

National market development strategy for used tyres

Final Strategy

19 June 2017



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Client



Government of Western Australia
Department of Water and Environmental Regulation



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Project Reference: PREC070

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Glossary of terms

Term	Description
Bitumen crumb rubber asphalt (BCRA)	An asphalt product which uses crumb rubber as a binder, typically for high traffic roads.
Casings	The rigid, inner of a tyre upon which a tread is placed. Typically, tyres good enough for retread or resale as seconds are referred to as casings.
Civil engineering	Engineering discipline that deals with the built environment, including works like roads, bridges, canals, dams, and buildings.
Crumb rubber	A highly-refined rubber product, typically less than 1mm in diameter, made from recycled tyres.
Domestic recycling	Activities that occur to recycle or reprocess waste tyres within Australia.
Dispersal to the open environment	The dispersal of rubber from in-use tyres to the open environment (land, waterways, etc.) due to wear of the tyre tread.
End-of-life fates	What happens to Australian EOLTs when they reach the end of their useful life (either in Australian or overseas). Common fates include: reuse, recycling, energy recovery, legal stockpiling, onsite disposal (at mining sites), illegal dumping or stockpiling, licensed landfilling, and dispersal to the environment (of the tread of the tyre during use).
End-of-life tyres (EOLTs)	A tyre that is deemed no longer capable of performing the function for which it was originally made. Often referred to as used tyres or waste tyres . The terms EOLTs, used tyres and waste tyres are used interchangeable throughout this document.
Energy recovery	The use of EOLTs in a thermal process to recover energy for electricity generation or industrial process.
Equivalent passenger units (EPUs)	A standard measure, based on the typical weight of a standard passenger tyre, used to quantify EOLTs in Australia.
In-use	Tyres that are in demand for the purpose for which they were originally made.
Landfill / unknown	The sum of the quantities EOLTs that are landfilled or are sent to other fates where little or no resource value is recovered and for which the quantities of each are unknown. Collectively referred to in this strategy as Landfill / unknown fate because currently available data does not enable the quantities of landfilled EOLT to be reported separately from other EOLT fates where no resource value is recovered and for which the quantities of each are unknown ¹ .

¹ Off-the-road (OTR) tyres from mining are an exception. It is understood to be common practice to manage OTR EOLTs, that are not recovered, by landfilling the EOLT into the mine void. For passenger and truck EOLTs, that are **not** recovered, there are a range of other fates that do not recover resource value, besides landfill, where the quantities of each are unknown.

	Examples of fates for which the quantities are unknown include illegal dumping, illegal stockpiling, burning and unreported exports.
Off-the-road (OTR)	Tyres for mining sites and heavy industry applications.
Recovery	Broadly refers to EOLT that are collected and either reused, recycled or recovered for embodied energy (energy recovery) either in Australia or overseas.
Recycling	Process to recover constituent materials from end-of-life tyres and use those materials to manufacture other products either in Australia or overseas.
Resource recovery	Refers to EOLT that are collected and either recycled or recovered for embodied energy (energy recovery) either in Australia or overseas.
Retreading	The preparation of used tyres for reuse by replacing the outer tread.
Reuse	The use of tyres for the purpose for which they were originally made, including use of retreaded tyres and second-hand tyres.
Rubber granule	A refined rubber product, typically 2mm – 15mm, made from recycled tyres.
Rubber modified sprayed seals	A road surfacing product that uses crumb rubber as a binder, typically on highly stress road areas.
tpa	Tonnes per annum
Tyre Derived Fuel (TDF)	Shredded tyres prepared to a specification for use in energy recovery.
Tyre Stewardship Australia	The not-for-profit company established to deliver the National Tyre Product Stewardship Scheme.
Tyre-derived aggregate (TDA)	Shredded tyres prepared to a specification for use as aggregate in civil engineering applications.
Tyre-derived products (TDPs)	Any product produced from rubber, steel, textiles or other material recovery from the recovery of EOLTs.

STRATEGY OVERVIEW

Strategy Vision	Australia has a strong and diverse market for recovery of end-of-life tyres with profitable domestic outlets for tyre-derived products (TDPs) that stimulates recovery and contributes to preventing stockpiling and illegal dumping.				
Strategy Purpose	To facilitate a national approach to market development for tyre-derived products, supported by state-based programs and underpinned by collaboration between government and industry.				
Goals What is government, TSA and industry trying to achieve.	EOLTs will only be disposed to landfill in very remote and regional areas where no viable options for recovery exist.	Programs and activities related to market development for tyre-derived products are designed to achieve maximum impact across Australia.	The current and future domestic uses of tyre-derived products are well understood and uptake of products is increasing year on year. The Strategy target is for: <i>“Consistent growth in domestic resource recovery of EOLTs against 2015-16 baseline data contributing to a future where EOLT stockpiling does not occur”</i>	EOLT recyclers are manufacturing high-quality, fit-for-purpose tyre-derived products at scale to meet market demand.	
Long Term Directions What do government, TSA and industry want to do differently.	To maximise the recovery of EOLTs that are sent to landfill and other fates where no resource value is recovered.	To support a nationally consistent approach to market development.	To promote greater diversity in tyre-derived products and their application.	To increase the usage of tyre-derived products in Australia learning from international experience.	To facilitate a more cohesive and progressive tyre recycling industry.
Five Year Strategic Objectives What government and TSA will focus on over the next five years.	Strategic Objective 1 Support development of the Australian EOLT recycling sector through: - a robust regulatory framework - a focus on products rather than wastes - improved price transparency for consumers - brand differentiation for the Australian tyre recycling industry.	Strategic Objective 2 Address barriers to growth in key TDP markets in Australia through: - early stage research for projects with national reach - support for emerging markets like crumb rubber explosives - links to sustainable procurement & rating tools.	Strategic Objective 3 Develop markets for TDPs in road construction through: - increased uptake of sprayed seals in QLD, SA and WA - a national program to address barriers impacting crumb rubber asphalt - building capacity in local government and industry.	Strategic Objective 4 Research long-term markets for TDPs in the rail construction sector through: - a long-term market entry program with key industry and government partnerships - a focus on rail maintenance and new rail construction.	Strategic Objective 5 Develop new markets for use of TDPs in civil engineering, through: - establishment of a national steering committee with a focus on tyre-derived aggregate (TDA) - early stage research and lab testing for TDA - development of national specifications for key markets.



THE END-OF-LIFE TYRE CHALLENGE

End-of-life tyres remain one of Australia's most significant waste management challenges. More than 56 million end-of-life tyres (EOLTs) are generated per annum. Australia needs a long-term strategy to meet these challenges and realise the opportunities that come with improved resource recovery

EXECUTIVE SUMMARY

The management of end-of-life tyres in Australia presents both a persistent challenge and a resource recovery opportunity. Tyres are strong and durable and difficult to reprocess economically when they reach the end of their useful life. However, the outputs of the recycling process, predominantly rubber and steel, are valuable commodities with several potential high-value applications.

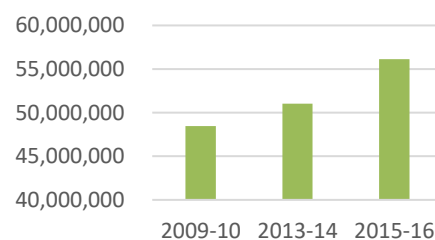
Sustainability Victoria (SV) and the Department of Environment and Heritage Protection (EHP) QLD are co-leading the development of a National market development strategy for used tyres (the Strategy). The Strategy, which is being co-funded by SV, EHP, Department of Water and Environmental Regulation WA, NSW Environment Protection Authority and Tyre Stewardship Australia (TSA), seeks to provide a framework for a national approach to market development for tyre-derived products (TDPs) in Australia.

In 2015-16, Australia generated some 447,000 tonnes or 56.3 million EPUs (equivalent passenger units) of end-of-life tyres (EOLTs), an increase of 16% since data collection began in 2009-10.

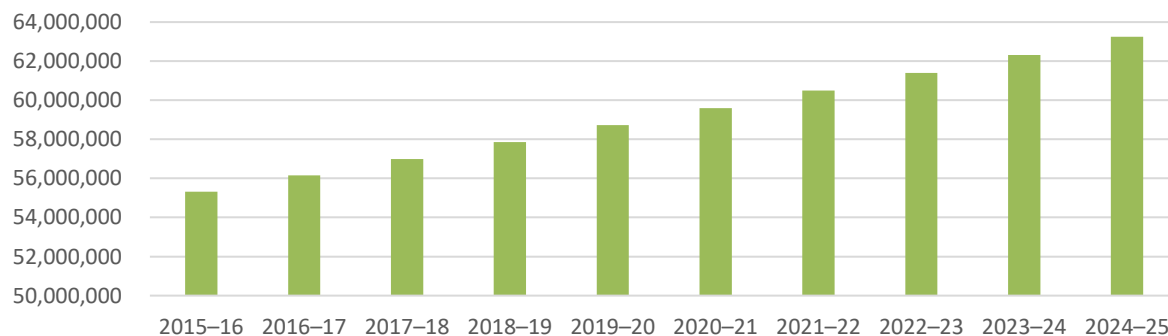
The increase in generation is being driven by rising vehicle registrations and the subsequent increase in new tyre sales (new passenger tyre sales have increased by more than 50% since 2007-08).

The EOLT generation challenge will continue to grow over the next 10-years. New tyre sales are estimated to exceed 63.3 million EPUs (around 506,000 tonnes) by 2024-25.

Generation of EOLTs from 2009-10 - 2015-16 (EPUs)



Projected tyre sales (EPUs) to 2024-25





The problem is not just a product of waste tyre generation in Australia. The real issue is the degree to which EOLTs are recovered and recycled into useful commodities.

Data from the last three national studies on EOLTs shows that around 60 – 65% of all waste tyres generated are disposed to landfill or go to other fates, such as dumping or illegal stockpiling, where little or no resource value is recovered and the quantities to each fate are unknown².

Poor management of EOLTs poses a significant environmental and human-health risk for Australia, through the risk of tyre fires. When burnt, tyres produce thick, toxic smoke that is dangerous when inhaled. The runoff produced when fighting fires can carry pollutants into nearby surface and ground water. In 2015, a significant tyre fire in Melbourne saw more than 100,000 tyres burnt with nearby businesses and residents evacuated.

The need for greater tyre recycling in Australia

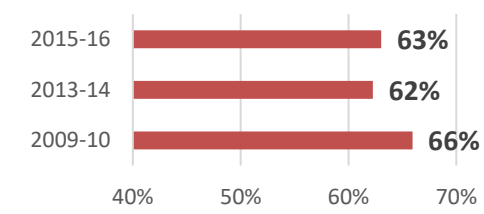
Historically, domestic recycling of EOLTs has been limited due to a lack of markets for tyre-derived products and strong international demand for tyre-derived fuel (TDF). In 2013-14, recycling of EOLTs in Australia had fallen to just 5%.

The 2015-16 data suggests that domestic recycling has increased significantly, doubling to around 44,000 tonnes or 10%. This is a positive sign and reflects the hard work being put in by industry and government to improve overall conditions.

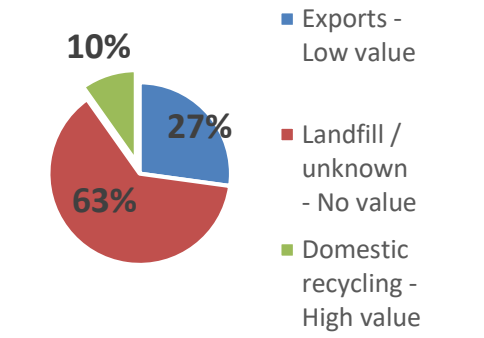
However, this is not universally applied across all tyre types. Just 4% of large, off-the-road (OTR) tyres from mining sites and heavy industry are recovered for recycling in Australia, with the remaining 96% or 123,000 tonnes being landfilled or managed “on-site” (buried at the mine site).

As has been the case for roughly the last decade, a considerable amount of EOLTs generated in Australia are exported for reuse and energy recovery, typically in cement kilns. In 2015-16, some 119,000 tonnes (almost 15 million EPUs) of EOLTs were exported for reuse or energy recovery.

Percentage of EOLTs going to landfill / unknown fates in Australia, 2009-10 – 2015-16



Fates of EOLTs in Australia, 2015-16



² ‘Landfill / unknown’ fates are referred to collectively because data does not allow the quantities of landfilled EOLTs to be reported separately from other EOLT fates where no resource value is recovered and for which the quantities to each are unknown. OTR tyres that are not recovered are an exception and are understood to be landfilled on-site into the mine.



VALUABLE PRODUCTS FROM WASTE TYRES

When collected and processed, EOLTs can be transformed into valuable commodities and products for sale into a variety of markets. Materials such as rubber and steel are valuable and regularly traded on international markets.

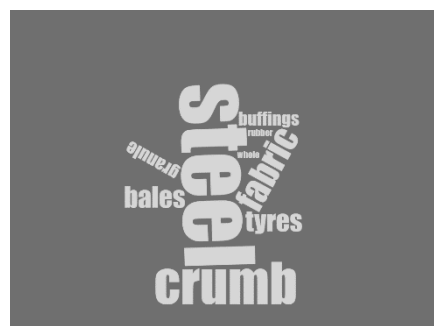
TYRE-DERIVED PRODUCTS

*In Australia, tyre recovery operations currently consist of a series of shredders, screens and granulators that separate EOLTs, by varying degrees, into individual materials known as **tyre-derived products (TDPs)**. The key outputs of these operations are shredded tyres, baled tyres, rubber, steel and fabric, which are then sold into commodity markets and manufacturing.*

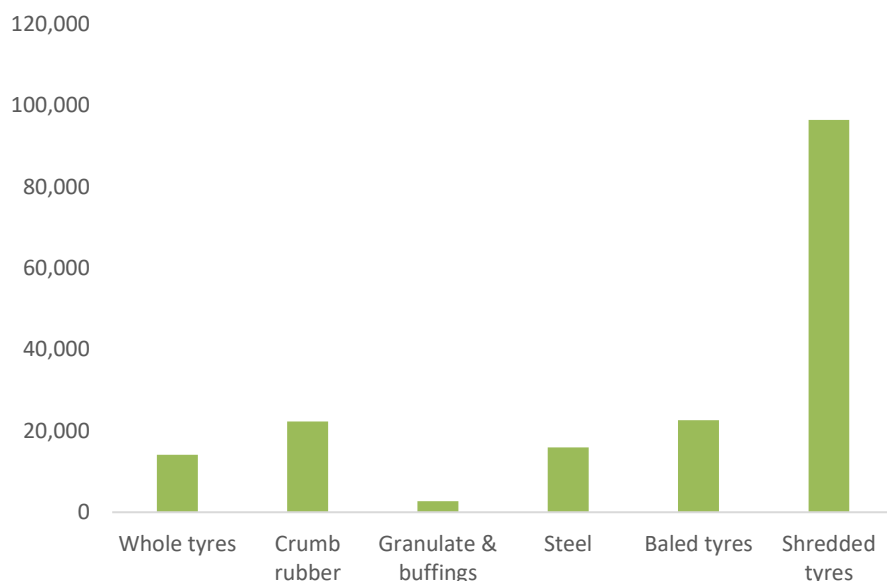
There are currently around 15 – 20 tyre recovery operations at scale in Australia. These businesses range from sophisticated recycling operations that process tyres down to highly refined “crumb” rubber to simple recovery operations that involve baling and exporting whole tyres.

The products or commodities produced by these operations depend on the level of infrastructure investment and desired end markets. A simple tyre baling arrangement could cost as little as \$30,000 whilst a fully scaled crumbing facility may cost more than \$10 million.

The figure below includes the tonnages of key TDPs coming out of the tyre recovery industry in Australia.



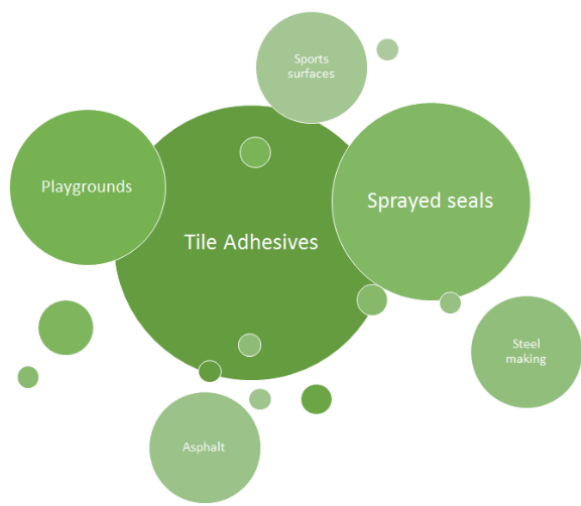
Key TDPs from Australian tyre recovery 2015-16 (tonnes)





Markets for tyre derived-products in Australia

The commodities coming out of tyre *recycling* businesses, such as rubber and steel, become primary inputs for manufacturing of other products in a range of sectors. These include crumb rubber in engineering construction to recycled rubber surfacing to local government playgrounds and sports fields.

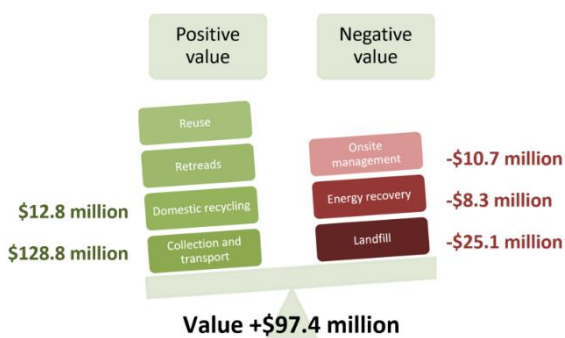


Current markets for these TDPs in Australia varies in strength and levels of consumption based on several factors, including cost, performance and perception. The largest and most productive domestic markets are crumb rubber in road sprayed seals and tile adhesives; the rubber acting as a flexible binding agent in both applications to reduce cracking and increase product life. Soft fall matting in playgrounds is another strong local market for EOLTs.

However, a lack of domestic recycling capacity for EOLTs in Australia is compounded by strong international energy markets, which consume around 27% of all EOLT generated. This is in the form of baled tyres and shredded tyres (tyre-derived fuel, TDF) which are used predominantly as a coal replacement in cement kilns, industrial boilers, power plants and paper and pulp production facilities.

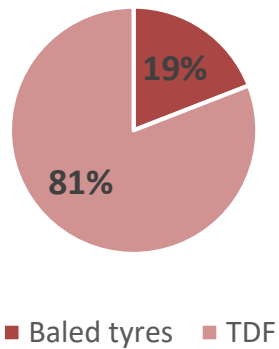
When burnt in a controlled environment, tyres have a similar calorific value to high quality black coal, which is around three times more than lower quality brown coal. EOLTs are not currently burned to recover embodied energy in Australia (TDFs are not currently used in Australia).

Market value of TDPs and EOLT services in Australia 2014-15



Note: negative values refer to fates of EOLTs with a cost to the market.

Type of TDP leaving Australia for export markets, 2015-16



STATE BY STATE MARKETS FOR EOLTs



Each state and territory has different conditions for tyre recovery, depending on the regulatory framework, demand from consumers, proximity to international ports and population density. Victoria, New South Wales and Queensland are major hubs for the tyre recovery sector.

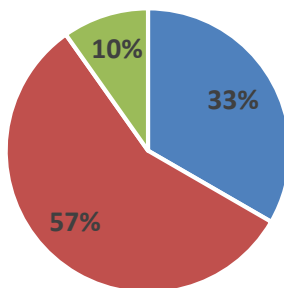
STATE BY STATE OVERVIEW (2015-16)

The EOLT market, both in terms of recovery, recycling and sale of TDPs, differs significantly from state to state, depending on the impact of regulation and specifications, the strength of the local reprocessing industry and influence from state and territory governments. The following is a snapshot of the EOLT market in each state and territory.

Australian Capital Territory

Population – 396,100

EOLT Generation – 650,000 EPUs

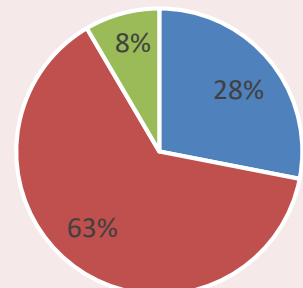


- Exported
- Landfill / unknown
- Domestic recycling

New South Wales

Population – 7,725,900

EOLT Generation – 15,875,000 EPUs

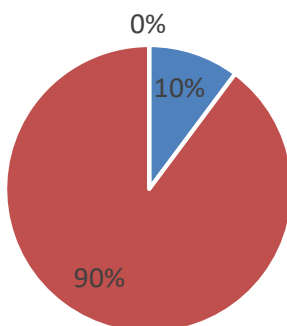


- Exported
- Landfill / unknown
- Domestic recycling

Northern Territory

Population – 244,900

EOLT Generation – 625,000 EPUs

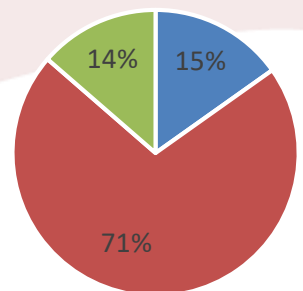


- Exported
- Landfill / unknown
- Domestic recycling

Queensland

Population – 4,844,500

EOLT Generation – 12,037,500 EPUs



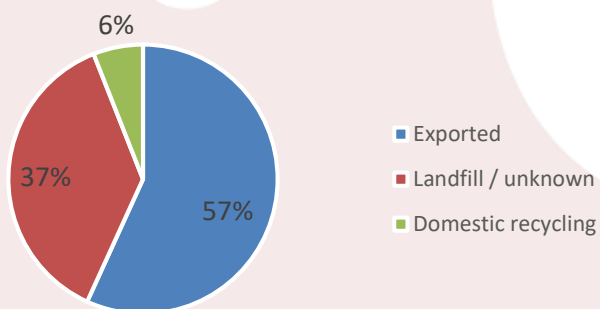
- Exported
- Landfill / unknown
- Domestic recycling



South Australia

Population – 1,708,200

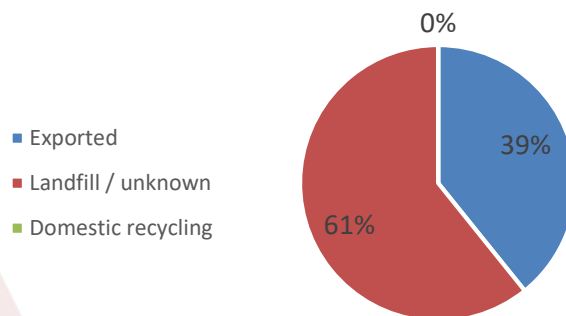
EOLT Generation – 3,762,500 EPU



Tasmania

Population – 519,100

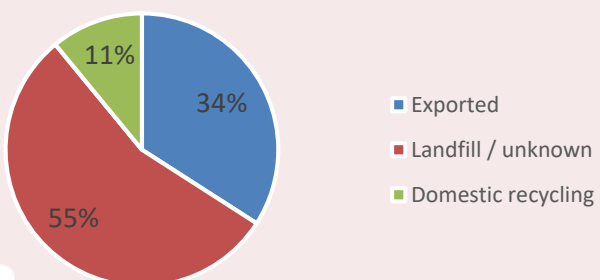
EOLT Generation – 1,287,500 EPU



Victoria

Population – 6,068,000

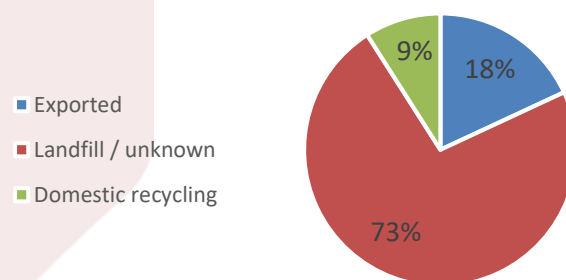
EOLT Generation – 13,463,000 EPU



Western Australia

Population – 2,617,200

EOLT Generation – 8,312,500 EPU





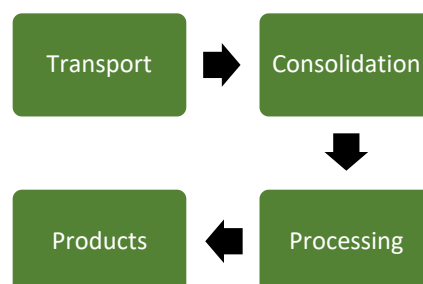
REMOVING MARKET BARRIERS

If the market for TDPs in Australia is to grow, consideration must be given to the barriers that restrict uptake. Such barriers are not unique to EOLTs, indeed they exist for most waste-derived commodities, these range from issues of supply and quality through to procurement and perceptions.

MARKET BARRIERS THAT IMPEDE GROWTH

Key market barriers will need to be overcome in order to realise market opportunities. There is a role for government and industry in addressing the impacts of such barriers to improve productivity of the whole EOLT value chain.

The EOLT market has several key transaction points that impact the viability of the overall business case for recovery. At the front end of the value chain there are collection and transport markets, which are heavily influenced by tyre retailers who control most EOLT feedstock. Processing markets are dominated by processing costs and regulatory conditions. Finally, product markets are subject to quality, certainty and performance specifications.



Low barriers to entry

In some jurisdictions, there are very low barriers to entry for both tyre collectors and tyre recyclers. New collectors can capture volume from tyre retailers using low collection fees. Similarly, tyre balers in Australia can undercut larger recyclers making crumb and granule products.

This encourages new players to come into the industry, however these players do not always have the capacity to deal with EOLTs appropriately, leading to cases of stockpiling and dumping.

Transport costs

Australia is a large country with significant distances between major cities and regional centres, with low population density in most regional and rural areas.

This poses a challenge for the economics of tyre collection and recycling, particularly in parts of QLD, WA and NT.

In areas where transport costs are prohibitive, tyres are landfilled at significantly higher rates, leading to a missed opportunity for resource recovery.

Regulatory settings

Regulatory settings remain a key barrier in the EOLT market. This manifests in several ways. States with a weak regulatory framework are prone to higher amounts of illegal stockpiles and dumping.

However, strong regulatory settings in some states restricts the storage of TDPs (processed EOLTs) to the point where large contracts cannot be effectively serviced.

In addition, industry players have suggested there is duplication in the audit and compliance work of Tyre Stewardship Australia vs the role of state regulators.





Infrastructure costs

High infrastructure costs are a considerable barrier for EOLT resource recovery, particularly those businesses looking to create high quality crumb and granule. The typical investment for even a modest rubber crumbing facility is likely to exceed \$2 million or \$10 million for a larger scale plant.

Those operators focusing on TDF also face considerable infrastructure costs with high capacity shredders ranging from around \$300,000 to over \$1 million.



Retailer disposal fees

Consumers pay a fee for disposal of their used tyres when new tyres are fitted to their vehicles. However, in many cases this fee is significantly inflated, as much as five times the actual collection fee and only a portion of this is passed through into the tyre recovery industry.

In addition, disposal fees can be misleading, for example when they are referred to as a “recycling fee” despite the tyre going straight to landfill.



Cheap imports

The import of cheap crumb rubber from international markets, for example Portugal and Canada, has been a considerable barrier in the last 12 – 24 months in particular. These jurisdictions often benefit from generous subsidies through collection systems and this allows them to produce product at a much lower cost.

Anecdotal evidence suggests that crumb has been imported into Australia at around 40% less than domestic prices.



Standards and specifications

In product markets, a specific set of requirements for performance and quality is often stipulated through a standard or specification. Lack of standards and specifications that apply directly to use of TDPs can be a significant barrier.

This may include markets where there are no relevant standards for TDPs or, more commonly, where broad standards exist that don't provide enough specific guidance on the use of a TDP.



Attitudes and awareness

Attitudes can be a key barrier to uptake of TDPs. In procurement, people tend to favour what has been done before rather than look for new opportunities. As such, new products can find it hard to enter existing markets.

Similarly, there is often a perception that TDPs are simply waste products and of little or no value, despite their obvious performance benefits in many instances.



Market scale

The products that TDPs compete against tend to be produced at significant scale, particularly when servicing construction markets. The entire capacity for producing high-value TDPs in Australia, such as crumb rubber and granule, is around 30,000 tonnes per annum.

The domestic recycling industry may therefore struggle to scale up to meet future demand in these markets.





OPPORTUNITIES FOR TYRE DERIVED PRODUCTS

There are a range of existing and emerging opportunities to utilise TDPs in value-add ways across Australia. These opportunities range from construction and engineering to high-end polymers to a new breed of water-resistant explosives.

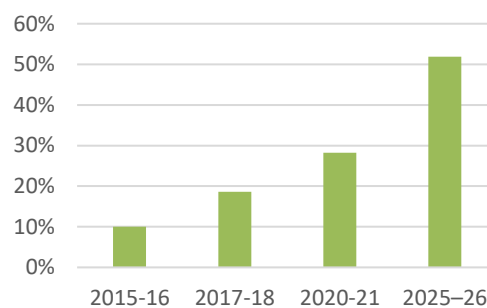
With new challenges come new opportunities. There are significant potential markets for TDPs in Australia, both through development of existing markets and breaking ground in new markets. Analysis of these opportunities suggests that, if they can be fully realised, domestic resource recovery of EOLTs could exceed 50% by 2025-26.

In undertaking the analysis of opportunities, projection modelling was developed to understand the potential short (2-year), medium (5-year) and long term (10-year) impacts on EOLT resource recovery in Australia.

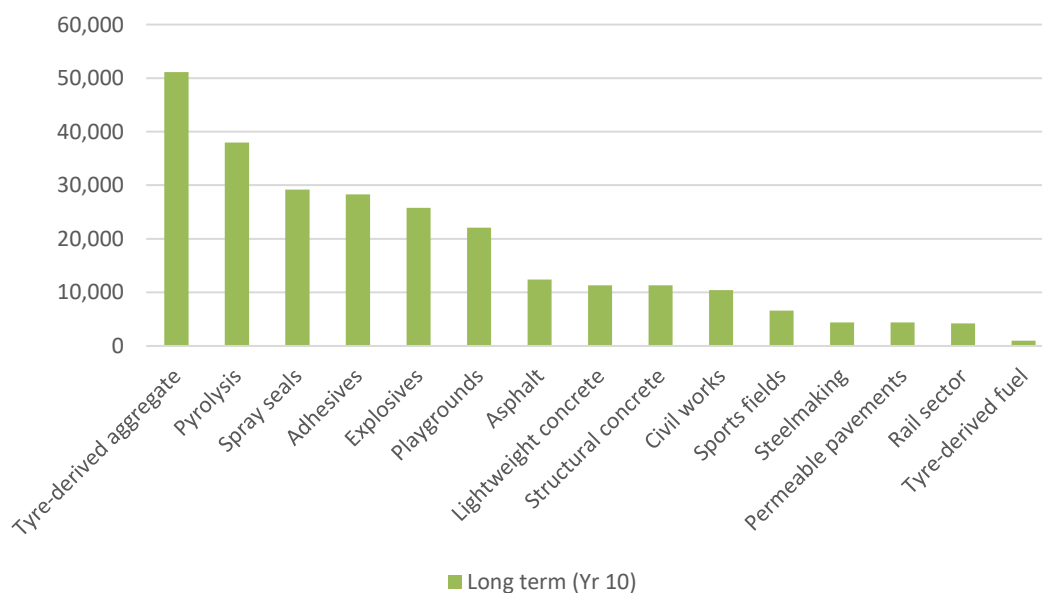
The projections of market impact for the opportunities for TDPs in Australia (see figure below) estimate that the current domestic resource recovery rate could increase fivefold to more than 50% by 2025-26. Projecting the future is inherently uncertain. Our projection modelling provides clearly articulated assumptions that support the projections included below.

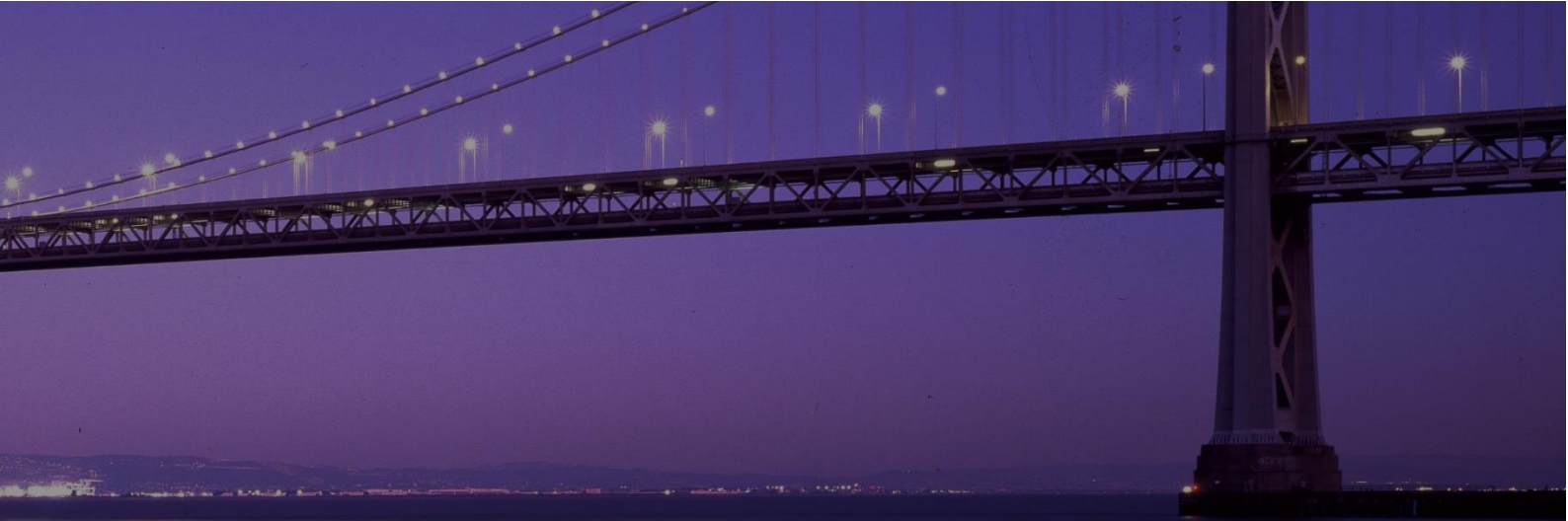
The *application* of relevant TDPs to the road, rail and non-structural civil construction sectors are discussed on Page xvii and detailed in Part 2 of the strategy.

Projected domestic recovery rate (%) 2015-16 to 2025-26



Projected long-term market impact of opportunities (tonnes) (at year 10)





EMERGING OPPORTUNITIES

There are number of emerging markets that could have a significant impact on the domestic resource recovery of EOLTs in Australia if key barriers were to be overcome and their full potential realised. A selection of these are discussed below.



Crumb rubber explosives

Recent project development has found that crumb rubber is an effective additive to traditional ammonium nitrate fuel oil in explosives. The addition of rubber improves blast efficiency and allows work to be undertaken in wet areas, which is a considerable weakness of current market products.

The long-term impact of this opportunity could be an additional 25,000 tonnes of EOLT recovery in Australia.



Tyre pyrolysis

New processing technology, which seeks to convert EOLTs back to oil, gas and carbon, is emerging in Australia. Several test facilities have begun operation with planning approval for full-scale facilities granted in at least three states.

If the viability of these facilities is proven, it could transform the EOLT processing market, moving away from size reduction to the creation of completely new products and markets.



Rubberised concrete

Concrete is the most commonly used material in the world. It is used in almost every construction activity; from footings and foundations, to bridges and tunnels.

Research has been undertaken in Australia and internationally on the benefits of rubberised concrete. However, whilst tensile strength is improved (as rubber is flexible and less prone to cracking), compressive strength is reduced. Further work is required to see the full potential of these markets.





OPPORTUNITIES IN ROAD, RAIL AND NON-STRUCTURAL CIVIL CONSTRUCTION

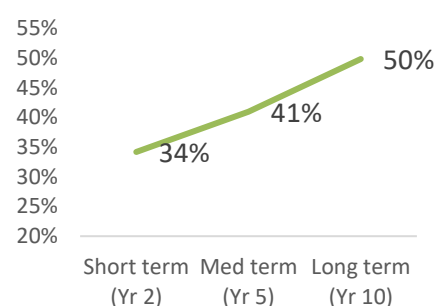
The road construction sector is already one of the largest consumers of EOLTs in Australia. However, there is scope for considerably more consumption in both sprayed seals and, in the longer term, bitumen crumb rubber asphalt.

KEY FOCUS AREAS FOR THE NEXT 5 YEARS

The construction sector remains the largest of the market opportunities for TDPs in Australia. Crumb rubber and granules can be used in road, rail and civil construction in bulk, adding valuable properties such as flexibility and longevity in a variety of applications. The Strategy focuses strongly on these three sectors as they offer potential for significant market growth especially where the use of TDPs can be influenced through Government procurement.

Current markets for TDPs in Australia vary in their strength and levels of consumption based on several factors, including cost, performance and perception. The largest and most productive domestic markets are crumb rubber in road sprayed seals and tile adhesives; the rubber acting as a flexible binding agent in both applications to reduce cracking and increase product life. Soft fall matting in playgrounds is another strong local market for TDPs.

Contribution to projected TDP consumption by construction markets (% of total)



Road construction

The road construction sector remains one of the most active users of TDPs in Australia. As a sector, road construction and maintenance is worth around \$25 billion per annum across an 875,000 km network of urban and rural roads.

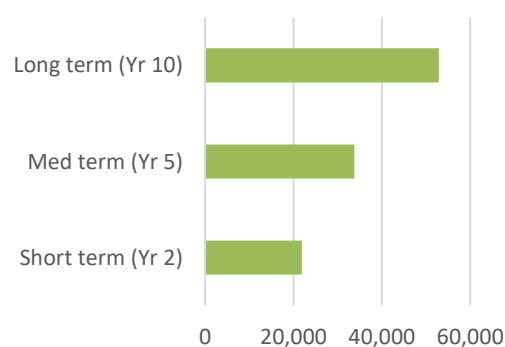
Crumb rubber is used as a polymer modified binder in production of sprayed seals and asphalt to increase flexibility and reduce the impacts of surface cracking. The market for bitumen in Australia is in the order of 800,000 tonnes per annum and products using rubber generally incorporate 10 – 25% rubber by weight, suggesting this is a significant opportunity.

However, work needs to be done to address key market barriers, including:

- setting the right specifications for rubber modified sprayed seals at state and national level
- the impact of the current specification framework for polymer modified binders on bitumen crumb rubber asphalt
- concerns about the impacts of emissions from bitumen crumb rubber asphalt on worker health and safety.

If these barriers can be overcome, the potential impact on the market in Australia could be significant, with projections indicating consumption of more than 50,000 tpa of EOLTs.

Projected best case consumption of EOLTs from road construction (tonnes)



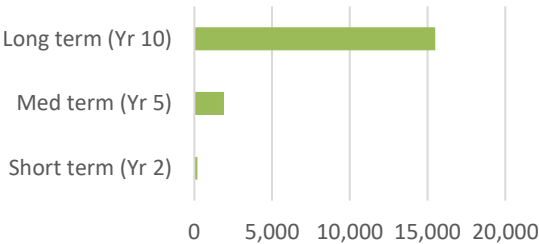


Rail construction

The rail sector presents an emerging opportunity for TDPs in Australia, with the potential to leverage current research being undertaken at the University of Wollongong and international experience using rubber where recycled rubber products has been used as ballast stabilisation.

There are some 33,000 kms of rail track in Australia, constructed, managed and maintained across a complex network of state and federal contracts. The structure of the rail sector remains a key barrier with each state and territory having its own arrangements and approvals processes.

Projected best case consumption of EOLTs from rail construction (tonnes)



However, there are considerable opportunities if the barriers to entry can be overcome. Projections estimate that in the longer term, the rail sector could consume more than 15,000 tpa of EOLT. This will require:

- strong partnerships between government, research bodies and industry
- suitable lab testing and field trials
- a model that looks to expedite type approvals at national level and proliferate these across states and territories.

Non-structural civil construction

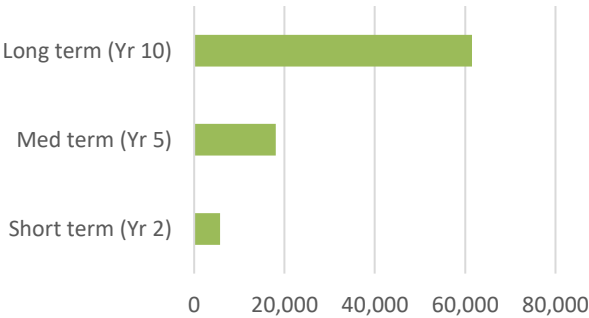
Outside of road and rail, civil construction offers broad appeal for TDPs in Australia. Current research suggests that more work is required to prove the case for rubberised concrete and therefore structural engineering is a longer-term opportunity.

Non-structural civil works however present an immediate opportunity, specifically the use of tyre-derived aggregate (TDA) as lightweight fill and as drainage medium in landfills.

Both these applications have proliferated exponentially in North America and are largely responsible for the clearance of tens of millions of stockpiled EOLTs. Further details of the North American experience are presented in Part 2.

Performance testing must be undertaken in a nationally coordinated program, leading to national product specifications. If this can be achieved, it is estimated that as much as 60,000 tpa of EOLT consumption could be delivered by 2025-26.

Projected best case consumption of EOLTs from non-structural civil works (tonnes)





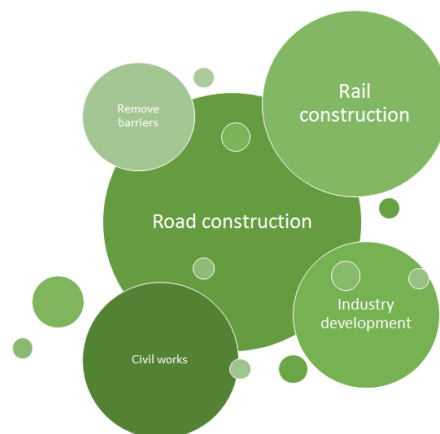
DELIVERING CHANGE IN THE MARKET

There are a broad range of opportunities to improve markets for TDPs in Australia. Activities driving the strategy need to be focused and be targeted toward key barriers that must be overcome.

STRATEGY FIVE-YEAR OBJECTIVES

The National market development strategy for used tyres will focus on five key objectives over the implementation timeline. This approach will address key barriers and blockages and provide government and industry with a roadmap for realising opportunities for TDPs.

The five strategic objectives for the Strategy are outlined below:



STRATEGIC OBJECTIVE 1 - SUPPORT DEVELOPMENT OF THE AUSTRALIAN EOLT RECYCLING SECTOR

State and territory governments, working closely with TSA should continue to support development of the domestic EOLT recycling sector, through:

- A robust legislative framework that discourages illegitimate operators and treats TDPs as products rather than wastes.
- Improved price transparency for tyre consumers.
- Brand differentiation for Australian made TDF to counter the impacts of cheaper imports.
- Long-term planning to ensure industry capacity can meet demand.
- Establishment of a national oversight group to oversee strategy implementation and monitor the Strategy's progress against baseline resource recovery data.

STRATEGIC OBJECTIVE 2 - ADDRESS BARRIERS TO GROWTH IN KEY TDP MARKETS IN AUSTRALIA

Current and potential opportunities for TDPs in Australia should be nurtured and developed to maximise penetration and uptake, through:

- Funding for early stage research for national opportunities.
- State government approvals for crumb rubber explosives.
- Improved linkages between use of TDPs and sustainable procurement policies, particularly with state and local government.
- Integration of TDPs into sustainable infrastructure rating tools.



STRATEGIC OBJECTIVE 3 – DEVELOP MARKETS FOR TDPs IN ROAD CONSTRUCTION

The road construction sector is one of the most attractive opportunities for TDPs in Australia. There is scope for large scale consumption of TDPs and it is a sector that is already moving in this direction. Work needs to be done to ensure TDPs can compete on all fronts, including:

- A focus on use of rubber modified sprayed seals in QLD, SA and WA.
- A national program to address barriers impacting markets for BCRA in Australia.
- Building capability and capacity in the local government sector.
- Building capability and capacity in the road construction industry.
- Completion of research into use of tyre-derived aggregate in road subbase.

STRATEGIC OBJECTIVE 4 – RESEARCH LONG-TERM MARKETS FOR TDPs IN THE RAIL CONSTRUCTION SECTOR

Entry into the rail construction sector will take a planned and coordinated approach based on early stage research supported by staged implementation thereafter. Government should take a partnership approach which includes:

- Detailed technical work into material applications in the rail sector.
- A funded program of laboratory testing.
- Bringing manufacturing partners and rail industry sponsors together.
- Field trials and type approvals.
- Training and industry capability building on a national level.

STRATEGIC OBJECTIVE 5 – DEVELOP NEW MARKETS FOR USE OF TDPs IN NON-STRUCTURAL CIVIL ENGINEERING APPLICATIONS

Building this market from the ground up will require a national program of research, testing and specification development, including:

- A national steering committee to guide use of TDPs in non-structural civil engineering applications with a focus on TDAs.
- Early stage research into use of TDA as lightweight fill and landfill drainage aggregate.
- Development of national specifications for key applications.
- Update existing specifications for use of whole tyres in civil construction.

1 Project introduction

Sustainability Victoria (SV) and the Department of Environment and Heritage Protection (EHP) Queensland are co-leading the development of a national market development strategy for used tyres (the Strategy). The Strategy, which is being co-funded by SV, EHP, Department of Water and Environmental Regulation WA, NSW Environment Protection Authority and Tyre Stewardship Australia (TSA), seeks to provide a framework for a national approach to market development for tyre-derived products (TDPs) in Australia.

Randell Environmental Consulting (REC), working with Reincarnate and Envisage Works, were appointed to develop the Strategy based on analysis of the current market and extensive consultation across industry and government.

1.1 Project background

Australia generates significant quantities of end-of-life tyres (EOLT) and only a small proportion are recycled domestically with the remainder being exported, landfilled, illegally dumped or stockpiled.

The landfilling of EOLT, which are comprised predominantly of rubber and high-tensile steel, represents a significant missed opportunity from the recovery and reuse of this material. The mismanagement of EOLT, via illegitimate stockpiling, burning and illegal dumping, poses a serious risk to the community through incidence of tyre fires. When burnt, tyres release toxic smoke and pollute ground water and surface water from contaminated runoff as the fire is being extinguished.

Australia has been historically poor at managing the risks associated with EOLT and in maximising their recovery and recycling. Domestic markets for tyre-derived products (TDPs) remain constrained and the tyre recovery industry is impacted by:

- lack of effective regulation in some jurisdictions
- disparities in the current costs imposed by retailers for collection and disposal of EOLT
- high cost of infrastructure to process EOLT
- the impact of cheap imported tyre-derived products
- limited acceptance of recycled-content products within specifications or tender documents
- barriers restricting the emergence of domestic energy from waste infrastructure
- barriers to addressing existing EOLT stockpiles.

In 2015, in response to several significant tyre fires around the country and increasing community concern, state environment ministers agreed to an increased focus on waste tyres and to hold a forum to determine the most effective approach to increasing the market for used tyres in Australia.

Representatives from industry and government subsequently agreed that a national market study and a more collaborative approach between states and territories was required to further develop the national market for used tyres. The findings of the forum were reported back to environment ministers in October 2015.

In December 2015, a Meeting of Environment Ministers (MEM) endorsed a national project to develop a market development strategy for used tyres ('the Strategy') as the next phase of work in the program.

1.2 Project aims

The project aims to develop a strategy that facilitates a national approach to market development for tyre-derived products, supported by state-based programs and underpinned by collaboration between government and industry. The following objectives guided the development of the Strategy:

- support a nationally consistent approach to market development
- increase the usage of tyre-derived products in Australia
- promote greater diversity in tyre-derived products and their application
- facilitate a more cohesive and progressive tyre recycling industry.

1.3 Strategy structure

Part 1 EOLTs in Australia

Part 1 provides analysis of the current ‘state’ of the tyre recycling market in Australia to support development of the Strategy and its implementation actions. Part 1 includes:

- examination of tyre-derived products, their broad applications and the required specifications
- overview of current market forces and trends
- material flow analysis of stocks and flows of EOLT in Australia and in each jurisdiction
- analysis of key policy and regulatory settings in Australia and in each jurisdiction.

To provide the reader with the appropriate context on the EOLT market in Australia, an overview of tyre-derived products and their applications is presented at the beginning of Part 1. This allows easier interpretation of the data analysis and market analysis presented in the latter sections. The product specifications required for TDPs are included in [Appendix 1](#).

The national MFA results are included in Part 1 and each jurisdictions’ results are included in [Appendix 2](#).

During Part 1 development, informal targeted consultation was undertaken with key industry players to discuss the current market conditions and to validate key data assumptions.

Formal, documented consultation was undertaken during Part 2 of the Strategy development (see below).

Part 2 – Analysis of barriers and opportunities

Part 2 provides a detailed and thorough analysis of the barriers that impede growth of domestic markets for TDPs, including competition analysis of key markets. Discussion then moves to focusing on existing and emerging opportunities and estimates of the potential impact (in additional tonnes of EOLTs) based on projection modelling undertaken by REC. A summary of opportunities for TDPs is provided, with detailed competition and market analysis for each opportunity provided in [Appendix 3](#). Part 2 also contains considerable analysis on three key market segments:

- Road construction
- Rail construction
- Non-structural civil engineering.

These markets are examined in detail, both in terms of their structure and the opportunities for TDPs. The road and rail sectors were chosen as focus areas by the Project Working Group, with the third market, non-structural civil engineering, being selected during a workshop with government representatives from the Project Working Group and the REC project team. Essentially, these markets represent the best opportunities for uptake of TDPs at scale.

Part 3 – Options for strategy implementation

Part 3 of the strategy provides the basis for a future 5-year implementation plan for the Strategy. It gives an overview of the types of options and strategies for addressing EOLT market challenges including how these apply to immature and mature markets alike.

At SV's request the draft 5-year implementation plan has been provided in a separate document titled **National market development strategy for used tyres – Draft implementation plan**. It is envisaged that a final implementation plan will be released along with the broader Strategy document when the implementation actions have been endorsed and responsibility assigned to the appropriate lead and support organisations.

Note: the footer refers to the Strategy Part number 1,2, or 3 to aid readers in document navigation.

1.4 Project methodology

Randell Environmental Consulting (REC), working with Reincarnate and Envisage Works developed the Strategy based on analysis of the current market and extensive consultation across industry and government.

