QUEENSLAND REGIONAL BUSINESS CASE FOR A CIRCULAR ECONOMY FOR USED TYRES

North & Far North Queensland

Executive Summary

July 2022

Australian Government Accredited Product Stewardship Scheme

TyreStewardship AUSTRALIA

Queensland regional business case for a circular economy for used tyres – North & Far North Queensland

Project:
UEP147

Client:
Tyre Stewardship Australia

Client contact:
Lina Goodman, CEO

Author:
Nathan Toovey and Nathan Malin
Urban Elements & Practice Pty Ltd

Quality information:

Document:	Queensland regional business case for a circular economy for used tyres – North & Far North Queensland final report
Reference:	UEP147-3 version 1.2
Date:	July 2022
Prepared by:	Nathan Toovey and Nathan Malin

Urban Elements & Practice Pty Ltd
ABN 41 164 939 968
Clifton Hill Victoria 3068
Phone: +61 432 391 835
nathan.toovey@urbanep.com.au

Commonly used abbreviations

Abbreviation	Description
COAG	Council of Australian Governments (since dissolved and replaced with National Cabinet)
DES	Department of Environment and Science (Queensland)
DTMR	Department of Transport & Main Roads (Queensland)
EOLT	End-of-life tyres
EPU	Equivalent passenger unit (as a unit of end-of-life tyre volumes) 1 EPU = 8 kilograms; 1 tonne = 125 EPU
FNQROC	Far North Queensland Regional Organisation of Councils
FTE	Full time equivalent (as a unit of employment)
LGAQ	Local Government Association of Queensland
NQROC	North Queensland Regional Organisation of Councils
OTR tyres	Off the road vehicle tyres (as used for mining, agricultural, earthworks and other applications)
SWQROC	South West Queensland Regional Organisation of Councils
TDF	Tyre derived fuel
TPA	Tonnes per annum
TSA	Tyre Stewardship Australia

Acknowledgements

The business case team recognises the input, expertise and time given by a range of organisations in supporting the preparation of this report. We unreservedly acknowledge the support, involvement and assistance of the following organisations:

- Tyre Stewardship Australia
- Local Government Association of Queensland
- Queensland Government
- FNQROC
- NQROC
- SWQROC
- City of Townsville
- Councils, businesses, government departments and other organisations that generously shared their knowledge, expertise and perspectives (as listed in Appendix 1).

Executive Summary

Introduction

The north and far north of Queensland – bounded by the North Queensland Regional Organisation of Councils (NQROC) and Far North Queensland Regional Organisation of Councils (FNQROC) respectively – are important and diverse regional economies with a growing interest in achieving greater success in recycling. The two regions have flagged tyre recycling as a priority for better environmental outcomes and job creation, predicated on establishing cost efficient and resilient supply chains and end markets for end-of-life tyres.

At present, the majority of end-of-life tyres arising in the two regions are transported to southeast Queensland for recovery in various ways, with a significant minority that may not be recovered or disposed of to landfill. This remaining fraction is understood to be stockpiled at the point of generation, illegally disposed of in the surrounding landscape, or in the case of large off the road (OTR) mining vehicle tyres, buried in mining pits.

There is the opportunity to do better, both in terms of establishing more efficient tyre recovery models for the 5,590 tonnes of tyres currently being processed from the regions each year; and in shifting the balance of tyres managed through recovery in preference to less sustainable stockpiling, burial and disposal practices.

This business case shows that there is no reason to neglect the untapped resources stored within the tyres of cars, trucks, buses and large OTR vehicles such as tractors, earthmovers and roadworks vehicles. Moreover, there are options at hand for north and far north Queensland to encourage a regionally based tyre recycling solution that delivers superior outcomes for their communities, pending the commitment to realise the option through actions applied in concert.

A regional tyre recycling solution provides superior results for north and far north Queensland in terms of:

- Capital investment in Queensland's north, in the order of $5 million in tyre recycling capacity and related infrastructure
- Regional employment outcomes in the order of 10 to 20 FTE, including the development of new skills that are transferable into other technical industries[1]
- Economic diversification and the creation of local business opportunities
- Retention of resources for use within the region, estimated at up to $5.2 million in annual value, and substituting for virgin materials that originate from outside the region
- Savings in the form of reduced costs to haul end-of-life tyres to recovery facilities in southeast Queensland, in the order of $500 per tonne, which may help to reduce incentives to stockpile or illegally dispose of tyres using rogue service providers.

The full capture of these benefits will require that a number of barriers to regional tyre recycling are dealt with, and a failure to take action will ensure the status quo continues. This business case has systematically identified those barriers relevant to the adoption of tyre recovery services; investment in services and infrastructure along the recovery supply chain; and the uptake of products using tyre derived materials in end markets within the state of Queensland.

A coordinated package of actions is recommended to address each market impediment in turn, and set the north and far north of Queensland on a path towards a circular economy for used tyres. To be clear, any residual barriers – such as uncertain demand for tyre recycling services and end products – may be interpreted as an undue market risk that blocks investment in a solution. A full and comprehensive approach is essential to stimulate a new tyre recovery industry in the north of the state.

[1] These employment estimates are based on figures provided during tyre recovery industry engagement.

Should the recommended actions in this business case be adopted through a coordinated approach, a regionally based tyre recycler will be able to count on favourable conditions across its supply chain and markets. This will lift confidence in and bring forward the necessary private investment, and then allow the recycler to refine a niche business model for regional recycling that may be progressively rolled out to other parts of the country.

End-of-life tyres as an early priority for regional circular economies

Through their regional resource recovery plans, many regional organisations of councils in Queensland are looking into options to move to circular economy models. Such models place emphasis on extracting greater economic and social value from materials circulating through their regional economies. The shift to circular economies is one of three priorities set out in the Queensland Waste Management and Resource Recovery Strategy.

