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Sustainable housing at a neighbourhood scale

From the AHURI Inquiry: Inquiry into housing in a circular economy

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Acronyms and abbreviations used in this report

ACT	Australian Capital Territory
AHURI	Australian Housing and Urban Research Institute Limited
BASIX	Building Sustainability Index
CASBE	Council Alliance for a Sustainable Built Environment
CE	Circular Economy
DE	Federal Republic of Germany (Deutschland)
EMF	Ellen MacArthur Foundation
ESD	Ecologically Sustainable Development
EU	European Union
GBCA	Green Building Council of Australia
GHG	Greenhouse Gases
HIA	Housing Industry Association (Australia)
LGA	Local Government Authority
QLD	Queensland
NABERS	National Australian Built Environment Rating System
NatHERS	Nationwide House Energy Rating Scheme
NCC	National Construction Code
NL	The Netherlands
NSW	New South Wales
PV	photovoltaic (technology to convert sunlight into electrical energy)
SA	South Australia
SE	Sweden
SSF	Sustainable Subdivisions Framework
SRS	Stockholm Royal Seaport
UDIA	Urban Development Institute of Australia
VIC	Victoria
WA	Western Australia
WSUD	Water sensitive urban design

Executive summary

Key points

- The research identified shortcomings in how sustainable development is defined in Australian urban policy frameworks. Weak statutory underpinnings for sustainability and for circular economy thinking result in a continuation of unsustainable urban development patterns.
- There is limited policy attention to the opportunities provided by the neighbourhood scale. This results in missed opportunities for scale efficiencies of designing for clusters of buildings, infrastructures, and facilities.
- Due to a reliance on the market to transform urban systems of provision, 'eco-neighbourhoods' continue to remain experiments in Australia.
- Realising sustainable neighbourhoods in urban infill locations is faced with even greater challenges than on greenfield or brownfield sites due to site restrictions and often complex ownership structures.
- Different policy interventions are required to support sustainable housing at a neighbourhood scale. Much higher regulatory standards for sustainability and Circular Economy (CE) considerations at both building and neighbourhood scale are needed. Policy attention should be directed to mechanisms able to support planning and development at a scale higher than the currently dominant building scale. Additional interventions in fiscal and financial frameworks, business support schemes, and education and training could help with industry transition.
- The research emphasised the importance of partnerships between governments, private developers, and local communities. It also emphasised the need for suitable governance approaches to realise and manage neighbourhoods and their infrastructures.

Key findings

This research aimed to understand how sustainable housing developments can leverage benefits of the neighbourhood scale. Neighbourhoods are the 'in-between scales' between individual buildings and the urban scale and have been described as 'building blocks' of a city (Tam, Karimipour et al. 2018). The neighbourhood scale offers sustainability gains and economies of scale for decentralised systems (such as water and energy) and opportunities for integrated land-use and transport planning, biodiversity planning and social sustainability. This research examined the challenges and opportunities that built environment professionals in Australia experience when planning, designing, and implementing sustainable housing developments at the neighbourhood scale. The research also examined strategies and policy levers employed in good practice eco-neighbourhoods from across Australia and Europe that can inform Australian policy and practice.

The definition of 'sustainability' used in this research extends beyond the focus of the Circular Economy (CE) concept. While CE is concerned with realising closed loop material flows (that is, avoiding the use of non-renewable resources, reducing waste, designing products and materials for reuse and recycling), the focus of this research also considered sustainable development goals of social and intergenerational equity, environmental protection, and economic prosperity. The focus on sustainable urban development, rather than CE (as used for the overarching Inquiry), was decided for two reasons. First, sustainability is well embedded in Australian urban planning discourse (although rarely clearly defined), whereas CE approaches are not widely used. This contrasts with the European examples analysed for this research, which have been explicitly framed around CE. Second, sustainability allows not only the consideration of technical aspects of planning and designing at the neighbourhood scale but also the relevance of residents' behaviour and lifestyle choices of these communities (Williams and Dair 2007).

The research found major challenges to realising sustainable housing at a neighbourhood scale in Australia. While awareness about the value of CE actions at the neighbourhood scale is growing among built environment professionals, they experience barriers to incorporating sustainability principles into plans and developments at this scale. Important barriers are the fragmentation of policy and regulatory frameworks for sustainable urban development and weak mechanisms for planning at the neighbourhood scale. Building regulations are set at federal level while state and territory governments are responsible for urban and regional planning policies. Housing developments are usually designed and realised at the scale of individual building sites, with weak mechanisms for planning and design at the neighbourhood scale. And while numerous dwelling and community-scale design and performance sustainability rating tools are now available in Australia, their use is voluntary and their application variable. The research found that built environment professionals find it challenging to navigate the governance and policy landscape, and to identify the relevant tools to plan, design, develop and evaluate sustainable housing at the neighbourhood scale.

There are a growing number of 'eco-neighbourhoods' internationally. Such initiatives are still niche experiments that face challenges in their realisation. Knowledge gained from realising sustainable neighbourhood projects is rarely mainstreamed into planning and development processes. In Australia, good practice eco-neighbourhoods rarely demonstrate a comprehensive vision for a sustainable neighbourhood and instead attention is focussed on selected key issues of sustainability or CE. Also, the opportunities afforded by a neighbourhood scale approach appear underused in Australian examples. The cases from Europe can offer inspiration for Australia on how integrated visions for sustainable housing at the neighbourhood scale can be realised.

To support sustainable housing at the neighbourhood scale in Australia, major regulatory and policy reform is needed. This should be complemented by education of all actors in relation to what CE or urban sustainability means in practice, and especially at a scale beyond the dwelling.

The institutional actors involved in the realisation of sustainable neighbourhoods are developers, urban designers/consultants, local council planning departments and state government planners. It is largely the interaction between these groups that determines what can be done in relation to sustainable development at the neighbourhood scale and beyond minimum planning and construction requirements. Statutory planners in local governments are critical gatekeepers of more progressive opportunities in relation to sustainability at the neighbourhood scale. State and territory government departments are important actors to set policy frameworks and initiate policy and regulatory change. However, given the weak policy frameworks available, political support at all government levels is required to ensure above-standard residential projects can be realised, especially at the neighbourhood scale.

Policy development options

The research found there is a need for stricter regulatory requirements on urban sustainability in general, and for policy frameworks and development models to support sustainable housing at a neighbourhood scale specifically. Policy expectations for sustainable neighbourhood developments should be performance-based, rather than prescriptive, and they should be supported by objectives and targets so that achievements can be measured and compared.

Many research participants called for mandatory targets, and for binding policies and regulation and sustainable housing and neighbourhood-scale developments to be coordinated across levels of government and jurisdictions. This indicates a realisation by stakeholders that a sustainability transition cannot be realised based on voluntary action but requires a strong steering from governments at all levels. Planning, designing, and implementing sustainable housing at a neighbourhood scale will only become more mainstream if the demands are lifted in planning and building regulations. Moreover, housing developments need to be coordinated with policy areas for transport, environment, and the economy to enable the realisation of sustainable neighbourhoods. Mainstreaming approaches to sustainable neighbourhoods will usefully be supported by a review of the current fragmented landscape of sustainability rating tools and by making sustainable community assessment tools mandatory.

Besides the need for stricter regulation, the transition to practices of sustainable urban development might be supported by other policy levers. Information, education, and training have been identified by research participants as important to help change the professional and public discourses on sustainability and the CE in the built environment. There may also be a role for temporary financial or fiscal incentives for industry to support the uptake of new approaches during a regulatory transition phase.

In terms of the planning process, the research highlighted the value of an integrated urban development vision for the proposed neighbourhood development that places sustainability or circularity at its core. Such strategic master planning documents can provide a decision framework over many years of implementing large-scale projects. A stronger focus in planning policy on supporting neighbourhood-scale developments, beyond the current dominant focus on individual lot development, will be essential. Design guidelines and similar tools can be useful complementary instruments to ensure the expectations for the sustainability of the large-scale development become a binding requirement.

Realising sustainable housing at a neighbourhood scale requires new governance models and partnerships of governments, private developers, and local communities. Projects such as eco-neighbourhood developments are frequently seen to place higher demands on planning and development processes and feared to result in higher costs for the maintenance of public assets created as part of projects. More support for local councils is therefore needed to reduce real or perceived risks attached to ‘untypical’ developments. This could, for example, take the form of new public-private-partnership models whereby local governments and developers share the benefits and additional costs of such developments. New models for public engagement, beyond statutory requirements, should also be considered to support a shift in behaviour of residents to internalise sustainable lifestyles. This can also help with ensuring that neighbourhoods continue to evolve through sustainability community initiatives and bottom-up CE innovation.

Securing the financing needed for sustainable neighbourhoods was identified as a major challenge by research participants. The actual costs of realising sustainable neighbourhoods can exceed budgets in the lengthy processes of gaining development approval for such 'untypical' projects. Lenders are often reluctant to support projects that are perceived as higher risk. To facilitate the realisation of such complex projects in future, policy support is needed to change the financing landscape, for example through ethical investment practices that prioritise quality and legacy of development projects over quick financial returns.

Finally, policy change that prioritises previously used and recycled materials over new ones so a market for such products can develop is important. There is a lack of consideration for reuse of construction materials in planning, design, and construction processes in Australia. New products and materials are favoured by regulatory standards and cheaper to procure than recycled ones. Databases of available second-hand constructions materials and structures (and accompanying warehouses for their storage) are being trialled in some of the European case studies and could be a useful tool also for Australian governments and developers to support efforts of procuring reused or recycled building material.

The study

This research is part of a wider AHURI Inquiry that addresses the overarching question of how the transition to a CE in housing can be implemented. This project was designed to contribute to the aims of the Inquiry by identifying opportunities for a CE approach at neighbourhood scale as a means to achieving sustainable housing.

Realising sustainable neighbourhoods involves multiple interconnected challenges for policy makers, planners, and developers. Understanding the on-the-ground complexities of these challenges, and how they play out in greenfield locations (land previously zoned for rural / agricultural use), brownfield (larger-scale urban renewal) and greyfield sites (smaller lots / urban infill) is key to developing effective and targeted policy responses that can facilitate the realisation of eco-neighbourhoods. The project analysed different dimensions of barriers and opportunities of planning and designing sustainable housing at the neighbourhood scale in both current mainstream housing development practices and good practice examples of eco-neighbourhoods. The project addressed four research questions:

1. Who are the key institutional actors for realising sustainable neighbourhoods in different locations?
2. What drivers and dynamics are critical in supporting a transition to sustainable neighbourhoods in different locations?
3. What are the needs and opportunities for professional training to support a transition to sustainable neighbourhoods?
4. What are the key policy instruments of relevance to achieve a transition to sustainable neighbourhoods in different locations?

To answer these research questions, the project applied a qualitative research design, incorporating a desk review of academic and policy literature, an online survey, case studies, and policy workshops. The online survey focussed on collecting data from actors in the volume housebuilding industry in Australia (including policy makers, public and private sector planners, property developers and architects and designers). They provided insights on their perceived opportunities for and barriers to realising sustainable housing at a neighbourhood scale. Altogether 123 responses to the survey were received. In addition, 15 detailed case studies of good practice 'eco-neighbourhoods' in Australia and Europe were undertaken. Ten case studies are located across Australia, in WA, SA, VIC, QLD, and ACT. Another five case studies from four European Union (EU) countries (The Netherlands (NL, 2 projects), Germany (DE), Sweden (SE), and Finland (one project each) were analysed. The case studies include a mix of government-led and developer-driven developments. Each case study comprised a desk analysis of policy and project documentation and semi-structured interviews with key actors to identify the motivations, barriers, and drivers for realising these developments. The findings from the desk review, the survey and the case studies were discussed in two online workshops with 21 participants from government, industry, and relevant non-governmental organisations from across Australia. These workshops contributed to validation of the findings and refinement of the suggestions for policy changes to support a transition towards sustainable housing at a neighbourhood scale.

1. Introduction: sustainable housing at a neighbourhood scale

- **This chapter sets out the research questions, the policy context, a review of existing research, and the research methods.**
- **The project focuses on a CE approach to achieve sustainable housing at the neighbourhood scale. This scale offers resource efficiencies beyond the individual building and opportunities for realising sustainable lifestyles through community involvement.**
- **Previous research on circularity and sustainability in the urban environment has mostly focussed on nations, regions, cities, or individual buildings, rather than the neighbourhood scale.**
- **Important barriers to realising sustainable housing at a neighbourhood scale in Australia are a narrow scope of planning systems which prioritises economic growth; a focus on the building scale in planning and development processes; a preoccupation with development assessment at the expense of strategic planning; and limited attention to how sustainability outcomes could be measured comprehensively.**
- **The research employed a qualitative methodology. An online survey of key actors in the Australian volume housebuilding industry provided insight into the current 'mainstream' practices of planning, designing, and realising sustainable housing at the neighbourhood scale. Case studies of 'good practice' sustainable neighbourhoods from Australia and Europe identified opportunities and barriers to their realisation. Online policy workshops with representatives from government, industry, and civic society helped to refine the research findings.**

This report presents the findings of a research project investigating the opportunities and barriers to delivering sustainable housing at a neighbourhood scale in Australia. The research examines how key built environment professionals in Australia experience the planning, designing, and implementing of sustainable housing developments at the neighbourhood scale. It also examines strategies and policy levers used in good practice eco-neighbourhoods from Australia and Europe to improve Australian policy and practice.

1.1 Defining and conceptualising key terms

The analytical focus of this research is the relevance of the neighbourhood scale for sustainable housing developments. To date, research and policy intervention on sustainability and CE approaches mostly focused on cities (Prendeville, Cherim et al. 2018) and on the scale of individual buildings (Economidou, Todeschi et al. 2020; Pomponi and Moncaster 2017). More recently, neighbourhoods have come into focus 'as an important scale to accelerate sustainability—small enough to innovate quickly and big enough to have a meaningful impact' (EcoDistricts 2014: 3).

Neighbourhoods are the 'in-between scale' between the individual building and the city (Oliver and Pearl 2018). A neighbourhood is defined as a cluster of residences, sometimes in conjunction with other land uses, and with shared infrastructure (Galster 2001). Besides the spatial definition, the term neighbourhood is also used to refer to a group of people based on a social understanding of the neighbourhood. Thus, neighbourhoods can be conceptualised as a physical place or a social construction (residents' identification with their locality) or, simultaneously, both (AlWaer, Speedie et al. 2021; Koch, Girard et al. 2012). According to Kearns and Parkinson (2001), a neighbourhood is a multi-layered phenomenon within an urban context that by residents is perceived to exist at three different scales. These scales are: the 'home area', typically delineated as an area of five to 10 minutes walk from one's home; the physical and social composition of a 'locality' (where planning decisions, service provision and housing market factors are important mechanisms); and the 'urban district or urban region', i.e. the landscape of social networks and economic opportunities.

Neighbourhoods have been recognised as a suitable scale to achieve resource efficiencies through energy micro-grids or water protection measures beyond the individual building scale (Bunning, Beattie et al. 2013; Moreau, Sahakian et al. 2017). Neighbourhoods also offer opportunities for integrated transport and land use planning, including greater potential for achieving mixed-use developments and walkable neighbourhoods (EMF and ARUP 2019a; EMF and ARUP 2019b; Marchigiani and Bonfantini 2022). Planning for green (natural and open spaces) and blue (water) infrastructures at a neighbourhood scale can maximise their benefits, as it enables the coordination of water bodies, open spaces, and the greening of streets and individual sites. Moreover, this scale allows consideration of the importance of communities and social capital for achieving a sustainability transition (Cooper and Baer 2019; Miller and Bentley 2012). They can offer a manageable environment for decisions taken with and by the local community 'against the chaos and organizational complexity of the city as a whole' (Kallus and Law-Yone 2000: 817). While neighbourhoods are much more complex than buildings, they are 'small enough to innovate in public policy, governance and sustainable urban design strategies, but large enough to create important social and ecological benefits that impact the city scale' (Oliver and Pearl 2018: 514). Appendix 1 provides an overview of the dimensions contributing to sustainable housing at a neighbourhood scale.

Neighbourhoods can vary in size depending on the context and factors such as density of development (Uda and Kennedy 2015)—as illustrated by the case studies included in this research. Although neighbourhoods are not usually defined as administrative units, they are characterised by clearly defined boundaries that can allow them to 'function as an autonomous or semi-autonomous piece of the city' (Newton, Newman et al. 2022: 36). Distributed technologies (such as for energy) require a clustering of participating properties, and economies of scale (reduced costs per unit through shared facilities) will have minimum as well as maximum thresholds to realise their efficiency. For such reasons it has been argued that defining a geographical boundary and setting up a clear governance structure for a neighbourhood may be more important than determining its size (Thomson, Newton et al. 2019).

The term 'neighbourhood' is often used interchangeably with the terms of community, precinct, or district. In this research, drawing on Uda and Kennedy (2015), the 'neighbourhood' is considered an all-encompassing term that captures the system of built form, natural environment, and community, whereas 'community' only refers to the people. Unlike neighbourhoods, 'districts' and 'precincts' are often delineated by administrative boundaries (Koch, Girard et al. 2012). The term 'precinct' is mostly used in the Australian context to denote 'private and public land with shared infrastructure' and is usually of a smaller scale than a neighbourhood (Thomson, Newton et al 2019: 220).

Governments, policy makers, and business advocates promote the CE as an approach to better manage resource flows by implementing closed loop systems (Geissdoerfer, Savaget et al. 2017; Kirchherr, Reike et al. 2017). The European Commission has adopted a comprehensive CE policy framework that includes legislative proposals to stimulate Europe's transition towards a CE (EC 2015; EU 2020). Several nations (such as China) and cities around the world (such as Paris and Amsterdam) have recently adopted CE strategies (Prendeville, Cherim et al. 2018; Williams 2022). In the built environment, CE approaches are proposed for water, energy, and material loops, with the focus on realising building and construction techniques that are designed for disassembly, material recovery, and value retention (Mercader-Moyano and Esquivias 2020).

The relationship between CE and sustainability is not always clearly expressed in the academic and policy discussions (Friant, Vermeulen et al. 2020; Geissdoerfer, Savaget et al. 2017; Kirchherr, Reike et al. 2017; Korhonen, Nuur et al. 2018; Sauvé, Bernard et al. 2016). While there are similarities between the concepts, CE focuses on models of economic production and consumption, while sustainable development emphasises a balance between economic, environmental, and societal objectives (Dempsey, Bramley et al. 2011; Geissdoerfer, Savaget et al. 2017; Pomponi and Moncaster 2017; Prendeville, Cherim et al. 2018). It is argued that the CE has shortcomings for urban development because it lacks a social dimension, ignores the importance of governance, and fails to territorialise CE in terms of scale or context (Kębłowski, Lambert et al. 2020; Williams 2022). Thus, while much of the discussion on CE focuses on the temporal dimension of life cycles of products and materials, its spatial dimension—whereby CE refers to the physical layout of a neighbourhood or city—is currently underexplored (Liaros 2021).

Previous research has put forward that sustainable neighbourhoods are designed at a human scale and characterised by moderate density and mixed-use development. Moreover, they have a focus on active and public transportation, and are literally 'green' (Tam, Karimipour et al. 2018; Thomson, Newton et al. 2019). Following Nakajima (2000) and Korhonen, Nuur et al. (2018), this research suggests that circularity (avoiding the use of non-renewable resources, reducing waste, designing products and materials for reuse and recycling) is a necessary, but not sufficient, condition for a sustainable urban system. To pursue long-term sustainability, other conditions, like behavioural changes in consumption patterns and lifestyles, must accompany the implementation of a closed loop system.

1.2 Policy and governance context for neighbourhood-scale residential development in Australia

The planning, design and implementation of sustainable housing at a neighbourhood scale is guided by policies from all tiers of government. Neighbourhood developments are subject to legislation from urban and regional planning, infrastructure, environment, public health, and building design. However, the unit of application of many policies is mostly the individual building site. For example, despite the availability of technical solutions for neighbourhood scale water management and renewable energy production and distribution, legislative and regulatory barriers make it difficult to implement CE measures at this scale (Crabtree and Hes 2009; Hood, Gardner et al. 2010; Wiktorowicz, Babaeff et al. 2018).

In Australia, the responsibility for urban and regional planning is with the states and territories. However, the Australian Government can influence urban development outcomes through infrastructure funding and other policies. Moreover, residential building performance is mandated by the National Construction Code (NCC), which is given legal effect through the relevant legislation of states and territories. The energy performance of newly constructed and existing dwellings is very low compared to international good practice (Horne 2018). As a result, there is criticism of the effectiveness of existing legal provisions in reducing emissions (O'Leary 2019). There are no binding federal regulations for energy efficiency or sustainability at scale larger than individual buildings.

The EU offers lessons for Australia on transitioning to a low-carbon building stock. Since the 2018 update of the *Energy Performance of Buildings Directive* (EU 2018), the standard for new construction and renovations is to achieve 'nearly zero-energy buildings.' In addition, and to promote energy savings through behavioural change, the *Energy Efficiency Directive* (EU 2012) introduced a mandatory requirement of consumption-based cost allocation of heating, cooling, and hot water in buildings that operate collective heating/cooling systems (such as apartment buildings). This provides residents with an incentive to adopt energy efficient practices (Economidou, Todeschi et al. 2020). Moreover, the *Energy Performance of Buildings Directive* (EU 2018) mandates that 'Energy Performance Certificates' are made available to buyers or tenants in real estate transactions to encourage them to choose higher than minimum standards (Visscher, Meijer et al. 2016). Expanding the legislation to the district level with standards for net zero energy districts[1] and positive energy districts[2] is under discussion (Economidou, Todeschi et al. 2020; Saheb, Shnapp et al. 2019; Shnapp, Paci et al. 2020).

Australia's states and territories have their own urban planning laws and procedures and are responsible for planning policies and processes in their jurisdiction. Aside from providing the legislative and policy frameworks for planning, this tier also has a direct role in local land use planning. Notably, this includes the designation of major infrastructure projects and large areas for urban expansion and urban renewal (Dühr and Pinnegar 2021). Ecologically Sustainable Development (ESD) has been a goal for urban and regional planning in Australia since the 1990s (Williams 2013). It is pursued through two approaches: sustainable patterns of urban growth, and improvements in built environment performance. While principles of compact and mixed-use developments that are well-served by public transport are now prominent in state and territory urban planning policy frameworks, there is limited integration with the standards and processes set out in building regulations (Collia and March 2012). This means that passive design options for ESD can be challenging to realise. Moreover, Australia's neoliberal policy agenda over the past two decades has prompted a paradigm shift away from strategy-led planning, towards market-driven ad hoc development. A lack of state-wide regulatory controls for urban sustainability in planning and development assessment processes means that decisions are taken in favour of economic growth rather than environmental sustainability and social justice objectives (Goodman, Maginn et al. 2013).

In Australia, local authorities have no constitutionally assigned powers for urban and regional planning. Rather, their role is defined by state and territory governments. This results in variation across the nation in the competences for local land use planning processes and in the role of local councils for planning policy- and decision-making processes. Local development plans[3] are generally expected to align with the provisions of strategic planning policies, and – where they exist - metropolitan or regional planning strategies, including in relation to sustainability objectives. Previous research on metropolitan strategies and local land use plans in Australia has, however, shown that these policy frameworks are selective when it comes to sustainable development. Although ESD has for decades been a key principle in planning and environment legislation across Australia's jurisdictions, state strategies and local plans rarely provide comprehensive visions on urban sustainability (Davidson and Arman 2014) and have also been criticised for contradictory policy principles in relation to ESD (Dühr, Kroll et al. 2020).

Development applications are assessed against the provisions of local land use plans, and the lack of strong policies on urban sustainability therefore presents challenges for demanding a comprehensive consideration of this principle in development proposals. Moreover, local planning decisions are subject to 'on balance' arguments, which allow for sustainability measures to be set aside if the project is deemed to meet other criteria, such as contributing to job creation (Mendes 2007).

1 Net Zero Energy Districts deliver the same amount of energy to the supply grids as they use from the grids, and do not require any fossil fuel for heating, cooling, lighting. These districts are connected to the national grid for backup and energy exchange (Shnapp, Paci et al. 2020).
2 Positive Energy Districts produce more renewable energy than they consume and deliver more renewable energy to the grid than they use (Shnapp, Paci et al. 2020).
3 Different terms are used in Australia's jurisdictions to denotate local land use planning instruments.

Nevertheless, local governments can be important actors for achieving higher standards through local planning processes (Collia and March 2012; Williams 2013). There are examples, such as in Victoria, where local councils implemented more stringent requirements for sustainability assessments and affected state policy changes. The Council Alliance for a Sustainable Built Environment (CASBE) succeeded in embedding stricter sustainability requirements in state planning policy, resulting in better coordination between the planning and building stages of the development (Doyon, Moore et al. 2020).

In terms of planning at the neighbourhood scale, large greenfield sites on the urban fringe and inner-city urban regeneration (brownfield) sites offer many opportunities for neighbourhood-scale planning. However, the traditional model of subdividing large blocks of land for development by developers means that neighbourhood-scale efficiencies are rarely realised. Master planning processes are sometimes used to require developers to provide the services and developments in the new neighbourhood that were traditionally delivered by state and territory governments. These processes could also be used to mandate above-code sustainability standards and foster social sustainability through instruments such as Design Guidelines (McGuirk and Dowling 2007; Ruming 2005). However, it has been noted that sustainability or community considerations rarely play a role in the planning and design of master-planned estates or other larger urban revitalisation projects. As a result, opportunities to use available instruments to plan at the neighbourhood scale, and realise to sustainability ambitions through integrated processes, are missed (Newton, Newman et al. 2022).

Realising neighbourhood-scale developments in greyfield (infill) locations is even more difficult. Existing planning policies facilitate the redevelopment of individual allotments as they become available, which presents challenges for neighbourhood-scale considerations (Newton, Meyer et al. 2017). While new developments must consider outcomes for a neighbourhood, these outcomes are usually confined to the character of a locality, but do not extend to sustainability considerations such as active transport connections or renewable energy networks. Current planning practice in urban areas seeks to:

> … increase density through blanket up-zoning for small-lot subdivision infill. However, this type of redevelopment emphasises site yield over site design quality. … In practice, most blanket up-zoning brings about a reduction in the urban amenity and liveability of an area due to increased car traffic, more noise generation, reduced privacy, loss of greenery, and increased hard surfaces (Newton, Newman et al. 2022: 1213).

Furthermore, planning policies aimed at urban infill developments have reportedly ‘not proven to be sufficient magnets for residential property developers’ (Newton, Newman et al. 2022: 3), not least because of the number of landowners involved.

There is now a range of sustainability rating tools available to measure sustainable urban development outcomes (Berardi 2013; Tam, Karimipour et al. 2018). Most tools focus on the building scale rather than the neighbourhood scale. The tools available to Australian planners and developers are largely unconnected to planning policies and have been criticised for being statically applied at one point in time only (Grazieschi, Asdrubali et al. 2020). Previous research has argued that a dynamic evaluation of the whole life cycle of buildings and neighbourhoods, from planning to the design and construction phases to occupancy and finally dismantling, is required (Berardi 2011). Importantly, the array of rating tools lead to confusion among built environment professionals as to their scope and the standards applied (Doan, Ghaffarianhoseini et al. 2017; Rauland and Newman 2015; Wilkinson 2013). There is evidence of ‘greenwashing’ of ratings by residential property developers (Martek and Hosseini 2018; Warren-Myers, Bartak et al. 2020).

Since 2011, new residential buildings in Australia have been required to meet a minimum six 'star energy rating' (out of 10) for thermal performance, measured by the Nationwide House Energy Rating Scheme (NatHERS)[4]. NatHERS is the most widely used instrument to demonstrate compliance with energy efficiency requirements as set out in the NCC. By law, formal accreditation is required only at completion of the building. There are discussions about expanding certification to include the planning and design stages of a project to allow a holistic consideration of higher energy efficiency performance (Commonwealth of Australia 2020). Calls have also been made to expand the scope of predictive assessment tools to post-occupancy measurements that would allow monitoring of the conditions of development and incentivise behavioural changes of residents (Dixon, Bright et al. 2014; Iyer-Raniga, Moore et al. 2014).

Given that the NCC's focus is largely on the thermal performance of buildings, some Australian states and territories have developed additional tools to assess the sustainability of proposed buildings more comprehensively (Enker and Morrison 2020). The tools differ in their scope and application. There are differences in relation to when in the process they are applied, the criteria covered, and whether they are mandatory or voluntary. However, it has been found that tools such as the NSW Building Sustainability Index (BASIX)—while covering additional sustainability features—do not necessarily ensure higher building standards *per se* than those required under the NCC (Berry, Moore et al. 2019).

In Australia, a range of assessment schemes able to capture the larger emissions abatement potential of neighbourhood-scale energy, water, waste systems, and transport options exists. The use of neighbourhood-scale rating tools—such as the Green Building Council of Australia's (GBCA) Green Star Communities or the Urban Development Institute of Australia's (UDIA) EnviroDevelopment—is voluntary. Moreover, these tools differ in their scope, which presents challenges for their application and for comparing outcomes (Green, Tiwari et al. 2018; Morris, Zuo et al. 2018; Xia, Chen et al. 2015).

1.3 Barriers and drivers for sustainable housing at a neighbourhood scale: previous research and conceptual framework

This section provides an overview of previous research on urban sustainability and neighbourhood-scale planning and sets out a conceptual framework of 'circular neighbourhood principles' and how they can be influenced through top-down intervention or bottom-up initiatives. In the introductions to chapters two and three, further relevant insights from the literature review are presented. These insights have informed the survey of professionals working in the volume housebuilding industry in Australia and the analysis of eco-neighbourhood case studies.

Despite the opportunities of neighbourhood-scale development for supporting an urban sustainability transition, eco-neighbourhoods remain experiments (Crabtree 2005). Their implementation frequently faces considerable political and economic challenges due to a reliance on the market to transform urban systems of provision in a neoliberal context (Williams 2022). Previous research has identified barriers to realising sustainability or CE ambitions in urban developments, including a lack of suitable regulatory and policy frameworks, competing policy goals and lack of policy coherence, and resource constraints (Mead and Wales 2005; Newton 2013; Rowley and Phibbs 2012; Yang and Yang 2015). In the Australian context, it has been argued that practitioners typically aim for minimum legal requirements rather than strive for broader resource-driven sustainability outcomes (Iyer-Raniga, Moore et al. 2014). A regulatory, prescriptive approach to implementing ESD through the planning process has therefore been identified as more effective than a discretionary, objectives-led approach. Calls have been made for sustainability assessment tools to become an integrated (and obligatory) part of the planning, design, and implementation of urban development projects (Collia and March 2012).

4 In August 2022, an increase to 7-stars was decided by state and territory ministers, to take effect from October 2023 (Hannam 2022).

Research has emphasised the need for: new governance models; partnerships between governments, private developers and local communities; and suitable governance approaches to realise and manage sustainable neighbourhoods and their infrastructures and services (EcoDistricts 2014; Newton, Newman et al. 2022). Different types of policy intervention have been identified as helpful for overcoming the barriers to CE implementation, including: regulatory frameworks; fiscal and financial frameworks; public procurement and infrastructure; collaboration platforms; business support schemes; and education, information, and awareness (knowledge development) (EMF and ARUP 2019a; EMF and ARUP 2019b; Prendeville, Cherim et al. 2018).

Drawing on key principles for the CE as identified by the Ellen MacArthur Foundation (EMF) – related to preserving and enhancing natural capital, optimising resource yields, and fostering system effectiveness - Prendeville, Cherim et al. (2018) proposed a framework for analysing policy and governance aspects for urban sustainability that conceptualises both top-down and bottom-up influences. They draw on the EMF's 'ReSOLVE' framework that identifies six actions (to regenerate, share, optimise, loop, virtualise, and exchange) through which CE principles can be translated into concrete outcomes. While the EMF framework is focussed on business activities, Prendeville, Cherim et al. (2018) have adapted the EMF's ReSOLVE framework to apply to urban activities. For the purposes of this research, Table 1 interprets this conceptual model for the neighbourhood scale. It provides examples of top-down intervention and bottom-up initiatives for circular neighbourhood principles that provide a framework for the discussion in the following chapters.