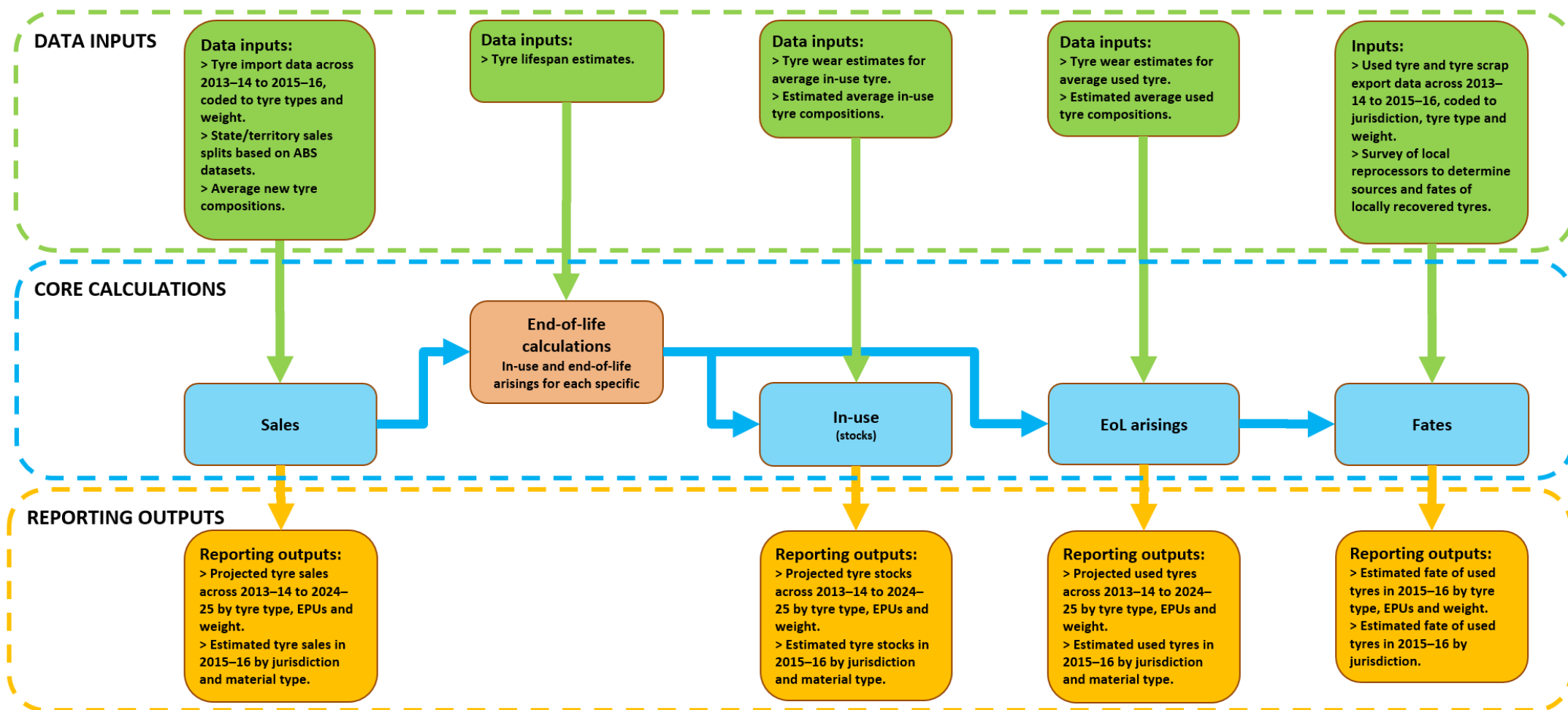
1.4.1 EOLT material-flow-analysis

The Strategy is founded upon a comprehensive materials flow analysis (MFA) for EOLTs. Figure 1 provides an overview of MFA including the main data inputs, calculations, and MFA outputs.

The EOLT MFA method can be summarised as follows:

1. The current and projected sales of tyres (passenger, truck and OTR) into the Australian market were estimated based primarily on a collation of tyre import data and market outlook data for future tyre sales.
2. For passenger, truck and OTR tyres the 'in-use' and 'end-of-life' arisings were calculated for each year (current and future) by application of an average lifespan for each tyre type.
3. The in-use and end-of-life tyre quantities for each tyre type and for each year were estimated. Importantly, this stage of the MFA estimated the tonnages of tyre rubber that is dispersed to the open environment due to the wear of the tyre tread during use. Another innovation of the MFA was to provide the quantities of EOLT in tonnages of materials that make-up EOLTs (i.e. rubbers, steel, plastic fibres). Providing the EOLT arisings data by material tyre enables analysis of the material opportunities, rather than focusing on the number of tyres, as most end markets do not make use of whole tyres.
4. For each tyre type and for each year the fate of EOLT arisings was estimated. This was based on a comprehensive review of EOLT export data **and** on successful and engagement with the Australian EOLT recovery industry. Consultation with the EOLT recovery industry has provided a robust 'baseline' estimate of the current tonnages of EOLTs that are being recycled in Australia.

Figure 1 EOLT material flow analysis methodology overview



Due to the specific scope and requirements for this project as compared with prior Australian work in this area ([Hyder 2015 Stocks & fate of end of life tyres - 2013-14](#)), an updated MFA been developed for this study. The MFA findings in this Strategy, while in reasonably close agreement, are not identical to the Hyder 2015 report findings for 2013-14, which is the overlapping year of reporting between this Strategy and the earlier Hyder work.

1.4.2 End-of-life fates

End-of-life fates mean what happens to Australian EOLTs when they reach the end of their useful life (either in Australian or overseas). Common fates include: reuse, recycling, energy recovery, legal stockpiling, onsite disposal (at mining sites), illegal dumping or stockpiling, licensed landfilling, and dispersal to the environment (of the tread of the tyre during use).

The MFA developed for this Strategy is arguably the best MFA for EOLTs ever produced for Australia.

However, there is a lack of data to support estimates of the quantities of EOLTs that are **not** recycled in Australia or recorded for export and recovery overseas. This means that the EOLT MFA provides less information than if could regarding EOLTs that are:

- landfilled
- illegally dumped or stockpiled
- exported under incorrect export codes.

The Strategy uses the term '**landfill / unknown**' fate to present this data limitation and uncertainty. The landfill / unknown grouping is the sum of the quantities of EOLTs that are landfilled or are sent to other fates where little or no resource value is recovered **and** for which the quantities of each are unknown. These fates are collectively referred to in this strategy as Landfill / unknown fate because currently available data does not enable the quantities of landfilled EOLT to be reported separately from other EOLT fates where no resource value is recovered and for which the quantities of each are unknown³.

To be clear, for the purposes of this Strategy, figures represented as 'Landfill / unknown' refer to quantities of EOLTs that are either sent to:

- licensed landfilling
- unlicensed landfilling
- illegal stockpiling
- illegal dumping
- untracked exports where tyres have left Australia under non-EOLT related codes.⁴

It was beyond the scope of this project to derive estimates for the quantities of EOLTs that sent to these fates. It is worth noting that the Landfill / unknown presents the total EOLT market opportunity and for a market development strategy it is useful is consider these fates as a sum total.

³ Off-the-road (OTR) tyres from mining are an exception. It is understood to be common practice to manage OTR EOLTs, that are not recovered, by landfilling the EOLT into the mine void. For passenger and truck EOLTs, that are not recovered, there is a range of other fates that do not recover resource value, besides landfill, where the quantities of each are unknown.

⁴ For example, "car parts" or other similar export codes

1.4.3 Opportunity modelling

The size of potential market opportunities for TDPs, presented in Part 2 of the Strategy, have been estimated using an “opportunity model”. The model considers key market characteristics, such as potential size, the percentage of the total size that could use TDPs, the estimated percentage ‘uptake’ of the TDP to model potential uptake. Projecting the future is inherently uncertain. Considering the level of uncertainty, the projections of opportunities are provided as a high, low and ‘best’ estimate. The best estimate is what the authors believe to be the most likely and the high and low estimates provide an indication of the level of uncertainty for each estimate.

Important: the figures for potential opportunity size have been used to assist in prioritising implementation actions but figures should be indicative estimates only.

1.4.4 Data considerations

Assurances were provided to the large number of stakeholders interviewed as part of this project on the confidentiality of their responses. This Strategy does not include any company-specific data.

Several new and existing data sources have been used in the development of the Strategy, including primary data on end-of-life fates collected by REC from the tyre recycling industry. It is likely that there will be variations between the data presented in this document and published data from other sources, such as state and territory governments. REC has developed a data methodology that looks to address both national data and state and territory data. In some instances, this will not align directly with the approach taken by individual states and territories, hence the differences in the data presented.

Regarding tyre stockpiles, data on “legal stockpiles” has been collated through industry consultation. These figures refer to material collected during the 2015-16 year but not processed by the end of the data reporting period. It should be noted that both Tasmania and South Australia show negative values for stockpiling in [Appendix 2](#). This represents work undertaken to process stockpiles (for example using a mobile shredder in Tasmania to address legacy stockpiles). Whilst it may be argued that some of this material is likely to come from previous data periods, it is important to tell this story given stockpile reduction is rare and this is a key step for Australia.

Industry consultation data collection indicates underreporting of EOLT exports remains an issue. Data collated from industry consultation suggests underreporting of around 8% (that is to say the figures provided during the industry data survey are roughly 8% higher than the ABS export data). Given the ABS data remains the predominant data source for previous studies, REC has used the lower figure of 119,000 tonnes but used the consultation data for state-by-state splits across the ABS total.

Throughout this Strategy most values in the text, tables and figures have been rounded. For this reason, minor discrepancies may occur between stated totals and the apparent summation of the determinate values. Percentage values have been calculated using the determinate values prior to rounding.

PART 1 – END-OF-LIFE TYRES IN AUSTRALIA

2 Tyre-derived products

This Strategy presents a significant amount of data and market information related to the generation and management of EOLTs in Australia. However, it is important when reading this analysis to understand the nature of products that are created from recovered EOLTs, and as such this section presents an overview of TDPs, including an overview of relevant standards and specifications.

The products or outputs from recovered EOLTs depends largely on the recovery process and the ultimate end use. Like most waste derived commodities, TDPs are essentially outputs from different levels of size reduction and material separation.

In Australia, tyre recovery is dominated by traditional methods which use a series of shredders, screens and granulators to separate materials. However, there is an emerging market for bespoke energy from waste (EFW) facilities that employ pyrolysis or gasification to essentially deconstruct a tyre back to its composite elements. At present, there are no tyre EFW facilities operating at commercial scale in Australia, however there are at least three facilities operating under test or development licenses in Victoria, NSW and Western Australia. Submissions for planning approval for several other facilities have also been submitted in recent years.

The manufacturing of TDPs across Australia differs across jurisdictions, depending on the availability of local markets and the level of investment undertaken by individual tyre recyclers. Table 1 provides an overview of TDPs and in which states and territories they are produced.

Table 1 Manufacture of TDPs and jurisdictions

Tyre-derived products	NSW	VIC	WA	QLD	SA	TAS	NT	ACT
Whole tyres / casings	✓	✓	✓	✓	✓	✓	✓	✓
Baled tyres	✓	✓	✓	✓	✓		✓	
Shredded tyres	✓	✓	✓	✓	✓	✓		
Granule / buffings	✓	✓	✓	✓	✓			
Crumb rubber	✓	✓	✓	✓	✓			
Steel	✓	✓	✓	✓	✓			
Nylon / rayon fabric	✓	✓	✓	✓	✓			
Syngas	✓*	✓*	✓*					
Carbon black / char	✓*	✓*	✓*					
Fuel oil	✓*	✓*	✓*					
Steam								

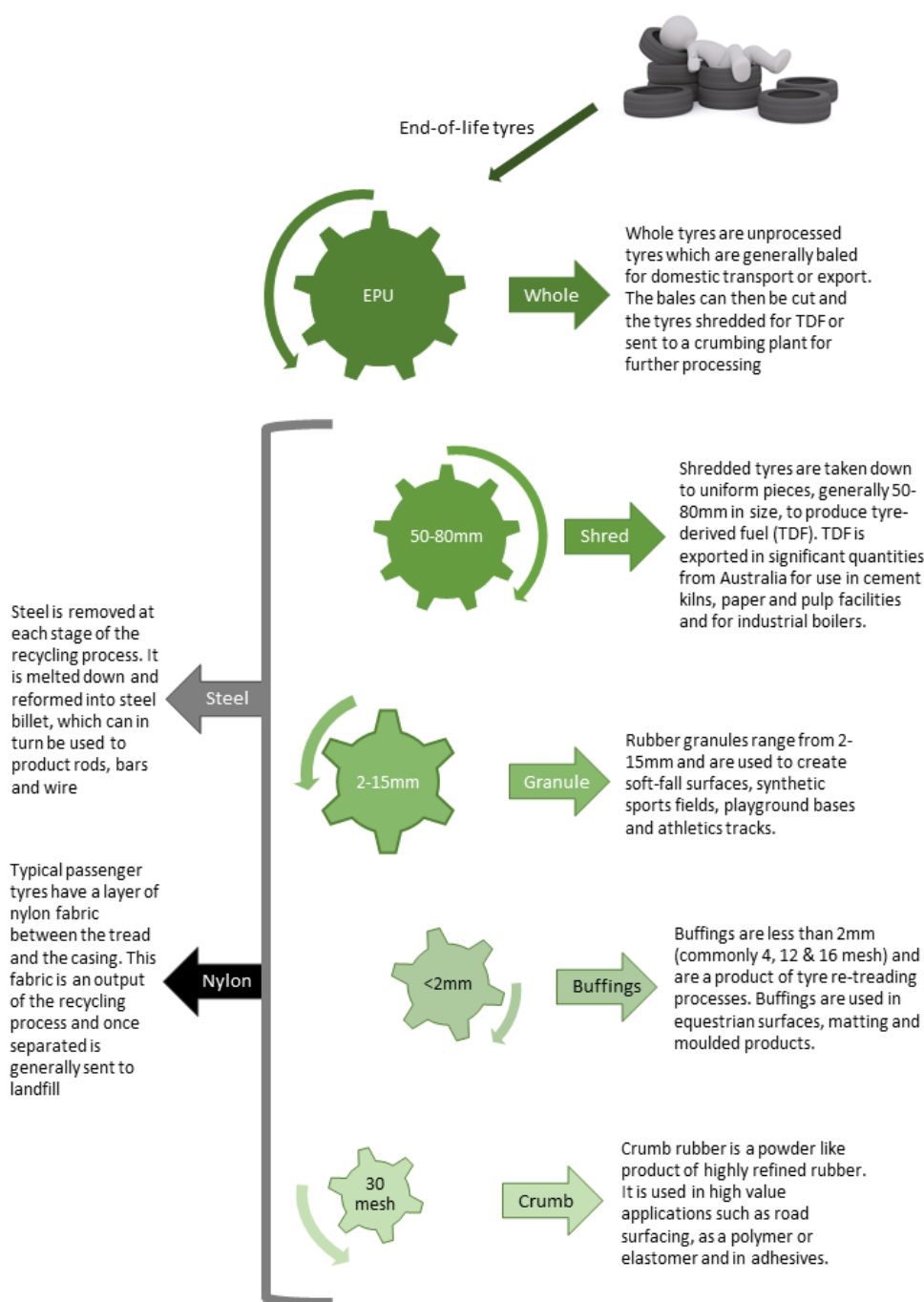
* Note: These TDPs are not yet being produced at commercial scale.

This chapter provides an overview of TDPs from both the traditional recovery market and the emerging EFW market and summarises the most common applications for these products.

2.1 Products of traditional EOLT recovery facilities

Figure 2 provides an overview of TDPs from the traditional EOLT recovery market and their common applications.

Figure 2 Overview of TDPs and applications



2.1.1 Whole tyres / casings

Whole recovered tyres (commonly referred to as “casings”) are unprocessed tyres which can be sold locally or exported for second hand reuse or retreading. Material recovered for domestic reuse is not counted in EOLT data, however exported casings are deemed to be EOLTs as they have reached end-of-life as far as use in Australia is concerned. Some estimates suggest that around 10% of used tyres are diverted into the casings market⁵.

The domestic market for casings has declined significantly in recent years with Australian consumers moving away from passenger tyre retreads. However, truck and light truck casings are still recovered for retreading with facilities operating in most capital cities. There is a strong casings export market from Australia into Asia and Africa.

2.1.2 Baled tyres

Whole tyres⁶ are compressed using a hydraulic bale press and then bound with high tensile wire to form a block shape. Baling is a fast process that can greatly improve efficiencies for both interstate and international transport. There several different sizes of tyre balers which in turn produce a different size bale. Bales typically contain more than 100 EPU's and range from 500 kg up to two tonnes in weight.

Tyre balers are relatively cheap, require minimal maintenance (when compared to a tyre shredder) and are easy to operate. The barriers to entry for this market are therefore relatively low.

2.1.3 Shredded tyres

Most recovered EOLTs in Australia end up in the form of shredded tyres with the dominant product in this market being tyre-derived fuel (TDF). Exports of EOLTs for energy recovery (which includes TDF and baled tyres) accounts for approximately 27% of the total tyre market. As with baled tyres, there are a broad range of shredded tyre shapes and sizes depending on the shredder used. Where EOLTs are destined for landfill a coarse shred may be appropriate (for example to 500mm), however smaller, more uniform tyre shred is required to produce TDF.

Internationally, shredded tyres made to a specification have been used as tyre-derived aggregate (TDA) in considerable volumes. The primary uses for TDA are drainage medium in landfills and as lightweight embankment fill.

Shredded tyres can also be used to increase transport efficiency where a course or primary shredder is used to process material for transport to a secondary crumbing plant or TDF facility.

Tyre shredders can range from \$150,000 for a course shredder to more than \$1,000,000 for a high capacity machine. A reliable, entry level shredder for producing a uniform TDF product currently costs in the order of \$300,000⁷. Maintenance costs for tyre shredders is typically high, primarily from blade sharpening and replacement.

2.1.4 Granule / buffing

Rubber granulate is generally in the order of 2mm – 15mm and is produced via a series of granulators and screens that further process shredded tyres into a refined, uniform product.

⁵ Stocks and fates of end of life tyres *Hyder Consulting 2015 page 56*

⁶ See this image (source – Direct Industry) http://img.directindustry.com/images_di/photo-g/57419-4374631.jpg

⁷ Confidential pers comm during consultations

Granulate is mostly free from contaminants with the metal and fabric removed via magnets and air separation respectively.

Buffings are pure tyre rubber that are effectively shaved off the remaining tread on a tyre casing during the retreading process. Casings are mounted on a rotating disk and a series of blades strip the tread to the point that the casing is ready for the new tread to be applied. Buffings are around 10 – 20mm in length and are highly valued due to the very low contamination levels.

Granule and buffings are used in soft-fall surfacing, moulded product, playgrounds and equestrian surfaces.

2.1.5 Crumb rubber

The most highly refined product from tyre recycling is crumb rubber (also known as rubber crumb, crumb or powder). Crumb rubber is less than 1mm and is produced using a three-stage grinding process to separate rubber, fabric and steel. Less commonly, crumb rubber can be produced using a cryogenic process where the rubber is frozen with liquid nitrogen and ground in a hammer mill.

Crumb rubber makes up a significant part of the domestic market for TDP with applications ranging from asphalt pavements to high value polymer products and explosives. However, infrastructure costs are high with a commercial scale crumbing plant likely to cost in excess of \$10 million. At present, crumb rubber sells for \$500 - \$600/tonne in Australia⁸.

2.1.6 Steel

Tyres often contain two steel products. A thin layer of high tensile steel, known as “steel belt” sits beneath the tread to provide reinforcement for the rubber and give the tyre strength in supporting heavy loads. In addition, the sidewall of a tyre contains steel beading or wire which keeps the tyre locked safely onto the bead of the wheel rim.

Steel is removed at several stages of the recycling process. At the front end, a specialised bead remover can be used to remove the steel beading prior to shredding. A series of magnets are used across each stage of size reduction to extract steel belt with the resulting product being finely shredded metal that resembles steel wool.

Recovered steel is processed by metal recyclers back into commercial grade steel billet. The global market for scrap steel has weakened considerably over the past eight years with prices now in the order of \$60 - \$80 AU /tonne⁹.

2.1.7 Nylon / rayon fabric

Passenger tyres commonly have a layer of nylon fabric beneath the tyre tread and the steel belt as further reinforcement. This is typically either nylon or rayon and can be extracted during the recycling process using air separation. The resultant material, a shredded fabric product often called “fluff” is predominantly sent to landfill in Australia.

There may be further application for recovered tyre fabric as a fuel, either blended into a refuse derived fuel or used directly in pyrolysis or other thermal facilities.

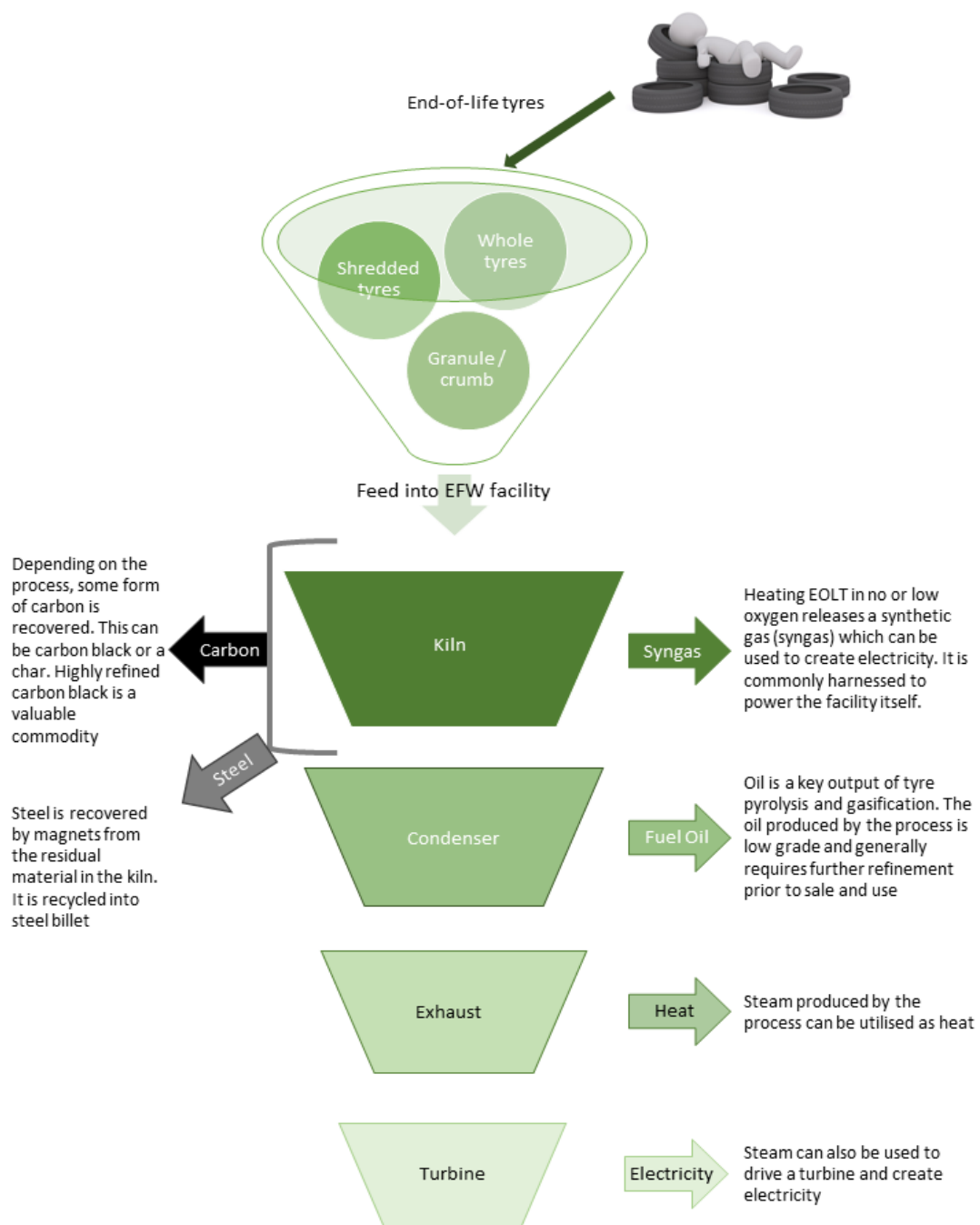
⁸ Confidential pers comm during targeted consultation

⁹ Industry sources pers comm

2.2 Products of pyrolysis and gasification

The development of bespoke energy from waste technologies designed to use EOLT as a primary or secondary feedstock, such as pyrolysis and gasification, create a second range of tyre-derived products. These technologies aim to recover embodied energy from EOLT and bring them back to their raw component parts. Figure 3 provides an overview of TDPs from energy from waste processing technologies.

Figure 3 Overview of TDPs from energy from waste processing technologies



2.2.1 Syngas

Syngas (or synthetic natural gas or synthesis gas) is produced when tyres are heated in low or no oxygen environments. Comprised mainly of hydrogen and carbon monoxide, syngas is combustible and can be used to generate electricity.

2.2.2 Fuel oil

The primary TDP from pyrolysis and gasification is fuel oil. Rubber is essentially vaporised during the process and the vapour is then extracted from the chamber and condensed as a fuel oil of varying quality. In its raw form the fuel can be used as low grade ship or “bunk” oil or may be further refined into higher quality diesel products.

2.2.3 Carbon black / char

The remaining solid material after the process (and the further removal of steel with a magnet) is a mostly carbon-based product. At best this product can be classed as carbon black and at worst as contaminated char or ash, which is typically classified as a hazardous waste. Biochar, when free from contaminants, can be used as a soil additive to increase moisture retention around crop roots and in Australia may be eligible for carbon credits under the Carbon Farming Initiative (CFI). Carbon black is a valuable commodity (when of high grade quality) used in the manufacture of new tyres and as a colour pigment in plastics and paints. The production of a high-quality carbon output from pyrolysis and gasification remains one of the most significant barriers to market development.

The term ‘activated’ carbon refers to carbon that is processed to have pores that increase the surface area available for adsorption¹⁰. Activated carbon has several high-value uses as a purification agent (for example, water purification and gold purification) and as a filtering agent (including gas and air filtration and sewage treatment). There is some potential for pyrolysis to generate activated carbon if the right processing conditions exist¹¹.

2.2.4 Steam

Steam can be captured from the EFW process and utilised as process heat or used to create electricity.

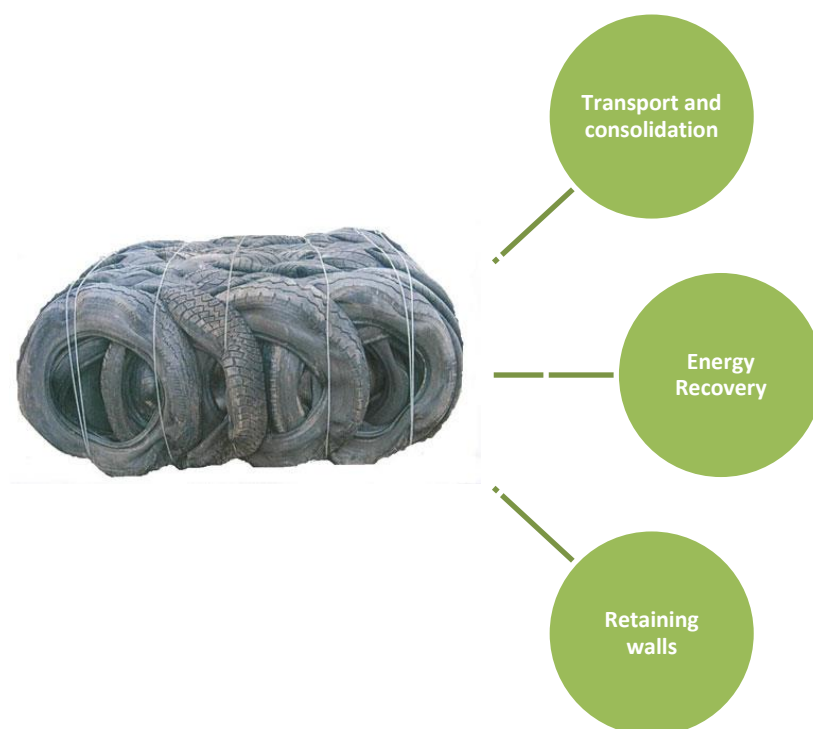
¹⁰ Wikipedia 2017. ‘[Activated carbon](#)’ *Wikipedia*, accessed April 2017

¹¹ Teng et al, 1995. ‘Reprocessing of used tires into activated carbon and other products’ *Industrial and Engineering Chemistry Research* 1995, 34(9), pp3102-3111

3 Applications for TDPs

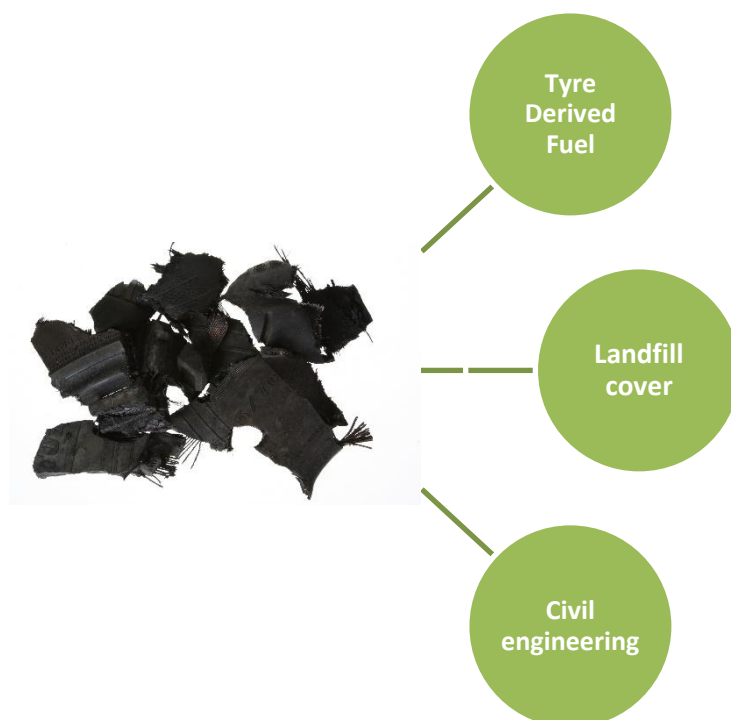
TDPs have a variety of applications both domestically and abroad. They can be used directly or as a raw material in manufacturing of other products. This chapter provides an overview of the main applications for TDPs with further detail provided in the analysis of barriers and opportunities in the next stage of the project.

3.1 Baled tyres



Application	Description
Consolidation and transport	In Australia, baled tyres are used to improve transport efficiency. For example, tyres are baled in regional Australia and transported to metropolitan centres, mainly for shredding into TDF for export.
Energy recovery	Baled tyres are exported in significant quantities, primarily to Korea, Malaysia and India where they are unbaled and used as fuel or further processed into crumb rubber.
Retaining walls	Bales tyres can be encased in concrete and used as a retaining wall system.

3.2 Shredded tyres



Application	Description
Tyre Derived Fuel	As there are currently limited markets for TDF in Australia, it is almost entirely an export product and a commonly traded global commodity. There are no official specifications or standards for TDF in Australia, rather customers set their own requirements depending on their needs. In general, TDF is produced to a uniform size of between 50-150mm ¹² and has a calorific value of around 7,200 – 8,300 kcal/kg, roughly the same as high quality black coal and around 25% higher than brown coal ¹³ . This makes it an ideal fuel to co-fire with traditional coal in power generation, paper and pulp facilities and cement kilns. The ratio for TDF to coal is between 1:20 and 1:5 depending on the plant and the application ¹⁴ . TDF is also used as a primary feedstock in tyre pyrolysis facilities, particularly in Korea and Malaysia.
Landfill construction and daily cover	Shredded tyres are commonly used in landfills, particularly in the United States, as back-fill in gas venting and leachate collection systems and as daily cover material.
Tyre-derived aggregate	Shredded tyres can be used as aggregate material (TDA) or lightweight fill in civil engineering projects, particularly on weak ground prone to settlement. This is a common market in North America and has been used to deal with legacy stockpile issues.

¹² Confidential pers comm during consultations

¹³ Tire derived fuel study *Tire Stewardship Manitoba*

¹⁴ Tire derived fuel study *Tire Stewardship Manitoba*

3.3 Granule / buffings



Application	Description
Soft surfacing	There are a wide number of soft surfacing products that are created using rubber granules / buffings. Playground and pathway surfaces use black or coloured granule bonded together to form a soft surface to reduce injuries from falling. This is applied wet ("wet pour") and sets hard the same way that concrete is applied meaning it can take any shape required. Granule / buffings are also used to create indoor and outdoor sport surfaces (including gymnasiums), either as rubber underlay or within the surface itself.
Rubber matting	Rubber matting products of all shapes and sizes are manufactured in Australia and internationally. Fine granules are compressed into rolls or blocks which can be then finely cut or sliced into mats of any size or length for use as flooring, underlay and matting
Equestrian surfacing	Rubber equestrian surfacing, for example on dressage areas, is a growing market in Australia. Granule / buffings are used in compressed surfacing to provide light cushioning and reduce the risk of injuries to the horse and the rider.
Moulded products	Highly compressed moulded products using granule / buffings include posts, fences and bollards.

3.4 Crumb rubber



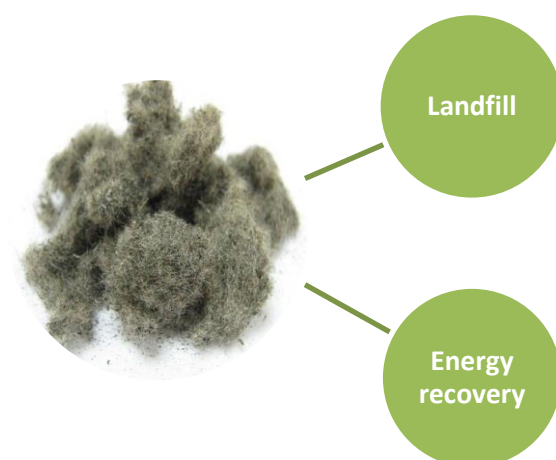
Application	Description
Road surfacing	Crumb rubber is used in significant volumes in road construction. It can be used as a replacement for traditional polymer modified binders (PMBs) in asphalt pavements and spray seals. The addition of crumb rubber increases the road's resistance to surface cracking and can reduce traffic noise. Road surfacing remains one of the largest markets for TDFs worldwide.
Polymers, elastomers and adhesives	Highly refined crumb rubber can be used in a variety of manufacturing applications where natural rubber and synthetic polymers are used. This includes use in adhesives, industrial compounds, plastics, coatings and sealants.
Explosives	Crumb rubber can be used in the manufacture of explosives in the mining industry. The rubber is blended with ammonium nitrate to increase the impact of the explosion and reduce the fuel amount required. The addition of rubber also improves the explosives usability in wet conditions.
Concrete	When added to concrete, crumb rubber can increase the flexibility and reduce the risk of cracking from subsidence and movement. Applications include concrete pavements, structural concrete and pre-fabricated panels.

3.5 Steel



Application	Description
Steel billet	Recovered steel is processed into steel billet as part of the scrap metal recycling process. Billet is a global commodity and is used in the manufacture of steel rods and wire.

3.6 Fabric



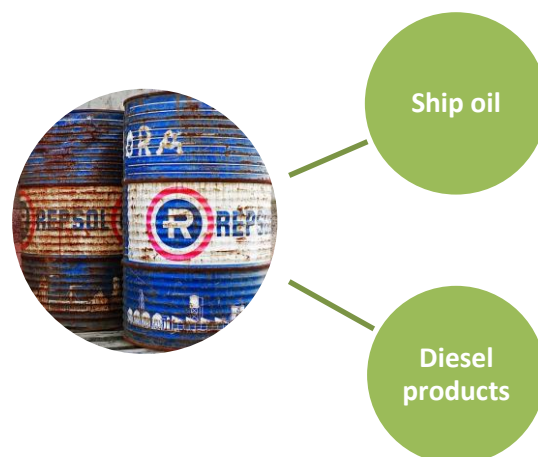
Application	Description
Landfill	Most fabric recovered from EOLTs in Australia is sent directly to landfill.
Energy recovery	Trials have been undertaken in Melbourne on the feasibility of recovered fabric as a fuel. This may open future markets for the material.

3.7 Syngas



Application	Description
Electricity	In small scale pyrolysis and gasification systems, syngas is commonly used to power the facility as the target outputs are fuel and carbon. Larger scale facilities can capture the gas and generate power to feed back into the electricity network.

3.8 Fuel oil



Application	Description
Ship oil / bunker oil	In its raw form, the fuel from pyrolysis and gasification is a heavy fuel oil that can be used as ship oil or “bunker” oil. Bunker oil is extremely viscous and generally requires heating prior to use in a ships furnace.
Diesel products	Fuel oil can be refined into higher quality diesel products for use as stationary fuel or diesel petrol, however further refinement may add considerable processing costs.

3.9 Carbon black / char



Application	Description
Tyre manufacture	The dominant market for quality carbon black (around 70% of the worldwide total) is as a reinforcing agent in the manufacture of new tyres and other rubber products. When added to rubber, carbon black increases wear resistance and tensile strength ¹⁵ .
Colour pigment	Carbon black is used as a black pigment for printing inks, paints and coatings and in the manufacture of plastic.
Soil additive	Char can be used as a soil additive to improve moisture retention. The primary benefit of using char in soil is to lock in carbon and potentially gain credits from the Carbon Farming Initiative program. However, it is unlikely that the organic content in tyres would be high enough to be classified as “biochar” and CFI credits for these applications are designed for pyrolysis of materials with high organic content such as timber and forestry residues.

¹⁵ Market study: Carbon black (2nd edition) - <http://www.ceresana.com/en/market-studies/chemicals/carbon-black/>

4 Specifications and standards relevant to TDPs

Standards and specifications can enable and expand uptake of TDPs or conversely, can restrict their usage where certain products and uses are excluded. There are several international, national and state-based specifications that relate to the application of TDPs. The success of market development initiatives is therefore intrinsically linked to the type and nature of standards and specifications.

A few key specifications are outlined below and these will be explored in more detail in subsequent stages of this project. For the purposes of this analysis, standards and specifications regarding the following key TDP markets have been addressed:

- bitumen crumb rubber asphalt (BCRA)
- rubber modified spray seals
- tyre-derived fuel
- tyre-derived aggregate
- baled tyre exports
- surfacing and soft fall matting
- explosives
- civil engineering
- fuel oil
- carbon black

Table 2 provides an overview of current state, national and international standards, with detailed market specific standards provided in [Appendix 1](#).

Table 2 Overview of specifications for tyre-derived products

Market	Internat'l	National	VIC	QLD	NSW	WA	SA	NT	TAS	ACT
BCRA and rubber modified spray seals										
Tyre-derived fuel										
Baled tyre exports										
Tyre-derived aggregate										
Surfacing and soft fall matting			Covered by Australian Standard							
Explosives										
Civil engineering (whole tyres)			Covered by Australian Standard							
Fuel oil			Covered by Australian Standard							
Carbon black			Covered by Australian Standard							

Legend: = targeted standard or specification solely for use of TDP; = general specification that contains some provisions for TDP use; = no specifications available

5 Current and projected national market for end-of-life-tyres

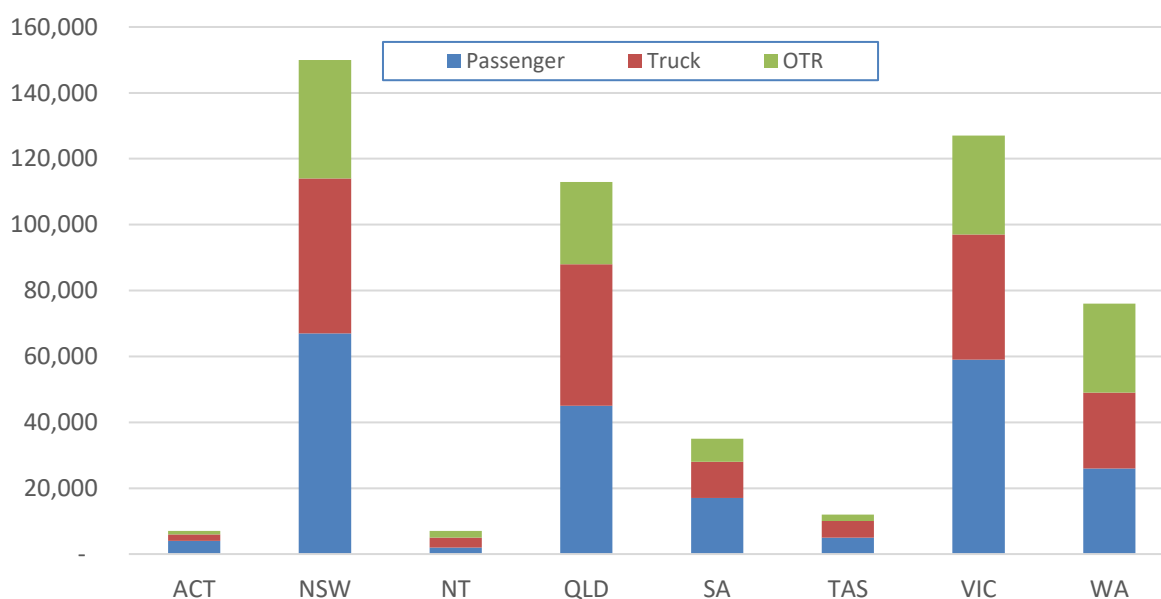
5.1 EOLT Consumption

In 2015-16, almost 56 million new tyre EPU (equivalent passenger units)¹⁶ were sold in Australia (tyre 'consumption') making the market worth over \$4.6 billion in revenue for the economy¹⁷. Industry statistics suggest that more than 2,100 businesses are involved in tyre retailing with major and independent outlets across metropolitan, regional and rural Australia. Most tyres sold in Australia, around 42% (by weight), are passenger tyres with truck and OTR tyres making up 32% and 25% of the market respectively. Table 3 and Figure 4 show the breakdown in Australian tyre sales by tyre type and jurisdiction in tonnes for 2015-16.

Table 3 Australian tyre sales 2015-16 by tyre type and jurisdiction (tonnes)

Jurisdiction	Passenger	Truck	OTR	Total
ACT	4,000	2,000	1,000	7,000
NSW	67,000	47,000	36,000	150,000
NT	2,000	3,000	2,000	7,000
QLD	45,000	43,000	25,000	113,000
SA	17,000	11,000	7,000	35,000
TAS	5,000	5,000	2,000	12,000
VIC	59,000	38,000	30,000	127,000
WA	26,000	23,000	27,000	76,000
Australia	225,000	172,000	130,000	527,000

Figure 4 Australian tyre sales 2015-16 by tyre type and jurisdiction (tonnes)



¹⁶ Based on import/export DFAT STARS Database, ABS Cat No 5368.0 and assumed new passenger tyre weight of 9.5 kgs.

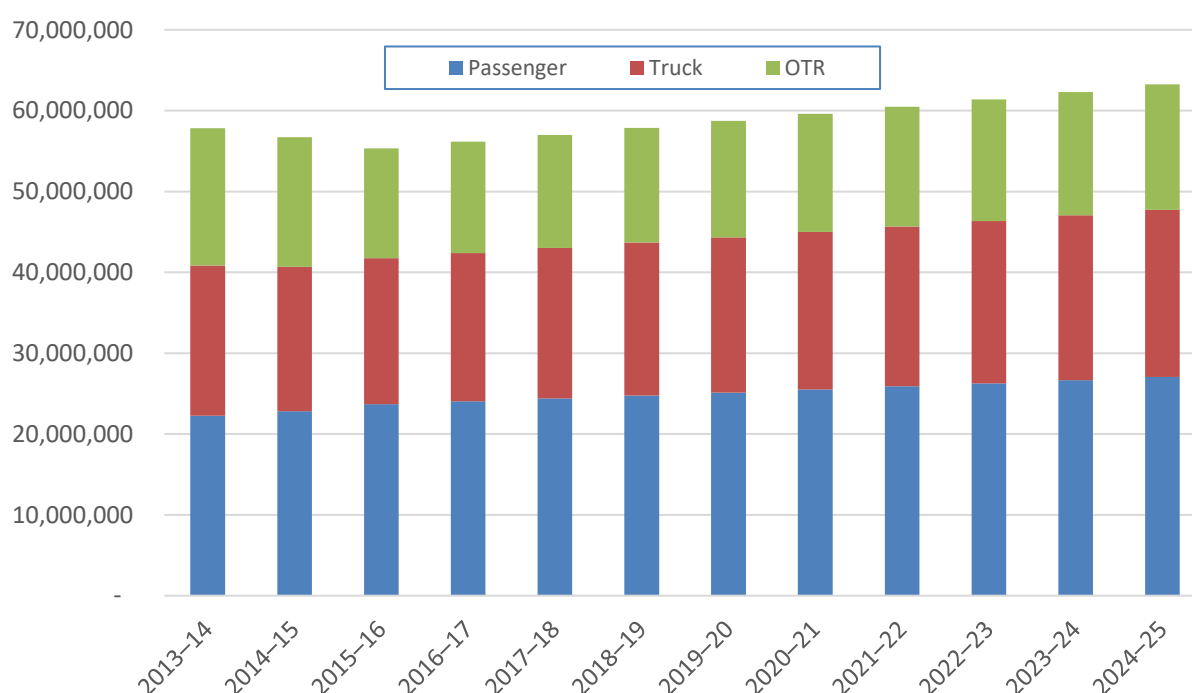
¹⁷ IBIS World Australia *Tyre retailing in Australia October 2015*

Between 2013-14 and 2015-16, consumption of tyres reportedly decreased by around 4%, primarily because of depressed GDP from the global financial crisis. However, the new tyre market is projected to grow by around 1.5% per annum and is heavily influenced by new vehicle sales, rubber commodity prices, fuel prices and the average age of vehicles on the road¹⁸. Projections undertaken by REC using industry data estimate that by 2024-25, new tyre sales in Australia will reach approximately 63.3 million EPU as can be seen in Table 4 and Figure 5.

Table 4 Australian tyres sales 2013–14 to 2024–25, by tyre type (EPUs)

Year	Passenger	Truck	OTR	Total
2013–14	22,284,000	18,547,000	17,000,000	57,831,000
2014–15	22,832,000	17,863,000	16,042,000	56,737,000
2015–16	23,684,000	18,074,000	13,558,000	55,316,000
2016–17	24,042,000	18,347,000	13,768,000	56,157,000
2017–18	24,400,000	18,621,000	13,968,000	56,989,000
2018–19	24,768,000	18,905,000	14,179,000	57,852,000
2019–20	25,137,000	19,189,000	14,400,000	58,726,000
2020–21	25,516,000	19,474,000	14,611,000	59,601,000
2021–22	25,895,000	19,768,000	14,832,000	60,495,000
2022–23	26,284,000	20,063,000	15,053,000	61,400,000
2023–24	26,674,000	20,368,000	15,274,000	62,316,000
2024–25	27,074,000	20,674,000	15,505,000	63,253,000

Figure 5 Australian tyres sales 2013–14 to 2024–25, by tyre type (EPUs)



¹⁸ IBIS World Australia *Tyre retailing in Australia October 2015*

5.2 EOLT in-use (stocks)

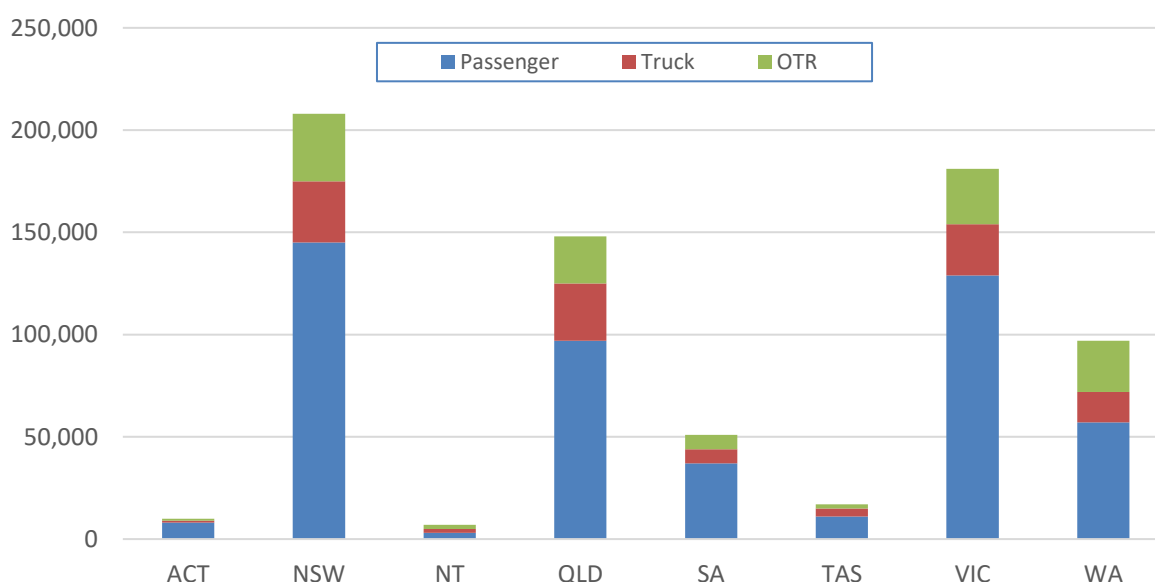
The useful life of a tyre is spent “in-use”, which essentially refers to the period in a tyre’s lifecycle where it is employed in the purpose for which it was made. In keeping with previous EOLT studies, retreaded tyres and second hand tyres are classed as “in-use”.

In 2015-16, some 82.2 million EPU (719,000 tonnes) were in-use in Australia¹⁹. Table 5 and Figure 6 show Australia’s tyre stocks in 2015-16 by jurisdiction and tyre type in tonnes^{20, 21}.

Table 5 Australian tyres stocks in 2015–16, by jurisdiction and tyre type (tonnes)

Jurisdiction	Passenger	Truck	OTR	Total
ACT	8,000	1,000	1,000	10,000
NSW	145,000	30,000	33,000	208,000
NT	3,000	2,000	2,000	7,000
QLD	97,000	28,000	23,000	148,000
SA	37,000	7,000	7,000	51,000
TAS	11,000	4,000	2,000	17,000
VIC	129,000	25,000	27,000	181,000
WA	57,000	15,000	25,000	97,000
Australia	487,000	112,000	120,000	719,000

Figure 6 Australian tyres stocks in 2015–16, by jurisdiction and tyre type (tonnes)



¹⁹ Assumes an in-use passenger tyre weight of 8.75 kilograms (due to wear)

²⁰ ABS publication 9309.0 - Motor Vehicle Census, Australia, 31 Jan 2016 is used to provide state/territory splits for passenger and truck tyre sales splits.

