AUSTRALASIAN RAILWAY ASSOCIATION

# Value of Rail 2020

## The rail industry's contribution to a strong economy and vibrant communities

**Prepared by Deloitte Access Economics**

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# Contents

# Welcome from the CEO

From the early days when our cities and towns were built around the local railway station, the rail industry has been a ubiquitous part of our economy and community. It has long been part of our daily commute, our trade across the country and the growth of our nation. As we look beyond 2020, it is clear rail remains more important than ever.

This year's Value of Rail report highlights the growing role rail is playing in our daily lives. More people rely on a job in the rail industry than they did just a few years ago, as the rise in rail projects attracts new employees across the country.

Demand for passenger services has been steadily rising, as more of us recognise the value of rail as a convenient, affordable and healthy choice to get us to school, work or wherever our lives take us. While many of us stayed closer to home as we rode out the pandemic this year, the long term trends suggest rail will continue to feature heavily in our daily lives over time.

The rail freight sector has continued its essential role underpinning the vitally important mining sector, growing its capacity to support rising demand for our natural resources. The growing national freight task will see the wider freight sector take on a greater role in the coming years, but we must address imbalances in the industry that often favour road over the safer, sustainable choice to use more rail.

Our manufacturing sector has proven a valuable contributor to jobs and skills development, particularly in regional centres. The industry's contribution to regional economies in particular highlights the importance of procurement policies that encourage a single national rail market and prioritise local content and innovation.

As the global community looks to a more sustainable future, rail's contribution to lower emissions, the health of communities and the connectedness of cities has never been more significant. The report's findings on the environmental cost should passengers fail to return to rail transport after the pandemic bring into focus the essential role rail plays in supporting the sustainable future of our cities and towns. This will be an issue that is likely to be of growing importance in the years ahead as the global community works towards a net zero emissions future.

The report shows that, while the face of rail may be different today than a century ago, the intrinsic value it delivers to our community has not diminished. As we move beyond 2020 and prepare for the next wave of rail construction, there is an even greater opportunity for the rail industry to make a difference. With this report we recognise the essential nature of rail, and the further benefits it is set to realise in the future.

**Caroline Wilkie**
Chief Executive Officer
Australasian Railway Association (ARA)

# Executive summary

Rail connects Australians: to each other, to job opportunities and to products and services. Rail carries passengers, transports businesses' goods and is instrumental in Australia's major export industries of coal and iron ore – which account for about 40% of Australia's merchandise exports.

Rail is a significant industry in Australia, creating economic activity through its operations and capital investments. It is an industry with activities across every major metropolitan and regional area and is supported by the full spectrum of skills in the Australian workforce.

In addition, rail plays an important role in enhancing the social and environmental outcomes from transport in Australia. Greater usage of rail can help reduce crashes, carbon emissions and air pollution.

In Australia's major cities, rail also plays a critical role in reducing congestion and making cities more liveable. While 2020 has seen major changes to the role of rail because of COVID-19 policies, forecasts developed for this report reflecting long-term growth highlight that, over time, the sector is likely to continue growing in significance.

In this context, Deloitte Access Economics has been engaged by the Australasian Railway Association to provide a picture of the contribution of rail to the Australian economy as well as its contribution to social and environmental outcomes. This report builds on previous reports by Deloitte Access Economics for the Australasian Railway Association in 2011 and 2017.

While benefits discussed here are considerable, we note that they are only part of the overall picture. There are many factors that affect choices around transport including price, availability, convenience and reliability. This analysis recognises the fact that the benefits to passengers and businesses are not reflected in industry prices and revenue alone. Partly, that is because transport prices are rarely the outcome of demand and supply and often do not include the broader social costs or benefits that are created by transport mode choices. This analysis is intended to fill this gap, by providing some estimates of social costs and benefits of different transport modes that might assist in making decisions and policy.

## The value of rail to the economy

In 2019, the rail industry contributed around $30 billion to the Australian economy and employed more than 165,000 workers (directly and indirectly in full-time equivalent terms, FTE). The industry is made up of around 900 businesses that are located in approximately 20 major hubs.

This overall contribution consisted of $16.1 billion of payments to employees and $13.7 billion in the gross operating surplus (GOS), which are equivalent to profits. The overall contribution represents around 1.5% of the Australian economy.

The value of the rail industry to Australia's economy grew by $3.7 billion since 2016, this is a 14% increase or roughly 4.5% a year. Employment in Australia's rail industry has grown faster, up 16% overall since 2016 – with 20,000 new workers in this time.

In 2019, passenger rail is estimated to have employed around 37,083 FTE workers in Australia, a 35% increase since 2016. Freight rail is estimated to directly employ 21,146 FTE workers in Australia in 2019, this is more than a 50% increase since 2016. Importantly, 56% of these freight jobs are located outside capital city regions with significant clusters in Rockhampton, Newcastle, Mackay and Gladstone.

The rail rolling stock manufacturing and repair industry has a revenue of just over $2.4 billion and a direct value-added of $515 million. In 2019, the rail rolling stock manufacturing and repair industry supported around 4,087 FTE workers, similar to the amount in 2016.

# The value of rail to society

## Passenger

Since 2010, the demand for rail in Australia has been steadily increasing by around 2% each year. In the past 10 years, the largest increase in rail patronage occurred in 2016, as rail patronage grew by 7% nationally. Updated Deloitte Access Economics forecasts predict that patronage could grow by another 16% from 2018 to 2026. This forecast does not take into account the impacts of the COVID-19 pandemic which have seen patronage levels fall significantly in 2020. Instead, this forecast reflects long term trends in the industry.

Rail transport generally generates fewer external costs than other modes of transport. In particular:

- Lower carbon emissions - Every passenger kilometre travelled by rail, instead of car or motorcycle, saves an additional 50 grams of CO2 equivalent being emitted, valued at 5c per journey.
- Lower congestion costs - Every commuter that changes to rail reduces the aggregate travel time across all remaining road users by up to 28 minutes, valued at between $3 and $10, depending on the city.
- Safety benefits from reduced crash costs - Every rail journey that replaces a car trip reduces accident costs by around $1.37.
- The health benefits from increased walking and reduced air pollution - Rail passenger travel generates 75 per cent less PM10 emissions for each kilometre travelled when compared to road travel, valued at 5c a trip. Further, every rail journey generates around $7.00 in health benefits from walking.

If Australia can keep maintaining the increase in the use of trains and trams instead of cars, then a further 20% increase in patronage could result in $1.2 billion in benefits per annum for society in terms of reduced carbon emissions, health benefits from reduced air pollution and more walking, less congestion and reduced road accident costs.

## Freight

Australia's freight task has grown to 759.6 billion net tonne kilometres (ntk) in 2019, an increase of 4.1% since the previous Value of Rail report in 2017. Rail freight is the main contributor to this new growth, accounting for 56% of the change over the period.

Rail freight is forecast to grow by 41% between 2016 and 2030. This equates to an annual growth rate of 2.5%, compared to road and coastal shipping at 2.0% and -0.1%, respectively.[1] Rail freight is expected to account for 72% of the growth in freight over the period, with bulk rail being the major driver.

Particular benefits of rail freight include:

- Lower carbon emissions - Rail freight produces 16 times less carbon pollution than road freight per tonne kilometre travelled, valued at 1c per tonne kilometre.
- Safety benefits from reduced road accident costs - Road accident costs are 20 times higher than rail for every tonne kilometre of freight moved. A single container of freight switched from road to rail, between Sydney and Melbourne, would reduce accident costs by around $109.
- Health benefits from reduced air pollution - Rail freight generates 92% less PM10 than road freight for each tonne kilometre of freight moved, valued at 1c per tonne kilometre.

Overall, for every 1% of the national freight task that moves to rail, there are benefits to society of around $72 million a year.

*1 Rail and road freight pre-COVID-19 forecasts derive from Deloitte Access Economics modelling, while the coastal freight forecasts given in this report are taken from BITRE (2019) Multimodal – Australian aggregate freight forecasts – 2019 update, available at: <https://www.bitre.gov.au/sites/default/files/documents/research_report_152-final.pdf>*

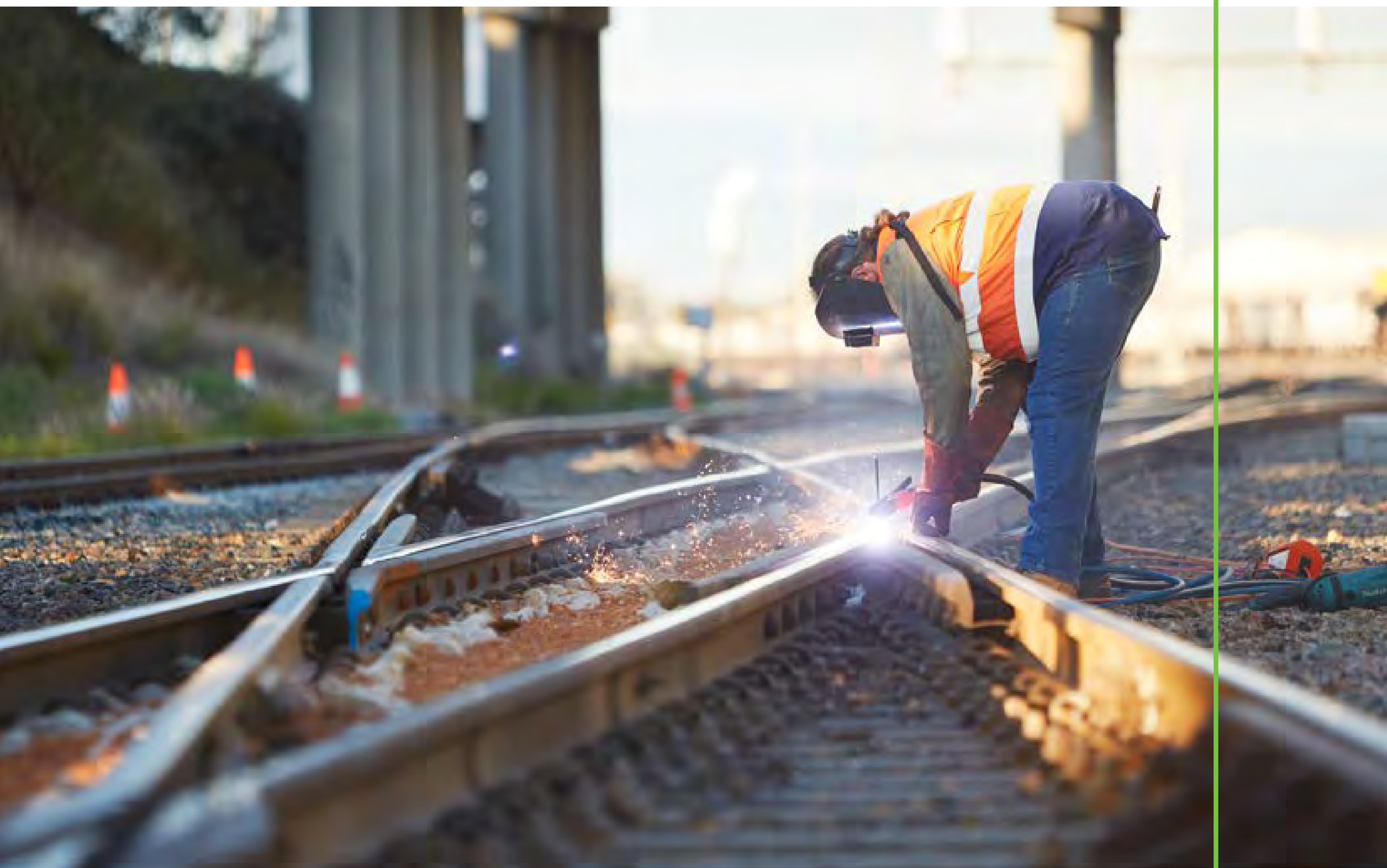
## Future of rail

Rail's ability to increase its economic contribution over time is dependent on the industry growing, adapting and improving, as well as ensuring that government policy enables industry. Based on a review of recent, relevant industry and government reports, there are a number of focus areas for the rail industry to ensure the industry's value is achieved.

- Getting the investment decision right – Capturing the up-to-date benefits identified in this report in decision making processes.
- Getting the price right – Moving towards reflecting social and environmental costs in the prices paid for transport.
- Strengthen opportunities for Australia's domestic manufacturers to compete – A broad based view across procurement, skills and commercial arrangements could help ensure Australia's manufacturing sector has appropriate opportunity to participate over the longer term, particularly in regional areas and high-end technology.
- Re-invigorating harmonisation – Building the implementation of the National Rail Action Plan into the responsibilities of new National Cabinet to ensure successful delivery.
- Using information to benefit the customer in both passenger and freight – Making use of internet of things and real time data analysis to provide better insights for freight customers and rail passengers. This can be one component of a broader range of measures to improve customer experience.

*Deloitte Access Economics*

# 1.
# Introduction



## Deloitte Access Economics has been engaged by the Australasian Railway Association to provide an up-to-date picture of the contribution of rail to the Australian economy.

Rail is both an industry – employing people, generating exports and supporting the Australian economy - as well as a mode of transport which can generate benefits in terms of reductions in congestion, accidents and emissions when compared to other modes of transport. This report builds on previous reports by Deloitte Access Economics for the Australasian Railway Association.

This report considers:

- The contribution of Rail to Australia's economy through its effect on GDP, employment and business activity. This covers both the direct effect and how the supply chain for the rail industry flows through the economy. We look at a broad definition of the rail industry that covers passenger, freight, rail construction, rolling stock manufacturing and repair.
- A number of areas where rail contributes to our quality of life. In technical language, rail reduces the negative externalities, costs borne by society, of undertaking the transport task in Australia. In practical terms this means that rail provides a transport option that helps manage our level of emissions, accidents and congestion – ultimately leading to more sustainable cities and communities.

The benefits considered here are only part of the overall picture. When choosing between road, rail, sea and air transport, passengers and businesses will usually compare the quality of the service (comfort, convenience, reliability, availability etc) against the prices and other costs they incur. We note that in transport, prices are rarely a simple outcome of demand and supply, but instead reflect a mix of costs, market forces and regulatory requirements. What they often don't include are the broader social costs or benefits that are created by transport mode choices. The chapters of this report on passenger and freight transport fill in this gap, providing some estimates of social costs and benefits of different transport modes that might assist in making decisions and policy.

The report concludes with a look at some key areas for focus that would help maximise rail's potential to contribute to our economy, our society and our environment:

- Accurately incorporating social and environmental benefits
- Reflecting differences in social and environmental costs in transport prices
- Strengthening Australia's domestic manufacturing capability
- Re-invigorating harmonisation
- Using information and emerging technologies to benefit the customer in both passenger and freight rail as one component of improving customer experience overall.

# 2.
# The value of rail to the economy

## Australia's rail industry is large

Rail connects Australians: to each other, to job opportunities and to products and services. In 2019, the rail industry contributed more than $29.8 billion to the Australian economy and employed more than 165,000 workers (in full-time equivalent terms, FTE) (Figure 2.1). This represents around 1.5% of the Australian economy.

This overall contribution consisted of $16.1 billion of payments to employees and $13.7 billion in the gross operating surplus (GOS), which are equivalent to profits.

Economic contribution studies provide a snapshot of an industry's role in the economy at a given point in time. The snapshot is based on tracing the linkages between the businesses in the industry itself and businesses across the wider economy. We can identify both the direct impact of the industry in the economy and the flow-on indirect contribution that occurs from the industry's connections to the rest of the economy.

An economic contribution study is undertaken using Input-Output (IO) modelling. The approach used to estimate the contribution of the rail is detailed in Appendix A. The approach used is consistent with the framework used by the Australian Bureau of Statistics (ABS) in compiling the Australian National Accounts.

The overall economic contribution comes through two measures:

- directly, through the industry's operations; and
- indirectly, as the impact of its economic activities filters through the economy.

The direct contribution of the rail industry of $15.1 billion occurs through the wages paid to workers as well as the profits from operations.[2] This includes the manufacturing and repair of rolling stock as well as the construction of railways and the operations of passenger and freight rail. Of this, $8.4 billion was in the form of wages to workers and $6.8 billion accrued as GOS to owners of capital. In 2019, it is estimated that the rail industry directly employed 71,442 FTE workers.

The indirect contribution of $14.7 billion measures the amount of upstream activity that rail generates in Australia's industries. For example, a rail operator might purchase telecommunications equipment for their network, which would increase demand for telecommunications equipment manufacturers, who would, in turn, demand plastics, metals and other inputs to make the equipment. In 2019, through the rail industry's purchase of intermediate goods, it created $14.7 billion in indirect value-added in upstream industries. This consisted of $7.7 billion in labour income and $6.9 billion in GOS. In total, this supported an estimated 93,979 FTE workers.

**Figure 2.1: The economic contribution of the rail industry, 2019**

| | Wages | Gross Operating Surplus | GDP | Employment |
|---|---|---|---|---|
| Direct contribution | $8.4 billion | $6.8 billion | $15.1 billion | 71,442 FTE |
| | + | + | + | + |
| Indirect contribution | $7.7 billion | $6.9 billion | $14.7 billion | 93,979 FTE |
| **Total** | **$16.1 billion** | **$13.7 billion** | **$29.8 billion** | **165,420 FTE** |

*Source: Deloitte Access Economics IO models based on ABS cat. 5209.0.55.001*

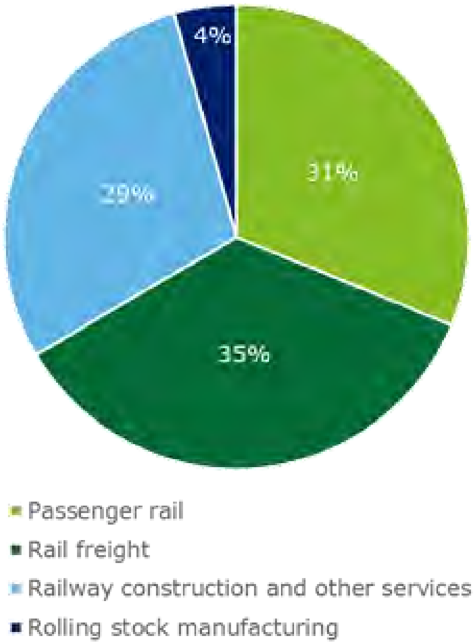
2 *This analysis does not include the overall net subsidy rail transport receives from the government.*

Of the overall direct contribution of $15.1 billion, freight rail contributes the largest share (35%), followed by passenger rail (31%). Due to the structure of the IO table categories, it is not possible to directly break down these sectors into more detailed segments.

Given that more than 90% of freight is bulk freight (coal, grains and iron-ore), bulk freight rail is likely to make up a significant portion of the direct contribution of freight rail. Similarly, for passenger rail, heavy rail is assumed to make up a significant portion of the direct contribution as 727 million of the 962 million passenger journeys made in 2018 were on heavy rail.[3]

The group of related industries in rail construction and other services makes up 29% of the industry with rolling stock manufacturing and repair making up the final 4% of the industry.

**Figure 2.2: Share of direct contribution by industry sector**




*Source: Deloitte Access Economics IO models based on ABS cat. 5209.0.55.001*

3 *BITRE (2019) Trainline 007, available at: <https://www.bitre.gov.au/sites/default/files/publications/train_007.pdf>*

## Rail's contribution is growing

### The value of the rail industry to Australia's economy grew by $3.7 billion since 2016, representing a 14% increase or roughly 4.5% a year.

Around half of this growth ($1.8 billion) is comprised of the direct contribution of rail, which is reflective of the growth of the rail industry over the past 3-4 years. Employment in Australia's rail industry has grown quickly and is up 16% since 2016 – with 20,000 new workers.

To put these figures into context, hypothetically, if the rail industry was a single organisation it would be the third-largest employer in Australia (only beaten by Wesfarmers and Woolworths) and in the top 10 firms in terms of revenue (ranking just behind Telstra).

Figure 2.3 shows that the increase in the direct contribution since 2016 is driven by the large growth in employees and wages, which grew by $1.6 billion (24%). This increase in wages is correlated with the 33% increase in full-time equivalent (FTE) employees in the rail industry since 2016.

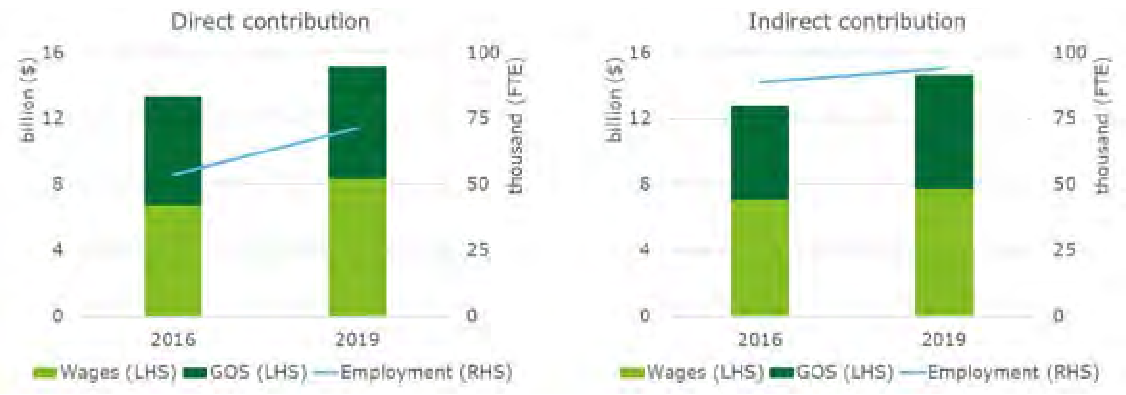
A part of this growth comes from the growth in railway construction. Since the last report in 2016, there have been many high-value rail projects planned and delivered, shown in Figure 2.4. In particular, major rail construction projects during this period included Queensland's Moreton Bay Rail Link, New South Wales' North-West Metro and CBD light rail and Victoria's Dandenong Rail Corridor. There have also been several large road projects delivered at around the same time. With many large rail and road projects, there has been increased competition for heavy construction skills and subsequent increases in the costs for these heavy and civil engineering services.

**Table 2.3: The economic contribution of the rail industry-comparison between 2019 and 2016**

| | Direct | Change since 2016 | Indirect | Change since 2016 | Total | Change since 2016 |
|---|---|---|---|---|---|---|
| *Wages ($billion)* | 8.4 | 24% | 7.7 | 10% | 16.1 | 17% |
| *GOS ($billion)* | 6.8 | 3% | 6.9 | 21% | 13.7 | 12% |
| ***Value-added ($billion)*** | **15.1** | **14%** | **14.7** | **15%** | **29.8** | **14%** |
| *Employment ('000s FTE)* | 71.4 | 33% | 94.0 | 6% | 165.4 | 16% |

*Source: Deloitte Access Economics IO models based on ABS cat. 5209.0.55.001*

**Figure 2.4: Comparison of direct and indirect contribution between 2016 and 2019**



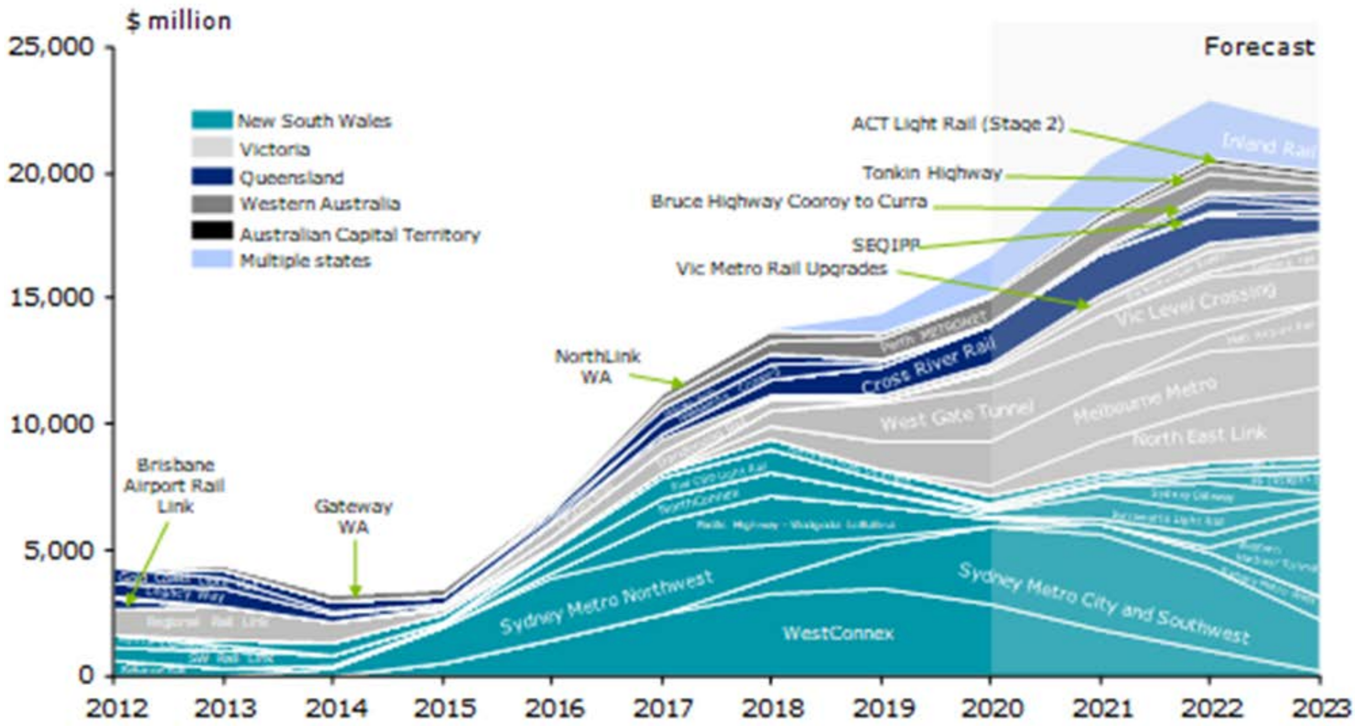

*Source: Deloitte Access Economics IO models based on ABS cat. 5209.0.55.001*

Major heavy and civil engineering construction is forecast to keep growing in the rail industry for the next few years. Projects such as the various stages of Sydney Metro, Melbourne Metro, Inland Rail and Brisbane's Cross River Rail are all under construction. This continued growth of major rail projects will contribute to the continued growth of the rail industry.