Table 1: Circular neighbourhood principles

Circular neighbourhood principle	Top-down intervention (examples)	Bottom-up initiatives (examples)
Regenerate	• Solar photovoltaic (PV) neighbourhood installations • Developing green spaces for biodiversity and to improve air quality	• Community micro-grids • Community gardens and urban agriculture
Share	• Policy and regulation on the sharing economy	• Car sharing; appliance sharing • Repair cafés
Optimise	• Smart LED lighting across the neighbourhood • Retrofitting existing building stock	• FabLabs (networks of workshops that provide (public) access to tools and skills) • Smart grids
Loop	• District heating • Waste recycling and composting facilities	• Community recycling initiatives • Community composting facilities
Virtualise	• Paperless e-government • Autonomous and connected public transportation	• Community-led digital platforms • Citizen-science climate monitoring
Exchange	• Circular construction / demolition materials and processes • Electric powered public transportation	• Organic and locally sourced markets

Source: Based on Prendeville, Cherim et al. 2018.

1.4 Research methods

The research employed a qualitative methodology combining a review of the academic and policy literature, an online survey, case study research, and policy workshops. The following research questions guided the study:

1. Who are the key institutional actors for realising sustainable neighbourhoods in different locations?
2. What drivers and dynamics are critical in supporting a transition to sustainable neighbourhoods in different locations?

3. What are the needs and opportunities for professional training to support a transition to sustainable neighbourhoods?
4. What are the key policy instruments of relevance to achieve a transition to sustainable neighbourhoods in different locations?

The following sections describe the specific research methods, data sources, and analytical techniques used to address these questions.

1.4.1 Stage one: Review of academic and policy literature on sustainable neighbourhoods

A comprehensive review of the Australian and international academic and policy literature was undertaken to identify issues relating to planning, designing, and realising sustainable neighbourhoods. The review examined research on barriers and opportunities for realising sustainable neighbourhoods. Together, this informed the design of the primary data collection methods and was the basis for identifying case studies for Stage three of the research.

1.4.2 Stage two: Online survey of key actors in the Australian volume housebuilding industry

An online survey of key actors in the Australian volume housebuilding industry was undertaken to gain insight into the current 'mainstream' practices of planning, designing, and realising residential developments, with a focus on the challenges and opportunities for achieving sustainability at the neighbourhood scale. The survey questions are reproduced in Appendix 2. The survey included closed and open questions. Responses provided data on the opportunities and barriers to realising CE in the built environment, and on training needs and possible policy instruments to support the realisation of sustainable neighbourhoods.

The link to the online survey and was sent to the following organisations in June 2021 with the request to disseminate the invitation to provide responses to their members:

- Planning Institute of Australia
- Australian Institute of Architects
- Renewal SA
- Green Building Council of Australia
- Urban Development Institute of Australia
- Master Builders Australia
- Cities Climate Council
- Australian Institute of Landscape Architects
- Australian Local Government Association.

Some of these organisations decided not to participate, citing survey fatigue during the pandemic. The survey was therefore also shared via other avenues such as social media and direct emails to individual key stakeholders to increase the response rate. When the survey closed in October 2021, 123 survey responses had been received. Respondents were asked to answer the questions of relevance to their profession and role within their organisation, and therefore not all questions were answered by all respondents. No statistical representativeness could be ensured based on the number of survey responses received. Consequently, the survey results were analysed qualitatively, reporting on the most significant findings per question while providing relevant context for the interpretation of the results based on the profession and geographical location of the respondents.

Of the 99 respondents who stated their profession, 34 identified as planners, 19 as architects, 12 as policy makers, seven as developers, six as builders, three as consultants, three as regulators, and two as engineers. Additionally, 12 respondents indicated they were from 'other' disciplines (specified in the open responses as sustainability officers; technical professions such as building surveyor, building designer or asset manager; or researchers). In terms of the employment sector, 39 responses were from the private sector, 37 from local government, nine from state government, six from professional associations, and nine from 'other' employment sectors, such as research institutes or universities.

Thirty-seven of the survey respondents (out of 100 who answered this question) stated that they work in South Australia, followed by 31 who practice out of Victoria. Further, there were 18 respondents each from New South Wales and Queensland. Fifteen of the respondents stated that they work in Western Australia, eight in the ACT, five in Tasmania and three in the Northern Territory. Forty-one of the respondents (out of 100) have worked in their current role for less than five years, 22 had been working in their current position for five to 10 years, and 37 had worked in their role for more than 10 years.

The findings from the survey analysis are discussed in chapter 2 of this report.

1.4.3 Stage three: Australian and international case studies of eco-neighbourhood developments

Fifteen case studies of good practice eco-neighbourhoods from Australia and Europe were analysed (see Table 2 in Chapter 3). National, regional and city governments in Europe have demonstrated strong policy support for CE approaches in the built environment in recent years, with the EU taking in active role in promoting and coordinating initiative on CE. The international cases were therefore included as their advanced engagement with CE principles in urban development can offer lessons for Australian policy makers. The 15 case studies were identified through an extensive internet and literature search and selected to reflect research criteria including that:

- They are considered innovative examples of sustainability or circularity within their specific institutional and cultural context and at the time of project conception. (This was deemed relevant as the minimum expectations for urban sustainability depend on the policy, governance and politico-economic context for the project and can change over time as stricter standards are introduced).
- They used a comprehensive definition of sustainability (rather than focusing on only one dimension, such as energy efficiency).
- The developments were recently completed or in the final stages of construction (to allow the identification of key actors and be able to position the project within the current policy environment).

In searching for suitable case studies according to these criteria, it became apparent that after a wave of several initiatives to develop sustainable neighbourhood projects during the 1990s there had not been many more such initiatives since. Although many of the earlier examples were intended to be showcases for urban sustainability, to this day sustainable neighbourhoods continue to be niche experiments in most parts of Australia. While there also seemed to have been a stagnation in the number of eco-neighbourhoods in Europe during the early 2000s, recent policy shifts by the EU and its member states to achieve international climate change targets have prompted a considerable number of CE strategies and sustainable urban development projects at different scales, including neighbourhoods. As this new generation of circular neighbourhoods was mostly still in the concept stage at the time of this research, they were not included in the selected case studies. However, once they are completed investigating them in future research could prove interesting.

The case studies analysed for this project are predominantly located in metropolitan or peri-urban locations. Some of the examples, such as Cape Paterson (Victoria) are eco-villages sited in more rural settings. Several of the case studies were developed on large brownfield sites (such as the conversion of former military area of Scharnhauser Park in Germany; or the regeneration of former industrial areas, such as the Dutch project of Buiksloterham or Bowden in SA). The size of such vacant land in inner-urban locations provided the opportunity for the preparation of integrated urban development concepts that are able to guide project realisation over many years. There are also some large greenfield developments in the sample, such as the urban fringe land for the Whiterock development in Queensland, which was released as part of the state's urban growth policies. No examples of true greyfield eco-precincts (in the sense of requiring consolidation of smaller lots or the cooperation of different landowners in an existing community) could be found. This reflects the observation of previous research that neighbourhood-scale developments in infill locations are challenging to realise.

The case study methods included a desk analysis of project materials and secondary sources, which for each case were complemented with two to seven semi-structured interviews with key actors involved in the realisation of the eco-neighbourhood. The respondents are anonymised in this report, but interviewees for the 15 case studies included public sectors planners and sustainability officers from the municipality or government department leading the project or responsible for plans and approvals; developer(s) as project initiator or involved in the design of housing as part of the project; planning and design consultants; and in some instances residents of the eco-neighbourhood. The interviews lasted about one hour each. Some were organised face-to-face, but most were held via telephone or internet. The interviews were recorded and subsequently transcribed for analysis, ensuring the confidentiality of respondents. The data collection and analysis were undertaken for each case study according to an analytical framework, which is reproduced as Appendix 3. The focus of analysis was on identifying potentials and barriers as experienced by those who have found ways to realise sustainable neighbourhoods. Moreover, interviewees were asked for their views on policy changes needed to facilitate sustainable housing at a neighbourhood scale, and possibilities for industry adjustment. For each case study, a report was prepared according to the following themes:

- rationale for the project and vision, including definitions of circularity and the neighbourhood scale as used in the eco-neighbourhood project
- policy framework under which the project was developed
- key actors and governance arrangements to realise the sustainable neighbourhood
- dimensions of sustainability and circularity as addressed in the project, particularly in relation to the neighbourhood scale
- arrangements for monitoring of project outcomes in relation to circularity and sustainability
- key facilitators and main challenges for the eco-neighbourhood under study.

On the basis of the case study analysis reports, the research team synthesised the main findings across the fifteen cases, which are presented in Chapter 4.

1.4.4 Stage four: Policy workshops

The findings from the first three stages of the research were discussed with 21 representatives from local and state and territory governments across Australia, industry bodies (HIA, UDIA), academic researchers, and planning and architecture consultants from across Australia. Discussions were conducted in two policy workshops of 90 minutes each that were held by Zoom on 28 and 29 April 2022.

The workshop participants were identified based on their involvement in relevant aspects of sustainable housing at a neighbourhood scale and to ensure a distribution across sectors and jurisdictions in Australia. Participants were invited individually. The number of participants was deemed sufficient to ensure breadth in perspectives while allowing for active participation in an online setting.

Appendix 4 sets out the approach to organising the workshops and to structuring the discussion. Prior to the workshop, confirmed participants were asked to set out their views on the key challenges to achieving sustainable housing at a neighbourhood scale in an email to the research team. The focus of the workshop discussions was to refine the project findings, and to discuss the policy changes required to support the realisation of sustainable housing at a neighbourhood scale. The main discussion points presented to the participants were how to move beyond the building scale in planning, designing and implementing residential developments in Australia and achieve resource efficiencies through a consideration of the neighbourhood scale. Further, the workshops focused on exchanging views on how a comprehensive and integrated consideration of sustainability or CE principles can be achieved in urban development projects, instead of the currently dominant practice of the selective treatment of certain dimensions (such as energy efficiency or water management). The workshops were recorded and transcribed for analysis.

The workshop responses were used to validate the Initial findings of the first stages of the research and to broaden the discussion of policy changes needed to support a sustainability transition. The findings from the workshop discussions are presented in the final chapter of this report and have informed the conclusions and recommendations of the project.

2. Survey of the volume housebuilding industry on opportunities and barriers to sustainable housing at the neighbourhood scale in Australia

- **The survey shows there is awareness about the value of incorporating CE actions in housing developments and for planning at the neighbourhood scale but realising these remains the exception.**
- **Many respondents feel that achieving more sustainability in housing developments is beyond their direct influence, and requirements or incentives for comprehensive and coordinated planning and development processes rarely exist.**
- **Sustainability and circularity are not comprehensively defined in policy and weakly regulated, resulting in a selective and partial engagement of these objectives in developments.**
- **Survey responses showed that the building scale is the dominant focus for planning and design decisions and for development activity in Australia, resulting in missed neighbourhood scale opportunities.**
- **Survey responses illustrate the challenges of relying on voluntary action for sustainable housing developments, with calls for stricter regulatory requirements on urban sustainability.**
- **Many barriers exist to realising sustainable housing developments at the neighbourhood scale. These barriers can only be overcome with policy frameworks and instruments that require scale considerations in planning, design and construction processes.**

2.1 Barriers to realising sustainable housing at a neighbourhood scale in Australia: previous research on actors, policies, and institutional dynamics

Research on the perspectives of Australian planners has highlighted how they experience existing institutional and policy arrangements as presenting important challenges for realising urban sustainability (Filion, Lee et al. 2015; Williams 2013). For Victoria, Collia and March (2012) found state planning policy only included broad ESD objectives and lacked criteria for how sustainable urban development could be achieved. Local government planners consequently struggle to justify higher sustainability standards in development assessment processes. For NSW, Williams (2013) identified a lack of state leadership on urban sustainability, insufficient regulation, and variable political attention to sustainable development as stumbling blocks for local government planners.

Achieving neighbourhood scale efficiencies is challenged by zoning and subdivision rules (Newton, Newman et al. 2022). In development assessment processes, Australian planning practitioners therefore traditionally only consider the actual development (i.e. the building(s)), rather than the urban planning context within which the development takes place (Moore, Moloney et al. 2017; Dühr, Kroll et al. 2021). Moreover, the neighbourhood scale offers little incentive for voluntary industry action given the dominant business model that emphasises yield over neighbourhood quality (Newton, Newman et al. 2022).

Other institutional barriers for urban sustainability have also been identified. In the context of neoliberalism, a lack of appropriate resourcing for planning in general, and especially at the local government level, is an impediment to the implementation of ESD (Williams 2013). The staffing and resources of local governments matter for their ability to develop visionary policy frameworks and achieve sustainable neighbourhood outcomes in negotiations with property developers and consultants. Property developers and architects can play a critical role in demonstrating innovation in all aspects of building and construction, including sustainable neighbourhood design that is attractive to potential buyers. However, there are few incentives for voluntarily exceeding standards (Newton, Newman et al. 2022).

Good practice examples of sustainable neighbourhood development can offer other professionals involved in urban development processes, such as developers or tradespeople, the opportunity for learning and to develop new skills (Cooper and Baer 2019). However, mechanisms for systematic knowledge exchange and learning about sustainable urban development based on innovative demonstration projects within the building industry are limited (Moore and Higgins 2016). Moreover, architects are involved in less than 5 per cent of new housing in Australia, which means that many houses are built by builders that tend to use the same project-home model (Newton, Newman et al. 2022). These conditions limit opportunities for innovation, learning and knowledge exchange.

Policy instruments such as taxation, zoning and land use regulation can be important top-down levers for sustainable urban development, but research shows that bottom-up drivers also matter and that consumer preferences and behaviour play a role for achieving higher standards (Hertwich, Lifset et al. 2020). Yet, many consumers rely on information from the property sector to develop their knowledge, and this information influences their preferences and behaviour. Consumers (and sometimes professionals) have been found to be unclear about what the many sustainability ratings tools measure and what the results communicate (Collia and March 2012; Green, Tiwari et al. 2018; Rauland and Newman 2015; Xia, Chen et al. 2015). Poor or inappropriate information from the property development and real estate sector—such as misuse or misinterpretation of sustainability ratings (Martek and Hosseini 2018; Warren-Myers, Bartak et al. 2020)—reinforces the status quo and can prevent industry innovation in response to consumer demands.

2.2 Perspectives of built environment professionals on the opportunities and barriers for realising sustainable housing at a neighbourhood scale

2.2.1 Introduction

This chapter outlines the findings from the survey analysis. Altogether 123 responses were received, with respondents invited to only answer questions relevant to their role. The following qualitative analysis of the survey results covers how the respondents apply CE principles for development infrastructure, how this is applies across different locations and type of construction, how CE matters in decision-making processes, and how environmental performance is defined and measured at the neighbourhood scale. The number of responses received is provided for each of the questions in the following discussion to allow for contextualisation.

2.2.2 Applying CE principles for development infrastructure

In response to how respondents' organisations typically approach the reduction of potable water (drinking water) use, 32 respondents (of 60) answered that their organisations seek to limit stormwater runoff through a reduction of soil sealing, swales, retention or detention basins, infiltration systems or green roofs. Twenty-five respondents stated they provide on-site rainwater capture beyond statutory requirements and 12 respondents indicated they implement neighbourhood distribution of recycled water (lilac pipe system). Neighbourhood greywater processing and reuse (7 responses) and neighbourhood blackwater processing and reuse (3 responses) received limited attention, likely due to statutory requirements for sewage treatment. Twenty-five respondents are not involved in the design or creation of water systems.

In response to how respondents' organisations typically approach the production of electricity on-site and/or the reduction of energy use, 34 (of 57) answered that their organisation is not involved in the design or creation of electricity systems, nor the design of energy efficiency measures. Twelve respondents stated that they are involved in above-code building energy efficiency measures, such as the Passivhaus standard, which is an individual building measure rather than delivered at neighbourhood scale. Other respondents said their organisations are involved in neighbourhood scale renewable energy generation (11 responses), or neighbourhood scale energy storage, such as community battery (nine responses). This suggests some of the stakeholders consider how they deliver energy infrastructure beyond the dwelling. Among other measures, PV (photovoltaic) panels were frequently mentioned. However, several responses highlighted the challenges of moving beyond the building scale in supporting electricity production, as the following comments highlight[5]:

> Solar is typically applied, but rarely at enough scale, very rarely is battery storage used. We encourage Power Purchase Agreements. Energy efficient appliances are encouraged but uptake lacks informed decision making and relies on habit and what are minimum requirements. (Private sector architect, NSW)

> Mainly on roof solar. Neighbourhood schemes are too hard to implement and not supported by energy industry. (Planning consultant, Victoria)

There were also some critical reflections on the limitations of the minimum standards of some rating tools, notably NSW's BASIX. One local government planner from NSW stated that 'BASIX requirements limit further measures that can be required' and a local government councillor from NSW explained how this consequently defines their role to 'negotiate higher than min[imum] BASIX Energy scores for some devel[opment] scenarios e.g. design excellence competitions'.

5 Direct quotes from the survey responses are cited verbatim, although typographical errors have been corrected and identifiable responses have been anonymised.

Several respondents commented on the difficulties of realising integrated transport and land use planning at the neighbourhood scale, given the traditional and dominant focus on the scale of individual buildings for housing developments in Australia. In response to how organisations approach the reduction of car use and environmental impacts from transport, 33 respondents (of 59) stated they seek to implement dedicated neighbourhood walking and cycling pathways; and 28 respondents named secure off-street bicycle parking facilities as 'typical' approaches used by their organisations. Ease of access to high quality public transport services for residents of the development received 25 responses. Other measures suggested in the survey, such as bike or car sharing schemes, received fewer responses. Nineteen respondents stated that their organisation is not involved in the planning or design stages where integrated land use and transport planning could be more fully considered. Some respondents suggested that an increasing awareness for the opportunities for end-of-trip mobility, and for electric vehicle charging provisions, was emerging. While these seem to be currently mostly small-scale, these issues will likely require more attention by professionals involved in the design and planning of residential neighbourhoods in future as demand scales up. There would clearly be value in considering such facilities at the neighbourhood scale. Although the usually generous statutory car parking provisions for residential and commercial developments in Australia are increasingly acknowledged as an effective barrier to sustainable mobility concepts, very few respondents mentioned their ambition to constrain on-site car parking.

In terms of the provision of green (vegetation) and blue (water) infrastructures in the planning and design of residential neighbourhoods, 32 (of 58) respondents stated that their organisation is involved in the planning and design of neighbourhood public and communal green spaces. Frequently mentioned as typical approaches were site design (such as passive solar gain through orientation of buildings) (27 responses) and tree selection and planting (27 responses). Passive cooling (such as site design to ensure airflow and cooling) was listed by 24 respondents as focus in their organisation's work. The survey responses suggest that the provision of artificial water bodies (19 responses) and nature development (optimising biodiversity and associate ecosystems) (19 responses) are not currently receiving much attention, despite the potentials of planning such features at the neighbourhood scale . Water sensitive urban design (WSUD), as part of road upgrades, was also mentioned in the open comments section. Eighteen respondents stated that they are not involved in the planning or design of green and blue infrastructures.

2.2.3 Applying CE principles for development location and for construction materials

There are many ways in which CE principles can be applied in a neighbourhood scale residential development (see Appendix 1). Respondents were asked about their approaches to the protection of non-renewable and scarce resources, and to the reuse, recycling or remanufacture of construction materials. Out of 53 responses to the question of whether the respondents' organisations prioritise brownfield or greyfield development over greenfield development, 31 respondents stated that their organisation is not involved in the selection of land for development. The main reasons given were land availability, weak government policies (including in relation to coordination of policies between different states and territories), and lack of restrictions on greenfield development or (conversely) a lack of incentives to develop brownfield or greyfield sites. The following quote from the open survey responses illustrate an almost fatalistic perspective by some respondents on the disadvantage of relying on market forces for determining the choice of land for development:

> … we will buy land wherever there is demand. Greenfield has massive demand in Australia and is not going to end anytime in the future - even if Sydney or Melbourne or Brisbane stop greenfield, the next biggest town/city will be developing greenfield. (Developer, Queensland)

Another respondent, a planning consultant from Victoria, pointed out that 'the government does not prioritise this [i.e. brownfield or greyfield development] unlike in the UK for instance'. These responses would suggest that there is a need for stronger policy frameworks and better coordination of land release between local government areas and across states and territories if a shift towards prioritising brownfield and greyfield developments is to be achieved.

Of the remaining answers to this question, 13 respondents stated a preference of their organisations to work on brownfield developments, five on greenfield developments, and four on greyfield (infill) developments. Among the explanations given for the focus on greyfield and brownfield development were environmental reasons ('to limit the impact of urban sprawl on biodiversity', 'sustainability benefit'), but also economic reasons ('no greenfield sites available', 'locality restrictions and economic restrictions'). Locational advantages and site characteristics ('higher density and existing infrastructure') were also mentioned. Government policy and land availability play an important role in directing development to previously developed land, as the following quotes illustrate:

> [Our] organisational objective has changed to focus on renewal projects rather than greenfield development in response to government policy (State government department, Victoria)

> I work for an inner city LGA so all of our land is grey/infill and we prioritise within that to align with metro planning policy preference for infill around train stations and activity centres (Local government planner, WA).

However, respondents especially from planning or architecture consultancy firms also noted that they are not involved in land decisions, but rather prepare plans and design dwellings for land that was already purchased by their clients.

In response to whether the respondent's organisation reuses or encourages the reuse of construction materials or whole structures in residential developments, 25 respondents (of 53 responses to this question) stated that their organisation does not typically use previously used materials, products or structures. Twenty respondents said that their organisation uses previously used bricks, and 20 stated that their organisation uses existing building shells whenever possible. There appears less attention to the reuse of other materials or products, such as timber (with 18 respondents stating they reuse timber) and entire doors or windows (10 responses).

Respondents mentioned other reused materials they typically source, but also pointed out challenges of integrating reclaimed materials in construction:

> We have salvaged steel and tried to encourage its reuse on-site, but this failed (frustratingly) due to engineering design and cost barriers. (Developer, SA)

However, in the absence of government regulation or incentives to reuse construction materials, (local) politicians currently have a potentially important role in encouraging the re-use of materials and products, either directly or through demanding sustainability accreditation:

> We encourage reuse of parts of buildings… Also we sometimes encourage / require Green Star which then triggers the materials credits and rewards (for) re-use. (Councillor, NSW)

Overall, however, reusing construction materials or products does not seem widely practiced, neither as a whole nor as aggregates. Twenty-one (of 52 respondents) answered 'no' to the question of whether the respondent's organisation incorporates, or encourages the incorporation of, recycled materials as part of new building materials. Of the respondents who stated that some recycled materials are used by their organisation, most commonly this was by as recycled aggregate in concrete (19, of 52 responses) for use as road base and surfacing. Responses suggest that an important barrier to the use of reclaimed materials are the provisions in building and planning codes.

However, respondents also pointed to examples of emerging good practices, such as:

> We require minimum percentages for demolition waste recycling (into road base etc.) and we operate a soil bank for reuse of excess site won soil as fill material (State government urban renewal authority, SA)

> [We] encourage use of tools like Ecospecifier to select materials[6] (Research consultant working with development industry and government in NSW, Victoria and Queensland)

Regarding consideration of the environmental impact of new materials, 24 respondents (of 51) stated they use sustainably certified timber, 16 respondents indicated their organisation uses sustainably certified insulation products, and 14 respondents noted that their organisation uses sustainably certified carpet. Another 24 respondents, however, answered that their organisation does not typically incorporate any sustainably certified products in new buildings. Several comments noted that respondents seek to encourage the use of re-claimed or sustainable materials but do not always succeed. This suggests that while expert input and advocacy can play a part in changing attitudes, real change will only come about with stricter policy requirements and / or industry commitments.

In response to the question of whether respondents' organisations require or encourage waste reduction actions or concepts for new developments beyond regulatory requirements, 22 (of 52) stated that this is not something their organisation is concerned with. Nineteen respondents answered that their organisation applies or encourages multi-bin construction waste management. Open responses suggest that local governments have scope to exceed current statutory requirements. For example, one local government policy maker stated that 'we req[uire] development proponents to complete our waste template which asks them to describe how wastes will be dealt with / recovered etc'.

Based on the survey responses, the incorporation of modular (pre-prepared) construction techniques or systems in new developments also appears to receive limited attention. Twenty-eight respondents (of 50) stated that their organisation does not incorporate modular units in creating new buildings. Sixteen respondents answered that their organisation uses modular (prefabricated) wall systems, and fifteen indicated that their organisation uses or has used prefabricated building frames. Only one respondent, an architect, referred to the use of entire prefabricated dwellings.

2.2.4 Sustainability considerations in decision-making processes

The survey also included questions to identify the reasons for, and key drivers behind, the decisions to take environmental sustainability actions and about the organisational capacity for making these decisions.

Twenty respondents (of 50) stated that their own organisation's management is responsible for implementing environmental actions in the planning or design of new developments. Twelve respondents stated it is 'all or most staff members' who are responsible, whereas in the organisations of 11 respondents a dedicated environmental manager is in charge. Ten respondents said that nobody in their organisation is responsible for implementing sustainability actions. However, the following quotes from the open responses suggest that in some organisations staff are instrumental in reviewing organisational processes to realise for a more systematic consideration of urban sustainability:

> Senior staff generally make design decisions including sustainability related elements. A small number of staff is beginning to push further. Generally, a lack of knowledge and experience beyond typical options hampers maximising opportunity. (Private sector architect, NSW)

> [Our organisation] has recently formed a Sustainability Committee selected from volunteers across the organisation to consider, develop, implement and innovate sustainability initiatives into our policies, developments and projects. (State government urban renewal authority, SA)

6 Ecospecifier is a database of sustainability products and materials (http://www.ecospecifier.com.au/)

In response to the question of whether staff members of the respondent's organisation received specific training in relation to the planning or design of sustainable neighbourhoods, 15 (of 48) responded that this has not been the case. Twenty-one respondents referred to tertiary qualifications, and 17 respondents listed industry-developed environmental training (such as HIA GreenSmart accreditation). Ongoing professional development by peak bodies (such as the Planning Institute of Australia) was listed as relevant in the comments. However, as one state government agency respondent noted, generally additional training 'is the individual's' responsibility not an agency led initiative'.

When asked why the respondent's organisation includes environmental actions in new developments, 30 (of 50) said that this was to meet the requirements of planning or building regulatory schemes. Some examples were provided of government agencies pushing for higher standards. For example:

> … in NSW BASIX sets the … energy water and thermal shell requirements – but we often negotiate above the minimum for larger developments – and we are driven to do this by our organisation's adopted environmental targets. (Councillor, NSW)

Only twenty-two respondents stated that environmental action was taken in response to the (perceived or expressed) wishes of the end-user. In the open responses, several respondents stated moral reasons for pushing for higher standards ('to do the right thing!!'; 'It's ethically responsible'), and a desire to set an example for what is possible ('To lead the development industry to more sustainable practices'; 'To be an exemplar of sustainability practice in the development industry').

2.2.5 How sustainability at the neighbourhood scale is quantified

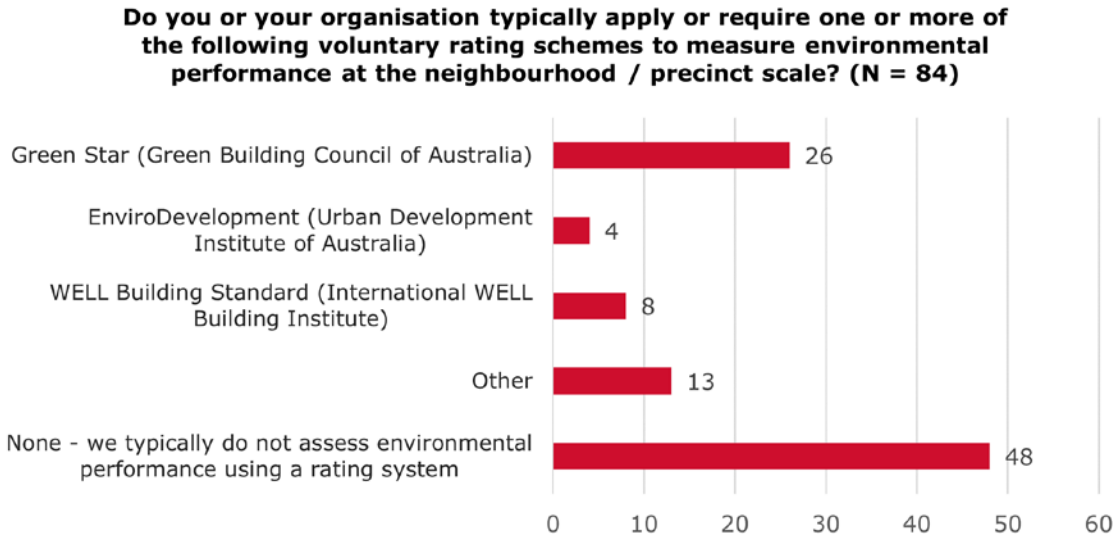
Of 84 respondents to a question on their use of voluntary tools, 48 indicated that they do not assess environmental performance at the neighbourhood scale using a rating system (Figure 1). Twenty-six respondents stated that they use the GBCA's Green Star Communities rating system, which may indicate a greater awareness of the Green Star system compared with other neighbourhood-scale rating tools. The international 'One Planet Living Framework'[7] was mentioned in some open responses. However, other open responses indicate confusion among respondents about the purpose, scope, and scale of rating tools, with listings under 'other rating schemes' referring to NatHERS, National Australian Built Environment Rating System (NABERS) or Passivhaus standard that all focus on individual building performance but do not including neighbourhood criteria.

Only thirty-four respondents answered the question of who is responsible for applying any voluntary neighbourhood-scale rating schemes in their organisation. Of these, 18 indicated that this assessment is undertaken by external contractors and 17 stated that it is done by someone within their organisation. On the question of the target audience for these rating schemes, 23 respondents (out of 32) stated that this was the end-user or customer. The information was commonly used in marketing, particularly for developments funded by government to communicate how they incorporate sustainability principles. Eleven respondents stated that the target audience was organisation owners or managers, and 10 respondents said that the information was aimed at government or regulatory agencies. Only one respondent stated that the use of such tools was included as requirement of tendering conditions. These responses suggest that unless neighbourhood-scale rating tools are explicitly required by government agencies or clients their use remains limited in urban planning and development processes.

7 https://www.bioregional.com/resources/one-planet-living-principles

Opinions were divided on the value of rating schemes to measuring and comparing the environmental performance of a neighbourhood development if their use is voluntary. Seventeen respondents (of 32) deemed voluntary rating tools useful, but 12 were of the opposite view. In the open comments, several respondents made a strong case for mandating the use of such tools to ensure their wide application and consequently also provide greater transparency about the sustainability performance of neighbourhood developments. For example, a private sector architect from NSW noted that while they consider the use of such tools useful, 'the appetite to excel is limited and sporadic. The higher end ratings are only sought when made mandatory'. A state government policy maker from Victoria responded that 'mandatory programs are generally more effective as this avoids developers selecting the approach that is easiest for them'. However, the answers received also show that the focus of both policy and the construction industry is overwhelmingly on individual dwelling quality and performance. There appears to be considerable confusion among professionals about the purpose and scale of different sustainability rating systems. Moreover, the limited responses to these questions in the survey suggest that the opportunities for sustainability at a larger scale may not be receiving much attention in planning and development processes.

Figure 1: Survey responses about use of voluntary rating schemes to measure environmental performance at the neighbourhood scale



Source: Authors

2.2.6 Enhancing social sustainability through mixed use neighbourhoods and a mix of dwelling types

At the neighbourhood scale, there are opportunities to increase social sustainability through a mix of land uses and different dwelling types. Survey questions focussed on understanding how the respondent's organisation approaches the selection or construction of building types and facilities in a single neighbourhood, and whether approaches are taken with a view to strengthening social sustainability.

