The Carbon & Ecological Footprints of the population of the ACT

Final results

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Fundamental Questions

Has the population of the ACT, on average, become more or less sustainable over the last 15 years?

What are the drivers behind the changes?

How to respond: policy, technological & personal?

Consumption viewpoint

- the ecological footprint, as envisioned by Wackernagel and Rees in the mid-1990s, is a measure of humankind's impact on the natural world

- the fundamental concept is to assess impacts in terms of the land area (in hectares) needed to support a population, expressed as a sum of the use of different types of biologically productive areas

- in some approaches at a national level, (un)sustainability is inferred by the difference between the required land and the nation's available biocapacity

- a consumption viewpoint means that for the ACT it is a measurement of all the Australian land area required to support the ACT's total population

Ecological Footprint components

- a *land disturbance* footprint approach is used here, which is a change from footprints calculated previously for State of the Environment Reports

- it is based on different areas of land use, then weighted by disturbance factors to account for how transformed each land type is from a pristine state

- in addition, "emissions land" is another ecological footprint component, where a factor is used to convert total GHG emissions to a disturbed land area

- the emissions land is calculated from a full carbon footprint (greenhouse gas Scopes 1, 2 & 3), again according to a consumption viewpoint

Ecological Footprint entities

- the responsibility of the impacts of the Australian economy, such as measured by the ecological and carbon footprints, are ultimately driven by the "final demand" of the Australian economy
- final demand comprises: private and government final consumption (FC), private and government gross fixed capital formation (GFC), changes in inventories (stocks), and exports
- an Australian footprint includes all these contributions, except exports
- the largest single contribution is from private final consumption, or in other words, what households buy directly to support their day-to-day lives
- for clarity we call the components of final demand "entities"
- footprint impacts from each "consuming" entity are illustrated on the next slide

Footprint entities - AUS economy

CF (t CO2-e)
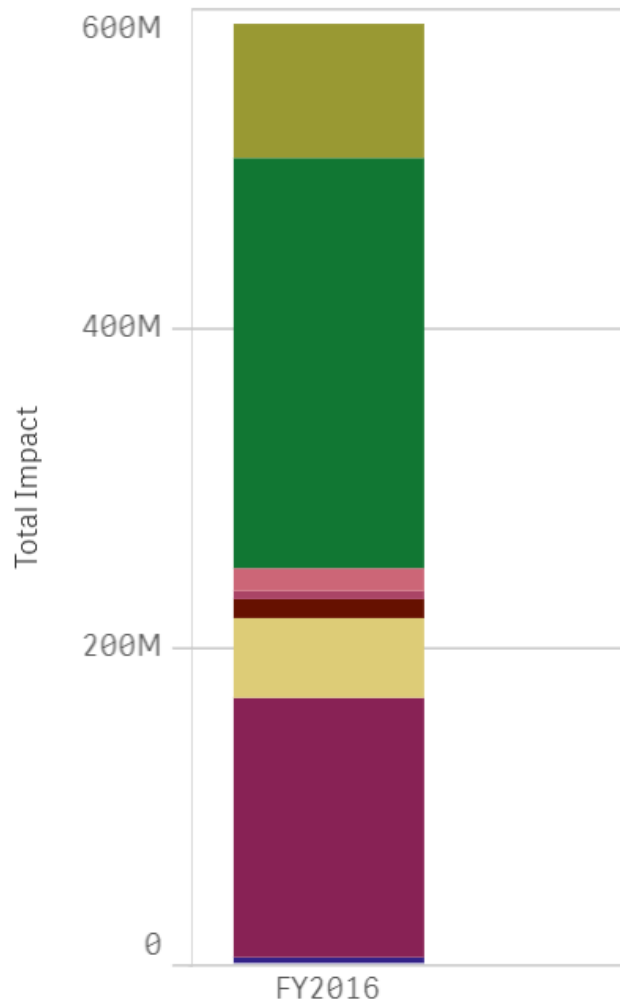
EF (ha)
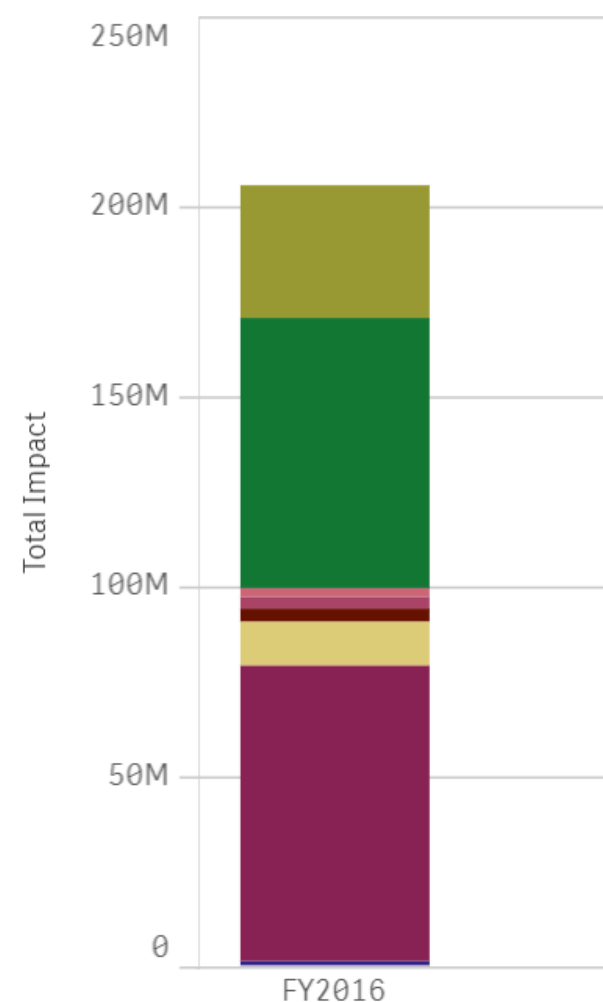
Legend:
- AUS Exports
- AUS Govt FC
- AUS Govt GFC
- AUS Inventories
- AUS PE GFC
- AUS Priv FC
- AUS Priv GFC

- Footprint contributions from the different consuming entities are shown
- Significant impacts from exports are removed for the calculation of the footprints for the Australian and ACT populations

Methodology summary

1. direct sources of emissions and land use are covered (ACT and Australian GHG accounts)

2. detailed expenditure profiles are established based on ABS data: the input-output tables, state & national accounts, the household expenditure survey (HES) & income and wealth accounts

3. other data are hybridised, meaning expenditure-based results are replaced with more accurate physical data, such as for emissions from electricity usage and transport

4. for a virtual city-state like the ACT, a national model is required to account for all wider effects

5. carbon sinks from the Australian agricultural & forestry industries are re-allocated and shared across all Australians on a per-capita basis

6. Total AUS/ACT Footprints = Direct Impacts + Private Financial Consumption + Other Australian Final Demand (Govt FC, All Capital & Inventories)   (ie. exports are removed)

Data sources and years

1. Background/baseline economic and emissions data (from Australian Industrial Ecology Virtual Laboratory, or AUS IELab)

2. Land use (ALUM) and then ISA land disturbance factors (from the University of Sydney)

3. Detailed national and state greenhouse gas inventories (AGEIS)

4. ABS Household Expenditure Survey (HES) data and mapping to a 344 sector model of the Australian economy (HES years: 2003-04, 2009-10 and 2015-16)

5. Expenditure data were also estimated for 2017-18 to provide as recent a footprint as possible

6. ACT HES includes ~300 houses. The expenditure breakdown is very detailed, but it is referenced against broader economic data (state income and expenditure accounts)

7. Physical data (electricity, fuel use, waste etc) such as from the ACT Greenhouse Gas Inventory

Overall results EF (total ACT)

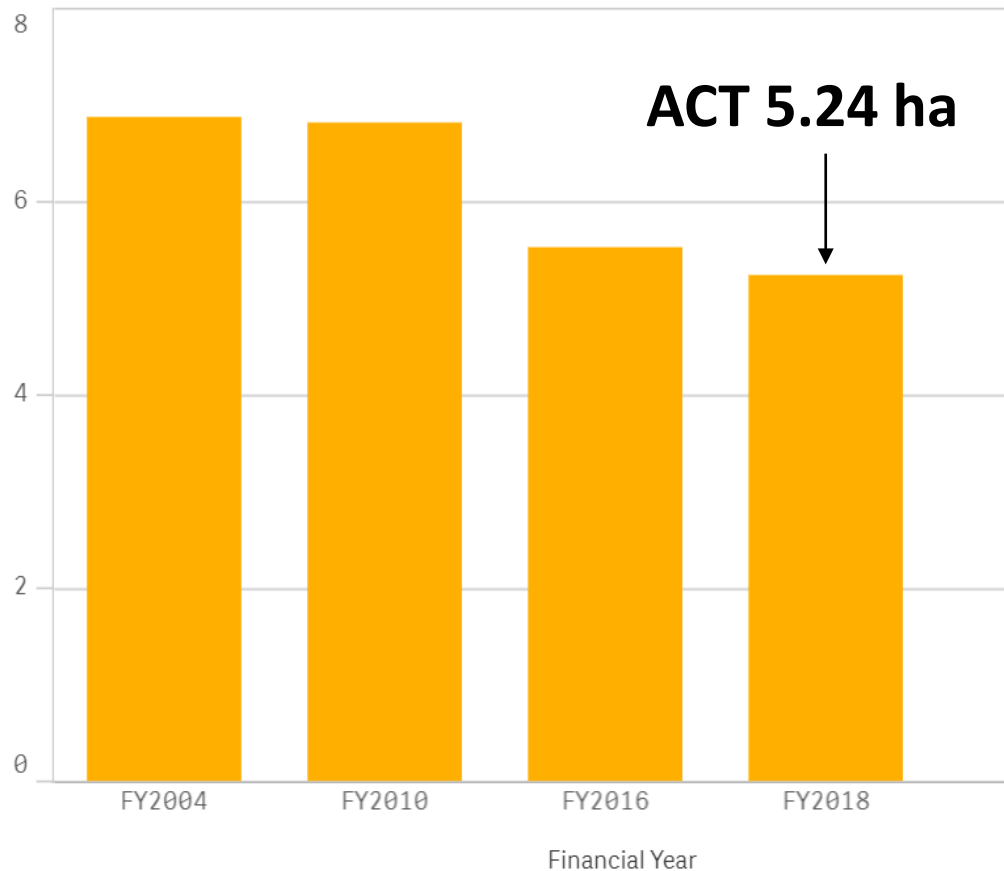Ecological Footprint - disturbance (ha)
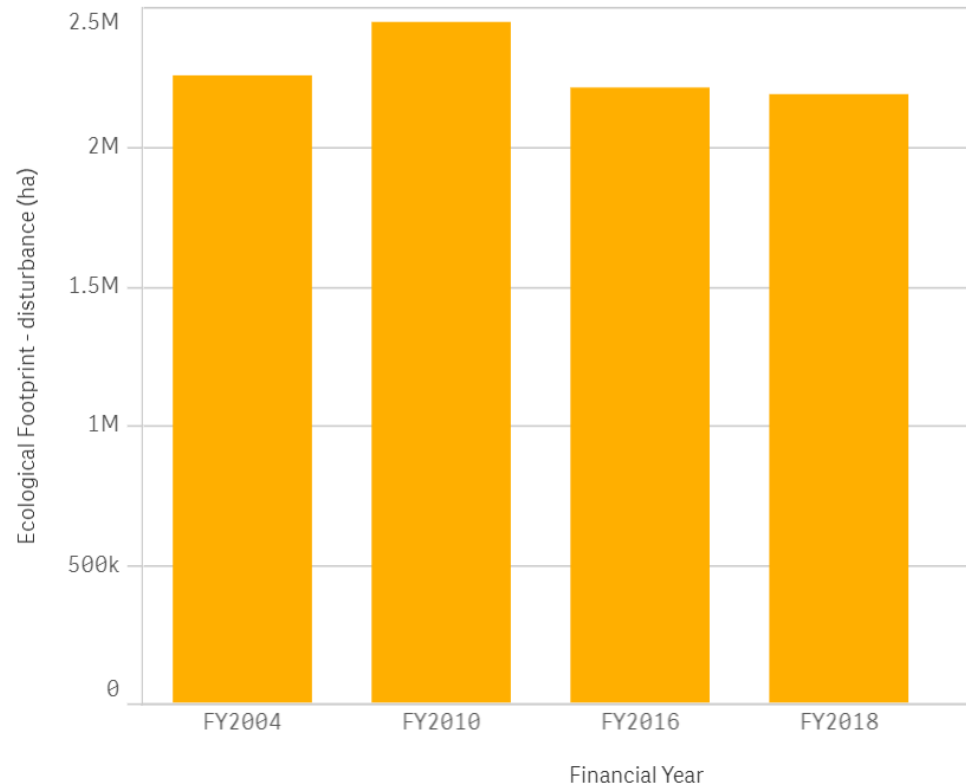
ACT Population (Number)
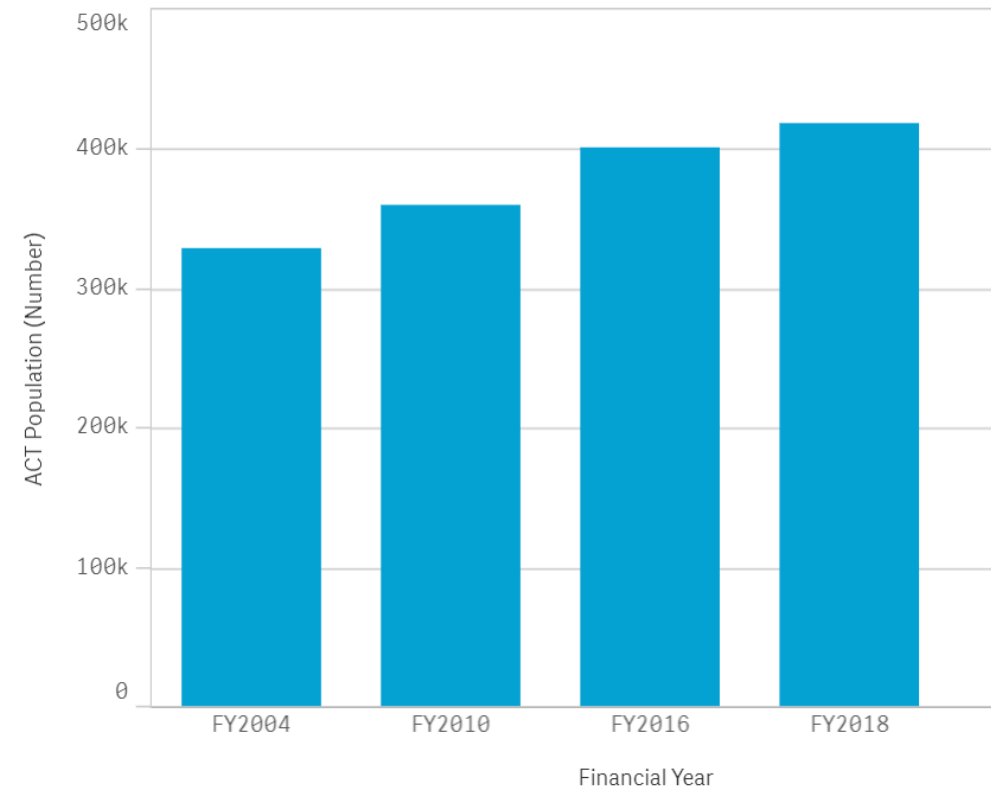
- The ACT total footprint peaked in 2009-10 at just under 2,450,000 hectares. Since 2008, the ACT population has increased on average by ~2% per year. Over the same timeframe, the average annual Australian population growth rate was 1.6%.