One avenue to achieve this end is to adopt stronger measures to divert material from landfill, and stoke local demand for these materials as an input to economic activities downstream of a recovery facility. The business case suggests that tyres present a prime candidate for regional organisations, councils and businesses in the north and far north of Queensland to achieve early successes in the transition to a circular economy. This view is shaped from the following observations:

- Current unsustainable practices in managing end-of-life tyres reflect a common problem for which a regional solution may be suitable
- Activities for handling and collecting end-of-life tyres involve manageable levels of complexity – tyres are a consolidated, relatively clean stream with maturing end markets – compared with commingled and/or more highly dispersed waste streams
- Commonwealth and Queensland Governments have both pledged funding for the improved management of end-of-life tyres, in line with helping the community to adjust to the ban on exporting whole or baled waste tyres
- TSA is an established and high performing product stewardship organisation with a pronounced focus on achieving regional outcomes away from larger population centres and spheres of economic activity
- The end markets for tyre derived product substantially involve public procurement measures at the local, regional and state tiers of government, giving local councils and the state government a direct means to drive demand for tyre recovery services.
- In past months, mining companies have expressed an evolving interest in recovering their large OTR tyres, which may be a means to augment the volume of tyres available for recovery, while delivering economies of scale to support investment in a regional solution.

On this basis, circular economy leaders and their stakeholders may consider the merits of regional tyre recovery as an entry point or test bed for circular economy approaches that may then be applied more widely to other products and materials.

Purpose of the business case

This business case aims to shed light on the extent that end-of-life tyres (EOLT, or waste tyres) are a problem in regional Queensland, based on prevailing management practices. It aims to test a range of commercially-led options to alleviate this problem, and which may be enabled through various forms of support and intervention.

Across Queensland, about 112,000 tonnes of end-of-life tyres arise each year, including tyres from passenger cars, trucks and off the road vehicles (used in mines, agricultural land, Defence installations, and on road and civil works projects). Of this quantity, about 67,000 tonnes or 60% are presently being recovered by recycling facilities concentrated in the state's southeast.

While there is no region-specific data for the total volume of end-of-life tyres generated in the north and far north each year, waste tracking data suggests that 5,590 tonnes are collected and processed from the NQROC and FNQROC council areas, using facilities in southeast Queensland.

In the absence of a tyre recovery rate for these regions, application of a 60% recovery rate (from state figures) without modification suggests that about 3,400 additional tonnes of end-of-life tyres are generated without being retrieved for recovery. The lack of tracking data for this volume suggests these tyres are being stockpiled, buried in mining pits, or illegally dumped.

The recovery rate may be somewhat less than this state-based 60% figure, due to obstacles arising from low quantities and large distances. While tyre recovery is currently occurring to some extent in regional Queensland, there are some concerns relating to:

- Low levels of recovery from some sectors and more remote geographies
- Persistent occurrences of illegal dumping activity
- Limited consideration of the efficiencies, outcomes and risks in relation to one recovery solution over another, which may indirectly impact the cost, stability and environmental benefit of recovery services used by end-of-life tyre generators in regional Queensland.

This work unpicks the barriers and challenges that block regional Queensland from accessing more sustainable and value-oriented methods to manage end-of-life, and sets out alternative options to recycle tyres arising from the regions in line with their benefit and cost profiles.

As requested by TSA and for the purposes of this business case, this work concentrates its analysis and findings on three regional areas of Queensland including regions bounded by:

- The South West Queensland Regional Organisation of Councils (SWQROC)
- The North Queensland Regional Organisation of Councils (NQROC)
- The Far North Queensland Regional Organisation of Councils (FNQROC).

After an initial analysis of the regions, it was determined that the regions could be analysed in terms of tyre recovery options and solutions for two areas, i.e.:

i) The SWQROC region as a single end of life tyre catchment; and

ii) The NQROC and FNQROC regions, treated as a combined end-of-life tyre catchment.

This split structure recognises the potential for a northern located facility to process tyres from FNQROC and NQROC as a single combined market (or catchment); whereas tyres arising from the SWQROC region are isolated by geography from the other two areas and are to be treated as a separate market involving much smaller quantities of tyre material.

Challenges in recovering tyres in regional Queensland

In undertaking this business case, a number of challenges for recovering end-of-life tyres from regional Queensland have come to light. These include to varying degrees across the regions:

- Large distances and small volumes across generators (e.g. tyre retailers, mechanic shops, car dealerships, public and commercial fleets) that are associated with remote locations, creating unfavourable transport overheads and limited scale economies which lead to high costs and/or poor access to tyre recovery services[2]
- Somewhat limited and disconnected resource recovery infrastructure networks in locations further away from main population and economic centres, which are not optimised for the efficient transport and consolidation of regional tyre volumes
- Regulatory gaps in collection and related tracking, allowing rogue collectors to set up business to collect tyres without adequate oversight to ensure their destinations involve legitimate disposal and/or recycling activities
- Lack of incentives to end stockpiling of large OTR tyres (e.g. removed from tractors and other farming vehicles) on agricultural properties
- Limited drive for shifting mining operations away from in pit burial of OTR tyres, combined with a lack of signals for the market to provide mining tyre recovery services
- Insufficient monitoring and enforcement of illegal dumping activities in more remote locations, such that there is limited private cost in opting for illicit disposal practices
- Incomplete vision and commitment to the use of tyre derived materials in local applications (even where standards and specifications allow for the use of such materials as a commercial input), which could otherwise help strengthen the case for regional tyre recovery
- Limited knowledge across the tyre recovery industry, regarding the commercial potential in dedicating focused operations in service to the north and far north of Queensland
- Limited price transparency for those accepting end-of-life tyres on behalf of a third party (e.g. transfer stations and tyre retailers that accept end-of-life tyres from vehicle owners), where the fees charged may not accurately reflect the true cost of recovery.