Respondents stated that in typical neighbourhood developments, their organisations usually provide family homes with backyards (29 of 50 respondents), multi-unit apartments and designated 'affordable' homes (24 responses each), or courtyard homes (23 responses). Nineteen respondents also listed designated social or public housing. Most respondents indicated that their organisation typically provides two or more of these dwelling types. Three of the respondents also referred to other housing types, such as student housing, eco-villages, or collaborative housing.

In response to the question which community facilities the respondent's organisation includes in a typical neighbourhood development, 24 respondents (of 50 responses) stated that their organisation provides children's play areas, followed by sporting fields (21 responses). Other facilities mentioned were community cooking provisions (19 responses) and community gardens (16 responses). Nineteen respondents stated that their organisation is not involved in the planning or design of community facilities in neighbourhood developments. Public open spaces and green spaces were mentioned by several respondents in the open comments as important features of neighbourhood developments. Some of the respondents' organisations also provide social infrastructures (such as child care) and education facilities (such as a library), sometimes in a 'community hub' setting that offers multiple facilities in the same location. Overall, however, the small number of responses suggests that more consideration could be given by those involved in the planning and design of residential developments to strengthen social sustainability and support community-building.

2.2.7 Innovation, cost and scale

An urban sustainability transition will require innovations, including in relation to achieving resource efficiencies through the scale of a neighbourhood. At the same time, the costs for realising higher sustainability standards can be an important consideration for housing developers if such action is voluntary. In the final section of the survey, open questions invited participants to document additional actions and innovations undertaken by their organisation to realise sustainable housing developments .

Examples were provided of local governments inserting specific clauses in the local planning policy framework that require developers to deliver above-minimum outcomes. Initiatives for coordination between local councils and platforms to share good practices were also mentioned.

Several comments were made about how the potential for 'sustainability innovation' is influenced by the geographical or economic situation of a locality, and on the role that attitudes of local councillors and end-users plays in achieving sustainability outcomes:

> [There are] very few [opportunities/innovations] as the increased cost of building in a regional cyclone prone area with a harsh climate is a significant barrier. (Local government sustainability officer, WA)

> The organisation would like to undertake more environmental sustainability innovations in the delivery of infrastructure to neighbourhoods such as in road works. These opportunities are usually constrained by local government's acceptance of innovation (Developer, Victoria)

> … we are looking to only provide what a customer wants, and customers do not value environmental elements unless it saves them money or effort (which generally the evidence does not support). (Developer, Queensland)

Such responses emphasise the need for higher regulatory requirements for both the quality of housing as such, and for sustainability considerations at the neighbourhood scale. These regulatory requirements would improve standards across Australia, independent of geographical, economic and local political context.

Surprisingly, given the increasing international acknowledgement of the importance of working with the community to create sustainable neighbourhoods, only one of the responses referred to the importance of community engagement in supporting an urban sustainability transition, through 'early engagement and activation e.g. temporary community hub/café' (State government policy maker, WA). Other respondents primarily referred to technical solutions that their organisations had implemented, such as examples of decentralised water infrastructure and district energy schemes.

The survey also included a question on approaches taken by the respondent's organisation to address the environmental sustainability of a neighbourhood versus that of a single building. Responses indicate that organisations are aware of the opportunities that the neighbourhood scale offers in relation to site orientation and design, access to green spaces, tree canopy cover, energy micro-grids, and sustainable mobility concepts. Responses also indicated an awareness that realising these at the neighbourhood scale would deliver improved outcomes for individual dwellings. However, respondents highlighted several barriers to realising sustainable housing at a neighbourhood scale resulting from existing policy frameworks that prioritise the building scale and as a consequence of land ownership structures:

> The design of a precinct should be undertaken with more care and consideration as it has a greater impact. The regulatory system however has minimal influence over precinct scale development compared to building scale development which is governed by Building Code requirements. (State government, SA)

> When delivering neighbourhood developments, we focus on the environment sustainability initiatives at the neighbourhood level as we focus on the sale of land lots. But in these developments, we do include design standards as a condition of sale and the design standards do require environmental sustainability measures to be incorporated into the dwelling build. It is a balance between affordability in construction pricing and sustainability. (State government, Victoria)

> The larger scale of a neighbourhood allows larger scale innovations - such as the benefit [load balancing through a mix of residential and commercial uses]. Storage on-site can also be sold into the market at summer peak times which results in cost savings to end users over the whole cycle. [Our organisation has the opportunity] to do these things at scale as we have master developer role and unitary ownership of relatively significant land holdings as opposed to piecemeal infill parcels. (State government urban renewal authority, SA)

In response to the question on how important additional marginal cost is to the respondent's organisation in relation to environmental performance of new developments, of 41 responses the majority said it was 'very important' or 'important'. Overcoming this would, according to some respondents, require improved regulation to mandate better outcomes and more ambitious government targets. Indeed, evidence from the EU shows that stricter regulatory requirements will in the medium- to longer-term also result in cost reductions for higher performing construction products and materials once these become the new standard.

Additional responses included concern over the diminishing role of local government in urban and regional planning in many Australian states following recent major policy reforms. Several respondents emphasised that this government tier has a central role in negotiating development outcomes that meet the requirements of their communities. Respondents also mentioned some examples of the pioneering role of local government, such as through CASBE, in requiring higher standards in the context of weak federal and state policy frameworks on sustainability.

Survey respondents also made suggestions on how planning practice could be improved. Transparency in relation to the sustainability criteria expected for residential developments, supported by suitable benchmarks or other tools, could help with the preparation and assessment of development applications. Respondents also mentioned the need for industry training and education, and the value of providing information on precedents and good practices to 'bring developers onboard'. Participants further identified a need to educate local and state and territory government politicians about the opportunities presented by sustainability and CE, and how to apply these concepts to decisions affecting the built environment.

2.3 Summary of key findings and policy implications

A diverse range of built environment professionals from across Australia completed the survey. Although the timing of COVID-19 related industry shutdowns and restrictions reduced the number of responses, the qualitative analysis of the survey responses allows useful insights into a cross section of the sector.

In general, sustainability and CE concepts were positively appreciated by the respondents. There is awareness of the opportunities that the neighbourhood scale offers and that realising sustainability outcomes at this scale (such as through overall site design, decentralised systems of production and consumption, and the social dimensions of sustainability) would also contribute to improved housing. However, built environment professionals and their organisations experience a wide range of limiting factors in realising sustainable housing at the neighbourhood scale. The barriers most commonly stated were:

- policy frameworks that perpetuate low standards and prevent both the consideration of a more holistic perspective of sustainability and the scalar opportunities afforded by planning at the neighbourhood (rather than individual building) scale;
- land ownership structures (especially in greyfield locations);
- costs/economics of realising higher standards; and
- a lack of sufficient technical expertise among key actors and sectors as well as limited opportunities for professionals to combine their expertise in shaping development outcomes.

There are currently weak mechanisms for realising sustainable neighbourhoods in Australia, with a dominant focus of planning and development processes on individual building sites that imply limited scope to consider wider effects of the development. Sustainability is given insufficient attention in urban development processes due to weak statutory underpinnings and an often merely selective focus on specific aspects. Partly, this is because of fragmented responsibilities in realising housing developments, with planners and architects rarely involved in land acquisition or subdivision decisions and thus limited possibilities for discussions on passive design options. Large-scale (urban renewal) developments, often driven by state governments, offer more opportunities to realise scalar benefits for sustainability from site orientation, planning for community facilities, and neighbourhood-scale networks. However, the survey responses suggest that also these projects face political, institutional, and budget challenges.

Despite policy emphasis on infill development, housing developments in greenfield locations are in many parts of Australia still the dominant model. The survey responses suggest that there is a need for stronger policy frameworks that prioritise previously used land over access to greenfield sites. Arguments were also made for the need for a better coordination of conditions on land release between local government areas and across states and territories to prevent a 'race to the bottom', with developers moving from higher regulation councils to neighbouring jurisdictions with easier access to greenfield land.

While mechanisms to realise sustainability at the neighbourhood scale are weak, many survey respondents also expressed disappointment at the low regulatory standards for building performance in Australia compared to other developed nations. The current requirements are seen to prevent industry innovation and as presenting considerable challenges for local governments trying to negotiate higher standards in planning and development processes. Some examples were provided of local governments inserting specific clauses in the local planning policy framework that require developers to deliver above-minimum outcomes, but such practices remain exceptions. The possibilities for raising standards locally are likely considerably influenced by the municipality's desirability as a development location. On the other hand, some respondents expressed concern also about the lack of local government support for development proposals that attempt to go beyond individual building sustainability and/or those that experience roadblocks to a more holistic consideration of urban sustainability in statutory planning processes. This points to the importance of attitudes of local councillors, statutory planners, and end-users in influencing the sustainability outcomes of development projects.

There is currently also limited attention to re-using materials in construction. Examples provided mostly focussed on down-cycling (such as the use of aggregate in concrete), while the use of entire building structures seems to be even more limited. Comments suggest that several respondents seek to encourage the use of re-claimed or sustainable materials but are presented with regulatory or practical challenges. This points to the need for stricter policy requirements and/or industry commitments to ensure that circular practices in construction can become more mainstream.

Overall, the survey responses make a strong case for higher regulatory requirements across Australia to lift standards independent of geographical, economic, and local political context on building performance. Moreover, many missed opportunities result from the weak frameworks for neighbourhood-scale planning. This results in missed opportunities for comprehensively considering integrated transport and land use planning at this scale and for strengthening of community building and social sustainability. Responses identified the important role of state and local governments in mandating or encouraging sustainable urban development not only through stricter regulation for building performance but also stronger policy frameworks for neighbourhood-scale planning and design of housing projects.

The implementation of (more ambitious) government policies on sustainable housing at a neighbourhood scale would need to be supported by targets and suitable tools able to measure achievements (including post-occupancy). Many respondents called for mandatory over voluntary targets and coordinated policies and systems. This indicates a realisation by many professionals in Australia that sustainability improvements in the construction industry will not materialise by chance but will require a strong steering from governments at all levels. Currently, the use of neighbourhood-scale sustainability rating tools is voluntary and while the survey responses suggest that there is some general awareness of these tools, they are not widely used. The responses also suggested considerable confusion over their scope and scale of application vis-à-vis (mandatory) building-scale performance rating tools. There would be arguments for mandating the use of neighbourhood-scale sustainability assessments, as they could be a central tool to guide decisions on plans, designs, and development applications and to measure compliance.

Stricter regulation may need to be supported by other policy instruments, especially ones aimed at overcoming the perception that higher environmental standards will have higher costs. Some respondents argued that concern over additional costs and delays presents major barriers for industry to realising higher standards and trialling innovation. A related challenge perceived by respondents is of an end-user market that does not sufficiently value sustainability over cost. To support industry transition, stricter regulation could therefore be supported by demonstrating how incorporating CE actions in the creation of neighbourhood scale urban developments can lead to cost savings. There might also be an argument for offering (time-limited) government subsidies to increase market uptake of certain products or approaches that are important to urban sustainability. The limitations reported in the survey suggest that the complexity of realising sustainable housing at a neighbourhood scale requires new governance approaches. This includes the need for new partnerships between public and private sector actors (and the professions involved in planning, designing, and building housing at this scale), and better coordination of planning policies and building regulations across administrative borders and across scales.

A comprehensive consideration of sustainability and CE approaches in planning and development processes requires relevant expertise across all built environment professions and among federal, state, and local policy makers. The survey responses suggest that more attention is needed to ensure sufficient capacity and knowledge on urban sustainability and how to achieve it, especially within government organisations. Some respondents argued that staff can play an important role in increasing attention for sustainability within an organisation. However, dedicated training on CE or sustainability is usually left to the initiative of employees rather than being an integral requirement of the organisation's professional development program Participants further identified a need to educate local and state government politicians about the opportunities of the concepts of sustainability and CE and how to apply them to decisions affecting the built environment. More knowledge and capacity on urban sustainability of key actors in statutory planning and development processes will be important to achieve policy change and a culture shift towards striving for higher standards.

3. Case studies of Australian and European eco-neighbourhood developments

- **While there are now many examples of eco-neighbourhoods, such initiatives remain niche experiments with knowledge rarely mainstreamed into planning and development processes.**
- **Ten case studies of eco-neighbourhoods from Australia and five from Europe were analysed. These eco-neighbourhoods are government or developer-driven good practice examples in urban brownfield or greenfield settings. Eco-neighbourhood developments in urban infill locations are rare.**
- **There is interest by a growing number of actors to change the status quo of housing developments, but realising sustainable neighbourhoods continues to face numerous challenges.**
- **There are lessons for Australia from the European cases about the value of comprehensively defining and operationalising sustainability and CE for residential developments to support shared ownership and ensure that outcomes can be measured.**
- **Australian cases focus on the building scale, with the potential of the neighbourhood scale underused.**
- **Stronger regulation on building performance and policy frameworks for neighbourhood-scale developments are needed for an urban sustainability transition.**

3.1 Drivers and challenges for realising eco-neighbourhoods: previous research on actors, policies and institutional dynamics

There are numerous examples of eco-neighbourhoods of varying size around the world that place sustainability ambitions (variously defined) at their core. Eco-neighbourhood developments can be prompted by different concerns, such as housing affordability, an interest to reduce the ecological footprint of urbanisation, or social drivers of community living.

Some eco-neighbourhoods are co-housing developments, that is, locally organised housing development models driven by a 'group of individuals acting together on the basis of a shared interest' (Crabtree 2018: 18). These can take various forms but are often led by a developer who gathers demand for the project, secures a site for development and oversees planning and design. Conceived in 1999, Christie Walk (SA) was one of the first community-driven inner-urban developments in Australia (Cooper and Baer 2019). State government-driven 'demonstration projects' such as Newington in Sydney (conceived in the mid 1990s) or White Gum Valley (WGV) in Fremantle (conceived in the 2010s) are often intended to inform industry practices. However, there is limited evidence that such pilots have prompted systematic learning processes in the property industry or become mainstream into planning policy and development processes.

Since urban and regional planning is the responsibility of state and territory governments in Australia, CE neighbourhoods are planned and developed under jurisdictional policy and regulatory frameworks or directly driven by the respective government land management agencies. Projects such as Lochiel Park (SA) or WGV (WA) that were led by the relevant state government land management departments to some degree allowed for these developments to be realised outside 'normal' development processes. They are usually supported by Design Guidelines for the entire neighbourhood, based on which private sector developers were invited to tender for the realisation of all or specific parts of the project (Berry, Davidson et al. 2013; Wiktorowicz, Babaeff et al. 2018). On the other hand, eco-neighbourhoods that are developed by intentional communities (Cooper and Baer 2019) of private parties are usually faced with many challenges. This is because they are seen as higher risk for local governments and lending institutions (Newton, Newman et al. 2022).

3.2 Findings from the case studies of eco-neighbourhoods in Australia and Europe

3.2.1 Introduction

In this section, the findings from 10 Australian and five European case studies of 'eco-neighbourhoods' are presented. The analysis of each of the case studies is presented below, with each outlining the project, vision for sustainability/circularity and main drivers and challenges. Following this, conclusions across the 15 projects are drawn out.

3.2.2 Case study: Bowden (SA)

Project description

The Bowden Urban Village project is located on a previously privately owned inner-urban brownfield site of 16 hectares, located 2.5 kilometres from Adelaide CBD. It is adjacent to parklands and well connected by public transport. The state government purchased the first tranche of land in 2008 and an adjacent site in 2010 to create SA's first higher density urban redevelopment project as a sustainable demonstration project. When completed (expected 2027), the project will be a mixed-use development with approximately 2,400 dwellings at a minimum of 160 dwellings per hectare, in addition to retail outlets and commercial offices around a town centre (Renewal SA 2016a). Several heritage buildings on the site are maintained and will be renovated or reused.

Vision for the sustainable or circular neighbourhood

The state government land development agency, Renewal SA, oversees the project and the vision is to enable 'a creative and diverse community, living and working in a high density sustainable urban environment' and to 'offer a new and distinctive place in Adelaide for residents and visitors' (Renewal SA 2016a). The definition of sustainability focuses on Bowden becoming a walkable neighbourhood with good public transport access; energy efficient site design including orientation of buildings to maximise natural sunlight and cross-ventilation; and the construction of buildings that incorporate principles of environmentally sustainable design for energy efficiency, renewable energy use and water management (including connection to the precinct-scale recycled water system) (Renewal SA 2016a). There is emphasis on a diversity of dwelling types, and on providing at least 15 per cent affordable housing for purchase and/or rent.

Main drivers and challenges

The Bowden redevelopment is guided by the metropolitan planning strategy, '30-Year Plan for Greater Adelaide' (SA Government 2010). This plan promoted higher density developments along major transport routes. A master plan drawn up for the site described: what commercial developers can build (and where); the style of construction; the materials to be used; and the GBCA's Green Star Communities environmental rating tool performance targets. The overall Bowden development is certified as a six Green Star—Community rating, in addition to each separate building achieving the required minimum five Green Star rating (Renewal SA 2016b). The Green Star system was chosen to ensure that environmental and social sustainability issues are considered for the entire project rather than focusing on the performance of individual buildings only. A Developer's Handbook and Urban Design Guidelines further detail the requirements and are binding to commercial developers (Renewal SA 2016a). All development proposals are reviewed by an independent 'Bowden Design Review Panel' to ensure the designs meet the Guidelines.

Some developers have voluntarily exceeded the minimum requirements stipulated. For example, the Prince's Terrace Adelaide project (a collaboration between Defence Housing Australia and the UK Prince of Wales Foundation) is the first residential project in SA to receive a six Green Star design rating from the GBCA. This project is estimated to use 50 per cent less energy and potable water than a typical townhouse development. The Nightingale project at Bowden seeks a minimum of 7.5 star NatHERS for thermal comfort for each apartment, with some apartments designed to achieve 8.7 stars.

Independent monitoring of performance targets (incl. post-occupancy) is not foreseen. It is therefore difficult to assess whether all expectations are being met, and whether the development will foster more sustainable lifestyles for its residents.

3.2.3 Case study: Lochiel Park (SA)

Project description

In 2001, the Land Management Corporation (LMC, later rebranded Renewal SA), an agency of the SA Government responsible for residential, commercial and industrial development, purchased 15 hectares of surplus government land at Lochiel Park (Land Management Corporation 2005). Zoned for residential development, the land is located adjacent to the River Torrens and approximately 8 kilometres north-east of the Adelaide central business district. Initially foreseen for traditional housing development, the new state government decided in 2003 that Lochiel Park should become a model Green Village of national significance, with near zero energy homes in a near net zero carbon impact estate. This included limiting development to 4.25 hectares and the remaining land to be open space with an urban forest and wetlands (Donaldson, Bishop et al. 2008). The construction of houses began in 2008, and by 2019 all 106 dwellings were completed.

Vision for the sustainable or circular neighbourhood

The construction was undertaken by only two companies, selected for their experience in sustainable building. A key aspect to the design of Lochiel Park was the use of physical and social infrastructure within a framework of a village to promote community interaction and create a sense of place and belonging. Thus, the estate is surrounded by green spaces and features a central 'square' for communal gathering. The estate also includes a large community garden that is managed by the village residents through a recognised community representative organisation.

Urban Design Guidelines were adopted for the project, against which the LMC assessed building and landscaping designs for compliance before granting development approval. The emphasis of Lochiel Park is on achieving net zero carbon impact. An extensive monitoring program was established at building and estate level to ensure Lochiel Park was performing as expected.

Main drivers and barriers

High-level political leadership facilitated the project and delivery. The explicit direction from then State Premier Mike Rann to develop a niche urban development of world standing was approached by establishing an Advisory Panel of state and local government officials and community representatives. The Panel was tasked with defining the project objectives and development guidelines (Donaldson, Bishop et al. 2008; Land Management Corporation 2005). The focus was not only on realising an ecologically sustainable urban design, but also better housing choices, enhanced biodiversity, a financial return to the state, and the reduction of energy, water, and waste related impacts.

The master planning process was coordinated by the LMC and facilitated by a supportive local council. The design and construction requirements for Lochiel Park were published as Urban Design Guidelines (Land Management Corporation 2009). These Guidelines specified mandatory actions and additional advisory recommendations for developers to achieve the stated environmental and social sustainability objectives. These requirements exceeded existing planning and construction codes.

The Guidelines were comprehensive at the time of their adoption, but despite political support not all objectives for sustainability could be achieved. For example, the circulation of recycled water from the aquifer was delayed due to technology problems and contractual disputes. The builders chose not to use recycled bricks for structural elements of the homes due to technical and cost barriers. Moreover, industry push back resulted in the original eight star NatHERS target for building thermal efficiency in the Urban Design Guidelines to be revised to a 7.5 star target. Industry practitioners involved with Lochiel Park noted that although there was significant learning within building companies and sub-contractors due to the higher performance specifications of the homes, in the absence of adjusted planning and building regulations, their practices subsequently reverted to the mandated (low) standards (Berry, Davidson et al. 2013).

3.2.4 Case study: Nightingale Village (VIC)

Project description

The Nightingale Village development is located in Brunswick, a suburb of the City of Merri-bek in the Greater Melbourne metropolitan region. The project is sited 200m from the key activity centre of Sydney Road, 250m from the Anstey railway station, and 5 kilometres north of Melbourne's CBD. There are six buildings of up to eight storeys within the village (ParkLife, Evergreen, Skye House, CRT+YRD, Leftfield, Urban Coup). Each building was designed by a different award-winning architect using the guiding principles of the Nightingale model (Nightingale Housing 2022a; Nightingale Housing 2022b). The total site is 4,500 square meters (Perinotto 2017) and will deliver 206 apartments across the six buildings (27–42 apartments per building) (Nightingale Housing 2022a). There is non-residential space located across the lower levels of many of the buildings. Part of the site for a 7th building was bought by the local council to create a new park to provide access to open space.

The land was purchased in 2016 by Nightingale Housing, with construction completed in 2022. Nightingale Housing is a not-for-profit organisation that according to their website builds 'apartments that are socially, financially and environmentally sustainable' (Nightingale n.d.). The Nightingale Housing model places emphasis on sustainability and affordability of housing located close to public transport and public facilities, and seeks to contribute to the strengthening of local communities. The model currently has more than 15 projects either completed or under construction (Nightingale Housing 2022b).

Nightingale Village is a progression of previous developments under the Nightingale Housing model (Doyon and Moore 2019; Moore and Doyon 2018). Previous developments were individual buildings, and the 'Village' scales up these earlier approaches and practices (Simple Dwelling 2020). Nightingale Village was informed by two previous developments—The Commons and Nightingale 1—which are located across the road from each other. This proximity allowed for the creation of a mini precinct that can offer wider benefits than were possible by just focusing on individual buildings (Thomas 2017).

Vision for the sustainable or circular neighbourhood

Nightingale Village does not have a definition for a CE or sustainable neighbourhood. Instead, it starts with the guiding principles of Nightingale Housing and looks to implement them in each building but also find opportunities to enhance these across the site. The guiding principles are: build less, give more; simply sustainable; carbon neutral; sustainable transport; comfortable, energy-efficient homes; healthy homes and gardens; and reduced cost of living (Nightingale Housing 2022a). Nightingale has a set price for apartments with a balloting system to purchase. A covenant on the property means it can only be re-sold for the average price rise of similar properties in the area to retain affordability. There is emphasis on shared facilities, such as laundries and rooftop gardens. In Nightingale Village, there are 21 social housing units (Community Housing Industry Association 2021). The development also includes micro apartments to help first home buyers enter the market.

Some sustainability efficiencies were possible at the larger scale of Nightingale Village as compared to previous projects, such as reduced car parking spaces, the provision of a car sharing scheme, shared infrastructures, and the opportunity to develop a community. A formal post-occupancy evaluation is not currently planned. However, earlier Nightingale Housing developments have been opened for tours from the public and the building industry. It is likely that a similar program will occur with Nightingale Village to encourage the sharing of knowledge.

Main drivers and barriers

The project was initiated by the Nightingale Housing core team. A number of other architects and urban consultants that had previously worked on sustainable housing developments of different scales also had a significant role in shaping the project (Thomas 2017). The local council was supportive of the ambitions. However, research participants noted that the approval process was still time-consuming and that some 'streamlining' would be beneficial to facilitate similar projects in future.

An initial Master Plan type document was prepared in conjunction with urban planners. This provided a loose framework within which individual architects operated to meet ESD requirements and stay within cost. The development planning application process included the use of the City of Merri-bek's Design Excellence Scorecard to ensure systematic consideration of certain principles and enable a smoother development assessment process. The design and construction process was set up to have peer feedback across the sites to draw on everyone's expertise (Perinotto 2017).

One of the main challenges was to secure financing. While each building has its own funding arrangements, this was all combined into one loan with the bank (at the request of the bank) and this created complexity for the development such as the need to contract only one builder. This limited the selection of builders to those with sufficient capacity and the required expertise. Other barriers related to the intent for more of the materials to be manufactured locally, which proved not possible. This was due to the scale of the project and the requirements of the selected builder who already had certain supply chain relationships. Another challenge was related to the project's inner-urban location, which—while providing many opportunities such as sustainable mobility—also

meant compromises in terms of scale. Interviewees noted that sites of sufficient size are difficult to obtain in central locations. There was also a perception that local councils are more hesitant to support projects that challenge the status quo and are more complex to realise than traditional plot-by-plot infill developments.

While Nightingale Village offers useful insights into the complexities of scaling up to the precinct scale, it also demonstrates that the focus remained on individual buildings, with limited consideration given to the in-between spaces. Several research participants noted that policy change was needed to not only lift the minimum quality and performance requirements for buildings, but also to facilitate neighbourhood-scale considerations (such as requirements for car parking spaces and sharing of other infrastructure).

3.2.5 Case study: Mullum Creek (VIC)

Project description

The Mullum Creek eco housing development is a 20 hectare site located in the suburb of Donvale (Melbourne), approximately 20 kilometre east of the Melbourne CBD (Mullum Creek 2022a). The land was purchased in 1958 by the parents of the developers (three siblings) (Mullum Creek 2022b). In 1972 the land was rezoned from rural to residential. Recognising the impact that traditional urban expansion development would have on the area, the developers' parents unsuccessfully attempted to coordinate the development of nearby properties. Their aim was to deliver a housing development that was sensitive to the local natural environment (Mullum Creek 2022b). This prompted the initiative for a sustainable residential development that would also lead the way in terms of conservation of local habitats.

Early design and planning work led to a planning application that was rejected by the local council. However, a subsequent application was approved in 2011 and the planning permit for the development granted in 2012 (Mullum Creek 2022b). Construction of stage one of the development commenced in late 2017 and the first houses were completed in 2018. The site has 56 residential lots ranging from 1,000m^2 to 3,250m^2 (Mullum Creek 2022a). Approximately 45 per cent of the land has been donated to Manningham City Council for inclusion in the local reserve system (Mullum Creek 2022c). At the time of writing, stage one was approximately 80 per cent completed and stage two was approximately 15 per cent completed.

Vision for the sustainable or circular neighbourhood

The Mullum Creek development is a reaction to surrounding unsustainable developments of large housing estates following the rezoning of the land to residential use. The Mullum Creek development was conceived to provide housing in a more sustainable way that reduces environmental impact through good design and throughout the lifecycle of the dwellings (Haar 2017; Mullum Creek 2022d). The vision for an integrated, holistic and comprehensive environmental development was also intended to showcase how things could be done differently (Mullum Creek 2022d).

The project had a long gestation period, but core ideas of the owners of the site guided decisions throughout the process and were further developed over time. These related to: conservation, landscape, good design and social responsibility (Mullum Creek 2022b; Mullum Creek 2022e). The focus for sustainability considerations is on the scale of individual buildings (including dwelling size, orientation, environmental performance), with standards much higher than minimum regulatory requirements. The site is not located near a public transport node meaning residents continue to rely on cars. There is attention to the neighbourhood scale through the protection of as much of the nature on the site as possible and the intention to create a sustainable community (Jewell 2014; Haar 2017).

Almost half of the land is dedicated to open space. The gifting of open space to the local council allowed for the extension of a linear path along the creek that is used for cycling, walking, running and other active movement, and that connects to local amenity and facilities such as schools. Water management approaches have been put in place and there are requirements for landscaping with the intent that this is a continuation and connection to the local nature reserve and complements the public reserve areas (Mullum Creek 2016a). There is emphasis on using more sustainable building materials. For example, the developers worked with a local hardware store to ensure the provision of sustainable timber for the construction (Haar 2017).

By the time more detailed planning and design for Mullum Creek was undertaken, several neighbourhood scale rating tools had been developed. The development achieved EnviroDevelopment certification[8] and was the third development to achieve this certification in Victoria (EnviroDevelopment 2022a).

Main drivers and barriers

The conception and initial design and planning of the Mullum Creek development began largely before any formal sustainability requirements within building codes or planning schemes were introduced. This meant that the initial concept for the site was developed through a knowledge gathering process and by engaging with experts. By the time the planning application was approved, minimum dwelling performance requirements had been introduced and then revised through what is now the NCC. In addition, the planning scheme had also evolved to include additional sustainability considerations.

The vision for the Mullum Creek site went significantly beyond minimum requirements of that time. To help deliver improved outcomes, the developers created a master plan that focussed on utilising the natural topography of the site and requirements for performance and aesthetics of the development. These requirements were implemented through Design Guidelines (Mullum Creek 2016a). Also, a design review panel was established. An amendment to local planning requirements on the site with a Section 173 Agreement which sets out requirements for development based on ESD principles provided the regulatory basis for the project (Mullum Creek 2016b). The focus of the Mullum Creek Design Guidelines (Mullum Creek 2016a), prepared in consultation with sustainability experts, was on lifting the minimum quality and performance of dwellings. They also included requirements for the protection and enhancement of the natural environment across the site. Each plot was provided with a Lot Plan that included site information and specific requirements for that development, including requirements resulting from the orientation and topography of the site. The lot plans also included three-dimensional envelopes in which buildings and vegetation (once of mature size) would need to be contained, to ensure protection of sunlight (at least 4 to 5 hours of winter sunlight) for each property. The Section 173 Agreement makes adherence to the higher quality and performance requirements for the development on site a mandatory condition of sales contracts. Evidence of compliance had to be submitted to the local council before planning approval for a dwelling was granted (Mullum Creek 2022f).

The support from local council for the development was variable over time, influenced by staff changes and the political composition of the council. One of the key concerns with the initial (rejected) planning application was the perceived burden that the Section 173 Agreement would create for local council. The resubmitted application was mostly unchanged except for a revision to the Section 173 Agreement process. This stipulated that the local council's involvement in implementing the Design Guidelines would be replaced with a design review committee. This committee was funded by the developer and set up to ensure that only high quality applications were submitted for council approval thus not exceeding demands on development assessment processes.

8 EnviroDevelopment is a sustainability assessment scheme for development projects. It awards certification to those developments that achieve outstanding performance across four or more defined dimensions of: Ecosystems, Waste, Energy, Materials, Water and Community (https://envirodevelopment.com.au/).

3.2.6 Case study: Cape Paterson Ecovillage (VIC)

Project description

The Cape Paterson Ecovillage project was conceived in the early 2000s following the purchase of 40 hectares of greenfield land in 2003. Construction started in 2013, with four stages of the development so far released and construction expected to be completed around 2024 (The Cape 2021). The site is located on the outskirts of Cape Paterson, a rural town approximately 120 kilometres south-east of Melbourne. When completed there will be approximately 230 detached homes, a small number of short-stay dwellings, a conference centre with a café, a community building and education centre, and a community urban farm. Approximately 50 per cent of the site will be open space (The Cape 2021; The Cape Ecovillage 2020). The project is the initiative of a private developer, who with the help of ethical investors, provided initial funding and oversees the process. The project is promoted as a demonstration that could 'break down' the perceived and real barriers of industry and housing consumers in achieving sustainability.

Vision for the sustainable or circular neighbourhood

There is no formal definition for circularity or sustainability for this project. This is said to be intentional to allow flexibility in adjusting to new knowledge and allow incorporation of emerging best practices. Instead of definitions, there is a guiding framework around maximising environmental and social sustainability, both at an individual dwelling level but also across the development. This informs, for example, considerations about the legacy of the development and the requirement for the energy efficiency of buildings. The timeframe is for the buildings' expected lifetime of around 100 years, thus rather than focus on the cost of construction the financial concerns are shifted to the running costs of households.

