# *Technology and Supply Chains for Critical Industries*

## Resources sector (Working paper 1 of 3)

*Department of Infrastructure and Regional Development*

*Resources sector*

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pwc

ranbury

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# Executive summary

PricewaterhouseCoopers Consulting (Australia) Pty Limited and Ranbury Pty Ltd (Ranbury) have prepared analysis of the resource sector supply chain on behalf of the Department of Infrastructure and Regional Development (DIRD) as part of the Inquiry into National Freight and Supply Chain Priorities (the Inquiry). This report analyses three key commodities in the resources sector – coal, iron ore, and bauxite.

The study analyses at a high level:

- the infrastructure underpinning the archetypal supply chains for each industry;
- supply chain costs;
- user needs;
- potential supply chain bottlenecks and considerations for Government and the National Freight Inquiry and Government; and
- technology, innovation and changing business practices impacting supply chains in the future, particularly in relation to infrastructure, service requirements and cost.

## The resources sector

### *Coal*

Australia produced approximately 516 million tonnes of coal in 2015. This included approximately 224 million tonnes of metallurgical coal, which is used in steel production, and 292 million tonnes of thermal coal, which is used to generate energy.

The major production regions for thermal coal are the Hunter Valley (NSW) and for metallurgical coal the Bowen Basin in Central Queensland. These regions exported 159 million tonnes and 212 million tonnes respectively in 2015. Total Australian exports in 2015 were approximately 390 million tonnes, with the balance of ~20 million tonnes exported from smaller export coal supply chains operate through Port Kembla and Brisbane.

The remaining domestic coal production is centred on supply to power generators, and to smaller domestic consumers, including steel mills at Port Kembla and Whyalla, cement plants and alumina refineries.

### *Iron ore*

Australia is the world's largest iron ore producer and has an estimated 28 per cent (54 billion tonnes) of the world's reserves. Australia produced 811 million tonnes of iron ore in 2016. The Pilbara region in Western Australia dominates the Australian iron ore production, accounting for 94 per cent of annual production.

### *Bauxite*

Australia produced 81.7 million tonnes of bauxite during 2015-16, and is the largest producer, accounting for 30 per cent of the world's production. The key production regions include Weipa in QLD and in the Darling Ranges near Perth.

## Supply Chains

The freight task for minerals and mineral concentrates is a bulk, point to point task. Given the remoteness of the resources and international markets, the optimal modal supply chains are those where payloads can be maximised at an efficient cost – such as rail and shipping.

Most of the resources supply chains are export-oriented, i.e. mine to port to ship, although there are significant supply chains serving domestic industrial customers and power stations.

### Supply chain costs

Supply chain costs are driven by mode and the standard of the infrastructure used. The cost of transporting coal is estimated to be 15 cents per net tonne kilometre (c/ntkm) by road, 4.1 c/ntkm by rail and roughly 1.4 c/ntkm by sea. The rail haul costs in the iron ore sector are estimated to be lower than coal (between one and two c/ntkm) as result of higher standard track, locomotives and wagons, higher volumes and higher iron ore density. Information for bauxite was not available but costs are likely to be similar to those of the coal industry. Publically available information on supply chain costs is generally limited due to commercial sensitivities.

### Supply Chain User Needs and Bottlenecks

The supply chain needs of each end user are bespoke and reflect the localised circumstances of specific operations. Furthermore, there is substantial interdependency between supply chain user needs generally – irrespective of sector.

Supply chain efficiency– and particularly cost minimisation and capacity – is a critical element of the overall global competiveness for Australia's resource sector and therefore a key user need. Key barriers to supply chain efficiency in resource supply chains include:

- the lack of capacity across the supply chain;
- operational constraints such as staffing arrangements, staff working practices and the ability of maintenance and emergency repair process to minimise outages; and
- lack of coordination in maintenance and operation across multi-user/multi-provider supply chains.

The incentives and ability of infrastructure owners to invest in capacity ahead of or in a timely response to proven demand are reduced due to the:

- regulation of commodity supply chain assets whereby asset owners are required to include and therefore justify to regulators capital investment in their regulated asset base;
- effort required and uncertainty associated with the need to address regulation requirements such as environmental and competition approvals; while the need for these processes is acknowledged;
- short timeframes required to reach commercial arrangements for the use of the asset with all parties, particularly in the case of multi-user systems; and
- the complexity of synchronising these multiple development streams to align with internal commercial capital budgeting processes.

### The impact of technology on the supply chain

In response to supply chain efficiency bottlenecks, resource companies and supply chain service providers have continued to focus on improving productivity and reducing costs through the use of new technologies. New technologies, which have been implemented or are currently being considered within the resources sector globally, include:

- robotics for the automation of elements of the supply chain;
- data driven software and devices designed to optimise asset utilisation;
- remote monitoring of the supply chain to regulate resource extraction in response to the capacity of upstream processing or transport; and

- remote monitoring of supply chain asset condition (ie below rail) to improve the effectiveness of maintenance.

# Contents

# 1 Introduction

PricewaterhouseCoopers Consulting (Australia) Pty Limited and Ranbury Pty Ltd (Ranbury) have prepared analysis of the resource sector supply chain on behalf of the Department of Infrastructure and Regional Development (DIRD) as part of the Inquiry into National Freight and Supply Chain Priorities (the Inquiry). This work is intended to assist the Inquiry in informing the forthcoming National Freight and Supply Chain Strategy to ensure:

- the cost of freighting Australia's agricultural and resource commodities and general freight to destination markets does not undermine the global competiveness of these industry sectors; and
- the cost of freighting imported goods domestically does not result in increased costs to Australians and ultimately undermine our standard of living.

## 1.1 Study objective

This study is an input to the Inquiry process and is intended to identify, at a high level, critical issues in supply chains for the resources sector. The study analyses at a high level:

- the infrastructure underpinning the archetypal supply chains for each industry;
- supply chain costs;
- user needs;
- potential supply chain bottlenecks; and
- technology, innovation and changing business practices impacting supply chains in the future, particularly in relation to infrastructure, service requirements and cost.

Data in this study is drawn from the following sources:

- BITRE (2014), Freightline One – Australia freight transport overview;
- BITRE (2014), Freightline Two – Australian iron ore freight transport;
- BITRE (2016), Freightline Four – Australian coal freight transport;
- Department of Industry, Innovation and Science (2017), Resources and Energy Quarterly June 2017;
- Department of Natural Resources and Mines (QLD) (2017), Queensland coal – mines and advanced projects;
- IBIS World (2017), Australia Industry Reports, Iron Smelting and Steel Manufacturing;
- National Transport Commission (2016), Land Transport Regulation 2040, Technology, trends and other factors of change;
- PwC (2017), Mine 2017;
- submissions to the National Freight Inquiry; and
- stakeholder consultations (see Table 1).

**Table 1: Stakeholder consultations**

| Discussion themes | Stakeholder | Supply chain position(s) |
|---|---|---|
| **User needs and bottlenecks** | Aurizon | Below rail operator – CQCCN<br>Above rail operator – CQCCN, HVCCN |
| | Dalrymple Bay Coal Terminal | Coal terminal – CQCCN |
| | BHP Mitsubishi Alliance (BMA) | Coal miner – CQCCN |

## 1.2 Resources analysed in this study

This working paper analyses three key resources which represent commodities with significant commodity flows as identified by BITRE.[1] Based on this criteria, the resources analysed in this working paper include:

- coal (thermal and metallurgical);
- iron ore; and
- bauxite.

## 1.3 Report Structure

Following this introduction, the report is structured as follows:

### Section 2: Coal

This section provides a high level summary of the freight task and a description of key coal supply chains including a description of predominant transport mode, participants, infrastructure capacity, supply chain costs and relevant regulatory regimes.

### Section 3: Iron ore

This section provides a high level summary of the freight task and a description of the Pilbara iron ore supply chain.

### Section 4: Bauxite

This section provides a high level summary of the freight task and a description of the Weipa bauxite supply chain.

### Section 5: Technology and innovation

This section provides a summary of the key technological advances in the supply chain and the impact of these changes.

### Section 6: User needs

This section provides an analysis of the use needs for each supply chain.

### Section 7: Bottlenecks

This section provides an analysis of bottlenecks in the supply chains.

[1] BITRE (2016), Freightline 1, accessed: https://bitre.gov.au/publications/2014/files/Freightline_01.pdf

## Section 8: Policy considerations

This section provides a list of policy considerations based on the user needs and bottlenecks identified in sections seven and 8.

# 2 Coal

This section provides an overview of Australia's black coal freight task and details key aspects of the Central Queensland Coal Chain Network (CQCCN), Hunter Valley Coal Chain Network (HVCCN), Port Kembla coal supply chain, West Moreton coal supply chain and the Powder Basin coal supply chain (USA). Brown coal (lignite) has not been considered in this analysis as it is typically extracted and consumed on site.

## 2.1 Freight task

### 2.1.1 Market overview

Australia produced approximately 440 million tonnes of saleable black coal in 2016-17. This included approximately 177 million tonnes of metallurgical coal, which is used in steel production, and 202 of thermal coal, which is used to generate energy.[2]

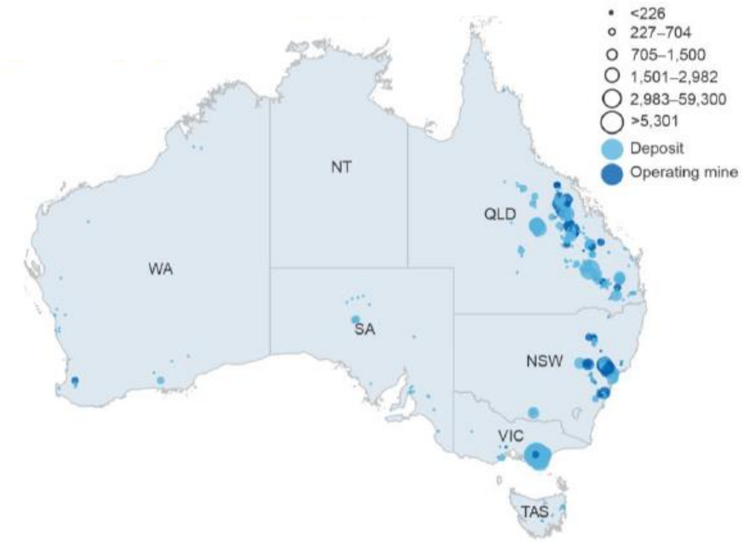
#### Key production regions

The key production regions for coal include the Hunter Valley (NSW) and the Central Queensland region which exported 159 million tonnes and 212 million tonnes respectively in 2015.[3] The Hunter Valley predominantly produces thermal coal while metallurgical coal is the main coal type mined from the Central Queensland region.

#### Coal tenements

There are significant coal deposits (deposits with supplies of greater than 2,983 Mt) located further inland from the operational mines in the Central Queensland coal basin, including the as yet un-tapped Galilee Basin, and major deposits in the Surat Basin, as shown in Figure 1 below.[4]

**Figure 1: Major Australian black and brown coal deposits (Mt)**




Source: Department of Industry and Innovation and Science (2017)

2 Department of Industry and Innovation and Science (2017)

3 2016-17 figures not available

4 Department of Industry and Innovation and Science (2017)

### 2.1.2 Coal producers

The coal production in Australia is fragmented as there were approximately 98 coal mines operated by 33 different mining companies at the end of 2015.

However, production is concentrated as the three largest companies, Glencore, BHP and Rio Tinto (and their respective joint ventures), accounted for approximately 46 per cent of total production in 2015 (236 million tonnes).

### 2.1.3 End markets

Black coal is primarily an export based commodity with approximately 86 per cent of production of total production exported in 2016-17 (379 million tonnes).

Approximately 14 per cent of black coal produced was consumed domestically in 2016-17 (62 million tonnes). Domestic consumption was largely driven by use in coal fired power stations.[5]

#### Exports

The major export markets for metallurgical coal, are:

- India - 40 million tonnes or 23 per cent;
- Japan - 39 million tonnes or 22 per cent; and
- China – 29 million tonnes or 16 per cent.[6]

The major export markets for thermal coal, are:

- Japan – 82 million tonnes or 41 per cent;
- China – 42 million tonnes or 21 per cent; and
- South Korea – 28 million tonnes or 14 per cent.[7]

#### Domestic

Almost all coal consumed domestically is used for energy generation, either for electricity production, or used as energy sources in manufacture of cement or other industrial processes, such as alumina refineries. The major black coal fired power stations include:

- 8 coal-fired power stations in QLD; and
- 5 coal-fired power stations in NSW.

The steel mills at Port Kembla and Whyalla are also significant consumers, as are cement works at Birkenhead, Angaston and Gladstone.

The supply chains vary, depending on the location of the mine and its customer. A number of power stations are located adjacent to their supplying coal mine, and utilise conveyors or local road delivery of coal.

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5 Department of Industry and Innovation and Science (2017)

6 Department of Industry and Innovation and Science (2017)

7 Department of Industry and Innovation and Science (2017)

### 2.1.4 Process description

Coal ore is typically extracted and loaded onto haul trucks for delivery to coal preparation plants (crushing/washing), and stockpiling, prior to loading onto rail for transport to the export terminals or direct to their domestic customers.

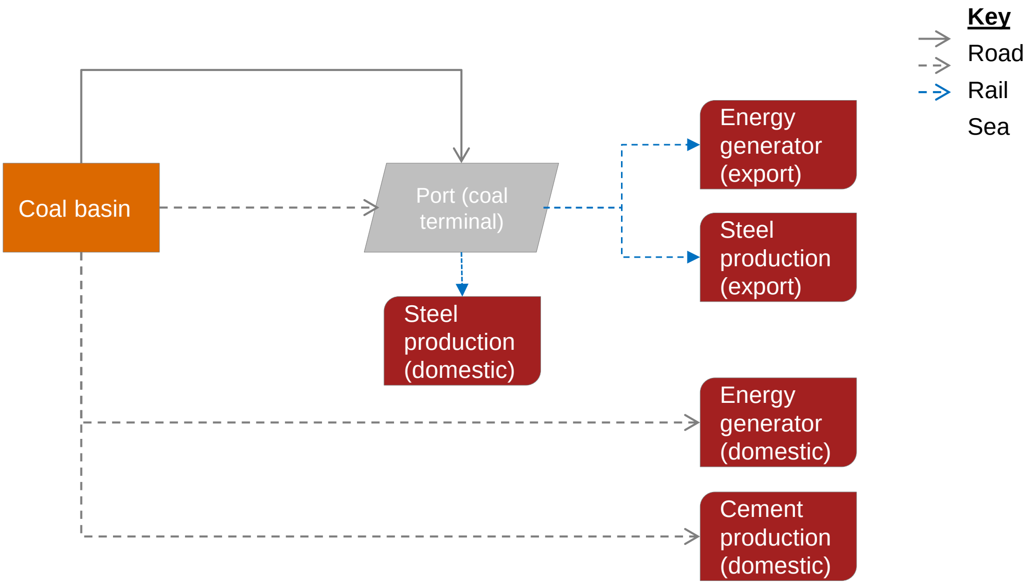
Coal is then unloaded and placed in stockpile prior to reclaiming and conveying to shiploaders for loading into dry bulk carriers. The large export coal terminals service a number of mines and an even larger number of coal types, requiring handling and storage to ensure segregation of these coal types.