Overall results EF (per-capita)

Ecological Footprint - disturbance (ha) / ACT Population (Number)

ACT 5.24 ha

Financial Year

Ecological Footprint - disturbance (ha) / Australian Population (Number)

AUS 5.22 ha

Financial Year
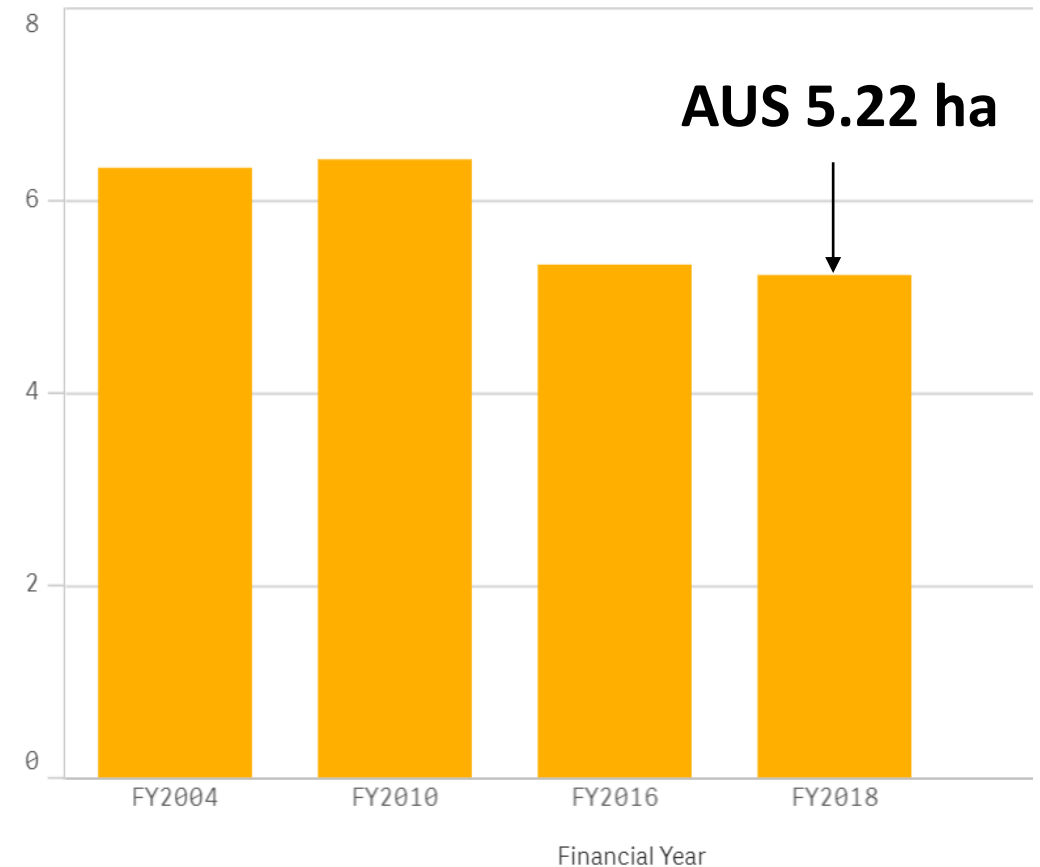
- With the population rise, total EF peaking in 2010 and then falling, per-capita footprints have fallen significantly over the timeframe, particularly for the ACT. The average ACT and Australian per-capita footprints were both 5.2 ha in 2017-18.
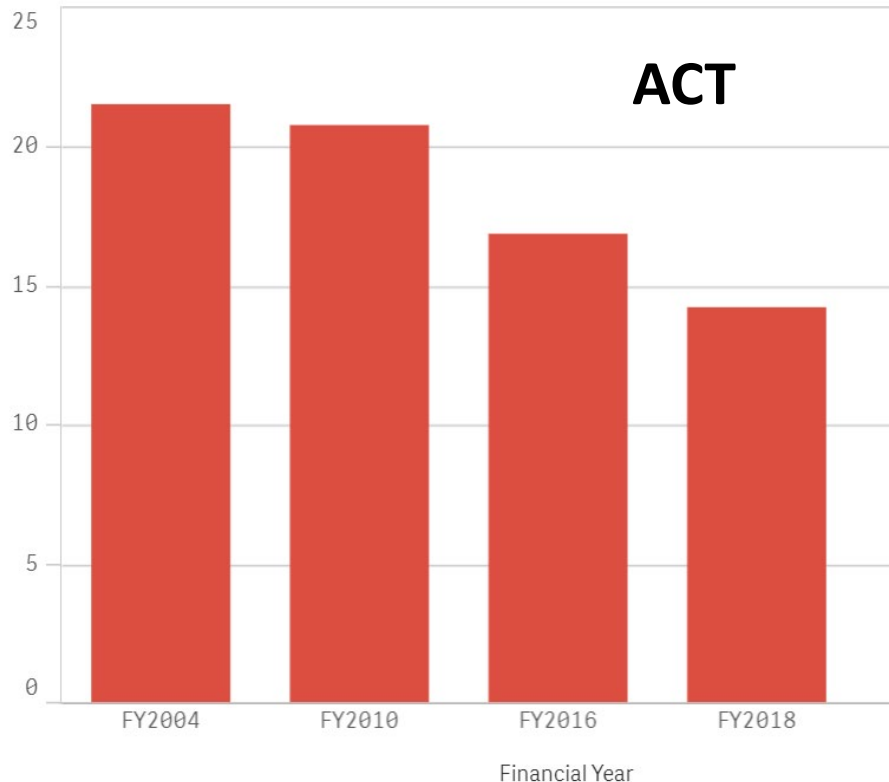
Carbon footprint - total ACT & AUS

ACT

AUS
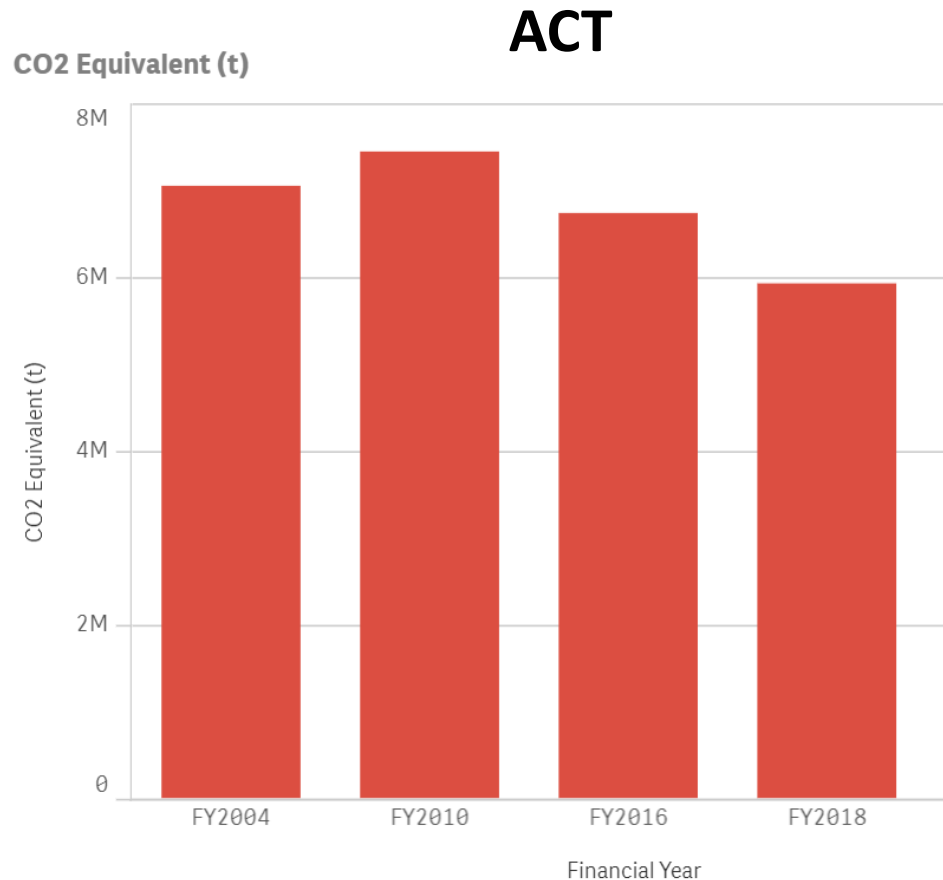
- The total carbon footprint of the ACT population was 6 million tonnes CO_2 equivalent in 2017-18, down from a peak of 7.45 Mt CO_2-e in 2009-10. The total Australian carbon footprint is steadier over the years, being 396 Mt CO_2-e in 2017-18.

Carbon footprint (CF) per-capita

CO2 Equivalent (t) / ACT Population (Number)

ACT

Financial Year

CO2 Equivalent (t) / Australian Population (Number)

AUS

Financial Year
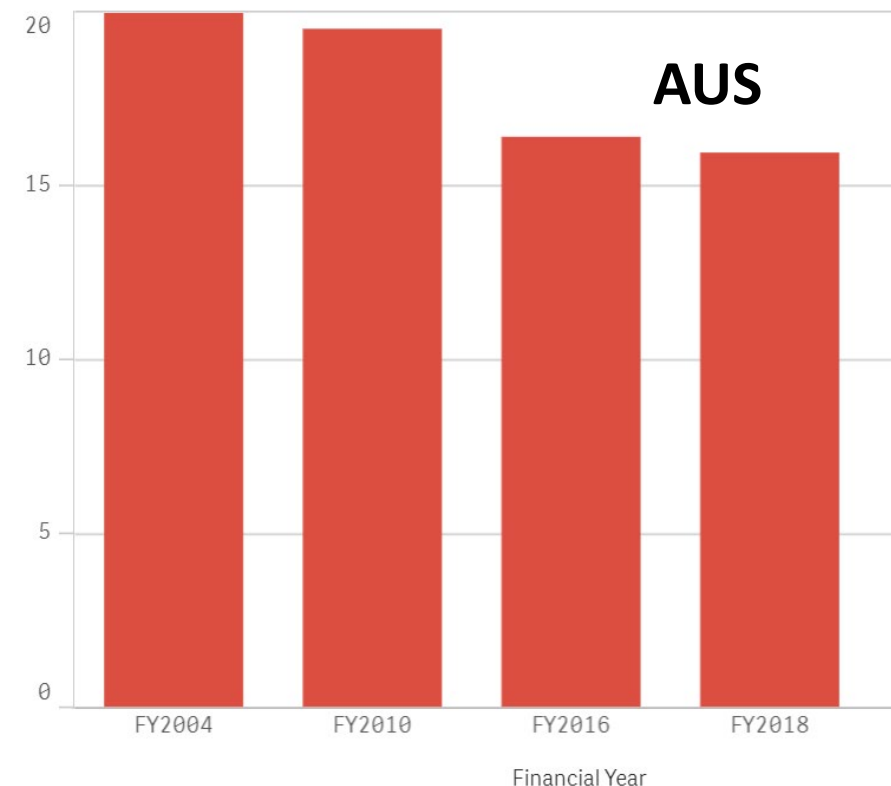
- The per carbon footprint of the ACT population has fallen from 21.5 to 14.2 t CO_2-e between 2003-04 and 2017-18. The per-capita ACT carbon footprint was 7.5% above the per-capita AUS footprint in 2003-04 but the ACT per-capita is now 11% below the AUS per-capita CF in 2017-18.