Additional to the above region-specific challenges, a number of issues are presently impacting the tyre recovery sector more generally. These include, for example, the need to respond to a ban on exporting whole end-of-life tyres and the recent rise in international shipping costs (which affects the use of tyre derived fuel in boilers, kilns and furnaces located throughout Asia).

These broader trends and developments add to the above listed regional challenges for tyre recovery. Yet this business case establishes that the impediments to better tyre recovery solutions for north and far north Queensland are not insurmountable. Rather, they can be overcome through a combined set of actions that signal a strong commitment to tyre recycling outcomes, and draw private operators to the profitable opportunities at play.

Northern Queensland's unique advantages for tyre recycling businesses

Against this backdrop of challenges, there are a number of positive factors in support of tyre recovery services tailored to north and far north Queensland. These include:

- A growing interest in a solution that best fits the region, alongside a willingness to collaborate at the regional scale, across councils and regional organisations active in the north and far north
- The Queensland Government's increasing levels of organisation towards and support for regional circular economy outcomes, as evidenced by its investment in regional resource recovery plans and other measures across the state

[2] https://bundabergtoday.com.au/news/2022/03/28/queensland-farms-becoming-dumping-grounds/

- As yet, the northern coastal and Cape York Peninsula parts of Queensland lack a regional facility, whereas the market for tyre recovery services in southeast Queensland may be close to saturation
- Based on the business case findings, the volumes of readily available tyres from the more accessible parts of NQROC and FNQROC (i.e. exceeding 5,000 tonnes per year) should be ample to support new facilities that specialise in tyre recovery from the region, which may compete on the basis of avoided long distance transport costs.

Responding to these regional advantages, new entrants in the tyre recycling sector have stated an interest in establishing operations in regional markets that are yet to become saturated, including north and far north Queensland, pending an environment conducive to investment.

This business case offers a clear and shared base of evidence from which to form decisions and establish a common agenda towards better tyre recycling outcomes in north and far north Queensland, helping partners to build an investment-attracting environment.

The opportunity for enhancing the recovery of OTR tyres

The FNQROC and NQROC regions may include or may be adjacent to commercial activities that generate large quantities of OTR tyres such as:

- Large bauxite mining operations at Weipa on the Cape York Peninsula
- Coal mines located in Bowen Basin, 500 to 700 km south of Townsville
- Mines near Cairns and Townsville and in the Charters Towers Shire Council area
- Cane growing and cotton growing interests in and near north and far north Queensland.

A majority of these generators currently stockpile OTR tyres on premises or bury them in mining pits, degrading the environment and failing to recover the substantial resources locked up in large tyres.

The availability of these tyres may not be critical to the long term commercial viability of a tyre recovery solution for the north and far north, but may be very useful in terms of providing a stable long term inflow of materials and recycling fee revenues that strengthen the case for investment in related infrastructure.

However, a dedicated OTR tyre recovery solution needs to factor in one or more mechanical processing stages at the front end, prior to receival at a facility designed to accept and process passenger car and truck tyres. This upstream stage is needed to ensure the OTR tyres are in a compatible form (e.g. shredded or sectioned), and may involve additional recycling fees for the OTR tyre generator.

There is no single recommended straightforward path to enable OTR tyres to feed into a regional tyre recovery solution, given dependencies around: source sectors; OTR tyre sizes and quantities; transport distances; requisite specifications dictated by downstream operations; and price tolerances around recycling fees charged to OTR tyre generators.

Moreover, engagement with source industries around a preferred solution and recycling outcomes that align with corporate responsibilities needs to occur, to ensure recovery operators are able to deliver results that comply with minimum corporate standards.

A more targeted industry engagement plan and technology-oriented business case is recommended to ensure a regional OTR tyre recovery solution is fit for purpose and connects with regional stakeholders' needs. This business case should test commercial arrangements amenable to the OTR tyre generator and the tyre recovery operator alike, factoring in features specific to the OTR tyre source and surrounding parts of the recovery supply chain.

Benefits of recovering end-of-life tyres

A range of benefits to north and far north Queensland arise in more fully recovering tyres, and shifting further away from practices involving mining pit burial, illegal dumping, and long term stockpiling.

While a majority of tyres of around 60% is assumed to be recycled through services in southeast Queensland, the remaining 40% of tyres represents a significant quantity dispersed across the countryside in public land, farming properties, and mining tenements. Significant benefits may emerge from the use of an updated approach to regulation and incentive frameworks that are fundamental to well functioning tyre recovery markets.

Environmental benefits

Environmental benefits from greater tyre recovery include the following, coming into play irrespective of whether the greater share of recovery occurs locally or via distant operations:

- Recovery of resources that will otherwise be lost from the productive economy
- Reduced exposure to harms caused by illegal tyre dumping and stockpiling including:
  - Risk of fire and costs associated with fire incident responses
  - Degraded natural environs and species habitats
  - Lost visual amenity, and reduced enjoyment of contaminated landscapes
  - Breeding grounds for vermin and animal and human disease vectors
- The opportunity to set an example and lift the accepted standard for managing end of life products and materials
- Better custodianship of land that has been leased to mining companies, realising tyre management outcomes in line with a 'caring for country' ethos.

Efforts to raise the level of tyre recycling may need to go hand in hand with effective regulation and enforcement against illegal dumping and restrictions against burial options, to stop leakage away from the recycling supply chain as led by rogue actors and others seeking to avoid responsibility for their waste streams.

At the same time, the availability of cost effective recycling services helps to lower the incentive for illegal services and business models, by ensuring that recycling fees for legitimate and trustworthy solutions are priced within affordability. Affordable and readily accessible tyre recovery services shrink the opportunity for rogue operators to undercut the market, and weaken the case for generators to avoid or defer the use of tyre recovery services.

Economic benefits

Economic benefits for the north and far north stem from expanded tyre recovery services offered to local businesses, individuals and councils. The scale of local benefit will largely mirror the extent that tyre recovery services are based in the region as opposed to being located elsewhere such as southeast Queensland, and are therefore solution-dependent.