There may be some blending of the coal types at the mine, or prior to loading into the ship, depending on specific customer requirements.

### 2.1.5 Archetypal supply chain

An archetypal typical coal supply chain, which includes the potential use of road transportation between the coal basin and the port, is shown in Figure 2 below.

**Figure 2: Typical coal supply chain schematic**




Source: PwC analysis

### 2.1.6 Structure

The archetypal coal supply chains are characterised by multiple participants at different positions in the supply chain, i.e. coal producers, below and above- rail providers and coal terminal owners and operators. Each of these participants make operational and investment decisions based on an individual profit maximisation objective which can be a determinant to the overall efficiency of the coal supply chain.

## 2.2 Supply chains – Central Queensland

### 2.2.1 Mode(s)

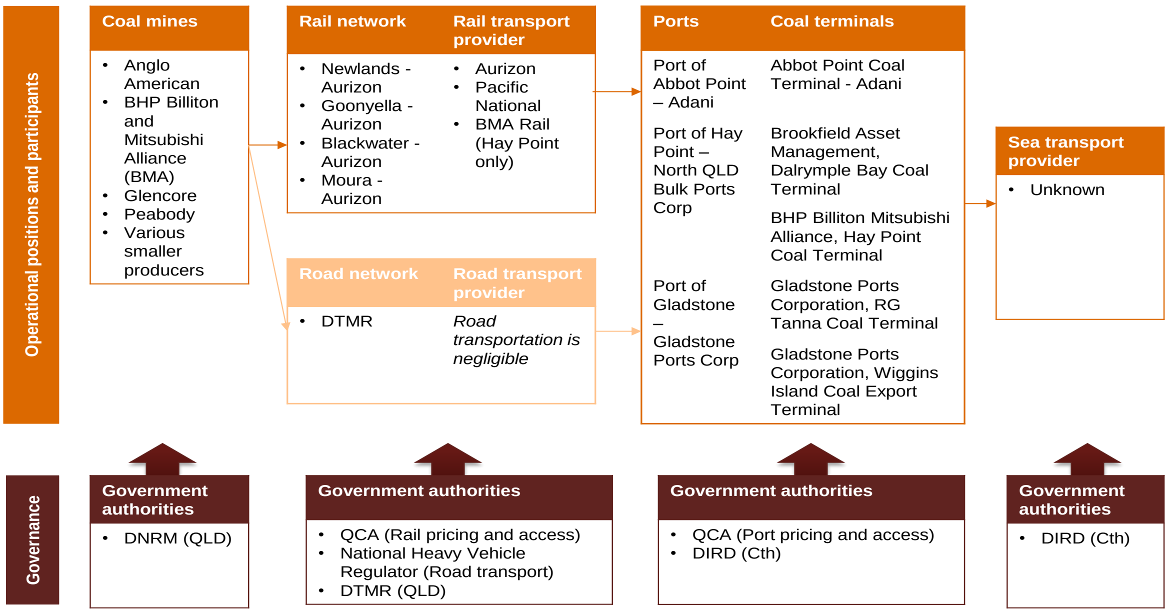
Rail is the predominant mode of transport in the CQCCN and is used to transport mostly metallurgical coal from the basin to export markets via the ports of Abbot Point, Hay Point and Gladstone. Together, these three ports handled approximately 212 million tonnes of coal in 2014-15, all of which was transported via Aurizon's rail network.[8]

There is some limited use of road transport for the short line-haul delivery of coal from some mines to some shared rail loadout facilities (eg Yarrabee and Jellinbah mines delivery to the Boonall train loadout near Blackwater).

## *2.2.2 Participants & operation*

The transportation of coal through the Central Queensland network involves a number of key supply chain positions and participants operating within each position. In some instances a supply chain participant occupies multiple positions i.e. Aurizon owns and operates the rail network and also provides above-rail services. The key positions and participants in this corridor are shown in Figure 3 below.

**Figure 3: Key positions and participants in the Central Queensland coal corridor**




Source: PwC analysis

## *2.2.3 Infrastructure capacity*

### Rail Network

Aurizon owns the current coal carrying rail network in the CQCCN. The 2,670km network comprises the Newlands, Goonyella, Blackwater and Moura rail systems. This network carried 226 million tonnes of coal in 2014-15 and has capacity to carry 310 million tonnes.

The key rail links between mine site and the port for this supply chain include:

- Newlands system feeding into the Port of Abbot Point which transported 29 million tonnes of coal in 2014-15;
- Goonyella system feeding into the Port of Hay Point which transported 115 million tonnes in 2014-15; and

8 BITRE (2016)

- Blackwater and Moura systems feeding into the Port of Gladstone which transported 79 million tonnes in 2014-15. (This included coal supplies to both Stanwell and Gladstone Power Stations, the two alumina refineries and cement works in Gladstone).

The network is narrow gauge (1067mm) and apart from the link to the small Minerva Mine south of Emerald, is built to a 26.5 tonne maximum axle load; however maximum train lengths and payloads vary on each system,

*Newlands*
The Newlands system (northern most) comprises 255km of single line, with a short 7km section of duplicated track which it shares with the Brisbane – Cairns North Coast Line. The Newlands system is inter-connected with the Goonyella system.

The system is not electrified and operates diesel powered trains. The system accommodates train rakes of up to 82 wagons long, with a nominal train payload of 6,800 tonnes.

The system currently has capacity for 50 million tonnes, of which 29 million was used in 2014-15, but Aurizon has identified expansion options to increase capacity to 170 million tonnes, via increasing train lengths, full track duplication, and additional holding roads and balloon loops to unloading pits at Abbot Point.

*Goonyella*
The Goonyella system comprises 635km of track including spur lines and balloon loops. The system is fully electrified and accommodates trains of up to 124 wagons long with a nominal maximum train payload of 10,300 tonnes.

The main trunk system is duplicated, and has a short three track section from the major train staging depot at Jillana connecting to the five coal unloading pits at the two export terminals at Hay Point.

The Goonyella system currently has capacity for 140 million tonnes, of which 115 million was used in 2014-15, but Aurizon has identified expansion options to increase capacity to 220 million tonnes. This includes extending duplication and extra trackage on the main trunk link, including over the steep Connors Range, and additional power systems upgrades.

The Goonyella system is interconnected with both the Newlands and Blackwater systems, providing flexibility for Goonyella system mines to access Abbot Point and Gladstone.

*Blackwater*
The Blackwater system comprises 697km of track including spur lines and balloon loops. The main trunk route from Gladstone to Burngrove is duplicated. This includes the shared track with North Coast Line passenger and non-coal freight from Gladstone to just south of Rockhampton.

The system is fully electrified (excluding to the small Minerva Mine) and accommodates train rakes of up to 100 wagons long with a maximum nominal train payload of 8,300 tonnes. The system operates as a swing electric/diesel hauled system, depending on locomotives available to the two current rail operators (Aurizon and PN).

The link to Minerva Mine is rated at 20 tonnes and is diesel only, and smaller trains service this mine.

The system, together with the Moura system, currently has capacity for 120 million tonnes, of which 79 million was used in 2014-15, but Aurizon has identified expansion options to increase capacity to 230 million tonnes. This includes additional trackage and increasing train lengths.

*Moura*
The Moura system comprises 235km of track, including spur lines and balloon loops.

The system is not electrified (diesel only) and accommodates train rakes of up to 100 wagons long, similar to the Blackwater system.

The system transported 12 million tonnes of coal in 2014-15.[9]

Significant expansion of the Moura system has been planned, linked to the previously proposed major development of the Surat Basin, and the construction of the 210 km long Surat Basin Railway, linking to the Moura system near Banana. This upgrade included increasing train lengths to 140 wagons, additional crossing loops and partial duplication, and a new rail link at Gladstone (Moura Link) to access WICET. Planning approvals are in place for these projects, if and when needed.

#### Rail Operators

There are three current Rail Operators in the CQCCN, being Aurizon, Pacific National (PN) and BMA. Aurizon currently has the major market share as the incumbent prior to opening up the network for 3rd party operators. PN has picked up market share since establishing its initial operation. BMA operate four electric hauled trains in the Goonyella system, catering for a small share of its total volume requirements in the CQCCN.

#### Ports

The CQCCN consists of five coal terminals, located across three ports, with a total throughput capacity of approximately 289 million tonnes per annum (mtpa). Table 2 outlines the key capacity metrics for each terminal.

**Table 2: Coal terminals in the CQCCN**

| | RG Tanna (Gladstone) | WICET (Gladstone) | DBCT ( Hay Point) | HPSCT (Hay Point) | APCT (Abbot Point) |
|---|---|---|---|---|---|
| **Current capacity** | 72Mtpa | 27Mtpa | 85Mtpa | 55Mtpa | 50Mtpa |
| **Storage** | 5.95Mt | 1.9Mt | 2.28Mt | 1.25Mt | 2Mt |
| **Ship loading** | 3 x 6,000 tph | 1 x 8,250 tph | 3 x 7200 -8650 tph | 1 x 6,000tph<br>2 x 8,400 tph | 1 x 6,000 tph<br>1 x 7,200 tph |
| **Berths** | 4 common user berths | 1 common user berth | 4 common user berths | 3 single user berths | 2 common user berths |
| **Reference vessel (max dead weight tonnes (dwt)** | 220,000 dwt | 220,000 dwt | 220,000 dwt | 180,000-220,000 dwt | 200,000 dwt |

Source: DBCT, BHP, North Queensland Bulk Ports, Wiggins Island Coal Export Terminal

### *2.1.1 Costs*

#### Rail costs

Rail costs are a combination of the price regulated track access charge, and the commercially contracted above-rail price for the specific rail haul. These will be a function of haul distance and train characteristics (gross to tare), traction type (diesel or electric), and rail system.

The track access charges on a net tonne kilometre (ntk) basis for the more heavily utilised Goonyella system are less than those for the other three systems, driven by the asset value

[9] BITRE (2016)

and throughput. Electric traction users in the Goonyella and Blackwater system also pay a similar access charge for utilisation of the electric traction system, as well as averaged power consumption costs.

The average freight cost of coal by rail is an estimated 4.1 cents per net tonne kilometre (c/ntkm), based on information provided by the Australian Rail Track Corporation. Furthermore, average conveyor transport costs are assumed broadly comparable with average rail costs.

#### Port terminal charges

Port terminal charges vary, depending on the terminal. Key components within the terminal charges are the asset value (and required ROI and the historical capital cost basis), and the terminal operating costs. DBCT is price regulated, with its pricing model determined by the QCA and incorporated into its Access Undertaking.

The other common user terminals have their own commercial pricing arrangements, but these are somewhat aligned to the cost model for DBCT (to forestall any move by users to have the terminal "declared"). All terminals (excluding BMA's Hay Point Terminal), involve "Take-or Pay" capacity contract provisions.

#### Shipping costs

Shipping rates vary, being heavily influenced by the charter market for dry bulk carriers (currently just coming off an historical low due to surplus capacity), and bunker fuel prices.

The average coastal shipping costs for bulk coal movements are also not publicly available, but are assumed to be one-third of average rail haul costs per tonne kilometre (~1.4 c/ntkm).[10]

### 2.1.2 Regulation

The rail corridors in the CQCCN are owned by the Queensland Government and leased to Aurizon, who own the rail infrastructure. The rail network is regulated through the Queensland Rail Access Regime (QRAR) and declared under the *Queensland Competition Authority Act*. The Queensland Competition Authority (QCA) is responsible for implementing the QRAR which provides a regulatory framework for third party access to rail infrastructure services. The QRAR is based on a negotiated/arbitrated regulatory approach, with aspects of direct price control, performance monitoring and information requirements.

Access to the network is regulated under the Access Undertaking developed by Aurizon and approved by the QCA. Above -rail operators and/or miners seeking to gain access to the rail network to transport coal freight apply to Aurizon for access with pricing determined based the undertaking. The current Access Undertaking (UT4) is the 4$^{th}$ iteration since the setting up of rail regulatory regimes, and the approval process remains arduous and lengthy, given the disparity between the users and Aurizon, and Aurizon's position as also providing above-rail services. (This is not the case with ARTC in the HVCCN.)

## 2.2 Supply chains - HVCCN

### 2.2.1 Mode(s)

Rail is predominant mode of transport in the HVCCN and is used to transport mostly thermal coal from the basin to export markets via the Port of Newcastle.

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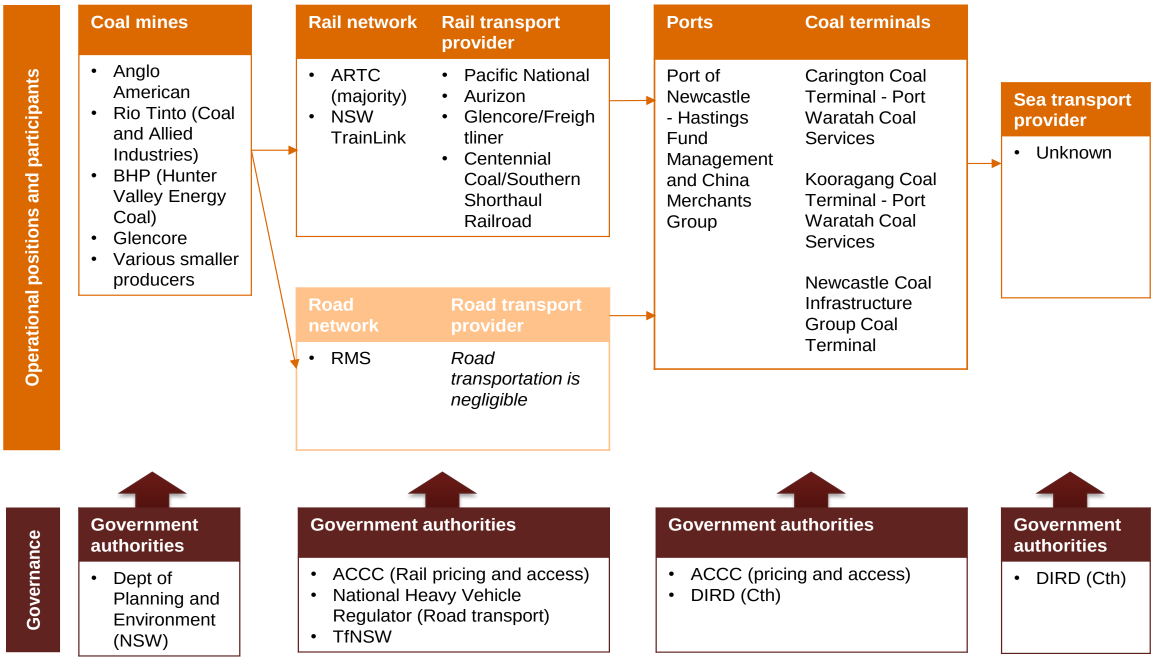
10 BITRE (2016)

In 2014-15, the Port of Newcastle handled 159 million tonnes of coal almost all of which was transported by rail. Small volumes of coal have been transported from the basin to the port via road, however, this volume is likely to be negligible.[11]

## 2.2.2 *Participants & operation*

The transportation of coal through the Hunter Valley corridor involves a number of key supply chain positions and participants operating within each position. The key positions and participants in this corridor are show in Figure 4 below.