At the neighbourhood scale a key feature is the 50 per cent of open space (with revegetation of more than 440,000 native plants already achieved). These green spaces are for use by both the new and the existing community. The large community urban farm on-site aims to provide a range of sustainability benefits, including reducing food miles, healthier eating, opportunity for selling produce, and providing a system to compost waste products created on-site (Schulz and Condon 2020). There are opportunities for households, as well as for the wider community, to become a paid member of the urban farm allowing them to use the farm facilities to grow their own produce. Additional produce will be sold to the local community.

The main focus at The Cape is on improving the sustainability of individual dwellings. Key requirements in the Design Guidelines include a minimum of 7.5 star NatHERS building performance, at least 2.5 kilowatts of solar PV, and rainwater tanks for garden and toilet flushing (The Cape Ecovillage 2020). In comparison, the neighbourhood sustainability is not as well defined. However, there is attention to water management on-site, providing electric vehicle charging points around the community and an education centre. Efficiencies have also been achieved in the master planning stages. This includes considered lot layout to maximise natural climatic conditions and thinking about connections around and through the site to maximise non-car travel. Given the location there is limited public transport currently available and travel to and from the site still relies on car travel. Other opportunities at the neighbourhood scale are being considered, such as the future inclusion of an energy micro-grid.

Main drivers and barriers

When the project was initially conceived in the early 2000s there were few examples in Australia of sustainable housing. National minimum performance standards had not yet been introduced. Victoria implemented state requirements for minimum performance of new housing in 2004. Additionally, there were few examples of sustainable housing at a larger scale or demonstrating how and where improved sustainability could be delivered by looking beyond the scale of individual dwellings.

Given this context, a master plan was created for the site in which basic design principles were established such as maximising the passive performance of dwellings that was ahead of its time. The master plan also included considerations for how the new development would interface with the existing community, including the use of public open space and the urban farm to foster connections. The project was also shaped by a range of sustainability, housing and planning experts who helped create and guide the project from the technical, social, and planning perspectives and that informed the Design Guidelines. These have largely remained as they were initially set. They are primarily focussed on individual dwellings with minimum requirements for the design and performance of individual dwellings. However, they also offer some pointers for how the new housing would be integrated into the wider development (The Cape Ecovillage 2020). In addition to the design guide there is a requirement that housing designs undertake a design review process that is assessed by a design review panel, with construction not permitted to commence until approval of the design is given by the panel. The project director paid some architect firms to design a set of freely available house plans that complied with the minimum design and performance requirements. This was intended to help reduce market hesitancy of needing to meet the Design Guideline requirements.

Research participants emphasised that having a focus that was not on maximising financial returns was important for ensuring the integrity of the development. Despite having ethical investors, the project almost stopped several times due to financial constraints and ongoing delays. There was a 10-year period between the purchase of the land and when the first dwelling was constructed. Initially, there were issues with obtaining council support and development approval, fuelled by significant local community concern about the development. However, over time this changed due to the alignment of state government support for the project and some staff changes in the local council, with incoming officers more interested in sustainability. The local community also became more supportive of the development over time.

3.2.7 Case study: White Gum Valley (WGV) (WA)

Project description

The White Gum Valley (WGV) project is a residential development of approximately 80 dwellings on 2.13 hectares, located 20 kilometres from Perth CBD and 3 kilometres from the City of Fremantle. The site was previously home to a government-managed school that closed in 2008. The WGV project was managed by Landcorp, later renamed Development WA, on behalf of the Government of Western Australia. WGV includes 23 single dwelling lots, four larger lots for multi-dwelling units, and a Generation Y demonstration housing lot (Landcorp 2016a). The project has been designed to allow all homes to integrate passive solar design principles and other sustainability initiatives. The range of lot sizes and configurations provides opportunities for housing diversity and a range of price points, specifically to support trends towards smaller households for singles, couples and seniors. By November 2021, there were 65 dwellings completed, with mostly the larger multi-dwelling developments yet to be finalised.

Vision for the sustainable or circular neighbourhood

The WGV project is intended to have an operationally net zero carbon impact on the natural environment. Sustainability is defined using the One Planet Living framework (Bioregional Development Group 2015). The WGV's One Planet Living Action Plan establishes a range of environmental and social sustainability goals. These include actions addressing:

- energy efficiency
- thermal efficiency
- climate responsive design
- renewable energy use
- water efficiency
- bore water use

- construction and post-consumer waste reduction
- building material selection
- biodiversity management
- transport
- cultural development
- housing affordability and access
- food sourcing (Landcorp 2015).

At neighbourhood scale, there is a focus on inclusivity through a range of dwelling types, affordable housing provision and rental/ownership options, and on reducing residents' costs for energy and water (Landcorp 2016b; Wiktorowicz, Babaeff et al. 2018). Water sensitive urban design is a guiding principle. In particular, the project incorporates water efficiency requirements (according to the Australia government's Water Efficiency Labelling and Standards (WELS) scheme), plumbed rain water tanks, passively irrigated trees and landscapes, communal bore water access, landscaped infiltration basin and on-site stormwater retention system (CRC for Water Sensitive Cities 2017). WGV is also a designated Smart Waste Zone, so all construction and demolition waste on the site is managed according to the guidance provided under the Master Builders Smart Waste program. The goal is to reduce material wastage to less than 10 per cent and increase recycling recovery rates to 80 per cent or more. The neighbourhood scale of the project is further considered in the realisation of the community scale battery storage system and the peer-to-peer renewable energy-trading scheme. As the site it is not well placed for public transport, the mobility actions focus on improved walking and cycling facilities.

Main drivers and barriers

The WGV project was supported through champions both within the state government's land development agency Landcorp, and from within the Fremantle City Council, including the mayor and senior planning officials. In addition, community groups and some community leaders were outspoken about the opportunity to create a more environmentally and socially sustainable project.

The WGV project is structured within multiple policy frameworks including the City of Fremantle's Local Planning Policy 3.15 (City of Fremantle 2014), and project specific WGV Design Guidelines published by Landcorp WA (Landcorp 2015). The WGV Design Guidelines include guidance addressing energy efficiency, thermal efficiency, climate responsive design, renewable energy use, water efficiency, bore water use, construction and post-consumer waste reduction, building material selection, and biodiversity management (Landcorp 2015). Except for specific requirements for energy, thermal and water efficiency, most CE aspects were covered as guidance only rather than required conditions for approval. A design review process was set up to help achieve desired outcomes, using a LandCorp appointed WGV Estate Architect who assisted residents and their builders in meeting the design criteria.

As part of Landcorp WA's 'Innovation Through Demonstration' program, the WGV project incorporated community participation through a series of workshops at an early stage, and before detailed planning was completed. This was designed to enhance local context, develop a sense of place, and recognise community aspirations, particularly relating to affordable and sustainable housing. There was also a process for bringing together various planning-related professionals such as urban planners/designers, engineers, landscape architects and estate architects. This was to ensure collaboration and facilitate peer reviewing and mutual learning, with the view to improving outcomes in the context of the developer's overarching vision for a sustainable development.

3.2.8 Case study Witchcliffe Ecovillage (WA)

Project description

Witchcliffe Ecovillage is a privately developed community in semi-rural Western Australia, located 8 kilometres south of Margaret River, and approximately 275 kilometres south of Perth. The project is adjacent to the existing small township of Witchcliffe, and the land was previously greenfield or partly used for agriculture. The Witchcliffe Ecovillage is a joint venture project between Sustainable Settlements Pty and Perron Developments Pty Ltd. It is the culmination of their 20-year partnership, which is focussed on the design and development of small-scale, environmentally sensitive land developments (Sustainable Settlements Pty Ltd 2020a). The land was bought in 2010 with the intention to develop a model ecovillage. The total site covers 119.1 hectares, with the majority to remain undeveloped as conservation areas, dams for local water supply, and agricultural uses.

Witchcliffe Ecovillage is designed to be a village that sustains as much as possible of the residential, commercial, and recreational needs of its community on a day-to-day basis. The Masterplan is structured around a series of residential clusters with a mix of building lot sizes for small, cottage- and family-sized homes. Each cluster surrounds a community garden that includes exclusive use areas adjacent to each home for food production. A network of walking paths and cycle trails connects the clusters (Sustainable Settlements Pty Ltd 2021a). When completed, the project will comprise:

- 320 dwellings
- 11 community gardens with productive landscaping and shared amenities
- a Village Square with café, tavern, creative hub, backpacker's accommodation, childcare centre, nature playground and outdoor meeting places
- a small aged care facility
- commercial facilities for retail, hospitality, and so on
- tourism accommodation
- a playing field
- a community hall (Sustainable Settlements Pty Ltd 2020b; Sustainable Settlements Pty Ltd 2021b).

By May 2022, 22 of the homes had been completed and 39 homes were under construction. Another 25 homes were in various stages of design approval. The final 5th stage lots are to be released to the public in 2023. The whole development is expected to be completed by year 2030.

Vision for the sustainable or circular neighbourhood

Environmental sustainability is at the core of the project. The development is designed to be 100 per cent self-sufficient in renewable energy and rainwater. The built environment is expected to be carbon negative on an annual basis, as well as carbon negative over the lifetime of the buildings (expected 80-year effective life). Other ambitions include the possibility for residents to grow their own food and to create an inclusive, active, cooperative, and resilient community.

The Witchcliffe Ecovillage Structure Plan details the allowed land uses, and the related connections with adjacent road, energy and water infrastructure (Sustainable Settlements Pty Ltd 2015). The plan is complemented by specific Building Design Guidelines (Sustainable Settlements Pty Ltd 2021c) and other site-specific documents and guides (Sustainable Settlements Pty Ltd 2020b; 2020c; 2020d; 2021b; 2021d). For all lots in the Witchliffe Ecovillage, Local Development Plans have been adopted by the Augusta-Margaret River (AMR) Shire to regulate the higher provisions for energy efficiency and other sustainability considerations than regulated by the AMR Shire's Local Planning Scheme 1, State Planning Policy 7.3 *Residential Design Codes*, and the *National Construction Code Volume 2*.

To ensure that new homes in the Ecovillage are designed in accordance with the sustainability objectives, each proposed new building must undergo a series of design reviews with the Witchcliffe Ecovillage Design Team. The design approval process is described in detail in the Witchcliffe Design Review and Assessment Process document (Sustainable Settlements Pty Ltd 2020c). The Witchcliffe Ecovillage Design Team also conducts mandatory mid- and post-construction inspections to ensure that all designs meet the Building Design Guidelines. All residential buildings at Witchcliffe are subject to assessment of their thermal efficiency minimum 8.0 NatHERS and must undergo a full lifecycle carbon assessment using the eTool software.

Main drivers and barriers

The Witchcliffe Ecovillage demonstrates what can be achieved in a residential subdivision with good planning, strong environmental and social principles, sensible financial management and technological innovation. The commitment of the landowners to their original concept for the Witchcliffe Ecovillage has been key to its realisation when faced with delays and increasing costs. The goal of meeting the day-to-day needs of a small village community of about 670 residents within a development that has no net energy, water or carbon impact is a challenge. Implementation towards its realisation appears to be on track. However, with less than 100 of the 320 dwellings built or under construction it is too early to determine the overall success of the project against the target goals.

Despite the landowners' commitment to the concept of sustainability and their combined experience in land development, planning approvals and construction commencement at the Witchcliffe Ecovillage have taken over 10 years. This is due largely to the unique nature of the undertaking. Research participants reported that the local council and the State planning department were interested in the proposals in principle. However, the departure from mainstream development resulted in time-consuming development assessment processes and, ultimately, a ballooning of costs. Another important challenge was to achieve a balance between sufficient residential density that can ensure economic viability of the estate commercial services (e.g. shops) and the interest to keep open spaces for amenity reasons and to provide sufficient community land for food production.

3.2.9 Case study: Whiterock[9] (QLD)

Project description

The Whiterock development is located on a greenfield site approximately 35 kilometres from the Brisbane CBD, 15 kilometres from the Ipswich CBD and 4 kilometres east of the Ripley township. The development is surrounded by land which is likely be developed in the future and also shares its boundary with the White Rock—Spring Mountain Conservation Estate (Eco Logical Australia 2019). The border to the nature reserve was seen as an opportunity to enhance community outcomes by ensuring direct paths into local reserve trails.

In 2010, the Queensland Government declared Ripley Valley (where Whiterock is located) a 'priority urban development area' (Queensland Government 2022a). This type of area is predicted to have significant residential growth, and should allow for up to 50,000 dwellings to accommodate around 120,000 people by 2031 (Urban Land Development Authority 2011). The priority urban development area was expected to achieve improved liveability, accessibility, prosperity, functionality and connection to nature (Urban Land Development Authority 2011).

The site for Whiterock was acquired by the developer in 2016 who immediately involved an urban design consultant to shape the concept. This was followed by engagement with the local council in 2017. Due to the size and complexity of the development, council approvals were sought in different stages, with approval for the change in use (context plan) achieved in 2019. The approval is for approximately 2,300 dwellings and a neighbourhood core that will include a school, sportsground, community centre, commercial space, retail and restaurants (Intrapac Property 2022a). The whole development has a 12-year construction timeframe, meaning the site should be completed by about 2032.

9 Note the development is spelt Whiterock but it is located next to White Rock (with a space) conservation area.

Vision for the sustainable or circular neighbourhood

There is no formal definition of CE or sustainable development provided for this project, but the understanding as presented by the developer is that of realising a liveable and resilient community. The topography and natural features of the site prompted the concept of multiple connected precincts that enable active lifestyles and social interaction. Broader sustainability at the individual dwelling level and across the neighbourhood was also established through achieving EnviroDevelopment certification.

The sustainability features of the development focus on:

- the protection of the natural ecosystem
- a requirement for all dwellings to achieve a minimum seven star NatHERS rating
- measures to maximise passive solar design elements
- a requirement for dwellings to meet key water efficiency and WELS-rating targets, and a rainwater harvesting pond within the central park to collect stormwater runoff
- the setting of high targets for recycling and reuse of materials during construction to reduce waste to landfill
- the use of recycled aggregates in road construction and seeking to source materials from responsible and sustainable supply chains
- the goal to create a socially sustainable community with access to good levels of amenity (Intrapac Property 2022b).

Main drivers and barriers

The developer created a master plan for the staged development (MacroPlan Dimasi 2021). The master plan and requirements for individual buildings aim to exceed minimum regulatory requirements and build upon previous developments. Design Guidelines are used, which set minimum design and performance requirements for individual dwellings. To ensure these guidelines are met, each dwelling and landscape plan must be submitted to a Design Assessment Panel. The plans are assessed by an experienced and qualified building certifier and are a legally binding part of the buyer's contract (Intrapac Property 2021).

Early discussions with the local council and the community were, according to research participants, helpful in ensuring a smooth planning process. However, some concessions had to be made by the developer to gain approval. These concessions included the number of car parking spaces and the use of recycled materials in infrastructure for which durability (and therefore maintenance requirements) was not yet established. The master plan established the key objectives for the site, but their realisation met some challenges due to the site's unique characteristics of creek lines and dispersive soils.

The developer has a long history of delivering developments that go beyond minimum planning and building regulations. The process of acquiring EnviroDevelopment certification for the Whiterock development was reported as smooth by the research participants, mostly because of the developer's previous experience with the scheme (EnviroDevelopment 2022b).

3.2.10 Case study: Carseldine Village (QLD)

Project description

Carseldine Village is being developed by Economic Development Queensland (EDQ), a Queensland Government agency. The site covers 15.7 hectares (WCG 2022) and is located on the former Queensland University of Technology campus at Carseldine, 16 kilometres by road or 30 minutes by train to Brisbane CBD. The site is in proximity to retail, restaurants, schools and healthcare facilities (Carseldine Village 2022). The development currently has approval for 606 dwellings, of which 330 are apartments. The site will also contain small-scale commercial and retail spaces and a five Green Star aged care facility (150-bed accommodation). The site is located within the Fitzgibbon Priority Development Area that was established by the Queensland Government in 2008 (Queensland Government 2022b;

Queensland Government 2022c). Priority Development Areas were defined to help provide housing for a growing population in areas that can accommodate increased growth, and can provide local amenity alongside the housing growth.

There will be more than 20 hectares of green and open space and extensive vegetation rehabilitation to the site (Queensland Government 2022d). All homes have been designed to be within close access to public transport. A sports centre and a 'vibrant village heart' are key features of the development. Existing facilities include the Government Office precinct, child care centre and Carseldine market. However, the child care centre will be relocated into a bigger facility next to the aged care facility to create an intergenerational connection between the two facilities (Queensland Government 2022d; Queensland Government 2022e).

The plan is to deliver Carseldine Village over five stages in seven years (Queensland Government 2022d; Queensland Government 2022e). The development was announced in 2016 (Your Neighbourhood 2016) with planning approvals first obtained in 2018. The sport and recreation precinct was completed in December 2019 and opened in January 2020 (Carseldine Village 2022). In February 2020, the sales and information centre opened with freehold turn-key terrace home and land packages for Stage 1A. The initial 2020 starting price of $374,900 is significantly below the area's median house price (Carseldine Village 2022; Queensland Government 2022d). Construction of subsequent stages was expected to commence in late 2022 (Carseldine Village 2021). The residential aged care facility opened in August 2022 (Carseldine Village 2022).

Vision for the sustainable or circular neighbourhood

Carseldine Village is described as 'an exemplar sustainable development—one of the first residential developments in Queensland to commit to delivering net zero energy emission homes' (Queensland Government 2022d). The project aims to create a sustainable, active and healthy community. This will be achieved by making use of the retainment of more than 75 per cent of the existing bushland and creating a network of pedestrian and cycle pathways, parks and a sports precinct hub (Carseldine Village 2022). There is no formal definition of circularity or sustainability for Carseldine Village, but key sustainability elements are included in the development scheme. Also, the development achieved a five Green Star Communities rating as well as EnviroDevelopment certification. These schemes helped to guide sustainability requirements at the neighbourhood scale.

Sustainability innovations include the goal of 100 per cent of the 182 freehold terrace homes being able to generate solar renewable energy and having battery storage on-site. As noted by the developer, the affordability and sustainability initiatives that are being delivered are largely driven through the scale of the development. According to research participants, the realisation was facilitated by a strong working relationship with only two builders.

Different water management approaches have been applied across the site. This includes a smart water irrigation system (with an integrated weather monitor) that can adjust frequency and use in response to the actual weather conditions at the sports precinct. There are provisions for a rainwater harvesting system to irrigate the sports fields, to be completed by the local council after the project has been delivered. Several energy production, consumption, and storage features have been included at a dwelling level that also have implications across the neighbourhood scale. For example, approximately 25 per cent of the peak energy consumption of the site will come from battery storage (GBCA 2022). The goal to achieve a neighbourhood that is fully powered by solar energy is achieved by equipping every home with a 3.6kW solar PV system combined with a 10.3kW battery. This will not only save individual home owners money but also allow pilot innovations to increase renewables uptake within the local energy infrastructure (Queensland Government 2021). Energy modelling for the terrace homes indicated that their solar systems would produce 122 per cent of their net annual energy needs. The use of efficient technologies at the individual dwelling level (such as heat pump hot water systems and smart air conditioning) will help reduce the overall energy demand on-site (Queensland Government 2021).

The master plan ensures that individual dwelling lots maximise passive solar outcomes through optimal orientation. There is also a focus on reducing urban heat island effects. This is addressed through the strategic use of vegetation to encourage passive irrigation and root protection (Queensland Government 2020). Each dwelling is located within proximity to public transport and includes a dedicated circuit for EV charging in each garage (Queensland Government 2022f). The site is designed to maximise walkability and encourage active movement. The development's main north-south entry road (Plaza Place) provides for separate, dedicated cycle and pedestrian lanes, and a connection to the local cycling network.

In 25 dwellings a pilot of a smart home energy management system will be realised. This pilot will monitor and respond to signals from the electricity grid. It will also offer insights into how home energy use can be modified to provide the best value to the home owner and avoid congestion on the grid (ESD Magazine 2021). The smart watering system will reduce water consumption by up to 30 per cent (Queensland Government 2020).

While all these are important sustainability considerations, the project could have arguably benefited from a more holistic vision of circularity. For example, there was little attention to using reused and recycled materials. There also does not seem much consideration to what happens with buildings and materials when they come to the end of their lifecycle.

Main drivers and barriers

Carseldine Village was one of several larger developments being led by the Queensland Government. According to research participants, this meant that there was no significant concern about the scale of the project beyond engaging with the wider community in planning for the site. The site was developed via a master plan that emphasises enhancing community outcomes. The other key achievement was the development of a flood mitigation strategy. This allowed to direct housing to be developed on the site without impacting roads and property upstream or downstream of flood-prone Cabbage Tree Creek.

Despite the house and land packages selling strongly, research participants did not notice that many consumers were specifically asking for sustainability beyond minimum standards. Respondents thought this was an effect of the limited number of examples of sustainable housing currently available and lack of awareness of possibilities among homebuyers.

One important challenge for the project results from the unique planning framework for the site. Being located in a priority development area, EDQ Development Assessment is the regulator, but Brisbane City Council is subsequently responsible for the public assets. The local council was not involved in the planning and development approvals. This meant that the design standards for public (contributed) assets and for assets designed to standards as required under the state government's Fitzgibbon PDA Development Scheme were not in accordance with Council standards. Research participants felt that resolving these discrepancies was time-consuming. They suggested that dealing directly with Council on the design and handover of public (contributed) assets has considerable potentials for saving time and money (Economic Development Queensland 2022).

3.2.11 Case study Ginninderry (ACT)

Project description

In June 2013, the ACT Government announced a joint venture with the Riverview Group for a project called Ginninderry to develop approximately 4,500 homes adjacent to West Belconnen over a period of 15 years (Elton Consulting 2013; Riverview Projects 2015). The proposal eventually grew into a larger project, intended to create a series of new suburbs for circa 30,000 people residing in 11,500 homes. This will be realised on a site of approximately 1,600 hectares, located about 15 kilometres north-west of Canberra City Centre. The site was previously used as farmland, agricultural industrial land, and also included a rubbish tip.

The site is defined on three sides by the Murrumbidgee River and its tributary the Ginninderry Creek, and on the fourth side by the established Belconnen suburbs of Holt and MacGregor. The project seeks to become a World Class exemplar for sustainable development at neighbourhood scale. The ambition is to represent best practice in urban development from a triple bottom-line perspective (Riverview Developments 2021). The whole project will take almost 40 years to complete and will increase the population of Belconnen by a third. Ginninderry welcomed the first residents in early 2020. By the start of 2022 the first neighbourhood/suburb of Strathnairn was almost completed and the neighbourhood of MacNamara was under construction.

Vision for the sustainable or circular neighbourhood

The joint venture partners of ACT Government and the Riverview Group have aspired to develop Ginninderry as an innovative sustainable community of international significance (Elton Consulting 2013). A Sustainability Vision for the project was prepared in 2009 (The Riverview Group 2014). It sets out 31 principles on partnering, evaluation, ecological, social and cultural sustainability, and economic principles (Riverview Developments 2021).

The development was a part of the Green Star Community pilot run by the GBCA, and six Green Star certification was achieved during the master planning process. The Master Plan (The Riverview Group 2014) and the Housing Design Guidelines (Riverview Developments 2020; Riverview Developments 2022) set out requirements or aspirations for sustainability. They cover requirements for water management, energy management, energy efficient site design, sustainable mobility, and green infrastructure. The selection of building materials and systems are assessed through a trial of a Lifecycle Assessment Tool to allow consideration of whole-of-life environmental impacts. Other requirements refer to waste reduction and social sustainability considerations (such as a diversity of dwelling types and affordable housing options). The project includes the reuse of multiple heritage buildings from the 19th and 20th Centuries. These are repurposed as community facilities such as arts communities and meeting places. The joint venture agreement defines the cooperation principles. For example, Riverview Developments is required to publish progress reports against the project's vision and objectives.

While many of these measures apply to the building scale, some are deliberately focussed on neighbourhood scale efficiencies. The neighbourhood scale of the project was also key to the trial of the community-scale battery storage system (sized at 275kWh) (CWP Renewables 2021).

Main drivers and barriers

One family wholly owns the company, Riverview Developments, which is driving the project. Their overarching goal for Ginninderry is to leave a physical legacy of a more environmentally and socially sustainable community than what is typical of current Canberra urban development. The joint venture partners have engaged widely with the Canberra community to develop a collective vision for the project. For example, in November 2013 the partners hosted a three day community workshop to seek feedback and consensus on the vision (Elton Consulting 2013).

The policy context in which Ginninderry is being developed includes the ACT Government policy goal of net zero emissions for the Territory by 2045, and the creation of new zero emission suburbs (ACT Suburban Land Agency 2021). The ACT Planning Strategy sets out the policy framework for the creation of new greenfield developments to cater for about 30 per cent of the projected population growth for Canberra (ACT Government 2018). As the project site covers land in both the ACT and NSW, rezoning approval from the planning authorities of both jurisdictions was required. In NSW, this included both the state government and the Yass Valley Council. As the development proposal covers land designated in the ACT under the National Capital Plan it also required rezoning approval by the National Capital Authority and the Commonwealth Minister for Territories.

In addition to the Territory Planning Codes, the developers prescribe a four phase design approval process overseen by the Ginninderry Design Team to ensure that all buildings meet the Design Guidelines (Riverview Developments 2020; 2022). These guidelines cover minimum energy and water system requirements (such as PV panels and inverters, energy efficient heating and cooling, and water savings and efficiency measures); as well as site specific requirements for drainage, air and noise pollution, and landscaping. A Ginninderry Compliance Officer undertakes a physical inspection of the development before an occupancy certificate is awarded (Riverview Developments 2022).

Research participants noted challenges in realising design aspirations for sustainability that exceed current standards and that are governed by policies from different public agencies. Finding solutions was time-consuming and resulted in additional costs, and meant that some of the initial intentions could not be realised. For example, the developer's goal of creating a quality urban infrastructure, and the government's responsibility to manage the ongoing costs of that infrastructure once built, revealed different expectations. While the developer was keen to create high quality public parklands within each neighbourhood with extensive BBQ and toilet facilities, the ACT Government wanted to avoid ongoing maintenance costs for such 'extras'. On the other hand, there are also examples where the significance and scale of the development allowed exceptions. For example, ACT infrastructure standards do not allow the use of recycled content in construction, but the Ginninderry project team achieved permission to use recycled materials in the asphalt.

3.2.12 Case study: Scharnhauser Park (Germany)

Project description

Scharnhauser Park is a conversion project of a former US-military site and army barracks. The site, around 150 hectares in size, is located in the municipality of Ostfildern to the south of Stuttgart. To the east and west of the site are main traffic arteries. The site is located close to a tributary feeder to the river Neckar and lies on a heavy clay hill.

Scharnhauser Park has been referred to as the largest urban development in the Stuttgart area in the early 21st century (Ramboll n.d.). The plans to develop a major sustainable urban expansion were conceived when the site became vacant following the departure of the US army forces in 1992. The City of Ostfildern (with considerable financial support from the government of Baden-Württemberg) bought the site from the German Federal Government. In 1992, an urban design competition was organised, with the selected urban development concept providing the basis for the site's master plan. This proposed a mix of uses: 40,000m^2 of industrial area in the southern part of the site, and 90,000m^2 of civic, commercial, and residential uses in the northern part (Tereci, Kesten et al. 2010). Providing facilities for all residents of the town, such as a new town hall, was deemed important to ensure integration with the existing town (Jessen 2005). Today, the site is home to 8,000–10,000 residents (approximately a quarter of the population of the entire town of Ostfildern which is currently around 40,000) and includes 2,000 places of employment.

The construction of residential and commercial buildings began in 1997 and was completed in 2006 (SEG 2017). Between 1996 and 2000, a light rail expansion was built to connect the new neighbourhood to Stuttgart. As part of the State Horticulture Exhibition in 2002, the landscaping was completed early in the process. Social infrastructures and commercial facilities were opened early in the process (including a kindergarten and supermarket in 1998, and a high school in 1999) to support the creation of a community as soon as residents moved into the new houses.

Vision for the sustainable or circular neighbourhood

The Scharnhauser Park project was designed as an exemplary ecological community development and is considered an important demonstration project for sustainability principles of large-scale urban developments. The neighbourhood scale was one of the main determinants for the project and has been integral to planning and design processes.

The definition of sustainability used for this development is comprehensive and integrated across the scale of the site through a master-planning process. The planning process involved many stakeholders, placed considerable emphasis on public engagement, and lasted more than twenty years from initial conception to completion. The key sustainability features are:

- reuse of a major brownfield site and (partial) reuse of buildings on-site
- sustainable mobility options, including an extension of the light rail line to Stuttgart with three stops on-site, and an emphasis on walking and cycling paths and the creation of spaces between dwellings that are effectively car-free by design

- integrated rainwater management that uses water retention as a landscape feature and prevents water run-off from the site
- a diversity of housing types, mostly with higher density and with buildings displaying higher levels of energy efficiency than mandated at the time of completion
- reuse of dismantled construction materials in the new development
- production of heat and electricity on-site, using biomass (mostly from regional timber sources) that covers a majority of the electricity and heating needs of the development, as well as PV electricity generation. The energy is distributed through a district heating network.

The majority of buildings on the site are newly built, with most housing now in private ownership. Some of the existing buildings were incorporated into the master plan for the site and retrofitted to achieve higher energy efficiency performance. They are now used for commercial purposes and housing. Due to initial opposition by the local population to the large scale of the project, the municipality decided against including social housing in the development. Also, the site is not car-free. According to research participants, this was not deemed feasible given the scale of the site. However, the urban design deliberately aimed at encouraging the use of public transport, walking and cycling, and at keeping cars mostly out of residential areas to facilitate social interaction.

An integrated urban development framework plan was developed that incorporates the key sustainability features of a mix of functions and integrated land use and transport planning, Other sustainability dimensions were: the provision of public facilities, green open spaces, integrated rainwater management, the creation of employment opportunities, and higher density residential development. The framework plan has provided the guiding vision for the project throughout the process of realisation. One of the innovative features of the site is the integrated water management concept that makes use of the site's topography through a centrally located large-scale 'landscape staircase'. This landmark feature keeps rainwater on the surface and ensures water retention and filtering of water run-off using a set of steps (Ramboll n.d.; SEG 2017). The Scharnhauser Park project received several awards for providing an example of a sustainable community (see SEG 2017 for a list), including the German Urban Development Award in 2006 (BauNetz 2006; Koch 2001).

Main drivers and barriers

Scharnhauser Park is a good example of sustainable regeneration of a brownfield site and of realising neighbourhood-scale efficiencies. An integrated urban development concept placed emphasis on higher densities, a mix of functions, energy production on-site and measures to reduce energy consumption through building insulation and other building energy efficiency measures. Integrated water management and rainwater retention on-site (notably through the 'landscape staircase'), and a focus on supporting a shift in mobility to public transport (through extension of the light rail connection to Stuttgart with three stops on-site, walking and cycling infrastructure) and direction of car traffic away from areas dedicated to 'people activities' are other important sustainability features of the development.

In Germany, land use planning is the constitutionally secured competence of local authorities (which must be coordinated with higher-level strategic spatial plans). For areas within a municipality where development is envisaged by the comprehensive municipal zoning plan (*Flächennutzungsplan*), a legally binding and detailed 'Local Building and Construction Plan' (*Bebauungsplan*) must be prepared. Buehler, Jung et al. (2015) have described how Germany's practice of zoning for smaller land areas and a comparatively flexible zoning code contributes to mixed use developments. This can reduce car dependence, as shops and public facilities are located close to housing.

The Scharnhauser Park was possible only because of the vision and leadership of the City of Ostfildern. Important aspects for ensuring the realisation of this sustainable neighbourhood project over many years of realisation were:

- key administrative staff, supported by the mayor and local council
- a visionary urban development framework plan and related concepts

- a major emphasis on public engagement
- the setting up of novel governance structures (such as an Urban Design Advisory Board, and workshops with developers and architects that are considered to lead to better outcomes by inviting direct competition between proposals).

