



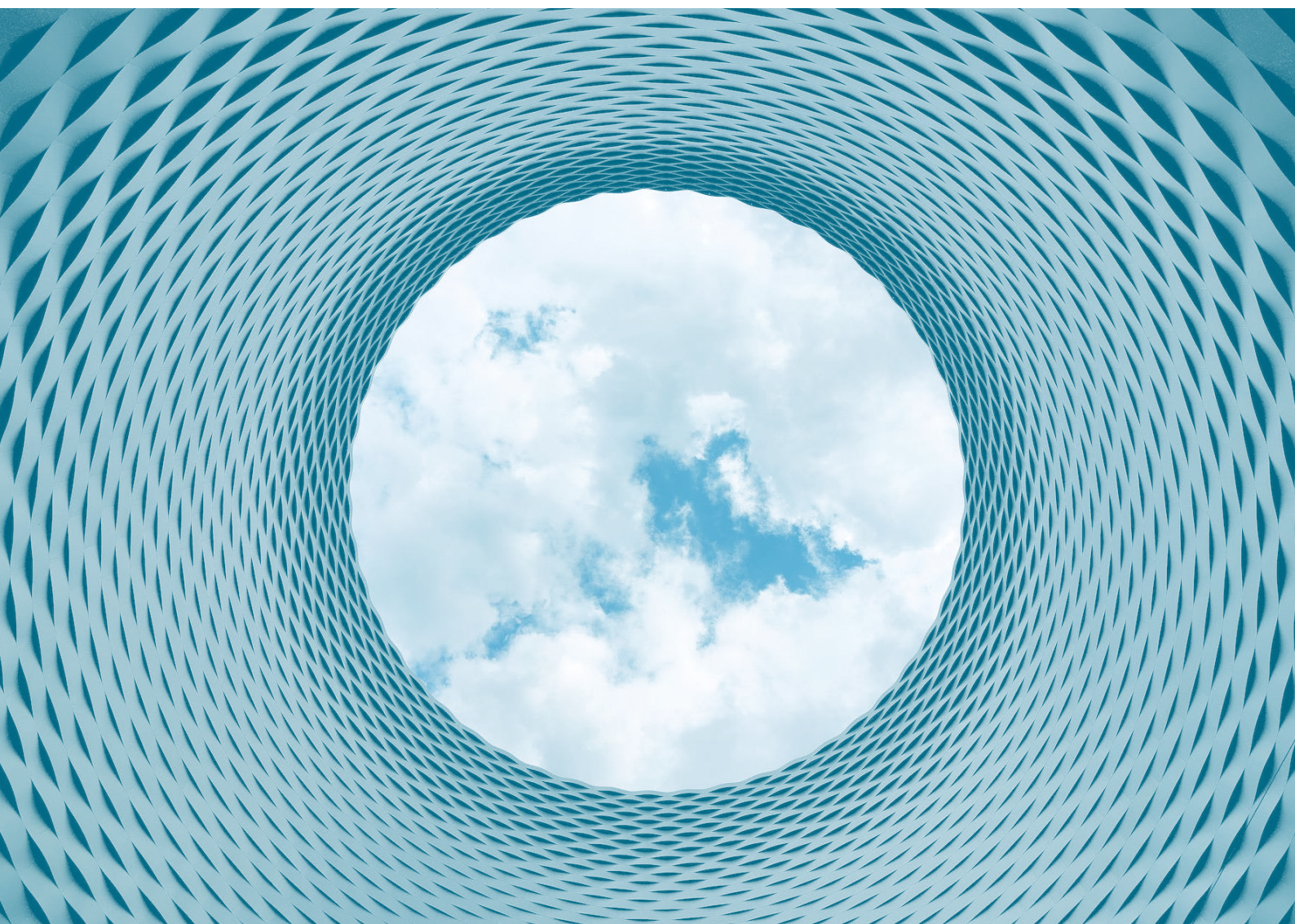
Australia's National  
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# Australian material flow analysis to progress to a circular economy

## Summary report

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# Australia is moving towards a circular economy, but more can be done

Australia is one of the world's top 10 extractors of natural resources. It is the largest exporter of primary materials in absolute terms and, except for some Middle East oil exporters, per capita.<sup>1</sup>

However, there are environmental costs and limits to that extraction. To protect the environment, we need to extract and use those materials as efficiently and sustainably as possible.

