SEPTEMBER 2021

SCOPE 3 GREENHOUSE GAS EMISSIONS IN THE ACT

AN INVESTIGATION OF CURRENT SCOPE 3 EMISSIONS AND POTENTIAL FUTURE REDUCTIONS

OFFICE OF THE COMMISSIONER
FOR SUSTAINABILITY AND
THE ENVIRONMENT

Acknowledgements

Main authors: Staff from the Office of the Commissioner for Sustainability and the Environment

Key technical analysis: UNSW, the University of Sydney, CSIRO Land and Water, and The Footprint Company

Contributions: Professor Alana Mann, University of Sydney
Bronwyn Wilkes, Australian National University
Adrian Piani, ACT Chief Engineer
Contributions were also received from many other sources and the authors are grateful for them.

Graphic design and typesetting: Big Dingo Media

ISBN 978-0-6487496-1-5

Office of the Commissioner for Sustainability and the Environment, 2021, Scope 3 Greenhouse Gas Emissions in the ACT, published by the Office of the Commissioner for Sustainability and the Environment, Canberra, 2021.

This document is available online at www.environmentcommissioner.act.gov.au

For further information, contact:
Office of the Commissioner for Sustainability and the Environment
GPO Box 158, Canberra ACT 2601

Telephone: (02) 6207 2626

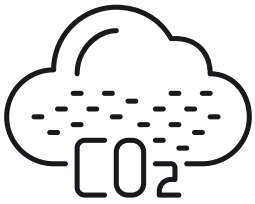
Email: envcomm@act.gov.au

Website: www.environmentcommissioner.act.gov.au

This report is printed on 100% recycled paper.

The ACT Government is committed to making its information, services, events and venues accessible to as many people as possible. If you have difficulty reading a standard printed document and would like to receive this publication in an alternative format – such as large print and audio – please call the Canberra Blind Society on (02) 6247 4580.

If English is not your first language and you require the translating and interpreting service, please call the Telephone Interpreter Service on 131 450. If you are deaf or hearing impaired and require assistance, please call the National Relay Service on 133 677.



SEPTEMBER 2021

SCOPE 3 GREENHOUSE GAS EMISSIONS IN THE ACT

AN INVESTIGATION OF CURRENT
SCOPE 3 EMISSIONS AND POTENTIAL FUTURE REDUCTIONS

OFFICE OF THE COMMISSIONER
FOR SUSTAINABILITY AND
THE ENVIRONMENT

Contents

Ngunnawal Translation

Dhawura nguna ngurumbangu gunanggu Ngunnawal

Nginggada dindi dhawura Ngunnawalbun yindjumaralidjinyin

Mura bidji mulanggaridjindjula

Naraganawaliyiri yarabindjula.

English Translation

This country is Ngunnawal ancestral, spiritual homeland

We all always respect elders, male and female, as well as Ngunnawal country itself

They always keep the pathways of their ancestors alive

They walk together as one.

Foreword

Climate change is already impacting Canberrans and will do so for decades to come. This Investigation was directed to my Office in the aftermath of the 2019–20 'Black Summer' bushfires.

The 2019–20 fire season was one of the worst on record. Across Australia, a total of 24.2 million hectares was burnt impacting life, property, the environment and community, with 80% of Australians exposed to toxic air quality due to bushfire smoke. For many days, the air quality in Canberra was the worst of any major city in the world, and the worst in Canberra since air quality monitoring started almost 40 years ago.

Just under 40% of the total land area of the Australian Capital Territory (ACT) was burnt, including 80% of Namadgi National Park. Much of the park has now been burnt twice in under 20 years.

The fires were a consequence of climate change which is contributing to more frequent heatwaves, and more severe fire seasons that are starting earlier and lasting longer.

Prior to the fires, in May 2019, the ACT Government declared a climate emergency. This declaration recognises the crisis of climate change and the urgency of action required to limit the degree of climate change and to avoid the worst social, economic, and environmental impacts of climate change. The declaration also recognises the importance of government leadership on climate change and energy policy.

I present this report on the ACT's complete greenhouse gas emissions profile against this critical climate background.

The ACT has led globally with an ambitious greenhouse gas reduction target of net zero emissions by 2045 at the latest, and clear interim targets. The ACT's current emissions targets include only scope 1 and 2 emissions (direct emissions in the ACT and emissions from purchased electricity respectively), and exclude scope 3 emissions (emissions generated in growing the food and producing all goods and services brought in from outside the ACT). This report provides the information on scope 3 emissions so the ACT can fully account for all greenhouse gas emissions and again lead an ambitious pathway to addressing future reductions.

My recommendations reflect that the ACT shares responsibility for scope 3 emissions and that reducing emissions from these sources provides an opportunity for true leadership and climate action.

Dr Sophie Lewis

Commissioner for Sustainability and the Environment

Executive Summary

The ACT has an ambitious greenhouse gas reduction target of net zero emissions by 2045. Currently, this considers only direct emissions in the ACT and emissions from purchased electricity, known as scope 1 and 2 emissions, respectively. Emissions produced by goods and services brought in from outside the ACT (scope 3 emissions) are not currently included. The purpose of this Investigation is to estimate the ACT's scope 3 emissions and to develop potential reduction targets that account for all embodied greenhouse gas emissions.

Scope 3 emissions represent most greenhouse gas emissions in the ACT, 93.6% of the ACT's total carbon footprint. The remainder are scope 1 emissions; as scope 2 emissions were reduced to zero when the ACT achieved 100% renewable energy supply in 2020.

The results of the analysis show that ACT is a consumer (not producer) Territory and demonstrate the essential need to account for and act to reduce scope 3 emissions. Approximately 30% of the ACT's scope 3 emissions originate outside of Australia and more than 50% originate from Queensland, New South Wales and Victoria combined. Scope 3 reductions should accompany the ACT's 2045 target of net zero emissions for scope 1 and scope 2 emissions.

The product groups with the highest scope 3 emissions within the ACT are transport, postal and warehousing services; food; retail trade; construction; public administration and safety; and manufacturing. The report focuses mostly on scope 3 emissions from food and construction, these being two of the product groups that contribute most significantly to scope 3 emissions in the ACT, and therefore provide great potential for achieving significant reductions.

Households account for almost 60% of the ACT's scope 3 emissions, followed by government operations, and finally businesses, stressing the key role consumers can play in reducing scope 3 emissions. Therefore, the report provides further information for end consumers about the potential impacts our individual choices have on greenhouse gas emissions. The report offers suggestions of behavioural measures to significantly reduce carbon footprints, such as decreasing consumption and waste, and exploring details of the origins of products purchased.

Canberra skyline. Source: Mark Jekabsons

Most ACT Government scope 3 emissions come from buildings and leased assets, and the remainder from goods and services. These contributions could be reduced through targeted sustainable procurement, reductions in office space, setting carbon performance targets in buildings, and estimating and reducing the carbon footprint of proposed ACT infrastructure.

Scope 3 emissions reductions in the ACT are one part of the collective global responsibility for limiting temperature increase to 1.5 degrees Celsius. The research undertaken for the Investigation shows an urgent need for reducing the ACT's carbon footprint, including through explicitly addressing scope 3 emissions. This reduction outcome is closely tied to the decarbonisation of the economy in Australia and in our key global trading countries. Future emissions projections also show that public administration and safety, food, and construction have the largest potential for reduction of all products groups in the ACT. It is noted that all projections are based on critical assumptions around future technological developments, economic variations, and other factors that cannot be predicted, and therefore should be considered 'best-case scenarios'.

The report sets out twelve recommendations to the ACT Government around the ACT's ongoing leadership on climate action; ACT Government operations; households; and planning, construction and infrastructure.

1. Introduction

1.1 Purpose of this Report

In August 2020 the ACT Minister for Climate Change and Sustainability, Shane Rattenbury MLA, asked the ACT Commissioner for Sustainability and the Environment to evaluate scope 3 greenhouse gas emissions for the ACT. The terms of reference were established by the Minister and are addressed in this report.

MINISTERIAL TERMS OF REFERENCE - August 2020

By September 2021, The Office of the Commissioner for Sustainability and the Environment will consider:

- methodologies for measuring scope 3 emissions,
- effective ways to reduce scope 3 emissions,
- any appropriate targets for reduction, and
- recommendations for short and long-term action in this area.

This report represents a summary of the comprehensive technical analysis commissioned by the Office of the Commissioner for Sustainability and the Environment and undertaken by the University of New South Wales (UNSW Sydney) and the University of Sydney. The Footprint Company[1] also completed an analysis on the scope 3 emissions of the ACT Government.

1.2 The Climate Emergency

The State of the Climate 2020 report[2] published by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology outlines a consistent picture of ongoing, long-term climate change in Australia. This includes observed warming of Australia by 1.44 degrees Celsius since 1910. This warming has led to an increase in the frequency of extreme heat events, changes in rainfall and streamflows, and changes in fire weather.

Canberra is projected to experience a significant increase in the number of days above 35 degrees Celsius by 2030 due to climate change. By 2050 it is expected that there will be an increase in Forest Fire Danger Index of up to 30%.[3]

1. The Footprint Company, https://footprintcompany.com/, accessed 11 August 2021.
2. State of the Climate, 2020. http://www.bom.gov.au/state-of-the-climate/, accessed 11 August 2021.
3. Lucas, C. et al., 2007. *Bushfire Weather in Southeast Australia: Recent Trends and Projected Climate Change Impacts*, Consultancy Report prepared for The Climate Change Institute of Australia.

The 2018 Intergovernmental Panel on Climate Change report on Global Warming of 1.5 degrees Celsius[4] outlines the urgency of the climate challenge. This highlights numerous climate change impacts that can be avoided by limiting global mean warming to 1.5 degrees Celsius, as "every bit of warming matters".

The latest Intergovernmental Panel on Climate Change report published in August 2021 outlines five scenarios for the future of the planet, based on different levels of greenhouse gas emissions. These were modelled using the best available science and provide five alternative futures for people on Earth as a consequence of different degrees of warming.[5]

One of the report's lead authors, Professor Mark Howden, says every continent, region and ocean around the world is heading "into a bad place" without strong climate action. He emphasised that "we need to take radical action very, very quickly" to reduce our greenhouse gas emissions.[6] The report states that we may have as little as 12 years from now before we need to reach net zero emissions based on our remaining carbon budget for a 1.5 degrees Celsius consistent pathway.[7]

"Delay is as dangerous as denial"

was the key message from the Australian Academy of Science report in which scientists urged the Australian Government to accelerate the transition to net zero emissions.[8]

The need for ongoing commitment to climate change mitigation is imperative for government. The ACT Government's declaration of a climate emergency in May 2019 recognises the urgency of action required to limit the severity of climate change and to avoid its worst impacts.

4. Summary for Policymakers of IPCC Special Report on Global Warming of 1.5°C approved by governments, https://www.ipcc.ch/2018/10/08/summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approved-by-governments/, accessed 11 August 2021.
5. IPCC Report, 2021. *AR6 Climate Change 2021: The Physical Science Basis*.
6. Howden, M., 2021. *ABC RN Breakfast*, Tuesday 10 August 2021, https://www.abc.net.au/radionational/programs/breakfast/ipcc-world-heading-bad-place-climate-change/13490142, accessed 25 August 2021.
7. IPCC Report, 2021. *Chapter 2: Mitigation pathways compatible with 1.5°C in the context of sustainable development,* https://www.ipcc.ch/sr15/chapter/chapter-2/, accessed 25 August 2021.
8. Australian Academy of Science, 2021. *The Risks to Australia of a 3°C Warmer World*.

In recent years, the ACT has demonstrated progressive commitments to climate change action with various targets being set and met (Figure 1).[9]

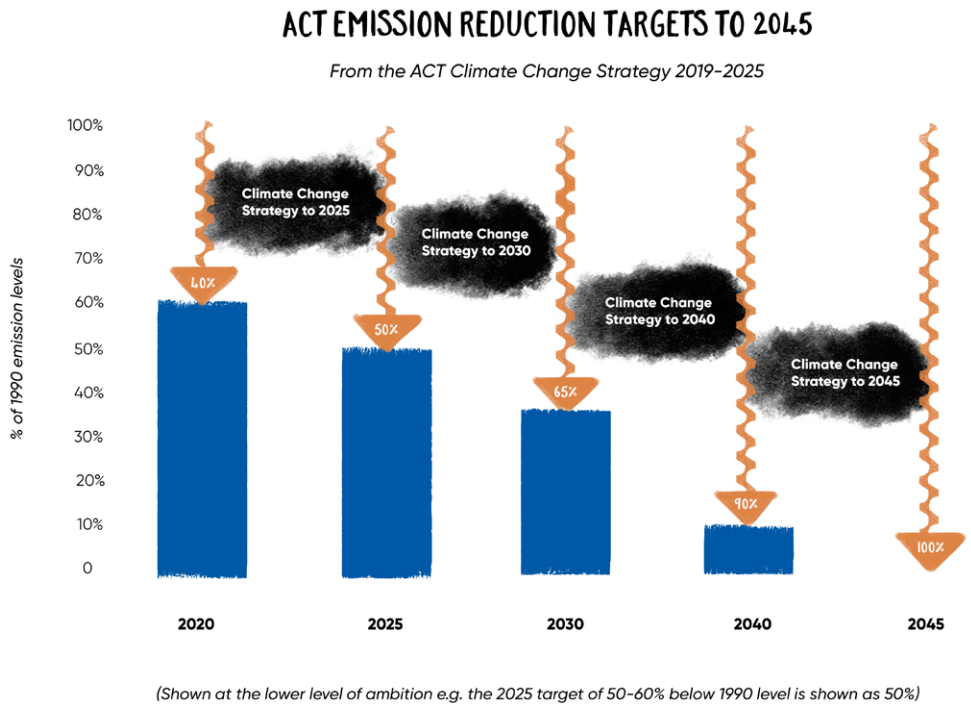


Figure 1: the targets set in the current ACT Climate Change Strategy. These targets only cover scope 1 and 2 emissions.

The 2020 targets have been met. This was based on a dual approach of reducing direct emissions from transport and gas (scope 1) and eradicating any indirect emissions from electricity (scope 2). The achievement of 100% renewable electricity supply was reached five years ahead of the original 2025 target. The ACT Government is now working towards the 2025 target of reducing emissions by 50%. To date, the targets have been focused on scope 1 and 2 emissions, i.e. targeting the "easy wins" for reducing emissions. For the ACT to reach true net zero emissions, it must consider scope 3 emissions reductions. Now is the time to consider those scope 3 emissions in greater detail (refer to "Definitions of Scope 1, 2 and 3 Emissions" infographic).

Between 1995 and 2015, global scopes 1, 2 and 3 emissions from industry grew by 47%, 78%, and 84% respectively.[10] This trajectory demonstrates the importance of considering scope 3 emissions when the ACT is working towards a zero emissions economy, as their contribution to global emissions is substantial. Measuring scope 3 emissions will ensure comprehensive accounting of all greenhouse gas emissions and provide the information needed to develop appropriate policies for reductions.

This Investigation of scope 3 emissions will be instrumental in informing future policies and pathways for the ACT Government to work towards true net zero emissions by 2045.

9. ACT Government, 2019. *ACT Climate Change Strategy 2019-25.*
10. Hertwich E. and Wood R., 2018. *The growing importance of scope 3 greenhouse gas emissions from industry*, Environmental Research Letters.

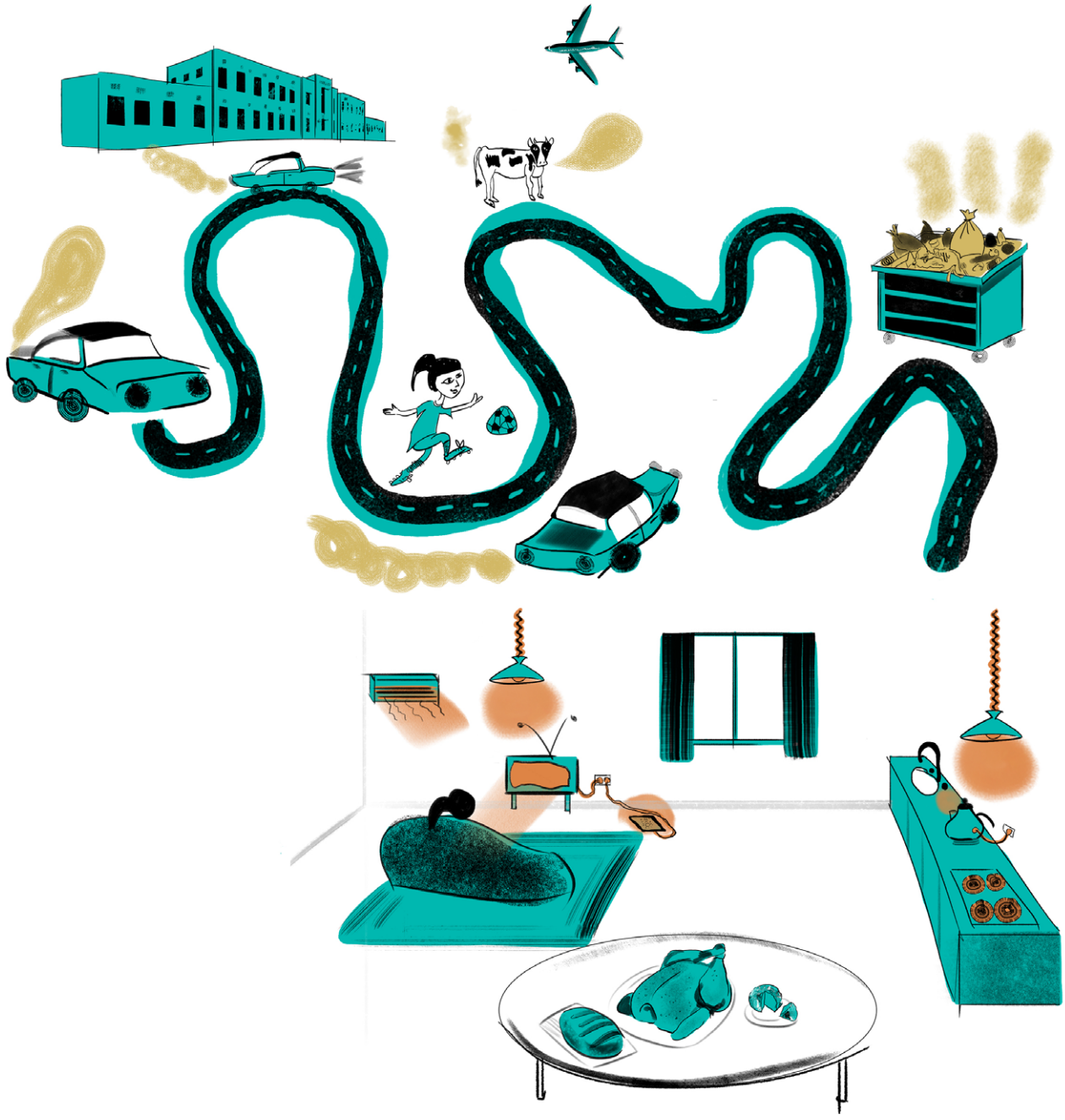
1.3 What are scope 1, 2 and 3 emissions?

DEFINITIONS OF SCOPE 1, 2 & 3 EMISSIONS

SCOPE 1: **Emissions released inside the city as a result of activities occurring in it.** This includes emissions from cars, trucks and buses travelling within a city, agriculture, and waste disposal.

SCOPE 2: **Any emissions released in the city from the use of grid-supplied electricity and energy purchased to be used inside the city.** This includes the emissions generated from the production of the electricity infrastructure.

SCOPE 3: **Emissions released outside the city as a result of activities occurring inside its boundaries.** This includes emissions generated from the production line for imported goods and services, such as consumer goods, food, construction materials, associated transport, and flights.



Other key terms used throughout the report which require explanation are outlined in Table 1.

Table 1. Explanation of Key Terms.[11]

Term	Definition
Direct emissions	Emissions directly associated with an activity, a process, or an entity.
Territorial emissions	Emissions occurring within a territory, such as a city, state or country.
Production-based accounting	Accounting scheme for emissions released during the production of goods and services by a certain entity (e.g. a person, firm, country, or region).
Indirect emissions	Emissions produced outside the entity boundary associated with the production of items and activities consumed within the entity.
Embodied emissions	Emissions associated with the production of the product in question.
Consumption-based accounting	Accounting scheme which assigns emissions from production to consumption, accounting for the direct and indirect emissions of final demand.
Carbon footprint	Direct and indirect emissions associated with a specific product or consumption activity or unit. Most literature only considers the direct and upstream indirect emissions, although life-cycle approaches often assign end-of-life impacts to individual products or consumption activities. For the purpose of this report, the "carbon footprint of the ACT" is identical to the ACT's consumption-based emissions.
Downstream emissions	Emissions associated with the distribution, retailing, use, and waste treatment of products produced by an entity.
Upstream emissions	In most cases, synonymous to the summation of both direct and indirect emissions, i.e. those associated with the production of inputs to an entity and the operation of the entity. In the Greenhouse Gas Protocol, this is a part of scope 3 emissions.

11. Lucas, C. et al., 2007. *Bushfire Weather in Southeast Australia: Recent Trends and Projected Climate Change Impacts*, Consultancy Report prepared for The Climate Change Institute of Australia.

1.4 Ways to Calculate Greenhouse Gas Emissions

There are two established ways of measuring greenhouse gas emissions: territorial (or production-based) accounting; and consumption-based accounting.

The most common approach for attributing greenhouse gases to a particular country or jurisdiction is production-based (territorial) accounting. This approach measures emissions released within a specific area and is used under the United Nations Framework Convention on Climate Change reporting on greenhouse gas inventories.

An alternative approach is consumption-based accounting, in which emissions are attributed to the final consumers of goods and services. Consumption-based accounting requires that emissions associated with production of goods be reallocated to the final consumer, and hence, requires additional information, including:

- supply chain information sufficient to link goods and services back to production
- measures of the environmental pressures associated with production, and
- measures of consumption of goods and services within national economies.

This investigation provides consumption-based emissions accounts for the ACT.

In addition to the added complexity of upstream supply chain analysis required for scope 3 accounting, there is the possibility of double counting emissions. Therefore, the greenhouse gas categories (scope 1, 2 and 3) are intended to be mutually exclusive to avoid double counting. Furthermore, scope 1 and 2 emissions are clearly defined such that two or more entities will not account for them in the same scope.

However, scope 3 emissions are more complex to account for than scope 1 and 2 emissions, since they are released outside the ACT. The methodology applied here apportions scope 3 emissions along the supply chain in a consistent manner so that double counting does not occur.

Consumption-based accounting processes using environmentally extended multi-region input-output models are recognised as the most appropriate tool for the calculation of a city's total carbon footprint as they include all direct and indirect emissions (see the UNSW Sydney's report on the Office of the Commissioner for Sustainability and the Environment website for more detail).[12]

12. UNSW, the University of Sydney, and CSIRO Land and Water, 2021. *ACT OCSE Investigation into Scope 3 Greenhouse Gas Emissions*, https://envcomm.act.gov.au/.

The analysis identifies emission 'hotspots' in the ACT. Potential targets for reduction are then proposed in order for the ACT to reach carbon neutrality. Carbon neutrality is the balancing of greenhouse gas emissions so that the net emissions of an activity are zero.[13] These targets to carbon neutrality were modelled according to this definition provided by Climate Active.

The ACT Government is committed to achieving emissions reduction targets and net zero emissions goal without the purchase of carbon offsets.[14] Offsets refers to the practice of paying for emission cuts or carbon removal (often in developing countries) rather than cutting emissions.

Offsetting can be fraught and cannot be a substitute for significant emissions cuts.[15] The best example of offsetting would be tree planting to preserve key habitats and reduce atmospheric carbon. The worst examples are those linked to harmful social and environmental outcomes which cause major embarrassment for those looking for cheaper credit or those who fail to properly explore what they are purchasing.[16]

The two key things that need to be considered in the case of offsets are:

- whether the offsets are genuinely being used as a last resort after reducing physical emissions as much as possible, and
- the quality of the offsets that are chosen, noting that it is the responsibility of the end user to ensure this.[17]

The approach of achieving net zero emissions without offsets has been adopted after advice from the ACT Climate Change Council. The Council considers purchasing carbon offsets a short-term solution that does not help the ACT to achieve true net zero emissions. Thus, it is necessary to focus on reducing the scope 1 and 3 emissions of the ACT rather than relying on offsets.

All greenhouse gas emissions, including carbon dioxide, methane and nitrous oxide, are reported in this Investigation in terms of "carbon dioxide equivalent", which measures emissions from greenhouse gases according to their global warming potential.

13. Climate Active, 2020. *Climate Carbon Neutral Standard for Precincts.* Canberra: Commonwealth of Australia.
14. ACT Government, 2019. *ACT Climate Change Strategy 2019-25.*
15. The Energy and Climate Intelligence Unit and Oxford Net Zero, 2021. *Taking Stock: A global assessment of net zero targets.*
16. The Fifth Estate, 2021. *On the shades of grey around carbon offsets...and finding their true value.*
17. Ibid.