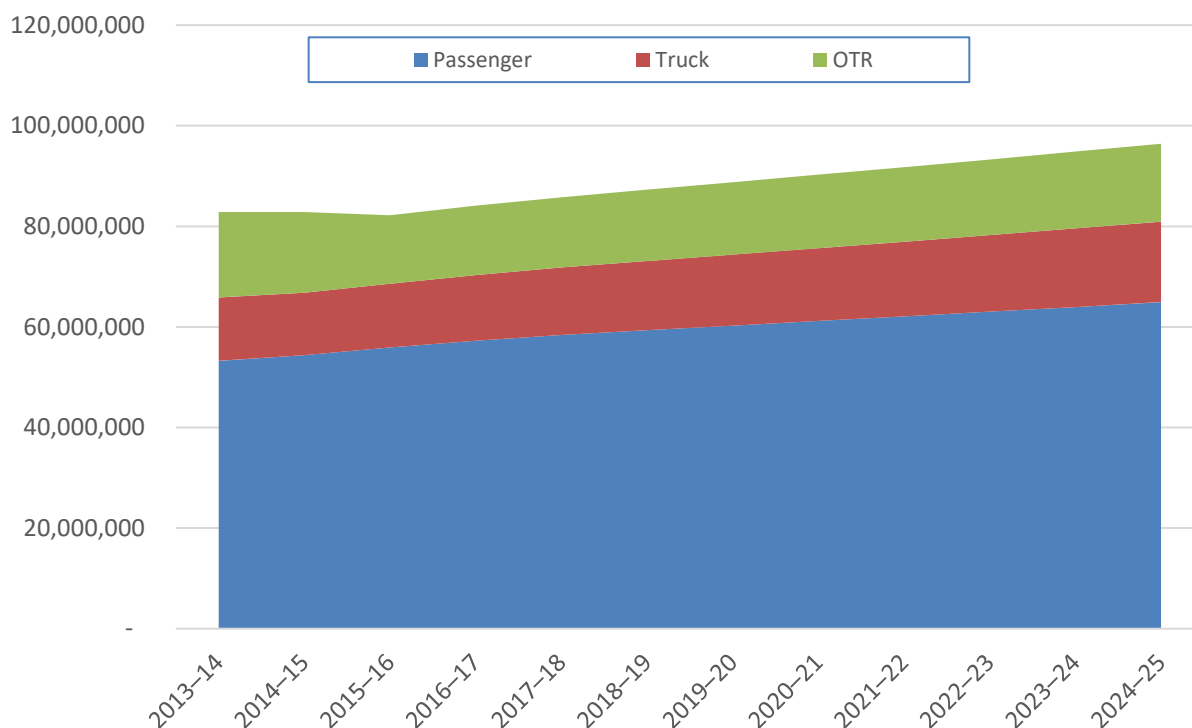
²¹ ABS publication 8155.0 Australian Industry, 2014–15. Table 6 – States and territories by industry division data is used to provide state/territory splits for OTR sales splits, as it is assumed that unregistered vehicles are predominately OTR and therefore can't be reasonably estimated using ABS 9309 publication data.

Based on projected rates of tyre consumption, Australian tyres stocks, presented in Table 6 and Figure 9, are projected to reach almost 97 million EPU by 2024-25.

Table 6 Australian tyres stocks 2013–14 to 2024–25, by tyre group (EPUs)

Year	Passenger	Truck	OTR	Total
2013–14	53,271,000	12,593,000	17,002,000	82,866,000
2014–15	54,377,000	12,418,000	16,044,000	82,839,000
2015–16	55,901,000	12,714,000	13,563,000	82,178,000
2016–17	57,262,000	13,055,000	13,766,000	84,083,000
2017–18	58,400,000	13,402,000	13,973,000	85,775,000
2018–19	59,366,000	13,754,000	14,182,000	87,302,000
2019–20	60,272,000	14,112,000	14,395,000	88,779,000
2020–21	61,176,000	14,474,000	14,611,000	90,261,000
2021–22	62,093,000	14,843,000	14,830,000	91,766,000
2022–23	63,023,000	15,216,000	15,053,000	93,292,000
2023–24	63,967,000	15,596,000	15,278,000	94,841,000
2024–25	64,926,000	15,981,000	15,508,000	96,415,000

Figure 7 Australian tyres stocks 2013–14 to 2024–25, by tyre group (EPUs)



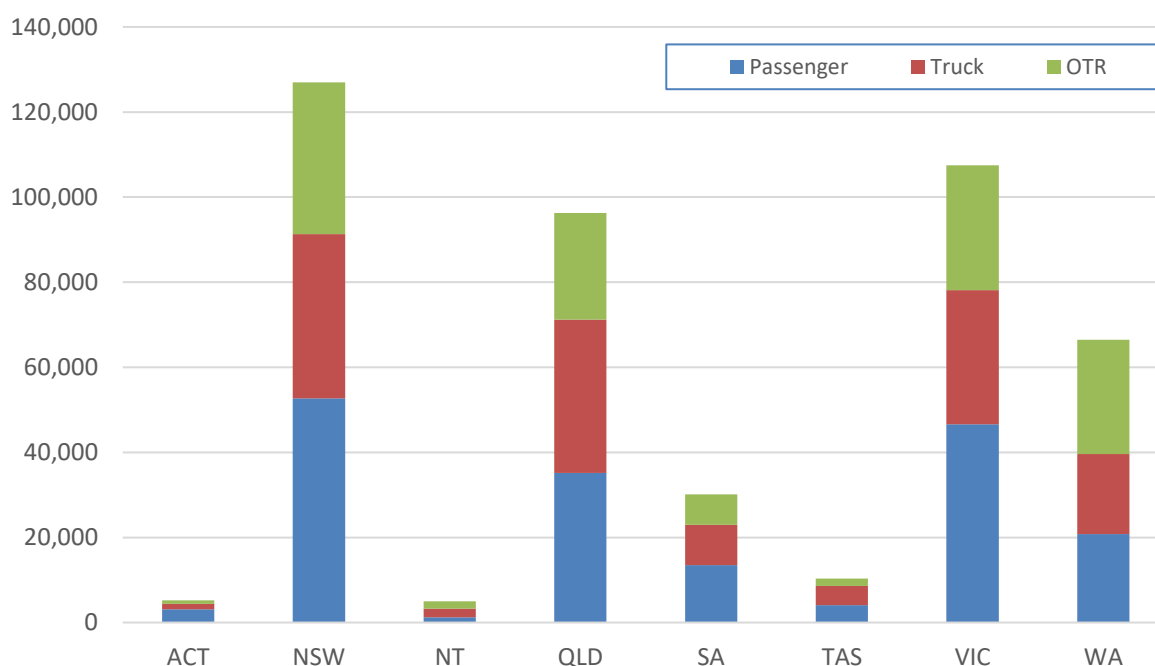
5.3 EOLT generation

The generation of EOLTs is determined by rates of consumption, stocks and the average lifespan of a tyre²². EOLT arisings in Australia reached approximately 451,000 tonnes or 56.3 million EPU in 2015-16²³. Table 7 and Figure 8 present EOLT arisings in Australia in 2015-16 in tonnes.

Table 7 Australian tyres reaching end-of-life in 2015–16, by jurisdiction and tyre type (tonnes)

Jurisdiction	Passenger	Truck	OTR	Total
ACT	3,100	1,300	800	5,200
NSW	52,700	38,600	35,700	127,000
NT	1,200	2,100	1,700	5,000
QLD	35,200	36,000	25,100	96,300
SA	13,500	9,500	7,100	30,100
TAS	4,100	4,500	1,700	10,300
VIC	46,600	31,500	29,400	107,500
WA	20,800	18,800	26,900	66,500
Australia	177,200	142,300	128,400	447,900

Figure 8 Australian tyres reaching end-of-life in 2015–16, by jurisdiction and tyre type (tonnes)



²² Average use phase assumed to be 3.5 years' passenger, 1.5 years' truck, 1 year OTR.

²³ Assuming an EOLT passenger weight of 8 kilograms.

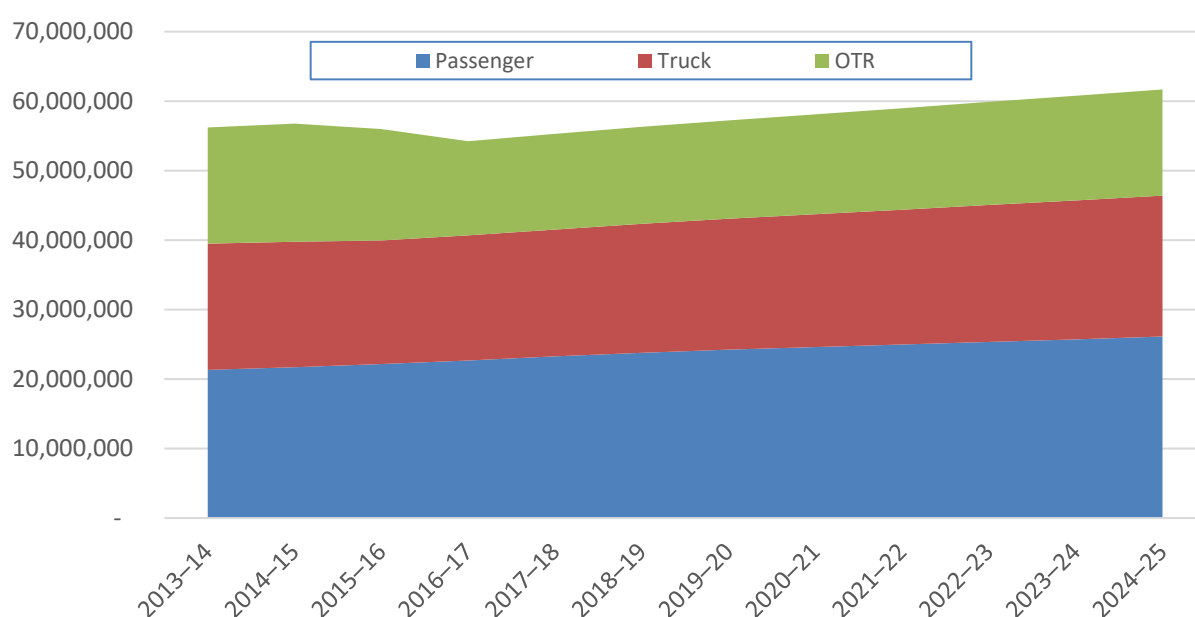
Jurisdictional analysis of the current data set shows NSW as the largest generator of EOLTs at around 127,000 tonnes (~16 million EPU), with Victoria and Queensland generating some 107,500 tonnes (~13.4 million EPU) and 96,300 tonnes (~12 million EPU) in 2015-16 respectively. These figures are not surprising given EOLT generation is closely tied to population.

Assuming per capita generation of EOLTs remains the same, population growth and the associated increase in tyre consumption is projected to push EOLT arisings in Australia past 61.5 million EPUs (493,000 tonnes) by 2024-25. This represents a further six million EPUs that will require end-of-life management. Table 8 and Figure 9 illustrate projected EOLT arisings in Australia to 2024-25 in EPUs.

Table 8 Australian tyres reaching end-of-life 2013–14 to 2024–25, by tyre type (EPUs)

Year	Passenger	Truck	OTR	Total
2013–14	21,327,000	18,165,000	16,697,000	56,189,000
2014–15	21,724,000	18,036,000	17,002,000	56,762,000
2015–16	22,159,000	17,781,000	16,044,000	55,984,000
2016–17	22,677,000	18,007,000	13,563,000	54,247,000
2017–18	23,260,000	18,277,000	13,766,000	55,303,000
2018–19	23,798,000	18,551,000	13,973,000	56,322,000
2019–20	24,230,000	18,829,000	14,182,000	57,241,000
2020–21	24,608,000	19,111,000	14,395,000	58,114,000
2021–22	24,979,000	19,398,000	14,611,000	58,988,000
2022–23	25,354,000	19,689,000	14,830,000	59,873,000
2023–24	25,734,000	19,984,000	15,053,000	60,771,000
2024–25	26,120,000	20,284,000	15,278,000	61,682,000

Figure 9 Australian tyres reaching end-of-life 2013–14 to 2024–25, by tyre type (EPUs)



5.4 EOLT derived materials

The value of waste commodities is directly linked to the physical composition of the material and the degree to which constituent parts can be recovered and resold.

Tyres are a composite product, made from a mix of:

- natural rubber
- synthetic rubber
- steel
- fibre (nylon, rayon and/or polyester)
- carbon black
- bonding agents.

The material composition of a tyre differs depending on the brand, type of tyre and its intended use. However, to assist in identifying the opportunities for market development, REC has used commonly accepted compositional data provided by the United Nations Environment Program (UNEP) as presented in Table 9 to quantify the individual commodities associated with EOLT generation. Table 10 and Figure 10 show a breakdown of EOLTs in 2015-16 by material type in tonnes.

Table 9 Main components of car and truck tyres (by % total weight)

Material	Passenger (%)	Truck (%)
Rubber / elastomers ²⁴	45	42
Carbon black and silica	23	24
Metal	16	25
Textile	6	
Zinc oxide	1	2
Sulphur	1	1
Additives	8	

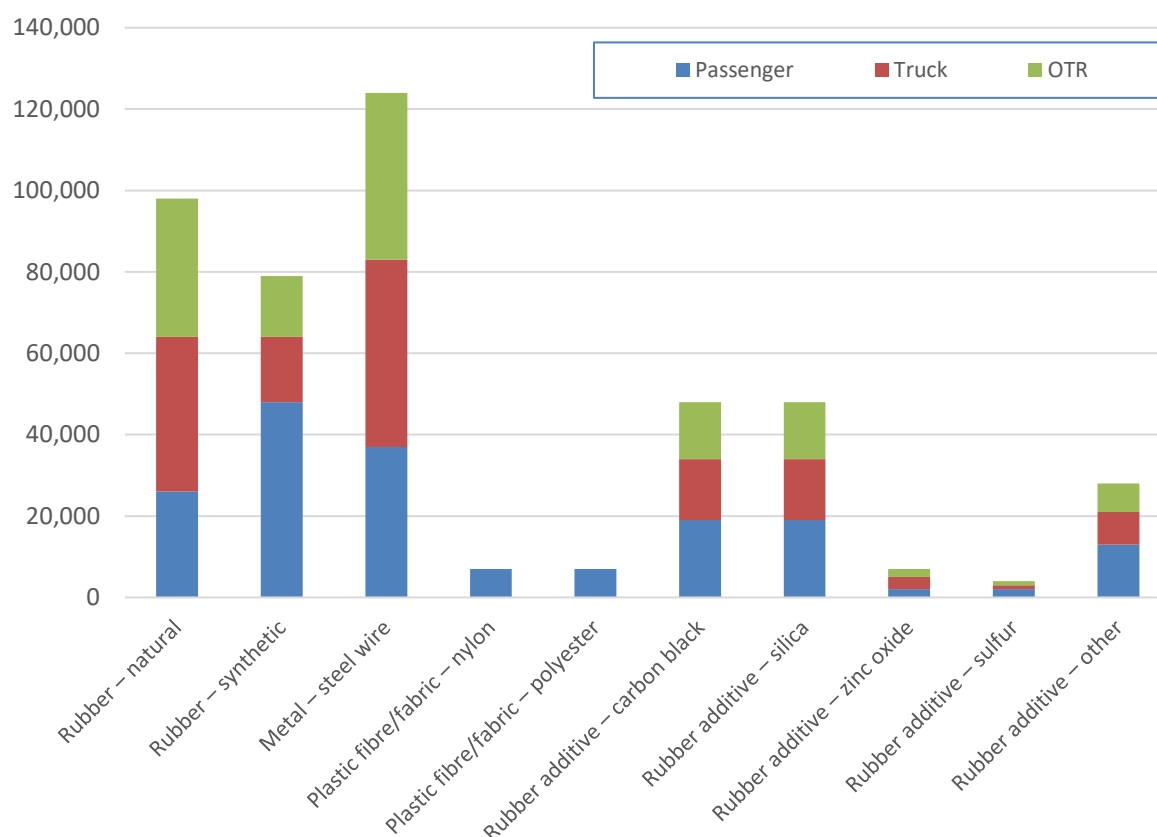
Table 10 Australian tyres reaching end-of-life in 2015–16, by material type and tyre type (tonnes)

Year	Passenger	Truck	OTR	Total
Rubber – natural	26,000	38,000	34,000	98,000
Rubber – synthetic	48,000	16,000	15,000	79,000
Metal – steel wire	37,000	46,000	41,000	124,000
Plastic fibre/fabric – nylon	7,000	0	0	7,000
Plastic fibre/fabric – polyester	7,000	0	0	7,000
Rubber additive – carbon black	19,000	15,000	14,000	48,000
Rubber additive – silica	19,000	15,000	14,000	48,000
Rubber additive – zinc oxide	2,000	3,000	2,000	7,000

²⁴ Note we have also used the UN guidelines estimated ranges for the breakdown of natural vs synthetic rubber. Assume truck tyres are 70% natural rubber and 30% synthetic and passenger tyres are 35% natural rubber and 65% synthetic rubber.

Rubber additive – sulphur	2,000	1,000	1,000	4,000
Rubber additive – other	13,000	8,000	7,000	28,000
Total	177,000	142,000	128,000	447,000

Figure 10 Australian tyres reaching end-of-life in 2015–16, by material type and tyre type (tonnes)



The analysis suggests that the current generation of EOLTs in Australia represents approximately 177,000 tonnes of natural and synthetic rubber, 124,000 tonnes of steel wire and almost 50,000 tonnes of carbon black. These are openly traded commodities with significant national and international markets for recovery.

5.5 2015-16 EOLT fates

Most EOLTs generated in Australia, around 279,000 tonnes (almost 35 million EPU) or 63% were disposed to landfill or to other fates, such as dumping or illegal stockpiling, where little or no resource value is recovered and the quantities to each fate are unknown.^{25 26} This figure includes

²⁵ 'Landfill / unknown' fates are referred to collectively because data does not allow the quantities of landfilled EOLTs to be reported separately from other EOLT fates where no resource value is recovered and for which the quantities to each are unknown. OTR tyres that are not recovered are an exception and are understood to be landfilled on-site into the mine.

²⁶ As documented in later sections of this Strategy most jurisdictions do not allow landfilling of whole tyres to licensed landfills. It is not understood to be common to shred tyres and send them to landfill. Hyder 2015 estimate of the proportion of EOLTs being sent to licensed landfill is most likely a significant over estimate for passenger and truck tyres.

some 123,000 tonnes (15.3 million EPU) of OTR tyres for which recovery and recycling options remain very limited.

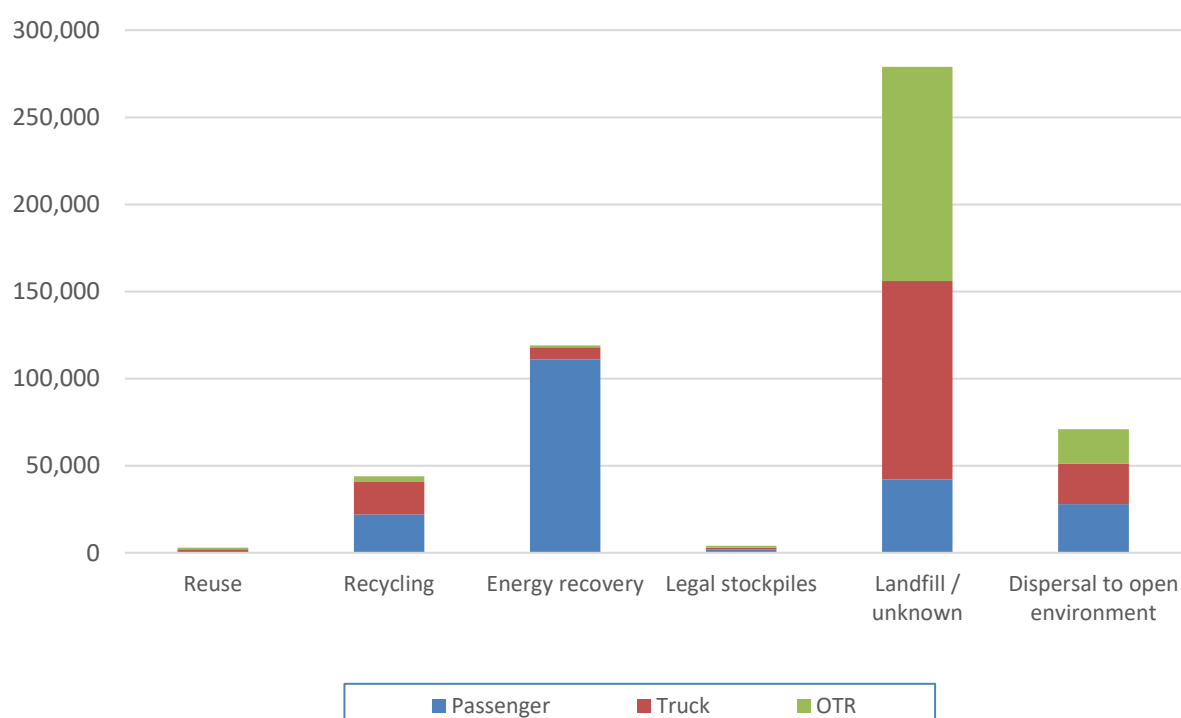
Domestic material recycling of EOLTs in Australia remains a relatively minor contributor to overall end-of-life fates in Australia with just 44,000 tonnes (5.5 million EPU) or 10% being locally recycled in 2015-16. The major market outlet remains the export market for baled tyres and shredded tyres (tyre-derived fuel) for energy recovery which constitutes some 119,100 tonnes (14.9 million EPU) or 27%. A further 3,000 tonnes (375,000 EPU) or around 1% are recovered for reuse and/or retreading. The fates for Australian EOLTs is presented in Table 11 and Figure 11.

A standard EPU loses an estimated 1.5kg of tread through general wear with this material being dispersed to the environment. RECs analysis presented in Table 11 indicates that some 71,000 tonnes of tyre material was dispersed to the open environment in 2015-16.

Table 11 EOLTs by fate 2015–16 (tonnes)

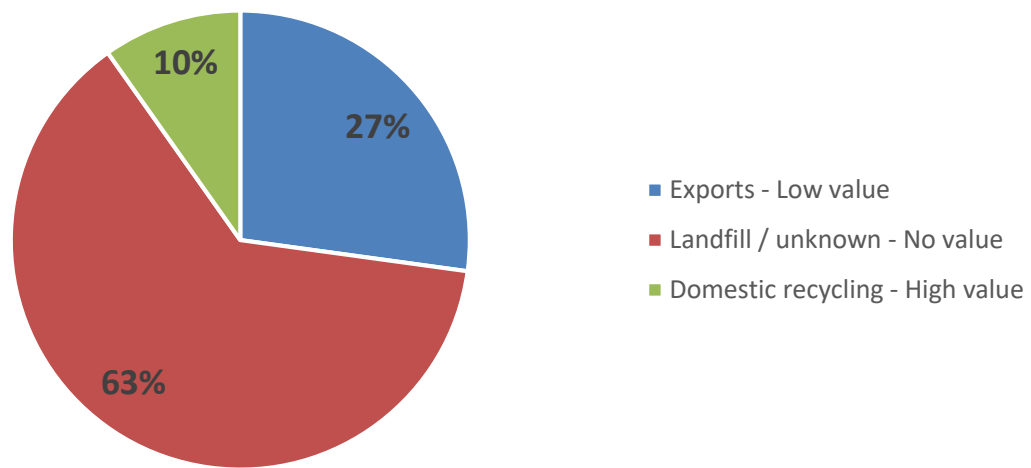
Fate	Passenger	Truck	OTR	Total
Reuse	0	2,000	1,000	3,000
Recycling	22,000	19,000	3,000	44,000
Energy recovery	111,000	7,000	1,000	119,000
Legal stockpiles	2,000	1,000	1,000	4,000
Landfill / unknown	42,000	114,000	123,000	279,000
Total (excl dispersal)	177,000	143,000	129,000	450,500
Dispersal to open environment	28,000	23,000	20,000	71,000
Total (incl dispersal)	205,000	166,000	149,000	520,000

Figure 11 EOLTs fate 2015–16 (tonnes)



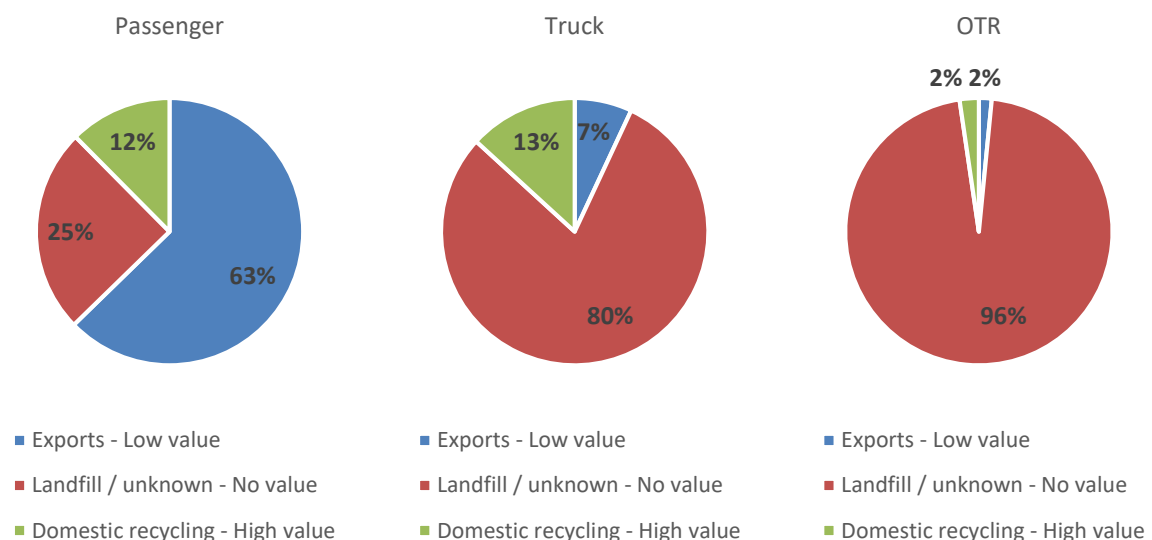
Whilst a full and complete breakdown of fates in Australia would provide detail of specific outcomes for EOLTs, for the purposes of understanding the opportunities for market development the fate analysis can be simplified considerably. Figure 12 shows the degree to which the value of EOLTs is returned to the Australian economy. Just 10% of material is recycled back into high-value commodities such as crumb rubber and granules. A further 27% is exported as low-value TDF, baled tyres or retreads. There is effectively no value extracted from the remaining 63% which are landfilled, dumped, disposed on-site or illegally stockpiled.

Figure 12 Percentage of tyres going to high, low and ‘no-value’ markets



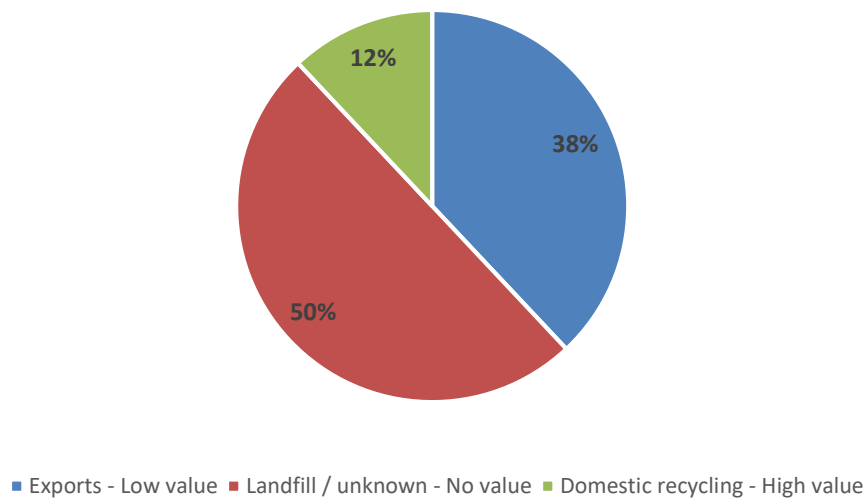
Analysis of fates by tyre type as presented in Figure 13 shows the impact that low recovery rates for OTR tyres has on the broader recovery market. An estimated 96% of OTR tyres go to no value end uses (landfilling onsite), compared to 25% of passenger tyres, which are typically used in production of TDF. Around 13% of truck tyres are used in domestic recycling (due to their high natural rubber content), 80% still go to no value end uses.

Figure 13 Percentage of tyres going to high, low and no-value markets, by tyre type



Given large OTR tyres are difficult to handle and transport because of their size and weight, they are not as accessible to the tyre recovery market as passenger and truck tyres. Figure 14 presents the percentage of “readily accessible” EOLTs (passenger and truck tyres) going to high, low and no-value markets (this figure excludes OTR tyre tonnages).

Figure 14 Percentage of "readily accessible" EOLTs going to high, low and no-value markets (excluding OTR tyres)



5.6 Further analysis of 2015-16 data on end-of-life fates

The primary data collection from industry consultation provides considerable insight into the fate of EOLTs in Australia. Whilst much of this data is confidential, the following discussion represents disaggregated data as far as is practicable without identifying individual companies.

5.6.1 Domestic recycling

The 2015-16 data indicates that domestic recycling accounts for around 10% or 44,000 tonnes of EOLT fates in Australia. The data collected during the industry survey allows further analysis of recycling fates and indicates that crumb rubber accounts for around half (22,000 tonnes) of all domestic recycling. Steel accounts for a further 16,000 tonnes with civil engineering accounting for around 5,000 tonnes and 2,700 tonnes respectively. A breakdown of domestic recycling fates is presented in Figure 15 and Figure 16.

Figure 15 Breakdown of domestic recycling by commodity type / TDP (tonnes) in 2015-16

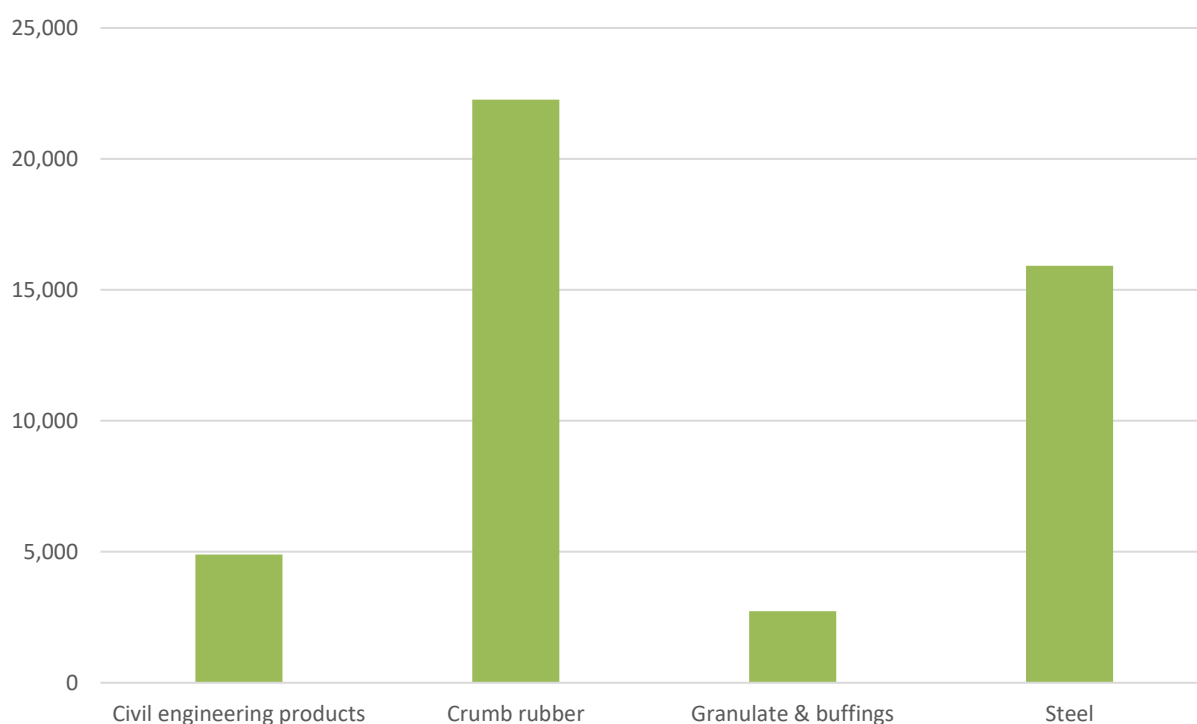
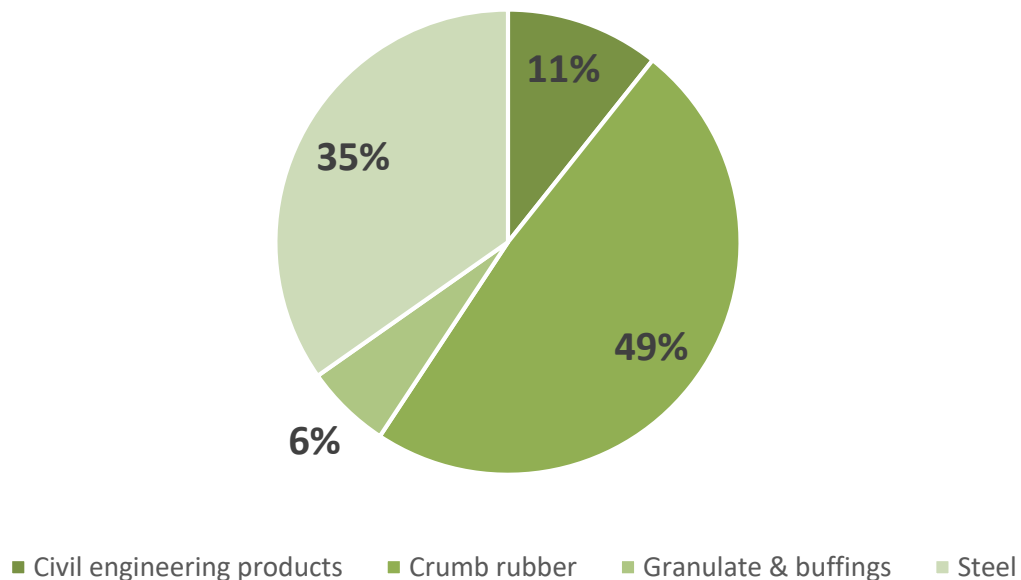
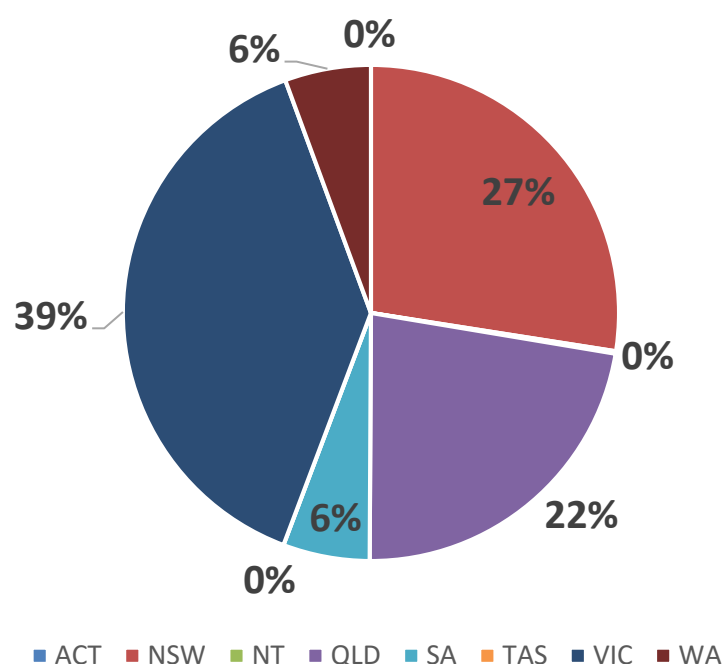


Figure 16 Breakdown of domestic recycling by commodity type / TDP (by % of total) in 2015-16



At state level, the relative contribution to overall domestic recycling (as shown in Figure 17) differs considerably, as would be expected given the degree to which industry has developed in each state and territory. Victoria is the largest contributor (by tonnes) to overall domestic recovery, accounting for around 39%. This reflects Melbourne's status as a resource recovery hub for EOLTs. NSW and QLD contribute 27% and 22% respectively with only minor contributions from the remaining states and territories.

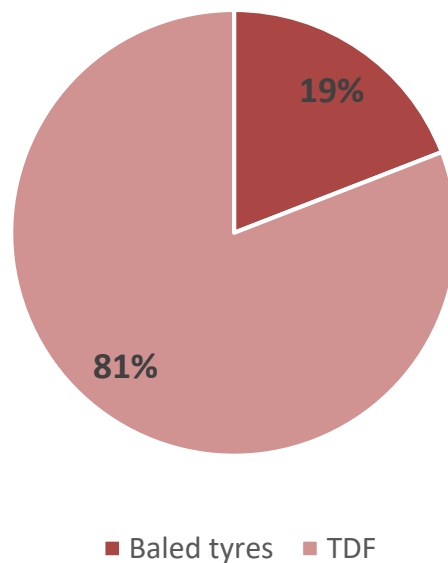
Figure 17 Relative contribution (by % of total) to domestic recycling of EOLTs by state for 2015-16



5.6.2 Export markets

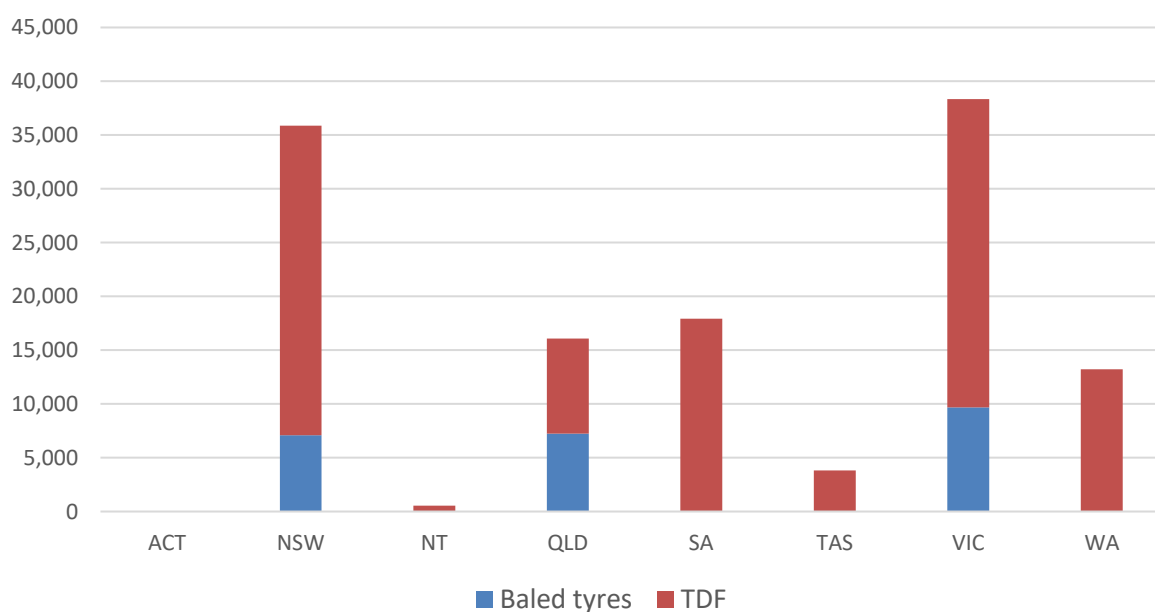
Similarly, the 2015-16 data can be used to analysis export commodities into overseas energy markets. Total export data presented in Figure 18 suggests that 81% or 96,000 tonnes of all EOLTs leaving Australia for energy recovery are in the form of TDF (shredded tyres) with the remaining 19% of 23,000 tonnes being baled tyres.

Figure 18 Breakdown of TDP commodities leaving Australia (by % of total) in 2015-16



Further analysis at state level, as presented in Figure 19, shows that baled tyre exports come predominantly from NSW, QLD and Victoria.

Figure 19 Breakdown of TDP commodities leaving Australia (tonnes) by state in 2015-16



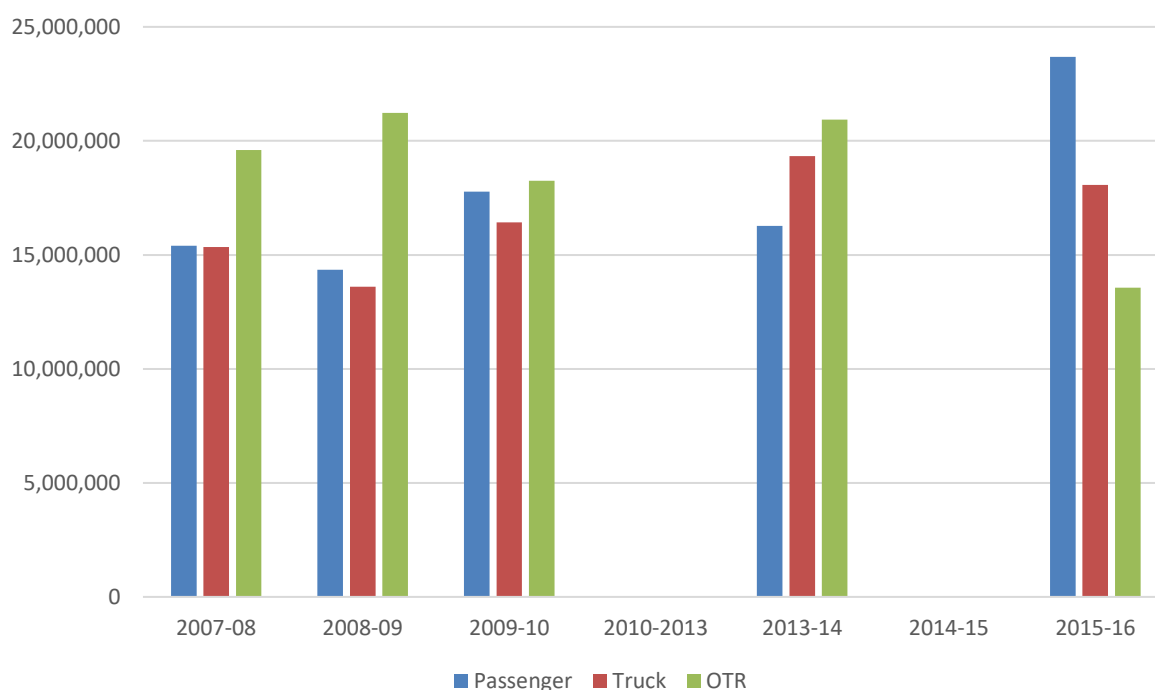
5.7 Time series data analysis

There has been a succession of EOLT studies in recent years, aimed at improving the data for generation and end-of-life fates. Whilst the methodologies and datasets differ across all three reports, they provide a worthwhile piece of analysis to support the Strategy.

5.7.1 New tyre sales / consumption

Tyre sales have progressively increased overall, with most of this growth occurring in the passenger tyre sector. Time series data for new tyre sales, presented in Figure 20 shows passenger tyre sales have increased more than 50% since 2007-08 whilst sales in OTR tyres have fallen by around 30% over the same period, driven by the downturn in resource commodities.

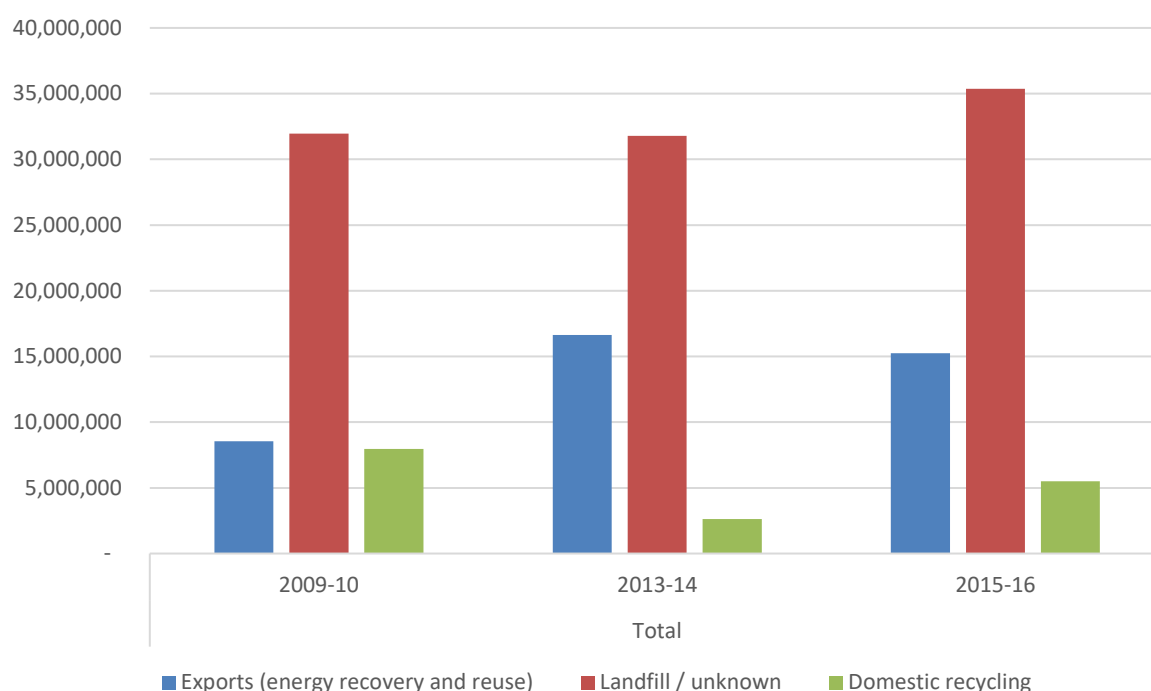
Figure 20 New tyre sales in Australia by tyre type, 2007-08 – 2015-16 (Hyder and REC data)



5.7.2 End-of-life fates

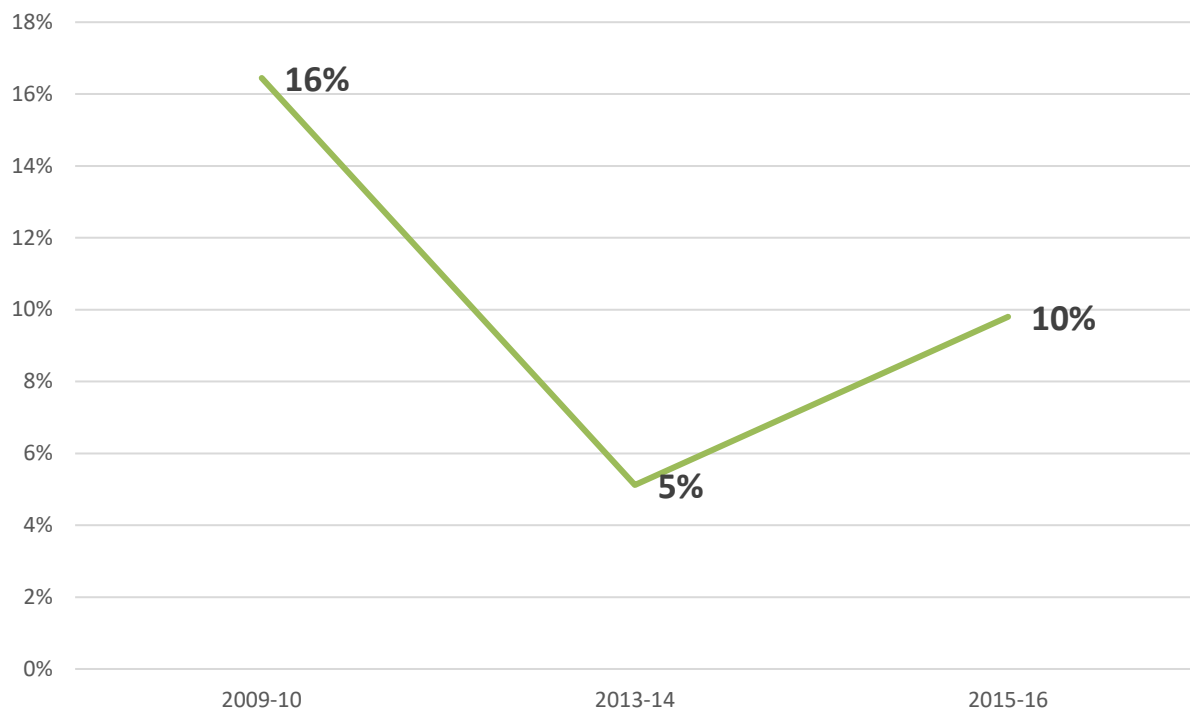
Analysis of current and historic data on end-of-life fates, presented in Figure 21 shows an increase of almost 80% in exports for energy recovery since data collection began in 2009-10. This reflects general demand for TDF internationally from around 2009-2013, with much of the current exports being a function of that earlier demand, despite much lower margins in recent years.

Figure 21 End-of-life fates of tyres in Australia, 2009-10 – 2015-16 (Hyder and REC data) (EPUs)



The proportion of landfill / unknown remains broadly the same across the three studies (relative to total end-of-life arisings), however domestic recycling has shown considerable fluctuation. The domestic recycling rate over the three report periods is shown in Figure 22. With only three years of recycling rate data available for EOLTs, it is difficult to comment on any trends or potential causes of the apparent fluctuations.

Figure 22 Domestic recycling rate for EOLTs in Australia (Hyder and REC data) (% of total)



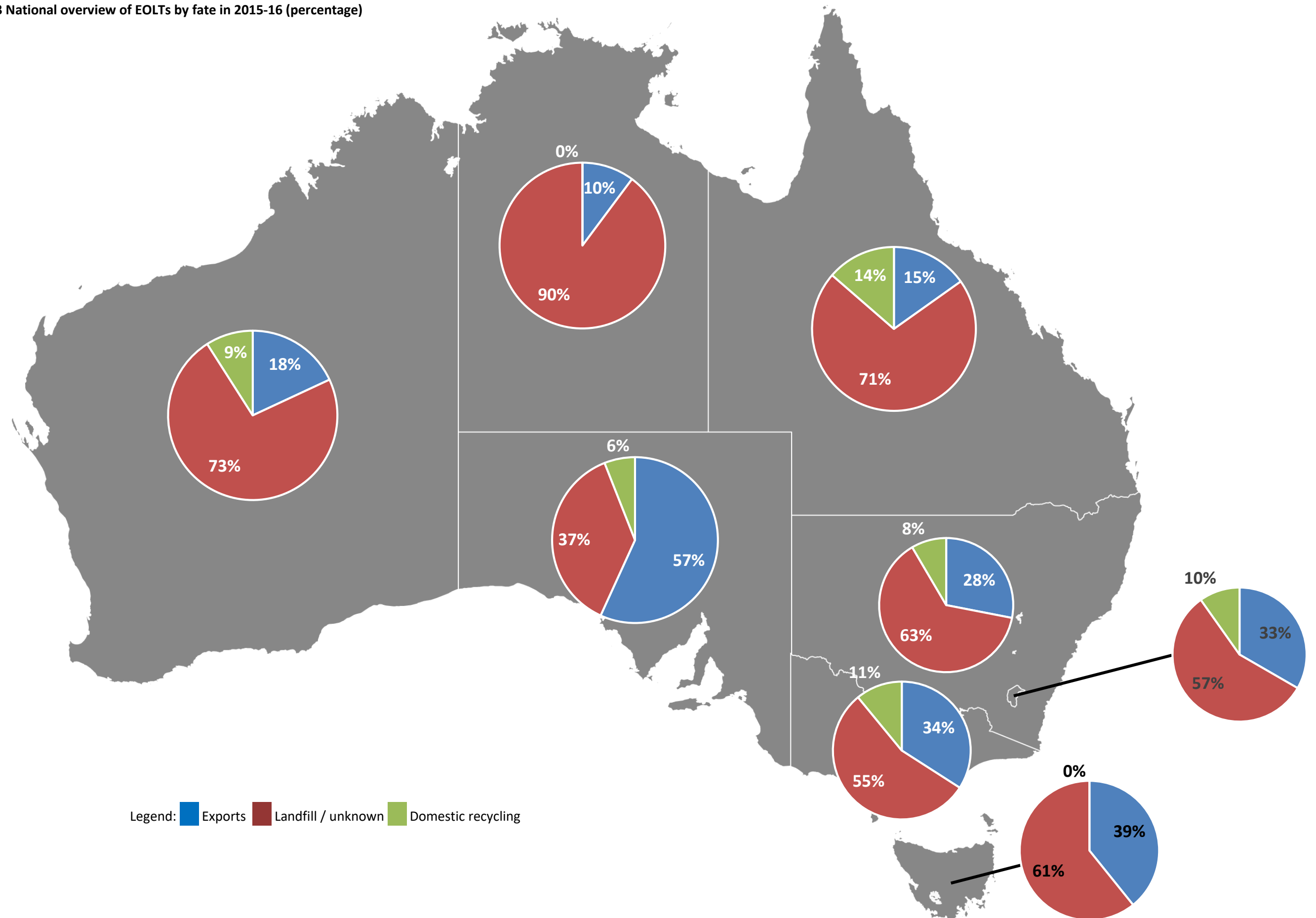
5.8 Management of EOLTs at state and territory level

The industry consultation provided significant detail on end-of-life fates at state and territory level to support the national dataset. An overview of state-by-state EOLT fates based on the degree to which EOLTs are recovered for valuable use or landfilled, stockpiled or dumped is presented in Figure 23.