## CSIRO's analysis of material flows show that we are improving, but have further to go

Over the last decade, Australia has successfully reduced its material footprint, increased its circularity rate, and curbed air emissions. However, the Australian economy uses four times the materials to fulfil each person's needs compared with the world average. This metric reflects Australia's economic structure and reveals the opportunities of a more circular and sustainable economy.

This report suggests how:

- Extraction of virgin materials in Australia continues to increase, even if most of these materials are shipped abroad for economic benefit. Yet, Australia's per capita 'material footprint' has fallen by 16 per cent since 2015, and its greenhouse gas emissions by 7.4 per cent.
- The circularity of the Australian economy has increased marginally since 2015. However, it remains at half the global average and only 11 per cent of what we should be aiming for.
- We need to consider further efficiencies in the way we measure, process, and use our materials and products if we are to be part of a sustainable economy.

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<sup>1</sup> UNEP. (2023). Global Material Flows Database. From <https://www.resourcepanel.org/global-material-flows-database>

# The sustainable use of our natural resources matters

Using our natural resources linearly and inefficiently will result in further environmental costs of climate change, biodiversity loss, and pollution. Global annual extraction of raw materials has tripled from over 30 billion tonnes to over 106 billion tonnes in the last 50 years, causing over 90 per cent of water stress and global biodiversity loss.

If the most immediate of these challenges is global warming, then the sustainable use of our natural resources is essential. Material use is the single largest determinant of our energy use and emissions, responsible for over 50 per cent of global warming, and so our biggest lever to reduce emissions.

Adopting a circular approach also has multiple, significant benefits to the economy and wellbeing. Finding new ways to deliver products and services with a smaller footprint will drive innovation and wealth in Australia's economy value chains. The re-use and recycling of goods will foster access to local jobs, second-hand goods, and new paths to equity and empowerment. These local supply chains are far more resilient to supply interruptions and other economic shocks than the capital-intensive global supply chains that favour virgin materials. Using non-virgin material as a valuable resource, along with renewable energy, will reduce the need and competition for global resources and so decrease the risk of geopolitical conflict. Our personal and public health will benefit from cleaner air, soil, and water. With less material being extracted and ending up in landfill, more land can be made available for other uses, especially near urban centres.

As a fully developed economy with one of the world's highest per capita wealth levels, Australia understands the need to free economic performance from unsustainable resource use.



# Australia's material use

A breakdown of what materials Australia extracts, imports and re-uses

The raw material flows through the Australian economy in 2019 are best represented by the 'Sankey diagram' below (so named after the Irishman who drew one in 1898 to show the energy efficiency of a new steam engine).

At the front end of the pipe (A), we extracted 2,587 million tonnes of virgin material from the Australian continent and its ocean shelves. To that, we added 119 million tonnes of imported material (mostly consumer goods) and another 39 million tonnes that was re-used after recycling. From this total material input (B), we exported 1,459 million tonnes, leaving 1,287 million tonnes of materials processed for domestic consumption (C). Most of this was put to 'energetic use' (D) relying on fossil fuels to power machines and to feed ourselves and our animals with biomass. Together with 371 million tonnes of mining waste (E), almost all of this was returned to nature in the form of solid, liquid, or gaseous wastes (F). The remaining 343 million tonnes were invested in buildings, roads, and other infrastructure.

