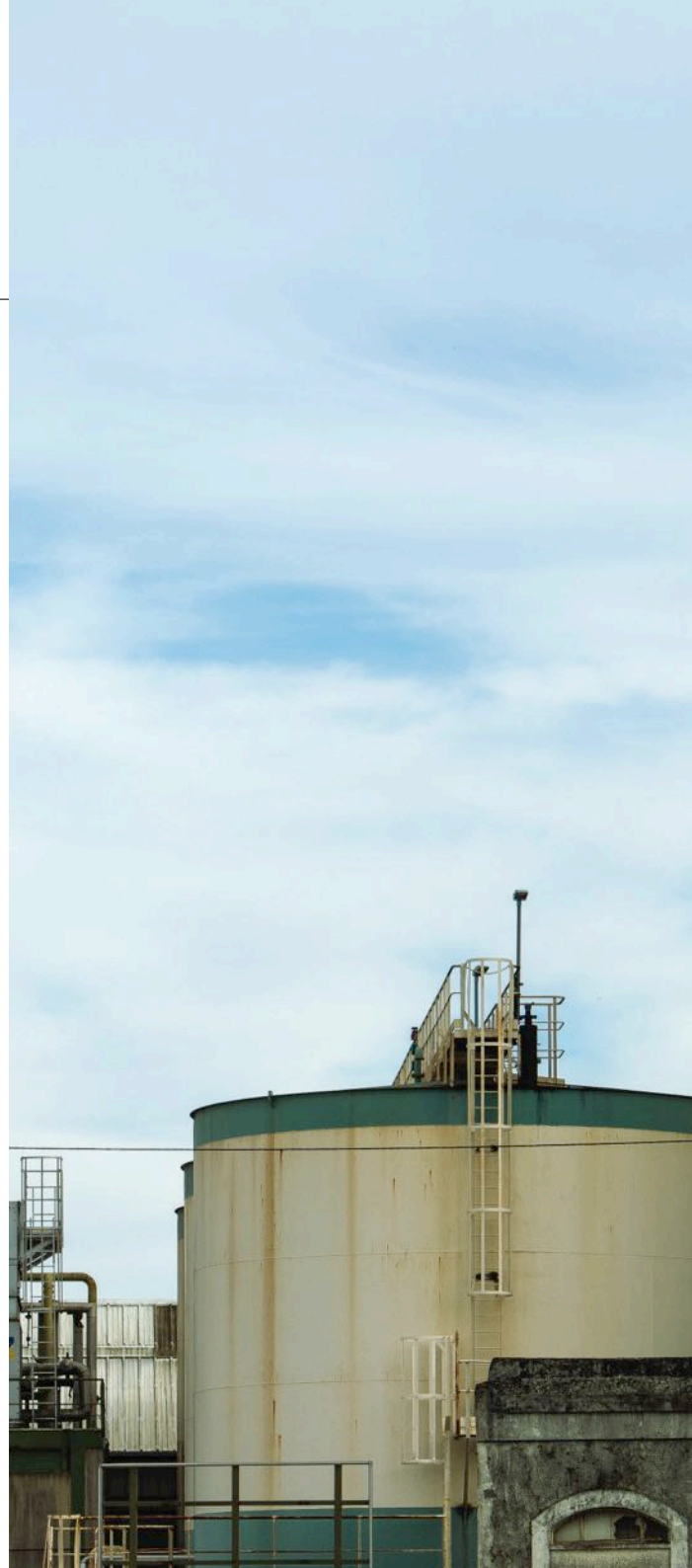


Figure 5: Scenarios ranked by type of emissions reduction

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

The following sections detail the scenarios and explain the carbon modelling settings and results.

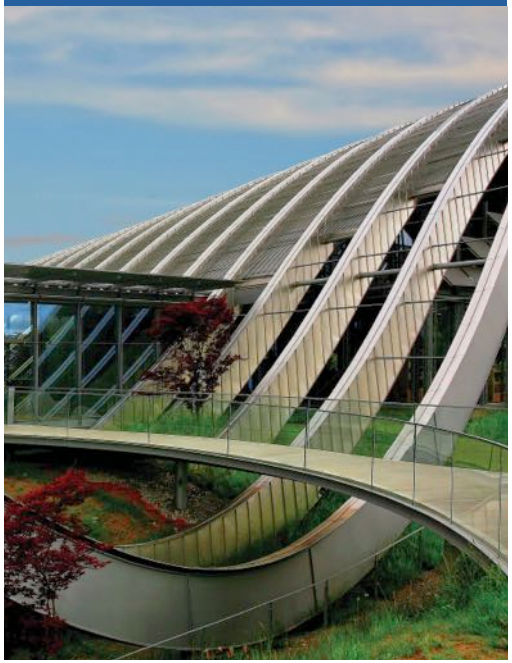


5.1 Clean-Tech Corporate Living

The Scenario

Keywords: Clean technology; ecological modernisation; price-driven efficiency; circular economy; service economy.

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



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

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

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

Information technology has helped to create a city that is smart and efficient. Competing investment in the ‘internet of things’ has been significant with the sale of privately held data now a significant contribution to GDP. Corporate competition in smart city technologies is a feature of life for citizens as multiple services from different companies compete to build their exclusive customer base. Robots and automation have reduced labour costs in many areas of production and service provision. Within the mix of products and services, the economic identity of the city is strongly consumerist, profit oriented and individualistic, with wealth, status and economic growth as a societal priority. However, there is a continued shift towards casualised labour with decreasing job security and the proportion of citizens in full-time work. Inequality of income, wealth and power is large, tempered only by the need to suppress social unrest. Government provides essential infrastructure for corporate activity and works with business to target a light level of regulation to ensure that yearly emission reduction targets are achieved.

How did it happen

Corporate capitalism came through for us. The competitive dynamism and enormous R&D and deployment capacity of corporations flowed into efficient and cleaner production processes, products and services. Growth became ‘decoupled’ from its resource and environmental constraints. The change was partly driven by increasing costs of resources for production and hence a drive for greater efficiencies that included circular economy techniques. Furthermore, the government introduced explicit and implicit environmental pricing schemes to guide clean investment, although otherwise operated with a light touch in encouraging a globally competitive clean tech economy. On the demand side, our love of shopping and consumerist lifestyles did not greatly change but we learned to buy clean products and services for socially prudential as well as economic reasons. We also became mostly trustful of commercial smart service providers in using personal data to run the minutiae of our lives more efficiently and sustainably.

Don't call it a carbon price

New pressures and policy issues arising in the post-mining boom and post-Paris climate agreement context were the first signals for a pivot towards a clean-tech economy. It became increasingly evident that neither a 'jobs and growth' agenda nor meeting the post-2020 emission target were achievable by clinging on to 20th century high-carbon industries. Fears were also being voiced by leaders in business and other sectors about the dangers of chaotic energy policy mix.

While the term 'carbon price' continued to be anathema during the late 2010s, through 2020-2025 Federal and State levels governments expanded and adopted schemes and programs which could be defined as implicit carbon price policies. These included expansion of existing green certificate schemes, emissions purchasing schemes, and, to a lesser extent, regulatory approaches. By 2030, an explicit carbon price was operating across the nation.

Rising resource costs and demand for green goods

Rising electricity prices and, by the mid-2020s, rising world prices of a number of resources and commodities, including food, oil and rare earth elements, provided strong signals to innovate and to overhaul the efficiency of many of our industrial systems.

Clarifying Directors' Duties on climate change

A recent legal opinion on Director's Duties states that under existing Australian law company directors who fail to adequately consider climate change risks now could be found liable for breaching their duty of care and diligence in the future. Climate change risk can include both *physical* risks related to changes to the climate system; and *transition* risks associated with the shift towards a lower carbon economy.

The lead author of the legal opinion, Noel Hutley SC, believes that "it is likely to be only a matter of time before we see litigation against a director who has failed to perceive, disclose or take steps in relation to a foreseeable climate-related risk that can be demonstrated to have caused harm to a company." Importantly, statements from the Australian Prudential Regulatory Authority on this issue suggest that the exposure of major banks, insurers and other regulated entities such as superannuation companies to climate change risk will be scrutinised more closely by the regulator.

Such developments credibly signal potential for pressure on company directors through climate change-related litigation in future. This could drive re-evaluation of the how climate risks and associated risks (e.g. regulatory or reputational risks) are being assessed and managed.

See: https://cpd.org.au/2016/10/directorsduties/

Who can make this happen, and how?

- Company Directors: evaluate and elevate climate risk as a Board-level material issue;
- Board Members: consider multi-dimensionality of climate risk including physical risks, transitional risks, and related legal, regulatory and reputational risks; and
- Regulators e.g. the Australian Prudential Regulatory Authority: continue increasing pressure.

Additionally, the demand for clean products and services became another driving factor for change. By 2025, the dangers of climate change were almost completely accepted, as was the social status of being perceived as a 'green' buyer.

Technological breakthroughs

The combination of these forces drove change not only as a necessity but also as the business opportunity of the century. In a global market, mega-corporations competed fiercely over hegemony in the sustainable technologies business. Export opportunities abounded, as many developing countries sought to bypass dirty industries and move to straight to clean production systems.

Massive private investment in research and development saw advances in many areas including renewable energy, low carbon and highly energy efficient homes and buildings (e.g. new materials), low carbon food production, and low waste production and recycling technologies. Global digital integration brought product cycles and systems closer together, enabling new innovations to spread quickly.

Business model innovations

Meanwhile, a new generation of leaders in business also stimulated business model innovation, many enabled by new technologies, new materials, and circular economy methods. For example, there were many business models based on leasing or renting of goods which allowed for more reuse or recycling on return. By 2030, access models (rather than ownership) shifted from a small number of niche markets popularised by a few evangelists in the 2010s to being genuinely mainstream business models.

Popularity of smart homes and services

One particular cluster of innovations were around ubiquitous sensors, the internet-of-things, enhanced analytics, and timely and accessible information. All sorts of applications from shopping, to travelling, to managing the home were very popular with a public who were mostly trusting in letting smart service providers have access to their personal data to more efficiently run their lives in terms of well-being, time use and expenditures.

From public goods and space to private assets and networks

The re-emergence of privatisation policy agendas in the mid-2010s had continued in the subsequent decades. This was partly motivated by debt level concerns along with beliefs about the efficiency benefits of privatisation. The development and commercialisation of smart city technologies contributed to the private management of city infrastructure and increased competition amongst service providers.

Cleantech breakthroughs from 'challengers' and industry incumbents

Critical tipping points can unlock rapid mainstream adoption of new clean technologies, including by bringing costs down to 'no-brainer, of course I prefer that' levels. Examples include Tesla's significant investments in battery manufacturing via its Gigafactory (for production of lithium-ion batteries), regular announcements by established market leaders to further explore opportunities in cleantech (e.g. IKEA in the UK has announced plans to sell solar power systems and home battery packs), and announcements by large automotive companies such as General Motors and Ford that they are recommitting to electric vehicles and plan to greatly expand their range of electric models. More locally, opportunities are also beginning to be explored to manufacture such technologies in Australia.

By around 2020 a broader range of products should be available and affordable for the mass market, including more affordable electric vehicles and energy storage units. Other low/zero-carbon substitutes are also expected to be commercialised and/or become more widely available over the coming decade such as substitute meat products (e.g. lab-grown meat products and more sophisticated plant-based fake meat alternatives) and low-carbon building materials.

Who can make this happen, and how?

- Companies: focusing marketing attention on overcoming consumer acceptance barriers e.g. commercialising lab-grown low-carbon meats;
- Investors: Australian challenges include barriers to securing venture capital and other financing methods such equity finance;
- Councils and Government: incentives and infrastructure to remove barriers to adoption, for example with electric cars: free and/or widespread and accessible charging; incentives or remove barriers (reduced rego cost, remove luxury car tax, X hours free parking in the city etc).

Quantitative Settings and Results

Table 3 shows the quantitative modelling settings for the Clean Tech Corporate Living (CTCL) scenario.

Domain	*Scenario description*	*Quantitative settings*
Electricity/ Energy	Technological breakthroughs in large scale electricity (clean coal, solar thermal, geothermal), biofuels and some decentralised RE and storage. Smart buildings / home energy management for wealthy Circular economy production reduces the demand for energy	Strong growth in overall electricity demand by 92% to 500 TWh (counter to current stagnation trends, because improvements in efficiency are offset by increasing electrification of buildings, transport, industrial processes and redistribution of economic activity from FF production.) 95% renewable electricity generation, 5% bio-fuels. Electricity generated by FF decreases by 93%, and by RE increases by 327% on per capita basis. For other forms of energy, efficiencies improve at a rate of 1.7% per annum (UNIDO (2010) benchmark level for 'Best Available Technologies'). This results in a 58% improvement in overall energy efficiency and subsequent reduction in final demand by 2040.
Transport	The city is dominated by personal vehicles for the wealthy, which are either electrified or highly fossil-fuel/bio-fuel efficient Smart vehicles ensure that driving is safe and enables workers to be productive while travelling The less affluent face poor transport infrastructure	No change to overall need to travel No change in number of car trips and passenger vehicles, but most are electric so carbon intensity of car travel is reduced by 90% No change in public transport use or active travel Reduced carbon intensity of freight due to better vehicle efficiencies
Food	In-vitro meat and GM foods Little urban agriculture but some high-tech large 'tower farms' (using hydroponics) within cities for vegetables and fish	Carbon intensity of meat production reduced by 60% Carbon intensity of food processing reduced due to increased energy efficiency (1.7% per annum—Best Available Technologies) Food consumption patterns remain the same but reduced food waste due to improved processes in storage and distribution. Increased production of food undercover
Goods	No reduction in consumption of goods, but less wastage during processing and more recycling 'cradle to cradle' / circular economy	No change in consumption of goods. Carbon intensity of manufacturing reduced due to increased energy efficiency (1.7% per annum—Best Available Technologies) in city, RoA and RoW regions.
Water	Privatised water production—including high tech waste and storm-water recycling	No change in energy demand for water recycling due to implementation of waste-to-energy measures.
Waste	High tech waste collection and transport (including vacuum systems) Large scale automatic 'centralised' systems for recovery and recycling Organic waste separated and sold as farm fertiliser	25% reduction in landfill waste. Reduction in chemical fertilisers for agriculture.

Table 3: Summary settings table for Clean Tech Corporate Living scenario

Figure 6 shows a reduction of more than 70% in overall per capita emissions and significant changes in the emissions profile by sector in 2040 (Figure 7) compared to 2013 (Figure 3 in Section 4). Emissions from electricity generation drop by 94%, and emissions from other significant sectors such as services, construction and industrial goods all reduce by more than 60%. Although emissions from agriculture, transport and waste also drop significantly, their contribution to overall emissions reductions is small in comparison. In 2013 the largest proportion of emissions were from electricity generation, but by 2040, due to introduction of renewable energy, this drops dramatically, shifting the largest proportion to industrial goods, reflecting the fact that there was little change to consumption patterns in CTCL. Overall emissions from the Greater Sydney, Rest of Australia (RoA) and Rest of World (RoW) regions drop by 70%, 75% and 57% respectively.

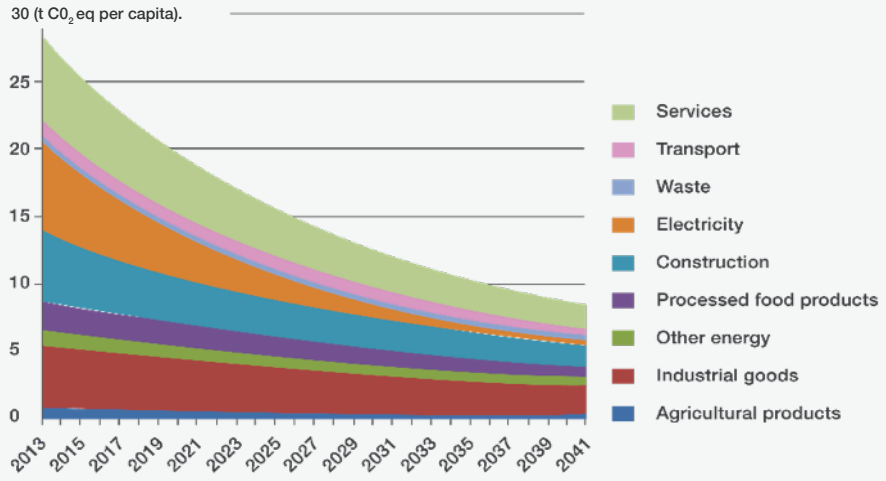


Figure 6: GHG emission reductions from 2013 to 2040 for CTCL scenario on a per capita basis.

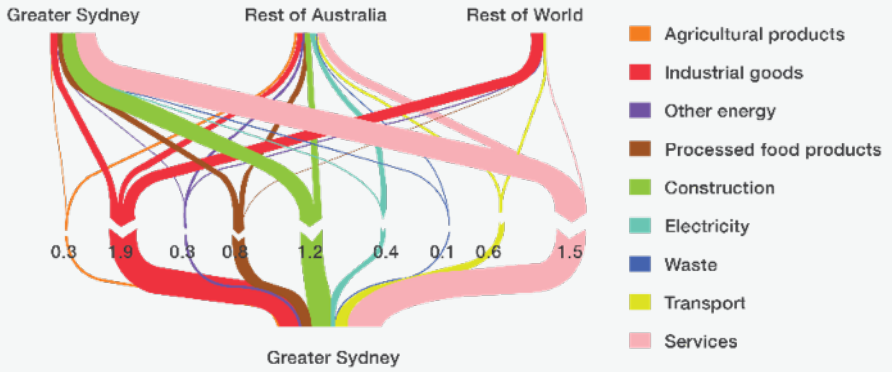


Figure 7: Distribution of GHG emissions across sectors and regions in 2040 for CTCL scenario (t CO_2eq)

Signals of change

A number of current and emerging signals of change lend some plausibility to this vision and change pathway. Some of these signals include:

- Cost breakthroughs in clean-tech (e.g. cheaper batteries, cheaper solar panels, etc.) and greater experimentation with new technological options. Solar power and wind power are now the leading sources of new electricity generation;[94]
- Growing prominence and celebration of superstar CEOs 'doing good' in addition to 'doing well' (e.g. Elon Musk);
- Development of new financing mechanisms (e.g. green bonds);
- Companies offering more service options (lease, rent) in addition to ownership;
- New models of collaborative consumption (the "sharing" economy);
- Circular economy initiatives;
- Popularity of eco-packaging as an example of greener consumption; and
- Development of a stronger consensus that the law permits or requires Australian company directors to respond to climate change risks as part of their Directors' Duties.

Additional possible (future) signals of change would also be indicative of such a pathway, although the plausibility of such events is inherently difficult to judge:

- Pricing carbon no longer anathema to Federal politicians and political parties;
- Eco options become the default option in the built environment (e.g. new home packages including energy storage and/or local electricity generation, new office buildings being at least 6 star green rated, etc);
- Green products becoming the default option in commercial services (not opt in);
- Commercially provided strong incentives to return old or used products become more common, thereby enabling a more 'circular' economy;
- Release of research reports showing stock-market outperformance of green companies;
- New for-profit business models for urban services being commercialised and out-competing public services (government-funded and/or provided services) such as new models of urban transport, or new models for waste collection and reuse; and
- Local government revenue being significantly impacted by emerging technologies, such as a growth in autonomous vehicles leading to declines in the use of inner-city car parking facilities.

94 (Blakers, 2016)

5.2. Planned Regulated Living

The Scenario

Keywords: Strong trusted government; sustainable urbanism; egalitarianism; public investment; public services; high taxes; social equity; trade-off between individual choices and sustainable prosperity

Key emission reductions: 100% renewable electricity—widespread electrification; 80% vehicles electric; 65% reduction in vehicle numbers; 300% mode shift to active and public transport; liquid fuel bio-diesel; 50% reduction in energy intensity; 50% reduction in material flows. Public refurbishment of buildings, precincts and cities; strict city boundaries—protection of peri-urban agriculture

This is a city of planned order. Significant past challenges and crises have created a democratic consensus that a carbon and resource constrained world is best addressed through tighter regulations and laws that limit behaviour and practices to an acceptable environmental norm. The provision of essential services (energy, water, transport, waste in particular) is seen as best achieved through publicly owned institutions; higher taxes to fund such services is accepted by the public. Some private service institutions were renationalised to achieve the new systems of provision. Rational and technocratic approaches guide all areas of development and the use of public assets and capital. Private sector activity is strongly regulated and there is great public trust that the balance between corporate profits and public needs is well managed by government. Environmental and social ethics is expected to guide all decision making for maximum societal benefits.

New behaviours and practices (and limitations on consumption generally) align with the imposed conditions as citizens accept the social value of such acquiescence; culturally this is much more significant than individuals who proactively seek more sustainable lifestyles. City/urban information systems are ubiquitous and publicly owned; they provide feedback on consumption levels, for individuals and for communities. Systems of provision of food, water, energy, transport, and waste emphasise diversity and redundancy to assist in creating a resilient city.

How did it happen

Political scepticism and the rejection of neo-corporatist economics

2016 began a long period of instability in political affairs. Citizens expressed concern that democratic and national interests were being corrupted by a globalised 'corporate agenda'. 'Protest' voting sent party politics into disarray. The Australian government responded by looking backwards, old certainties about growth/jobs, stirring up fear of the transition to renewable energy. Voters saw the government as paralysed, captured by fossil fuel and mining interests. Polls consistently showed high concern about climate change which the government ignored to satisfy climate deniers in its ranks. Climate shifts and extreme weather regularly disrupted city infrastructure, impacting on food, electricity and water supply. Citizens acted where they could; household PV rooftop and battery installation funded from household budgets expanded rapidly, reshaping the energy system. These 'electricity producers' became a real political force.

Transparency – freedom of information

Exposures of political corruption and revelations on the influence of corporate lobbying/ donations recurred throughout 2016-2019; some government responses were seen as

cynical cover-ups. There were regular exposures of public subsidies used for private wealth. State level systems (whistle-blower, FOI, anti-corruption) gained voter confidence. There was successful prosecution of company directors.

Re-empowering democracy – 'millennials' and local (state/city) governance

Australian politics 2016-2020 was partly a contestation between the different tiers of government and between generations. Political events exposed real differences in aspirations of younger voters. These 'millennials' were less swayed by neo-liberal economics. Paralysed, dysfunctional federal politics saw attention shift to states and cities (particularly in terms of action on renewable energy, energy efficiency, green industries and jobs). States/capital cities pursue their own path to decarbonisation, explicitly promoting a new economic agenda. States/cities invest in new electricity infrastructure, and create a new 'national' system including CO_2 trading.

Citizens as producers (not passive consumers)

Renewable electricity production grew at around ten times the rate of economic growth. A state-coordinated overhaul of the National electricity market in 2018-9 supported households/small businesses to share and sell electricity in the market.

Public ownership of distributed localised infrastructure systems

2015-25: Public investment for low carbon infrastructure and services increased significantly. The focus was on resilient, localised and networked solutions for water, food, energy, transport and waste. Water infrastructure remained in public ownership with innovative local infrastructure for drought and flood. The success with water made public investment in other resource systems politically acceptable. With food policy, state responses increasingly reflected what the press came to dub 'feed Australia first'. Public energy investment extended from procurement (purchase contracts) to ownership of local systems of production and retrofitting buildings. The electricity storage component of the national market was substantially owned by state and local governments. Pent up pressures in city transport leads to disruptive innovation. NSW transport planning accepted projections of innovation—e.g. that shared driverless taxis will progressively reduce the space required for vehicle movement and storage. Infrastructure spend was reduced accordingly. Redundant parking space was sold. Sydney pilot tested a low-speed, local, driverless taxi system that radiated out from railway stations, creating 'to-the-home' public transport. The early name for these vehicles CAMEH, pronounced 'come-ere' (from 'CArryMeHome') quickly joined the national lexicon. CAMEH vehicles were intentionally slow and operated on local roads; it spread to other cities, based on public investment.

Levees and the rise of hypothecated taxes for critical public services

In 2018 the Queensland government purchased a large landholding to protect the Barrier Reef. This proved popular. There was national and global attention to the progressive death of the reef. The potential loss of this national icon, and its 70,000 jobs, pushed Queensland to introduce a state levee system to 'develop the economy in ways that are compatible with nature tourism, renewable infrastructure and green innovation'. The Australian government attacked the levee as 'left-green' madness;

Increased government intervention in energy markets

Direct government investments and intervention in cleaner energy systems and options have been significant over the past two years. Some actions have responded to energy system shocks and challenges, such as the South Australian government's investment in a large-scale battery storage facility along with the State Premier's stated intent to exercise greater control over the State's electricity supply. The Victorian Government has similarly announced major investments associated with its plan to achieve 40% renewable energy by 2025. At the Federal level, the recent attention placed by the Turnbull Government on gas market issues and electricity sector policy is consistent with signals of change towards growing governmental involvement in energy markets and related State-Federal policy tensions.