A detailed overview of the market for EOLTs in each state and territory is provided in [Appendix 2](#), including:

- regulatory frameworks
- general market conditions
- EOLT consumption, in-use and generation
- EOLT fates.

Figure 23 National overview of EOLTs by fate in 2015-16 (percentage)



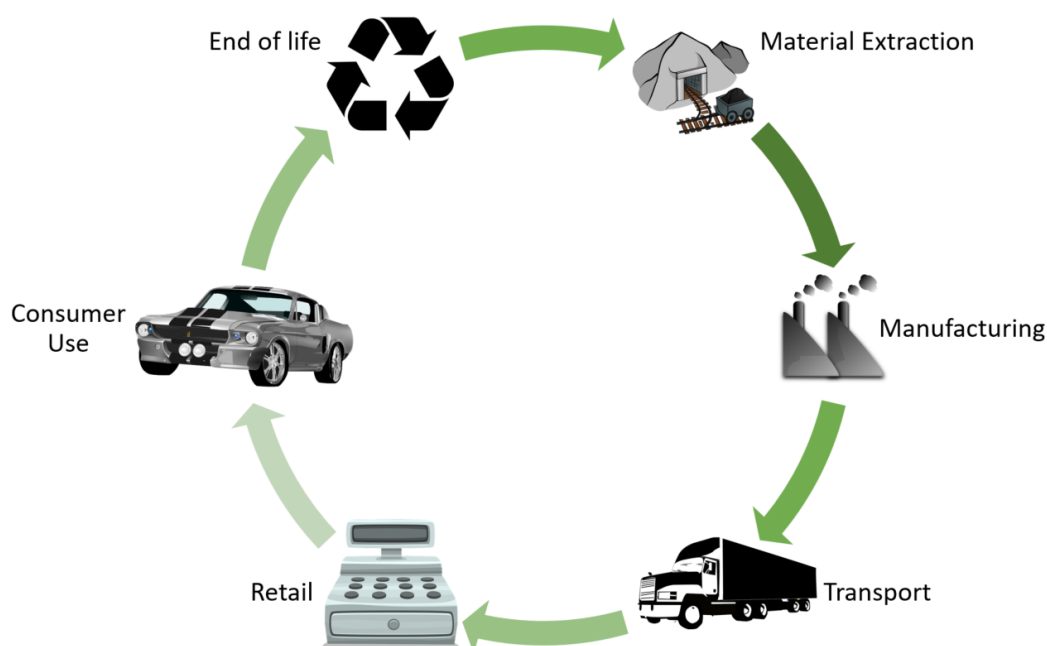
6 National regulatory framework

Policy and regulation related to waste management, including management of EOLT, is mostly devolved down to state and territory governments. However, from a national perspective, the EOLT market is influenced by several national and international policy settings, discussed below.

6.1 National Waste Policy

The National Waste Policy (NWP) was released in 2009 with the intent of providing a 10-year strategic direction for waste management in Australia. Whilst policy and regulation related to EOLT is generally the purview of each state and territory, at a national level the NWP has as a core principal the idea of product stewardship as a means of addressing specific waste product challenges. Product stewardship is an approach which recognises that all participants in the product chain, as represented for EOLT in Figure 24, have a responsibility to ensure that the product can be appropriately managed at end of life.

Figure 24 Illustration of stages in product lifecycle



Following the development of the NWP, the *Product Stewardship Act 2011* was introduced. The management of EOLT in Australia has been a priority under the Product Stewardship Act which culminated in the development of a voluntary, industry-led scheme administered by Tyre Stewardship Australia (outlined later in this chapter).

In 2017, the Federal Government announced it will undertake a formal review of the Product Stewardship Act as is required under the legislation. The review is likely to focus on the impacts of co-regulatory and voluntary stewardship schemes and the ability to which they can affect positive change in the market.

6.2 Basel Convention

The *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal*²⁷ (the “Basel Convention”) regulates the movement of hazardous wastes across international boundaries. Australia was a foundation signatory to it in 1992, when it came into force.

The Convention puts an onus on exporting countries to ensure that hazardous wastes are managed in an environmentally sound manner in the country of import. These obligations are placed on countries that are party to the Convention. One hundred and fifty-one countries have ratified the Basel Convention as at December 2002. The obligations are to:

- minimise generation of hazardous waste
- ensure adequate disposal facilities are available
- control and reduce international movements of hazardous waste
- ensure environmentally sound management of wastes
- prevent and punish illegal traffic.

Signatories are required to implement systems that ensure the notice, consent and tracking of hazardous waste across national boundaries, including annual reporting requirements.

Article 1 of the Basel Convention (page 97) includes the following:

“Scope of the Convention

1. The following wastes that are subject to transboundary movement shall be “hazardous wastes” for the purposes of this Convention:

(a) Wastes that belong to any category contained in Annex I, unless they do not possess any of the characteristics contained in Annex III; and

(b) Wastes that are not covered under paragraph (a) but are defined as, or are considered to be, hazardous wastes by the domestic legislation of the Party of export, import or transit.”

Waste tyres are not listed in Annex I, however, waste tyres are regulated as a hazardous or controlled waste in all jurisdictions in Australia, except for Victoria²⁸. Therefore, consistent with Article 1 (b) above, Australia reports waste tyre generation within Basel reporting as part of a subtotal of ‘additional waste categories’ that are not included in Annex I.

It is also worth noting that Annex IX LIST B (page 140) includes the following:

“Wastes contained in the Annex will not be wastes covered by Article 1, paragraph 1 (a), of this Convention unless they contain Annex I material to an extent causing them to exhibit an Annex III characteristic

... B3140 Waste pneumatic tyres, excluding those destined for Annex IVA operations”

This excludes waste tyres from Basel transboundary movement requirements, including export permits, unless the waste tyres are being exported to be disposed (i.e. not exported for recycling).

²⁷ <http://www.basel.int/Portals/4/Basel%20Convention/docs/text/BaselConventionText-e.pdf>

²⁸ See further discussion within each jurisdiction’s chapter.

6.3 Hazardous Waste (Regulation of Exports and Imports) Act 1989

The Australian Government Department of the Environment and Energy implements its Basel Convention responsibilities through the *Hazardous Waste (Regulation of Exports and Imports) Act 1989*²⁹ (the “Hazardous Waste Act”), which regulates (via a permitting system) movement of hazardous wastes in and out of Australia.

The object of the Hazardous Waste Act is to:

“... regulate the export, import and transit of hazardous waste to ensure that exported, imported or transited waste is managed in an environmentally sound manner so that human beings and the environment, both within and outside Australia, are protected from the harmful effects of the waste.”

The Department assesses hazardous waste import and export permit applications. As discussed above waste tyres being exported for recycling are excluded from the Basel Convention reporting requirements (under Annex IX LIST B) and therefore Hazardous Waste Act requirements for import and export permits.

6.4 National Environment Protection (Movement of Controlled Waste between States and Territories) Measure 1998

The *National Environment Protection (Movement of Controlled Waste between States and Territories) Measure 1998* (Controlled Waste NEPM) provides a framework for managing the movement of controlled wastes between states and territories. The NEPM relates only to interstate and not intrastate movement.

Tyres are listed as a controlled waste under Schedule A (List 1) of the Controlled Waste NEPM, therefore states and territories are required to have systems in place that track the interstate movement of EOLT. However, the degree to which states and territories are set up to track the movement of EOLTs differs.

As noted above tyres are not classified as a hazardous waste in Victoria and therefore interstate movements in and out of the Victoria are not reported. The reporting of interstate movements in Australia is based on incomplete state-based data and estimates of material moving to and from Victoria.

6.5 OECD Decision Regulations

To support its member countries in meeting the obligations of the Basel Convention (through the harmonised OECD Decision C (2001)107), the Organisation for Economic Cooperation and Development (OECD) has published a *Guidance Manual for the Control of Transboundary Movements of Recoverable Wastes*. The guideline lists waste tyres under the “green control procedure”, which requires that the material must be:

“destined for recovery operating within a recovery facility which will recover them in an environmentally sound manner according to national laws, regulations and practices”.

²⁹ <https://www.environment.gov.au/protection/hazardous-waste/about>

6.6 Australian Customs Regulations

A significant number of EOLTs are exported from Australia each year. The *Customs Act 1901* provides a legislative framework for the exportation of goods from Australia, including the prohibition and setting of requirements and conditions. The Act requires that goods being exported from the country be reported to the Department of Immigration and Border Protection.

The *Export Control Manual* sets out the requirements for the export of goods from Australia. Specifically, the manual outlines reporting requirements, including the process for obtaining an Export Declaration Number (EDN) and the numbering conventions which apply to shipments under the Australian Harmonised Export Commodity Classification (AHECC).

6.7 Climate change and alternative energy policy

The management of EOLT intersects with areas of climate change and alternative energy policy at a Federal level. The remit of the Australian Renewable Energy Agency (ARENA) is to increase the supply of renewable energy in Australia and to develop more affordable renewable energy solutions. As part of its funding program, ARENA has financed a project examining the feasibility of pyrolysis applications for mining tyres and the ongoing focus on biofuels technology links well with emerging tyre processing technologies that have a fuel output (such as pyrolysis and gasification).

The Clean Energy Finance Corporation (CEFC) invests in commercial energy projects to drive the transformation toward cleaner, more efficient modes of energy generation. Tyres have a renewable component wherever nature rubber is used and burned more efficiently than coal. CEFC has drafted a position paper on how and where energy recovery from EOLT may fit its investment portfolio.

6.8 Tyre Stewardship Australia

In 2014, representatives from industry and government launched TSA, a not-for-profit company established to deliver the National Tyre Product Stewardship Scheme (the Scheme). The Scheme, which is a voluntary stewardship scheme, aims to:

- reduce in the number of tyres not going to an environmentally sound use
- enhance the Australian recycling industry
- develop sustainable markets for recycled tyre products
- improve conditions for tyre collectors and recyclers
- increase consumer awareness of the impacts of end-of-life tyre disposal.

Effectively, the Scheme is an accreditation program which seeks to promote those tyre collectors and recyclers in the industry that have committed to responsible end of life management of tyres. This is achieved through:

- accreditation and promotion of participants in the Scheme
- a detailed audit and compliance program to ensure best practice is being achieved
- an industry development program aimed at improving the capability and capacity of the tyre recycling sector
- investment in research and development to identify new and expanded markets for tyre derived products in Australia.

To date, more than 1,200 organisations are accredited, including most tyre collectors and recyclers, with TSA. Over the coming years, TSA will focus on further improving the accountability to tyre retailers, collectors and recyclers through improved reporting and auditing processes.

6.8.1 TSA Best Practice Guidelines

Although not strictly regulations, TSA has released a number of Best Practice Guidelines which set out the requirements for participants in the scheme. Of relevance to the tyre recycling industry are:

- *Best Practice Guideline for Downstream Vendor Management and Verification* – This guideline set out the practices and principles related to the export of TDP from Australia, providing specific guidance on customs requirements and the documentation required to ensure material is reaching an environmentally sound use at its end destination.
- *Best Practice Guideline for Fire and Emergency Preparedness* – This guideline provides industry with information on how to manage the risk and compliance requirements to ensure appropriate planning and management for tyre-related fires. This includes contingency planning, on-site fire management systems and protocols for training and servicing of plant and equipment.

The implementation of the guidelines as part of the TSA audit and compliance function is likely to assist all participants in meeting their regulatory requirements.

6.8.2 TSAs impact on the market

Despite a slow start in getting, in particular, tyre manufacturers to join the scheme, TSA has made considerable progress in the past 18 months. Presently, all major tyre recyclers in the country have become TSA accredited which has been driven primarily by the uptake of the scheme from major tyre retail chains such as Bridgestone, Beaurepaires, Bob Jane and Tyrepower. Tyre retailers are only able to pass used tyres onto TSA accredited collectors and recyclers, in effect forcing most market participants to join the program.

The most significant impact in the market has come from TSA's internal audit and compliance program which ensures that all accredited tyre collectors and recyclers are fully audited for environmental, health and safety (EHS) compliance under the scheme. These audits have identified over 25 high-risk non-compliances to date which in turn has driven improvements in site management, fire risk planning and tyre storage³⁰. The audit and compliance program complements existing compliance activities by state-based regulators and holds operators to higher account than state requirements in some instances.

In addition, the investment by TSA in market development activities is contributing to longer term growth in domestic markets for TDPs. More than \$1.5 million has been committed to research and development projects across Australia with specific focus on partnerships between industry, government and consumers of TDPs³¹. TSA is supporting the research with work on specifications and bringing key industry and government agencies together to develop existing opportunities. Whilst there will be a "lag" time for the impacts of this investment to come through, the work being undertaken by state government in supporting TSA investment is likely to ensure many of these areas can be fully realised.

³⁰ Pers comm Tyre Stewardship Australia Audit and Compliance Manager

³¹ TSA R&D funding guidelines <http://www.tyrestewardship.org.au/funding/funding-2>

7 National market conditions

The tyre recycling market in Australia is dominated by low-value, high-volume transactions that make it vulnerable to changes in trading conditions. In the past 5 years, the market has been significantly impacted by falls in the international commodity prices for steel, coal and oil. Whilst these markets have improved in the past 12 – 18 months, the “new normal” for these commodities remains significantly lower than pre-GFC levels. The following provides a high-level overview of the current market conditions in Australia.

7.1 Tyre collection, consolidation and transport

The tyre recycling industry, like most waste industries, is heavily reliant on collection fees or “gate fees” which are typically paid by waste generators to have materials collected and processed. The bulk of industry revenue is generated at this end of the value chain, rather than by the sale of end products.

Over the past 3 – 4 years, almost all states and territories have increased their regulatory oversight over the tyre collection and recycling industry through additional legislation and other mechanisms such as licencing and approvals. For example, in 2015 NSW EPA launched the WasteLocate system which tracks EOLTs from the point of generation through collection, transportation to the point of recycling or disposal. Similarly, the Victorian Government introduced new regulations imposing licensing conditions on those operators temporarily storing more than 5,000 EPU on site at any time. This, combined with the push of TSA to certify and promote best practice operators, has worked to remove or restrict the impact of illegal or illegitimate operators who have traditionally undercut the collection fees.

In addition, in recent years the industry has benefited from a focus on collection fees by government and environmental lobby groups who are keen to see the true cost of recycling being passed through by tyre retailers. This is also a focus of TSA who note that “there is a cost associated with ensuring the environmentally sound use of end-of-life tyres” and that these costs will be largely borne by consumers at the point of disposal³².

These factors have enabled many players in the industry to increase collection fees to offset the impacts of lower commodity prices. The use of baling and consolidation, particularly in regional centres, has also assisted operators in improving transport efficiency and improving margins.

7.2 Exports of tyre-derived fuel and baled tyres

Whilst the collection market has seen some improvement in conditions since the last national report ([Hyder 2015](#)), the market for exports of tyre-derived fuel (TDF) remains challenging. Whilst volumes of TDF leaving Australia have reportedly increased, it continues to cost operators in the order of \$40 per tonne to move material offshore from most major ports³³.

³² [Tyre Product Stewardship Scheme Guidelines](#), page 10

³³ Confidential pers comm during industry consultations

Downward price pressure on TDF exports is being driven by two key factors:

1. Persistently low oil and coal prices, which decrease the attractiveness of TDF as a fossil fuel replacement
2. Increased demand for baled tyre exports for energy recovery.

The move toward baled tyres has seen demand for baled exports increase significantly over the same period, particularly into India and Korea where they are mostly processed into TDF or crumb rubber for use in pyrolysis facilities. Shredding and crumbing costs in these countries are lower than Australia and as such baled tyres are a more attractive commodity under this scenario.

Despite ongoing price pressure, the export of EOLTs for energy recovery remains the major market outlet for Australian TDPs. At almost 120,000 tonnes in 2015-16, it dwarves the local reprocessing market almost three-fold and the reliance on this sector presents a significant ongoing risk to tyre recycling in Australia.

Changes in international policy settings in strong Asian markets for EOLTs such as Malaysia, Korea and India could rapidly devastate the industry in Australia. In recent years, the market has seen the closure of pyrolysis facilities in India and cement kilns in Malaysia and the Philippines³⁴ which reduced demand for TDF from Australian producers. Similarly, when a large consumer of Australian TDF in Korea had an extended closure for maintenance, industry reports suggests a glut of TDF, some of which was sent to landfill.

There is already evidence that points to the impacts of stronger regulatory controls on waste imports for low value markets like TDF. For example, in February 2013, the Chinese Government introduced “Operation Green Fence” in response to increasing imports of poor quality recyclables coming into the country from North America and Europe. Some 22,000 containers of material were returned to their export country of origin in the first year³⁵ having a significant impact on plastics recycling in particular.

7.3 Domestic manufacturing of mats, playgrounds and surfaces

Industry feedback indicates that consumer demand for “traditional” products using rubber granule, buffings and crumb rubber have increased marginally in recent years. These include playground surfaces, soft-fall matting and rubber matting of various types. The use of recycled tyre rubber in equestrian surfacing for example is generating considerable value for tyre recyclers, particularly in regional Australia.

However, in the past 12 – 18 months the industry has seen considerable increase in competition from imported crumb rubber for these applications. For instance, the Australian Tyre Recyclers Association (ATRA) notes that crumb rubber from Portugal, where the tyre recycling industry remains heavily subsidised, can be imported into Australia for as little as \$350 - \$400 AUD/tonne, around 20% lower than locally produced material³⁶.

The import of cheap crumb rubber may have long term impacts on the viability of domestic production of crumb and granules into these markets.

³⁴ RJA 2012. [‘Tyre pyrolysis: an epic fail or a recycling nirvana?’](#) *Rubber Journal of Asia* December 20, 2012

³⁵ Waste 360. [‘What Operation Green Fence has meant for recycling’](#). *Waste 360* Feb 10 2016.

³⁶ Pers comm Australian Tyre Recyclers Association

7.4 Markets for high-quality crumb rubber

The market for crumb rubber continues to expand because of investment by TSA and a push from state governments to support the domestic tyre recycling industry. Industry consultation suggests that markets for crumb rubber in road construction in both Victoria and NSW (particularly across the Hunter Valley) have grown since the last national report. In NSW, the use of BCRA and rubber modified sprayed seals have been driven by significant surface cracking in areas where slag and fly ash have been used to replace Portland cement in the original road construction process.

Recent investment by TSA in research and development projects is likely to unlock opportunities for “rubber in roads” in other jurisdictions through testing and updates to existing specifications.

7.5 Import conditions impacting domestic producers

The domestic market for crumb rubber and rubber granules is currently under considerable pressure from cheaper products imported from other countries. Anecdotal evidence suggests that crumb rubber and rubber granule can be imported from jurisdictions such as Portugal for around \$200/t less (\$350 - \$400/t delivered to port) than locally manufactured material³⁷. Such countries benefit from nationally mandated producer responsibility (product stewardship) schemes that allow tyre recycling operators to be in effect subsidised through a state collected levy on consumers³⁸. The net impact of this is a reduced price for end products like crumb and granule.

Industry consultation highlighted specific impacts of these imports in QLD and NT where manufacturers of rubber product (such as matting and soft fall surfacing) have opted for imported crumb rubber. Local recyclers have reported a direct loss of business and revenue as a result; in some cases significant substitutions between local and imported product have been made³⁹.

7.6 Energy from waste markets

Small to medium scale, bespoke pyrolysis facilities for processing EOLTs have been constructed in NSW (Global Distillation Technologies), WA (Pearl Global) and Victoria (Clean Energy Group). However, as yet none of these facilities are operating at commercial scale, rather they are at testing or development phase and operating under typical R&D licenses from the respective EPAs. Planning applications have been lodged in a number of other jurisdictions for additional facilities indicating that the market remains keen to invest in this type of infrastructure.

The impact of energy from waste facilities of this nature on the Australian tyre recycling market is yet to be seen. Questions remain over the quality of end products such as oil and carbon black and their potential resale value. Recent anecdotal evidence indicates that oil from Australia pyrolysis facilities in testing and development phase has been successfully refined into higher grade distillate for use as a drop-in fuel^{40, 41}. This marks a very positive step in exploring the viability of commercial pyrolysis of EOLT.

³⁷ Anecdotal evidence supplied by three separate sources during industry consultation

³⁸ Valorpneu, 2017. [‘The SPGU System’](#) Valorpneu. Portugal’s product stewardship scheme management company

³⁹ Confidential pers comm during consultations

⁴⁰ Confidential pers comm during consultations

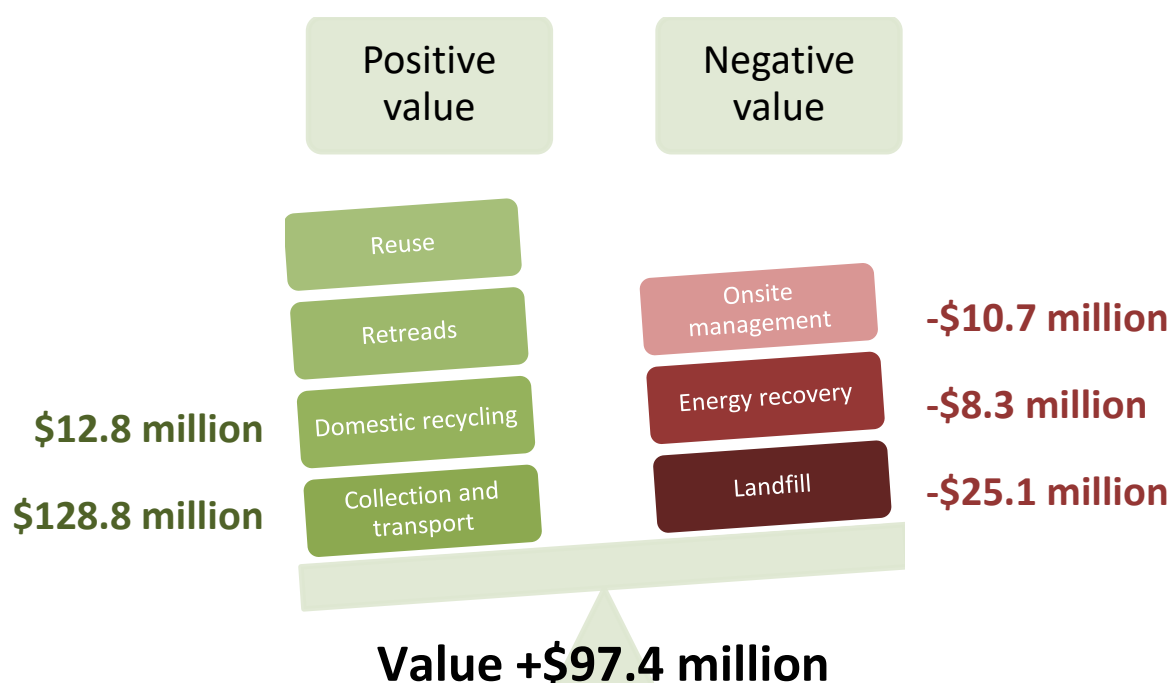
⁴¹ “Drop-in” fuel refers to alternative fuels (such as biofuels) that can replace traditional fuels without significant changes to engines or infrastructure

7.7 Current market value

It is difficult to accurately quantify the value of the current market for EOLTs in Australia, due to differences in collection fees, disposal fees, export prices and local TDP prices. However, using average prices across the country, the value of the EOLT market for 2015-16 can be estimated as is shown in Figure 25.

The collection and transportation of EOLTs remains the largest contributor to the market, driven by gate fees paid by tyre retailers (and ultimately the consumer) to tyre collectors. Based on the average commodity prices for crumb rubber and granule, the domestic market for material recycling is worth in the order of \$12.7 million, however this does not consider the products manufactured using TDPs which would be valued significantly higher.

Figure 25 Estimated 2015-16 value of the tyre recycling sector in Australia



The cost of disposal to landfill and onsite management of OTR tyres is estimated at around \$36 million. Costs to export baled tyres and TDF come in at around \$8 million in 2015-16.

7.8 Future market considerations

The long-term future for the tyre recycling market in Australia is unclear. Whilst commodity prices have improved modestly since the GFC, the reliance on high-volume, low-value exports of baled tyres and TDF continues to leave the industry exposed to international forces. A number of tyre recycling operations have recently closed or are currently for sale suggesting that further market consolidation may be likely, particularly in WA and Victoria.

However, it is worth noting that positive market changes have been occurring in jurisdictions where tyre recycling has typically been problematic. A new venture in Tasmania, which has been heavily influenced by the cessation of stockpiling at the Longford site, is seeing significant volumes of EOLTs being shredded and shipped to Melbourne for further processing and export. Given the restrictions on further stockpiling at Longford, it is likely that this new market will grow rapidly over the coming

years. Similarly, activity being led by government, industry and TSA is looking for new opportunities for EOLT consolidation and/or processing in the NT.

Overall, increased regulatory oversight and the increasing influence of TSA through its audit and compliance program is likely to support a gradual increase in collection fees. Operators who have undercut the market through illegitimate behaviours will be forced to exit the industry or to get up to the required level of compliance. More standardised collection fees across the country can only benefit the industry as operators must look for the best end-markets to gain a cost advantage over their competitors. Businesses relying more on high-margin outputs such as crumb rubber and granule are therefore likely to benefit on the proviso that strong, local markets for this material can be achieved.

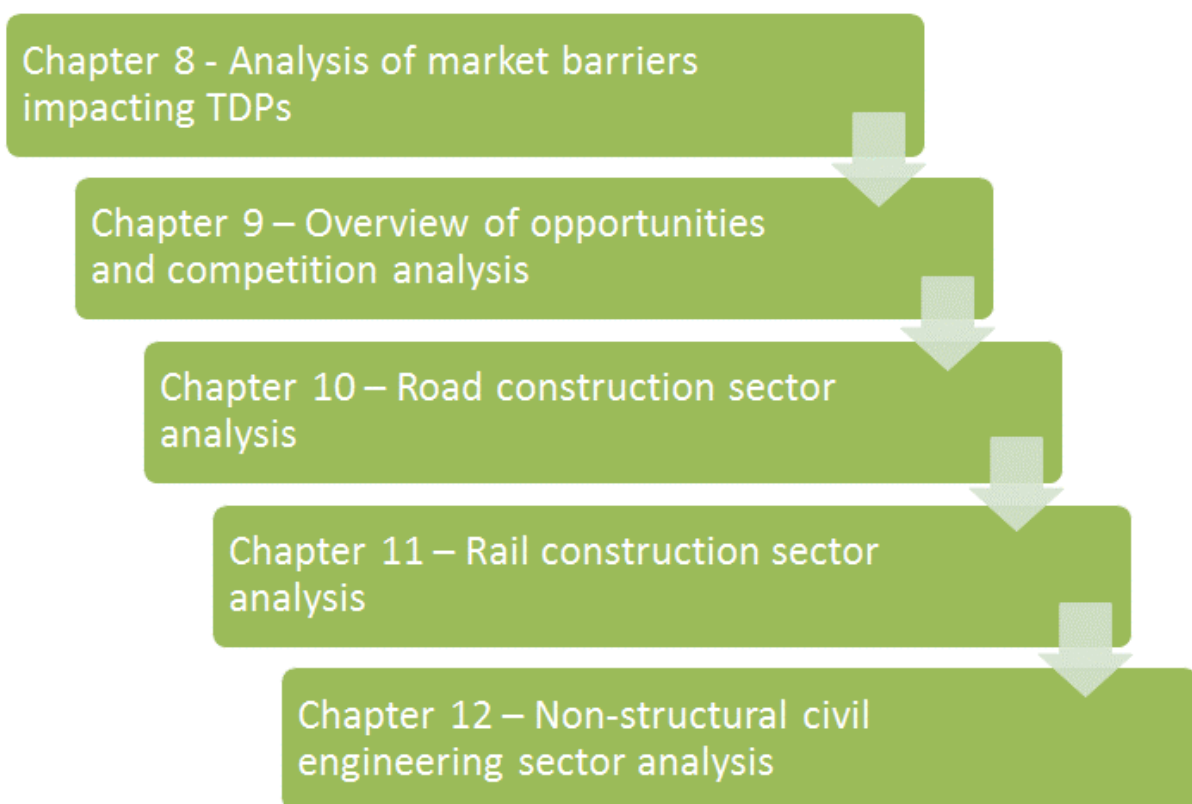
PART 2 – ANALYSIS OF BARRIERS AND OPPORTUNITIES

Overview of Part 2 – Analysis of barriers and opportunities

Part 1 of this Strategy sets the scene for the EOLT market in Australia. It provides an overview of key data and statistics, introduces how the market functions, what it produces and how it operates on a state-by-state context.

The key requirement of this strategy however is to identify and explore opportunities for new or expanded markets for TDPs in Australia. Part 2 (as outlined in Figure 26) takes a sequential path that moves from highlighting key market barriers and identifying general market opportunities, through detailed analysis of the key target sectors of road, rail and civil engineering, and finally provides a detailed overview of key opportunities and strategies for realising these.

Figure 26 Overview of Part 2 – Analysis of barriers and opportunities.



8 Market barriers

There are a broad range of factors that impact the ability of markets for TDPs to grow and expand. These exist across the value chain from collection, through processing to the point of product sale. This chapter explores at high level some of the key barriers and how they manifest in real market conditions.

8.1 Collection and transport



The profitability of TDPs is intrinsically linked to the costs of collection and transport. The key barriers impacting the industry at this stage of the product chain are presented in Table 12.

Table 12 Barriers impacting the collection and transport market for TDPs

Barrier / Factor	Impacts
Transportation costs	The cost of up front collection and consolidation remains a considerable factor in the TDP market. The primary source of EOLTs is tyre retail stores and whilst some stores may be large enough to warrant a full truck load, in most instances drivers are collecting from multiple stores in each run. This impacts efficiency and adds to fuel, staff and maintenance costs. This is particularly prominent in regional and rural areas where transport efficiencies can be too low to attract any tyre collectors. The impact of global oil prices and the resultant local petrol/diesel price is a key factor in the market. Operators look for opportunities for consolidation and bulk transport where possible, however given the disparate nature of tyre retail outlets this can be difficult to achieve.
Low barriers to entry	The tyre collection market is exposed to the emergence of new market participants due to very low barriers to entry. This is further aided by the transient nature of agreements between tyre retailers and collectors. In many instances, there are no formal agreements and tyre retailers will simply use the collector offering the lowest price. This encourages new players to come into the industry, however these players do not always have bone fide credentials or strong outlets for the tyres they collect.
Regulatory settings	Some jurisdictions have traditionally not set strong regulatory frameworks to ensure new market entrants can operate effectively. For example, a lack of tyre storage limits can allow operators to

[collect large volumes of tyres without a viable market outlet](#) leading to illegitimate stockpiling and other issues.

8.2 Recycling / reprocessing



The recycling and reprocessing portion of the value chain is impacted by a unique set of barriers, predominantly related to infrastructure costs and market competition. These are explored in detail in Table 13.

Table 13 Barriers impacting the recycling market for TDPs

Barrier / Factor	Impacts
Regulatory settings	Whilst regulatory settings are required to ensure that the risk of poor operators or illegitimate or illegal practices are minimised, they need to be designed to consider the impact on <i>bona fide</i> recyclers. Consultation with tyre recyclers indicated that tyre storage limits in many jurisdictions are being applied to both loose tyres and manufactured product and this is a significant barrier in being able to supply high volume contracts. For example, the five tonne tyre storage limits in NSW applies to loose tyres and manufactured product such as crumb rubber. Even a small section of road using crumb rubber spray seal would require more than this volume meaning that recyclers have difficulty in supplying quantities without breaching their storage limits. This is an issue that has been highlighted as a significant barrier to expansion of TDPs. An example provided in WA suggested that a large infrastructure provider was unwilling to use a TDP for a project because of the issues associated with storage during the project⁴².
Infrastructure costs	High infrastructure costs are a considerable barrier for the tyre recycling industry, particularly those businesses looking to create high quality crumb and granule. The typical investment for even a modest rubber crumbing facility is likely to exceed \$2 million or \$10 million for a larger scale plant. Those operators focusing on TDF also face considerable infrastructure costs with high capacity shredders ranging from around \$300,000 to over \$1 million⁴³.

⁴² Confidential pers comm during stakeholder interviews

⁴³ Pers comm during industry consultations

	Maintenance costs can also be significant with industry estimates suggesting costs of up to 30% of the purchase price per annum (for a high-capacity shredder) ⁴⁴ .
Cost of transport to port	Once a tyre has been collected and processed into TDF or bales for export, there are additional costs to get this material to an international port. This can be a factor for even centrally located operators however it manifests more prominently for regional recyclers. This is also a particular issue in Tasmania where there is no international port and material must be first moved to Melbourne, effectively doubling the transport costs and leading to much higher collection fees.
Low barriers to entry	As with the tyre collection market, the recycling part of the value chain is also exposed to new market entrants facing low barriers to entry. Whilst infrastructure costs for most recycling operations is high, it is markedly lower for tyre balers. A used baler can be purchased for as little as \$50,000 ⁴⁵ and requires significantly less maintenance as the tyre is simply compressed. This means that those businesses who have invested significantly in crumbing infrastructure must compete against tyre balers who have lower costs and barriers to entry.
Retailer disposal fees	A significant barrier impacting the tyre market is the pass-through of disposal fees from the tyre retailer to the tyre collector / recycler. In some cases, consumers pay disposal or recycling fees of up to \$10 per tyre⁴⁶ yet only a fraction of this, around \$2.00 - \$2.50 is passed on to the tyre collector. This downward price pressure applied to the tyre collector can distort the market, particularly in the mind of the consumer who believes that the recycling industry has been paid a premium. This has been documented in detail in previous tyre market studies.

8.3 Product markets



At the final end of the value chain, TDPs experience their own unique set of barriers that can impede growth. Essentially, overcoming these barriers is the primary target of this Strategy. We have

⁴⁴ *Emerging Materials Market Analysis* Hyder (2014) unreleased report

⁴⁵ *Emerging Materials Market Analysis* Hyder (2014) unreleased report

⁴⁶ A fee of \$10 per tyre was recently reported by a confidential source from Sydney

explored these barriers at high level in Table 14, with more specific detail provided in the in-depth sectoral analysis to follow.

Table 14 Barriers impacting product market for the tyre recycling industry

Barrier / Factor	Impacts
Lack of standards and specifications	In product markets, a specific set of requirements for performance and quality is often stipulated through a standard or specification. Lack of standards and specifications that apply directly to use of TDPs can be a significant barrier. This may include markets where there are no relevant standards for TDPs or, more commonly, where broad standards exist that don't provide enough specific guidance on the use of a TDP.
Competition from existing products	In most markets, there are existing products that TDPs must compete against. These products often have an advantage in that they are well known and have been used for many years. Historically, TDPs tend to be more expensive than the incumbent products and therefore need a differentiator (such as lower life cycle costs) to compete.
Attitudes and awareness	A key barrier that has been documented previously relates to existing attitudes and awareness about TDPs and their competitor products. Behaviours tend to favour what has been done before and as such those purchasing or specifying products may be unwilling to accept new products such as TDPs. Similarly, TDPs are often associated as waste products rather than products in their own right. This can impact the markets willingness to choose a TDP rather than another product even where the TDP has been proven to outperform its competition. The market also has limited awareness of TPDs and their applications in some sectors.
Health and safety concerns	In two key markets – road surfacing and sports fields – there are existing health and safety concerns with the use of TPDs. In the case of road surfacing, historical issues associated with odour (mainly from older practices that are not used today) hamper uptake of TDPs. There is direct evidence that one of the largest road surfacing producers in Australia remains reluctant to use TDPs for this reason. In the market for sports fields concern, mainly in the USA, about the impacts of inhaling rubber from surfaces made with TDPs has severely restricted sales in recent years. The US EPA has committed to undertaking a study on the issue to address public concerns⁴⁷
Technical performance	As noted previously, it is often the case that a product must conform to a technical standard or specification. In some instances, a barrier remains the of lack long-term testing to prove the efficacy of a TDP in a certain situation. This is evident in the roads sector where the relative newness of the industry means technical performance of a

⁴⁷ [Federal research on recycled tyre crumb used on playing fields](#) US EPA 2016

	road surface manufactured with TDP over an extended period (such as 10 – 15 years) is difficult to prove in-situ.
Quantity and quality of products	As in all manufacturing sectors, some producers have in the past sold poor quality material (for example with high levels of steel and fabric contamination) into the market. Where these have not performed well, the reputation of the overall product and industry have been damaged. In addition, the major producers of TDPs such as crumb and granule tend to have different infrastructure setups which can produce slightly different products (for example small differences in size and shape across manufacturers of crumb). In some applications, this may be enough of a barrier to impede this uptake of TDPs. It should also be noted that apart from TDF, most TDPs in Australia are not produced at significant scale. In infrastructure markets where huge volumes of material may be required, this can be a barrier to uptake particularly on larger projects. In some states (NT and Tasmania), there are no facilities producing TDPs such as crumb and granule and as such entry into these markets is difficult.
Policy settings	Policy settings related to the collection and processing industry have been explored above, however a lack of focused policy relating to sustainable procurement remains a barrier to product markets. Whilst most levels of government and business have some reference to sustainable procurement, it is typically an overlay that is not weighted strongly in procurement decisions. TDPs should be able to compete in their own right against competition, however sustainable procurement policies should ideally improve the ability of TDPs to compete and this is often not the case.
Import conditions	Australia takes a largely free market approach to imports and exports. Whilst this assists the market in terms of TDF exports, the import of cheap crumb rubber from international markets, for example Portugal and Canada, has been a considerable barrier in the last 12 – 24 months. These jurisdictions often benefit from generous subsidies through collection systems and this allows them to produce product at a much lower cost. Anecdotal evidence suggests that crumb has been imported into Australia for as little as \$300/tonne, some 40% lower than domestic prices of around \$500/tonne.

8.4 Analysis of barriers at jurisdictional level

The differing market conditions of each jurisdiction, as explored in the state by state profiles at Sections 9 – 16, mean that the barriers explored above do not manifest evenly across Australia. For example, the impacts of transport costs are felt more significantly in QLD, WA and NT where distances are greater and population density is lower than NSW and Victoria.

Table 15 provides an overview of the relative impacts of market barriers across each state and territory.

Table 15 Overview of market barriers and relative impacts at jurisdictional level

Market barrier	National	VIC	QLD	NSW	WA	SA	NT	TAS	ACT
Collection and transport									
Transportation costs									
Low barriers to entry									
Regulatory settings									
Recycling									
Regulatory settings									
Infrastructure costs									
Cost of transport to port									
Low barriers to entry									
Retailer disposal fees									
Product markets									
Lack of standards and specifications									
Competition from existing products									
Attitudes and awareness									
Health and safety concerns									
Technical performance									
Quantity and quality of products									
Policy settings									
Import conditions									

Legend: = market barrier that has no or negligible impact on TDPs; = market barrier that has moderate impact on TDPs; = market barrier that has a significant impact on TDPs

9 Market opportunities and competition analysis for TDPs in Australia

There are a significant number of opportunities for the use of TDPs in Australia. When steel and fabric have been removed, recycled tyre rubber has several beneficial properties. It is:

- flexible
- elastic
- strong
- resilient
- absorbs shock, sound and vibration
- hydrophobic.

In addition, recovered tyres may be used whole in engineering applications, either as compressed bales or joined together as a matrix and filled with soil or crushed rock.

This section provides a detailed overview of the key market opportunities for used tyres in Australia outside of roads, rail and civil engineering applications (non-structural) (which are addressed individually in later sections of this Strategy). The analysis includes analysis of competing products and barriers to market entry. This is not an exhaustive list, rather it covers the main product categories and the most common uses or likely future uses. REC has structured this analysis around sectors and, to keep the analysis brief, sought to use traffic lights augmented with some commentary on the major competition issues

A summary of opportunities for TDPs has been provided in this section, with detailed competition and market analysis for each opportunity provided in [Appendix 3](#).

9.1 Summary of market opportunities

The key opportunities for the Strategy have been prioritised using three stages of analysis discussed below.

1. Competition analysis – to assess how well TDPs do or will compete in the open market and to understand the strengths and weaknesses of competing products.
2. Potential market size / scale – to have a significant impact, opportunities that have the potential to consume significant volumes of TDPs should be prioritised.
3. Market maturity – markets that are in the ‘growth’ or ‘mature’ stage are more likely to drive outcomes in the short to medium term (1 – 5 years) than markets in their early phases.

9.1.1 Competition analysis

The use of TDPs has been compared across 10 competition factors and analysed against the major competing products for each opportunity. An overview of this analysis is presented in Table 16.

Table 16 Overview of opportunities for TDP and their ability to compete

Market opportunity	Cost	Lifecycle	Efficiency	Performance	Market scale	Market readiness	Greenhouse emissions	Longevity	Future recyclability	Patents / licensing
Crumb rubber explosives										
Crumb rubber spray seals										
Crumb rubber bitumen										
Vibration dampening for rail tracks										
Rubberised structural concrete										
Lightweight rubberised concrete										
Permeable pavements										
Tyre-derived aggregate										
Whole tyres in civil works										
Crumb rubber sports fields infill										
Playground / soft-fall surfaces										
Binders, glues and adhesives										
Crumb rubber in steelmaking										
TDF for domestic markets										
Oil from pyrolysis										
Carbon black from pyrolysis										

Legend: ■ = TDPs compete well against competitors; ■ = TDPs compete well on some elements and less well on others or more information is required; ■ = TDPs do not compete well against competitors

In general, TDPs compete well on technical performance, greenhouse gas emissions and lifecycle costs. However, in some circumstances the upfront costs can be considerably higher, patent and licensing issues exist and the current market is not prepared to meet a rapid escalation in demand.

9.1.2 Potential market size / scale

Estimates of the size of potential opportunities have been developed using an ‘opportunities model’ which considers factors such as the current market size, market share of competitive products and degree to which TDPs can penetrate new and existing markets. The model provides ranges for base case projections (i.e. likely market growth over time without intervention) and the potential impact

of government and / or industry intervention. Sensitivity analysis has also been applied to provide high, low and best estimates for the opportunities.

The potential market size of opportunities presented in Table 17 shows the best estimate projections for each opportunity and the relative projected consumption of EOLTs over a 10-year horizon. These figures represent the cumulative impacts of the base case growth of the market and the impact of potential interventions (for the best estimate projection).

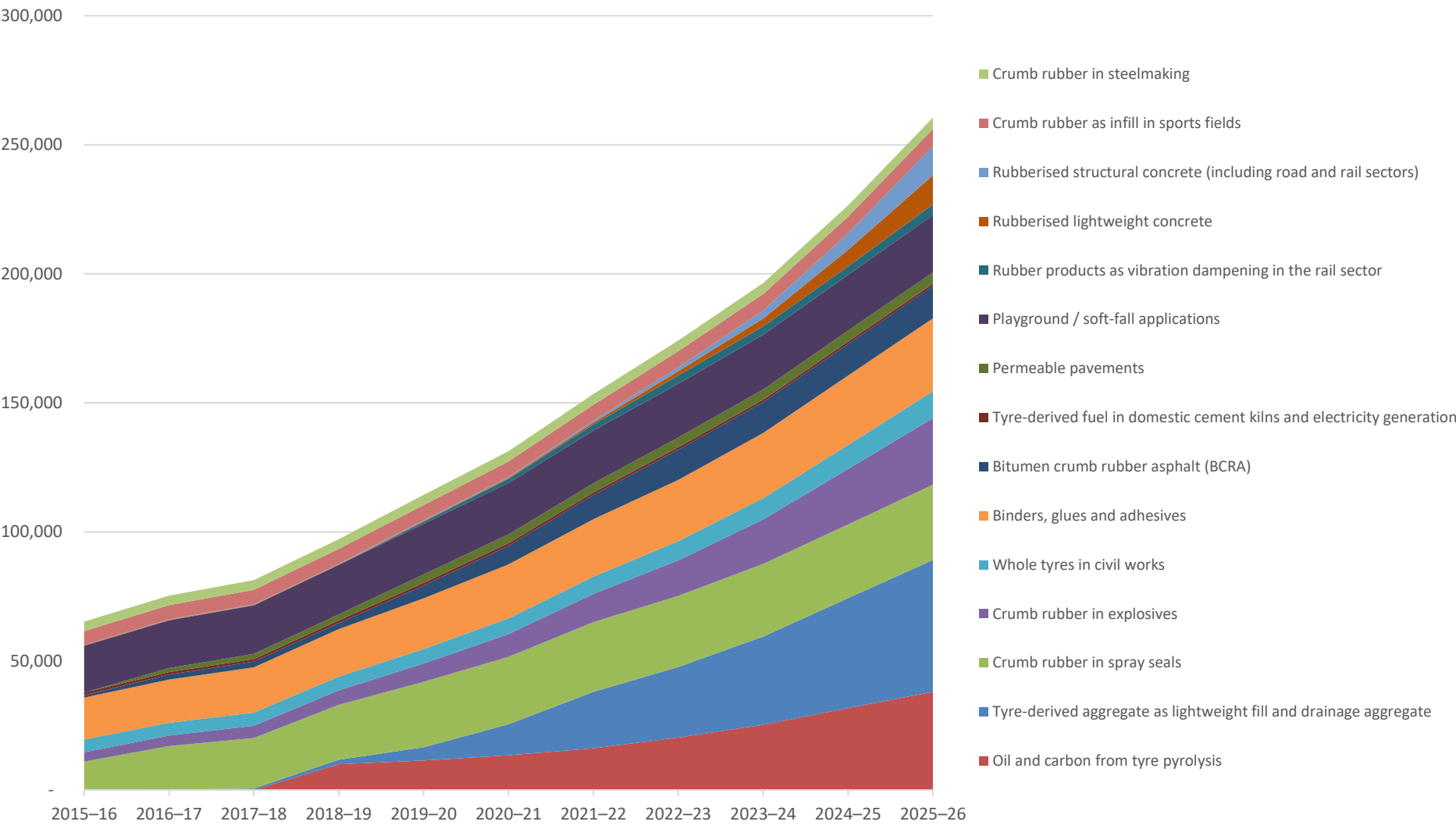
Table 17 Overview of potential market size for TDP opportunities (ranked in size of *total* tonnes per annum of EOLTs consumed) over the short, medium and long term – best estimate

Opportunity	Short term (Yr. 2)	Med term (Yr. 5)	Long term (Yr. 10)
Crumb rubber in spray seals	19,500	26,200	29,200
Binders, glues and adhesives	17,500	20,900	28,300
Playground / soft-fall applications	18,800	20,000	22,100
Oil and carbon from tyre pyrolysis	-	13,400	38,000
Tyre-derived aggregate as lightweight fill and drainage aggregate	600	12,000	51,100
Crumb rubber in explosives	4,800	8,800	25,800
Bitumen crumb rubber asphalt (BCRA)	2,200	7,200	12,400
Whole tyres in civil works	5,100	6,100	10,400
Crumb rubber as infill in sports fields	5,600	6,000	6,600
Crumb rubber in steelmaking	3,800	4,000	4,400
Permeable pavements	2,000	3,400	4,400
Rubber products as vibration dampening in the rail sector	-	1,500	4,200
Tyre-derived fuel in domestic cement kilns and electricity generation	1,000	1,000	1,000
Rubberised lightweight concrete	200	400	11,300
Rubberised structural concrete (including road and rail sectors)	200	400	11,300
TOTAL	81,300	131,300	260,500

Whilst projections of the future are inherently uncertain, the best estimate projection presented above provides an indication of the potential impact that the Strategy could have on EOLT arisings over the next 10-years.⁴⁸ As can be seen in Figure 27, this could have a significant cumulative impact with domestic recycling potentially exceeding 260,000 tonnes by 2025-26 which would equate to a recycling rate of more than 50% in 2015-26.

⁴⁸ Assumes all interventions are delivered in full (cumulative impact of all interventions).

Figure 27 Cumulative impact of base case growth and interventions for key TDP opportunites in Australia (2015-16 – 2025-26) – best estimate (tonnes)



When modelled over a longer period of 20-years as seen in Figure 28, the case becomes more compelling still. The impact of interventions and base case market growth, in addition to exports for energy recovery (assumed to remain at around the same level as today) shifts total EOLT recovery to the level where it meets and potentially even exceeds total EOLT generation (arising).

Figure 28 Projections of EOLT generation (arising) and best estimate recovery against total unrecovered EOLTs (tonnes)

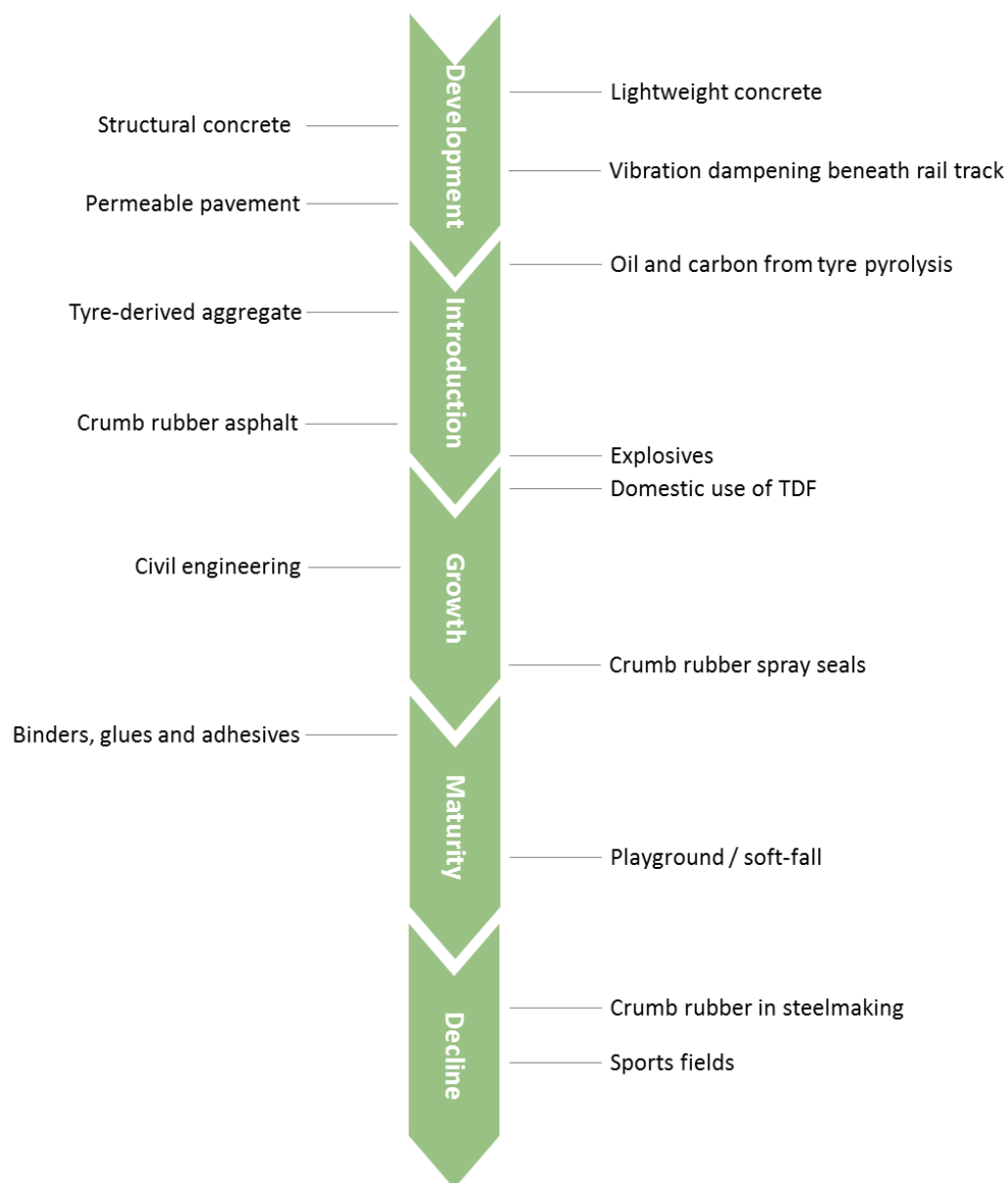


9.1.3 Market maturity

Finally, opportunities have been examined in terms of their market maturity. Markets that are in the growth stage or are mature but have additional capacity are likely to offer the best outcomes in the short to medium term. Opportunities that are in development or just being introduced into the market are likely to require a longer-term perspective.