**Figure 4: Key positions and participants in the HVCCN**




Source: PwC analysis

## 2.2.3 *Infrastructure capacity*

### Rail Network

The Hunter Valley rail system comprises 450km of track connecting 35 mines in the basin. The majority of the network is operated by ARTC with NSW TrainLink operating a small section servicing the Mandalong and West Wallsend mines. ARTC took over a 60 year lease of the Hunter Valley system in 2004. The short 24 km long South Maitland Railway, linking to Austar's mine near Cessnock is privately owned, as mine spur lines and balloon loops.

The coal network comprises a dedicated double track section from Newcastle to Maitland, and shares the two/three track section west to Muswellbrook. The lines west and north of Muswellbrook are single track with crossing loops.

Most of the network supports loads of 30 tonnes per axle (120 tonnes per wagon), however the North Coast Line section is limited to 25 tonne axle load, and the small Austar Mine operation is restricted to 19 tonne axle load.

Maximum permitted train lengths vary, with maximum train lengths (dependent on route) up to 1,572 metres. Actual train lengths and payloads also vary, subject to Rail Operator

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[11] BITRE (2016)

equipment deployed, infrastructure limits (axle load and crossing loops), and mine or customer requirements. The average coal train payload in 2016 was approximately 8,000 tonnes. This is increasing as more of the network is upgraded.

Contracted volumes were around 200 million tonnes in 2016. ARTC's network upgrade strategies are in place to progressively expand capacity, up to 250 – 290 million tonnes per annum if demand warrants.

The upgrades include a combination of increasing train lengths (longer crossing loops), extra trackage to increase train paths, signalling upgrades, improved train control asset management.

#### Rail Operators

There are three current rail operators in the HVCCN. Pacific National is the incumbent and has the largest market share. Aurizon has achieved a significant market share since establishing its base. Glencore recently sold its Hunter Valley coal train fleet to GWA with a significant on-going Take-or Pay commitment, and GWA would be expected to compete for additional coal customers.

#### Ports

The HVCCN consists of three coal terminals, all located at the Port of Newcastle, with a total throughput capacity of approximately 211 million tonnes per annum. Table 3 outlines the key capacity metrics for each terminal.

**Table 3: Export coal terminals in the HVCCN**

| | Carrington Coal Terminal | Port Waratah Coal Terminal | Newcastle Coal Infrastructure Group Coal Terminal |
|---|---|---|---|
| **Current capacity** | 25Mtpa | 120Mtpa | 66Mtpa |
| **Storage** | 0.75Mt | 4.2Mt | 6.1Mt |
| **Ship loading** | 2 x 2,500tph | 3 x 10,500tph | 2 x 10,500tph |
| **Berths** | 2 common user berths | 4 common user berths | 3 common user berths |
| **Max Reference vessel** | 180,000 dwt | 210,000 dwt | 165,000 dwt |

Source: Port Waratah Coal Services, Newcastle Port Corporation, Hunter Valley Coal Chain Coordinator

### *2.2.4 Costs*

Rail costs are a combination of the track access fee imposed by the rail network owner, and the commercially determined above rail costs. The average freight cost of coal by rail is an estimated 4.1 cents per net tonne kilometre (c/ntkm), based on information provided by the Australian Rail Track Corporation.

Export coal terminal costs vary, subject to the business model for each, value of the underlying terminal infrastructure (sensitive to when built), and actual terminal operating costs.

### *2.2.5 Regulation*

Access to ARTC Hunter Valley rail network is regulated via an access undertaking with the Australian Competition and Consumer Commission (ACCC). The Hunter Valley Coal Network Access Undertaking (HVAU) outlines ARTC's obligations to entities seeking access (Access Seekers) and covers:

- pricing limits, indicative prices, criteria for differentiating prices and the method for annual price adjustments;
- how ARTC will manage network capacity including interaction with the Hunter Valley Coal Chain Coordinator (HVCCC);
- how parties can connect to ARTC's network;
- the means by which investment in the network will be carried out and related consultation processes with the HVCCC, those parties holding an Access Holder Agreement (Access Holders) and Access Seekers; and
- performance measurement.

## 2.3 Supply chains – Southern NSW

### 2.3.1 Mode(s)

The Southern NSW coal supply chain relies on both road and rail transportation to freight coal (most thermal) from the Southern and Western Coalfields of NSW for export via Port Kembla and also for domestic consumption.

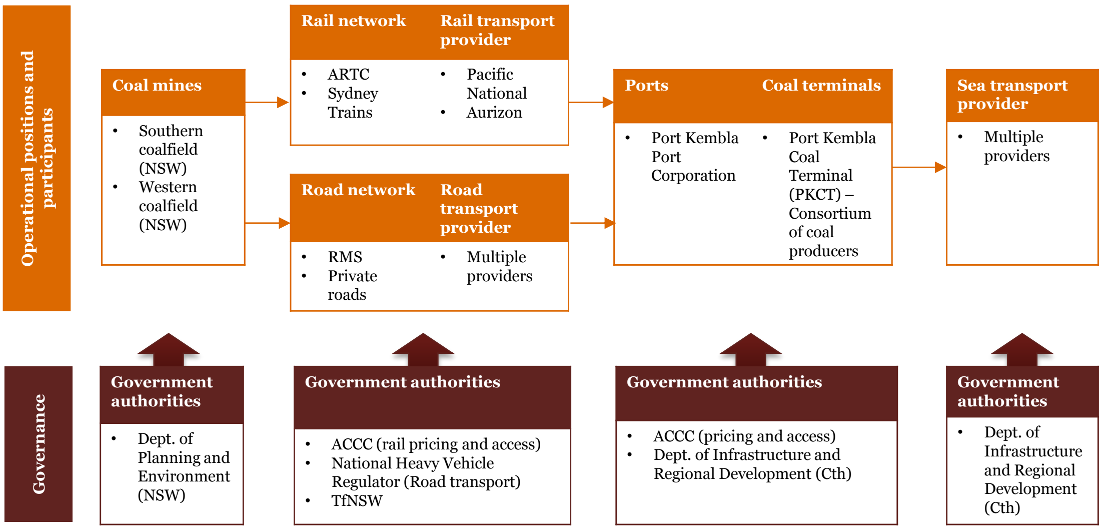
In 2015, Port Kembla Coal Terminal exported 12.9 million tonnes of coal of which 60 per cent was transported by rail and 40 per cent by road.[12] The relatively heavy reliance on road transportation from the very close mines in the region, in comparison to the CQCCN and HVCNN, represents a defining feature of this coal supply chain.

### 2.3.2 Participants & operation

The transportation of coal through Port Kembla involves a number of key supply chain positions and participants operating within each position.

The key positions and participants in this corridor are show in Figure 5 below.

**Figure 5: Key positions and participants in the Port Kembla coal supply chain**




Source: PwC analysis

12 BITRE (2016)

### 2.3.3 Infrastructure capacity

#### Rail

The Southern NSW coal rail system consists of approximately 400 km of track serving 13 mines where most of the coal produced was transported to Port Kembla. This rail network includes the:

- Sydney Trains operated Illawarra Line and Western Line, which form part of Sydney's Metropolitan Network. Both are restricted to 25 tonne axle load (100 tonne wagons):
  - The Illawarra Line restricts maximum train lengths to 900 metres (48 wagon trains); however the predominant train length comprises two locomotives and 45 wagons, with a nominal payload of 3,300 tonnes.
  - The Western Line to Lithgow permits freight train lengths to 1,280 metres; but trains to this length cannot progress further onto the Illawarra Line. All freight trains are severely constrained on the shared sections of the Sydney metro network, with the imposition of extended freight curfews around the weekday passenger peaks.
- Moss Vale to Unanderra Line which provides alternate rail access to Port Kembla from the south. This permits slow speed operation at 25 tonne axle load, but train lengths are also limited by crossing loop length and limitations at the Port Kembla Coal Terminal.
- ARTC operated Main South Line (Macarthur to Albury) connects to the Port Kembla link at Moss Vale. The section permits trains to 1,500 metre length at 25 tonne axle load.

Coal freight capacity on the Southern New South Wales coal rail system is estimated at 12.5 million tonnes per annum and Moss Vale – Unanderra is estimated at 6.5 million tonnes per annum. The overall capacity of this network is limited relative to other coal networks due to the presence of competing services which are given priority - the Illawarra and Western Lines are used for both passengers and freight services, which limits freight related services to eight hours a day.[13]

The previously proposed Maldon – Dombarton rail link, providing a more direct route to Port Kembla and obviating the need to route trains from the Lithgow area via the Illawarra Line, has not proceeded, due to its high cost and insufficient projected rail volumes.

#### Road

The key coal road freight routes in the Port Kembla region are the Appin, Picton Roads and Mount Ousley Roads which link the Appin, West Cliff and Russell Vale mines in the Southern coalfield to Port Kembla. Current road deliveries involve approximately 420 truck movements per day, with the predominant vehicle being a B Double with a payload of 40 tonnes.

Heavy vehicles freighting coal to the Port Kembla account for approximately 16 per cent of traffic on the Mount Ousley Road section of the Sydney to Wollongong road corridor south of Bulli Tops. This section of the road network is considered congested with traffic volumes in the order 35,000 to 37,000 vehicles per day (2009).[14]

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[13] BITRE (2016), ACIL Tasman (2011)

[14] ACIL (2009)

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The Port Kembla Coal Terminal (PKCT) is privately managed by South32 on behalf of the Port Kembla Coal Terminal Limited consortium which consists of six coal mining companies: Glencore, South32, Centennial Coal, Wollongong Coal, Tahmoor Coal and Peabody.

Table 4 below outlines the key ports infrastructure metrics for the Port Kembla Coal terminal which forms part of this supply chain.

**Table 4: Port Kembla Coal Terminal**

| Port Kembla Coal Terminal | |
|---|---|
| **Current capacity** | 18Mtpa |
| **Storage** | 850.000 t |
| **Ship loading** | 2 x 6,000 tph |
| **Berths** | 2 coal user berths; however the 2nd berth has very limited functionality and use |
| **Reference vessel (max dwt)** | 166,000 dwt |

Source: Port Kembla Coal Terminal

### 2.3.4 Costs

Actual costs are commercial in confidence. They comprise a multi –part make-up, including track access fees, above-rail costs, and terminal charges. Key considerations include length of line hauls, relatively small payload trains, ability to achieve effective asset utilisation and cycle times, given the impact of need for most railed freight to access through the Sydney network, and actual terminal through-puts.

### 2.3.5 Regulation

Network access on the non ARTC network is currently regulated by the NSW Independent Pricing and Regulatory Tribunal (IPART). The PKCT is not regulated.

## 2.4 Supply chains – West Moreton

### 2.4.1 Mode(s)

The West Moreton coal supply chain relies on rail to transport coal from the Clarence-Moreton and Surat Basins to the Port of Brisbane for export. Exports in 2015 were 7.2 million tonnes.

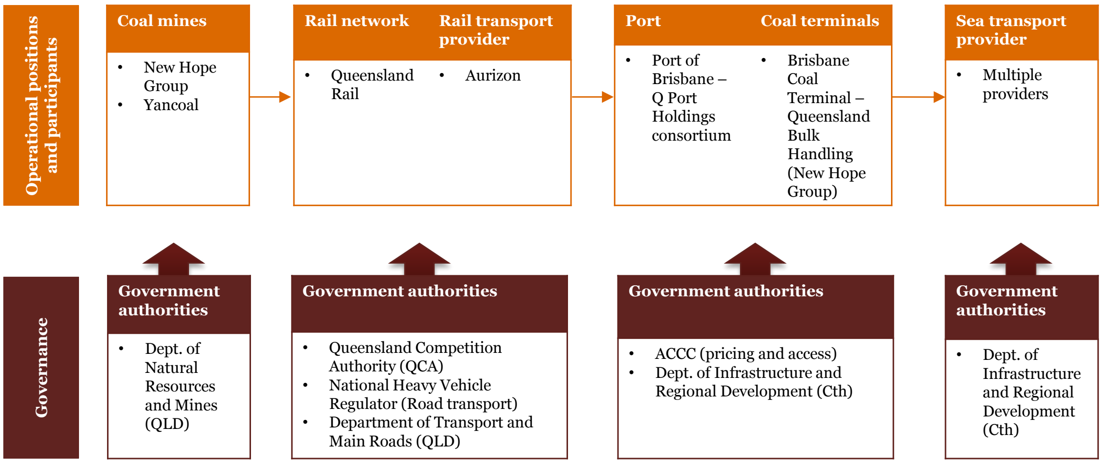
Future production from the Surat Basin is expected to be transported by rail to the Port of Gladstone on the proposed 210km Surat Basin Railway.[15]

### 2.4.2 Participants & operation

The key positions and participants in the West Moreton coal supply chain are shown in Figure 6 below.

[15] DTMR (2016), Coal transport infrastructure development, DTMR, Brisbane. URL: www.tmr.qld.gov.au/business-industry/Transport-sectors/Coaltransport- infrastructure-development.

**Figure 6: Key positions and participants in the West Moreton coal supply chain**




Source: PwC Analysis

## 2.4.3 *Infrastructure capacity*

### Rail

The West Moreton System is operated by Queensland Rail (QR) and comprises 314 km of track between Miles and Rosewood, and the Brisbane metro system from Rosewood to Fishermans Island. The route through the Brisbane metro is approximately 74 km long, of which 21 km is a dedicated freight track (Dutton Park to the port).

The West Moreton system is limited to 15.75 tonne axle load, and diesel hauled trains of 655 metres, with a nominal payload of 1,940 tonnes. The system includes steep grades, sharp curves and 11 tunnels with clearance limitations, which limits the overall capacity of the system.

The capacity constraints are the crossing of the Toowoomba Range, and accessing through the Brisbane network. West of Rosewood it shares track capacity with a limited number of bulk grain and livestock trains, and the twice weekly return Westlander passenger train.

The legacy infrastructure standards and limited capacity result in significantly higher network maintenance and train operating cost/tonne, compared to the CQCCN and the HVCCN.

Aurizon is the only current freight service operator on the system (for both coal and the other minor freights), and the combination of lack of scale and requirement for bespoke low axle load rollingstock (locomotives and wagons), makes this unattractive for potential competitors. The Aurizon rollingstock is well past its economic life, with locomotives of early 1970's vintage, and similarly for wagons.