The other half of this growth ($1.9 billion) comes from the indirect contribution. The growth in the indirect contribution of the rail industry is driven by a $1.2 billion increase in industries supported by rail.

Figure 2.5 shows this is largely driven by the high investment in rail infrastructure in 2019 resulting in increased activity in the construction, property operators and finance industries. This reflects the intensive increase in rail capital investment in the past few years and the mix of services that are required to deliver these large projects.

**Figure 2.5: Deloitte's Investment Monitor for road and rail projects worth more than $1bn**



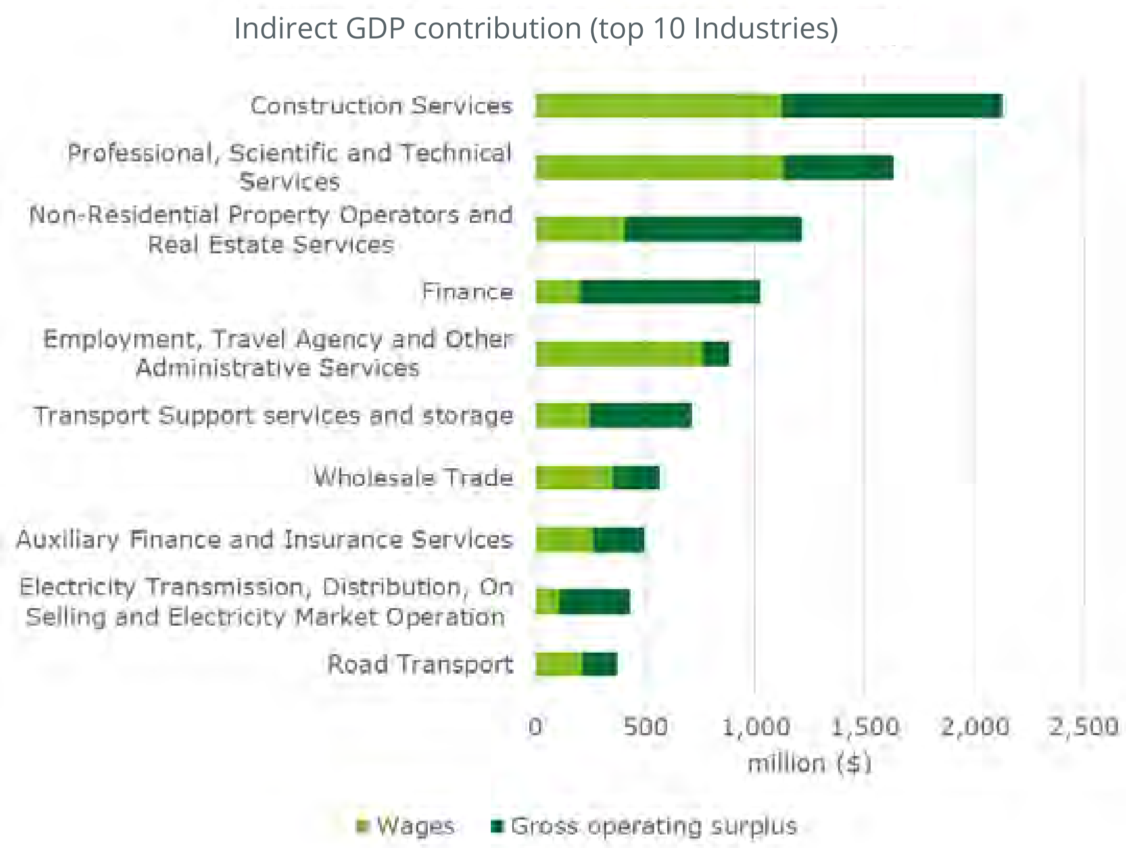

*Source: Deloitte Access Economics*

Construction services make up 15% of the total indirect contribution of rail. These businesses include land development and subdivision, site preparation services, electrical services and the hiring of construction machinery with operators. These services support construction in major rail projects as they facilitate land development and associated services.

Non-Residential Property Operators and Real Estate services make up 8% of the total indirect contribution of rail. These businesses include the renting or leasing of agricultural land, commercial or industrial property and warehouses. Rail companies use these services to rent their office spaces, industrial areas and warehouses and in organising the acquisition of land for new projects.

Finance services make up 8% of the total indirect contribution of rail. These businesses provide services such as banking, financing and investment. They arrange the debt and equity for acquiring the capital for these major rail heavy and civil engineering construction projects. While rail investment makes up a small component of the finance industry, finance is an important part of the rail industry, especially for individual rail operators managing capital investments day-to-day and for funding major rail projects.

**Figure 2.6: Indirect value-added of rail to the top 10 industries supporting rail, 2019**



## The direct contribution of passenger rail

Passenger rail is a key component of how many people travel around Australia, especially in urban areas.

In 2017-18, more than 1 billion passenger journeys were completed on urban and non-urban rail,[4] meaning that pre-COVID-19, an average of 3.5 million passenger journeys are made in Australia each weekday.

The input-output analysis indicates that Australian households spent more than $4.2 billion on rail transport.[5] This means passenger rail accounts for about 31% of the total direct contribution of the rail industry.

In 2019, passenger rail is estimated to have employed around 37,083 FTE workers in Australia, a 35% increase since 2016. The passenger rail industry represents a slight majority of rail employment in Australia.[6] ABS Census data confirms these jobs are clustered around the major state capitals, with Brisbane, Sydney and Melbourne accounting for 93% of total passenger rail employment.[7] Although Tasmania does not operate passenger rail networks for the purposes of transit, there are some historical trains tailored for tourists to the area, employing a total of 116 Tasmanians in 2016.

**Figure 2.7: Top 10 regional passenger rail employment clusters in Australia**


*Source: ABS Census (2016)*

*4 BITRE (2019) Trainline 007, available at: <https://www.bitre.gov.au/sites/default/files/publications/train_007.pdf>*
*5 The ABS IO tables do not distinguish between passenger and freight rail. It was assumed that all spending by industry (rather than consumers) on rail transport is freight-related as movement of employees via rail is negligible economic activity and therefore the total household consumption amount would be a good indicator of the value of passenger rail. Note that these numbers reflect the spend in 2016-17 rather than 2019 as these numbers are taken directly out of the latest IO table and therefore has not been modelled to be the 2019 figures.*
*6 ABS Census (2016) Place Of Work (POW) ANZSIC Industry Data*
*7 Ibid*

## The direct contribution of rail freight

Rail plays a vital role in Australia's freight movements. Freight rail excels in moving bulk commodities (e.g. grains, timber, iron ore and coal), facilitating a significant proportion of Australia's agricultural and mining exports from regional areas to coastal ports.

Rail freight is a key input for many Australian industries, which collectively spend nearly $4.7 billion on rail transport,[8] an increase 43% since the previous report.

This increase is fundamentally driven in large part by the ongoing growth of Australia's freight task overall, which grew by 4.1% since the previous report and is associated with strong population and economic growth. However, the strong growth in the contribution of rail freight has largely come from the bulk rail sector with a smaller contribution from containerised freight.

The mining industry is still the largest user of freight rail, spending $1.5 billion on rail transport. The metal manufacturing industries together spent a further $500 million, while the wholesale and retail trade industry spent $570 million. Agricultural industries spent $87 million on freight rail.

Freight rail is estimated to directly employ 21,146 FTE workers in Australia in 2019, a more than 50% increase since 2016.[9] Importantly, as Figure 2.8 shows, 56% of these jobs are located outside capital city regions with significant clusters in Rockhampton, Newcastle, Mackay and Gladstone.[10]

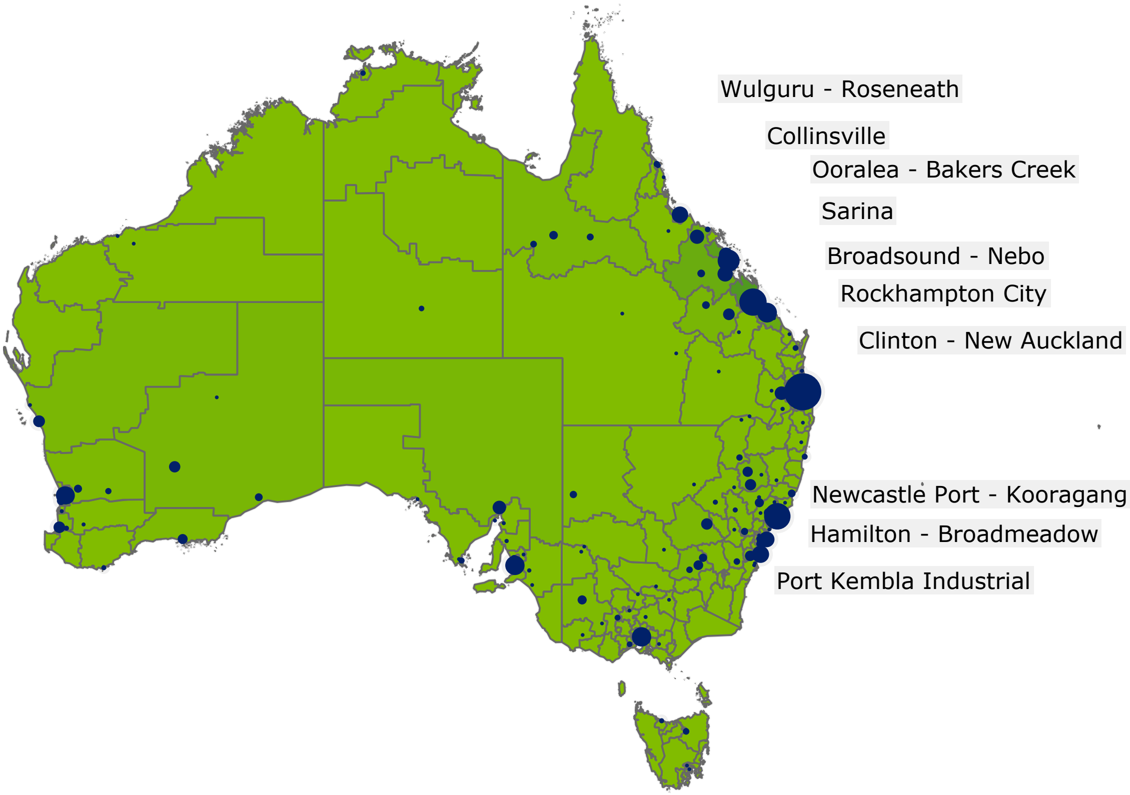
**Table 2.2: Major regional employment hubs for rail freight by SA2 and SA3[11, 12]**

| SA2 | SA3 | Jobs |
|---|---|---|
| Rockhampton City | Rockhampton | 419 |
| Newcastle Port - Kooragang | Newcastle | 393 |
| Sarina | Mackay | 268 |
| Hamilton - Broadmeadow | Newcastle | 215 |
| Clinton - New Auckland | Gladstone | 215 |
| Port Kembla Industrial | Dapto - Port Kembla | 161 |
| Wulguru - Roseneath | Townsville | 148 |
| Broadsound - Nebo | Bowen Basin - North | 127 |
| Collinsville | Bowen Basin - North | 110 |
| Ooralea - Bakers Creek | Mackay | 108 |

*Source: ABS Census (2016)*

*8 The ABS IO tables do not distinguish between passenger and freight rail. It was assumed that all spending by industry (rather than consumers) on rail transport is freight-related as movement of employees via rail is negligible economic activity. Note that these numbers reflect the spend in 2016-17 rather than 2019 as these numbers are taken directly out of the latest IO table and therefore has not been modelled to be the 2019 figures.*
*9 Ibid*
*10 ABS Census (2016) Place Of Work (POW) ANZSIC Industry Data*
*11 Ibid*
*12 Statistical Area Level 2 and 3 are geographic levels used by ABS for data collection based on population size. SA2s have a population range of 3,000 to 25,000 persons, and have an average population of about 10,000 persons, while SA3s generally have populations between 30,000 and 130,000 persons.*

**Figure 2.8: Top 10 rail freight employment clusters in Australia**




*Source: ABS Census (2016)*

## Contribution of rolling stock manufacturing and repair

The rail rolling stock manufacturing and repair industry has revenue of just over $2.4 billion and a direct value-added of $515 million.

In 2019, the rail rolling stock manufacturing and repair industry supported around 4,087 FTE workers, similar to the amount in 2016. For every one million dollars spent by the rolling stock manufacturing and repair industry, around 1.32 (direct and indirect) FTE roles are generated.

The rail rolling stock manufacturing and repair industry spends five times more on intermediate inputs than wages, whereas the average across the entire economy is closer to two times. For example, it spends more than $300 million on intermediate inputs from the structural metal product manufacturing industry and professional, scientific and technical services industry.

The rail rolling stock manufacturing and repair industry's expenditure on intermediate inputs also boosts employment, especially for labour-intensive industries such as iron and steel manufacturing industry. This shows that rail rolling stock manufacturing can play a significant role in boosting activity all along the supply chain.

Rolling stock manufacturing accounts for 11% of rail employment in Australia.[14] As shown in Figure 2.9, employment is largely concentrated in the Sydney and Melbourne metropolitan areas, which together account for 50% of the national total but tends to be in outer-metropolitan areas. The main non-capital city employment bases can be found in Newcastle, Maryborough and Lake Macquarie.[15]

Dandenong is the leading employment location for rolling stock manufacturing and repair services within Victoria, with a count of 286 employees in the ABS Census, or 36% of rolling stock manufacturing and repair services employment in Victoria. A major industry employer in the region is Bombardier, a multinational firm who designs, engineers, manufactures and maintains rolling stock across Australia but whose operations and manufacturing headquarters are based in the Dandenong.

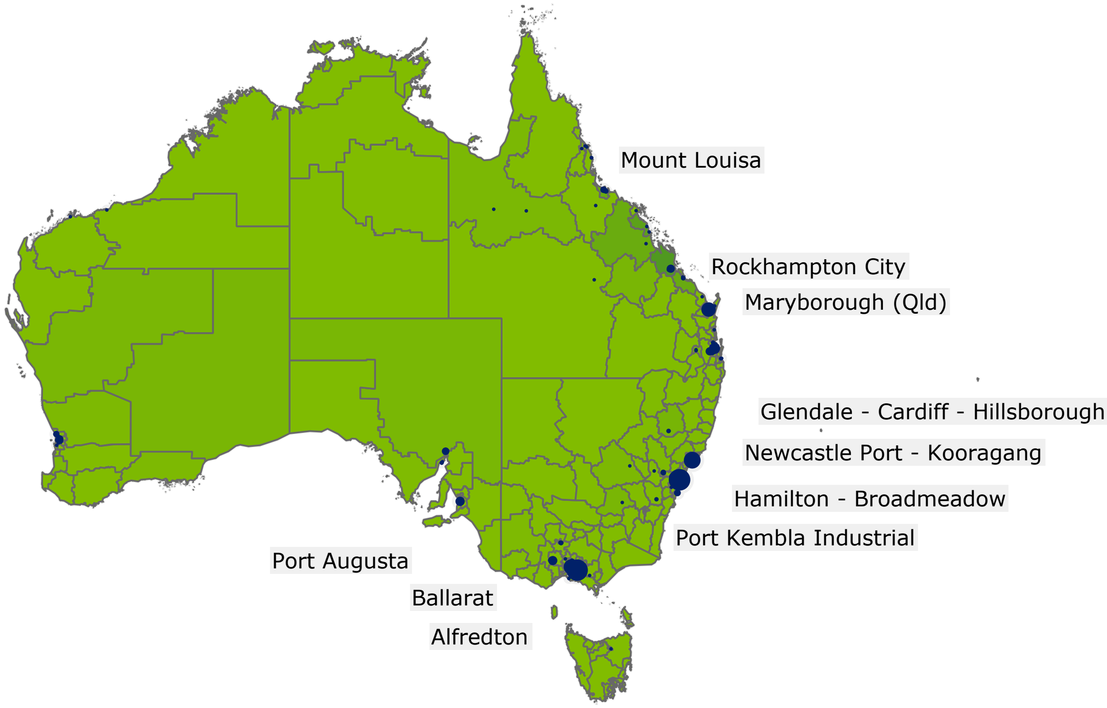
**Table 2.3: Major regional employment hubs for rolling stock manufacturing and repair**

| SA2 [13] | SA3 | Jobs |
|---|---|---|
| Hamilton - Broadmeadow | Newcastle | 174 |
| Maryborough (Qld) | Maryborough | 127 |
| Glendale - Cardiff - Hillsborough | Lake Macquarie - East | 110 |
| Ballarat | Ballarat | 49 |
| Rockhampton City | Rockhampton | 39 |
| Newcastle Port - Kooragang | Newcastle | 39 |
| Port Augusta | Outback - North and East | 33 |
| Port Kembla Industrial | Dapto - Port Kembla | 26 |
| Mount Louisa | Townsville | 25 |
| Alfredton | Ballarat | 24 |

*Source: ABS Census (2016)*

*13 Dandenong is the leading employment location for rolling stock manufacturing and repair services within Victoria with a count of 286 employees. A major industry employer in the region is Bombardier, who designs, engineers, manufactures and maintains rolling stock across Australia. Dandenong is part of Greater Melbourne as defined by ABS and therefore was not included in the table and following map.*
*14 ABS Census (2016) Place Of Work (POW) ANZSIC Industry Data*
*15 Ibid*

**Figure 2.9: Top 10 regional rolling stock manufacturing and repair employment clusters in Australia**




*Source: ABS Census (2016)*

## Rail businesses

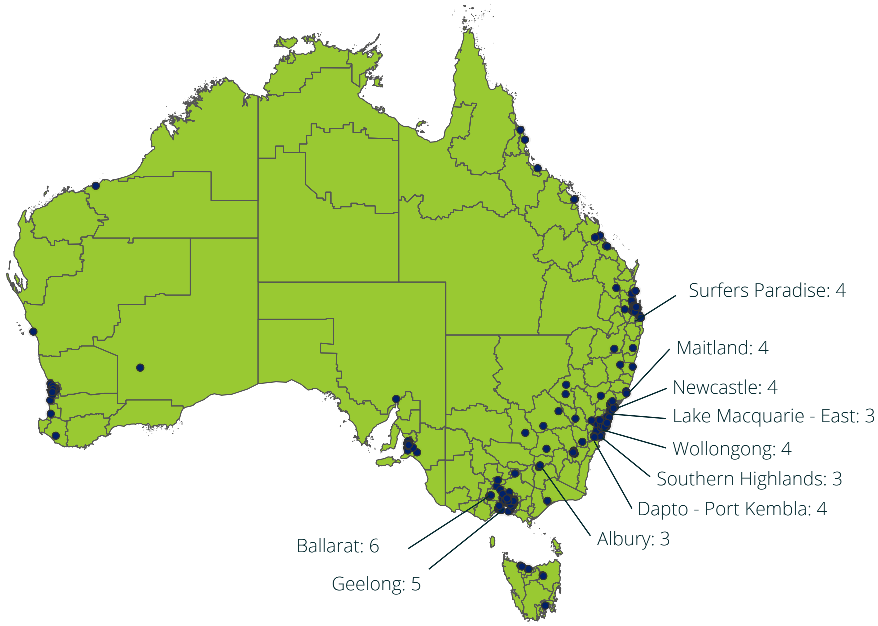
A review of a range of data sources, including ABS, public business directories and data maintained by the ARA, indicates that Australia's rail industry is made up of a core of around 900 rail businesses.

These businesses provide a broad array of services covering rail transport, network design, rail operations management, finance and operations. These businesses are spread around the country but do tend to cluster in specialist hubs. About a quarter of Australia's rail businesses are located in 20 major hubs. Table 2.4 shows major businesses within a selection of the largest hubs.

**Table 2.4: Major rail business hubs in Australia**

| Hub Location | Business Count | Example Businesses |
|---|---|---|
| Sydney CBD | 63 | Alstom, Downer, UGL, CPB Contractors, Laing O'Rourke, Pacific National, TfNSW, Relience Rail, NSW TrainLink, John Holland |
| Melbourne CBD | 41 | Siemens, Coleman Rail, Yarra Trams, VicTrack, V/Line, Transdev Australasia |
| Brisbane CBD | 23 | Hitachi Rail, Inland Rail, Queensland Rail, Aurizon |
| Perth | 15 | Pilbara Iron Company Services, Fortescue Metals Group, |
| Outer Sydney | 14 | Martinus Rail, Knorr-Bremse Australia |
| Dandenong | 12 | Bombardier Transportation Australia |
| Newcastle | 9 | Port of Newcastle Operations, Varley Group, Hancock Sheetmetal, Bradken, Lycopodium |
| Altona | 8 | SCT Logistics, Top Rail Services, Technica Engineering, Traction Motor Repairs |

**Figure 2.10: Top 10 locations of main offices for Australia's major rail businesses in regional areas**



# **3.** The value of passenger rail to society

In the progress of moving people to their destinations, passenger rail supports economic development, connects regional communities and brings social and environmental benefits in the process. In 2018, the network spanned over 21,000 route-kilometres, on which more than 962 million trips were made.

The majority of Australia's passenger networks are located in the major capital cities with dense networks in the Central Business Districts (CBDs), as shown in Figure 3.1. Australia's two largest heavy and light urban rail networks are located in Melbourne, being 413 kilometres and 250 kilometres, respectively (Table 3.1). The heavy rail networks in Brisbane and Sydney are just slightly smaller than Melbourne's.

**Figure 3.1: Australia's railway network map, September 2020**


*Source: Australian Rail Maps (2020)*

**Table 3.1: Network coverage of passenger rail**

| Route-kilometres | NSW | VIC | QLD | SA | WA | ACT | Across multiple states |
|---|---|---|---|---|---|---|---|
| Urban heavy | 400 | 413 | 396 | 126 | 181 | | |
| Urban light | 16 | 250 | 20 | 17 | | 12 | |
| Non-urban | 4,261 | 1,737 | 4,380 | | 836 | | 7,957* |

** as the data is presented through the network operators, Great Southern Rail and Heritage's network coverage are not split into specific states as they operate across numerous states. Source: BITRE (2019)*

Passenger rail goes beyond just transporting people from place to place. Rail is attractive to many types of consumers from families to retirees to short and long distance commuters. It contributes to the sustainable development, decentralisation, diversification and management of tourist flows.[16] Pre-COVID-19, tourism was one of Australia's fastest growing industries,[17] suggesting there is a significant growth opportunity for rail tourism.

For example, Great Southern Rail operates the longest non-urban passenger rail in Australia, operating journeys from Adelaide to Darwin and Sydney to Perth. Great Southern Rail's network coverage is over 7000km long, however, this is mostly integrated with other rail operators (passenger and freight) through shared tracks.

**Rail tourism can include:**

- Rail journeys as tourism products, such as the Ghan on the Adelaide–Darwin railway;
- Rail providing sustainable mobility to key tourist destinations connected to mainlines, such as The Byron World First Solar Train, QLD;
- Trains in scenic areas, such as Scenic Railway in the Blue Mountains, NSW; and
- Heritage railways, such as Puffing Billing Railways, VIC and West Coast Wilderness Railway, TAS.

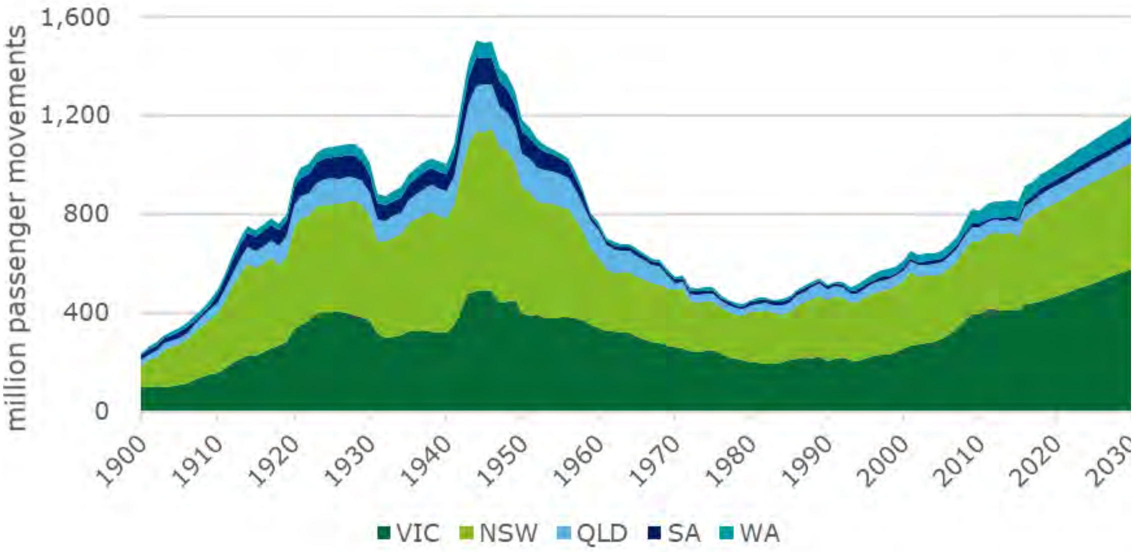
## Patronage

Light and heavy rail have facilitated travel for Australians for over a hundred years. In the early 20th century, as more trams and heavy rail networks were constructed in urban cities, rail passenger journeys steadily increased from 200 million in 1900 to over 1.5 billion in 1945 (Figure 3.2).

After a period of decline from the 1950s to the 1980s, rail has grown significantly and is once again pushing towards levels not seen since the 1940s. In 2018, over 962 million journeys were made on heavy and light rail in Australia and our forecasts indicate that, by 2030, there will likely be around 1.2 billion passenger movements a year.[18] This growth can be attributed to the large increases of the population in metropolitan cities in the past 30 years, together with significant rail network expansions and increasing road congestion.

