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EXECUTIVE SUMMARY

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Building materials in a circular economy

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

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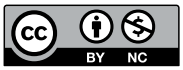

Executive summary

Key points

- **The housing industry is an institution with recognisable 'rules of the game' that shape industry structure and actor interactions, which in turn will shape responses to the development of a circular economy (CE) strategy.**
- **Understanding the structure of building-material supply chains is essential for policy development seeking to reduce carbon intensity of new material choice and use in the housing industry.**
- **Housing industry engagement with the CE and reducing greenhouse gas (GHG) emissions by relying less on virgin materials and increasing reuse, recycling and resource recovery will require development of efficient and responsive 'used' materials markets.**

Key findings

There has been limited consideration and engagement with circular economy (CE) principles within the residential housing industry and its material supply chains. A starting point for informing the development of a CE is to analyse the institutional arrangements of material supply chains that supply manufactured building materials containing embodied GHG emissions to the residential housing industry. This type of analysis can assist in showing how the housing industry and its supply chains can contribute to reducing GHG emissions by using low-carbon materials and relying less on virgin materials. It can also assist by showing how the industry can close loops by reducing waste through reusing, recycling and recovering resources in the industry and its supply chain.

The material flow analysis (MFA) found that data for tracking material stocks and flows throughout the residential construction sector is inadequate. This applies to new and existing materials as they move into the construction and demolition waste stream. A novel approach was developed, using top-down available datasets and bottom-up generation of data. It showed that the use of concrete continues to increase, which is increasing the carbon intensity of housing. Further, while the number of houses constructed each year has not changed significantly over the past 50 years, the size of houses constructed and the changes in materials have significantly increased the carbon intensity of new housing. The improved understanding of material flows is important for developing an industry CE. The analysis can be extended and improved through the development of better data systems.

Analysis of two sustainable housing developments in Victoria (The Cape and Nightingale Village) highlighted the challenges facing the introduction of CE. Both case studies examined building design and construction, and searched for practices that could be regarded as CE practices. The Cape builders sought to respond to CE principles by facilitating stakeholder collaboration in the design, construction and occupation phases. At the Nightingale Village—while the building life cycle was considered—the emphasis was on reducing costs and meeting environmental objectives by reducing material use. These cases highlight the challenges the industry faces. Some changes were easy, such as brick reuse, while others, such as timber reuse, were constrained by concerns about structural integrity. Also, material reuse was constrained because of the lack of onsite storage space between deconstruction and construction. Further, the cost of disassembly and material reuse incurs costs that builders cannot meet on their own.

The research found through three case-study analyses of material supply chains—concrete, steel and timber—that builders source materials from suppliers without assessing embodied carbon created by manufacture. All three supply chains have local and global features, which means that reducing emissions requires governance arrangements that span multiple jurisdictions. At a global level, high-emission concrete and steel industries have committed to staged emission reductions. Their decarbonisation 'pathways' will require significant reinvestment in plant and equipment, product innovation, and change in design and patterns of use in downstream supply chains. Timber use in housing is bifurcated. It continues to be used extensively in detached residential housing. However, its proposed use in the multi-unit apartment industry has stalled. Because the proportion of multi-unit apartment housing is increasing, this means that the carbon intensity of housing as a whole is increasing. Material supply-chain decarbonisation and CE development will require close attention to supply-chain institutional arrangements and collaborative reform supported by broader public policy.

Policy development options

Important policy issues and possible policy responses were identified during the course of the research, which focussed on:

- mapping and analysing the flow of materials into and out of the housing system, and the availability and quality of the necessary data
- design and onsite decisions about material choice and material reuse for low-rise and multi-unit apartment housing construction
- the institutional arrangements of manufactured material supply chains that supply materials to housing industry builders.

The following areas for policy development were identified, and preliminary ideas for their further development are outlined.

- **Materials data collection and analysis:** The research identified significant data gaps that need to be filled if we are to understand the flow of materials used in housing construction; materials already in the housing system; construction and disassembly waste; and reuse. The Commonwealth Scientific and Industrial Research Organisation (CSIRO) has made considerable progress in the development of a data system with its Australian Housing Data Portal. However, further initiatives such as required submission of 'as-built documentation' (ABD), and use of 'material passports' will vastly improve stock in-use and materials tracking. Data should also be geocoded to support analysis at a regional and local scale.
- **Incentivising disassembly and reuse:** It is difficult for building-industry stakeholders to economically justify disassembly and reuse. Policy development should focus on incentivising disassembly for material reuse, as well as encouraging other ways to reduce embodied energy through material selection and the use of local products. Creating markets for materials reuse within Australia is important, but as many materials and products are imbricated in global supply chains, it is likely that these markets will also be connected to international markets. It is important to ensure that local building-industry actors seeking to reuse materials are not penalised by markets that do not value construction waste.