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ACT Ecological footprint (EF) totals
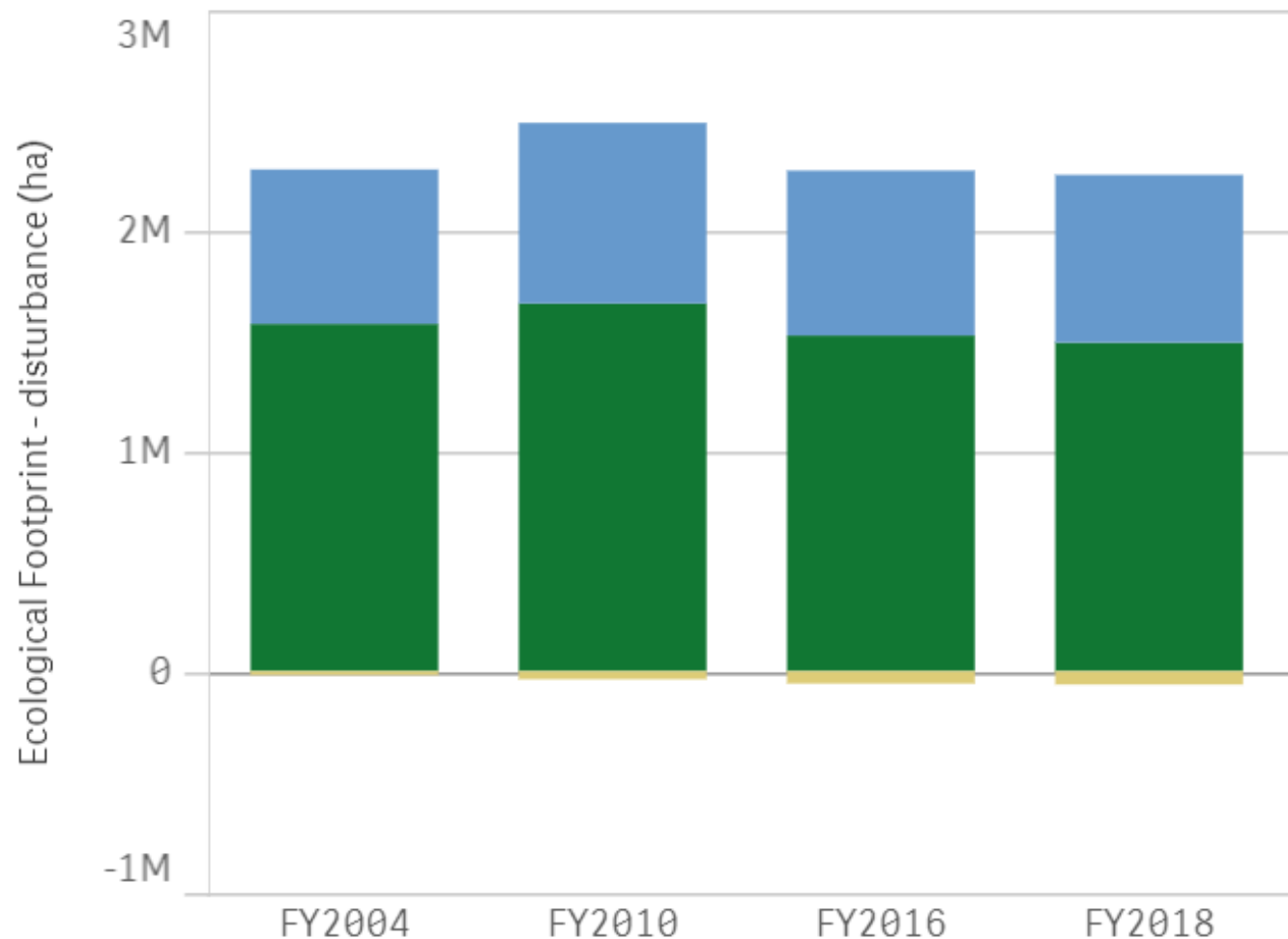
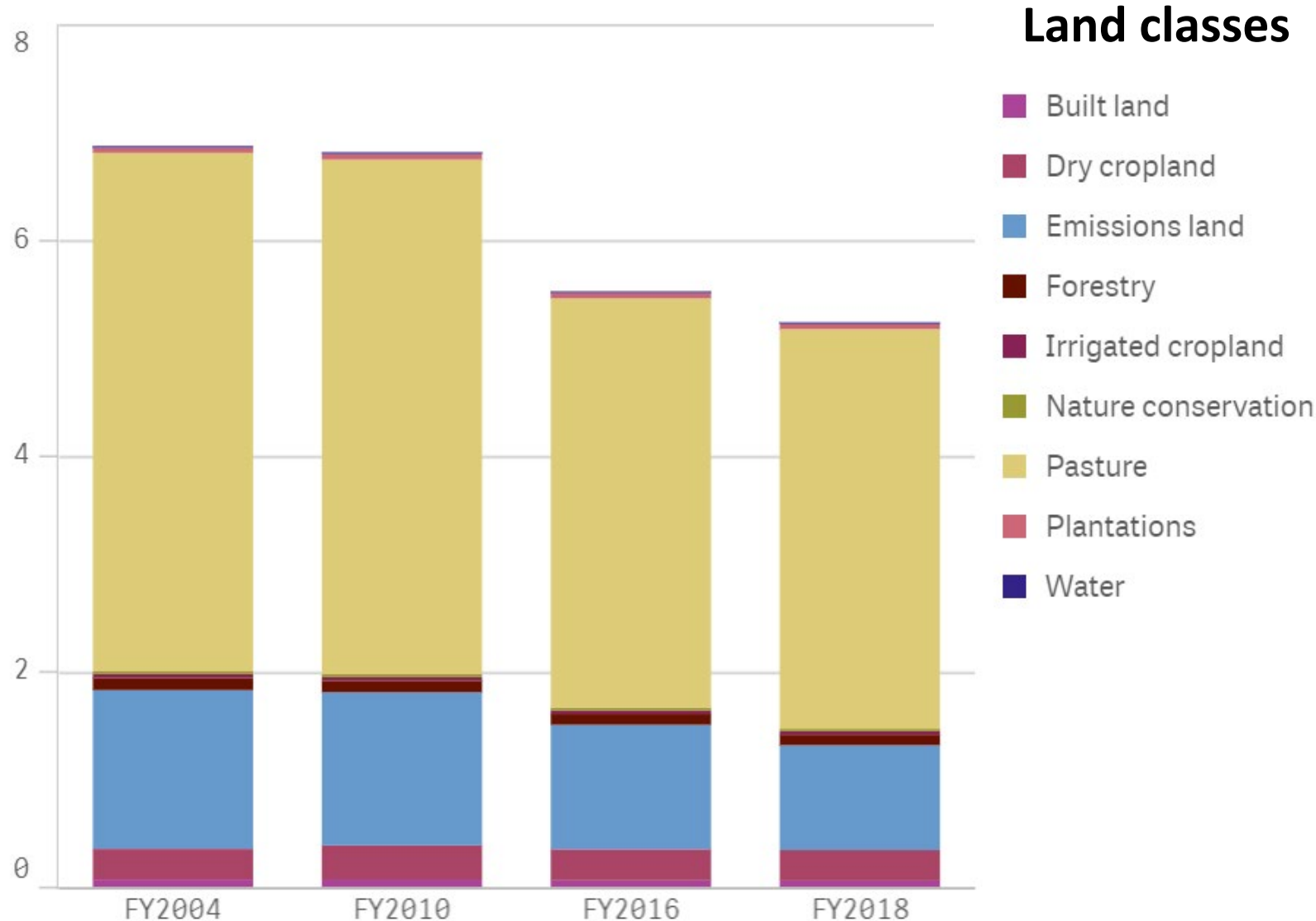## Final demand contributions

Entity
- ACT GHG Sinks
- ACT HES FC
- ACT Total Other FD

- Household final consumption is the main consumption entity of an Australian footprint, though Other final demand (government activities and capital) is significant.
- The negative footprint from GHG sinks is relatively small, though increasing over the timeframe.

ACT EF Components per-capita (ha)

Land classes

Legend:
- Built land
- Dry cropland
- Emissions land
- Forestry
- Irrigated cropland
- Nature conservation
- Pasture
- Plantations
- Water

- Land disturbance from the large land area used for grazing dominates the land classes of the ecological footprint.
- The falling contribution from emissions land is apparent as the renewable electricity supply increases.
- Other land classes have a relatively small contribution to the total land disturbance footprint.
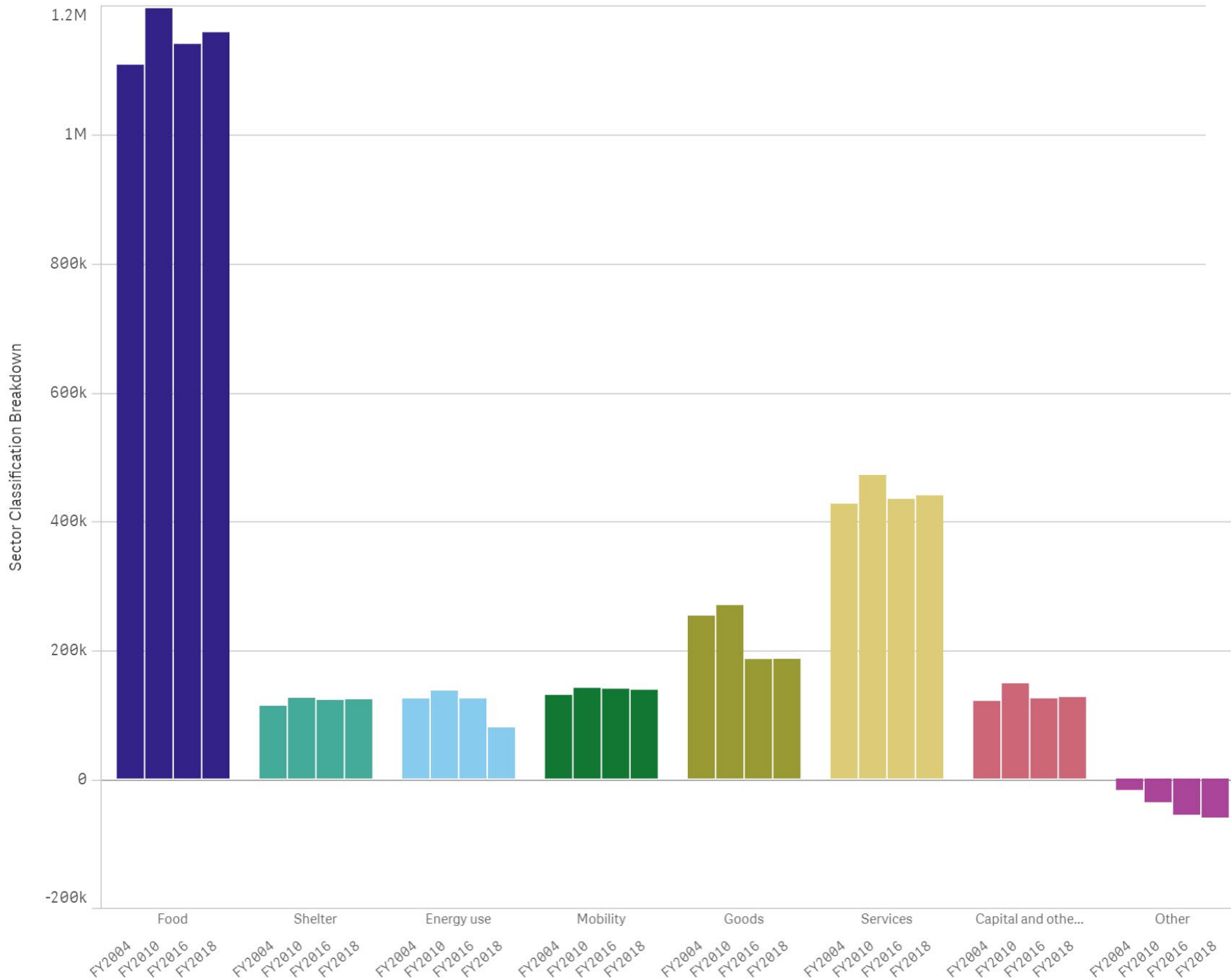
ACT total EF by expenditure group & year (ha)

- The provision of food dominates most ecological footprints due to the extensive land required for the average diet.
- The contribution from goods is falling as expenditure patterns shift further towards services.

ACT total CF by expenditure group & year (t CO2-e)
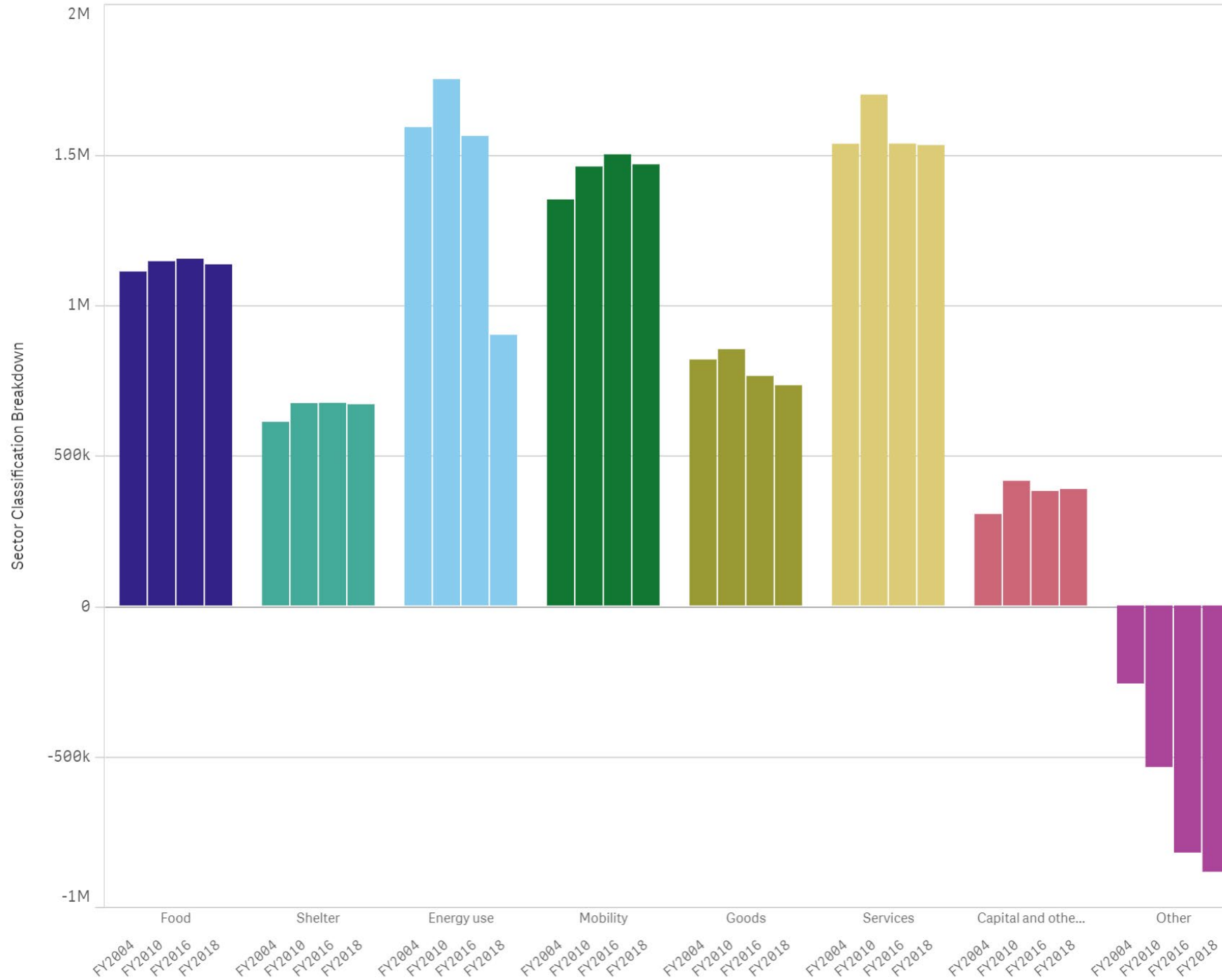
- For carbon footprints the expenditure groups have a much more even contribution.
- There is a notable fall in the FY18 carbon footprint from energy use, due to the increase in ACT renewable electricity.
- Emissions from mobility are trending upwards.