For example, a completely local tyre recycling supply chain that recovers tyres from across the north and far north of Queensland may yield up to 20 direct ongoing full time positions in regional locations. These positions will involve practical skillsets that will prepare the workforce for wider employment opportunities, while offering a level of stability linked to the ongoing supply and demand for resources recovered from tyres. Local employment will be much lower if operations based in the region are limited to handling and consolidation jobs prior to freighting tyres to economic centres based in the southeast of Queensland.

Additional economic benefits from a major lift in tyre recovery through recycling operations based in the region (i.e. in or near Townsville) include:

- The recovery of economically useful resources, worth up to $5.2 million in annual value (assuming the main products come from a crumbing and granulation facility with focused production of rubber crumb, rubber granule and recovered steel)

- The allocation of up to $5 million in financial capital to the regional economy, as needed to construct and commission a main tyre recycling facility in or near Townsville
- The annual retention of 1,700 to 2,000 tonnes of locally recovered steel and 3,900 to 6,300 tonnes of high value rubber commodities for use in the regional economy, displacing the need for customers to import equivalent virgin materials from other parts of the country or from international suppliers
- Avoided costs from sending end-of-life tyres to southeast Queensland, with a net reduction in costs in the order of $500 per tonne or $2.8 million to $4.5 million per year (assuming 5,600 to 9,000 tonnes locally processed each year).

These outcomes stress the greater economic benefit in committing to and supporting a local model for increased tyre recovery, over and above the environmental benefits explained above.

The combined environmental and economic benefits underscore the value of adopting a regional circular economy model for end-of-life tyres, wherein partners collaborate across end markets and supply chains to ensure as much material is retained for local economic use as is warranted, with proactive support to drive demand for tyre derived products.

Recovery options in detail

In investigating different options to improve tyre recycling from the north and far north of Queensland, the business case took the opportunity to explore passenger car and truck tyre recovery according to:

- Commercially available technologies and their end markets, including:
  - Shredding to around 50 to 150 mm fragment size, for use as a tyre derived fuel
  - Grinding tyres to a smaller particle granule (for use in niche flooring and surfaces and civil applications) or crumb rubber (for use in road construction and maintenance) alongside recovered steel sold into scrap metal markets[3]
  - Pyrolytic decomposition into carbon char, fuel oil and recovered steel, sold into relevant commodity markets and industrial processes (e.g. roadworks)
- Potential location of domestic and international buyers (relevant to tyre derived fuel only)
- Potential to operate a facility in northern Queensland or continue to rely on operations based in southeast Queensland.

In short, the following configurations of technology, end market and location were deemed the most likely pathways to improve tyre recovery from north and far north Queensland, and were therefore analysed in detail in this business case. This determination is based on their technical capacity to process commercial volumes of tyres at competitive prices; the presence of stable and/or growing markets for their products; the presence of supporting and/or complementary commercial activities, and other factors relevant to a Queensland market context.

[3] While a crumbing and granulation plant would also have the means to produce tyre shred, it is unlikely that this would be the main product recovered from a crumbing and granulation plant as such a facility would be an example of over-capitalisation for this product compared to a facility that produced shred only. For these reasons, crumbing and granulation is treated as entirely distinct from shredding in this analysis.

Technology	Products	Potential facility location(s)
Shredding plant selling to offshore customers	Tyre derived fuel (for energy users abroad)	Southeast Queensland (existing)
Shredding plant selling to Australian customers*	Tyre derived fuel (for domestic energy users)	Southeast Queensland (existing)
Crumb and granulation plant	Rubber crumb, rubber granule and steel	Southeast Queensland (existing) North Queensland (new operation)
Pyrolysis plant	Carbon char, fuel oil and steel	Southeast Queensland (existing) North Queensland (new operation)

* See further explanation in the text below.

However, the option to shred tyres and sell to a domestic energy buyer (marked with an asterisk above) underwent a partial investigation only, due to a lack of market precedents on which to base a confident assessment of supply chain and market risks. The absence of historic buyers in the Australian market prevented a full financial analysis of this option. The report therefore focuses on a discussion of issues and factors for interested parties to attend to in exploring this option further.

The sections below outline key findings from a more in depth analysis contained in the main report. Taken together, the findings point to preferred options to recover tyres from the north and far north Queensland, while setting out the actions needed to address one or more barriers to investment and commercial operation.

Indicative profitability of tyre recovery options

In conducting a comparison of alternative options, a key consideration is whether a given model to recover tyres from the regions represents a cost effective solution.

For the purposes of this business case, cost effectiveness was compared by building a financial profile of the different options investigated, factoring in underlying supply chain costs and the availability of revenues from the sale of products and recycling fees. To enable a fair comparison across options, a uniform recycling fee of $12 per passenger car tyre was applied and it was assumed that tyres were collected from sources in the vicinity of Townsville Regional Council.

Other parameters were as determined according to the technologies, products and end markets in question, and the transport overheads related to regional versus southeast Queensland siting.

The business case recognises that any commercial operator will need to retain a margin above and beyond operating costs, both to deliver profits but also to account for a range of additional business pressures and needs outside of its physical operations. This is treated as a 'surplus net of recycling', i.e. a margin that allows the business to grow over time, deliver returns to shareholders, and weather commercial unknowns that are challenging to predict over the medium to long term.

In principle and for a given recycling fee (as described above), this potential margin serves as an indicator of the cost effectiveness of one recovery pathway over another, and the capacity of the supply chain to withstand less favourable market conditions. For each of the recovery options included in this business case and treated with a set of market-relevant operating assumptions, the figure below sets out projected margins per tonne of tyres processed. A key take away from this figure is that solutions with a higher margin are better positioned to outcompete those with a lower margin, all else being equal. That is, they are reflective of a more economically efficient recovery pathway for the region.