1.5 The Production Journey of a Consumer Product

For every item that is brought into the ACT, there are significant greenhouse gas emissions produced due to extensive production chains.

The "Why does my t-shirt have a carbon footprint?" infographic (refer to page 18) demonstrates that the emissions associated with the production of a t-shirt are all scope 3 emissions, apart from those involved once the t-shirt enters the ACT. It represents just one possible route a t-shirt could have taken to be delivered to you in the ACT through online shopping. It only focuses on the carbon dioxide equivalent emissions that result from this process and does not analyse the ethical or social issues, or even the level of pollution created.

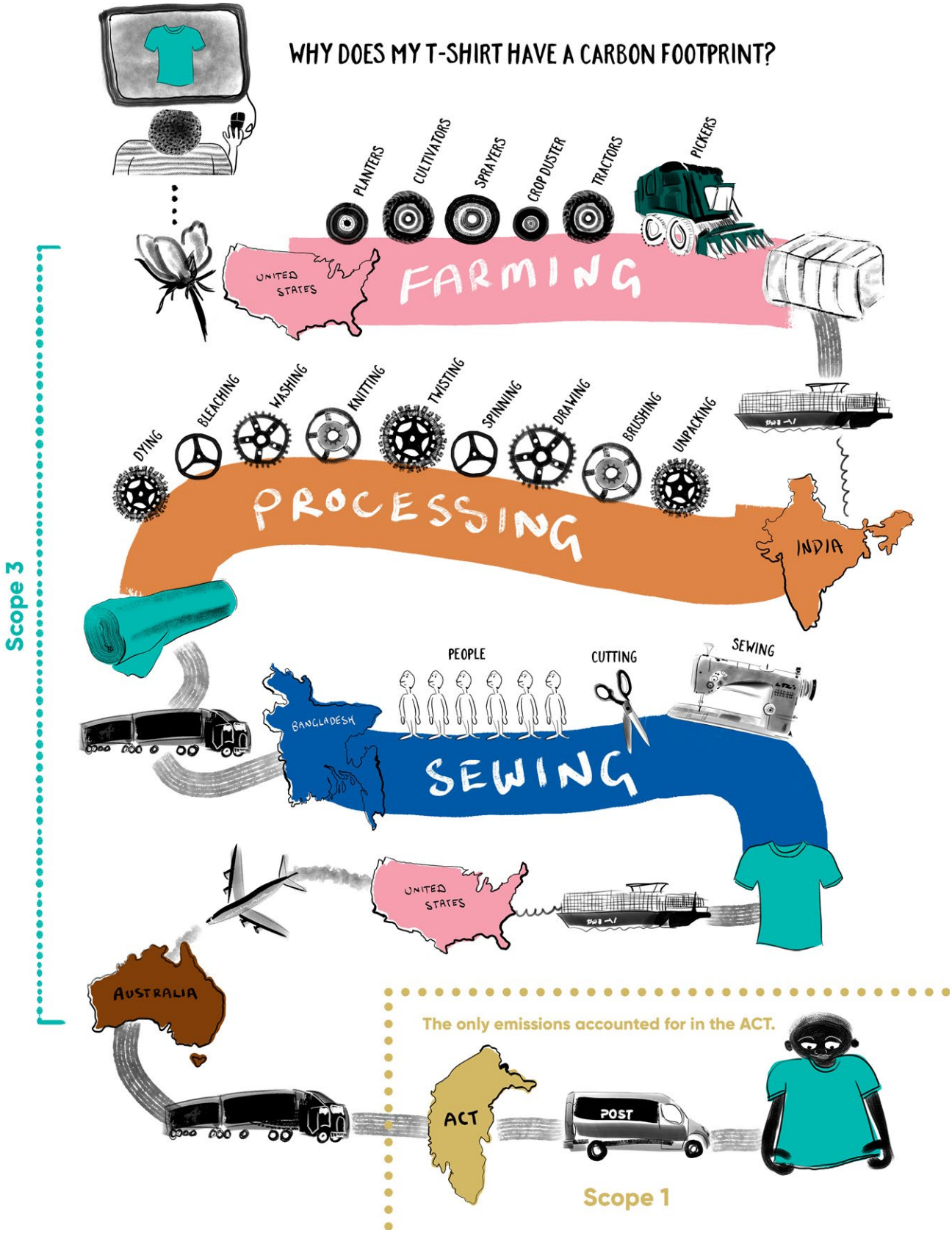
Even if most of the production steps occurred in a single country, every step would occur in a different location, requiring transportation and warehouse storage between each destination, producing emissions throughout. Every point at which there is a machine involved energy is required, most likely provided through fossil fuels.

Usually, the most labour-intensive step is assembly, the most electricity-intensive step is processing, and the most fuel-intensive steps are farming and transportation. Transportation as an industry creates approximately 14% of global greenhouse gas emissions.[18] One cotton harvester consumes approximately 45 litres of diesel for every hectare of harvested cotton, and two separate machines are needed for packing and unpacking the cotton bales.

Car factory. Source: Carlos Aranda - Unsplash

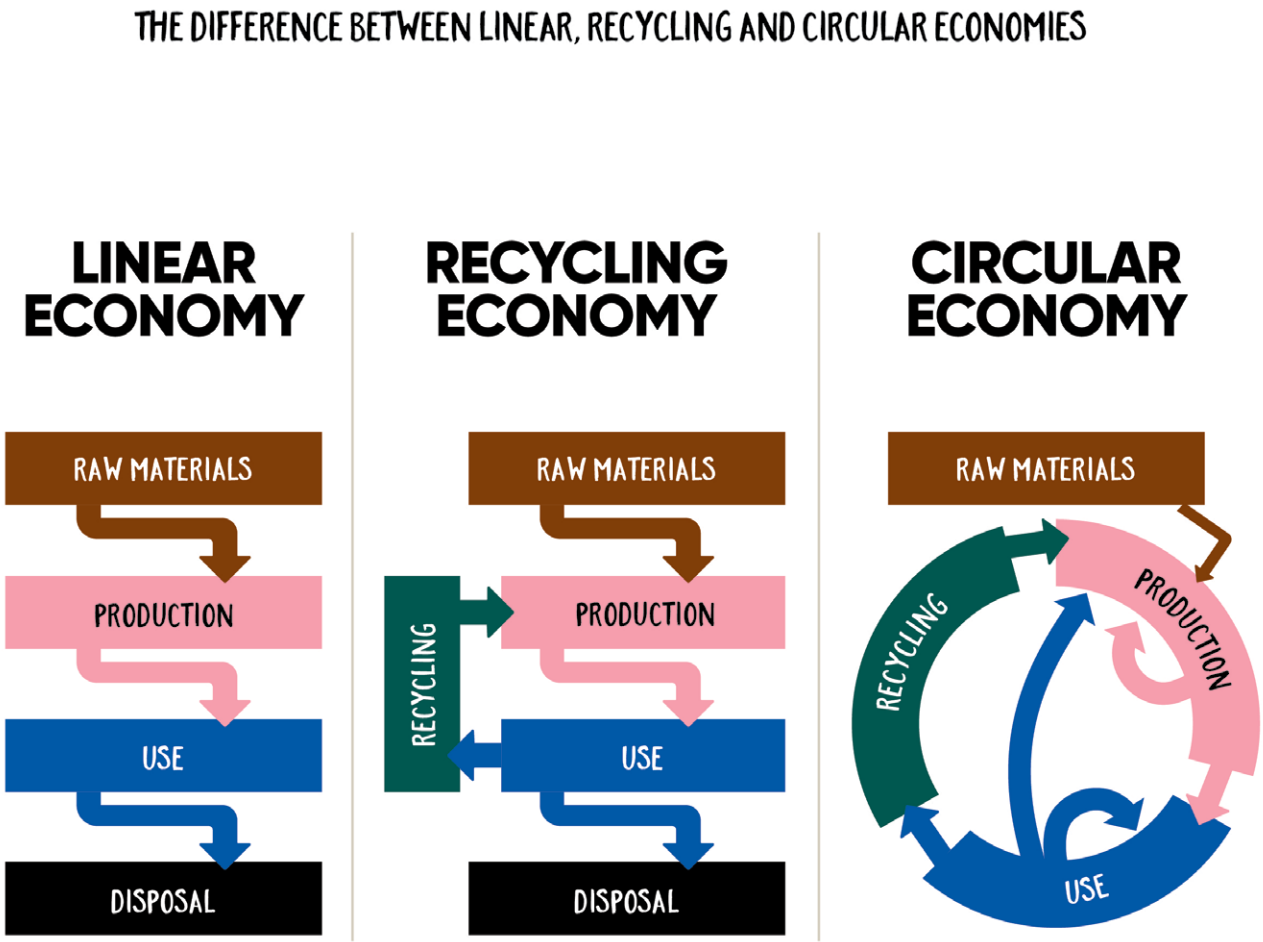
18. Lamb et al., 2021. *A review of trend and drivers of greenhouse gas emissions by sector from 1990 to 2018*, Environmental Research Letters, 16 (7).

The infographic highlights the significant scope 3 emissions associated with producing an item for ACT residents and the need to consider how these can be reduced.



1.6 What is the circular economy?

Scope 3 greenhouse gas emissions are inextricably linked to the usage of energy, resources and raw materials. In order to have a chance of achieving the ACT's scope 3 emissions reduction goals, there must be a much greater focus on a circular economy, rather than a linear economy or even a recycling economy. Circular economy principles involve a reduction or elimination of waste and pollution by keeping products and materials in use, and regenerating natural systems, differing from the linear or recycling economies (refer to "The Difference Between Linear, Recycling and Circular Economies" infographic).



19. Dickson, K. and Auty, K., 2019. Circular_CBR – *Unlocking the potential of the Circular Economy in the ACT*, Office of the Commissioner for Sustainability and the Environment.

2. How was the ACT carbon footprint calculated?

For this Investigation, the carbon footprint was calculated using a consumption-based accounting approach. This approach considers the full life cycle emissions of all goods and services from production — no matter where — through to consumption within the Territory. The emissions associated with goods and services produced and consumed within Canberra's boundaries are scope 1 and 2 and those produced outside Canberra but consumed inside are scope 3.

The carbon footprint of the ACT is modelled using the City Carbon Map framework, which identifies emissions by various categories.[20] These categories include scope 1, 2 or 3 emissions for product groups, consumer groups (government, business and households) and at several spatial scales (cities, regional, national, global).

The framework also ensures there is no double counting of emissions. It is based on an environmentally-extended input–output method, which combines environmental data with traditional financial flow data from national and regional economic accounts. Data on the use and supply of products is obtained from the Australian System of National Accounts[21] which is published by the Australian Bureau of Statistics.[22] The latest year of availability for some of the data was 2017-18. As such, the most recent results presented in the UNSW report[23] were 2018, even though some data sets were available for more recent years.

Data on greenhouse gas emissions is sourced from the Australian Greenhouse Emissions Information System and includes the State and Territory Greenhouse Gas Inventories, the National Inventory by Economic Sector and the Australian National Greenhouse Gas Inventory (see UNSW report).

The environmentally-extended input–output method aggregates financial data into a defined number of economic or industry sectors, assuming emissions from all products in the same industry are equivalent, i.e. have the same specific emissions per dollar spent. While this may not affect the estimation of the total city carbon footprint, it does limit tracking the impact of individual products or brands. It should be noted that there are uncertainties and limitations around this methodology, however, it was the best approach for this Investigation.

20. Wiedmann, T. O., Chen, G., and Barrett, J., 2016. *The Concept of City Carbon Maps: A Case Study of Melbourne, Australia*. Journal of Industrial Ecology, 20(4), 676-691.
21. ABS 2016. Australian System of National Accounts: Concepts, Sources and Methods, 2015. *ABS Catalogue Number 5216.0*. Australian Bureau of Statistics, Canberra, ACT, Australia.
22. ABS 2021. Australian System of National Accounts. *ABS Catalogue Number 5204.0*. Australian Bureau of Statistics, Canberra, ACT, Australia.
23. UNSW, the University of Sydney, and CSIRO Land and Water, 2021. *ACT OCSE Investigation into Scope 3 Greenhouse Gas Emissions*, https://envcomm.act.gov.au/.
24. Crawford et al., 2018. *Hybrid life cycle inventory methods – A review.* Journal of Cleaner Production, 172, 1273-1288.

An alternative method is a hybrid Life Cycle Assessment.[24] This method combines the top-down approach of input–output analysis, with the bottom-up approach of life cycle analysis, which accounts for emissions associated with individual products or services across their whole-of-life. However, this method is more labour intensive and difficult to update so was not used in this Investigation.[25]

Heavy Canberra traffic. Source: Ryan Colley

25. Yu, M., and Wiedmann, T., 2018. *Implementing hybrid LCA routines in an input–output virtual laboratory*. Journal of Economic Structures, 7(1), 33.

3. Results

3.1 Breakdown of ACT Scope 1, 2 and 3 Emissions

The ACT has the second largest per person carbon footprint, and per person scope 3 emissions of all Australian states and territories (Figure 2). While the ACT's population only makes up 1.6% of Australia's population, its carbon footprint accounts for 2.3% of the nation's total footprint.

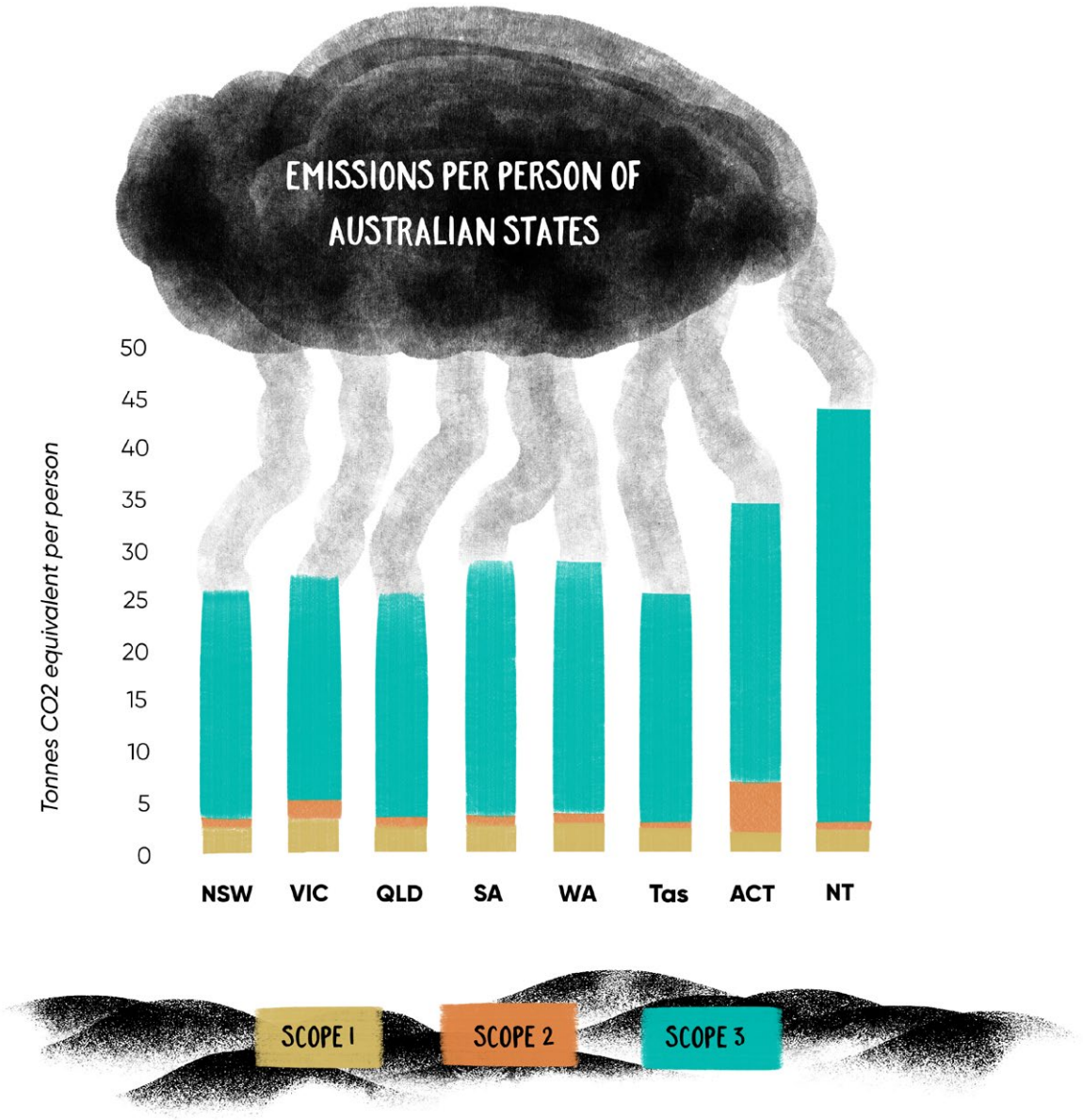


Figure 2: Breakdown of scope 1, 2 and 3 emissions for Australian states and territories in 2018, in tonnes of carbon dioxide equivalent per person. Note from 2020 onwards, these ACT scope 2 emissions are zero.[26]

26. UNSW, the University of Sydney, and CSIRO Land and Water, 2021. *ACT OCSE Investigation into Scope 3 Greenhouse Gas Emissions*, https://envcomm.act.gov.au/.

The results using the 2018 data for the ACT found the scope 1 and scope 2 emissions, at 0.7% and 16% respectively, were low compared to scope 3 at 83.3%. This is more significant given the data was from 2018 and by 2020 scope 2 emissions were zero, as 100% renewable energy supply had been achieved in the ACT.

Extrapolating the 2018 data into 2020 suggests that scope 3 emissions were 93.6 %of the ACT's total carbon footprint (see Figure 3). Scope 3 emissions are clearly the next priority to reduce the ACT's total emissions.

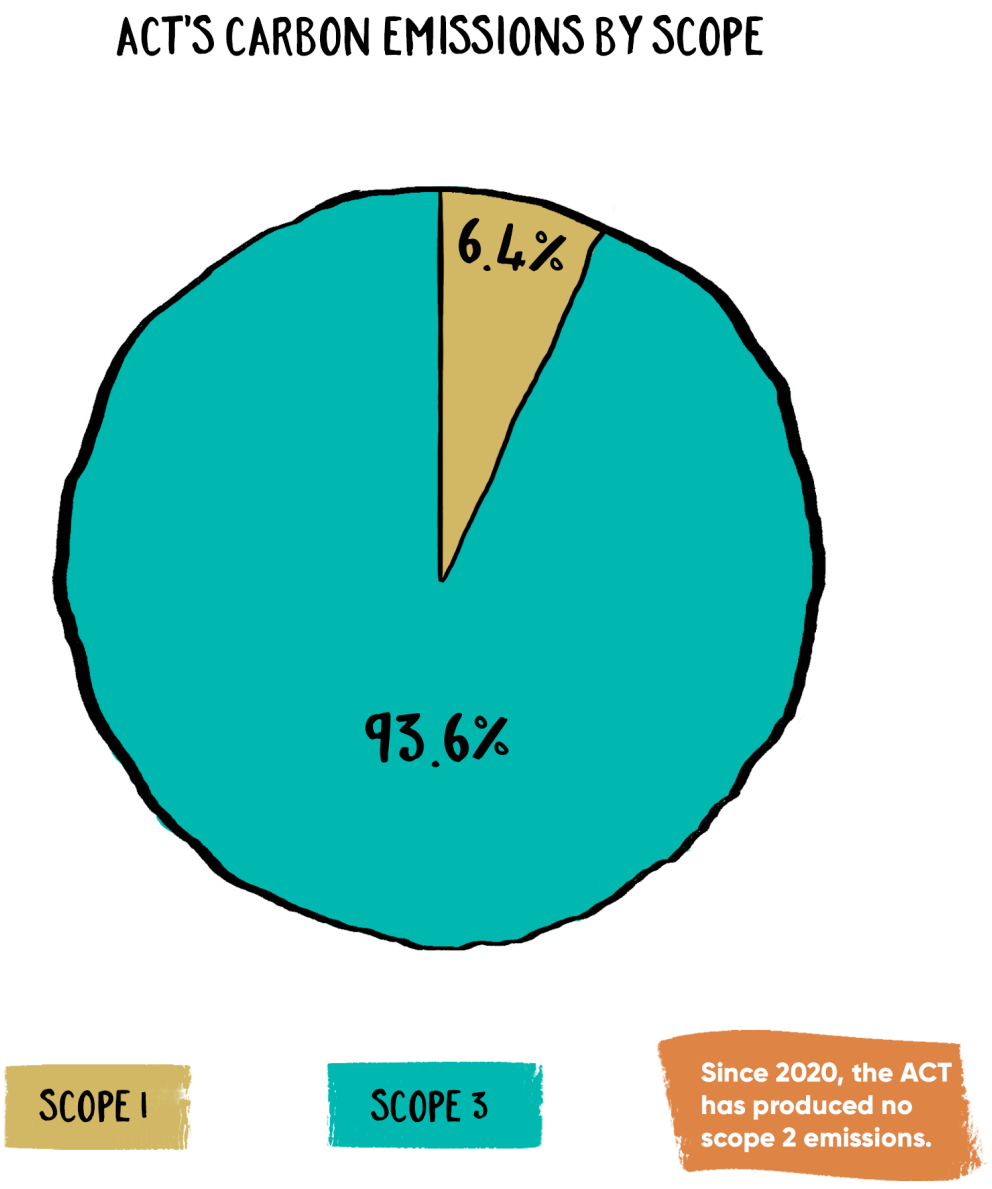


Figure 3: Total carbon footprint of the ACT in 2020 by scope, estimated from 2018 data.

Warehouse. Source: Ruchindra Gunasekara - Unsplash

3.2 Details of ACT Scope 3 Accounts

The analysis confirms that the ACT is a 'consumer' Territory not a 'producer' Territory,[27] with the high level of scope 3 emissions associated with consumption. This is not surprising, given the ACT's small size and geographic composition which limits local production at a scale to meet the demand of its residents. This is true for many Australian cities as they rely on imported emissions — from other parts of Australia and the world — to satisfy consumption.

Breakdown of ACT Scope 3 Emissions by Product Group

The total carbon footprint is broken down into 26 industry sectors as classified under the Australian Bureau of Statistics State Accounts.[28] A breakdown of the carbon footprint by product group, scope and origin helps to identify emission hotspots for the ACT more precisely.

"The ACT's Highest Scope 3 Product Groups" infographic[29] (refer to page 26) identifies the total scope 3 emissions contributions from the top six product groups. Electricity services was removed as it is all scope 2, which has been zero in the ACT since 2020.

27. UNSW, the University of Sydney, and CSIRO Land and Water, 2021. *ACT OCSE Investigation into Scope 3 Greenhouse Gas Emissions*, https://envcomm.act.gov.au/.
28. ABS 2020. Australian National Accounts: State Accounts. In: STATISTICS, A. B. O. (ed.) *ABS Catalogue Number 5220.0*. Canberra: Australian Bureau of Statistics.
29. UNSW, the University of Sydney, and CSIRO Land and Water, 2021. *ACT OCSE Investigation into Scope 3 Greenhouse Gas Emissions*, https://envcomm.act.gov.au/.

THE ACT'S HIGHEST SCOPE 3 PRODUCT GROUPS

1 **14.7%**

TRANSPORT, POSTAL & WAREHOUSING

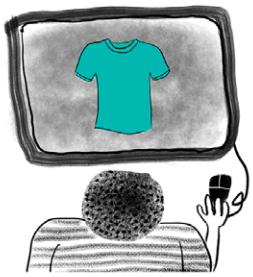
Public and privite road, rail, air and marine transport.

2 **11.9%**

FOOD

Agriculture, forestry and fishing, as well as food items from other categories.

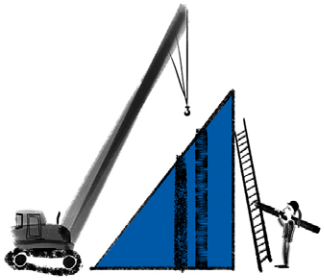
3 **11.7%**



RETAIL TRADE

International trade, manufacturing, and transport.

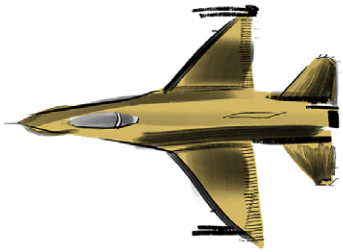
4 **9.3%**



CONSTRUCTION

Primarily driven by emissions in the rest of Australia, ultimately manufacturing, electricity, gas, water and waste services, and the construction industry directly.

5 **9.1%**



PUBLIC ADMINISTRATION & SAFETY

Services such as the police force, judicial and correctional system, and defence force.