Research participants regarded the urban development concept that resulted from the 1992 urban design competition as an important instrument to manage such a long-term process. This concept—while setting out a comprehensive vision—also provided some flexibility for adaptations and stimulating a process of learning.

Public participation played a major role in Scharnhauser Park. Public consultation as legally required by the Federal Building Code (*Baugesetzbuch*) was undertaken on the detailed 'Local Building and Construction Plans' for successive stages of the project. In addition, the municipality invested extensively in voluntary public engagement activities to gain wider input into the plans and ensure community support for the development. Another important facilitator was to showcase the project as part of the Baden-Württemberg's Horticulture Exhibition in 2002. This allowed the completion of the landscaping early in the process and according to research participants contributed to a shift in public perception towards a positive image of the area and to attracting investors.

Early in the process the building energy efficiency standards for housing in Scharnhauser Park were set at a minimum of 25 per cent below the national standard of the then applicable 1990s federal energy legislation. In later phases, project-specific standards became superfluous after the introduction of EU and German legislation for near zero carbon buildings.

For land purchase and major infrastructure developments (such as the rail link), funding from the German federal government, the state government of Baden-Württemberg and the local government (City of Ostfildern and surrounding county) were combined. State government funding of €7 million were important in the early stages of housing construction, until private and commercial developers started to invest in the site (SEG 2017). All social infrastructures were financed by the municipality, and it was an important aspect of the development project that these would be available as soon as residents were moving in. The City of Ostfildern team was also successful with attracting EU funding (Eicker 2012; EC n.d.; POLYCITY n.d.), which according to research participants was useful to generate wider awareness for the project.

A major urban expansion project such as Scharnhauser Park, which was implemented over a period of 20 years, requires considerable financial, staffing, and organisational resources from a small municipality such as Ostfildern (Jessen 2005). It is therefore particularly noteworthy that there have been no major delays during the completion period. However, there were some challenges. Many banks considered the risk too great for a small municipality to realise a project of this size, and thus securing loans and financing the process was complicated. Initial ambitions to downgrade a state road that effectively separates Scharnhauser Park from the existing town could not be realised because political support for this initiative changed after a local election. A further expansion of the Scharnhauser Park project was initially foreseen, but in recent years research participants noted a shift in political attitudes that would make realising such plans less likely today.

3.2.13 Case study: Buiksloterham (Netherlands)

Project description

The Buiksloterham (BSH) district is located in the north of Amsterdam, separated from the historic centre by the river Ij. The site is an old-industrial port area and partly contaminated. The BSH project is 130 hectares in size, of which 80 hectares are for residential development to provide almost 9,000 dwellings (City of Amsterdam 2022). The project was initiated in 2006, with a zoning plan adopted in 2009. Based on the experience with Amsterdam's first sustainable tender in 2009 for the BSH development, the City of Amsterdam issued a 'Roadmap Circular Land Tendering' (City of Amsterdam 2018) that set out circular economy criteria for development. In 2020 a 'Reassessment Investment Decision' (City of Amsterdam 2020a) was adopted by the city council and firmly anchors circularity and sustainability in plan development and implementation to create a circular, productive, and undivided BSH. The project is expected to be completed by 2030.

Vision for the sustainable or circular neighbourhood

The vision for the project is guided by a dedicated national and local policy framework for a CE. The 'Amsterdam Circular Strategy 2020–2025' (City of Amsterdam 2020b) sets out targets for a 50 per cent reduction in primary raw material use by 2030 and a fully circular city by 2050. The 'Roadmap Amsterdam Climate Neutral' sets the target of a 55 per cent reduction in CO_2 emissions by 2030, and a 95 per cent reduction by 2050, compared to 1990 levels. By 2050, 100 per cent of Amsterdam's energy should come from renewable energy sources.

In 2015, more than 20 stakeholders including the City of Amsterdam, the local water utility, and social housing corporation De Alliantie, signed a 'Manifesto Circular Buiksloterham' (Gladek, van Odjik et al. 2015). This is a guiding document that sets out a comprehensive commitment to achieving a CE transition. It covers the following areas:

- energy
- waste and material flows
- wastewater and rainwater
- ecosystems and natural capital
- infrastructure and mobility
- diversity, liveability and inclusivity of the residential neighbourhood
- local economy and entrepreneurship
- cultural health and safety.

The 'Manifesto Circular Buiksloterham' was prepared after the zoning plan had already been adopted and several plots of land been sold. According to research participants, this limited the impact of the manifesto on the possibilities for achieving the comprehensive vision for CE. Even so, some ideas were taken forward in policy documents such as the 'Reassessment Investment Decision'. Also, some developers, including the social housing provider De Alliantie, voluntarily committed to achieving higher sustainability standards in their developments. In the case of the buildings owned by De Alliantie, this included a strong focus on strengthening social sustainability through shared facilities.

BSH is set up as Circular Living Lab, combining different initiatives that are intended to support learning-by-doing by trialling new CE approaches. These focus on the areas of energy, raw materials, adaptive and demountable buildings, green infrastructures and biodiversity, water, and sustainable mobility (City of Amsterdam 2022). Municipally owned vacant sites are made available for circular experiments. One such experiment is 'De Ceuvel', constructed on a contaminated site, which uses phyto-remediating plants to decontaminate the soil. Also, helophytic filtration systems are used to enable on-site recycling of grey water, and dry composting toilets and separated urine collectors allow the retrieval of fertilizer for local food production. Workshops, offices, and a café are located on houseboats near these activities (Williams 2022).

BSH consists of 75 plots, of which the municipality owns one third. The remaining two-thirds, called 'transformation plots' are issued on a long-term lease arrangement (in Dutch 'erfpacht') or are privately owned (City of Amsterdam 2022). Principles of a 'circular building approach' are included in the 'Reassessment Investment Decision' (City of Amsterdam 2020) and guide the development of these plots. These principles (such as on-site carbon-neutral energy generation) are supported by aims and targets (that 50% recycled and 30% renewable materials must be used in construction). All developments must comply with the circular building principles for BSH, whether they are social rental housing (40%), medium rental housing (40%) or to be offered as free market housing (20%). The decision processes vary depending on ownership. For municipal plots, tenders are selected based on their circular building features. For the 'transformation plots', the principles of the 'Reassessment Investment Decision' are a binding part of the agreement. The municipality invites the private developer to an early discussion on the expectations for the site, and checks the preliminary and final designs in relation to their sustainability contribution. The municipality also carries out sample checks at the construction site and upon delivery to ensure compliance with the circular building principles (City of Amsterdam 2022).

Circular economy ambitions have also been defined for the public spaces, including the aim to create an energy-neutral public space (0.5 to 1 MW renewable energy locally generated); use of 80 per cent circular (demolition) materials in public space; high quality green space in the neighbourhood using nature inclusive measures; and a circular water system through 12,000m^3 water storage to capture rainwater for management tasks in the neighbourhood and to mitigate heat stress. As part of the principle on re-using materials, an existing complete bicycle bridge will be moved from another site to be installed in Buiksloterham (City of Amsterdam 2022). Nevertheless, the development of the site is still done plot by plot. This limits opportunities for neighbourhood scale systems beyond attention to public spaces, although the municipality facilitates cross-plot experiments such as smart grids, smart mobility, and food composting systems. However, there are some (sub-)initiatives in BSH, such as Schoonschip: a community of about 40 floating houses, that are focussed on neighbourhood scale efficiencies with shared mobility solutions and product sharing.

The municipality set up a digital materials database in which materials previously used in public spaces are recorded to facilitate their procurement and further use. In a corresponding physical warehouse, the municipality stores these materials and products until a new use has been found (City of Amsterdam 2022).

Main drivers and barriers

The dedicated policy framework and strong leadership by the municipality (including a dedicated team for sustainable area development) are important factors to realise this project. Political support and interdisciplinary working were also mentioned by research participants as essential to realising ambitious and cross-sectoral projects such as BSH. To help self-builders (individual developers) achieve the sustainability objectives for their dwelling, the municipality provides dedicated information materials and advice.

In terms of challenges, a comprehensive policy framework that ensures the integration of CE principles in the planning and design of the entire BSH neighbourhood has arguably come too late. By the time the 'Manifesto Circular Buiksloterham' was signed, and binding policy documents (such as the 'Reassessment Investment Decision') had been adopted, several sites had already been tendered without the strict requirements for sustainability that are at the core of the development vision. Perhaps most importantly, however, are the financial barriers to realising such a complex initiative. Research participants referred to cuts to public budgets that present challenges for ambitious area development projects. Shifting to the construction of circular buildings and neighbourhoods also results in higher costs, until such materials and products are more widely available. Research participants argued for a costing model for urban development projects. Such a model should allow the internalisation of what are currently external costs of circular approaches, such as embodied carbon in new versus reused materials.

3.2.14 Case study: SUPERLOCAL - Super Circular Estate (Netherlands)

Project description

The project SUPERLOCAL—Super Circular Estate is located in the municipality of Kerkrade, a town on the border to Germany in the southernmost Dutch province of Limburg. Kerkrade is a former mining community. Since 1999, it has been cooperating with seven other municipalities in the city-region of Parkstad Limburg (Dutch for Park City) to improve public services, transport, and housing on a regional level. The region has been undergoing transition following the decision by the Dutch Government in 1965 to terminate the mining of coal. In terms of population development, the region has been experiencing population decline and ageing because of both declining birth rates and outmigration, with young people moving to urban agglomerations in the west of the country such as Amsterdam and Rotterdam. The projection is for Parkstad Limburg's population to shrink by 27 per cent over the coming 30 years (Housing Europe n.d.; ILB 2012). It is against this background of economic and demographic transformations that the project SUPERLOCAL was conceived. The demographic trends had already resulted in high vacancy rates in apartment buildings in the town of Kerkrade. It was generally recognised that housing provision in this part of the country would need to be adapted in response to projected reduced demand, as well as the requirements of an ageing population.

The site of SUPERLOCAL, in Bleijerheide in the eastern part of Kerkrade, used to be occupied by four high-rise apartment buildings of ten storeys each and with a total of 400 apartments. They were constructed in the 1960s in response to growing housing demand in the area (Gemeente Kerkrade n.d.; Jongen Bouwbedrijven n.d.). However, in the early 2000s, there was no longer sufficient demand for the apartments due to demographic changes, and the buildings were deteriorating (Kennis voor Krimp 2017). Moreover, the apartments were poorly insulated and did not meet current-day requirements for energy efficiency.

In 2012 the first of these apartment buildings was demolished, with the demolition waste going to landfill. It was planned to also demolish the other three buildings. However, the resident population raised concerns that the traditional approach of first clearing a site before new housing developments can be constructed would result in lasting disruption to existing social connections. Moreover, there were concerns that the demolition of the apartment buildings would limit the availability of affordable rental homes in the area. Lastly, research participants emphasised that there was also a shift in understanding at the time about the need to reduce construction waste and move towards a more sustainable approach to building.

In response to these concerns, the owner of the apartment buildings (social housing provider[10] HEEMwonen) proposed an alternative approach to the Municipality of Kerkrade (owner of the surrounding land). On this basis, in 2014 the two project leaders decided to apply CE principles to the regeneration of the existing housing stock and the renewal of the neighbourhood. The aims were to achieve significant reuse of materials from the existing buildings for new construction, to create high quality affordable housing and to implement a development process that would allow for strong social connections to remain intact. Thus, there was a specific focus on public engagement processes to allow residents to contribute to shaping the proposals. This was to active stimulate former inhabitants to return to the neighbourhood after redevelopment. There was also considerable attention to supporting the integration of new residents into the neighbourhood. For new housing on the site, the goal was to retain as many of the existing housing qualities as possible. These included spacious floor plans, low rents, and quality of urban design (HEEMwonen 2018; Jongen Bouwbedrijven n.d.).

Vision for the sustainable or circular neighbourhood

The project uses a comprehensive definition of CE that focuses on achieving 90 per cent reuse of building materials and products from existing buildings on-site for the new development. There has also been attention to establishing an experimental closed water cycle, car-reduced mobility, and on-site solar electricity production. Regarding the latter, it should be noted that this was not an explicit goal for SUPERLOCAL. Rather, the use of solar energy—as well as high energy efficiency of buildings—has become standard practice for housing developments in the Netherlands and the EU. The approach for SUPERLOCAL extends beyond the CE concept, because there has been considerable emphasis on social sustainability. This has been realised by ensuring socio-economic diversity supported by different dwelling types, through considerable community engagement, and by enabling interactions so that social connections can foster between residents and the neighbourhood functions as a community. To facilitate community engagement, a 'Neighbourhood Sounding Board' (in Dutch: Klankbordgroep) was set up. This was a governance platform to actively engage residents from surrounding areas and previous tenants. This co-design process also involved the tenants of the 15 newly constructed single-family homes and potential future residents of the new neighbourhood.

The new development comprises 125 new affordable (social housing) rental dwellings and 25 'free-market' dwellings (Kennis voor Krimp 2017). A mix of social housing and free market housing was deemed important for integrating different socio-economic groups. The free-market housing includes 15 CE houses on-site. These were built predominantly from reused materials and with a view to an easy disassembly so materials can be reused should the need occur in future. The walkways and cycle paths were created with recycled concrete from the demolished apartment building (Dusseldorp 2021).

10 It should be noted that there are considerable differences between the social housing sectors in Australia and the Netherlands, both in terms of size (in 2009, approximately 5% of dwellings were social housing in Australia, compared to 32% in the Netherlands), as well as in terms of their organisation, with the Netherlands displaying a much more diversified social housing sector. Dutch housing associations are private organisations with a public responsibility to provide affordable (highly subsidized) rental housing and have control over a considerable volume of assets (Blessing 2012; Milligan, Dieleman et al. 2006).

In line with EU and Dutch legislation, the houses are almost energy neutral. On the ground floor of the refurbished apartment building there are approximately 300m^2 of communal facilities that offer spaces for social interaction. The public spaces around the buildings were redeveloped in consultation with the local community and future tenants. This included the design of multifunctional facilities that can be flexibly used. This process was set up to foster connections between residents of the SUPERLOCAL estate and those living in the surrounding neighbourhoods.

The project won awards such as the Dutch Building Prize (Nederlandse Bouwprijs) in the category 'Building materials and building systems' in 2019, and the 'Innovation in Politics' award in 2020. In 2021 the project was awarded the title of 'Deserving City' from the Guangzhou International Award for Urban Innovation.

Main drivers and barriers

The project was developed in cooperation with social housing provider HEEMwonen and the municipality of Kerkrade (responsible for the preparation of the urban design concept) and realised with a range of other partners. In terms of policy frameworks, in 2016, the Dutch Government adopted a CE strategy that stated an ambition for the Netherlands to become circular by 2050 (Rijksoverheid 2016). The EU's Green Deal also has a CE at its core, and this focus has been incorporated into EU funding programs that the SUPERLOCAL project successfully applied for. Research participants emphasised that the national policy context provided a useful framework for justifying local ambitions. EU project funding allowed to test novel approaches to the reuse of materials. Research participants mentioned the importance of partnership working as well as community engagement to realise circular urban development projects.

Other important facilitators were the successful application for participation in the Internationale Bauausstellung (IBA)[11] initiative in 2015; with the 'IBA Parkstad' taking place in 2020. IBA Parkstad was the first International Building Exhibition to take place in the Netherlands (IBA Parkstad n.d.). In 2017 the experimental demolition of one of the high-rise apartment buildings was undertaken. Entire apartment blocks from the top floor of the existing building were used to construct the IBA Expobuilding (Dusseldorp 2021; Wagenborg Engineering n.d.). Elements from the staircase, railings and radiators were also used, as well as recycled materials from the demolished apartment buildings. Based on the experience with the Expobuilding, three circular pilot houses were constructed. This was undertaken with financial support from the EU's Urban Innovative Action Programme, and aimed for the use of at least 90 per cent of reused materials from the development site (Dusseldorp 2021; UIA 2021). The experiences from these pilots were scaled up to build another 15 houses on the site, for which any required additional materials had to be sourced from renewable (plant-based) sources.

Research respondents mentioned several barriers, related to deep-seated expectations of politicians, administrators and the public for how urban development projects should be planned and realised. Agreeing on different approaches with the aim of circularity proved time-consuming to address. Additional costs for circular initiatives, both in terms of financing but also in relation to time and staff capacity were also perceived as challenges. Overall, SUPERLOCAL is a good example of applying a CE approach with the reuse of materials and products from decommissioned high-rise buildings in the construction of new and near zero-energy housing. The 'experimental' nature of the development—parts of it only made possible through EU funding—suggests however that despite the commitment of local and regional actors to CE neighbourhoods these approaches may not be easily scaled up.

11 IBAs - International Building Exhibitions - originated in Germany in the early 20th century, initially as international showcases of architectural achievements, but over time widening their scope and broadening their ambitions to becoming major sites for experimentation on urban regeneration and to stimulate political national and international debates on urban and regional planning and development (https://www.internationale-bauausstellungen.de/en/).

3.2.15 Case study: Kera (Finland)

Project description

The Kera project is situated between the cities of Helsinki and Espoo. It is a privately owned 58 hectare brownfield site previously used for warehouse and logistics operations (City of Espoo 2019). The area is bisected by the Coastal Railway line and has a functioning train station. Kera is as an example of urban CE living where circularity is embedded in every phase of the district from pre-construction, reuse of buildings to post-occupancy everyday life. The project started in 2018 and is expected to be completed by 2035.

The City of Espoo has formulated the ambition to develop Kera into an international example of a CE district. This is realised through the 'Smart and Clean Kera' project and the 'KIEPPI project'. The 'Smart and Clean Kera' project aims to turn the industrial district into a smart and circular city district that consists of repurposed buildings and new circular buildings. The buildings will be residential, creating housing for 14,000 residents, as well as commercial and office space for 10,000 employees (Ramboll Finland Oy 2021a). A physical hub in the district will be created to facilitate the co-creation of new CE ideas via networking, experimenting, and prototyping. The hub will be supported by a digital platform where solutions and applications can be tested. The 'KIEPPI' project is based on a partnership model for sustainable neighbourhoods. The focus is on realising a circular and sharing economy in the Kera neighbourhood with closed material loops for businesses based on an industrial symbiosis concept ('waste from one business is used as a raw material by another business') (Circular City Funding Guide n.d.).

The Kera district has been divided into three zones (southern, inner-north, and outer-north) and will be developed around the railway connection in phases over the next 20 years. The station area will be transformed from a logistics site into an urban centre that caters to pedestrians and cyclists. There is no car parking directly assigned to houses. Instead, car parking is located mainly on access roads around the district's periphery to incentivise the use of more sustainable modes of transport (Circular City Funding Guide n.d.).

Vision for the sustainable or circular neighbourhood

The area is being developed as an example district of CE with a major role for digital technologies. In this understanding, the sharing economy is integral aspect of the CE vision as it can reduce individual resource consumption. There is emphasis on involving the business community as well the public in the planning for the site. While a comprehensive vision for CE is provided, the neighbourhood scale is not explicitly defined in the project documentation. It is implicit in that the area will be divided into zones of different functions, with sub-master plans to be created for each zone.

The CE strategy for Espoo is organised around the following comprehensive themes: digital platforms; energy solutions; design and construction; housing and work; mobility and logistics; urban production; CE and sustainable lifestyles; and wellbeing and related services. The ambition for Kera focuses on reducing CO_2 emissions from energy (heating, cooling and electricity), transport, building construction and infrastructure (Ramboll Finland Oy 2021a). Kera is intended to become a model energy positive district where on-site energy production serves all local needs and excess is exported to other localities (Ramboll Finland Oy 2021b).

Three overarching programs were identified for implementation in Kera: energy, transport, and sharing economy. The design of the overall energy system for the district commenced in 2022 and will involve piloting of different energy solutions. These will be implemented through successive phases of the district's development. It is anticipated that these will include solar panels, geothermal energy, and other certified carbon-neutral energy generation methods (Ramboll Finland Oy 2021a; Ramboll Finland Oy 2021b). There will be a major reliance on digital technologies to produce and distribute energy within and beyond the district. The various energy production and distribution methods are envisaged to form an energy 'ecosystem' that will also connect to the 'Transport' and 'Share Economy' programs in Kera (Ramboll Finland Oy 2021b). Transport emissions will be reduced through land use planning measures that ensure a dense and efficiently structured network of services. The district centre will be located next to the existing railway station and priority will be given to walking and cycling over motorised traffic. Car ownership is anticipated to be a quarter of the Espoo average and the goal is to reduce emissions from transport to one-third of the Espoo average (Ramboll Finland Oy 2021a).

Together, the programs of Energy, Transport and Sharing will comprise a total of 15 projects, intended to trial new approaches and, if successful, to scale these up. Two projects already in place are the Automated Bus service and the Reuse Centre. The Automated Bus service has been created through the collaboration of the City of Espoo with three partner companies (City of Espoo 2022). The Reuse Centre sells donated goods to residents. The next step in the process is to generate a business model for repairing damaged and broken goods or repurposing goods so they remain in the consumption cycle for as long as possible before being recycled.

Main drivers and barriers

The City of Espoo has signed the EU-wide 'Circular Cities Declaration' to demonstrate their commitment to CE principles. In 2017, the Espoo City Planning Board approved the goal for the Kera district to become an area for sustainable development and a CE model (City of Espoo 2019). The site was subsequently re-zoned so that redevelopment for housing and office uses could proceed in line with the Regional Plan. The rezoning also included that existing buildings could be used for alternative purposes pending redevelopment (City of Espoo 2020; City of Espoo 2021a). The Kera sub-regional plan became law in 2018 and provides the broad framework for development (City of Espoo 2021a).

As the land is currently privately owned, a Development Commitment has been created as an Attachment to any future land use agreements (City of Espoo 2021b). Developers are required to create a development plan for the site that demonstrates how they will address the CE objectives of the Development Commitment. The City of Espoo has provided examples of how to meet the CE requirements, but there is an explicit invitation to developers to be innovative in responding to the objectives. Given the focus on innovation, research participants emphasised that developers will not be penalised if they do not meet the objectives as planned.

3.2.16 Case study: Stockholm Royal Seaport (Sweden)

Project description

Stockholm Royal Seaport (SRS) is an ambitious sustainable urban development project that will include a mix of residential developments, cultural and community facilities, and public and private sector employment (Williams 2019). On completion the area is expected to have 12,000 dwellings, 35,000 jobs and 600,000m^2 of office space (City of Stockholm 2017a). Located 5 kilometres north-east of central Stockholm, SRS is a publicly owned, inner-urban brownfield site of 236 hectares. It extends along the 8 kilometre coastline from Hjorthagen in the north to Loudden in the south. The site became available after the gasworks in Hjorthagen had been decommissioned. Some heavy industry will remain on site, and the central-south section of the coast will continue to function as a national and international port.

SRS is divided into four areas: Hjorthagen, Värtahamnen, Frihamnen and Loudden. These areas are further divided into sub-zones with the timing of development, from construction through to occupancy, beginning in 2010 and envisaged to end in the late 2020s. Some of the land in the Hjorthagen district had already been sold prior to the decision to make SRS a national and international model of sustainability. These sites are exempt from the requirements of the sustainability program (City of Stockholm 2017a).

Vision for the sustainable or circular neighbourhood

With international attention on climate change, the initial objective for developing SRS was on reducing greenhouse gas emissions and becoming fossil fuel free by 2030 (City of Stockholm 2017b). This objective has since been elaborated into a holistic vision also encompassing broader social and environmental goals. The vision for SRS is set out in the guiding policy document. It anticipates:

> … a dense and multifunctional city [that] will provide the foundations for an inclusive urban lifestyle, prudent use of resources, and reduced climate impact. Participation, creativity and innovation… [will be] thriving in an inspiring urban environment. (City of Stockholm 2017a)

Five strategies have been identified to achieve urban sustainability: vibrancy; accessibility; resource efficiency and climate responsibility; fostering ecosystem services; and community participation and consultation (City of Stockholm 2020; City of Stockholm 2021). Closed loops and CE are the goal for materials reuse and recycling (City of Stockholm 2015), especially in relation to the construction sector (City of Stockholm 2017a). There is emphasis on building knowledge about circularity both in the construction sector and in household consumption patterns (City of Stockholm 2017a).

There is no explicit focus on the neighbourhood scale in the SRS documentation. However, there is consideration to development of 'in-between spaces' through the master planning process and because the four zones of SRS will be developed in parallel. Development Agreements are used that set out specific targets and monitoring requirements for each stage of the development in relation to the sustainability objectives. As SRS is being developed on publicly owned land, the City of Stockholm is responsible for overseeing the project and for preparing the master plans for each zone.

SRS uses a staged land release process. Developers are selected through a competitive process based on demonstrating their potential to meet the sustainability targets set for each zone (City of Stockholm 2021). Once selected, each developer is required to engage several architects, at their own expense, to create different drawings for their site. They will then work with City of Stockholm's Development Administration to identify the proposal that is most likely to meet the sustainability targets and expectations for the zone as set out in the plan. This 'co-production' process provides an opportunity for both the developers and the municipality to identify and address challenges prior to construction and maximise the success of meeting the principles and targets for the zone.

Main drivers and barriers

The City of Stockholm is the driving force behind SRS. It was initially established to accommodate Stockholm's anticipated growth to more than 1 million people (City of Stockholm 2017a). In 2009, the decision was taken to make environmental sustainability a core principle of the SRS development (City of Stockholm 2020). This decision was part of the broader ambition for Stockholm to apply for the European Green Capital award. During the year of the award (2010), Stockholm showcased its experiences with sustainable urban practices through the earlier `Hammarby Sjöstad' project and promoted the intentions for the SRS development under CE considerations (City of Stockholm 2008; City of Stockholm 2017b).

Planning and development of SRS has occurred within the broader context of the changing emphasis of Sweden's social and environmental sustainability policies. The 'Swedish Strategy for Sustainable Development' of 2003 (Ministry of the Environment 2003) identified the built environment as a key site for improving resource utilisation and energy efficiency. Since the mid-2010s, National Government Ministries ranging from Finance and Culture to Environment and Enterprise and Innovation have instituted a range of policies, platforms and initiatives on sustainability, climate change, energy, and the CE. However, it was only in 2018 that the National Government, under the auspices of the Ministry of the Environment, implemented Sweden's first national urban policy. The 'Strategy for Liveable Cities' focuses on the four dimensions of social equity, building and construction, green spaces, and active transport (Ministry of the Environment and Energy 2018).

At the municipal level, SRS sits within the policy framework of 'Vision 2040: A Stockholm for Everyone' (City of Stockholm 2015) and its related 'Sustainable Urban Development Programme' (City of Stockholm 2017a). The latter is the policy document directly governing SRS. It outlines the vision for SRS and its zones, and sets out the five strategies to realise urban sustainability. For each strategy, headline targets and sub-targets for measuring performance are defined, with an emphasis also on knowledge generation and learning (City of Stockholm 2021).

There is a strong emphasis on partnerships and training within the SRS project, which is intended to support cooperation between the local authority, property developers, infrastructure owners, consultants, academia, and suppliers. The Development Administration hosts workshops on topics such as energy, ventilation or water management for newly signed developers to assist them in meeting their commitments. The Development Administration prepares an annual sustainability report to measure performance and contributes to an open information exchange. The results present a mixed picture of achievements, suggesting that realising comprehensive sustainability ambitions is challenging even in a supportive policy environment.

3.3 Summary and policy implications

The fifteen case studies analysed for this research have highlighted a growing interest by government and private sector actors to change the status quo and develop sustainable neighbourhoods. But they also highlighted that realising such projects are time-consuming and require strong leadership and dedication to overcoming challenges. In many cases, the original ambitions for sustainability had to be reviewed over the course of the project duration, and/or or some of the original intentions could not be realised for technical, regulatory, or political reasons. This may be inevitable for concepts such as the circular economy where the understanding on how to realise them in urban projects is still evolving. In comparison to the European examples it appears that the Australian cases started with considerably more modest ambitions for sustainability. Moreover, during the planning and implementation processes they also proved more vulnerable to external influences that required compromises and often resulted in a lowering of standards.

Table 2 summaries the location of the case studies, the key actors and main policy drivers. No examples of sustainable neighbourhoods in infill locations could be identified. This reflects earlier observations that realising neighbourhood-scale developments on sites characterised by complex ownership structures and existing infrastructures is faced with even greater challenges than on brownfield or greenfield sites. Several of the case studies were government-driven. However, reflecting the competences for urban planning there are clear differences between the Australian cases (where state governments are usually the responsible actor for major urban renewal projects) and the European examples (where the local authority is acting as the project leader). Whether or not projects are led by state governments (in Australia) or local governments (in Europe), the cases have shown that clear responsibilities, coordination between government levels (and sometimes across jurisdictions), as well as partnerships of government, the private sector and local communities are important for the implementation (and later functioning) of eco-neighbourhoods. Moreover, also government-led projects showed the importance of continuing political support. In the cases under study, this was provided through policy changes that enabled such developments in the first place, or by equipping the responsible government authorities with the necessary resources and expertise to realise such complex projects. In some examples, direct involvement of political leaders was required overcome barriers in the development process.

The analysed private-sector led projects in Australia faced considerable challenges with ensuring continuing council support for their plans and – in the face of resulting delays due to sometimes lengthy negotiations – securing project funding. Several project leaders mentioned resistance from local planning departments because of the 'non-standard ways of doing things', such as higher environmental standards or fewer car parking spaces than current policy guidance. Areas of contention were related to managing more demanding development assessment processes resulting from binding requirements for (higher-than-mandated) sustainability standards and the costs related to maintaining public assets after completion. Further training of statutory planners to strengthen their capacity to engage with innovative proposals would be important. This would support them in leading on policy change and would increase experiences with how sustainable outcomes might be better supported in development assessment processes. This could be complemented by governance models for such projects that exemplify how both the benefits and the additional demands on assessment and maintenance of eco-neighbourhoods could be more fairly shared by public and private actors.

In comparison to the notion of sustainability, which is now well embedded in Australian urban planning discourse (although rarely clearly defined), CE approaches are not yet widely used or understood. In contrast, the more recent EU examples have been explicitly framed around the concept of a CE; a policy discourse strongly promoted by the EU and its member states. Perhaps more important than the choice of the overarching concept for the neighbourhood development is that for most of the Australian projects no formal definition of sustainability was presented to guide their realisation. Moreover, none of the Australian cases presented a comprehensive vision for realising a sustainable neighbourhood. Rather, the focus was on selected dimensions of sustainability that perhaps most deeply resonated with the preferences of key actors. The attention to sustainability was therefore much more selective than in the European examples that are notable for the considerable efforts invested into agreeing a comprehensive vision on CE or sustainability among key stakeholders from the outset.

In terms of policy instruments, n both the Australian and the European examples, master plans, Design Guidelines (with binding requirements for developers) or similar tools were important instruments. They were used to ensure that the expectations for the sustainability of the development is realised by the usually considerable number of actors involved in the process. However, evidently only those aspects included in the plans and guidelines will be followed through. Several of the Australian case studies used existing sustainability assessment tools, such as OnePlanet Living or EnviroDevelopment, to provide a benchmark and identify targets. However, the findings of this research suggest that compromises made during the process of implementation often result in a watering down of initial ambitions, and ultimately a selective focus on some aspects of sustainability in the projects. On the other hand, the European case studies highlighted that a comprehensive consideration of sustainability or CE as set out in an integrated urban development vision or similar policy framework can play an crucial role in realising ambitious objectives across many dimensions. The vision for urban sustainability in such framework documents then provides the basis for detailed plans and provide a decision framework over many years of implementation.