(While the business case looked at the option to recover tyres as a waste derived fuel for domestic cement kilns, an inability (due to a lack of reliable data) to perform a quantitative financial analysis on this option means that it has not been included in figure 1)

Margins net of core operations (mid range value)

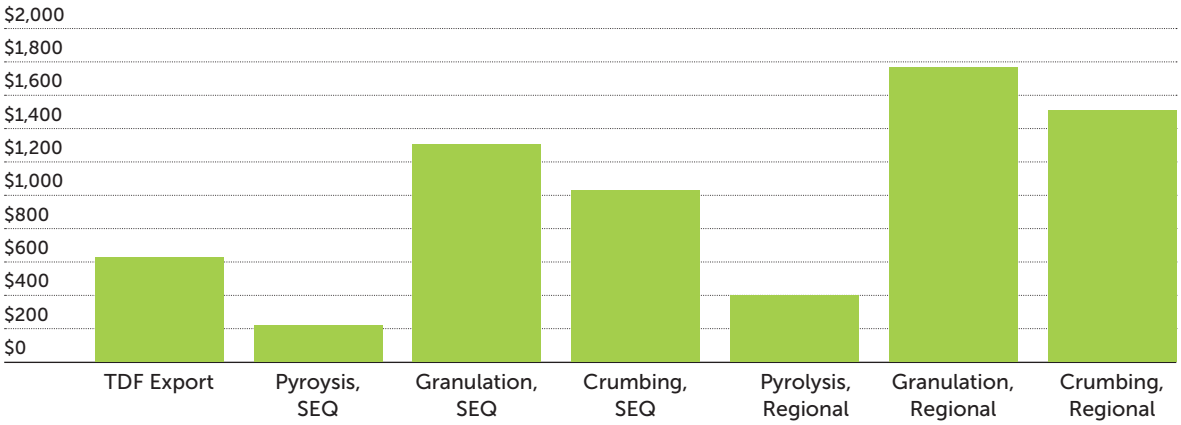

Figure: Mid range surpluses (per tonne) net of recycling operations, estimated for seven recovery pathways for end-of-life tyres generated in the NQROC and FNQROC regions. This chart assumes a recycling fee of $12 per EPU for tyres recovered from NQROC. While there are larger transport costs involved in processing tyres from FNQROC, it is assumed that this is fully offset through a slight increase in recycling fees.

Some factors that drive the observed margins and corresponding cost effectiveness include:

- The high capital costs of pyrolysis plants based in Australia and operating at relevant scales of throughput, combined with the production of commodities currently saleable at the lower end of the value spectrum, lead to low operating margins for this option at the present point in time.
- Although shredding has a comparatively low capital and operating cost profile, international buyers are presently paying low prices for tyre derived fuel (with limited chance of a lift in prices in the foreseeable future) while shipping costs have risen significantly since the Covid-19 outbreak. This results in a net cost to the shredding plant operator, which has to be recovered through recycling fees and leads to eroded commercial margins compared with other options examined.
- A crumbing and granulation facility has moderate to high capital and operating costs compared with shredding, but this is more than compensated by the value of products sold to domestic markets and the avoidance of international shipping overheads.
- In comparing regional operations to those based in southeast Queensland, there may be marginal scale economy advantages in operating a facility in southeast Queensland compared with a smaller regional facility. However, these advantages are more than offset in favour of a regional recycling facility, due to the avoidance of expenses related to freighting end-of-life tyres over 1,400 kilometres to a southeast Queensland facility. For a given recycling fee, a regional crumbing and granulation facility is expected to be more cost effective and profitable compared to a southeast Queensland facility, when undertaking a whole-of-supply chain financial analysis.

To summarise, the financial comparison exercise indicates that the most cost effective option for recovering end-of-life tyres from north and far north Queensland would involve a new crumbing and granulation facility based in or near Townsville. However, this is predicated on accessing an ample quantity of tyres to ensure the new infrastructure is used productively. Research suggests that tyres arising across the north and far north and in adjacent townships south of NQROC would be sufficient to meet this need.

A market analysis also suggests significant demand for crumb rubber and other products in regional markets in northern Queensland, although the operator may need greater certainty of buying volume in target markets such as road construction and niche flooring and surfaces.

In practice, the operator may need to sacrifice some of its margins (as above) in order to set a recycling fee low enough to outcompete other service providers currently based in southeast Queensland, and have confidence of achieving the necessary throughput to drive profitability. The business case finds that a regional facility could lower prices beyond the nominal $12 per passenger car tyre while still delivering a commercial surplus to investors. Other competing technologies with lower margins may have less latitude to lower their recycling service fees.

Supply chain and market strengths and weaknesses

A quantitative financial analysis provides partial insight on the commercial viability of different solutions to recover tyres from north and far north Queensland. Each supply chain may be exposed to a range of risks and opportunities, both as part of their operating circumstances and in response to evolving commercial environments. The business case sheds light on these wider factors through a descriptive process, with findings set out as advantages and disadvantages in the table across the following pages, along with actions to address key commercial weaknesses.

As a general rule, the key challenges for a regional crumbing and granulation facility revolve around gaining access to adequate supplies of end-of-life tyres and having certainty regarding the demand for its tyre derived products. For the most part, these are issues pertaining to commercial ramp up, and may be mitigated through a coordinated set of actions to drive market uptake at the upstream and downstream end of the supply chain.

A key advantage for a crumbing and granulation facility is that it allows the operator to pivot[4] between products and markets (subject to the selection and configuration of its componentry), whereas pyrolysis and shredding plants may be less able to pivot in response to shifting market opportunity and risk profiles. Shredding plants in particular appear to be geared towards large volume purchasers of tyre derived fuel, mainly located overseas, whose interest may be influenced by fluctuating freight costs, trade policies, exchange rates and other factors outside the direct control of either party.

Irrespective of the technology involved, the use of a regional tyre facility presents additional advantages beyond transport savings compared with a southeast Queensland operation, by virtue of its enhanced visibility to regional stakeholders and customers. Those looking to drive circular economy and related development outcomes in the north and far north may find it easier to leverage interest from commercial partners if they can point to a local physical presence.