*16 Railway Technology (2017) TopRail: promoting sustainable rail tourism, available at: <https://www.railway-technology.com/features/featuretoprail-promoting-sustainable-rail-tourism-5852451/>*
*17 Austrade (2019) Tourism Forecasts, available at: <https://www.destinationnsw.com.au/wp-content/uploads/2019/09/tourism-research-australia-tourism-forecast-report-2019.pdf>*
*18 BITRE (2019) Trainline 007, available at: <https://www.bitre.gov.au/sites/default/files/publications/train_007.pdf>*

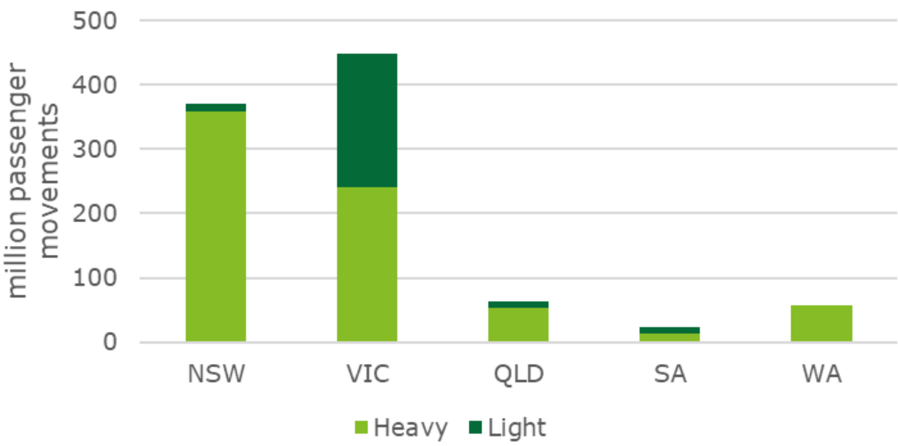
**Figure 3.2: Historical trend and forecast of urban passenger movements on heavy and light rail [19]**




*Note: The kink in passenger movements in 2015 is due to a different methodology in reporting patronage data, as the data before 2014 were adjusted to allow comparisons across networks, while data from 2015 are those reported by operators. These forecasts also do not include the impacts of COVID-19 on patronage.*
*Source: BITRE (2019)*

The majority of these journeys were made in New South Wales and Victoria with patronage in these two states accounting for over 88% of the total rail journeys in Australia in 2018. This reflects both their extensive rail networks as well as their share of population in Australia.

**Figure 3.3: Urban passenger movement by heavy and light rail in major states in 2018 [20]**




*Source: BITRE (2019)*

Figure 3.3 shows that of these journeys, 727 million, were made on heavy rail and 235 million were made on light rail. The majority of light rail journeys were in Victoria due to the extensive tram networks, but light rail patronage is growing in NSW, Queensland and the ACT in particular.

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*19 BITRE (2019) Yearbook 2019, available at: <https://www.bitre.gov.au/publications/2019/yearbook_2019> and DAE modelling*
*20 Ibid*

## Growth in patronage in the past 10 years

Since 2010, the demand for rail in Australia has been steadily increasing by around 2% each year. As increases in patronage are closely linked with population growth, comparing the growth rates in the movements and the movements per capita shows the extent that factors such as population drive these changes.

Figure 3.4 shows that since 2010, passenger patronage has been increasing in all states with an extensive urban rail network. In particular, New South Wales and South Australia have been experiencing levels of growth above the national average. For example, in South Australia, an average individual took 14 rail journeys in 2018, a very large increase compared to the average of five rail journeys in 2010.

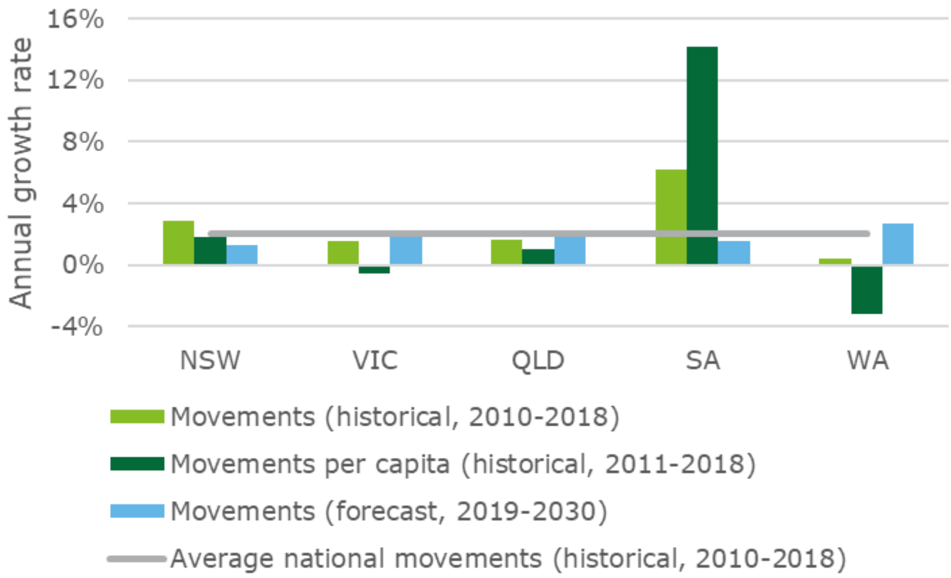
In addition to the increased demand, this increase in journeys per capita in South Australia can also be attributed to the increased supply of rail during this period, as the Rail Revitalisation Programme, which finished during this period, resulted in some temporarily closed lines opening back up.[21] The Rail Revitalisation Programme saw the South Australian government invest more than $2 billion over 10 years to upgrade the existing passenger rail network, the investments included gauge standardisation and future-proofing the network for gauge conversion.[22]

Although not to the same degree, both New South Wales and Queensland also saw an increase in the average patronage per capita since 2010. On average, individuals in New South Wales and Queensland have been making more journeys on rail compared to the previous years.

In comparison, in Victoria and Western Australia, on average, an individual makes fewer journeys on rail compared to previous years. However, patronage has still increased in these two states, suggesting that more people are using trains and trams. This could be driven by the sustained high population growth in these two states, for example, the population in Western Australia grew at more than twice the rate as that of New South Wales and South Australia.

In the past 10 years, the largest increase in rail patronage occurred in 2016,[23] growing by 7% nationally. This was mainly driven by a 12% increase in patronage in New South Wales and a 7% increase in patronage in Victoria. This increase in patronage could be linked to the high level of economic growth in the two states in that year. In 2016, the gross state product (GSP) per capita in New South Wales grew at more than three times the national average, while the GSP per capita in Victoria was nearly two times the national average.

**Figure 3.4: Comparison of historical and forecast patronage growth rates by state**

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*21 Acciona (2020) Adelaide Rail Revitalisation project, available at: <https://www.acciona.com.au/projects/construction/railways-and-tunnels/adelaide-rail-revitalization/>*
*BITRE (2017) Trainline 005, available at: <https://www.bitre.gov.au/sites/default/files/train_005.pdf>*
*22 Ibid.*
*23 The changes from 2014 to 2015 were not included as there different methodology in reporting patronage data, as the data before 2014 were adjusted to allow comparisons across networks, while data from 2015 are those reported by operators.*

## Forecast patronage

The previous Value of Rail report (2017) drew on publicly available information which forecast the passenger task to grow by 19% from 2016 to 2026, which is an average rate of 1.9% per year. Rail patronage grew by 5% between 2016 to 2018,[24] which is an average rate of 2.5% per year, well above expectations from the previous report.

Deloitte Access Economics' updated forecasts were developed from the bottom up using an in-house model, it predicts that passenger rail could grow slightly beyond these previous forecasts. Rail patronage is forecasted to grow by another 16% from 2018 to 2026, at an average rate of 2.0% per year.

> This rail patronage increase of 2% per year takes 12 million car journeys off the road.

The largest forecast growth rate is in Western Australia. As the population in Western Australia is projected to grow significantly, the rail patronage there is forecast to grow at an average rate of 2.7% every year until 2030. In pratice, this suggests that the MetroNet rail programme will work to offset recent declines in passenger rail demand in Western Australia.

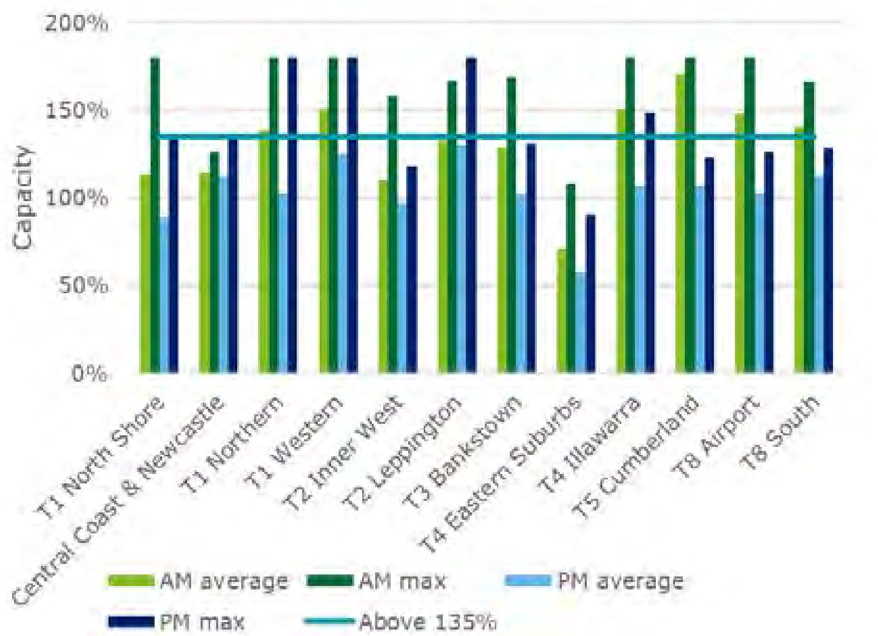
Rail patronage in New South Wales is forecasted to grow at an average rate of 1.3% every year until 2030. These forecasts do not take into account the impact the Sydney Metro, as it is uncertain of the extent of the impact it will have on overall rail patronage compared to displacing customers off the existing network. Sydney Metro has a target capacity of 40,000 passengers per hour and is expected to increase the overall network capacity by up to 60%.[25] While the additional stations from Sydney Metro will allow more people to access the light rail, the extent to which the Metro will substitute for journeys previously made on heavy rail is uncertain. This suggests potential upside to the overall rail forecasts.

These forecasts also do not account for the impacts of COVID-19 as the long run effects are still highly uncertain. The uncertainty of COVID-19 could greatly impact or delay the trajectory of this forecast and are analysed in the next section.

## Passenger rail capacity

Building a picture of total network capacity in passenger rail is challenging as capacity varies significantly by time of day and, during peaks, the actual number of passengers can exceed nameplate capacity.

**Figure 3.5: Peak train loads by line in Sydney, March 2019**




*Note: The data from March-19 was used rather than the latest data from Sept-19 data as season factors from school holidays are included in the Sept-19 dataset.*
*Source: Transport for NSW Open data hub.*

*24 BITRE Yearbook*
*25 NSW Government (2020), About Sydney Metro, available at: <https://www.sydneymetro.info/about>.*

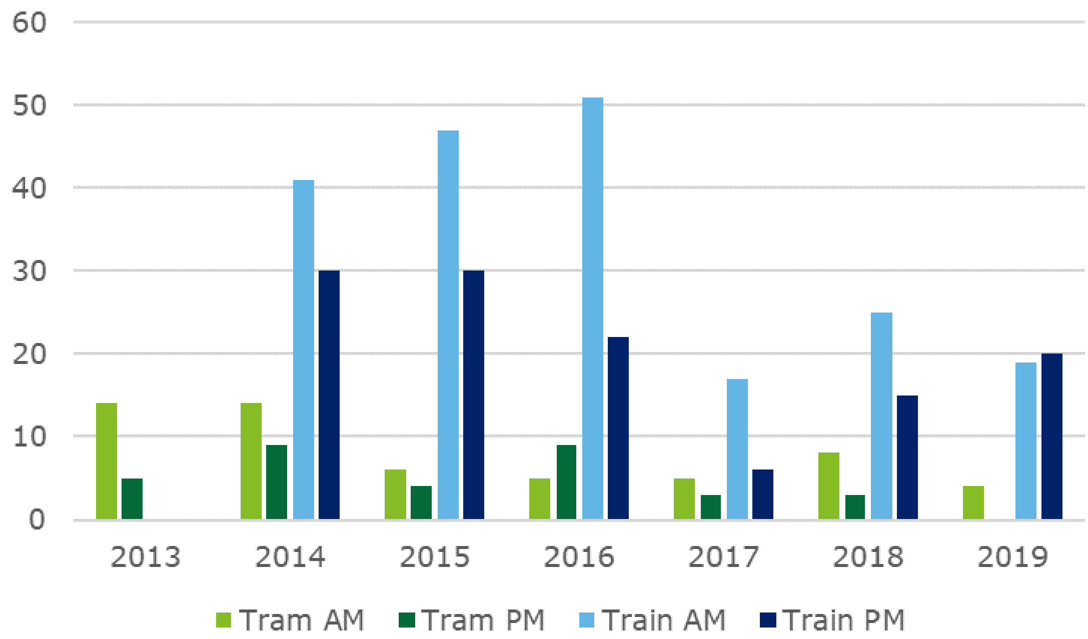
For example, in peak weekdays in Sydney, urban trains are scheduled to transport around 98,000 passengers in one hour. Most trains in Sydney in the morning are, however, operating well above 100% capacity. Figure 3.5 shows that the capacity of an average morning train on six lines in Sydney is higher than 135%, with the maximum load factor on four lines reaching 180% capacity at one point.

In Victoria, the number of overcapacity trams has been decreasing over the years as seen in Figure 3.6. The number of overcapacity trains, however, has been increasing. A reconfiguration of trains in 2017 to accommodate more commuters resulted in a change in the benchmark and a decrease in the number of overcapacity trains in 2017. However, since 2017, the number of overcapacity trains has been slowly increasing. This result is consistent with the growth in the patronage of medium to long distance commuters on rail in Victoria in recent years.

Various measures are being implemented to address these capacity constraints. This includes:

- Sydney's More Trains, More Services project, where more than $4.3 billion is invested in infrastructure improvements to track, signalling and station platforms to give customers reliable and frequent services. Since 2017, the project has delivered more than 1700 additional weekly services across the rail network.[26]
- Melbourne's Metro Tunnel project, which will build a 9km twin tunnel and five underground stations, freeing up space in the city loop allowing for more train services.[27]
- Brisbane's Cross River Rail project, which aims to overcome the single river crossing constraint that limits train services by building a new line that includes a second river crossing.[28]

**Figure 3.6: Number of peak capacity breaches on trams and trains in Victoria, 2013-19**




*Note: In 2017, metropolitan trains were reconfigured to accommodate 102 more commuters and therefore the benchmark standard of capacity was raised from 798 to 900 as a result. Due to the nature of the overcapacity data for Victoria, using counts the number of breaches based on a benchmark rather than extent of overcapacity as used in NSW, the two overcapacity figures are not directly comparable.*

*Source: Transport for Victoria.*

26 Transport for NSW (2020) More Trains, More Services, availabile at: <https://www.transport.nsw.gov.au/projects/more-trains-more-services>
27 Metro Tunnel (2020) About the project, available at: <https://metrotunnel.vic.gov.au/about-the-project>
28 Cross River Rail (2020) Project Overview, available at: <https://crossriverrail.qld.gov.au/about/project-overview/>

## Impact of COVID-19 on passenger patronage and rail capacity

There are numerous ways in which COVID-19 is impacting the way people use rail. For those who are working from home, the everyday rail commute has been eliminated. Various governments' policies on social distancing mean that light and heavy rail can only operate at certain capacities. People also changed their preferences for public transport to private vehicles due to the uncertainty resulting from the virus. All these factors are currently decreasing the patronage of passenger rail in Australia.

Figure 3.7 shows how stark this decrease in patronage has been. In March 2020, the number of trips on trains, the metro and light rail in Sydney decreased by 29 million (a decrease of 89%) compared to the average number of trips made in 2019.

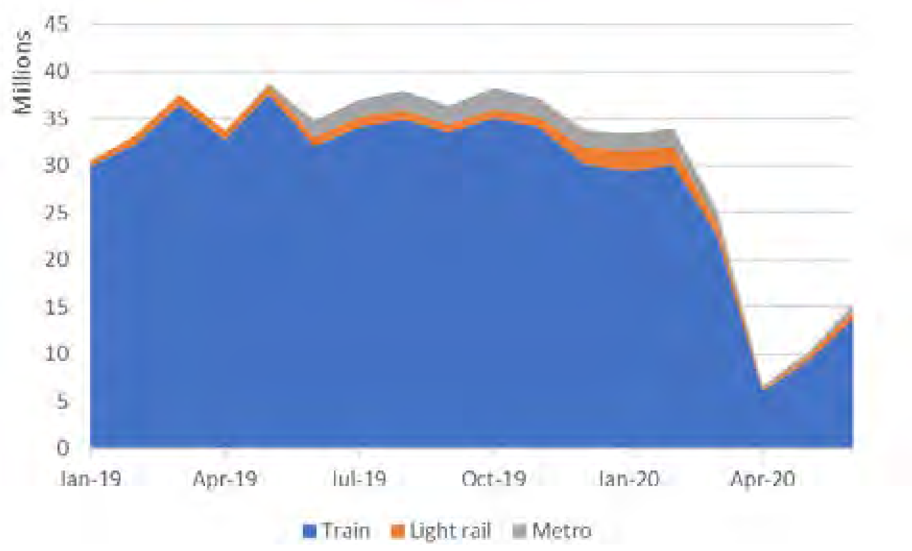
Similar decreases were felt across other cities. In Melbourne, the number of train and tram passengers decreased by 85 to 90% compared to pre-COVID numbers.[29] Similarly, the number of rail and light rail patronage in South East Queensland and the light rail in the ACT was one-fifth that in the previous years.[30]

In May, the Sydney network imposed social distancing restrictions[31] which meant that trains could only carry passengers at 25% of their original capacity. Assuming that the average of 33 million passengers the train network delivers each month is 'normal' network capacity, the decrease to 6 million passengers on the network in April 2020 suggest that the network was only operating at 18% of its normal capacity.

As restrictions loosen rail patronage is expected to increase but may take some time to reach pre-pandemic levels. Figure 3.7 shows early signs of this with the increased number of trips in May.

The future of rail patronage and public transport after the pandemic is uncertain, as it is dependent on the extent of behavioural changes resulting from this pandemic. While patronage is likely to recover from current COVID-19 levels, trends such as more employees being inclined to work from home and preference for other forms of transport resulting from the pandemic might stick and have long term impacts on passenger rail patronage.

**Figure 3.7: Opal trips in Sydney trains, lights rail and the metro, January 2019 to May 2020**




*Source: Transport for NSW open data hub*

29 The Age (2020) Crisis talks as Melbourne's train, tram passenger numbers slump by 90%, available at: <https://www.theage.com.au/national/victoria/crisis-talks-as-melbourne-s-train-tram-passenger-numbers-slump-by-90-percent-20200327-p54elv.html>

30 ABC News (2020) How public transport usage is creeping back after coronavirus lockdown, available at: <https://www.abc.net.au/news/2020-05-14/public-transport-usage-during-pandemic/12246518>

31 NSW Government, (May 2020) Physical distancing on transport key to a safe pathway back to work, available at: <https://www.nsw.gov.au/media-releases/physical-distancing-on-transport-key-to-a-safe-pathway-back-to-work>

## The value of passenger rail

Passenger rail is the connective tissue that runs through our cities and towns. It brings together people to work, go to school and live their lives as part of a healthy and sustainable community. CBD-bound commuters in Sydney, Melbourne, Brisbane, Perth and Adelaide choose rail before any other mode of transport.

### The most popular choice

Rail is the choice of 34 per cent of commuters – more than any other mode of transport. The longer your commute, the more likely you are to choose rail.

### The first choice for young women

A total of 40 per cent of women under 30 years of age use rail.

### An accessible choice

Rail is the most used mode of transport for commuters who need assistance with core activities. More than a quarter (26 per cent) of people requiring assistance choose rail.

### An affordable choice

More low income commuters use rail than any other mode of transport, with 30 per cent preferring rail services.

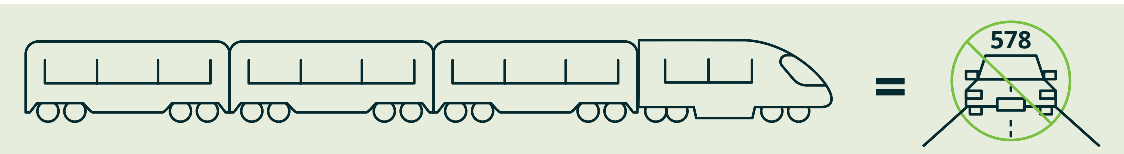
## Social and environmental benefits

Both road and rail transport generate costs and benefits to society that are not reflected in the prices travellers pay.

These costs or benefits, known as externalities, are borne or enjoyed by individuals or society (with the mix depending on how prices are set or regulated). Not reflecting these costs or benefits in prices means that travellers do not make 'socially optimum' transport decisions as they may over or under utilise transport modes with relatively higher/lower external costs compared to what would be socially optimal.

Rail transport generally generates fewer external costs than other modes of transport. The following analysis measures the extent of the benefits of passenger rail compared to its main competitor, road transport by estimating:

- The environmental benefits from lower carbon emissions
- Lower congestion costs in terms of the value of travel time saved and idle pollution
- The safety benefits from reduced accident costs, and
- The health benefits from increased walking and reduced air pollution.



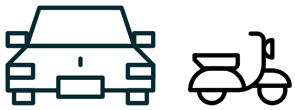
The benefits of rail that we look at are only part of the overall picture. When choosing between road, rail, sea and air transport people necessarily consider the price they pay, the quality of their experience and their impact on society and the environment. Prices in transport are determined by a combination of costs, market forces and regulatory requirements. The benefits for rail that are estimated here fit in as part of this overall decision but are important pieces which are often not front of mind, undervalued, or missed entirely.

## Environmental benefits

Cars, other road vehicles and trains produce greenhouse gases and other emissions, and this imposes a cost on society through its impact on the environment. In Australia, car and motorcycle travel caused 45 million tonnes of greenhouse gas emissions (measured in CO2 equivalent) in 2017-18.[32] Emissions from rail were notably less compared to road because of its lower emission intensity and lower total passenger task. It is estimated that rail generated only 2 million tonnes of CO2 equivalent in 2017-18.[33]

Table 3.2 shows that adjusting for total passenger distance travelled, cars and motorcycles generates around 0.15 kilograms of CO2 equivalent per passenger kilometre travelled. While passenger rail generates 0.11 kilograms of CO2 equivalent per passenger kilometre. This means that every passenger kilometre travelled by rail, instead of car or motorcycle, prevents 50 grams of CO2 equivalent from being emitted.

**45 million tonnes of CO2 in 2017-18**



**2 million tonnes CO2 in 2017-18**

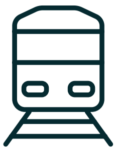


**Table 3.2: Greenhouse gas emissions from passenger transport in 2017-18**

| | Total emissions (Million tonnes of CO2 equivalent) | Total distance travelled (Billions of passenger km) | Emissions/km travelled (Kilograms of CO2 equivalent per passenger km) |
|---|---|---|---|
| Cars and motorcycles | 45.3 | 294.8 | 0.15 |
| Rail | 1.9 (a) | 17.6 | 0.11 |
| Difference | | | 0.05 |

*Notes: Figures do not add due to rounding. There are no estimates on CO2 emissions available for private use of light commercial vehicles and therefore they have been excluded. (a) Sum of electric and non-electric.*
*Source: BITRE (2009; 2016) and Deloitte Access Economics calculations.*

*32 Note that this figure includes the emissions from the private use of cars and motorcycles but does not include emissions from the private use of light commercial vehicles these emissions are not separately reported by BITRE.*
*33 This is estimated based on the emission intensity of rail passenger transport in 2006-07 BITRE (2009) and the total passenger rail task in 2017-18 reported in BITRE (2018).*

This differential may increase if the take up of renewable energy in the National Electricity Market (NEM) is faster than the conversion to electric passenger and freight vehicles. While there is an increased adoption of hybrid or electric passenger vehicles, electric vehicles for freight is still some way off with some companies using electric freight vehicles, but the majority still in the testing and trialling stages.[34]

Figure 3.8 shows that rail emissions per passenger kilometre has remained relatively stable since the 1990s while road emissions per passenger kilometre have been consistently decreasing since the mid-2000s due to the introduction of more energy-efficient vehicles and, more recently, electric vehicles.

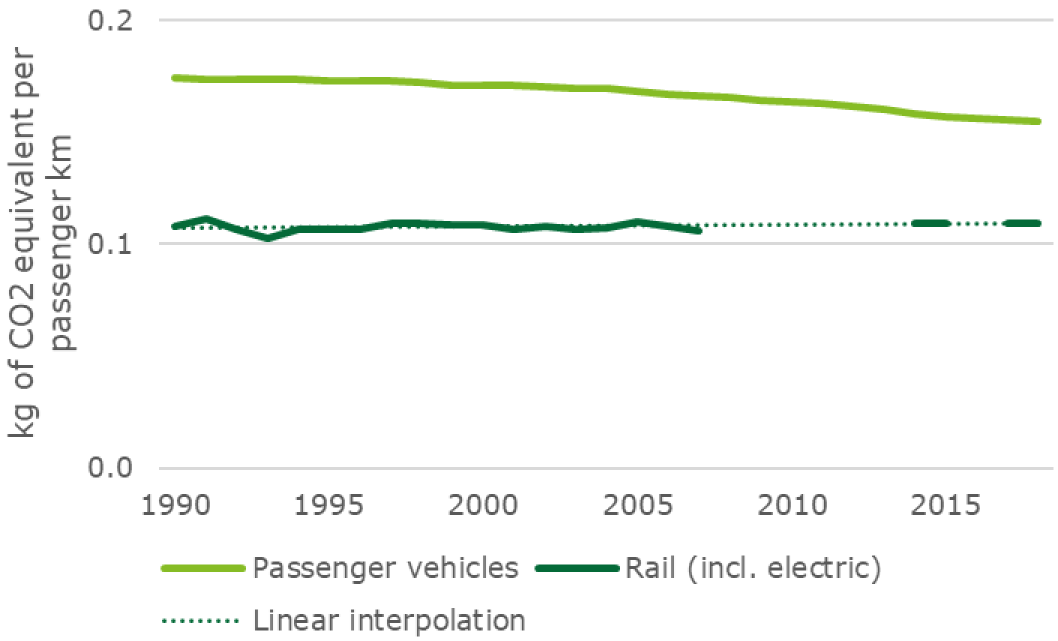
For rail transport's relative environmental advantage over road transport to continue in the long-term, rail transport will need to diversify its fuel sources and allow further substitution of fossil fuels with renewable energy sources. This can be done through increasing the electrification of networks, where possible, or could also be achieved by a more radical shift towards trains with low emission combustion engines such as natural gas or even hydrogen-powered traction.