6 **9.1%**

MANUFACTURING

Within Australia and overseas, including fuels burnt and gases released in the manufacturing of materials. Aluminium, steel and cement require significant amounts of energy to be produced.

1. Transport, postal and warehousing, including public and private road, rail, air, and marine transport, has the highest scope 3 emissions in the ACT. Transport is notable for being high both within Canberra (scope 1: approximately one third of total emissions) and the rest of Australia and internationally (scope 3: approximately two thirds of total emissions). This finding echoes the ACT Greenhouse Gas Inventory 2018–19[30] which found that transport was the highest contributing sector to ACT greenhouse gas emissions, representing over 40% of territorial emissions.

   The model used does not split transport, postage, and warehousing into subcategories. However, based on household expenditure data[31] it is estimated that 13% of household expenditure in this category is air travel, corresponding to approximately 0.37 tonnes of carbon dioxide equivalent per person per year. Additional contributions to the footprint for government and business are expected, although not estimated here.

2. The scope 3 emissions from food, which are driven primarily by agriculture, forestry and fishing within the rest of Australia, include items such as methane from enteric fermentation in cattle and sheep, and greenhouse gases from manure management and fertilisers.

3. Retail trade has a particularly high contribution of scope 3 emissions due to international imports, particularly driven by international retail trade imports and associated manufacturing, and transport, and is number three in emissions in the ACT.

4. Construction, by contrast, is primarily driven by emissions in the rest of Australia, ultimately from manufacturing, electricity, gas, water and waste services, and the construction industry directly. Emissions reduction opportunities include reducing waste, increasing recycling and the use of low carbon materials.[32]

5. Public administration and safety includes services such as the police force, judicial and correctional system, and defence force. Scope 3 emissions for public administration are driven by electricity usage from emissions in the rest of Australia.

6. The scope 3 emissions for the manufacturing industry are largely self-created likely reflecting fuels burnt and gases released in the manufacturing process. Manufacture of materials such as aluminium, steel and concrete in particular require significant amounts of energy. A secondary driver of scope 3 emissions in manufacturing is electricity usage.

30. Environment, Planning and Sustainable Development Directorate, ACT Government, 2020. *ACT Greenhouse Gas Inventory for 2019–20*.
31. ABS 2017. Household Expenditure Survey, Australia. *ABS Catalogue Number 6530.0*. Australian Bureau of Statistics, Canberra, ACT, Australia.
32. Yu et al., 2017. *The carbon footprint of Australia's construction sector*, Procedia engineering, 180, 211-220.

3.3 Where do the ACT's scope 3 emissions originate?

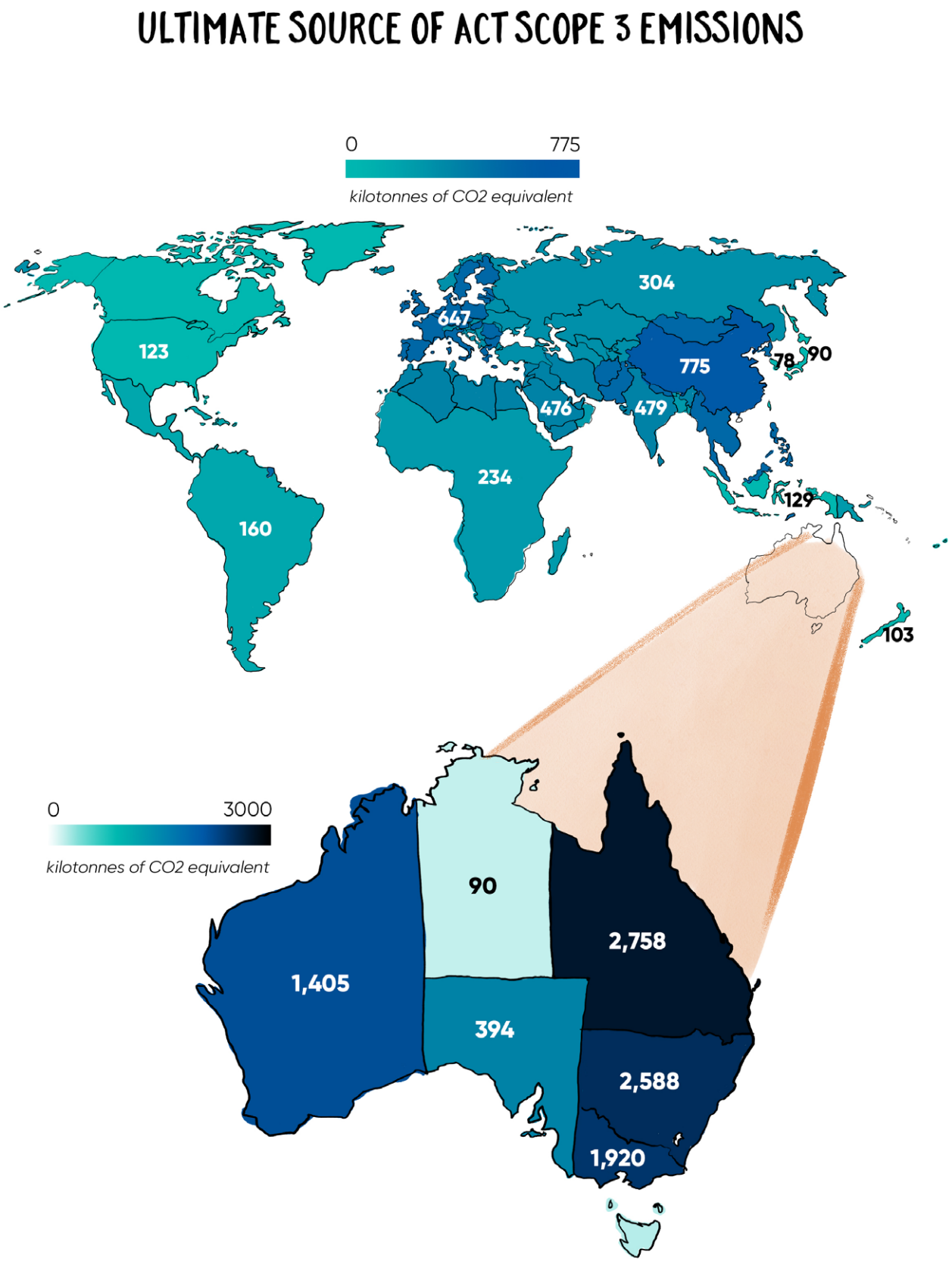


Figure 4. Breakdown of ACT scope 3 emissions by location (within Australia and main international trading partners). Units for the map are kilotonnes of carbon dioxide equivalent.[33]

33. UNSW, the University of Sydney, and CSIRO Land and Water, 2021. *ACT OCSE Investigation into Scope 3 Greenhouse Gas Emissions*, https://envcomm.act.gov.au/.

Scope 3 emissions of the ACT can be broken down to where the emissions originated from, based on where the product was produced and from where it was imported (Figure 4).

For the ACT, the top four scope 3 emission origins are:

- international (the highest is China followed by Europe) (28.8%)
- Queensland (19%)
- NSW (17.8%), and
- Victoria (13.2%).

It is important to note that Queensland, Victoria and NSW are all dependent on black and brown coal-fired power so any products originating from these states will have significant embodied emissions attached to them.[34] While these states all have strategies in place to work towards net zero emissions by 2050, these will all be done in different ways (e.g. Queensland plans to have 50% renewable energy by 2030), and 2050 is still almost three decades away.

The ACT will need to be selective choosing products produced by renewable energy sources to reduce the embodied emissions of products imported to the Territory.

Partnerships with suppliers and supplying regions that are committed to reducing emissions will be vital; reductions elsewhere in Australia will reduce our emissions.

The ACT Government can lead the way by using sustainable procurement to encourage shifts in people's consumption to goods and services with lower associated emissions.[35]

34. UNSW, the University of Sydney, and CSIRO Land and Water, 2021. *ACT OCSE Investigation into Scope 3 Greenhouse Gas Emissions*, https://envcomm.act.gov.au/.
35. C40 Cities Climate Leadership Group, 2018. *Consumption-Based GHG Emissions of C40 Cities*.

3.4 Government and Households Drive Carbon Footprint in the ACT

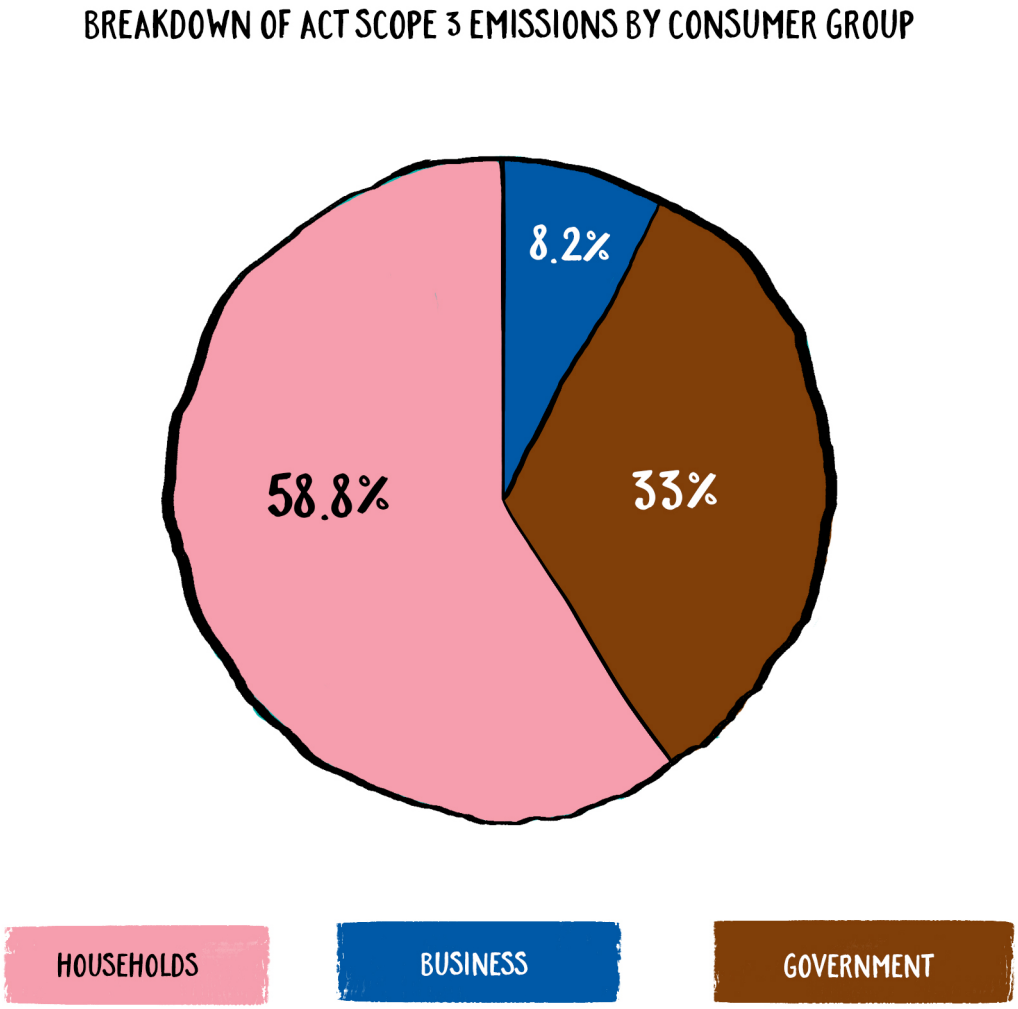


Figure 5: Breakdown of ACT scope 3 emissions by business, government and households.[36]

Household consumption is the main contributor to the ACT's total carbon footprint at 59%,[37] see Figure 5. Household emissions are primarily related to transport, international retail trade and food from other Australian states.

Government also generates a significant proportion of emissions. Government scope 3 emissions refer to government services provided by the rest of Australia, including payments from the Commonwealth Government to State Governments for maintenance of Commonwealth owned property, and joint Commonwealth/State Government programs based in Canberra. This is followed by healthcare, construction and education within Australia and retail trade outside Australia.

36. UNSW, the University of Sydney, and CSIRO Land and Water, 2021. *ACT OCSE Investigation into Scope 3 Greenhouse Gas Emissions*, https://envcomm.act.gov.au/.
37. Ibid.

Focus Areas for This Investigation

Food and the construction sector (including materials and processes) are both significant contributors to scope 3 emissions in the ACT, comprising approximately 16% of scope 3 emissions. These two topics are explored in Sections 4 and 5, providing relevant information for Canberra residents about the environmental impacts of possible choices, including low carbon options existing and emerging.

An estimation of the overall footprint of the ACT showed that food presents one of the highest carbon footprints of all economic groups,[38] and within households.

Construction is also a high contributor to the ACT's carbon footprint, responsible for 9.3% of scope 3 emissions. The ACT Infrastructure Plan[39] and 2019–20 Budget outline a $3 billion pipeline of infrastructure projects over the next four years. This includes priorities such health infrastructure, construction of public housing, building three new schools, extending the light rail network and footpaths and cycleways, and a new Canberra Theatre. The ACT Government is in prime position to reduce the scope 3 emissions of these proposed projects. How these hotspots for change can be converted into targets for emissions reductions for the ACT is explored in Section 7.

It is noted that other product groups, such as transport and retail trade, contribute significantly to ACT scope 3 emissions. These product groups need to be areas of future focus if the ACT is to reduce its carbon footprint comprehensively.

Transport was not a focus area for this Investigation for several reasons. The ACT Climate Change Strategy 2019–25 has a strong emphasis on scope 1 emissions reduction for transport. Initiatives include improving access to public transport and active travel options such as cycling, to disincentivise the use of private cars, introducing electric and hybrid buses, and encouraging zero-emissions private vehicles.

Transport of goods, including scope 3, is covered in the food and construction sectors in relation to those product groups. It is also included in our recommendations around the circular economy. However, initiatives to reduce scope 3 transport emissions need further attention.

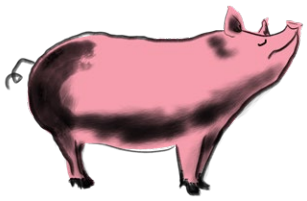
38. Office of the Commissioner for Sustainability and the Environment, Canberra, 2019. http://actsoe.com.au/report/human-settlements/indicator-hs1-acts-ecological-footprint/.
39. ACT Government, 2019. *Infrastructure Plan: Planning for the future,* Canberra, ACT Government.

4. Scope 3 Emissions from Food

Food production has a considerable impact on climate change, accounting for at least a third of human caused greenhouse gas emissions globally,[40,41] and 80% of it is consumed in urban areas.[42] Accordingly, food-related greenhouse gas emissions have gained a great deal of attention as one of the main areas for directing climate action for the government, community, and households. For households, food choices are a valuable opportunity to lower personal environmental impact. Research undertaken for C40 cities, a group of 97 cities committed to tackling climate change, shows that emissions associated with food account for 13% of total consumption-based emissions, and most (75%) originate from the consumption of animal-based foods.[43] Food waste is also a big emitter, contributing 8% of annual greenhouse gas emissions globally.

Food's carbon footprint is the second largest source of emissions in the ACT, after transport, postal and warehousing services; making it one of the hotspots for targeted emissions reduction efforts. A total of 11.9 % of the Territory's scope 3 emissions are associated with food consumption, most of which are imported from elsewhere in Australia. Most food related emissions originate from households, representing 16.4% of the total carbon footprint of household consumption.

For this report the carbon footprint of the ACT's food consumption was measured using the City Carbon Map framework (refer to Section 2). Another common method used to calculate the carbon footprint of a particular food item is a life cycle assessment, which considers all resources and energy involved at each step of an item's production or through its supply chain. For instance, in the case of food items, its carbon footprint would be estimated starting from the land use, cultivation and farming stages, followed by transportation, processing and preparation, to the point of waste.[44] This method is difficult to implement at larger scales given the high amount of information and detail needed. Educating consumers, and encouraging suppliers to inform themselves and consumers about the practices surrounding the food supply chain, is an efficient and comprehensive approach to inducing people to adopt sustainable and low carbon emission diets.



40. Mbow, C., et al., 2019. *Food Security. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*. In press. https://www.ipcc.ch/srccl/chapter/chapter-5/. Accessed 24 August 2021.
41. Crippa, M., et al., 2021. *Food systems are responsible for a third of global anthropogenic GHG emissions*, Nature Food, 2(3), 198-209.
42. Food and Agriculture Organisation of the United Nations. *FAO launches Green Cities Initiative to help transform agri-food systems, end hunger and improve nutrition.* 19 February 2019, New York. http://www.fao.org/news/story/en/item/1308436/icode/. Accessed 24 August 2021.
43. C40 Cities, Arup & University of Leeds 2019. *The Future of Urban Consumption in a 1.5C World*. Headline Report. Leeds: University of Leeds.
44. Food in a Warming World, World Wildlife Fund (WWF) Report, 2018. *The changing Foods on the British Plate.* https://www.wwf.org.uk/sites/default/files/2018-03/Food_in_a_warming_world_report.PDF. Accessed 24 August 2021.

4.1 The Carbon Footprint of the Food Supply Chain

The supply chain of food is complex, and emissions related to each stage vary among different types of food and within the same food categories. Most food-related greenhouse gas emissions originate at the production phase, such as changes in land use, and agriculture. Production accounts for more than 70% of food's greenhouse gas emissions.[45,46]

Land Use and Land Use Change

More than half of the world's habitable land surface is used for food production, and three-quarters of this is for livestock.[47] Changes in land use involve vegetation alteration and deforestation, which are a major source of carbon emissions, estimated to account for 8% to 10% of total anthropogenic emissions.[48,49] Green plants take in carbon dioxide through photosynthesis and store it in their biomass and soil. Therefore, practices involved in preparing land for agriculture such as deforestation and wetland degradation not only release carbon to the atmosphere, but also prevent continued carbon storage.

Farming

All activities that involve cultivating crops and keeping animals for food are considered farming, contributing 10% to 12% of total human related emissions.[50,51] Agricultural practices produce carbon emissions through processes that affect soil, such as tillage, and herbicide use; all of which are significant sources of greenhouse gas emissions. Most of these emissions occur in developing countries, but are associated with food consumption in industrialised countries, which highlights the importance of accounting for scope 3 emissions.[52]

Fuel for farming machinery and fertilisers are major emission contributors. There has been a notable increase in the use of energy in the agricultural sector in the last 30 years, and emissions from fertilisers and pesticides have increased globally in the recent decades.[53]

---

45. Poore, J., and Nemecek, T., 2018. Reducing food's environmental impacts through producers and consumers, Science. 360, 987–992.
46. Crippa, M., et al., 2021. Food systems are responsible for a third of global anthropogenic GHG emissions, Nature Food, 2(3), 198-209.
47. Ritchie, H., and Roser, M., 2020. Environmental impacts of food production. Published online at OurWorldInData.org. https://ourworldindata.org/environmental-impacts-of-food. Accessed 24 August 2021.
48. Mbow, C., et al., 2019. Food Security. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. In press. https://www.ipcc.ch/srccl/chapter/chapter-5/. Accessed 24 August 2021.
49. Lamb, W. F., et al., 2021. A review of trends and drivers of greenhouse gas emissions by sector from 1990 to 2018, Environmental Research Letters, 16(7), 073005.
50. Mbow, C., et al., 2019. Food Security. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. In press. https://www.ipcc.ch/srccl/chapter/chapter-5/. Accessed 24 August 2021.
51. Lamb, W. F., et al., 2021. A review of trends and drivers of greenhouse gas emissions by sector from 1990 to 2018, Environmental Research Letters, 16(7), 073005.
52. Crippa, M., et al., 2021. Food systems are responsible for a third of global anthropogenic GHG emissions, Nature Food, 2(3), 198-209.
53. Ibid.

Farming ruminant livestock is one of the most carbon intensive activities. This is largely due to the gastrointestinal system of animals like cows and sheep, which produces methane — a greenhouse gas 28 times more potent than carbon dioxide.[54] Animal feed is another important source of emissions, involving crop production and processing to feed farm animals.[55]

Microbes living in flooded rice plantations can produce significant amounts of methane but not as high as livestock production. In the case of wild caught fish, emissions are associated with the fuel used by fishing vessels.

Processing, Transport, Packaging and Retail

The remaining food supply chain accounts for roughly 18% to 29% of global emissions, and includes processing (4%), transport (5%), packaging (5%) and retail (4%).[56,57] Food convenience is more valued than ever before, and emissions related to food processing, transporting, and packaging are increasing worldwide. However, there is a high level of uncertainty and lack of documentation on emissions at these stages of the food supply chain, causing substantial variation in these emissions estimations.[59]

Globally, most food transport emissions are related to local and regional movement using roads, while highly perishable fresh produce, often transported by air, has a very high carbon footprint.[60] In terms of packaging, materials like pulp and paper produce the highest emissions, followed by aluminium, metal and glass.[61] Plastic is less emission intensive than most materials, helping to keep food fresh for longer, but plastic waste is very polluting.

Emissions from the food retail sector are mostly related to energy used to stock and prepare different food products. For instance, refrigeration accounts for 2% of food related emissions worldwide, and it is mostly linked to retail in industrialised countries. Some major food retailers in Australia have set their own goals to reduce their carbon emissions, which opens an opportunity for local government to assess these goals and engage with retailers to reduce emissions at higher levels of the supply chain, and to inform consumers.[62]

54. Saunois, M., et al., 2020. *The Global Methane Budget 2000–2017,* Earth System Science Data. 12(3), 1561-1623.
55. Ritchie, H., and Roser, M., 2020. *Environmental impacts of food production*. Published online at OurWorldInData.org. https://ourworldindata.org/environmental-impacts-of-food. Accessed 24 August 2021.
56. Ibid.
57. Crippa, M., et al., 2021. *Food systems are responsible for a third of global anthropogenic GHG emissions*, Nature Food, 2(3), 198-209.
58. Ibid.
59. Mbow, C., et al., 2019. *Food Security. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*. In press. https://www.ipcc.ch/srccl/chapter/chapter-5/. Accessed 24 August 2021.
60. Ritchie, H., and Roser, M., 2020. *Environmental impacts of food production*. Published online at OurWorldInData.org. https://ourworldindata.org/environmental-impacts-of-food. Accessed 24 August 2021.d
61. Crippa, M., et al., 2021. *Food systems are responsible for a third of global anthropogenic GHG emissions*, Nature Food, 2(3), 198-209.
62. Net Zero Momentum Tracker, Retail Sector, 2020. Climate Works Australia, Monash University. https://www.climateworksaustralia.org/publications/. Accessed 24 August 2021.

Even though emissions from this sector are small compared to the rest of the food supply chain, retail has a major influence on consumers' choices, since it selects producers, suppliers, and manufacturers of the food offered to the public.[63]

4.2 The Carbon Footprint of Different Food Types

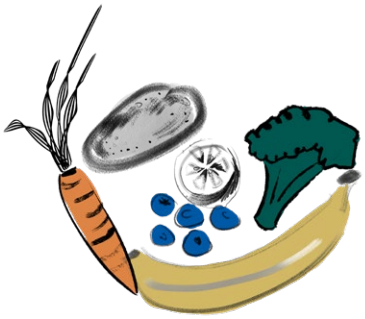
Determining the carbon footprint of different food categories is complex due to variations in production methods, food classification, and data availability and quality. There is also variability in emissions within the same type of food, which depends on production practices, quality, transportation methods, among other examples. Numerous studies have provided evidence to effectively rank different food categories according to their emission contributions (refer to "Carbon Footprint of Different Food Types" infographic), showing large variations within some food categories.[64] This infographic encompasses scope 1, 2 and 3 emissions.

To simplify the carbon footprint comparison among food types, they are grouped in three main categories:

- **Fresh Animal Food Products**
  minimally processed animal products like meat and dairy.
- **Fresh Plant-Based Food Products**
  minimally processed plant products such as fruits, vegetables, and staples like cereals, legumes, tree nuts and seeds.
- **Non-Perishable and Highly Processed Food Products**
  highly processed food items that are ready to eat such as snack foods, alcoholic and non-alcoholic drinks, processed meats, and oils.

Each category identifies the carbon footprint of different common food items, taking into consideration that some equivalent types of food can show great variation in their carbon footprint.

In general, emissions associated with food in cities account for roughly 13% of total consumption-based emissions, 75% of which are from consumption of animal-based foods and the remainder from plant-based foods.[65]



63. Ibid.
64. Poore, J., and Nemecek, T., 2018. *Reducing food's environmental impacts through producers and consumers*, Science. 360, 987–992.
65. C40 Cities, Arup & University of Leeds 2019. *The Future of Urban Consumption in a 1.5C World*. Headline Report. Leeds: University of Leeds.

CARBON FOOTPRINT OF DIFFERENT FOOD TYPES

(measured in kg of CO2 equivalent per kg of food)

Fresh Animal Food Products

Nearly 60% of emissions associated with food production are related to animal products, and half of these come from livestock.[66] Ruminant livestock, such as cows and sheep, produce large amounts of methane gas when digesting food, known as enteric fermentation; and are associated with the highest greenhouse gas emission values of any food type around the world.