- **Regulation for low carbon:** The National Construction Code (NCC) is a performance-based code that sets minimum levels for the safety, health, amenity, accessibility and sustainability of buildings. The scope of its sustainability regulation could be expanded to support the decarbonisation of the housing system. It could regulate to require the documentation of embodied carbon in material flows and the reuse of construction and demolition waste (CDW). This regulation could be supported by a simple-to-use digital recording system that records the flow of materials into the housing system. Most regulations on recycling and reuse focus on end-of-pipe solutions for CE. They should also support better measurement of material flows, as well as reuse, rethink, repurpose or remanufacture.
- **Tilting investment flows:** Policy makers can shape investment flows in ways that support the decarbonisation in the materials industries. This form of investment, accompanied by regulation, can support the decarbonisation of materials manufacturing and stimulate demand for recycled materials. Strategic use of public procurement is a complementary form of support. The use of taxation policy can also guide optimisation of resource use across materials life cycles, from resource taxes on raw materials to tax relief on reuse and repair, and creation of carbon credits to incentivise reduced emissions.
- **Building capacity:** Expanding the pool of people with a knowledge of CE is a high priority and requires developments in education, training and skills development. This can be done through curriculum development for use in universities and TAFEs, along with professional development in-service training that presents built-environment embodied carbon and CE concepts. These education and training programs would focus on topics such as materials manufacturing, material supply chains, materials innovation, construction, maintenance and deconstruction processes, building-industry institutional arrangements and emissions reduction policy.
- **Developing low-carbon supply chains:** Building-material supply chains are complex and involve different actors that are often uncoordinated and have conflicting interests. They include manufacturers, distributors, retailers, regulators, professional consultants, contractors and subcontractors. There is a case for establishing housing industry low-carbon supply-chain councils. Council members would be drawn from industry and professional associations, along with civil society social movement organisations, including relevant unions. Each council, supported by a federal government industry agency, would support a deliberative consultative process that prepares plans for the development of low-carbon supply chains for the housing industry.

The study

This research is part of the AHURI *Inquiry into housing in a circular economy* which asked: *How can the transition to a circular economy in housing be implemented to provide more sustainable housing?* The focus of this project (which is one of four projects) presented in this report is on the flow of building materials through supply chains into and out of the residential housing system. These supply chains start with the exploitation of natural resources and CO_2-emitting and other greenhouse-gas-emitting manufacturing industries. The aim of the project was to understand the following:

- The structuring and functioning of the material supply chains supplying manufactured building materials containing embodied GHG emissions to the Australian residential housing industry.
- How the housing industry can contribute to the CE by reducing GHG emissions through reducing waste by reusing, recycling and recovering resources and relying less on virgin materials to close the material flow loop.

The context for this research into building-material supply chains is dynamic, as the mitigation of climate change has become increasingly challenging in a globalised society.

Four features of this context stand out:

- Global and Australian Government commitments to reducing GHG emissions have increased.
- Continuing rapid urban development using manufactured building materials is a major contributor to global GHG emissions.

- There are inadequate responses to growing volumes of waste and disposal, valuing, reusing, reprocessing and recycling of waste across all stages of the dwelling life cycle.
- A fragmented housing industry has limited capacity to create demand for a low-carbon building materials market.

The research was undertaken across three work packages:

- **Work package 1** modelled the stocks and flows of material flows in the Australian residential sector through material flow analysis (MFA), using data from multiple datasets. Some data gaps were filled by 'bottom-up' historical analysis of phases in housing construction through collaboration with an experienced quantity surveyor.
- **Work package 2** evaluated two 'best in class' residential housing case studies. They were selected through a desktop review of recent projects (2017–2021) using CE criteria that identified 82 potential cases. Two cases in Victoria were selected: a low-density development (The Cape) and a medium-density apartment development (Nightingale Village). Semi-structured interviews were undertaken with 13 research participants with deep involvement in the developments. The interviews were supplemented with site visits, photographs and document review. Recorded interview data were transcribed and analysed deductively using key words from the framework created by Potting, Hekkert et al. (2017) to analyse product chain innovation.
- **Work package 3** examined building-material institutional arrangements for products used extensively in housing construction: concrete, steel and timber. Three methods were used. First, academic and grey literatures and websites were reviewed. Second, industry supply chains were mapped using IBISWorld industry reports (Gecz 2019). Third, semi-structured interviews (n=20) were conducted with industry insiders who had deep knowledge of their industries. In addition, 15 participants drawn from key actor groups in the building materials and residential housing industry contributed to a practitioner workshop. Participants were sent a paper, *Building materials in a circular economy: Workshop briefing paper* (see Appendix 1), and responded to questions and provocations (see Appendix 1), as well as contributing to an online whiteboard.

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