The maturity of markets for potential opportunities is mapped out in Figure 29.

Figure 29 Maturity of markets for TDP opportunities in Australia



9.2 Summary of opportunities

The three stages of analysis above suggest the following key opportunities outside of the roads and rail sector:

Short to medium term (1-5 years)

- 1 Use of tyre-derived aggregate as lightweight fill and as a drainage aggregate
- 2 Additional penetration into the glues, binders and adhesives market (including tile adhesive)
- 3 Further uptake of crumb rubber in road spray surfacing
- 4 Domestic use of tyre-derived fuel in cement kilns and electricity generation
- 5 Crumb rubber in explosives
- 6 Whole tyres in civil engineering (including ground stabilisation in the rail sector)
- 7 Bitumen crumb rubber asphalt
- 8 Oil and carbon from tyre pyrolysis facilities

Longer term (5 - 10 years)

- 9 Rubber products as vibration dampening in the rail sector
- 10 Permeable pavements
- 11 Rubberised lightweight concrete
- 12 Playground / soft-fall applications
- 13 Rubberised structural concrete (including road and rail sectors)

10 Opportunities in the road construction sector

10.1 Overview⁴⁹

The road construction sector remains one of the most active users of tyre-derived products in Australia. Predominantly, crumb rubber is used as a polymer modified binder in production of sprayed seals and asphalt (referred to respectively as rubber modified sprayed seals and bitumen crumb rubber asphalt (BCRA) in this Strategy).

Uses of rubber modified bituminous materials in road making are well developed and are supported by decade's worth of laboratory studies and field trials. When first introduced into Australia in the 1970s, crumb rubber bitumen mixtures were created on site with rubber added directly into the hot bitumen while being loaded into the bitumen sprayer. The addition of cold rubber into hot bitumen resulted in excessing foaming and odour issues and led many contractors to move away from rubber modified mixes completely.

Modern methods have advanced considerably with separate on-site blending tanks now commonly used (for example, Sprayline use this approach extensively in Victoria) and, more recently, crumb rubber bitumen binders are being prepared in an off-site manufacturing facility (for example Downer EDI), giving greater control over the blending process and reliability of the binder properties.

10.2 Specifications

At a national level, the use of these products is supported by the Austroads *Specification Framework for Polymer Modified Binders* (Austroads Test Method AGPT/T190-14). It includes requirements for the application of crumb rubber as well as properties of crumb rubber bitumen binders. The Austroads framework contains separate requirements for PMBs used in sprayed seal and asphalt applications. Requirements for crumb rubber binders are further separated into pre-blended grades designated with the suffix 'R' for crumb rubber and field prepared grades carrying the suffix 'RF'.

The national specification framework supports the current market for sprayed seals well through the inclusion one pre-blended crumb rubber bitumen grade and two field produced grades, however it does not currently include any pre-blended product for asphalt applications. It includes only one RF asphalt grade (nominally 27% crumb rubber) intended for use in the dry mix process. "Dry mix" refers to the blending of crumb rubber with asphalt aggregates in an asphalt mixer prior to addition of bitumen binder. The use of pre-blended mixtures of bitumen and crumb rubber as binders for hot mix asphalt is commonly referred to as "wet mix" to differentiate it from the dry mix process. There is therefore scope for further work to be done at national level in expanding the specification for BCRA blends and techniques.

At state level, specifications for crumb rubber applications generally support the use of rubber modified sprayed seals as state specifications tend to reference the Austroads framework when stipulating the polymer modified binders that may be used. Conversely, the lack of inclusion of BCRA products in the Austroads framework manifests in the opposite way, suggesting that a national approach to BCRA may be an opportunity.

⁴⁹ Rebbechi, 2017. 'Use of Rubber in Roads', *Roadcor Pty Ltd*.

10.3 Road construction market in Australia

The Australian road network is estimated at almost 875,000km⁵⁰ and is managed through a complex framework of state government agencies, local government, transport and safety departments and private companies, and is overseen by the recently formed Infrastructure Australia.

Road construction includes new roads and maintenance and upgrades to existing roads, with the major infrastructure types being outlined in Table 18.

Table 18 Description of typical road types in Australia⁵¹

Road Type	Description
Highways and arterials	High-volume roads which form the major traffic routes in metropolitan areas and between cities and towns. These roads carry significant numbers of passenger and commercial vehicles.
Local roads	Roads servicing local traffic, such as residential streets and commercial areas, and roads servicing regional and rural areas. Generally managed by local government authorities.
Private toll roads	Major arterials that are privately owned, leased and/or operated. Charges (tolls) apply for each vehicle trip.
Runways	Runway surfaces and taxiing roads at airports.
Subdivisions	Roads constructed within private subdivision developments, both commercial and residential.
Access roads	Roads that link sites such as industrial facilities, mine sites, ports etc.
Road bridges and tunnels	Bridges and tunnels constructed for the road network.
Support infrastructure	Includes posts, crash barriers, sound barriers, embankments and other infrastructure that supports roads and traffic.

The roads sector is one of Australia's largest contributors to GDP and is worth more than \$25 billion annually⁵². The size of the overall market can be described in terms of annual spend and network size, which are presented respectively in Table 19 and Table 20.

Table 19 Total road expenditure (\$ million) by state/territory and level of government (2013-14)⁵³

Source of expenditure	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	Other	Total
Commonwealth	1,934	1,884	1,101	124	377	62	100	76	7	5,667
State/territory	3,157	893	5,240	529	1,907	233	207	269	-	12,435
Local	1,862	1,316	2,233	387	824	133	-	-	-	6,735

⁵⁰ BITRE, 2016. '[Australian infrastructure statistics yearbook 2016](#)', Bureau of Infrastructure, Transport and Regional Economics

⁵¹ BIS Shrapnel 2017. '[Road construction in Australia 2017 – 2031](#)' BIS Shrapnel industry report

⁵² BITRE, 2016. Based on 2013-14 roads expenditure.

⁵³ BITRE, 2016.

Private sector	458	19	334	44	75	19	0	32	0	1,413
TOTAL	7,411	4,112	8,909	1,085	3,183	447	288	377	7	26,251

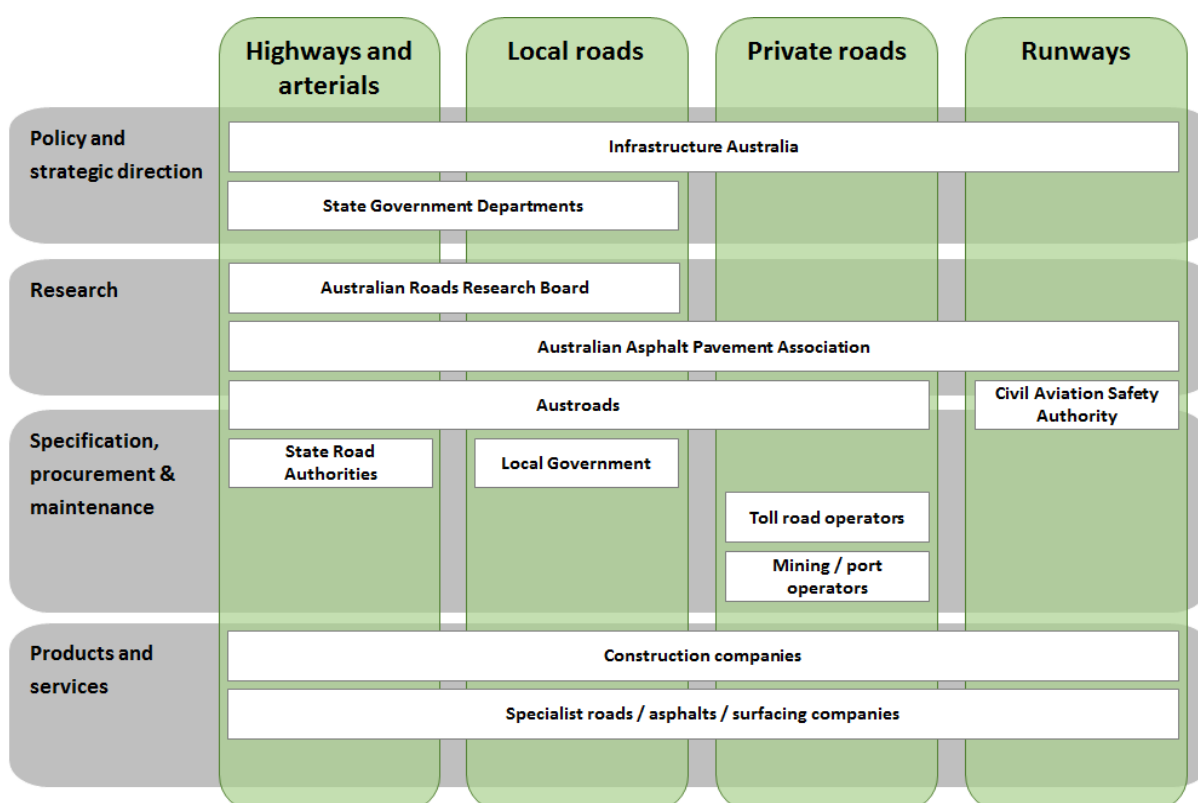
Table 20 Total road length (km's) by state/territory and by road type (2015)⁵⁴

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	Other	Total
Urban	39,450	34,417	30,091	12,729	18,954	3,948	1,280	3,057	-	145,928
Non-urban	167,789	109,320	193,297	84,212	138,449	16,004	18,001	391	182	727,644
TOTAL	207,239	145,736	223,388	96,941	157,403	19,951	19,282	3,448	182	873,573

Despite being a significant contributor to the economy, a recent report undertaken for Infrastructure Australia indicates there is a deficit between the current allocation of state funding to road development and road maintenance and the likely future cost of aging road assets (particularly roads and bridges)⁵⁵. It is therefore likely that additional revenue will flow into the sector over coming years and products that perform well from a maintenance perspective will be highly valued.

As with other infrastructure types, the sector has a complex array of stakeholders across the private and public sector, which is presented in Figure 30, each with a different remit and different degree of influence in the specification, design and development of new products.

Figure 30 Overview of key stakeholders in the road construction sector



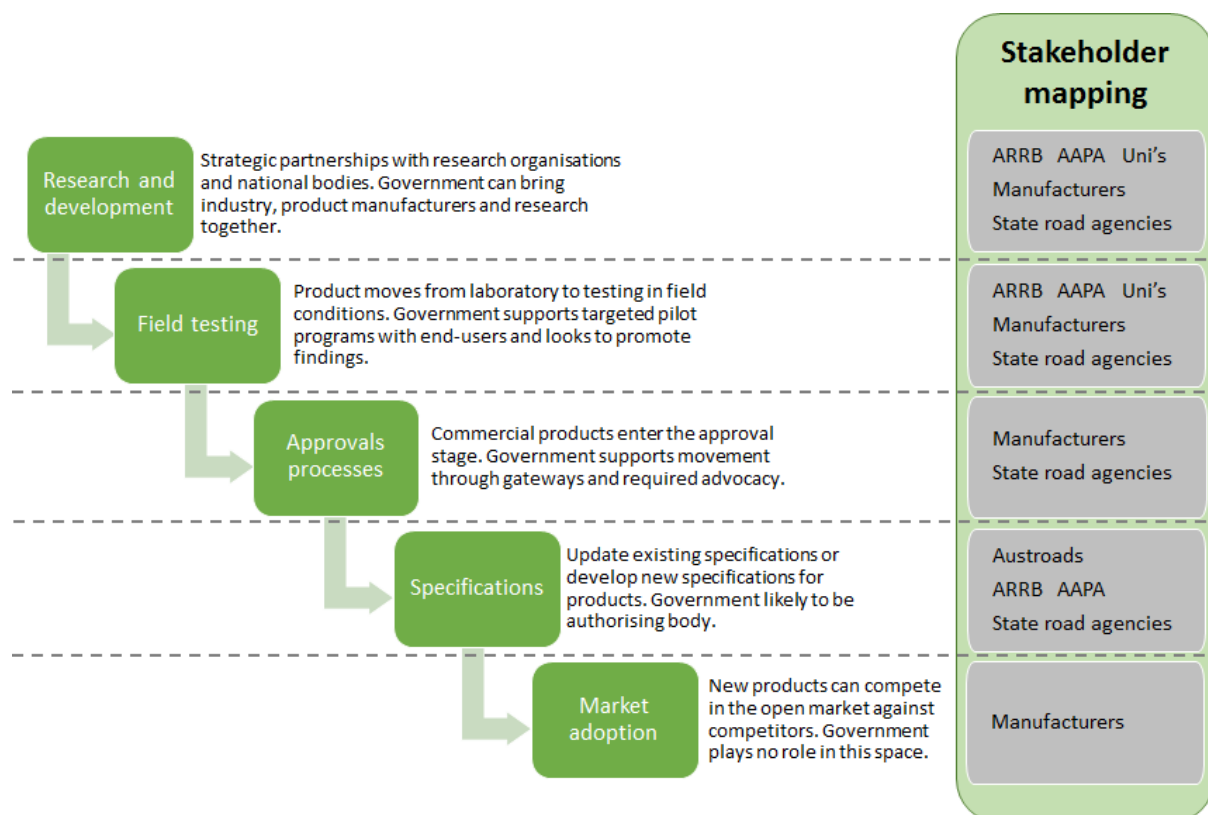
⁵⁴ BITRE, 2016

⁵⁵ GHD, 2015. '[Infrastructure maintenance: A report for Infrastructure Australia](#)' GHD Consulting, March 2015

The sector functions primarily on a state by state basis, with each road department or agency setting its own requirements and specifications. However, at national level there is improved coordination through research bodies such as the Australian Roads Research Board (ARRB) and Austroads, both of which are funded by the state road agencies. The Australian Asphalt Pavement Association (AAPA) represents the industry and provides a range of research and training programs to support innovation in the road sector. These organisations would be essential partners in delivering a national program for rubber in roads.

Whilst each state has its own specifications, there is good sharing of knowledge and the pathway for new products follows a relatively standard pathway as outlined in Figure 31.

Figure 31 Overview of development process for engineering products in the road sector.



Whilst the state road agencies control almost half of all road construction spending, some 26% or around \$6 billion comes from local government who manage around 650,000kms of local roads⁵⁶. There are 546 local government authorities across Australia⁵⁷, each with their own internal road procurement protocols. This part of the market is therefore significantly harder to reach and influence.

As noted previously, there are currently two types of TDPs commonly used in the road network, being modified sprayed seals and asphalt using crumb rubber binders. These are explored in further detail in the following sections.

⁵⁶ ALGA. 'Roads and transport strategy 2006 – 2016'. Australian Local Government Association

⁵⁷ DIRD, 2017. 'Local Government'. Department of Infrastructure and Regional Development

10.4 Current state of the market for crumb rubber spray seals in Australia

There are several types of sprayed seals used in Australia, from single seals used in low traffic areas up to diverse special purpose seals for high traffic environments. Crumb rubber seals tend to belong to the latter and are generally used in the following products:

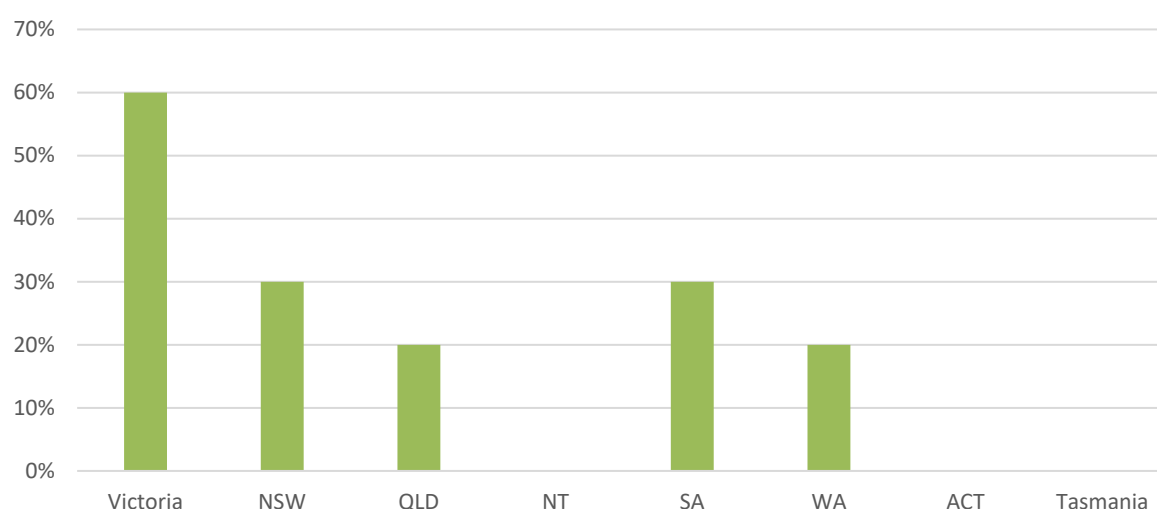
- High-Strength Seals (HSS) – Seal made with a PMB for high stress and high traffic loading areas, such as corners and high-speed road sections. Commonly use 5% – 10% crumb rubber by weight.
- Strain Alleviating Membrane (SAM) – Used as surface sealing for cracked pavements, bridges or anywhere that reflective cracking or waterproofing is an important consideration. Typically use 15% – 18% crumb rubber by weight.
- Strain Alleviating Membrane Interlayer (SAMI) – A highly modified version of a SAM seal used to greatly reduce reflective cracking and improve waterproofing. These products can contain high quantities of PMBs or crumb rubber. Can use up to 25% crumb rubber by weight.

Take up of rubberised sprayed seals has been significant, benefiting from a general increase in consumption of road seals that contain polymer modified binders. The use of crumb rubber sprayed seals makes up a considerable portion of the total sealing market, with industry sources reporting that around 60% of all sprayed seals applied in Victoria and around 30% of all sprayed seals in NSW and SA contain crumb rubber. The market maturity for crumb rubber sprayed seals by jurisdiction and approximate market penetration (as a % of the total sprayed seal market) by jurisdiction is presented in Table 21 and Figure 32 respectively.

Table 21 Overview of market maturity for sprayed seals by jurisdiction in Australia

Product stage	VIC	QLD	NSW	WA	SA	NT	TAS	ACT
Under consideration	✓	✓	✓	✓	✓	✓	✓	✓
Research and development	✓	✓	✓	✓	✓			
Field testing	✓	✓	✓	✓	✓			
Approvals process	✓		✓	✓	✓			
Specification	✓		✓	✓	✓			
Early industry take-up	✓		✓	✓	✓			
Intermediate industry take-up	✓		✓	✓	✓			
Broad market adoption	✓							

Figure 32 Approximate market penetration of crumb rubber sprayed seals by jurisdiction in Australia⁵⁸



10.5 Current state of the market for BCRA in Australia

In comparison to crumb rubber spray seals, the use of BCRA in Australia is significantly lower with industry sources suggesting that less than 500 tonnes of crumb rubber went into asphalt production in 2015-16⁵⁹. The market maturity for BCRA is presented in Table 22.

Table 22 Overview of market maturity for BCRA by jurisdiction in Australia

Product stage	VIC	QLD	NSW	WA	SA	NT	TAS	ACT
Under consideration	✓	✓	✓	✓	✓	✓	✓	✓
Research and development	✓	✓	✓	✓	✓			
Field testing	✓		✓					
Approvals process	✓		✓					
Specification	✓		✓					
Early industry take-up	✓		✓					
Intermediate industry take-up								
Broad market adoption								

The use of BCRA in Australia is best explored in terms of the different asphalt types commonly installed. The primary divisions between asphalt mix types are based on grading (particle size

⁵⁸ Based on indicative estimates provided during consultation with road agencies and industry players

⁵⁹ Confidential pers comm during consultations

distribution), however further divisions for specific applications may also include properties of component materials (aggregates, binder, additives, etc.). An outline of the key asphalt types in Australia are as follows:

Asphalt type	Description
<i>Dense Graded Asphalt</i>	Dense graded asphalt is the most widely used form of asphalt in both structural (base asphalt) and wearing course applications. PMBs, including crumb rubber, are particularly used in wearing course asphalt mixes for improved performance in heavy duty applications. Previous studies have shown that crumb rubber bitumen binders with properties comparable to competing SBS polymer modified binders translated into similar performance in terms of deformation resistance and fatigue but at higher total binder contents⁶⁰. This is also consistent with North American practice. However, whilst commercial blends of BCRA performed well in early trials, they required total binder contents of at least 8% to achieve the desired performance benefits, which resulted in significantly higher costs. This has been and remains the major prohibitor to the uptake of BCRA in Australia.
<i>Open Graded Asphalt</i>	Open Graded Asphalt (OGA) is a porous asphalt mixture that provides reduced tyre noise and reduced water spray, making it particularly suitable for use as wearing course on urban freeways and other high speed roads. Experience from the USA market suggests that usage of crumb rubber modified binder (wet mix process) in open graded asphalt can result in a significant increase in durability and potential improvement in resistance to heavy traffic. Whilst this may lead to a decrease in porosity and increase in water spray, such mixes would still be expected to retain suitable texture depth and hence good skid resistance. The increased durability of BCRA used in OGA mixes provides an opportunity for TDPs as maintenance and repair of high traffic roads is expensive and problematic in terms of traffic control. The potential reduction in noise (see below) from BCRA products adds to the compelling case for use in OGA mixes.
<i>Low Noise Asphalt</i>	The use of BCRA in high traffic areas can reportedly have benefits in noise reduction, a key consideration in constructing new or resurfacing existing urban roads. A 6-year study in Sacramento County on the degree to which rubberised asphalt can reduce traffic noise in open graded friction course found that: <i>The conclusions of the 6-year study indicate that the use of rubberized asphalt on Alta Arden Expressway resulted in an average four (4) decibel reduction in traffic noise levels as compared to the conventional asphalt overlay used on Bond Road. This noise reduction continued to occur six (6) years after the paving with rubberized asphalt. This degree of noise attenuation is significant, as it represents a 60% reduction in traffic noise energy, and a clearly perceptible decrease in traffic noise⁶¹.</i>

⁶⁰ Austroads, 1999. 'The use of recycled crumb rubber in asphalt'. *APRG Technical Note 10*, Austroads.

⁶¹ Bollard & Brennan, 1999. '[Rubberized Asphalt Traffic Noise Reduction Study](#)' Sacramento County DERA and Bollard & Brennan, Inc.

	BCRA products manufactured in Australia have been tested for the same properties and have been shown in road trials in various Australian States to be effective in a measurable reduction in tyre road noise ⁶² .
<i>Gap Graded and Stone Mastic Asphalt</i>	The two existing standards for BCRA in Australia – by VicRoads and RMS NSW – are written around the dry mix process using a relatively high proportion of bitumen and crumb rubber additive in a coarse gap graded asphalt mix. The gap grading is employed to provide sufficient space (measured in VMA or voids in mineral aggregate) to accommodate the high proportion of bitumen and crumb rubber while maintaining sufficient air voids in the mixture to avoid instability at very low air void contents. Again, the high proportion of bitumen and crumb rubber have resulted in expensive products for these applications which speaks strongly to the current limited use of BCRA products.

10.6 Key barriers

Consultation with state road agencies across Australia indicates that there are persistent concerns relating to odour and fumes despite numerous studies showing that these risks are largely perceived. Modern “warm mix” techniques and the development of exhaust ventilation and capture devices on paving equipment have improved overall conditions for asphalt workers and a leading provider of BCRA noted during consultations that a range of internal testing has been done to appease concern from workers, customers and unions.

Regardless of the perceived odour issues, the key barrier related to take up of BCRA appears largely commercial. Whilst crumb rubber spray seals are cost competitive (if not cheaper) with other polymer modified seals, BCRA remains a costlier product as it requires larger quantities of bitumen (the most expensive ingredient in asphalt) to produce. Frank dialogue with at least two state road agencies indicated little interest in the use of BCRA unless these commercial issues can be overcome, both noting that other cheaper polymer modified binders can produce similar quality asphalt at a lower cost.

In addition, only a handful of suppliers are currently equipped in Australia for the blending of crumb rubber mixtures. Therefore, more capital investment in blending and storage equipment will be required. For wet mix products, external supply of blended materials to an asphalt manufacturer would still require extra storage facilities for handling of the modified binder. The dry mix process is less capital intensive although still requiring some equipment for handling and adding the crumb rubber to the asphalt mixture.

10.7 Use of other TDPs in the road construction sector

There are several other infrastructure and support systems that are part of the road construction sector. These include structures, such as bridges and tunnels, barriers for reducing sound and limiting the impacts of vehicle crashes, traffic management tools and the underlying engineering products.

⁶² Self reporting by confidential road surfacing companies. These reports have not been made public.

The use of TDPs in these parts of the network are less advanced, particularly areas such as traffic lights, bridges and tunnels. Research and industry consultation highlighted the following potential opportunities:

Product / application	Overview
<i>Guide posts</i>	Roadside guideposts are upright posts with a reflector attached to allow drivers to see the boundaries and direction of a road at night. Guideposts using recycled rubber hinges (so the guidepost will snap back into position after vehicular impact) are already available on the market
<i>Rubber kerbs</i>	Used primarily for “blister islands” or in car-parks, rubber kerbing is less prone to cracking and can be made offsite and quickly installed where required. There are some recycled rubber kerbs currently available in Australia.
<i>Wheel stops / edging</i>	Used in carparks, recycled rubber wheel stops are a common product, moulded to a set size and usually black with yellow coloured stripes. Meeting an existing Australian Standard AS2890.1:2004, recycled rubber wheel stops are sold in Victoria, Queensland and NSW and are the largest market segment in this category.
<i>Noise barriers</i>	Whilst not yet available in Australia, there are international examples of recycled rubber noise barriers being manufactured. A recent project in Croatia has seen recycled rubber noise barriers produced for use along motorways and main roads. The rigid panels are around three meters in height and consume almost 8,000EPUs per km of road ⁶³ .
<i>Crash cushions / barriers</i>	Temporary crash cushions or barriers, for example used between lanes at tollway pay points, have been manufactured with recycled rubber in Australia.
<i>Speed humps</i>	There are a number of recycled rubber speed humps on the market in Australia and industry consultation suggests there perform well on the market (in terms of cost and performance).

Consultation with retailers and wholesalers of these products in NSW and Victoria indicates that they are almost entirely manufactured overseas and imported into Australia for sale. It was suggested during these consultations that Australian made recycled products, for example a recycled plastic wheel stop, struggled to compete and could cost as much as three times more than imported rubber products⁶⁴. It would appear difficult for locally made wheel stops and speed humps to compete with imported products without some sort of “buy Australian” driver.

The use of TDPs in road support structures, such as bridges and tunnels, is an area that is not common in Australia or internationally. These materials require high tensile and compressive strength and the current academic evidence suggests that rubber modified concrete reduces compressive strength and as such this is likely to present a significant barrier. Our analysis of

⁶³ EASME, 2015. ‘[Recycling rubber to reduce noise](#)’. European Commission: Executive Agency for SMEs.

⁶⁴ Pers comm during consultations with suppliers in NSW and Victoria.

rubberised concrete provided earlier suggests this is not likely to be an area of significant consumption of EOLTs in the short or medium term.

However, the use of TDPs in non-structural geotechnical applications is more common, particularly in the USA. Recent work undertaken by Swinburne University, in partnership with SV, TSA and Tyrecycle, suggests that the addition of tyre-derived aggregate into road subbase can be beneficial, particularly where recycled crushed concrete is being used⁶⁵. Recycled concrete has a tendency to re-cement making it more rigid and prone to cracking. The addition of small quantities of tyre-derived aggregate (1% - 2% by volume) may assist in increasing flexibility and mitigating these issues, although the research suggests that the addition of rubber can impact compaction and field trials may be required to test this.

Other geotechnical applications for TDPs in the road sector will not be explored here, rather they have been more broadly examined in the analysis of civil engineering applications at Section 12.

Our analysis of opportunities for TDPs in the rail construction sector is provided in Section 11.

⁶⁵ Swinburne, 2017. 'Tyre-derived aggregates as a supplementary material in pavement subbases', *Swinburne University Outcome Summary Report*, provided by SV for the purposes of this project.

11 Opportunities in the rail construction sector

11.1 Overview

The Australian rail network spans more than 33,000kms in length and provides vital passenger and freight transport both intrastate and interstate. Australia is unique in having a number of different track gauges across the states and territories which makes construction of interstate routes challenging.

Until recently, there had been little done to investigate the potential for recycled rubber products in the sector; however, a project being undertaken by the University of Wollongong investigating whole tyres in subbase stabilisation has gained attention within government and across the sector.

Whilst newly emerging in Australia, there are many international examples of the use of recycled rubber in rail construction and in rolling stock. However, whilst the sector holds promise it also offers a number of challenges and high barriers to entry. Some of these are discussed in this section.

11.2 Rail construction market in Australia

The rail network in Australia is responsible for the transport of Australia's bulk commodities in the resources and agriculture sectors, along with a smaller degree of non-bulk freight. In total, the rail network moves more than 250 billion tonne-kilometres of domestic freight per annum⁶⁶.

In addition, it plays a considerable role in passenger transport, particularly inner urban commuting in Melbourne, Sydney, Brisbane and Perth, with additional capacity provided through light rail transport. In 2013-14, there were more than 670 million passenger movements on heavy rail and a further 184 million passenger movements on light rail⁶⁷.

The sector can be broken down by rail type as presented in Table 23.

Table 23 Description of typical rail types in Australia and support infrastructure⁶⁸

Rail Type	Description
Heavy haul	Network of bulk haul rail moving resource and agricultural commodities from production to domestic consumers and to international ports for export.
Interstate	There are limited interstate rail networks considering Australia's size. Interstate rail is primarily used for freight (bulk and non-bulk) with minor passenger services between Melbourne, Sydney, Adelaide, Perth and Darwin.
Regional rail	Regional rail networks are considerable in Victoria, NSW, QLD and WA. These networks are a mix of passenger links and freight.
Urban rail	Passenger transport networks in urban areas, generally bringing commuters into urban centres.
Rail bridges and tunnels	Bridges and tunnels constructed for the rail network.

⁶⁶ BITRE, 2016. Based on 2010-11 figures

⁶⁷ BITRE, 2016. Based on 2013-14 figures

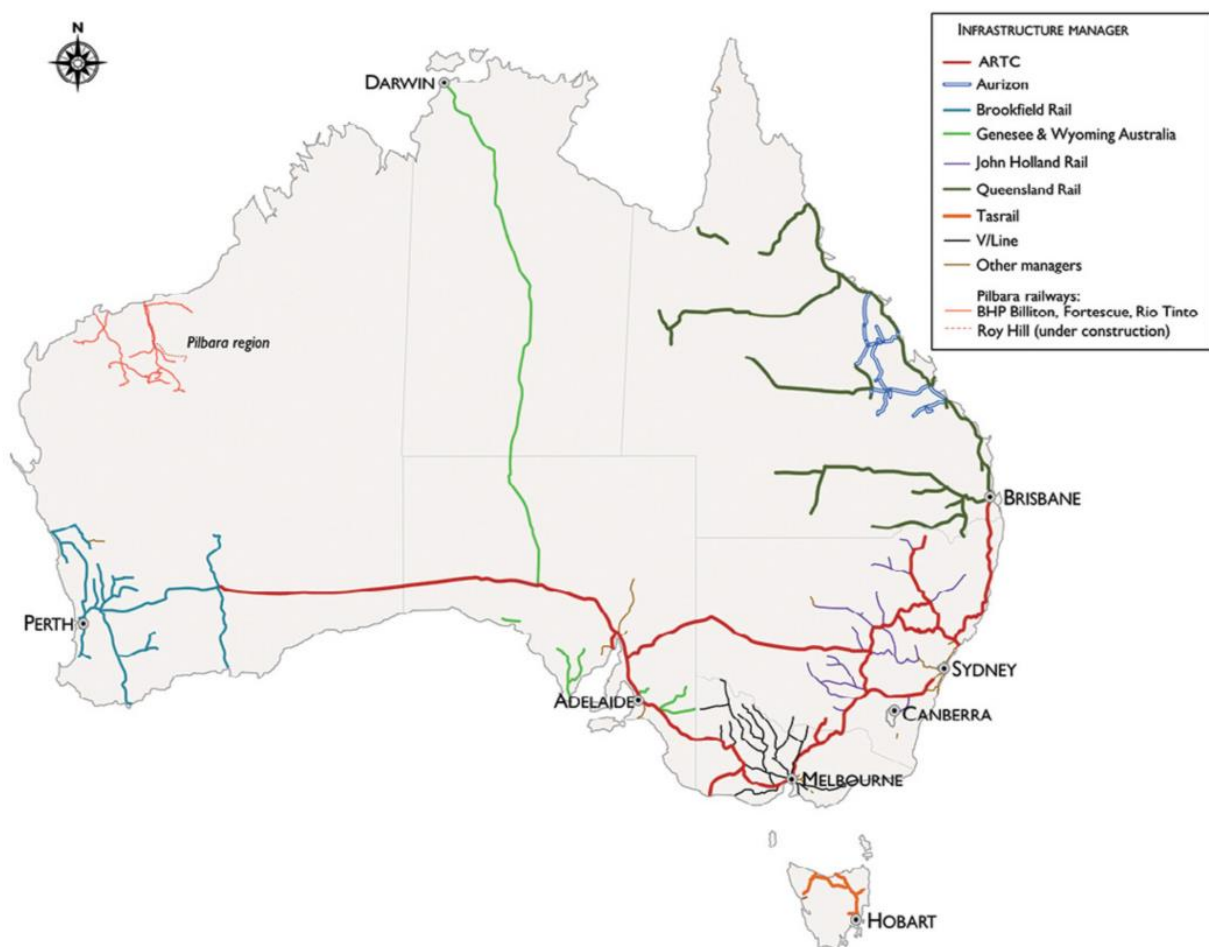
⁶⁸ BIS Shrapnel 2017. '[Road construction in Australia 2017 – 2031](#)' *BIS Shrapnel industry report*

Support infrastructure

Includes signals, stations, posts, barriers, embankments and other infrastructure that supports rail tracks.

The network is predominantly owned by state government and is managed by state-owned companies who were created in the 1990's during a period of intense privatisation. Operation of the network is often contracted out or leased out to private companies with separate maintenance and operations contracts. Similarly, the operation and maintenance of regional vs urban rail is also disaggregated, leading to a complex web of infrastructure managers across the country as can be seen in Figure 33.

Figure 33 Overview of infrastructure managers across the Australian rail network⁶⁹



In terms of track distribution, QLD, WA and NSW have the largest share, collectively having around 2/3 of the total network length. This reflects both the strong markets for bulk haul and passenger rail in these jurisdictions. Table 24 presents an overview of the rail network by gauge and jurisdiction in Australia.

⁶⁹ BITRE, 2016. Note, this does not include infrastructure managers for inner city heavy or light rail

Table 24 Total rail length (km's) by state/territory and by rail gauge (2015)⁷⁰

Jurisdiction	Gauge					Total
	1 067	1 435	1 600	Dual	Other	
New South Wales	8	7,083	73		1	7,165
Victoria	16	1,222	2,921	32	30	4,221
Queensland	8,093	117		36	4	8,250
South Australia	561	3,114	253	22		3,950
Western Australia	2,970	4,214		207		7,391
Tasmania	667					667
Northern Territory	3	1,690				1,693
ACT		6				6
Total	12,318	17,446	3,247	297	35	33,343

Whilst not as significant as road construction, the rail sector contributes more than \$9 billion to Australia's GDP, mostly coming from investment by state government. As can be seen in Table 25, NSW and Victoria represent the bulk of expenditure.

Table 25 Total rail expenditure (\$ million) by state/territory and level of government (2014-15)⁷¹

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	Total
State Government	3,666	3,263	1,500	113	38	17	0	23	8,621
Federal Government	276	144	248	0	0	5	0	0	741
TOTAL	3,942	3,407	1,748	113	38	22	0	23	9,362

Expenditure is likely to increase significantly over the next few years with the development of Inland Rail, a continuous freight line between Melbourne and Brisbane. Infrastructure Australia suggests a further \$10 billion will be spent developing Inland Rail over the next decade⁷².

11.3 Stakeholders and sector procurement

There are opportunities for the consumption of TDPs in the rail construction sector (outlined further on) and the existing work being undertaken indicates a general interest from some parts of the industry. However, a key challenge in accessing the sector lies in the complex web of stakeholders and approvals that exist.

Our discussions with the industry, both government and private organisations, suggests that there are considerable barriers to entry as a result of the state-based models and the required testing and approvals process for new products and materials.

REC identified some 25 public and private organisations with responsibility for operation, planning and maintenance of the rail network, as can be seen in Figure 34 Overview of key stakeholders in the

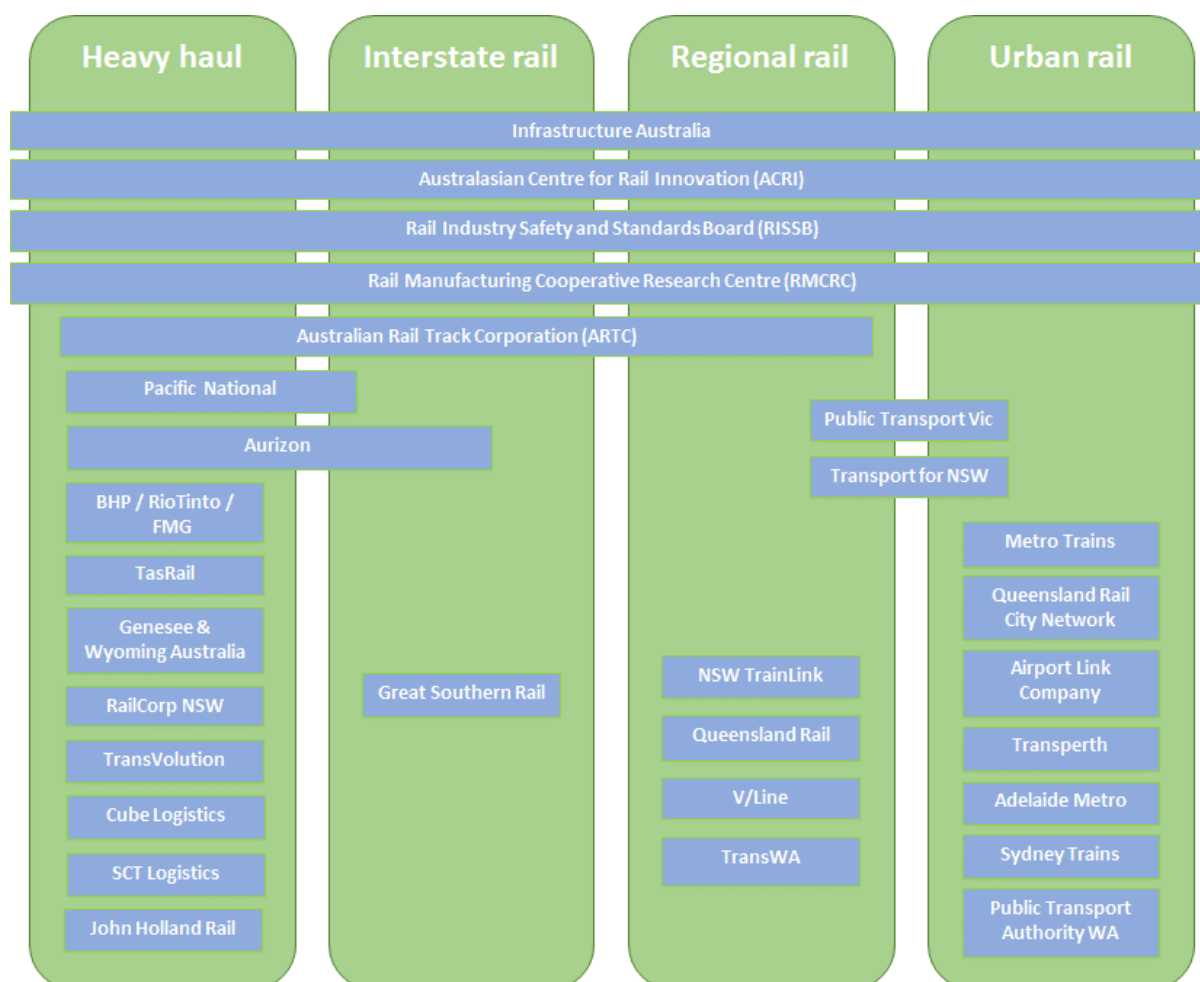
⁷⁰ BITRE, 2016

⁷¹ BITRE, 2016.

⁷² DIRD, 2015. '[Inland Rail: At a glance](#)' Department of Infrastructure and Regional Development – Infrastructure Australia

rail construction sector. Most have their own suppliers and networks and their own approvals processes which are not necessarily transferable across the network.

Figure 34 Overview of key stakeholders in the rail construction sector

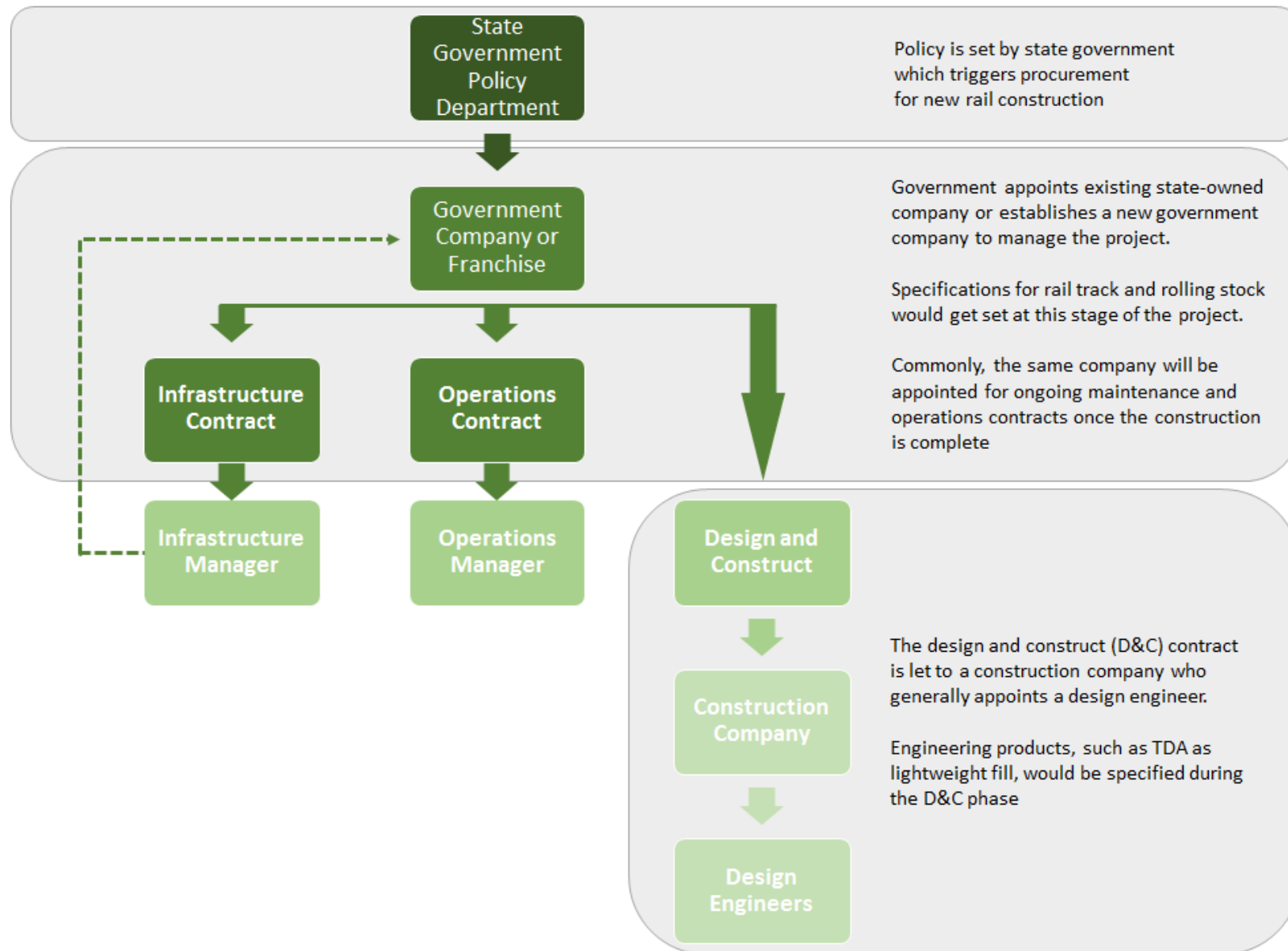


Perhaps most importantly for the purposes of TDP market development, there are a number of national training, research and safety bodies which may offer a better market entry point than working at state level.

Procurement and approvals processes are complex, with most organisations requiring new products to go through a “type approvals” process. This is not standardised or national approach to type approvals and each state operator will have its own approvals process. However, products that can pass through the type approval process with key organisations (for example ARTC) may expedite the process in other jurisdictions. Independent research and product evaluation exercises can feed into and support the type approvals process.

There are several sector procurement models, ranging from fully separated models where contracts for design and construction, operations and rolling stock maintenance are separated, to integrated models where a single infrastructure contract is let. There is no accepted industry sector procurement model, however a typical procurement model from the Australian rail sector (based on industry consultation) is presented in Figure 35

Figure 35 Typical sector procurement model for rail construction



With regard to the use of TDPs in the rail sector, the procurement model outlined above contains a number of key decision and influence points.

1. Policy level – State transport departments generally set the overarching framework for rail construction projects and provide the funding. There is some scope at this level to use sustainable construction / procurement approaches to support uptake of TDPs in the project.
2. Procurement level – Responsibility for the project is generally allocated to an existing or new government company – for example the Australian Rail Track Corporation has been given responsibility for constructing Inland Rail on behalf of the Commonwealth Government. The specifications for rail track and rolling stock will generally be set at this level of the procurement process. TDPs related to track work and rolling stock would need “type approval” to be considered.
3. Contract level – There is generally three contracts let as part of a rail procurement.
 - a. The design and construction (D&C) tender is put out for competitive bids with a consortium of large construction contractors generally appointed. The engineering requirements are set at this level, generally in coordination with a design engineer. Therefore, TDPs in the civil or geotechnical engineering space must be considered by the construction contractor in order to be used.
 - b. The infrastructure contract is let (either directly or by competitive tender) to ensure ongoing management of stations, track and signalling infrastructure once the construction is complete. It is often the same government company who manages the construction project that is appointed as the infrastructure manager.
 - c. Finally, the operations contract is let (either directly or by competitive tender) which allows for a provider to operate the rolling stock (i.e. the trains and their passengers).

The entry points for TDPs will differ based on the state model in question and the procurement model chosen for each particular project.

11.4 Current state of the market for TDPs in the Australian rail sector

At present, there are a very limited number of TDPs installed on the Australian rail network. Anecdotal evidence suggests that some recycled rubber pads have been used on level crossings, however details of where these products came from and where they have been used was not available. It is likely, based on experience with similar products in the road construction sector, that these were imported.

However, as noted earlier there are research projects underway looking at specific applications for TDPs in Australia. In addition, international experience suggests a raft of other potential opportunities for use of TDPs in the rail sector. An overview of likely applications for TDPs in the rail sector, based on international experience, is presented in Table 26.

Table 26 Overview of current and potential applications for TDPs in the rail sector

Product / application	Overview
<i>Subbase stabilisation</i>	Research work is currently underway at the University of Wollongong considering the use of tyres to stabilise subbase beneath rail track, particularly in areas prone to subsidence. Using a derivative of the EcoFlex system, early results suggests both a cost benefit and a performance benefit over existing geomembrane products.
<i>Recycled rubber matting as vibration dampening</i>	The use of recycled rubber matting as vibration dampening under rail track is common in Europe. The matting aims to reduce vibration and noise and improve the longevity of railway ballast, which is prone to degradation over time. Research at the University of Wollongong is also underway in this area with outcomes expected within the next two years.
<i>Crumb rubber in railway ballast</i>	A study undertaken in Europe in 2015 showed that the addition of 10% crumb rubber by volume could reduce ballast degradation, improve the capacity of the ballast layer to dissipate energy and reduce overall track settlement ⁷³ . The cost effectiveness of this would need to be considered in Australia and may be a focus for future study.
<i>Tyre-derived aggregate layer beneath railway ballast</i>	To reduce the impacts of noise and vibration, a ~300mm layer of TDA is placed beneath the sub-ballast layer of the rail track to stop vibration moving offsite. This has been successfully deployed on light rail systems in North America and would require further investigation locally ⁷⁴ .
<i>Railway sleepers</i>	Industry consultations indicated a willingness by the recycling market to manufacture a recycled rubber railway sleeper, most likely as a composite rubber-plastic product ⁷⁵ . The move toward concrete sleepers in most states however poses a challenge as they may be unwilling to consider new products after such investment. There may be middle ground here with a recent study in India showing that addition of crumb rubber to concrete sleepers can increase impact strength by around 60% and still reach the required design strength ⁷⁶ .
<i>Platform gap fillers or adjustable coping for platform edges</i>	There is a potential market for recycled rubber platform gap fillers and adjustable coping for platform edges. These safety features are commonly used on commuter rail.
<i>Preform recycled rubber slabs for level crossings</i>	In the UK, rail level crossings across metropolitan and regional areas are built using preform recycled rubber slabs. There is anecdotal evidence to suggest they have been used in Australia also, however it was suggested these products were imported rather than locally made.

As is the case with our analysis of the road sector, use of TDPs in civil engineering applications will not be addressed here but is incorporated in the sector study at Section 12.