Future capacity upgrade strategies include:

- construction of Inland Rail, removing the infrastructure constraints of the Toowoomba and Little Liverpool Range sections, and providing the basis for further investment in increasing axle loads and train lengths on the balance of the system. The Inland Rail Business Case assumes an uplift in coal tonnages to approx. 20 Mtpa). Train payloads under this scenario would depend on which upgrade path for the line west of the Inland Rail junction near Kingsthorpe was adopted; and

- the proposed 210 km long Surat Bain Railway, linking mines in the Wandoan region to export via the Moura System and Gladstone. This link, if built could be extended to the existing Cameby Downs mine and other potential mines south of Wandoan, to take advantage of this high capacity export path, with proposed train payloads up to 11,600 tonnes.

### Ports

The Port of Brisbane has one coal terminal, owned and operated by Queensland Bulk Handling Pty Ltd, which is wholly-owned by the New Hope Group who also own the major supplying mine at New Acland. The nominal capacity is rated at 10 million tonnes per annum.[16] The only other current user is Yancoal, who operate the Cameby Downs mine near Miles.

The stockpile capacity and loading speed of this terminal is significantly lower compared to the terminals in the CQCNN and HVCCN which reflects the smaller volumes on this system.

Table 5 below outlines key infrastructure metrics for the Brisbane Coal Terminal which is the only terminal servicing this supply chain. It is noted that the terminal could be upgraded to cater for up to 20 Mtpa.

**Table 5: Brisbane Coal Terminal**

| Queensland Bulk Handling Coal Terminal | |
|---|---|
| **Current capacity** | 10Mtpa |
| **Storage** | 900,000t |
| **Ship loading** | Average of 2,000 tph |
| **Berths** | One coal berth<br>(owned and operated by Qld Bulk Handling Pty Ltd) |
| **Reference vessel (max dwt)** | 140,000 dwt |

Source: Queensland Bulk Handling

## 2.4.4 Costs

Transport supply chain costs in the West Moreton- Brisbane coal supply chain include the regulated track access fee, plus the above rail costs and port terminal charges. The above rail operations are not realistically open to competition (as noted above), and involve small train payloads, low asset values but high maintenance costs. The bulk terminal similarly has a comparatively low asset value compared to the CQCCN and HVCCN, but again has low throughput. Commercial stay-in-business considerations for both service providers, provide a cap on ability of the coal producers to absorb the supply-chain costs for the lower priced thermal coals in this supply chain.

## 2.4.5 Regulation

Access to the network is managed by Queensland Rail and is provided through a declaration, under the *Queensland Competition Authority Act 1997*. Rail operators and other access seekers using the West Moreton network are required to negotiate an access agreement with QR. The access process is governed by Queensland Rail's Access Undertaking, which is approved by the QCA.

The QBH terminal is not regulated

[16] Port of Brisbane 2016, QBH 2016

# 2.5 International case study – Powder Basin

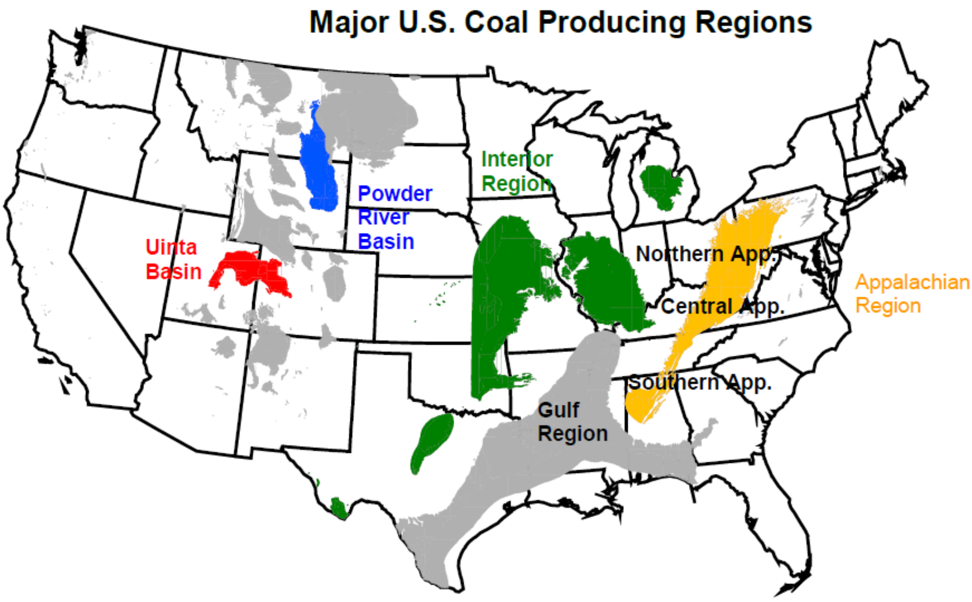
## 2.5.1 Description

The Powder River Basin is major coal production region located across Montana and Wyoming. The Basin produced 341 million tonnes of coal in 2015 which accounts for over 50 per cent of total US production. The output from the region is dominated by the North Antelope/Rochelle and Black Thunder Mines.

Most of the coal produced in the United States is thermal coal used to generate electricity domestically. The Powder Basin coal is an attractive product for power generation given its ease of mining. Despite a relatively long distance to some internal markets, it has the advantage of low mining costs through seams having low overburden ratios and substantial seam thickness.

Figure 7 below shows the key coal production regions in the US.

**Figure 7: US coal regions**



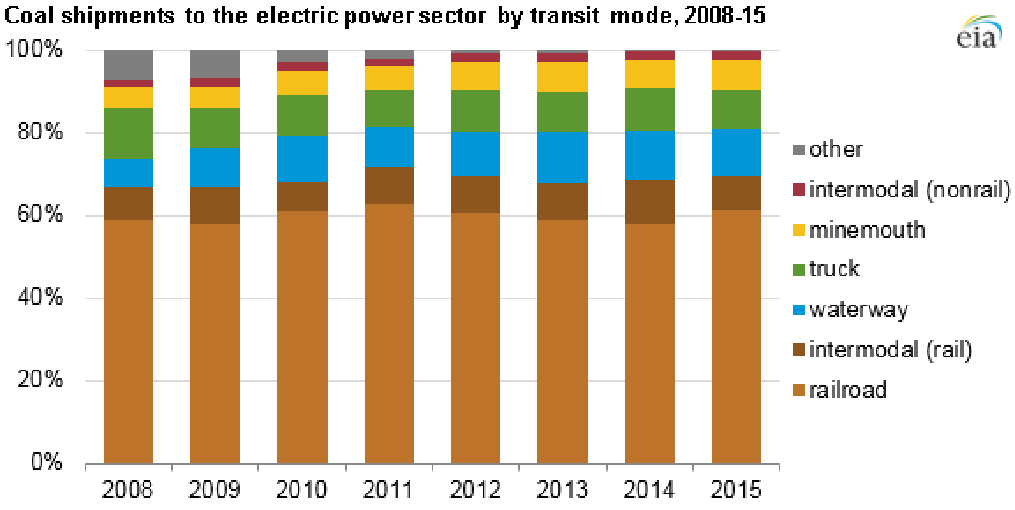

Source: AAR – Railroads and Coal – June 2017

## 2.5.2 Supply chains

### Mode(s)

The transport of coal output from mines to customers is dominated by rail in the USA. This is particularly the case with coal used for domestic power generation where almost 70 per cent of all transport of coal for electricity was delivered by rail to customers.

## Figure 8: Coal Transport Mode Share (US)




Source: U.S. Energy Information Administration, Form EIA-923, Power Plant Operations Report
**Note:** Other includes pipeline, other waterway, barge, and coastal ports. Intermodal covers multiple modes of delivery.

### Volume by mode

The majority of coal produced in this Basin is transported to power stations by rail. The exact figure is unknown but it is estimated to be in the vicinity of 240 million tonnes per annum based on the national average of rail use.

### Participants & operation

In the Powder River Basin, two major rail companies own networks and provide services for customers. These are Union Pacific (UP) and BNSF who are the largest rail service providers in the USA. Over recent years as electricity generation has diversified away from coal, coal production has reduced which in turn has reduced the volumes transported by rail. While these railed volumes are still significant, it is a high volume bulk commodity that has a lower relative revenue yield compared to other commodities in the US. The UP coal haul task is 94 per cent domestic coal, with 77 per cent of all coal hauled sourced from the Powder River Basin.

### Infrastructure capacity (rail)

Generally, the US networks can accommodate a much larger rolling stock gauge (train envelope) than east coast Australia, which enables the deployment of larger locomotives and wagons. The train lengths can be in the order of 2.4 km long and have between 120 and 150 wagons, requiring four to five locomotives to haul a train of this length and weight. The motive power required would be determined by the trailing load (payload plus wagon tare) and the ruling grades on the various routes.

For heavy haul rail tasks such as coal haulage or double stacked intermodal services, networks have been upgraded to 39 tonne axle load (36 TAL).

The networks developed by the rail companies also reflect the capacities required in individual regions for specific customer demand and products. While the majority of the network is single line track with passing loops, sections of the network has been expanded and augmented over time to meet capacity requirements. Exchange agreements exist between different rail operators to facilitate the transport of rail freight across the networks of competitor operators as required.

### Regulation

The Federal Railroad Administration (FRA) oversees the regulation of the rail industry in the USA. The FRA through inspections undertake compliance and enforcement activities including:

- hazardous materials;
- motive power and equipment;
- operating practice;
- signal and train control; and
- track.

The FRA can set maximum freight rates where no effective competition for rail services is possible. If rail companies exhibit unreasonable conduct or pricing, the FRA has authority to intervene on behalf of customers.

The level of regulation governing this supply chain has reduced since the Staggers Rail Act of 1980. This Act removed the many regulatory restraints on the railroad industry, providing the industry increased flexibility to adjust their rates and tailor services to meet shipper needs and their own revenue requirements. The Staggers Rail Act of 1980 limited the authority of the Surface Transportation Board (STB), to regulate rates only for traffic where competition is not effective to protect shippers. The STB estimates that roughly 20 percent of traffic is still regulated and circa 50% of all traffic based on a revenue basis is exempt from regulation.

### 2.5.3 *Lesson learned*

#### Reduced regulatory constraints could lead to improved freight service standards

Prior to the Staggers Act, the rail industry in the USA was subject to economic regulation that impacted pricing flexibility and the ability to rationalise branch lines. The FRA has indicated that:

- services have improved, haulage rates have decreased and safety performance in the rail industry has improved with accident rates reducing by around 65 per cent;[17]
- rail market share has stabilised at 40 per cent after a period of decline prior to 1980 reducing where it reduced from 56 per cent to 37 per cent;
- return on investment capital (ROIC) levels have improved. It was eight per cent between 1990 and 2009; and
- investment in the industry has increased, with approximately $500 billion of capital improvements undertaken up to 2009.[18]

It is worth noting that some participants in the supply chains advocate for a more regulated model and open access on private networks for an access fee to increase competition. However, the rail industry believes this would inhibit network investment.

#### Significant differences in haulage distances reduce the ability for Australian supply chains and policy makers to adopt learnings

In addition, the coal haulage routes in the US are much longer than the rail haulage undertaken in Australia. Haulage from the Powder River Basin to customers in the Chicago region would involve a one way haul distance on this route of 1,650 km and New Orleans would be 2,600 km. In comparison, Australian haulage tasks from mines in the Bowen Basin

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17 Palley (2011)

18 Palley (2011)

(e.g. Goonyella Mine) to export coal terminals at Mackay would involve a one way route distance of 200 to 300 km.

# 3 Iron ore

This section provides an overview of Australia's iron ore coal freight task and details the key aspects of the Pilbara iron ore supply chain.

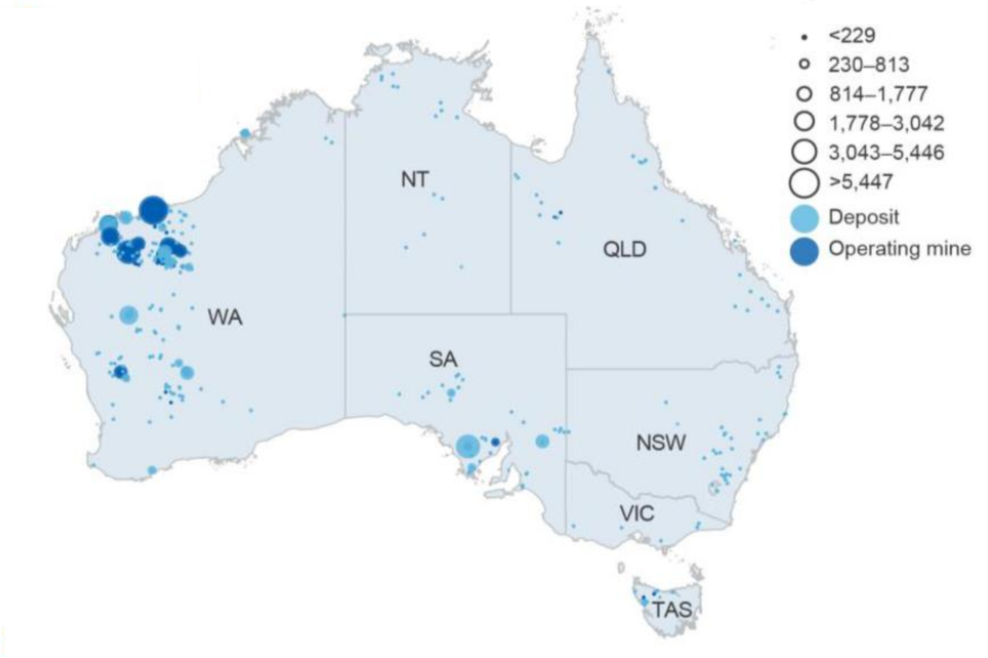
## 3.1 Freight task

### 3.1.1 Market overview

Australia is the world's largest iron ore producer and the source of roughly 28 per cent (54 billion tonnes) of the world's reserves. Australia produced 873 million tonnes of iron ore in 2016-17.[19] The Pilbara region in Western Australia dominates the Australian iron ore market, accounting for 99 per cent of annual production.

There are relatively smaller deposits of iron ore in Australia in central-west WA and the south of South Australia as shown in Figure 9 below.

**Figure 9: Major Australian iron ore deposits (Mt)**




Source: Department of Industry and Innovation and Science (2017)

### 3.1.2 Iron ore producers

The Australian iron ore market is highly concentrated and dominated by three 'major' companies:

- Rio Tinto (40 per cent share of total Australian iron ore exports in 2016-17)
- BHP Billiton (32 per cent)

19 Department of Industry and Innovation and Science (2017)

- Fortescue Metals Group (21 per cent).

The remaining seven per cent is attributable to small, independent iron ore miners who each have less than five per cent market share.