Another important difference between the Australian and the European examples is that the planning instruments, such as Design Guidelines, of the former often only focus on the building scale, whereas the latter also included provisions for the neighbourhood scale. The master plans and development plans in the European cases incorporated the vision for the neighbourhood not only for individual building performance, bur especially for the in-between spaces. The examples demonstrate considerable attention to realising key infrastructures (such as public transport connections) or landscaping (including water management approaches). Using such structures as backbone of the new housing developments also meant they were in several cases realised early in the development process. This is an important aspect of fostering sustainable behaviour among new residents, such as choice of public transport over the private car. There are missed opportunities of making use of the neighbourhood scale in all of the Australian case studies. The EU cases can offer lessons in this respect, but they highlight the need for governments to play a leading role to allow for comprehensive master planning processes to be realised and for neighbourhood-scale planning and design to be translated into binding requirements for developers in line with an overarching vision.

Overall, what the case studies have clearly shown is that more regulation on urban sustainability and policy guidance on neighbourhood scale planning and design is needed in Australia. A move to net zero building performance - already regulated in the EU – is overdue for Australia to catch up with other advanced economies. In addition, stronger policy frameworks for sustainability are needed that move beyond the building scale to enable the realisation of resource efficiencies at a higher scale. Without such regulatory and policy changes, it will be challenging if not impossible to move such initiatives from a niche market into mainstream practices. Such policy change would usefully be supported by more attention to setting out clear targets for urban sustainability at the beginning of a project, and performance evaluation during the implementation process and post-occupancy. Several of the Australian case studies achieved certification for community sustainability using different rating systems (Table 2). This assessment is undertaken at the planning and design stage of a project, with limited incentives to measure actual outcomes and to implement feedback loops that can inform other projects.

Several of the European case studies were accompanied by research projects, intended to inform the planning, design and implementation process. EU funding in particular allowed experimentation with new approaches and techniques and helped to raise wider awareness for the project. Moreover, major exhibitions or awards were used to showcase the project, with the extended media coverage helping to ensure enthusiasm from politicians and the public and interest from investors. For the Australian cases, the use of such catalysts was not reported. Perhaps the opportunities to allow project leaders to commission research and to make use of the ‘locomotive effect’ (Mayer and Siebel 1998) of major national or international events are currently more limited. It may also be that complex processes such as for sustainable neighbourhood developments do not easily fit into the existing award categories of professional bodies such as the Planning Institute, UDIA or the Institute of Architects that arguably perpetuate the traditional focus on the design of individual buildings. Given the importance of garnering support among many stakeholders and actors in project-based planning processes, more incentives for trialling new approaches and showcasing achievements could usefully be considered by Australian policy makers and professional bodies. This would not only facilitate the realisation of ‘non-standard’ projects, but also support knowledge exchange and mutual learning around CE and urban sustainability.

Finally, the effort extended in the European case studies to community engagement and what might be referred to as 'co-design processes' deserves attention. Previous research has emphasised the importance of communities for achieving a sustainability transition and ensuring sustainable lifestyles post-occupancy. Yet, the Australian case studies show considerably less attention to this aspect than the European ones. Future eco-neighbourhood projects may want to consider novel ways of involving local communities and new residents more actively. This will help to create ownership for sustainability ambitions and increase awareness of the need to change both production and consumption patterns in CE neighbourhoods.

Table 2: Location, main actors, and key drivers of case studies of good practice 'sustainable neighbourhoods' in Australia and Europe

Project	Jurisdiction	Location	Description	Key actors involved in project / governance arrangements	Key policy drivers
Bowden	South Australia	Urban brownfield	State government-led urban renewal development in Adelaide on 16ha. Higher density mixed-use development with appr. 2400 dwellings and with good access to public transport. Site Design Guidelines binding for developers. Project started in 2011, expected to be completed in 2027.	• State government South Australia as landowner and project leader • Development proposals are assessed by an independent 'Bowden Design Review Panel' for compliance with Design Guidelines	• Master plan, Developer's Handbook and Urban Design Guidelines set out binding requirements for developers • Use of GBCA Green Star system
Lochiel Park	South Australia	Suburban brownfield	State government-led 15ha site, of which 4.25ha allocated as an example project of ecologically sustainable development with 106 houses. Remaining land preserved as urban forest and wetlands. Main emphasis of development on reduced energy consumption and water management. Project started in 2003, with construction completed in 2019.	• State government South Australia as landowner and project leader • High-level political support • Advisory Panel of state and local government officials and community representatives to shape project objectives and development guidelines • Supportive local council	• Master plan and Urban Design Guidelines against which development applications were assessed
Nightingale Village	Melbourne, Victoria	Urban brownfield	Promoted as Australia's first carbon neutral residential precinct, comprising 206 apartments across six buildings of 7-8 storeys each. Lower levels of many of the buildings will have other uses. Scaling up of 'Nightingale model' of sustainable housing developments of individual apartment buildings to neighbourhood scale. Purchase of land in 2016, with construction completed in 2022.	• Nightingale Housing (not-for-profit organisation) • Supportive local council • Core group of architects with experience in sustainability	• Master plan • Use of local authority's Design Excellence Scorecard to prepare development application with systematic consideration of key principles
Mullum Creek	Victoria	Peri-urban greenfield	Private developer-led 20ha eco-development in Melbourne. Development approval for 56 dwellings granted in 2011 with construction estimated to be completed by 2027. Design guidelines focus on the sustainability of the buildings only. Approximately 45% of the land has been donated to Manningham City Council for inclusion in the local reserve system.	• Private landowners as project leader and developer • Design Review Panel (set up by owner) to ensure compliance with Section 173 requirements • Local council support variable over time	• Master plan • Sustainable building Design Guidelines • Amendment to local planning requirements on the site with a Section 173 Agreement setting out binding requirements for environmental sustainability • EnviroDevelopment certification

Project	Jurisdiction	Location	Description	Key actors involved in project / governance arrangements	Key policy drivers
Cape Paterson Ecovillage	Victoria	Rural greenfield	Private developer-led project conceived early 2000s, to be completed in 2024. Approximately 230 detached homes, some short-stay dwellings, a conference centre with café, community building/ education centre and community urban farm. The site is approximately 40 ha, of which half is open space.	• Private developer • Input from sustainability, housing, and planning experts into Design Guidelines • Ethical investors • Design review panel	• Master plan • Sustainable building Design Guidelines
White Gum Valley	Western Australia	Peri-urban brownfield	Government-led development for approximately 80 dwellings on 2.13ha near Perth to be net zero carbon. Focus on different dwelling types with climate sensitive designs. Design Guidelines cover energy efficiency, climate responsive design, renewable energy use, water efficiency, construction, and post-consumer waste reduction, building material selection, biodiversity management, etc. Project launched 2015, One Planet Living accreditation achieved 2016.	• State government Western Australia as landowner and project leader • Supportive local council • Early community participation through a series of workshops • Design review panel, with appointed a WGV Estate Architect to provide advice	• Design Guidelines • One Planet Living accreditation
Witchcliffe Ecovillage	Western Australia	Rural greenfield	Private developer-led low-density eco community. 119.1 ha, with 320 dwellings to be completed in 2030. Other uses include community gardens, commercial and civic facilities. Much of the land will be conservation area or used as agricultural lots.	• Private landowners and developers • Witchcliffe Ecovillage Design Team (design review panel) • Local council (variable support over time)	• Witchcliffe Ecovillage Structure Plan (master plan) • For all lots in the development, Local Development Plans have been adopted by the Augusta-Margaret River Shire that regulate the higher provisions for energy efficiency and other sustainability considerations • Building Design Guidelines
Whiterock	Queensland	Peri-urban greenfield	Developer-led project in a Queensland Government 'priority urban development area'. Development approval for approximately 2,300 dwellings and community and commercial functions. Process started in 2016 and is expected to be completed by about 2032.	• Private landowner and developer • Urban Design consultant • Design Assessment Panel	• Master plan • Design Guidelines • EnviroDevelopment certification
Carseldine Village	Queensland	Peri-urban brownfield	Government-led re-development of former university campus with commitment to net zero energy homes. Planned are 606 dwellings in addition to the non-residential buildings and spaces on 15.7ha with access to public transport, with an additional 20ha of green and open space rehabilitation. Project initiated in 2016 with construction to be completed by 2023.	• State government Queensland as landowner and developer • Local council (discussion over maintenance of public assets)	• Master plan • Flood mitigation strategy • GBCA Green Star Community certification • EnviroDevelopment certification

Project	Jurisdiction	Location	Description	Key actors involved in project / governance arrangements	Key policy drivers
Ginninderry	ACT	Peri-urban brownfield and greenfield	Partnership of ACT government and private developer. Large-scale development of approximately 11,500 dwellings. Construction period about 40 years. The project seeks to become a World Class exemplar for sustainable development at precinct scale.	• Joint venture by ACT government and private developer • Community engagement at beginning of process • State/territory and local councils in NSW and ACT • Ginninderry Design Assessment Team	• ACT Government policy goals of net zero emissions by 2045 and creation of zero emission suburbs • Sustainability Vision for Ginninderry project • Master plan • Housing Design Guidelines • GBCA Green Star Community certification
Scharnhauser Park	Ostfildern (near Stuttgart), Germany	Urban fringe brownfield	Government-led conversion of former US-military site and army barracks (approximately 150 ha). Water and ecosystems management and transport planning (light rail connection to Stuttgart) are integral part of master plan. Mix of types of housing, commercial, industrial, and civic uses. Strong municipal leadership. Planning started in 1992 and development completed in 2006. Today home to approximately 10,000 residents and circa 2,000 jobs.	• Local authority (landowner and project leader) • Local political support • State government Baden-Württemberg • Comprehensive community engagement throughout process • Innovative governance structures for the time, including Urban Design Advisory Board, workshops with developers and architects	• Urban design competition • Integrated urban development concept and Master plan • State Horticulture Exhibition (2002) • Funding from federal, state, county and municipal governments for infrastructure (e.g. rail link) • EU funding for research and awareness-raising
Buiksloterham	Amsterdam, The Netherlands	Urban brownfield	Large-scale development of approximately 14,000 homes on former industrial area combined with commercial spaces and facilities. Started in 2006, completion expected by 2035. Strong CE policy framework and municipal leadership to drive comprehensive sustainability redevelopment agenda.	• Local authority (part landowner, project leader) • Political support / political commitment to circular economy • Stakeholder engagement, resulting in 'Manifesto Circular Buiksloterham'	• Amsterdam Circular Strategy 2020-2025 • Roadmap Amsterdam Climate Neutral • Roadmap Circular Land Tendering (City of Amsterdam) • Reassessment Investment Decision (City of Amsterdam) with aims and targets • Manifesto Circular Buiksloterham • Circular Living Lab (space for experimentation on municipal-owned land) • Municipality-held database and warehouse for previously used materials • Municipal advice on circular economy design and building to self-builders (individual developers)

Project	Jurisdiction	Location	Description	Key actors involved in project / governance arrangements	Key policy drivers
SUPERLOCAL Super Circular Estate	Municipality of Kerkrade, The Netherlands	Urban brownfield	Innovative reuse of existing high-rise apartment buildings in an area affected by population decline and ageing to provide approximately 125 near-zero-energy dwellings. Strong leadership by social housing association, municipality, and city-region. EU funding was important to allow trialling of CE approaches to re-using at least 90% of existing products and materials.	• Social housing provider (owner of apartment buildings) • Local authority (landowner) • Community engagement / Neighbourhood Sounding Board and co-design process	• Dutch national circular economy strategy (2016) • Urban design concept • EU funding to trial CE approaches • IBA Parkstad 2020 to showcase experiences
Kera	Espoo, Finland	Urban brownfield	Example of urban CE living embedded in every phase of the district from pre-construction to post-occupancy. Started in 2018, to be completed by 2035. Mixed-use development with housing for approximately 14,000 residents, office space for circa 10,000 employees, cultural activities, and other services on 58ha of largely privately owned land previously used for warehouse and logistics operations.	• Municipality (project as showcase for circular economy) • Private landowner	• City of Espoo signatory to EU-wide Circular Cities Declaration • Circular Economy strategy for Espoo • Kera sub-regional plan and master plans with CE principles • Development Commitment to be attached to any future land use agreements
Stockholm Royal Seaport	Stockholm, Sweden	Urban brownfield	Sustainable urban development on 236ha publicly owned, inner-urban brownfield that on completion will include a mix of residential developments (12,000 dwellings), cultural activities and public and private sector employment (35,000 jobs). Project started in 2010, completed by late 2020s.	• Municipality (landowner, project leader) • Co-production of city administration and developers to achieve best sustainability outcomes • Public workshops by City of Stockholm on key themes to stimulate learning and knowledge generation	• National policy coordination on sustainability, climate change, energy, and the circular economy • Stockholm as European Green Capital (2010) • City of Stockholm's Sustainable Urban Development Programme, with detailed performance targets for defined dimensions of sustainability • Master plans / strategies for four zones of project area • Competition to select innovative investors • Development Agreements include targets and monitoring requirements for each stage of the development in relation to sustainability objectives • Annual sustainability report on performance by City of Stockholm

Source: Authors.

4. Discussion, conclusions, and policy development options

- **The policy and regulatory framework for sustainable urban development is highly fragmented in Australia. Building regulations are set at the federal level; and states and territories are responsible for urban and regional planning policies. There is a range of sustainability rating tools by different providers to support assessment of building performance and community-scale aspects of developments.**

- **The research found that in Australia, sustainability in planning policy and urban development processes is rarely comprehensively defined. The result is a selective consideration of certain dimensions of sustainability, instead of a more holistic approach that would help close resource loops, avoid the use of non-renewable resources, and achieve inter-generational equality.**

- **The traditional focus of urban development on individual building sites in Australia means that there are considerable barriers to realising the opportunities of neighbourhood-scale planning and design.**

- **There are now many examples of eco-neighbourhoods on greenfield and brownfield sites across Australia. While realising these have not been without challenges, there are even greater trials involved in realising sustainable housing at a neighbourhood scale in urban infill locations.**

- **Discussions in the policy workshops confirmed the research findings and added further insights to policy recommendations.**

- **Different types of policy intervention are required to support sustainable housing at a neighbourhood scale. Higher regulatory standards are needed for both building energy efficiency as well as performance standards for neighbourhood-scale developments.**

- **The research has shown the importance of partnerships of governments, private developers and local communities and suitable governance approaches to realise and manage sustainable neighbourhoods and their infrastructures and services.**

In this chapter, the main points arising from the policy workshops in response to the research findings are first presented. The chapter then turns to drawing overall conclusions from the research in response to the four research questions and to discussing policy implications.

4.1 Key findings from the policy workshops

The exchange with 21 built environment professionals from different sectors across Australia showed great awareness of the benefits of neighbourhood-scale planning for sustainability. Respondents listed several areas for scale efficiencies, including: energy production, group purchasing of green power and community-scale batteries; storm- and rainwater management and water sensitive urban design; urban heat management and green space planning; and the sharing of appliances to achieve a shift to 'providing a service rather than a product' (as a participant from Victoria phrased it). There was also attention to economies of scale in relation to procuring low carbon building materials and energy-efficient products (such as high-performance windows) that are currently more expensive than traditional construction materials. Participants noted that if these materials were purchased for an entire neighbourhood instead of individual buildings considerable cost savings could be realised. Also, it was well understood that costs for sustainable construction products would drop once higher regulatory standards make their use mandatory.

Workshop participants identified numerous challenges to realising sustainable housing at a neighbourhood scale. They confirmed the research findings that sustainability is poorly defined and insufficiently regulated in planning policies and building regulations in Australia. They also agreed that more effective instruments and processes for neighbourhood-scale planning and design are needed. The lack of sufficiently clear definitions of sustainability, let alone CE, in planning and building policies was emphasised as a problem by all participants. Sustainability principles in the strategic planning frameworks of Australian states and territories are very general. This lack of outcome-based thinking filters down to a weak consideration of sustainable development in local planning frameworks. Planning policies rarely provide measurable standards for sustainability, and this presents major challenges for statutory planners when assessing subdivision applications and development applications.

For large developments on greenfield or brownfield land, participants discussed the challenges for neighbourhood-scale sustainability. They suggested that the separation of the subdivision processes into separate land titles on the one hand, and the development assessment process of building applications for the resulting individual lots on the other, presented major challenges for realising neighbourhood-scale efficiencies. Participants agreed that the greatest opportunity to realise sustainability is at the land subdivision design scale (in relation to the layout of streets, open spaces, block size and lot orientation) and in setting building design parameters (through binding Design Guidelines or similar. This is because unless restrictions are placed on the lot titles at the subdivision stage, there are no development assessment mechanisms to ensure that neighbourhood scale policy will be adhered to. This ' sustainability policy gap' was illustrated with the example of Clause 56 on Residential Subdivisions of the Victoria Planning Provisions. A workshop participant from local government in Victoria argued that 'poorly oriented lots at subdivision stage flow through to challenges of achieving optimal energy efficiency at lot level'. Participants provided some examples of demonstration projects in metropolitan locations where it had been possible to consider ESD policy at both the neighbourhood- and the building scale by integrating the processes of subdivision and development approval [12]. To improve the mainstream practice,

12 For Victoria, the examples provided by workshop participants were the Fishermans Bend Framework Plan, the Arden Structure Plan and the Preston Market Structure Plan.

CASBE and partner councils in Victoria have recently undertaken a trial of a Sustainable Subdivisions Framework (SSF). The SSF is intended to provide statutory planners with a basis for measuring and achieving stronger sustainability outcomes in residential subdivisions.[13]

Even where master plan processes and Design Guidelines are used for larger scale developments, many challenges for ensuring sustainability principles are realised at the neighbourhood scale remain. The master plan and Design Guidelines may not include robust sustainability principles to begin with. Moreover, as a participant from South Australia observed, the stated sustainability principles may not be ' followed consistently'. Also, since the implementation of large developments usually takes place over many years, the 'masterplan is [often] not updated iteratively as staged development occurs'.

According to participants, fragmentation in the development process is exacerbated by a fragmentation of stakeholders: land developers are responsible for the subdivision process and volume housebuilders for developing housing. Participants pointed out that for the volume house building industry lot yield is the key concern. This results in a higher economic value being placed on the dimensions of the house (often placed so close to the boundary that airflow is restricted, and most surfaces are sealed) than on design for sustainable and optimal energy efficiency, including solar orientation and water-sensitive urban design. A participant from Victoria criticised that 'often the low hanging fruit of north facing orientation to living areas is avoided in favour of maximising dwelling floor area for future resale value'. Moreover, the popular development model of 'house and land packages' usually means there is little guidance for buyers about the site conditions to realise sustainable designs.

Participants acknowledged that the challenges to realising sustainability at a neighbourhood scale are even greater for infill developments than for subdivision processes. This is due to existing ownership structures and established infrastructures. Lot consolidation processes were seen as lengthy and therefore costly for private landowners who often act as developers and also have to oversee the construction. Aside from ownership structures, participants also identified challenges from planning policy that usually requires new development in an infill location to comply with the character of the existing neighbourhood. This limits opportunities for innovation or the consideration of a long-term perspective of how this neighbourhood might develop. Realising community infrastructures in infill locations can be difficult, as a planner from the ACT explained with the example of battery storage: 'from a statutory policy perspective unless someone volunteers their land, they cannot really be required to deliver this for the benefit of the broader community'.

In terms of circularity within the construction process, a participant from a local authority in Victoria argued that 'changing existing supply chains (from linear to circular) takes time and basically costs developers money to change'. Unless stricter regulations are put in place that require CE approaches in housing development and construction, there is no incentive for developers to change their procurement practices. Higher standards for circular approaches to construction materials and products could, according to participants, be usefully supported by practical examples that demonstrate the benefits of the CE to industry (including in relation to cost advantages).

Several participants remarked on the reluctance of local governments to engage with the perceived risk of 'non-standard' development applications, including in relation to the question of maintenance of public assets. They argued for new funding models and new governance arrangements for neighbourhood-scale infrastructure. It was noted that there are:

> … very entrenched barriers around ownership of land and responsibilities (perceived or otherwise) in the costs for the management of infrastructure …. For example, the coordination of various stakeholders and the timing and delivery of green infrastructure (and then ongoing management) requires considerable effort (State government planner, SA).

13 https://www.casbe.org.au/what-we-do/sustainable-subdivisions/

In addition, if landscaping is delayed until the end of the project it is not unusual that 'much of the remaining budget has been eaten into and landscape (and community areas in general) become less than was originally proposed' (State government planner, SA). A representative from the development industry argued that:

> … local governments within in a typical greenfield setting should take on the roads and the maintenance of the infrastructure after completion, but there is resistance to take this on if the maintenance is perceived as demanding. Also, if the development application proposes to use recycled material in the roadways and this doesn't meet their engineering standards …. then local government often simply rejects it, even though there are sustainability benefits.

Workshop participants identified many political and institutional challenges for sustainable neighbourhood developments. The fragmented policy environment of Australia to realise sustainability was frequently mentioned. The challenges arise not only from the separation of planning and building permit processes (and their origins at different government levels) but also materialise across jurisdictions. A local government planner from Victoria argued that:

> … larger developers who operate across multiple states and are possibly interested in larger neighbourhood scale development face additional regulatory risk as the planning systems are quite different in each state. Moreover, often NCC requirements also are different in each state.

While state and territory governments are key actors for setting planning policy frameworks and leading on urban renewal projects, local councils and their administrations have an important role in local planning and development assessment processes. One workshop participant from a local authority in Victoria noted that 'political support [from council] is essential to support CE markets'. Workshop participants acknowledged that many statutory planning authorities, especially those outside metropolitan areas, have limited resources and lack the capacity to comprehensively review development applications in relation to sustainability. A local government representative noted a 'skill shortage, generally, in the sector, particularly in engineering, project management, environmental health, and sustainability'. Therefore, in a smaller council:

> … the sustainability area might end up in the engineering department, with the engineer being the one to manage questions related to urban sustainability or CE in planning and may not have that sort of skill set or interest or be risk averse to actually trying something different. (Workshop participant from local government)

In terms of policy implications, there was general agreement among workshop participants that higher regulatory standards for both building performance and neighbourhood-scale sustainability are essential for an urban sustainability transition. A state government planner from SA argued that 'unless it's embedded in legislation, we might have some good demonstration projects and ideas, but it won't become mainstream'. To improve the opportunities for sustainable neighbourhood planning, many workshop participants emphasised the need for higher and—importantly—performance-based and measurable standards. It was argued that these must be dynamic so that they can be adapted to improving sustainability standards over the often many years of project implementation. If requirements for sustainability at the neighbourhood scale were clearly defined from the outset, then workshop participants believed that development industry practices would quickly adapt. A state government planner from SA suggested that 'if the mindset was that this is expected then the coordination and facilitation of sustainability would become routine'. Workshop participants emphasised that performance-based policies for sustainable housing at a neighbourhood scale would require investment in public planning authorities, so that planning officers had the capacity and also the required expertise to assess such development proposals.

There was agreement among workshop participants that different neighbourhood typologies (greenfield, brownfield, infill, medium density, high density) require different approaches to realising sustainable housing at a neighbourhood scale. It was acknowledged that Australia has a major task to catch up to other advanced economies in sustainability and CE after years of lacking government leadership and the resulting 'regulation void' (urban planning consultant, Victoria). It was argued that a sustainability or CE transition will require:

> … a better partnership between all the regulators, that is, local government, state government, different state government departments, infrastructure providers, to make sure we can get better integrated infrastructure and sustainable neighbourhood design. (workshop participant from development industry)

In terms of realising the policy transition, a workshop participant from the housing industry argued that:

> … the only way you're going to move that dial is to legislate, regulate, whichever word you want to use. You've got to bring some minimum requirements into the game on the neighbourhood scale if we want to see real change.

There were arguments that regulatory reform should be supported by an 'ecosystem of solutions, with policy changes occurring over the short term, medium term and long term, integrated with capacity building across stakeholders' (workshop participant from a local authority, Victoria). Several participants thought that political processes, such as changes to the planning system, will require a longer timeframe. This prompted a discussion about the 'quick wins' that could be realised in the interim. At building scale, mandatory disclosure of building energy efficiency, as already practiced in the ACT, was suggested. Further, a participant from the NSW state government argued that:

> … consumer awareness and the financial sector are two levers that could be considered in the shorter term. At a precinct level, for example, could you have some way of having home upgrades done efficiently across the whole block with all solar panels and battery installed together [and thus more cheaply, and possibly supported by financial incentives for applications by communities]?

Aside from policy and regulatory reform and financial incentives, there was a general agreement among workshop participants that more education and training on sustainability and CE will be required. This would be beneficial not only for local councillors and government planners, but also for industry and consumers/the public. A workshop participant from a state government department in Victoria said that based on previous studies they found that developers do not have:

> … heaps of confidence in the builders to get it to seven star or wherever you're trying to get it. And there isn't a lot of confidence in the salespeople either, they don't know the ins and outs of energy efficiency and sustainability features of homes.

In some jurisdictions, there is some attention to the upskilling of volume builders already underway, such as in the context of Sustainability Victoria's Seven Star Homes program. The 'opt-out model' for house and land packages that is being practised by a large housebuilder in Victoria was also mentioned as a possible approach to overcome the limitations of poor ESD literacy by sales consultants and to stimulate more attention to longer term savings for running costs of higher performing homes. This approach stands in contrast to the traditional model, whereby potential buyers are presented with sustainability 'add-ons' such as PV panels, and was seen as being able to contribute to higher standards in new houses. Yet, also more education of 'consumers' (houseyers or tenants) was deemed necessary. A workshop participant from the ACT Government argued that:

> … even with a 10 star house, you can have a one star user living in it. So people can have the best house and … still be guzzlers of electricity.

Others felt that there may be considerable awareness in communities already of what sustainability means at the neighbourhood level, but that realising it is fraught with practical barriers. Several participants suggested that local councils could have a central role in providing support for residents and (small) developers to help them realise their sustainability ambitions, including with advice on sustainability retrofitting and lot consolidation.

4.2 Who are the key institutional actors for realising sustainable neighbourhoods in different locations?

When analysing mainstream housing practices, the research demonstrates that neighbourhood-scale developments and sustainable circular urban development outcomes are not well institutionalised. Current policy frameworks favour the building scale, and prioritise economic yield over sustainable design outcomes. There are insufficient requirements nor specific incentives for developers to work at the neighbourhood scale. Sustainability is often vaguely defined in planning policy. There is insufficient focus on to setting clear objectives and measurable targets for sustainability—at a building scale and beyond the building scale—that enable performance to be monitored.

In Australia, the key institutional actors involved in realising sustainable housing at a neighbourhood scale are state and territory government planners (for urban renewal projects), local government planning departments (for subdivision, lot consolidation and development assessment processes), developers and urban designers and consultants. It is largely the interaction between these groups of actors that determines what, if anything, can be done in relation to CE at a neighbourhood scale beyond any minimum planning and construction requirements. Within the current framework, local councils and statutory planners are critical gatekeepers of more progressive opportunities in relation to sustainability at a larger scale. With policies that favour the building scale and prioritise economic investment over sustainability aspirations, it is the local planning authority that often decides the fate of innovative proposals that exceed minimum requirements. If a development proposal is assessed by a risk averse statutory planning department - be it because of lack of interest in sustainability, lack of expertise, or concerns over maintenance costs of public assets as part of the development – considerable delays and cost increases are often the consequence. In several of the cases analysed, the sustainability ambitions for the development proposals were watered down in response to requirements stipulated by the local authority.

Clearly, these 'implementation' actors work within the statutory structures adopted by parliament or local councils, with ministers and local councils frequently also involved in decisions on development proposals. State governments have a central role as policy makers for urban and regional planning frameworks, and for setting political priorities in relation to sustainability and CE and neighbourhood scale developments. State government agencies also play a role as a developer of major urban renewal projects, and for demonstrating good practices in sustainable neighbourhood developments. The Australian Government, as the guardian of the NCC, plays an important role for standards on building sustainability. Australia's renewed commitment to international agreements on climate change might also prompt policy change of relevance to urban sustainability and CE at state and local levels. Depending on the division of competences within states and territories, local councils can be key players for local policy innovation on sustainability. In the context of weak measurable standards for sustainable neighbourhood developments, the political composition of local councils can play an important role in supporting or hindering their realisation. Given the weak policy frameworks currently available to realise sustainable housing at a neighbourhood scale in Australia, political support at all government levels is a key factor. Achieving an urban sustainability transition and facilitating neighbourhood-scale developments requires political leadership and support for far-reaching regulatory and policy changes.

Other actors play a role in structurally influencing opportunities for sustainable housing at a neighbourhood scale. Local communities can be supportive and provide useful inputs for the project, or they can be vocally opposed to the development and thereby influence local political decision-making. Early cooperation with communities, beyond statutory requirements, can help with turning critics into supporters for the ambitions of eco-neighbourhoods. There are currently few incentives for developers to use recycled materials and reused products in construction, and to addressing the challenges related to changing supply chains from a linear to a circular model. The research found that financing of eco-neighbourhoods, and of infrastructure at neighbourhood scale more generally, can present important challenges. Sustainable neighbourhood projects are often faced with increasing costs due to delays in the process and with lenders often reluctant to support projects that are perceived as higher risk.

4.3 What drivers and dynamics are critical in supporting a transition to sustainable neighbourhoods in different locations?

In Australia, planning policies and building regulations favour the building scale, with weak instruments available for coordinating the realisation of neighbourhood-scale developments. In greenfield and brownfield locations, the separation of subdivision processes and development assessment procedures presents important challenges. Unless binding Design Guidelines or similar instruments have been drawn up and their implementation is monitored any neighbourhood scale considerations as expressed in a master plan are impossible to filter down to the lot scale. Yet even with Design Guidelines in place, the research found that sustainability in Australian neighbourhood-scale developments is mostly focused on selected aspects of the concept instead of being comprehensively considered. Also, there is currently insufficient attention to assessing whether development outcomes are compliant with permit conditions in terms of both building performance and neighbourhood-scale sustainability.

The challenges for greyfield / urban infill neighbourhood development are even greater due to fragmented ownership structures. Processes for lot consolidation can be complicated and time-consuming to realise. Requirements for infill development to correspond to the character of the existing neighbourhood and limitations for realising community infrastructures on private land present important challenges. As a consequence, examples of infill eco-neighbourhoods are difficult to find. New development models will be needed to support lot consolidation processes for sustainable neighbourhood planning and design. Given the complexity of these setting, projects will require local governments and developers to work closely with the community of existing residents.

While eco-neighbourhoods on greenfield land (through developing virgin land) add to the environmental footprint of urban development, they also face challenges in reducing reliance on private cars. This is because access to public transport is usually limited or non-existent. Moreover, there can be negative local attitudes to 'untypical' eco-neighbourhood proposals that depart from the established status quo of large lots and detached dwellings in rural or peri-urban settings. On the other hand, despite a policy emphasis on urban renewal and infill development, rezoning of previously undeveloped land remains a popular practice in Australia. Land in greenfield locations is therefore still easy to access, and often cheaper, than sites in urban locations. Unless the protection of greenfield land is taken seriously by all governments in Australia there will be limited incentives to improve the current models for greyfield development. On the other hand, developing eco-neighbourhoods in a peri-urban or rural setting also offers the opportunity for realising truly off-the-grid and self-sufficient communities. Brownfield sites may be contaminated or have a 'dirty' image that can present challenges. However, as with infill developments, they are usually located in an urban development context that offers many opportunities in terms of higher densities (and smaller ecological footprints), sustainable mobility, and establishing connections to the existing community.

Overall, the research found that clear leadership and transparent responsibilities are very key to realising eco-neighbourhood developments. The case studies demonstrate that a strong and comprehensive vision for the sustainable or CE neighbourhood is important. In particular, the European cases highlighted the value of wide stakeholder and community engagement in ensuring this vision is widely supported. To ensure that the guiding vision for the sustainable neighbourhood will be respected over many years of implementation, policy instruments such as master plans, urban development frameworks, or binding Design Guidelines proved important. Competitions and tendering can play an important role in lifting standards and fostering innovation, but such instruments appear to be currently underused in Australia.

The research highlighted the central role of local planners to influence sustainable neighbourhood ambitions. Interested and responsive local council officers who are willing to work with the developer to identify the best possible outcome were frequently cited as key to realising sustainable neighbourhoods. They can champion the proposed project in discussion with local politicians and the community. Some of the case studies experienced major challenges after a supportive officer changed roles. There are other examples of local planning departments delaying or blocking non-traditional proposals due to a lack of understanding, risk aversity or concerns over maintenance costs for community infrastructures that were to be developed as part of the proposed project. Given weak mandatory standards, in the current system the capacities and expertise of statutory planners, and their interest in sustainability, are essential to facilitate the implementation of 'above-code' projects.