Such initiatives may signal an important future shift towards strategic state-level energy policy-making. Much depends on Federal Government policy commitments beyond 2020 (e.g. whether the Clean Energy Target recommended by the Finkel Review is legislated by the Turnbull Government or subsequent governments). Further changes towards governmental intervention also signal potential reassessments of laissez-faire style policy, particularly with respect to energy policy. Greater debate about such policy norms is therefore also an important signal to watch for.

Nationalisation of key industries moving back on the political agenda

The recent UK general election put the spotlight back on the potential for part or full renationalisation of some industries; the Labour Party's 2017 manifesto outlined plans to bring energy supply, rail transport, water industries back into public ownership. Prominent local Australian academics such as John Quiggin—a former board member of the Climate Change Authority – have recently advocated for similar policy changes. Quiggin argues that grid renationalisation is required to address current electricity sector challenges via the creation of "a unified, publicly owned, National Grid encompassing the ownership of physical transmission networks in each state and interconnectors between states"—that is, bringing key elements of the electricity sector back under government ownership. Advocates such as Quiggin are calling attention to concerns that market players are 'gaming the system' in ways that lead to greater costs and impair change.

Signals of further shifts in this direction, should they occur, will be apparent in possible changes to the policy platforms of Australian political parties. Intensification of key issues raised by proponents of such change, such as electricity price rises, may also prompt policy re-evaluation.

See: https://www.uq.edu.au/news/article/2017/03/expert-calls-grid-renationalisation

Who can make this happen, and how?

- Government, driven by political movements: a sharp move away from privatisation approaches of recent decades would clearly be a radical shift in government policy and action. Major debate within political parties and relevant policy communities would be necessary to secure such change.

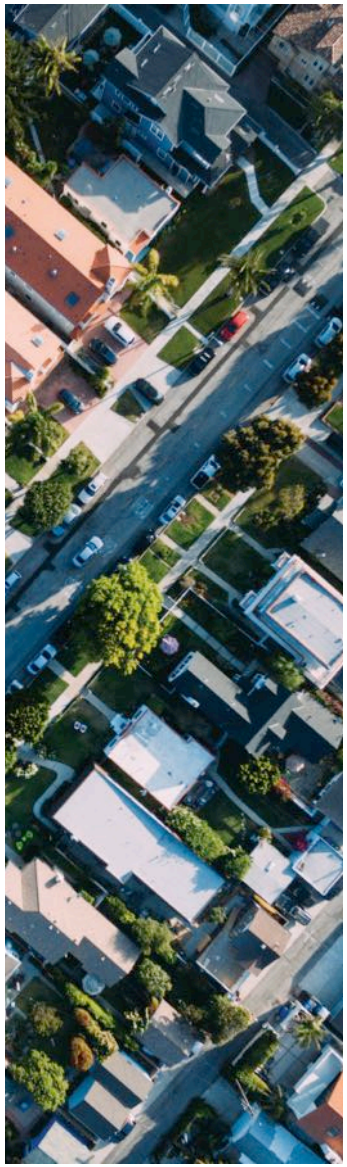
however it proved positive at the ballot box. Levees for other 'renewable future' programs proliferated across the country. This created a steadily rising support for higher taxation and 'hypothecated taxes' for social and environmental good.

Failures of 'too big to fail' corporations and smart systems; regulation and '(re)nationalisation'

By 2020, the number of corporations competing in 'smart city' infrastructure systems was economically significant. Corporate systems forced citizens to select between 'providers' operating different networks for transport/mobility (and energy management). Early driverless taxis (except CAMEH) and in-car intelligence for 'drivered' vehicles operated on competing networks, until a catastrophic failure of the system in 2022. A hacking attack on the Telstra road/vehicle/energy network brought transport to a halt nationally along with essential infrastructure. Autonomous vehicles on the road abruptly stopped. City transport gridlocked. Emergency services were crippled. Estimated losses from the attack were staggering. Public fear grew rapidly when the attack was labelled as 'terrorist'. Shares of urban data businesses collapsed. Repairing the network was estimated to take months with capital investment way beyond the company's resources. Facing bankruptcy Telstra turned to government for its lifeline, creating in effect, the renationalisation of the corporation. A new government agency was created to run the entire urban data network and it bought out all the old (financially teetering) corporate players.

New federalism and governance

As states pursue energy (and transport) planning they set up consultative bodies including 'their' senators regardless of party affiliation, echoing the original concept of the Senate as the 'state's house'. By 2040 'federalism' has changed significantly, after years of debate about the appropriate boundaries of 'national' interest, social equity and distributed governance.



Quantitative Settings and Results

Table 4 shows the quantitative modelling settings for the Planned Regulated Living (PRL) scenario.

Domain	*Scenario description*	*Quantitative settings*
Electricity/ Energy	Pervasive building codes, regulations and subsidies for energy efficiency, renewable energy. Government investment in R&D on biofuels (from non-food sources) Local public energy infrastructures (smart grids and energy generation hubs).	Moderate growth in overall electricity demand by 27% due to regulatory measures, awareness campaigns and public infrastructure improvements (more transport demand is met by public transport rather than private electric vehicles and improvements in building codes for energy efficiency are significant). 100% renewable electricity generation Electricity generated by fossil fuels decreases by 100%, and by renewable energy increases by 345% per capita. For other forms of energy, efficiencies improve at a rate of 1.2% per annum (UNIDO benchmark level for 'Best Practice Technologies'). This results in a 38% improvement in overall energy efficiency and subsequent reduction in final demand by 2040.
Transport	Massive shift to use of electrified, integrated, public transport systems, including small autonomous electric taxis (some as small, slow local transport from train/tram stops) High vehicle registration costs, congestion charging, and car bans have reduced the incentive for car ownership Denser cities have reduced the need for travel, as has investment in teleworking centres	Overall need to travel reduced by 10% due to denser cities and teleworking centres. 70% reduction in number of passenger vehicles and number of car trips. 100% reduction in carbon intensity of passenger vehicles and electrified public transport. travel due to switch to electric or biofuel vehicles. 100% increase in public transport travel. Active travel increased by 325%.
Food	Regulations and nudging for behavioural change in diet (e.g. school menus, junk food advertising); reduced meat, increased seasonal food Mandatory food labelling including emissions Efficient freight systems	Diet change to diet recommended in Australian Guide to Healthy Eating. Food waste reduced by 50% across the food chain (15% reduction in consumption overall) due to government policy. 50% reduction in consumption of highly processed foods. Carbon intensity of food processing and freight reduced due to increased energy efficiency (1.2% per annum – Best Practice Technologies).
Goods	Some reduction in consumption of goods, less wastage during processing and more recycling	Awareness and recycling reduce consumption of goods overall by 25%. Carbon intensity of manufacturing reduced due to increased energy efficiency (1.2% per annum—Best Practice Technologies) in city, Rest of Australia and Rest of World regions.
Water	Public ownership of water infrastructure—use of recycled and storm water—multi pipe systems	Increased demand for plumbing materials and services by 30%
Waste	High separation of waste categories pre-collection	50% reduction in landfill waste

Table 4: Summary settings table for the Planned Regulated Living scenario.

Similar to CTCL Figure 8 shows a reduction of more than 70% in overall per capita emissions and significant changes in the emissions profile by sector in 2040 (Figure 9) compared to 2013 (Figure 3 in Section 4). Overall emissions from electricity generation drop by 98%, reducing their proportional contribution to overall emissions from 23% in 2013 to just 1.5% in 2040 due to the introduction of 100% renewable energy. Emissions from other significant sectors such as services, construction and industrial goods all reduce by 60-76%. Overall emissions from the Greater Sydney, Rest of Australia (ROA) and Rest of World (RoW) regions drop by 70%, 76% and 54% respectively.

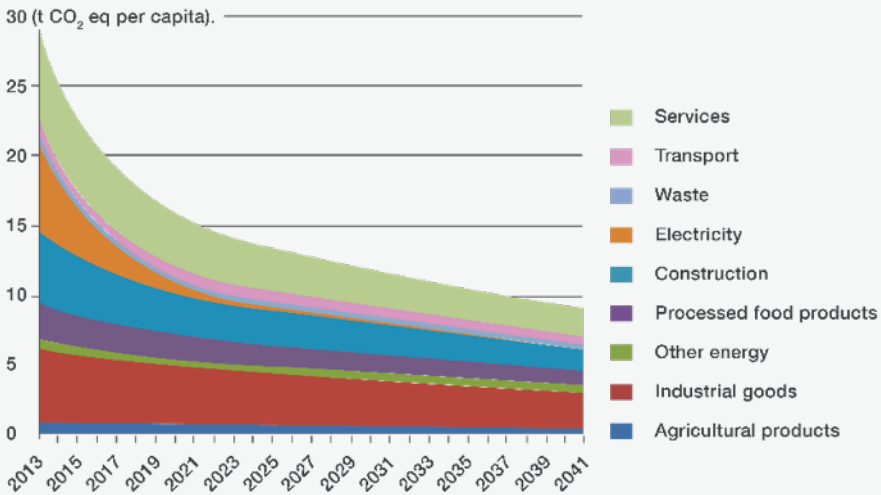


Figure 8: GHG emission reductions from 2013 to 2040 for PRL scenario on a per capita basis.

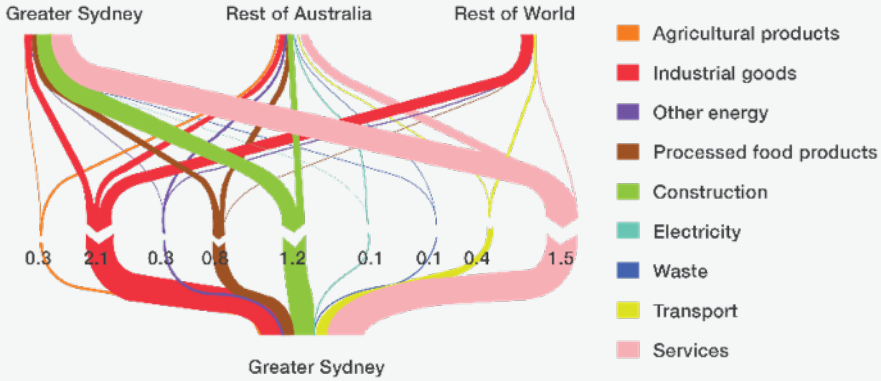


Figure 9: Distribution of GHG emissions across sectors and regions in 2040 for PRL scenario (t CO_2 eq).

Signals of change

A number of current and emerging signals of change lend some plausibility to this vision and change pathway. Some of these signals include:

- Local councils adopting new financial models to encourage greater uptake of urban energy efficiency and renewable energy retrofitting;
- State government interventions in energy systems (e.g. the South Australian government's investment in large-scale battery storage);
- Participation of Australian cities in various organisations and initiatives such as the Global Parliament of Mayors, C40, ICLEI and Compact of Mayors, who are all becoming increasingly prominent in global climate change governance;
- Increasing local government policies focussed on fostering urban greening, such as the City of Melbourne's urban forest strategy;
- Real estate values typically higher near good quality public transport—this may support greater government investment and related value capture schemes; and
- The history of Australian state governments taking the lead in climate change policy and action (e.g. during the Federal Howard Liberal-National government).

Additional possible (future) signals of change would also be indicative such a pathway, although the plausibility of such events is inherently difficult to judge:

- Rising public and political support for a re-nationalised electricity grid and supply and open discussions of similar initiatives in public transport;
- Significant additional government actions to expand, tighten and enforce building regulations and mandatory disclosures; and
- Massive public rallies, social commentators and social media calling on government to take charge on climate action.
- State governments and city councils taking action (e.g. on renewable energy generation and storage) explicitly referring to federal government paralysis
- Successful—publicly supported—introduction of pseudo-hypothecated taxes, e.g. additional taxes introduced as 'levees' for environmental and social programs.

5.3. Networked Entrepreneurial Living

The Scenario

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

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

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

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

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

The 80% reduction on greenhouse emissions have arisen from various forms of collaborative production and consumption, including: renewable energy (particularly electricity); diverse shared transport systems; inventive use of and reuse of spaces; a vibrant repair sector; and local manufacturing.

Production and storage of electricity from a wide range of technologies form the basis of many small enterprises, so that this is now highly decentralised; there is also peer-to-peer energy trading through local micro-grids. Information systems for managing energy, water, food, waste and transport systems are highly advanced. Citizens are energy and resource savvy, relying on various digital monitoring and feedback technologies and online information sharing to make better consumption choices. Travel has also been reduced due to the increased use of online digital interactivity; local small businesses and freelance workers operate from home and public spaces.

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

How did it happen

Radical connectivity changed everything. A combination of new technologies, individualistic and anti-establishment ideology, and the failure of government and multinational corporations to respond to the adverse consequences of globalization, climate change and resource constraints, all converged in a major shift of the way we organized society. The power of big institutions was upturned as new networking capabilities allowed more control to be distributed to citizens and radically upended our way of living; from how we shop, to how we work, to how we govern. The 'End of Big' was the end of top-down, centralised hierarchical control.

Frustration with big government and big business

As the 2020s saw society growing in complexity, technological innovations gathering pace and individual needs becoming increasingly differentiated, the bureaucracies and rigid hierarchies remained inflexible and unable to adjust to emerging problems.

Growing frustration with the lack of action on climate change and the perception that vested interests were preventing real action from being taken further undermined confidence in big business and government.

Furthermore, flailing under trade wars initiated by popularist political leaders, growing resource constraints, a generally murky business environment undermined economic growth and government revenue. Austerity measures turned people away from thinking that they could rely on the government as a safety net.

By 2030, state and corporate governance had become relatively weak and the world had settled into an unstable equilibrium in which neither government nor multinationals had their once dominant role.

Crowd capitalism—David slays Goliath

While the uncertain business environment during the 2020s was already leading many large corporations to shrink their core employee base and outsource work, peer-to-peer networking technologies were radically shifting the balance of power so that small organizations could now compete on equal footing with bigger rivals. By the mid-2020s, "the commoditization of scale" meant that many large corporations no longer had a special advantage due to their size.

The development of the P2P currency Bitcoin and the Kickstarter crowdfunding platform in the 2010s were representative forerunners of innovations in finance that emerged in the 2020s that enabled the mass participation of many sectors previously dominated by a few incumbents.

Choice, control, and self-reliance

Parallel to these developments, a cultural shift was occurring in people's attitudes on the autonomy and control that they had over various aspects of their life. From the 2010s, the Tinder generation's sense that there was always a better option ahead with the next click or swipe became a mindset that contributed to an erosion of faith in the major political parties, corporates brands and traditional worker contracts.

Voters began shifting their loyalty away from the two major parties towards smaller political parties. By the 2030 election, less than 50% of the electorate was voting for either of the major two parties. Similarly, more and more graduates were seeking jobs in start-ups and micro-business rather than become cogs in giant corporations with little ability to generate change.

P2P energy trading experiments and related microgrid innovations

Multiple enabling technologies such as energy storage technologies (e.g. cheaper batteries) and blockchain are being brought together by innovators exploring ways of developing distributed models of renewable electricity generation and associated sharing/trading platforms. Novel experiments are exploring application in new housing estates and local microgrids, as well as new commercial electricity retailer models. Illustrative examples include:

- Energy trading among residents in a new housing development (the White Gum Valley project in Western Australia). The development includes solar PV on north-facing homes, local energy storage (via battery storage), and energy efficiency measures, and is utilising a peer-to-peer trading platform. The trading platform uses blockchain technology to enable residents to trade electricity at a price which is higher price than feed-in tariffs and lower than residential tariffs. This system will provide approximately 70% of the needs of 80 apartments;
- Solar sharing microgrid experiment (South Australia) will use a P2P platform and blockchain to enable a local energy marketplace: this experiment is expected to make up to 6MW of distributed solar generation sited on farmland in Riverland region available on a local energy marketplace in late 2017 (or early 2018). The company behind this initiative, LO3 Energy (developers of the TransActive Grid platform), also developed a blockchain-enabled microgrid in Brooklyn, New York; and
- New solar power products which incentivise or reward local solar power investment (via a higher feed-in tariff) and facilitate distribution of 'exported' electricity in the local area (e.g. to those who cannot invest in solar power, such as people who are renting). A prominent example is Powershop who have developed a product called Your Neighbourhood Solar.

Successful trials of new approaches (like those above) may lead to the adoption of similar models in other new housing projects/estates and by other electricity industry participants.

See https://onestepoffthegrid.com.au/lo3-unveils-game-changing-solar-sharing-micro-grid-south-australia/, https://www.newscientist.com/article/2079334-blockchain-based-microgrid-gives-power-to-consumers-in-new-york/ and https://blog.powershop.com.au/your-neighbourhood-solar/

Who can make this happen, and how?

Further socio-technical experiments similar to those listed above. The White Gum Valley project in Western Australia was originally conceived as a 'living lab' funded by the CRC for Low Carbon Living and it trials a 'shared strata' system co-developed by CRC participants;

- Capturing and disseminating lessons from these experiments, via collaborations such as the CRC for Low Carbon Living and via published evaluations; and
- Examination of regulatory and institutional factors which may hinder the commercial development of such approaches (i.e. beyond small-scale trials).

The gig and 'uberfied' economy

All these forces propelled the rise of the 'gig economy'. This referred to the growing number of workers abandoning traditional 9 to 5 employment in favour of working independently on a task-by-task basis for various employers. By 2028, 45 percent of Australian workers were independent contractors.

P2P platforms and blockchain technology were also spurring a revolution in direct exchange, by-passing retail intermediaries in various sectors. By 2028, nine million Australians were selling everything through online marketplaces like Etsy and ebay.

Similarly, millions of Australians were exploiting the services of owned idle assets including vehicles, spaces, consumer goods, time and skills. This explosion of small-scale trading activity made some wonder whether this was a return to the economy of the 18th century and before, described by the 'father of economics' Adam Smith in 'The Wealth of Nations' living just before the era of mass production and industrialism.

Diverse innovators – misfits, makers and hackers

A consequence of the gig and uber economy was that by 2030 the majority of the population had dipped their toes into entrepreneurial waters, and many were now willing to take on more risky ventures. They joined the world of 'hackers', 'hustlers', 'makers' and 'misfits' who had long represented the spirit of rebellion, curiosity and control that was now part of a new paradigm. By 2040 it was these 'misfits' rather than visionary chief executives who were the central driver of innovation.

Commercial 3D printing marketplaces and the fostering of collaborative 'makerspaces' and related skills

Whilst a strong open source ethos informed the development and use of many 3D printers – both in terms of the hardware itself and sharing product designs – these commons approaches have in many cases been captured for private profit. This has included development of proprietary hardware and materials, the proliferation of online marketplaces for buying and selling designs for use in 3D printers, and development of specialty commercial 3D printing services offering new ways of manufacture products either for sale or other uses.

Some state governments such in South Australia are also seeking to help enable the growth of collaborative community 'makerspaces' which are intended to facilitate the prototyping of ideas and skills development for new forms of manufacturing. Whilst such makerspaces are typically public spaces (i.e. shared community facilities) – which offer access to equipment like 3D printers and computer assisted design software, as well as other machines and tools – the intention is often to also encourage the development of production and design skills (which may be subsequently used in entrepreneurship) which can also boost associated economic activity. Related potential businesses may in future include "fix-it clinics" and repair cafes, which may provide ways of utilising emerging technologies to repair and reuse products (or to access related commercial services).

Who can make this happen, and how?

- Research investigating the environmental implications of new manufacturing approaches (e.g. examination of their potential carbon footprint benefits). Positive benefits are widely expected via the potential for more localised production, however other impacts also need to be considered along with the potential for other unintended consequences.

Quantitative Settings and Results

Table 5 shows the quantitative modelling settings for the Networked Entrepreneurial Living (NEL) scenario.

Domain	*Scenario description*	*Quantitative settings*
Electricity/ Energy	Households prefer renewable energy autonomy, including storage, and trade excess on peer-to-peer trading networks. Small tech apps help energy-savvy users efficiently managed their energy consumption.	A shift towards distributed systems, energy being produced where it is used (reducing transmission losses) limits overall increase in electricity demand to 27%. Electricity generated by fossil fuels decreases by 100%. Electricity generated by renewable energy increases by 345%. For other forms of energy, efficiencies improve at a rate of 1.0% per annum (UNIDO benchmark level for 'Business as Usual'). This results in a 38% improvement in overall energy efficiency and subsequent reduction in final demand by 2040.
Transport	An efficient use of a diverse range of personal low-carbon transport (electric and biofuel vehicles), that are available for fare, rental and share, and whose use is coordinated via networking technology. Online interactions and working from home reduces the need for daily travel.	Overall need to travel is reduced by 20%. 20% reduction in number of passenger vehicles and 10% reduction in car trips (for profit ride sharing increases expectations of availability, requiring more vehicles than CBL). 95% reduction in carbon intensity due to switch to RE powered electric vehicles. 80% reduction in public transport travel (little public investment in infrastructure). 195% increase in active travel (car sharing facilitates some increase in walking / cycling due to people need to travel short distances to car share hubs).
Food	Local food delivery to home or work via smart apps. Some food production in the city and p2p networks to exchange / sell produce.	No change in diet 15% reduction in food consumption overall across all food groups due to halving of food waste via food exchange/ selling apps. Carbon intensity of food processing (and other manufacturing) reduced due to increased energy efficiency (1.0% per annum – UNIDO benchmark for 'Business as Usual').
Goods	Less consumption of new goods and more trading of second hand goods.	Growth of sites like eBay and Gumtree creates active market in re-selling goods. Reduces overall consumption by 50%. Carbon intensity of manufacturing reduced due to increased energy efficiency (1.0% per annum—Business as Usual) in city, RoA and RoW regions.
Water	Distributed water trading as businesses.	More rainwater tanks and pipes are required increasing demand for plumbing materials and services by 50%.
Waste	Reduced waste due to goods re-sale and sharing economy	25% reduction in landfill waste.

Table 5: Summary settings table for the Networked Entrepreneurial Living scenario

The NEL scenario has a less significant reduction of 66% in overall per capita emissions compared to 2013 (Figure 10). Similar to CTCL and PRL, emissions from electricity generation drop significantly by 94%, and emissions from other significant sectors such as services, construction and industrial goods reduce by 74%, 73% and 57% respectively. The largest proportion of emissions also shifted from electricity generation in 2013 to industrial goods in 2040 (Figure 11). Overall emissions from the Greater Sydney, Rest of Australia (RoA) and Rest of World (RoW) regions drop by 67%, 72% and 51% respectively and RoW regions drop by 67%, 72% and 51% respectively.

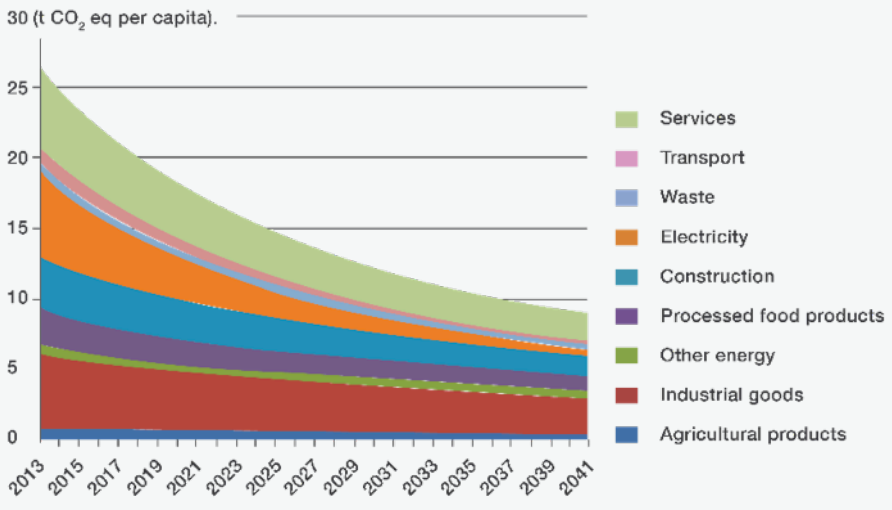


Figure 10: GHG emission reductions from 2013 to 2040 for NEL scenario on a per capita basis.

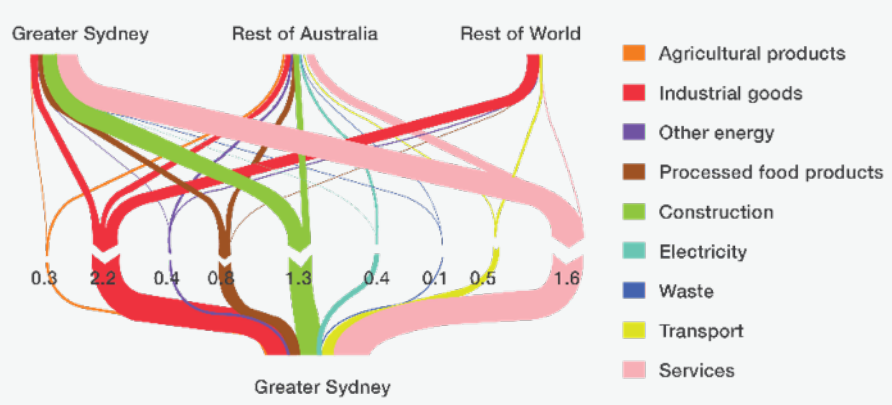


Figure 11: Distribution of GHG emissions across sectors and regions in 2040 for NEL scenario (t CO_2 eq).