There are opportunities for mitigation in livestock agriculture practices. The Australian Government, through the Climate Change Research Program, funded the Reducing Emissions from Livestock Research Program. This initiative has addressed livestock emissions through different approaches, such as measuring the role of gut microbes, alternative diets, dietary supplements, breeding low methane emitters, and manure management, among others.[67] Australia's carbon footprint of beef and lamb is the lowest when compared to the world's average.[68] The Australian red meat industry lowered its emissions by 57.6% between 2005 and 2016, and has a goal of achieving carbon neutrality by 2030. However, emissions from livestock are still responsible for 10% of Australia's carbon footprint.[69]

Meat and by-products from non-ruminant livestock, like pork and poultry, do not produce methane gas through digestion. Therefore their carbon footprint in general is lower than ruminant livestock but still much higher than plant-based foods.[70]

Australia's pork meat has the highest mean carbon footprint value per kilogram when compared to the world average.[71] Fish and shellfish vary greatly in their emissions, depending on the species and the fishing or farming practices. In general, the carbon footprint of farmed fish is lower than wild caught fish, because the latter require more energy to catch, especially boat fuel. However, fish farms are associated with other environmental issues, such as ocean pollution through food waste faeces and parasites.

Chicken and eggs have similar carbon footprints — generally much lower than beef and pork meats. Most of their associated emissions come from the protein used to feed the chickens and the farming methods.

66. Clune, S., et al., 2017. *Systematic review of greenhouse gas emissions for different fresh food categories*, Journal of Cleaner Production, 140, 766-783.
67. Australian Government, 2019. *Australia's Farming Future: Livestock Emissions.* https://www.agriculture.gov.au/ag-farm-food/climatechange/australias-farming-future/livestock-emissions. Accessed 12 May 2021.
68. Clune, S., et al., 2017. *Systematic review of greenhouse gas emissions for different fresh food categories*, Journal of Cleaner Production, 140, 766-783.
69. Australian Government, 2019. *Australia's Farming Future: Livestock Emissions*. https://www.agriculture.gov.au/ag-farm-food/climatechange/australias-farming-future/livestock-emissions. Accessed 12 May 2021.
70. Clune, S., et al., 2017. *Systematic review of greenhouse gas emissions for different fresh food categories*, Journal of Cleaner Production, 140, 766-783.
71. Ibid

Australia's dairy industry has one of the lowest carbon footprints in the world but it still accounts for 12.5% of the country's agricultural emissions and 2% of Australia's total emissions.[72] The largest source of emissions in dairy farms is associated with methane gas produced by ruminant livestock's digestive system, and excretions, accounting for 75% of emissions on average. The remaining 25% is linked to fertilisers, fossil fuel use, electricity, and feed.[73] Cheese, butter, and cream are more emission intensive than milk and yoghurt, since they use a high concentration of milk, while milk has a similar carbon footprint to yoghurt. Non-dairy milks, like oat, almond and soy, have much lower emissions values than dairy milk, with oat milk the lowest of the three. The dairy industry has committed to a 30% reduction of greenhouse gas emissions by 2030, with 2015 as the baseline.[74]

Fresh Plant-based Food Products

The carbon footprint of unprocessed fruits and vegetables is the lowest of all types of food, especially field grown ones, showing little variation between different producers. Emissions from fruit and vegetables grown in "passive greenhouses" are slightly higher than field grown ones, while those grown in heated greenhouses are markedly higher. Emissions from cultivating fruit and vegetables are mostly linked to the energy used for all cultivation processes such as fertilisers, fuels and energy for irrigation systems and machinery, transport, and refrigeration.

Cereals (e.g. barley, maize, oats, rye, corn and wheat), legumes (e.g. beans, peas, peanuts, lentils and ground nuts), tree nuts (e.g. chestnuts, almonds, pistachios, hazelnuts, walnuts, pam-nuts kernels and cashews) and seeds (e.g. canola, mustard, sesame and sunflower) all present low carbon footprints when compared to animal-based foods. Rice has the highest impact in terms of average emissions compared to other field crops, but it is still lower than all meats.

Heavily Processed and Non-perishable Food Products

Heavily processed foods usually refer to "ready to eat" foods, including crackers, deli meats, alcoholic and non-alcoholic drinks, chips, oils, and prepared meals like frozen pizzas. Greenhouse gas emissions from processed food are highly variable and depend on the amount of energy spent on their production. Processed foods containing animal products, especially meat, have much larger carbon footprints than those that do not.

Processed food consumption is on the rise. In addition to emissions from the food itself, associated packaging is high in embodied carbon. Emissions related to beer and wine packaging represent more than 40% of its total emissions, and for some fruit and vegetables it represents 10% to 22% of their emissions.[75]

72. Climate Change and Dairy, 2021. Dairy Australia. https://www.dairyaustralia.com.au/dairynsw/land-water-and-climate/climate-change-and-dairy/preserve#.YNlXcDgzZaQ. Accessed on 17 May 2021.
73. Ibid.
74. Dairy Australia on behalf of Australian Dairy Sustainability Framework. *Reducing Environmental Impact*. https://www.sustainabledairyoz.com.au/reducing-environmental-impact#.YNloMjgzZaQ. Accessed on 17 of May 2021.
75. Crippa, M., et al., 2021. *Food systems are responsible for a third of global anthropogenic GHG emissions*, Nature Food, 2(3), 198-209.

The Carbon Footprint of Coffee

Coffee is one of the most widely consumed beverages in the world[76] and in Australia,[77] and one of the most traded food products in the world.[78] It has a high carbon footprint per kilogram of product, comparable, for example, to cheese and chocolate.[79] The international economic importance of coffee has brought attention to its carbon footprint, especially as its global annual demand is expected to triple by 2050.[80] Canberrans are major coffee consumers.[81,82] All of it is imported to the ACT — most coffee plantations are in tropical countries in South America, Asia, and Africa,[83] with a small but growing coffee cultivation industry in Australia[84] — so its carbon footprint falls under the scope 3 category.

The life cycle of coffee has four general stages: cultivation, transportation, roasting, and consumption. At the cultivation stage, coffee uses nitrogen rich fertilisers, which generate greenhouse gas emissions such as nitrous oxide.[85] Research has shown that emissions reduction can start here, by using less fertiliser and more renewable energy sources. During the transport phase, exporting coffee by cargo ship instead of freight flight would reduce emissions and roasting the beans before exportation would reduce their weight, therefore reducing the emissions footprint.[86] The specific environmental requirements to grow coffee are being threatened by climate change due to altered temperatures and rainfall patterns, leading producers around the world to work on adaptation strategies and mitigation plans to reduce its carbon footprint.[87]

In Australia, people generally prefer to drink their coffee with milk — lattes are the leading preference in coffee shops, while flat whites are the most popular choice in the ACT[88] — increasing the coffee-based drink's carbon footprint. This opens an opportunity to reduce the carbon footprint of coffee by replacing dairy milk with plant-based milk or by choosing to drink it black. Of the non-dairy milk alternatives, oat milk is the least emission intense when compared to soy and almond milk.

Homegrown vegetables. Source: Wikimedia Commons

76. Butt, M. S., and Sultan, M. T.,2011. *Coffee and its consumption: benefits and risks*, Critical reviews in food science and nutrition, 51(4), 363-373.
77. Australian Health Survey: Nutrition First Results, 2014. - Foods and Nutrients, Australian Bureau of Statistics. https://www.abs.gov.au/statistics/health/health-conditions-and-risks/australian-health-survey-nutrition-first-results-foods-and-nutrients/latest-release. Accessed 21 April 2021.
78. Lashermes, P., et al., 2008. *Genomics of coffee one of the world's largest traded commodities*, Genomics of tropical crop plants, 203-226.
79. Ritchie, H., and Roser, M., 2020. *Environmental impacts of food production*. Published online at OurWorldInData.org. https://ourworldindata.org/environmental-impacts-of-food. Accessed 24 August 2021.
80. Nab, C., and Maslin, M., 2020. *Life cycle assessment synthesis of the carbon footprint of Arabica coffee: Case study of Brazil and Vietnam conventional and sustainable coffee production and export to the United Kingdom*, Geo: Geography and Environment, 7(2).
81. Circular_CBR – Unlocking the Potential of a Circular Economy in the ACT, Issues Paper 2019/3. https://envcomm.act.gov.au/. Accessed 1 June 2021.
82. Craig, A., 2015. *Does Canberra have too many coffee shops?* https://the-riotact.com/does-canberra-have-too-many-coffee-shops/150166. Accessed 1 June 2021.
83. Jones, L., 2018. Coffee: Who grows, drinks and pays the most? BBC News. https://www.bbc.com/news/business-43742686. Accessed 1 June 2021.
84. Australian specialty coffee, 2017 *Five things you probably didn't know about Australian grown coffee*. https://australianspecialtycoffee.com.au/whats-future-australian-subtropical-coffee/. Accessed 1 June 2021.
85. Killian, B., et al., 2013. *Carbon footprint across the coffee supply chain: the case of Costa Rican coffee*, Journal of Agricultural Science and Technology. B, 3(3B), 151.
86. Nab, C., and Maslin, M., 2020. *Life cycle assessment synthesis of the carbon footprint of Arabica coffee: Case study of Brazil and Vietnam conventional and sustainable coffee production and export to the United Kingdom*, Geo: Geography and Environment, 7(2).
87. Ibid.
88. The 2019 Square Australian Coffee Report, 2019. https://squareup.com/au/en/townsquare/2019-australian-coffee-report. Accessed 2 June 2021.

4.3 Expert Commentary: Food in a Changing Climate

by Alana Mann, Associate Professor, Department of Media and Communications, University of Sydney, Australia.

Climate change is already impacting our food system in many ways, from declining wheat harvests to the disruption of fisheries by shifting ocean currents. Tropical zones are moving from optimal conditions for cereal crops like rice and corn into extreme and prolonged summer temperatures. Growing seasons in temperate zones are lengthening with gains offset by extreme weather events like the Australian bushfires of 2019–20, which followed the longest drought in living memory. Meanwhile, the Intergovernmental Panel on Climate Change reports that our global food system is responsible for as much as 37% of total greenhouse gas emissions.[89] One third of food produced globally is wasted — a 'double waste' in terms of the non-consumed food energy and inputs required for production, transport and distribution.[90]

These data prove that rather than sustaining us, 'how the food system operates is a significant threat to the ecosystem's future and humanity's within that'.[91]

The pandemic has made this threat highly visible. It has exposed the fragility of a just-in-time model of industrial over-production and supply that enables some markets 'to pile it high and sell it cheap' while depriving others of adequate healthy, affordable, and culturally appropriate food. Port closures and shortages of agricultural labour have exacerbated food insecurity in countries already crippled by climate shocks, corruption and conflict. Low and middle income countries — among those least responsible for producing emissions — are not only most vulnerable to global warming but also they are the primary sites of land grabs, labour exploitation and environmental degradation including depleted soils, polluted waterways and deforestation.

These wrongs can be traced back to colonial food empires which shaped a global division of labour and resources where the over-production of commodity crops harms ecosystems, livelihoods and collective well-being. Local hotspots, those most vulnerable to slow-onset impacts like water stress, crop failure and sea level rise, are creating waves of climate refugees. In- and out- migration from coastal and rural places to urban and peri-urban centres is placing

89. Intergovernmental Panel on Climate Change, 2019. *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in territorial ecosystems*. Retrieved from https://www.ipcc.ch/srccl/chapter/summary-for-policymakers/.
90. Vittuari, M., et al., 2016. *The hidden burden of food waste: The Double energy waste in Italy*, Energies. 9(660).
91. Lang, T.,2020. *Feeding Britain: Our Food Problems and How to Fix Them*. UK: Pelican, page 197.

increasing pressure on housing and transport infrastructure, social services, and employment opportunities. Australians will suffer, but not to the extent of our Pacific neighbours, for example. As changes in water temperature and ocean acidification compound the impacts of commercial fishing fleets from distant nations, their healthy traditional food source is replaced by cheap imports of fatty meat and processed food that contributes to food insecurity and some of the highest incidence of non-communicable disease in the world.[92]

These damaging and discriminatory externalities of production, the structural barriers to eating well, are too frequently deflected onto individuals. Attempts to embed sustainability principles into dietary guidelines such as the *Food in the Anthropocene: EAT-Lancet Commission on Healthy and Sustainable Food Systems*[93] recommend universal diets for 'planetary health' that fail to meet the diverse cultural preferences, nutritional needs and lived realities of most eaters. Interest groups and media respond by polarising public opinion on specific agricultural products, including meat and dairy. Novel food entrepreneurs adapt by creating plant-based protein replacements, marketed as a climate fix. Among these are ultra-processed products that rely on unsustainable, industrially-grown monocultures in climate shock prone regions like the tropics, thus displacing threats posed by livestock production.

Widespread expectations that innovations like cultured meat are adequate solutions to global warming dismiss more immediate and significant sustainability gains that are already available. Stewarded by Traditional Owners, Indigenous land management practises like firestick farming and the cultivation of climate-resilient native varieties of flora and fauna can play an important role in our collective food future.[94,95] Many Australian farmers are practising agroecological farming methods that not only foster ecosystem restoration but also promote values of "communality, reciprocity, consensus, equity, and intersectional social justice" in their communities.[96]

Climate change, like the pandemic, is sharpening our focus on how we live. In this complexity, food cannot be divorced from wider social, economic and political goals. Beyond tracking emissions we need to transition to a food system that restores — rather than damages — the environment and guarantees a safe, equitable and resilient food supply into the future. This means supporting our farmers to ensure a sustainable, domestic food supply, and considering our extra-territorial obligations to other nations beyond the Territory, including our neighbours in the Asia–Pacific region. This is a roadmap to a sustainable and sustaining food system, for everyone.

92. Winders, B., and Ransom, W., 2019. *Global Meat: Social and Environmental Consequences of the Expanding Meat Industry*. Cambridge, MA. The MIT Press.
93. Willet, W. et al., 2019. *Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems*. The Lancet, 393(10170), 447-492.
94. Intergovernmental Panel on Climate Change, 2019. *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in territorial ecosystems*. https://www.ipcc.ch/srccl/chapter/summary-for-policymakers/.
95. Steffensen, V.,2020. *Fire Country: How Indigenous Fire Management Could Help Save Australia*, Melbourne: Hardie Grant Publishing.
96. Figueroa-Helland, L., et al., 2018. *Decolonizing food systems: Food sovereignty, indigenous revitalization, and agroecology as counter-hegemonic movements*. Perspectives on Global Development and Technology. 17, 173-201.

4.4 Opportunities for Reducing Emissions from Food

Climate change and the current food production system affect each other. Changing climates are affecting the production of food that has been grown and farmed in the same areas for centuries. Conversely, changes in land use, deforestation and emissions released from growing food, have greatly impacted climate change. Other elements of nature and society are also being threatened by climate change and the food production system, such as biodiversity loss and food security. This complex scenario calls for solutions that can account for all these challenges, including the introduction of technology, the provision of better choices from the private and public sectors, and behavioural changes from consumers — all of which combined can reduce our carbon footprint.

Raising Awareness on the Origin and Sustainability of Food

Today, farming and food production are not part of city centres. This profoundly changes people's relationship with food, and disconnects them with the origin and practices surrounding what they eat. Linking food choices to information about the origin and production methods of individual food items allows the public to choose what to eat by prioritising, limiting, or avoiding food items according to their carbon footprint, and according to other sustainability practices, such as their impact on ecosystems and human systems. A 2021 study by Swedish researchers found that labelling systems with information about the carbon footprint of food items are effective tools to change consumer behaviour, and therefore an opportunity to reduce emissions.[97]

This disconnection also has health consequences, limiting the amount of information available about the nutrients, quality, and substances present in our food. Improving the understanding and information surrounding our food's origin and production processes is a powerful tool to make better choices for our health, society, and planet.

Canberra Organic Garden Society garden in Mitchell. Source: Google Creative Commons

97. Edenbrandt, A. K., et al., 2021. *Interested, indifferent or active information avoiders of carbon labels: Cognitive dissonance and ascription of responsibility as motivating factors*, Food Policy.

Diet Changes

Beef and lamb meat are the most emission dense foods, and any reduction in their consumption translates to lower emissions.[98] Consumption of lamb and beef in Australia has decreased in the last two decades, while pork, chicken and kangaroo has increased, a trend that may result in a decrease in per person emissions from meat consumption.[99] Animal products also have a major impact on land use, which could potentially be repurposed for climate change and biodiversity loss solutions.

It is now possible to explore diets according to their nutrient content and greenhouse gas emissions contributions, supported by information from scientific studies.[100,101] Energy-dense and nutrient-poor foods have been found to have the highest environmental impact, regarding emissions, water and land use.[102] Cooking with raw and minimally processed food items avoids emissions from industrial processing and packaging, and from a health perspective, provides control over the ingredients. Increasing access to healthy, fresh cooked meals for low income and time poor households could improve health outcomes and reduce emissions from food. Reducing over-consumption and avoiding food waste throughout the supply chain are both goals that will help reduce food's carbon footprint. However, in order to achieve healthy sustainable diets that reduce emissions, the majority of emphasis on change should focus on food producers rather than consumers.[103]

Reducing Food Waste

Worldwide, 8% of annual greenhouse gas emissions are produced by food waste: it being considered the third major greenhouse gas emitter on the planet when compared to countries, only surpassed by China and the United States. When organic waste, including food waste, decomposes without oxygen in landfill, it produces methane, a powerful greenhouse gas, making it a significant contributor to climate change. Roughly one third of all food produced is wasted, adding up to nearly a billion tonnes per year of wasted food globally, which occurs at all stages of the supply chain.[104] Food waste and loss also have considerable environmental impacts through wasted water, land, and energy resources invested in unconsumed food, costing the Australian economy approximately $20 billion annually.[105]

98. Mbow, C., et al., 2019. *Food Security. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*. In press. https://www.ipcc.ch/srccl/chapter/chapter-5/. Accessed 24 August 2021.
99. Ratnasiri, S., and Bandara, J., 2017. *Changing patterns of meat consumption and greenhouse gas emissions in Australia: Will kangaroo meat make a difference?* PLoS ONE 12(2).
100. Wilson N., et al., 2013. *Foods and Dietary Patterns That Are Healthy, Low-Cost, and Environmentally Sustainable: A Case Study of Optimization Modelling for New Zealand*, PLoS ONE 8(3).
101. Hendrie G. A., et al., 2014. *Greenhouse Gas Emissions and the Australian Diet—Comparing Dietary Recommendations with Average Intakes*, Nutrients., 6, 289-303.
102. Ridoutt, B. G., et al., 2021. *Diets within planetary boundaries: What is the potential of dietary change alone?* Sustainable Production and Consumption, 28, 802-810.
103. Ibid.
104. Gustavsson, J., et al., 2011. *Global food losses and food waste*, Food and Agriculture Organization of the United Nations. http://www.fao.org/3/mb060e/mb060e00.pdf, Accessed on 29 April 2021.
105. Australian Government, Department of the Environment and Energy, 2017. *Fact sheet: Working together to reduce food waste in Australia*, Commonwealth of Australia, 2017.

Developing a Local Food System

The benefits of developing a local food production system go beyond reducing the carbon footprint of food miles. In general, food transportation is less significant in terms of emissions than the type of food consumed, such as animal-based products (refer to Section 4.1). The carbon footprint of locally produced food and its potential to reduce emissions depends on the practices surrounding its production, especially at the farm stage.[106] It also depends on multiple local conditions, such as water availability, weather, and seasonality. If local food can be produced more efficiently than imports, eating local can also save emissions at other points of the supply chain such as transport and waste. However, this is not always the case, and imported food can be produced generating less emissions than local alternatives.[107] From an emissions perspective, practices that reduce the production and consumption of dense emission foods – such as animal products – at land use and farming stages, can be far more effective than 'eating local'. Yet, establishing a local food supply chain has many other benefits. It can help build a resilient food system in the face of extreme weather events that facilitates tracking the associated emissions and social practices of the food produced, as well as connecting consumers with their food.

Free range hens on an ACT farm.
Source: Office of the Commissioner for Sustainability and the Environment

106. Mbow, C., et al., 2019. *Food Security. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*, In press. https://www.ipcc.ch/srccl/chapter/chapter-5/. Accessed 24 August 2021.
107. Tobarra, M. A., et al., 2018. *Is seasonal households' consumption good for the nexus carbon/water footprint? The Spanish fruits and vegetables case*, Environmental science & technology, 52(21), 12066-12077.

Food in The Canberra Region

Food production in the ACT is limited. Most of the Territory is occupied by nature conservation areas, and agricultural land occupies roughly 15% of the region (Figure 6). Less than 1% of the ACT's workforce is employed in the agriculture, forestry, and fishing sector; while 'accommodation and food services' comprises approximately 20% of the ACT's workforce.[108] Cattle and sheep were the most important agricultural product in the ACT from an economic perspective in 2018–19, contributing to 59% of the total value of agricultural production in the region, but less than 1% of agricultural production in Australia. Wine production is significant in the ACT Region, with producers adapting to the increasing droughts and heatwaves in the Territory.[109] There are also many community food and agriculture groups in the ACT, such as the Canberra Organic Growers Society. These urban farm initiatives show Canberrans want to participate and create more sustainable local food systems.

A study by the University of Canberra in 2017, focused on the importance of developing climate change adaptation strategies in a broader region comprising the ACT and surrounding local government areas of NSW, referred to as the Australian Capital Region.[110] Since climate change does not affect single jurisdictions, it is important to establish inter-regional plans to tackle the difficulties associated with the more extreme climatic events the region is already facing, such as droughts, fires, and floods. Agricultural land in New South Wales surrounding the ACT, is referred to as the "Capital Region NSW",[111] and it occupies 64% of the region, corresponding mostly to grazing and modified pastures.

The difficulties of establishing a cross-border and inter-government larger region are also emphasised. Nevertheless a few governance mechanisms between ACT and the surrounding NSW local government regions have already been established.[112] A study from 2014 using the ACT as a case study on establishing local food systems, also touched on the need for creating a larger land area to produce food.[113]

In terms of food, the study highlights the need for local food production, encouraging urban agriculture and community gardens; as well as farmers' markets and hobby farm developments as pathways to local food self-sufficiency, and the need for more market spaces where local growers can offer their produce.[114] The COVID-19 pandemic has made more evident the importance of long-term food security, and supporting sustainable local food production can be crucial when global trade becomes more difficult. Planning sustainable ways of producing fresh food in cities, such as developing urban gardens for food supply, can also support a growing population, and contribute to building resilience in a changing climate.

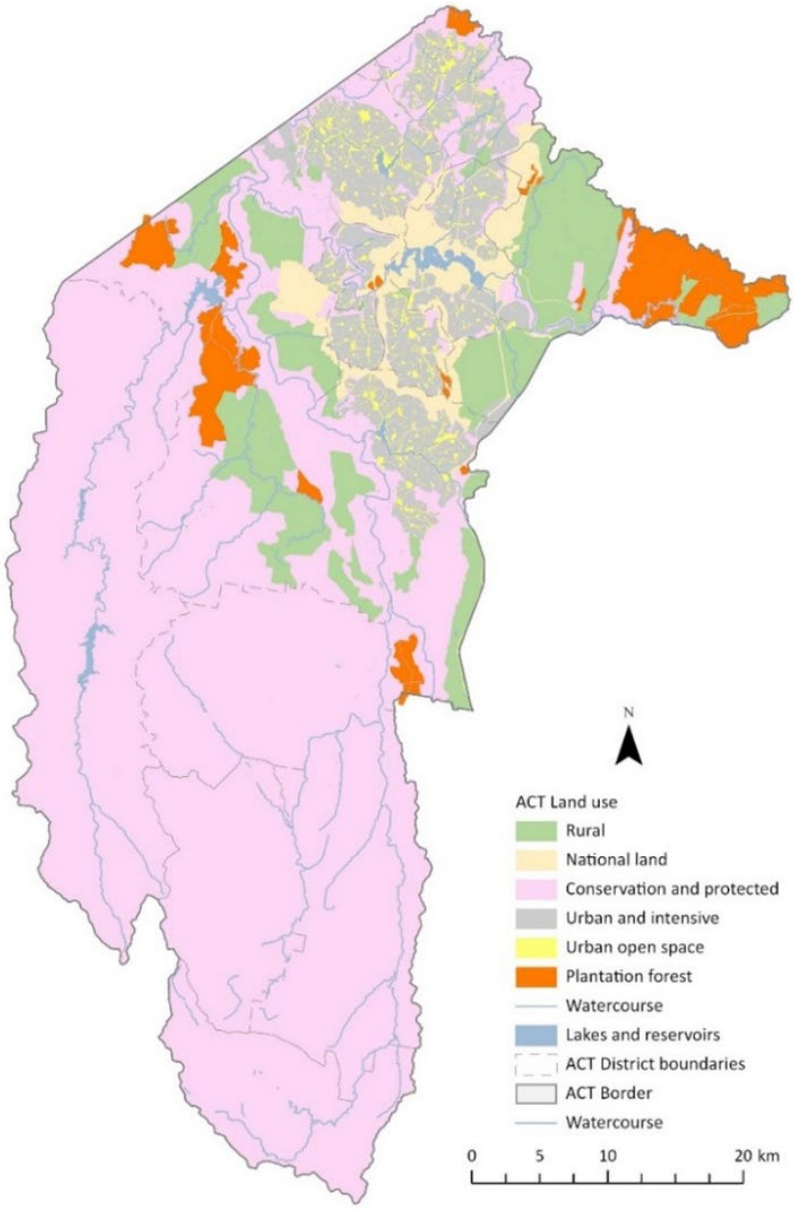


Figure 6. Broad land use in the Australian Capital Territory.