EF Contributions ACT Total

There are many, many smaller contributions to the total footprint
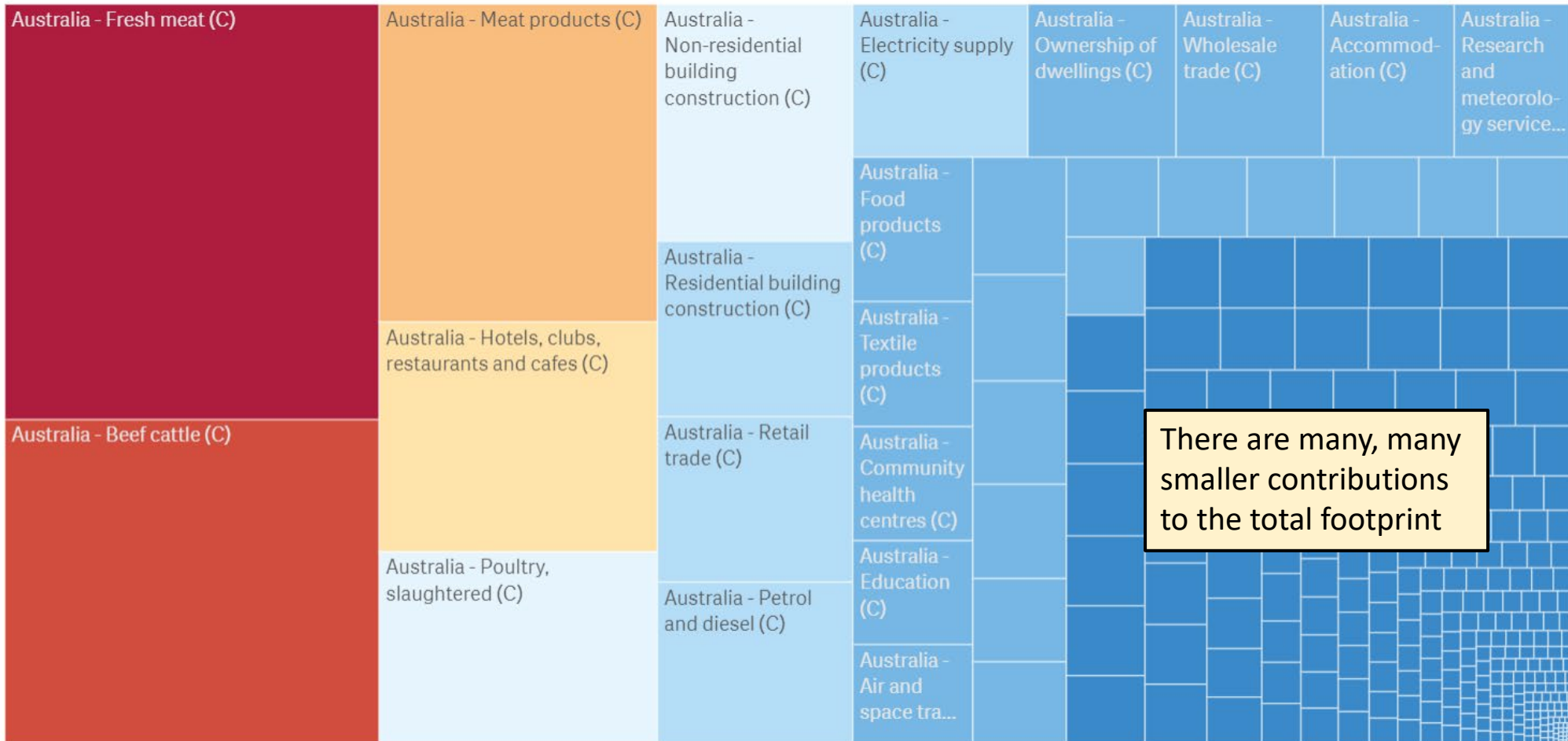
- The areas depict the major contributions to the total ACT EF. The unnamed areas in blue demonstrate the myriad of smaller contributions to the total footprint.

Typical CF Breakdown – ACT Total FY16
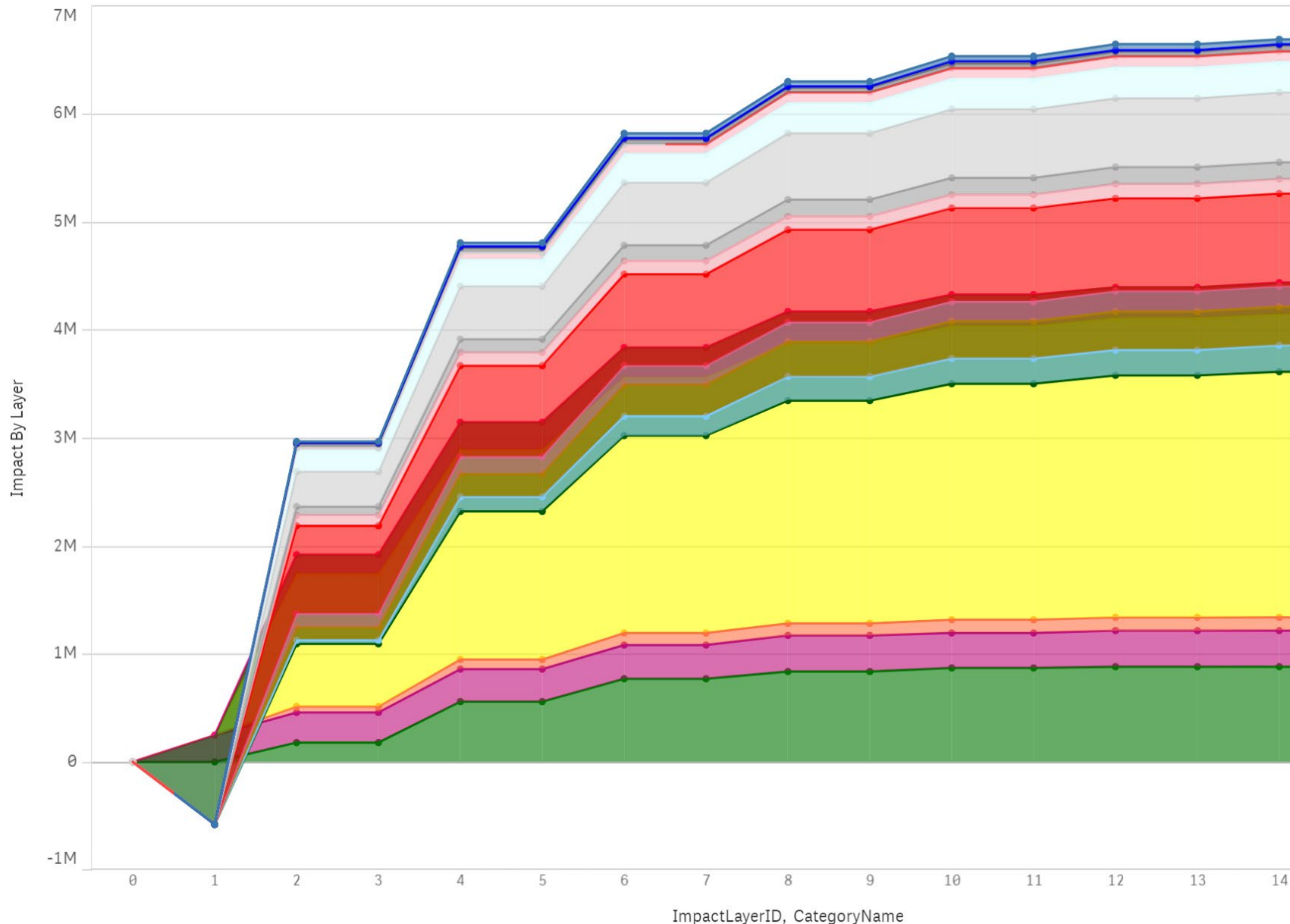
- The horizontal axis shows the depth through the economy as more impacts are captured through higher levels of the supply chain.
- The importance of emissions from electricity is readily apparent (yellow area).

Top ACT EF paths from an SPA – FY18

Australia - Beef cattle (IC) > Australia - Fresh meat (IC)	215,397.71
Australia - Beef cattle (IC) > Australia - Meat products (IC)	134,275.78
Australia - Beef cattle (IC) > Australia - Poultry, slaughtered (IC)	78,131.04
Australia - Petrol and diesel (IC)	52,355.68
Australia - Electricity supply (IC)	40,348.32
Australia - Beef cattle (IC) > Australia - Fresh meat (IC) > Australia - Hotels, clubs, restaurants and cafes (IC)	24,643.53
Australia - Sheep and lambs (IC) > Australia - Fresh meat (IC)	21,343.71
Australia - Shorn wool (IC) > Australia - Textile products (IC)	19,650.64
Australia - Ownership of dwellings (C)	15,696.09
Australia - Beef cattle (IC) > Australia - Poultry, slaughtered (IC) > Australia - Hotels, clubs, restaurants and cafes (IC)	14,368.93
Australia - Sheep and lambs (IC) > Australia - Meat products (IC)	13,323.77
Australia - Air and space transport (IC)	12,044.98
Australia - Beef cattle (IC) > Australia - Meat products (IC) > Australia - Hotels, clubs, restaurants and cafes (IC)	10,998.14
Australia - Beef cattle (IC) > Australia - Fresh meat (IC) > Australia - Food products (IC)	10,851.20
Australia - Shorn wool (IC) > Australia - Human-made fibres (IC)	10,103.18
Australia - Untreated milk (IC) > Australia - Dairy products (IC)	9,998.87
Australia - Beef cattle (IC) > Australia - Retail trade (IC)	9,765.52
Australia - Shorn wool (IC) > Australia - Cotton fabrics (IC)	9,058.98

- A structural path (SP) analysis delves into the detailed contributions to the overall footprint.
- Individual EF paths are then ranked from highest to lowest.
- Typically there are many thousands of non-negligible paths.
- Due to the vast amount of land area used for grazing in Australia it is not surprising that grazing paths feature prominently in this listing.

Top ACT CF paths from an SPA – FY18

Australia - Petrol and diesel (IC)	764,239.99
Australia - Electricity supply (IC)	587,120.01
Australia - Ownership of dwellings (C)	229,140.00
Australia - Air and space transport (IC)	175,839.09
Australia - Beef cattle (IC) > Australia - Fresh meat (IC)	75,710.90
Australia - Gas supply (IC)	52,962.89
Australia - Beef cattle (IC) > Australia - Meat products (IC)	47,197.06
Australia - Crude oil (IC) > Australia - Petrol and diesel (IC)	34,658.72
Australia - Untreated milk (IC) > Australia - Dairy products (IC)	30,840.76
Australia - Beef cattle (IC) > Australia - Poultry, slaughtered (IC)	27,462.55
Australia - Motor vehicle parts (IC)	23,954.20
Australia - Knitting mill products (IC)	23,784.61
Australia - Footwear (IC)	23,388.20
Australia - Wine (IC)	21,735.06
Australia - Water supply; sewerage and drainage services (IC)	20,530.80
Australia - Road freight (IC)	19,606.13
Australia - Fruit (IC)	17,817.84
Australia - Vegetables (IC)	17,194.43
Australia - Ownership of dwellings (IC)	16,666.49