### 3.1.3 End markets

Iron ore is an export based commodity with approximately 819 million tonnes (or 94 per cent of production) exported in 2016-17. Australia is the world's largest iron-ore exporter, accounting for 53 per cent of world exports (Brazil is the second most prominent exporter with a market share of 24 per cent). Small amounts of iron ore are used in domestic steel production.

#### Export

The Pilbara region in the north-west of Western Australia accounted for approximately 99 per cent of production, and accordingly exports, in 2016-17.

China is by far the largest export destination for West Australian iron ore, accounting for approximately 83 per cent of exports (676 million tonnes) - the next largest destination for iron ore from the Pilbara is Japan who account for eight per cent of exports.

#### Domestic

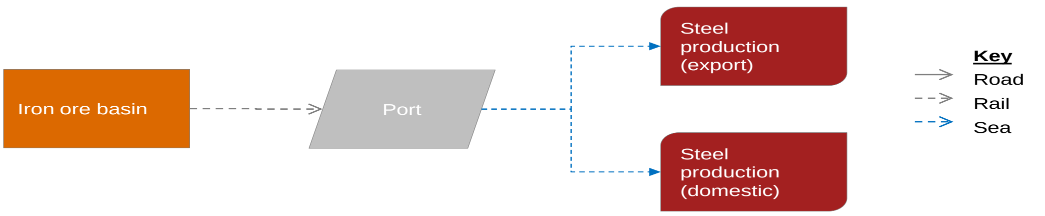
Only six per cent of iron ore is consumed domestically, in the production process of steel at Whyalla and Port Kembla. Both these plants struggle to compete on price with the now much large steel industries in Asia. Market growth for domestic consumption of iron ore is expected to be limited.

### 3.1.4 Process description

Iron ore in is typically extracted from the mines using drill and blast techniques and hauled by truck to on site processing plants for crushing and refinements. The processed ore is carried by conveyor to stockpiles where it is loaded onto trains for transportation to the port. The ore sits in stockpiles in the port before being loaded on bulk carriers for transportation to export markets.

A typical iron ore supply chain in this corridor is shown in Figure 10 below.

**Figure 10: Supply chain schematic for iron ore (Pilbara)**




Source: PwC analysis

## 3.2 Supply chain – Pilbara

### 3.2.1 Mode(s)

The Pilbara iron ore supply chain is a predominantly rail based supply chain , linking the mines to the one of three ports (Port Hedland, Port of Dampier, Cape Lambert) for export. Approximately 819 million tonnes of iron ore was transported by rail for export in 2016-17.[20]

[20] Department of Industry and Innovation and Science (2017)

A small, residual volume of iron ore is also moved by road from the stockpiles in the mine sites to the ports, typically by 'junior' miners or mines in remote areas. An example of this is the remotely located Atlas Iron operation at Mt Webber which cannot be accessed by rail. This, and other remote iron ore mines, make up an only a very small proportion of iron ore transport, as rail transport is a much more cost-effective way of moving large quantities of iron ore long distances.

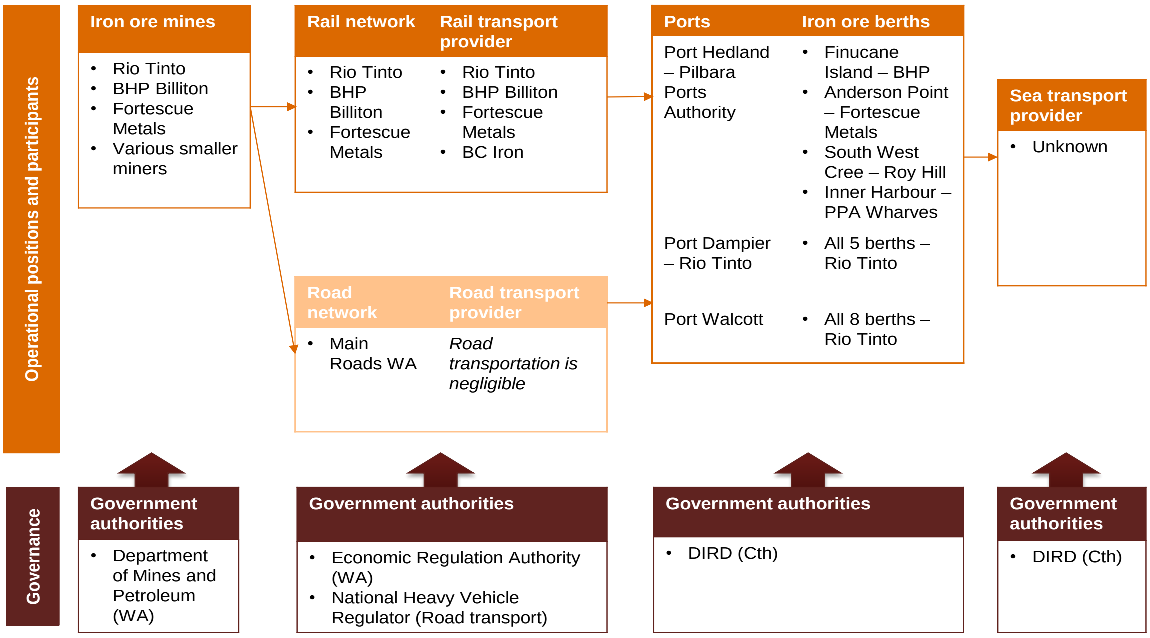
### *3.2.2 Participants & operation*

The transportation of iron ore through the Pilbara involves a number of key supply chain positions and participants operating within each position.

The Pilbara iron ore supply chains are dominated by the three vertically operated miners (Rio Tinto, BHP and FMG).

The key positions and participants in this corridor are show in Figure 11 below.

**Figure 11: Key positions and participants in the Pilbara corridor**




Source: PwC analysis

### *3.2.3 Infrastructure capacity*

#### Rail

The three 'major' iron ore miners in the Pilbara region own and operate their own private rail networks to transport ore from the mines to the ports.

Each rail system operates to very high axle loads (pushing the boundaries of wheel-rail steel technology), and utilise high performance diesel locomotives, on purpose designed rail systems with very flat ruling grades and horizontal alignment to suit very long trains. Wagons are top loading and require tipplers to unload. Rail productivity is leading world class.

*Rio Tinto – Hamersley and Robe River railways*

Rio Tinto own and operate the Hamersley and Robe River railways, spanning roughly 1,400 kilometres across 12 mines. The capacity on this particular section of track is for iron ore volumes of up to 346 million tonnes per annum – transport of volumes over and above this level would require further investment. The tracks are standard gauge with a maximum tonne axle load of 37.5 tonnes. .Rio Tinto operate trains up to a length of 2.4 kilometres, with a payload around 26,000 tonnes.

*BHP Billiton – Mt Newman and Goldsworthy railways*
BHP Billiton own and operate the Mt Newman and Goldsworthy railways, which together span approximately 800 kilometres and connect BHP's ten iron ore mines to Port Hedland. The tracks are a standard gauge with a maximum tonne axle load of 50 tonnes.

BHP operate trains up to 3.2 km long on the Mt Newman system, with payloads up to 37,000 tonnes. The smaller Goldsworthy system only utilises trains up to one km long with a payload of 7,600 tonnes.

*Fortescue Metals Group*
FMG owns and operates approximately 620 kilometres of rail line in the Pilbara. The maximum axle load across all lines is 42 tonnes and the current rail capacity is approximately 170 Mt per annum.

FMG operate trains up to .7 km long (250 wagons) with a nominal payload of 35,000 tonnes.

FMG currently provides iron ore haulage services to BC Iron.

### Ports

The major iron ore ports are managed and operated by the Pilbara Ports Authority and include:

- Port Hedland;
- Port of Dampier; and
- Cape Lambert.

Collectively, these three ports have 32 berths of which only four are common user berths. This represents a major impediment to potential market entrants as it is likely to be challenging to secure adequate access or capacity. Conversely for the three major miners who operate the majority of these berths (BHB, Rio Tinto and FMG), access and capacity is secure and, subject to regulation and approvals, only limited by their willingness to invest to address future bottlenecks.

*Port Hedland*
There are currently 19 operational berths; four of which are common user terminals. Twelve of the 15 privately owned berths are owned by the three major iron ore companies for export of iron ore (approximately 97 per cent of the port's total trade throughput).

Berth one has two access ramps connecting it to a hardstand area. The berth has two access ramps to 9,000m$^2$ of open hard standing space. Additionally, Berth three has a hardstand area immediately behind a cargo shed. Pilbara Ports Authority has approximately 67,000m$^2$ of available cargo lay down area of which approximately 30,000m$^2$ is within the secure port boundary.

The ship loading infrastructure has average tonne per hour load rate ranging from 12,000tph to 13,500tph. Channel depth ranges from 14.6m to 16.8m and the maximum ship length is 330 metres.

Fortescue's Herb Elliott Port at Port Hedland sits on two hundred hectares of land with five operating berths that are capable of exporting more than 165mtpa. Other features of the port include: three inload and outload circuits with three train unloaders, 54 kilometres of conveyor systems, three stackers, three reclaimers, transfer stations, drive stations, sample stations, and power and control systems.

*Port Dampier*
Port Dampier is the second largest iron ore port in Australia, comprising five iron ore berths across two terminals (all operated by Rio Tinto). The Port has a total handling capacity of approximately 150 Mtpa and roughly 850 vessel arrivals each year. The required gross loading rate is 9,000 tph across all iron ore berths. Details of the terminal infrastructure is as follows:

- The first terminal, the East Incourse Island, has one berth with a shallowest depth of 9.4 metres that can accommodate a vessel of 340m length and 58m width. Its maximum capacity is 50 Mtpa.
- The second terminal at Parker Point has maximum capacity of 100Mtpa and the reference vessel is 235,000 dead weight tonnes. Channel depth is either eight or 10 meters, depending on the berth.

*Port Walcott (i.e. Cape Lambert)*
Port Walcott, like Port Dampier, is exclusively run by Rio Tinto. It has eight berths over two iron ore terminals with a total 180 Mtpa capacity:

- Cape Lambert A terminal has capacity of 85 Mtpa and can accommodate vessels of 255,000 tonnes. There are four berths with shallowest depth of either 9.6m or 10.6m at the end of a 3km long jetty. The gross loading rate is 9,000tph across each berth.
- Cape Lambert B terminal has capacity of 100 Mtpa and can also accommodate vessels of 255,000 tonnes. There are four berths with shallowest depth of either 10.0m. The gross loading rate is 10,000tph across each berth.

Port Walcott also has a general purpose facility, with a single berth, used predominantly by Rio Tinto, for break-bulk or general cargoes using vessel gear or mobile crane.

### 3.2.4 Costs

#### Rail costs
The average rail transport costs on the Pilbara networks are between one and two c/ntkm (cents per net tonne kilometre) with the estimated cost including backhaul components. Rail has a cost advantage in this sector compared to road as a result of:

- scale arising from volumes and high product density of iron ore;
- point to point movement;
- the ability of participants to vertically integrate above and below rail operations;
- the high standard of track infrastructure (good horizontal alignment and grading, and high earthworks and track standards with sleepers and weight of rail capable of high axle loadings); and
- rolling stock condition – newer heavy duty and high performance locomotives and well-maintained wagon fleets.

The rail network has high average energy efficiency (e.g. 0.002 litres of diesel per one tonne kilometre of iron ore.

#### Road costs
The estimated average road transport cost is between 15 and 20c/ntkm. This estimate is based on an estimated average operating cost between 10 and 15 c/ntkm for a fully laden road train, plus the cost of the empty return leg.

The Pilbara Infrastructure (2008) submission assumed an average long-haul road transport cost of 15 c/ntkm for movement of iron ore from the Pilbara to ports.

### *3.2.5 Regulation*

#### Rail access

The Economic Regulation Authority Western Australia (ERA) is responsible for implementing the WA Rail Access Regime framework for 5,000 km of rail infrastructure services in the region. The ERA regime provides a framework for third parties to access rail infrastructure and covers the Pilbara Infrastructure owned by Fortescue Metals Group (FMG).

These rail systems have a theoretical obligation to cater for third party access, but in practice in the past the companies have successfully argued that they do not have spare capacity. FMG sought access on the BHP system for a lengthy period, prior to admitting defeat and proceeding to build its own rail network. FMG in turn is currently in dispute with a junior miner seeking access to the FMG network.

The other recourse to junior miners gaining access to existing rail networks includes joint venture arrangements with the rail network owner, as has occurred with the development of the Hope Downs mine.

#### Road access

Road freight transportation is subject to a consistent national regulatory approach. Current heavy vehicle charges are based on pricing principles set by national organisations, ensuring consistency across the country.[21] Road freight operators also have the option to be accredited with the National Heavy Vehicle Regulator (NHVR) to comply with all state and territory legislation across Australia. The current heavy vehicle usage charges include a fixed cost which is the heavy vehicle registration, and a variable cost which is a fuel-based road user charge. These charges aim to recover the marginal and attributable costs of road wear and tear, as well as negative environmental externalities in the form of green fuel taxes.

Other types of road regulation include those relating to transporting dangerous goods, the safe movement of goods and the 'chain of responsibility'. The *Heavy Vehicle National Law Act 2012* for example, details a range of requirements associated with 'chain of responsibility' and the safe movement of bulk freight. The Australian Dangerous Goods Code (ADGC) does not classify iron ore as a dangerous good so ADGC regulations do not apply to land freight transport.

#### Shipping access

Ports are often regulated due to the monopoly nature of the asset. Regulation is designed to allow equitable access to the coastline. Most jurisdictions have broad regulations that cover all ports, considering factors such as safety, equal access and pollution. Individual ports rarely have unique regulations imposed.

For the shipping of iron ore, the Australian Maritime Safety Authority (AMSA) implements the International Maritime Organisation (IMO) regulations as they pertain to general and dangerous goods cargo. Transporters of cargo are subject to International Convention for the Safety of Life at Sea (SOLAS) and will be inspected to verify compliance with cargo requirements including: stowage, segregation, packaging and documentation.

Iron Ore shipments fall under the Bulk Cargoes Marine Orders 34 and 35. In addition, the AMSA has issued an exemption for Iron Ore shippers to evaluate the corrosive properties

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[21] The Transport and Infrastructure Council and the Council of Australia Governments

and hazard risk of moving these goods using an alternative method than prescribed in the orders.

Resource companies may also be exposed to export regulations, such as the *Maritime Transport and Offshore Facilities Security Act 2003 (Cth) (Facilities Security Act),* as well as the Export Control Act (1982) and associated regulations.

### Coastal trading act[22]

Depending on the vessel voyage, the vessel charterer or operator may also be required to satisfy a range of regulatory requirements established through the *Coastal Trading (Revitalising Australian Shipping) Act 2012 (Cth) (the Act),* including authorisation to move goods within or between Australian states through Coastal Trading License. The Act revised the competition rules of our coastal shipping trade and limited the ability for foreign ships to access our ports; a longstanding feature of our coastal trade. A tiered licensing system was brought in to replace the single and continuous voyage permits which prevailed prior to the Act. This discriminated against foreign ships; increasing the transport and administration costs of our domestic trade and making it more difficult to find coastal shipping providers.