108. Department of Agriculture, Water and the Environment, 2021. *About my region - Australian Capital Territory*, Australian Government. https://www.agriculture.gov.au/abares/research-topics/aboutmyregion/act#regional-overview. Accessed 18 May 2021.
109. Wine Australia, 2020. *Environment and climate*, Australian Government. https://www.wineaustralia.com/growing-making/environment-and-climate. Accessed 18 May 2021.
110. Mummery J., et al., 2017. *Climate Change Adaptation in the Australian Capital Region: Emerging issues in the context of regional planning*, University of Canberra, Australia.
111. Department of Agriculture, Water and the Environment, 2021. *About my region - Australian Capital Territory*, Australian Government. https://www.agriculture.gov.au/abares/research-topics/aboutmyregion/act#regional-overview. Accessed 18 May 2021.
112. Mummery J., et al., 2017. *Climate Change Adaptation in the Australian Capital Region: Emerging issues in the context of regional planning*, University of Canberra, Australia.
113. Turner, B., et al., 2015. *Planning for Regional Food Security: A case-study of the Australian Capital Territory*, The Australasian-Pacific Journal of Regional Food Studies.
114. Mummery J., et al., 2017. *Climate Change Adaptation in the Australian Capital Region: Emerging issues in the context of regional planning*, University of Canberra, Australia.
115. Pörtner, H.O., et al., 2021. *IPBES-IPCC co-sponsored workshop report on biodiversity and climate change; IPBES and IPCC*. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and Intergovernmental Panel on Climate Change (IPCC), 28 p.

4.5 Case study: Food Waste in the ACT

Food Waste Reduction Plans

In 2015 the United Nations released a list of 17 Sustainable Development Goals, and number 12 is to "ensure sustainable consumption and production patterns".[116] Under this goal, one of the main targets is to reduce global food waste per person by half at every step of the food supply chain, from production to consumption.

In 2017 the Australian Government committed to cut food waste in half by 2030 and developed a *National Food Waste Strategy*, with the major goal of cutting food waste from households.

The focus is on household waste because 74% of the waste ending up in landfill comes from our own houses — the avoidance of food waste is where the most significant gains can be made. This strategy is based on "The Food Waste Hierarchy" (refer to infographic "The Food Waste Hierarchy"). The fifth action in that hierarchy, "Energy recovery", refers to technology that obtains energy from unconsumed food through incineration or anaerobic digestion.

Australia and Canberra's Food Waste Problem

In Australia, each household wastes an average of 2.89 kilograms of food per week, a figure that increases in families with children, and higher income.[117] Residents on lower incomes do not necessarily have regular access to food, which has been accentuated by the pandemic,[118] making food waste measurements even more relevant, as well as food donation strategies.

A major issue preventing food waste reduction is that people tend to underestimate how much they waste. This is heightened by the belief that food is only wasted when it is sent to landfill.[119] Composting and repurposing foods that were produced for human consumption are forms of food waste, especially considering all the resources invested and emissions generated to produce it (see Food Hierarchy infographic). Demand for food in Australia is on the rise and consumers, retailers and governments can all play important roles in identifying and reducing food waste.

116. United Nations General Assembly, 2015. *Resolution adopted by the General Assembly on 25 September 2015*, Transforming our world: the 2030 Agenda for Sustainable Development.
117. Karunasena, G., et al., 2021. *Australian household food waste: A summary of behaviours, attitudes, perceived and actual food waste*, Fight Food Waste Cooperative Research Centre, Adelaide. Australia.
118. Food Bank Australia, 2020. *Food Insecurity in the Time of COVID-19.* Foodbank Hunger Report 2020.
119. Ibid.


THE FOOD WASTE HIERARCHY
AVOID
Reuse
RECYCLE
REPROCESS
energy recovery
DISPOSE

Canberra's food waste per household is slightly higher than the Australian average, estimated at 2.97 kilograms per week.[120] In Canberra, 65,000 tonnes of organic waste go to landfill each year, and most of it comes from food.[121] These figures are expected to decrease in the coming years, with several plans being developed to reduce food waste at different stages of the food waste hierarchy (see infographic). In 2018, the ACT launched a Waste Feasibility Study, which aimed to improve waste management in the Territory in partnership with the community. The initiatives undertaken by ACT Government to tackle food waste and its associated emissions range from educational campaigns to food waste composting:

Community Education Campaign

The ACT launched in 2020 a pilot communication campaign entitled "Love Food, Hate Waste", based on a successful campaign, under the same name, carried out in the United Kingdom. Its main goal is to educate people on how to effectively plan, shop, store and cook the food they consume, to avoid wasting it. The program also tackles food waste at the highest level of the food waste hierarchy, before it is donated, fed to animals, or composted. Available online resources include a "weekly food waste audit" template to keep track of households' avoidable food waste, a meal planner and shopping list template, and printable labels for freezer containers; among many others.
They can all be found at: https://www.act.gov.au/foodwaste.

The "Food Waste Challenge"

The Food Waste Challenge program aims to modify Canberrans' behaviours and form habits around meal planning. The challenge is focused on encouraging householders to plan their meals before shopping, making a shopping list and sticking to it, and buying only what is needed. It works online and is communicated through emails, and motivates participants through reinforcement like vouchers from partner businesses. The pilot program was launched in April 2021.

A Canberra-wide 'FOGO' Service

Organic waste is the largest waste stream in the ACT, with food organics representing 37% of household waste (refer to "Food organics in the kerbside waste collection" infographic).[122] In response, the ACT is developing a 'Food Organics and Garden Organics' (FOGO) program. The goal is to add organic food waste to the kerbside green bins that currently collect garden waste from single-unit dwellings. Approaches for multi-unit dwellings are also being developed. This is becoming especially relevant as more people are living in apartments and have limited opportunity for composting their own food waste. The success of a program of this magnitude depends on effective communication with households through educational campaigns that reach as many people as possible, informing them on the type of food waste that can be placed in the green bins.

120. Food Bank Australia, 2020. *Food Insecurity in the Time of COVID-19*, Foodbank Hunger Report 2020.
121. ACT No Waste, 2018. Waste Feasibility Study, *Roadmap and Recommendations*, ACT Government.
122. Ibid; based on 2014-15 baseline data.

A FOGO service also requires a suitable composting facility within the ACT that can process both food and garden organics. This is outlined in the *ACT Climate Change Strategy 2019–2025* as a key priority, and will reduce emissions from landfill, since composting decomposes organic waste using oxygen dependant bacteria, which does not produce methane. This next step is under development, and is expected to be implemented in the next few years.

The overall long-term goal is to establish a social norm around food waste for ACT households, in which Canberrans understand that food waste occurs every time food is bought and not consumed. Ideally, this will reduce the amount of avoidable food waste going to landfill, initially by planning and buying just what is needed, and then by composting only unavoidable organic food scraps.

4.6 Expert Commentary: A Systems Approach is Required to Reduce Food-related Emissions in Just and Sustainable Ways

by Bronwyn Wilkes, PhD Scholar, Fenner School of Environment and Society, Australian National University

Food systems both affect and are affected by global environmental change. They comprise numerous activities from production, processing, distribution and exchange, to consumption and post-consumption waste management.[123] These activities interact with various different ecological and social processes. For example, they influence and are influenced by climate change, nutrient cycles, soil health, water quality and availability, and biodiversity.[124] Similarly, food system activities interact with the physical, psychosocial, and cultural health of farmers, food system workers, and consumers in multiple ways.[125,126] Such health impacts may be experienced differently based on gender, cultural identity, and other social and economic factors.

Food systems are complex and adaptive – changing one element will cause change in other elements of the system. Given their complexity, some of these changes may be immediate and anticipated, while others may be unintended or not become apparent for some time after the initial change. When exploring options to reduce greenhouse gas emissions from food systems, it is important to consider interactions with other aspects of the environment and human health.[127] A human–ecological systems approach would consider interactions between: our cultural worldviews and values, our policies and actions, our physical environment, and our health and wellbeing.[128] Such an approach may help identify options for reducing greenhouse gas emissions that also support other aspects of environmental and human health, and avoid unintended consequences.

Reducing greenhouse gas emissions from food systems will require multiple approaches at multiple scales. In order to foster adaptability and resilience in food systems, it will be important to promote diversity rather than seek single 'optimal' solutions.[129] An overarching principle that can unite diverse approaches to sustainable, just and healthy food systems is biosensitivity – being "in tune with, sensitive to, and respectful of the life processes that underpin our existence".[130]

One food system example that has strong capacity for biosensitivity is Community Supported Agriculture (CSA). Research conducted at the ANU found that CSA can encourage greater consideration of farmers and environmental impacts of food systems, and facilitate dietary improvements and reduced food waste.[131] CSA can also improve financial stability and quality of life for farmers, and support their ability to improve soil health and adapt to climate change.[132] Other examples that can change the way people relate to food include: home and community gardens, regional farmers' markets, and subscriptions such as Southern Harvest Association's multi-farm produce boxes.[133] Encouraging such systems could be important in promoting biosensitivity in the context of just and sustainable circular economies, particularly if paired with measures to support equitable access to culturally appropriate food across the community.

Ange's green tomato harvest. Source: Ange McNeilly

123. Ingram, J., 2011. *A food systems approach to researching food security and its interactions with global environmental change*, Food Security, 3(4), 417–431.
124. Campbell B. M., et al., (2017). *Agriculture production as a major driver of the Earth system exceeding planetary boundaries*, Ecology and Society, 22(4), 8.
125. IPES-Food, 2017. *Unravelling the Food-Health Nexus: Addressing practices, political economy, and power relations to build healthier food systems* (p. 120). The Global Alliance for the Future of Food and IPES-Food.
126. Dyball, R., 2015. From industrial production to biosensitivity: The need for a food system paradigm shift. *Journal of Environmental Studies and Sciences*, 5(4), 560–572.
127. Pörtner, H.O., et al., 2021. *IPBES-IPCC co-sponsored workshop report on biodiversity and climate change*; IPBES and IPCC. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and Intergovernmental Panel on Climate Change (IPCC), 28 p.
128. Dyball, R., and Newell, B., 2015. *Understanding human ecology: A systems approach to sustainability*. Routledge.
129. Grumbach, S., and Hamant, O., 2020. *How humans may co-exist with Earth? The case for suboptimal systems*, Anthropocene, 30, 1.
130. Boyden, S., 2016. *The Biohistorical Paradigm: The Early Days of Human Ecology at The Australian National University 1*, Human Ecology Review, 22(2), 25–46.
131. Wilkes, B. (forthcoming). Australian National University Open Research.
132. Wilkes, B., 2019. *A snapshot of Community Supported Agriculture in Australia and Aotearoa New Zealand 2018*, Australian National University Open Research.
133. O'Kane, G., 2016. *A moveable feast: Contemporary relational food cultures emerging from local food networks*, Appetite, 105, 218–231.

Light rail construction. Source: Wikimedia Commons

5. Scope 3 Emissions from Construction

The construction sector is the largest consumer of materials globally.[134] Construction, including materials and all construction-related processes, is a clear hotspot for carbon-intensive goods. Steel and cement alone represent over 10% of anthropogenic carbon dioxide emissions.[135] Aluminium is also responsible for a significant proportion of greenhouse gas emissions.[136] This high footprint can be traced to their high energy requirements during production and to the long distances across which they are traded, both of which produce significant greenhouse gas emissions.

Globally and in Australia, scope 3 emissions in the construction sector are significant. In Australia in 2013, the construction sector contributed 18.1% of the total national carbon footprint, scope 3 emissions comprised 78%, scopes 1 and 2 the remainder.[137]

National-level change is needed to drive fundamental changes to the construction industry's reduction of scope 3 emissions. This includes through legislation that requires the use of lower carbon construction materials and incentives to encourage companies to use these alternatives. Consideration also needs to be given to the fact that this will impact our trading patterns, as the majority of imported building and construction materials come from China.

134. Giesekam, J., Barret, J. and Taylor, P. 2016. *Construction sector views on low carbon building materials*, Building Research and Information, Vol. 44, No. 4, 423–444.
135. Moran, D., Hasanbeigi, A. and Springer, C. 2018. *The Carbon Loophole in Climate Policy: Quantifying the Embodied Carbon in Traded Products*.
136. Schinabeck, J. and Wiedmann, T., 2014. *The Long road to zero-embodied carbon in the built environment*, The Fifth Estate.
137. Teh, S. et al., 2019. *Assessing Embodied Greenhouse Gas Emissions in the Built Environment*, Decarbonising the Built Environment.

5.1 ACT Context

There are many opportunities to reduce emissions in the construction sector which, for the purposes of this Investigation, include the materials used in the construction of buildings and all the processes related to the actual construction of the buildings.

In the ACT, the construction sector is responsible for 9.3% of scope 3 emissions, the fourth largest product group. This includes the construction, maintenance and refurbishment of buildings and infrastructure and is primarily driven by emissions in the rest of Australia from manufacturing, electricity, gas, water and waste services, and the construction industry directly.

The ACT Infrastructure Plan[138] and the 2020–21 Budget outline a plan to spend $2.6 billion on allocated capital works and $1.7 billion on infrastructure investment provisions over the next four years. Some of the significant projects include:

- building Light Rail to Woden and raising London Circuit
- the Canberra Hospital expansion project
- growing and renewing public housing
- Monaro Highway upgrades
- the construction of a high school in Taylor and the expansion of Margaret Hendry primary school in Taylor, and
- the Big Canberra Battery.

There are also several new large residential developments underway in the ACT in response to the increasing population.

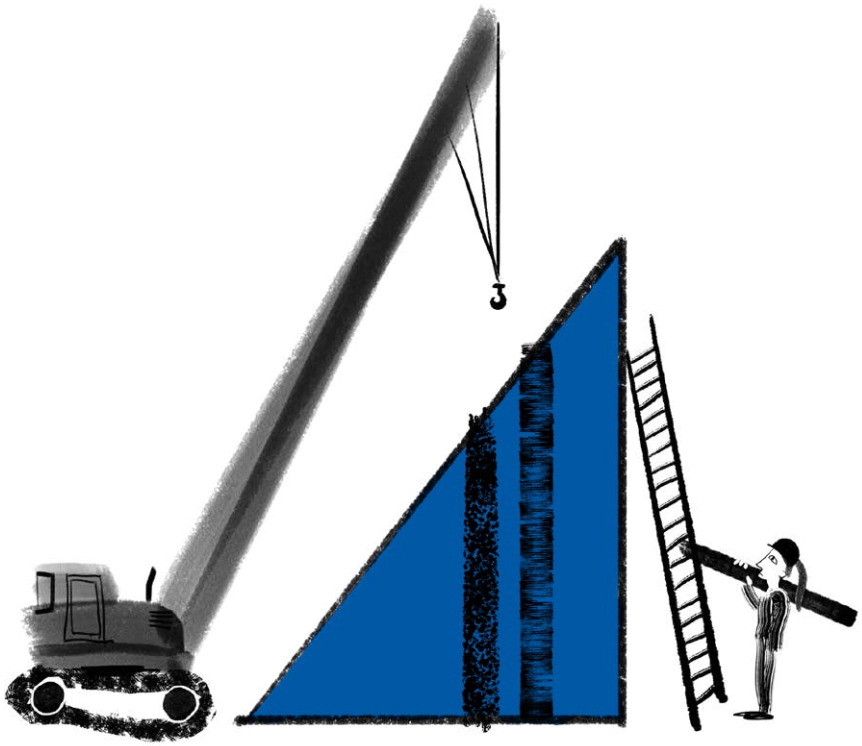
The ACT Government administers grant schemes such as the Low-Income Household Program, the Sustainable Household Scheme and No Interest Loan Scheme, which focus on energy efficiency in running the buildings (operational efficiency) rather than reducing the embodied emissions in the materials (embodied efficiency). While it is imperative to design and build houses that have low energy use requirements once they are established, it is also vital to consider the energy embodied in various building materials, as this figure is considerable. In fact, the proportion of energy consumption used in making the materials needed for a passive, low energy building is higher than a conventional building.[139] In addition, as energy efficiency in buildings improves with technological advances, embodied energy in the materials becomes more important.[140,141]

138. ACT Government, 2019. *Infrastructure Plan: Planning for the Future*.
139. Man, et al., 2016. *The carbon footprint of Australia's Construction sector*, Procedia Engineering 180, 211–220.
140. Teh, S. et al., 2019. *Assessing Embodied Greenhouse Gas Emissions in the Built Environment*, Decarbonising the Built Environment.
141. Thorpe, D., 2020. *How to disembody your carbon*. The Fifth Estate, How to disembody your carbon | The Fifth Estate, accessed 23 June 2021.

There is capacity for further education about the impact of embodied emissions in the supply chain of goods and services to assist in the uptake of lower emission options.[142]

Local authorities, such as the ACT Government, have the ability to influence impacts from sectors such as infrastructure and construction through effective planning, such as for:

- high-density residential developments
- consumption-based accounting standards for cities
- building standards and improved building design
- supply chain efficiency and transparency measures
- influencing urban form and function to promote durable infrastructure that is sustainable, adaptable and reusable
- product and resource efficiency standards
- refundable recycling fees for goods
- incentives to reduce consumption and the generation of waste
- support for adaptive reuse and the sharing economy
- leading by example to shape user behaviour, such as travel patterns and lifestyle
- partnering with industry, organisations and other regional or national governments, and
- joint emissions reduction targets.[143,144]



142. Burbridge, C., 2018. *Carbon Neutrality Assessment of the ACT*, Honours Thesis, University of NSW, Sydney.
143. Millward-Hopkins et al., 2017. *Uncovering blind spots in urban carbon management: the role of consumption-based carbon accounting in Bristol*, UK. Regional environmental change, 17, 1467–1478.
144. Sudmant et al., 2018. *Producer cities and consumer cities: Using production and consumption-based carbon accounts to guide climate action in China, the UK and the US.* Journal of cleaner production, 176, 654–662.

Light rail construction. Source: Wikimedia Commons

5.2 Opportunities for Reducing Scope 3 Emissions from Construction

Scope 3 emissions are typically harder to reduce or avoid than scope 1 and 2 emissions. While decarbonising electricity production will eliminate emissions associated with electricity consumption, emissions from the production of concrete or steel and the operation of heavy machinery during the construction process will only be marginally reduced.[145]

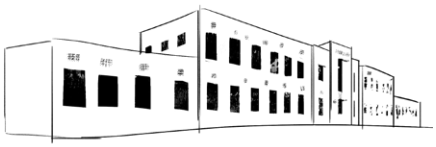
The complex and intertwined nature of supply chains has been clearly evident over the past 18 months during the global coronavirus pandemic. In the construction industry in Canberra, the supply of some materials has been delayed by many months. This has emphasised our reliance on products from other areas of Australia and the rest of the world and the impacts that supply chain disruption can have on our ability to deliver construction projects.

In a global study, four main interventions[146] were proposed to reduce emissions in new buildings and infrastructure, including progressive targets for 2030.

These interventions focus on materials used in construction as they are the main source of emissions. These are in descending order, with the strategies at the top predicted to have the most impact in terms of emissions reduction:

- Material efficiency: 28% reduction in steel; 32% reduction in cement. Material switching: 75% of residential and 50% of commercial buildings to be timber. (Other low carbon materials include hempcrete walls or rammed building rubble, engineered wood products, bamboo, straw and limit the use of plastic).
- Enhance building use: 10% reduction in demand for new buildings.
- Low-carbon cement: 50% of cement replaced with low-carbon alternatives.
- Reuse of building components: 11% reduction in virgin metal and petrochemical-based materials.

These could be considered according to the context and needs of the ACT.



145. Hertwich, E. and Wood, R., 2018. *The growing importance of scope 3 greenhouse gas emissions from industry*, Environ. Res. Lett. 13, 104013.
146. C40 Cities, Arup and University of Leeds, 2019. *The Future of Urban Consumption in a 1.5C World*. Headline Report. Leeds: University of Leeds.

Additional actions include using local products to reduce transportation emissions, preparing buildings offsite and assembling onsite, and minimising waste during construction (reduce, reuse and recycle materials). Experience in other cities has demonstrated that reusing and recycling construction materials can be enhanced through partnerships with demolition companies, recycling centres and cement factories. High building design and quality will likely lead to high energy performance and long-lasting buildings. Checking embodied carbon compliance in buildings should also become compulsory.[147,148,149]

Refer to "Scope 3 Building Checklist" infographic (page 60) for a summary of these interventions.

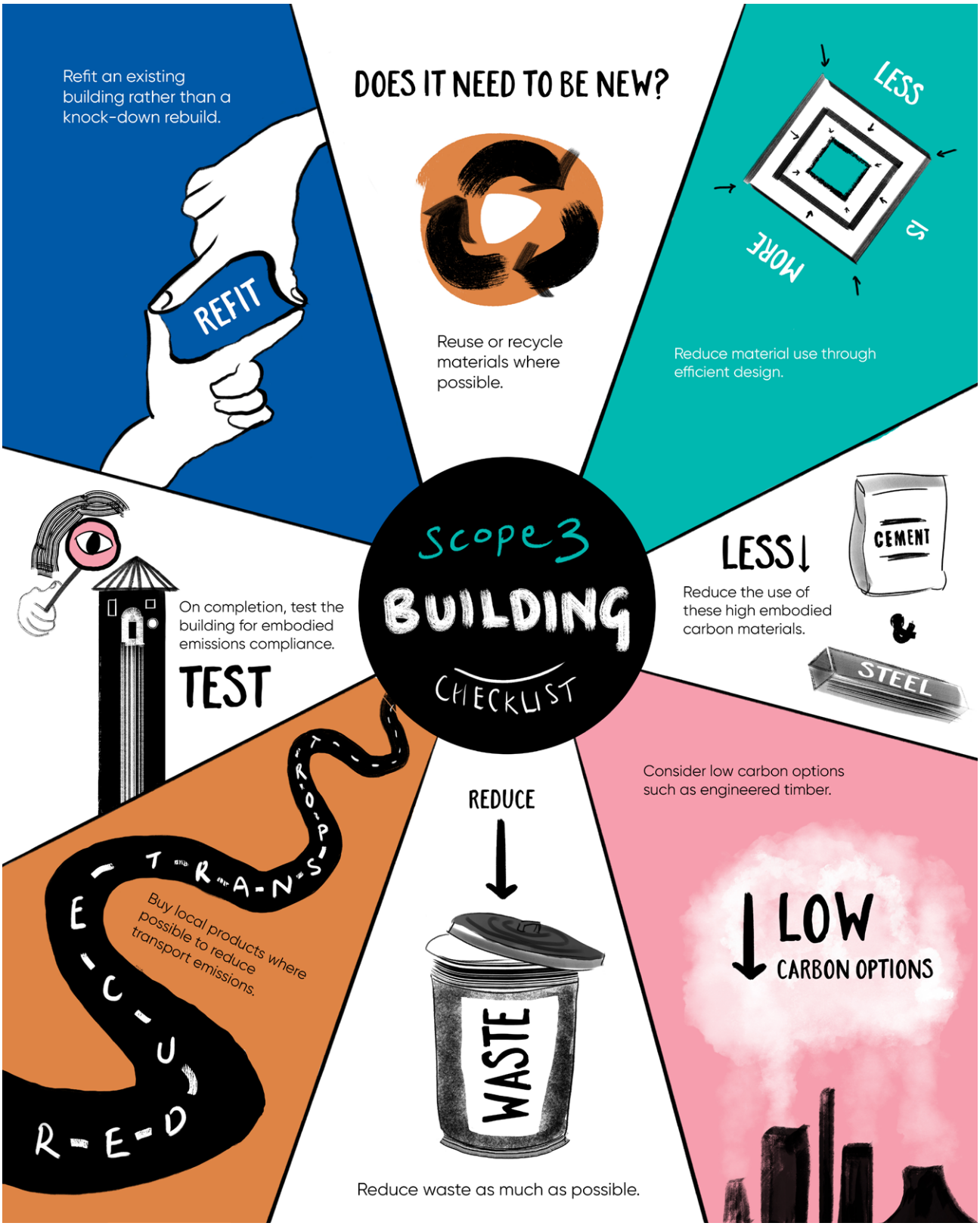
Globally, the uptake of these options has been slow due to resistance to innovation and outdated regulatory requirements, which do not keep up with developments in technology. Cost is always going to be an issue, as well as lack of technical and client knowledge.[150] Tools used to assess embodied carbon in products and buildings are also limited but there are emerging embodied carbon assessment tools and databases to help developers. For example:

- a greenhouse gas evaluation tool for construction industry developed by the University of Melbourne,[151] and
- The Green Book developed by The Footprint Company is a database of embodied carbon in different construction materials.