[4] In principle, a crumbing and granulation facility also has the means to produce shred, e.g. for tyre derived fuel markets. However, it may struggle to compete with dedicated shredding facilities given the larger capital outlay needed for a crumbing facility versus a shredding facility.

Processing technology	End markets	Advantages	Disadvantages	Supporting activities
Shredding whole tyres to meet TDF specification • Larger scale existing facilities in southeast Queensland only *Likely applicable to passenger car tyres only*	Kilns, furnaces and boilers located in Asia (e.g. Malaysia, India)	• Operations well established at commercial scale • Limited capital costs and operating costs (per EPU) • High volume end markets	• Very low value product, often below cost to process • High cost to deliver to international end markets • Exposure to market risks – e.g. shipping cost volatility and access to containers, trade policy risks, currency exchange risk, limited visibility on downstream social and environmental impacts • Limited ability to pivot to more profitable products • Road freight costs in moving tyres to SE Queensland	Ongoing market and supply chain risk analysis to help tyre recovery industry participants plan market entry and market exit based on risk/return profile
Shredding whole tyres to meet domestic use TDF specification (assumed to be consistent with international TDF requirements) • Larger scale existing facilities in southeast Queensland • New regional facility processing 5,000+ tonnes/year *Likely applicable to passenger car tyres only*	Domestic alternative solid fuels (i.e. cement kilns, including cement manufacturing in Queensland)	• Operations well established at commercial scale • Limited capital costs and operating costs (per EPU) • Low cost to ship to target customer(s) *For existing SEQ facilities:* • Able to pivot from domestic to international buyers *For new regional facilities:* • Reduced transport cost in freighting TDF directly from region to buyer	• Customers yet to emerge, limited price discovery • Many sellers and few buyers – limited market influence • Ongoing risk of collapse in demand without notice • Limited ability to pivot to more profitable products *For existing SEQ facilities:* • Extensive transport of tyres south then product north *For new regional facilities:* • Commercial risk of capital relying on a single buyer	Facilitated engagement between cement industry, tyre recovery industry and regulators to reduce uncertainty and instability for those seeking to supply local waste derived fuel markets

Processing technology	End markets	Advantages	Disadvantages	Supporting activities
Pyrolysis to generate thermal desorption products (steel, carbon char, fuel oil) • Larger scale existing facilities in southeast Queensland • New regional facility processing around 5,000 tonnes/year *Applicable to all tyre types*	• Carbon char commodity markets • Low grade fuel oil applications • Recovered steel (scrap metal) market	• Able to take truck and passenger car tyres without separation • Multiple products allowing some level of market diversification *For existing SEQ facilities:* • Capital recovery spread across larger volume *For new regional facilities:* • Reduced transport cost for whole tyres to processor	• Unproven at commercial scale in Australia • Carbon char and fuel oil products yet to attract high demand levels • High capital and operating costs • Exposure to competition from global supply chains *For existing SEQ facilities:* • High transport overheads for tyres to processor *For new regional facilities:* • Potential lack of regional demand, requiring transport of products	Engagement with pyrolysis operators on the quality and volumes of main outputs, and their potential markets (including support for independent quality testing, if and when appropriate). Support with market development activities, pending capacity to reliably produce useful products of a given standard.
Granulation using rubber crumbing facility • Larger scale existing facilities in southeast Queensland • New regional facility processing 5,000+ tonnes/year *Applicable to all tyre types, although operator may tend to use passenger car tyres if able to remove nylon mesh from product streams.*	• Niche mats and flooring • Niche industrial products • Civil applications (permeable pavements; lightweight concrete) • Recovered steel (scrap metal) markets	• Well established at commercial scale • Higher margin products • Established and emerging markets for granule • Options to switch markets based on better returns • Option to switch to crumb products pending acceptance as a road input *For existing SEQ facilities:* • Able to leverage existing capacity & capital *For new regional facilities:* • Reduced transport cost for whole tyres to processor • Localised circular economy	• Significant capital costs and operating costs (per EPU) • Some markets yet to fully mature • Some potential challenges in removing and dealing with nylon mesh (depending on operator competencies) *For existing SEQ facilities:* • High transport overheads for tyres to processing plant *For new regional facilities:* • Demand uncertainty may defer or impede investment or increase financing costs	Ongoing market development targeting emerging applications (e.g. civil applications), to establish sustained market acceptance *For new regional facilities:* Pending interest from private investors, there may be a basis for public capital allocation, in recognition of residual commercial risks and positive spillovers to the region.

Processing technology	End markets	Advantages	Disadvantages	Supporting activities
Crumbing using a rubber crumb facility • Larger scale existing facilities in southeast Queensland • New regional facility processing 5,000+ tonnes/year *Applicable to all tyre types, although operator may tend to use truck and OTR tyres.*	• Crumb rubber modified spray seals and asphalts • Recovered steel (scrap metal) markets	• Well established at commercial scale • Higher margin products • Stable and growing road building markets for crumb rubber • Potential use in local / regional circular economy • Option to switch to granule products when market conditions suit *For existing SEQ facilities:* • Able to leverage existing capacity & capital *For new regional facilities:* • Reduced transport cost for whole tyres to processor • Localised circular economy	• Significant capital costs and operating costs (per EPU) • Potential that the market becomes flooded with crumb rubber sourced from passenger car tyres (as a potential downstream impact of flight from exported bale and TDF markets) *For existing SEQ facilities:* • High transport overheads for tyres to processing plant *For new regional facilities:* • Demand uncertainty may defer or impede investment or increase financing costs	Promotion and demonstration of road projects using crumb rubber in the two regions, to showcase crumb rubber in roads as a 'low hanging fruit' for those pursuing local circular economy outcomes Ongoing watching brief regarding cascading effects on the crumb rubber sector, in response to shifts in passenger car tyre recovery markets. For new regional facilities: Public capital allocation to new facility, in recognition of residual commercial risks and positive spillovers to the region. Proactive procurement of crumb rubber modified seals & asphalts

Value of recovered materials

Regional stakeholders may prefer to support a recovery model that generates higher value outputs, and that makes a greater contribution to the regional economy beyond diverting material from landfill, as opposed to support for a model in which the products hold marginal value and in which the economic utility of the recovery process may be called into question.