[22] Minerals Council of Australia (2017), Submission on Coastal Shipping Reforms Discussion Paper, accessed: http://www.minerals.org.au/news/submission_on_coastal_shipping_reforms_discussion_paper

# 4 Bauxite

This section provides an overview of Australia's bauxite freight task and details the key aspects of the Weipa bauxite supply chain.

## 4.1 Freight task

### 4.1.1 Market overview

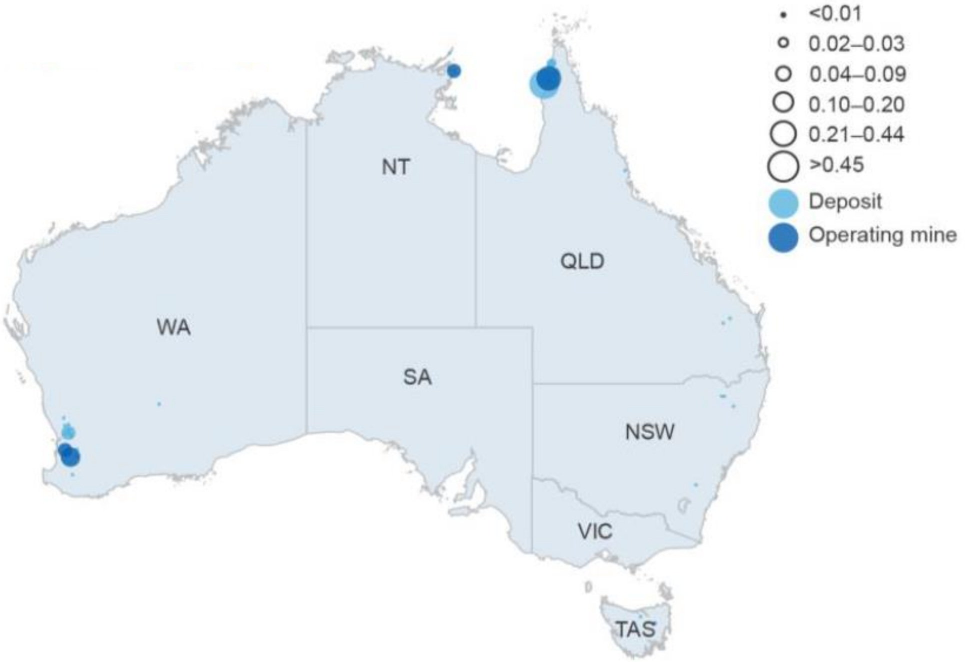
Australia produced 84.9 million tonnes of bauxite in 2016-17, and is the world's largest producer of bauxite, with 30 per cent of the world's production.

Western Australia accounted for approximately 53 per cent of total production in Australia in 2016-17 (45 million tonnes).[23] Production in Western Australian is concentrated in the Huntly region in the Darling Ranges which produces low grade bauxite (i.e. 27 – 30 per cent alumina).

Queensland accounted for approximately 35 per cent of Australian bauxite production in 2016-17 (30 million tonnes).[24] Production is concentrated in the Weipa region which produces high-grade bauxite (roughly 49 – 53 per cent alumina).

All regions with significant amounts of bauxite deposits (which are processed in alumina) contain operational mines (see Figure 12).

**Figure 12: Major Australian alumina deposits (Gt)**




Source: Department of Industry and Innovation and Science (2017)

[23] Department of Industry and Innovation and Science (2017)

[24] Department of Industry and Innovation and Science (2017)

### 4.1.2 Bauxite producers

The market for bauxite production is highly concentrated, with only three companies accounting for 95 per cent of the industry's production and revenue. The three largest bauxite miners by way of market share are:

- Rio Tinto Limited, 51 per cent (Weipa, QLD, Gove, NT);
- Alcoa of Australia Limited, 30 per cent (Huntly, WA and Willowdale, WA); and
- South32 Limited, 14 per cent (Boddington, WA).

### 4.1.3 End markets

End markets for bauxite include:

- export to international markets as bauxite (bulk); and
- domestic consumption which involves refinement into alumina, which may in turn be smelted in Australia into aluminium, or exported to smelters overseas.

#### Export

Exports of bauxite, alumina and aluminium account for approximately 46 per cent of industry revenue. China is a key export market for bulk bauxite consuming 98 per cent of Australia's bauxite exports. Bauxite which has been processed into aluminium is predominantly exported to Japan and South Korea.

A key export corridor for bauxite ore is from Weipa (QLD) to Gladstone (QLD) for processing before being exported to end users in Russia, Canada, China and New Zealand. Approximately 34 per cent of Australia' bauxite production flows through this corridor.

#### Domestic

Bauxite consumed in Australia is transported from mine sites in WA, NT and QLD to refineries for conversion into alumina at refineries located in the same jurisdictions as the mines. The alumina is transported to smelters located in Tas, QLD, Vic and NSW for conversion into aluminium.

## 4.2 Supply chain – Weipa (QLD)

### 4.2.1 Process description and mode(s)

Bauxite in this corridor is predominately transported by rail (very short haul only at Weipa) and sea to key export and domestic markets.

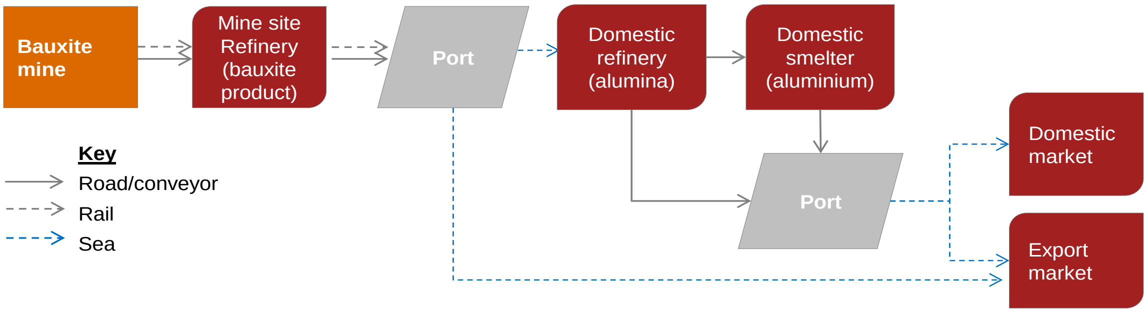
Approximately 29 million tonnes of bauxite is mined using the open-cut technique and loaded on trucks that transport the ore to the dump station. Conveyors (East Weipa) or rail transport (Andoom), are then used to move the bauxite to the beneficiation plants, where the ore is processed into bauxite product and then placed into stockpiles at the Port of Weipa prior to loading onto ships.

The Port of Weipa exports bauxite to two Rio Tinto alumina refineries at Gladstone QAL (capacity of 3.95 Mtpa of alumina) and Yarwun (capacity 3.4 Mtpa). The balance of bauxite produced at Weipa is exported.

As a general rule, bauxite supply chains are very closely interlinked with their immediate refinery and smelter customers. These supply chains are also characterised by significant vertical integration in the production chain.

A typical bauxite supply chain for this corridor is show in Figure 13 below.

**Figure 13: Supply chain schematic for bauxite**



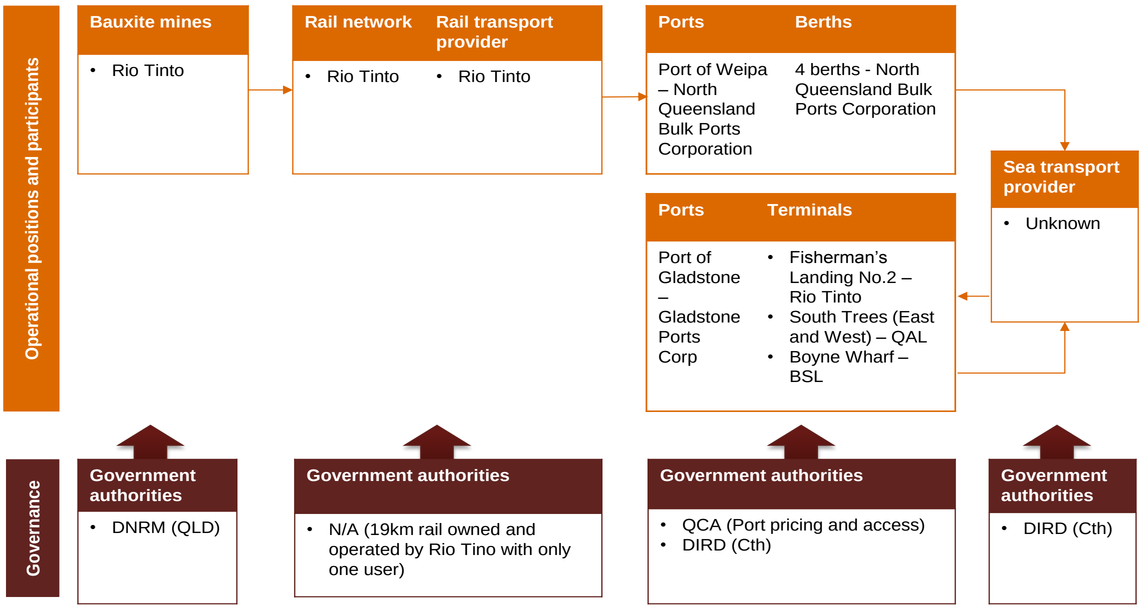

Source: PwC analysis

## 4.2.2 Participants & operation

The transportation of bauxite through the Weipa corridor involves a number of key supply chain positions and participants operating within each position. This corridor is vertically integrated, for example, Rio Tinto operates mines, rail networks and processing facilities further downstream.

The key positions and participants in this corridor are show in Figure 14 below.

**Figure 14: Key positions and participants in the Weipa corridor**




Source: PwC analysis

## 4.2.3 Infrastructure capacity

### Ports

Rio Tinto transport bauxite ore from the Andoom mine to the beneficiation plants via 19km of rail. This infrastructure is owned and operated by Rio Tinto who are the only users of the track. Information around TAL and travel speeds is unknown.

*Port of Weipa*
The Port of Weipa is owned and controlled by the North Queensland Bulk Ports Corporation. The port has two bauxite berths that are owned and operated by Rio Tinto. These berths are connected to the bauxite basin by a 19km rail line.

The port operates two travelling/slewing ship loader – one each at Lorim Point East and Lorim Point West. These operate with an average loading capacity of 5,000 tph or a maximum capacity of 6,400 tph. The port allows for a maximum vessel of 88,000 dwt.

*Port of Gladstone*
The Port of Gladstone is operated by the Gladstone Ports Corporation and has four berths which are used in the bauxite supply chain.

South Trees Wharves (West) is owned and operated by QAL and receives bauxite from Weipa. The berth has two travelling gantry ship unloaders which can unload at a maximum rate of 3,300 tph. This berth can handle vessels up to 80,000 dwt in size.

South Trees Wharves (East) is owned and operated by QAL and is used to export alumina (produced by Rio Tinto's QAL and Yarwun refineries). The berth has one travelling gantry loader with telescopic spout which can load alumina as a maximum rate of 1,500 tph. The maximum vessel size for unload is unknown.

Boyne Wharf is owned by the Gladstone Ports Corporation and operated by Boyne Smelters. This berth is used to export aluminium and operates lifting gear which can load 18,000 tonnes of cargo in 3.5 days. Aluminium products are stored on a seal open area near the wharf approach. The berth can handle ships of up to 60,000 dwt in size. The maximum vessel size for unload is 60,000 dwt.

Fisherman's Landing No.2 is owned and operated by Rio Tinto and used to receive bauxite from Weipa and also to export alumina to smelters in Australia and overseas. Ship unloading facility includes one travelling gantry ship unloader with a clamshell grab which operates at an average unloading rate of 1,250 tph or a maximum rate of 2,400 tph. Ship loading facility includes one travelling gantry with telescopic pout with an average loading rate of 1,140 tph or a maximum rate of 1,500 tph. The maximum vessel size for unload is 80,000 dwt.

Conveyors are used for the land transport connections between the berths and the refineries, or from the QAL refinery and Boyne Smelter, for transport of bauxite or alumina.

#### Intermediate production
The downstream bauxite supply chain for the Weipa corridor is characterised by a concentration of refineries and smelters based in Gladstone, often adjacent to the bauxite receival facilities. The following are significant facilities:

- Rio Tinto Aluminum own and operate the Yarwun refinery, situated 10 km north west of Gladstone, with a capacity of 3.4 million tonnes of alumina per year.
- The Queensland Alumina Limited (QAL) produces alumina on behalf of Rio Tinto. It is located adjacent to the wharf along with storage facilities. The QAL has capacity to process up to 4.0 million tonnes of alumina a year.
- Boyne Smelters Limited operates the largest aluminium smelter in Australia, located approximately 20 km south of Gladstone at Boyne Island. The smelter has a capacity of 570,000 tonnes of aluminum annually. Once processed the aluminium is shipped from the Port of Gladstone to export markets in solid ingot form.

### 4.2.4 Costs
Freight costs for bauxite could not be identified from publically available sources.

### *4.2.5 Regulation*

Rail access

The short rail link at Weipa is a private use only rail system and treated as part of the mine operation.

Shipping access

Ports are often regulated due to the monopoly nature of the asset. Regulation is designed to allow equitable access to the coastline. Most jurisdictions have broad regulations that cover all ports, considering factors such as safety, equal access and pollution. Individual ports rarely have unique regulations imposed. For the shipping of Bauxite, the Australian Maritime Safety Authority (AMSA) implements the International Maritime Organisation (IMO) regulations as they pertain to general and dangerous goods cargo. Transporters of cargo are subject to International Convention for the Safety of Life at Sea (SOLAS) and will be inspected to verify compliance with cargo requirements including: stowage, segregation, packaging and documentation. Bauxite shipments fall under the Bulk Cargoes Marine Orders 34 and 35. In addition, AMSA has issued an exemption for Bauxite shippers to evaluate the corrosive properties and hazard risk of moving these goods using an alternative method than prescribed in the orders.

Resource companies may also be exposed to export regulations, such as the *Maritime Transport and Offshore Facilities Security Act 2003 (Cth) (Facilities Security Act),* as well as the Export Control Act (1982) and associated regulations.

Coastal Trading Act[25]

Depending on the vessel voyage, the vessel charterer or operator may also be required to satisfy a range of regulatory requirements established through the *Coastal Trading (Revitalising Australian Shipping) Act 2012 (Cth) (the Act)*, including authorisation to move goods within or between Australian states through Coastal Trading License. The Act revised the competition rules of coastal shipping trade and limited the ability for foreign ships to access our ports; a longstanding feature of our coastal trade. A tiered licensing system was brought in to replace the single and continuous voyage permits which prevailed prior to the Act. This discriminated against foreign ships; increasing the transport and administration costs of domestic trade and making it more difficult to find coastal shipping providers.