> Rail passenger travel generates 30 per cent less carbon pollution than road travel for each kilometre travelled.

It is hard to fully estimate the social costs of carbon emissions as they can have long term future costs that are difficult to predict. There are two main methods to estimate the cost of carbon emissions. The first method directly estimates the social cost of carbon using the cost of all dimensions of the environmental impacts of carbon emissions. Instead of estimating its direct costs, the second approach estimates the costs of action needed to offset the increase in emissions.

To estimate the social costs of carbon emissions from road and rail transport, this report uses the first approach. A cost of $74.30 per tonne of CO2 equivalent (2019 prices) is used to convert carbon emissions into a dollar value.[35] At this price, every kilometre of passenger travel moved from road to rail transport results in a reduction in carbon pollution costs of 0.33 cents.

**Figure 3.8: Greenhouse gas emissions from passenger transport over time**




*Source: Deloitte Access Economics calculations using BITRE (2019 and 2009).*

*34 Freight Waves (2019) Down Under Trucking: Electric truck revolution gets underway in Australia, available at: <https://www.freightwaves.com/news/down-under-trucking-electric-truck-revolution-gets-underway-in-australia>*

*35 Based on the numbers developed by US Interagency Working Group and adopted by the US Environmental Protection Agency, converted to $AUD at current exchange rates and adjusted for inflation.*

**Table 3.3: Avoided carbon costs of one commuting trip made by rail instead of road, 2019 prices**

| City | Average trip (km) | Potential carbon cost saving (cents) | Potential carbon cost saving for 1,000 commuters over one year |
|---|---|---|---|
| Sydney | 15.3 | 5.1 | $12,248 |
| Melbourne | 15.4 | 5.2 | $12,360 |
| Brisbane | 15.4 | 5.2 | $12,384 |
| Perth | 15.2 | 5.1 | $12,215 |

*Source: Distances were sourced from ABS 2071.0.55.001.*

Table 3.3 shows the possible reduction in carbon costs of an average commute trip within the four largest Australian cities using rail instead of road transport. Every rail journey that replaces a car trip reduces the cost of carbon emissions by around 5 cents. These carbon costs are the dollar value of all the environmental impacts from carbon emissions that society must bear. Based on this per journey cost, it is estimated that carbon emission costs could be reduced by between $12,215 and $12,360 per year (depending on the city) if 1,000 commuters switched from road to rail. This number of commuters is roughly equivalent to one additional train at slightly above seated capacity per day. Appendix B considers the effect of alternative carbon emissions pricing on these calculations.

Each train of commuters is equivalent to planting **1800 trees a year.**

## Reduced congestion

Congestion occurs when transport demand exceeds capacity and often results in slower speeds, longer trip times and vehicle queuing. Congestion is usually a much greater issue for road rather than rail systems and is more likely to occur in densely populated areas.

Once the capacity of a road is reached, each additional user imposes a cost on existing road users in terms of increased travel time, travel time uncertainty and reduced driving amenity. Congestion also increases fuel consumption and consequently air pollution and greenhouse gas emissions, imposing additional costs to road users and society overall.

Centralised scheduling of train services means that it is less subject to congestion compared with road.

While increased demand for rail can result in crowding on trains – which reduces the amenity for passengers – rail doesn't generally suffer from the same increased travel time and other costs that arise from road congestion.

To quantify the reduced congestion benefit associated with shifting from road to rail transport, the following factors were considered:

- Origin and destination of commuter journeys
- Time of day that journeys are made
- Capacity and layout of the road network
- Location of railway stations
- Frequency of rail services, and
- Available alternative modes such as buses, walking or cycling.

These factors differ from city to city and over time. As such, congestion costs are best estimated using models that simulate the transport network and its use in a particular city or locality.

This report uses two such models: the Metropolitan Scanner for Transport and Infrastructure (MetroScan-TI) and the Transport and Environmental Strategy Impact Simulator (TRESIS), developed at the Institute of Transport and Logistics Studies at the University of Sydney. The models use granular geographic data, behavioural data, information on road networks and public transport options, and additional models about non-work trips. Further detail for both models is provided in Appendix C.

Regression analysis was used to estimate the effect of moving a single person from road to rail transport as described in Appendix D. The regression analysis uses the results from MetroScan-TI and TRESIS to estimate the change in travel time for existing road users as people move from road to rail transport.

For example, Table 3.3 shows that, in Sydney, a single commuter trip moved from road to rail reduces the total travel time summed across all road users by 28 minutes. This is equivalent to only a fraction of a second per road user. However, if a Sydneysider's daily commute to and from work was moved from road to rail, the time saving for other road users that year would be more than 3 days and 19 hours. If 1,000 people shifted from road to rail for their commutes, road congestion time saving would be in the order of 10 years and 3 months, if other commuters maintained their behaviour.

**Table 3.4: Avoided travel time per commuter trip switching from road to rail in 2019**

| City | Avoided travel time for existing road users (minutes) | Value of travel time saving ($) |
|---|---|---|
| Sydney | 28.1 | $10.23 |
| Melbourne | 24.5 | $8.93 |
| Brisbane | 8.5 | $3.09 |
| Perth | 14.2 | $5.17 |

*Notes: MetroScan-TI; TRESIS; Deloitte Access Economics estimates; BITRE (2019).*

Every commuter that changes to rail reduces aggregate travel time for remaining road users by up to 28 minutes.

The dollar value of these travel time savings can be estimated using the standard Australian approach for economic appraisals of transport initiatives. Table 3.6 shows the value of one hour of travel time saved for business travel is $57. This value estimates the foregone productivity from travel time and is estimated as 128% of Average Weekly Earnings (AWE).[36] For leisure trips, the value of one hour of travel time saved is $18 and is 40% of AWE.[37] Assuming 10% of trips are made for business purposes, the weighted average value of travel time savings per trip is estimated to be $21.

This amount is used to estimate the dollar value of the travel time saved for road users if a single commuter trip moved from road to rail. Table 3.4 shows that in Sydney if a single commuter trip moved from road to rail, it reduces the cost of congestion for road users by $10.

**Table 3.5 Value of travel time savings, in 2019 prices**

| Trip purpose | Value per trip |
|---|---|
| Private (commuting and other) | $17.72 |
| Business | $57.48 |
| All purposes (weighted average)(a) | $21.80 |

*Notes: (a) Assuming that 10% of trips are made for business purposes based on Sydney data (Transport for NSW, 2018). Source: Transport for NSW (2018).*

Improving congestion also reduces CO2 emissions due to the reduced amount of time vehicles are idle. The Transport for NSW appraisal guidelines estimate that idling engines emit around 4.6 kilograms of CO2 equivalents per hour. [38] The amount of avoided CO2 emissions and its dollar value ($74.30 per tonne of CO2 equivalent, see the environment section for more details) from the reduced congestion is calculated in Table 3.6.

**Table 3.6 Avoided CO2 emissions from congestion per avoided car trip**

| City | Reduction in CO2 emissions (kg) | Reduction in CO2 emissions ($) |
|---|---|---|
| Sydney | 2.1 | $0.14 |
| Melbourne | 1.6 | $0.12 |
| Brisbane | 0.6 | $0.04 |
| Perth | 0.9 | $0.07 |

*Source: MetroScan-TI, Deloitte Access Economics estimates, Transport for NSW (2016).*

Table 3.7 shows the total congestion savings if one commuter switched one trip from road to rail. Every passenger rail journey reduces road congestion costs by between $3 and $10, depending on the city. These results indicate that if 1,000 commuters switched their mode of transport from road to rail, this would reduce costs from congestion by between approximately $750,000 and $2.5 million per year (depending on the city).

*36 Transport for NSW, (2018) Principles and Guidelines for Economic Appraisal of Transport Investment and Initiatives June 2018, available at: <https://www.transport.nsw.gov.au/system/files/media/documents/2019/Principles%20and%20Guidelines%202018%20No%20appendix%204.pdf>*
*37 Ibid*
*38 This captures all emission types including CH4, N2O, NOX, CO, Volatile organic compounds, PM10, SO2 and CO2.*

A year commuting by train saves your fellow commuters enough time to master 20 new languages each year.

**Table 3.7 Avoided congestion costs per trip switching from road to rail**

| City | Travel time ($) | Carbon emissions ($) | Total ($) |
|---|---|---|---|
| Sydney | $10.23 | $0.14 | $10.37 |
| Melbourne | $8.93 | $0.12 | $9.04 |
| Brisbane | $3.09 | $0.04 | $3.13 |
| Perth | $5.17 | $0.07 | $5.24 |

*Note: A sensitivity analysis of these estimates is included in Appendix B.*
*Source: Deloitte Access Economics estimates* [39]

## Safety benefits

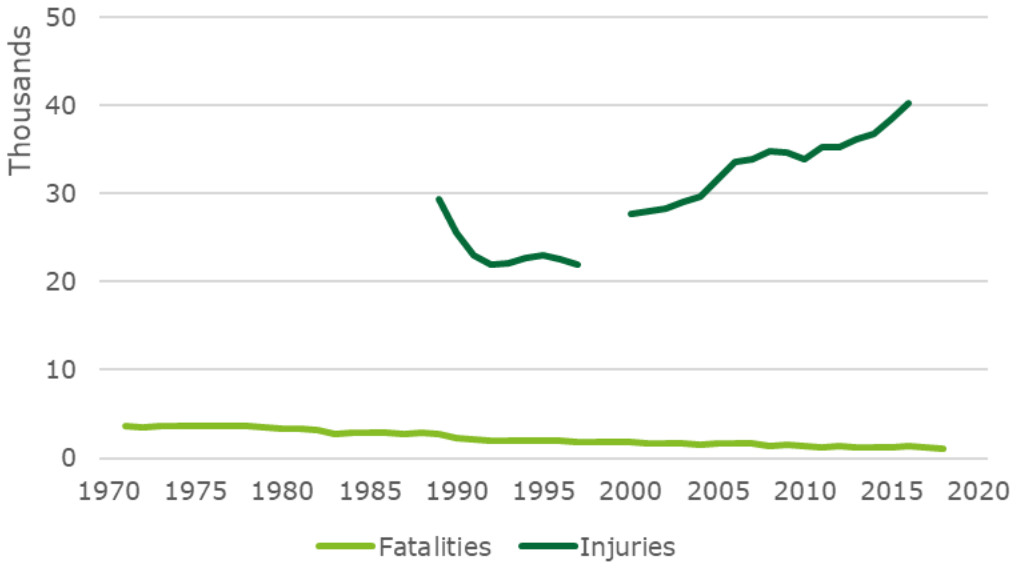
Tens of thousands of Australians are involved in road incidents and accidents every year. The latest BITRE yearbook figures show that road incidents and accidents in Australia were responsible for 1,136 fatalities in 2018 and 40,203 injuries in 2016.[40] Figure 3.9 shows that fatalities from road incidents and accidents have been steadily declining, while injuries have been quite volatile but follows an upward trend. This reflects improvements in vehicle safety features over time.

In comparison, there are notably fewer fatalities and injuries from rail incidents and accidents. Figure 3.10 shows that rail fatalities have been on a downward trend since 1980. Rail injuries have had some fluctuations year on year, but are showing an overall downward trend since 2001. The spike in rail injuries can be partially attributed to the Kerang train accident that occurred in 2007. It was the deadliest rail incident in Australia since 1977 and occurred when a truck collided with a train at a level crossing between the Piangil railway line and Murray Valley Highway.[41]

The latest figures show that rail incidents and accidents in Australia were responsible for nine fatalities in 2018 and 49 injuries in 2013. It should be noted that the recently lower number of rail fatalities and injuries can be attributed to a change in the data collection methodology, as from 2012 onwards, the dataset excludes fatalities and injuries from suspected suicide and trespass incidences.

Without the forecasted increase in rail patronage of 2% per year, commuter times will increase by 1,111 years for the remaining road users.

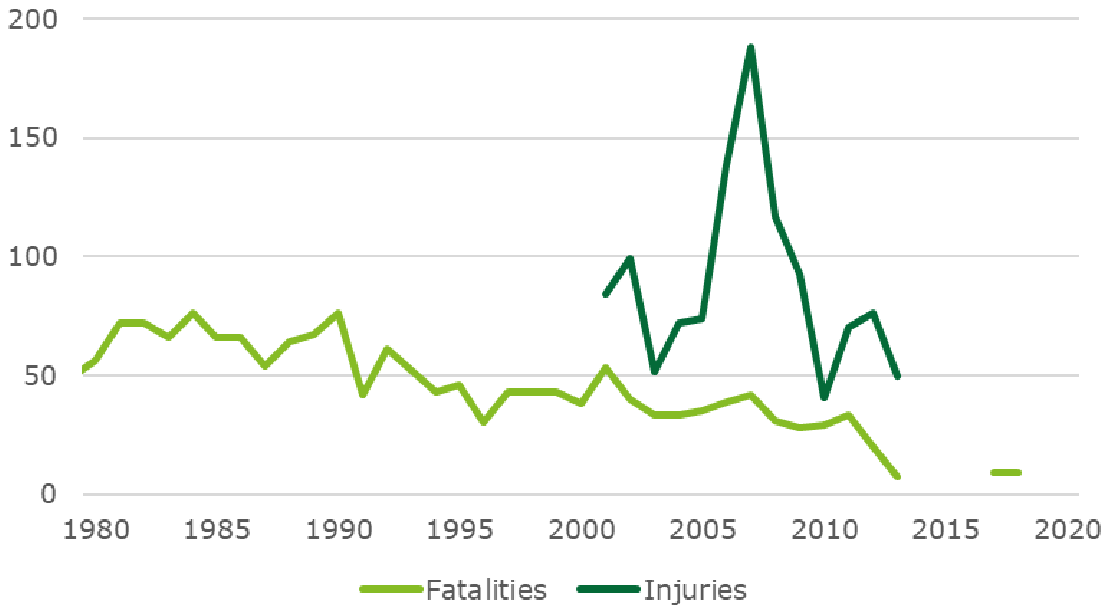
**Figure 3.9: Fatalities and injuries due to road incidents and accidents over time**




*Source: BITRE (2019)*[39]

39 BITRE (2019) Yearbook
40 We note that the 2019 road fatalities data and 2017 road injuries data is available but have used the 2018 fatalities and 2016 injuries figures from the 2019 BITRE Yearbook for consistency with rail fatalities and injuries numbers. The fatalities figures for 2019 and 2018 and injuries figures for 2017 and 2016 are very similar.
41 ABC News (2007) Three still missing after Vic train smash, available at: <http://www.abc.net.au/news/2007-06-06/three-still-missing-after-vic-train-smash/59834>

**Figure 3.10: Fatalities and injuries due to rail incidents and accidents over time**




*Note: Rail fatality and injury data from 2012 onwards excludes suspected suicide and trespass incidences.*
*Source: BITRE (2019)[42]*

Road has a much larger passenger task compared to rail and this could be one reason for it's higher amount of fatalities and injuries compared to rail. For example, in 2018, road transport activity recorded 291 billion passenger kilometres, compared to the 18 billion passenger kilometres moved by rail.

Table 3.8 shows that even accounting for the higher transport activity of road, rail still has lower fatalities and injuries rate compared to road. Rail transport causes seven times fewer fatalities and 44 times fewer injuries than road transport per passenger kilometre.

**Table 3.8: Road and rail fatalities and injuries comparison**

| | Road | Rail |
|---|---|---|
| Fatalities (person, in 2018) | 1,136 | 9 |
| Injuries (person, latest data) (a) | 40,203 | 49 |
| Passenger task (billion passenger km, in FY2018) | 291.4 | 17.6 |
| Passenger task (billion passenger km, in FY2016 / FY2013) (b) | 285.6 | 15.5 |
| Fatalities per billion passenger km (person) | 3.9 | 0.5 |
| Injuries per billion passenger km (person) | 140.8 | 3.2 |

*Note: (a) Values refer to 2016 for road and 2013 for rail, while the ONRSR reports the serious rail injuries to be 100 in 2017-18, the time-series of road and rail injuries is taken from the BITRE Yearbook for consistency (b) These values refer to 2015-2016 for road and 2012-2013 for rail.*
*Source: Deloitte Access Economics calculations based on BITRE (2019).*

These fatalities and injuries create incredible amounts of pain and grief for victims and their families and also generate large costs for society. These costs include medical care, disability care, support services and the cost of emergency services.

Other additional costs include damages to property, losses in productivity from death or disablement, reduction in the quality of life. Most of these costs are borne by people who are directly affected by an accident and society.

*42 BITRE (2019) Yearbook*

Two methods are used to compare the cost from road and rail fatalities and injuries: the human capital method and the willingness to pay method. The human capital method uses assumptions about the future production potential (e.g. wages) of an individual's life to estimate the cost of loss of life. While the willingness to pay method estimates the extent an individual is willing to pay (or willing to accept compensation) for small changes in their probability of survival in an incident or accident.

## Human capital approach

The latest publicly available estimate of the costs associated with rail and road crash costs using the human capital approach is from two BITRE reports in 1999 for rail and 2006 for road. The two studies adopt slightly different methodologies because generally less detailed data is available on rail accidents.[43] While these reports are dated, it is likely that cost relativity between road and rail has not changed significantly and therefore, these calculations are based on these two reports assuming that the cost of road and rail accidents have grown in line with the Consumer Price Index (CPI).

Using the human capital approach, BITRE estimates that the total socio-economic cost of road accidents in 2006 was $17.9 billion (in 2005-06 prices).[44] Around 10% of road fatalities are associated with articulated trucks,[45] it is assumed that the 90% rest of this cost can be attributed to passenger vehicle crashes, making up around $16.1 billion in costs. The major costs are workplace and household productivity losses (32% of total costs) and repair costs (24% of total costs).[46] Other costs include disability-related costs, quality of life losses (including the pain, grief and suffering of relatives and friends), insurance costs and medical costs.

The socio-economic costs of rail accidents were estimated to be $143 million in 1999 (in 1998-99 prices).[47] As rail costs were not split by passenger and freight, it is assumed that 30% of these costs are for freight,[48] which would imply passenger rail accident costs amount to around $100 million. Around half of these costs result from human costs, including work and household productivity losses, medical costs and losses in quality of life, while the other half results from property costs.[49]

The accident cost per passenger kilometre travelled in 2006 was 7.8 cents for road and 0.9 cents for rail in 1999. Converted to 2019 prices using inflation, the accident cost per kilometre traveller for road was 10.4 cents and 1.5 cents for rail. Rail transport, therefore, saves 9.0 cents of accident costs per passenger kilometre travelled compared to road.

**Table 3.9: Crash costs from road and rail passenger transport in Australia**

| Unit | Road | Rail |
|---|---|---|
| Total cost ($ million)(a) | $16,065 | $100 |
| Passenger task (billion passenger km)(a) | 206 | 12 |
| Crash cost (cents per passenger km, in original prices)(b) | 7.8 | 0.9 |
| Crash cost (cents per passenger km, in 2019 prices) | 10.4 | 1.5 |
| **Avoided crash costs from using rail instead of road (cent per passenger km)** | | **9.0** |

*Note: (a) Values refer to 2005-06 for road and 1998-99 for rail, (b) These figures are expressed in 2005-06 prices for road and 1989-99 prices for rail. Source: Deloitte Access Economics calculations based on BITRE (2009) and BTRE (2002).*

Using the human capital approach, accident costs for rail are seven times less than road accident costs per passenger kilometre travelled.

*43 BITRE may have further developed its methodology in the period between these two reports. Changes made between the costing of road accidents in 1996 and 2006 account for around 1 per cent of total 2006 costs (BITRE, 2009).*
*44 BITRE (2009) Cost of road crashes in Australia 2006 Research Report 118, available at: <https://bitre.gov.au/publications/2010/report_118.aspx>*
*45 Table 5 in Laird, Philip (2005) Revised land freight external costs in Australia, available at: <https://ro.uow.edu.au/cgi/viewcontent.cgi?article=1765&context=infopapers> shows that around 10-11% of road crashes from 1999 to 2003 involved articulated trucks.*
*46 BITRE (2009) Cost of road crashes in Australia 2006 Research Report 118, available at: <https://bitre.gov.au/publications/2010/report_118.aspx>*
*47 BITRE (2002) Rail accident costs in Australia Report 108, available at: <https://bitre.gov.au/publications/2003/report_108.aspx>*
*48 Laird, Philip (2005) Revised land freight external costs in Australia, available at: <https://ro.uow.edu.au/cgi/viewcontent.cgi?article=1765&context=infopapers>.*
*49 Ibid*

**Table 3.10: Accident costs per trip, in 2019 prices**

| City | Average trip distance (km) | Potential cost saving ($, average trip) | Potential cost saving ($, 1000 commuters per year) |
|---|---|---|---|
| Sydney | 15.3 | $1.37 | $328,333 |
| Melbourne | 15.4 | $1.38 | $331,348 |
| Brisbane | 15.4 | $1.38 | $331,994 |
| Perth | 15.2 | $1.36 | $327,472 |

*Source: Deloitte Access Economics calculation based on BTRE (2002); BITRE (2009) and BITRE (2015), ABS 2071.0.55.001.*

The use of rail over road results in large cost savings as illustrated by Table 3.10, which compares the potential cost savings for an average commute trip in Australia's four largest cities.

For example, people in Melbourne travel on an average of 15.4 kilometres per trip to get to work, switching this commute from road to rail can result in $1.37 cost savings per kilometre in accident costs. If 1,000 commuters switch from road to rail in Melbourne, this results in a $331,348 decrease in accident costs per year.

The forecasted increase in rail patronage will result in $32 million in savings from accident costs per year.

The forecasted increase in rail patronage of 2% per year, will result in $32 million saved from accident costs each year.

## Willingness to pay (WTP) approach

The willingness to pay method estimates the extent an individual is willing to pay (or willing to accept compensation) for small changes in their probability to avoid fatalities, major and minor injuries in a road or rail incident or accident by estimating the value of risk reductions or value of statistical life (VSL).

Usually, WTP values tend to be higher than the human capital values as the WTP approach takes in to account subjective preferences and reflects the extent people value their own lives and that of others. For example, the use of VSL estimates instead of the human capital values could increase BITRE's socio-economic costs of road accidents from $17 billion to $28 billion.[50]

Table 3.11 uses the most up to date transport appraisal guidelines from the Transport and Infrastructure Council is used to estimate the yearly socio-economic costs associated with road and rail facilities and injuries using the WTP approach.

**Table 3.11: Road and rail related crash costs in 2018, in 2019 prices**

| | Number of fatalities or injuries (person) | Crash cost ($ million per fatality or injury) | Total costs ($ million) |
|---|---|---|---|
| Road fatalities(a) | | | |
| NSW | 355 | $9.3 | $3,289.9 |
| VIC | 270 | $9.4 | $2,535.6 |
| QLD | 219 | $8.9 | $1,945.6 |
| SA | 114 | $8.7 | $990.5 |
| WA | 163 | $8.9 | $1,456.5 |
| TAS | 32 | $8.6 | $275.9 |
| NT | 36 | $9.8 | $353.0 |
| ACT | 6 | $10.3 | $61.9 |
| Australia | 1,195 | | $10,908.8 |
| Road hospitalised injuries | | | |
| Australia | 39,330(a) | $0.3(b) | $8,329.6 |
| **Total road crash costs** | | | **$19,238.4** |
| Rail fatalities(c) | 9 | $8.5 | $76.1 |
| Rail injuries(d) | 100 | $0.2 | $23.1 |
| **Total rail crash costs** | | | **$99.2** |

*Note: (a) The latest injuries data is from 2017 (b) Injury crash costs includes hospitalised injuries. Excludes minor injuries and cost of only property damage road crashes. Cost per injury rate was calculated using a weighted average of the integrated willingness-to-pay values of serious and hospitalised injuries in urban and non-urban settings reported in Transport and Infrastructure Council, 2016. Assumption of the portion of urban crashes and portion of serious injuries is based on the Road trauma Australia 2019 statistical summary form BITRE. (c) Fatality costs are based on the value of statistical life as published in Transport and Infrastructure Council (2016) and fatalities excludes suspected suicide occurrences. (d) In the absence of more granular data on the type of injuries related to rail accidents, a weighted average cost per injury of $230,659 has been assumed. This is in line with the average cost per road injury and assumes 25% serious injuries and 75% hospitalised injuries of all reported rail related injuries as reported by the ONRSR rail safety report (2019).*
*Source: Deloitte Access Economics calculations based on BITRE (2019); Transport and Infrastructure Council (2016) and ONRSR rail safety report (2019).*

50 Tooth, R. (2010) The cost of road crashes: A review of key issues. Published by LECG and the Australasian Railway Association, available at: <http://www.econ.mq.edu.au/Econ_docs/research_seminars/2011_research_seminars/Tooth_Accidents_180311.pdf>

In 2018, rail crash costs were only a fraction of road crash costs. The costs related to rail fatalities and injuries were $99 million, while it was over $19,000 million for road. Costs related to road fatal and injury crashes are estimated to be $19 billion in 2018, with $10 billion from road fatalities and $8.3 billion from road injuries. This estimation does not include costs related to property damage crashes only and minor injuries due to the lack of data. While costs related to rail crashes are estimated to be $76 million and injuries are estimated to be $23 million.

The fatality cost per kilometre travelled for road is calculated to be 3.7 cents and 0.4 cents for rail, while the injury cost per kilometre travelled is calculated to be 2.9 cents and 0.1 cents for rail. Rail transport, therefore, saves a total of 6.0 cents per passenger kilometre travelled compared to road using this methodology

Using the willingness to pay method, road fatality costs per passenger kilometre are ten times higher than rail.