Signals of change

A number of current and emerging signals of change lend some plausibility to this vision and change pathway. Some of these signals include:

- Growing percentage of workers who do some freelance work (currently 32% of working-age Australians), related growth of the 'gig economy';
- The emerging concepts of peer-to-peer energy trading and prosumers and related experimentation with new service and business models;
- Growing prominence of IT-enabled services and practices which can reduce greenhouse gas emissions (e.g. e-medicine, telework, etc);
- New and emerging technological platforms disrupting (or having the potential to disrupt) existing mobility services, financial services, etc;
- Growing prominence of FabLabs (digital fabrication laboratories) becoming a mainstream place to socialise and turn ideas into new products and prototypes; and
- Inventive reuse of urban space is becoming increasingly visible (e.g. pop-up stalls, restaurants, music venues in out-of-hour car spaces).

Additional possible (future) signals of change would also be indicative of such a pathway:

- Major corporate brands are no longer the valuable asset they once were as consumer turn away;
- 3D printers become the Christmas toy-de-jour and mainstreamed as a useful household tool; and
- Commercial repair and recycle shops are increasingly visible and accepted as convenient, economic and sustainable.

5.4. Community Balanced Living

The Scenario

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

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

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

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

This is a strong collaborative economy, with exchanges that are driven by a shared sense of social responsibility and altruism, operating on a non-profit basis. There is also a strong local community dimension to these exchanges, with an emphasis of local production and trading systems. A high proportion of the population works only part-time in the mainstream economy, with time freed for other pursuits that range from creative activity to co-operative work contributing to building community resources. Some community work is supported through local currencies. Communities generally have much greater responsibilities for the creation, improvement and maintenance of commons spaces or essential resources, including food production, renewable energy generation, rainwater collection, storage and distribution, the maintenance of built infrastructure, urban forestation, education and training, aged care and so on.

Recycling and repair of most goods is an important service for small businesses and co-operatives. A high proportion of new building and building refurbishment depends on the contribution of co-operative, community labour and the repurposing of recycled materials. While this description fits the city as a whole, there is a great diversity of social and community cultures across the city—communities are diverse with some degree of specialisation in their contributions to the creation of goods and services and patterns of consumption.

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

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

How did it happen

'The crisis', a period of economic and social turmoil, was the catalyst for a fundamental reshaping of our lifestyles and relationships. A breakdown in the global economy, government austerity programs and chronic unemployment caused a collapse in confidence in the existing political and economic order. A number of devastating weather events and the collapse of the West Antarctic ice shelf also focused minds on the environmental failures of the existing system. Through choice and necessity many people turned to their local communities for mutually supportive relationships in order to survive. Out of these interactions emerged numerous social innovations in production and consumption as well as new less-materialist attitudes towards what was considered a 'good life'. By 2040, low consumption lifestyles, local modes of sustainable production and exchange, and relationships driven by empathy and sharing had demonstrated that human flourishing was possible without high economic growth or relentlessly competitive relationships.

'The Crisis'

The events that led up to what was later to be labelled the 'the crisis' could be described as a perfect storm of mutually interacting economic, political, social and environmental failures. As many countries elected populist leaders with anti-immigration and protectionist policies, the impact on the global supply chains of multinational corporations and economies, already strained by significant inequality, was severe. Diminishing government revenue and subsequent austerity programs only magnified the downturn and diminished already tight social security programs. Significant private sector job cuts and a collapse in incomes from superannuation funds added to the turmoil. By the mid-2020s the public had rapidly lost confidence in the ability of government or big business to deal with the turmoil, including climate change, which was having increasingly severe impacts.

The turn to local communities

Out of the chaos, many people turned to their local communities for support. The spirit of community cohesion, particularly for helping those struggling to adapt to the new conditions, had partly been seen before in precursor emergencies such as the Greece debt crises.

As grid electricity became less reliable and more expensive, community solar projects became more popular and allowed renters to participate

Community energy initiatives

'Community energy' refers to community-based activities to develop and deliver sustainable energy through supply-side projects (e.g. renewable energy investments) and demand-side initiatives (e.g. for energy efficiency, demand management, and community education), as well as efforts to develop new forms of electricity distribution and 'trading' that are more community-based. Projects tend to be run as social or community enterprises in local communities, with benefits often going back to local stakeholders and individuals. Examples include:

- Crowdfunding community investment in solar projects for local buildings: this refers to the pooling of resources to support projects/initiatives, typically via internet-based approaches and campaigns which collect donations for projects. An example crowdfunding platform is The People's Solar which was developed by Energy for the People;
- Community wind farms;
- Community investor-owned solar projects such as projects organised by Repower Shoalhaven, SolarShare, and ClearSky Solar Investments.

Community energy may fill a 'scale gap' between utility scale projects and household-level power systems. For example, the Scottish community energy sector which developed over 300 operating community renewable energy projects in a single decade. A further potential signal of future growth could be a rise in energy co-operatives, akin to Germany which has over 800 energy co-operatives.

See: https://www.dgrv.de/weben.nsf/web/cooperatives and http://www.visionsandpathways.com/wp-content/uploads/2014/05/Alexander_Disruptive-Innovation_290514.pdf

Who can make this happen, and how?

The Coalition for Community Energy (C4CE) has identified 5 priority action areas:

- Community energy models: clarifying and documenting standardised "models" of community energy development which form the basic components of a project;
- Funding and financing: identifying the funding and finance needs of community energy projects and the wider community energy sector;
- Capacity building: building the capacity of community energy proponents;
- Profile raising and stakeholder support to make community energy mainstream; and
- Policy and regulatory reform: articulating the government interventions and support programs required to grow the community energy sector and remove institutional barriers. For example, modification of regulatory structures related to community off-grid or micro-grid systems, policies that address barriers and challenges related to electricity network use, and addressing barriers to selling power to the grid at a fair price.

in solar energy. Makeshift education and health care were set up, as well as other training. ‘Mens Sheds’, tool libraries, maker spaces, became repair hubs.

Local charismatic leaders helped attract and encourage a neighbourhood co-operative movement in housing, food, transport and other areas. Meanwhile, local government helped drive through local governance changes to support and enable new forms of co-operatives and social enterprises, and more generally pushed a sustainability agenda.

Necessity as the mother of innovation

The innovations that emerge in these communities were a mixture of low-tech and high-tech, and emphasized finding new opportunities to make the most of local resources on hand and share them in a just manner. For example, as car ownership fell, carparks were converted into community gardens and the produce shared and sold in local markets.

Meanwhile, networking technologies had greatly enabled various types of selling, bartering and true sharing systems of time, skills, energy and resources within and between local neighbourhoods. Social entrepreneurship was flourishing and focused not on building personal wealth but creating better communities.

Rethinking the good life

These pro-social values were part of a broader re-evaluation of what it meant to have a ‘good life’. In experiencing a simpler mode of living, people saw the benefits of a more balanced life and that life is made meaningful by relationships with family, friends and the community.

Working hours had dropped to 21 hours per week by 2032. This was to ensure that everyone could have an income; but it was also very popular. With greater spare time, many discovered the joys of volunteer helping and taking part in co-operative labour like building communities centres or the regular rubbish ‘clean-up’ days.

There was also a growing recognition of the vital and inherent connections of people to the natural world. These new values led to more responsible and sustainable behaviours and valuing of the natural environment. We didn’t mind that we could not eat as much meat or travel abroad so frequently. We liked our new life.

The voluntary simplicity movement

This loose-knit social movement is comprised of those people seeking low consumption lifestyles which are perceived to provide a higher quality way of life. “In practice, this way of life might involve growing organic food or supporting local farmers’ markets, harvesting rainwater, mending or making clothes, cycling or walking rather than driving, avoiding airflight, limiting work hours, co-housing, purchasing second-hand or ‘fair trade’, progressively reducing energy consumption, and generally minimising waste and all superfluous purchases”. There could be 200 million people in the developed regions of the world exploring such lifestyles.

It can be considered an emerging climate solution because: (i) the scale and speed of greenhouse gas emissions reduction required for climate stabilisation will require major cut-backs in consumption, partly due to potential delays scaling up other solutions (e.g. renewable energy); (ii) transitioning beyond fossil fuels has “hugely significant lifestyle implications” which require reimagining the ‘good life’; and (iii) reductions in consumption may have additional macroeconomic implications that help to enable reductions in emissions.

See: http://www.visionsandpathways.com/wp-content/uploads/2014/05/Alexander_Disruptive-Innovation_290514.pdf

Who can make this happen, and how?

- Existing movement participants: exploring new ways of communicating and sharing the benefits of low-consumption lifestyles;
- Scientists and scholars: demonstrate a necessary link between responding to climate change and consuming less;
- Continuing development of “both a ‘group consciousness’ and a ‘political sensibility’” which “are arguably necessary for any social movement to use its collective power in influential ways”

Quantitative Settings and Results

Table 6 shows the quantitative modelling settings for the Community Balanced Living (CBL) scenario.

Domain	*Scenario description*	*Quantitative settings*
Electricity/ Energy	Community and household renewable energy systems. Less demand for electricity from simpler lifestyles, smaller homes and local living.	Co-housing, simpler lifestyles with less electrical gadgets and transport shifts to significantly more walking and cycling result in a reduction in electricity demand by 36%. Electricity generated by fossil fuels decreases by 100%, electricity generated by renewable energy increases by 345% . For other forms of energy, efficiencies improve at a rate of 1.0% per annum (UNIDO benchmark level for 'Business as Usual'). This results in a 38% improvement in overall energy efficiency and subsequent reduction in final demand by 2040.
Transport	Living in 20-minute suburbs, where most goods and services are available, reduces the need for travel. Walking and cycling is embedded into healthy lifestyles. When longer-range travel is required, ride-sharing, bio-gas public buses and public trains are used.	Overall need to travel is reduced by 30% due to 20 minute cities. 50% reduction in passenger vehicles due to 20 minute cities and ride sharing. 80% reduction in number of car trips/car travel. 50% reduction in use of public transport services. 75% increase in active travel.
Food	Widespread growing of food within urban boundaries. 'Farming' is a mixture of commercial, community, school and individual gardens and also council-run horticulture for 'social food'.	Largely vegan diet with some local animal products. Food waste reduced by 75% across the food chain due to sharing and local processing facilities. 100% reduction in consumption of bottled water and soft drinks. 90% reduction in consumption of highly processed foods. Carbon intensity of food processing (and other manufacturing) reduced due to increased energy efficiency (1.0% per annum—corresponds to business as usual).
Goods	Significantly less consumption of goods, local sharing and reuse.	Sharing of white goods, large household appliances (washing machines, vacuum cleaners) and tools, high reuse of clothing and furniture, so reduced consumption by 75%. Carbon intensity of manufacturing reduced due to increased energy efficiency (1.0% per annum—Business as Usual) in city, RoA and RoW regions.
Water	Distributed, storage of rainwater. Extensive, local low-tech (vegetative) cleaning of wastewater.	More rainwater tanks and pipes are required increasing demand for plumbing materials and services by 40% (less than the NEL scenario due to some infrastructure being shared).
Waste	Highly distributed local collection and reuse. Organic waste used for city greening and food production. Aim is to effectively separate and minimise transport distances.	Consumption of goods significantly decreased due to sharing and reuse, so landfill waste is significantly reduced by 75%. Significantly reduced chemical fertilisers for agriculture.

Table 6: Summary settings table for the Community Balanced Living scenario

The CBL scenario has a reduction of 66% in overall per capita emissions compared to 2013 (Figure 12), slightly more than NEL and slightly less than both CTCL and PRL. Similar to PRL, emissions from electricity generation drop significantly by 98%, due to combination of a shift to clean energy generation and drop in demand, and emissions from other significant sectors such as services, construction and industrial goods reducing by 76%, 76% and 59% respectively. The largest proportion of emissions also shifted from electricity generation in 2013 to industrial goods in 2040 (Figure 13). Overall emissions from the Greater Sydney, Rest of Australia (RoA) and Rest of World (RoW) regions drop by 68%, 75% and 52% respectively.

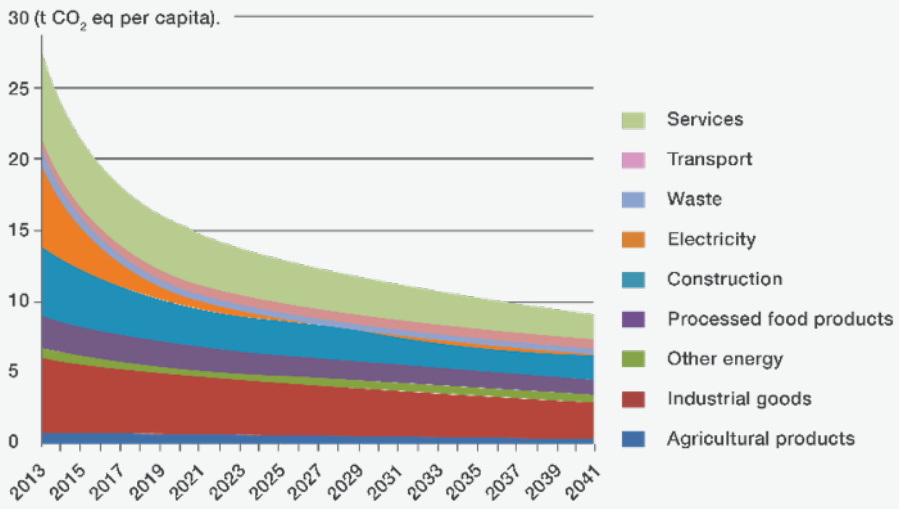


Figure 12: GHG emission reductions from 2013 to 2040 for CBL scenario on a per capita basis.

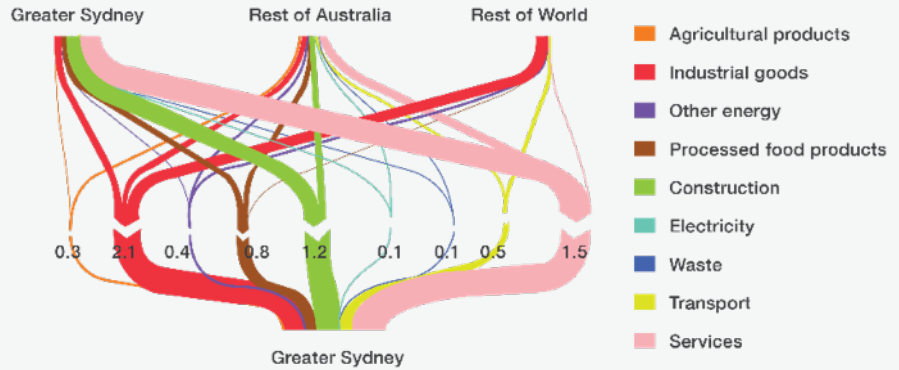


Figure 13: Distribution of GHG emissions across sectors and regions in 2040 for CBL scenario (tCO_2 eq).

Signals of change

A number of current and emerging signals of change lend some plausibility to this vision and change pathway. Some of these signals include:

- Localised electricity generation and creation of 'micro-grids' (e.g. for 'edge of grid' developments and for new multi-dwelling developments);
- Growth of local community-based sharing schemes (e.g. car sharing schemes, tool sharing) and local food and produce markets;
- New social enterprises such as Mens Sheds and alternative food enterprises;
- Product re-use and swap/ exchanges facilitated by technologies;
- Rising popularity of and acceptance of community gardens (e.g. community gardens were included in Plan Melbourne in 2017 for the first time);
- Mistrust of government and big business; and
- Influence of housing affordability issues on housing preferences and types.

Additional possible (future) signals of change would also be indicative such a pathway:

- Terms like 'Timebanking' and 'Pay it forward' start becoming modern parlance;
- Private fences begin being removed as some household begin to share property for food production, activity spaces, etc;
- Urban Food Street, the Sunshine Coast urban design project for neighbourhoods to grow commercial quantities of fresh fruit and vegetables is adopted by increasing number of communities around Australia; and
- Flourishing town hall events and a renaissance of support for local government.

5.5. Discussion of Plausibility and Desirability

There are questions about the plausibility of each scenario (vision and pathway) and the emissions reduction outcomes that could be achieved. The initial modelling results show that although significant reductions were achieved across all scenarios, none reached the 80% target. In addition to this, while all scenario emissions profiles were different to the baseline, they were not significantly different from each other. These results are potentially due to a combination of the limitations of the initial modelling method and the modelled scenario characteristics (in that they were not significant enough to bring about sufficient emission reductions). This indicates that it is necessary to investigate in more detail what interventions would be necessary bring about the required urban transformation, and whether it would be necessary to combine certain scenario characteristics to achieve the emission reduction target.

The desirability of aspects of each vision and associated pathways were also often contested by workshop participants, though it may be possible for policymakers to build support for new policy solutions by tapping into emerging aspirations for new forms of urban living. Throughout the workshop process, from the early 'dreaming' visions to the more iterative reflections on scenarios and pathways as they developed, there were repeated 'fault lines' that appeared to divide respondents attitudes to 'desirable' futures. It was not possible to investigate these in detail, so that precise lines of demarcation or the strength of opposing views cannot be reported.

However in broad terms there were issues about which people disagreed (or at least diverged in terms of values) that were noted regularly by the researchers. They include:

- Bottom-up versus top-down, as a stance towards the dynamics of change. This reflected attitudes to power; a divergence particularly evident in the consideration of a corporate or government driven future.
- Preference for, or acceptance of, technology as the predominant basis of future solutions (often leading to what was categorised by the researchers as 'high-tech' versus 'low-tech' groups);
- A sharp divide, exposed in debates around scenarios of 'smart' city systems (with the generation and use of urban data for the management of the city) which reflected the above divisions but invoked some strongly expressed fears about privacy and surveillance, corporate control of citizen's lives, and technological dependency/lock-in as a vulnerability in the context of exogenous challenges like natural disasters and extreme weather events;
- In futures that explored the potential for involvement of citizens in production as well as consumption, there was a proportion of people who expressed a clear preference for a 'serviced life' that did not involve them in growing food, or producing energy, or handling waste, etc. This included people who were otherwise positive about changing production so that it was more localised, diverse and distributed.

In this section we comment on the scenarios from a qualitative perspective, in light of:

- the participant responses in the stakeholder workshops;
- how they can be located within the broader literature on scenarios and futures thinking; and
- critiques and analysis of whether or how the underlying narrative, worldview and political framework can deliver the transformational change required.

At the Stakeholder Workshops held in Melbourne in March 2017, participants discussed the challenges and tensions which may impact the feasibility of this pathway and raised associated questions about both whether it could happen, and whether they would want it to do so. The challenges, tensions and specific questions raised by stakeholders are summarised in Boxes 1-4.

Situating these within broader scenario literature and futures work includes comparing them to a set of scenarios proposed by the Global Scenario Group (GSG), first convened in 1995 by the Stockholm Environment Institute (SEI) and Tellus Institute (GSG 2005). We make these comparisons because these global scenarios have become archetypes for much scenario work and they have arguably stood the test of time in terms of presenting a set of logical, coherent and plausible paths to our collective futures according to a number of researchers (e.g. Hunt 2012; Riedy, 2013). We will also comment on whether there are reasons to believe they are relevant, or not, to Australia given local conditions and trends.

The GSG developed six scenarios, categorised into three scenario classes with two variants for each class. These were: Conventional Worlds with the variants Market Forces and Policy Reform; Barbarization with the variants Breakdown and Fortress World, and; Great Transition with the variants Eco- Communalism and New Sustainability Paradigm. These three scenarios classes

can be distinguished by, respectively (i) essential continuity, (ii) fundamental but undesirable social change, and (iii) fundamental and favourable social transformation.[95] The VP2040 scenarios resonate to varying degrees with the Conventional Worlds and Great Transition scenario classes. While the Barbarization scenarios are not part of the VP2040 scenario end-states, we did use economic and social crises as components of some of the pathways narratives.

95 Raskin, P., Banuri, T., Gallopín, G., Gutman, P., Hammond, A., Kates, R., & Swart, R. (2002). *Great Transition: The Promise and Lure of the Times Ahead*. Boston: Stockholm Environment Institute.

Clean-Tech Corporate Living

The VP2040 Clean-Tech Corporate Living scenario belongs to the archetype the GSG called the 'Market Forces' scenario. This is the first of the Conventional Worlds scenarios which envision the future evolving without major surprises, sharp discontinuities or fundamental transformations in the basis for human civilisation. Market Forces is constructed as a future in which free market optimism remains dominant and proves well-founded. Technology is the dominant driver for sustainability as problems such as climate change or resource constraints are solved by the self-correcting logic of competitive markets.

For many scenario research projects, this scenario is often considered a 'reference' or 'business-as-usual' scenario. Indeed, these terms were the original labels for the GSG Market Forces scenario. In other scenario projects that we have followed, Market Forces variants are readily apparent. For example, in the UK 'Realising Transition Pathways' project[96] they have a 'Market Rules' scenario which envisions a continued dominance of the market-led logic for the governance of UK energy systems. A decarbonized energy supply is achieved by market actors (mostly large incumbent energy companies) freely interacting within a high-level policy framework (such as an emissions trading scheme). The EU project 'Creating Innovative Sustainability Pathways' (CRISP), similarly, has an 'i-Tech' scenario where technological innovation drives everything in a highly competitive world.[97] In looking at general scenarios of Australia in 2050, Costanza et al.[98] include a 'Free Enterprise' scenario in there is an emphasis on technological or market-driven responses to expand the limits for economic growth.

For Clean-Tech Corporate Living, the pathways drivers of high-level policy guidance (e.g. carbon pricing), efficiency-driven innovation caused by increasing resource costs, and demand for clean products and services by consumers is sufficient to create a low carbon society. However, many other studies using a Market Forces type scenario deem it as having weak environmental outcomes (whilst having strong outcomes for the economy and technology) including the original GSG Market Forces scenario and the Costanza et al. Free Enterprise scenario, suggesting skepticism of the scenario.

96 Foxon, T. (2013). Transition pathways for a UK low carbon electricity future. *Energy Policy*. 52, 10-24.

97 CRISP. (2014). *Final Report Synthesis of three sustainable pathways.* TNO Report RN10225, available at http://www.crispfutures.eu/display/CRISPSITE/Welcome+to+CRISP%21

98 Costanza, R., Kubiszewski, I., Cork, S., Atkins, P., Bean, A., Diamond, A., … Kimberley, P. (2015). Scenarios for Australia in 2050: A Synthesis and Proposed Survey. *Journal of Futures Studies,* 19(3), 49-75.

Box 1: Clean-Tech Corporate Living

Challenges and tensions identified by workshop participants

- Mobilisation of large amounts of capital and developing/mainstreaming new means for achieving this (e.g. green bonds, etc.)
- Potential reliance on large corporates with altruistic motives
- Social risks of 'eco-disruption' e.g. benefits not equally shared, social effects of technological disruption, people being left behind, etc.
- Potential to intensify socio-economic disempowerment and social inequity
- Private data ownership and data trading raises privacy and data security risks
- Proprietary competition could lead to duplication and related inefficiencies
- Alternatively, greater control by larger corporations may result in less competition

Concerns about homogenisation and loss of community

Specific questions raised by workshop participants

- Does government need to play a stronger role (than is envisioned by this pathway)?
- Can the change be achieved via price signals, or will regulatory controls also be needed? What incentives do corporates need to move?
- How can governments set sufficiently strong market rules given the power of incumbents and the corporate sector? Will corporates undermine environmental regulations?
- Do the values of consumers also have to change to support this scenario (i.e. valuing emissions reduction, being less concerned about inequality)?
- Will consumers learn to buy green or will other factors need to force them?
- Will climate change impacts and associated issues (e.g. climate refugees) undermine the viability of this approach?
- Will resource constraints drive a shift to services and experiences and limit consumption?
- Will the perceived excesses of big corporates (e.g. Uber, Apple, etc.) lead to revolution?

The literature on the failures of corporate capitalism for the environment is large and includes critiques from many schools of thought. Naomi Klein's 'This Changes Everything: Capitalism versus The Climate'[99] is perhaps the most well-known recent book arguing for the need to abandon the dominant free market ideology, restructure the global economy, and remake our political systems. For a less polemic perspective, 'Climate Change, Capitalism, and Corporations'[100] by two Australian academics, Christopher Wright and Daniel Nyberg, provides an excellent analysis of the complex and multiple ways that corporations are shaping humanity's response to the climate crisis. Ways that, they argue, are inadequate to the challenge at hand. Among the reasons they provide is the interview evidence pertaining to the struggle that corporate employees with genuine environmental concerns have to be heard within profit-obsessed companies.