- A structural path (SP) analysis delves into the detailed contributions to the overall footprint.
- Individual carbon footprint paths are then ranked from highest to lowest.
- Typically there are many thousands of non-negligible paths.
- The top four CF paths all relate to energy use, directly or indirectly.
- Ownership of dwellings (C) includes the combustion of natural gas and other direct emissions, as well as emission from waste.
- Notably, emissions from air travel are increasingly important.
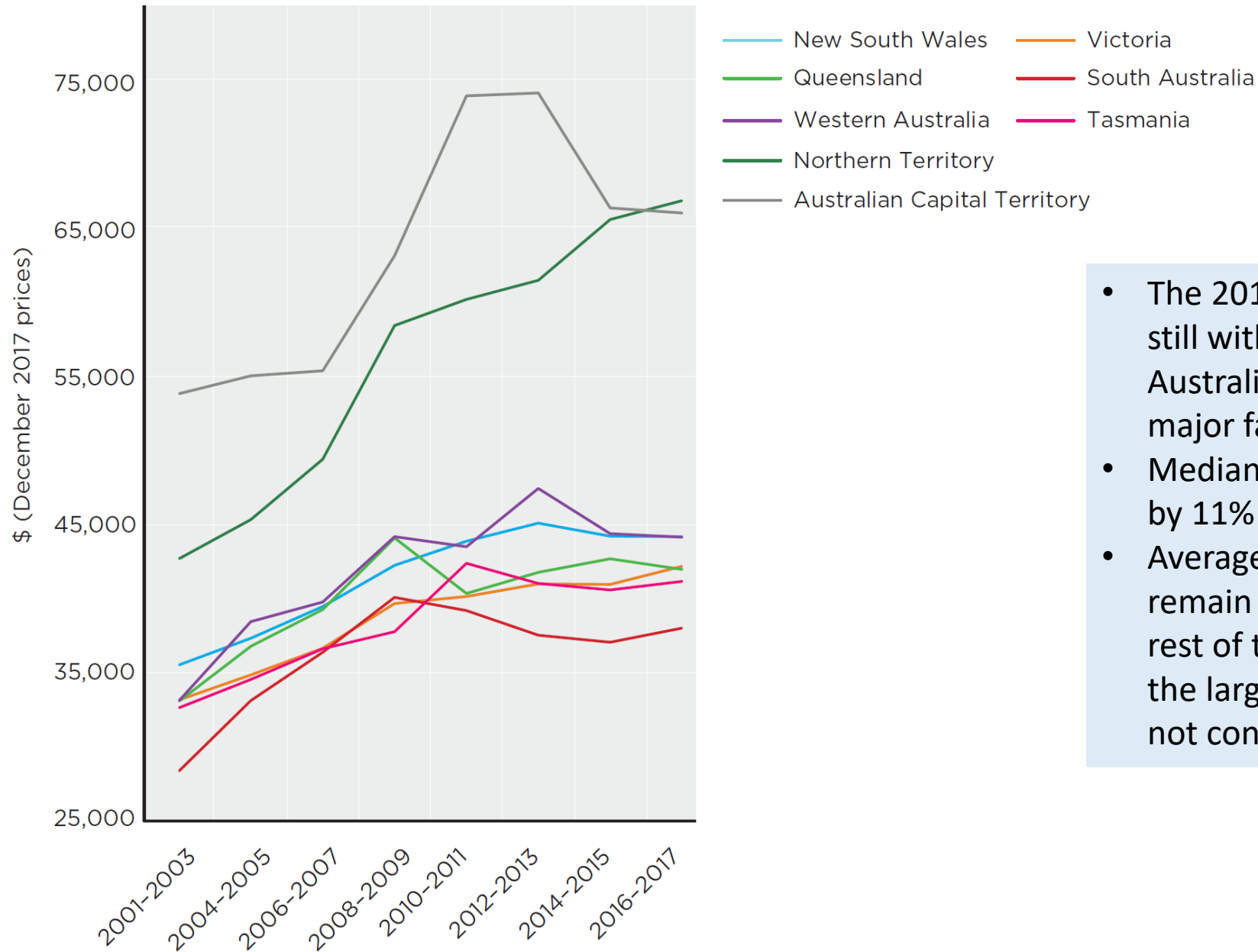
Drivers of change   1. ACT Population
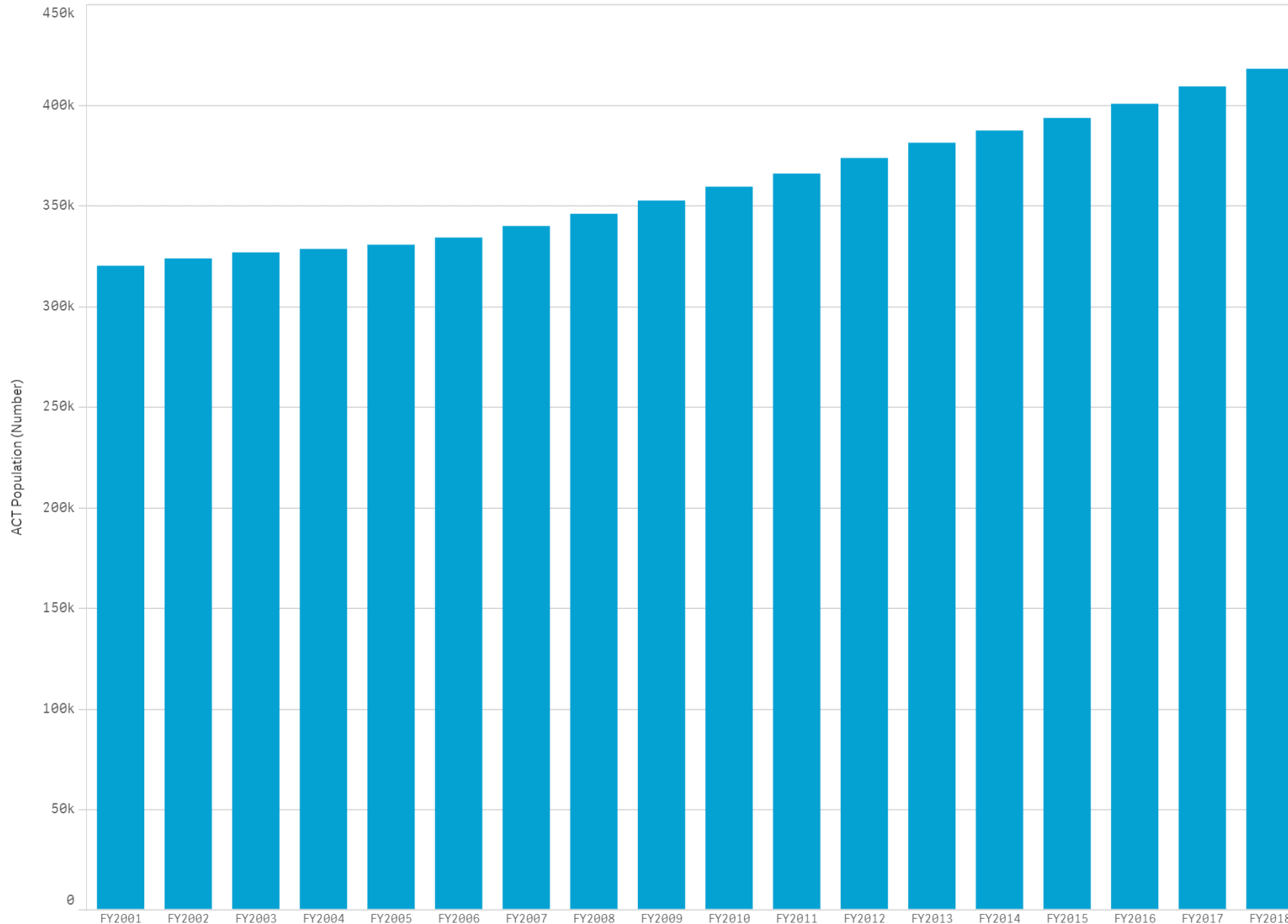
- The steady increase in the ACT population has been an increasing component of overall economic growth.
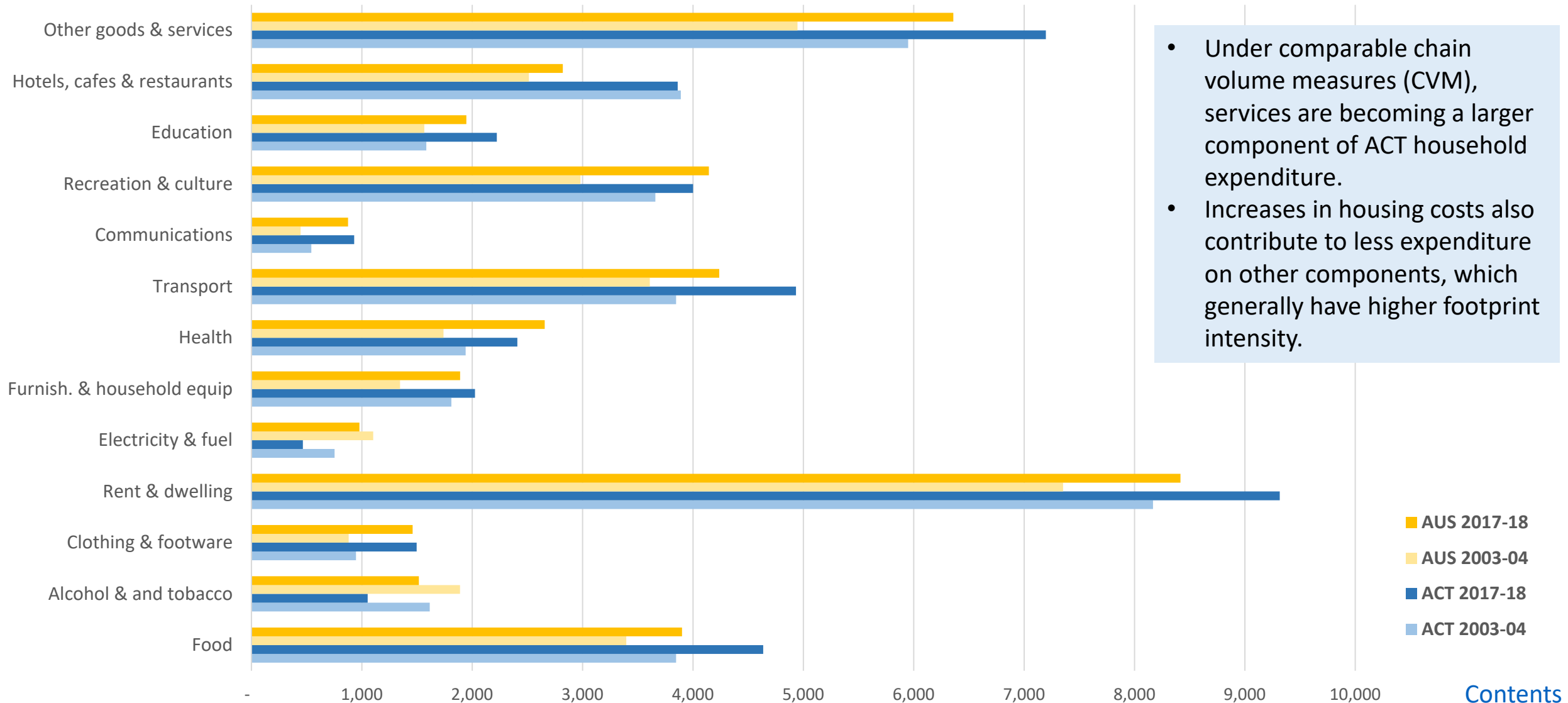- The rate of growth increased from 2007-08.

Drivers of change   2a. Overall expenditure

Total HH FC expenditure (per capita 2016-17 CVM)
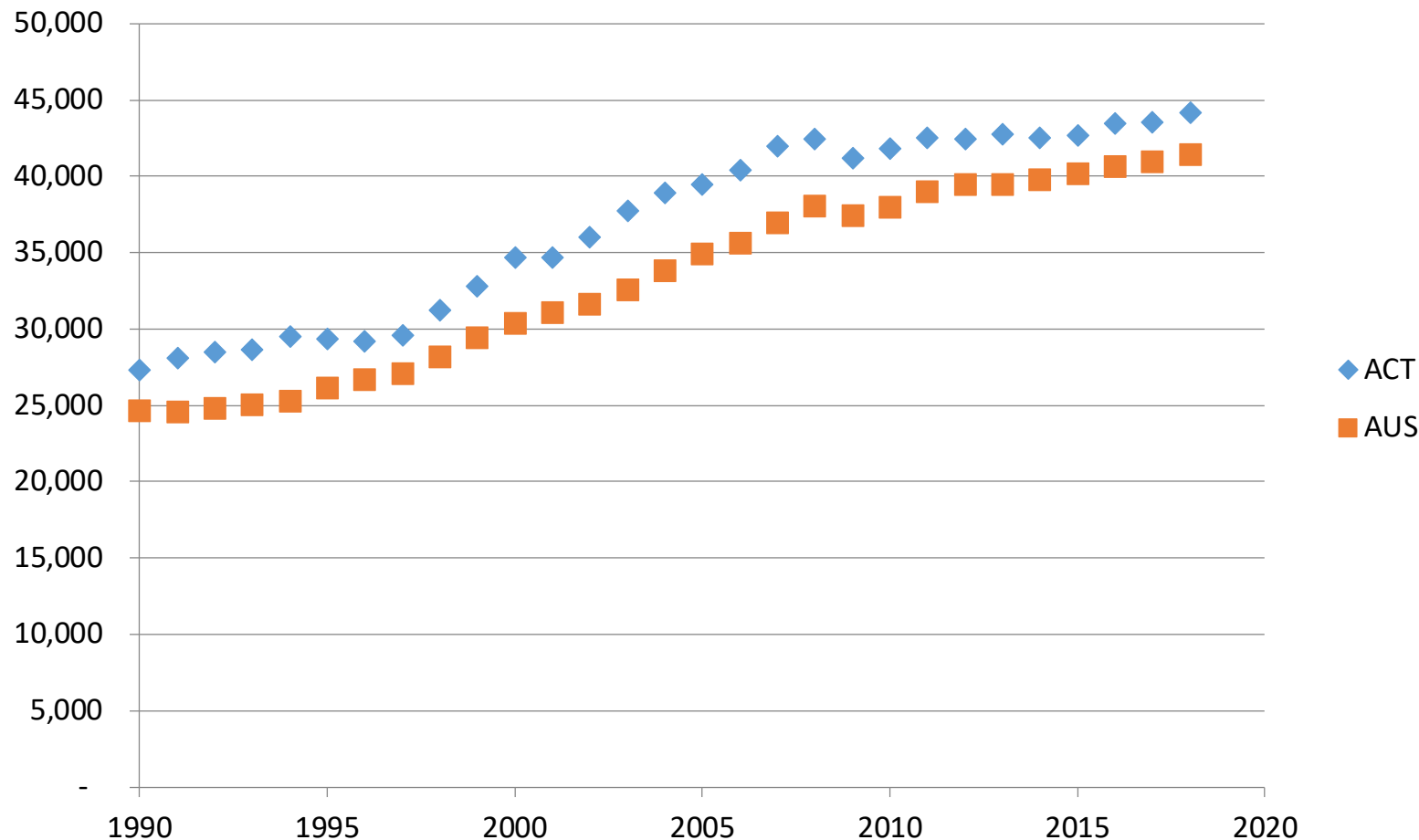
- After a strong increase in ACT household (HH) final consumption (FC) expenditure from the late 1990s, since 2008 there has been a very slow rate of increase in HH FC in the ACT.
- This trend was much smoother in Australia as a whole and has contributed to a substantial lowering of the expenditure gap between the ACT and the rest of Australia in the last 10 years.
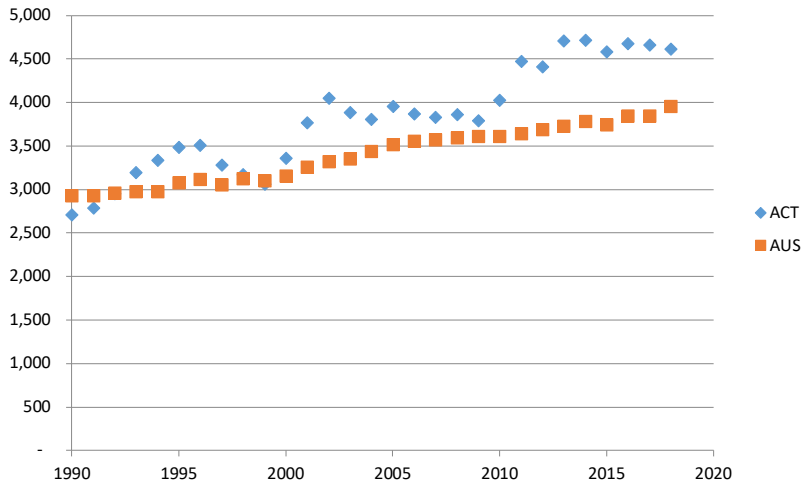- CVM = chain volume measures.