⁷³ Sol-Sanchez et al, 2015. [‘A study into the use of crumb rubber in railway ballast’](#) *Construction and Building Materials*, v75, pp 19-24.

⁷⁴ Humphrey ~1992. [‘Tire Derived Aggregate – A New Road Building Material’](#) Dana Humphrey, University of Maine.

⁷⁵ Confidential pers comm during consultations

⁷⁶ Hameed and Shashikala, 2016. [‘Suitability of rubber concrete for railway sleepers’](#) *Perspectives in Science* 2016, v8, pp32 – 35.

Whilst there are clearly barriers impacting the uptake of TDPs in the rail sector, most notably the long testing and type approvals process, the opportunities may be considerable. There is a clear push at state and federal government level for additional investment in rail infrastructure. Our analysis, which is presented in Table 27, suggests there are almost \$50 billion in new rail construction projects planned over the next 10 years.

Table 27 Key rail opportunities over the next 10 years⁷⁷

Project	Description
Inland Rail	\$10 billion freight link between Melbourne and Brisbane, to be managed by ARTC
North-west Rail Link (NSW)	Passenger rail from north-west suburbs into Sydney central, eight new stations and 4,000 commuter car parks, circa \$5 billion
Sydney Light Rail (NSW)	12km light rail with 19 stops, link to Inner West Light Rail
Morton Bay Rail Link (QLD)	\$650 million new rail line with 6 new rail stations
North-south Rail and Bus Tunnel (QLD)	Proposed 5km dual train and bus tunnel under the Brisbane river with a value of some \$5 billion
Metro Tunnel (VIC)	\$11 billion north-south train link and new metro tunnel with new stations at Parkville, Arden and Domain and two new CBD stations.
Level Crossing Removal Authority (VIC)	Removal of 50 priority level crossings and construction of new track work and stations, with a cost of almost \$700 million.
Pakenham – Cranbourne Rail Corridor Project (VIC)	Exclusive negotiation underway on a \$2.5 billion project including upgrades, track and signalling improvements, level crossing removals and new rolling stock to improve line service and capacity.
Forrestfield Airport Link (WA)	Newly commenced \$2 billion project to link Perth Airport, with new stations at Forrestfield, Airport Terminal and Airport West precinct.
Metro Express Light Rail (WA)	Proposed 22km of light rail from Mirrabooka to Perth and through the CBD. Approximate value \$2 billion
Rolling stock	Estimates suggest state government could spend \$30 billion over the next 30 years on rolling stock.
TOTAL	Approximate expenditure over the next 10 years is around \$49 billion, including \$39 billion on infrastructure and a further \$10 billion on rolling stock.

11.5 Rail maintenance

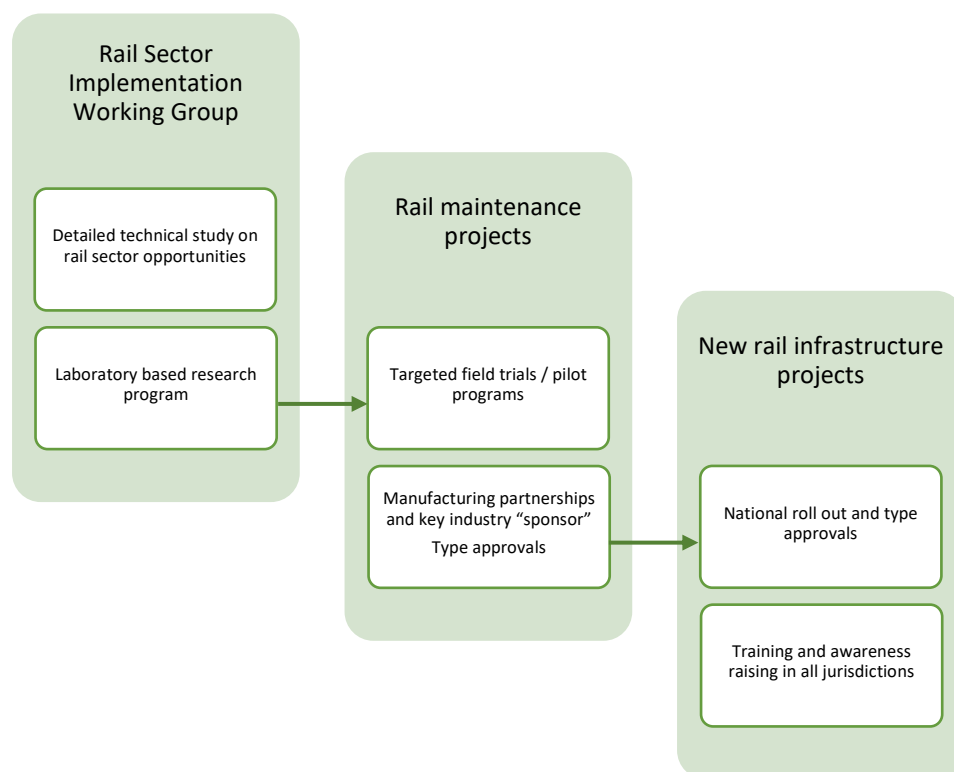
New rail construction is earmarked for considerable expenditure; however, this will be a market that is difficult to enter due to the high levels of competition and existing materials in the sector. Rail maintenance therefore may offer a viable entry point for new products and applications of TDPs.

⁷⁷ ICN 2014. '[Advancing the Australian Rail Industry](#)' *Industry Capability Network*

Maintenance programs and minor upgrade works on replaceable infrastructure (such as ballast and rail sleepers) is a common part of rail sector expenditure. These smaller programs of work could be an ideal scenario to introduce and test TDPs in the sector. Controlled field trials at this level can also be effective, when combined with research and performance evaluation, in giving the market the required information to allow uptake in other jurisdictions.

A market entry strategy for the rail sector should therefore consider both new rail infrastructure and entry points into the rail maintenance market. A potential rail market entry strategy that could be based around early adoption in rail maintenance programs is presented in Figure 36.

Figure 36 Potential rail market entry strategy



12 Opportunities for TDPs in civil engineering applications (non-structural)

12.1 Overview

Civil engineering is a broad church, essentially incorporating the design, construction and maintenance of the built environment, from buildings to dams to roads and bridges. The analysis undertaken in the Strategy has already examined road and rail construction as civil engineering sub-categories, and REC has already explored the issues with use of rubberised concrete in structural engineering. The analysis in this section will therefore focus on use of TDPs in non-structural civil engineering, including:

- coastal management (such as reefs, storm barriers, coastal protection)
- geotechnical applications (such as subbase, embankment fill, mining sector applications)
- environmental engineering (such as use in landfills)
- water resources (including hydrology, dams, pipelines, water supply networks).

12.2 Civil engineering market in Australia

Despite strong investment in transport infrastructure, the overall civil construction market has fallen considerably in recent years due to the slowdown in the resources sector, completion of major liquid natural gas (LNG) projects and changes in the political landscape⁷⁸.

Of most relevance to this Strategy is the heavy and civil engineering construction sector which represents some \$68 billion in revenue and employs more than 150,000 people⁷⁹. This market segment has fallen around 6% over the past 5 years⁸⁰.

Data from the Australian Industry Group presented in Figure 37, suggests that rail, telecommunications, roads, water resources (sewage, draining and water storage) and pipelines are key growth markets moving forward. Conversely, the data indicates a significant drop in expenditure on mining, electricity and gas supply and oil refineries over coming years⁸¹.

It is important when considering opportunities for TDPs in civil engineering that general market trends and projections are considered to leverage positive market conditions wherever possible.

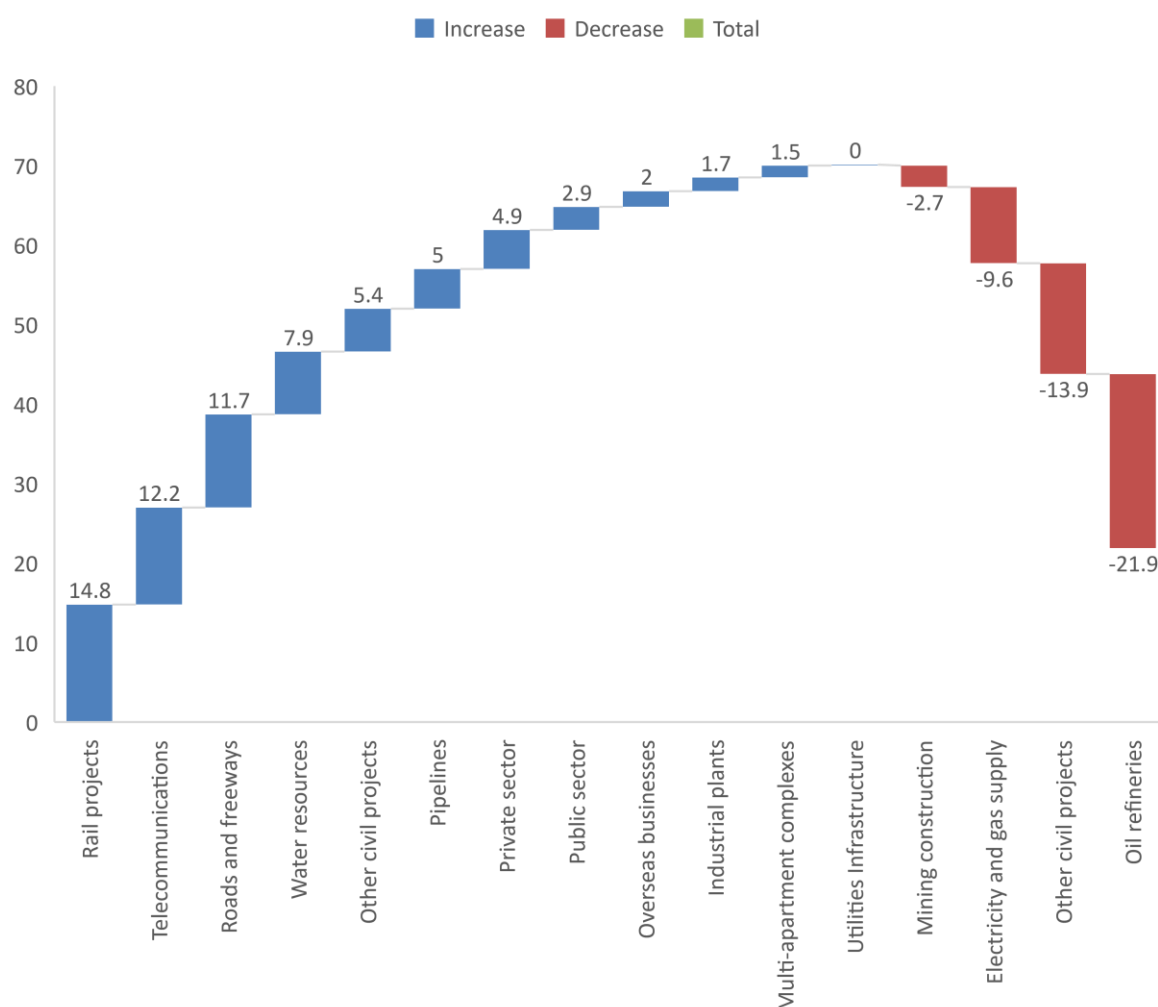
⁷⁸ BCI 2015. '[Prospering in a slowing economy: Australian construction outlook 2015-16](#)' BCI Economics

⁷⁹ ABS 2013. '[8772.0 - Private Sector Construction Industry, Australia, 2011-12](#)'

⁸⁰ IBIS World 2017. '[Heavy Industry and Other Non-Building Construction in Australia](#)', IBIS World 2017

⁸¹ AI Group 2016. '[Construction Outlook](#)' June 2016. Australian Industry Group and Australian Contractors Association

Figure 37 Civil construction outlook data⁸²



12.3 Current state of the market for TDPs in the civil engineering sector

Despite considerable opportunities for TDPs in non-structural civil engineering, current use in the market is restricted to two applications for whole tyres, EcoFlex and C4M. EcoFlex is a system of truck casings with the sidewall removed and laid horizontally for stabilisation of ground works, or vertically in a honeycomb pattern for retaining walls. The system has been approved for use in temporary applications in NSW (under the beneficial reuse approval), for example service roads or temporary hardstands (such as crane pads at construction sites).

The C4M wall system utilises a tyre bale encased in concrete as a retaining wall, impact barrier or insulated wall. It has been used in several construction projects in WA.

As has been identified earlier in this Strategy, there are several opportunities for TDPs in the civil engineering space that have led to significant consumption of EOLTs internationally and these are explored in Table 28. In the US, civil engineering applications for TDA consumes around 75 million EPU per annum⁸³.

⁸² Data taken from AI Group 2016

⁸³ Wikipedia. '[Waste Tyres](#)'

Table 28 Overview of current and potential applications for TDPs in non-structural civil engineering

Product / application	Overview
<i>Retaining walls</i>	Whole tyres used as a retaining wall system, either filled with compacted rock or soil or baled and encased in concrete. This approach has also been used in coastal areas as beach stabilisation or shore protection.
<i>Subbase stabilisation</i>	Whole tyres used as ground stabilisation on poor soils prone to subsidence. The tyres work to keep rock and soil from spreading, thus reducing subsidence and cracking.
<i>Artificial reefs</i>	Whole tyres have been used as artificial reefs in many parts of the world. An artificial reef seeks to encourage fish and marine creatures into an area to build local ecosystems, for protection of existing ocean floor and / or to encourage tourism.
<i>Lightweight embankment fill and backfill</i>	Particularly in the US, tyre-derived aggregate used widely as lightweight fill in embankments (commonly road embankments) and as retaining wall backfill. TDA has considerable advantages, being lighter and improving drainage significantly over soil.
<i>Landfill drainage aggregate</i>	TDA is commonly used internationally as drainage aggregate in landfills. Whilst a thicker draining layer is required when using TDA (to account for compression), over time the airspace is recovered as the TDA settles with the weight of waste on top of it. Use of TDA improves drainage for leachate collection and facilitates more effective landfill gas capture systems.
<i>Landfill daily cover</i>	TDA can also be used in a landfill as daily cover, a layer of material placed over the live tipping face to avoid excessive odour from oxidation. CalRecycle for example lists TDA as one of 11 options for alternate daily cover ⁸⁴ .

These applications are explored further in the commentary below.

12.3.1 Retaining walls

Use of whole tyres in construction of retaining walls is common, typically with tyres stacked in rows and filled with dirt or crushed rock. In Australia, the C4M system developed in WA uses compressed tyre bales encased in concrete to form a strong and durable retaining wall system, which has the added benefits on noise reduction due to the tyre rubber.

Care must be taken in these applications to ensure that the wall is not prone to collapse during high rain or flood events. Tyres were used in Australia as erosion control in the 1970s – 80s, particularly in regional areas. However, they became mobile in flood conditions leading to significant damage and clean-up costs and are no longer recommended for use as erosion control.

⁸⁴ CalRecycle. [‘Daily/Intermediate Cover and Alternative Daily/Intermediate Cover Guidelines’](#) CalRecycle

12.3.2 Subbase stabilisation

Whole tyres with the sidewall removed have been successfully used as medium for subbase stabilisation. When new infrastructure works are undertaken on areas of poor soil strength, there is an inherent risk of subsidence which can lead to movement and cracking (for example of a road surface). Tyres are laid on their side in a matrix pattern and filled with crushed rock and/or soil. The structure of the tyres stops lateral movement and allows the area to be more effectively built upon.

In Australia, the EcoFlex system, which can be seen in Figure 38, is a good example of EOLTs being used in civil engineering as subbase stabilisation.



Figure 38 Example of tyres being used in subbase stabilisation⁸⁵

12.3.3 Artificial reefs

Use of EOLTs as artificial reefs involves the deliberate sinking of tyres, generally bound together with wire or similar, with the intent that overtime the tyres act as habitats for fish and plants. There are reportedly more than 1,000 of these reefs around the world, mostly off the coasts of North America, Israel, Japan and Malaysia⁸⁶. This approach has been used with discarded vessels which can then also act as diving attractions for tourism.

However, tyres have proven to be 40% less effective in supporting colonisation than reefs made from concrete⁸⁷. In addition, tyres have come loose in flooding events and moved considerable distances causing further costs and issues. Similarly, a high profile artificial reef in Florida failed dramatically when some 700,000 tyres, held together with nylon and steel failed leading to significant pollution and more than \$2 million in clean-up costs⁸⁸. Due to these risks, REC has not explored this application further in the Strategy.

12.3.4 Lightweight embankment fill

Large construction projects use significant amounts of fill, mostly in the form of soil, on embankments, bridge abutments and behind retaining walls. Soil is dense and when saturated becomes extremely heavy, putting pressure on these structures and leading to subsidence in areas where infrastructure is developed on poor soil.

In the 1990s, the use of lightweight fill expanded rapidly. This process replaces a proportion of the soil with a strong, lightweight material typically in the form of expanded polystyrene blocks⁸⁹. TDA has been found to be an effective medium for lightweight fill due to its physical properties. It is relatively lightweight, produces about half of the pressure on walls as soil, absorbs vibration, has a

⁸⁵ EcoFlex 2008. 'Case Study: Tully Alliance' *EcoFlex Australia Pty Ltd* provided by Jim Grant

⁸⁶ Phys Org 2015. ['France hits reverse on sinking tyres for artificial reefs'](#) *Phys Org* May 22, 2015.

⁸⁷ Phys Org 2015.

⁸⁸ Guardian 2015. ['Florida retrieving 700,000 tires after failed bid to create artificial reef'](#) *The Guardian*, May 2015

⁸⁹ Raid et al, 2004. ['Design of lightweight fills for road embankments on Boston's central artery tunnel project'](#). *Proceedings: Fifth International Conference on Case Histories in Geotechnical Engineering*, NY, April 13-17, 2004. Paper no 8.07.

high permeability and perhaps most importantly can significantly reduce construction costs⁹⁰. Use of TDA in these applications has the potential to consume significant volumes of EOLTs, on the proviso that suitable testing and specification work is undertaken to support it.

12.3.5 Landfill drainage aggregate

The use of shredded tyres (TDA) as lightweight aggregate in landfill leachate collection and gas capture systems is common in North America as a means of improving drainage and providing new markets for EOLTs. For instance, in Alberta, Canada, some 30 municipalities have employing this application consuming more than 40 million tyres across 74 landfill cells⁹¹. The use of TDA as drainage aggregate has an estimated cost saving of around \$30/t over conventional aggregate⁹².

Quality control and use of technical specifications is essential to manage the key risks of using TDA as landfill drainage, most notably the risk associated with puncturing geomembrane liners and the potential for clogging.

12.3.6 Landfill daily cover

In addition to its use as drainage medium, TDA can also be used in landfills as daily cover. It is reported that TDA can be applied in relatively thin layers and use less volume compared to sand or soil, therefore increasing the working volume of the landfill cell⁹³.

12.4 Experience in use of TDA in civil engineering from North America

Given the lack of existing precedent in Australia for use of TDA in civil engineering works, it is worth considering the experience in North America, where these applications have been essential in dealing with tens of millions of legacy stockpiled tyres.

Consultation with Dana Humphrey, Professor of Civil Engineering, University of Maine, suggests that work undertaken in Arizona, California and Maine (along with several other states) in the 1990s provided the drive and framework for rapid and significant uptake of TDPs. This came in response to significant tyre fires in the 1980s, one of which burnt for some 9 months⁹⁴.

Central to developing new markets for TDPs in North America over the past two decades has been three key factors:

- Introduction of point of sale consumer levies which go directly to tyre recycling programs (39 of the 50 US states have a levy of typically \$1 - \$2 per tyre and all Canadian provinces have some form of product stewardship scheme in place).
- Development of stronger regulation for the management of EOLTs.
- Early stage research and development of standards and specifications.
- Intervention by government on either or both the supply side and demand side.

These factors have all been important in development of markets for TDA in civil engineering applications. In Maine for example, a Recycling Assistance Fee (currently \$1 per tyre) was introduced

⁹⁰ Humphrey ~2005. [‘Tire Derived Aggregate – A New Road Building Material’](#), D. N. Humphrey, Malcolm Long Professor of Civil Engineering, University of Maine, Orono, Maine, USA

⁹¹ ARMA ~2010. [‘Technical Bulletin: Examining the safety and effectiveness of tyre derived aggregate for use in leachate systems’](#). Alberta Recycling Management Authority

⁹² ARMA ~2010.

⁹³ IRC (undated). [‘Landfill Construction Applications’](#) Industrial Resources Council Fact Sheet

⁹⁴ Winchester, Virginia tyre fire

in 1990 as a means of supporting recycling initiatives, supported by stronger regulations on the storage, transportation and handling of EOLTs. This was followed by an extensive program of laboratory testing and field trials, for example testing on use of TDA in civil engineering applications, to provide the necessary support and guidance for use of TDPs.

According to Dr Humphrey, this alone was not enough to drive the market to act and further intervention on both the supply side and the demand side was required. The Maine Department of Transportation (DOT) and Department of Environmental Protection (DEP) entered a partnership whereby a guarantee to purchase TDA for civil works at the standard market rate was given by DOT for road infrastructure projects. DEP then worked with the recycling market to produce TDA at the required volumes and quality to meet these contract needs.

This approach was successful not only at building markets for current EOLTs, but in addressing legacy stockpile issues with some 14.5 million stockpiled tyres remediated since 1996. It must however be noted that funding was provided to bridge the deficit between the market price paid by DOT and the cost to supply the TDA from stockpiled sites with a cost to government of some USD\$12 million over the remediation program.

12.5 Key Barriers

As this market is emerging in Australia, the barriers are likely to be technical in nature, specifically the lack of testing, evidence and supporting standards and specifications. Whilst there is a significant amount of information from international markets, this will need to be translated into the Australian context.

In addition, tyres are compressible and this should be considered in any applications for TDA in civil engineering. For example, evidence in Canada suggests that TDA will compress by around 50% under 50 metres of waste in a landfill cell. Specifications and testing for use should consider these issues from the outset.

There is also a significant issue of perception, one which has been evident throughout the consultation for this Strategy. Whilst the use of TDPs in civil engineering has been a considerable success in the US, in Australia some of these applications may be considered sanctioned dumping. Therefore, state and territory governments and TSA should proceed with a clear strategy to ensure these perceptions can be managed from the outset. A focus on value-added TDPs and the use of specifications and guidelines should underpin this strategy.

With regard to addressing legacy stockpiling issues, the negative value of discarded EOLTs must be recognised as a critical barrier. The North American example shows a program across many states that has successfully mitigated millions of stockpiled EOLTs. However, in each and every instance encountered in developing this Strategy there was some form of economic support provided, either through a benefit – subsidy scheme or through government assisted procurement or both.

PART 3 – OPTIONS FOR STRATEGY IMPLEMENTATION

Overview of Part 3 – Options for Strategy Implementation

Part 3 of the strategy (presented in Figure 39) provides the basis for a future 5-year implementation plan for the Strategy. It gives an overview of the types of options and strategies for addressing EOLT market challenges including how these apply to immature and mature markets alike.

At SV's request the draft 5-year implementation plan has been provided in a separate document titled ***National market development strategy for used tyres – Draft implementation plan***. It is envisaged that a final implementation plan will be released along with the broader Strategy document when the implementation actions have been endorsed and responsibility assigned to the appropriate lead and support organisations.

This Strategy should be read in conjunction with the draft implementation plan.

Figure 39 – Structure and overview of Part 3 of the Strategy

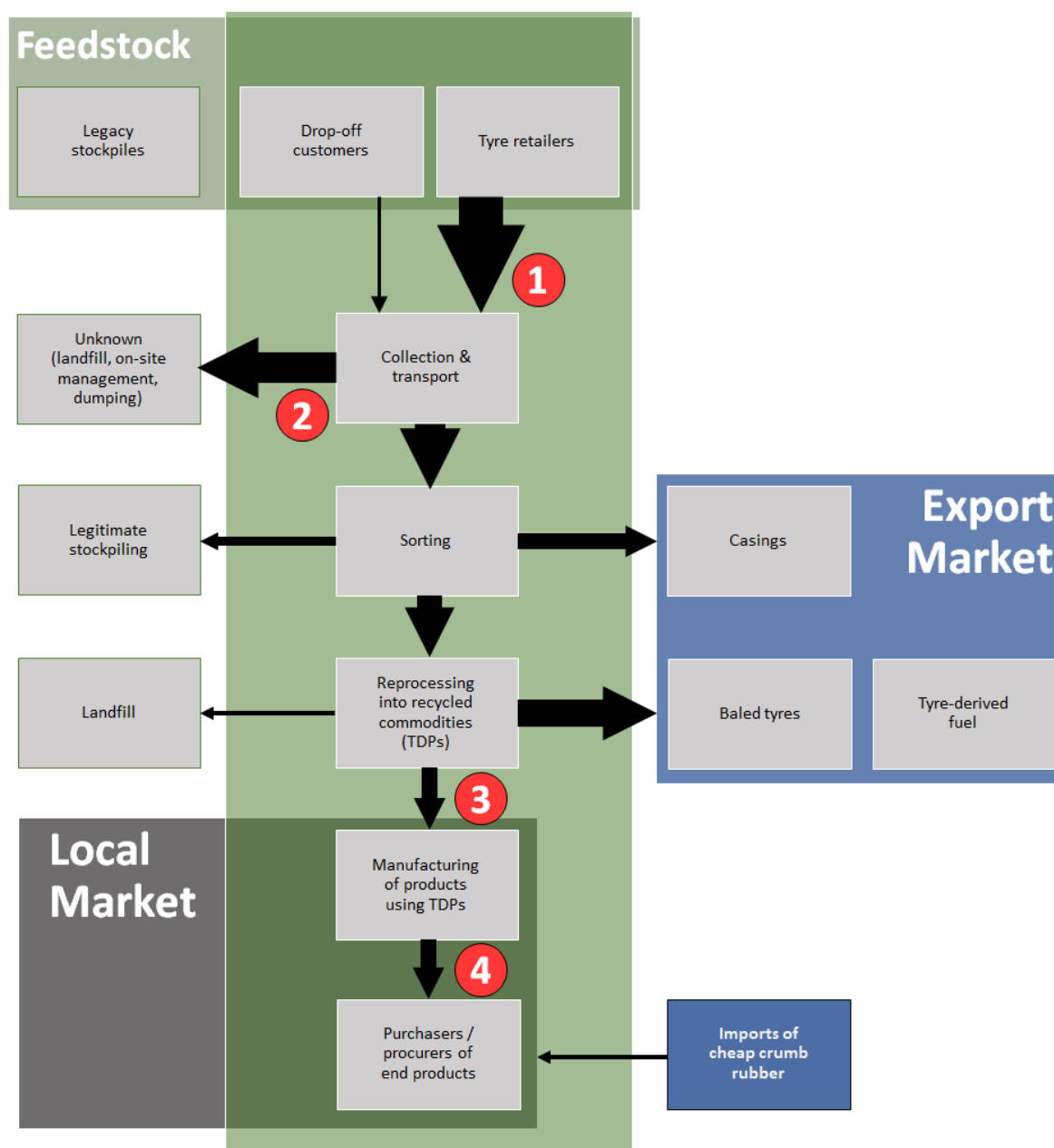


13 Key transaction and intervention points in the TDP product chain

Recycled products such as TDPs face significant barriers in when entering new markets. Some barriers may be product related (for example a lack of adequate testing), some may be sector related (for example procurement processes or approvals gateways) and others market related (for example market failure).

The options and strategies for addressing these challenges will depend on the nature of the problem and the intervention points within the product chain, which is presented in Figure 40.

Figure 40 Overview of the TDP product chain showing key transaction points



The types of options and strategies for addressing market issues at the various transaction points mapped in Figure 40 are explored in Table 29.

Table 29 Options and strategies for addressing market issues at key transaction points in the TDP product chain

Trans- action Point	Strategies for improving outcomes	Possible interventions
1	The key transaction point in the upstream market occurs at the point that a tyre retailer pays a tyre collector to pick up used tyres. The market for TDPs essentially begins at this point as this material will ultimately become the feedstock for those products. The upstream market has a considerable impact on the condition of end markets for TDPs. Price undercutting by “rogue” operators undermines the overall business case for producing high-value TDPs, driving many collectors toward the cheaper and easier export markets for TDF and baled tyres. Strategies for improving outcomes at this end of the market are likely to be based around regulation and consumer education; the former aiming to keep operators on a level playing field, and the latter aiming to use consumer sentiment to encourage greater materials recycling. Industry may also seek to improve consolidation and economies of scale to minimise costs.	▪ Regulations ▪ Product stewardship ▪ Licensing ▪ Waste tracking ▪ Consumer education campaigns ▪ Consolidation
2	The data presented in this Strategy suggests that the destination of a significant amount of EOLTs is still unknown, including material sent to landfill, managed on-site and illegally dumped or stockpiled. There is a key transaction point at this stage of the product chain that influences the degree to which EOLT material is channelled into materials recycling, versus other less productive fates. Details around this remain largely unknown, for example whether material is moving straight from a retailer to an unknown fate or whether there is a secondary step in between. Changing these market behaviours is likely to require significant intervention, for example regulation or market based instruments that discourage landfilling / dumping and/or encourage resource recovery. This transaction point is specifically targeted in benefit-subsidy product stewardship schemes where the levy is refunded only at the point where an EOLT reaches a legitimate recycling facility.	▪ Regulatory / co-regulatory product stewardship ▪ Landfill levies ▪ Regulations ▪ Subsidy / refund schemes (such as container deposit schemes)

3	The commoditisation of TDPs occurs at the last point of the reprocessing chain where products such as TDP, crumb and granule are sold as bulk commodities into an end use market. The push-pull relationship that is common to waste commodities occurs here, with reprocessors keen to get volume into the market to make way for new feedstock coming in upstream. Key strategies for improving outcomes for TDPs at this stage of the product chain are likely to focus on efficiency, capacity, quality, consistency and scale. The sector needs to be able to produce high-quality commodities at scale to meet market demand and this requires suitable capacity in infrastructure. Strategies at this point should also consider the degree to which TDPs can be classed as products in their own right rather than waste materials as product stockpiling is often required to meet large scale project orders.	▪ Industry benchmarks ▪ Codes of practice ▪ Guidelines ▪ Product specifications ▪ Quality testing ▪ Infrastructure funding and investment ▪ End-of-waste criteria
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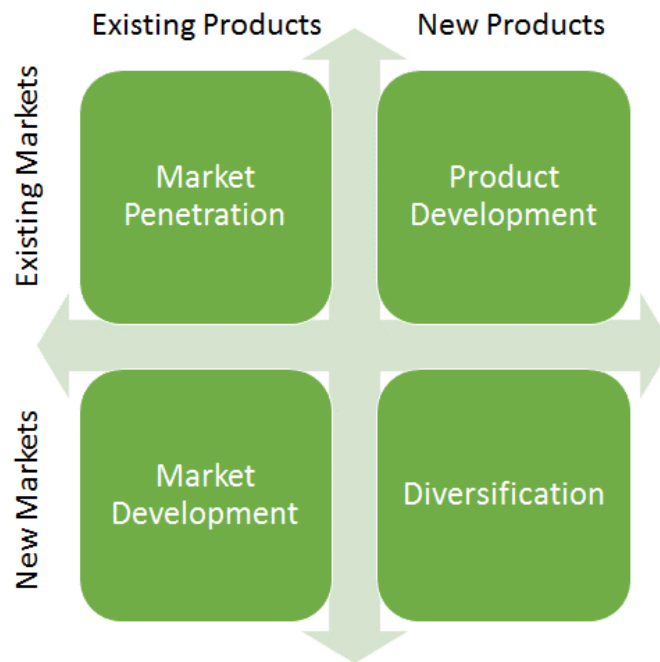
4	Finally, commoditised products are purchased (generally in bulk) and used as raw inputs into manufactured products such as road surfaces, adhesives, rubber products and fuels. From a market development perspective, this point of the product chain is where most strategies are likely to be targeted, focusing on removing barriers and overcoming market failures. TDPs need to compete against a range of existing products, therefore strategies should focus on performance, cost (and lifecycle cost if relevant) and marketing. The point of applying these strategies needs to consider how and when procurement decisions are made and by whom. Market maturity is another important factor as marketing should be tailored to deliver general product and brand awareness, costs and benefits.	▪ Standards ▪ Specifications ▪ Product testing ▪ Product trials ▪ Research ▪ Patents and licensing ▪ Procurement support ▪ Marketing ▪ Advertising ▪ Education / awareness ▪ Training
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The analysis presented above suggests there are a range of interventions that can be deployed by government, either in isolation or working closely with industry, to affect change in the market for TDPs. In some instances, it may be prudent to target single barriers at a single transaction point, however in others it is likely that a broader program of works will be required which targets multiple transaction points in the one TDP market.

13.1 Stages for market development and maturity

When considering opportunities for market development, which are presented in detail in the following section, it is also useful to consider the product-market growth matrix, which is presented in Figure 41.

Figure 41 Product-market growth matrix⁹⁵



The matrix essentially represents the different types of strategies used for developing markets, depending on the maturity of products and the target markets. The matrix can be described as follows:

- Market penetration – Increasing the market share of TDPs within existing markets, for example getting greater uptake of crumb rubber tile adhesives. Key strategies for market penetration include advertising and promotion, price cutting, product improvements and acquisition of rival products.
- Market development – Extending the use of current TDPs into new markets, for example encouraging local cement kilns to use TDF. This can be achieved by looking at new jurisdictions and targeting different customer segments.
- Product development – Developing new TDPs for existing markets, such as new blends of crumb rubber asphalt. This is heavily dependent on research and development and often requires investment in new processing or manufacturing infrastructure.
- Diversification – Development new TDPs for new markets, such as products for the rail sector. This is a difficult strategy and may require commercial partnerships, development of new intellectual property or business acquisition.

Consideration has been given to the stages of the product-market growth matrix when developing the Strategy and its recommended actions.

⁹⁵ Ansoff, 1957. 'Strategies for Diversification', *Harvard Business Review*, Vol 35, Issue 5, 1957 pp113-124

APPENDIX 1 – DETAILED OVERVIEW OF SPECIFICATIONS

14 Detailed overview of specifications

14.1 Bitumen crumb rubber asphalt and crumb rubber modified spray seals

The market for crumb rubber in road construction remains one of Australia's largest domestic channels for TDP. Only Victoria and NSW have dedicated specifications for crumb rubber products, however several other states have inclusions for BCRA and rubber modified spray seal in general specifications for surfacing.

The following provides a high-level review of relevant specifications in road surfacing. Further detail on specifications for road construction will be provided in the sector specific analysis.

Jurisdiction	Dedicated Specification	Details
International		ASTM D6114 / D6114M Standard Specification for Asphalt-Rubber Binder provides a standard approach to crumb rubber asphalt recommending a minimum 15% of rubber by weight of the total blend
National		Austrroads Specification Framework for Polymer Modified Binders outlines the requirements for polymer modified binders, including crumb rubber, in BCRA and rubber modified spray seal applications.
Victoria		Section 421 Bitumen Crumb Rubber Asphalt and Code of Practice RC500.01 set allowances and provisions for use of crumb rubber asphalt in Victoria. Bituminous Sprayed Surface Manual and Technical Note TN14 provide guidelines and requirements for rubber modified spray seals.
Queensland		No dedicated specifications, however the following general specifications refer to crumb rubber: Technical Specification MRTS 11 – Sprayed Bituminous Surfacing provides guidance and procedures for use of crumb rubber binder in spray seals Technical Specification MRTS18 - Polymer Modified Binder provides guidance and requirements for use of crumb rubber binder in BCRA
NSW		Specification R118 Crumb Rubber Asphalt provides a dedicated specification for use of BCRA. Specification R107 Sprayed Bituminous Surfacing provides guidance for use of polymer modified binders including rubber modified spray seals.
WA		No dedicated specifications, however the following general specifications refer to crumb rubber: Specification 511 – Materials for Bituminous Treatments provides some information related to crumb rubber treatments for bitumen products such as BCRA and rubber modified spray seals.
SA		No dedicated specifications, however the following general specifications refer to crumb rubber: Part R25 Supply of Bituminous Materials and Part R26 Guidelines provide guidance on the blending and application of crumb rubber binders for asphalt and spray seal.
NT		No dedicated specifications, however the following general specifications refer to crumb rubber: Spray Seal Surfacing – Selection of Binder Type and Standard Specification for Roadworks contain some requirements and details regarding use of crumb rubber binders.
Tasmania		No dedicated specifications, however the following general specifications refer to crumb rubber:

		Sprayed Bituminous Surfacing and Guidance Notes for Bituminous Surfacing Specifications provide broad guidelines for road construction, including use of crumb rubber binders.
ACT		No dedicated specifications, however the following general specifications refer to crumb rubber: ACT Trunk Road Infrastructure Technical Specification No. 04 – Flexible Pavement

14.2 Tyre-derived fuel

At present the market for Australia TDF is entirely export based. There are no national or state-based specifications for domestic TDF use, however NSW lists EOLTs in the Eligible Waste Fuels Guidelines as an eligible waste fuel when used in an approved cement kiln and are permitted to be accepted at energy recovery facilities once approved and in operation. Specific energy from waste policies at state level are explored in the state-by-state market overviews in the following sections of the Strategy. Several these policies support the recovery of energy from end-of-life tyres where other options for recycling and reuse have been proven unviable.

The following standards and specifications are relevant for tyre-derived fuel exports; however, it should be noted that this analysis does not include emissions standards from the consumption of TDF or other fuels in thermal facilities.

Jurisdiction	Dedicated Specification	Details
International		None. In general, each customer sets their own specifications for size, quality and contamination rates. ASTM International has a Standard Practice for Use of Scrap Tyre-derived Fuel (ASTM D6700) which provides guidance for the use of TDF, however this is not a mandated specification.
National		None
USA		The Rubber Manufacturers Association is an industry association for rubber manufactures and has developed TDF-003 Using tire shreds as tire-derived fuel along with a series of other documents and guidance notes.
Malaysia		None
Korea		None
India		None

14.3 Baled tyre exports

The export of whole baled tyres is becoming increasingly common from Australia as margins for TDF have reduced. In general, baled tyres are further processed into shred or crumb rubber for use in cement kilns or pyrolysis facilities primarily in Korea and India.

There do not appear to be any specific standards relating to baled tyres.

14.4 Tyre-derived aggregate

There is limited current use of TDA in Australia, however it is extremely common internationally, particularly in North America where a program of work to push TDA into civil engineering applications has significantly reduced legacy stockpiles.

Whilst there appear to be no existing specifications in Australia, there are several international examples that could be used in the development of local specifications. The following key standards and specifications are relevant for TDA:

Jurisdiction	Dedicated Specification	Details
International		ASTM D6270 Standard Practice for Use of Scrap Tyres in Civil Engineering Applications is an international standard that provides guidance on the use of scarp tyres as TDA for embankment fill, drainage medium and backfill.
National		None
USA		There are state level specifications in place for TDA use. For example, in California, CalRecycle has developed specifications for two types of TDA based on size classifications and use.

14.5 Explosives

The use of crumb rubber in explosives is an emerging area, however the potential for significant uptake of TDF indicates this is an area of potential future growth. The industry is heavily regulated due to the inherent safety risks associated with blasting activities. In many instances, the requirements for explosives composition is included within the requirement OHS or dangerous goods regulations.

However, unlike other areas where TDPs are used there appears to be little information available about specification related to the composition of explosives, particularly the degree to which crumb rubber may be used. It is likely that regulation in this area is defined more by proven safety and performance and further investigation on specifications may be required as part of the sectoral analysis.

The following key standards and specifications are relevant for the explosives market:

Jurisdiction	Dedicated Specification	Details
International		None
National		Australia is currently developing standard regulations for explosives through Safe Work Australia. A decision regulatory impact statement has been recently released.
Victoria		All explosives manufactured or imported into Victoria must be authorised by Worksafe under the Dangerous Goods (Explosives) Regulations 2011 which set out the requirements for management of explosives.
Queensland		Explosives must be approved by the Chief Inspector of Explosives under the Explosives Act 1999 . The Department of Mines and Energy has published Guidance Note QGN10 Handling explosives in surface

		mines and quarries bringing together requirements from health and safety regulations. In addition, Transport and Main Roads Specifications MRTS55 Use of Explosives in Roadworks exists for road blasting.
NSW		The Explosives Act 2003 (NSW) and Explosives Regulation 2013 set the requirements for the authorisation, handling and storage of explosives.
WA		An Explosives Manufacture (MPU) License is required under the Dangerous Goods Safety (Explosives) Regulations 2007 and the Explosives and Dangerous Goods (Explosives) Regulations 1963
SA		The Explosives Act 1936 and Explosives Regulations 2011 set out requirements for manufacture and storage and handling of explosives.
NT		The Dangerous Goods Act 2012 and Dangerous Goods Regulations 2015 stipulate that all explosives must be approved by NT Worksafe prior to import, manufacture or use.
Tasmania		The Explosives Regulations 2012 requires authorisation of explosives prior to import or use in Tasmania.
ACT		Anyone involved in the storage, transport or use of explosives must be licensed under the Dangerous Substances (Explosives) Regulations 2004 .

14.6 Surfacing and soft fall matting

There are several potential applications for crumb rubber and granule / buffings in surfacing. The current Australian Standard is the predominant specification applied to many products using rubber in surfacing and soft fall matting.

The following specifications are related to the most common applications in Australia.

Jurisdiction	Dedicated Specification	Details
International		ASTM International has developed the Standard Specification for Loose-Fill Rubber for Use as a Playground Safety Surface under and around Playground Equipment
National		AS/NZS 4422:1996 Playground surfacing - Specifications, requirements and test method sets out the safety and performance requirements for playground surfacing AS/NZS 4288 – Soft underlays for textile floor coverings sets out requirements for carpet underlay

14.7 Civil engineering (whole tyres)

The use of TDP in civil engineering will be explored in detail in the sectoral analysis for road and rail construction. The following standards and specifications are relevant to the use of whole tyres in civil works such as retaining walls, artificial reefs and ground stabilisation.

Jurisdiction	Dedicated Specification	Details
International		ASTM D6270 Standard Practice for Use of Scrap Tyres in Civil Engineering Applications is an international standard that provides guidance on the use of whole tyres in civil engineering applications such as culverts and retaining walls.

National		AS3600 – Concrete structures and AS4678 Earth retaining structures provide requirements for strength, durability, construction and performance. These are not specific to the use of TDPs.
NSW		NSW has a resource recovery exemption and order in place for EOLTs (2014) that allows their use in civil engineering structures and road making activities. The order and exemption includes acceptable chemical attributes and uses, which cannot be below the water table.

14.8 Fuel oil

There are several standards and specifications related to fuel in Australia, along with a well-established international convention on fuel tyres and purity.

The following relates to relevant standards and specifications for pyrolysis fuel oil and its derivatives.

Jurisdiction	Dedicated Specification	Details
International		International standard ISO8217 Bunker fuel standard sets international requirements for ship oil quality and grading, including maximum sulphur levels.
National		The Fuel Quality Standards Act 2000 and the Fuel Quality Standards Regulations 2001 set the framework for fuel quality in Australia, including bunk oil and distillate variations.

14.9 Carbon black

Carbon black is a globally traded commodity. The following specifications relate to carbon black for use in tyre manufacture and as a colour pigment.

Jurisdiction	Dedicated Specification	Details
International		ISO23900 – Pigments and extenders provides an international standard for use of pigments including carbon black. ATSM D1765 Standard Classification System for Carbon Blacks Used in Rubber Products provides an international standard for rubber grade carbon black. In markets for colour pigment, ASTM D561 - 82(2014) Standard Specification for Carbon Black Pigment for Paint specifies performance and colour standards for pigment use. In addition, the International Colour Index is a globally recognised colour classification system which includes requirements for carbon black (PBK-7). However, as carbon black is organic and therefore not permanent, there are some specifications that restrict its use, including ASTM E979 - Standard Specification for Pigments for Making Integrally Coloured Concrete .
National		AS/NZS 2642.1:1994 - Polybutylene pipe systems and AS/NZS 4131:2003 Polyethylene (PE) compounds for pressure pipes and fittings provides requirements for the quality of carbon black in plastics

APPENDIX 2 – EOLT MARKETS FOR EACH STATE AND TERRITORY

15 Victoria

15.1 2015-16 market overview

Victoria by numbers

Population

6,068,000

Size

227,416 km²

Consumption

127,000 tonnes

15,875,000 EPUs

In-use

181,000 tonnes

22,625,000 EPUs

EOLT Generation

107,700 tonnes

13,463,000 EPUs



Melbourne is a key hub for the Australian tyre recycling industry with two of the country's largest producers of crumb rubber and rubber granule based to the north of the city. In addition, there are three other tyre recyclers collecting and processing considerable volumes of baled tyres and TDF for export.

In 2014, the Victorian Government released its new waste policy Getting Full Value, which has a strong focus on market development for waste-derived materials. The EOLT market has benefited from this focus through market development and infrastructure investment by Sustainability Victoria. SV has successfully developed a working partnership with VicRoads and TSA to push greater volumes of crumb rubber into road construction.

However, a significant tyre fire in January 2016 saw more than 100,000 EPU's burnt in the northern suburbs making it one of Australia's largest ever tyre fires. The fire caused considerable damage to the state's second largest producer of crumb rubber and rubber granule, reducing Victoria's production of valuable TDPs.

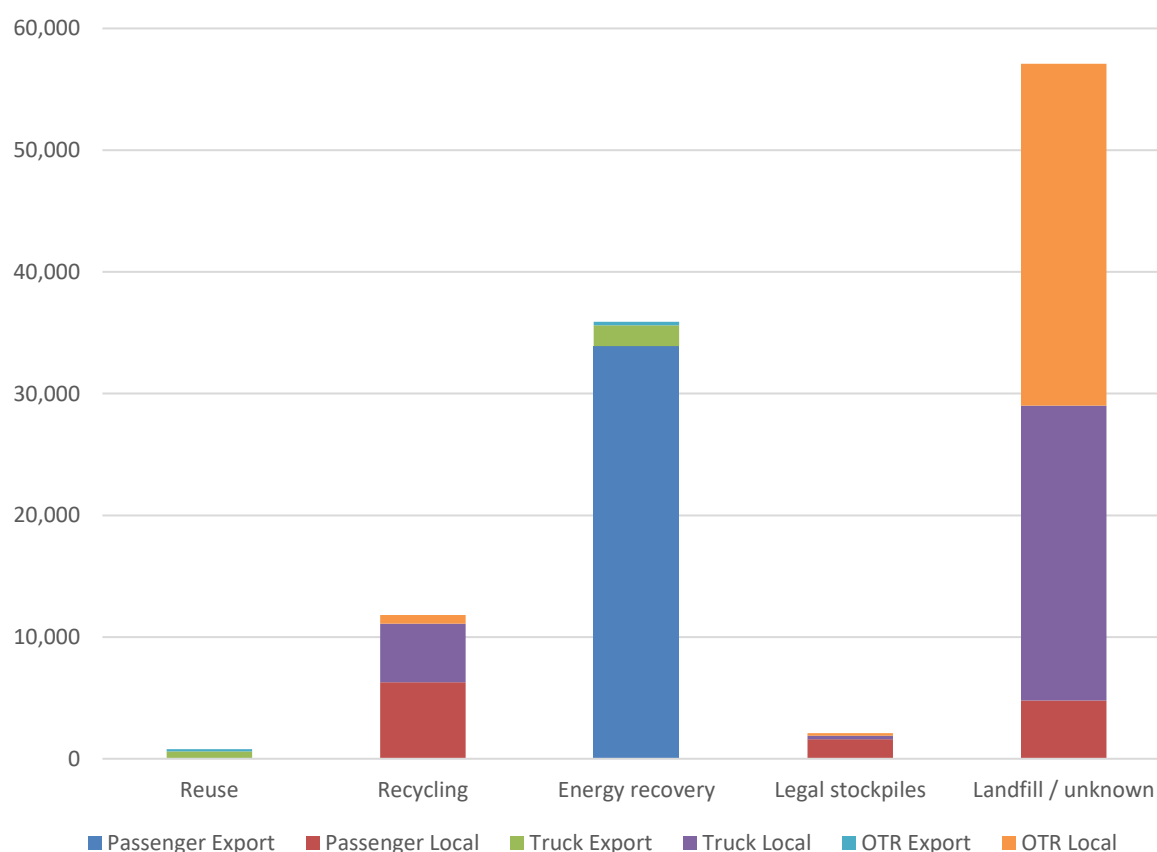
15.2 EOLT fates

The EOLT fates data indicates that Victoria generated some 107,700 tonnes (or 13.6 million EPU's) of EOLTs in 2015-16. Around 33% or 35,900 tonnes (4,487,500 EPU's) is exported for energy recovery while 53% or 57,100 tonnes (7,137,500 EPU's) is disposed to landfill or unknown fates. The data shows material recycling accounts for 5% or 6,800 tonnes (850,000 EPU's). Table 30 and Figure 42 show an overview of EOLT fates for Victorian tyres.

Table 30 Vic EOLTs fate 2015–16 (tonnes)

Fate	Passenger	Truck	OTR	Total
Reuse	0	600	200	800
Recycling	6,300	4,800	700	11,800
Energy recovery	33,900	1,700	300	35,900
Legal stockpiles	1,600	300	200	2,100
Landfill / unknown	4,800	24,200	28,100	57,100
Total	46,600	31,600	29,500	107,700

Figure 42 Vic EOLT fates 2015–16 (tonnes)



15.3 Policy and regulatory settings⁹⁶

The current policy and regulatory settings related to EOLT management in Victoria are summarised in the table below.

⁹⁶ Policy and regulatory settings for EOLTs in Australia have been well explored. REC has summarised these in state by state tables across the Strategy and these tables using information from state EPAs, Hyder Consulting 2015 and [TSAs Best Practice Guideline documents](#) by Arcadis Asia Pacific and Equilibrium OMG.

Area	Enabling Regulation ⁹⁷	Details
Tyre storage	✓	sets licensing requirements for premises that store more than 40 tonnes or 5,000 waste tyres
Transportation	✗	None
Waste tracking	✗	None
Recycling	✗	None, only required for tyre storage as outlined above
Disposal	✓	EOLTs cannot be landfilled whole, however they can be landfilled when shredded into pieces no greater than 250mm in any direction
Landfill levy	✓	EOLTs attract the landfill levy in Victoria, which is currently \$62.03/tonne in metropolitan areas and \$54.37/tonne in regional areas
Reuse	✓	Reuse options for EOLTs are limited under the Environment Protection Act with several “unacceptable” reuse options documented
Fire safety	✓	Guidelines for the safe storage of tyres indoor and outdoor have been published by the Metropolitan Fire Brigade (MFB) and Country Fire Authority (CFA)
Energy recovery	✓	Energy from Waste Guideline (Publication 1559) provides high-level guidance on the siting, design, construction and operation of energy from waste facilities, including those accepting EOLTs

15.4 Effectiveness of regulatory framework

Historically, Victoria has a poor record in managing the risks associated with EOLTs, particularly regarding illegitimate stockpiling. Significant stockpiles exist in several regional towns, including Australia’s largest known stockpile in Stawell where up to 1.4 million EPU’s exist at a site east of town⁹⁸. The introduction of new regulations on tyre storage has been driven by community concern arising from the Stawell site, and other large stockpile sites such as Numurkah and Seymour.