For Australia, one of the leading free-market economies, the VP2040 Clean-Tech scenario is a highly relevant scenario. Many participants in our workshop could not imagine a successful transition to low carbon living which didn't involve harnessing the industrial might of corporations. This was partially because they couldn't imagine another way that the speed and scale of technological change could unfold.

However the optimism of this scenario is a highly contested one. Critiques of corporations' role in the climate change response;[101] and of techno-optimist scenarios that don't require behavioural, cultural or even moral changes,[102,103] are clearly applicable here.

A number of aspects of this scenario point to potential "dark sides" that need to be considered and which raise further policy and socio-economic questions. These were regularly raised during the workshops. They include:

- Increasing socio-economic inequality and related social problems;
- Privatisation of public and open spaces in Australian cities—capture of civic value by private interests;
- Technological unemployment; and
- Greater private ownership of private data and related privacy concerns.

The unease suggested in relation to these 'dark sides' is captured in the final participant question which refers to 'revolution'. Are the broader socio-economic implications of this scenario actually 'bearable'—can it be expected that the population would accept /acquiesce to this scenario, or might the breakdown in social contract and citizen well-being be such that a social response and push-back as has been/is being seen globally would emerge?

99 Klein, N. (2015). *This Changes Everything: Capitalism versus The Climate*, Simon & Schuster.

100 Wright, C., & Nyberg, D. (2015). *Climate Change, Capitalism, and Corporations.* Cambridge University Press.

101 Pearse, G. (2012). Greenwash: *Big Brands and Carbon Scams.* Black Inc, Australia.

102 Heinberg, R. (2017) *Why Climate Change Isn't Our Biggest Environmental Problem, and Why Technology Won't Save Us.* Post Carbon Institute. Available at http://www.postcarbon.org/why-climate-change-isnt-our-biggest-environmental-problem-and-why-technology-wont-save-us/

103 yan, C., Twomey, P., Gaziulusoy, A. I., McGrail, S., Chandler P. (2016). *Scenarios 2040 - Results from the second year of Visions and Pathways 2040: Scenarios of Low Carbon Living.* Melbourne, Australia. Available at http://www.visionsandpathways.com/wp-content/uploads/2016/05/VP-2040_second_year_report1.pdf

Planned Regulated Living

The Planned Regulation Living scenario resonates with another GSG 'Policy Reform' scenario. That scenario assumes comprehensive and coordinated government action is initiated for poverty reduction and environmental sustainability, rooted in social democratic rather than neoliberal economic sensibilities. The large-scale government-led effort to achieve sustainability happens with some rewiring of modern capitalism but without major changes in the state-centric international order, modern institutional structures, and consumerist values.

Again, this is also a relatively common scenario archetype.[104] For example, the UK 'Realising Transition Pathways' project[105] have a government-led pathway for the UK energy system called 'Central Co-ordination'. In Costanza et al.[106] there is a 'Coordinated Action' scenario which includes "hierarchical, top-down planning, and regulation to protect collective interests".

One of the main criticisms of this pathway, which many of our own workshop participants noted, is the plausibility of achieving the necessary political will. Indeed, a commonly accepted frustration for many a sustainability researcher goes along the lines: "We know what we need to do. The technologies, plans and designs, even the economics, are all there. Why can't we just make the collective decision to do it?" Another frequently stated response to this scenario in the VP2040 workshops was "this is great but it could never happen in Australia". How could rejuvenated governments emerge in Australia to vigorously coordinate and implement such actions while rectifying the instabilities induced by over-reliance on market mechanisms?

Box 2: Planned Regulated Living

Challenges and tensions identified by workshop participants

- This pathway requires a strong democracy
- Trust will need to be built to enable this—trust in government, trust in other governmental institutions —especially given higher taxation and roles played by technocrats;
- Potential for problems of bureaucracy, corruption, etc., in a 'big government' society;
- Potential that new regulatory frameworks could inhibit necessary innovations; related concerns about regulatory/ compliance burdens;
- Potential for political cycles to prevent long-term decisive policy initiatives;
- Showing that this society 'works' (e.g. provision of high quality, more affordable housing);
- Potential for taxpayers to be hit by 'white elephants' due to the difficulty of predicting the best technology (i.e. limited ability to pick winners?)
- Decoupling vested corporate interests (e.g. fossil fuel interests) from government actions;
- Local governments will need to work together across current council boundaries.

Specific questions raised by workshop participants

- How do you counter the power of vested interests which is likely to be marshalled against such an approach?
- How can a culture of participatory democracy be restored?
- Will this pathway be agile/flexible enough?
- How do you develop and renew a culture of skilled public service?
- Could this pathway be undemocratic (or be perceived as undemocratic)?

In some versions of this scenario archetype, global synchronized regulations and incentives under the United Nations, WTO or other multilateral institution are a pathway mechanism of transformation.[107] Other scenario variants rely on civil society to press for government action through education, lobbying and protests. This is a key driver of the VP2040 version of this scenario. In our scenario, failure at the national and supra-level of government are used to spur citizens to work with state and metropolitan levels of government to drive transformation.

The argument that our cities, their governments, and their mayors could lead the work of dramatically lowering our greenhouse gas emissions is expounded in the work of political theorist Benjamin Barber. His final two books 'If Mayors Ruled the World'[108] and 'Cool Cities'[109] explores how cities, by assuming important aspects of sovereignty, could take the lead from faltering nation states in fighting climate change. Barber argues that "if presidents and prime ministers cannot summon the will to work for a

104 Hunt, D., Lombardi, D., Atkinson, S., Barber, A., Barnes, M., Boyko, C., … Rogers, C. (2012). Scenario Archetypes: Converging Rather than Diverging Themes. *Sustainability*, 4, 740-772.

105 Foxon 2013, see above.

106 Costanza *et al.* 2015 p.57, see above.

107 Raskin, P. (2016). *Journey to Earthland*. Tellus Institute, Sweden.

108 Barber, B. R. (2013). *If mayors ruled the world: Dysfunctional nations, rising cities*. Yale University Press.

109 Barber, B. R. (2017). *Cool Cities: Urban Sovereignty and the Fix for Global Warming*. Yale University Press.

sustainable planet, or even live up to the modest agreements they so reluctantly negotiate, mayors can."[110] The strong reaction by U.S. city mayors following the withdrawal of the United States to the UNFCCC Paris climate agreement provides some evidence for this optimism.

In Australia, the active participation of many of our cities in various organisation and initiatives such as the Global Parliament of Mayors, C40, ICLEI and Compact of Mayors, who are all becoming increasingly prominent in global climate change governance adds plausibility to this pathway narrative. At the state government level, the history of Australian states in taking the lead in climate action, particularly during the Howard government years in Australia, also adds some credibility to this scenario, although their efforts were still unable to reduce Australia's total emissions. We note that just days after writing this illustrative pathway narrative we were to read that the South Australian government was to fund the construction of a new gas-fired power station and support the construction of the nation's largest battery in a $550 million plan to fix its energy problem following blackouts and public debate. While not a renationalisation of the electricity system, it does provide a counterexample to the trend of the last decade of deregulation and privatisation.

Networked Entrepreneurial Living

The Networked Entrepreneurial Living scenario is the most novel scenario of the four and does not have a close relative in the GSG scenarios. It partly takes its inspiration from the explosion of interest in the potential of peer-to-peer networking,[111] the collaborative economy and 'crowd-based capitalism,'[112] and how new technologies and modes of organization may diminish the importance of scale and lead to the 'end of big.'[113] Among the researchers for our project there was at least one who thought that this complex of innovations represented the most important development for understanding the trajectory of sustainable futures. However, the team was also sensitive to the hype cycle of the latest innovation fashion and whether it could move to become a comprehensive paradigm.

At a general level, the bottom up nature of the scenario has parallels with some of the projects previously mentioned. For example, the UK 'Realising Transition Pathways' project[114] has a scenario called a 'Thousand Flowers' in which citizens take a leading role in the decisions relating to how their local and national energy systems operate, resulting in a highly diversified

110 Ibid p.62.

111 Chase, R. (2015). Peers Inc: *How People and Platforms are Inventing the Collaborative Economy and Reinventing Capitalism*. Headline Publishing London.

112 Sundararajan, A. (2016). *The Sharing Economy: The End of Employment and the Rise of Crowd-Based Capitalism*. MIT Press.

113 Mele, N. (2013). *The end of big: How the internet makes David the new Goliath.* Macmillan.

114 Foxon 2013, see above.

Box 3: Networked Entrepreneurial Living

Scenario challenges and tensions identified by workshop participants

- Risk-tolerance/taking and venture capital are limited in Australian cities;
- Educational implications: changes in education may be required to enable such changes (e.g. greater entrepreneurship, risk-taking, etc.), perhaps starting in primary school;
- Ethical and societal implications of "hustlers, pirates and thieves" being dominant actors;
- Breaking up (or the breakdown of) large corporates
- Strong governance and governmental leadership may be needed (e.g. emergence of strong governments willing to break up large corporates);
- Global competition may impair the success of local entrepreneurs and local "hustlers";
- Potential for higher transaction costs;
- Uncertainty over speed and scale of change, and the emissions reduction potential.

Specific questions raised by workshop participants

- What is the likelihood of achieving the social and environmental outcomes without a strong governmental driver forcing "hustlers, pirates and thieves" to do the right thing?
- Is this pathway conditional on urban form?
- Regarding future climate change effects, how would the social justice and environmental justice issues be handled in this society?
- Will the lack of coordination hamper the delivery of emission reductions?
- Will deficits of trust and collegiality/sharing constrain innovation?
- If you can "do it yourself" then you're a winner, but if you can't you are on your own?

set of new actors using various technologies and modes of ownership. However, this scenario includes some of the community values and behavioural-based changes that situate more readily in our Community Balanced Living scenario. For Costanza et al (2015), their 'Strong Individualism' scenario has parallels with the VP2040 scenario with both having a for-profit attitude and limited government. The pathways for this scenario are also similar in relying on resource related limits, conflicts, political unrest and the demise of the global economy as a contributing pathway mechanism. However the Costanza et al. scenario makes no reference to peer-to-peer networking or crowd-based capitalism as a defining feature of the scenario.

Victor Kostakis and Michel Bauwens are two scholars who have perhaps have done the most to articulate scenarios and pathways that build upon the idea that peer-to-peer infrastructures will gradually become the general conditions of work, economy and society.[115] Their analysis includes a four scenario approach of how peer-to-peer networking may evolve; that analysis raises issues that the VP2040 scenario remained agnostic on in the development of these initial four scenarios. For example, there is a tension between the current monopolistic tendencies of actors in the peer-to-peer platform space such as Google, Facebook, Airbnb and Uber (tendencies which perhaps fit more naturally into the Clean-Tech Corporate Living scenario) versus the opportunities for common or public based ownership of key infrastructures and platforms using new technologies and shared ownership structures such as blockchain and crowdfunding.

The VP2040 pathway to a future in which big business and government are significantly less influential and in which there is a highly decentralised, diversified economy, did seem possible to a number of the workshop participants. Furthermore, if this development was to happen globally for developed countries there is no indication to believe that Australia would be exceptional. Indeed, if it is to happen, it is heavily reliant on strong global knowledge collaboration.

However, there was an understandable scepticism as to whether this scenario could achieve the 80% emissions target reductions. Emission reductions driven by asset-use efficiency and innovations driven by a bottom-up entrepreneurial spirit may be significant but not enough. There is increasing evidence that these concerns are legitimate, as increasing scholarship on the 'sharing' and 'collaborative' economies suggests that innovative technologies and entrepreneurialism by themselves are/will not achieve significant social and environmental outcomes. Similarly to the critique of CBL, it is strongly suggested that new forms of social contract, governance and institutions, policy etc will be required to direct them towards the publicly required outcomes.

In the editorial of the special issue of the Journal of Environmental Innovation and Societal Transitions (June 2017), focused on *Sustainability Perspectives on the Sharing Economy*, editor Koen Franken concluded that "the early claims of the inherent sustainability of the sharing economy are ill-founded. Not only are many providers and users primarily motivated by the economic gains to be made by trading on sharing platforms, the environmental effects may anyway well be rather limited due to increased demand triggered by lower prices as well as various rebound effects. What is more, the gains of the sharing economy are unevenly distributed and may even increase inequality, since those with the most valuable possessions can realize the largest rents from sharing them. Having said this, the sharing economy —and the regulatory institutions evolving with it—is still very much under construction. Supplementary institutional changes are conceivable that would reinforce the sustainability impacts of sharing and would redistribute the economic gains more evenly. A key question will be what institutions will promote the sustainability-enhancing platforms. In the coming decade, we will witness whether sharing will constitute new regimes in sectors like hospitality, transportation and food and how such new regimes will be shaped by innovation, contestation and regulation all at the same time."[116]

Responses to these tensions—and the possible pathways or synergies that might resolve it—are explored more fully in the second Action Pathway (Commons Transition). This scenario allows the technologies and services of the peer-to-peer, decentralised and entrepreneurial NEL to be managed and put to work by the engaged communities of CBL, with changing governance and institutions providing some support that can be considered as elements of PRL.

Community Based Living

The localism element of the Community Balanced Living scenario resonates with the GSG *Eco-Communalism* scenario. This is a green vision of bio-regionalism, localism, face-to-face democracy, small technology, and local economic independence[117]. It is a world with high equity and low economic growth, embracing the principles of strong decentralisation and small-scale technology.

Variants of this scenario archetype also appear in some of the projects previously mentioned. For example, CRISP has a *Local Community* scenario for a sustainable EU, whose features include strong regional identity, local production for local consumption, emphasis on social relationships, vegetarianism, social cohesion, individual responsibility and sharing consumption. Costanza et al. (2015) have a *Community Well-Being* scenario that emphasises

115 Kostakis, V., & Bauwens, M. (2014). *Network Society and Future Scenarios for a Collaborative Economy*. Palgrave Macmillan, England.

116 Frenken, K. (2017). *Sustainability perspectives on the sharing economy, Environmental Innovation and Societal Transitions*, 23, 1-2. ISSN 2210-4224, https://doi.org/10.1016/j.eist.2017.04.004

117 Raskin *et al* 2002, see above.

polycentrism and subsidiarity and an Australia that does not make economic growth an overriding goal or requirement, but rather focuses on equity and quality of life. SPREAD, another EU project focusing on sustainable lifestyles for Europe in 2050, has a similar scenario called *Empathetic Communities*.

A key pathway plausibility issue that arises in this scenario archetype is how such a dramatic shift in values and lifestyles could emerge. This is particularly relevant for Australia where, one could arguably claim, we appear to be locked into, if not all completely content with, high consuming, long working, and car loving living patterns. In many pathway narratives of this scenario, including the GSG's version, some type of societal breakdown is used to bring about such a radical change. This is indeed partly how the VP2040 illustrative pathway has been composed. However, a more optimistic stance would hope that the current niche activity in this area can somehow scale-up in an evolutionary manner without the cauldron of suffering concomitant to a breakdown. And certainly our workshop participants could point to many community initiatives, organizations and behavioural changes that could be the seeds of such change. Nevertheless there was no confidence that this could scale up to replace the current economic and societal paradigm.

At the Melbourne workshop, this scenario was the most preferred by participants when asked which scenario they would like to live in. However, it was also the scenario perceived to be the least likely to occur. This result parallels the findings of a national survey of the scenarios by Costanza and his colleagues, which we have shown above to share some common features to our own scenarios.[118] Their preliminary results showed that 71% of a randomly selected sample of over 2000 participants preferred the *Community Wellbeing* future. However, they also found that this was thought to be Australia's least likely future, with just 17% believing this is where Australia is heading. The most likely future people saw for Australia was a continuation of *Free Enterprise*, which has similarities to our Clean-Tech Corporate Living. They note, and we agree, that "these results showed the significant difference between where Australians felt Australia was heading and where they wanted it to go."[119] This in itself suggests a significant problem with what Australians want and who is deciding what happens. This tension, and some possibilities for how it could be changed are explored in the Action Pathways that follow.

118 Costanza, R., Atkins, P., Boltona, M., Cork, S., Grigg, N., Kasser, T., Kubiszewski, I. (2017). Overcoming societal addictions: What can we learn from individual therapies? Ecological Economics, 131, 543–550.

119 Ibid p.547.

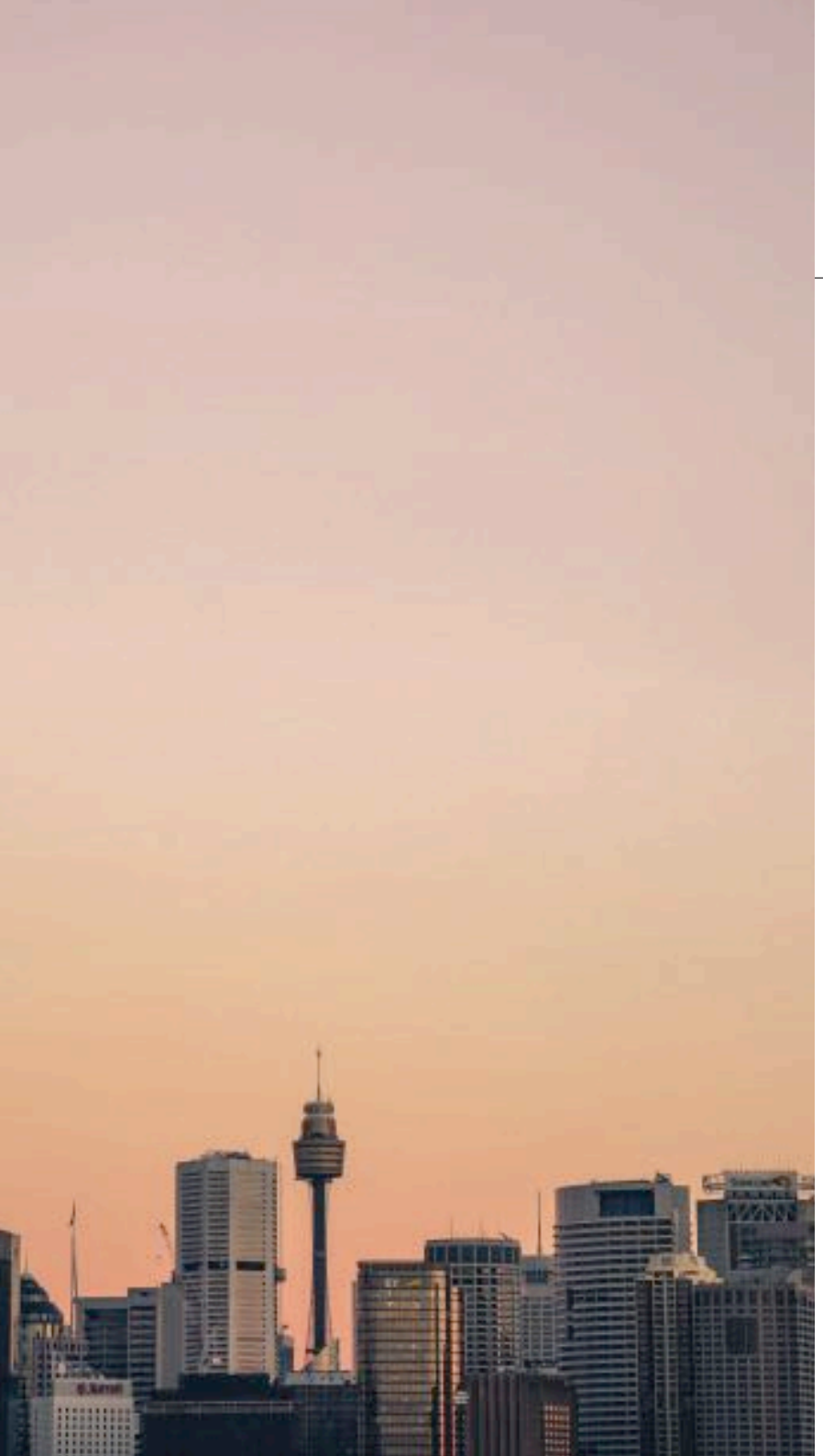
Box 4: Community Balanced Living

Scenario challenges and tensions identified by workshop participants

- Pathway requires regulatory changes (e.g. removing barriers to new uses of public space);
- Diversity of values and preferences may present a major challenge;
- Related reliance on skills development, education and intergenerational cultural change;
- Risk that small-scale decision-making at the local level can get tied up in attempts to achieve consensus, etc: bottom-up change may be too slow or not occur;
- Community-scale focus may prevent the adequate resourcing of disruptive change and creation of new of modes of work, new technologies etc (e.g. community-scale organisations are often poorly resourced, with reduced ability to make/implement anything);
- Achieving required coordination between local, state and federal governments;
- Potential for losses in actual (or perceived) quality of life, autonomy, and freedom/choice may generate challenges (e.g. could such concerns provoke a backlash?).

Specific questions raised by workshop participants

- What 'crisis' is required to enable such a shift?
- Is there a risk of this pathway being overwhelmed by external events related to such crises (e.g. major climatic events, influx of climate refugees, etc.)?
- To what extent is 'community living' (as depicted in the scenario) attractive to people? Will psycho-social factors/ aspects limit its real-world appeal?
- Can we really go back to a simpler, past way of life? What about public transport? Universities? Economies of scale in manufacturing and research?
- Can we count on people's activism? Free riders undermine others willingness to contribute to community
- Is it possible to achieve the necessary large-scale change via decentralised approaches?
- Will this look different in different communities (e.g. local spatial and cultural factors)?
- Is it possible to have this without simultaneous reinvigoration of the far right?



6. Two Action Pathways

Each of the four exploratory scenarios presented above is 'artificially' constrained in key ways that make achieving the required emissions reductions and a 'plausible' pathway to how we could actually get there very challenging. More plausible scenarios for achieving this can be developed by relaxing the differentiating constraints and enabling elements like technology, social change and governance to combine and co-contribute to achieving emissions reductions.

Responding to the tensions and critiques discussed above in relation to the four exploratory scenarios, we have streamlined the scenarios into two 'combined' scenarios that provide clearer Action Pathways for cities. These two new scenarios allow for more coherent and multifaceted activities and responses to drive climate response, more fully exploring the possibilities presented in the first four scenarios. They are:

Commons Transition

– *Vision:* Bottom-up/Commons revolution/degrowth and dematerialisation—rapid consumption reduction—shift in power structures to democratic and participative communities—highly technology enabled;

– *Pathway:* Citizens and communities create and apply new ways of providing for themselves, building sophistication in how they manage these systems for the common good as peers. Governance and institutions adapt and evolved to operate as a 'Partner State' facilitating commons management.

Green Growth

– *Vision:* The right policies are in place to incentivise corporate innovation for rapid decarbonisation— government and business working together, within the current economic and neoliberal paradigm;

– *Pathway:* Cities led, building political pressure to drive changes to state and national policy.

The two scenarios have a number of key dynamics in common, it is the way that these play out that distinguishes between them. These include:

- The technology trajectories and innovations that can be seen already continue and drive disruptive changes in both scenarios, like driverless cars, ubiquitous sensors and data-driven cities, process automation, blockchain enabled energy management etc;
- Massive automation and associated significant loss of jobs occurs, with major economic and social ramifications; and
-
- 'Cities' and municipal jurisdictions are leaders, innovatively applying their resources to facilitate and enable forces of change to reduce emissions and adapt to climate change.

The Action Pathways are intended to provoke, challenge and inspire. The Australian political context is such that the multitude of technical pathways are clear, but the cultural, political and economic pathways are not—it is much harder to imagine how this change can happen. These two Action Pathways draw heavily on the four Scenarios to describe technical and service innovations, but diverge significantly in how and why this happened. They are explorations of the choices and action of key actors as much as—or more than—the technological and social innovations they have to hand.

6.1. Commons Transition

The City is a network of 'Commons' where local communities organise themselves to manage key resources and systems of provision,[120] in collaboration with business and government. The pervasive ideas, models and technologies of P2P—collaboration 'peer-to-peer' or 'person-to-person'—have evolved to transform how decisions are made and who is involved. The will of the 'people' has been clearly and loudly expressed in actions to reduce greenhouse gas emissions by over 80%, as the focus on creation of common value for everyone has trumped creation of private value for a few. The City is 'post-growth', 'post-smart', 'post-hierarchy' and 'post-pollution'—with the new structures and institutions that make sense for this new world continuing to emerge. People consume less, work for themselves and their communities, and use much use less energy.

A meshwork of ubiquitous decision-making systems make 'being informed and involved' as easy as swiping left or right, or tagging the person you nominate as your proxy. People can directly shape what happens at a neighbourhood level, as well as through to regional and national issues. This 'real people' governance has reshaped many areas of life: technology, energy, food, waste, housing, and production. Informed citizens make decisions about spending on key services like health and education, infrastructure, taxes and incentives, procurement and trade policies.