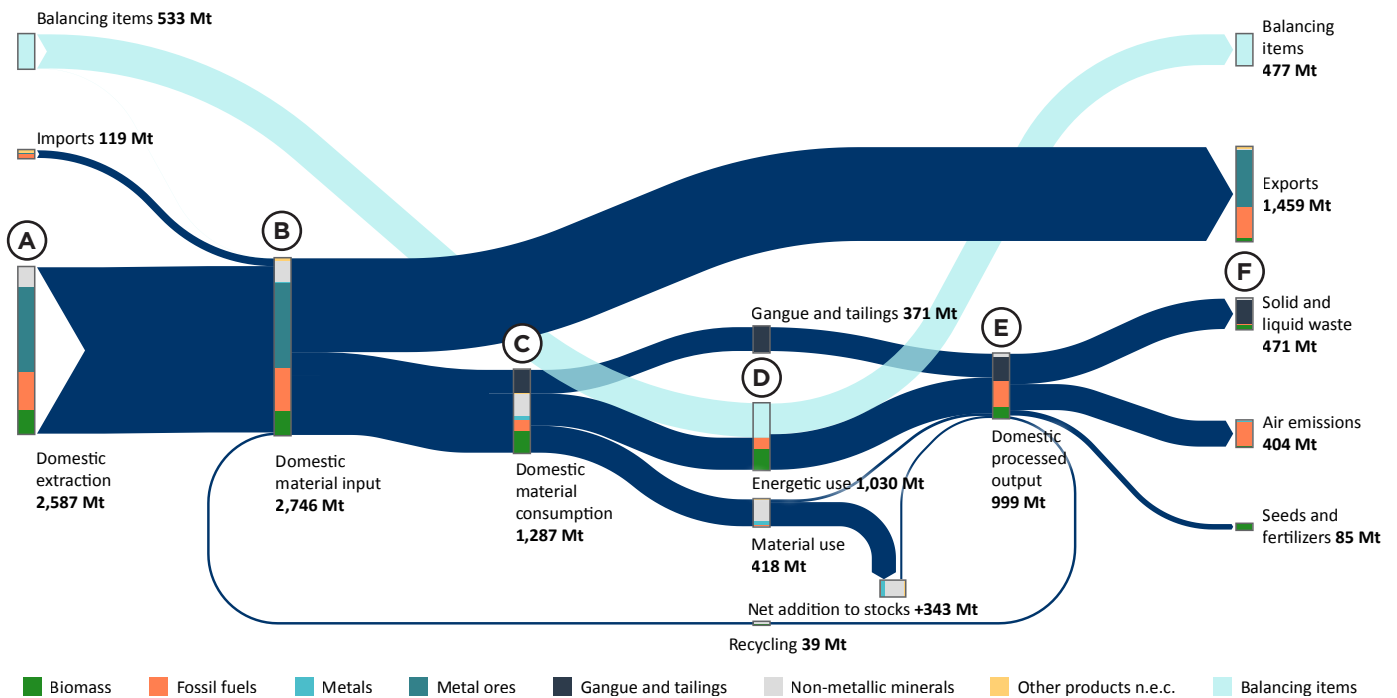


Figure 1 – Material flows through the Australian economy in 2019. The displayed units are million metric tons (Mt).

Assessing this material flow data with other things (the past, our population, and our economy), our findings suggest:

- **Raw material extraction, though financially valuable, is having a rising impact on our environment.** Of the 2,587 million tonnes of virgin material Australia extracted, 56 per cent was exported, including 838 million tonnes of iron ore (three-quarters going to China) and 393 million tonnes of coal. There is no doubting the global economic benefits of these exports. However, the environmental impacts are under increasing scrutiny, particularly for fossil fuels. A strong record of managing these impacts and offering alternatives increases Australia's competitive advantage.
- **The material footprint of the Australian consumer is improving.** It seems that Australians are using more materials than ever before. The 1,287 million tonnes consumed in 2019 (C) was 24 per cent more than that consumed in 2015, while our population rose only 6.6 per cent in that time. However, this does not tell the whole story.
- **The material intensity of our economy is high and increasing.** We now require 0.61 kg of materials for each dollar of GDP, slightly up from 0.56 kg/\$ in 2015. Again, while Australia needs more material to produce each unit of wealth, much of this material is exported to other countries. We can reduce material intensity by processing raw materials more and exporting them for higher value.
- **'Waste' going back to the environment seems high at 999 million tonnes, but the comparative data are unclear.** Our total waste emissions of just shy of a billion tonnes include metal processing waste of 371 million tonnes, liquid and solid waste of 101 million tonnes, of which biomass contributes 64 million tonnes, and construction of 21 million tonnes. Greenhouse gas and other air emissions are falling modestly, from 412 million tonnes to 404 million tonnes since 2015 and from 17.2 t to 15.9 t per capita.

A complementary measure is our 'material footprint,' which looks at the materials we actually draw on and ignores whether its original extraction or processing occurs here or overseas. As it excludes the entire supply chain of exported materials, it is a clearer picture of what our households, businesses, and governments draw from the planet. If we wish, we can prefer to import products with a smaller material footprint or fewer products than before. The data suggest that we did: our material footprint fell from 1,123 million tonnes in 2015 to 996 million tonnes in 2019 in absolute terms and from 46.9 to 39.3 tonnes per capita.



# The ‘circularity’ of our economy is only half the global average

At the bottom of the Sankey diagram (Figure 1) is the 39 million tonnes we currently recycle. This mass is about half (51.1 per cent<sup>2</sup>) of all materials captured through municipal, industrial, and construction waste schemes. That’s not far off South Korea’s global standard of 57 per cent – though it still means almost half this valuable resource is going to landfill.

When all our material flows are considered, they reveal an official measure of 3.7 per cent circularity for the Australian economy. In other words, for every 100 kg of resources we use, 96.3 kg are virgin materials. This result is a slight improvement from our 3.5 per cent in 2015 but well short of the 7.2 per cent global average. Albeit with a very different economy, the Netherlands has reached a world-leading 24.5 per cent circularity.

However, this official measure of circularity is unduly negative. It is not possible for it to reach over 32.5 per cent because many materials are irreversibly transformed during use: once fossil fuels are converted to energy and emissions, they cannot be reconstituted. Based on that theoretical maximum, Australia has achieved some 11 per cent circularity, implying a potential circularity ‘gap’ of 89 per cent that we should aim to close; see Figure 2 below. That gap may never be closed entirely, as CSIRO’s [2015 report on Australia’s circular economy](#) estimated that only a 20 per cent circularity rate could be realistically achievable for our economy when considering today’s technology and progressive degradation of materials<sup>3</sup>.