However, only two licenses have been issued since the introduction of new requirements the new tyre storage requirements in 2014⁹⁹. Instead, most operators have chosen to remain under the 5,000

⁹⁷ REC has provided state-by-state breakdowns of the regulatory framework for EOLTs. Our analysis provides a tick for regulation that enables the EOLT markets for recycling and recovery to function more effectively. In some instances a cross may be given despite some regulation being in place where the regulation in question does not enable the market effectively.

⁹⁸ Identifying and addressing barriers to recycling tyres at Stawell – Stage 1 report, Hyder Consulting 2016

⁹⁹ EPA Victoria press releases and website license search

EPU threshold, suggesting that whilst the new regulations may restrict large scale stockpiling, they will not significantly impact practices in the recycling industry.

In addition, the lack of requirements on transportation of EOLTs also restricts Victoria's ability to collect accurate information on the movement and fate of EOLTs in the state. Victoria is the only state that does not report interstate movement of EOLTs as part of Controlled Waste NEPM reporting.

EPA Victoria recently completed an independent review of its operation with the final report making several recommendations for reform. Central to this is a likely overhaul of the Environment Protection Act 1970 and subsequent changes to compliance and enforcement activities.

15.5 Barriers and opportunities

Melbourne is a key hub for the Australian tyre recycling industry with two of the country's largest producers of crumb rubber and rubber granule based to the north of the city. In addition, there are three other tyre recyclers collecting and processing considerable volumes of baled tyres and TDF for export.

Victoria remains a leader in the area of rubber modified sprayed seals with VicRoads internal spray seal provider, SprayLine, using a minimum of 10% crumb rubber in all its spray seals across the road network. Anecdotal evidence suggests this may increase to 20% in the coming years which offers a considerable opportunity for greater uptake of crumb rubber in Victoria¹⁰⁰. In addition, TSA has funded research at Melbourne University examining the effectiveness of crumb rubber in lightweight composite building panels for pre-fabricated construction¹⁰¹.

¹⁰⁰ Confidential pers comm during consultations

¹⁰¹ <http://www.tyrestewardship.org.au/funding/summary-of-current-projects>

16 Queensland

16.1 2015-16 market overview

Queensland by numbers

Population

4,844,500

Size

1,730,648 km²

Consumption

113,000 tonnes

14,125,000 EPU's

In-use

148,000 tonnes

18,500,000 EPU's

EOLT Generation

96,300 tonnes

12,037,500 EPU's



Queensland is the third largest market for EOLTs in Australia and is serviced by a number of medium to large-scale tyre collectors and recyclers. The Brisbane area, with its proximity to the Gold Coast and strong international port, is well-served and has typically seen lower than average market rates for collection (due to no landfill levies).

In recent years, Queensland has seen expansion of crumb rubber production and key recycler ChipTyre is leading the market development for crumb rubber explosives which may lead to a new domestic sector for TDPs.

16.2 Policy and regulatory settings

The current policy and regulatory settings related to EOLT management in Queensland are summarised in the table below.

Area	Enabling Regulation	Details
Tyre storage	✗	None
Transportation	✓	Tyres are a regulated waste under Schedule 7, Part 1 of the Environmental Protection Regulation 2008. Transportation of tyres as a regulated waste requires an approval for ERA 57 – Regulated waste transport .

Recycling	✓	Tyres are a regulated waste and tyre recyclers must obtain an ERA 59 – Tyre recycling approval (where 1,000 EPU's or more are received per annum)
Waste tracking	✓	Tyres are listed as a trackable waste in Schedule 2E of the Environmental Protection Regulation 2008. Registered regulated waste transporters must submit tracking documentation within 7 days.
Disposal	✓	EOLTs may be landfilled whole or shredded only at landfills licensed to accept tyres
Landfill levy	✗	None
Reuse	✗	None
Fire safety	✓	Fire and Rescue Service Act 1990 (Requisition 1) 2011 requires any person who stores more than 500 tyres to take steps to minimise the risk of fire, including pile size and separation distances.
Energy recovery	✗	None

16.3 Effectiveness of regulatory framework

In 2012, Queensland removed its \$35/tonne landfill levy after just seven months in operation¹⁰² and in March 2013 deregulated storage of EOLTs as part of a push to reduce “green tape”¹⁰³. This has had a significant negative impact on the tyre recycling industry, encouraging landfilling and opening the door for illegitimate operators. In 2016, a high-profile case emerged with around one million EPU's being stored across two sites in Brisbane¹⁰⁴ by an operator who had accumulated the material in less than 12 months¹⁰⁵.

The lack of storage regulations and waste tracking for EOLTs in Queensland is a concern for the industry. However, the Queensland Government is currently undertaking a review of Environmentally Regulated Activities (ERAs) and it is suggested that new requirements on tyre storage may be introduced in coming years.

16.4 EOLT fates

Queensland generated more than 96,000 tonnes (~12 million EPU's) of EOLTs in 2015-16 of which around 67% or 64,600 tonnes (~8 million EPU's) went to landfill or unknown fates. Queensland has one of the highest domestic recycling rates of any state with some 14% or 13,100 tonnes being

¹⁰² <https://www.regyp.com.au/qld-waste-levy-to-be-removed/1563/>

¹⁰³ <http://www.insidewaste.com.au/general/news/1003990/removal-tyre-storage-regulation-burns-qld-wrig>

¹⁰⁴ ABC News <http://www.abc.net.au/7.30/content/2016/s4509432.htm>

¹⁰⁵ From NearMap imagery

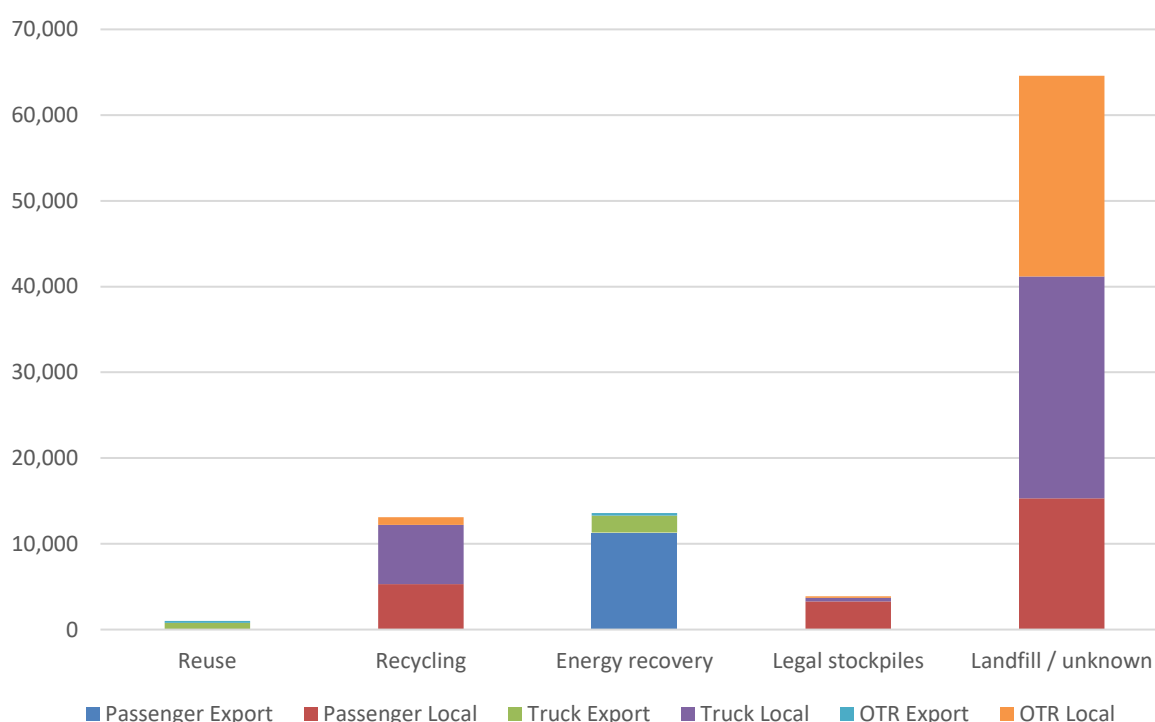
recovered for local recycling. A further 13,600 tonnes (1.7 million EPU's) is recovered for export into energy recovery markets from the Port of Brisbane.

Fates of EOLTs from QLD in 2015-16 are presented in Table 31 and Figure 43.

Table 31 Qld EOLTs fate 2015–16 (tonnes)

Fate	Passenger	Truck	OTR	Total
Reuse	0	800	200	1,000
Recycling	5,300	6,900	900	13,100
Energy recovery	11,300	2,000	300	13,600
Legal stockpiles	3,300	400	200	3,900
Landfill / unknown	15,300	25,900	23,400	64,600
Total	35,200	36,000	25,000	96,200

Figure 43 Qld EOLTs fate 2015–16 (tonnes)



16.5 Barriers and opportunities

The lack of a strong regulatory framework for the management of EOLTs remains a significant barrier in Queensland, and when combined with low landfill gate fees (no landfill levy) this significantly diminishes the business case for investment in materials recycling. Whilst the economies of scale in Brisbane and key regional centres provide incentive for recovery and reprocessing, large regional distances and persistently low collection fees mean that the recovery outside of built-up areas is low.

Queensland remains one of the largest producers of recycled rubber products through ongoing investment by A1 Rubber. New commercial and domestic products have been released in recent

years and the current focus on rubber in mining explosives may see Queensland emerge as a leader in end markets for TDPs. The import of cheap crumb rubber however is an ongoing threat to these markets with Queensland being a key target for importers.

17 Western Australia

17.1 2015-16 market overview

Western Australia by numbers

Population

2,617,200

Size

2,529,875 km²

Consumption

76,000 tonnes

9,500,000 EPU_s

In-use

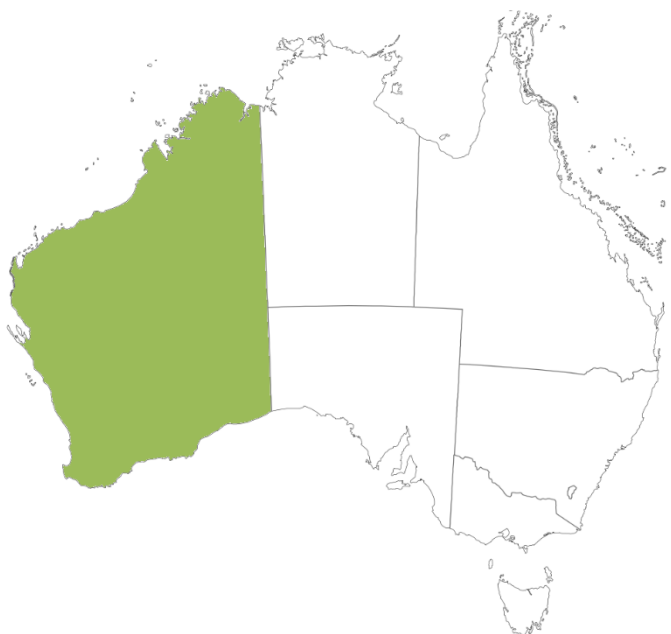
97,000 tonnes

12,125,000 EPU_s

EOLT Generation

66,500 tonnes

8,312,500 EPU_s



Western Australia, due to its isolation, tends to operate more independently than the east-coast markets. Apart from the transfer of a small number of truck tyres to Melbourne, WA relies on its own end-use markets and international exports. As there is limited capacity for producing crumb and granule products in WA, the Port of Fremantle remains a strong channel for exports of baled tyres and TDF.

There has been some shift in the WA tyre recycling market over the past 12 months. Long-term investment by Lomwest into baled tyre retaining walls (the C4M systems) has seen this technology recently licensed to BCG Precast which will likely see further uptake of this product. However, industry sources suggest that a large tyre collector based in Perth has recently ceased operation which may reduce the WA market's collection and recycling capacity.

17.2 Policy and regulatory settings

The current policy and regulatory settings related to EOLT management in WA are summarised in the table below.

Area	Enabling Regulation	Details
Tyre storage	✓	Part 6 of the WA Environment Protection Regulations 1987 stipulate that sites storing more than 100 tyres must be licensed.
Transportation	✓	Waste tyres are a controlled waste under the Environmental Protection (Controlled Waste) Regulations 2004 and as such permitting and tracking is required when EOLTs are transported from commercial premises.
Waste tracking	✓	Paper based, records must be kept for 3 years.
Recycling	✓	The WA Environment Protection Regulations 1987 set requirements for the storage, handling, transportation and disposal of EOLTs in WA. The Environment Protection Act 1986 and the Waste Avoidance and Resource Recovery Act 2007 contain provision relevant for tyre recycling.
Disposal	✓	Disposal of EOLTs is restricted within the Tyre Landfill Exclusion Zone.
Landfill levy	✓	EOLTs disposed to landfill are subject to the inert landfill levy rate which is currently \$50/tonne
Reuse	✗	No reuse options listed
Fire safety	✗	None
Energy recovery	✓	EPA WA has undertaken analysis of the environmental and human health impacts of waste to energy technologies to inform policy and regulatory decision making. The WA Waste Authority Waste to energy position statement aims to provide guidance for potential proponents and complements the Waste to energy advice under Section 16e

17.3 Effectiveness of regulatory framework

WA has a comprehensive policy framework regarding the storage and handling of EOLTs. However, the lack of specific fire safety guidelines does not give the market a strong framework for managing fire risks. In addition, the tyre storage requirements under the EP Regulations do not set an upper limit for tyre storage and there are some industrial sites in WA licensed to store significant volumes of ELTs in much larger numbers than allowed in other jurisdictions.

17.4 EOLT fates

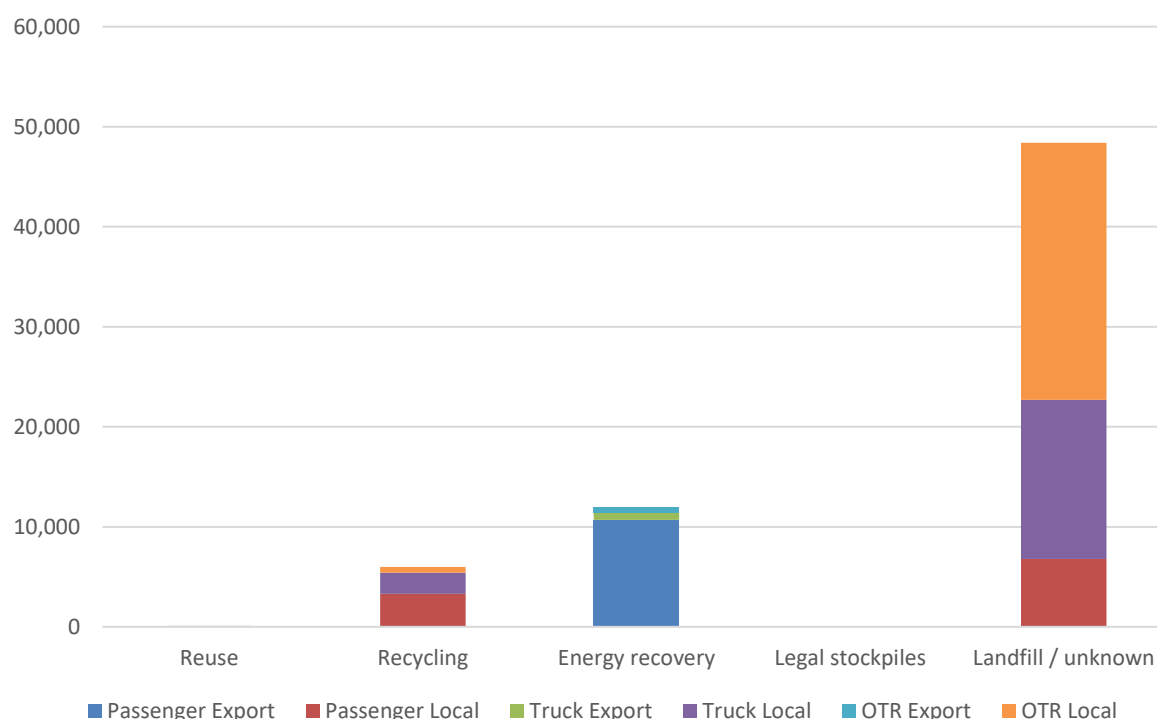
In 2015-16, WA generated more than 66,000 tonnes (~ 8.3 million EPU) of EOLTs of which around 73% or 48,400 tonnes (~6 million EPU) went to landfill or unknown fates. Materials recycling accounted for around 9% or 6,000 tonnes (~0.75 million EPU) whilst the strong pull for TDF and baled tyres saw around 18% or 11,900 tonnes (~1.5 million EPU) leave the Port of Fremantle for energy recovery markets.

A breakdown of fates for EOLTs from WA in 2015-16 is presented in Table 32 and Figure 44.

Table 32 WA EOLTs fate 2015–16 (tonnes)

Fate	Passenger	Truck	OTR	Total
Reuse	0	100	0	100
Recycling	3,300	2,100	600	6,000
Energy recovery	10,700	700	500	11,900
Legal stockpiles	0	0	0	-
Landfill / unknown	6,800	15,900	25,700	48,400
Total	20,800	18,800	26,800	66,400

Figure 44 WA EOLTs fate 2015–16 (tonnes)



17.5 Barriers and opportunities

The margins for tyre collectors and recyclers in WA are low and increasing transportation costs have impacted the ability of collectors to reach into regional and rural areas. Generous licencing

conditions for mine operators, which allow “in-pit” disposal, remains a key barrier to genuine recovery of OTR tyres in WA.

The recent agreement to commercially license the C4M retaining wall system however may see more domestic opportunities for recovered tyres in WA. In addition, the WA government is actively investigating opportunities to utilise crumb rubber in BCRA and rubber modified sprayed seals. Any activity on rubberised explosives in Queensland is also likely to benefit tyre recyclers in WA over the longer term.

18 New South Wales

18.1 2015-16 market overview

New South Wales by numbers

Population

7,725,900

Size

800,642 km²

Consumption

150,000 tonnes

18,750,000 EPU's

In-use

208,000 tonnes

26,000,000 EPU's

EOLT Generation

127,000 tonnes

15,875,000 EPU's



NSW has a diverse tyre recycling market with broad collection networks across metropolitan and regional areas. Both Newcastle and Sydney act as collection and consolidation hubs with a significant volume of TDF leaving the international ports.

Like most jurisdictions, NSW has had issues managing the impacts of illegitimate and illegal operators in the market with historically high levels of underreporting of waste tyre exports. However, the introduction of the country's most comprehensive regulatory and reporting framework for EOLTs has significantly improved market conditions.

18.2 Policy and regulatory settings

The current policy and regulatory settings related to EOLT management in NSW are summarised in the table below.

Area	Enabling Regulation	Details
Tyre storage	✓	Protection of the Environment Operations (Waste) Regulations 2014 set licensing requirements for all operators who store more than 5 tonnes or 500 waste tyres at any time.
Transportation	✓	Section 143 of the Protection of the Environment Operations Act 1997 (POEO Act) requires waste tyres be

		transported only to a place that can lawfully accept them.
Waste tracking	✓	Those involved in the waste tyre value chain are required to register and report through the WasteLocate system. This system allows the tracking of EOLT consignments from the retailer to the point of recycling, storage or disposal.
Recycling	✓	Protection of the Environment Operations (Waste) Regulations 2014 set licensing requirements for all tyre recyclers processing more than 5,000 tonnes of waste tyres per annum
Disposal	✓	Whole tyres cannot be landfilled in metropolitan areas, in regional areas disposal of tyres to landfill is at the discretion of local government
Landfill levy	✓	EOLTs attract the landfill levy in NSW, which is currently \$135.70/tonne in metropolitan areas and \$78.20/tonne in regional areas.
Reuse	✓	NSW EPA allows for the lawful land application of EOLTs under specific circumstances outlined in a resource recovery order and exemption .
Fire safety	✓	NSW Fire Brigade Guidelines for Bulk Storage of Rubber Tyres set requirements for open and indoor storage of waste tyres.
Energy recovery	✓	The NSW Energy from Waste Policy Statement sets out the considerations and criteria that apply to recovery energy from waste materials, including EOLT. Under the policy, waste tyres can be used for energy recovery at purpose-built energy recovery facilities. The Eligible Waste Fuels Guidelines also list EOLTs as an eligible waste fuel in NSW when used in an approved cement kiln.

18.3 Effectiveness of regulatory framework

The introduction of the WasteLocate tracking system for EOLTs in NSW sets the state apart as leaders in regulatory and policy settings for waste tyres. NSW EPA effectively tracks all EOLT consignments from the point of generation through to the point of disposal in real time. The current framework requires licensing under the POEO Regulations and sets upper limits for stockpiling, including requirements for fire and emergency management.

Ongoing investment in market development and new recycling infrastructure through the Waste Less, Recycle More program has, and continues, to benefit the sector.

18.4 EOLT fates

NSW is a significant generator of EOLTs in Australia with some 127,100 tonnes (~16 million EPU) reaching end-of-life in 2015-16. Whilst high landfill levies have driven diversion in Sydney and surrounds, an estimated 63% or 80,300 tonnes (~10 million EPU) were disposed to landfill or to unknown fates.

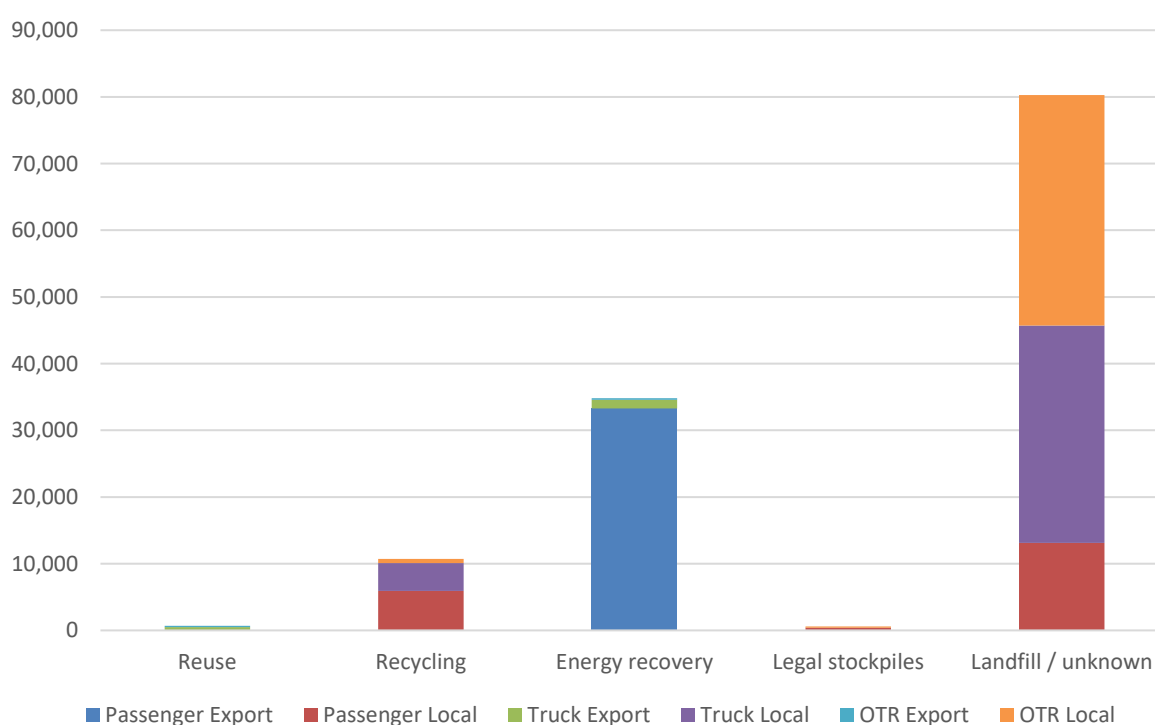
With good access to ports and international backloading, some 27% or almost 34,800 tonnes (~4,4 million EPU) were exported as baled tyres and TDF for energy recovery. Due to the strong market for TDF, domestic recycling is relatively low at around 8% or 10,700 tonnes (~1.4 million EPU).

The EOLT fates for NSW in 2015-16 are presented in Table 33 and Figure 45.

Table 33 NSW EOLTs fates 2015–16 (tonnes)

Fate	Passenger	Truck	OTR	Total
Recycling	0	500	200	700
Energy recovery	5,900	4,200	600	10,700
Landfill	33,300	1,300	200	34,800
Stockpiling	400	0	200	600
Other / unknown	13,100	32,600	34,600	80,300
Total	52,700	38,600	35,800	127,100

Figure 45 NSW EOLTs fates 2015–16 (tonnes)



18.5 Barriers and opportunities

There are few significant barriers impeding market growth in NSW apart from the impacts of cheap freight and easy port access. This drives operators to favour exports over local market opportunities.

NSW is fortunate to have two organisations investing heavily in research and development for TDPs. The University of NSW SMART Centre has developed a long-standing partnership with OneSteel to continue expanding the use of crumb rubber additives into coking coal for steel making. In addition, the University of Wollongong is undertaking research into the use of recycled rubber products in railway engineering.

Several state and national highways through NSW that use concrete pavements (rather than bitumen) are due for improvement works in the coming years. The flexibility of BCRA and rubber modified sprayed seals is likely to be beneficial to the type of “crack and seat” works required in NSW. This may offer a considerable opportunity for the NSW market. In addition, anecdotal evidence suggests that strong demand for equestrian surfacing in regional NSW is driving solid opportunities for regional reprocessing of crumb, granule and buffings¹⁰⁶.

¹⁰⁶ Confidential pers comm during consultations

19 South Australia

19.1 2015-16 market overview

South Australia by numbers

Population

1,708,200

Size

983,482 km²

Consumption

35,000 tonnes

4,375,000 EPU_s

In-use

51,000 tonnes

3,375,000 EPU_s

EOLT Generation

30,100 tonnes

3,762,500 EPU_s



South Australia is a relatively small market with Adelaide being the primary hub of activity. Whilst crumb rubber and granule is produced in small volumes, the primary market outlet is TDF and baled tyres for export.

Regionally, tyres are collected from across the state with some interstate movements into Victoria and NSW.

19.2 Policy and regulatory settings

The current policy and regulatory settings related to EOLT management in SA are summarised in the table below.

Area	Enabling Regulation	Details
Tyre storage	✓	The Environment Protection Act 1993 requires an environmental authorisation for the reception, storage, treatment or disposal of EOLTs for quantities exceeding 5 tonnes or 500 EPU _s per annum.
Transportation	✓	The Environment Protection Act 1993 requires an environmental authorisation to transport EOLTs
Waste tracking	✓	Paper based waste tracking to track where tyres are collected and where they are taken, to be

		completed by both the generator, transporter and disposal operator.
Recycling	✓	The Environment Protection Act 1993 requires an environmental authorisation for the reception, storage, treatment or disposal of EOLTs for quantities exceeding 5 tonnes or 500 EPU's per annum.
Disposal	✓	Whole tyres are banned from landfill in SA under the Environment Protection (Waste to Resources) Policy 2010 .
Landfill levy	✓	The SA waste levy applies to shredded tyres sent to landfill. Current rates are \$76/tonne in metropolitan areas and \$38/tonne in regional areas.
Reuse	✓	A development approval is required for structural reuse of tyres (such as erosion control) involving more than 5 tonnes per annum.
Fire safety	✓	The General Guidelines for Rubber Tyre Storage developed by the SA Fire Authorities provide guidance for indoor and outdoor storage of waste tyres.
Energy recovery	✗	Interim Consultation Paper on Waste to Energy (Interim Position Paper) is the first step in development of a formal energy from waste policy.

19.3 Effectiveness of regulatory framework

There is a strong framework for the management of EOLTs in SA which is supported by paper based tracking and an increasing landfill levy. The SA Government is currently finalising new legislation for the waste management and recycling sector which may further improve conditions for the tyre recycling industry, see [Explanatory paper: consultation draft Environment Protection \(Waste Reform\) Amendment Bill 2016](#). The current draft Waste Reform Amendment Bill would introduce significant changes to stockpiles governance in South Australia. The Act amendments will implement a range of changes for stockpiles management including:

- Mass balance reporting and upfront levy payment (like the NSW model).
- Improving licence controls including limits on tonnages and the use of audits.
- Requiring financial assurances from sites that stockpile.
- The 'recovery of illegally obtained economic benefit'.

19.4 EOLT fates

South Australia generated some 30,100 tonnes of EOLTs in 2015-16, which equates to more than 3.7 million EPU's. Of this material, around 6% or 1,800 tonnes (~225,000 EPU's) with some 40% or 12,000 tonnes (~1.5 million EPU's) going to landfill or unknown fates. South Australia has the highest rate

exports or energy of any state at 56% or 16,800 tonnes (~2.1 million EPU) according to the current data set.

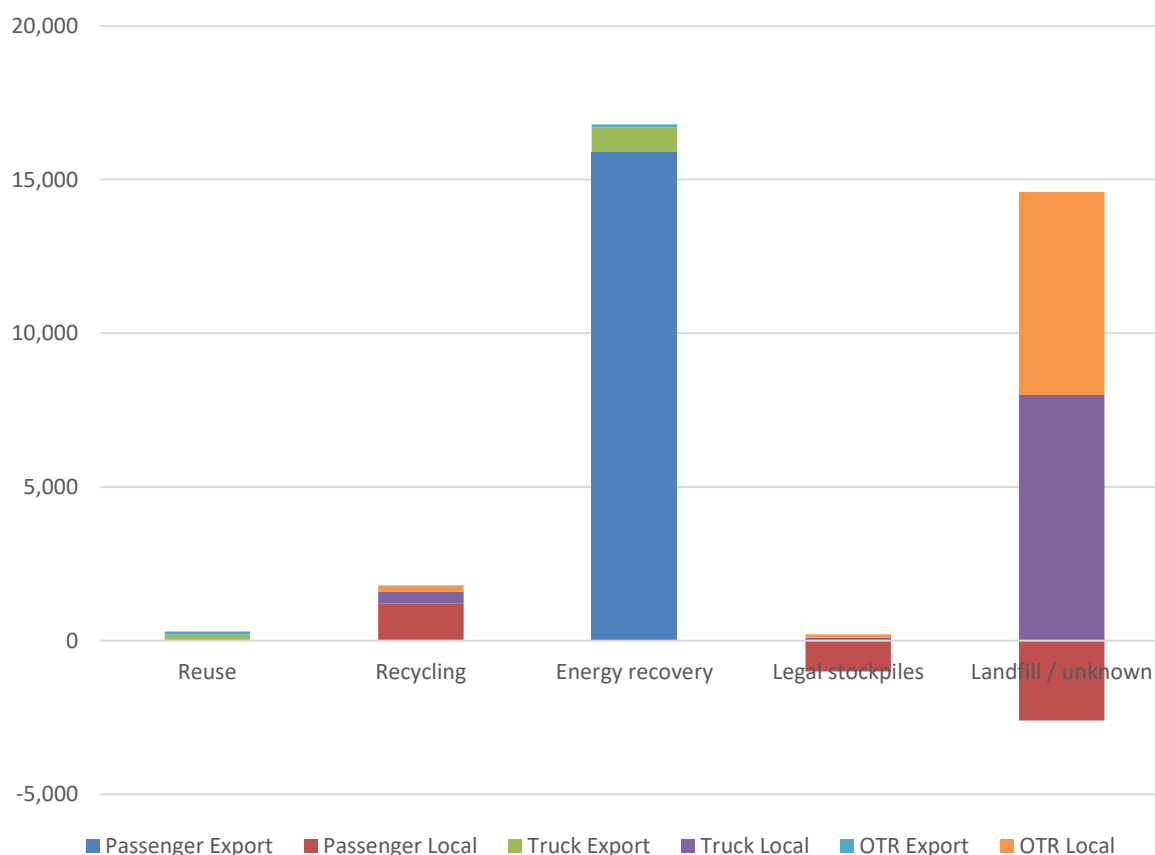
It should be noted that the SA data contains a minor anomaly, with passenger tyres showing a net deficit in disposal to landfill. It is likely that this has occurred due to overreporting of TDF exports for passenger tyres.

An overview of EOLT fates from SA in 2015-16 is presented in Table 34 and Figure 46.

Table 34 SA EOLTs fates 2015–16 (tonnes)

Fate	Passenger	Truck	OTR	Total
Reuse	0	200	100	300
Recycling	1,200	400	200	1,800
Energy recovery	15,900	800	100	16,800
Legal stockpiles	-1,000	100	100	(800)
Landfill / unknown	-2,600	8,000	6,600	12,000
Total	13,500	9,500	7,100	30,100

Figure 46 SA EOLTs fates 2015–16 (tonnes)



19.5 Barriers and opportunities

There is considerable opportunity to improve recovery and recycling in South Australia. Lack of economies of scale remain a challenge as does the low population density of the state outside of Adelaide.

However, industry evidence suggest that crumb rubber produced in the state is selling very well with demand currently outstripping supply. Additional capacity and production, in conjunction with a push by state government to see rubber in roads may offer opportunities in the state.

20 Tasmania

20.1 2015-16 market overview

Tasmania by numbers

Population

519,100

Size

68,401 km²

Consumption

12,000 tonnes

1,500,000 EPU_s

In-use

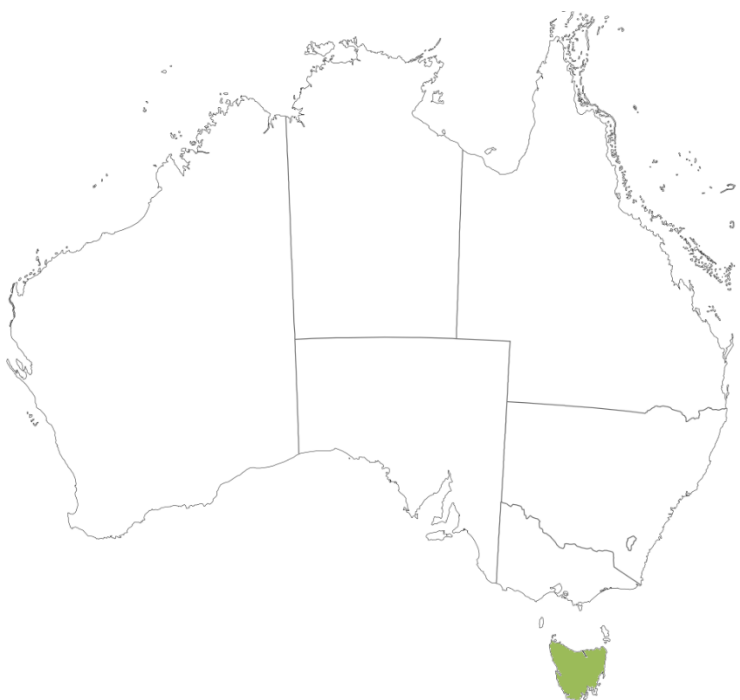
17,000 tonnes

2,125,000 EPU_s

EOLT Generation

10,300 tonnes

1,287,500 EPU_s



Tyre recycling has technically not existed in Tasmania until recently. Historically, tyres not sent to landfill have been stockpiled at a site in Longford without further processing or use. A push from state and local government has seen the stockpiling in Longford cease with Tyrecycle processing some 2,600 tonnes of material at the site using a mobile shredder.

A new tyre recycler, Barwicks, has commenced operating north of Hobart. Tyres are course shredded and shipped to Melbourne for processing into export grade TDF.

20.2 Policy and regulatory settings

The current policy and regulatory settings related to EOLT management in Tasmania are summarised in the table below.

Area	Enabling Regulation	Details
Tyre storage	✗	There are no tyre storage requirements except for landfill operators who must not openly store more than 200 EPU _s under the Environmental Management and Pollution Control (Waste Management) Regulations 2010
Transportation	✓	Tyres are a controlled waste under the Environmental Management and Pollution Control (Controlled

		Waste Tracking) Regulations 2010 and operators involved in the production, transportation and receipt of EOLTs must be registered.
Waste tracking	✓	As above
Recycling	✓	Tyre recyclers must be licensed under the Environmental Management and Pollution Control (Waste Management) Regulations 2010
Disposal	✓	Whole tyres may not be landfilled in Tasmania. Shredded tyres can be accepted at secure landfills.
Landfill levy	✗	Tasmania does not have a landfill levy
Reuse	✗	No reuse options listed
Fire safety	✗	There are no specific requirements or guidance notes for fire safety, however the General Fire Regulations 2010 provide provisions for general site requirements.
Energy recovery	✗	None

20.3 Effectiveness of regulatory framework

Like Victoria, Tasmania has legacy tyre stockpiles that have resulted from poor state and local government regulation and enforcement. Until recently, EOLTs have been collected from around the state and stockpiled at a site in Longford, just south of Launceston. The site reportedly contains more than 1 million EPU, although these are relatively well managed in separated piles.

The lack of tyre storage requirements at state level does not set a strong signal to the market to invest in legitimate tyre recycling operations. However, action by local government to end stockpiling at the Longford site has worked to stimulate new investment in tyre shredding in Hobart, offering a new channel for recovery.

20.4 EOLT fates

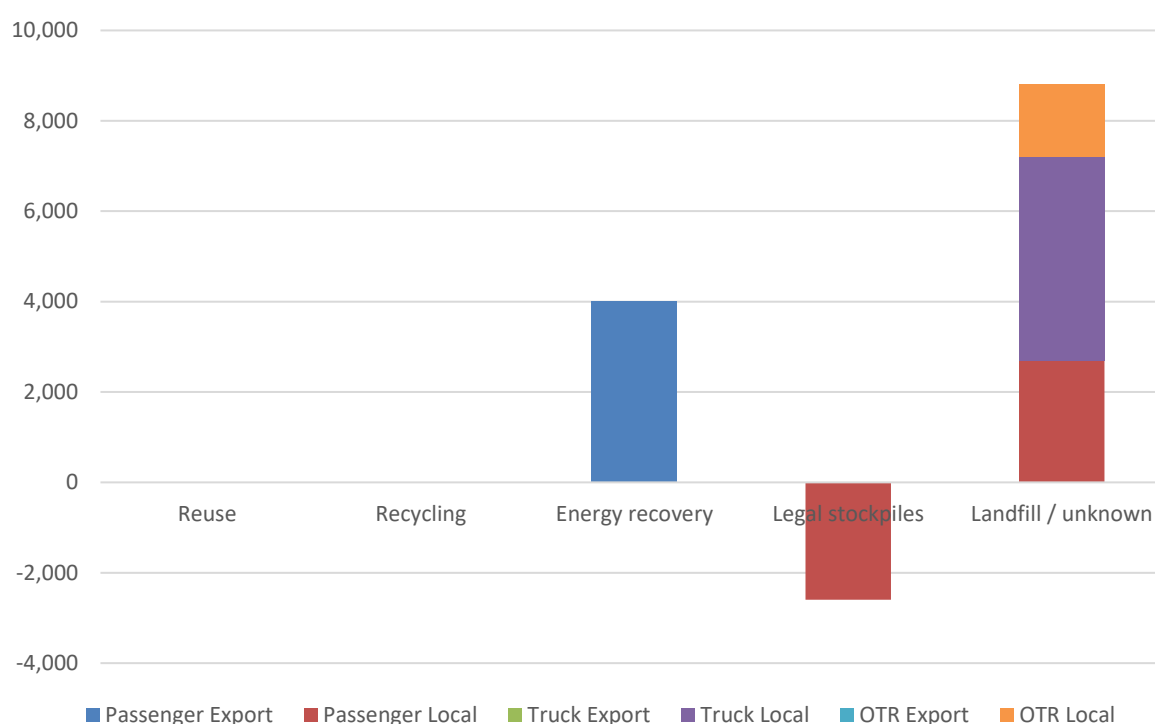
The data on EOLT fates in Tasmania reflects work by Tyrecycle to shred and ship more than 2,600 tonnes of material to Melbourne for processing into TDF. However, considerable stockpiling still occurred throughout the 2015-16 year and the numbers clearly under-represent this and it is likely that some of the 8,800 tonnes of material for which the fate is landfill or unknown represents material going to Longford.

Some 10,200 tonnes (1.6 million EPUs) of EOLTs were generated in Tasmania in 2015-16 with around 86% or 8,800 tonnes (1,100,000 EPUs) being sent to landfill or unknown fates. Of the remainder, around 4,000 tonnes (500,000 EPUs) went to export markets for energy recovery. As noted earlier, there was a net decrease in stockpiling of around 2,600 tonnes because of a stockpile reduction program. The EOLT fates data for Tasmania for 2015-16 is presented in Table 35 and Figure 47.

Table 35 Tas EOLTs fate 2015–16 (tonnes)

Fate	Passenger	Truck	OTR	Total
Reuse	0	0	0	0
Recycling	0	0	0	0
Energy recovery	4,000	0	0	4,000
Legal stockpiles	-2,600	0	0	-2,600
Landfill / unknown	2,700	4,500	1,600	8,800
Total	4,100	4,500	1,600	10,200

Figure 47 Tas EOLTs fate 2015–16 (tonnes)



20.5 Barriers and opportunities

The lack of an effective regulatory framework to manage the risk of EOLT stockpiling has been a considerable barrier for the Tasmanian tyre industry. In addition, Tasmania does not have an international port which adds considerable cost in moving material to Melbourne for processing and export. The cessation of stockpiling at the Longford site is likely to manifest in higher disposal fees for retailers and inevitably consumers.

Given the size of the infrastructure market in Tasmania and the lack of a local crumbing facility, it is likely that the opportunities centre on greater industry development and improvements to recycling capacity in the state.

21 Northern Territory

21.1 2015-16 market overview

Northern Territory by numbers

Population

244,900

Size

1,335,742 km²

Consumption

7,000 tonnes

875,000 EPU_s

In-use

7,000 tonnes

875,000 EPU_s

EOLT Generation

5,000 tonnes

625,000 EPU_s



The EOLT market in NT is small with only two tyre significance recyclers servicing Darwin and Alice Springs respectively. The number of rural and remote communities in the NT, many of which are huge distances from urban towns, make tyre collection difficult and not economically viable.

At present, the NT Government, working closely with the tyre industry and TSA, is examining opportunities to improve the industry and expand local recycling capacity.

21.2 Policy and regulatory settings

The current policy and regulatory settings related to EOLT management in NT are summarised in the table below.

Area	Enabling Regulation	Details
Tyre storage	✓	Activities involving the collection, transport, storage, recycling, treating or disposing of tyres (a listed waste) require an environmental protection licence under the Waste Management and Pollution Control Act and Waste Management and Pollution Control (Administration) Regulations .
Transportation	✓	As above
Waste tracking	✗	None

Recycling	✓	Activities involving the collection, transport, storage, recycling, treating or disposing of tyres (a listed waste) require an environmental protection licence under the Waste Management and Pollution Control Act and Waste Management and Pollution Control (Administration) Regulations .
Disposal	✓	As above
Landfill levy	✗	None
Reuse	✗	None listed
Fire safety	✗	None
Energy recovery	✗	None

21.3 Effectiveness of regulatory framework

Despite being the third largest state or territory in Australia, generation of EOLTs in the NT is relatively low due to the small, dispersed population. Whilst the regulatory framework for EOLTs in the Territory suitably covers the activities of the two listed tyre recyclers, the lack of a landfill levy and significant transportation distances means that most EOLTs are disposed to landfill.

Illegal dumping and roadside litter of EOLTs remains a considerable challenge, particularly in regional and remote parts of the state where communities do not have access to mainstream waste management services.

21.4 EOLT fates

Around 90% or 4,400 tonnes (~550,000 EPU) of EOLTs generated in NT in 2015-16 were disposed to landfill or unknown fate. Around 500 tonnes (~62,500 EPU) were exported for energy recovery (via Adelaide). Local recycling is limited with less than 50 tonnes used in domestic markets¹⁰⁷.

The fates of EOLTs in NT from 2015-16 are presented in Table 36 and Figure 48.

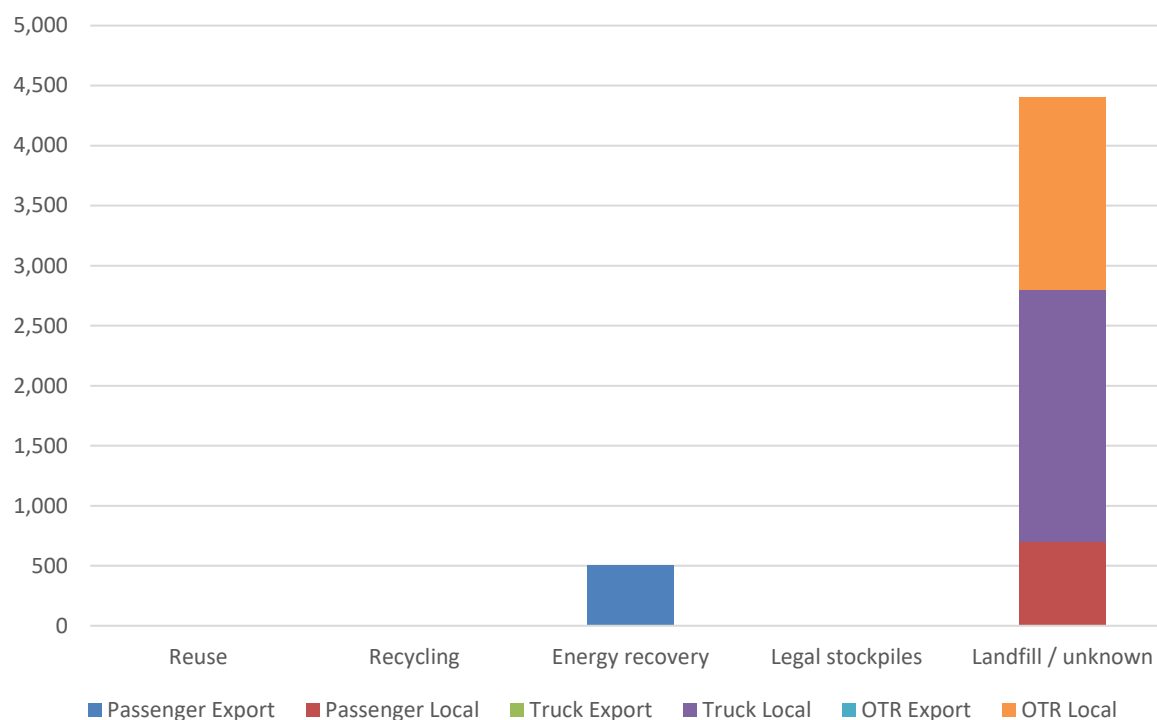
Table 36 Fates of EOLTs from NT in 2015–16 (tonnes)

Fate	Passenger	Truck	OTR	Total
Reuse	0	0	0	-
Recycling¹⁰⁸	0	0	0	-
Energy recovery	500	0	0	500
Legal stockpiles	0	0	0	-
Landfill / unknown	700	2,100	1,600	4,400
Total	1,200	2,100	1,600	4,900

¹⁰⁷ Note that the MFA model rounds off to the nearest 100 tonnes and as such domestic recycling has rounded down to 0 tonnes

¹⁰⁸ As per comment above

Figure 48 Fates of EOLTs from NT in 2015–16 (tonnes)



21.5 Barriers and opportunities

The lack of developed recycling infrastructure and poor economies of scale, significantly impedes the development of the industry in NT. The opportunities for TDPs such as crumb rubber are likely to be limited as this material would need to be imported from other states at considerable transport cost. Opportunities in NT are therefore likely to centre on improved consolidation and outlets for baled tyres and TDF.

The NT EPA, working with the Motor Trades Association NT (MTANT) has commissioned a study to further examine markets for EOLTs in the NT.

22 Australian Capital Territory

22.1 2015-16 market overview

ACT by numbers

Population

396,100

Size

2,358 km²

Consumption

7,000 tonnes

875,000 EPU_s

In-use

10,000 tonnes

1,250,000 EPU_s

EOLT Generation

5,200 tonnes

650,000 EPU_s



Australia's smallest jurisdiction, the ACT does not have a large EOLT industry with just one local collector (who is currently not TSA accredited). National contracts are serviced by operators from NSW with material moving to Sydney for processing into TDF for export markets.

22.2 Policy and regulatory settings

The current policy and regulatory settings related to EOLT management in ACT are summarised in the table below.

Area	Enabling Regulation	Details
Tyre storage	✓	Section 49.1(a) of the Environment Protection Act 1997 requires businesses involved in the storage, transport, disposal or processing of tyres to obtain an environmental authority (license). Storage is limited to 25 tonnes and areas must be clearly marked and segregated
Transportation	✓	As above
Waste tracking	✗	None
Recycling	✓	Section 49.1(a) of the Environment Protection Act 1997 requires

		businesses involved in the storage, transport, disposal or processing of tyres to obtain an environmental authority (license). Storage is limited to 25 tonnes and areas must be clearly marked and segregated
Disposal	X	Tyres are permitted to be landfilled whole or shredded, costs are around \$300 per tonne for tyres
Landfill levy	X	There is no landfill levy in the ACT
Reuse	X	None listed
Fire safety	X	None
Energy recovery	X	None

22.3 Effectiveness of regulatory framework

The ACT is Australia's smallest EOLT market with most tyres being managed effectively through the current regulatory framework. However, it should be noted that controls on tyre recyclers outside of licencing conditions are not strong and the only tyre collector and recycler is not TSA accredited.

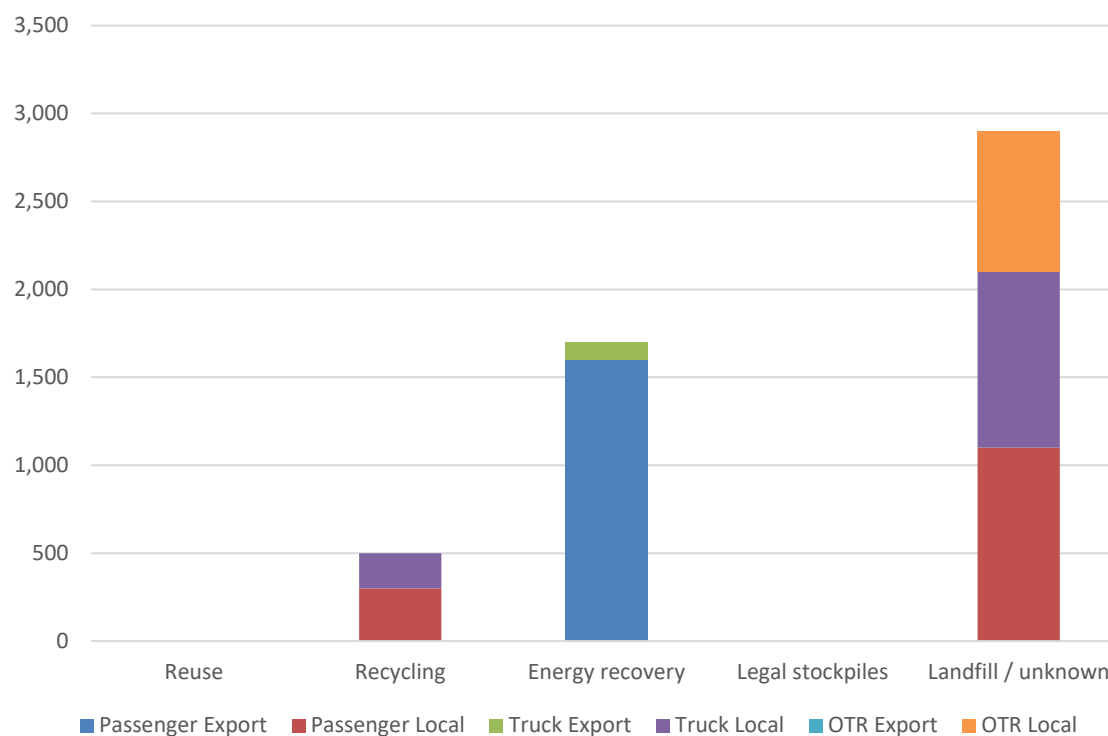
22.4 EOLT fates

The EOLT fates in 2015-16 in ACT are presented in Table 37 and Figure 49 and illustrate that around 57% or 2,900 tonnes of material is disposed to landfilled or unknown fates. A small number, around 500 tonnes or 10% is recovered for domestic recycling with a further 33% being recovered for energy recovery.