120 Adapted from Commons Transition Coalition. (2017). *Commons Transition and P2P: A Primer.* http://commonstransition.org/commons-transition-p2p-primer/

Google and Facebook over-reached and fell out of favour with the public, who rejected Silicon Valley princelings and their creation of so few winners and too many losers. Co-operative ownership of rideshare, social care and task-based work platforms provide community controlled alternatives to former monopolies Uber, TaskRabbit and Amazon, whose rent-seeking business models exacerbated inequality and weakened local economies. Community ownership through platform co-operatives gives users, creators and cities the power to control the technology, algorithms, data and artificial intelligence they depend upon for a range of essential services. This city has all the tech, but the value created from these platforms stays with those who use them.

Data is a key asset class and building block for a decarbonised urban environment. Data ownership is tied to citizen rights and city sovereignty to protect personal identity and public infrastructure from market enclosure and value extraction. Protocols which support data sovereignty and transparency are the norm.[121] Open data commons ensure that mutual infrastructure like autonomous vehicle fleets, which enable demand sufficiency for carbon reductions, share data between users, manufacturers and government to enable better infrastructure planning and to actually reduce emissions.

121 https://www.decodeproject.eu/what-decode

Energy users predominantly co-own or co-manage infrastructure through co-operatives, public utility trusts and public buy-backs of formerly privatised assets. Renewable energy infrastructure is distributed across networks spanning households, neighbourhoods, cities and beyond and the benefits flow back into the communities that own and run them. 'Wind Turbine Syndrome' was alleviated once communities owned their own wind farms and benefited from them.[122] Residential, business and government users generate their own energy locally and exchange any surplus through blockchain technologies and smart contracts.[123]

Maker culture is everywhere. The power of open source knowledge creation to develop technologies and systems that draw on the best global knowledge to meet specific local needs has been demonstrated over and over, leaving the old IP regimes in tatters. Easily accessible platforms for open software, hardware and design are now commonplace, and the most exciting and innovative livelihoods are on the cusp of these productive practices. Forms of open design and distributed manufacturing (ODDM) now take place in every community through a diversity of enterprises, often

121 Chapman, S. (2016). *World's largest wind farm study finds sleep disturbances aren't related to turbine noise.* The Conversation. Available at https://theconversation.com/worlds-largest-wind-farm-study-finds-sleep-disturbances-arent-related-to-turbine-noise-60189

123 UNFCCC. (2017). *Blockchain Technology Can Boost Climate Action.* United National Framework Convention on Climate Change. Available at http://newsroom.unfccc.int/climate-action/how-blockchain-technology-could-boost-climate-action/

co-operatively owned and run.[124] These produce goods from medical devices and vehicles, to furniture, machinery, and clothing.

Cities boom with ideas and productive capacity as clusters of makerspaces pool resources and leverage proximity, talent and population density for greater impact. These clusters perform complex production tasks that single makerspaces could not do alone, and enable circular economies for resource recovery and waste minimization.

Waste is “designed out” with durable goods that are easy to repair. People demand quality and expect a product that can evolve with their changing needs. Neighbourhood Repair Cafes have evolved into vibrant community centres for production and trade, with high status afforded to elder “bush mechanics” who can re-purpose what’s at hand into new uses and applications. People don’t spend money on new items when they can get what they need through fast and efficient semantic data-matching distribution markets that have evolved from Freecycle and Streetbank.[125] The new Landfill Access Trusts have ever-tightening rules about what can be considered ‘irretrievable’, and transparency around who applies to them and for what acts as a strong social deterrent—or incentive to find a way to upcycle it.

Food is recognised as a commons—everyone has a right to eat and a stake in the resources that make that possible. Land Trusts, Food Trusts, Co-operatives and Communities have secured land for food production that meets dietary needs in a sustainable way, providing access for young farmers and incorporating ecological regeneration and community life. Water, soil, seeds and pollination are managed as vital common resources. Food forests and grazing[126] permeate public open space and vibrant local farming, processing and retail businesses are mixed into residential neighborhoods. Community-owned infrastructure such as shared kitchens, cooking equipment and canning facilities support local enterprise development and give residents access to low-cost, high quality food. Organic resources are managed via sophisticated data-enabled local collection and reuse networks.[127] Edible leftovers and excess are re-distributed or sold to others, while inedible parts are composted or digested. This produces energy to power other urban infrastructure, such as water treatment, and fuel biogas transport, as well as fertiliser for city greening and food production.

People can pursue their interests and have time to get involved in their communities, because housing options are plentiful and cheap if your expectations are modest. The ability to design and order a flat-packed, modular, flexible and easy to assemble housing kits that you can move with you, has fueled the revival of the self build movement and disconnected ownership of housing from ownership of land. With less need for their own money and more time, people have the freedom to participate in stewardship of common resources like green space, tool libraries, renewable energy infrastructure, makerlabs and open technology.

Hybrid forms of cross-sector collaboration with the support of anchor institutions connect communities, businesses, municipalities and states, facilitating capabilities to solve complex societal production challenges.[128] A number of currencies, many of which are dedicated to city-based economic development, circulate locally, regionally and globally, interlinking enterprises in dynamic, common-profit, value production chains.

The new story is that “humans and nature do better together” and opportunities abound to be at the forefront of creative exploration of how to make this work. People in this city are used to a “post-growth” economy, as year-by-year demand for energy and consumption of material goods decreases.[129] The idea that infinite growth is possible on a finite planet with physical limits has simply become irrelevant[130] as communities strive for ethical livelihoods, sufficiency and well-being.

124 Kostakis, V., Niaros, V., Dafermos, G., & Bauwens, M. (2015). Design global, manufacture local: Exploring the contours of an emerging productive model. *Futures*, 73, 126-135.

125 http://wiki.p2pfoundation.net/Redistribution_Markets

126 http://www.streetgoat.co.uk/news

127 https://sharewaste.com/

128 http://community-wealth.org/content/cleveland-model-how-evergreen-cooperatives-are-building-community-wealth

129 http://postgrowth.org/learn/about-post-growth/

130 Stockholm Resilience Center. (2015). What is resilience? *Stockholm Resilience Center*. Available from: http://www.stockholmresilience.org/research/research-news/2015-02-19-what-is-resilience.html.

Scenario Pathway

Cracks appear in the facade of inevitable corporate dominance—maybe there is another way?

The dominance of Google, Facebook and Amazon in the deployment of smart cities and the Internet of Things resulted in further enclosures of the urban commons through privatized "smart" platforms for managing critical infrastructure like water, energy, waste, data and transportation systems.[131] People got angry about having to continuously pay for things that were powered by their own data, and the ever-creepier privacy incursions.

As viable and useable alternatives that enabled them to own and control access to their data emerged, the inevitability of everything being owned and controlled by private corporations started to wane. When the Australian midata.coop[132] service was launched in 2019 and it worked much better than the Government's clunky and painful medical records systems, becoming easier to manage access to your medical data yourself. Once the idea was planted, it quickly spread to all other data—why should an energy company be able to sell my energy data? Isn't it mine to share how I choose? Smart useable apps developed and freely shared by global open source communities made data sovereignty a no-brainer.

Similarly, early successes like the Sydney-based Taxi Platform Co-operative 'Harbour Taxi', which by 2021 had a 40% market share, showed that co-operative ownership was price competitive and kept the value in the city, among drivers, owners and taxpayers. With most Sydneysiders using the service, the idea of having a stake in the platforms that provided your essential services became commonplace.

By 2024 prolific co-operative enterprise experimentation and peer-to-peer movements had provided a recipe for deeper shifts in citizen perceptions of what they might be able to achieve together, without relying on corporations and government. More and more people were not just connected to the co-operative form, they were invested as owners, decision-makers and key stakeholders. There was an explosion of commons transition experiments, with ever-increasing visibility driving society wide learning and getting more and more people involved.

New Models emerge

Midata.coop enables citizens to securely store, manage and control access to their personal data by helping them to establish and own national/regional not-for-profit MIDATA co-operatives. It is citizen-owned, not-for-profit and open source, with an initial focus on health related data since these are most sensitive and valuable for personal health. Users can decide when to share data with friends or physicians or to participate in research by providing access to subsets of their data. They can actively contribute to medical research and to clinical trials by providing access to sets of their personal data across co-operatives.

See https://midata.coop/

Green Taxi is a driver-owned co-operative in Colorado that distributes profits back to its members. 800 driver-member-owners are authorized to capture up to 37% of the Denver/Boulder metro taxi market. It offers the same convenience and functionality of Uber but shares 100% ownership among its member-owners.

See http://greentaxico-op.com/ and https://www.shareable.net/blog/denver%E2%80%99s-green-taxi-co-op-fights-for-its-right-to-compete-with-uber

Newly empowered citizens turned their attention to the urban commons, taking responsibility for Universal Basic Access to energy, food and housing.

The urgency for deep emissions reductions had escalated dramatically in the aftermath of the Mission 2020[133] and Deadline 2020[134] campaigns, with the window for serious action to avoid climate catastrophe rapidly closing. It was clear that the deep emissions cuts that people wanted weren't coming from government action and corporate innovation. People who had previously been disempowered or angry had by now been exposed to (and experienced) the possibility of managing things better themselves.

In 2025 a coalition calling itself "Power to the People" formed with the intent to dramatically change energy governance in Victoria. Power to the People followed the lead of the citizens movement in Hamburg which won a referendum to buy back formerly privatized energy infrastructure and Entrust (formerly Auckland Energy Consumer Trust).[135] Power to the People was able to drive the establishment of the Victorian Energy Transition Trust (VETT), tasked with expanding Victoria's renewable energy portfolio by establishing a variety of energy co-operatives. Other cities experienced

131 Sterling, B. (2014). *The epic struggle of the Internet of things.* Strelka Press.

132 https://midata.coop/

133 http://www.mission2020.global/

134 http://www.c40.org/other/deadline_2020

135 https://www.shareable.net/sharing-cities

successful citizen-led campaigns to put energy infrastructure under public control with investment priorities quickly reoriented towards renewables, supporting community energy co-operatives and shared ownership of larger scale wind and solar infrastructure.

Food Trusts proliferated, enabling co-operative ownership of agricultural land, co-management of water resources, co-production of food, and co-finance.[136]

136 Quilligan, J. (2012). *Why Distinguish Common Goods from Public Goods?* In Bollier, D. & S. Helfrich, eds. (2012). The Wealth of the Commons. A world beyond market & state. Levellers Press. Amherst, MA. Abridged version available at http://p2pfoundation.net/Public_ Goods_vs_Common_Goods

The revolution in housing affordability and access was fundamental to freeing up time and energy for people to get involved in the commons. The affordability and social isolation crises reached breaking point in the 20-teens, leading many to reconsider the value of shared housing—especially as the ageing baby boomer population who owned the housing stock faced the spectre of for-profit and exploitative nursing homes. This, combined with the emergence of quick, cheap and awesome modular housing, and housing co-operatives and land trust based strategies were able to stabilise land values and reduce speculation.

Enclosing the Commons

Entrust (formerly the Auckland Energy Consumer Trust) placed private energy providers under the ownership of a public trust, whose voting membership is comprised of the energy consumers themselves who receive electricity dividend payments.

See https://www.entrustnz.co.nz/

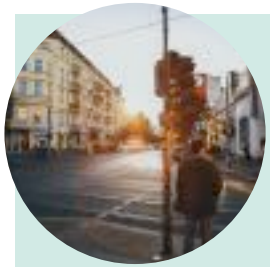
ORICoop (the Organic & Regenerative Investment Co-operative) is a new co-operative venture emerging in Australia to open up investment, education and growth opportunities across the organic, regenerative, biodynamic and agro-ecology farming and food sector. This includes acquisition and preservation of farmland, specific business opportunities, and long term involvement of members and investors in the future growth of the Co-operative, land ownership and stewardship in Australia. It offers a powerful new collaborative vehicle that combines investment, intention, community, education and preservation across the organic and regenerative farming and business sector in Australia.

See http://www.organicinvestmentcooperative.com.au/

City participation was critical to incubating the Commons Transition movement, and helping it gain traction

The Cities and municipalities that were supportive early made a huge contribution to the Transition, removing barriers to emerging commons initiatives that enabled 'runs on the board' for broader segments of society to see, feel and get involved in. Free use of public spaces, municipal buildings and advertising space for the new economy leaders made all the difference in the early years.

Direct investment in open design and distributed manufacturing infrastructure like makerspaces and FabLabs, drove the development of local circular economies and began to reduce the need to import goods, further driving down emissions. Makerspaces and open design libraries provided the citywide infrastructure for new livelihoods that drove local economic development and the co-operative creation of value. Institutions like the University of Melbourne and City of Melbourne used their purchasing power to prioritise and strengthen these new industries, building community wealth and creating a new industrial base.



City Actions

FAB City aims to create city scale open design distributed manufacturing, a new urban model to transform how cities source and use materials based on localised circular economy strategies. This prioritises local production using recycled materials, supports local needs and shifts imports and exports to immaterial forms including knowledge, design and code.

See http://fab.city/faq/

The City of Bologna's 'Regulation on Collaboration Between Citizens and the City for the Care and Regeneration of Urban Commons' supports active citizens to co-lead city interventions through 'collaboration agreements', an instrument that aligns deliberative processes and intent with a legal contract between citizens and the municipality.

See: https://www.shareable.net/blog/bologna-celebrates-one-year-of-a-bold-experiment-in-urban-commoning

Citizen movements have recently won elections in Spanish cities including Barcelona, Madrid and Valencia. They have formed municipal coalitions to address inequality and drive policy changes to provide access to housing, health and education for residents in need.

See: Bauwens et al (2017). Commons Transition and P2P: a primer. The Transnational Institute. http://commonstransition.org/commons-transition-p2p-primer/

Leading cities re-designated their urban environment as 'transition arenas' for citizen-led experimentation.[137] By 2023, Melbourne signed into law citizen-led agreements making citizens equal partners in protecting and extending the urban commons (e.g. open spaces, vacant buildings, etc). These agreements created a new political contract which reframed citizens from 'city users' to 'city makers'. Coalitions of municipalities with these kinds of agreements worked together to embed citizen-led urban governance across municipalities, transcending traditional political jurisdictions. Some were focused on bioregional sustainability challenges, while others were values-based innovation zones (the Brunswick to Castlemaine resilience corridor). The evolution of local government into municipal coalitions amplified the capacity for collective action at a state level and beyond.

City governance followed the same pattern as ODDM, with successful policies and supports moving rapidly through networks of the most progressive global cities—competing in their ability to unleash creative citizens taking ownership of transformative change. The City as Commons Coalition gathered momentum as more and more global cities recognised the opportunity to follow their citizens to real change.[138]

137 Evans, J., Karvonen, A., & Raven, R. (Eds.). (2016). *The experimental city.* Routledge.

138 Foster, S. and Iaione, C. (2016). The City as a Commons, *Yale Law. & Policy Review*, 34, p.281. http://ylpr.yale.edu/city-commons.

Dramatic changes in how democracy works had reconfigured power, making it easy for people to participate in city making—and nation building

In 2017, the Federal Government planted the seeds of a citizenry that insisted on being heard by insisting on a public vote on marriage equality. People liked the idea, and thought perhaps they could vote on some other things—like the wisdom of government loans to Adani. At the beginning of 2018, WeVote launched a platform enabling rapid voting on policy announcements or anything tabled in Parliament, matched to the electoral rolls and enabling instantaneous and representative input on key issues. The people's view on the issue, in real-time and broken down by electorate was easily accessible to all Parliamentarians on their phones.

Powerful citizen movements formed quickly around strategic priority areas. Taking cues from the Occupy, Sunflower, Podemos and Barcelona en Comu citizen's movements, experiments in participatory democracy became an increasingly potent force in changing dominant government and business institutions.[139] New technologies such as liquid democracy, Loomio, pol.is and Sovereign, provided an array of tools for citizen-led decision-making which stretched across scales, from the community to the national and the transnational.[140]

These movements were able to drive the changes needed at a State and National level to further accelerate the Commons Transition. For example, further increases to housing supply were driven through taxes on vacant housing, government land grants, tax incentives to support Community Land Trusts, and higher capital gains tax.

139 Burgen, S. (2016). *How to win back the city: the Barcelona en Comú guide to overthrowing the elite.* The Guardian. Available from: https://www.theguardian.com/cities/2016/jun/22/barcelona-comun-guide-how-win-city-elite

140 Nanalyze. (2017). *7 Startups Working on Voting Machine Technology.* Available from: http://www.nanalyze.com/2017/09/7-startups-voting-machine-technology//

New Democracy?

Liquid Democracy is a recent innovation in democratic decision making, using web technologies that allow voters to become policy makers and delegates. It has been used by a German Bundestag Enquete Commission, political parties in Germany and the Five Star Movement in Italy, and is filtering into a variety of new applications.

See: https://www.shareable.net/blog/liquid-democracy-the-app-that-turns-everyone-into-a-politician

In 2014, the Sunflower Movement in Taiwan, a coalition of students, citizens and NGOs, challenged the governmental policy making process, first through protest and later through the occupation of the Legislative and Executive Yuan (congress). The occupation led to major reforms, heightened transparency, due process and citizen involvement in the formulation of policy and law. The groundwork for the movement had been laid by a network of hacker activists called g0v (pronounced "Gov Zero"). The reforms also led to the implementation of digital democracy systems, for example vTaiwan.

See:https://civichall.org/civicist/vtaiwan-democracy-frontier/

Sovereign is one of a number of recently launched voting systems, capable of applying Liquid Democracy to any organisation or group. It is powered by blockchain technology (similar technology to what underpins bitcoin), which makes it very secure. Sovereign is an open source project of the not-for-profit Democracy Earth.

See: http://www.nanalyze.com/2017/09/7-startups-voting-machine-technology/

By 2034, pressure on state and federal governments from citizen movements, influential think tanks and municipal coalitions had eliminated the practice of cash for influence by corporate and commercial interests, through political campaign donations. Anti “revolving door” laws were passed to restrict former politicians from using their privileged positions to gain lucrative private sector contracts. Caps on corporate campaign funding, greater citizen oversight and participatory democracy created new levels of accountability and transparency. State government had begun to be re-envisioned as a partner for empowering citizen projects, municipal transition initiatives, platform co-operatives and advanced open design and distributed manufacturing.

By 2040, the majority of citizens are involved in some level of collaborative governance across all aspects of social life. Self provisioning at city, town and municipal scales in the areas of energy, food, housing, technology, production and many other areas has become the ‘background normal’, accepted as an obvious and logical way to achieve sufficiency with integrity to planetary boundaries and carbon budgets. While the AI/automation revolution initially disrupted employment, open AI is harnessed by platform co-operatives, deepening their capacity to support ethical livelihoods.

6.2. Green Growth

The Scenario

Cities arose from markets and it is markets that run the cities in 2040. This is a city of clean and efficient production, a model for the application of circular economy principles and clean-tech innovation. Large corporations, with the resources to manage infrastructure and rapidly scale innovations, are the driving force of the economy. They have decarbonised the cities through lean and clean product and service design, and the adoption of low-carbon clean technologies. Consumption has been minimally disturbed – shifted and supported where necessary to keep the motor running. The private sector owns and manages a lot of the city infrastructure including energy supply to transport and building technologies to water.

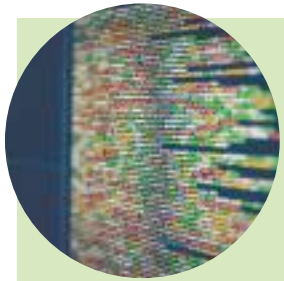
The 80% reduction in greenhouse emissions has been achieved through decarbonisation of the electricity system, substitution of electricity for other forms of renewable energy (e.g. wind, solar PV), high energy efficient products and a substantial increase in the service sector. Electricity is now more than 95% renewable even though consumption of electricity has grown. Renewable energy generation involves rooftop PV and surface PV cladding of buildings (with a high proportion provided by corporate companies as a leasing arrangement) and the adoption of bladeless wind generation in the lower density suburbs; however, most electricity still comes from large-scale wind, solar and geothermal plants beyond the city boundaries. Systems of provision of food, water, energy, transport, waste have diversified as innovative, entrepreneurial start-ups develop and apply new ways to meet the city's needs. Successful models are quickly acquired and consolidated by dominant corporate operators who have the resources to then rapidly include them in their service offering in many other cities. New ideas and technologies are quickly commercialised and scaled by their corporate owners. Those that can't be readily monetised or controlled are also bought, but swiftly buried. Benefits flow to corporate shareholders everywhere.

But they aren't doing it alone. The invisible hand of the market is engaged in a strong handshake /arm wrestle with the visible hand of the public sector. Infrastructure management operates within a strong regulatory framework that tries to ensure a competitive market can operate. Carbon and resource costs drive innovation and change, because massive political shifts have ensured that these costs are passed through the market – there is long-standing, trusted and effective carbon price and public subsidies to fossil fuels are long-gone, as is the revolving door between ministers and mining industries.

Technology and business are focused on delivering highly energy efficient products and related services. The services sector is large including, for example, a diverse range of products for the efficient management of buildings, energy, food, water, transport and waste from a carbon emissions reductions perspective. Transport involves a mix of private vehicles, privately owned and run public transport (trams, buses and trains) and competing smart driverless taxi pods; the majority of all transport is electric powered, with some use of biofuels.

Information systems are ubiquitous; they provide feedback on consumption levels, for individuals and for communities. These systems have helped to create a city that is smart and efficient. Competition in smart city technologies saw early proliferation in ideas and technologies from different companies, but in many cases these have given way to one or two market monopolies, leading to virtual network lock-in for consumers. While some cities fight this and try to even the playing field, others work closely with the 'winning' company to develop Public-Private agreements that enable them to access and use citizens' data for public policy making at reasonable cost, and sometimes even to enable citizens to access the data themselves. Publicly collected and managed data is available for new innovative uses, but the same cannot be said for that collected by Amazooglebook.

Robots and automation have reduced labour costs (i.e. jobs) in many areas of production and service provision. The reduction of wasteful processes and the need for employees to travel to work has had emissions benefits. However, with very few jobs in driving, retail, manufacturing or construction, the social division between 'knowledge' and 'doing' workers has never been starker. Those who 'have' are strongly consumerist, profit oriented and individualistic, with wealth, status and economic growth as a societal priority. However, for many the shift towards casualised labour and



Example Approaches

Sesame Credit is a pilot social credit scheme of the Chinese government and Ant Financial Services, affiliate of online retail giant Alibaba. It is designed to use big data to steer the market behaviour of companies and the personal and financial conduct of citizens. The score is derived from a wide range of data, from financial status, social worth of purchasing habits to traffic violations. The hope is that users will want to flaunt high social credit scores, and it has become a basic part of many online dating profiles. While there at the moment there is not explicit punishment for a low score, a high score will grant easier access to things like loans, job listing and travel opportunities.

See http://www.bbc.com/news/world-asia-china-34592186 and https://www.merics.org/fileadmin/user_upload/downloads/China-Monitor/merics_ChinaMonitor_39_englisch_Web.pdf

The CSIRO has identified long term potential for carbon forestry in Australia. Once a clear and stable market price for carbon has been set, and with continuous investment by 2050 they calculate that 10 to 20 Mha of plantings across marginal land could sequester 50-100 Mt CO_2/yr. A successful plantation requires land be set aside for at least a decade with no flexibility to change to cropping or grazing making it much more suited investment by a third party than local farmers. To be viable carbon forestry relies on an economy of scale that favours low overheads, low upkeep and monoculture plantations at a minimum area of 100 hectares. The loss of land management flexibility, lack of labour opportunity and high capital costs of establishment makes carbon forestry an ideal investment vehicle for the climate savvy investor.

See Polglase, P. et. al. (2011). Opportunities for carbon forestry in Australia: Economic assessment and constraints to implementation. Australian Commonwealth Scientific and Industrial Research Organisation.

decreased job security has meant that getting by on the basics provided by Carbix (Car*bon-Weet*bix), while far from fulfilling, is much less stressful.

Individual and hence society-wide carbon allocations are monitored and managed algo-cratically e.g. sophisticated algorithms ensure that basic living requirements can be met by each citizen, but that costs escalate to incentivize 'good' behavior. Every citizen has a 'sufficient' allocation of Carbix tokens on the AusChain that allow for purchase of universal basic living expenses—this can include rent/housing expenses and utilities (a big challenge for many); basic foodstuffs, clothing and household items. This spending is closely integrated with carbon metrics and other data to strongly incentivize purchasing decisions that are in that citizen's and society's best interests. If they are close to exceeding their carbon quota then, for example, price of red meat will rise into the next bracket, likely making it inaccessible.

Citizens are able to participate in a form of individual carbon trading, those who elect to go without more carbon intensive goods and services can trade their unmet allocation to other citizens. Those with the credit to invest in renewable energy can also generate additional tokens. Much like the Chinese Sesame Credit system, those who have demonstrated commitment to their ecological principles through the Carbix algorithms may find themselves given priority access to job listings, extra app features and other corporate and government incentives.