New research on the transition to net zero direct and embodied emissions in the built environment in Australia highlights that it is possible to achieve a net-negative emissions outcome by 2050 through rapid decarbonisation of the energy system, material substitution (e.g. timber) and rigorous resource management to avoid the loss of embodied carbon at the end-of-life of buildings.[152,153]

Government needs to take the lead. Although, the Australian Government has developed the Climate Active Carbon Neutral Standard for Buildings, it is a voluntary standard and only covers a very small portion of scope 3 emissions, i.e. is not comprehensive. The inclusion of low-carbon design requirements in building codes and infrastructure contracts is critical to see a significant reduction in scope 3 emissions from construction.[154,155]

147. Ibid.
148. Giesekam, J., Barret, J. and Taylor, P. 2016. *Construction sector views on low carbon building materials*, Building Research and Information, Vol. 44, No. 4, 423–444.
149. Man, et al., 2016. *The carbon footprint of Australia's Construction sector*, Procedia Engineering 180, 211-220.
150. Arora et al., 2014, and Persson & Gronkvist, 2014, in Man et al., 2016. *The carbon footprint of Australia's Construction sector*, Procedia Engineering 180, 211-220.
151. EPiC Database, https://msd.unimelb.edu.au/research/projects/current/environmental-performance-in-construction/epic-database, accessed 18 August 2021.
152. Allen C., et al 2021. *Modelling ambitious climate mitigation pathways for Australia's built environment*. Sustainable Cities and Society, manuscript under review.
153. Churkina et al., 2020. *Buildings as a global carbon sink*. Nature Sustainability, 3, 269-276.
154. Giesekam, J., Barrett, J.R., and Taylor, P. 2016 in Wiedmann et al., *Three-scope carbon emission inventories of global cities*.
155. Giesekam, J., Barrett, J. R., and Taylor, P., 2016. *Construction sector views on low carbon building materials*. Building Research & Information, 44(4), 423–444.


Scope 3
BUILDING
CHECKLIST
DOES IT NEED TO BE NEW?
Refit an existing building rather than a knock-down rebuild.
REFIT
Reuse or recycle materials where possible.
LESS
IS
MORE
Reduce material use through efficient design.
On completion, test the building for embodied emissions compliance.
TEST
LESS↓
Reduce the use of these high embodied carbon materials.
CEMENT
STEEL
Consider low carbon options such as engineered timber.
LOW
CARBON OPTIONS
REDUCE
WASTE
Reduce waste as much as possible.
E-T-R-A-N-S-P-O-R-T
E-C-U
R-E-D
Buy local products where possible to reduce transport emissions.

In 2020, France announced that new public buildings built after 2022 will be at least 50% timber or another bio-sourced material.[156] The country's first mass timber residential tower of 16 stories is currently under construction in Bordeaux. The push to use sustainable materials on building projects is happening in other French cities too.

In June 2021, the NSW Government announced the deployment of new, smart technology to check compliance with building regulations and track supply chains, including material used in NSW that comes from outside the state.[157] This could lead to the capacity to create embodied carbon certificates to clearly communicate the level of embodied carbon that is present in a building.

These are the sorts of innovative approaches the ACT Government needs to consider.

Brindabella Business Precinct. Source: Mark Jekabsons

156. Franklin, S., 2020. *France mandates public buildings be built with at least 50% timber*, The Architect's Newspaper, https://www.archpaper.com/2020/02/france-public-buildings-timber-mandate/, accessed 24 June 2021.
157. Frew, Wendy, 24 June 2021. *NSW working on embodied carbon certificates for construction*, the Fifth Estate.

5.3 Expert Commentary: A Message from the ACT Chief Engineer

Adrian Piani

The ACT is a global leader on climate change action. With some of the most ambitious emissions reduction targets in the world, we live in a city powered by 100% renewable electricity.

As evidenced in this report, scope 3 emissions in the construction sector make a significant contribution to the overall emissions of the ACT. With the substantial pipeline of major infrastructure projects identified for the Canberra region, there are many opportunities to reduce embodied energy and scope 3 emissions through the design and construction phases of our infrastructure asset lifecycle.

A significant proportion of the greenhouse gases from the construction sector are produced by the manufacture of concrete which relies on cement as a key ingredient. We know greener alternatives with robust engineering properties are readily available in the market and are currently being used in Canberra. Recent examples where lower carbon concrete have been used include Stage 1 of the light rail system (which also won a national sustainability award) and, more recently, the Campbell Primary School expansion project.

There are examples where the innovative use of new technologies and building materials are creating substantial carbon savings. The use of engineered wood products such as Cross Laminated Timber and Glulam not only reduce the carbon footprint of the building but can also lead to innovative design with strong engineering and architectural benefits. The recently opened Stromlo Leisure Centre and the Australian National University's Union Court redevelopment are two such examples. No doubt there are many more projects across Canberra, which are proving that low carbon concrete and other low carbon materials are viable alternatives to traditional approaches.

The ACT Government already promotes sustainable procurement processes through its Charter of Procurement Values. The ACT Climate Change Strategy requirement for larger government projects to obtain – or be consistent with – independent sustainability ratings such as those offered by the Infrastructure Sustainability Council of Australia and the Green Building Council of Australia also provides a strong mechanism to promote the use of lower carbon materials.

Looking forward, I am confident that our existing partnerships with industry and the supply chain will find innovative ways to deliver the infrastructure we need whilst optimising environmental, social and economic outcomes.

5.4 What does low carbon construction look like?

There is no single approach to building with materials that have low carbon emissions — options vary according to the location, community and delivery team. For a thorough comparison of construction methods and materials, a Life Cycle Assessment of each option is essential. It is the most accurate way of determining the carbon impact. It includes assessing the extraction of raw materials, manufacturing processes, transportation to the construction site, construction processes, the operational phase and the end-of-life recycling and potential for reuse.[158] This is a complicated process, with a large number of variables and uncertainty around the calculations. The impacts of embodied energy within various building materials should be considered early in the design stage to allow the most effective outcome.[159]

Increase Material Efficiency and Substitute Materials

The largest contributors within the total embodied greenhouse gas emissions of industrial products in Australia are:

- cement, lime, plaster and concrete products (39%)
- iron and steel products (38%), and
- wood products (7%).[160]

Australia manufactures around 30 megatonnes of building products every year, which includes large proportions of concrete (56%), bricks (23%) and steel (6%).

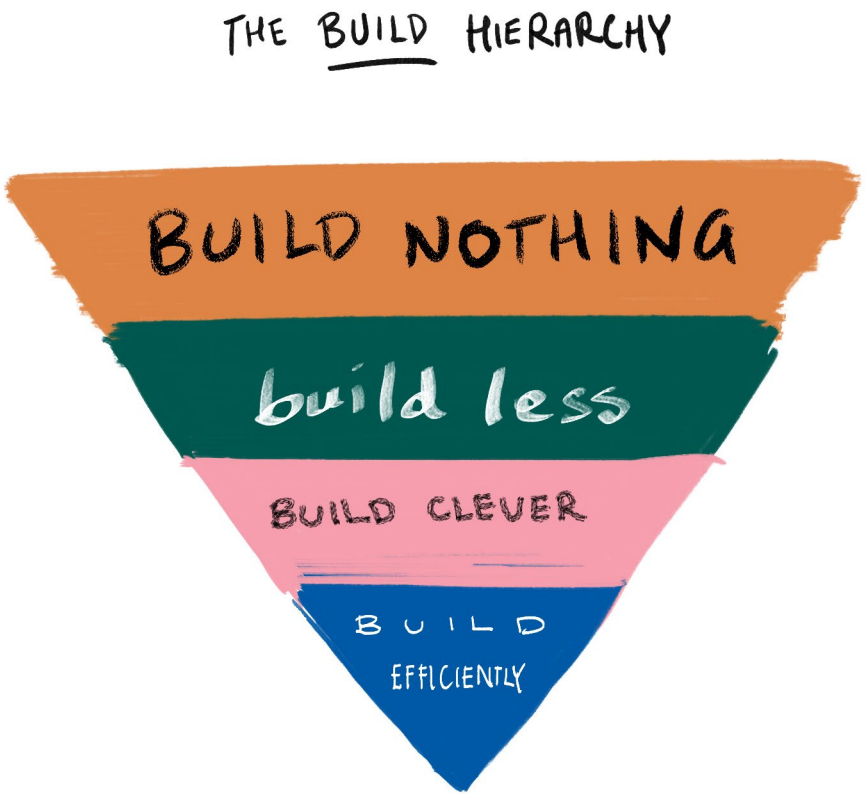
The use of wood in a building instead of concrete can significantly reduce embodied emissions. A study in the United States found that substituting steel or concrete with wood in residential buildings, could save 20% to 50% of greenhouse gas emissions.[161] Only a small portion of the building materials needed changing to gain these improvements. Replacing 100% reinforced concrete with engineered wood products in all new residential buildings in Australia could save 119 megatonnes of carbon dioxide equivalent, including sequestration abilities.[162] It is important to use timber from sustainable forestry sources to prevent additional adverse environmental consequences.

158. Ding, G., 2014. *Life cycle assessment of sustainable building materials: an overview*, pp. 38–62.
159. Häkkinen, T. et al., 2015. *Reducing embodied carbon during the design process of buildings*, Journal of Building Engineering, 4, 1-13.
160. Teh, S. et al., 2019. *Assessing Embodied Greenhouse Gas Emissions in the Built Environment*, Decarbonising the Built Environment.
161. Upton, B., et al., 2008. *The greenhouse gas and energy impacts of using wood instead of alternatives in residential construction in the United States*, Biomass and Bioenergy 32, 1–10.
162. Man, et al., 2016. *The carbon footprint of Australia's Construction sector*, Procedia Engineering 180, 211-220.

There are new technologies available which capture carbon within building materials. One such company which does this is Mineral Carbonisation International.[163] In partnership with the University of Newcastle, the company has developed a way to turn carbon emissions into a solid material that can be used in green construction materials — the carbon emissions are being transformed from a gas to a stable solid material that can be used to make buildings. This is a transitional solution for countries that rely on carbon-intensive power generation.[164] It involves treating waste products as resources to create new products.

It is important to consider how embodied carbon in materials will vary depending on the increase in supply of renewable energy in other states. For example, the production of steel using renewable energy makes it significantly less emission intensive.

The ACT Government has the opportunity to grow the market for low carbon building materials by restructuring procurement processes and requiring embodied carbon to be included in the assessment process. Other actions include setting ambitious low carbon targets for major projects, and engaging with engineers, architects, contractors and material suppliers to encourage them to find the lowest-carbon, most feasible options for a given project.[165]



163. Mineral Carbonation International, https://www.mineralcarbonation.com/, accessed 23 June 2021.
164. Architect, 2017, *Building Materials from Carbon Dioxide Emissions*, https://www.architectmagazine.com/technology/building-materials-from-carbon-dioxide-emissions_o, accessed 23 June 2021.
165. Lehne, J. and Preston, F. 2018. *Making Concrete Change: Innovation in Low-carbon Cement and Concrete*, Chatham House Report.

Enhance Building Use

Enhancing building use is about carefully considering construction and whether it is absolutely necessary. Unfortunately, this is not often the encouraged approach in a world where economic growth and development is encouraged.

When making decisions about new construction, following "The Build Hierarchy" (refer to infographic) would be an important advance. The first step is to evaluate if the build is necessary, and avoid unnecessary construction. If building is unavoidable, consider a refit instead of creating a new building. When undertaking a construction, use low carbon materials and minimise resource consumption. Finally, build efficiently by using available construction technologies and reducing waste.[166]

Use Low Carbon Cement

Cement and concrete are often used interchangeably, however, cement is actually an ingredient of concrete.

Concrete is the second most used material, after water.[167] As urbanisation increases, so does the environmental impact of concrete.

A Queensland based company, Wagners, is already making and using what they call "earth friendly concrete", which reduces the carbon dioxide emissions associated with the production of traditional cement by 80% to 90% and has engineering properties that are as good or better than normal concrete.[168] Earth friendly concrete is produced from two industrial waste by-products from iron and coal fired power generation. Several large-scale projects have been completed using this concrete and provide an example to the rest of Australia of its feasibility and durability.

The current manufacturing process for cement, called Portland cement, accounts for 8% of global emissions.[169] The key raw material for Portland cement is limestone, which releases carbon dioxide as it is heated in a cement kiln, which accounts for over 55% of cement-related emissions.[170] Alternatives, such as geopolymer cements, already exist and have much lower carbon emissions at a similar cost. Governments can take the lead in introducing regulations and incentives to encourage the adoption of alternatives in order to reduce demand for older, more carbon intensive cement production. There are also options to invest in further research on types of cement that can absorb carbon dioxide over time and therefore act as a carbon sink.[171]

166. Thorpe, D., 2020. *How to disembody your carbon*. The Fifth Estate, How to disembody your carbon | The Fifth Estate, accessed 23 June 2021.
167. Thorpe, D., 2021. *How to make net-zero work in the concrete industry*, The Fifth Estate.
168. Wagners, Earth Friendly Concrete, https://www.wagner.com.au/main/what-we-do/earth-friendly-concrete/efc-home/, accessed 7 April 2021.
169. Beyond Zero Emissions, August 2017, *Zero Carbon Industry Plan, Rethinking Cement summary*.
170. Ibid.
171. Ibid.

Fly ash, a waste product of coal burning, is a key ingredient in low carbon cement production. In Australia, fly ash is easily available due to more than 100 years of burning this fossil fuel. The use of this waste product could supply Australia with approximately 20 years of cement production and see Australia leading the world in the zero-carbon cement industry.[172]

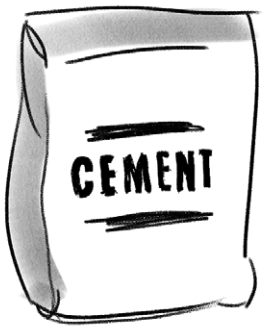
Barriers to decarbonisation of cement include that:

- there are only a few major producers of traditional cement and they are cautious about new products
- the absence of a carbon pricing signal means there is little short-term economic incentive to make any changes
- alternative materials are often not easily available at the required scale, and
- architects, engineers, contractors and clients are cautious about novel building materials.[173]

As it is a relatively small Territory with its main industry being construction, the ACT is the perfect place to implement a transition in this sector.

Lower carbon cement is already being supplied to Canberra, however further analysis through the supply chain is needed to determine the percentage of this supply. Many ACT concrete suppliers already have the ability to offer a low carbon concrete, mainly through replacing some of the cement with fly ash/slag. There are also suppliers who can provide advanced geopolymer concretes. Subsequently, the specific barriers and opportunities to increase the supply of low carbon cement need to be determined to understand what can be done to promote more uptake of it in industry.

There are also innovative new products being developed, such as eMesh which replaces steel reinforcement in concrete with recycled plastic. This kind of product could be used for standard concrete solutions like footpaths, bike paths, traffic islands, drains, landscaping, outdoor patios and ground slabs for small sheds.[174]



172. Beyond Zero Emissions, August 2017, *Zero Emissions Carbon Industry Plan, Rethinking Cement summary*.
173. Lehne, J. and Preston, F., 2018. *Making Concrete Change: Innovation in Low-carbon Cement and Concrete*, Chatham House Report.
174. Fibrecon, eMesh.

Reuse Materials and Reduce Waste

According to the 2018 National Waste Policy Report, 20.4 million tonnes of waste are produced by the construction and demolition industries in Australia every year. This corresponds to almost a third of all waste produced in the country,[175] and the figure is increasing annually.

Currently the recycling rate in Australia is much lower than that of other OECD countries. Using waste from old buildings in the construction of new buildings or retrofitting existing buildings should be encouraged. Approximately 67% of this waste is recycled, however, the difficulty in reducing waste in construction is often due to a lack of coordination or communication between builders, contractors and subcontractors. Financial incentives for reusing materials could assist to overcome the extras costs in time spent preparing the material and associated project delays.

In Germany, legislation requires manufacturers to assume responsibility for any product that produces waste, especially the recycling of old products. This creates an incentive for companies to prevent waste during product design and creation, as well as ensuring end-of-life products can be reused or recycled. Thus, products are considered a reusable resource not a waste product requiring disposal.[176]

Australia has the *Recycling and Waste Reduction Act 2020* which provides the framework to effectively manage the environmental, health and safety impacts of products, especially their disposal. This Act has recently been reviewed and some mandatory arrangements are now included, however the current focus for compliance is to communicate and educate.[177] Compliance and enforcement of waste disposal needs to become a focus to ensure adherence to the legislation.

Disposal of construction and demolition waste in the ACT is an issue. There is a considerable lack of data to understand what is occurring, however, indicators are that most construction and demolition waste is sent to landfill. This is due to non-sorting, contamination and lack of facilities to sort and/or capacity to remanufacture into reusable materials.[178] It is estimated that the level of construction and demolition recycling in the Capital Region is around 50%, compared with the NSW average of 75% and international best practice — Germany at 92%, the Netherlands almost 100%.[179] There is a great opportunity for improvement here.

175. Weiner, S., 2019. *Building without the Waste*, Renew, https://renew.org.au/renew-magazine/reuse-recycling/building-without-the-waste/, accessed 14 April 2021.
176. *Product Stewardship and Waste Management*, https://www.umweltbundesamt.de/en/topics/waste-resources/product-stewardship-waste-management accessed 24 August 2021.
177. Australian Government Department of Agriculture, Water and the Environment, 2020. *Our approach to product stewardship compliance*, https://www.environment.gov.au/protection/waste/product-stewardship/compliance, accessed 21 April 2021.
178. Canberra Business Chamber, 2014. *Building and construction waste materials: REDUCE, REUSE AND RECYCLE - Opportunities and strategies for the Capital region*, https://www.canberrabusiness.com/wp-content/uploads/2014/12/Building-Construction-Waste-Materials-FINAL-edited-Jul15a.pdf, accessed 14 April 2021.
179. Ibid.

Concrete waste. Source: Santeri Viinamäki

The Brema Group in Canberra is a demolition company that recycles 85% of its waste.[180] They sort all their waste in their own facilities to maximise recycling potential and economic return.

Different materials have different capacities to be recycled and reused e.g. bricks are very sturdy and are easily reused in all types of builds. The cost of materials and the carbon footprint of the building will be significantly less when using recycled products.[181]

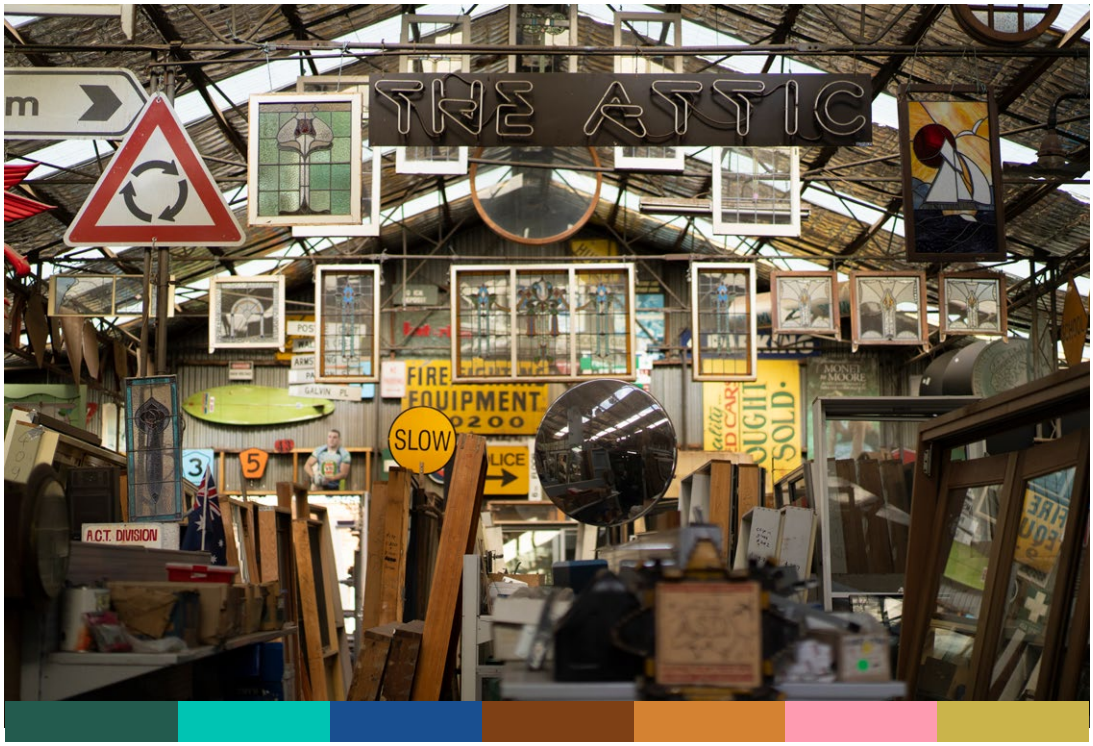
The most important step in increasing the uptake in the use of recycled materials is convincing builders that they can trust these materials and create a market for them. There needs to be a system in place to check that recycled materials have minimum required levels of quality and strength. Once a guarantee is given, people will feel confident using these materials.[182]

"We need to make it easier to reuse materials instead of discarding them."[183]

The focus on reducing construction waste has mainly been large-scale projects. However, homeowners either constructing or renovating can reduce waste on their properties as well. The most effective way of reducing waste is to spend more time on the design process so that fewer changes are made during the building process. Being clear to the team from the start that there is a desire to minimise waste will also help. Education and engagement with each level of the construction industry is necessary for changes to occur.

180. Brema Group, Recycling, https://bremagroup.com.au/service/recycling, accessed 21 April 2021.
181. Architecture and Design, *Recycled building materials: Best reclaimed construction ideas*, https://www.architectureanddesign.com.au/features/list/recycled-building-materials-construction-ideas#.
182. Equilibrium, 2019. *Review of Standards and Specifications for Recycled Content Products*, Department of the Environment and Energy.
183. Weiner, S., 2019. *Building without the Waste*, Renew, https://renew.org.au/renew-magazine/reuse-recycling/building-without-the-waste/, accessed 14 April 2021.

Handyman's Trading post. Source: Office of the Commissioner for Sustainability and the Environment



Some recycled building materials for sale in the Handyman's Trading Post.
Source: Office of the Commissioner for Sustainability and the Environment

Earthship Ironbank. Source: https://www.earthshipironbank.com.au/

Earthships are a type of house which have very low embodied carbon as they are constructed using only natural and recycled materials such as earth-packed tyres and bottles. They are also fully self-sufficient in power, water and sewage treatment so their ongoing energy demands are very low. Earthship Ironbark was the first to be built in Australia, near Adelaide (see photo).[184]

The design ensures that winter sun gets in and summer sun stays out, resulting in comfortable indoor living conditions without the need for an air-conditioner. A food producing garden is also part of the Earthship design. Earthship construction methods are easy to do yourself so you can save money by putting in your own labour and only pay the builder to do the hard stuff.

Earthships are also very bushfire resilient (theoretically) as they are earth-sheltered buildings; surrounded by non-flammable material (earth).

184. Earthship Ironbank, https://www.earthshipironbank.com.au/, accessed 24 August 2021.

Earthship Ironbank. Source: https://www.earthshipironbank.com.au/

5.5 Projects in Canberra Promoting Low Embodied Energy Construction

Appendix 1 of the *Parliamentary and Governing Agreement for the 10th Australian Capital Territory Legislative Assembly* discusses scope 3 emissions. Item A.3.ii states:

> *"Driving sustainable building innovation by piloting land release to include at least one 'showcase' sustainable development each year, such as a 150% living infrastructure plot ratio or a 'scope 3' zero-emissions development that produces no net greenhouse emissions during construction and operation, and reduced car parking."*

ACT Government directorates and agencies are currently investigating how scope 3 emissions can potentially be mitigated in future 'showcase' sustainable building developments. Findings from this Investigation have been shared for collaboration across the ACT Government.

A greenhouse gas calculator tool is currently being developed by Arup for testing in the construction of the Woden Canberra Institute of Technology campus. Once finalised, this tool will be provided to infrastructure delivery contractors to report on the consumption of materials with a focus on greenhouse gas emission intensive materials.