[25] Minerals Council of Australia (2017), Submission on Coastal Shipping Reforms Discussion Paper, accessed: http://www.minerals.org.au/news/submission_on_coastal_shipping_reforms_discussion_paper

# 5 Technology and innovation

Resource companies continue to focus on improving productivity and reducing costs through the use of new technologies. Rio Tinto, BHP and FMG are recognised as world leaders in innovation and the application of technology in their mining and heavy haul rail operations, to increase asset utilisation and take costs out of their iron ore businesses.

New technologies which have been implemented or are currently being considered within the resources sector globally include:

- robotics for the automation of elements of the supply chain; and
- data driven software and devices designed to optimise asset utilisation.26

This section focusses on the current and upcoming technologies which impact the transportation of commodities from their source to end users. Supply chain technologies represent potential solutions to alleviating the bottlenecks discussed in Section 7.

The likely impacts of these technologies on the supply chains and infrastructure requirements is based on results from existing implementations where available. The potential impact of these technologies within the Australia context should be verified via stakeholder consultations with industry and government.

This section will provide an analysis of possible technological impacts on supply chain - including test of:

- take up;
- impact on supply chain; and
- relevance to sector.

## 5.1 Supply chain automation

### 5.1.1 Automated rail systems

| | |
|---|---|
| ***Description*** | Automated rail systems involve the use of robotics to control and manage the rail system which transports resources from the mine basins to the port |
| ***Commodities impacted*** | Iron ore, coal |
| ***Take up*** | The technology is currently being implemented by Rio Tinto in its rail system in the Pilbara (WA). Known as the AutoHaul™ system, the system is still in operational testing and represents the first example of an automated heavy-haul rail system in the world.[27] When complete, it is expected that 180 autonomous trains will run on Rio Tinto's 1500km Western Australian rail network connecting Pilbara iron ore mines and three |

[26] PwC (2017), Mine 2017, accessed: https://www.pwc.com.au/publications/pdf/global-mine-2017.pdf

[27] National Transport Commission (2016), Land Transport Regulation 2040, Technology, trends and other factors of change, accessed: https://www.ntc.gov.au/Media/Reports/(5DC20551-A325-68C1-486E-D10212E19A15).pdf

| | |
|---|---|
| | ports.<br>The system is expected to be fully implemented by the end of 2018 |
| ***Likely impact on supply chain and infrastructure requirements*** | Automated rail systems may reduce supply chains costs as it provides additional capacity required to meet increasing production without investment in additional trains. Based on Rio Tinto's implementation of the technology, it is estimated that each of the autonomous haul trucks at Rio Tinto's Pilbara iron-ore operations operated an additional 1,000 hours and at 15% lower cost than conventional haul trucks.[28]<br>These benefits could result in a decreased need for infrastructure investment for rail and sea transportation. |
| ***Use case example(s)*** | Rio Tinto's driverless trains in the Pilbara. |

Source: National Transport Commission (2016), Mining Magazine (2017)

### 5.1.2 Remote controlled equipment

| | |
|---|---|
| ***Description*** | Remote controlled machines, involving control of mining equipment, train loading and unloading, and export terminals operations (stacking/reclaiming/loading) from remote operations control centres. |
| ***Commodities impacted*** | Iron ore, coal |
| ***Take up*** | This technology is already in use at mine sites (eg driverless trucks), and terminals (eg at BMA's Hay Point Coal Terminal), with the operations controlled from Perth and Brisbane respectively. DBCT in the CQCCN is planning introduction for its yard machines. |
| ***Likely impact on supply chain and infrastructure requirements*** | Remote controlled equipment reduces operating costs and on-site manning, and provides for continuous operation, increasing capacity, |
| ***Use case example(s)*** | This is well established technology. Rollout is subject to the scale of operations and business case economics. Particularly attractive in remote locations where attracting and retaining equipment operators is difficult. |

## 5.2 Greater use of data

### 5.2.1 Port Community Systems

| | |
|---|---|
| ***Description*** | Ports Community Systems involve the use of an open computer system that allows supply chain participants to exchange important supply chain information including:<br>• Container numbers<br>• Voyage number<br>• Receiver address.<br>This information becomes the main source of information on a particular commodity that can be used by all systems within that supply chain.<br>These systems were originally developed for containerised freight but have since been adapted to bulk freight. |
| ***Commodities impacted*** | Iron ore, coal, steel, bauxite |

[28] Mining Magazine (2017), Rio provides AutoHaul update, accessed: http://www.miningmagazine.com/future-of-mining/future-of-mining-innovation/rio-provides-autohaul-update/

| | |
|---|---|
| ***Take up*** | Current |
| ***Likely impact on supply chain and infrastructure requirements*** | Ports Community Systems could result in:<br>• increased reliability and certainty of freight status for freight originators and end users<br>• improved asset management transportation companies and infrastructure as transportation companies can load a ship, truck or train with higher volumes of commodities and will also be able to sell empty cargo space<br>• better bulk storage planning and truck turnaround times.<br>More efficient asset utilisation could result in a decreased need for infrastructure investment for road, rail and sea transportation. |
| ***Use case example(s)*** | Unknown |

Source: Chamber of Commerce and Industry of Western Australia (inc)

### 5.2.2 Supply monitoring systems

| | |
|---|---|
| ***Description*** | Supply monitoring systems involve a remote monitoring and control which can connect and communicate with mine and processing sites. The systems can allow the extraction of resources to be regulated according to process demands. |
| ***Commodities impacted*** | Iron ore, coal, steel, bauxite |
| ***Take up*** | Current<br>Supply monitory systems and similar technologies have been implemented by Rio Tinto and Vale (S11D project) |
| ***Likely impact on supply chain and infrastructure requirements*** | Supply monitoring systems could result in more efficient asset utilisation could result in a decreased need for infrastructure investment for road, rail and sea transportation. |
| ***Use case example(s)*** | Unknown |

Source: PwC (2017)

## 5.3 Remote equipment monitoring

### 5.3.1 Rail systems and rollingstock

| | |
|---|---|
| ***Description*** | This includes a range of equipment and materials monitoring to detect and allow planned intervention to prevent catastrophic failures, Includes wayside monitoring of rollingstock pass-bys (axle bearings, wheels), automated monitoring of track infrastructure, train control systems, telecommunication networks, on-train performance and equipment condition |
| ***Commodities impacted*** | All rail based supply chains |
| ***Take up*** | Significant current take up by individual rail companies (network asset owners and rail operators). Level of take-up across this proven technology class subject to individual rail system operating scale |
| ***Likely impact on supply chain and infrastructure requirements*** | Improved reliability, reduced unplanned outages, reduced costs (of rectifying damage), and increased realizable capacity |

Source: PwC (2017)

# 6 User needs

This section provides an overview of a user's needs from its supply chain, which can be generally applied to most users and supply chains in the resources sector. Three major supply chain dimensions have been identified as core needs of any user from its supply chain, however the relative importance of the three major dimensions will vary depending on the user and particular supply chain circumstances.

The following section covers a generalised segmentation of users and description of user needs, and some typical examples.

## 6.1 Segmenting Users

Users of the supply chain have been defined as per Table 6 below.

**Table 6: User segments**

| User | Example/Description |
|---|---|
| **Existing user with access to sufficient capacity** | This user has adequate capacity and is not seeking additional capacity. This user would want to be assured that it would not be disadvantaged by any new user/s, including impacts on pricing, service standards and reliability of the supply chain. |
| **Existing user requiring additional incremental capacity** | This user's ability to access capacity is dependent on position within the rail/port and the impact of accessing additional capacity on supply chain dimensions (price/cost and reliability). Examples would include any existing miners seeking to use current non-contracted capacity in existing supply chains, such as WICET in Gladstone. |
| **New user with small volumes accessing a multi user supply chain** | In this context small is relative to the extra capacity "solution", where this user requires only part of the extra capacity associated with expansion of the supply chain. Examples include the original seven mining companies forming the WICET consortium, underpinning funding of a new coal terminal in Gladstone, and associated major rail network upgrades; or the investors in the new NCIG terminal in Newcastle. |
| **New user with large volumes accessing a single user supply chain** | This user has full control of its supply chain, and exercises control over its own investment decisions on new mines or mine expansions, and requirement for extra supply chain capacity. Typical examples include BHP-Billiton and Rio Tinto in their Pilbara iron ore operations. |

## 6.2 User Needs

User needs generally relate to one of the following:

- cost;
- capacity; and
- reliability.

### 6.2.1 Cost

Supply chain costs are fundamental to resource projects being competitive in global markets, or in the domestic market. This includes consideration of landside line-haul costs (rail or road), shipping costs, and the costs of mode changes from mine to port. This is more significant where supply chain costs are a significant proportion of product price, typical for resource products such as iron ore, coal and bauxite, but less so for mineral concentrates, and not particularly relevant for precious metals.

User needs relating to cost are driven by the need for cost efficiency to remain competitive globally in export markets. The factors that determine cost efficiency include:

- operational efficiency (including cycle times, train and ship payloads, manning levels and labour costs, energy efficiency and cost);
- capital efficiency (suitability of asset standard, asset utilisation);
- the cyclical nature of sensitivity to price – boom (capacity sensitive) vs bust (price sensitive); and
- the ability to control costs/prices, which in turn, can vary depending on the user:
  - Individual miners in a multi user/provider supply chain are price takers in their supply chain, with each of the suppliers pricing its particular component. In the east coast export coal supply chains this includes separate pricing for rail access, provision of rail line-haul services, and terminal prices. These will generally entail requirements for Take-or Pay for contracted capacity. The below rail access charges in both NSW and Queensland are price regulated, as is Dalrymple Bay Coal Terminal, but the provision of rail services are competitively tendered, and the other export terminals have differing pricing arrangements. Individual miners have limited ability to influence the efficiency of the components (and cost efficiencies) of their respective supply chains.
  - In the single user/provider supply chain typified by the three major iron ore miners in the Pilbara, each has full control over its landside supply chain and export terminal/s, and investment decisions and operating arrangements can be optimised to more effectively manage their supply chain costs.

### 6.2.2 Capacity

All users or potential users require supply chain capacity across each of the elements of the supply chain, and an individual user's perspective on capacity is influenced by its position as detailed in Section 6.1.

For a user with sufficient capacity, its need is that it will not be disadvantaged by the provision of additional capacity to other users. This can be in terms of impact on price, service quality and availability.

In some circumstances the allocation of spare capacity, or the provision of incremental capacity, has the effect of lowering the costs for all users where pricing is socialised. In this case the incumbent user will benefit from capacity provided to other users. This can typically apply where additional capacity can be readily provided by adding additional passing loops on a rail system, or by other relatively low capital cost capacity enhancements.

However, the allocation and utilisation of capacity can also have negative impacts on existing users, such as imposing additional queuing (and operating costs) in a supply chain. It can also reduce the flexibility to cater for seasonal peaks, or impact the recovery time from unplanned outages affecting individual users.

For new capacity seekers, the options for gaining access include:

- increased utilisation of existing latent capacity;
- making use of capacity relinquished by other users; and

- accessing additional capacity to be provided in the supply chain which could arise from:
  - incremental upgrades for small tonnes (e.g. an extra train or new crossing loop)
  - large step function upgrade or new infrastructure (e.g. WICET or Adani's Carmichael project new rail link).

### 6.2.3 Reliability

Reliability of the supply chain is a key requirement of users and their customers. This includes consideration of total capacity, peak capacity, number and duration of planned and unplanned outages, and the ability to recover from outages. The supply chains need to be designed to cater for the planned mode of operation, allowance for outages, and size of stockpiles at the mode change points and end customer, to cater for supply chain performance variability.

The complex mechanical and electrical equipment in export terminals have numerous potential points of failure. These can take minutes or some weeks to rectify. A major rail derailment could take up to a week to rectify. The supply chain equipment maintenance regimes (including inspections, availability of resources, spares) are therefore critical to individual systems' performance.

In multiple party supply chains, the physical interfaces, different contracting arrangements, and variable producer and customer requirements, add complexity to the operation of the supply chains and varying supply chain reliability impacts.

A recent example in the CQCCN was the impact of Tropical Cyclone Debbie, which resulted in a five week shut-down of the Goonyella rail system to repair major landslides and flood damage. The incident also required shutdowns of one – two weeks on the other rail systems in the CQCCN. The port coal stockpiles at both Hay Point terminals were rapidly exhausted, leading to a spike in coking coal prices, an increase in the ship queues, production delays at some mines, and additional costs added to the supply chain.

# 7 Bottlenecks

This section provides a high level discussion of potential bottlenecks that can occur in the resource sector supply chain, identifies where these bottlenecks occur relative to supply chain moves and provides examples of bottlenecks drawn from:

- Wiggins Island Coal Export Terminal (WICET); and
- Pilbara iron ore supply chain.

There are four key types of bottlenecks that occur in resource sector supply chains:

- Capacity;
- regulatory;
- approvals; and
- commercial.

## 7.1 Capacity bottlenecks

Capacity bottlenecks in existing supply chains arise where there is insufficient capacity in the network to enable efficient freight movement. These can arise from:

- Operational issues – this relates to how the supply chain components are operated and maintained. This could include inadequate staffing levels or skill levels, impact of work practices and procedures, an inadequate asset management regime, lack of spare parts and delays in rectifying outages.
- Physical bottlenecks – this could include track capacity limiting available train paths, stockpile capacity, conveyor speeds, axle load and train length limitations.
- A lack of harmonisation across multi user/provider supply chain – this could include non-alignment of planned shut-downs, and sub-optimising outcomes in a specific part of the supply chain at the expense of overall system capacity outcomes.

Addressing capacity bottlenecks can involve relatively simple changes to work practices and procedures with or without an impact on operating costs and/or:

- small capital investment to provide small volume incremental capacity (e.g. add another train set or extra passing loop); and/or
- large capital investment and large volume step-change capacity enhancement e.g. build a new export terminal or major expansion to an existing terminal, or build a new railway.

## 7.2 Regulatory bottlenecks

Regulatory bottlenecks includes the impact of any competition regulator role in the decision making by the regulated entity in undertaking capacity upgrades. This can include :

- rules on the process for new capacity access seekers, and whether these add cost and delays to decision making; and
- a requirement to approve the addition of new assets to the Regulated Asset Base for pricing purposes, and needing to approve the prudency and value of the particular

upgrade. There is no ability under current access undertakings for regulated asset owners (ARTC, Aurizon Network, Queensland Rail and DBCT) to invest in "spare" capacity ahead of committed demand.

For large step change investments in capacity, such as rail capacity associated with Wiggins Island Coal Export Terminal (WICET) at Gladstone, and the new rail link from the Goonyella system to Abbot Point (GAPE rail project), the regulatory approach and eventual approval of the commercial arrangements added additional uncertainty and delays in the negotiations leading to each project's financial close.