With the right policy settings, the markets began to redirect 'footloose' capital into large scale, high capital, low input, low labour carbon offset and agricultural projects to produce the low-carbix good and services required. Carbon forestry, automated agriculture, lab grown meat and solar power became common features of the rural landscape. While they offer little in the way of reliable employment,[141] with the bulk renewable and offsetting purchase agreements coordinated amongst local urban councils they do offer a decent return on investment and new opportunity for superannuation funds and are considered a safe bet. A concerted effort finally standardised all the freight rail gauges across and between states and helped get commodities onto rail —mostly benefitting intensive automated farms that moved bulk product nationally and to the Ports.

People who can get by on their Carbix tokens have a lot of leisure time and there are thriving industries providing low-cost techtravel – full immersion virtual reality experiences of travel and adventure that can be undertaken without going anywhere and at very little cost. This has significantly reduced emissions of air travel, which is now only available to the very rich.

How did it happen

The renewable tide washed in, and turned coal dust to mud

Australian politics 2016-2020 was partly a contestation between the different tiers of government and between generations. Paralysed, dysfunctional federal politics saw attention shift to states and cities (particularly on renewable energy, energy efficiency and green industries and jobs).

141 Fraser, E & Charlebois, S. (2016). *Automated farming: good news for food security, bad news for job security?* The Guardian. Available at https://www.theguardian.com/sustainable-business/2016/feb/18/automated-farming-food-security-rural-jobs-unemployment-technology

As the complete lack of preparedness of the national energy system for climate change became evident, with prices rising accordingly, the investment case for renewables became clear to all but the national parliament. Cities and states started to signal and move towards direct investment in their own energy and other infrastructure systems, regardless of national policy frameworks that directly dis-incentivised doing so (like extremely low feed-in tariffs). Accessible renewable charging infrastructure, reduced parking costs and and partial exemptions from congestion charges saw a leap in use of electric cars and bikes—with immediate and visceral changes to air quality and corresponding political popularity.

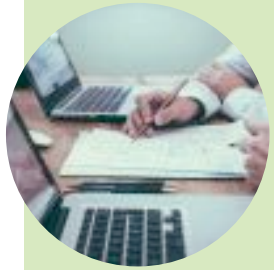
Across cities (and outside them), those who could installed renewable power and battery systems to protect themselves from out of control energy costs. As those who could afford to protected themselves, the costs escalated further for those who couldn't—making energy costs a major social justice issue. This 'death spiral'[142] of the traditional energy providers, and the enormous and growing distance between energy 'haves' and 'have-nots' threatened to bring the whole system down in a heap if something wasn't done.

Cities frustrated by lack of State and national action expanded and coordinated their strategies

By 2020, Australia's climate-leading municipalities had become frustrated by the jurisdictional limits on their abilities to meet the bold, progressive emissions reductions targets they had set in the early 2000s. Even with the strong leadership and major investments they were now making, there was only so much they could do alone. As the homes of many economic and cultural leaders, they set about driving changes to corporate behaviour AND turning up the heat on state and federal governments.

As the 'climate-action' population centres of Australia, the major cities quietly took steps to enable and strengthen the activist movements calling a halt to fossil fuels. They provided space and support and wondered if and how they could do more. Their answer was to set about methodically removing any taint of association with fossil fuel development, starting with their own investments and rapidly moving through all contracts, procurement, partnerships and associations with any organisation that wasn't doing so. The Cities started to hold commercial residents to account—anonymity was no longer an option. They ramped up promotions (use of public space) and incentives (rate-penalties) to make the city warm and welcoming for new industries, and cold and unfriendly for the old. Those continuing

142 Martin, P. (2017). *Death Spiral: why electricity prices are set to climb ever higher.* Sydney Morning Herald. Available at http://www.smh.com.au/comment/why-electricity-prices-are-set-to-climb-ever-higher-20170919-gykx0w.html



Who Pays—Financing large-scale investment in decarbonisation

Earlier in 2017 the Commonwealth Bank issued its first 'climate bond' which raised A$650 million for investment in projects meeting the Climate Bond Standard, which can include renewable energy projects, energy efficient buildings projects and low-carbon transport projects. Apple Inc. has also been an early mover in the green bond market, issuing a US$1.5 billion bond in 2016 and a further bond in 2017, used for investments in renewable energy and energy efficiency (e.g. for their facilities and supply chain), recycling and resource recovery initiatives, and sustainable materials projects.

The bond market is a US$100 trillion market and thereby offers the potential to mobilise a very large amount of capital for climate solutions. As new bond markets continue to develop – such as green and climate bonds – large banks and other large companies will have new ways to mobilise debt capital markets for climate change solutions. This offers ways of accessing more patient capital and borrowing against expected economic benefits.

These emerging financing approaches were noted at the 'Future Finance and Business' expert workshop organised by VP2040, along with challenges faced to-date in the Australian context.

See: http://www.visionsandpathways.com/research/reports/; www.climatebonds.net and https://www.cefc.com.au/media/feature-articles/files/australias-budding-green-bond-market.aspx

Who can make this happen, and how?

- Government: policy certainty regarding renewable energy projects and related institutional arrangements is needed to unlock the supply of green bonds in the Australian context
- Large institutional investors (e.g. superannuation funds): attention to risk profiles
- The Climate Bonds Initiative has identified five priority policy areas—requiring attention by bond market actors and others such as policymakers—including addressing market integrity, tax incentives, strategic issuance guidance, market development, and risks-return profiles.

to participate in fossil fuel industries started to rapidly lose their social licence to operate. By 2023 most cities and municipalities were refusing to procure from, do business or partner with any organisation that had not extricated themselves from fossil fuels.

Climate-Star urban Mayors joined forces, taking their profile and political success to Canberra

As the climate situation deteriorated, and the wrestle with xenophobia and fear gathered momentum across the world and at home, the ability to get things done had an ever increasing requirement for an ability to cut through with a simple message. The battle between 'fear' and 'future' was intense. Charismatic 'Elon Musk style' techno-entrepreneurial leaders emerged from the 'green-tech islands' of the inner cities and captured the public imagination. The only thing everyone could agree on was something had to be done, and the way ahead had been sold by blue-sky moonshot Ted talks.

Driven at heart by the need of capital for a clear source of future returns, and the political influence of leading corporations in the financial and other services sectors in the cities—the simple, clear, hopeful and seemingly apolitical message of the high tech, big corp future was the only ideology left standing.

Building on their success in progressive cities, the celebrity Mayors formed alliances that went to Canberra—initially lobbying with their collective strength and business partnerships. But as the actual emissions reductions and strong economic growth generated by their actions became evident their mandate shifted. By 2025, successful clean-tech mayors were leveraging their popularity to comprehensively win national seats and hold the balance of power. At last, transformative nationally consistent policies were put in place to price carbon and transform the electricity sector.

Unpopular fossil fuel dinosaurs were cleaned out, making way for sexy new corporate masters

While the celebrity Mayors were young and powerful, they drove key structural changes through the Parliament e.g. removal of all fossil-fuel subsidies; cessation of fossil-fuel exploration and a shut-down plan for all fossil-fuel energy generation. The fossil fuel death knell rang loudly across the country.

The very memorable 2027 Climate Cities of Australia Mayors of Australia gathering was timed to coincide with the passing of both the *Parliamentary Pension and Entitlements Cancellation for Corruption* amendments (cancelling all benefits for Ministers who worked in related energy or mining industries to portfolios they had held within 20 yearsof

Climate Emergency Declarations

New "local-first" strategies seek local government declarations of a climate emergency, with a view to influencing actions at higher levels of government. Darebin Council was the first local government to develop and then formally adopt a climate emergency plan in which the Council unanimously declares a "state of climate emergency" and commits to related actions. Other local councils in inner Melbourne such as the City of Yarra have also passed formal climate emergency declaration motions. Darebin Council has also developed innovative approaches for making investment in solar power more affordable to lower-income residents (see the Solar Saver program) and has an associated target to double the amount of solar PV in Darebin over the next four years (2017-2021). Importantly, Darebin Greens Councillor Trent McCarthy contends that such actions are a natural justification of the responsibilities of every Council and Councillor under the Victorian Local Government Act.

Campaigning group Community Action in the Climate Emergency (CACE) has developed tools to assist other activists to campaign for similar declarations and actions by their local council (see http://www.caceonline.org).

If this bottom-up approach to climate change advocacy and action takes off we will see:

- Efforts by activists to engage more local councils in Victorian and across Australia;
- Where such local campaigns are successful, actions to develop, debate and/or pass motions regarding a 'climate emergency' and associated plans;
- Potential activism by engaged councils and councillors to promote similar declaration of climate emergency at higher levels of government; and
- Wider diffusion of innovative programs seeking to enable investment in solar power

Who can make this happen, and how?

As per the CACE campaign, this approach centrally involves residents engaging their local council and action by councillors. Changes to the Local Government Acts – such as including action on climate change as a Council responsibility – would also help to support further action.

leaving Parliament) AND the cancellation of all fossil fuel subsidies, exploration and generation extensions. Those few with seats in Parliament were joined outside by another 250 or so currently sitting Mayors and business leaders, and a massive celebratory crowd—as they symbolically threw lumps of coal out of Parliament. Even those representing the 'old guard' knew that their time had come. A great night was had by all.

Policy certainty and removal of the old guard led to a frenzied 'land-grab' as the private sector rushed to fill, and control, the renewable energy production and distribution systems —and associated government portfolios. The transformation was fast and messy, but the job got done. Before long, the new corporate puppet-masters of Australia were settling into their Canberra offices.

Corporate data control enabled more and more insight into consumer and society-wide carbon accounting

The seductive convenience of ubiquitous smart-data systems informing every area of life and supporting (making?) our decisions for us, outweighed any niggling unease people had about who knew what. Privacy positions moved insidiously from "I'm not doing anything wrong so I don't mind who knows", through "that's slightly weird that they know about that conversation, but yes I do want a new electric car and yes blue is my favourite colour" to "the carbon emissions implications of my every move are known, measured, and impact my economic and social standing". Other decisions that have a socialised cost, like healthy eating, were also incorporated into tokenised 'incentive' systems that editing the 'choices' of lower income groups. The political class decreed "Let them eat 5 serves of fruit and veg, and whole grains."

The need to shore up a consumer class (and prevent political shift affecting corporate control) led to introduction of tokenised Universal Basic Income

Using the universal provision of a 'reasonable' safety net to shape carbon consumption choices was a techno-political breakthrough, delivering the political benefits of a 'New Deal 3.0' by giving the growing population of precarious workers an option to keep consuming and taking the heat out of the inequality movements in the early 2020s. Watching and learning from the concerning rise of social and economic justice movements across Europe and the USA (Sanders, Corbyn, Podermos etc), Australian politicians at all levels were relieved to find a way to take the wind out of their Australian sails.

Popular movements had their focus split between trying to negotiate with mildly sympathetic politicians and party leaders, campaigning for social and economic justice, fending off far-right nationalism and trying to keep the big picture environmental issues in focus. Once people were sure of having just enough to keep consuming, and reassured that 'they' (the government and industry) would sort out this climate thing, they were happy to just roll with it. No major change required.

Carbix effectively provides a government subsidy for low-carbon products and services, driving a strong market signal through business and industry to innovate and fill that market. The introduction of this scheme also relieved political pressure or expectation to 'provide jobs', firmly hammering the last nail into the coffin for unsustainable forestry or fossil fuel development.

6.3. Quantitative Settings

'Green Growth' pathway incorporates substantial increases in energy and material efficiency and circular economy practices, as well as a significant shift to low-carbon energy sources and focus on non-energy emissions abatement (i.e. in agriculture sector) and sequestration.

The 'Commons Transition' pathway has more moderate increases in efficiencies but with an accompanying reduction in demand for both energy and material demand through better sizing, using and sharing, with the remaining demand being met via low-carbon distributed energy generation and recycling. Agriculture also becomes 'renewable' by incorporating agro-ecological principles. These changes are implemented without incorporating any "rebound effect," or "takeback," where efficiencies and subsequent cost savings can result in further economic growth and consumption. Absence of rebound is consistent with, for example, an economy operating under an imposed cap on the resource use system.

Key Sectors	*Green Growth*	*Commons Transition*
Population and Lifestyle (and Economic factors?)	According to ABS population projections (Series B),[143] the total population in greater metropolitan areas of southern Australian cities (Melbourne, Sydney, Perth and Adelaide) will increase by 56%, from 12.4 million in 2013 to 19.3 million in 2040. This is a higher rate than the total Australian population, which is predicted to increase by 46.7%, from 23.1 million in 2013 to 33.9 million in 2040. By 2040, 56.8% of the Australian population will be living in southern cities. The majority of the population (75%) have little alteration to their lifestyles ('haves'), while the bottom 25% who are largely reliant on Carbix or low-income service occupations ('have nots') experience significant changes. Consumption and related lifestyle factors (aside from those specified below) have been adjusted iteratively for the target higher unemployment rate of 6-8%.	According to ABS population projections (Series B),[144] the total population in greater metropolitan areas of southern Australian cities (Melbourne, Sydney, Perth and Adelaide) will increase by 56%, from 12.4 million in 2013 to 19.3 million in 2040. This is a higher rate than the total Australian population, which is predicted to increase by 46.7%, from 23.1 million in 2013 to 33.9 million in 2040. By 2040, 56.8% of the Australian population will be living in southern cities. By 2040, everyone's lifestyles have shifted from unsustainable consumption patterns of 2013 to reduced and re-organised patterns. Unemployment is higher (12-17%) because it is not necessary to work full-time anymore and reduced consumption of imported goods allows for a reduction in carbon intensive exports while still maintaining the trade balance.
Electricity & Energy	Transition to 95% renewable electricity generation by 2040. Black and brown coal fired power plants are decommissioned at accelerated rates due to carbon abatement incentives and phased out by 2035. Expansion of gas fired plants in the short-term to cover shortfall but all new growth is met by wind and solar. By 2040 electricity generation is 5% gas, 1% biomass, 20% solar thermal, 46% solar PV, 16% wind, 4% geothermal and 4% hydro.[145] Any variable renewable technologies are also assumed to be increasingly deployed with some electrical storage. Non-electricity energy demand of residential and commercial buildings is reduced by 50% due to electrification of white appliances, hot water systems and heating and cooling systems. Manufacturing efficiency improvement at 1.2% per annum according to rate for 'Best Practice Technologies',[146] reducing energy demand by 38%. New industrial assets are also electrified, focusing mainly on heating processes, reducing energy intensity.	Rapid uptake of rooftop solar with battery storage due to rising costs and unreliability of centralised energy supply during peak periods. Fossil fuel powered plants are decommissioned faster than expect due to reduced demand and economic factors. A transition to majority renewable electricity generation is achieved by 2040 with 11% gas, 63% solar PV, 21% wind and 5% hydro. Any variable renewable technologies are also assumed to be increasingly deployed with some electrical storage. Energy intensity and non-electricity energy demand of residential and commercial buildings is reduced by 50% due to widespread use of installation of solar hot water and better passive design features such as double glazing and insulated ceilings and walls. Manufacturing efficiency improves at 1.2% per annum according to rate for 'Best Practice Technologies',[146] reducing energy demand by 38%.
Transport & Mobility	Shift to greener transport technologies (electric and gas) at an accelerated rate due to carbon abatement incentives. From 2020, all new personal and light commercial vehicles are 100% electric, transit vehicles are 50% electric and 50% gas, and intercity vehicles are 100% gas. Freight vehicles are 50% electric and 50% gas, and freight modes have shifted to 50% rail and 50% by ship. There is a 25% reduction in car ownership per household by 2040 and similar reduction in trips per household ('have nots' don't have cars and travel very little). The mode of travel for local trips shifted to 33% car, 33% public transport and 33% walking/cycling, intercity trips 44% air, 28% bus & 28% rail and international trips 50% air & 50% ship. Carbon intensity of air travel has been reduced by 90% due to the electrification of aircraft.[147]	Due to car sharing schemes and '20 minute' walkable cities, there is a 67% reduction in car ownership per household, 50% reduction in public transport trips and a 30% reduction in the average distance travelled by car. The occupancy of each car has doubled per trip due to sophisticated ride sharing schemes. The mode of travel for local trips shifted to 25% car, 25% public transport and 50% walking/cycling, intercity trips 50% bus & 50% rail and international trips 50% air & 50% ship. The remaining car fleet is transitioned to greener transport technologies (electric and gas) due to rising costs of fossil fuels. From 2020, all new personal and light commercial vehicles are 100% electric, transit vehicles are 50% electric and 50% gas, and intercity vehicles are 100% gas. Freight vehicles are 50% electric and 50% gas, and freight modes have shifted to 50% rail and 50% by ship. Cars are made here, to reduce imports from overseas.

Table 7: Settings for 'Green Growth' and 'Commons Transition' action pathways

Key Sectors	*Green Growth*	*Commons Transition*
Food and Agriculture	Majority (75%) of the population continue existing diet trends which show a slow switch from red meat to pork and chicken. For those reliant on Carbix for income support/ basic needs (25%), a mainly plant-based diet is the only option by 2040. Carbon intensity of meat production is reduced by 60% due to in-vitro meat production and precision farming techniques reduce fertiliser use. The reduction in red meat and other food consumption overall make remaining land available for forestry and carbon sequestration.	Diet by 2040 is 'flexitarian'[148] for everyone—mostly plant-based with only local sources of animal products. Except for areas with high quality soil (Liverpool plains, Darling Downs, peri-urban agricultural areas), the majority of crop land is shifted to mixed grazing/cropping with regenerative agricultural practices over ten years starting in 2025. Crops are grown 1 in 5 years and livestock numbers increased on native grazing land for the other 4 in 5 years. The reduction in red meat and other food consumption overall make remaining land available for forestry and carbon sequestration.
Urban form	Increase to 25% housing share for multiple dwelling units from 2026 to 2040 (to house 'have nots'). Trend for dwelling floor area for single dwelling units follows increasing historical trend, while trend for area of multiple dwelling units reverses to 65-90sqm per dwelling by 2040 (according to minimum floor area standards[149]). New dwellings use light insulating outer structures, keeping thermal mass inside, resulting in past trends continuing over 20 years until a 50% decrease in overall building mass is achieved. There are no changes to building composition however, clinker substitution and carbon capture and storage (CCS) allow a 67% reduction in emissions intensity of cement production, reducing the embodied emissions in concrete building materials.	Housing unaffordability leads to more instances of co-housing—by 2040 the average number of people per dwelling has doubled (represented by an increase in dwelling units per household by 50%). This also drives a increase in the proportion of multiple dwelling units such as apartments to 50% overall. Office space intensity per worker is reduced by 30% due to hot-desking and shared facilities. New dwellings use light insulating outer structures, keeping thermal mass inside, resulting in past trends continuing over 20 years until a 50% decrease in overall building mass is achieved. Building material composition has been adjusted to higher percentages of glass and wood, and lower percentages of brick and concrete.
Goods and Manufacturing	Reduction in consumption of consumable such as paper, textiles, chemical, and other non-specific goods by 80% for those reliant on Carbix, but not no change in consumption for the majority of the population—reduction of 20% overall. Aluminium process emissions are eradicated by 2050 due to inert node technology. Carbon capture and storage (CCS) allows for a reduction of about 30% of emissions from lime, limestone and dolomite. Overall reduction of emissions from chemicals of 67% due to CCS and broad use of catalysts to reduce N2O emissions. The primary materials required for manufacturing are adjusted to allow a proportion to be supplied from equivalent recycled material to simulate circular economy practices.	Reduction in consumption of consumable such as paper, textiles, chemicals, and other non-specific goods by 50% overall due to sharing and reuse, and also extended product lifetimes by 100% because goods are built to last. Ownership fraction of residential white appliances such as washing machines and dishwashers is reduced by 50% due to sharing and co-housing. Aluminium production and other heavy industry production is reduced due to the reduction in exports made possible by the reduction in consumption of imported goods. Reuse of goods is simulated by adjusting the domestic material demand. The remaining materials required for manufacturing are adjusted to allow a proportion to be supplied from equivalent recycled material.
Water	Reduced wastewater emissions intensity by 60% due to biogas incorporated in centralised treatment plants (waste to energy).	Reduced wastewater emissions intensity by 60% due to biogas incorporated in distributed treatment plants (waste to energy).
Waste	Edible food waste is reduced by 50% by 2030 according targets set and enforced within the National Food Waste Strategy. Inedible food waste is used as feedstock for centralised biogas plants to transform waste to energy. Discarded materials are diverted to recycling with primary focus on reducing landfill waste volume and associated emissions.	Edible food waste is reduced by 90% by 2030 due to sophisticated food sharing and reuse practices and networks. Inedible food waste is used as feedstock for small-scale biogas plants to transform waste to energy. Other landfill waste (and associated emissions) are reduced due to overall reduction in consumption of goods, extensive reuse and some recycling.

Table 7: Settings for 'Green Growth' and 'Commons Transition' action pathways (continued)

143 ABS, 2013. *Population Projections*, Australia, 2012 (base) to 2101 (cat. no. 3222.0).

144 ibid.

145 ClimateWorks *et al* 2014 (see above)

146 UNIDO (2010). As above.

147 ibid.

148 Monaghan, A., (2017). *EasyJet says it could be flying electric planes within a decade.* TheGuardian. Available at https://www.theguardian.com/business/2017/sep/27/easyjet-electric-planes-wright-electric-flights

149 Hosie, J., (2016). *Flexitarianism predicted as key food trend for 2017.* The Independent. Available at http://www.independent.co.uk/life-style/food-and-drink/flexitarianism-predicted-as-key-food-trend-for-2017-vegetarian-less-meat-a7465156.html

150 Victorian Government (2016). *Better Apartments — Apartment Amenity Design Measures* (2016). Office of the Victorian Government Architect

6.4. Results

Figure 14 shows how overall emissions for southern Australian cities reduce over time for the 'business as usual' (BAU) trajectory (based on previous work by Turner et al 2017),[151] and for the Green Growth (GG) and Commons Transition (CT) low-carbon pathways.

Both low-carbon pathways show a sharp reduction in emissions after 2020 compared to BAU. The total emissions for the GG pathway drop lower than for CT initially, but then converge again after 2030. Both low-carbon pathways effectively achieve an 80% reduction in emissions compared to 2013 levels by 2040. The reduction is sustained after 2040 even with rising urban populations, however zero-net carbon is not achieved until just before 2100 (not shown).

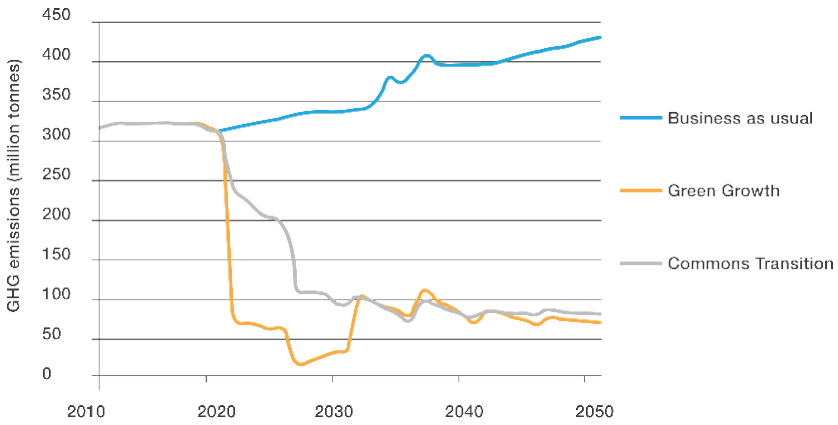
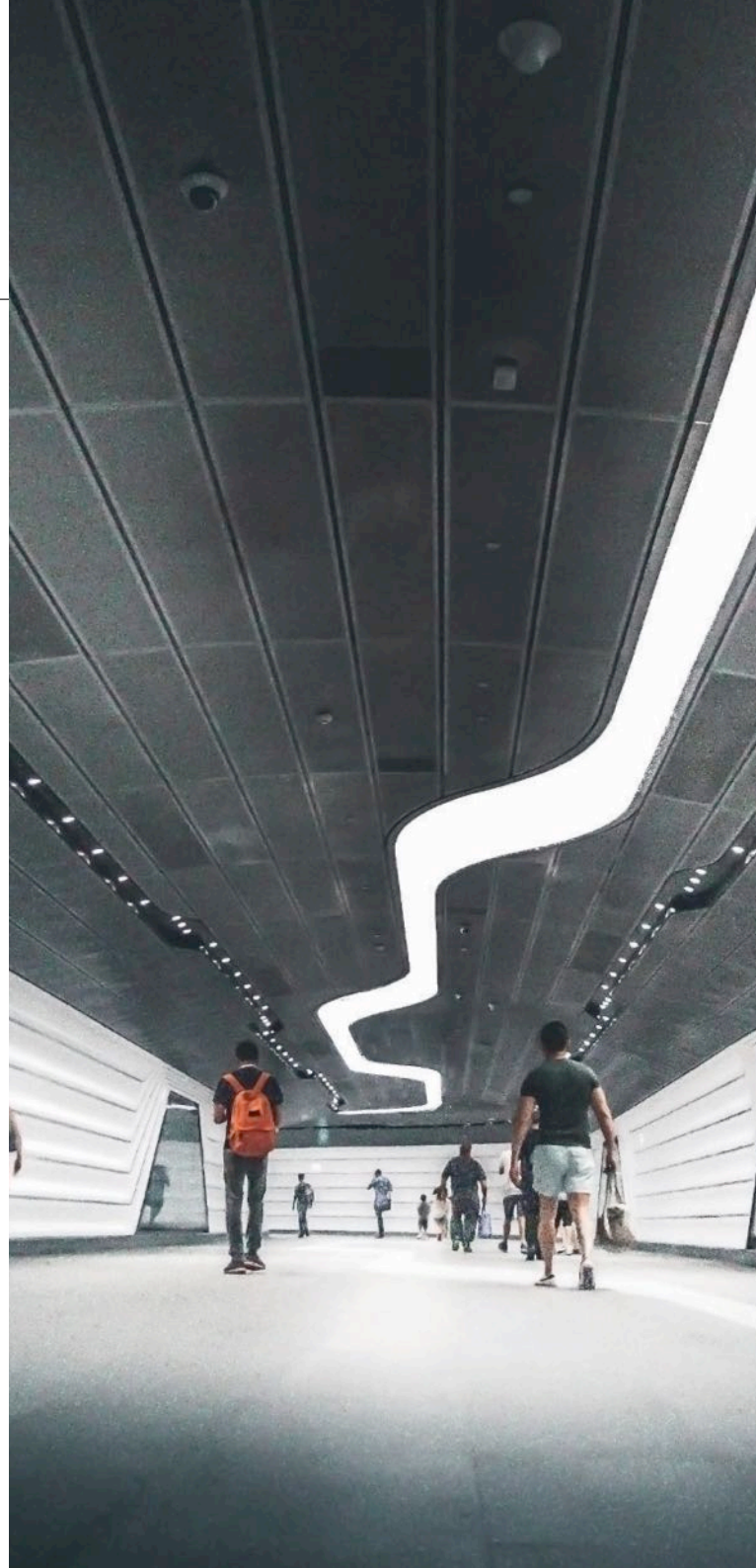


Figure 14 - Total emissions for southern Australian cities for BAU, GG and CT pathways.