Table 37 ACT EOLTs fates 2015–16 (tonnes)

Fate	Passenger	Truck	OTR	Total
Reuse	0	0	0	-
Recycling	300	200	0	500
Energy recovery	1,600	100	0	1,700
Legal stockpiles	0	0	0	-
Landfill / unknown	1,100	1,000	800	2,900
Total	3,000	1,300	800	5,100

Figure 49 ACT EOLTs fates 2015–16 (tonnes)



22.5 Barriers and opportunities

The ACT market is small and can be well serviced by local and NSW collectors and recyclers. The barriers and opportunities presented in Section 18 should therefore be considered as complementary to the ACT.

APPENDIX 3 – COMPETITION AND MARKET ANALYSIS FOR TDP OPPORTUNITIES IN AUSTRALIA

23 Detailed competition analysis for TDP opportunities

23.1 Mining sector

Opportunity: Crumb rubber in mining explosives

Description: Crumb rubber is blended into traditional ammonium nitrate fuel oil (ANFO) in explosives to increase blast efficiency (via slower reaction rate) and improve the ability to blast in wet conditions.

☒ National	☐ Victoria	☒ WA	☐ Tasmania
☒ NSW/ACT	☒ QLD	☐ SA	☒ NT

Competition analysis

Competing products:

1. Diesel

Upfront cost / price		The market price for crumb rubber is around \$500/t - \$600/t ¹⁰⁹ which is significantly less than traditional diesel fuel of around \$1,750/t (\$1.30 litre) ¹¹⁰ .
Lifecycle cost / price		Short lifecycle so upfront cost is the key measure here.
Efficiency		Crumb rubber blended fuel oil improves blast efficiency by slowing the reaction rate of the explosion, meaning more controlled and effective blasting.
Quality and performance		Improved blasting performance and outcomes when compared to traditional diesel based explosives. In addition, it is reported that issues associated with fumes will be reduced where diesel is substituted by crumb rubber.
Market scale / ability to meet demand		Explosives market around 3 million tpa ¹¹¹ . The entire market for crumb rubber in Australia is around 11,000 tpa suggesting a potential for undersupply risks.
Market readiness		The market is already using small quantities of crumb rubber explosives with around 1,000 tpa currently being consumed. However, work is required to increase scale of product.
Greenhouse gas emissions		Anecdotally, the replacement of a fossil fuel (diesel) with crumb rubber will have a positive benefit in terms of greenhouse gas emissions, however there is no available data at this stage.
Longevity	NA	
Future recyclability	NA	
Patents and licensing		There are likely to be constraints on the competitiveness of crumb rubber explosives based on existing IP ownership and patents.

¹⁰⁹ Pers comm, Tyrecycle and ATRA

¹¹⁰ It must be noted that bulk diesel is likely to be less expensive than retail pricing. In addition, anecdotal evidence indicates further refinement of crumb is required to make it market ready. Overall however crumb is still likely to be cheaper than diesel fuel.

¹¹¹ IBIS World Report [Explosives Manufacturing in Australia](#)

Potential size of opportunity

The market for explosives is around 3 million tpa in Australia. Assuming a high rate of early growth (based on the current market movement) and sustained uptake by industry, the size of the market opportunity is in the order of almost 26,000 tpa of EOLT consumption in the long term (10 years).

Size estimates (tonnes of EOLTs consumed)	Short term (2 years)	Med term (5 years)	Long term (10 years)
	4,800 tpa	8,800 tpa	25,800 tpa

Summary of opportunity and critical success factors

The use of crumb rubber in mining explosives has significant potential to increase domestic markets for TDPs in Australia, with current penetration already reaching more than 1,000 tpa¹¹². However, the presence of existing patents may be a barrier to competition and this should be considered in the overall scope of this opportunity.

¹¹² Waste Management Review, December 12, 2016. '[Explosive potential for tyre crumb](#)' Waste Management Review, Issue 9, p18.

23.2 Construction sector

Opportunity: Crumb rubber sprayed seals

Description: Crumb rubber is added as a binder to traditional road sprayed seals (essentially the top coat on a road surface) to improve flexibility and reduce surface cracking.

☒ National	☒ Victoria	☒ WA	☐ Tasmania
☒ NSW/ACT	☒ QLD	☒ SA	☐ NT

Competition analysis

Competing products:

1. Styrene-butadiene-styrene (SBS)
2. Other synthetic polymer modified binders (PMBs)

Upfront cost / price		Industry consultation suggests that crumb rubber is cost competitive with traditional PMBs such as SBS ¹¹³ , however, there are likely to be set up costs for new players to adopt crumb rubber, including staff training.
Lifecycle cost / price		Spray seals containing rubber are less prone to surface cracking which improves the longevity of the road surface overall and reduces maintenance requirements and costs.
Efficiency		The use of crumb rubber in spray seals can reportedly lead to additional wear on truck pumps and the integration of crumb rubber on site can add additional time to the spraying process.
Quality and performance		There are significant benefits to using crumb rubber in spray seals in terms of performance, including improved aggregate retention, reduced surface cracking, increase shear resistance and extended life of seals ¹¹⁴ .
Market scale / ability to meet demand		The market is currently well serviced with spayed seal accounting for almost 6,000tpa ¹¹⁵ of crumb rubber consumption (or approximately 11,000 tpa of EOLTs). There are good relationships between recyclers and end market producers, however if other states were to mirror Victorian's current consumption then the existing recycling market would struggle to meet demand.
Market readiness		The market has a number of commercial products and suppliers already operating in this space.
Greenhouse gas emissions		The production of bitumen (asphalt of spray seal) with or without crumb rubber leads to greenhouse gas emissions. However, given pavements with crumb rubber spray seal last longer, the overall life-cycle impact is lessened ¹¹⁶ .
Longevity		Roads using crumb rubber sprayed seals are less prone to surface cracking which in turn improves longevity of road infrastructure ¹¹⁷ .

¹¹³ Feedback from ARRB Queensland during industry consultations

¹¹⁴ SAMI, 2009. '[Crumb rubber sprayed seal binder](#)' Presentation to the Strategic Alliance Reference Group

¹¹⁵ Industry estimates, not validated by the road market

¹¹⁶ Bartolozzi et al., 2011. '[Life cycle assessment of rubberised asphalt road pavement in Lamia, Greece](#)' Proceedings of the 3rd International CEMEPE & SECOTOX Conference, p897

Skiathos, June 19-24, 2011,

¹¹⁷ SAMI, 2009.

Future recyclability	As crumb rubber binders are relatively new (i.e. last 20 years) there have been limited examples of roads been pulled up and recycled. However, Caltrans research has shown that RAP (recycled asphalt pavement) containing crumb rubber can be readily incorporated into base-course with improved properties ¹¹⁸ .
Patents and licensing	Whilst there are no specific patents on crumb rubber sprayed seals, some companies have created proprietary mixes and blending techniques to improve application and mixing of crumb rubber binders.

Potential size of opportunity

The sprayed seal market offers considerable opportunity for consuming EOLTs at scale. According to industry estimates, roughly 3,500 EPU are consumed per 5km of road sealing (for 9m wide road)¹¹⁹. Current market size for bitumen sprayed seals in Australia is around 400,000 tonnes¹²⁰. Total market saturation (given average crumb rubber sprayed seals contain 10% crumb rubber) would be in the order of 40,000 tpa of crumb rubber or 72,000 tpa of EOLTs. The current push by state government suggests good short and medium term growth with a projected market of almost 30,000 tpa of EOLT consumption in 10 years.

Size estimates (tonnes of EOLTs consumed)	Short term (2 years)	Med term (5 years)	Long term (10 years)
	19,500 tpa	14,600 tpa	29,200 tpa

Summary of opportunity and critical success factors

Several commercial operators produce a market-ready crumb rubber sprayed seal and in Victoria these products are becoming the standard for road sealing. Further uptake is likely in NSW and QLD in coming years. Unlike BCRA, the market appears ready to broadly adopt rubber modified sprayed seals.

Opportunity: Bitumen crumb rubber asphalt (BCRA)

Description: Crumb rubber is used as a binder in the production of asphalt (BCRA) for road surfacing.

☒ National	☒ Victoria	☒ WA	☒ Tasmania
☒ NSW/ACT	☒ QLD	☒ SA	☒ NT

Competition analysis

Competing products:

1. Styrene-butadiene-styrene (SBS)
2. Other synthetic polymer modified binders (PMBs)

Upfront cost / price	Whilst crumb rubber is broadly cost competitive with traditional PMBs, the additional requirements with mixing and the limited demand has kept upfront costs for BCRA higher than traditional asphalt mixes. In addition, the production of BCRA requires additional bitumen which aids performance but increases costs.
Lifecycle cost / price	A key advantage of BCRA, which broadly offsets upfront cost issues, is that the thickness of the road surface can be reduced due to the

¹¹⁸ Opus, 2015. '[Removing barriers to the use of crumb rubber in roads](#)' Opus Research, November 2015.

¹¹⁹ SAMI, 2009.

¹²⁰ Holtrop, 2008. '[Sprayed sealing practice in Australia](#)' Australian Asphalt Pavement Association

		increased resistance to cracking and subsidence ¹²¹ . This greatly improves overall road efficiency and costs. In addition, BCRA requires less maintenance and reduces surface cracking leading to overall improved lifecycle costs against traditional asphalt mixes.
Efficiency		At the development stage (i.e. where the Australian market currently sits) there is an impact to efficiency through the need for infrastructure upgrades, additional training of staff and addition work to ensure appropriate blending.
Quality and performance		There are well documented advantages to use of BCRA in many circumstances, including increased skid resistance, improved flexibility and crack resistance and reduced traffic noise ¹²² .
Market scale / ability to meet demand		There are developed links into the sector which can leverage off the expansion of rubber modified sprayed seal. However, large arterial and highway projects would need considerable volumes of rubber and storage issues may be a barrier given current regulations.
Market readiness		The market is evolving; however some bitumen producers are reluctant to work with BCRA due to historical issues with odour and foaming. Whilst these issues have been addressed with new wet mix techniques, the perception still remains in some parts of the market.
Greenhouse gas emissions		The production of bitumen (asphalt or spray seal) with or without crumb rubber leads to greenhouse gas emissions. However, given pavements with rubber modified spray seal last longer, the overall life-cycle impact is lessened ¹²³ .
Longevity		Roads using BCRA are less prone to surface cracking which improves longevity of road infrastructure ¹²⁴ .
Future recyclability		Research by Caltrans has shown that RAP (recycled asphalt pavement) containing crumb rubber can be readily incorporated into base-course with improved properties ¹²⁵ .
Patents and licensing		Whilst there are no specific patents on BCRA, some companies have created proprietary mixes and blending techniques to improve application and mixing of crumb rubber binders.

Potential size of opportunity

The total potential market size in Australia for BCRA is around 40,000 tpa based on the state of the current bitumen market. In the USA, which is one of the most mature markets for BCRA, consumption is around 12 million EPU's per annum, suggesting that a similar level of BCRA penetration in Australia could consume more than one million EPU's per annum. The market for

¹²¹ Lo Presti, 2013. 'Recycled Tyre Rubber Modified Bitumens for road asphalt mixtures: A literature review' *Construction and Building Materials*, Vol 49, 863 – 881.

¹²² Lo Presti, 2013.

¹²³ Bartolozzi et al., 2011. '[Life cycle assessment of rubberised asphalt road pavement in Lamia, Greece](#)' *Proceedings of the 3rd International CEMEPE & SECOTOX Conference*, p897
Skiathos, June 19-24, 2011,

¹²⁴ SAMI, 2009.

¹²⁵ Opus, 2015. '[Removing barriers to the use of crumb rubber in roads](#)' *Opus Research*, November 2015.

BCRA remains constrained with projections for modest growth until the medium term with good long term prospects if key barriers can be overcome.

Size estimates (tonnes of EOLTs consumed)	Short term (2 years)	Med term (5 years)	Long term (10 years)
	2,200 tpa	7,200 tpa	12,400 tpa

Summary of opportunity and critical success factors

The proliferation of BCRA requires a greater degree than rubberised sprayed seal due to persisting perceptions around odour and the limited push from both supply side and demand side players. Lessons from other countries suggest that without a strong push from those procuring or specifying road infrastructure, market growth is likely to remain slow.

Opportunity: Vibration dampening in rail track construction

Description: There are opportunities for recycled rubber in a number of forms as vibration dampening beneath rail track and as track stabilisation

☒ National	☒ Victoria	☒ WA	☒ Tasmania
☒ NSW/ACT	☒ QLD	☒ SA	☒ NT

Competition analysis

Competing products:

1. Natural rubber
2. Geosynthetic membranes

Upfront cost / price		Anecdotal evidence suggests TDPs will compete very well on price with current products in the market, however further research is required.
Lifecycle cost / price	NA	Further research required.
Efficiency	NA	Further research required.
Quality and performance		Initial evidence suggests that TDPs can outperform existing products on performance.
Market scale / ability to meet demand		Depending on the type of product and application, supply side issues could be a concern. The scale of rail track projects (for example inland rail) is significant.
Market readiness		These products have very little profile in the current market and significant work is required on the demand side.
Greenhouse gas emissions	NA	Further research required.
Longevity	NA	Further research required.
Future recyclability		The use of TDPs beneath track work may require planning for recycling at the end of the infrastructure life. It is possible that at the end of the infrastructure life the material would be sent to landfill if it could not be readily separated. More research required.
Patents and licensing		There are existing patents currently in place for new products being developed. Partnerships between government and research bodies with sharing of IP may alleviate these issues.

Potential size of opportunity

The potential size of this market is difficult to quantify given most products are in the development phase. We have assumed low growth in the short and medium term, with longer term prospects indicating more than 4,000 tpa of EOLT consumption. However, if bulk applications (for example shredded tyres as ballast protection) were proven effective then uptake could be considerably greater than these estimates.

Size estimates (tonnes of EOLTs consumed)	Short term (2 years)	Med term (5 years)	Long term (10 years)
	0 tpa ¹²⁶	1,500 tpa ¹²⁷	4,200 tpa

Summary of opportunity and critical success factors

These applications are largely emerging and significant further research is required. It is likely that performance and cost can be proven to be effective in many applications (given prices for natural rubber and synthetic products) however the complexity of the rail sector and long approval times suggest these are longer term options for TDPs.

Opportunity: Rubberised structural concrete

Description: Crumb rubber is added to traditional structural concrete to increase impact resistance, reduced shrinkage and cracking and increased flexibility.

☒ National	☒ Victoria	☒ WA	☒ Tasmania
☒ NSW/ACT	☒ QLD	☒ SA	☒ NT

Competition analysis

Competing products:

1. Aggregate
2. Portland cement

Upfront cost / price		The market price for bulk cement is around \$15/t ¹²⁸ which is significantly lower than crumb rubber at around \$500/t - \$600/t ¹²⁹ . Whilst rubber is likely to be added in small percentages of the overall concrete mix, the upfront costs will still be significantly higher than competing products.
Lifecycle cost / price		Unclear at this stage of research. Ideally, the addition of crumb rubber will increase longevity and reduce incidence of cracking therefore reducing overall lifecycle costs. There is not enough trial evidence at this stage to be conclusive in this area.
Efficiency		Some work is required in the manufacturing process to ensure the crumb blends into the overall concrete mix and “binds” as required.
Quality and performance		The key issue to date relates to performance with testing suggesting reduced overall compressive strength when rubber is

¹²⁶ The testing and approvals process in the rail sector suggests short term consumption of EOLTs is unlikely.

¹²⁷ Assume modest uptake of TDPs in ground stabilisation on project by project basis

¹²⁸ Boral Cement <http://www.boral.com.au/PromoList/product-price-increases.asp>

¹²⁹ Pers comm, Tyrecycle and ATRA

		added ¹³⁰ . Whilst suitable mixes can be obtained to meet specifications, there is still a reduction in strength when compared to traditional concrete ¹³¹ .
Market scale / ability to meet demand		The cement market in Australia is around 10 million tpa ¹³² . The entire market for crumb rubber in Australia is around 11,000 tpa suggesting a potential for undersupply risks.
Market readiness		The market is currently immature and there has been little if any penetration at this stage.
Greenhouse gas emissions		Production of Portland cement is energy intensive leading to greenhouse gas emissions of around 0.72 t CO ₂ -e per tonne of cement ¹³³ .
Longevity		Addition of crumb rubber can increase impact resistance and benefit earthquake prone areas. However, as noted previously this can come at the cost of compressive strength. Additional research is required.
Future recyclability		More research may be required to understand the recyclability of crumb rubber concrete at the end of its life, for example as an aggregate for road base.
Patents and licensing		None uncovered during research.

Potential size of opportunity

Overall the potential size of the opportunity could be significant given the amount of concrete used in Australia. However, it appears that more research and testing is required in the short to medium term to fully understand the opportunity given the issues with reduced compressive strength. Projections of consumption show limited growth in the short to medium term, however if issues of compressive strength and cost can be overcome, the market could exceed 11,000 tpa of EOLT consumption in 10 years.

Size estimates (tonnes of EOLTs consumed)	Short term (2 years)	Med term (5 years)	Long term (10 years)
	200 tpa	400 tpa	11,300 tpa

Summary of opportunity and critical success factors

Adding crumb rubber to concrete can increase impact resistance, absorption of vibration and flexibility. However, this comes with an increase in cost and reduction in compressive strength that is likely to restrict uptake at least whilst additional research is undertaken to find suitable applications and mixes. It is likely that niche markets absorbing small volumes of crumb rubber will emerge rather than large scale take up of these products.

¹³⁰ Youssf et al (2014). Prediction of crumb rubber concrete strength, *Australasian Conference on the Mechanics of Structures and Materials* pp261-266

¹³¹ Li et al (2014). Abrasion and impact resistance investigation of crumb rubber concrete, *Australasian Conference on the Mechanics of Structures and Materials* pp255-260

¹³² Cement Industry Federation www.cement.org.au/AustraliasCementIndustry.aspx

¹³³ Cement Industry Federation www.cement.org.au/AustraliasCementIndustry.aspx

Opportunity: Lightweight crumb rubber concrete

Description: Crumb rubber is used as a replacement, or in addition to, expanded polystyrene (EPS) in the manufacture of lightweight concrete for use in prefabricated panels or other products.

☒ National	☒ Victoria	☒ WA	☒ Tasmania
☒ NSW/ACT	☒ QLD	☒ SA	☒ NT

Competition analysis

Competing products:

1. Expanded polystyrene
2. Foam
3. Balsa wood

Upfront cost / price		Difficult to quantify as EPS is volume driven and crumb rubber is weight driven. Market information suggests that use of crumb rubber will result in some increase in overall production costs.
Lifecycle cost / price	NA	More research is required on overall lifecycle costs.
Efficiency		Production efficiency likely to remain unchanged as EPS needs to be injected in a similar fashion. There is a reduction in overall density when rubber is mixed with EPS ¹³⁴ .
Quality and performance		There are several potential uses for lightweight concrete, however recent testing for manufacture of lightweight concrete panels with crumb rubber showed higher compressive strength, movement capacity and impact resistance than with EPS alone ¹³⁵ .
Market scale / ability to meet demand		Likely to be added at low percentages relative to overall weight. The lightweight concrete market tends to be product based (rather than bulk order) and may be more suitable in terms of market scale than other opportunities for this reason.
Market readiness		The market for lightweight concrete is mostly product based and is therefore used to new products and innovations. Market take up would not be impeded significantly once momentum is gained.
Greenhouse gas emissions		This depends on the alternative product. If new EPS is used, then recycled rubber would have a GHG emissions advantage ¹³⁶ , however if recycled EPS is used then GHG emissions would be largely even.
Longevity		Performance is improved therefore longevity is likely to be increased, however further research is required.
Future recyclability		Whilst further research is required, from the perspective of competition the future recyclability of the competitor products (lightweight concrete with EPS) is equally unknown.

¹³⁴ X. Ma et al (2014). Structural performance of composite panels filled with light-weight crumb rubber concrete, *Australasian Conference on the Mechanics of Structures and Materials* pp669-674

¹³⁵ As above

¹³⁶ Note we have not considered the initial GHG intensity of new tyre production, rather the intensity of recycling a discarded tyre

Patents and licensing		Likely to be a considerable factor as this market appears largely product based rather than bulk purchase based.
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Potential size of opportunity

There is limited information available about the current lightweight concrete market in Australia. University of South Australia research used 12g rubber per 2.2kg concrete in testing suggesting lightweight concrete may only present a moderate opportunity for TDP uptake. We have assumed the same factors as for structural concrete in the projection modelling.

Size estimates (tonnes of EOLTs consumed)	Short term (2 years)	Med term (5 years)	Long term (10 years)
	200	400	11,300

Summary of opportunity and critical success factors

Whilst the performance and benefits of adding crumb rubber into lightweight concrete are positive, the existing research suggests that each product may only use a very small amount of rubber suggesting that “at scale” consumption of TDPs is unlikely.

23.3 Civil engineering sector

Opportunity: Permeable/porous pavements using crumb rubber.

Description: Permeable pavements are substitutes to concrete or standard paving to allow water to soak through rather than runoff into stormwater. They can be manufactured using crumb rubber or rubber granule.

☒ National	☒ Victoria	☒ WA	☒ Tasmania
☒ NSW/ACT	☒ QLD	☒ SA	☒ NT

Competition analysis

Competing products¹³⁷:

1. Gravel
2. Engineered permeable pavers

Upfront cost / price		Largely unknown at this stage, however, use of crumb rubber and rubber granule in permeable pavement is likely to significantly increase upfront cost when compared with gravel. Impacts may be less when compared with other engineered products.
Lifecycle cost / price	NA	More research is required on overall lifecycle costs.
Efficiency	NA	More research is required
Quality and performance	NA	Current research is underway at University of Melbourne
Market scale / ability to meet demand		The market is likely to be a combination of products and bulk purchase. The cost disadvantage over gravel suggests uptake will not quickly exceed supply.
Market readiness		The market for permeable / porous surfaces is growing in Australia, driven by sustainable design initiatives and a push from water authorities to better manage runoff in urban areas. However, the additional sub-grade work required compared to traditional paving ¹³⁸ suggests take up may be slow.
Greenhouse gas emissions	NA	More research is required
Longevity	NA	More research is required
Future recyclability	NA	More research is required
Patents and licensing		Likely to be a considerable factor as this market appears largely product based rather than bulk purchase based.

Potential size of opportunity

The market size for permeable pavement in Australia is unknown, however estimates suggest Germany, the market leader in this area, has already installed some 18,000,000m² of these

¹³⁷ Note we have compared crumb rubber permeable pavements against other permeable pavements, rather than comparing against standard concrete pavements.

¹³⁸ Architecture and design story <http://www.architectureanddesign.com.au/features/product-in-focus/permeable-pavers-why-it-s-not-a-thing-yet-and-why>

pavements¹³⁹. Potential use in bike paths and carparks, with up to 60% rubber content in some test cases, could make a considerable positive impact in this market.

Size estimates (tonnes of EOLTs consumed)	Short term (2 years)	Med term (5 years)	Long term (10 years)
	2,000	3,400	4,400

Summary of opportunity and critical success factors

The market for permeable pavements is relatively new in Australia with work required to push greater uptake. The broader market for these products needs time to mature, however if crumb rubber permeable pavement can be shown to be commercially viable and high-performance it may be able to lead as the market in Australia develops.

Opportunity: Shredded rubber as aggregate replacement

Description: Shredded tyres can be used as aggregate replacement (commonly referred to as tyre-derived aggregate or TDA), particularly as an effective drainage medium in areas where lightweight fill is required. This analysis will also include use as landfill drainage aggregate and landfill cover.

☒ National	☒ Victoria	☒ WA	☒ Tasmania
☒ NSW/ACT	☒ QLD	☒ SA	☒ NT

Competition analysis

Competing products:

1. virgin aggregate
2. recycled aggregates
3. soil/clean fill.

Upfront cost / price		TDA can be produced to a similar specification as TDF, therefore the existing market could supply the material for low cost based on negative cost of export. This would be extremely cost competitive against virgin or traditional aggregate.
Lifecycle cost / price		Depends on application but upfront cost likely to be the key driver here.
Efficiency		Lower bulk density than competitors reducing transport efficiency, however much lighter therefore offsetting some of that impact.
Quality and performance		TDA is around 66% lighter than soil and drains around 10 times more effectively. In addition, it has thermal insulation and vibration dampening properties.
Market scale / ability to meet demand		The market is already geared up to produce TDF with several operators working at volume around Australia. In addition, experience in the United States suggests that stockpiled tyres may be effectively used to create TDA ¹⁴⁰ .
Market readiness		Significant research has been undertaken globally on the use of TDA in various applications, particularly as landfill drainage aggregate and lightweight fill in embankments.

¹³⁹ Van Diemen (2009). [Permeable Paving Systems](#), International Specialised Skills Institute, Victorian Government

¹⁴⁰ [Waste Management Review](#), December-January 2017. *An American success story* pp46-47

Greenhouse gas emissions		Likely to be on par with production of aggregate
Longevity	NA	More research is required
Future recyclability		Unlikely to be an issue in landfills, however may be of concern in embankments, particularly the degree to which it could be separated and recovered at end of life. More research required.
Patents and licensing		Not likely to be an issue.

Potential size of opportunity

The scale of this market could be considerable given the diversity and range of potential applications. In the landfill market, a cell of 4,000m² could use 90,000EPU's and highway embankment projects in the US have consumed as much as 1.2 million EPU's for one project.

The modelling of opportunities suggests that TDA offers the best long term opportunity for consumption of EOLTs, under the assumption that its use can be approved and specifications adopted relatively quickly. In 10 years, the model projects more than 50,000 tpa of EOLT consumption could be attributed to TDA use in lightweight fill and landfill drainage.

Size estimates (tonnes of EOLTs consumed)	Short term (2 years)	Med term (5 years)	Long term (10 years)
	600 tpa	12,000 tpa	51,100 tpa

Summary of opportunity and critical success factors

The international market for TDA is significant and the cost competitiveness and performance of TDA in landfills and as lightweight fill suggests the opportunity for consumption of TDA at scale. In addition, TDA has been an effective market for consumption of stockpiled tyres at low cost. The key to market expansion lies in development of specifications and the required testing and regulatory approvals (for example use of TDA in landfills).

Opportunity: Whole tyres as baled or matrix structures in civil works

Description: Whole tyres can be used in construction project, either in encased bales or when packed with soil or rock as ground stabilisation¹⁴¹.

☒ National	☒ Victoria	☒ WA	☒ Tasmania
☒ NSW/ACT	☒ QLD	☒ SA	☒ NT

Competition analysis

Competing products:

1. concrete retaining walls
2. timber retaining walls
3. geotextile membranes.

¹⁴¹ This section of analysis refers specifically to fully designed and tested products and applications, such as EcoFlex and the C4M wall system. It does not include sporadic use of tyres as erosion control or for artificial reefs as these are not recommended

Upfront cost / price		Whole tyres are cheaper when used as retaining walls (\$30 - \$35 cheaper in the case of the C4M wall system ¹⁴²) and as ground stabilisation.
Lifecycle cost / price		Lifecycle costs also lower, for example use of tyres in a honeycomb pattern as sub-base stabilisation uses around 60% less rock than with geotextiles ¹⁴³ .
Efficiency		Production time similar for retaining walls, however use of tyres as sub-base stabilisation can increase installation time when compared to geotextiles.
Quality and performance		Extensive testing on both C4M and EcoFlex have proven to perform as well as or better than the competing products.
Market scale / ability to meet demand		Use of these systems is scalable and likely to be project based. However, a large project could consume over two million EPU's which the current producers of these engineering products do not have access to ¹⁴⁴ .
Market readiness		The use of these products is already underway, however there are several barriers that are impeding uptake. More work is required to remove these barriers to allow the market to respond.
Greenhouse gas emissions		In the case of the C4M system, the use of baled tyres reduces use of virgin concrete which has a higher carbon footprint.
Longevity		Existing research shows products last as long as conventional alternatives
Future recyclability		This is a perceived issue with use of whole tyres in civil engineering applications. Tyres have a life that is likely to exceed that of infrastructure and can be reclaimed and recycled at that time.
Patents and licensing		Both products are subject to current and future patents and/or licencing agreements.

Potential size of opportunity

Large projects, such as sound barriers, sub-grade stabilisation and retaining structures could consume more than one million EPU's per annum. Both models are flexible and scalable. Growth in this market in the past two years has influenced the model projections with as much as 10,000 tpa of EOLT consumption projected in the long term.

Size estimates (tonnes of EOLTs consumed)	Short term (2 years)	Med term (5 years)	Long term (10 years)
	5,100 tpa	6,100 tpa	10,400 tpa

Summary of opportunity and critical success factors

There are a variety of uses for both products discussed in this section and it is likely that as the market matures other products will be introduced. There is considerable scope for at-scale consumption of EOLTs, however there are remaining barriers related to perception, concerns related to use of tyres below the water table and specifications that need to be developed or improved.

¹⁴² Pers comm, Cliff Strahan Lomwest

¹⁴³ Pers comm, Jim Grant Ecoflex

¹⁴⁴ Pers comm, Cliff Strahan Lomwest, based on a 6km canal project using C4M system

23.4 Community / leisure sector

Opportunity: Crumb and rubber granule based sports fields

Description: Crumb rubber and/or rubber granule used in the production of sports fields and surfaces, specifically it is used as “infill” to replicate the feeling and performance of soil in synthetic pitches.

☒ National	☒ Victoria	☒ WA	☐ Tasmania
☒ NSW/ACT	☒ QLD	☒ SA	☐ NT

Competition analysis

Competing products:

1. virgin crumb rubber
2. silica sand
3. thermoplastic elastomer (TPE)
4. ethylene propylene terpolymer (EPDM)
5. cork.

Upfront cost / price		Recycled crumb rubber competes on price with virgin rubber, TPE and EPDM. However, crumb is significantly more expensive than sand.
Lifecycle cost / price		It is unclear if lifecycle costs make up for increased upfront cost when compared to sand. A combination of sand and crumb rubber is often used to get the benefits from both products (sand adds weight to keep artificial turf grounded) at a reasonable price. Crumb rubber has lower replacement costs than EPDM over life of the field.
Efficiency		No information available
Quality and performance		Crumb rubber performs well against the alternatives as it offers strength, abrasion resistance and is UV stable. Outperforms TPE in hot climates.
Market scale / ability to meet demand		Sports fields are project based and crumb rubber provided on an as needs basis to producers. Local manufacturing already exists for these products and demand and supply appears balanced.
Market readiness		The market is mature in Australia, however there has been considerable negative press about the use of crumb rubber infill in synthetic playing surfaces. This has been driven by the presence of styrene butadiene rubber (SBR) in passenger tyres, which may be carcinogenic when users are exposed. All research to date has found no evidence of a link between recycled rubber infill and cancer or any other human health risk ¹⁴⁵ . Despite this, concern in the US has prompted the US EPA to undertake a specific study into the issue ¹⁴⁶ . It is likely that this will impact the Australian market also.

¹⁴⁵ [Synthetic Turf Council](#) summary of available research

¹⁴⁶ [US EPA Research project](#)

Greenhouse gas emissions		No information available, however recycled crumb rubber is likely to have lower emissions than virgin rubber, TPE and EDPM. Production of silica sand and crumb rubber likely to be on a par.
Longevity		Performs well against EDPM which and TPE which require regular top ups.
Future recyclability		No information available
Patents and licensing		No issues identified

Potential size of opportunity

The market is unlikely to grown on current consumption unless key issues related to health and safety can be overcome.

Size estimates (tonnes of EOLTs consumed)	Short term (2 years)	Med term (5 years)	Long term (10 years)
	5,600	6,000	6,600

Summary of opportunity and critical success factors

The market for crumb rubber infill in synthetic surfaces is mature and well developed. There may be an opportunity for government to address the two key barriers, being import of cheap crumb and the perception risks related to health and safety. However, at-scale impact is unlikely and the current concern about health and safety issues may significantly constrain this market over the period of the strategy.

Opportunity: Playground and soft-fall surfaces

Description: Crumb rubber and rubber granule is used in production of soft fall matting and playground surfacing. These are typically coloured with dye, mixed with a resin and poured in place to set ("wet pour").

☒ National	☒ Victoria	☒ WA	☒ Tasmania
☒ NSW	☒ QLD	☒ SA	☒ ACT

Competition analysis

Competing products:

1. virgin crumb rubber / granule
2. mulch / tan bark.

Upfront cost / price		Recycled crumb rubber is cheaper than virgin alternatives, however it is considerably more expensive than mulch which can be obtained in bulk for around \$50 per tonne ¹⁴⁷ .
Lifecycle cost / price		The additional upfront cost is largely offset by lower ongoing costs. Mulch needs to be raked and regularly maintained and topped up as much as four times per annum ¹⁴⁸ .
Efficiency		New wet pour mixes are easily installed and require less maintenance.
Quality and performance		Soft fall surfaces with recycled rubber perform to the Australian Standard AS 4685.1: Playground equipment and surfacing.

¹⁴⁷ Based on bulk price of \$25 per m³ with a density of around 500kg/m³

¹⁴⁸ [Choice](#) review of playground surfaces

		However, the increase in “bounce” when compared to mulch can increase some injuries.
Market scale / ability to meet demand		Soft fall surfaces are installed on a project basis, ranging from small residential projects to large sites such as schools and hospitals. This market is well developed and already largely saturated with providers in most states and territories. This remains one of the largest domestic markets for crumb rubber.
Market readiness		The market is very mature in Australia.
Greenhouse gas emissions	NA	No information available
Longevity		Outperforms tanbark and mulch considerably in longevity. New processes have improved the life of dye colour and resistance to UV light.
Future recyclability	NA	No information identified, however this is a uniform product that can be removed and potentially recycled
Patents and licensing		No issues identified

Potential size of opportunity

This market remains one of the largest contributors to domestic EOLT consumption. However, additional growth on the current consumption appears unlikely unless lifecycle benefits can be better articulated.

Size estimates (tonnes of EOLTs consumed)	Short term (2 years)	Med term (5 years)	Long term (10 years)
	18,800	20,000	22,100

Summary of opportunity and critical success factors

The market for soft fall surfaces from recycled rubber is very mature and well developed. This is a significant market in Australia, however there appears to be limited scope for significant additional tonnes, however protection of additional tonnes from cheap imports is a factor.

23.5 Manufacturing sector

Opportunity: Crumb rubber binders, glues and adhesives

Description: Highly refined crumb rubber (30 mesh, also known as rubber “powder”) can be used in any application where a polymer modified binder (PMB) is required. The largest segment of this market is the tile adhesive market.

☒ National	☒ Victoria	☒ WA	☒ Tasmania
☒ NSW	☒ QLD	☒ SA	☒ ACT

Competition analysis

Competing products¹⁴⁹:

1. synthetic rubber (styrene-butadiene rubber (SBR))
2. thermoplastic elastomers (TPEs)
3. other synthetic polymer and co-polymers such as acrylonitrile butadiene styrene (ABS), styrene-acrylonitrile, styrene-isoprene-styrene (SIS) and ethylene-vinyl acetate.

Upfront cost / price		Recycled crumb rubber is cost competitive with market ready SBR which sells for around \$1,000/tonne and elastomers which range from \$600 – \$1,000/tonne ¹⁵⁰ .
Lifecycle cost / price		Crumb rubber has competitive overall lifecycle costs (as a product of upfront cost and longevity).
Efficiency		Limited evidence, however the manufacturing process appears largely the same with crumb rubber versus its competitors.
Quality and performance		Performance is largely covered by Australian and international standards and all products must meet these standards. For example, tile adhesive is governed by ISO 13007-1:2014 Ceramic tiles – Grouts and adhesive (AS 4992).
Market scale / ability to meet demand		The market already services the tile adhesive industry well with developed relationships and products. As the largest current market for domestic recycling, future growth is likely to be met through these relationships.
Market readiness		The market is very mature in Australia.
Greenhouse gas emissions	NA	No information available
Longevity		Tile adhesives with crumb rubber are less prone to cracking due to increase flexibility ¹⁵¹ . They must meet the requirements of the standard for performance and adhesion.
Future recyclability	NA	Likely to become part of C&D waste stream as would other tile adhesives.
Patents and licensing		No issues identified

¹⁴⁹ Note we have not compared crumb rubber to Portland cement as this remains the primary ingredient in all tile adhesives whether they contain SBR, crumb or other PMBs

¹⁵⁰ Note these are based on 2012 prices released by [AK Elastomer](#)

¹⁵¹ Tyrecycle January 2015 ‘Tyres take on a new surface’ Online [press release](#)

Potential size of opportunity

Whilst the market for crumb rubber adhesives is mature there is scope for further uptake and product development (our research suggested around 10-20% of tile adhesives contain crumb rubber). The current market is estimated at 5,000 – 10,000 tonnes per annum

Size estimates (tonnes of EOLTs consumed)	Short term (2 years)	Med term (5 years)	Long term (10 years)
	17,500 tpa ¹⁵²	20,900 tpa ¹⁵³	28,300 tpa

Summary of opportunity and critical success factors

The tile adhesive market is reportedly the largest domestic recycling market in Australia. REC estimates that around 10,000 tpa is already consumed by this market. Despite this maturity, many adhesives are still manufactured purely with Portland cement suggesting further penetration, particularly into premium adhesives is possible.

23.6 Steel manufacturing

Opportunity: Crumb rubber injection into electric arc furnaces

Description: Highly refined crumb rubber (30 mesh) is used to replace a portion of coking coal in electric arc furnaces that produce steel.

☐ National	☒ Victoria	☐ WA	☐ Tasmania
☒ NSW/ACT	☒ QLD	☒ SA	☐ NT

Competition analysis

Competing products:

1. coking coal.

Upfront cost / price		Recycled crumb rubber is around double the cost of hard coking coal which currently sells at approximately \$250/t ¹⁵⁴ .
Lifecycle cost / price		Reduction in electricity costs of around 3% from the introduction of crumb rubber and 16% reduction in use of coking coal offsets the additional upfront costs ¹⁵⁵ .
Efficiency		Significant efficiency improvements with use of crumb rubber leading to a reduction in electricity usage of 12 – 18 kWh/tonne ¹⁵⁶ .
Quality and performance		The use of crumb rubber injected into the steel making process improves slag foaming ability which in turn offsets coking coal requirements.
Market scale / ability to meet demand		Limited number of EAFs in Australia and these are already using some crumb rubber. The market is capable of responding effectively to current and future demand.
Market readiness		The market is limited but already using this process.

¹⁵² Current estimate of market size based on industry feedback

¹⁵³ [Tile Today 2015](#). 'Ceramic tile imports: new record levels in 2015'. Tile market in Australia growing at around 10% per annum according to Tile Today plus an assumed 5% increased penetration

¹⁵⁴ [ABC News](#) September 13, 2016. 'Coking coal price shoots up taking markets by surprise' ABC Online

¹⁵⁵ [The Australian](#), November 8, 2008. 'OneSteel runs with tyres in steel', The Australian Online

¹⁵⁶ ABC Radio interview with [Veena Sahajwalla](#)

Greenhouse gas emissions		Reduction in electricity usage will lead to a direct greenhouse gas saving in all Australian jurisdictions. In Victoria, a reduction of 18kWh/t equates to a GHG saving of around 21kg CO ₂ -e ¹⁵⁷ .
Longevity	NA	Consumed during the steel making process
Future recyclability	NA	Consumed in the process
Patents and licensing		Patents remain a constraint to expansion of the market with an existing patent in place. Would require a license agreement through existing patent.

Potential size of opportunity

The local market is relatively small with only 3-4 EAFs operating in Australia. The potential closure of Whyalla will reduce capacity significantly. Current market consumption estimated at around 2,000 tpa of crumb rubber (around 3,600 tpa of EOLTs)¹⁵⁸

Size estimates (tonnes of EOLTs consumed)	Short term (2 years)	Med term (5 years)	Long term (10 years)
	3,800 tpa	4,000 tpa ¹⁵⁹	4,400 tpa

Summary of opportunity and critical success factors

The application of crumb rubber injection into EAF steelmaking is highly innovative and demonstrates the value of recycled tyres as a source of carbon. However, the market is limited and likely to be at the point of decline in Australia due to closure of steelmaking facilities.

¹⁵⁷ Cool Australia 'Calculating greenhouse gas emissions' - Victoria has the highest emission factor from electricity generation due to dependency on brown coal. Factor of 1.17 used as referenced by [Cool Australia](#)

¹⁵⁸ Estimates based on OneSteel figures of 1.4 million EPU's consumed over 5 years between 2008-2013.

¹⁵⁹ Assumed that this market will not grow unless BlueScope Steel licenses the technology

23.7 Energy from waste sector

Opportunity: Tyre-derived fuel in domestic cement production / electricity generation

Description: TDF used as fuel in thermal facilities in Australia, for example cement production or energy production, typically as a replacement for coal.

☒ National	☒ Victoria	☒ WA	☒ Tasmania
☒ NSW/ACT	☒ QLD	☒ SA	☒ NT

Competition analysis

Competing products:

1. coal
2. gas.

Upfront cost / price		Domestically, the price of TDF is much lower than brown and black coal. Under current market conditions, TDF could be delivered free plus the cost of transport (assume around \$20/t) versus the current market price for thermal coal of around \$100/t ¹⁶⁰ .
Lifecycle cost / price		TDF performs well on price and efficiency, therefore is likely to have upfront and lifecycle cost savings.
Efficiency		TDF has a calorific value of around 30 – 32 MJ/kg ¹⁶¹ , which is similar to high quality black coal but 3 times higher than brown coal commonly used in Australia (particularly Victoria) ¹⁶² .
Quality and performance		Quality of cement outputs remains the same when TDF is used as a fuel source. In addition, in cement kilns, ash associated with TDF has less heavy metals than ash from straight coal combustion ¹⁶³ .
Market scale / ability to meet demand		The market is already producing and exporting almost 120,000 tpa of TDF for international markets. The ability to scale up to serve domestic markets is already present in the current capacity.
Market readiness		There is existing precedent in Australia with Blue Circle Southern Cement utilising a reported 14,400 tpa of TDF ¹⁶⁴ prior to the closure of its Waurin Ponds clinker facility. However, it is likely that upgrades to fuel feed systems in excess of \$1 million would be required for each facility using TDF as fuel ¹⁶⁵ .
Greenhouse gas emissions		The GHG emissions profile depends on which fuel TDF is replacing. However, according to a recent study by the Australia Tyre Recyclers Association (ATRA), each tonne of TDF used saves 1.16 t/CO ₂ e compared to brown coal and 1.05 t/CO ₂ e compared to

¹⁶⁰ [Australian Mining News](#), October 25, 2016

¹⁶¹ Estimates range from around 28MJ/kg - ETRMA 2011, '[End of life tyres - A valuable resource with growing potential - 2011 edition](#)', European Tyre & Rubber Manufacturers' Association, Brussels to as high as 34MJ/kg - JATMA, 2012, '[Tyre LCCO2 Calculation Guidelines Ver 2.0](#)', Japan Automobile Tyre Manufacturers Association, Tokyo – we have presented an average range accordingly

¹⁶² Warnken ISE, 2017 – '[Carbon Value Proposition: Resource Recovery using Tyre Derived Fuel](#)', Australian Tyre Recyclers Association.

¹⁶³ As above

¹⁶⁴ Concrete Concepts Case Study (no date) '[Alternative fuels use at Waurin Ponds, Victoria cement plant](#)'

¹⁶⁵ As above, case study notes Blue Circle invested some \$2.6 million in 1994. Industry sources suggest current range of \$1m - \$2m per facility.

		brown coal. However, TDF performs worse than gas with an increase of around 0.14 t/CO ₂ e per tonne of TDF ¹⁶⁶ .
Longevity	NA	
Future recyclability	NA	
Patents and licensing		Not likely to be an issue as TDF is used widely around the world.

Potential size of opportunity

There is currently no local market for TDF use as the only facility capable of using it was closed circa 2013. However, Australia consumes some 136,000,000 tonnes of coal per annum¹⁶⁷ suggesting even minor market penetration would consume significant amounts of EOLT. However, we note that Australia is shifting toward a clean energy future and any use of TDF locally is unlikely over the Strategy period.

Size estimates (tonnes of EOLTs consumed)	Short term (2 years)	Med term (5 years)	Long term (10 years)
	1,000 tpa	1,000 tpa	1,000 tpa

Summary of opportunity and critical success factors

The export market for TDF is around 10 times larger than all other TDP markets in Australia. Even a minor penetration into the domestic market for coal would consume a significant amount of EOLTs. Whilst energy recovery is lower on the waste hierarchy than materials recycling, a domestic energy recovery market could augment current and future markets for crumb and granule. The push for lower emissions intensity in energy generation may be a key driver in realising this opportunity and as such REC has deemed it unlikely.

Opportunity: Production of oil from tyre pyrolysis or gasification¹⁶⁸

Description: EOLTs are used as the primary feedstock in pyrolysis, gasification or other chemical destruction processes to recover oil, gas and carbon.

☒ National	☒ Victoria	☒ WA	☒ Tasmania
☒ NSW/ACT	☒ QLD	☒ SA	☒ NT

Competition analysis

Competing products:

1. diesel
2. bunker oil.

Upfront cost / price		There is currently no commercial scale production of pyrolysis oil in Australia and as such prices are hard to gauge. The price also depends on the level of refinement undertaken by the producer. Low quality bunker oil in Australia ranges from around \$400/t to
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¹⁶⁶ Warnken ISE, 2017 – '[Carbon Value Proposition: Resource Recovery using Tyre Derived Fuel](#)', Australian Tyre Recyclers Association.

¹⁶⁷ The Energy Consulting Group '[Australia Oil and Gas Overview](#)', US Energy Information Administration figures for 2012 quoted.

¹⁶⁸ Note: The analysis of products from pyrolysis and gasification has been limited to oil and carbon. Electricity generation is covered earlier and synthetic gas is largely used to power the plant in order to produce oil and / or carbon

		\$840/t depending on quality and port location ¹⁶⁹ . Wholesale stationary diesel costs around \$1.18/litre ¹⁷⁰ .
Lifecycle cost / price	NA	Market operates on upfront cost
Efficiency	NA	Further research required
Quality and performance		Quality and performance is dependent on the effectiveness of the pyrolysis process and the level of refinement undertaken before sale. There are existing standards for both diesel and bunk oil performance. Market ready diesel blended with 10% pyrolysis oil has been found to result in increased brake thermal efficiency and lower brake specific fuel consumption ¹⁷¹ . Further investigation is required.
Market scale / ability to meet demand		The lack of commercial scale facilities at this stage suggests the current market is unable to provide supply.
Market readiness		There is significant public interest in pyrolysis oil from tyres and industry sources suggest testing at two oil refineries has indicated very positive results. Offtake agreements have reportedly been signed for pyrolysis oil from at least three proposed facilities ¹⁷² .
Greenhouse gas emissions		Further investigation is required, however a recent study by Queensland University of Technology found pyrolysis oil blended with diesel has the same performance but with lower levels of NO _x compared with regular diesel ¹⁷³ .
Longevity	NA	
Future recyclability	NA	
Patents and licensing		Not likely to be an issue as pyrolysis facilities can be purchased “off the shelf”

Potential size of opportunity

Bespoke tyre pyrolysis facilities are scalable but commonly have a capacity of around 20,000 tpa. Depending on the process, this can produce around 8 million litres of pyrolysis per annum¹⁷⁴. The size of the opportunity depends on the degree with which commercial scale plants become operational.

Size estimates (tonnes of EOLTs consumed)	Short term (2 years)	Med term (5 years)	Long term (10 years)
	0 tpa	13,400 tpa ¹⁷⁵	38,000 tpa ¹⁷⁶

Summary of opportunity and critical success factors

The development of tyre pyrolysis facilities is advancing rapidly with at least 3 facilities now operational at development scale. Based on the assumption that these facilities

¹⁶⁹ Ship & Bunker ‘[Pacific Bunker Prices 15 February 2017](#)’

¹⁷⁰ Australian Institute of Petroleum ‘[Terminal Gate Prices 15 February 2017](#)’

¹⁷¹ Patel et al 2013. ‘[Performance studies of Tire Pyrolysis Oil blends with Diesel Fuel](#)’ *International Journal of Engineering and Advanced Technology*, Vol3, Issue 2, December 2013 pp219 - 221

¹⁷² Confidential Pers Comm during consultations.

¹⁷³ GDT 2016. ‘[Oil from recycled tyres has less emissions, but same performance](#)’. GDT Website, December 12 2016

¹⁷⁴ GDT 2016. ‘[Oil from recycled tyres has less emissions, but same performance](#)’. GDT Website, December 12 2016

¹⁷⁵ Assume one facility is operating at half capacity within 3 years

¹⁷⁶ Assume 2-3 facilities operating at full capacity within 10 years

progress to commercial scale within 5-years, the market could absorb as much as 60,000 tonnes per annum. However, the opportunity depends on the degree to which commercial scale plants become operational and REC has assumed more conservative estimates based on the time plants are taking to get to commercialisation.

Opportunity: Production of carbon black / char

Description: EOLTs are used as the primary feedstock in pyrolysis, gasification or other chemical destruction processes to recover oil, gas and carbon black / char.

☒ National	☒ Victoria	☒ WA	☒ Tasmania
☒ NSW/ACT	☒ QLD	☒ SA	☒ NT

Competition analysis

Competing products:

1. virgin carbon black.

Upfront cost / price		Further research is required as there are no commercial scale producers of carbon black from tyre pyrolysis in Australia. Prices for virgin carbon black are around \$1,300/t ¹⁷⁷ .
Lifecycle cost / price	NA	Further research required
Efficiency	NA	Further research required
Quality and performance		This will depend on the quality produced through the pyrolysis process. Carbon outputs can range from contaminated ash to char to good quality carbon black. In the market, carbon black must perform to national and international specifications.
Market scale / ability to meet demand		The lack of commercial scale facilities at this stage suggests the current market is unable to provide supply.
Market readiness		Research related to pyrolysis facilities in Australia appears to have focused more on oil products rather than carbon. The market will require priming and further development.
Greenhouse gas emissions	NA	Further investigation is required
Longevity	NA	
Future recyclability	NA	
Patents and licensing		Openly traded commodity

Potential size of opportunity

NA

Size estimates (tonnes of EOLTs consumed)	Short term (2 years)	Med term (5 years)	Long term (10 years)
	NA	NA	NA

Summary of opportunity and critical success factors

¹⁷⁷ Asian Carbon Industries 'OTC QB: ACRB April 2012'

Further work is required to understand the size and nature of carbon black / char markets in Australia. This will depend heavily on the process and the quality of the outputs from pyrolysis facilities.