## Health benefits

The two health benefits associated with the shift of road passengers to rail passengers estimated in this section are the benefits of reduced air pollution and increased physical exercise.

Transport is one of the main contributors to air pollution. Although air pollution isn't often seen as a significant public health threat, its impact is so detrimental that it is estimated to account for more deaths than Australia's road toll.[51] Air pollution, especially in dense cities, is linked to negative health outcomes, with the main health costs being mortality caused by the effects of airborne particulate matter (PM), oxides of nitrogen, sulphur dioxide, carbon monoxide and volatile organic compounds.[52]

This section of the report focuses on the reduction in PM emissions from shifting road passenger to rail and estimates the dollar value of the health benefits from this modal shift.

PM has two main classifications:

- PM10 (coarse particulate matter) defined as all particles with an equivalent aerodynamic diameter of fewer than 10 micrometres, and
- PM2.5 (fine particles) defined as all particles with an equivalent aerodynamic diameter of fewer than 2.5 micrometres.[53]

The main health effects of PM are through causing breathing difficulties and exacerbating respiratory diseases, such as asthma, cardiovascular disease and chronic obstructive pulmonary disease, with potential for premature mortality.[54,55]

BITRE estimates that motor vehicles (passenger and freight) in Australian metropolitan cities will emit around 14.0 thousand tonnes of PM10 in 2018.[56] Using the freight and passenger splits from the Air Emissions Inventory for the Greater Metropolitan Region in NSW for PM10 in 2013, 36% or 5.1 thousand tonnes of this is allocated to passenger vehicle emissions.[57]

PM10 emissions for rail are harder to come by. The best estimate is from the 2013 Locomotive Emissions Project report for NSW EPA. It estimates that locomotives (freight and passenger) in Australia produced 1.3 thousand tonnes of PM10 in 2012 and 1.7 thousand tonnes of PM10 in 2022.[58] A linear trend indicates that locomotives will produce around 1.5 thousand tonnes of PM10 in 2018. Using the proportion of annual diesel consumption between passenger and freight rail, 5% or 0.07 thousand tonnes is attributed to passenger rail.[59]

*51 Begg, S, Vos, T, Barker, B, Stevenson, C, Stanley, L, Lopez, A, (2007). The burden of disease and injury in Australia 2003. AIHW cat. no. PHE 82. Canberra: Australian Institute of Health and Welfare (AIHW) available at: <www.aihw.gov.au/bod/index.cfm>*
*52 AMA (2013) Submission to the Senate Inquiry into the impacts on health of air quality in Australia available at: <https://ama.com.au/sites/default/files/documents/AMA_submission_inquiry_into_health_impacts_of_air_quality_.pdf>*
*53 Amoako, Lodh & Risbey (2005) Health impacts of transport emissions in Australia: Economic costs, available at: <https://www.bitre.gov.au/sites/default/files/wp_063.pdf*
*54 Ibid - Table 4.1*
*55 AMA (2013) Submission to the Senate Inquiry into the impacts on health of air quality in Australia available at: <https://ama.com.au/sites/default/files/documents/AMA_submission_inquiry_into_health_impacts_of_air_quality_.pdf>*
*56 BITRE (2003) Urban Pollutant Emissions from Motor Vehicles: Australian Trends to 2020, available at: <https://www.bitre.gov.au/sites/default/files/cr_002.pdf>*
*57 NSW EPA (2020) 2013 Calendar Year Air Emissions Inventory for the Greater Metropolitan Region in NSW, available at: <https://www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-inventory-2013>*
*58 NSW EPA (2013) Locomotive Emissions Project, available at: <https://www.epa.nsw.gov.au/~/media/EPA/Corporate%20Site/resources/air/locoemissrep.ashx>*
*59 Ibid.*

**Table 3.12: PM10 emissions from passenger transport, 2018**

| | Total emissions (Million kg of PM10 equivalent) | Total distance travelled (Billions of passenger km) | Emissions/km travelled (kg of PM10 per million passenger km) |
|---|---|---|---|
| Road vehicles | 5.1 | 291.4 | 17.4 |
| Rail | 0.07 | 17.6 | 4.3 |
| Difference | | | 13.1 |

**Table 3.13: Avoided PM10 costs of one commuting trip made by rail instead of road, 2019 prices**

| City | Average trip (km) | Potential cost saving (cents) | Potential cost saving for 1,000 commuters over one year |
|---|---|---|---|
| Sydney | 15.3 | 5.3 | $12,756 |
| Melbourne | 15.4 | 5.4 | $12,873 |
| Brisbane | 15.4 | 5.4 | $12,898 |
| Perth | 15.2 | 5.3 | $12,722 |

*Source: Distances were sourced from ABS 2071.0.55.001.*

Table 3.12 shows that adjusting for total passenger distance travelled, road vehicles generate around 17.4 kilograms of PM10 per million passenger kilometres travelled. While passenger rail generates 4.3 kilograms of PM10 per million passenger kilometres travelled.

Rail passenger travel generates 75% less PM10 emissions for each kilometre travelled when compared to road travel.

Thorough and detailed valuations of the changes in air pollution use the impact pathway approach. This method calculates the pathway from emissions to costs using ambient concentrations, exposure and health impacts for a specific project or area. However, as this calculation is very resource-intensive, damage cost tables are usually used to allow a direct comparison of cost per tonne of emissions.[60] The damage cost of $267 (2019 prices) per kilogram of PM10 emitted in capital cities is used to convert the health impacts of PM10 into a dollar value.[61] At this price, every kilometre of passenger travel moved from road to rail transport results in a reduction in PM10 health costs of 0.35 cents.

Table 3.13 shows the possible reduction in PM10 health costs of an average commuter trip within the four largest Australian cities using rail instead of road transport. Based on this per journey cost, it is estimated that PM10 health costs could be reduced by between $12,722 and $12,898 per year (depending on the city) if 1,000 commuters switched from road to rail.

Each train of commuters reduces air pollution costs by **$26,000 per year.**

Rail also contributes to health by enabling walking. As people usually need to travel to and between public transport stations, studies have shown there is a correlation between public transport use and physical activity. For example, using Australian data, it was found that public transport accessibility was positively correlated with walking at recommended levels (including for those people who were not actively exercising).[62] Such levels of physical activity has positive impacts on reducing the morbidity and mortality of individuals.[63]

*60 NSW EPA (2013) Methodology for Valuing the Health Impacts of Changes in Particle Emissions, available at: <https://www.epa.nsw.gov.au/~/media/EPA/Corporate%20Site/resources/air/HealthPartEmiss.ashx>*
*61 Department of Infrastructure and Regional Development (2016) Vehicle emissions standards for cleaner air, available at: <https://www.infrastructure.gov.au/vehicles/environment/forum/files/Vehicle_Noxious_Emissions_RIS.pdf>*
*62 Barr, A., Rebecca B., Julie A. S., Jan S., Neville O., David D., Lukar T., Lauren K., and Anne K. (2016), Associations of public transport accessibility with walking, obesity, metabolic syndrome and diabetes. Journal of Transport & Health, Volume 3, Issue 2, Pages 141-153, available at: <http://www.sciencedirect.com/science/article/pii/S2214140516000086>*
*63 Mulley, C. (2016) Editorial - Public transport and health: Publicising the evidence, Journal of Transport & Health, Volume 3, Issue 2, Pages 131-132, available at: <http://www.sciencedirect.com/science/article/pii/S2214140516301487?via%3Dihub#bib1>*

**Table 3.14: Health benefits from rail use in 2019 in Sydney, in 2019 prices**

| Walking task (in km) | Unit value ($/km) | Total health benefits | Health benefits per train trip |
|---|---|---|---|
| 312 million | $3.09 | $964 million | $7.00 |

*Source: Transport and Infrastructure Council (2016); MetroScan-TI.*

However, these health benefits associated with the active travel required to reach public transport and then the final destination (access and egress) are still neglected in health and transport research. As a result, these benefits are largely ignored by transport economists, or, worse, walking time to and from public transport and interchange is considered a disutility.[64]

The health benefit of using trains was calculated using the annual distance travelled by individuals walking to, from and between train stations in Sydney using MetroScan-TI data and the value for health benefits related to walking using the Australian transport appraisal 2016 guidelines. Using that data, is it estimated that an average rail user walks 2.26 kilometres to, from and between train stations each day, this can include 850m on either side of the trip and movements between train stations and modes as required. This means that Sydney train users walk a total of 1 million kilometres every day. As shown in Table 3.14, train users in Sydney walked 312 million kilometres in 2019, generating $964 million in health benefits, equivalent to a benefit of $7.00 per train user.

The recommended value of $3.09 per kilometre walked (in 2019 prices) by Australian transport appraisal guidelines was used to measure health benefits.[65] This unit value captures the value people place on reduced morbidity and mortality using a willingness-to-pay approach and the value of the reduction in health care related expenditure. Health benefits from active travel are derived from a reduction in the risks of cardiovascular disease, Type 2 diabetes, some cancers and osteoporosis (Transport and Infrastructure Council, 2016). Other health benefits include reduced obesity, high blood pressure and high cholesterol and mental health benefits. The value does not include productivity benefits as there is insufficient evidence on the causality between active transport and reduced sick days.

Over a year, walking to the train station provides exercise that is the equivalent of 5.8 marathons.

## Social inclusion

Transport enables the movement of people and allows people to access desired goods, services, activities and destinations. Different modes of transport have varying barriers to access and therefore result in different social outcomes for certain groups. For example, only those who physically can and are financially able to drive can access the mobility benefits from passenger cars.

Public transport can enhance social inclusion as usually, it has lower barriers of access compared to cars. For example, it usually costs less compared to cars which require large costs related to vehicle ownership, registration, insurance and licensing. Therefore, public transport is an affordable way for most demographic groups to access jobs and other economic opportunities.

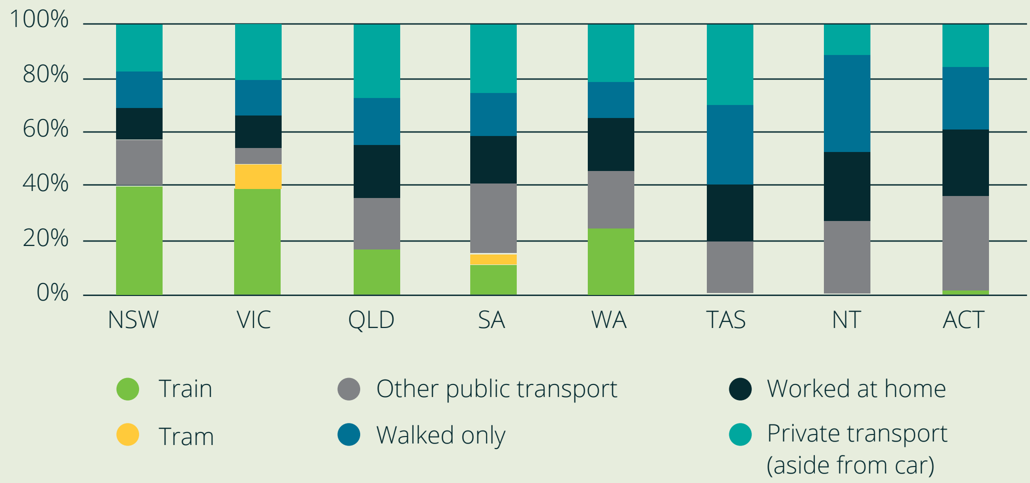
The 2016 census showed that while cars make up the majority of the transport Australians used to travel to work, more than 836,000 Australians rely on trains and trams to get to work. Excluding cars as a mode of transport, Figure 3.11 shows that more than 40% of people in New South Wales and Victoria rely on trains and trams to access their work.

In addition to accessing work, local public transport can greatly benefit certain demographic groups who are either physically unable to drive or cannot financially afford to drive, distributing the economic benefits of mobility and allowing these individuals more opportunities and improve their social outcomes. These groups can include:

- People on low incomes and unemployed people, including people working part time and those claiming state benefits
- People living in remote areas, such as rural areas or urban peripheries
- Disabled people, including people with mobility limitations, sensory disabilities and people with mental wellbeing disabilities
- Older people, including retired people (aged 60/65 and over) and, potentially, older working aged people (aged over 55)
- Younger people and children, including younger adults aged 16-24, and
- Single parents.[66]

These advantages of public transport are recognised by the UN as it encourages use of public transport in its Sustainable Development Goal of developing Sustainable Cities and Communities. The UN calls on its Member States to "provide access to safe, affordable, accessible and sustainable transport systems for all ... notably by expanding public transport, with special attention to the needs of those in vulnerable situations".[67]

**Figure 3.11: Method of travel to work (removing cars) by states and territories in 2016**



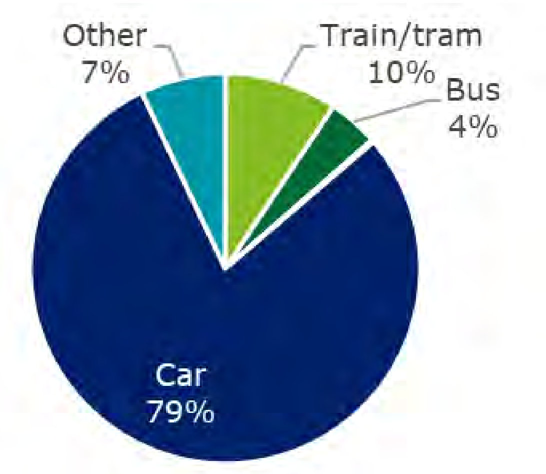

*Source: ABS Census (2016)*

*66 Mott MacDonald (2013) Valuing the social impacts of public transport – Final report, prepared for the Department of Transport, available at: <http://www.socialvalueuk.org/app/uploads/2016/07/DfT-final-report.pdf>*
*67 United Nations (2020) Goal 11: Make cities inclusive, safe, resilient and sustainable, available at: <https://www.un.org/sustainabledevelopment/cities/>*

## Benefits of modal shift

The majority of Australians still use cars to travel to work, with nearly four in five Australians travelling to work via a car (as a driver or passenger) in 2016.[68] Trains and trams account for the next most frequent type of transport used to travel to work, with 10% or one in 10 Australians using trains or trams to get to work in 2016 (Table 3.12). Other methods used include buses, walking, bicycle, motorbikes and ferries.

**Figure 3.12: Proportion of method people used to travel to work by mode, 2016**

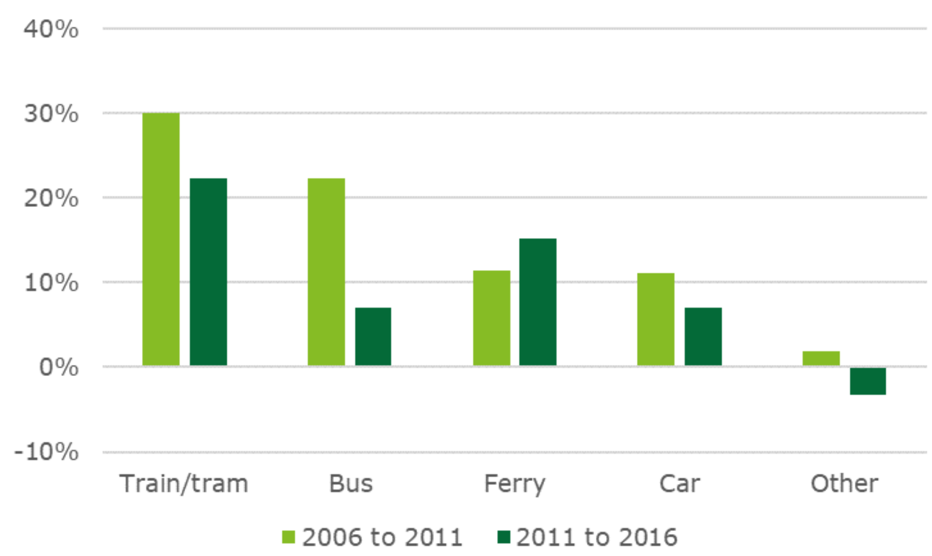



*Source: ABS Census 2016*

Public transport has seen significant levels of growth since the early 2000s. This is due to two main drivers: as metropolitan cities become denser, the cost of driving and parking at work is becoming increasingly expensive both in terms of direct financial cost as well as time delays caused by congestion. In addition, major upgrades to public transport infrastructure has made public transport travel cheaper and more accessible, resulting in more Australians using public transport as a part of their journey to work.

Trains and trams have experienced the most growth since 2000, with the number of people using them to travel to work increasing by 30% from 2006 to 2011 and 22% from 2011 to 2016 as seen in Figure 3.13. Buses saw similar levels of growth in the early 2000s, however, only grew by 7% from 2011 to 2016. Car transport to work has also increased since 2006, however, at much smaller growth rates of 11% and 7% over 2006 to 2011 and 2011 to 2016 respectively.

**Figure 3.13: Change in method people used to travel to work by mode, 2006 to 2016**




*Source: ABS Census 2016, 2011, 2006*

*68 Latest method of travel to work census data available.*

**Table 3.15: Total benefits from a 20% increase of rail use by 2021, in 2019 prices**

| | Benefit per average trip on rail ($) | Benefit from 20% increase in rail passengers per year ($mil) |
|---|---|---|
| Carbon emissions savings | $0.05 | $4 |
| PM10 savings | $0.05 | $4 |
| Congestion savings (for all road users) | $6.94 | $558 |
| Crash cost savings | $1.37 | $110 |
| Walking benefits | $7.00 | $562 |
| **Total** | **$15.42** | **$1,239** |

*Note: We assume that the benefits per average trip remain the same and therefore numbers are taken from the previous section. The calculations are made using the following method (1) A 20% increase of train travellers result in an additional 167,310 Australians using rail instead of road to get to work (2) The figure in (1) is used multiplied with the average benefit per rail trip to obtain the total benefit from this 20% increase (3) The figure in (2) is then annualised by multiplying by 480 (assumption of 2 trips per day over a five day work week over 48 weeks per year).*

If Australia can keep maintaining this increase in the use of trains and trams instead of cars, it could result in significant levels of environmental and social benefits as estimated in the previous section.

If an additional 20% of people use train or trams to travel to work (compared to 2016), it could result in $1.2 billion per annum of social and environmental benefits for society by 2021.

Using the COVID-19 example, if individuals continued using road rather than rail even after the end of the pandemic, it could result in huge environmental and social costs to society. If one in 10 of rail passengers who switched to road transport does not switchback, it could result in $2 million of costs from increased carbon emissions, another $2 million of costs from increased air pollution from PM10 emissions and $55 million in additional crash costs.

# 4. The value of rail freight to society

## Rail freight is critical for the Australian economy, directly contributing $5.28 billion to the economy in 2019 and enabling the smooth running of modern supply chains.

Rail freight carries the majority of Australia's freight task by net tonne kilometres and does so while being the lowest emitting of all the freight modes per tonne in CO2 equivalent and PM10.

Rail freight is most competitive as distances between origin and destination increase and as the volume of the goods increase. Given this, Australia's rail freight task is primarily made up of bulk commodities such as coal, grain and in particular iron ore. Rail is instrumental in the export of these commodities which are, in turn, instrumental in Australia's economy. Iron ore and coal exports make up almost 40% of the value of Australia's physical exports.

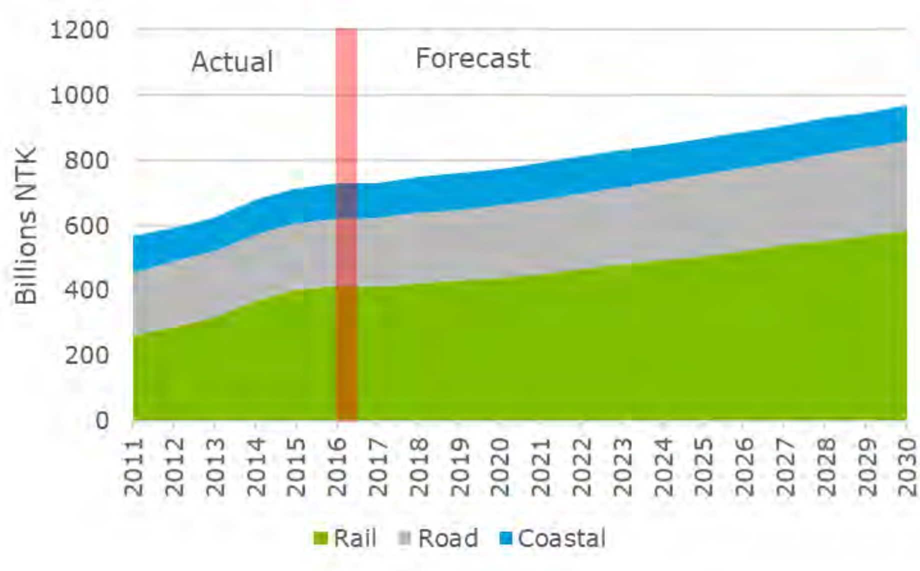
# Freight task

Australia's freight task has grown to 759.6 billion net tonne kilometres (ntk) in 2019, an increase of 4.1% since the previous Value of Rail report in 2017.[69] Rail freight is the main contributor to this new growth, accounting for 56% of the change over the period. This has led to rail being the largest part of Australia's freight task (56% in 2019) and rail is expected to maintain this status over the next ten years (growing to 60% in 2030) as shown in Figure 4.1.

## Rail freight

From 2011-2016 rail freight was the fastest growing of all the freight modes with a compound average growth rate (CAGR) of 9.6% a year and accounted for 93% of the total national freight task growth over the period. This coincided with the peak of the early 2010s' mining boom - with rail being the mode of choice for bulk commodity freight – leading to a once in a generation explosion in growth in rail freight.

**Figure 4.1: Australia's national freight task historical and forecast, 2019**




*Source: BITRE (2019); DAE (2020) forecasts*

*69 Estimates of Australia's freight task differ to those used in the previous Value of Rail report which derived from NTC (2016) Who Moves What Where. Estimates in this iteration come from a mixture of BITRE data and DAE modelling. Rail freight task estimates from BITRE end in 2015-16, while road freight ends in 2018-19 and coastal freight ends in 2016-17. Estimates of rail and road freight tasks after the end of their respective BITRE estimates derive from DAE modelling, while coastal estimates derive from BITRE forecasts. Important to note these estimates do not account for the impact of COVID-19 on freight demand and supply given data limitations when this report was produced.*

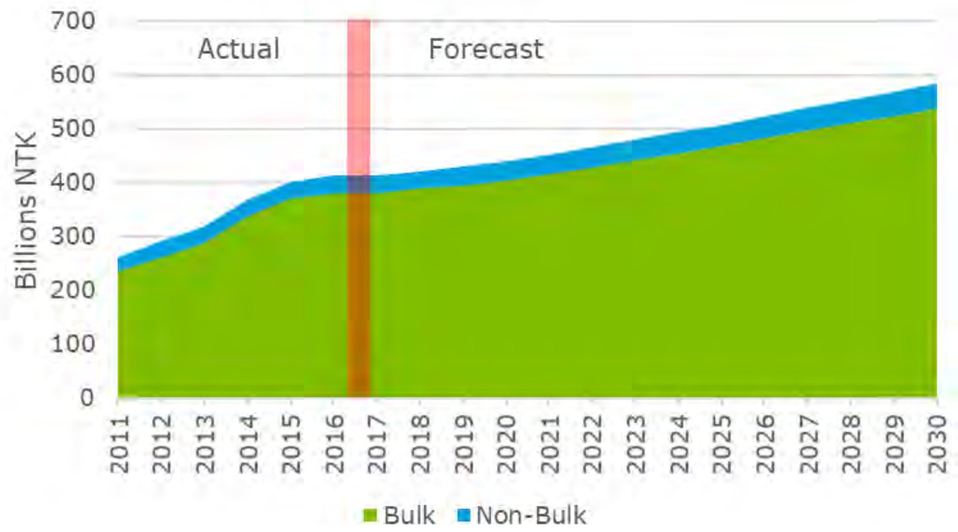
Despite the slow-down in growth since the mining boom, rail is still expected to be the fastest growing part of the freight task going forward. Overall, we estimate rail freight to grow by 41% between 2016 and 2030. This equates to a CAGR for rail of 2.5%, compared to road and coastal shipping at 2.0% and -0.1%, respectively, with rail freight accounting for 72% of the growth in freight over the period. Annually, this corresponds to an average increase of 39.66 million tonnes of goods moved by rail freight between 2016 to 2030, equal to the payload capacity of 894,452 B-Double Higher Mass Limit (HML) trucks.[70] However, these estimates do not incorporate the impact of COVID-19 on the national freight task.

Rail freight in Australia is predominately made up of bulk freight, estimated to be 395 billion ntk in 2019, nearly five times larger than bulk road freight's estimate that year.

Australia's rail freight task is set to grow by 41% between 2016 and 2030, more than any other freight mode. Equivalent to the payload of 894,542 B-Double trucks per year.

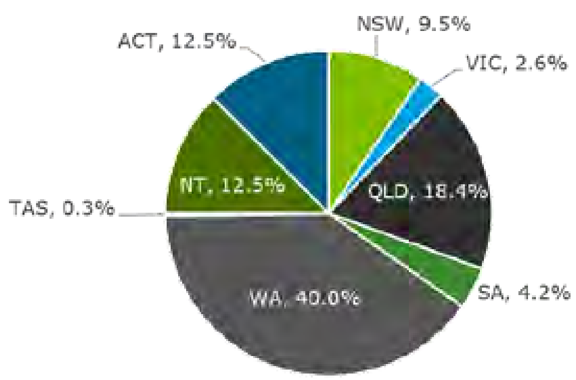
The breakdown between bulk and non-bulk in rail has been relativly stable in recent years, with an average of 91% between 2011 and 2016. Bulk's dominating share of rail freight is expected to be roughly the same for the foreseeable future at an average of 92% of total rail freight to 2030.