Local communities can also play an important role in shaping sustainable neighbourhood projects and possibly influencing the local council's position on whether to support the proposal. The examples show the value of engagement and co-design processs with local communities (both those adjacent to the development and future residents of a proposed eco-neighbourhood) in shaping outcomes. Arguably, this aspect would benefit from more attention in Australian planning and development processes.

4.4 What are the needs and opportunities for professional training to support a transition to sustainable neighbourhoods?

The research showed that education for all stakeholders on what CE or urban sustainability means in practice is vital, particularly at a scale beyond the individual building. Even the Australian good practice eco-neighbourhoods analysed for this research demonstrated limited engagement with a comprehensive understanding of sustainability or CE. While CE may still be a new concept in Australia, there has been much work undertaken internationally on defining and operationalising sustainable development and developing targets and indicators to measure whether sustainability is achieved in urban development. Yet, the research found little evidence of such frameworks being used in Australian processes. They are not required in a policy setting where sustainability is usually defined in vague terms only. However, even the case studies of eco-neighbourhoods analysed for this research did not use a comprehensive definition of sustainability, and there was little attention to how outcomes could be measured.

Statutory planners keen to improve sustainability outcomes find it difficult to require higher sustainability outcomes if demands cannot be justified based on existing policy. For all actor groups in Australia, there is more education and training required on sustainability, and on neighbourhood scale approaches and how to realise them. The European case studies showed the value of providing information to local politicians on sustainable development and neighbourhood-scale approaches. This increases their awareness of available opportunities and fosters interest in urban sustainability initiatives. Local council officers were identified as being a key point in the process where things could be held up. Some of this relates to a lack of capacity or lack of interest in sustainability by individuals. However, it is likely also indicative of limited knowledge and capacity within the institution and a risk averse political context. A skills shortage has been identified for many local governments across Australia, and in relation to sustainability expertise especially in smaller councils. The survey results highlighted that the value of ongoing training on concepts such as sustainability and CE, where knowledge on 'how to do things' is still emerging, is widely recognised. However, the research found no evidence that there is systematic consideration to these topics in organisational training processes of government departments or industry, with upskilling usually left to the individual employee's initiative.

4.5 What are the key policy instruments of relevance to achieve a transition to sustainable neighbourhoods in different locations and what are the main policy recommendations?

The research found major challenges to realising sustainable housing at a neighbourhood scale in Australia. Important barriers are the fragmentation of policy and regulatory frameworks for sustainable urban development, a weak statutory basis for sustainability, and inadequate mechanisms for realising neighbourhood scale projects. Building regulations are set at a federal level, while states and territories are responsible for urban and regional planning policies. Housing developments are usually designed and realised at the scale of individual building sites. While numerous dwelling and community-scale design and performance sustainability rating tools are available in Australia, their use is mostly voluntary and their application consequently variable. The research found that while awareness about the value of CE actions at the neighbourhood scale is growing among built environment professionals, they find it challenging to navigate the governance and policy landscape.

There is a growing number of eco-neighbourhoods internationally. Such initiatives are still niche experiments that face challenges in their realisation. There is no evidence that insights from sustainable neighbourhood projects are mainstreamed into planning and development processes. In Australia, good practice eco-neighbourhoods rarely demonstrate a comprehensive vision for a sustainable or CE neighbourhood, and instead focus on selected dimensions of sustainability. Also, the potentials of a neighbourhood scale approach are not fully realised in many Australian examples. While there is scope for improvement across all case studies analysed, the case studies from Europe offer more convincing examples of how integrated visions for sustainable housing at the neighbourhood scale can be realised. They reflect a maturing understanding of urban sustainability and CE in the built environment, and are shaped by supportive political and economic realities of planning and implementing large urban CE projects.

A key finding of the research is that minimum building requirements and planning policy frameworks in Australia are currently insufficient to support an urban sustainability transition. Much stricter regulatory standards for sustainability will be needed at both the building and the neighbourhood scale. This indicates a realisation by stakeholders that a sustainability transition cannot be realised based on voluntary industry action but requires a strong steering from governments at all levels. Planning, designing, and implementing sustainable housing at a neighbourhood scale will only become common practice with stricter standards and mandatory targets on sustainability in planning and building regulations and for neighbourhood-scale developments. These policies and standards should be coordinated across levels of government and between jurisdictions and would ideally be developed in discussion with policy sector departments for transport, environment, and the economy. Mainstreaming sustainable neighbourhoods would usefully be supported by a review of the current fragmented landscape of sustainability rating tools and by making sustainable community assessment tools mandatory.

In terms of building performance, the standards of the NCC will require significant strengthening if Australia is to catch up to international practices. There are good arguments for complementing stricter NCC standards with mandatory disclosure requirements on building performance as already practiced in the ACT. Experiences from the EU on the value of energy labels for new-built or retrofitted dwellings to lift standards, make them comparable, and to increase consumer awareness, can also offer inspiration.

There was great support from research participants for clear definitions, goals, and targets on sustainable development and CE in planning policy frameworks. Most research participants argued for such standards and targets to be performance-based to leave flexibility for how sustainability goals are achieved in different contexts and over time. A focus on performance will, however, require the setting up suitable monitoring systems to assess compliance during construction and post-completion. This not currently given sufficient attention in development processes in Australia where permits and sustainability certification ends with the development approval stage. Defining urban sustainability performance-based standards is primarily a role for state and territory governments as the responsible tier for urban and regional planning. However, ideally, these would be developed jointly by states and territories to create a level playing field across jurisdictions. There would also be considerable value in involving local governments in these discussions, as the government tier closely involved with development dynamics and community concerns and where policy innovation on urban sustainability is already occurring.

In terms of realising sustainability at the neighbourhood scale, the research found that policy frameworks in Australia are overwhelmingly focussed on the scale of the individual building. Insufficient attention is afforded to the opportunities of the neighbourhood-scale in achieving sustainable housing outcomes. An important first step to ensure that neighbourhood sustainability considerations are carried forward to the actual development stage would be an integration of the subdivision and development assessment processes under ESD considerations for developments on large greenfield and brownfield sites. The experiences of CASBE and Victorian partner councils on the SSF can provide inspiration for other groups of local councils and/or state and territory governments to review their processes.

The current instruments for master planning in Australia would usefully be strengthened to ensure they allow a comprehensive consideration of sustainability. Examples from Europe with comprehensive urban sustainable development frameworks can offer inspiration for how sustainability or CE objectives can be interpreted for specific contexts and translated into legally binding plans. The research demonstrates how such frameworks can be important to communicate the vision for the project to relevant stakeholders and the wider public to ensure widespread support. The European examples show how integrated urban development frameworks have been used to guide eco-neighbourhood developments over many years of implementation while allowing flexibility to adapt to new standards and knowledge. In Australia, Design Guidelines are an important instrument to ensure that master plan requirements become binding for individual lot developers. However, the research found that such instruments often focus on building scale conditions only, with limited consideration of neighbourhood-scale requirements.

In terms of the process management of realising eco-neighbourhoods, the case studies have shown the importance of realising 'key structuring features' on the site before housing is built. Landscaping, such as green and blue infrastructures, public transport connections and active travel solutions, can improve housing quality and foster sustainable lifestyles. In Australia, such infrastructures and services are often provided only at the end of the development process, after housing construction has been completed. This leaves little opportunity for fostering community connections and for reducing car dependence.

Changes to the financing landscape will be important to facilitate the realisation of sustainable neighbourhoods. For example, ethical investment practices could be rewarded that prioritise quality and legacy of development projects over quick financial returns. Related to this is the question of financing of infrastructures at the neighbourhood scale. The research identified the need for new financial models to support the realisation of such community structures in different development locations. There might also be a role for new partnership models for local councils and developers to share the benefits and additional costs of the community provisions of sustainable neighbourhood developments. The case studies offer some examples of how this could be achieved. Also, new models for public engagement, beyond statutory requirements, should be considered to support a shift in behaviour of residents to internalise sustainable lifestyles and bottom-up CE innovation.

Stronger policy frameworks and higher regulatory standards will be needed if sustainable housing at a neighbourhood scale is to move from niche product into the mainstream. There are additional policy instruments that can support the transition and adjustment of the development and housing industry. The research identified education and training of key actors and the community/consumers as very important to support the urban sustainability transition. There may also be a role for temporary financial or fiscal incentives to support industry in the uptake of new practices and communities in retrofitting their neighbourhoods. There is also a need for new governance models. Partnerships between planning authorities and private developers in development assessment processes and to maintain community infrastructures have been trialled in some Australian cases. Examples from Europe of new governance approaches and partnership models between public and private sector actors and local communities can also offer inspiration for Australia. The analysis has shown how a focus on governance and co-creation helped with gathering support for the proposals and to enable bottom-up CE initiatives and experimentation.

Delays in development assessment processes can result in considerably higher costs for developments that exceed minimum requirements, and sometimes put the entire project in jeopardy. The research found that a lack of interest or lack of expertise of statutory planners and fear of risks (for example in relation to maintenance costs of community structures) are often the reason for hesitation to grant development approval. If sustainable neighbourhood developments are to become common practice, then such processes need to be improved. Higher regulatory standards might eventually remove such barriers, but they may take some time to become adopted. In the meantime, more support for local councils to lower the risks perceived as inherent in 'untypical' developments such as eco-neighbourhoods will be important. Projects that exceed minimum requirements are often seen as placing higher demands on planning and development processes and as resulting in higher costs for the maintenance of public assets developed as part of such projects. Shifting the attitudes of statutory planning departments will require support from state and territory governments to increase capacity of desk

officers and education of politicians. Better resourcing of local councils would also put them in a position to become a one-stop-shop on neighbourhood sustainability, able to provide information and offer advice to developers (such as on lot consolidation) and to residents (such as on sustainable retrofitting of their neighbourhood).

Finally, there is policy change needed that prioritises previously used and recycled materials over new ones so that a market for such products can develop. There is a lack of consideration for the re-use of materials and structures in construction. New products and materials are still cheaper to procure than recycled ones. They are also favoured by regulatory standards. There needs to be a policy change to support the use of reused and recycled products and materials in urban development so that an industry can develop. The databases and physical warehouses of previously used materials and structures, such as those trialled in some of the European case studies, can be useful tools to facilitate the procurement of reused or recycled building materials and products.

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Appendix 1: Dimensions of sustainable housing at a neighbourhood scale

Land use	• Efficient and effective use of land (densities, layout, access to infrastructures and services) • Prioritising brownfield and greyfield development over greenfield development
Housing	• Mix of dwelling types • Mix of tenure • Affordable housing • Variety and flexibility in designs, floor areas and layouts
Community spaces to protect resources and strengthen social interactions	• Community spaces (local meeting spaces, community gardens etc.) • Community facilities (shared laundry facilities etc.) • Design safety and security at a neighbourhood scale (natural oversight of walkways and public spaces)
Greenhouse gas emissions reduction and energy conservation	• Passive solar design: orientation of buildings and site layout (passive solar gain, solar control / shading, natural ventilation) • On-site renewable energy production • Distributed renewable energy systems and energy storage / micro-grids • Community renewable-energy schemes (e.g. peer-to-peer energy trading) • Electric vehicle charging points
Water conservation	• Integrated neighbourhood-scale water systems • Rainwater harvesting • Stormwater retention and treatment, incl. permeable paving for on-site stormwater retention • Greywater recycling for non-potable use • Water-sensitive dwelling and precinct design
Green and blue infrastructures, ecology and biodiversity	• Native vegetation and enhancing biodiversity • Access to quality public green spaces • Water-sensitive urban design • Facilitating food production on-site / community gardens
Reduction of heat island effects	• Green space provision • Passive cooling through shading and natural ventilation
Mobility	• Integrated transport and land use planning • Mixed-use developments to reduce need to travel • Public transport access (selection of location) • Walkable neighbourhood designs and sidewalk improvements • Bike lanes • Active travel options, incl. end-of mile facilities • Minimise car parking spaces • Bike sharing • Car-pooling / car-sharing systems • E-mobility and ride-sharing opportunities

Waste minimisation	• Composting facilities • Exchange and repair services • Recycled construction and demolition waste • Reused materials in surfaces etc.
Materials	• Renewable/sustainable sources in construction or for infrastructures (e.g. sustainably forested timber) • Refurbishment of existing buildings • Reuse of previously used structures (e.g. parts of buildings) • Reuse of recycled materials in construction (e.g. bricks) • Recycled content used (e.g. recycled aggregate in concrete or for road / path paving)
Adaptability and resilience	• Adaptive reuse of existing buildings on-site • Planning for 'life cycles' of residents

Source: Based on Collia and March (2012); Newton, Newman et al. (2022); EcoDistricts (2014); Liaros (2021).

Appendix 2: Screenshot of online survey questions as disseminated to key built environment professions in Australia

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Page 1

Sustainable housing at neighbourhood scale

We invite you to complete a survey on Sustainable housing at neighbourhood scale. We are interested in the way the planning and urban development sector is applying aspects of circular economy thinking to new urban infill and greenfield developments.

By the term 'circular economy' we mean the approach taken by the planning and urban development sector to protect non-renewable and scarce resources, and eliminate waste. In particular, it refers to the systems used to minimise resource inputs, and approaches to reusing, repairing, refurbishing, remanufacturing and recycling materials and products to create a closed-loop system that reduces waste and emissions in urban planning, design and construction.

The target audience for the survey includes individuals and organisations working on neighbourhood scale residential developments. 'Neighbourhood' means projects of multiple buildings or dwelling units in a single precinct and that may share infrastructure (e.g. water, energy).

We are seeking feedback from:

Architects Builders Consultants Developers Engineers Landscape Architects Planners Policy Makers Regulators Trades Urban Designers. The survey contains a short set of easy to answer open and closed questions on the challenges and opportunities for sustainable housing at neighbourhood scale. All responses will be confidential, data will be coded to protect your privacy, and findings will be aggregated to safeguard anonymity.

This survey is part of a project funded by the Australian Housing and Urban Research Institute (AHURI) and undertaken by researchers from the University of South Australia and RMIT University. Project findings are expected to inform policy-makers and industry about the opportunities and challenges for achieving sustainable housing.

The project has been granted ethics approval by the University of South Australia (ID: 203944), and the survey meets the requirements of the National Statement on Ethical Conduct in Human Research. For further information about the project please contact the Project Leader, Professor Stefanie Dühr, University of South Australia (email: stefanie.duehr@unisa.edu.au, phone: +61 8 83020636)

Thank you for participating in the survey.

AHURI Australian Housing and Urban Research Institute

University of South Australia

RMIT UNIVERSITY

Survey Guide

Most questions provide a selection of common responses, plus an opportunity for you to add a supplementary response. Please select one or more of the answers within a single question that best represents your typical experience.

There are a number of open ended free text questions that allow you to describe your experience in your own words.

You can save your responses and return to the survey at a later time. Please note the unique code that is provided when you choose to save and return. When returning using the standard web link, the returning button is on the top right of screen.

We anticipate the survey will take between 10-20 minutes to complete depending on your level of involvement with circular economy practices.

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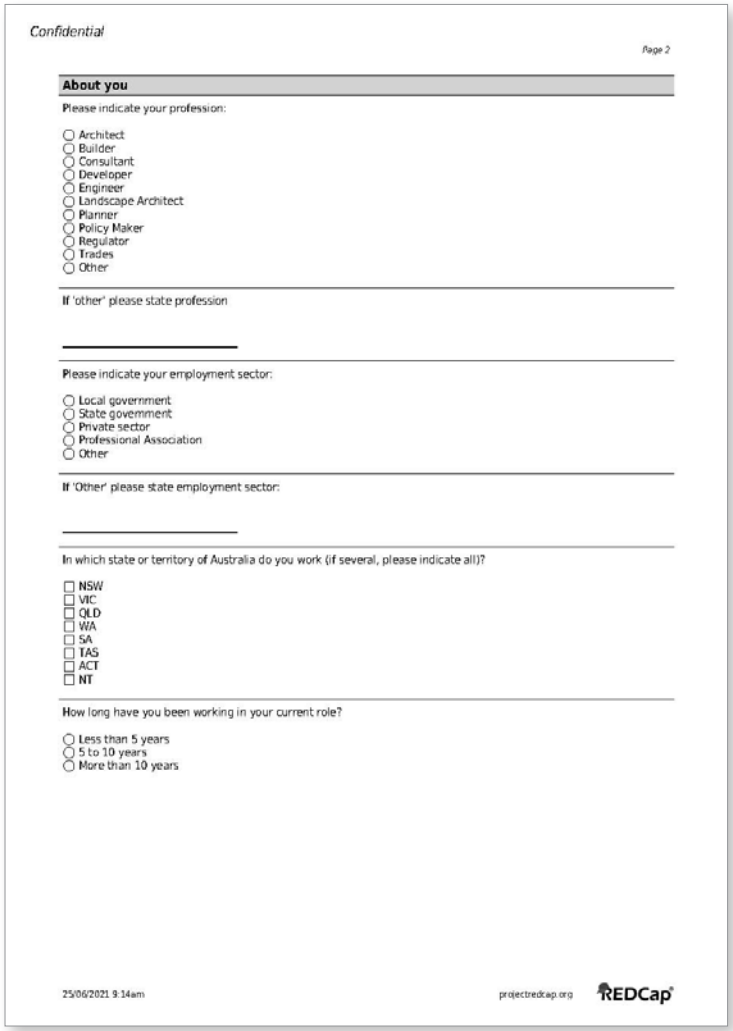

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About you

Please indicate your profession:

- ○ Architect
- ○ Builder
- ○ Consultant
- ○ Developer
- ○ Engineer
- ○ Landscape Architect
- ○ Planner
- ○ Policy Maker
- ○ Regulator
- ○ Trades
- ○ Other

If 'other' please state profession

_____

Please indicate your employment sector:

- ○ Local government
- ○ State government
- ○ Private sector
- ○ Professional Association
- ○ Other

If 'Other' please state employment sector:

_____

In which state or territory of Australia do you work (if several, please indicate all)?

- ☐ NSW
- ☐ VIC
- ☐ QLD
- ☐ WA
- ☐ SA
- ☐ TAS
- ☐ ACT
- ☐ NT

How long have you been working in your current role?

- ○ Less than 5 years
- ○ 5 to 10 years
- ○ More than 10 years

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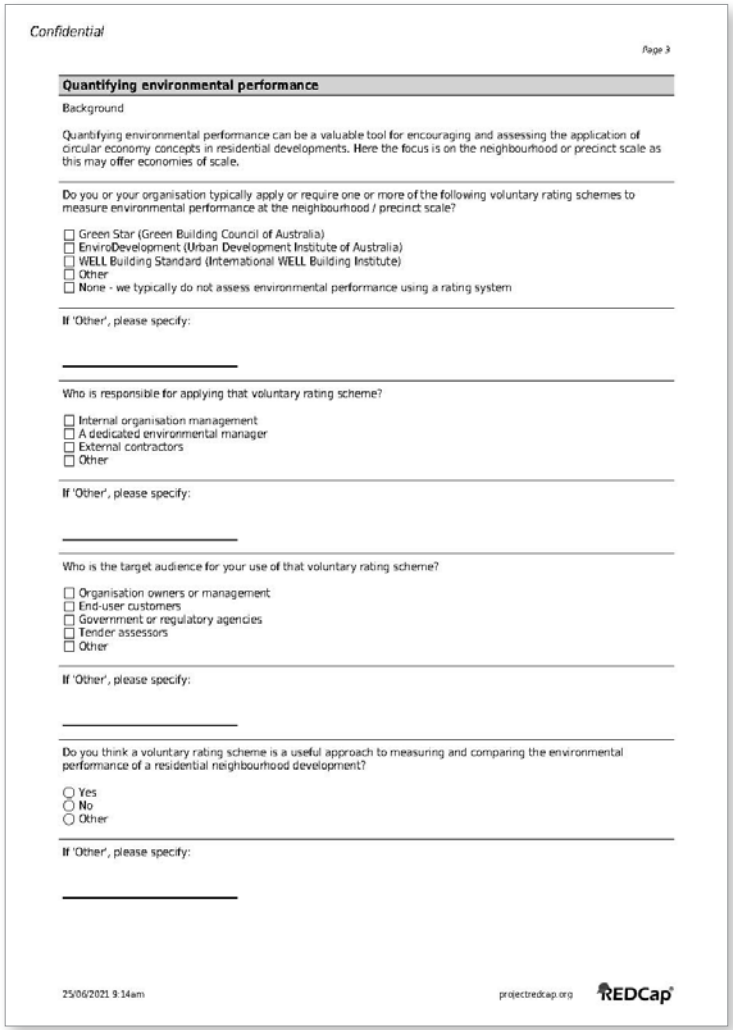

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Page 3

Quantifying environmental performance

Background

Quantifying environmental performance can be a valuable tool for encouraging and assessing the application of circular economy concepts in residential developments. Here the focus is on the neighbourhood or precinct scale as this may offer economies of scale.

Do you or your organisation typically apply or require one or more of the following voluntary rating schemes to measure environmental performance at the neighbourhood / precinct scale?

- ☐ Green Star (Green Building Council of Australia)
- ☐ EnviroDevelopment (Urban Development Institute of Australia)
- ☐ WELL Building Standard (International WELL Building Institute)
- ☐ Other
- ☐ None - we typically do not assess environmental performance using a rating system

If 'Other', please specify:

_____

Who is responsible for applying that voluntary rating scheme?

- ☐ Internal organisation management
- ☐ A dedicated environmental manager
- ☐ External contractors
- ☐ Other

If 'Other', please specify:

_____

Who is the target audience for your use of that voluntary rating scheme?

- ☐ Organisation owners or management
- ☐ End-user customers
- ☐ Government or regulatory agencies
- ☐ Tender assessors
- ☐ Other

If 'Other', please specify:

_____

Do you think a voluntary rating scheme is a useful approach to measuring and comparing the environmental performance of a residential neighbourhood development?

- ○ Yes
- ○ No
- ○ Other

If 'Other', please specify:

_____

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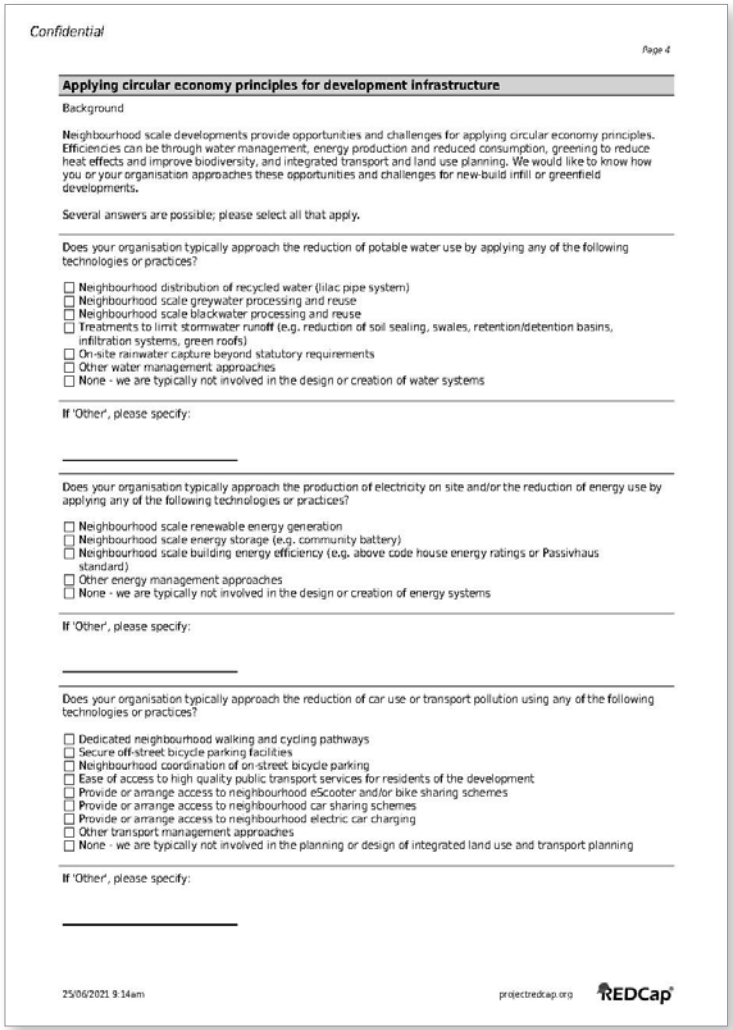

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Page 4

Applying circular economy principles for development infrastructure

Background

Neighbourhood scale developments provide opportunities and challenges for applying circular economy principles. Efficiencies can be through water management, energy production and reduced consumption, greening to reduce heat effects and improve biodiversity, and integrated transport and land use planning. We would like to know how you or your organisation approaches these opportunities and challenges for new-build infill or greenfield developments.

Several answers are possible; please select all that apply.

Does your organisation typically approach the reduction of potable water use by applying any of the following technologies or practices?

- ☐ Neighbourhood distribution of recycled water (lilac pipe system)
- ☐ Neighbourhood scale greywater processing and reuse
- ☐ Neighbourhood scale blackwater processing and reuse
- ☐ Treatments to limit stormwater runoff (e.g. reduction of soil sealing, swales, retention/detention basins, infiltration systems, green roofs)
- ☐ On-site rainwater capture beyond statutory requirements
- ☐ Other water management approaches
- ☐ None - we are typically not involved in the design or creation of water systems

If 'Other', please specify:

_____

Does your organisation typically approach the production of electricity on site and/or the reduction of energy use by applying any of the following technologies or practices?

- ☐ Neighbourhood scale renewable energy generation
- ☐ Neighbourhood scale energy storage (e.g. community battery)
- ☐ Neighbourhood scale building energy efficiency (e.g. above code house energy ratings or Passivhaus standard)
- ☐ Other energy management approaches
- ☐ None - we are typically not involved in the design or creation of energy systems

If 'Other', please specify:

_____

Does your organisation typically approach the reduction of car use or transport pollution using any of the following technologies or practices?

- ☐ Dedicated neighbourhood walking and cycling pathways
- ☐ Secure off-street bicycle parking facilities
- ☐ Neighbourhood coordination of on-street bicycle parking
- ☐ Ease of access to high quality public transport services for residents of the development
- ☐ Provide or arrange access to neighbourhood eScooter and/or bike sharing schemes
- ☐ Provide or arrange access to neighbourhood car sharing schemes
- ☐ Provide or arrange access to neighbourhood electric car charging
- ☐ Other transport management approaches
- ☐ None - we are typically not involved in the planning or design of integrated land use and transport planning

If 'Other', please specify:

_____

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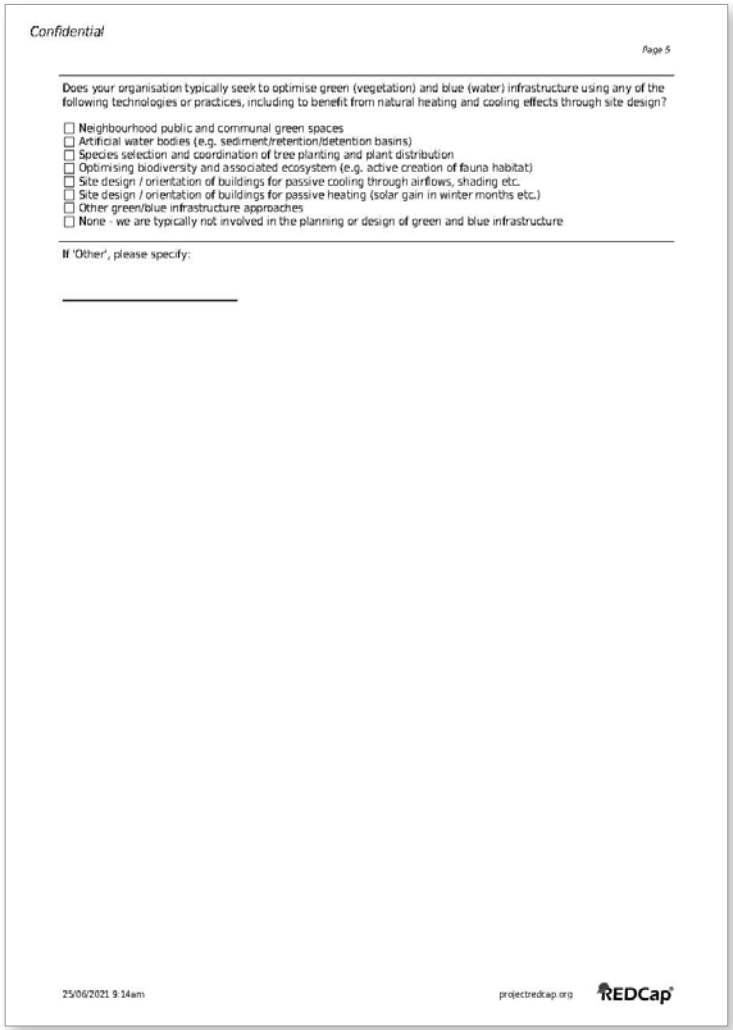

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Does your organisation typically seek to optimise green (vegetation) and blue (water) infrastructure using any of the following technologies or practices, including to benefit from natural heating and cooling effects through site design?

- ☐ Neighbourhood public and communal green spaces
- ☐ Artificial water bodies (e.g. sediment/retention/detention basins)
- ☐ Species selection and coordination of tree planting and plant distribution
- ☐ Optimising biodiversity and associated ecosystem (e.g. active creation of fauna habitat)
- ☐ Site design / orientation of buildings for passive cooling through airflows, shading etc.
- ☐ Site design / orientation of buildings for passive heating (solar gain in winter months etc.)
- ☐ Other green/blue infrastructure approaches
- ☐ None - we are typically not involved in the planning or design of green and blue infrastructure

If 'Other', please specify:

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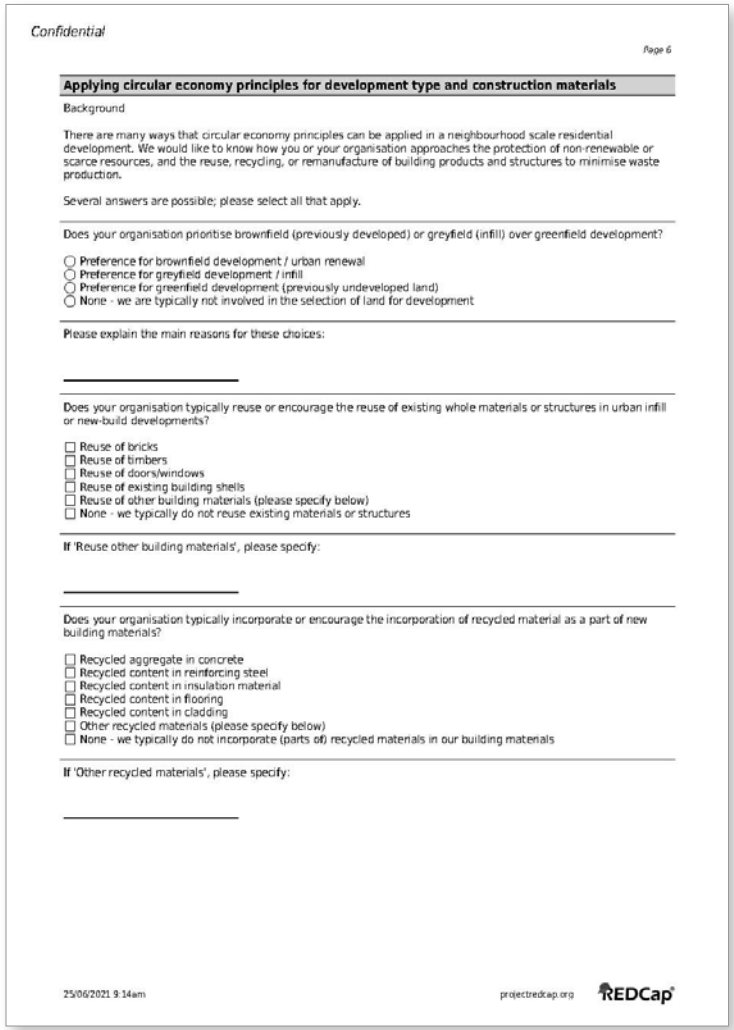

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Applying circular economy principles for development type and construction materials

Background

There are many ways that circular economy principles can be applied in a neighbourhood scale residential development. We would like to know how you or your organisation approaches the protection of non-renewable or scarce resources, and the reuse, recycling, or remanufacture of building products and structures to minimise waste production.