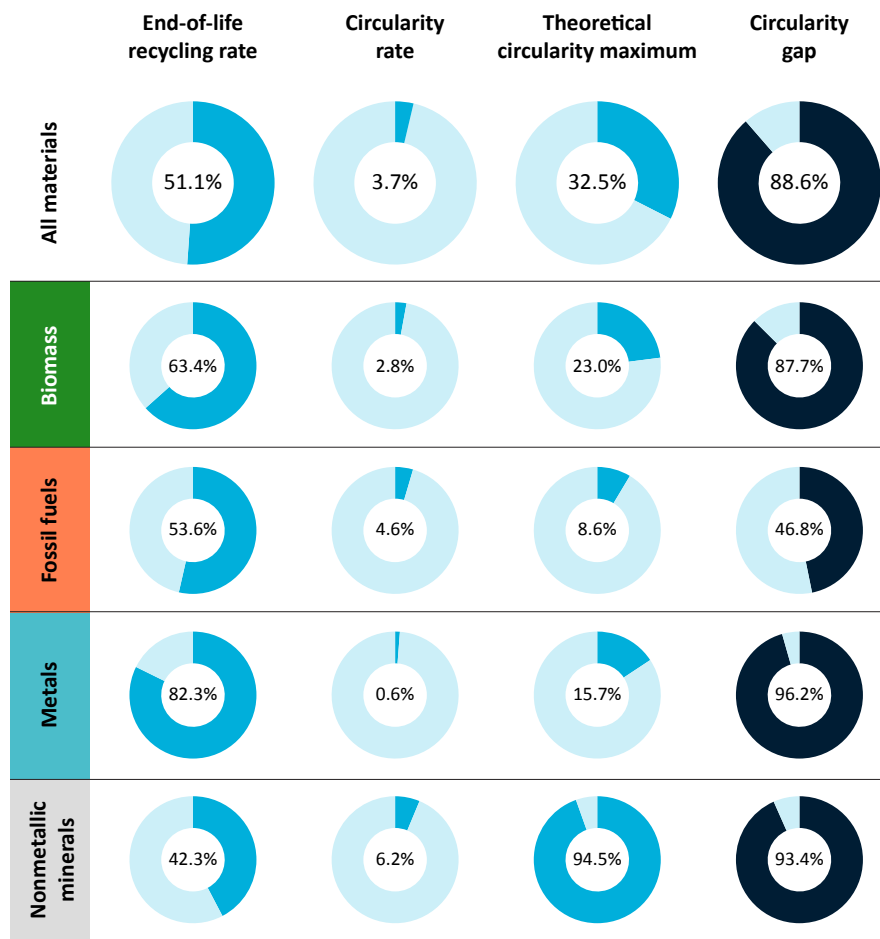


Figure 2 – Circularity indicators for all materials and four material subcategories for Australia in 2019.

2 Note that this value comes from a waste input-output table from the Australian Bureau of Statistics. The official Australian recycling rate is 58.7%.

3 The seven considered in this analysis are housing, mobility, food, energy, communication, waste management, and ‘other’ (this last category includes systems like healthcare, education, governance, and so on).

# Moving forward

## Embracing circularity to benefit our economy, our health and the environment

Our material flow analysis highlights the current environmental performance of our economy and what we may do to improve it. These findings can inform Australian policy through the following:

- **Better understanding of material flows.** While emissions and GDP are end-of-system measures, the material flows that CSIRO measures represent the full system. Operating without those measures is akin to driving a car with a speedometer but no fuel gauge. Opportunities to keep that fuel gauge healthy by increasing circularity exist in mining, construction, manufacturing, agriculture, and resource recovery.
- **Adding more value to raw material exports.** If we are to deplete our natural resources, we should also seek to extract the maximum from them so that we have the national income to re-invest in our natural capital. Local processing would add national and regional income, jobs, and complexity to our economy. The National Reconstruction Fund and its aims to diversify and transform Australia's economy is aiming to address this.
- **Focussing on housing and transport can make a real difference.** Of all the 'provision systems'<sup>23</sup> on which we rely, housing and transport make up 53 per cent of our material footprint (food is responsible for another 22 per cent). Australia's current policy focuses on packaging and consumer goods, yet their material volumes are small by comparison. Australia could, for example, incorporate more crushed concrete into new concrete, within quality and safety limits. It might also reverse our recent trends to larger cars and bigger homes by aligning mobility and housing to the needs of smaller families and providing better alternatives. Making parking spots wider does not foster a circular economy.
- **Consistent international standards for measuring material flow and circularity.** Countries and regions have different measures, making comparing performance and setting meaningful targets harder. For example, Australia's total waste has reached 39 tonnes per capita, which appears high compared to Europe's claimed 9 tonnes per capita. However, Europe does not count metal processing, legal waste disposal, or seeds and fertilizers spread through agriculture. Further work is needed to align and compare these figures and allow for the different make up of national economies. They might also consider the relative toxicity of waste streams: sand and gravel may be more easily absorbed by local environments than chlorine and phosphate, but they are measured as equals.

Our research aims to measure and increase our understanding of material flow performance, resource use, and how to deliver improvements to support a circular economy in Australia.

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