The *Canberra Low Carbon Housing Challenge*[185] is a local competition which opened in July 2021 to showcase a range of houses with low carbon footprints. The footprint of each house is calculated using an online lifecycle analysis tool called RapidLCA. The winners will be chosen by a combination of expert jury and people's choice voting. The aim is to demonstrate the many low carbon houses already in Canberra and help to educate the community that low carbon housing is not difficult or limited to 'alternative or luxury' housing. In order to achieve the greatest possible public impact, the team plans to prepare a temporary spatial installation in the city and link into the Design Canberra Festival in November 2021.

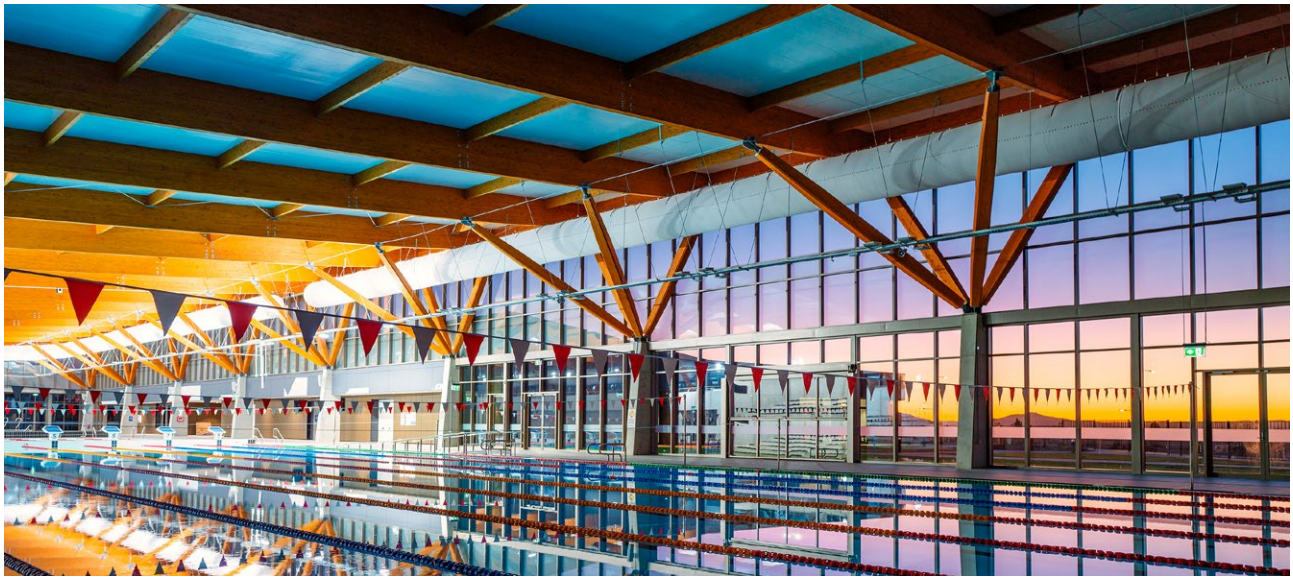
The Australian National University recently voluntarily implemented embodied carbon performance metrics in their Kambri redevelopment. A "not to exceed" embodied carbon performance metric was used and it delivered a ***40% embodied carbon reduction*** across 95,000 square metres of buildings and avoided 34,000 tonnes of carbon dioxide equivalent in absolute terms. This was equal to around 56 years of the operating carbon that would have been produced under scope 1 and 2.[186]

Another project which uses a significant amount of timber instead of concrete is the Stromlo Leisure Centre which was completed in 2020.

185. Canberra Low Carbon Housing Challenge, www.lowcarbonhousing.com.au, accessed 24 August 2021.
186. The Footprint Company, 2021. *Scope 3 Carbon Assessment: ACT Government Directorates, July 2021,* commissioned by the Office of the Commissioner for Sustainability and the Environment.

Wood used to reduce embodied carbon in the Marie Reay building in the Kambri precinct. Source: Australian National University

More wood in the interior of the Marie Reay building. Source: Australian National University



Stromlo Leisure Centre. Source: YMCA New South Wales

6. What can I do to reduce my own scope 3 emissions?

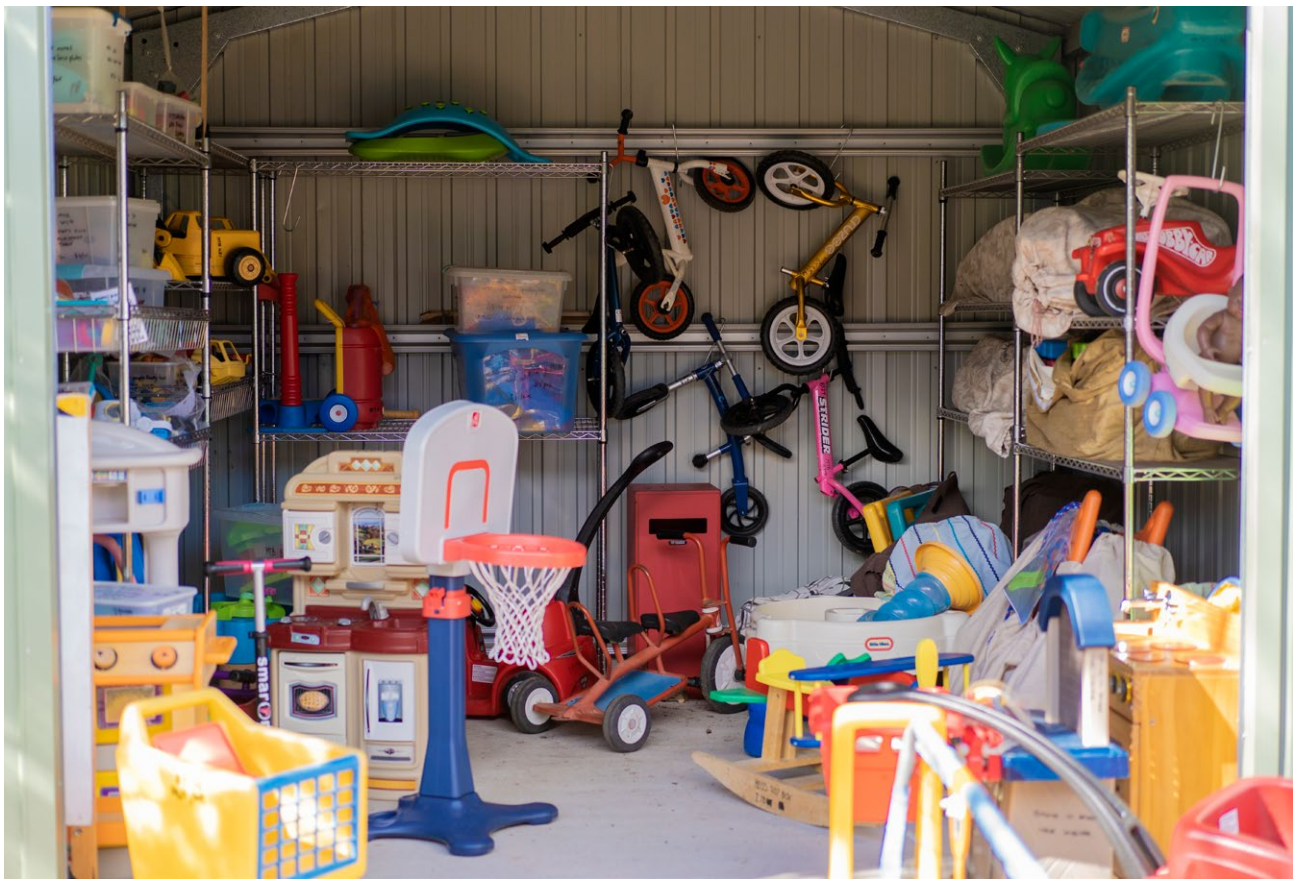
The challenges are significant: reducing scope 3 emissions will require substantial changes at every step from the point of production through to the ultimate consumer. Small changes, such as recycling plastic waste, will no longer be sufficient.

Householders (i.e. end consumers) have been a focus of this Investigation because they are the largest contributor to scope 3 greenhouse gas emissions (59%) in the ACT out of the three consumer groups (businesses, government and households). Consumers have a powerful role in reducing greenhouse gas emissions related to the production of goods and services.[187] Transport, food consumption, buying products and construction of dwellings are the four key areas where people can make informed choices for enormous reductions in emissions.

Second-hand clothes shop in Fyshwick, Canberra. Source: Office of the Commissioner for Sustainability and the Environment

Scope 3 emissions are typically difficult to measure and understand, and have not been considered in most climate change policies. Residents of the ACT need further information to better understand the potential impacts of their consumer choices on greenhouse gas emissions and areas in which they could make the most difference by adapting their current behaviour. How this information is communicated to the public is also critical as it is a complex and technical topic and requires non-expert translation.

Second-hand cloth nappies from a Buy Nothing Group. Source: Office of the Commissioner for Sustainability and the Environment



Toy Library in Hackett, Canberra. Source: Office of the Commissioner for Sustainability and the Environment

Things we can each do to reduce our scope 3 emissions:

- if possible, buy local food, use unprocessed ingredients, and avoid food and packaging waste
- reduce your own red meat consumption
- support the sharing and hiring of durable items such as tools and equipment
- buy from second-hand markets to reduce the purchase of new clothing items, appliances, furniture, gadgets and toys
- buy items that can be repaired
- buy certified carbon-neutral products whenever possible
- avoid air travel – cycle, walk or take public transport whenever you can, and
- when building a new house or extension, spend time on the design phase to use space and resources efficiently, choose low carbon materials and reduce waste where possible.

In order to meet these goals, the community needs to be provided with clear analyses on low carbon options so they can make informed choices about their consumption habits.

187. Koide, R. et al., 2021. *Exploring carbon footprint reduction pathways through urban lifestyle changes: a practical approach applied to Japanese cities*, Environ. Res. Lett, 16, p. 84001.

In terms of an overall message to reduce our scope 3 emissions, this is the same no matter what topic is in question, i.e. whether it is food, construction or any other topic, each of us needs to:

1. buy less
2. consider the composition and origin of the product
3. repair products if possible or use them for as long as possible, and
4. reduce waste.

Individual consumers can decide how much they consume and which products they buy, although they are limited by the options available. The challenge laid out above will require profound and widespread lifestyle and consumption changes, which governments can support with policy, financial incentives and new business models. Producers who provide the goods, services and resources to the ACT also have a responsibility for the production process, such as whether renewable energy and resources are used in this process. The key to reducing scope 3 emissions is about finding *joint* solutions for mitigating emissions that cut across individuals, government and business.

Cycle Jam. Source: the Canberra Environment Centre

6.1 Tools for Estimating Carbon Footprint

Following is a selection of tools that can assist organisations and individuals to estimate their carbon footprint. This is not a comprehensive list, and there are many other tools online to be explored.

- **The Environmental Performance in Construction (EPiC) Database**, developed by the University of Melbourne, is an open-access Life Cycle Inventory of environmental flow coefficients, including embodied greenhouse gas emissions, for building materials. https://msd.unimelb.edu.au/research/projects/current/environmental-performance-in-construction/epic-database
- **Embodied Carbon Explorer (ECE)** is an online tool to calculate scope 3 emissions of projects. It was created by the Sustainable Assessment Program at UNSW Sydney and The University of Sydney, supported by the CRC for Low Carbon Living, and based on the Australian Industrial Ecology Virtual Laboratory (IELab). https://ece.ielab-aus.info/IndustrialEcology/
- **The Green Book**, developed by The Footprint Company, is a database of embodied carbon data of different construction materials. https://footprintcompany.com/thegreenbook/
- **Carbon Neutral** is a profit-for-purpose carbon solutions provider and carbon offset developer. A carbon footprint calculator can be found on their website. https://carbonneutral.com.au/
- **Evalue8** is carbon accounting software to estimate carbon emissions of organisations, enabling them to report and track their carbon footprint. https://evalue8.net/
- **Offline Carbon Footprint Calculator** is available to download as an excel sheet and can be used to calculate CO_2 emissions for individual activities, including electricity consumption and travel by bus, car and train. https://timeforchange.org/offline-carbon-footprint-calculator/
- **Ecological Footprint Calculator WWF Australia** is an environmental footprint calculator that considers individual carbon footprint. It measures the environmental footprint according to food, housing, and transportation choices. https://www.wwf.org.au/get-involved/change-the-way-you-live/ecological-footprint-calculator
- **Climate Hero Carbon calculator** is an online calculator that focuses on the carbon footprint of individual choices in housing, travelling, food and shopping. https://climatehero.me/

7. ACT Government Operations

7.1 Scope 3 Emissions of ACT Government

The Footprint Company was engaged to assess the scope 3 emissions of the ACT Government. The assessment included the ACT Government's seven directorates and considered goods and services, capital goods, business travel and leased/owned assets. The study is a desk-top data analysis, using published records and audit reports for the financial year. The 2018–19 data was used on the basis that it represents the most recent typical year of operations due to the influence of the coronavirus pandemic in the most recent financial years.

Methodology for the assessment was aligned to the Greenhouse Gas Protocol which includes the world's most widely used greenhouse gas accounting standards. The data and results in this section, were taken from this analysis by The Footprint Company, unless referenced otherwise. For further detail, refer to The Footprint Company report, *Scope 3 Carbon Assessment* on the Office's website.[188]

The majority of scope 3 emissions from the ACT Government — approximately 60% of the total — come from buildings and leased assets (Figure 7) and the remainder from goods and services.

The total scope 3 emissions for 2018–19 were substantially higher than the scope 1 and 2 emissions, even within the data limitations encountered:

- total scope 3 emissions were 1.4 megatonnes of carbon dioxide equivalent, and
- 98,000 tonnes for scopes 1 and 2.

Figure 8 displays a breakdown of scope 3 emissions from each directorate, while Figure 9 shows scope 3 emissions per full-time equivalent employee. The Transport Canberra and City Services Directorate's contribution is high compared to other directorates, and this does not include bus or tram drivers. This is due to the directorate's role in major capital infrastructure construction in the Territory.

188. The Footprint Company, 2021. *Scope 3 Carbon Assessment: ACT Government Directorates, July 2021,* commissioned by the Office of the Commissioner for Sustainability and the Environment, www.envcomm.gov.au.

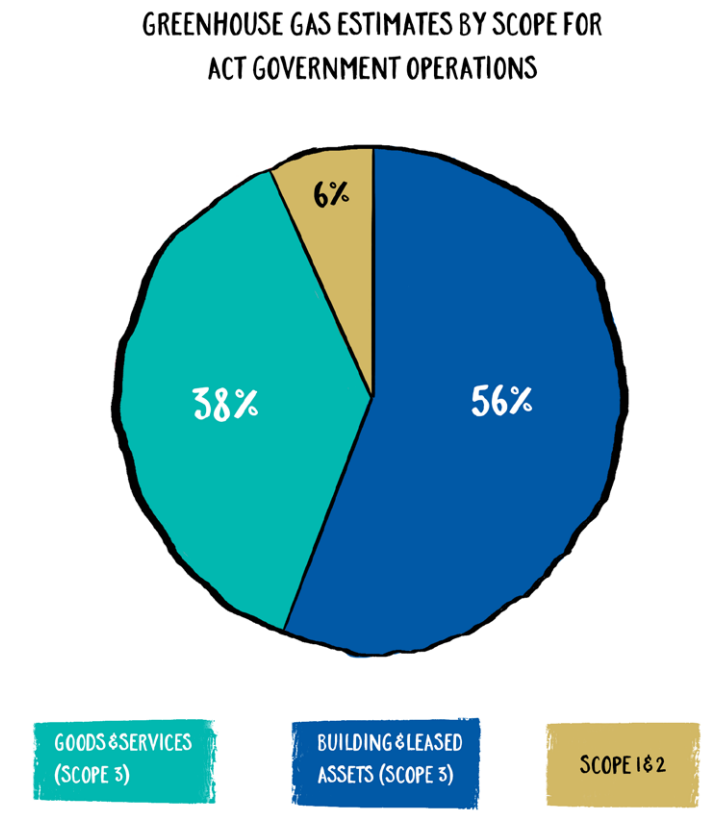


Figure 7: Greenhouse gas estimates by scope for ACT Government operations.

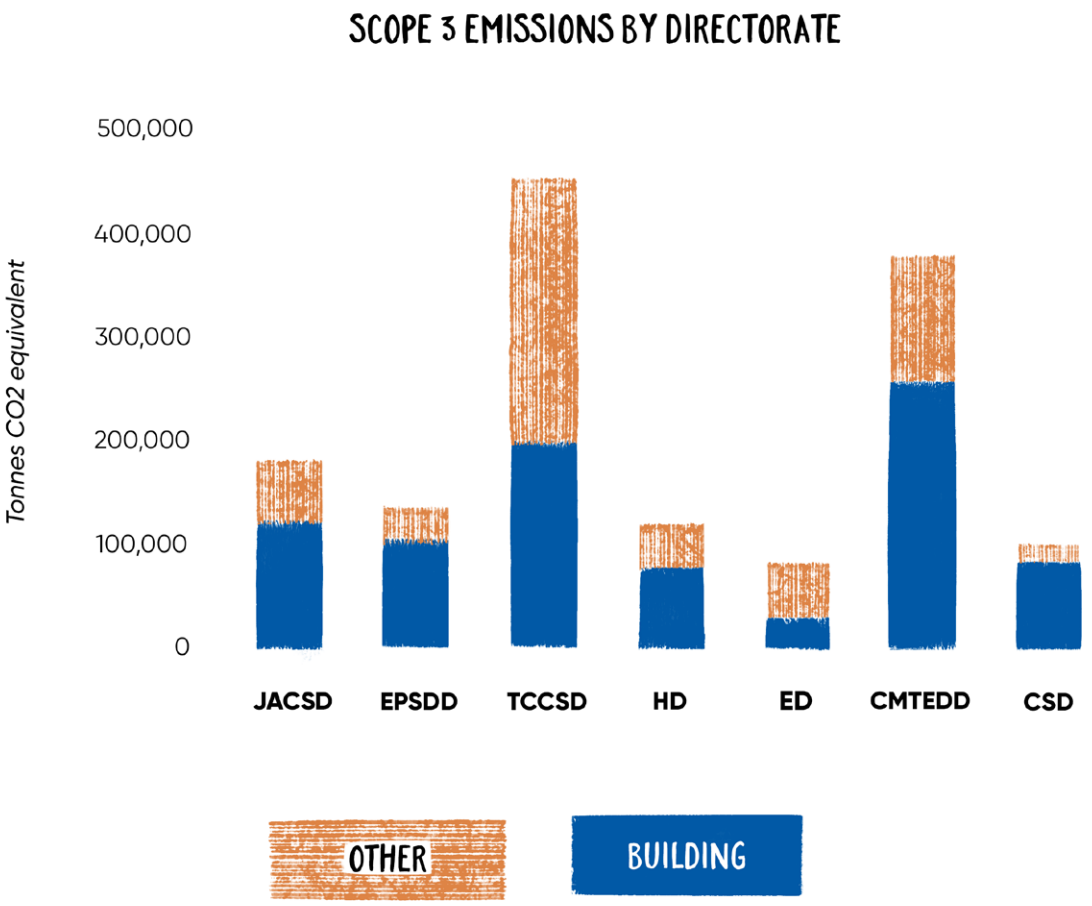


Figure 8: Scope 3 emissions by directorate. JACSD (Justice and Community Safety Directorate), EPSDD (Environment, Planning and Sustainable Development Directorate), TCCSD (Transport Canberra and City Services Directorate), HD (Health Directorate), ED (Education Directorate), CMTEDD (Chief Minister, Treasury and Economic Development Directorate) and CSD (Community Services Directorate).

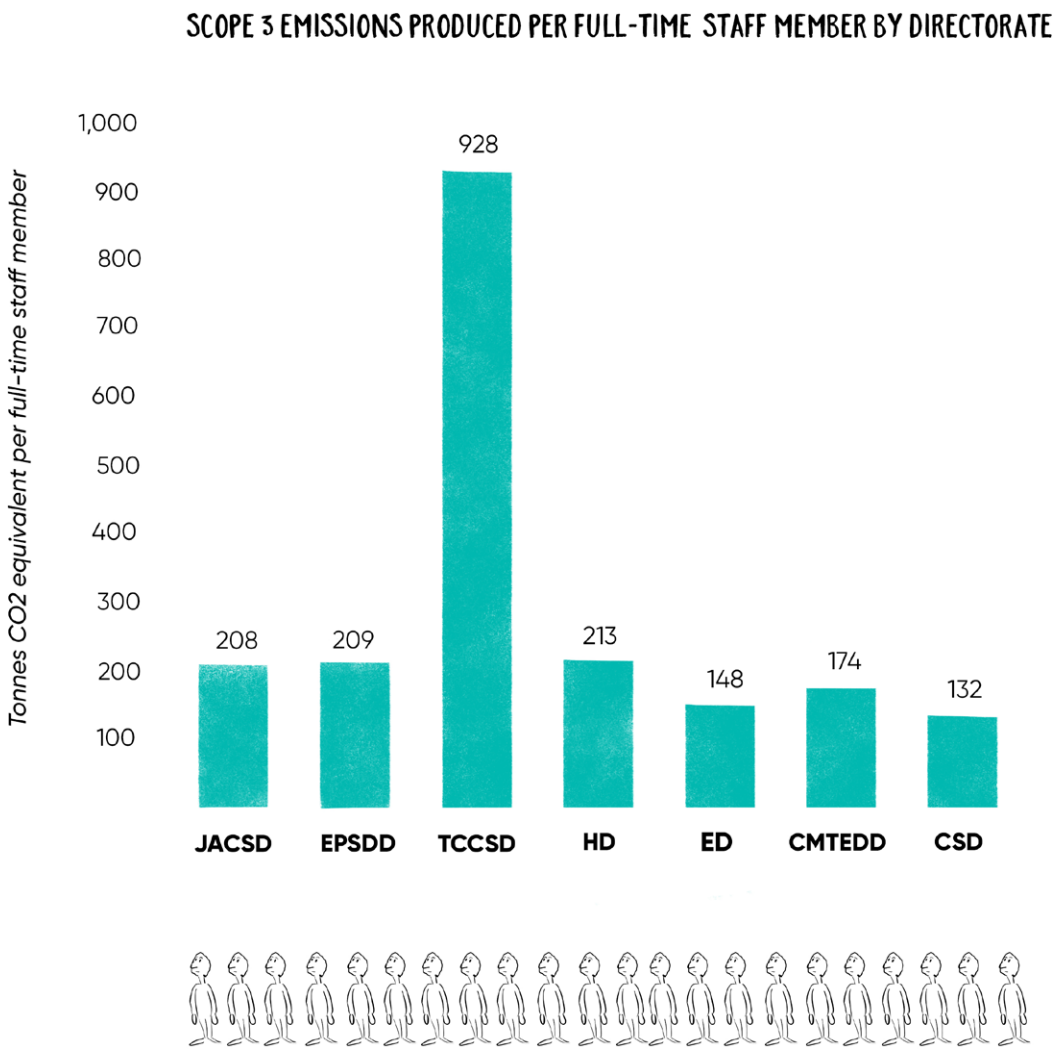


Figure 9: Scope 3 emissions produced per full-time staff member by directorate.

Care should be taken when interpreting the results due to data limitations, including that for the Education Directorate, which did not include any data from schools. There are also inconsistencies across the directorates in accounting and disclosure of full-time equivalent staff.

A key performance indicator per full-time equivalent or per person at the directorate level would be a meaningful measure for directorate leadership on mitigation action. Since this is a potential foundational measurement of efficiency, it is recommended that further work includes a more comprehensive analysis and directorate engagement to streamline full-time equivalent accounting. It is important to note that different directorates perform very different functions so comparisons among directorates may not be adequate.

Office workers. Source: Israel Andrade - Unsplash

7.2 What can the ACT Government do to reduce its scope 3 emissions?

Due to the limitations of the study and available data, it was not possible to generate a complete estimate of emissions mitigation potential or recommend a precise approach. It is estimated that a 40% reduction of scope 3 greenhouse gas emissions related to ACT Government supplies and property could be achieved by 2040, however additional modelling is recommended to confirm these figures.[189] A number of key mitigation pathways are identified and estimates of reduction provided, based on design or procurement alternatives.

Sustainable Procurement

The most prominent and powerful tools available to governments to influence indirect carbon emissions are sustainable procurement and public tenders. As the ACT Government sets up direct contracts with suppliers, manufacturers, contractors, construction companies and service providers, it has direct leverage to require low-carbon products or alternatives.[190] This will also be useful during times when supply chains are disrupted, as was experienced during the coronavirus pandemic.

Office Space and Usage

The average office space occupied per full-time equivalent of staff was 14 square metres. This compares to the commercial industry best practice benchmark of 7–8 square metres per person, with a move to 'hot-desk' and working from home.

A recent example of a reduction in space occupied by staff was the move to the new ACT Government building in Dickson. The previous building's (Dame Pattie Menzies House) 15 square metres per person was reduced to 12.5 square metres per person through planning efficiency and 'hot-desking' arrangements in the new building. However, this requires staff to work from home some of the time.