Drivers of change   2b. Median income (HILDA)

- The 2019 HILDA report shows the ACT still with the highest median income in Australia (similar to the NT) but with a major fall from 2011.
- Median equivalised ACT HH income fell by 11% in the four years to 2016-17.
- Average and median income levels still remain high in the ACT compared to the rest of the Australia but it is clear that the large increases in expenditure are not continuing.
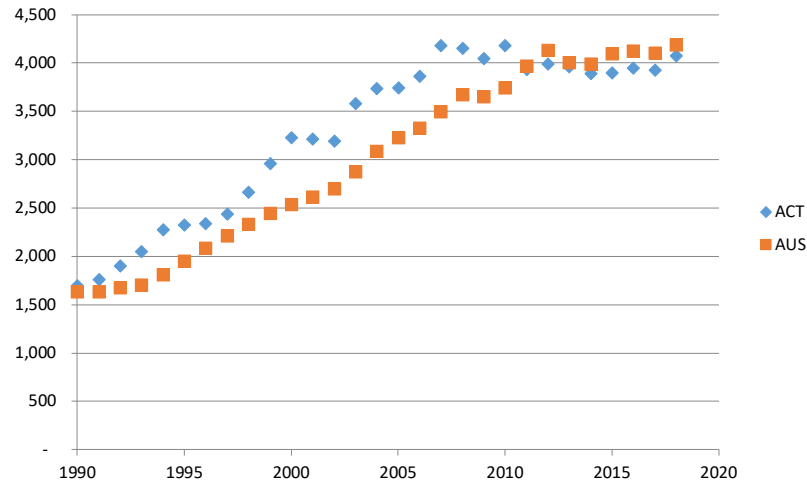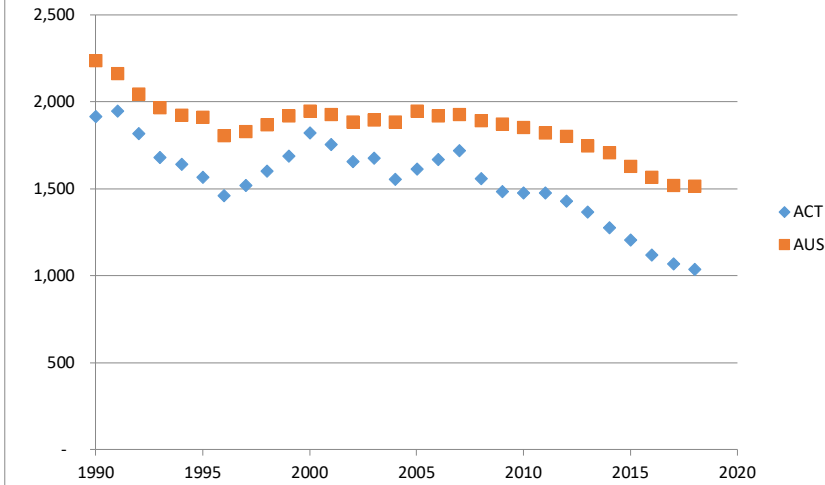
Drivers of change   2c. Expenditure patterns

- Under comparable chain volume measures (CVM), services are becoming a larger component of ACT household expenditure.
- Increases in housing costs also contribute to less expenditure on other components, which generally have higher footprint intensity.

Drivers of change

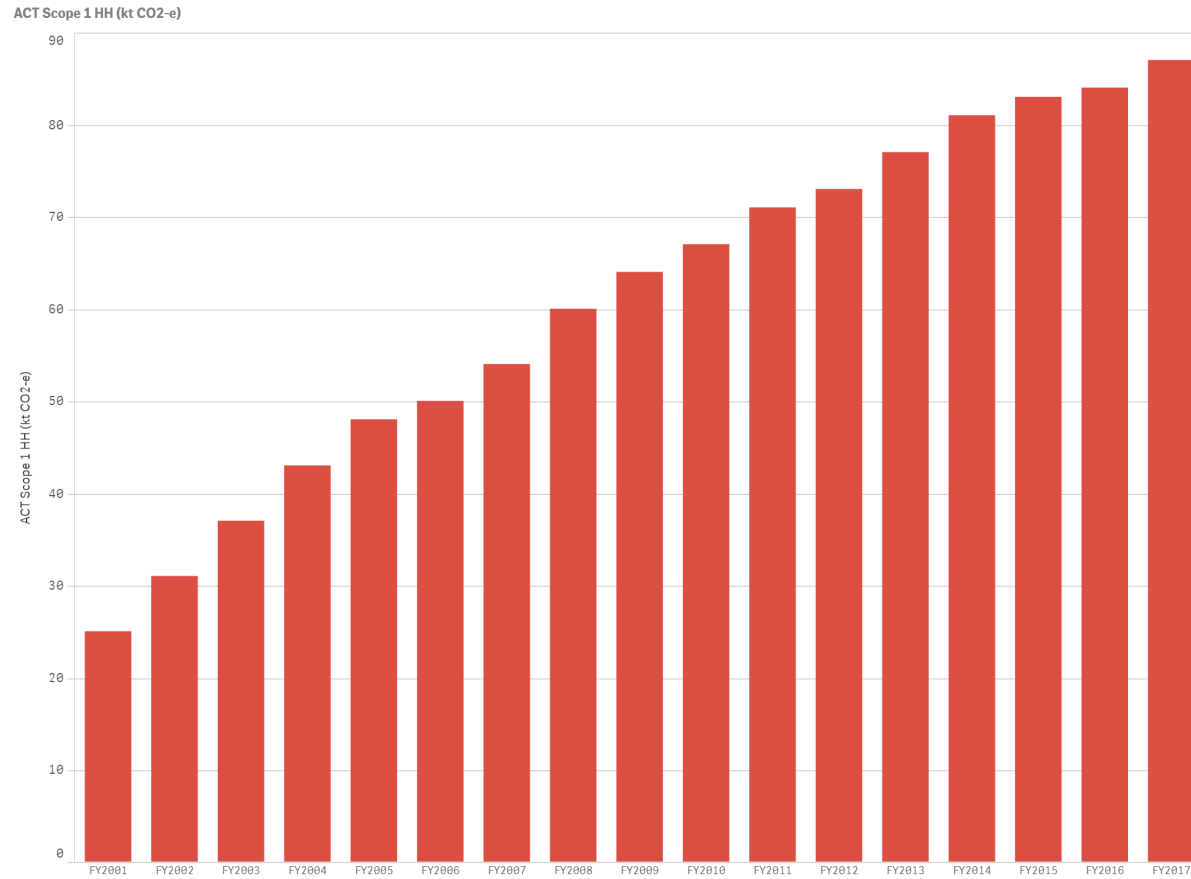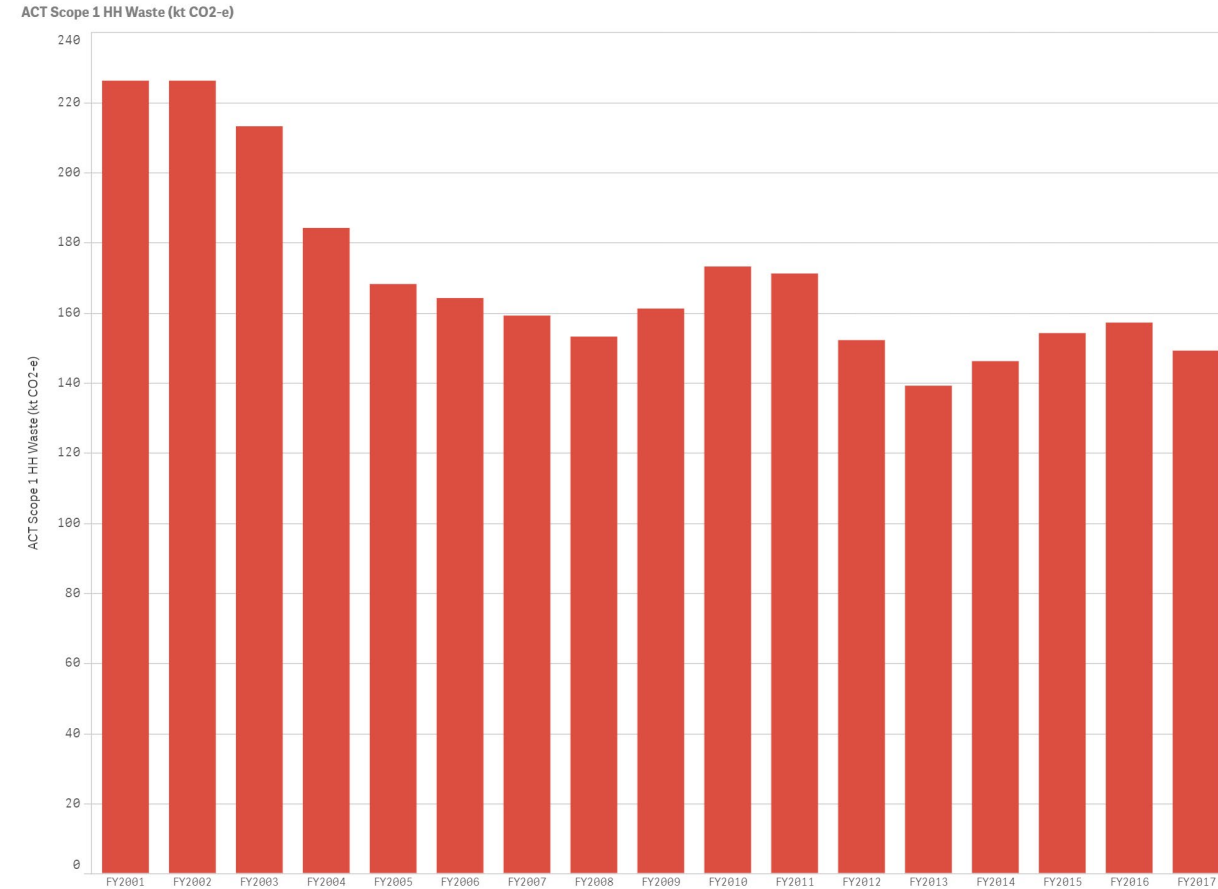# 2d. Expenditure trends

- Under comparable chain volume measures (CVM) there are some major changes in spending trends in the last 10 years.

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Drivers of change   3a. ACT Scope 1 Emissions
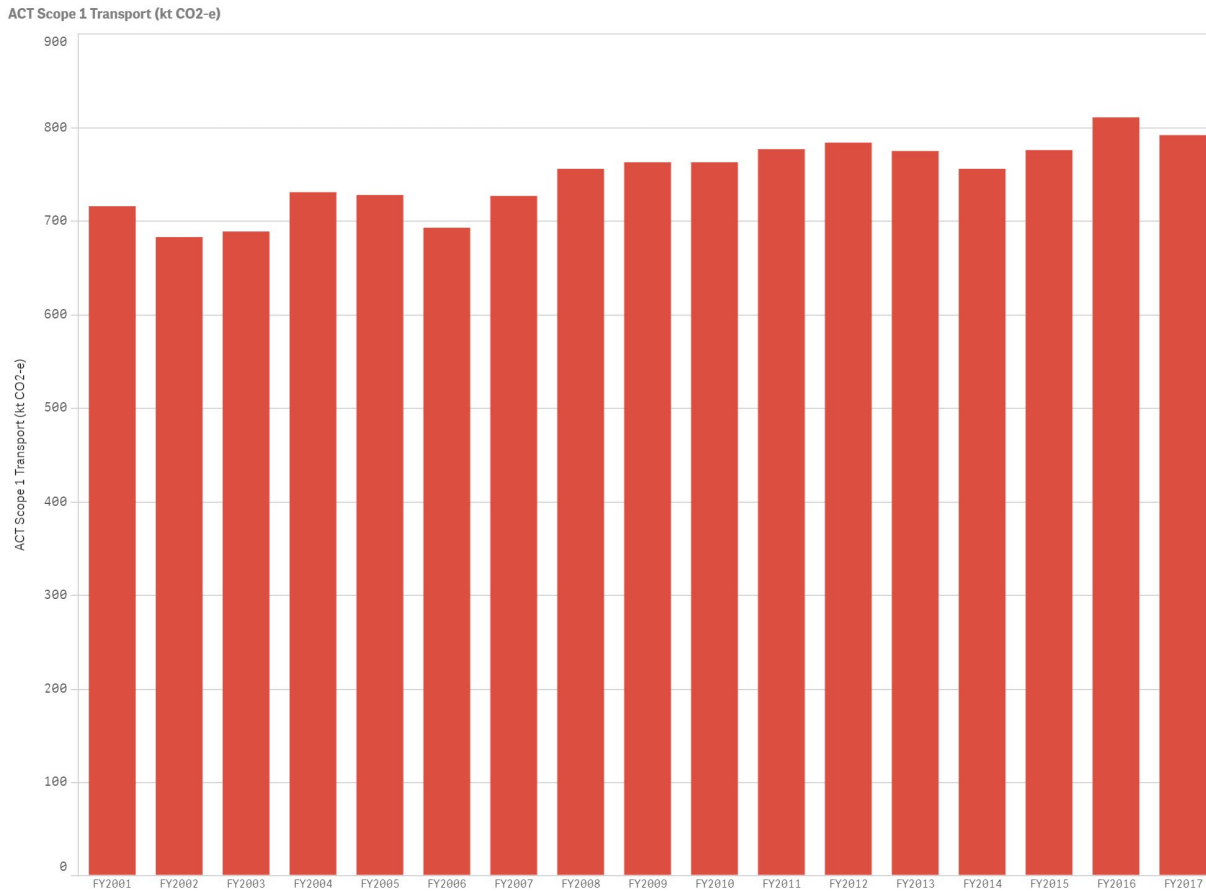