Several answers are possible; please select all that apply.

Does your organisation prioritise brownfield (previously developed) or greyfield (infill) over greenfield development?

- ◯ Preference for brownfield development / urban renewal
- ◯ Preference for greyfield development / infill
- ◯ Preference for greenfield development (previously undeveloped land)
- ◯ None - we are typically not involved in the selection of land for development

Please explain the main reasons for these choices:

Does your organisation typically reuse or encourage the reuse of existing whole materials or structures in urban infill or new-build developments?

- ☐ Reuse of bricks
- ☐ Reuse of timbers
- ☐ Reuse of doors/windows
- ☐ Reuse of existing building shells
- ☐ Reuse of other building materials (please specify below)
- ☐ None - we typically do not reuse existing materials or structures

If 'Reuse other building materials', please specify:

Does your organisation typically incorporate or encourage the incorporation of recycled material as a part of new building materials?

- ☐ Recycled aggregate in concrete
- ☐ Recycled content in reinforcing steel
- ☐ Recycled content in insulation material
- ☐ Recycled content in flooring
- ☐ Recycled content in cladding
- ☐ Other recycled materials (please specify below)
- ☐ None - we typically do not incorporate (parts of) recycled materials in our building materials

If 'Other recycled materials', please specify:

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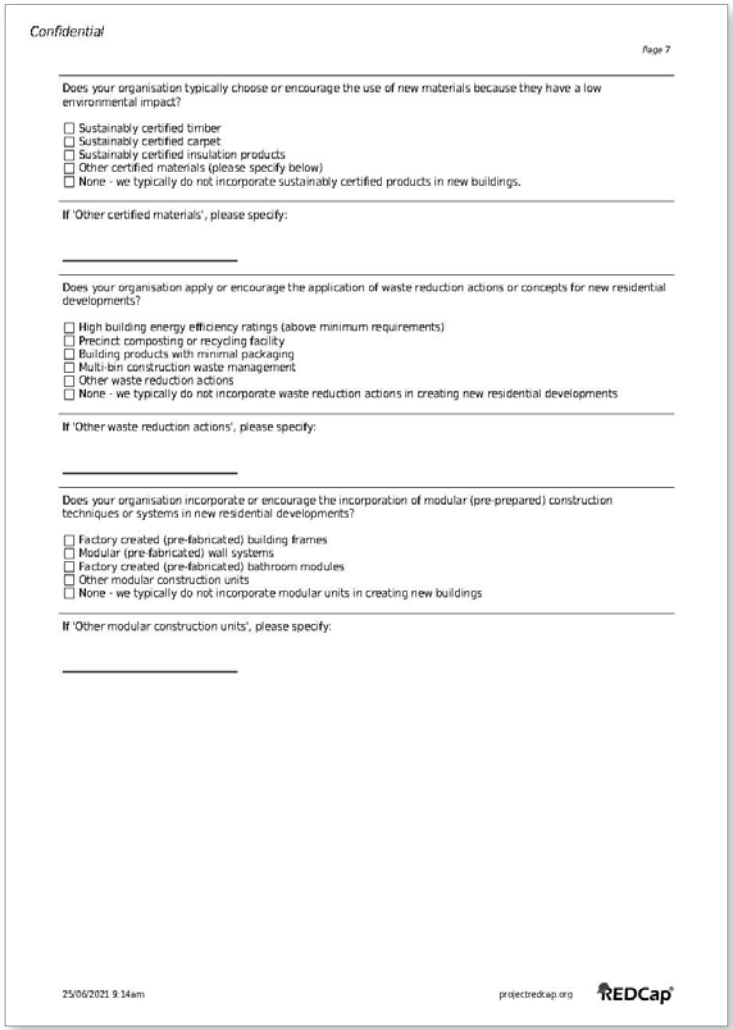

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Does your organisation typically choose or encourage the use of new materials because they have a low environmental impact?

- ☐ Sustainably certified timber
- ☐ Sustainably certified carpet
- ☐ Sustainably certified insulation products
- ☐ Other certified materials (please specify below)
- ☐ None - we typically do not incorporate sustainably certified products in new buildings.

If 'Other certified materials', please specify:

Does your organisation apply or encourage the application of waste reduction actions or concepts for new residential developments?

- ☐ High building energy efficiency ratings (above minimum requirements)
- ☐ Precinct composting or recycling facility
- ☐ Building products with minimal packaging
- ☐ Multi-bin construction waste management
- ☐ Other waste reduction actions
- ☐ None - we typically do not incorporate waste reduction actions in creating new residential developments

If 'Other waste reduction actions', please specify:

Does your organisation incorporate or encourage the incorporation of modular (pre-prepared) construction techniques or systems in new residential developments?

- ☐ Factory created (pre-fabricated) building frames
- ☐ Modular (pre-fabricated) wall systems
- ☐ Factory created (pre-fabricated) bathroom modules
- ☐ Other modular construction units
- ☐ None - we typically do not incorporate modular units in creating new buildings

If 'Other modular construction units', please specify:

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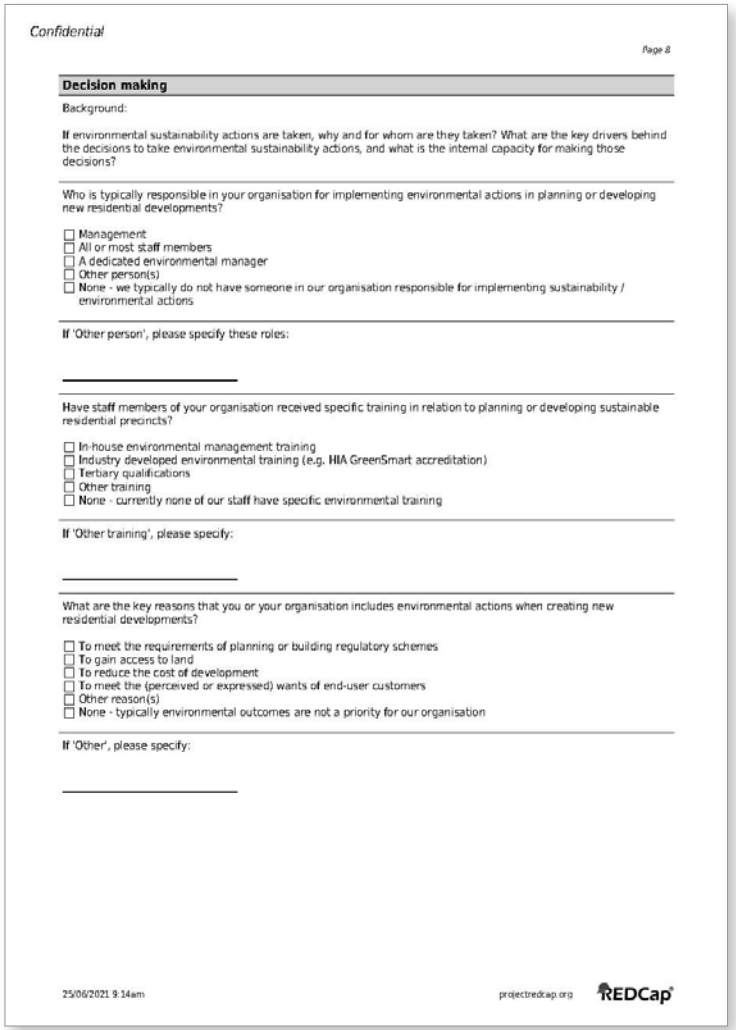

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Decision making

Background:

If environmental sustainability actions are taken, why and for whom are they taken? What are the key drivers behind the decisions to take environmental sustainability actions, and what is the internal capacity for making those decisions?

Who is typically responsible in your organisation for implementing environmental actions in planning or developing new residential developments?

- ☐ Management
- ☐ All or most staff members
- ☐ A dedicated environmental manager
- ☐ Other person(s)
- ☐ None - we typically do not have someone in our organisation responsible for implementing sustainability / environmental actions

If 'Other person', please specify these roles:

Have staff members of your organisation received specific training in relation to planning or developing sustainable residential precincts?

- ☐ In-house environmental management training
- ☐ Industry developed environmental training (e.g. HIA GreenSmart accreditation)
- ☐ Tertiary qualifications
- ☐ Other training
- ☐ None - currently none of our staff have specific environmental training

If 'Other training', please specify:

What are the key reasons that you or your organisation includes environmental actions when creating new residential developments?

- ☐ To meet the requirements of planning or building regulatory schemes
- ☐ To gain access to land
- ☐ To reduce the cost of development
- ☐ To meet the (perceived or expressed) wants of end-user customers
- ☐ Other reason(s)
- ☐ None - typically environmental outcomes are not a priority for our organisation

If 'Other', please specify:

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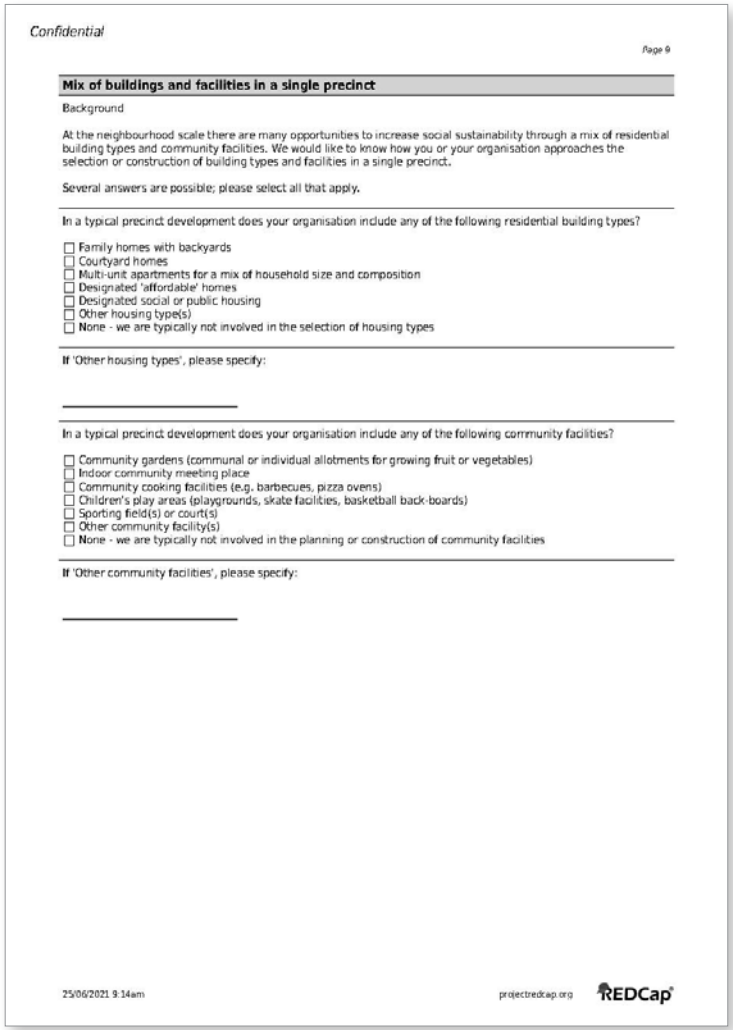

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Mix of buildings and facilities in a single precinct

Background

At the neighbourhood scale there are many opportunities to increase social sustainability through a mix of residential building types and community facilities. We would like to know how you or your organisation approaches the selection or construction of building types and facilities in a single precinct.

Several answers are possible; please select all that apply.

In a typical precinct development does your organisation include any of the following residential building types?

- ☐ Family homes with backyards
- ☐ Courtyard homes
- ☐ Multi-unit apartments for a mix of household size and composition
- ☐ Designated 'affordable' homes
- ☐ Designated social or public housing
- ☐ Other housing type(s)
- ☐ None - we are typically not involved in the selection of housing types

If 'Other housing types', please specify:

In a typical precinct development does your organisation include any of the following community facilities?

- ☐ Community gardens (communal or individual allotments for growing fruit or vegetables)
- ☐ Indoor community meeting place
- ☐ Community cooking facilities (e.g. barbecues, pizza ovens)
- ☐ Children's play areas (playgrounds, skate facilities, basketball back-boards)
- ☐ Sporting field(s) or court(s)
- ☐ Other community facility(s)
- ☐ None - we are typically not involved in the planning or construction of community facilities

If 'Other community facilities', please specify:

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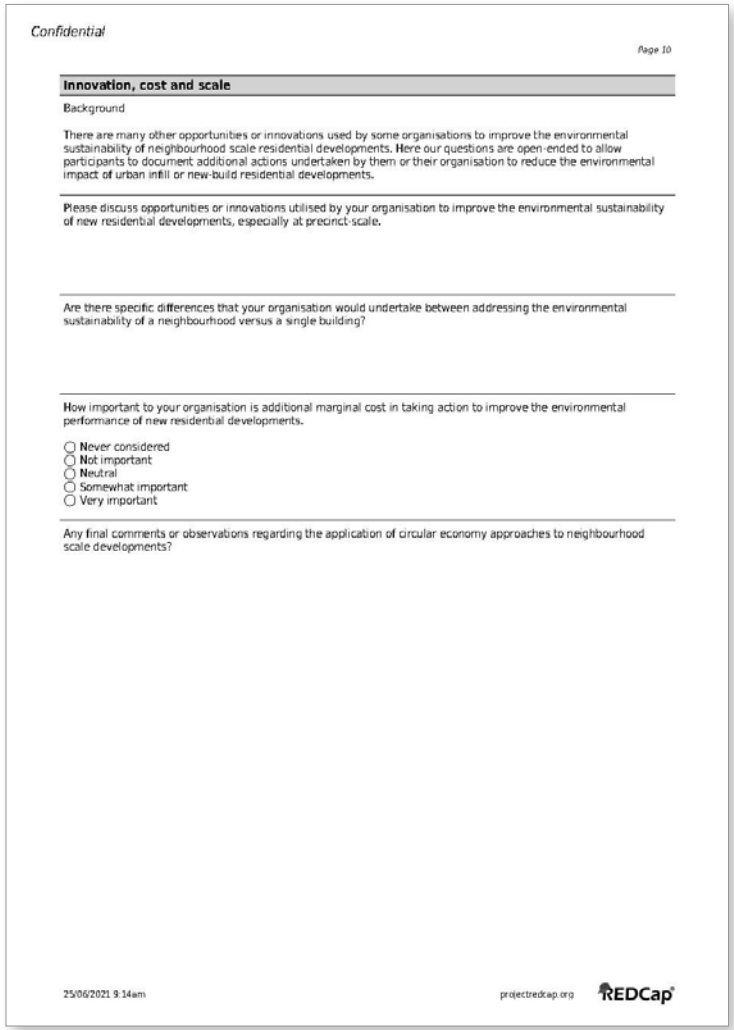

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Innovation, cost and scale

Background

There are many other opportunities or innovations used by some organisations to improve the environmental sustainability of neighbourhood scale residential developments. Here our questions are open-ended to allow participants to document additional actions undertaken by them or their organisation to reduce the environmental impact of urban infill or new-build residential developments.

Please discuss opportunities or innovations utilised by your organisation to improve the environmental sustainability of new residential developments, especially at precinct-scale.

Are there specific differences that your organisation would undertake between addressing the environmental sustainability of a neighbourhood versus a single building?

How important to your organisation is additional marginal cost in taking action to improve the environmental performance of new residential developments.

- ◯ Never considered
- ◯ Not important
- ◯ Neutral
- ◯ Somewhat important
- ◯ Very important

Any final comments or observations regarding the application of circular economy approaches to neighbourhood scale developments?

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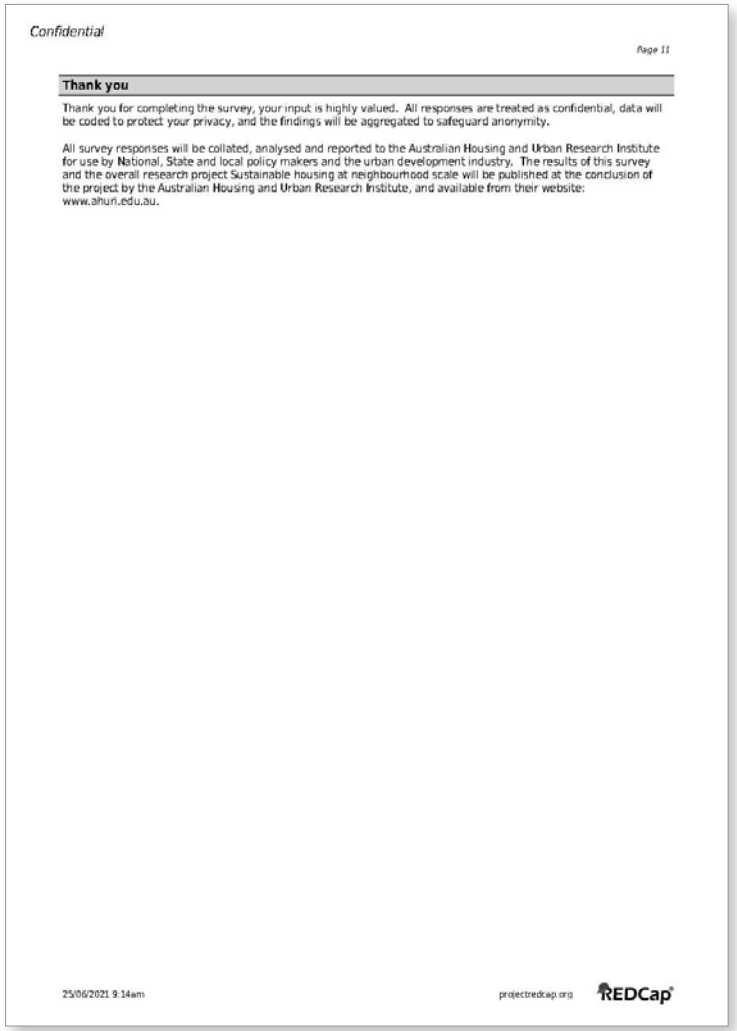

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Thank you

Thank you for completing the survey, your input is highly valued. All responses are treated as confidential, data will be coded to protect your privacy, and the findings will be aggregated to safeguard anonymity.

All survey responses will be collated, analysed and reported to the Australian Housing and Urban Research Institute for use by National, State and local policy makers and the urban development industry. The results of this survey and the overall research project Sustainable housing at neighbourhood scale will be published at the conclusion of the project by the Australian Housing and Urban Research Institute, and available from their website: www.ahuri.edu.au.

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Appendix 3: Case study research design

To ensure comparability across the 15 case studies, data were collected for each project through desk analysis and semi-structured interviews, following the same analytical framework and guideline questions as described below. On this basis, for each case study a report was prepared according to an agreed structure. This allowed synthesising the key findings across the 15 projects, as discussed in chapter 3 of this report.

Analytical framework for desk analysis of case studies

For each case study, first a desk study analysis of the 15 eco-neighbourhood case studies was undertaken, based on available materials (plans, policy documents, media releases, etc.), with information recorded in response to the following themes:

- When was the project conceived, and over which period completed? At which stage of realisation is the project?
- Why was the project initiated? What current or future gap is it meant to be addressing?
- Where is the project located, and what is the scale?
- Who initiated the project? Which other key actors were involved in the planning, design, and realisation phases?
- What is (or was) the policy and planning framework within which the project was developed? Were specific instruments (e.g. binding master plan, design guidelines) used to guide the planning, design and implementation of the project and to ensure sustainability standards were complied with?
- How are 'circular economy neighbourhood' or 'sustainable neighbourhood' defined in the project? What are / were the main concerns in relation to (a) sustainability / circularity, and (b) the neighbourhood scale as apparent from the project materials?
- Which issues in relation to circularity / sustainability at the neighbourhood scale (see Appendix 1) and within the context of the wider urban (or regional) environment are considered by the project, and how?
- How does the project exceed minimum regulatory standards (e.g. for energy efficiency, water management etc.?)
- Is the sustainability / circularity performance (proposed to be) measured (pre-occupancy) and / or monitored (post-occupancy)? If so, how?

Guideline questionnaire for semi-structured interviews with key actors involved in case study project

For each case study, a minimum of three interviews with 'CE leaders' was conducted. Interviews were informed by previous desk analysis of project documentation and conducted with the help of the following guideline questionnaire:

- What is your current role and what has been your previous experience in the construction/planning/residential industry, especially in relation to sustainable housing at the neighbourhood scale?

- What are some of the notable developments you have worked on from a sustainability/CE perspective? What made them good examples of sustainability/CE?
- Could you briefly explain your involvement in the project, as well as (if applicable) the role of your organisation in its planning, design and/or realisation?
- What were the ambitions for the project in terms of circular economy principles and sustainable development? Did you try to implement a comprehensive / holistic vision of circularity with a balance of environmental, social, and economic objectives through your project, and if so, how was this achieved?
- What trade-offs, if any, were made from the initial ambition for the project to the final plan and realisation? Why were these made?
- Did the project use any specific standards / tools to ensure sustainability ambitions were achieved at the neighbourhood scale? If yes, why those ones and not others?
- Was there specific attention to the neighbourhood scale for your development, and the possibilities this could offer for economies of scale and resource efficiencies? How did your approach in this respect differ to 'mainstream' developments or the development of a single building?
- What were the main institutional, regulatory, and financial barriers experienced during the planning, design, and construction phases of your eco-neighbourhood? Were there any issues that were specific to the neighbourhood-scale of your project and that might not have been so relevant for the scale of an individual building?
- Which barriers did you manage to overcome, and what, or who, was helpful in overcoming these barriers?
- For which issues could no solution be found, or where did you have to compromise? What could have helped with achieving your original vision of a sustainable / CE neighbourhood?
- Were there any policy levers or governance arrangements that were particularly important to help you realise your eco-neighbourhood, or that shaped the outcome either positively or negatively?
  (e.g. certain partnership models / governance approaches? Specific urban planning approaches / specific planning tools? Dedicated government support such as a special planning procedure or advantageous access to building land?).
- What roles did the public sector (e.g. planning authority), the private sector (e.g. developers) and the community / civic society play in shaping and realising your project? Did these actor groups have sufficient awareness and knowledge of approaches to achieving circularity in residential neighbourhood developments, or were there specific gaps in skills, information or knowledge that presented challenges for realising a sustainable neighbourhood?
- Was it your experience that 'consumers' (house buyers or tenants) are asking for sustainability or CE beyond minimum standards?
- Based on your experience with this project, which institutional, regulatory, financial, or cultural changes would help with making sustainable neighbourhoods such as yours a mainstream approach? Which policy instruments could achieve an upscaling of standards for sustainable housing at a neighbourhood scale, and help to realise them in different locations?
- Did you try to re-use materials or acquire recycled or sustainable materials for your project, and if so, did you experience any challenges?
- What checks or balances did you apply to ensure that you have met key outcomes for the project? How did you monitor achievements during construction and how do you measure sustainability performance post-occupancy?
- In your opinion, what are the benefits of your CE neighbourhood (especially in relation to the neighbourhood scale), and how are you communicating these (and to whom)?
- What are the key learnings you are taking to the next project you work on?

Structure of case study reports (based on data collected through desk analysis and interviews with key stakeholders of the project and with final assessment by research team)

1. Brief project description
2. Definition of 'sustainability' or 'circularity' and of 'neighbourhood scale' in the project
3. Rationale for the project and vision
4. Policy framework
5. Key actors and governance arrangements
6. Dimensions of sustainability / circularity as addressed in the case study, and especially in relation to the neighbourhood scale (cf. Appendix 1 for list)
7. Arrangements for monitoring of project outcomes in relation to circularity / sustainability
8. Key facilitators and main challenges
9. Critical assessment of (envisaged) achievements in terms of sustainability / circularity by researchers, and suggestions for policy changes.

Appendix 4: Design of online policy workshops

The two online policy workshops followed the same structure. Below is the information provided to individually invited participants prior to the workshop, and the discussion points based on project findings from stages one, two and three presented to workshop participants.

Email invitation sent to registered participants prior to the workshops to collect their views on key challenges for realising sustainable housing at a neighbourhood scale

"During the workshops, we are looking to discuss with you:

a. how the neighbourhood scale could be used to greater advantage in the design, planning, and implementation of residential developments than is currently the case; and

b. how a shift towards a more holistic approach to sustainability could be achieved in residential developments across Australia.

The initial research findings from our project suggest that housing developments in Australia are generally focussed on the scale of individual building sites, yet there are many efficiencies that could be achieved by planning and delivering sustainability at the precinct or neighbourhood scale through design, material and technical opportunities (e.g. water management, energy production) and/or by strengthening communities and sharing economies.

Furthermore, our research found that sustainability at neighbourhood scale is rarely comprehensively considered in planning policy and building regulations, nor given sufficient attention during the design and implementation stages for residential developments in Australia. This often results in the consideration of only specific dimensions of sustainability in developments, such as through as a selective focus on energy efficiency or water management, instead of a more holistic approach that could contribute to a circular economy / sustainability paradigm in the sense of closing resource loops and waste avoidance and leveraging other sustainability opportunities. However, we have also explored several Australian and international case studies that demonstrate the benefits of considering sustainability comprehensively at the neighbourhood scale. The question is, how do we make these types of developments more common in Australia?

In the workshops, we would like to present you with some statements on the barriers and opportunities to neighbourhood scale planning and design of residential development in Australia that we identified in our research and will ask your reflections on how a transition to sustainable housing at the neighbourhood scale could be achieved in Australia. We are particularly interested in your views on suitable policy and planning levers to help realise sustainable housing at a neighbourhood scale, and how, and over which time, these could be realised.

In preparation for the workshop, we would appreciate to hear from you about the main challenges that you identify or have experienced with (a) planning for residential development at a neighbourhood scale and (b) to implement circular economy or sustainability principles in the planning, design, and realisation of residential developments, especially at the scale beyond the individual building.

Please tell us, in an email, how your organisation currently addresses circular economy principles / sustainability principles in residential developments and how you plan and design at the neighbourhood scale (or if not, why not), and please also tell us what you think is the most important challenge (or two or three challenges) with realising sustainable housing at a neighbourhood scale."

Script for the running of the workshops

(Welcome and Introduction)

"Thank you for joining us today for a discussion on the opportunities and challenges for achieving sustainable housing at a neighbourhood scale. This workshop is the final part of a project funded by the Australian Housing and Urban Research Institute (AHURI). We would like to discuss with you the findings from our research so far. There are two main themes we would like to talk to you about, namely:

a. how the neighbourhood scale could be used to greater advantage in the design, planning, and implementation of residential developments than is currently the case; and

b. how a shift towards a more holistic approach to sustainability could be achieved in residential developments across Australia.

Some organisational matters first: We would like to record the meeting as this will help us to write up the main points from our discussion. We will anonymise your responses in our report to ensure that you can express your views freely. However, if you prefer that this discussion is not recorded, please tell us.

To structure the discussion today we will present you with some statements that we have derived based on our research findings from the earlier parts of the project and ask your responses to these. The statements and questions are formulated in a rather open manner. This is intentional because you are all from different parts of Australia and represent different sectors, and we are keen to hear your views based on your experience and maybe illustrated by examples. Specifically, we want to hear your suggestions for policy changes that would be useful to achieve a transition to sustainable housing in Australia, and to making better use of the resource efficiencies that the neighbourhood scale offers."

(Statements and questions)

1. The challenge of planning and realising housing developments at the neighbourhood scale

Our research found that there are many efficiencies that could be achieved by planning and delivering sustainability at the precinct or neighbourhood scale through design, material and technical opportunities (e.g. water management, energy production) and/or by strengthening communities and sharing economies. However, our project findings also show that there are considerable barriers to realising these opportunities in the current policy and regulatory context. Housing developments in Australia are generally focussed on the scale of individual building sites. Planning policies, ownership structures, building regulations etc. all favour the building scale, whereas there is considerably less attention to facilitating master planning, precinct planning, or other neighbourhood-scale approaches.

Question 1: What policy changes would be needed to allow us to move from designing houses to creating sustainable neighbourhoods in Australia?

2. The challenge of realising a holistic and integrated vision of urban sustainability

Our research has found that in Australia, sustainability in urban development processes is rarely comprehensively considered. This often results in the consideration of sustainability only for specific dimensions of the proposed developments, such as through a selective focus on energy efficiency or water management, instead of a more holistic approach that would allow to close resource loops, avoid the use of non-renewable resources and also allow the consideration of social sustainability dimensions. We have explored several Australian and international case studies that have shown that an all-society comprehensive sustainability approach to the development of urban neighbourhoods is possible and can achieve many community and environmental benefits that are otherwise difficult to realise. The question is, how do we make these types of developments more common in Australia and how could comprehensive sustainable development strategies in urban development be better supported?

Question 2: What policy changes are needed to enable a comprehensive consideration of sustainability across all dimensions (environmental, social / cultural, and economic), in urban (residential) development in Australia?

Back-up questions (time permitting):

3. The challenge of achieving an urban sustainability transition – and higher regulatory standards - in a reasonable timeframe

The climate crisis is here, and the built environment is in the spotlight as a major emitter of greenhouse gases. Given Australia's - in comparison to other developed nations – very low standards for sustainability and building energy efficiency, major and concerted efforts will be needed to achieve a transition to sustainable urban development and to prevent further global warming and resulting devastating consequences for communities in Australia and worldwide.

In terms of achieving higher sustainability standards in Australia's built environment, currently much relies on voluntary action by developers. However, in our research we found overwhelming support among key professions for stronger regulations to improve sustainable housing outcomes and to bring Australia in line with other advanced economies on housing standards. Yet even with political will it will take some time to achieve the major institutional and policy changes needed for an urban sustainability transition in Australia.

Question 3: What policy levers – 'sticks' (regulation), 'carrots' (subsidies), 'sermons' (discourses, information, and communication) – need most urgent attention to support an urban sustainability transition? What should happen first, and who should take the initiative? Over which timeframe could higher built environment standards in Australia be realistically achieved to afford a transition period for industry and also bearing in mind the time needed to implement large urban development projects?

4. The challenge of a policy coordination in Australia's federal system and the role of education and training

The policy and regulatory framework for sustainable urban development is highly fragmented in Australia. Building regulations are set at federal level; states and territories are responsible for urban and regional planning policies, and there are now a wide range of sustainability rating tools available to assess building performance as well as community-scale aspects of new developments. Our research findings show that even built environment professionals can find it challenging to navigate this governance and policy landscape, and to identify the relevant tools to plan, design, develop and evaluate sustainable housing at a neighbourhood scale.

Question 4: How could policy and governance coordination be improved in Australia to better support sustainable urban development? And what is the role of training and education of key built environment actors to increase awareness of approaches and tools to achieving sustainable housing and to realising neighbourhood resource efficiencies?

5. The challenge of realising sustainable housing at a neighbourhood scale in urban infill locations

Urban consolidation and higher densities, achieved through infill / greyfield development, have for many years been explicit goals for urban and regional planning in Australia's states and territories. However, achieving these goals is frequently confronted with considerable challenges of infill development due to fragmented land ownership structures, the challenge of fitting new housing in with existing infrastructures and services, and also opposition by residents and other interests to higher densities and a possible reduction of open spaces in their neighbourhood.

Realising sustainable housing, and achieving neighbourhood scale opportunities, may therefore require even more effort in urban infill locations than for brownfield of greenfield developments, because they are smaller and often characterised by complex ownership structures. Also, realising precinct-scale energy, water, or social infrastructure systems in infill locations may, due to pre-existing networks, require different approaches than for 'master-planned' developments.

Question 5: What policy changes are needed to support sustainable urban infill development and for such projects to be able to contribute to achieving neighbourhood scale resource efficiencies?

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