The differences in the two low-carbon trajectories are a result of the dynamics of emissions generated over time from various sources. As discussed in Section 4.3, consumption-based greenhouse gas emissions attributable to cities include both those emitted directly within the city (scope I), from production of electricity used in the city (scope II) and from production of goods and services consumed in the city (scope III). The distribution of greenhouse emissions reductions by category are discussed further below and illustrated in Figure 15a, 15b and Figure 16a and 16b.

The categories that represent emissions produced within the geographical boundaries of the cities constitute around 16% of overall city emissions in 2013. These are shown in Figures 15a and 15b and include residential (non-electricity emissions such as natural gas use), landfill, wastewater, personal vehicles (direct emissions from operation of cars), transit vehicles (public transport operation), light commercial vehicles, commercial and institutional, and a proportion of intercity transport and passenger air travel. Residential emissions fall more sharply in the CT pathway due to changes modelled to simulate co-housing (higher occupancy in houses, so fewer houses required overall). Although both pathways include recycling, the lower consumption patterns in the CT scenario result in less landfill emissions by 2050. Personal transport emissions fall slightly faster in the CT pathway than GG because of the larger switch to active transport, but it is the change to electric vehicles coupled with clean electricity generation that makes the biggest impact.



151 Turner, G.M., Larsen, K.A., Candy, S., Ogilvy, S., Ananthapavan, J., Moodie, M., James, S., Friel, S., Ryan, C.J., Lawrence, M.A., 2017. *Squandering Australia's Food Security— the Environmental and Economic Costs of our Unhealthy Diet and the Policy Path We're On*. J. Clean. Prod. (in press). doi:10.1016/j.jclepro.2017.07.072

Green Growth

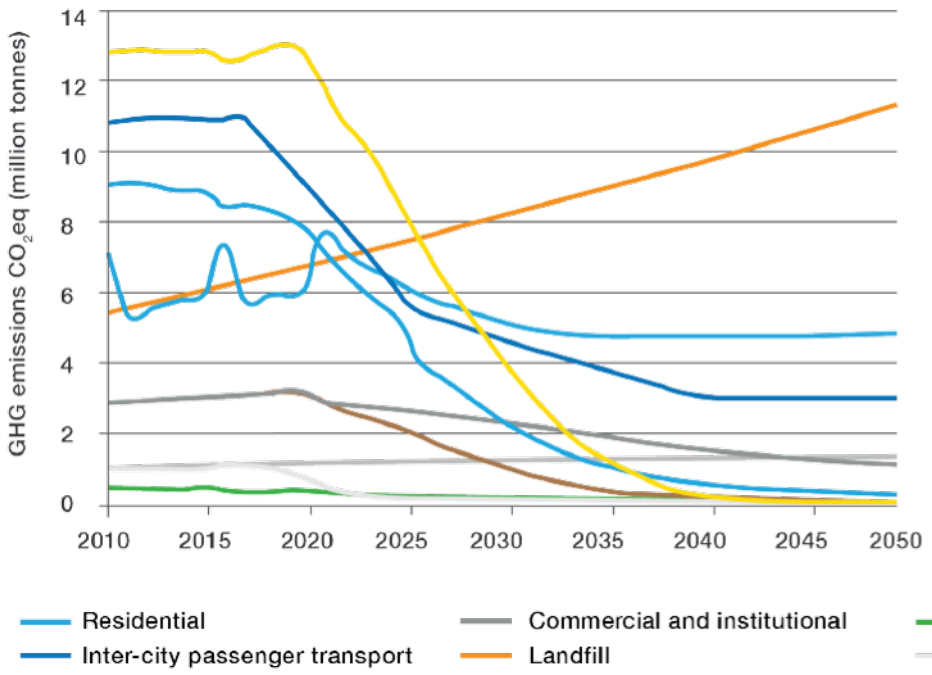


Figure 15a - Emissions generated within urban boundaries to support urban lifestyles by category for Green Growth pathway

Commons Transition

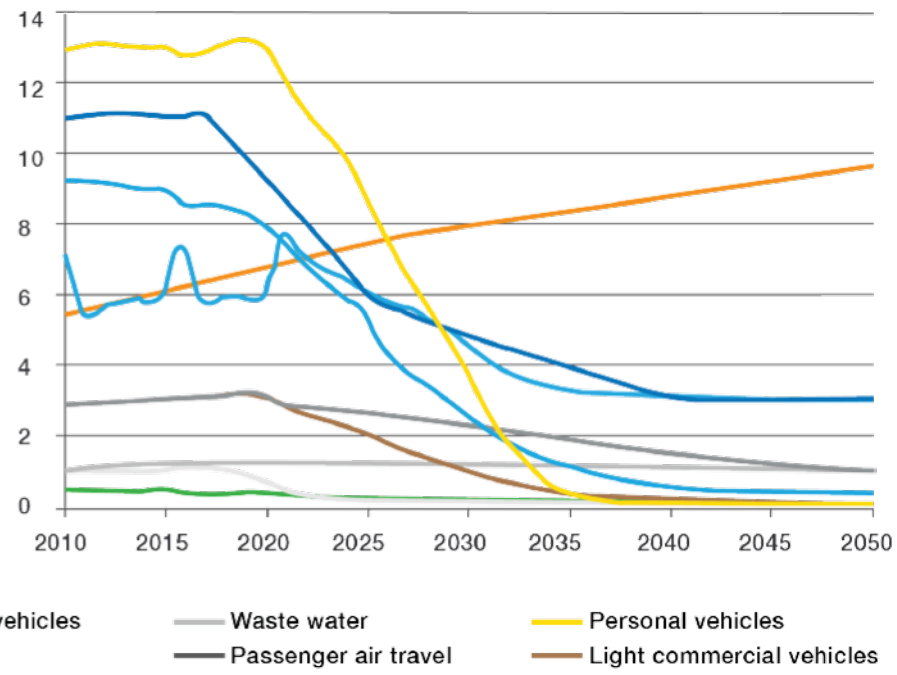


Figure 15b - Emissions generated within urban boundaries to support urban lifestyles by category for Commons Transition pathway

The large majority of consumption-based city carbon emissions are attributable to activities which actually occur outside city boundaries, such as electricity generation, other heavy industry, and primary industries such as agriculture, mining and forestry (specifically those associated with forest clearing). These are shown in Figures 16a and 16b. For both low-carbon pathways, the accelerated replacement of fossil fuel power stations with clean generation technologies leads to a steady decline in electricity emissions, and a large reduction in overall city emissions. This also has an associated impact on city-based residential and transport emissions (Figures 15a and 15b) due to the switch to electric technologies in these categories.

The switch from forest clearing to significant forest planting leads initially to substantial carbon sequestration (negative emissions) in the forestry sector for both pathways, but the impact lessens over time until a steady state is reached. This is because as forests mature, trees both absorb less carbon and emit carbon when some of them die.

As can be seen in the results for both pathways, carbon sequestration is necessary to reach the 80% emission reduction target. The amount of sequestration required in the CT pathway, however, is less than for the GG pathway, because overall emissions in other sectors are lower due to reduced consumption of goods and services and lower exports of emissions intensive products.

Green Growth

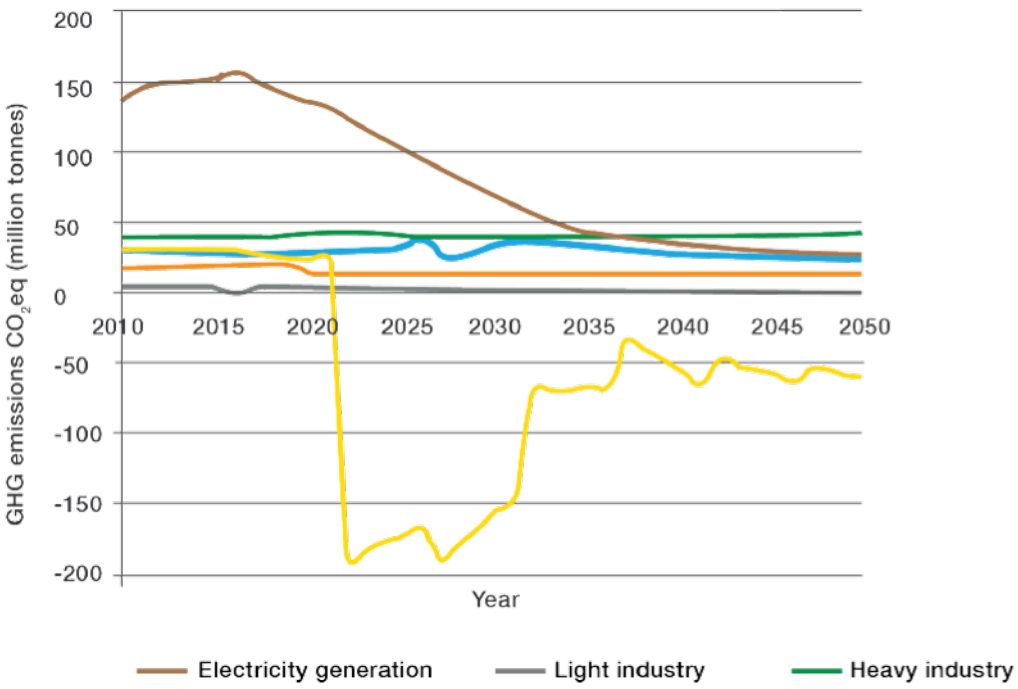


Figure 16a - Emissions generated outside urban boundaries to support urban lifestyles by category for Green Growth pathway

Commons Transition

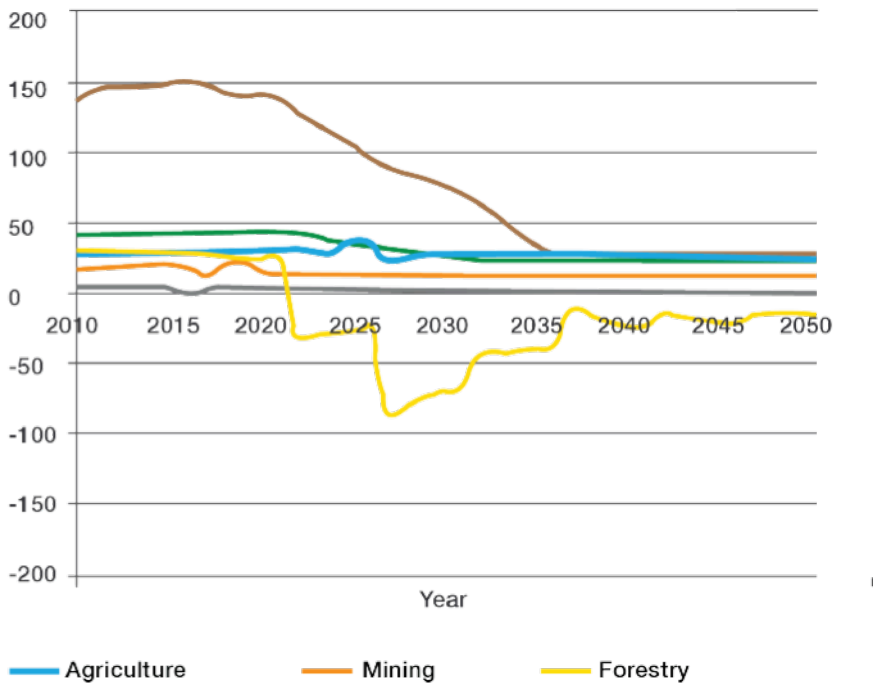


Figure 16b - Emissions generated outside urban boundaries to support urban lifestyles by category for Commons Transition pathway

Although city-based emissions are comparatively smaller than other categories, it does not mean they should be overlooked. Emissions across these categories will grow with population increase unless low-carbon transformative strategies are implemented to change urban lifestyles. Landfill emissions, for example, would grow at an exponential rate, increasing tenfold by 2100, and all city-based transport related emissions would double by 2050 if left unchecked.

For both low-carbon pathways it is clear that the greatest reductions can be achieved by focusing on activities that typically occur outside city boundaries but support urban lifestyles. This includes transitioning to clean, renewable electricity generation and reducing heavy industry production, as well as addressing primary industry emissions related to agriculture, mining and forestry. The majority of emissions from heavy industry (excluding electricity generation) are embodied in exports. Reducing production will require a parallel reduction in consumption of imported goods to maintain the trade balance. Likewise, a reduction in export as well as domestic consumption of emissions-intensive agricultural products will be required. Changing consumption and export patterns are a critical part of shifting from emissions-intensive land uses to land uses that can sequester carbon in both scenarios.

6.5. Discussion

As outlined in the introduction to Section 6 these two Action Pathways are intended to provoke, challenge and inspire. While they draw heavily on the four scenarios to describe technical and service innovations, they diverge significantly in how and why this happened. They are explorations of the choices and action of key actors as much as – or more than – the technological and social innovations they have to hand.

The Action Pathways can be considered in relation to three elements:

- Ability to reduce emissions by 80%
- Plausibility – are these pathways believable?
- Desirability – is this the future or the world we want?

Emissions Reductions

The difference between the two action pathways is not so much about how and where emissions are reduced. This is because achieving these emissions reductions in this timeframe really requires everything we have. When translating the scenarios to quantitative settings for the modelling it becomes clear that there is little room to move – trajectories to zero net emissions mean that there can be no emissions.

However, myriad analyses have explored technology pathways to achieving 80% emissions reductions by 2040. While undoubtedly challenging, this transformation could be achieved with existing or emergent technologies.[152] Many (indeed most) of the technologies contributing to this achievement in 2040 are apparent or readily imaginable now. Un-anticipated breakthrough technologies would simply make it easier or cheaper.

The modelling described in Section 6.3 has demonstrated a physical and technical ability to meet these emissions reductions. Achieving emissions reductions of this magnitude requires transformation of major sectors in a way that is effectively non-negotiable in any scenario. There are 'no brainers' – things that must be done regardless of the social, political or economic framing of how they get done. These include:

- 95-100% switch to renewable technologies and accelerated shut-down of fossil fuel infrastructure;
- Reduction in per capita and overall energy use of 50% – whether by demand reduction, technical and process efficiency, or both;
- Switch from forest clearing to forest preservation and regeneration, and rapid increase in other land uses and initiatives (including agricultural production systems and urban forestry) that can sequester carbon;
- Electrification of transport – both personal and commercial;
- Reduced consumption (and export) of emissions intensive agriculture e.g. red meat; and
- Elimination of waste going to landfill.

Carbon sequestration is necessary to reach the 80% emission reduction target in both pathways, but to a lesser extent in CT than for the GG pathway, as reduced consumption and export of goods and services lowers overall emissions in other sectors.

This sequestration is a short-term mechanism, as the net effect in a given area will rise to a peak and then decline due to the physical profile of carbon sequestration as trees mature. So if no additional land is available, there is a physical limit to the total carbon abatement potential from revegetation. This indicates that reforestation provides a temporary reduction in emissions only, to buy time for long-term low-carbon structural changes in the energy sector and broader economy.[153]

The short term abatement of land-based sequestration is however of critical significance in both scenarios. This is equivalent to 58% of 2013 emissions from other sectors in GG and 25% in CT.

Counter-intuitively, the slower planting rates in the CT pathway result in higher forestry land use (88 Mha) than in the GG scenario (73 Mha). This is due to the more staggered planting rate in CT, which allows for a proportion of the trees planted earlier to reach a sufficient age to emit carbon at the same time as trees planted later are absorbing carbon, resulting in lower net sequestration.

The land use figures calculated in ASFF, however, are based on conservative mixed native planting rates for carbon sequestration on land exclusively set aside for that purpose. This may lead to both an underestimate in the potential sink and unnecessary/overestimation of tensions with other land uses like food production and biodiversity. For example:

- Similar long term sequestration potential is possible with less land use if the proportion of carbon planting (eucalyptus monocultures) is increased, but would need to be managed to prevent detrimental effects on biodiversity.[154]
- Tree-planting does not need to replace agriculture – it can be co-located through: production of tree-crops (nuts, fruits, fodder etc); grassland management and silvopasture – pastures strewn or crisscrossed with trees sequester five to ten times as much carbon as those of the same size that are treeless, storing it in both biomass and soil.[155]

152 Hawken, P. (Ed.). (2017). *Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming.* Penguin Books.

153 Bryan BA, Hatfield-Dodds S, Nolan M, McKellar L, Grundy MJ, McCallum R (2015) Potential for Australian land-sector carbon sequestration and implications for land use, food, water, and biodiversity: Report for the Australian National Outlook 2015. CSIRO, Australia.

154 ClimateWorks et al., 2014. As above

155 Hawken, P. (Ed.). (2017). As above and at http://www.drawdown.org/solutions/food/silvopasture

It is important to note however, that when reducing emissions by this amount the subtleties of differences in technological approach can be difficult to differentiate in quantitative settings. Where the action pathways differ is in how these changes are driven, by whom, and how the costs are distributed. The major quantitative differences are described in the Settings tables and results, but can be briefly summarised as largely production-based in GG and consumption-based in CT, although there is some crossover for certain technologies and consumption patterns.

Plausibility

For Australia, imagining this scale of greenhouse gas emission reductions being achieved requires cultural and political imagination. Most of the strategies that were considered plausible in the past have been tried, and failed. Things are getting worse.[156] So the two Action Pathways focus on space to dream about radical political and cultural shifts that could actually make this scale of change possible.

For many partners and readers the Green Growth action pathway is likely to read as more plausible, because it requires much less radical change in culture or political system from what we have now. It describes a possible pathway to existing economic and political systems actually delivering the needed change – which is what many people have been hoping for and working towards for many years.

The increasing focus on climate action and cumulative political power of local authorities (e.g. local governments, Mayors, etc) and Cities is reflected in intergovernmental networks such as the C40 Cities Climate Leadership Group and the Compact of Mayors, and the hope and intention that they may be able to influence broader changes related to decarbonisation processes.[157] As outlined in Section 2, the wide range of policies and actions being taken by leading cities and municipalities suggests this intention, but whether it can achieve critical mass to impact national and international political action remains to be seen.

While the plausibility of the scenario can be readily drawn from existing structures and behaviours, it is far from expected or inevitable. If this is the future we want, then city-led actions will need to move past 'doing what we can, but relying on changes to state or federal policy'.

156 Slezak, M. (2017). *Australia's greenhouse gas emissions soar in latest figures.* The Guardian. Available at https://www.theguardian.com/australia-news/2017/aug/04/australias-greenhouse-gas-emissions-soar-in-latest-figures

157 Berry F. C., & Berry, W. D. (2014). Innovation and diffusion models in policy research, in Sabatier, P.A. & Weible C. M., (Eds.) *Theories of the Policy Process* (Third Edition). Westview Press..

The Green Growth scenario poses the question 'but what else could cities do?'. It invites partners and readers to consider what other actions would be required to trigger political changes of this magnitude, and explore their own potential power in progressing these. It particularly points to stronger action to remove the social license to operate of entities that are not explicitly and proactively on this pathway, and the potential for social and political mobilisation to drive out both the complicit acceptance and corruption that allows participation in fossil fuels to continue.

The Commons Transition scenario is a much more radical departure from the status quo, exploring the possibility of radical social, economic and political transformation. Its perceived plausibility therefore requires a more detailed discussion. Preparing this Action Pathway in close collaboration with Melbourne-based 'commons' leaders Jose Ramos[158] and Darren Sharp,[159] we drew on a wealth of global expertise and experience – including direct communication with many of the people at the forefront of this movement worldwide. The discussion below outlines more the detailed evidence and examples informing our proposition that this pathway is a viable possibility for the low-carbon cities we seek.

One of the critical assumptions of the Commons Transition pathway is the emergence of a 'post-growth' sufficiency based-model. The logic of growth is woven into our society and part of the Keynesian inspired full employment formula, to stimulate demand during times of economic downturn. Growth is assumed into our systems of debt-based capital investment. The political establishment relies on growth for its legitimacy and growth is part of our cultural fabric through consumerism. Yet, economic growth has been shown to be a very poor overall indicator of societal progress, let alone wellbeing.[160] Growth in material and energy use, when compounded year on year, has been shown to be fundamentally unsustainable.[161] Finally, growth has also been shown to be consequence of energy acquisition following the discovery of fossil fuels.[162] It is extremely challenging to the politics of now, but if we can't – or aren't willing – to try to imagine beyond growth then we are overlooking potentially useful pathways. To be sure, there are significant vested interests in perpetuating the growth model, and there are also critical contradictions and shifts that indicate its end.

The Commons Transition scenario attempts to imagine how a post-growth social model might work. Energy demand sufficiency assumes community driven year-on-year reductions in energy use.[163] In a post full employment world, how might people live with sufficiency? This scenario suggests that universal access to basic assets (housing and food) and open design distributed manufacturing provide some answers.

The importance of technology in this scenario relates to how successfully co-operative ownership models can be deployed to provide alternatives to platform monopolies like Uber, TaskRabbit and Airbnb which leverage data commodification, value extraction and precarious labour through rent-seeking business models.[164] The technology stack of this scenario rests on data sovereignty, commons-based peer production and platform co-operativism which provide the elements for an ethical alternative to platform monopolies.

Commons-based peer production pioneered by the open source and free software movements, gives individuals, communities

158 Jose Ramos is director of the transdisciplinary consulting group Action Foresight (actionforesight.net), and a researcher with the P2P Foundation (p2pfoundation.net), writing widely on economic, political and cultural transformations.

159 Darren Sharp is the director of Social Surplus (socialsurplus.com.au), the Australian editor of Shareable and is undertaking doctoral research into urban experiments for sustainability transitions through Curtin University, funded by the CRC for Low Carbon Living.

160 Kubiszewski, I., Costanza, R., Franco, C., Lawn, P., Talberth, J., Jackson, T., & Aylmer, C. (2013). Beyond GDP: Measuring and achieving global genuine progress. *Ecological Economics*, 93, 57-6.

161 Grosse, F. (2010). Is recycling "part of the solution"? The role of recycling in an expanding society and a world of finite resources. *SAPI EN. S. Surveys and Perspectives Integrating Environment and Society*, (3.1).

162 Floyd, J. (2014). Sense-making and acting for descent futures: human and cultural pathways. *Foresight*, 16(6), 586-607.

163 Floyd, J. (2016). City Commons and Energy Demand, In Ramos, J. M. (Ed). *The City as Commons: A Policy Reader*. Commons Transition Coalition: Melbourne.

164 Scholz, T. (2016). Uberworked and Underpaid: How Workers are Disrupting the *Digital Economy*. John Wiley & Sons.

and firms the ability to co-produce mutual and non-rivalrous value through code, hardware and design.[165] This enables new post-growth innovation ecosystems to emerge that give peers the right to create shared value and keep common-pool resources in circulation for mutual benefit.