**Figure 4.2: Historical and forecast domestic rail freight task, 2019**




*Source: BITRE (2019); DAE (2020)*

**Figure 4.3: Rail freight task by state, 2016**




*Source: BITRE (2019); DAE (2020)*

*70 Assuming a maximum payload capacity of a B-Double HML Truck is 44.39 tonnes, taken from Australian Trucking Association (2018) Technical Advisory Procedure, available at: <https://www.truck.net.au/system/files/industry-resources/TAPs%20-%20Truck%20Impact%20Chart%20March%202018.pdf>*

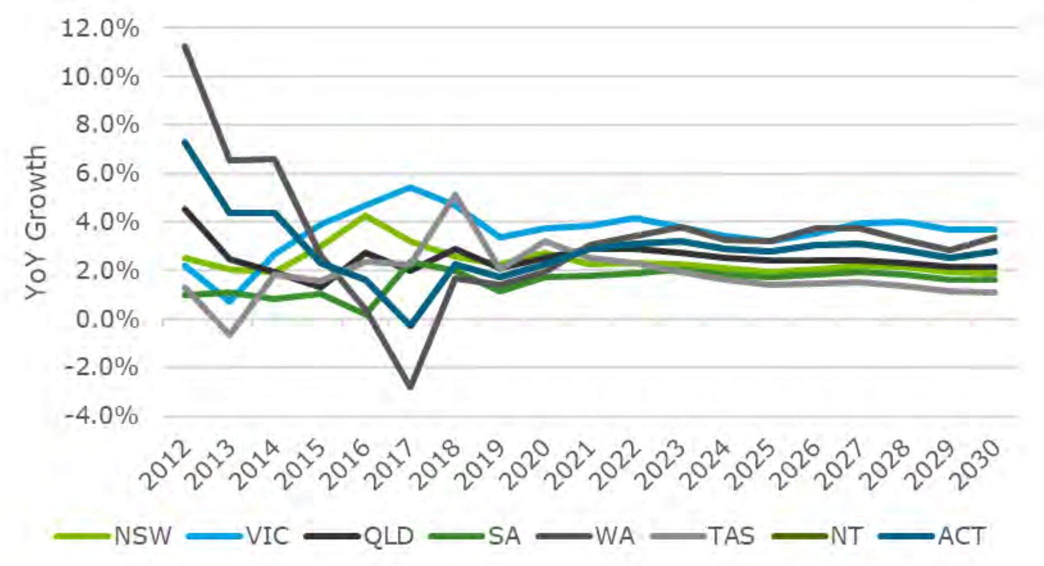
Bulk's dominance is not surprising when looking at the state breakdown below. Historically, the more resource intense jurisdictions have made up the majority of the domestic rail freight task, with Western Australia, Queensland and the Northern Territory accounting for over 70% of total rail freight in 2016.[71]

These resource intensive states were the main drivers of growth during the early 2010s, particularly Western Australia. On average, rail is the most efficient means of moving large volumes of commodities from pit-to-port, leading rail freight to be the mode of choice for coal and iron ore exporters. For an example, according to BITRE, 62% of the national rail freight tonnage is derived from Pilbara iron ore transport.[72]

However, as the mining boom slowed down so too did rail freight growth in these states. The following years saw a significant decline in growth rates for these regions, with growth in Western Australia dipping to a low of -2.8% in 2017.

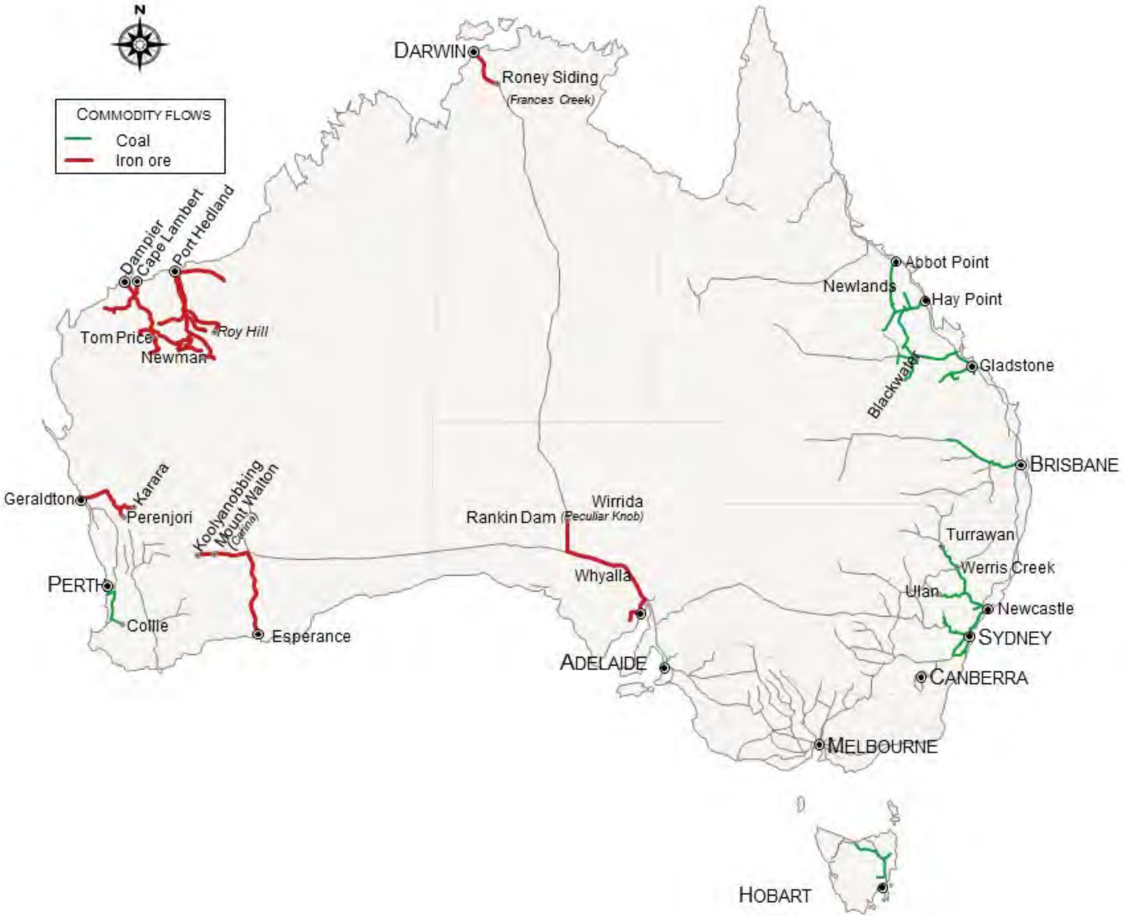
Despite this, we estimate that growth will largely stabilise over the period of 2019 to 2030, with the highest CAGR being that of Victoria at 3.7% and the lowest in South Australia at 1.8%. Despite Victoria's status of highest growth, this is from a relatively low base, increasing its share of the national rail freight task from 2.9% to 3.1% before accounting for the impact of COVID-19. As the impact of COVID-19 has been particularly severe in Victoria, the state rail freight task may differ.

**Figure 4.4: Year on year growth rates of rail freight task by state, 2019**




71 *DAE modelling using BITRE estimates of state breakdowns that ended in 2009-10.*
72 *BITRE (2019) Trainline 007, available at: <https://www.bitre.gov.au/sites/default/files/publications/train_007.pdf>*

**Figure 4.5: Principal commodity flows**




*Source: BITRE (2019)*

On the other hand, Western Australia is expected to increase its share from 38.6% to 40.3% of the national rail freight task between 2019 and 2030. Again, this is largely driven by its predominance in mining.[73]

Growth in bulk and non-bulk freight given above derives largely from forecasted population and GDP growth rates, with particular export commodities and projects playing a large role in bulk freight. Growth in bulk freight has been significant and has largely been driven by increased mining output. and this is expected to continue but at a lower – more incremental – pace. Non-bulk rail freight, on the other hand, has shown modest growth historically and we expect this trend to continue with potential upside from major changes such as Inland Rail (see case study below).

## Road freight

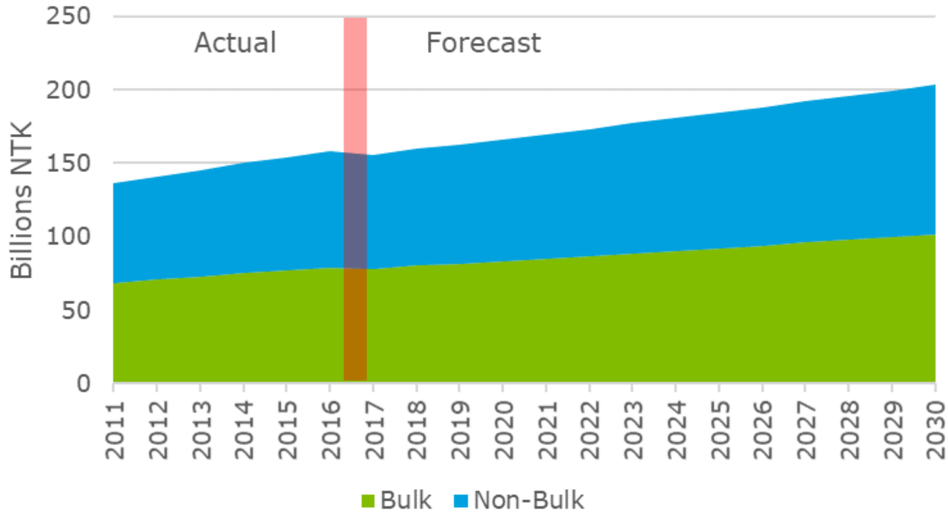
While rail dominates bulk freight movements, non-bulk freight is more mixed. The majority of non-bulk freight is moved on roads. Non-bulk is the main type of road freight and is expected to be well into the future. The non-bulk market is highly competitive with a range of factors affecting whether road, rail, sea or air is most competitive. Road excels at transport in urban areas, over short hauls, on short notice and when time is critical. Rail tends to become more competitive when distances between destinations are greater, when freight movements are consistent over the longer term and when the timing isn't critical. In addition, short haul rail is relatively more efficient compared to road, with one short haul port train able to carry a payload equivalent to 41 B-Double Higher Mass Limit (HML) trucks.[74]

*73 Ibid*

*74 Assuming a representative short haul port train is made up of 24 loaded 60' wagons and a B-Double HML truck has the same characterstics used in the previous example.*

One short haul port train can carry as much as 41 B-Double trucks

**Figure 4.6: Historical and forecast domestic road freight task, 2019**

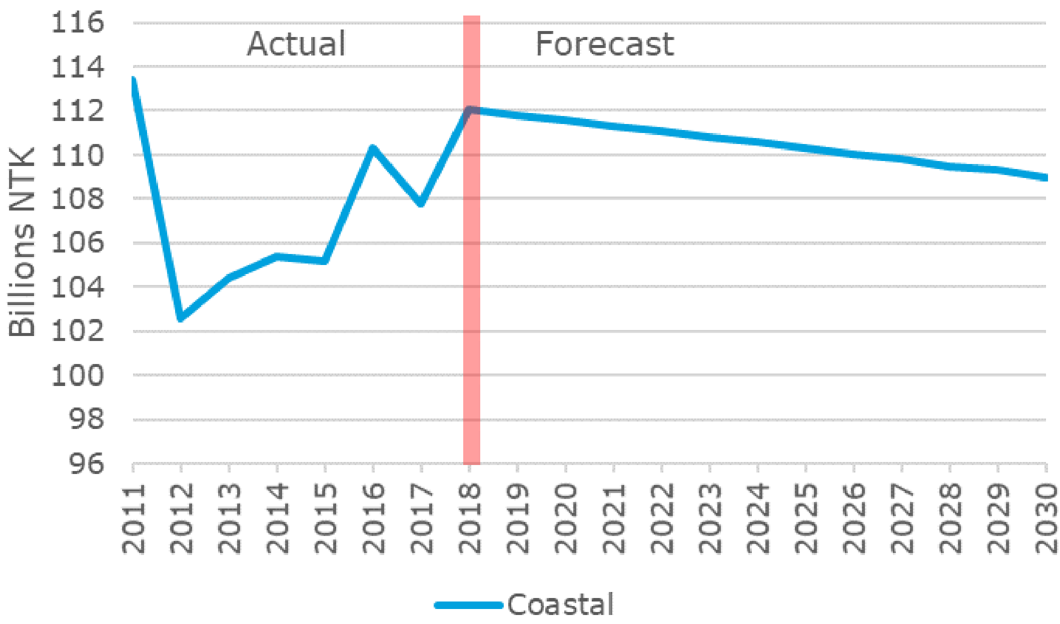



*Source: BITRE (2019); DAE (2020)*

## Coastal freight

Until the late 1970s, coastal freight made up the majority of Australia's national freight task, however the entire coastal freight task has largely stayed at the same level since this period.[75] With such stagnation, road and, in particular, rail overtook domestic coastal freight, with our estimates of the rail task being close to four times that of coastal in 2019. Given this, it is unsurprising that BITRE forecasts of the coastal freight task show largely similar levels to those seen historically.[76]

**Figure 4.7: Historical and forecast domestic road coastal task, 2019**




*Source: BITRE (2019)[77]*

75 Coastal freight is defined as domestic freight travelling from port-to-port by sea.
76 BITRE (2019) Australian aggregate freight forecasts – 2019 update, available at: <https://www.bitre.gov.au/publications/2019/australian_aggregate_freight_forecasts_2019>
77 BITRE forecasts do not provide bulk and non-bulk breakdown of freight tasks.

# Social and environmental benefits

In practice, prices paid by individual freight transporters do not necessarily reflect the actual costs incurred by freight activities. These unpaid costs or externalities are usually paid for by society. An inaccurate reflection of these prices distorts transport decisions by disadvantaging the socially optimal use of certain types of freight vehicles or rail.

Similar to the passenger section, the following modelling evaluates the extent of benefits of transporting freight using rail compared to road by estimating:

- The environmental benefits from reduced carbon emissions
- The safety benefits from reduced crash costs, and
- The health benefits from reduced air pollution.

## Environmental benefits

Rail accounts for over half of land-based freight transport, playing a very large role in the movement of goods around Australia. In 2017-18, road freight generated 32 million tonnes of CO2 equivalent emission while rail generated only 4 million tonnes in 2015-16. Even though road moves less goods, road freight generated almost nine times as much CO2 equivalent emission as rail freight. Table 4.1 shows that the difference in the carbon emission intensity of road and rail freight is estimated to be 0.14 kilograms of CO2 equivalent per tonne kilometre travelled.

> Rail freight produces 16 times less carbon pollution than road freight per tonne kilometre travelled.

The same social cost, used in the passenger section, of $74.30 per tonne of CO2 equivalent (2019 prices) is assumed to convert carbon emissions into a dollar value.[78] At this price, every tonne kilometre of freight transported using rail instead of road results in a reduction in carbon pollution cost of 1.01 cents.

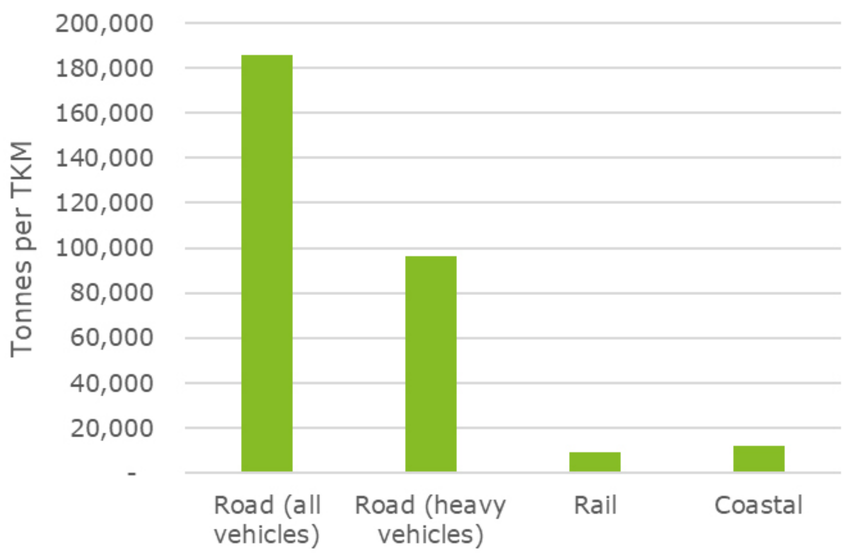
**Table 4.1: Carbon emissions of freight**

| | Total emissions (million tonne of CO2 equivalent) | Total distance travelled (billion tonne km) | Emissions/tonne km travelled (Kilograms of CO2 equivalent per tonne km) |
|---|---|---|---|
| Road in 2017-18 | | | |
| Light commercial vehicles | 11.3 | 5.4 | 2.07 |
| Rigid trucks | 8.4 | 39.0 | 0.22 |
| Articulated trucks | 12.3 | 175.6 | 0.07 |
| Total road | 31.9 | 220.1 | 0.15 |
| Rail in 2015-16(a) | | | |
| Total rail | 3.6(b) | 413.5 | 0.01 |
| Difference | | | 0.14 |

*Notes: (a) Estimate includes emission from power generation for electric rail. (b) Sum of electric and non-electric.*
*Source: Deloitte Access Economics estimates using BITRE (2006 and 2019)*

*78 Based on the numbers developed by US Interagency Working Group and adopted by the US Environmental Protection Agency, converted to $AUD and adjusted for inflation. This value is the standard value of carbon used by Deloitte Access Economics but does differ from values suggested in Australian Government guidelines.*

**Figure 4.8: Emissions intensity by freight modes (carbon dioxide equivalent), 2017**




*Source: BITRE (2019)*

Table 4.2 shows the possible reduction in carbon costs if a single container, with nine tonnes of freight in it, was moved by rail transport instead of road transport between some Australian cities. For example, a single container, weighing around nine tonnes transported from Melbourne to Brisbane using rail rather than road, can result in $173 of cost savings in carbon emission per year.

**Table 4.2: Example carbon cost savings for intercity freight, in 2019 prices**

| City | Sydney | Melbourne | Brisbane |
|---|---|---|---|
| Sydney | | | |
| Melbourne | $85 | | |
| Brisbane | $88 | $173 | |
| Perth | $378 | $316 | $465 |

*Notes: Distances are taken from BITRE (2019), rail emissions from BITRE (2009); assumption of 9 tonnes per vehicle.*

## Safety benefits

There are many more fatalities and injuries from road freight vehicles compared to rail freight. For example, every year an average of 80 workers are killed working in or around trucks and another 4,000 workers in the road freight sector is estimated to be injuried.[79] This is compared to the zero fatailies and injuries that occurred due to freight rail derailments and collisions in 2018-19.[80]

*79 WorkSafe Australia (2012) Infographic for Road Transport, available at: <https://www.safeworkaustralia.gov.au/system/files/documents/1704/infographic-road-transport-big-picture_0.pdf>.*
*80 The Office of the National Rail Safety Regulator (ONRSR) (2019) Rail Safety Report, available at: <https://www.onrsr.com.au/__data/assets/pdf_file/0004/25663/ONRSR-Safety-Report-2018-2019.pdf>.*

Using the same approach as in the passenger section, the human capital approach estimates that freight road accidents costs around $1.8 million in 2006 (in 2005-06 prices).[81] While the socio-economic costs of freight rail accidents are estimated to be $43 million in 1999 (in 1998-99 prices).[82]

Table 4.3 shows that this means the accident cost per tonne kilometre of freight moved in 2006 was 1.0 cents for road and 0.04 cents for rail in 1999. Converted to 2019 prices using inflation, the accident cost per tonne kilometre of freight moved for road was 1.4 cents and 0.1 cents for rail. Freight rail, therefore, saves 1.3 cents of accident costs per tonne kilometre of freight moved compared to road. The annual total crash costs for road freight in Australia is estimated to cost over $3,000 million compared to the $282 million for rail freight.

**Table 4.3: Crash costs from road and rail freight transport in Australia**

| Unit | Road | Rail |
|---|---|---|
| Total cost ($ million)(a) | $1,785 | $43 |
| Freight task (billion tonne km)(a) | 173 | 106 |
| Crash cost (cents per tonne km, in original prices)(b) | 1.0 | 0.04 |
| Crash cost (cents per tonne km, in 2019 prices) | 1.4 | 0.1 |
| **Avoided crash costs from using rail instead of road (cents per tonne km)** | | **1.3** |
| Total crash costs ($ million, latest date)(c) | $3,030 | $282 |

*Note: (a) Values refer to 2005-06 for road and 1998-99 for rail, (b) These figures are expressed in 2005-06 prices for road and 1989-99 prices for rail, (c) Values refer 2017-18 for road and 2015-16 for rail as they are the latest BITRE Yearbook statistics reported for the amount of domestic freight (bulk and non-bulk) by transport mode.*
*Source: Deloitte Access Economics calculations based on BITRE (2009b) and BTRE (2002).*

Road accident costs are 20 times higher than rail for every tonne kilometre of freight moved.

To put this figure into context we can look at the overall effect if a single container, weighing around nine tonnes and being transported between some Australian cities, was moved by rail transport instead of road transport. The total accident cost saved for various city combinations is given in Table 4.4.

This results in large cost savings if more freight was transported using rail rather than road. For example, a single container, weighing around nine tonnes was transported from Melbourne to Brisbane using rail rather than road, can result in $224 of cost savings in accident costs per year.

**Table 4.4: Example of avoided crash costs for nine tonnes of intercity freight moved by rail instead of road, in 2019 prices**

| City | Sydney | Melbourne | Brisbane |
|---|---|---|---|
| Sydney | | | |
| Melbourne | $109 | | |
| Brisbane | $114 | $224 | |
| Perth | $487 | $408 | $601 |

*Note: Distances are taken from BITRE (2019), assumption of 9 tonnes of freight.*

*81 This is calculated as 10% of the total $17.9 billion (in 2005-06 prices) of socio-economic costs from road accidents, per BITRE (2009) Cost of road crashes in Australia 2006, Research Report 118, available at: <https://bitre.gov.au/publications/2010/report_118.aspx>. This percentage was used as Table 5 in Laird, Philip (2005) Revised land freight external costs in Australia, available at: <https://ro.uow.edu.au/cgi/viewcontent.cgi?article=1765&context=infopapers> shows that around 10-11% of road crashes from 1999 to 2003 involved articulated trucks.*

*82 This is calculated as 30% of the total $143 million in 1999 (in 1998-99 prices) of socio-economic costs from rail accidents, per BITRE (2002) Rail accident costs in Australia, available at: <https://bitre.gov.au/publications/2003/report_108.aspx.> This percentage assumption was used per Laird, Philip (2005) Revised land freight external costs in Australia, available at: <https://ro.uow.edu.au/cgi/viewcontent.cgi?article=1765&context=infopapers>.*

## Health benefits

As stated in the passenger section, transport is one of the main contributors to air pollution in dense cities, resulting in negative health outcomes. Particulate matter causes breathing difficulties and exacerbates respiratory diseases, ultimately this leads to lower quality of life and reduced lifespans. These costs are particularly high for populations such as the elderly with respiratory and cardiovascular conditions as well as children with asthma are particularly vulnerable to these emissions.[83], [84]

Around 14.0 thousand tonnes of PM10 was emitted by motor vehicles (passenger and freight) in Australian metropolitan cities in 2018.[85]

Using the same approach in the passenger sections, 64% or 9.0 thousand tonnes of this is allocated to the road freight vehicle emissions using the freight and passenger splits from the Air Emissions Inventory for the Greater Metropolitan Region in NSW for PM10 in 2013.[86]

For rail freight, a similar approach to the passenger rail PM10 emissions was taken. Using the best estimate from available sources indicates that locomotives will produce around 1.52 thousand tonnes of PM10 in 2018.[87] Of these emissions, 95% or 1.45 thousand tonnes is attributed to freight rail using the proportion of annual diesel consumption between passenger and freight rail.[88]

Table 4.5 shows that adjusting for total tonne kilometre of freight moved, road vehicles generate around 41.5 kilograms of PM10 per million tonne kilometres of freight moved.

**Table 4.5: PM10 emissions from freight transport, 2018**

| | Total emissions (Million kg of PM10 equivalent) | Total distance travelled (Billion tonne km) | Emissions/km travelled (kg of PM10 per million passenger km) |
|---|---|---|---|
| Road vehicles | 9.0 | 216.2 | 41.5 |
| Rail | 1.5 | 413.5 | 3.5 |
| Difference | | | 38.0 |

83 Amoako, Lodh & Risbey (2005) Health impacts of transport emissions in Australia: Economic costs, available at: <https://www.bitre.gov.au/sites/default/files/wp_063.pdf> – Table 4.1
84 AMA (2013) Submission to the Senate Inquiry into the impacts on health of air quality in Australia available at: <https://ama.com.au/sites/default/files/documents/AMA_submission_inquiry_into_health_impacts_of_air_quality_.pdf>
85 BITRE (2003) Urban Pollutant Emissions from Motor Vehicles: Australian Trends to 2020, available at: <https://www.bitre.gov.au/sites/default/files/cr_002.pdf>
86 NSW EPA (2020) 2013 Calendar Year Air Emissions Inventory for the Greater Metropolitan Region in NSW, available at: <https://www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-inventory-2013>
87 NSW EPA (2013) Locomotive Emissions Project, available at: <https://www.epa.nsw.gov.au/~/media/EPA/Corporate%20Site/resources/air/locoemissrep.ashx>
88 Ibid.

While freight rail generates 3.5 kilograms of PM10 per million tonne kilometres of freight moved.

Rail freight generates 92 per cent less PM10 than road freight for each tonne kilometre of freight moved.

The damage cost of $267 (2019 prices) per kilogram of PM10 emitted in capital cities is used to convert the health impacts of PM10 into a dollar value (see the passenger section for details around why this price is used).[89] At this price, every tonne kilometre of freight moved using rail instead of road results in a reduction in PM10 health costs of 1.01 cents.

Table 4.6 shows the possible reduction in pollution costs if a single container, weighing nine tonnes, was moved by rail transport instead of road transport between some Australian cities. For example, a single container, weighing around nine tonnes was transported from Melbourne to Brisbane using rail rather than road, can result in $173 of cost savings in PM10 health costs.

Every tonne kilometre of freight moved using rail instead of road results in a reduction in PM10 costs of around 1 cent.