Dickson Offices. Source: Mark Jekabsons

189. The Footprint Company, 2021. *Scope 3 Carbon Assessment: ACT Government Directorates, July 2021*, commissioned by the Office of the Commissioner for Sustainability and the Environment.
190. UNSW, the University of Sydney, and CSIRO Land and Water, 2021. *ACT OCSE Investigation into Scope 3 Greenhouse Gas Emissions*, https://envcomm.act.gov.au/.
191. Ibid.

Achieving a move towards 10 square metres per person would result in a total emissions mitigation in excess of 90,000 tonnes of carbon equivalent across property rental, operating costs, fit-out and maintenance costs.[191] It would also save on cost and has the potential to improve employee experiences through enhancing work/life balance. The option to work from home also saves travel time and emissions. In summary, a more efficient space for work would provide social, environmental and economic benefits.

Figure 10 shows a comparison between the estimated embodied carbon emissions of current office fit-outs of all directorates and the potential footprint if space and embodied carbon in the fit-out were reduced.

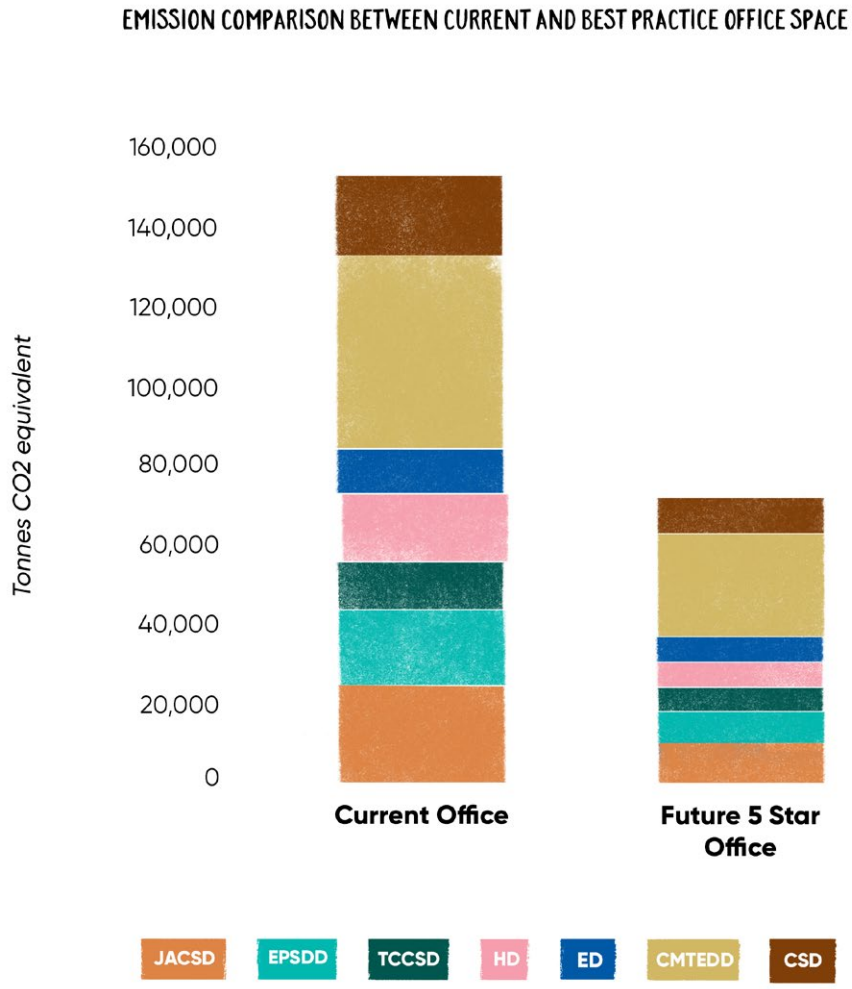


Figure 10: Estimated carbon footprint of existing office fit-outs versus best practices fit-outs with reduced carbon (Future 5 Star Office), of all ACT government directorates.

Carbon Performance Targets in Buildings

Approximately 30% of scope 3 emissions in ACT Government assets are associated with ownership, repair, renewal and improvement of buildings and built infrastructure.[192] The vast majority of these buildings are office buildings, and include the emissions associated with fit-out. This does not include hospital buildings and some school/classroom buildings as suitable data on these assets was not available. However, this still represents an opportunity for ACT Government to make significant reductions of embodied carbon. Internationally there is a consensus for a 40% reduction in 'average' practice for embodied carbon, moving to 65% by 2025 and net zero by 2040.[193]

There is significant opportunity for the ACT Government to demonstrate best practice in implementing mandatory "not to exceed" embodied carbon performance metrics in all new and replacement building, fit-out and infrastructure works (e.g. kilograms of carbon dioxide equivalent per square metre of functional area). This approach was recently used in the Australian National University's Kambri development in the centre of Canberra, which delivered a 40% reduction of embodied carbon.

There is an immediate opportunity to implement a similar approach for the procurement of the Canberra Institute of Technology's proposed New Technology Campus building in Woden and other infrastructure that is currently being planned.

It is recommended that further work is undertaken to establish a comprehensive series of carbon performance targets across all directorates. The highest value, lowest cost mitigation potential exists for capital works and new building investment. The implementation of contractually deliverable embodied carbon performance (in kilograms of carbon dioxide equivalent per unit of building), if employed by ACT Government would set a world benchmark in carbon mitigation leadership. Moreover, it would have the effect of transforming the construction and materials sector, in the same way that the ACT Government's leadership on home energy/star rating legislation transformed operating energy footprint in the 1990's.[194]

192. The Footprint Company, 2021. *Scope 3 Carbon Assessment: ACT Government Directorates, July 2021*, commissioned by the Office of the Commissioner for Sustainability and the Environment.
193. Ibid.
194. Ibid.

Estimating the Carbon Footprint of ACT Infrastructure

To understand the total emissions produced from the development and ongoing management of ACT Government public infrastructure, The Footprint Company estimated the embodied carbon per unit of asset type. Stormwater infrastructure has the largest embodied carbon impact of all existing infrastructure assets in the ACT, with bridges and roads next (Figure 11).[195]

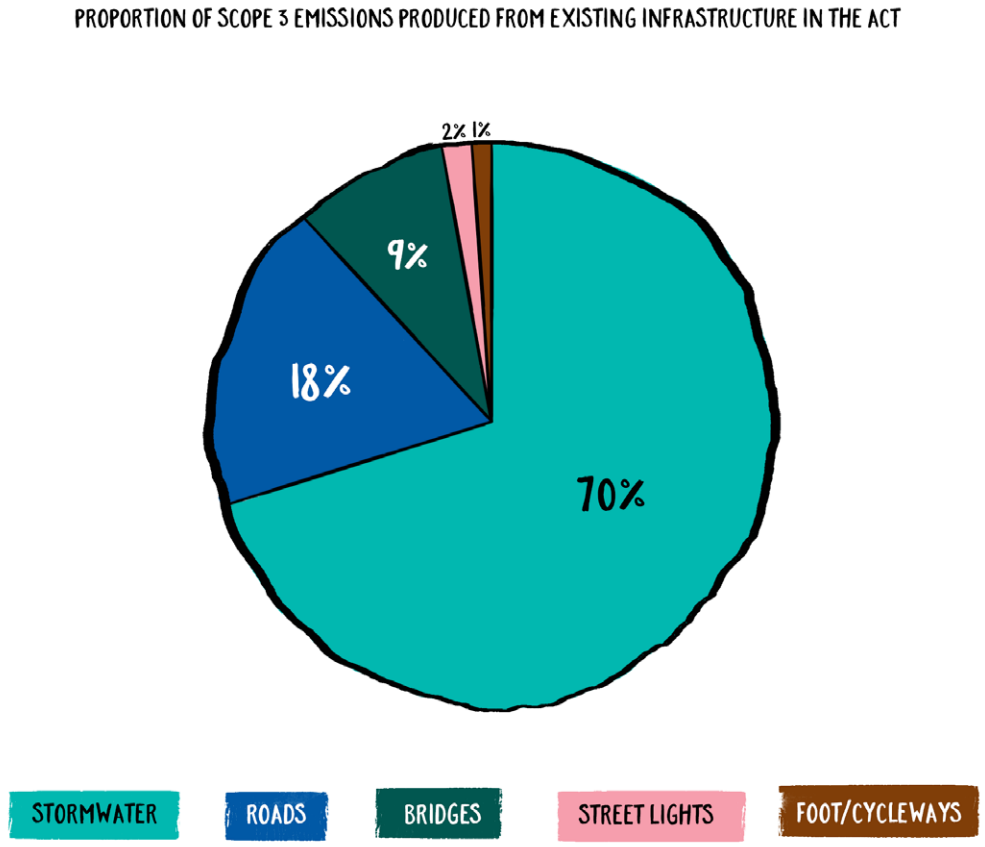


Figure 11: Proportion of ACT Government scope 3 emissions produced from existing infrastructure.

The future procurement, construction and maintenance of infrastructure presents a significant opportunity for the ACT Government to transform this sector to one of low embodied carbon. Infrastructure assets present a particular opportunity for embodied carbon mitigation due to their relative concentration of high intense materials such as steel, concrete, aluminium and copper.

The first step towards reducing embodied carbon in capital works and infrastructure is to set a benchmark of 40%–50% reduction for embodied carbon and for this to be included in procurement processes.

195. The Footprint Company, 2021. *Scope 3 Carbon Assessment: ACT Government Directorates, July 2021*, commissioned by the Office of the Commissioner for Sustainability and the Environment.

Potential Carbon Sequestration Opportunities in the ACT

The ACT has a large area of land in nature reserves or national parks. The annual carbon sequestration of biological assets can be considered as a pathway to reducing net carbon emissions. Specifically, the consideration of enhancements, restoration, soil carbon, tree planting within reserves and parks, are all valid initiatives to support. The added benefit from biological asset enhancement is that you get better ecological condition as well as higher carbon sequestration.

The annual sequestration on the basis of the land area and approximate land types in the ACT is approximately 2.4 megatonnes of carbon dioxide equivalent. There could be some interesting initiatives to support local economic development.

Implementing such a strategy would require:

- clear mapping of all land types and ownership
- engagement with the Australian Government to understand how or if they are accounting for the ACT land value in the national carbon accounts, to avoid double-counting
- identifying types of projects (in particular some of those now funded under Commonwealth climate funds), and
- developing feasibility of project types and assessing how much uplift is available.

Canberra skyline. Source: Matt Sherren

8. Projections and Targets for Scope 3 Emissions

8.1 Future Projections of Scope 3 Emissions

How were the projections developed?

One of the objectives of this Investigation was to model the potential to reach net zero emissions in the ACT by 2045 through a highly ambitious global pathway that limits warming to 1.5 degrees Celsius. These future projections for the ACT were based on existing scenarios of modelled studies and projections within Australia (see ClimateWorks Australia)[196] and internationally (see International Energy Agency).[197] This means the projections for the ACT were made for 2050 instead of the ACT's target of net zero emissions by 2045. It also means that the ACT's economic sectors presented in Section 3 were aggregated to match those from the studies mentioned above (further details in UNSW report).[198]

Assumptions regarding greenhouse gas emissions trajectories for Australia for most economic sectors are based on the '1.5 degrees Celsius All-in' scenario from ClimateWorks Australia (see UNSW report), which is the most ambitious of the scenarios proposed. This scenario models an emissions outcome for Australia that is consistent with limiting the global temperature increase to 1.5 degrees Celsius, and is assumed to be led by three key drivers that should develop and implement decarbonisation solutions.

- **The first driver is policy**, which is led by government, and manages emission reduction pathways through direct intervention, implementation of policies that limit and regulate emissions, and incentives for investment in climate change solutions.
- **The second key driver is businesses and individuals**, which influence emission reductions by making decisions on consumption, investment, and advocacy. Businesses would focus on transitioning to develop and use low emission products and services, and individuals would demand and invest in low carbon products and services, serving as signals to peers, businesses, and government.
- **The third driver is technology**, both existing and emerging, that will facilitate emission reduction targets.[199]

196. Climateworks Australia, 2020. *Decarbonisation Futures: Solutions, actions and benchmarks for a net zero emissions Australia*. Melbourne, ClimateWorks.
197. International Energy Agency, 2017. *Energy Technology Perspectives 2017*. Paris, International Energy Agency.
198. UNSW, the University of Sydney, and CSIRO Land and Water, 2021. *ACT OCSE Investigation into Scope 3 Greenhouse Gas Emissions*, https://envcomm.act.gov.au/.
199. Climateworks Australia, 2020. *Decarbonisation Futures: Solutions, actions and benchmarks for a net zero emissions Australia*. Melbourne, ClimateWorks.

Other assumptions behind this model are based on key emissions reduction solutions from different economic sectors, such as electricity, buildings, transport, industry, and agriculture and land. These solutions include energy efficiency technologies, renewable energy, energy demand management, circular economy practices, sustainable agriculture, and plant-based food substitutes. The projections exclude the use of carbon offsets such as reforestation or negative emissions technologies such as biofuels combined with carbon capture and storage.

To calculate the carbon footprint projections through to 2050, it was necessary to make assumptions about how direct emissions were produced per dollar spent in each economic sector, and how this will vary over time. Overall, emissions associated with each sector will change over time as a result of mitigation and decarbonisation, as well as economic growth. A limitation to this approach is the assumption that the structure of the economy will remain the same, with annual growth projections applied equally across sectors. In reality, the future structure of the global economy is highly uncertain, and an analysis of the implications of potential changes are beyond the scope of this study. Therefore, all targets for reduction proposed should be considered with caution. Given the ACT's reliance on the rest of Australia and the world for products, our target of reaching net zero emissions by 2045, if embodied emissions are included in the targets, will be closely dependent on the decarbonisation pathways of these locations.

Projections are provided in five-yearly intervals, and for this study the annual values are estimated through modelling. For details of setting targets for each economic sector, refer to the UNSW report.[200]

Projections Results and Reduction Targets

The results for the future projections, based on limiting temperature to 1.5 degrees Celsius, show a rapid decline in the per person carbon footprint from 2018 to 2050 (Figure 12), falling to approximately 10% of original emissions (from 34.7 tonnes of carbon dioxide equivalents per person to 3.7). The remaining carbon footprint after 2050 is largely comprised of scope 3 emissions from the rest of the world (65%), and the rest of Australia (30%). The rapid decline in carbon footprint, modelled for Australia (ClimateWorks Australia, 2020) and globally (IEA, 2017), are highly ambitious and should be considered 'best case' scenarios. While the reductions are significant, the trajectory fails to reach a net-zero carbon footprint for the ACT by 2045 or even 2050, highlighting that such an outcome is closely tied to the decarbonisation of the economy in Australia and in our key global trading countries.

It is worth noting that the emissions modelling by ClimateWorks for Australia achieves a net-zero outcome by 2050 through the inclusion of substantial carbon sequestration through forestry. Similarly, the global modelling by the International Energy Agency reaches a net zero result by 2060 through the inclusion of negative emissions technologies, which remove carbon dioxide from the air. Including the use of offsets and negative emissions technologies would assist the ACT reaching absolute carbon neutrality, but these are not included in these projections.

200. UNSW, the University of Sydney, and CSIRO Land and Water, 2021. *ACT OCSE Investigation into Scope 3 Greenhouse Gas Emissions*, https://envcomm.act.gov.au/.

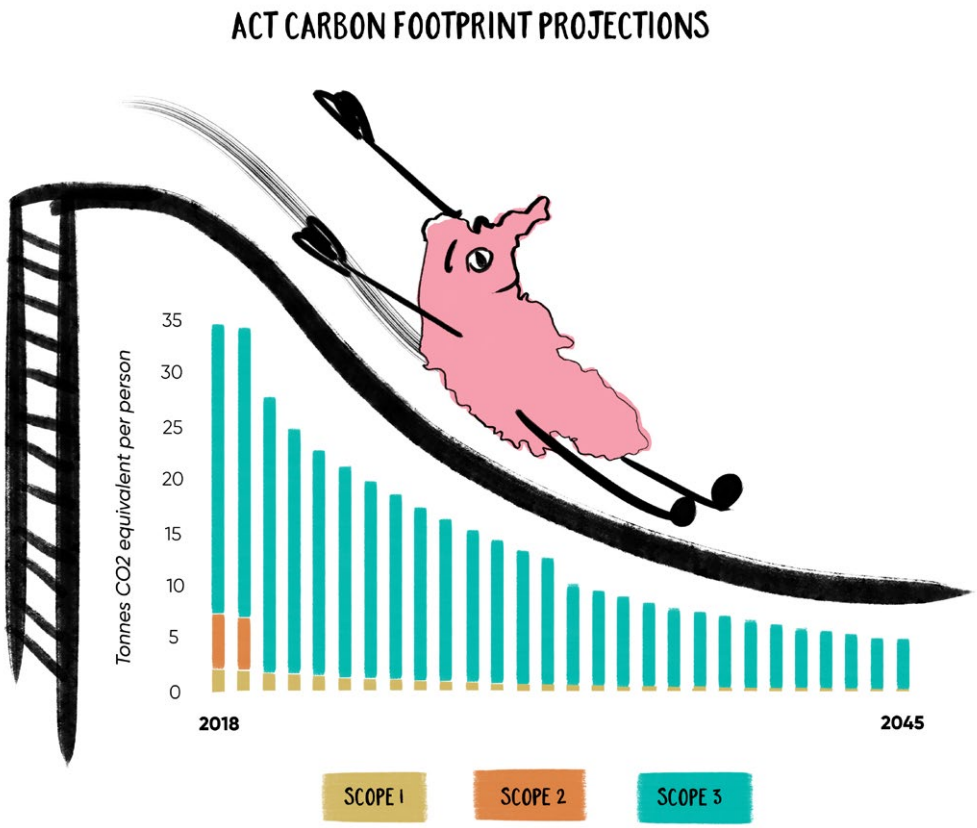


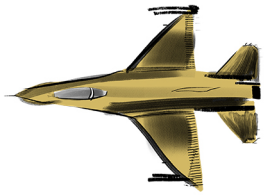
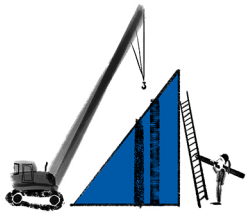
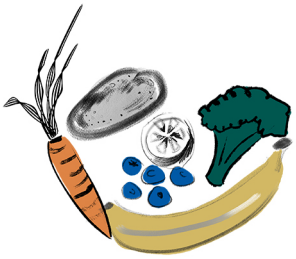
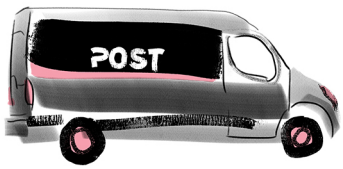
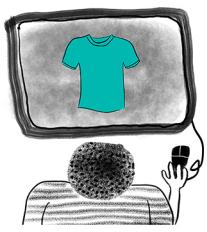
Figure 12: ACT carbon footprint projections to 2045 based on the most ambitious scenario that limits warming to 1.5 degrees Celsius for Australia and the world.[201]

In the absence of offsets, the ACT will have to actively engage with its carbon trading partners to enable decarbonisation outside of the Territory. The Territory must also address the increasing consumption of goods and services imported to the ACT. Carbon taxes have been recognised as effective measures to increase the cost of emitting carbon, therefore motivating consumers to adopt more sustainable behaviours.[202]

201. UNSW, the University of Sydney, and CSIRO Land and Water, 2021. *ACT OCSE Investigation into Scope 3 Greenhouse Gas Emissions*, https://envcomm.act.gov.au/.
202. Dahal and Niemelä 2017 in Burbridge, C., 2018. *Carbon Neutrality Assessment of the ACT*, Honours Thesis, UNSW, Sydney.

Ferris wheel at Floriade. Source: Wikimedia Commons

TARGETS FOR REDUCTION

Product Group	*Proportion of potential emissions reduction from:* 2018-2030	2030-2050
 PUBLIC ADMINISTRATION & SAFETY	86%	9%
 CONSTRUCTION	84%	10%
 FOOD	69%	16%
 TRANSPORT, POSTAL & WAREHOUSING	64%	23%
 RETAIL TRADE	53%	23%

8.2 Targets for Reduction of Scope 3 Emissions

The "Targets for Reduction" infographic (refer to page 92) shows projection outcomes of product groups in the ACT with the largest potential for reduction of all emissions. This includes scope 1, 2, and 3 emissions, however, scope 3 emissions are the largest by far. For instance, the product group 'Public Administration and Safety', shows a potential reduction of 86% in emissions between 2018 and 2030 when applying the suggested solutions. A further 9% reduction in emissions could be accomplished on the remaining carbon footprint between 2030 and 2050.

Many of these solutions are related to alternative energy technologies and practices, such as moving to renewable sources of electricity, moving away from fossil fuels to zero or near-zero emission alternatives, reducing electricity waste, and moving away from energy-intensive products and services.[203] Solutions based on existing technology include transitioning to electric vehicles, and emerging technologies such as hydrogen fuel for vehicles, and biofuels for air, water and long-distance land trips. In agriculture, many solutions are directed to cutting down emissions from cattle (beef and dairy), through plant-based substitutes, and emerging technologies such as lab-based meat and vaccines that reduce emissions from live animals.[204]

203. Climateworks, Australia 2020. *Decarbonisation Futures: Solutions, actions and benchmarks for a net zero emissions Australia*. Melbourne, ClimateWorks.
204. Ibid.

9. Conclusion

> *"To avoid climate breakdown, emissions from global urban consumption must halve by 2030. For this to be achieved, emissions from consumption in high-income cities must decrease by two thirds within the next decade."*
>
> *– C40 Cities, ARUP and University of Leeds 2019. The Future of Urban Consumption in a 1.5C World. Headline Report. Leeds: University of Leeds.*

This is especially relevant for the ACT as a region that does not produce many materials, rather it relies heavily on consuming imports from the rest of Australia and the world. Scope 3 emissions represent 93.6% of the ACT's carbon footprint.

Achieving net zero carbon emissions in the ACT by 2045 will be very closely coupled with the decarbonisation of Australia and the world.

The Territory does not have to wait for carbon neutrality in a broader sense to happen and can initiate, support and promote changes to behaviours and practices now. Scope 3 reductions should accompany the ACT's 2045 target of net zero emissions for scope 1 and scope 2 emissions as scope 3 emissions represent such a high percentage of total emissions in the Territory. It is also vital that the ACT Government regularly assesses its progress to neutrality using consumption-based accounts that include scope 3 emissions.

The pathway to ACT scope 3 emissions reduction will involve actions from the ACT Government, ACT residents, and businesses. These will include changes to diets, transport, living and consuming.

Shipping containers. Source: Chuttersnap - Unsplash

10. Recommendations for ACT Government

ACT Climate Leadership

1. ACT Government to implement a methodology (such as that presented in this Investigation) to report on scope 3 emissions across the Territory every three years.

2. ACT Government to work in partnership with state, territory and national governments to discuss initiatives to reduce scope 3 emissions across jurisdictions.

ACT Government Operations

3. Standardise and improve collection and publication of data to ensure accurate calculation can be made of the scope 3 emissions of the ACT Government.

4. Set scope 3 emissions reduction targets for ACT Government operations and assess progress towards these targets every three years.

5. Implement sustainable procurement principles, including developing mandatory embodied carbon limits of procured equipment, items and materials, and supporting the longevity of equipment and waste reduction.

6. Reduce the physical footprint of ACT Government staff, with the aim of 7 square metres per person.

7. Develop and implement a policy for flexible business operations that supports reduction of scope 3 emissions such as working from home and reducing business travel.

View of South Canberra. Source: Mark Jekabsons

Households

8. Develop and implement education and awareness-raising campaigns for residents on reducing household scope 3 emissions. Key areas of focus should include low carbon building products, adopting the circular economy, and household food waste reduction.

9. In alignment with the national target, implement a 50% food waste reduction by 2030 target in the "Food Organics Garden Organics" program, using a consistent methodology to track progress.

Planning, Construction and Infrastructure

10. Undertake analysis to determine the barriers and opportunities to increase the supply of low carbon cement to the ACT.

11. Define and implement scope 3 performance metrics for at least 65% of the highest emission intensity infrastructure types by 2025.

12. Review and expand legislation and ensure compliance of new building regulations related to scope 3 emissions, such as:

a. incentivise renovation of existing buildings instead of demolition

b. undertake a carbon impact assessment and implement mandatory embodied carbon limits for all new and replacement buildings, fit-out, and infrastructure

c. implement allowable low carbon material lists for construction

d. develop an exemplar infrastructure project to demonstrate low embodied energy building principles

e. increase the reuse of construction and demolition materials for public and private buildings, including the development of an accreditation system to ensure quality of the materials for reuse, and

f. increase inspections and reporting of compliance of building codes.

OFFICE OF THE COMMISSIONER
FOR SUSTAINABILITY AND
THE ENVIRONMENT