To this end, the table below sets out the value of recovered resources across the three main recovery technology and end market combinations studied in this business case. For simplicity, upper estimates of each commodity value are used, noting that caution needs to be exercised in interpreting the figures to allow for price fluctuations over a given period. Prices are treated as independent of facility location, i.e. in Townsville or in southeast Queensland, noting that a regionally located facility may lead to a retention of resources usable in local economic activity.

The figures in this table show that the recovery of tyres through crumbing and granulation may yield resources with an aggregate value in the range of $3.2 million to $5.2 million, depending on the recovery rate and throughput achieved. In the case of pyrolysis, this range sits between $0.9 and $1.5 million, although these estimates are qualified in recognition that tyre pyrolysis is an emerging sector in Australia and market information is therefore limited. In the case of shredding to produce a tyre derived fuel for sale to international buyers, this range is between $280,000 and $450,000 per year. However, market research during the business case reveals that some tyre shredding operators are willing to offload tyre derived fuel at no charge to the customer, so actual revenues from its sale may be substantially less than the figures used here.

Table: Market value of recovered materials for a given set of technologies and their recovered products.

Resource	Volume (60% recovery)	Sales	Volume (100% recovery)	Sales
Shredding to produce tyre derived fuel				
TDF (at $50/t)	5,590 tonnes	$279,500	8,990 tonnes	$449,500
Total		**$279,500**		**$449,500**
Crumbing and granulation				
Rubber granule (at $600/t)	1,260 tonnes	$756,000	2,280 tonnes	$1,368,000
Rubber crumb (at $800/t)	2,620 tonnes	$2,096,000	4,000 tonnes	$3,200,000
Steel (at $240/t)	1,720 tonnes	$412,800	2,720 tonnes	$652,800
Total		**$3,264,800**		**$5,220,800**
Tyre pyrolysis				
Carbon char (at $200/t)	1,400 tonnes	$280,000	2,250 tonnes	$450,000
Fuel oil (at $140/t)	1,680 tonnes	$235,200	2,700 tonnes	$378,000
Steel (at $240/t)	1,680 tonnes	$403,200	2,700 tonnes	$648,000
Total		**$918,400**		**$1,476,000**
Recycling fees (at $750/t)	5,590 tonnes	**$4,192,500**	8,990 tonnes	**$6,742,500**

Capturing the opportunity through coordinated efforts

This business case establishes that tyre recovery from the north and far north regions of Queensland could be improved in a number of ways. These improvements span the augmented supply of end-of-life tyres to strengthening the demand for tyre derived products, and may include points along the supply chain between these two extremities.

Irrespective of the tyre recovery solution serving the regions, there is a basis to tighten regulation and enforcement activities to lower leakage of usable tyre resources to other practices like illegal dumping. Similarly, end-of-life tyre transport and consolidation arrangements for more distant parts of the regions could be rendered more efficient, using a combination of back hauling, coordinated and shared use of collection services, and the use of transfer stations and other sites as a regionally functional resource consolidation network.

OTR tyres also provide a path to grow the volume of tyres available for recovery from the two regions (and in adjacent mining centres such as Bowen Basin), although more effort and engagement is needed to determine a sustainable commercial model and equipment suitable to allow large OTR tyres to work as a feedstock alongside passenger car and truck tyres.

This business case indicates that a regional crumbing and granulation facility may provide superior recycling and commercial outcomes compared to alternative options including the status quo reliance on facilities based in southeast Queensland. Such a facility may provide the basis for using recovered crumb rubber in nearby state and local government road building and maintenance projects, while helping to bypass unnecessary freight of tyres to southeast Queensland. Other products such as granule may also be used locally in some civil works or made available to buyers in the flooring and civil infrastructure sectors, based elsewhere in the country including southeast Queensland. Unlike other technologies investigated in this work, a crumbing and granulation operation focuses on higher end products and end markets, while allowing the operator to pivot from one product-market combination to another in line with trending demand levels and profit margins.

This facility could contribute to more sustainable road and other assets in the north and far north, while symbolising a regional circular economy model that uses an identified priority waste stream. However, private investment in a regional crumbing and granulation facility may be contingent on certainty that there are buyers – principally road building and maintenance teams (for crumb) and civil works and flooring manufacturers (for granule) – who are willing to take its products at an acceptable price.

Local and state road network managers have a role in proactively placing expectations on road construction and maintenance contractors to use crumb rubber as a binder material wherever suitable. Similarly, civil works procurement teams and engineers could include the exploration of rubber granule containing civil assets such as permeable pavements, playground and recreational/sporting field surfaces, and lightweight concrete composites used in movable bollards and other traffic control devices. TSA and the state government, in line with their roles in market development and industry stimulus, have access to a range of levers and experience to apply in creating, maturing and stabilising end markets at regional, state and larger scales.

Parties looking to invest in and operate a new regional tyre recovery facility may nonetheless face residual levels of risk, particularly during the early years of operation, when the amount of tyres received, processed and sold as products is ramping up and as other links in the supply chain configure to support the facility. There are also a range of environmental and planning approval hurdles that must be overcome before the construction phase. These factors represent risk to the project, which may lead to stalled investment and recovery service delivery.

To counteract this scenario, there may be merit in the Queensland Government providing a capital allocation to a new facility which will bring the risk-return profile of the investment to within commercial tolerances. The offer of co-funding over a limited timeframe may spur private investors to commit in the near term, rather than indefinitely park their investment plans.