Household direct emissions
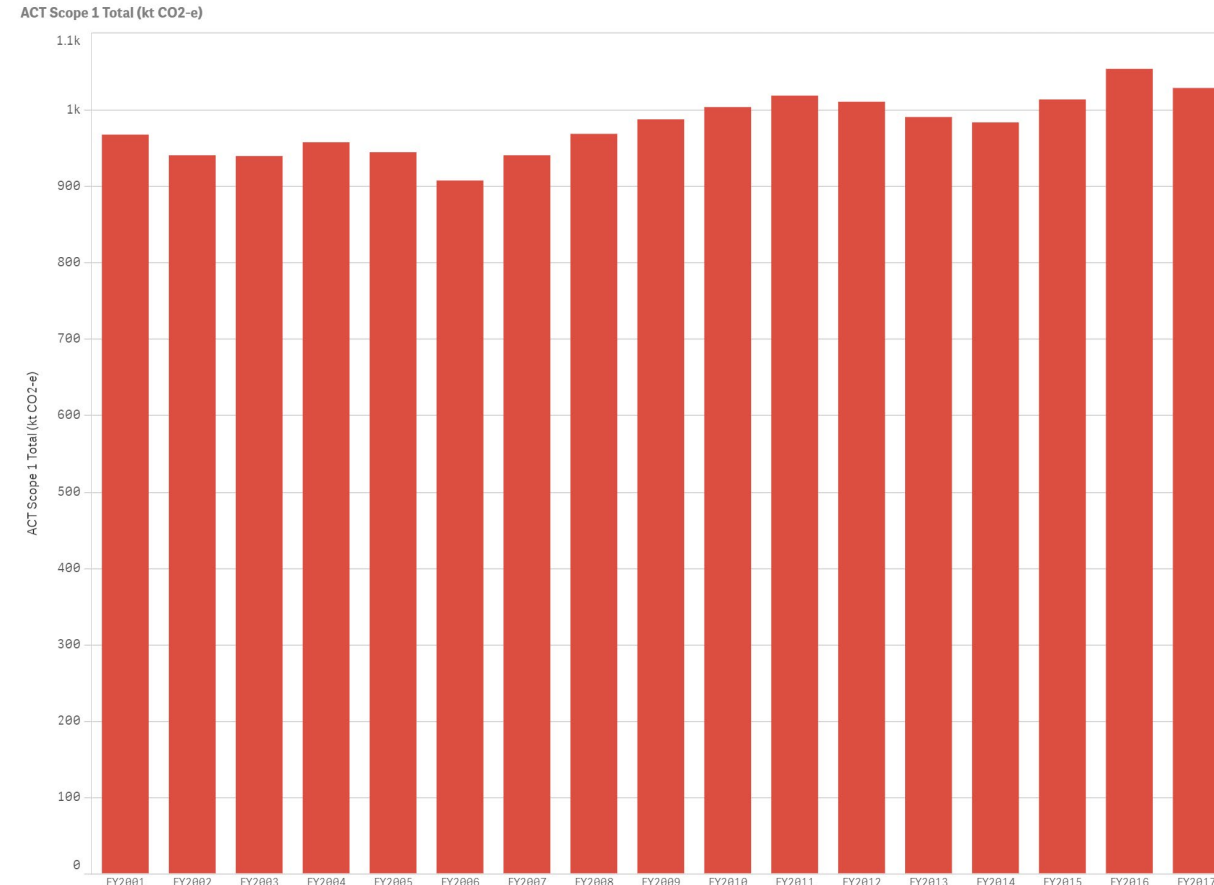
Emissions from waste

Household direct emissions are increasing, but are relatively small.
Waste emissions are also modest and remaining steady.

Drivers of change   3b. ACT Scope 1 Emissions
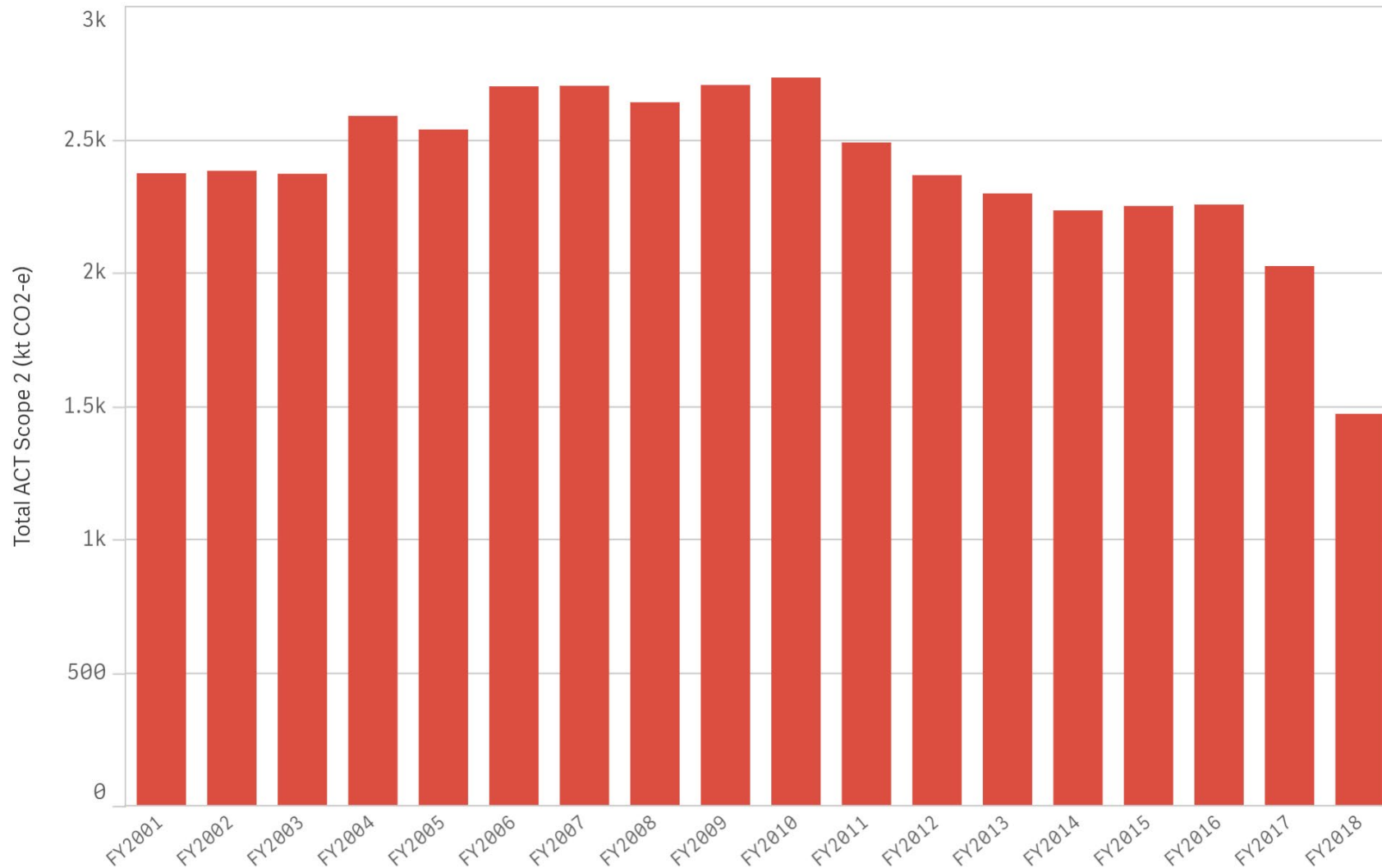

Transport emissions

Overall Scope 1 emissions

Transport-related emissions are the largest component of Scope 1. Despite population growth they have both been fairly stable over the last 10 years.

# Drivers of change   3c. ACT Scope 2 Emissions

Total ACT Scope 2 (kt CO2-e)

- Emissions factor changes in NSW and Victoria first, then secondly the steady increase in renewable electricity supplied (and generated) is leading to a steady fall in ACT electricity-related emissions.
- Especially for 2017-18, this has a clear impact on lowering the CF and EF for the ACT.

Drivers of change   3d. ACT Renewable elect.
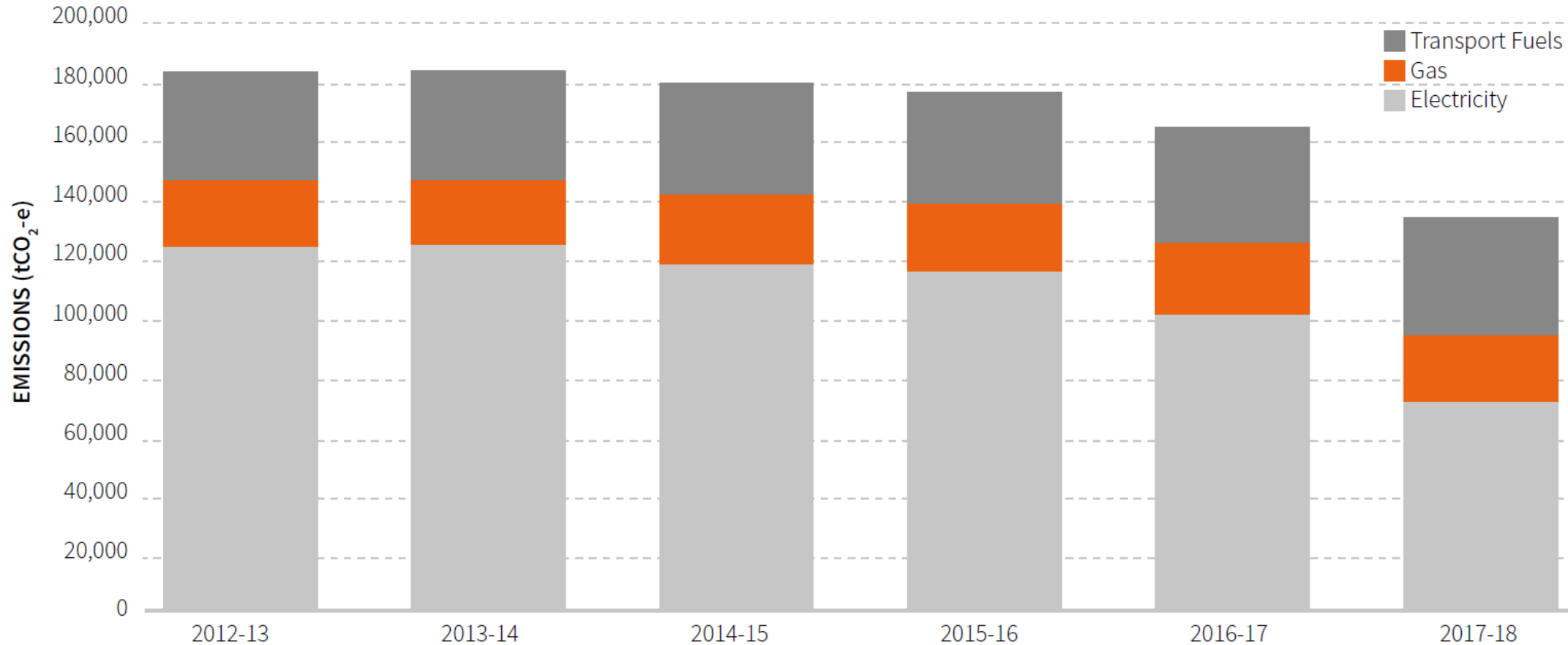
ACT Renewable Electricity (GWh)
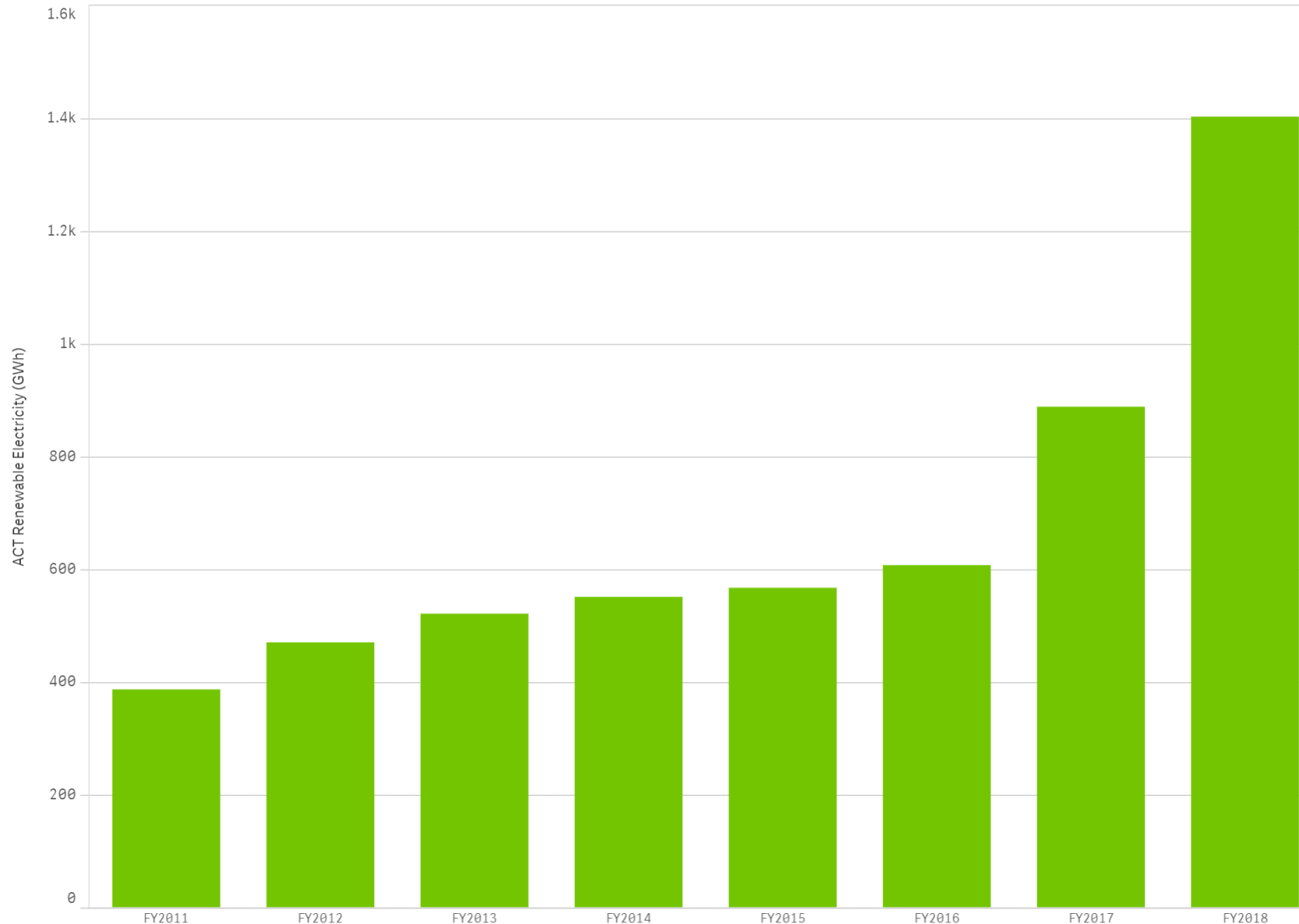
- Approximately half of the ACT electricity was from renewable sources in 2017-18.
- This is anticipated to reach 100% by 2020-21

Drivers of change   4. ACT Govt Emissions

Figure 1: ACT Government greenhouse gas emissions by source from baseline year to 2017–18.