**Table 4.6: Example PM10 savings for intercity freight, in 2019 prices**

| City | Sydney | Melbourne | Brisbane |
|---|---|---|---|
| Sydney | | | |
| Melbourne | $85 | | |
| Brisbane | $88 | $173 | |
| Perth | $377 | $316 | $465 |

*Notes: Distances are taken from BITRE (2019), rail emissions from BITRE (2009); assumption of 9 tonnes per vehicle.*

89 Department of Infrastructure and Regional Development (2016) Vehicle emissions standards for cleaner air, available at: <https://www.infrastructure.gov.au/vehicles/environment/forum/files/Vehicle_Noxious_Emissions_RIS.pdf>

# Modal shift

As given by our discussion of the benefits associated with rail as well as the case studies above, modal shift away from road to rail will reduce the social costs created through emissions, crashes and accidents and health costs from particulate matter. The below briefly identifies the extent of each these costs, given a 1% shift in the national freight task.[90]

## Accidents

With a total cost difference 13 cents per tonne kilometre (tkm), a 1% shift away from road to rail will reduce accident costs nationally by $28.6 million a year. To see the impact at a more granular level, the below table looks at the overall reduction in accidents from a shift of freight from road to rail per TKM between the major cities in Australia.

**Table 4.7: Example of avoided crash costs for intercity freight moved by rail instead of road per TKM, in 2019 prices**

| Accidents ($) | Sydney | Melbourne | Brisbane |
|---|---|---|---|
| Sydney | | | |
| Melbourne | $12.16 | | |
| Brisbane | $12.63 | $24.87 | |
| Perth | $54.13 | $45.38 | $66.74 |

## Emissions

> A 1% shift of freight moved from road to rail will reduce accident costs nationally by $28.6 million a year.

As seen above, road is substantially more carbon intensive than rail on a TKM basis with a difference of 14 cents. With a 1% modal shift away from road, this would result in reduction in emissions nationally of 330,150 tonnes of $CO_2$ equivalent, reducing the cost of environmental damage by $22.9 million

**Table 4.8: Example of reduced emissions costs for intercity freight moved by rail instead of road per TKM, in 2019 prices**

| Carbon emission ($) | Sydney | Melbourne | Brisbane |
|---|---|---|---|
| Melbourne | $9.42 | | |
| Brisbane | $9.78 | $19.28 | |
| Perth | $41.95 | $35.16 | $51.72 |

## Health benefits

There are also health benefits associated with increasing the rail freight task as demonstrated above. With a 1% modal shift away from road, this would result in reduction in health costs caused by PM10 emissions nationally by $20.5 million annually. To see the impact at a more granular level, the below table looks at the overall reduction health costs due to PM10 emissions from a shift of freight from road to rail per TKM between the major cities in Australia.

**Table 4.9: Example of avoided health costs for intercity freight moved by rail instead of road per TKM, in 2019 prices**

| PM10 ($) | Sydney | Melbourne | Brisbane |
|---|---|---|---|
| Melbourne | $8.63 | | |
| Brisbane | $8.96 | $17.65 | |
| Perth | $38.42 | $32.20 | $47.37 |

## Summary benefits

Total benefits described above amount to $71.9 million for a 1% modal shift from these three forms of social costs. It is important to note that these are not the only costs that derive from a shift from road to rail, such as benefits associated with reduced degradation of roads. Therefore, this is only an indicative estimate and the true benefit could be different. The below totals the safety, emissions and health costs above per TKM between the major cities.

**Table 4.10: Example of reduced safety, emissions and health costs for intercity freight moved by rail instead of road per TKM, in 2019 prices**

| Total costs saved ($) | Sydney | Melbourne | Brisbane |
|---|---|---|---|
| Melbourne | $30.20 | | |
| Brisbane | $31.37 | $61.80 | |
| Perth | $134.49 | $112.74 | $165.83 |

> A 1% shift of freight moved from road to rail will reduce accident, emission and health costs nationally by $71.9 million a year.

90 *Incorporating the BITRE estimate of 220.1 billion tkm in 2018-19*

## Case studies

The benefits given in section 4.2 have real world implications, with this section putting these benefits into a more tangible context.

The calculated values in these case studies are indicative as the external costs and benefits associated with modal shifts in this section primarily focus on the categories discussed in section 4.2: safety, emissions and health. While these are important and large contributors to the costs and benefits that might not be reflected by the price of a particular freight mode, they are not the only ones. There are many more factors such as convenience, local infrastructure needs and regulatory constraints that have not been accounted for.

### Increased costs in the Eyre Peninsula from the loss of rail

In 2019, grain movements on the Eyre Peninsula in South Australia were transferred from rail and onto road.

With this shift, approximately 97 million ntk of grain previously being moved by rail in an average year to Port Lincoln will now be moved by road freight and this is likely to be the case for the next few decades.[91] The reasoning behind this shift has been attributed to the capital costs associated with upgrading the rail infrastructure of the region.

The shift from rail to road will bring greater costs in the form of emissions, accidents and damage to roadways that will ultimately be borne by the community and have significant implications for local infrastructure. Using the national averages given in the previous section,[92] we estimate the shift from rail to road will increase emissions, safety and health costs by approximately $3.2 million a year, with a 30-year net present value of $38.9 million.[93]

This could mean an average increase of 13,560 tonnes of CO2 equivalent per year, corresponding to average annual cost of just over $1 million. Accident costs might increase by $1.26 million on average. In addition, the cost in health PM-10 emissions may rise by $0.9 million. However, these costs may differ given a specific site, fleet, technology and — in the case of the health costs — the population density near the road and rail networks.

**Figure 4.9: Rail network on the Eyre Peninsula**


*Source: SMEC (2018)*

*91 Freight task given from consultation with One Rail Australia*
*92 Note: these are applying national averages to a local context due to data availability. Emissions and accidents distributions per ntk are likely to differ between a national and local level.*
*93 Utilising a 7% discount rate*

Additional costs will also likely include upgrades to the road network in order to accommodate the extra traffic. For instance, Lincoln Highway, Bratten way and Tod Highway have been highlighted as routes that currently lack overtaking opportunities, narrow roads or bridges and pot holes among others.[94] By increasing the traffic of heavy vehicles on the network, repair costs will likely need to see a commensurate increase to ensure current road standards are maintained.

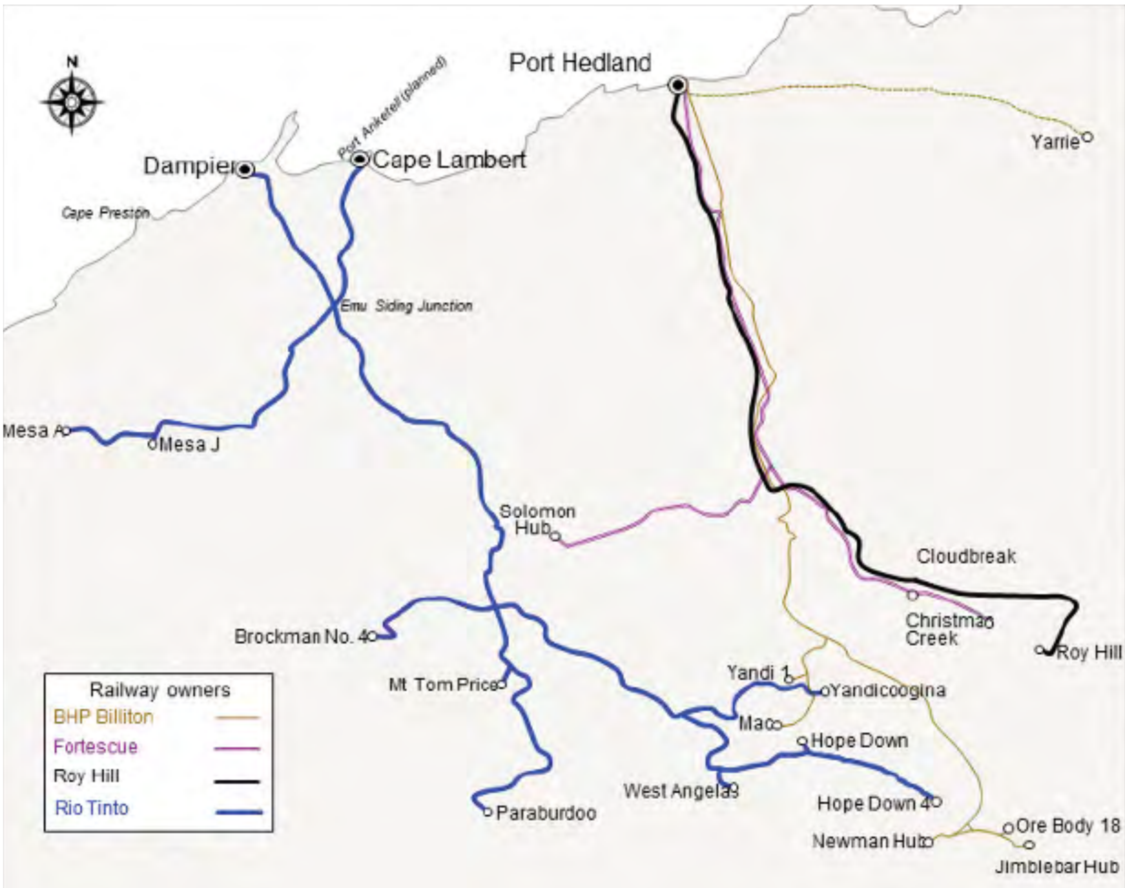
As the freight operator does not currently bear these sorts of external costs, this would favour a cost-benefit scenario of switching to road-based freight compared to the real capital costs that the freight operator would bear to upgrade the rail network of the region. This illustrates some of the issues of market failures, where negative externalities are not appropriately priced and incorporated into a cost-benefit framework, where a change of behaviour might be financially more efficient but will bring greater societal costs.

A shift from rail to road on the Eyre Peninsular could result in a 15x increase in emissions costs and a 14x increase in accident costs

## The crucial role of rail in the Pilbara

Australia is a global leader in the mining of iron ore accounting for approximately 29% of global reserves and 36% of output in 2018, adding $45.5 billion to the Australian economy in direct output.[95,96] Of Australia's total iron ore production, 92% is located in Western Australia, the largest concentration of which are based in the Pilbara region. Port Hedland is the main port for many of the iron ore operators, seeing 506.6 million tonnes (Mt) of iron ore exports in 2018/19,[97] accounting for 56% of the entire domestic production.[98] Given the scale of the task in the region, rail is the most efficient means for transporting iron ore from pit-to-port.

**Figure 4.10: Rail operations in the Pilbara**




*Source: BITRE (2019)*

94 SMEC (2018) Eyre Peninsula Freight Study, available at: <https://www.dpti.sa.gov.au/__data/assets/pdf_file/0008/540872/Eyre_Peninsula_Freight_Study.pdf>
95 Geoscience Australia (2019) Australian Resource Reviews Iron Ore 2019, available at: <https://d28rz98at9flks.cloudfront.net/134851/134851_00_0.pdf>
96 ABS (2019) Cat.5204.0 Australian System of National Accounts - Table 5 Gross Value Added (GVA) by Industry
97 Pilbara Ports Authority (2020) Pilbara Ports Authority Annual Report 2018-19, available at: <https://www.pilbaraports.com.au/about-ppa/publications/annual-report>
98 Geoscience Australia (2019) Australian Resource Reviews Iron Ore 2019, available at: <https://d28rz98at9flks.cloudfront.net/134851/134851_00_0.pdf>

Iron ore production in the Pilbara is some of the most efficient mined in the world, with output from Fortescue and BHP costing only US$12.54 and US$13 per wet metric tonne (wmt), the lowest of any of the major international competitors.[99] With the distances between pit-to-port being quite vast, rail is a key contributor to keeping iron-ore from the region globally competitive despite these barriers.

The rail network underpinning these operations totals 3,664 km.[100] Despite the remoteness of the location and length, rail line operations in the region are world leading with the network having some of the highest axle loads in the world and some of the most innovative technologies. This includes the introduction of the world's first fully automated heavy-haul rail network, with the capability of moving a million tonnes of bulk haul a day, a feat only capable on rail.[101] Each automated train can move 28,000 tonnes per trip, equivalent to 631 B-Double trucks, with the daily network capability equivalent to 22,553 B-Doubles.[102]

The payload capacity of one automated train in the Pilbara is equivalent to 631 B-Double trucks.

To understand the cost savings associated with moving iron ore by rail to Port Hedland, we first need to estimate the total freight task be undertaken. Data on this is actually limited with an indicative value being derived from comparing two approaches to estimating the task.[103] From this we estimate the total rail freight task to be 246.6 billion tonne km a year, at present.

Given the extent of the iron ore freight task to Port Hedland, rail is the only logical choice. For example, even if the task was complete with BAB Quad trucks operating at Higher Mass Limits (HML) it would still require about 2.7 billion truck movements per year – an impossible task. To convey the extent of this, our estimate indicates that even a 10% shift from rail to road would result in a combined environmental and accident cost worth $577 million annually.

Just over 44% of this cost would derive from emissions, which would jump dramatically by an average of 3.4 million tonnes of CO2 equivalent every year. This equates to 0.9% of Australia's entire emissions output in 2018.[104] As with our other case study examples, these estimates are indicative as national averages have been applied to regional freight tasks.

Rail in the Pilbara saves billions of dollars in reduced costs to the environment and from accidents

## Inland Rail opens up the Toowoomba to Perth corridor

Currently, the only method of rail transit from Brisbane to Melbourne is through Sydney, which has become less competitive than road due to its network length, negotiating through Sydney rail traffic as well as tunnels that prevent double stacking.

Inland Rail is Australia's largest rail infrastructure project intended to reduce costs of freight and increase linkages between the east and west coast. This will result in a 1,700 km of freight rail network from Brisbane, bypassing Sydney, through to Melbourne. The project focuses on upgrading 1,100 km of existing track while also building 600 km of new track.

The critical components of the project are the intermodal terminals located at Parkes, NSW and Toowoomba, QLD. In Parkes, freight is able to change from the Brisbane to Melbourne route with Adelaide and Perth, allowing access to the west coast from Brisbane, which was previously not achievable.

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*99 Q4 2019 comparison of cost per tonne of production taken from Fortescue, Vale, Rio Tinto and BHP Billiton quarterly production reports*

*100 Found on the websites of the major network operators/owners seen given Figure 4.10. This includes BHP (1,000km), Rio Tinto (1,7000km), Fortescue (620km) and Roy Hill (344km)*

*101 Rio Tinto (2020) Pilbara, available at: <https://www.riotinto.com/en/operations/australia/pilbara>*

*102 Assuming a maximum payload capacity of a B-Double HML Truck is 44.39 tonnes, taken from Australian Trucking Association (2018) Technical Advisory Procedure, available at: <https://www.truck.net.au/system/files/industry-resources/TAPs%20-%20Truck%20Impact%20Chart%20March%202018.pdf>*

*103 To derive at our estimate, we utilised two methods. Available data includes the 2018-19 iron ore tonnage that passes through Port Hedland, the 2011-12 rail freight task and volume in the Pilbara from BITRE (2014) Freightline 2 and the current rail network to Port Hedland. Our first approach scales up the BITRE estimate of the iron ore freight rail task to Port Hedland in 2011-12 by the growth in iron ore movements through Port Hedland between 2011-12 and 2018-19, arriving at an estimate of 172.2 billion tkm. The second approach takes a weighted average of the BHP, Fortescue and Roy Hill's rail journey to Port Hedland based on each companies respective current rail network and 2011-12 volume output from BITRE estimates, multiplying this by the total iron ore tonnage from 2018-19, resulting in an estimate of 321 billion tkm.*

*104 Our World in Data (2020) Annual production-based emissions of carbon dioxide ($CO_2$), measured in tonnes per year available at: <https://ourworldindata.org/co2-emissions>*

Not only do the intermodal terminals increase freight accessibility but they will also connect regional centres with global supply chains, spurring development. Intermodal operations at Parkes will increase its role as a key location for logistics, increasing the need for firms in freight handling, maintenance, and logistics to move to the region and allow last leg operations by road freight to their customers final destination. This in turn will stimulate the local economy through the indirect value add from the increase in employment and activity due to the freight operations resulting in a multiplier effect.

Toowoomba will also benefit from being one of the main intermodal terminals. Given its importance as a large regional centre known for its strength in the agricultural industry, increased access to the rest of the east coast (and through Parkes the west coast) will facilitate more efficient trade and opportunities. On top of this, plans for Inland Rail beyond Toowoomba are still being finalised, and therefore Toowoomba is well placed to be a significant logistics hub much like Parkes in facilitating final destination road freight to Greater South East Queensland.

As Parkes also sits on the East-West rail line connecting to Perth, the connection between Toowoomba and Parkes will significantly open up rail movements between Queensland and Western Australia compared to current circumstances. Inland rail will reduce the emissions and accident costs as more of the freight task between Brisbane to Perth with likely modal shift from road to rail. We estimate the road task between the two cities to be approximately 1.23 billion ntk in 2018-19 and therefore a 50% shift in this task could result in a combined reduction in emissions and accidents costs by $14.4 million annually. [105],[106]

Benefits will also arise from a rise in trade opportunities due to increased accessibility. After accounting for the differences in the size of state economies, if the trade between Queensland and Western Australia was similar to the level of trade between New South Wales and Western Australia,[107] then there would potentially be an additional 450kt of freight moved each year, which would be approximately 1.9 billion ntk. Toowoomba is only 6% further from Perth than Sydney, suggesting that the difference in level of trade likely reflects the historically poor rail connections between Queensland and Western Australia and not just additional distance.

105 *ABS (2015) Road Freight Movements, Australia, 12 months ended 31 October 2014; BITRE (2019) BITRE Statistical Year Book*
106 *Scaling the most recent ABS estimates of road freight origin-destination tables from 2014 between states.*
107 *BITRE (2010) Interstate freight in Australia; ABS (2007) Australian National Accounts: State Accounts*

**Figure 4.11: Inland Rail alignment**


*Source: Inland Rail (2019)*

SUSTAINABLE DEVELOPMENT GOALS

# The sustainable value of rail

The rail industry is widely acknowledged for the sustainability benefits it delivers. There are a number of ways the rail industry aligns with the UN's Sustainable Development Goals.

### GOOD HEALTH AND WELLBEING

When people travel by rail, they increase how much they are moving and contribute to reduced air pollution, supporting good health and well being for people of all ages.

### DECENT WORK AND ECONOMIC GROWTH

In 2019, the rail industry supported more than 165,000 workers through direct and indirect jobs, providing quality work for more people.

### INDUSTRY, INNOVATION AND INFRASTRUCTURE

In 2019, increased investment saw more activity in construction, property and finance, contributing to the sustainable development in our community.

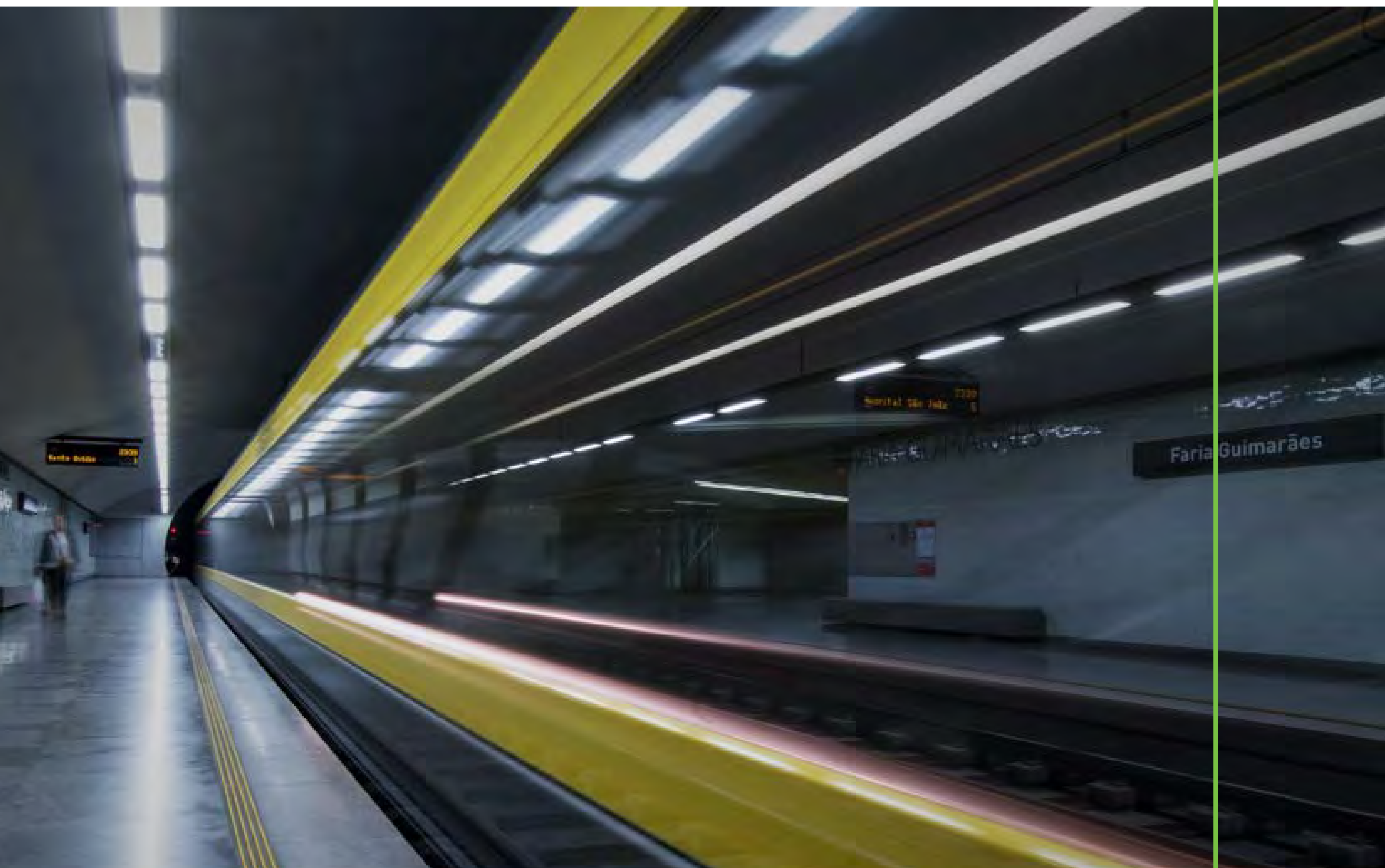
### SUSTAINABLE CITIES AND COMMUNITIES

More than 836,000 people rely on rail to get to work, helping cities function effectively and providing access to transport for all members of the community.

### CLIMATE ACTION

Commuting on the train instead of using a car for a year is the equivalent of planting 1.8 trees. Rail travel contributes to the fight against climate change.

# **5.** Future of rail



This report has shown that rail contributes significantly to Australia's economy both in dollar terms through employment, wages and value add as well as by generating social and environmental benefits – every passenger or tonne of freight on rail reduces carbon emissions, reduces accidents, lowers congestion and provides health benefits.

For example, every commuter that moves to rail can generate benefits for society of up to $15 a trip while a tonne of freight transported between Sydney and Melbourne by rail generates benefits of around $30.

Rail's ability to continue making, and increasing, this contribution is dependent on growing, adapting and improving. Based on discussions with the ARA as well as a review of recent, relevant industry and government reports, there are a number of focus areas for the rail industry to ensure the industry's value is achieved.

## Getting the investment decision right

The potential benefits of rail aren't fully captured in current approaches to choosing which transport projects are invested in. The current guidelines, i.e. the National Guidelines for Transport System Management in Australia, are based on figures that, in some cases, date back decades and don't reflect the current contribution of rail. For example, in the national guidelines for transport assessment, the value of carbon used is around $10 a tonne, well below most current valuations, and costs associated with air quality find their way back to a 1999 working paper.

As an example, Table 5.1 compares the estimated cost savings from shifting urban freight from road to rail between the National Guidelines for Transport System Management in Australia and this report. Our report estimates that air pollution and greenhouse externality savings from shifting freight from road to rail is much larger than what is used in project assessments. With the addition of accident costs, the positive benefits for society of shifting freight from road to rail is more than twice what is estimated in the national guidelines.

It's clear that these values need to be updated and this report shows that the social and environmental benefits of rail aren't stagnant, they are growing over time and this needs to be reflected in how rail projects are assessed.

**Table 5.1: Comparison of cost savings from shifting urban freight from road to rail between the National Guidelines for Transport System Management in Australia and this report, in 2019 prices**

| Externality savings (cents) from moving from road to rail per ntkm | National Guidelines for Transport System Management in Australia | This report |
|---|---|---|
| Air pollution | 0.89 | 1.01 |
| Greenhouse/climate change | 0.06 | 1.01 |
| Noise | 0.15 | |
| Water | 0.13 | |
| Nature and landscape | 0.25 | |
| Urban separation | 0.19 | |
| Accidents | | 1.31 |
| Total savings | 1.67 | >3.34 |

*Source: Australian Transport Council (2006) and Deloitte Access Economics*

## Getting the price right

Australia's approach to charging for transport is on the cusp of change. Excise tax is facing a long-run decline and the potential for revolutions in vehicle ownership due to autonomous and shared vehicles – which will lower registration revenues. This presents the opportunity to go one step better than ensuring that rail's true benefits are captured when choosing between projects and to actually reflect the benefits of rail in the price that transport users face.

This could take many forms but an area that is primed for focus is the pricing of congestion. Congestion costs have been frequently estimated for Australia and often fall in the range of around $20 billion a year. The technology needed for congestion pricing is now straight forward, and most Australian Governments have access to real-time data on the performance of key routes as well as access to electronic tolling in most vehicles. The congestion benefits of rail are already, to some extent, recognised in subsidisation of fares for peak-time commuters. Pricing congestion accurately would help fix a widening revenue gap for governments, reduce costs for society, build on current policy towards alleviating congestion and wouldn't be hard to implement. A congestion tax has seen support from organisations such as Infrastructure Australia and the Grattan Institute.

Updated metrics can include the costs of the road maintenance, for example, the forecasted increase in rail patronage of 2% per year will result in $15 million saved from road maintenance costs each year. Other updated metrics to help get the price right include incorporating some of the measures in this report, such as safety benefits from reduced fatal and serious injuries, health benefits including reduced air pollution and increased exercise.