Arguably, this public investment is additionally justified in light of the local and regional spillover benefits including private investment in the regional economy; creation of long term jobs; improved accessibility and affordability of tyre recycling services in remote locations; and potentially, reduced instances of illegal disposal and other negligent practices by virtue of having a more visible and regional tyre recovery solution.

In summary, the combined measures outlined above aim to signal a safe and compelling regulatory and market environment to attract investment in a regional facility, and grant confidence that the facility can generate ample returns over its operating lifespan. But in the absence of investment at the regional scale, above-stated measures that seek to encourage greater adoption of tyre recovery services (currently based in southeast Queensland) will deliver a more partial success, albeit with many of the economic benefits transferred to actors based in southeast Queensland and elsewhere.

Should a regional facility be agreed as a top priority for NQROC, FNQROC, their councils and the Queensland Government, the measures in the table below need to be taken on in full and delivered in a coordinated fashion. This will grant greater certainty of attracting a legitimate regional solution, while also providing for a collaboration model that may be reused and adjusted as necessary for other circular economy priorities of the NQROC and FNQROC regions.

The key benefit in taking a collaborative approach is in ensuring that the influence of different actions applied across each point in the supply chain – from point of generation to end market, and all points in between as necessary – will be reinforcing in nature.

It is hoped that this strategy will help tyre recovery in the NQROC and FNQROC regions achieve a tipping point, where tyre recovery is both maximally efficient yet resilient, and is seen as an appealing option for all end-of-life tyre generators active in the area. Moreover, should this approach be successful in attracting a regional operator servicing the north and far north, it will help to ensure that economic value and environmental benefits are retained in the north of the state while providing a template to apply in other areas of the circular economy.

Table 4: Overview of actions to address barriers and points of friction in improving tyre recovery from the NQROC and FNQROC regions, and drive investment in an appropriate tyre recovery facility located towards Queensland's north.

Thematic focus	Response	Lead organisations
Illegal dumping of end-of-life tyres	Improved licensing and waste tracking/ reporting systems for tyre collectors and recyclers. Improved monitoring (e.g. geospatial imaging) and tracking (e.g. electronic tags) of dumping and stockpiles. Greater efforts towards surveillance and enforcement against illegal tyre disposal.	DES with TSA and council support Note: Organisations nominated may be revised in line with establishing an independent environmental regulatory body.
Increased recovery of tyres from selected OTR vehicle industries	Direct engagement with mining and other regionally important OTR tyre sources (and their OTR tyre suppliers), aiming to determine a service model and equipment suitable for using OTR tyres as a feedstock alongside passenger car and truck tyres.	TSA with council, DES and industry body (e.g. Queensland Resource Council) support, along with leading OTR tyre users.

Thematic focus	Response	Lead organisations
Consolidated handling and transport Transport efficiencies gained through intra-regional linkages	Investigate opportunities to: • Better leverage public infrastructure (e.g. transfer stations) as a transport and consolidation network across the two regions • Establish and expand collective procurement of tyre recovery and collection, which may include request for backhauling services	Councils and tyre recovery sector, with TSA support
Demand for end products, as relevant to encourage stable and mature markets and adequate sales revenue to encourage a regional tyre recovery facility	Proactive road construction and maintenance procurement settings, favouring the use of (locally supplied) crumb rubber in place of synthetic polymer binder where relevant, in spray seal and asphalt roads. Exploration of increased use of rubber granule in civil works (permeable pavements), traffic management devices, and niche surfaces (e.g. playground and sporting field surfaces) owned and used by local government. Exploration and uptake may be supported through research funding, demonstration projects, and dedicated regional collaboration bodies (e.g. technical / advisory groups).	Local and state road network managers, supported by TSA, LGAQ and DSDILGP Local and state civil asset managers and engineers, supported by DES, LGAQ and TSA
Measures to bring forward private investment in a regional tyre recovery facility, based on an acceptable risk-return profile and in recognition of public spillover benefits	Allocation of proportional public capital allocation in line with perceived public benefits and appropriately share risks. Terms and conditions to drive preference towards serving the regions as a whole, return useful products to local and regional economies, and support economic inclusion.	DSDILGP with support from TSA and councils offering a nominated waste and resource recovery precinct

Taking the next steps for tyre recovery in regional Queensland

The above table sets out recommended actions for TSA, Queensland Government, regional bodies and councils, and other partners to drive a sustained solution for tyre recovery in north and far north Queensland. In the near future, it would be suitable to widely engage with current and aspiring tyre recovery businesses on the opportunity to deliver services tailored to customers based in and near the NQROC and FNQROC regions. Based on their interest and feedback, it may then be suitable for the partners to develop and commit to a coordinated plan to deliver the recommended actions.

As a national product stewardship organisation, TSA is uniquely positioned to play a lead role in facilitating and coordinating phased implementation of actions to achieve regional recovery as outlined above. Yet there is a strong argument for leadership from NQROC and FNQROC and the Queensland Government, based on their preferred approach to realise the Queensland *Waste Management and Resource Recovery Strategy* through the development and adoption of regional resource recovery plans.

A collaborative approach between TSA and local, regional and state tiers of government may help to establish a precedent partnership framework that may be applied to other product stewardship priorities of the Queensland Government.

Similarly, a successful regional collaboration model for improved tyre recovery may provide lessons for TSA to adapt elsewhere, particularly in more distant regions across Australia that face problems in recovering tyres and which have features in common with the north and far north of Queensland.

TyreStewardship AUSTRALIA

Australian Government Accredited Product Stewardship Scheme

Tyre Stewardship Australia's National Tyre Product Stewardship Scheme has been recognised as best practice product stewardship by the Commonwealth Government. The accreditation, under the government's new Recycling and Waste Reduction legislation, provides independent verification of the Scheme's positive environmental and human health outcomes and will help TSA expedite the markets, funding and solutions associated with end-of-life tyres.