Emerging platform co-operatives like Stocksy United, Fairmondo and Up&Go address concerns for social equity and worker's rights through new digital platforms that promote solidarity through worker-owned enterprise structures.[166] Open design and distributed manufacturing could also unleash the productive capacity of communities and drive local economic development within post-growth ecological boundaries through circular resource recovery. Promising breakthrough innovations include Wikihouse,[167] an open source low-cost housing platform and LocalMotors which builds 3D printed cars through open design and networks of micro-factories.[168] The emerging application of ODDM explicitly to energy and carbon emissions reduction was highlighted at POC 21, which gathered global leaders in open source hardware and software for sustainability together near Paris and ran concurrently with COP 21 in 2015.[169]

Platform co-operatives and open design and distributed manufacturing will be necessary vehicles to protect the interests of people who produce the shared value and infrastructure required to advance local sufficiency at appropriate scales. These issues are becoming acutely important given rapid advances in artificial intelligence, automation and concern over the rise of "algocratic" governance[170] or control by algorithm. Commons governance and co-operative ownership of technology resources has the capacity to shape the way AI and automation unfolds so that ethical livelihoods and sufficiency can be created.

A final critical tension in this scenario relates to political power. This scenario assumes the possibility for both the emergence of effective citizen movements that democratise infrastructure and the ability for citizens to play an effective role in governance of common resources. Today, many factors might be seen to be obstacles to this: a culture of political infantilisation persists (the once every 3 year voter), with low appetites for 'extracurricular' political engagement; the capture of state policy by corporate lobbies and oligarchs;[171] the legal weight and complexity of our political systems; and excessive housing costs consume household finances leading to precarity and little time for public life. Faced with this, many are left stuck between hopelessness and the naïve hope that others will fix society's problems.

A new narrative with citizens at the vanguard fundamentally contradicts this disempowerment, and is already leading to sweeping social changes in cities around the world. Citizen movements in Spain, Iceland, Taiwan, Korea, Italy and elsewhere have not just challenged power, but have forged new political contracts. Cities like Ghent, Bologna, Amsterdam, Barcelona, and Madrid have innovated forms of commons governance through support for citizen-led projects, participatory budgeting, support for the creation of co-operatives, mutual infrastructure and urban food production.[172] Indeed, new polities are consolidating around the city.[173] *Sharing Cities: Activating the Urban Commons* (see

165 Benkler, Y. (2006). *The wealth of networks: How social production transforms markets and freedom.* Yale University Press.

166 Scholz, T. and Schneider, N. (Eds.). (2016). *Ours to hack and to own: The rise of platform cooperativism, a new vision for the future of work and a fairer Internet.* OR books.

167 https://wikihouse.cc/

168 https://localmotors.com/

169 http://www.poc21.cc/

170 Rainie, L., & Anderson, J. Q. (2017). Code-Dependent: Pros and Cons of the Algorithm Age. *Pew Research Center.* Availble at http://www.pewinternet.org/2017/02/08/code-dependent-pros-and-cons-of-the-algorithm-age/

171 Gilens, M., & Page, B. (2016). Testing Theories of American Politics: Elites, Interest Groups, and Average Citizens. Perspectives on Politics, *American Political Science Association*, 12(3), 564-581.

172 https://www.shareable.net/blog/ghents-quick-rise-as-a-sustainable-commons-based-sharing-city

173 Curry, A. (2017). The City, the Country, and the New Politics of Place. *Journal of Futures Studies*, 21(3), 3-16.

Sharing Cities

Sharing Cities: Activating the Urban Commons published by Shareable, contains over 100 case studies and model policies from more than 80 cities in 35 countries that showcases how city residents are using commons-based strategies to meet their needs in housing, food, transportation, technology and energy. From participatory budgeting in Brazil, to resident-managed public spaces in Italy, to taxi co-operatives in the U.S., the book shows how citizens are coming together in cities around the world to develop solutions for the commons good. Shareable was one of the key initiators of the sharing cities movement and this book demonstrates how communities, organisations, and local governments are increasingly sharing labour, knowledge, space, and goods, to overcome scarcity by building and maintaining vital common resources. The book is a practical reference guide for community-based solutions to urgent challenges faced by cities everywhere.

Link:https://www.shareable.net/sharing-cities

breakout box on page 76) provides dozens of real-world examples in driving carbon reduction through the democratisation and collaborative governance of infrastructure.[174] Finally, we are witnessing an explosion of technologies for participatory deliberation, decision-making and voting.[175] The future of democracy and citizen-run cities is far from determined.

Desirability

The VP2040 project aimed to explore scenarios and demonstrate pathways to achieving major emissions reductions from Australia's cities. Both of the Action Pathways do so, and therefore from an emissions reduction perspective both are desirable.

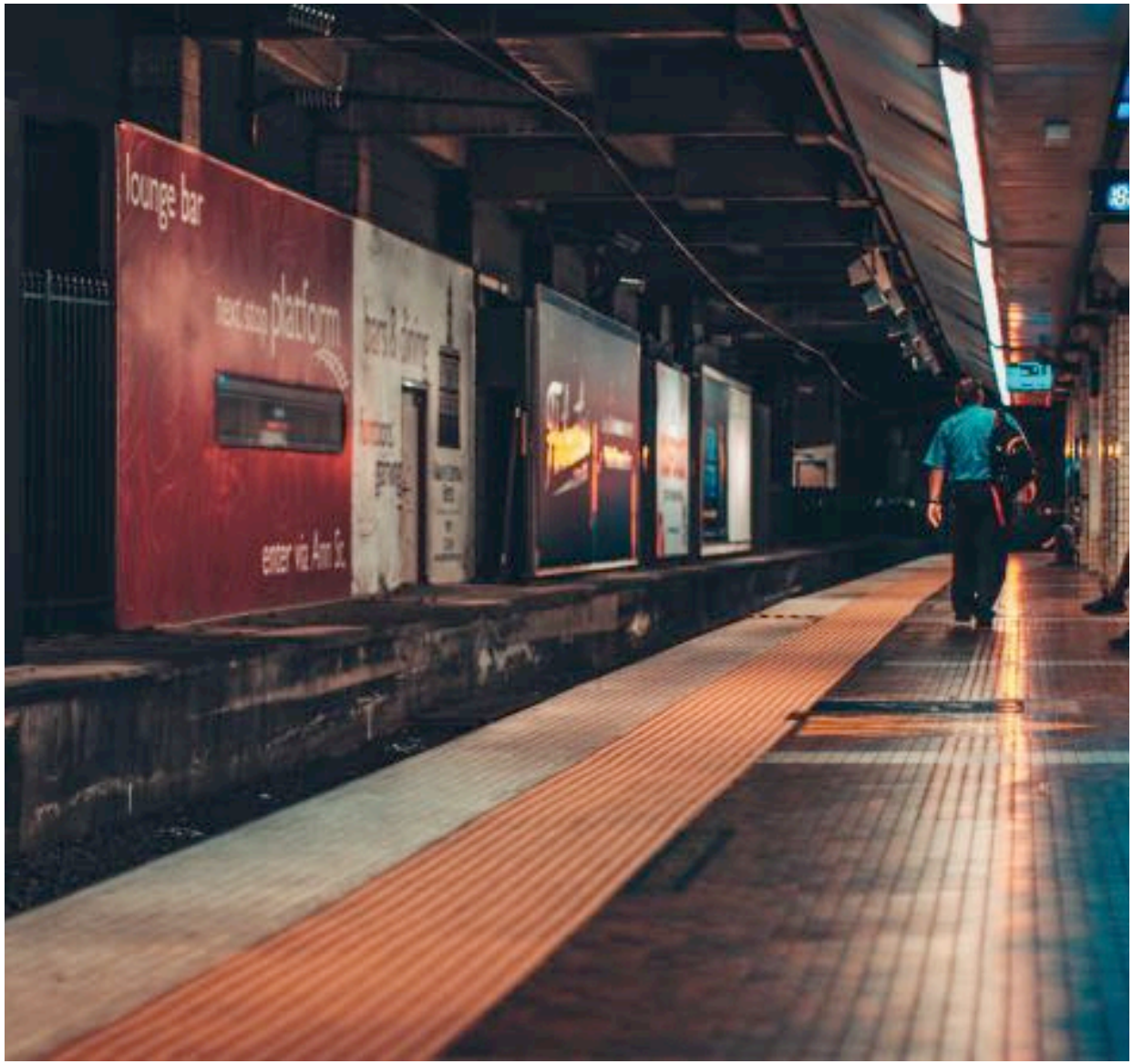
While the technologies themselves may not differ vastly across the two action pathways, how they are applied and for whose benefit might be. The difference between the two action pathways is about how the changes and costs are distributed across society, who benefits from and pays for the changes, and the kind of society we live in as the emissions reductions are achieved.

The desirability of social, cultural and economic patterns of these future cities is inherently subjective, as all political and economic frameworks are desired by some more than others. The winners and losers of these two transitions would likely differ. Both also have potentially significant dark sides: the loss of privacy, autonomy and increasing inequality in Green Growth; and the reduction of personally high relative wealth and need for social participation would be significant challenges for many in a Commons Transition.

As with all scenario work, the future will be neither exclusively Green Growth or Commons Transition. It will likely be some components of both and many other elements not discussed here. We invite the reader to use these Action Pathways as tools to explore, and then work for, their own personal or organisations' preferred future.

174 Gorenflo, N. (Ed.). (2017). *Sharing Cities: Activating the Urban Commons.* Shareable, San Francisco. https://www.shareable.net/sharing-cities

175 See Nanalyze 2017.



7. Using the Scenarios

VP2040 has developed resources to facilitate use of these scenarios, as individuals or within your organisation.

The resources present key material from the project in an easily digestible and communicable form. For example, they include video summaries of the project and scenarios to quickly and easily convey the essence to new groups of people. There are also readily printable scenario summaries of both the four exploratory scenarios and the two action pathways.

Two workshop outlines have been developed to support you and/or your organisation to expand your vision of what a low-carbon future could be; consider how prepared you are to handle, respond or make use of changes that happen; and imagine (plan) your role in pathways for getting there.

The Exploratory workshop draws on the four exploratory scenarios developed as part of the project. It helps your organisation think more imaginatively about what could happen in a low-carbon future city, and define the kind of low-carbon city that your organisation is aspiring to. This explorative workshop uses scenarios as a way into questioning, testing, and beginning to understand your organisation's role in achieving more sustainable cities. It presents key questions for you to explore, and suggests how to use the exploratory scenarios to:

- identify emerging challenges and opportunities;
- test current plans and processes;
- explore or prepare for disruptions, including how you might respond or shape those changes.

The Action Pathways workshop builds on the new scope and sense of possibility opened up by the Exploratory workshop. It helps your organisation define a more active role in achieving a more sustainable future, drawing on the two action pathways outlined in this report. As with the Exploratory workshop, the Action Pathways workshop opens up ideas about the scale and array of actions available to your organisation, and should expand thinking on what possible pathways could look like. This workshop helps your organisation place itself within larger, more transformative action pathways. It is intended to inform and strengthen commitment to action and the development of strategy and implementation plans.

Visit www.visionsandpathways.com/tools/ for more information.

7. Conclusion

In signing the Paris Agreement, Australia has committed to limiting greenhouse gas emissions as part of holding "the increase in the global average temperature to well below 2°C," and achieving carbon neutrality in the second half of this century. The Paris Agreement target has been criticised as insufficient to stabilise climate and prevent catastrophic warming, with a stronger target of carbon neutrality by 2050 proposed and a focus on rapid decarbonisation.[176] Achieving zero net carbon by 2050 will require steep rates of reductions in our national emissions and increases in carbon sequestration in the intervening years. An absolute emissions reduction target of 80% by 2040 for Australian cities is on a strong trajectory to carbon neutrality by 2050 and therefore in line with these recommended targets.

VP2040 has a focus on cities because they contribute disproportionate amounts to national emissions, have significant influence on national economies and progressing change, and are demonstrating strong climate leadership globally and in Australia. The consumption-led emissions of cities account for around 63% of Australia's total emissions, and reducing these is critical to achieving carbon neutrality by 2050. The VP2040 project explored reduction of these emissions in two ways:

- 80% reduction in carbon footprint on 2012/13 i.e consumption emissions per capita (used for analysis of the four exploratory scenarios in Section 5); and[177]
- 80% absolute reduction on 2012/13 consumption emissions by 2040 (used for analysis of the two Action Pathways in Section 6).

176 Ramanathan, V., Molina, M.J., Zaelke, D., Borgford-Parnell, N.,Xu, Y., Alex, K. ... Victor, D. (2017). *Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change*. Institute of Governance and Sustainable Development, Washington DC.

177 Per capita emissions targets have been used by other Australian decarbonisation work, such as the ClimateWorks' Deep Decarbonisation Pathways Project analysis, which presented an illustrative deep decarbonisation pathway by which energy-related emissions are reduced by over 80% per capita nationally by 2050.

The analysis demonstrated that emissions reductions of this scale can be achieved, but will require – and drive – massive transformation of our cities and perhaps our societies, economies and politics. Critically, the modelling demonstrated the significance of emissions attributable to city-based consumption but occurring outside the cities, which account for 84% of overall 'city-based' emissions. This emphasises the important role of cities as cultural and political leaders – understanding, supporting and demanding change in production sectors and land-use outside the cities – as well as making the changes needed in the cities themselves. The required early and radical changes to land-use and management for carbon sequestration to 'buy time' for structural change of other economic sectors, points to a critical role for urban citizens as consumers of forestry and agricultural/ food products, as well as directly in urban forestry.

'Good' scenarios are useful fictions. VP2040 views 'dreaming' about the future as a critical and necessary facet of action for urban, low-carbon transitions. In Section 5 of this report, VP2040 presents four provocative and exploratory 'vision and pathway' scenarios of how Australian cities could be transformed to radically reduce greenhouse gas emissions and increase resilience. These exploratory scenarios can be used for exploration of key questions like "what could happen?", "are we ready?" and critically "how could we accelerate/slow aspects of this that we like or dislike?".

These scenarios enabled us to more clearly define some of the emerging disruptive innovations that could assist a transition to low-carbon resilient futures for Australian cities; they helped to identify drivers of change and critical uncertainties associated with those innovations. We see communication and amplification of these possibilities as the first step in accelerating them and inspiring our partners and readers to act. But that is only the first step.

At the time of writing, Australia is not on track to achieve even its stated emissions reductions targets. These targets have been put into place by successive governments masterful at confusing the numbers and the criteria – and still we cannot meet them. Since the removal of the carbon price, Australia's emissions have actually increased. We are going the wrong way.

The two Action Pathways presented in Section 6 focus the reader on the forces of change that might be required to actually achieve the drastic greenhouse gas emissions reductions that we seek. They are intended to provoke, challenge and inspire. The Australian political context is such that the multitude of technical pathways are clear, but the cultural, political and economic pathways are not. The Action Pathways are explorations of choices and actions for decarbonising cities.

The Green Growth scenario invites partners and readers to consider what is required to trigger political changes of this magnitude, and explore their own potential power in progressing these. It particularly points to stronger action around the social license to operate for entities that are not explicitly and proactively decarbonising. It suggests the possibility of social and political mobilisation to drive out both the complicit acceptance and corruption preventing rapid reduction in the development and use of fossil fuels.

The Commons Transition scenario paints a new narrative with re-empowered citizens at the vanguard that is already evident in sweeping social changes in cities around the world. It draws on leading innovations in: sharing and shareable cities; P2P;

Open Design Distributed Manufacturing (ODDM), cooperatives and platform cooperative movements; and new more radical narratives of cultural, political and economic transformation. These new narratives are already gaining momentum and starting to be explicitly 'named' and 'described' in the public discourse.[178,179] Citizen movements in Spain, Iceland, Taiwan, Korea, Italy and elsewhere have not just challenged power, but have forged new political contracts that place citizens at the centre of city decision-making.

To believe that these exploratory scenarios and action pathways are possible, any of them—let alone the ones we actually want —requires a leap of imagination. To make them possible requires a corresponding leap of determination. We invite readers and project partners to read and reflect on both the exploratory scenarios and the action pathways, to consider the key questions they ask and to explore the tools we have provided, to shape the vision and pathway that you—and your organisation—are ready to travel.

178 Monbiot, G, (2017). *Don't let the rich get even richer on the assets we all share*. The Guardian. Available https://www.theguardian.com/commentisfree/2017/sep/27/rich-assets-resources-prosperity-commons-george-monbiot

179 Hickel, J., (2007). *Want to avert the apocalypse? Take lessons from Costa Rica*. The Guardian. Available https://www.theguardian.com/working-in-development/2017/oct/07/how-to-avert-the-apocalypse-take-lessons-from-costa-rica

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10. Appendices

Appendix 1: References for City Target and Actions Review (Tables 1 and 2)

References—Table 1

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Appendix 2: Sydney workshop process (August 2016)

The objective of these two workshops was to co-develop with stakeholders and relevant experts a pathway narrative for each scenario; that is, the basic elements of a story describing why, and to less extent how, the scenario could plausibly occur and thereby result in the low-carbon outcomes for Australian cities that are envisaged by the scenario endstate. The workshop was held twice (morning and afternoon sessions) and aimed to draw on, and draw out, the knowledge of experts and built environment sector actors.

The first stage of the workshop involved small group discussions of perceived "disruptive forces" (see Table 8) and the barriers to change/obstacles relevant to creating low-carbon pathways in Australian cities (see Table 9). These ideas were initially brainstormed individually and then shared with others at each table. Following a short presentation outlining the four VP2040 scenarios, the participants' ideas (regarding disruptive forces and barriers to change/obstacles) were reviewed and voted on.

Table 8: Top Ten disruptive forces identified by workshop participants

Disruptive force	*Votes*
Increasing focus on wellbeing not wealth	6
Radical changes to personal mobility: autonomous/driverless vehicles, electric vehicles, and their impacts (e.g. on electricity grid/infrastructure)	5
Impacts of climate change / ecological limits (e.g. on public perceptions and will for action)	5
Energy market reform	4
Take-up of renewables/new technological options (e.g. battery storage, micro grids)	4
Cost reduction for renewable/green energy technologies	3
Housing unaffordability forcing experimentation with alternative housing models (e.g. cooperative living)	3
Younger generation: 'carbon aware' and knowledgeable generations assuming influential roles (becoming decision-makers/leaders)	3
Better platforms to share carbon impact data (e.g. enabling dashboards for cities, organisations), enabling benchmarking, gamification, etc.	3
Robots	3

Table 9: Top ten barriers identified by workshop participants

Barrier to low-carbon cities	*Votes*
Inequality / increasing inequality	7
Influence of vested interests, "NIMBY" factor, and incumbents	7
Lack of courage, fear of failure and/or change	5
Fragmented ownership of inputs and outcomes (governance barriers)	4
Political leadership and renewables [lack of], making carbon reduction high on the political agenda [barriers to this]	4
Current values (consumerist/ materialist values) and energy-intensive lifestyle	4
Existing urban density – need to work within this	3
Institutional barriers: lack of metropolitan-scale planning; inertia in trades, professions and investors; BAU macroeconomic institutions	3
Automation-driven unemployment	3
Vulnerability to global supply chains	3

The second stage involved splitting participants up into new small groups which each worked on a different scenario. Participants were instructed to explored the scenario they found the most interesting and/or thought they felt best-placed to contribute to. A three-step process was used which followed a backcasting-like approach to brainstorming pathway narratives:

- First, participants considered the core "zeitgeist" changes that were envisaged in the scenario to be the new 2040 reality in southern Australian cities. Key zeitgeist themes were agreed and then focussed on in the remainder of the process;
- Second, participants brainstormed present signals of changes in Australia or elsewhere consistent with such changes. These signals were termed "seeds of change"; and
- Thirdly, participants discussed what events or changes could occur over the next 24 years, and why, through which these present seeds could grow into the transformative changes required to produce the envisaged 2040 outcomes.

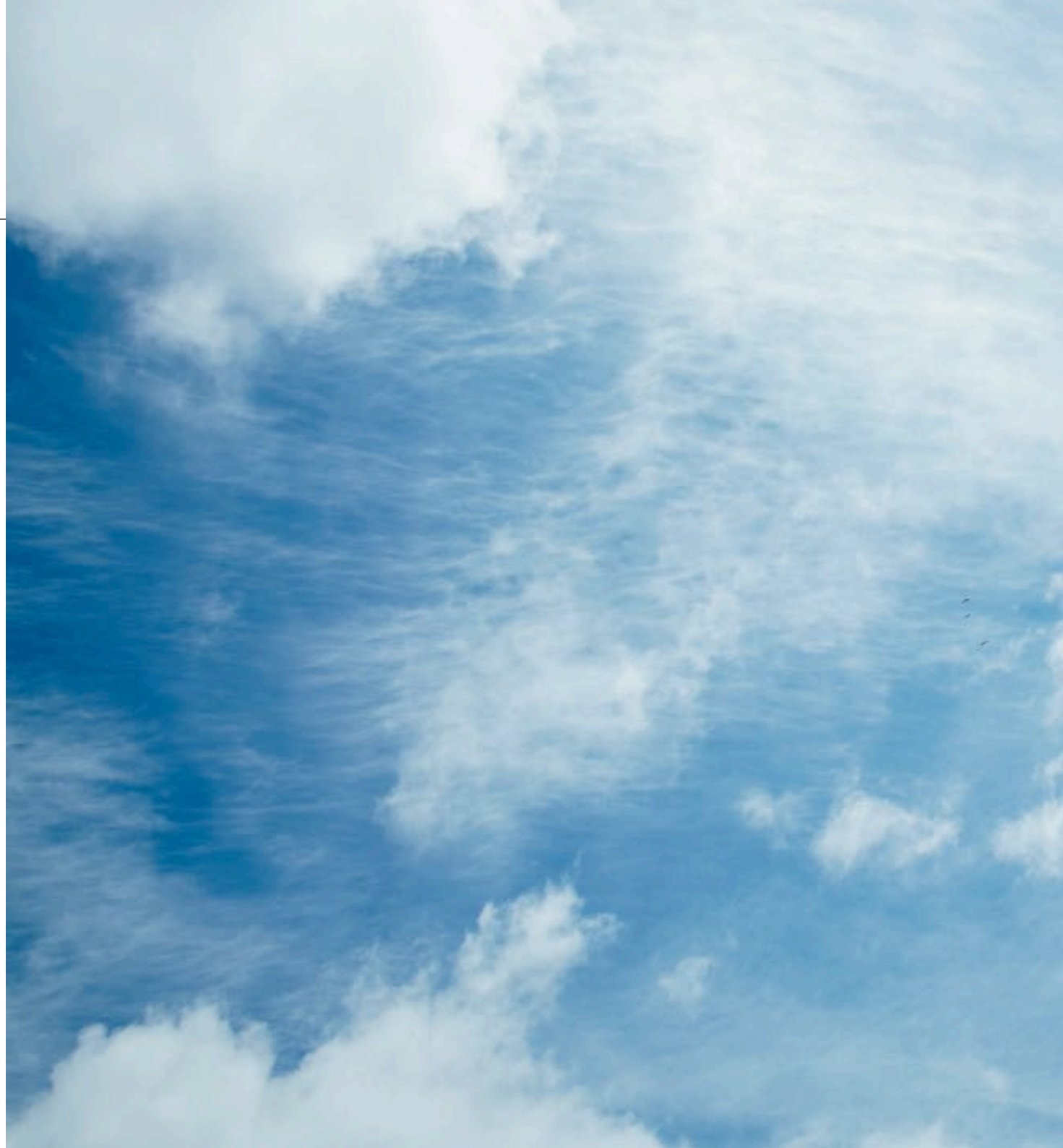
Appendix 3: Melbourne workshop process (March 2017)

This second pathways workshop was held to involve additional experts and industry and community stakeholders in the process of refining each illustrative pathway narrative and the associated scenario conceptualisation. The workshop participants included relevant experts and actors identified by the research team and representatives from project partners. The research team sought broad feedback on each scenario as well as specific suggestions for refining and developing each pathway.

The workshop involved the following activities:

- Idea sharing amongst participants, focussed on their key proposals for new actions and/or new policies to enable greater change towards low-carbon urban futures;
- A presentation outlining the scenarios and each illustrative scenario pathway;
- Small group discussion (at each workshop table) of the perceived positive and negative elements of each scenario and potential pathway issues (e.g. challenges and tensions for each pathway); and
- Scenario-focussed group discussion focussed on the main decarbonisation elements of a focal scenario and associated pathway ideas, including discussion of potential 'branching points' related to each scenario and policy considerations. This activity involved breaking into small groups comprised of participants who wanted to focus on that scenario.

The workshop outputs included high-level pathway considerations (e.g. aspects/factors relevant to considering the plausibility of each scenario and associated envisaged change processes), possible policies and actions relevant to each scenario, and identification and scenario-specific issues and themes which influence stakeholder judgments about scenario desirability.



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