## Strengthen opportunities for Australia's domestic manufacturers to compete

Experiences during COVID-19 have prompted a public discussion about the reliability of global supply chains and to what extent Australia needs local manufacturing capabilities to deliver critical transport infrastructure and services.

Expanding opportunities for local suppliers to compete does not need to involve direct subsidies or blunt procurement regulations favouring Australian suppliers. Instead, a broad based view across procurement, skills and commercial arrangements could help ensure Australia's manufacturing sector has appropriate opportunity to participate over the longer term. Australian Governments could coordinate ordering to create more reliable pipelines of work for local manufacturers. Governments could work with industry to identify any barriers to competitiveness in the local industry, such as skills/labour market issues or regulation. Governments can look for opportunities for local players to participate in procurements through components, maintenance and repairs.

Strengthening opportunities for domestic manufacturers could enhance competitive tension, and create more economic stimulus in regional areas; our analysis shows the majority of rail manufacturing is done regionally.

The increasing use of automated and connected technologies combined with the critical role that rail transport plays in our economy suggests that Australia may need to enhance its domestic capabilities in areas such as cyber-security and telecommunications in rail in particular.

## Invigorate containerised rail freight

Rail excels at carrying bulk commodities like iron ore and this is where most of the growth in rail freight has been in the last few years. There is, however, room to enhance rail's role in containerised freight over long and short distances. If rail's share of containerised freight could be increased then there would be significant environmental, social and economic benefits.

For containerised rail freight to work for Australia's industries there needs to be an improvement in both hard and soft infrastructure. Significant investments in containerised freight infrastructure will be coming online in the next few years -- Inland Rail in particular -- but there are still gaps for containerised freight in densely populated metropolitan areas. These gaps will need to be assessed, prioritised and filled in over time.

Soft infrastructure (the rules, processes, regulations and incentives) that are in place around containerised rail freight are just as critical as the underlying hard infrastructure. We can make the most of the multi-billion investment in hard infrastructure by improving the soft infrastructure.

Soft infrastructure is more difficult to improve than hard infrastructure and requires dedicated and focussed interventions that combine industry and government. For example, Heavy Vehicle Road Reform is focussed on changing the soft infrastructure around road transport in Australia and features prominently in transport and infrastructure department priorities. The Rail Action Plan sets out high level goals around skills and labour, standards and interoperability that will need to be supported through a soft infrastructure focus – rail could look towards a Containerised Freight Rail Reform agenda that extends across the country.

## Use information to benefit the customer in both passenger and freight

In the passenger segment, the role of rail is to safely deliver passengers from where they are to where they want to be. Changes in technology are, however, creating the opportunity to make this experience more streamlined and enjoyable for passengers. In particular, the internet of things combined with real time data analysis opens up new possibilities. One example includes how Australia's rail industry has demonstrated some of the potential here with real time updates on available capacity in response to COVID-19.

In the long run, this could be extended with real-time data and/or internet of things to manage and streamline the flow of passengers – collecting data on the number of passengers waiting at the stations, in each carriage and at different times of the day. This can be used to optimise services based on commuters' needs and demands and ultimately increase the number of people likely to use trains.

Using information to enhance passenger experience will need to be just one aspect. To ensure ongoing appeal for customers who will have an increasing array of travel options available to them will require improvements in other areas such as the quality of the passenger carriage fleet, first and last mile journey improvements, safety while travelling and accessibility of stations.

Similarly, in freight, there is a significant opportunity from using GPS, telematics and big data analysis to enhance our understanding of freight movements. Better freight data will allow industry and government to invest more wisely and ultimately improve outcomes for freight customers.

# **Appendix A.** Economic contribution modelling

## Methodology for the overall economic contribution

The analysis chiefly relies on the ABS 2016-17 Input-Output (IO) tables. IO tables show an industry's compensation to employees, gross operating surplus and an industry's purchase of intermediate goods by industry.

The first task in estimating the economic contribution of the rail industry is to define the scope of the rail industry. Defining the industry is complex as there are a number of Input-Output Industry Groups (IOIGs) with rail-related activities. However, for many of these industries, rail activities only make up a proportion of the entirety of the industry's value added.

Seven IOIGs were identified as rail-related using the Australian and New Zealand Standard Industrial Classification (ANZSIC). Of these industries, there are two core rail industries: Railway Rolling Stock Manufacturing (IOIG 2303) and Rail Transport (IOIG 4701). These two IOIGs are entirely part of the rail industry.

The other five industries were partially included as rail industries based on the extent to which they interact with the two core industries. For instance, the Rental and Hiring Services IOIG is, for the most part, not rail related; however, the industry group includes railway stock leasing activities.

Roughly 0.5% of the industry is estimated to interact with the Railway Rolling Stock Manufacturing or Rail Transport industries, so 0.5% of the Rental and Hiring Services industry was counted as part of the rail industry and the other 99.5% was treated as non-rail in the modelling. The full list of industries included in the definition of the rail industry is included in the table below.

**Table A.1: IO industries included in the rail industry**

| Code | Input-Output industry groups | Rail-related activity | Inclusion |
|---|---|---|---|
| 2303 | Railway Rolling Stock Manufacturing | Rolling stock manufacturing | Total |
| 4701 | Rail Transport | Freight and passenger rail services | Total |
| 301 | Forestry and Logging | Railway sleeper hewing | Partial |
| 2004 | Plaster and Concrete Product Manufacturing | Concrete railway sleeper manufacturing | Partial |
| 3101 | Heavy and Civil Engineering Construction | Railway permanent way construction and repair, subway construction and railway bridge construction | Partial |
| 4801 | Water, Pipeline and Other Transport | Scenic railway operations | Partial |
| 5201 | Transport Support services and storage | Rail freight forwarding, railway container terminal operation, railway station operation and railway stock leasing | Partial |
| 6601 | Rental and Hiring Services | Railway stock leasing | Partial |

# Appendix B. Sensitivity analysis

The price of carbon has bearing of the emissions externalities benefit from rail calculated in Chapter 2 and 3. However, there are a number of factors that make pricing carbon challenging. For example, the effect of today's emissions will happen from now into the distant future.

Further challenges include that the magnitude of effects are highly uncertain, impacts are felt globally, and they depend on the trajectory of emissions over time (that is, the damages depend on the level of greenhouse gas concentration already in the atmosphere).

For these reasons, the assumed carbon cost of $74.30 per tonne is not necessarily representative of the true cost of carbon emissions. Table B.1 therefore uses a range of carbon costs to derive unit values of avoided carbon emissions from replacing road by rail transport.

**Table B1: Avoided carbon costs from using rail instead of road transport at different carbon prices, in 2019 prices**

| Carbon price ($/tonne) | Avoided emissions cost (cents/passenger km) |
|---|---|
| 20.00 | 0.09 |
| 50.00 | 0.23 |
| 74.30 | 0.33 |
| 75.00 | 0.34 |
| 100.00 | 0.45 |

The cost of congestion is also difficult to assess. Different values for travel time savings significantly alter the values calculated. Table B.2 sets out a sensitivity analysis for the value of time, using plus and minus 20% of the parameter values set. This accounts for the uncertainty of the correct value of travel time which is difficult to measure empirically.

**Table B2: Avoided congestion costs sensitivity analysis, in 2019 prices**

| City | Core estimate | VTTS +20% | VTTS -20% |
|---|---|---|---|
| Sydney | $10.23 | $12.28 | $8.19 |
| Melbourne | $8.93 | $10.71 | $7.14 |
| Brisbane | $3.09 | $3.70 | $2.47 |
| Perth | $5.17 | $6.20 | $4.13 |

Table B.3 presents a range of other carbon prices to calculate potential carbon emission cost savings from using rail for freight instead of road.

**Table B3: Carbon emissions costs at different carbon prices, in 2015-16 prices**

| Carbon price ($/tonne) | Emissions cost (c/tonne km) |
|---|---|
| 20.00 | 0.27 |
| 50.00 | 0.68 |
| 74.30 | 1.01 |
| 75.00 | 1.02 |
| 100.00 | 1.36 |

# Appendix C. Transport modelling

## Overview

Transport modelling was undertaken by the Institute of Transport and Logistics Studies at the University of Sydney Business School using their in-house land use and transport models. The outputs used for this study are based on two different model versions. For Brisbane, Perth and Melbourne, the study relies on the outputs generated in 2011 using the TRESIS model. For Sydney, the study uses a combination of outputs generated by TRESIS and MetroScan-TI. MetroScan-TI was developed from the TRESIS model; however, it uses updated parameter values and inputs, includes a model related to private trips and includes a higher granularity of regions. The following Section describes the TRESIS model, while Section A.3 presents MetroScan-TI.

## Tresis

The Transport and Environmental Strategic Impact Simulator (TRESIS) is a microsimulation package, developed at the Institute of Transport and Logistics Studies (ITLS), part of the University of Sydney. It is designed as a policy advisory tool to evaluate, at a strategic level, the effect of policy instruments on urban passenger travel behaviour and the environment. Versions of TRESIS can be applied to Canberra, Sydney, Melbourne, Brisbane, Adelaide, and Perth.

As an integrated model of many aspects of household decision-making such as location of home and work as well as vehicle stock, TRESIS offers users the ability to analyse and evaluate a variety of land use, transport, and environmental policy strategies or scenarios for urban areas.

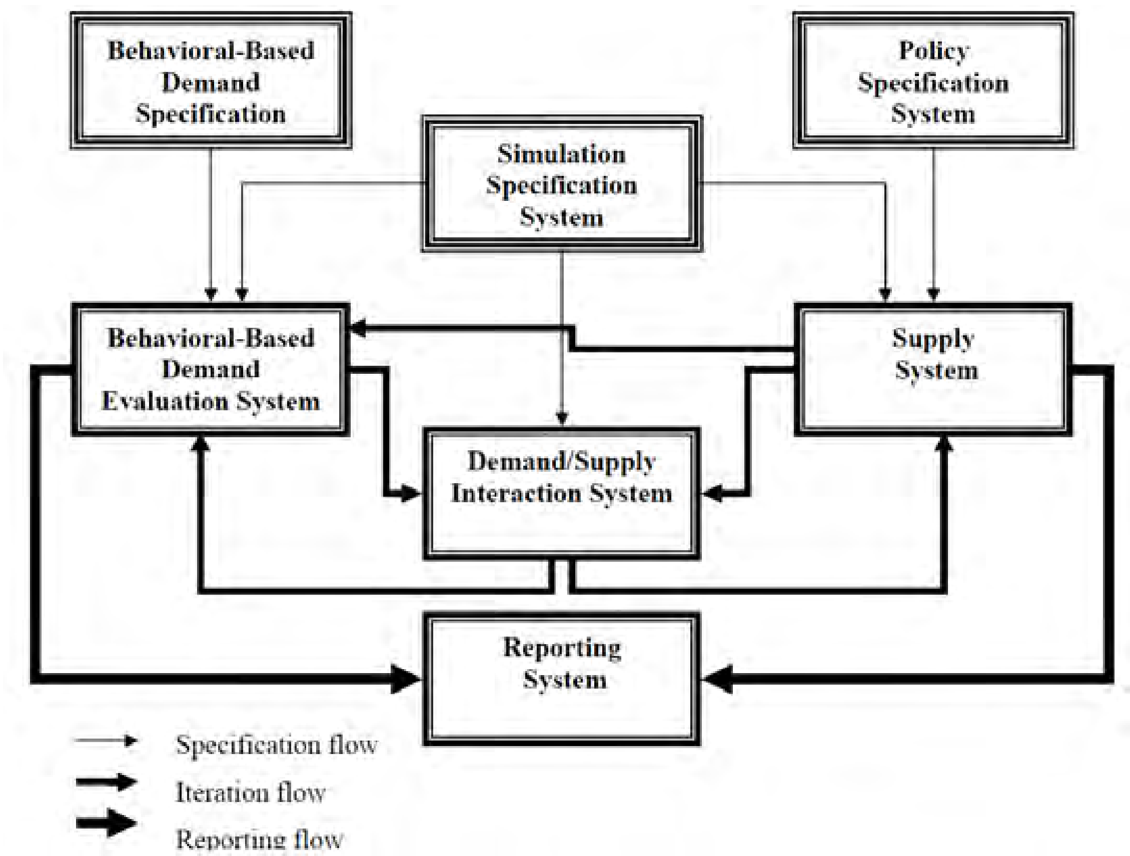
The behavioural engine of TRESIS encompasses key household, individual, and vehicle-related decisions; in particular:

- Residential location of households;
- Type of dwelling;
- Location of employment;
- Household's number and type of vehicles;
- Modes of transport; and
- Time of travel.

From this, a range of economic and environmental impacts are estimated on a year by year basis. The results of a base case scenario are used as references to compare with those of the policies and projects to be tested. The system generates a number of performance indicators to evaluate these effects in terms of economic, social, environmental and energy impacts.

TRESIS is structured around seven key systems, set out in Figure A.1.

**Figure C.1: TRESIS' component systems**




*Source: Hensher (2004)*

## Simulation specification system

This system provides a means for users of TRESIS to control factors such as:

- the types, sources, and locations of input and output from TRESIS;
- the heuristic rule for accommodating the temporal adjustment process;
- the number of future years to be simulated from the present year; and
- the specification to control the calibration and iteration process of TRESIS run.

The heuristic rule for accommodating the temporal adjustment process needs to be clarified. The model system in TRESIS is static and hence produces an instantaneous fully adjusted response to a policy application. In reality, choice responses take time to fully adjust, with the amount of time varying by specific decision. We expect that it would take longer for the full effect of the change in residential location to occur and much less time for departure time and even choice of transport mode.

TRESIS allows users to impose a discount factor that establishes the amount of a change in choice probability that is likely to be taken up in the first year of a policy. It removes the rest of the change and uses the new one-year adjustment as the starting position for the next year.

## Behavioural demand specification system

This system provides the household characteristics data and model formulation for the behavioural demand evaluation system of TRESIS. It contains a module for constructing a synthetic household database as well as a suite of utility expressions representing the behavioural system of choice models for individuals and households. These models are based on mixtures of revealed and stated preference data. Each synthetic household carries a weight that represents its contribution to the total population of households. Through time TRESIS carries forward the base year weights or, alternatively, modifies the weights to represent the changing composition of households in the population.

Households adjust their residential location in response to changes in the transport system and for other reasons. Consequently, any one of a number of strategies can influence the probability of a household both living in a particular location and the type of dwelling they choose to occupy. At any point in time there will be a total demand for dwelling types in each residential location. Excess demand will result in an increase in location rents and dwelling prices; excess supply will result in a reduction in the respective rents and prices. In TRESIS, dwelling prices are used to clear both the market for dwelling types and location.

Disequilibrium is allowed for when an injection of new dwellings creates excess supply given the number of households. Any additional dwellings will be left vacant in the particular year as an indication that property developers may have created too much stock at that time. In future years as households grow the take up rate increases without creating increases in dwelling prices until the market is cleared.

## Supply system

This system contains four key databases:

- Transport network database (with different levels of service for each time of day for each of six main modes of transport including drive alone, ride share, train, bus, light rail and busway)
- Land-use zone database (with attributes such as number of different dwelling types and associated prices, number of jobs, etc.);
- Automobile technology or vehicle database (number of different vehicle types and associated performance and energy indicators); and
- Policy and environment parameters database (carbon contents in petrol, diesel, CNG and electric vehicles and others).

Key attributes (such as travel times for different times of the day, demand level and associated prices of housing) of transport network and zone databases are updated dynamically at run time during the calibration process to reflect the impact of the demand system on the supply system. In return, the newly updated attributes of the supply system will have an impact on the behavioural demand evaluation system. The iterative control process is handled by the demand/supply interaction system.

## Policy specification system

A rich array of policy instruments is supported in TRESIS, such as new public transport, new toll roads, congestion pricing, gas guzzler or greenhouse gas taxes, changing residential densities, introducing designated bus lanes, implementing fare changes, altering parking policy, introducing more flexible work practices, and the introduction of more fuel efficient vehicles.

The policy specification system employs a graphical and map-based (Map Objects) user interface to translate a single or mixture of policy instruments into changes in the supply system.

## Behavioural demand evaluation system

Given the input from the behavioural demand specification system and the supply system, the characteristics of each synthetic household are used to derive the full set of behavioural choice probabilities for the set of travel, location and vehicle choices and predictions of vehicle use.

## Demand/Supply interaction system

This system contains three key procedures to control or equilibrate the three different types of interactions between demand and supply. The key mechanism for driving these three procedures is the level of interaction between demand and supply. The three procedures are:

- Equilibration in the residential location and dwelling type market involves establishing total demand for different dwelling types in each residential location calculated at any point in time. Excess demand will result in an increase in location rents and dwelling prices. In TRESIS, prices for different dwelling types are used to clear the markets for dwelling types and locations, in the absence of data on location rents.
- For equilibration in the automobile market: a vehicle price relative model is used to determine the demand for new vehicles each year. This model controls the relativities of vehicle prices by vintage via given exogenous new vehicle prices. A vehicle scrappage model is used only to identify the loss of used vehicles consequent on vintage and used vehicle prices, where the latter are fixed by new vehicle prices in a given year. The supply of new vehicles is determined as the difference between the total household demand for vehicles and the supply of used vehicles after application of the scrappage model based on used vehicle prices.

- For equilibration in the travel market: households might adjust their route choices between origin and destination, or trip timing and/or mode choice in response to changes in the transport system, particularly the travel time and cost values between different origins and destinations. In other words, different households can have different choices in responding to changes in different levels of service at different times of day.

### Output

TRESIS provides a comprehensive set of outputs representing performance indicators such as impacts on greenhouse gas emissions, accessibility, equity, air quality and household consumer surplus. The output is in the format of summary tables cross-tabulated by household types, household incomes and residential zones and in more detailed format by origin and destination, by different times of day and by different simulation years.

It contains a set of choice models for:

- commuting — includes choice of working hours, departure time, mode of transport and workplace location;
- automobile choice — type of vehicle and number of vehicles per household;
- residential — location and dwelling type; and
- automobile use — annual vehicle and kilometres travelled by the household and the spatial composition of this travel.

This input is combined to create a model where households select their home and work locations as well as their transport decisions, including whether to own a car or not. TRESIS has been used to analyse diverse situations including the benefits that could flow from increased bus use in Melbourne (Stanley 2007), an improved road connection in north east Sydney (Hensher et al., 2004) and from congestion pricing on Sydney's roads (Hensher, 2008).

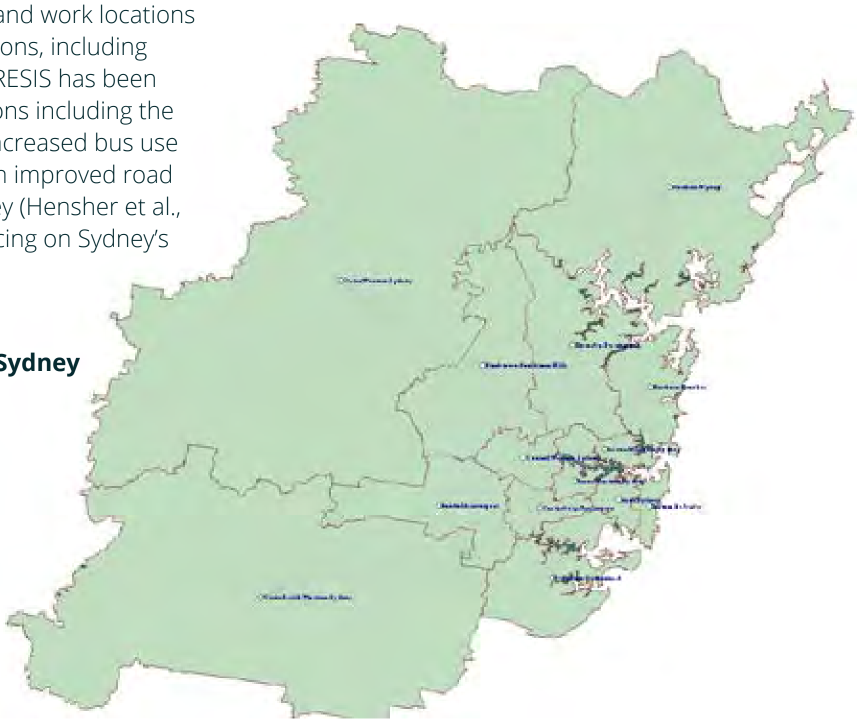


**Figure c.2: TRESIS regions in Sydney**

*Source: TRESIS*

One key advantage of TRESIS is that it allows modelling to be targeted to each major Australian city. This report focuses on congestion costs for Sydney, Melbourne, Perth and Brisbane. Each city is represented by a number of regions with each region having road, rail and bus links to other regions. Sydney, for example, is made up of 14 regions, as is shown in Figure A.2.

## MetroScan-TI

MetroScan-TI is the successor model of TRESIS. Compared to TRESIS, it has updated parameter values, inputs, more granular geographic detail and additional models related to non-work trips. In particular, MetroScan-TI seamlessly integrates the latest releases of Economic Development Research Group's TREDIS and the TRESIS models. MetroScan-TI uses integrated passenger, freight, land-use and economic models that have rich feedback between location and travel related decisions, using detailed behavioural data.

The main outputs of used for this study are:

- Number of business and commuting trips made by rail in Sydney (2016-2022);
- Number of business and commuting trips made by car in Sydney (2016-2022); and
- Total kilometres walked by train users in Sydney.

These outputs were provided for an average weekday and then annualised with a factor of 248.

# Appendix D. Approach to estimate congestion cost

The outputs used from TRESIS and MetroScan-TI to estimate rail transport externalities were:

- Total travel time; and
- Annual number of journeys by each mode.

Both models also provide information on carbon emissions. To estimate congestion costs for Melbourne, Perth and Brisbane, this study uses a 2011 model run from TRESIS (these costs were adjusted for the purpose of this report to reflect increases in congestion costs since 2011). The 2017 version of the MetroScan-TI model and previous TRESIS modelling results were used to generate congestion cost estimates for Sydney.

Following an approach developed for the NSW government (CRAI 2008, LECG 2009), this study measures congestion costs in terms of the increase in travel time and carbon emissions imposed by an extra road user on all existing road users.

Generally, we can say that travel time is an increasing function of journeys by both road and rail. Considering congestion, there should be a quadratic relationship between the number of journeys and total travel time; this is because each additional road user will generate congestion externalities which increase the average travel time for all other road users. In contrast, the relationship between total travel time and the number of train journeys should be linear as the central organisation of the train system should be able to manage additional journeys.

This leads to the following functional form for a relationship between the number of journeys and total travel time:

$$\text{Total travel time} = \beta1*(\text{rail journeys}) + \beta2*(\text{road journeys}) + \beta3*(\text{road journeys})2$$

This parameterisation allows the identification of average journey time for the different modes of transport. For rail, the average journey time is given by β1 while for road the average journey time is:

$$(\beta2*(\text{road journeys}) + \beta3*(\text{road journeys})2) / (\text{road journeys})$$

Here, average road travel time depends on the number of road journeys, this reflects the congestion externality.

Using output from TRESIS on how people change their transportation decisions when the train fare is increased or decreased, the parameters (β1, β2 and β3) can be extracted using ordinary least squares regression.

Once these parameters have been extracted, we can then carry out the thought experiment of moving one person from road to rail transport

$$\text{Total travel timebase} = \beta1*(\text{rail journeys}) + \beta2*(\text{road journeys}) + \beta3*(\text{road journeys})2$$

$$\text{Total travel timeexperiment} = \beta1*(\text{rail journeys}+1) + \beta2*(\text{road journeys}-1) + \beta3*(\text{road journeys}-1)2$$

We can then find the different in total travel time

$$\text{Total travel time}_{experiment} - \text{Total travel time}_{base}$$

This difference is made up of three components, the increase in rail travel time for the passenger that has been shifted, the decrease in their road travel time and the decrease in other people's road travel times. We can identify these three components as:

$$\text{Average increase due to own shift to rail} = \beta1$$

$$\text{Average decrease due to own shift from road} = -(\beta2*x + \beta3*x2)/x$$

This leaves an amount which is unaccounted for, the externality on other road users.

This approach gives the following results presented in Table D.1.

**Table D1: Congestion externality modelling results - 2011 models**

| City | β1 | β2 | β3 |
|---|---|---|---|
| Sydney | 56.56 | 54.26 | 4.27×10-8 |
| Melbourne | 71.69 | 32.59 | 3.68×10-8 |
| Brisbane | 67.22 | 26.53 | 2.89×10-8 |
| Perth | 57.94 | 21.94 | 4.59×10-8 |

*Note: All coefficients are statistically significant at the 1% level of significance.*

Based on these coefficients, the change in travel time for existing road users were calculated for the 2011 study (refer to first column of Table D.2). For the purpose of this report, it was estimated that these costs have increased in line with BIITRE estimates on congestion costs in major Australian cities. BITRE (2015b) estimates that congestion costs have increased by 43% in Melbourne, 44% in Brisbane and 54% in Perth between 2011 and 2019.

**Table D2: Change in travel time for existing road users (minutes)**

| City | 2011 estimates | 2016 estimates | 2019 estimates |
|---|---|---|---|
| Melbourne | -17.10 | -21.3 | -24.5 |
| Brisbane | -5.90 | -7.3 | -8.5 |
| Perth | -9.20 | -12.1 | -14.2 |

*Source: MetroScan-TI, Deloitte Access Economics calculations.*

The MetroScan-TI model provided updated 2016 and forecast rail and car trips enabling to estimate travel time savings due to reduced congestion related to one traveller switching from road to rail. The results are presented in Table D.3, together with the 2011 value calculated for the Australasian Railway Association (2011) report using a similar approach.

**Table D3: Change in travel time for existing road users in Sydney (minutes)**

| City | Reduction in travel time |
|---|---|
| 2011 | 22.50 |
| 2016 | 27.30 |
| 2017 | 27.58 |
| 2018 | 27.85 |
| 2019 | 28.13 |
| 2020 | 28.41 |
| 2021 | 28.70 |
| 2022 | 28.98 |

*Source: MetroScan-TI, TRESIS, Deloitte Access Economics calculations.*

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