GHG Inventory for the ACT Government – increased renewable capacity after 2015-16.

Drivers of change   5a. Private car use

Private car (G vkm)
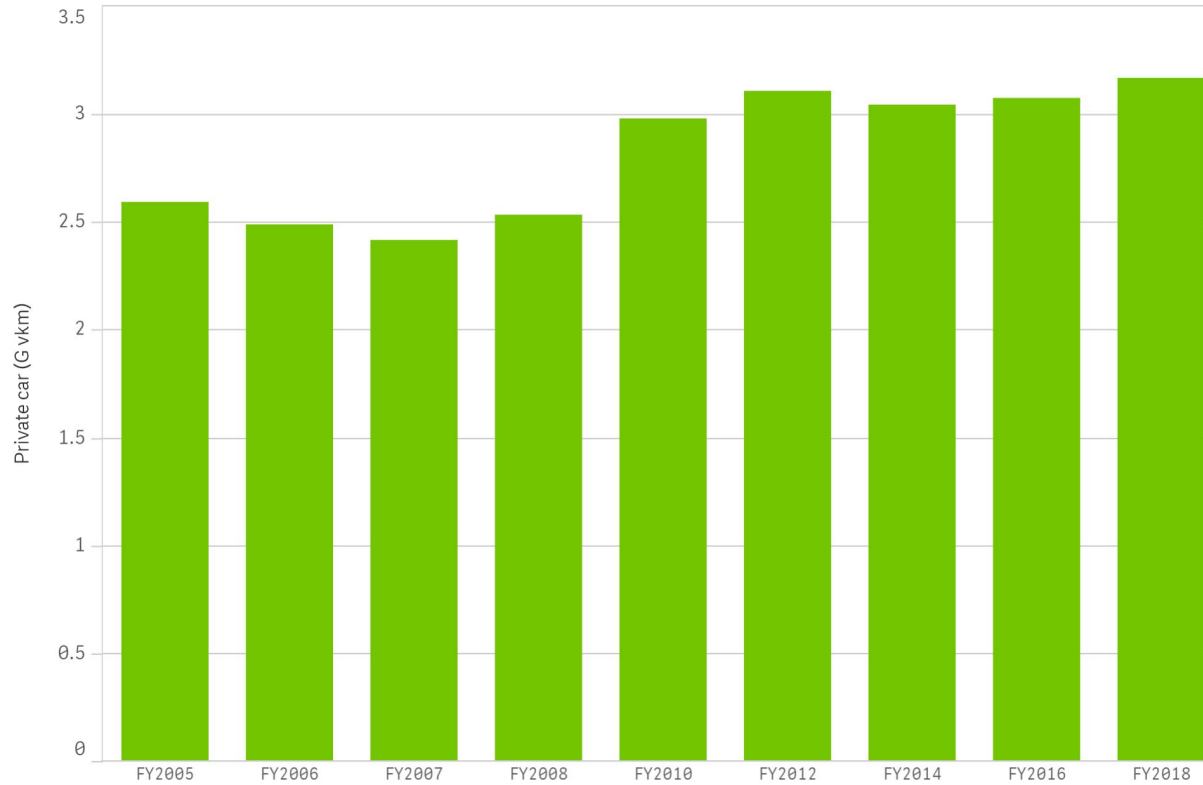
Private car travel (G pkm)
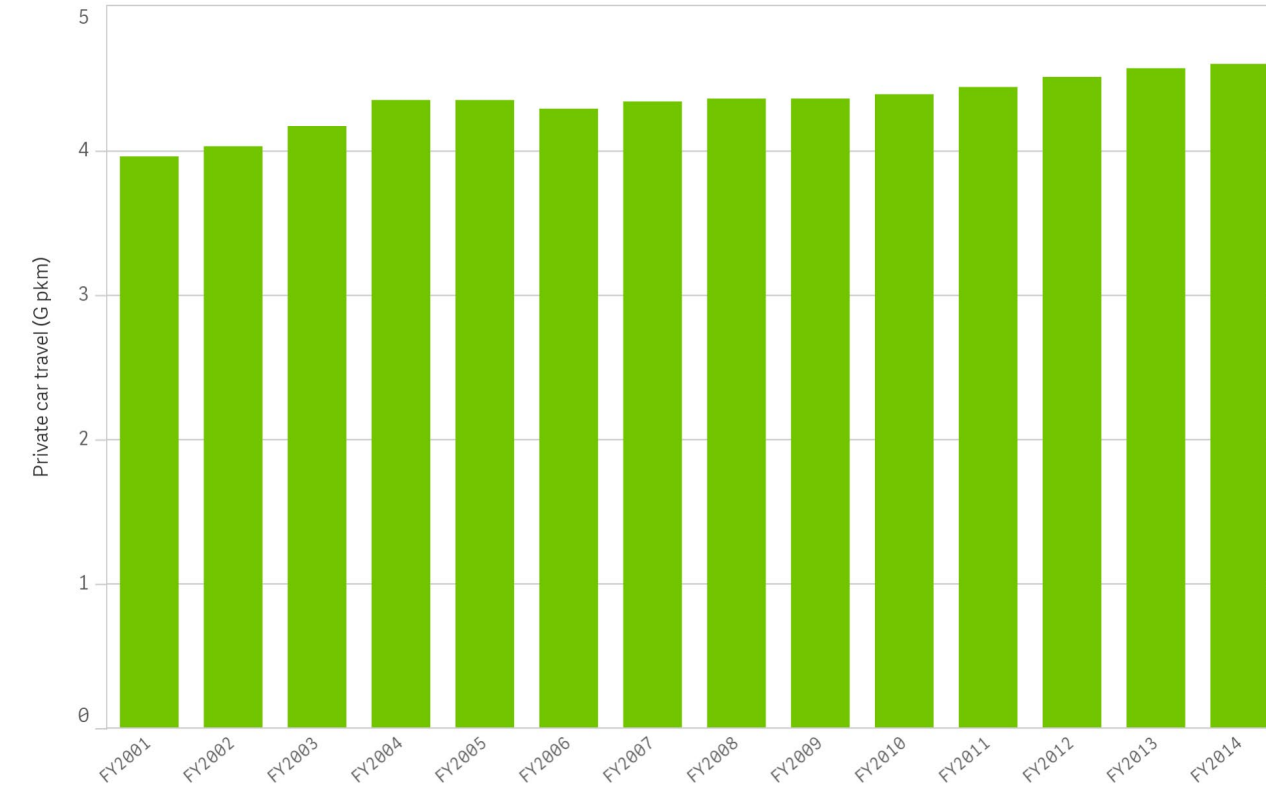
- Private car vehicle-km (left graph) increased slightly between FY16 and FY18.
- Private car passenger-km (right graph) increased steadily between FY04 and FY14.
- This is despite the strong population growth.
- These two graphs can be used to infer an average vehicle occupancy of 1.5.

Drivers of change   5b. Commuting times

Mean daily commuting times of employed persons (minutes)
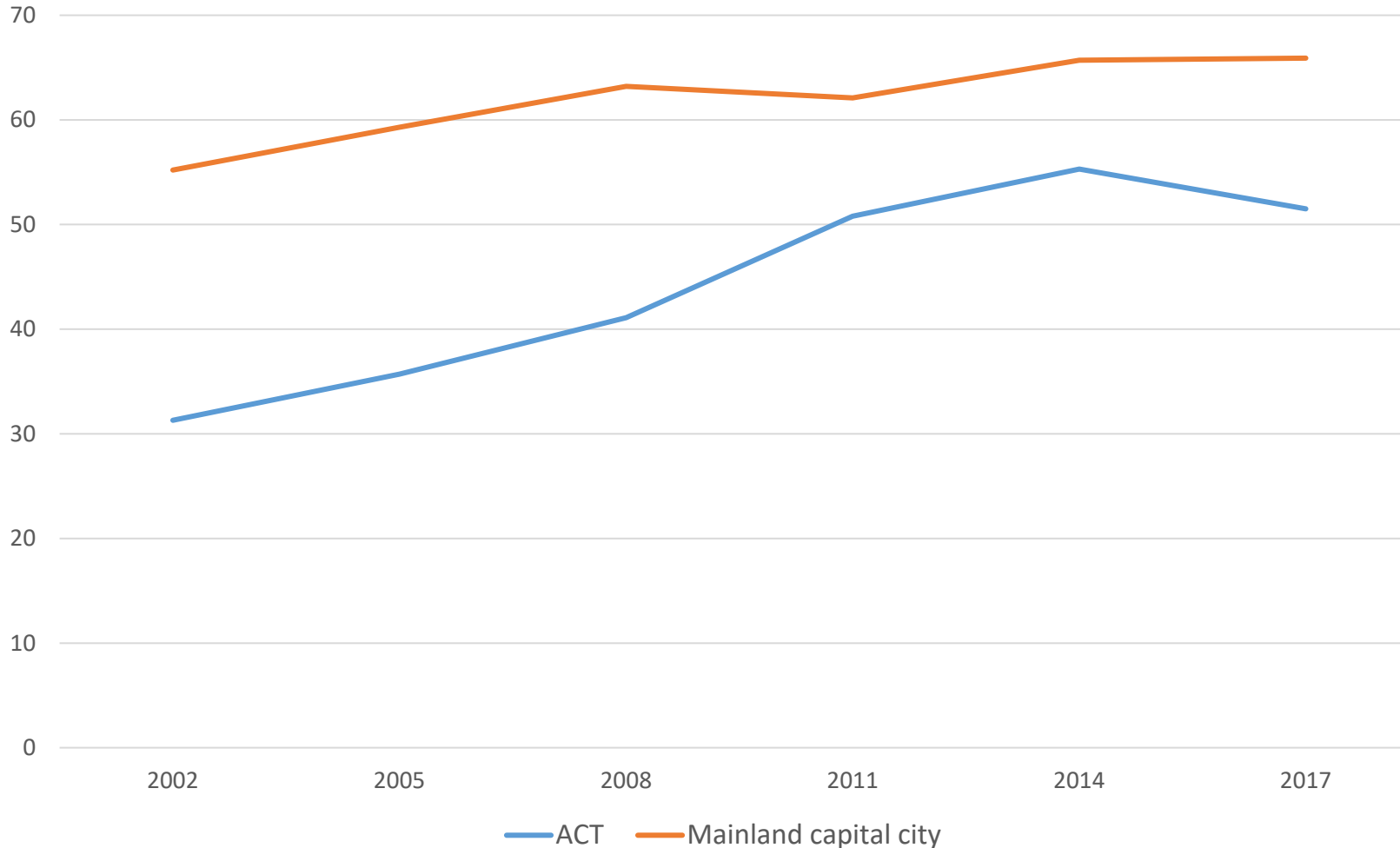
- Between 2002 and 2017 the mean commuting time for ACT employed persons increased by 65%.
- In the other mainland capital cities it increased by only 20%.

Drivers of change 2003-04 to 2017-18 (Summary)

- **Economy-wide**
  - ↓ ↓ much slower increase in real incomes since 2010
  - ↓ fall in the emissions intensity of many Australian industries
  - ↓ changes in Australian land use
  - ↓ ↓ population increases being an increasing part of economic growth
  - ↑ increases in government expenditure and capital (after the GFC), but less so recently

- **Expenditure patterns**
  - ↓ plateauing of expenditure increases (especially for the median household)
  - ↓ further shifts to more expenditure on services (health and education in particular)

- **Energy systems**
  - ↓ accelerating shift of the ACT to renewable electricity

- **Behavioural**
  - ↑ car distances on average have still been increasing (slightly), commuting times significantly
  - ↓ last 2-3 years, some changes in diets
  - ↓ anecdotal evidence for more conscious consumption (next HES will confirm)

Responses

- **Policy**
  - ➢ the significant recent increase in the renewable electricity supply to the ACT is expected to continue to reach 100% within 2-3 years.
  - ➢ with the fall in electricity emissions, emissions from private car travel are now the biggest emissions component. Further policies and inducements to reduce vehicle distances, increase occupancy rates and reduce emissions per v-km are required.

- **Technological**
  - ➢ aggressively targeting private vehicle emissions efficiency, including but not limited to electric vehicles (charged using renewable electricity) is an opportunity.
  - ➢ more locally-produced, and alternative sources of protein with lower footprints, could substantially reduce the overall footprint of the ACT.

- **Personal**
  - ➢ air travel is ~3.5% of the average FY18 ACT carbon footprint (much smaller in the EF), but is growing, driven by people increasingly seeking experiences more than traditional consumption. However it is not clear that the (Swedish) concept of "flygskam" (flight shaming) will be a factor in Australia, due to our relative global isolation and the paucity of effective long-distance transport alternatives.
  - ➢ further behaviour change, education and awareness-raising on "mindful consumption" can be used to target the indirect components of both the ecological and carbon footprints (still the majority contribution).

Results explorer in Qlik

- All results and components of the footprint "engine" are pushed through and visualised using Qlik Sense
- The use of selective filtering reveals important trends and relationships powerfully but intuitively
- Many more results than the ones shown here can be demonstrated on request using Qlik

Further work & vision

- This work here represents a major data integration exercise

- The measurement of consumption footprints could be part of an overall strategy, such as SEEA accounts, built on regional input-output tables

- This will allow both production and consumption based accounting to be done regularly

- The data collection and approach here is built on the most recent database and data-warehousing technology, with results visualised using Qlik Sense

- Such a generalised and integrated approach could be used to address the broader set of Wellbeing Indicators for the ACT

- For comprehensive sustainability accounting, a consistent methodology is required across economic, social and environmental dimensions

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