The supply chain coordination arrangements, leading to the establishment of the HVCCC and the Goonyella Integrated Logistics Company also required approval by the ACCC in respect of potential anti-competitive behaviour by the stakeholders in sharing information and cooperating in the management of these supply chains.

## 7.3 Approvals bottlenecks

Approvals bottlenecks relate to the requirement to obtain planning and environmental approvals for new mines, railways and export terminals, or major expansions or enhancements to existing mines and infrastructure.

These typically entail undertaking Environmental Impact Assessments, and may include approvals from all three levels of Government. While the need for rigorous assessment and approval processes are critical, the regulatory planning and environmental lead times are increasing, and the uncertain outcomes and timelines are now the most significant bottleneck in the resources supply chains.

Table 7 below provides examples of the duration of coal projects in Queensland.

**Table 7: Coal project duration (QLD)**

| Mine | Process commenced | State Approval | Cth Approval | Duration |
|---|---|---|---|---|
| Clermont Mine | Aug-03 | June-05 | NA | 22 months |
| Daunia Mine | May-08 | Oct-09 | NA | 17 months |
| Caval Ridge Mine | May-08 | Aug-10 | NA | 27 months |
| Byerwen Mine | Feb-11 | Jul-14 | Oct-14 | 44 months |
| New Acland Stage 3 | Apr-07 | Dec-14 | Jan-17 | 117 months |
| Carmichael Project | Oct-10 | May-14 | Oct-15 | 60 months |
| *Rail Projects* | | | | |
| Northern Missing Link | May-06 | Oct-06 | NA | 17 months |
| Moura Link | Sep-07 | Oct-09 | NA | 25 months |
| Surat Basin Railway | Nov-07 | Dec-10 | NA | 37 months |
| North Galilee Rail Project | May-13 | Aug-14 | Oct-15 | 29 months |
| ***Coal export terminals*** | | | | |
| Abbot Point Stage 3 | Apr-05 | Aug-07 | NA | 28 months |
| WICET | Sep-05 | Jan-08 | Apr-08 | 31 months |

Source: Qld Coordinator General website

Issues with the planning and approvals process from a supply chain bottleneck perspective include:

- extended timelines involved, and non-alignment with the resources market cycle;
- uncertainty on outcome and conditions of approval; and
- decision making subject to extended rights of appeal by any party.

The processes and the uncertainty surrounding planning and environmental approvals are more challenging for small mining start-up participants. The delays and uncertainty also have flow on impacts on the ability of proponents to also address the commercial bottlenecks (where these exist) as described in the following section.

### *7.3.1 Commercial Bottlenecks*

Commercial bottlenecks include the complexities and lead-times in the negotiation of all the commercial agreements inherent in resource projects and in supply chains. They are particularly apparent in the mutli-user/multi-supplier supply chains, typified within the east coast coal supply chains. They are much less an issue in the predominantly single user supply chains typified with the three major iron ore producers in the Pilbara (of less complexity).

Small volume, incremental capacity seekers in multi-service provider supply chains must deal with each of the parties separately, and align these with their planning approvals and financiers to achieve a positive investment decision outcome. The rail network access provider and export terminal will typical have a pre-determined set of protocols and requirements in relation to obtaining access and pricing arrangements, and will require Take-or-Pay provisions to ameliorate its risks. These will be a mandated by the competition regulator, or as adopted by the asset owner in response to the threat of being declared and regulated.

For multi-part participants in major step function capacity enhancements, the complexities and risks of achieving financial close increase for all parties involved. This includes the increase in the number of counter-parties involved and their legal teams, the much greater scale of the investment decisions involved, and possibly complexities as to ownership and operation of the new asset. WICET and NCIG are typical examples of this in the east coast coal supply chains. This complexity can include other investment approvals required including FIRB approvals, where applicable, and ACCC considerations.

The investment decision go–no go decision making by the individual parties must navigate through this, with alignment of decision making, and agreement on contractual matters. The risk profile for is also increased with multiple parties, which may also vary considerably in terms of their size and capability. In the WICET example three of the eight founding participants are no longer in business, only two years after commencing operations.

By contrast single user owned supply chains are much simplified, generally involving major entities with substantive internal resources and capability, and ready access to funding.

The competition regulatory arrangements applicable to the east coal rail networks, and DBCT, add another complexity for consideration. However, the Access Undertakings provide some level of certainty of process and outcomes, where capacity upgrades are considered as business as usual for the regulated entity. It is noted that Aurizon argued that the Goonyella Abbot Point Expansion Project (GAPE) and Wiggins Island Rail Project (WIRP) were outside the regulated asset base and associated Access Undertaking, and hence subject to its ability to deal separately with these. Ultimately they were deemed included, but with a separate risk premium approved to address the higher business risks involved. It should be noted that these utilisation risks have eventuated with the subsequent coal market downturn.

## 7.4 Occurrence of Bottlenecks

### 7.4.1 WICET

The Wiggins Island Coal Export Terminal arose from the emerging port capacity bottleneck in Gladstone, following the Stage three expansion of the RG Tanna Coal Terminal. The nominal capacity of RGTCT was quoted at 68 Mtpa, upon the completion of Stage three in 2006. This has subsequently been up-rated to a nominal 72 Mtpa.

The major trigger for WICET was the proposed Wandoan Mine in the Surat Basin by Xstrata and Glencore and also the planned Surat Basin Rail Link. However, there were 18 mining entities interested in capacity originally, who contributed to the detailed planning studies and design between 2008 and 2010. This was reduced to eight mining entities who took an equity position in the establishment of WICET, and underpinned its Stage one capacity of 27 Mtpa.

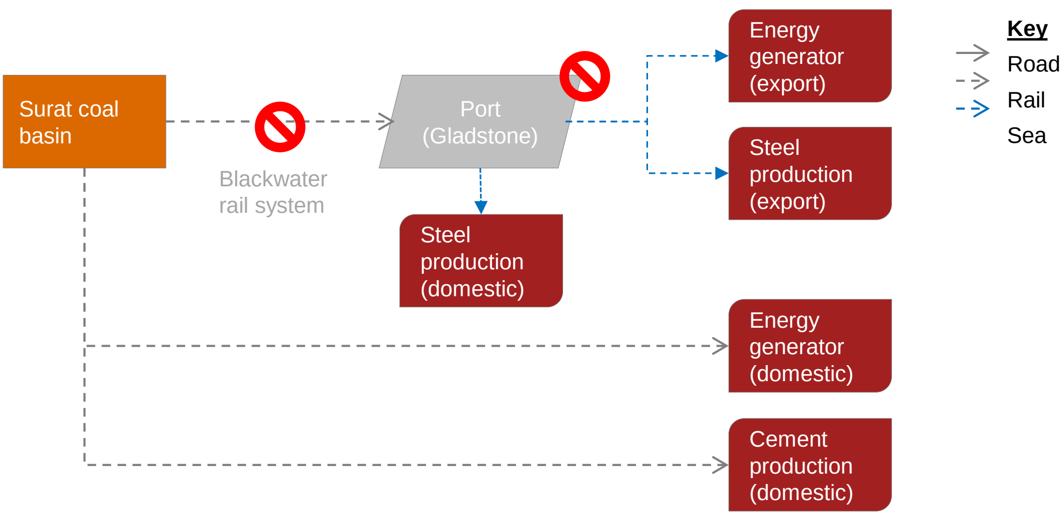
Project financial close occurred in September 2011, and construction commenced late 2011, for a planned completion in 2014. Construction was slowed down with the coal market downturn, and the first coal was eventually shipped in late-April 2015. Debt funding of US$3 billion was obtained for WICET via a group of 20 banks.

Prior to and since that time three of the original consortium (Bandanna Energy, Cockatoo Coal and Caledon Coal) experience financial difficulties and have ceased operations. Glencore did not proceed with its Wandoan Mine and the SBR has not proceeded.

In parallel with WICET, the rail network feeding the Gladstone export coal chain needed to be upgraded to provide the additional 27 Mtpa of contracted capacity. The Wiggins Island Rail Project (WIRP) undertaken by Aurizon, included completing the duplication of the remaining single line sections on the Blackwater system between Rocklands and Burngrove, upgrades to the Moura Line, in addition to rail link into WICET. This was funded by Aurizon, but with contracted Take or Pay contracts with the eight WICET miners for their respective contracted tonnages.

Figure 15 below shows the location of the bottlenecks within the supply chain faced by Xstrata and Glencore.

**Figure 15: Rail and port capacity bottleneck faced by Xstrata and Glencore**




Source: PwC analysis

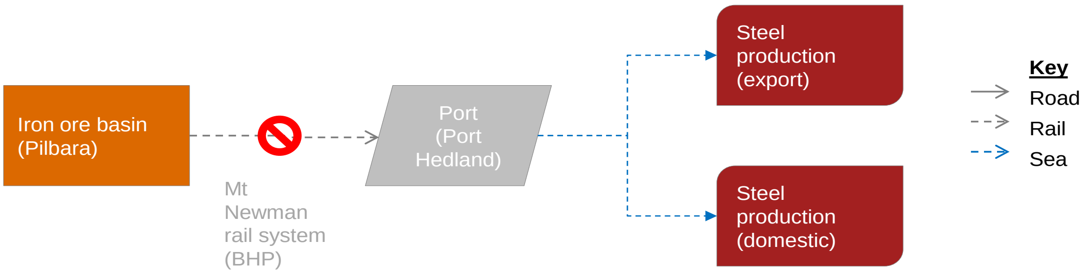
**Table 8: WICET bottlenecks**

| Bottleneck | Mine | Rail Network | Above Rail | Port | Comments |
|---|---|---|---|---|---|
| **Capacity** | Y | Y | Y | Y | Required new port and rail capacity, triggered by new mines and mine expansions by the eight miners, plus new coal terminal, plus additional rail capacity and train sets |
| **Regulatory** | | Y | | | Dispute between Aurizon and QCA on how the risks were addressed. (Resulted in a premium on the normal WACC on the WIRP asset base for the contracted entities. |
| **Planning Approvals** | Y | Y | | Y | Approval lead-times were not excessive |

## *7.4.2 Pilbara– Fortescue Metal Group*

The FMG success story in the Pilbara offers a significant alternative path to the initial mine and export volume start-up, and the subsequent substantial expansions. FMG sought rail capacity on the BHP Mount Newman rail system for many years, with no success, with court rulings supporting BHP's position that the rail system was an extension of its mining process. The location of this bottleneck within the iron ore supply chain is shown in Figure 16 below.

**Figure 16: Rail access/regulatory bottleneck faced by FMG**




Source: PwC analysis

FMG made the decision to build its own railway and export terminal complex at its Herb Elliot Terminal at Port Hedland, to service the initial Cloudbreak Mine, and achieved first shipments in 2008. The railway system and export terminal has been progressively expanded since, with current export tonnages of over 170 Mtpa. This is served by around 620 km of railway also linking the Solomon Mine complex, and five ship loaders and berths at the export terminal. FMG has also invested in the shipping stem, with four large capsize bulk ore carriers in use, and another four due for delivery in 2018.

From a supply chain perspective, FMG has been in control of its iron ore supply chain, including part of its shipping stem, and has been very successful in optimising its supply chain operation, driving increased efficiencies in its supply chain, and taking costs out of its operation.

Table 9 below outlines the bottlenecks encountered by FMG.

### Table 9: Pilbara (FMG) bottlenecks

| Bottleneck | Mine | Rail Network | Above Rail | Port | Comments |
|---|---|---|---|---|---|
| **Capacity** | Y | Y | Y | Y | The project required a new railway and port infrastructure. The FMG mine-port supply chain is vertically integrated, leading to timely decisions to invest in new infrastructure capacity, and de-bottleneck the operation of the existing infrastructure. |
| **Regulatory** | | | | | No competition regulatory constraints apply |
| **Planning Approvals** | Y | Y (new railways) | | Y | Planning and environmental approvals are still required for new mines, new rail links, and port upgrades |
| **Capacity** | Y | Y | Y | Y | The FMG mine-port supply chain is vertically integrated, leading to timely decisions to invest in new infrastructure capacity, and de-bottleneck the operation of the existing infrastructure. This has been on-going in response to market growth |
| **Regulatory** | | | | | No competition regulatory constraints apply |

# *Appendices*

# Appendix A Central Queensland Coal Chain Network

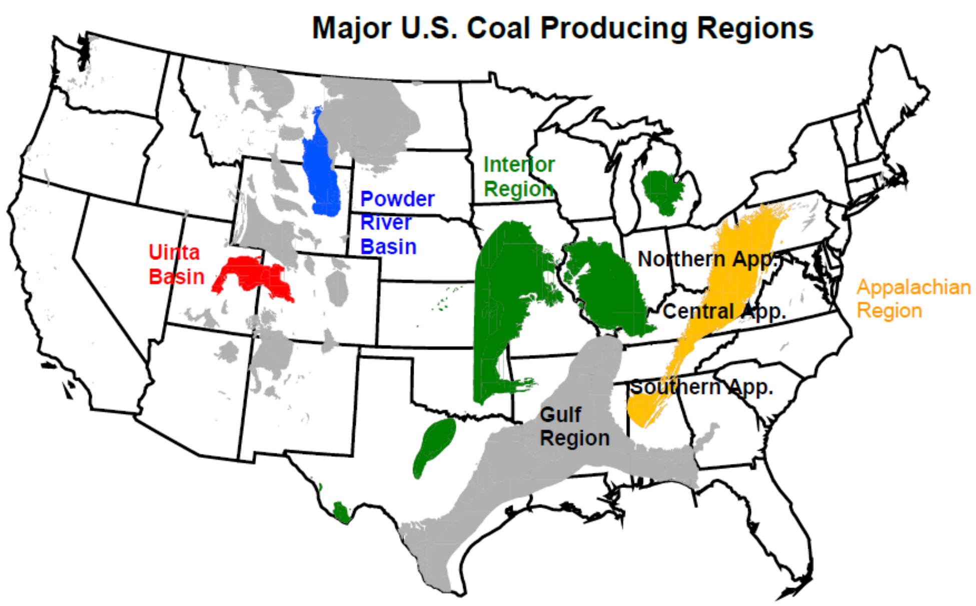
(Attached with this report)

# Appendix B Powder Basin case study

## 1 Demand and Production

In the US, there are a number regions across the country producing coal for domestic consumption and export to a lesser degree. The Powder River Basin is the major coal production area in the country.

**Figure 17: Coal regions**




Source: AAR – Railroads and Coal – June 2017.

Coal production in the United States totalled 739 million short tons (607 million metric tonnes) in 2016 (US-EIA 2017). There was an 18% reduction compared to 2015 and the lowest level since 1978. The Powder River Basin in Wyoming produced 376 million short tons (341 metric tonnes) in 2015. The output from the region is dominated by the North Antelope/Rochelle and Black Thunder Mines.

**Table 10: Powder River Basin Wyoming Coal Region Production**

| Operator | Mine | Production (Short Tons) |
| --- | --- | --- |

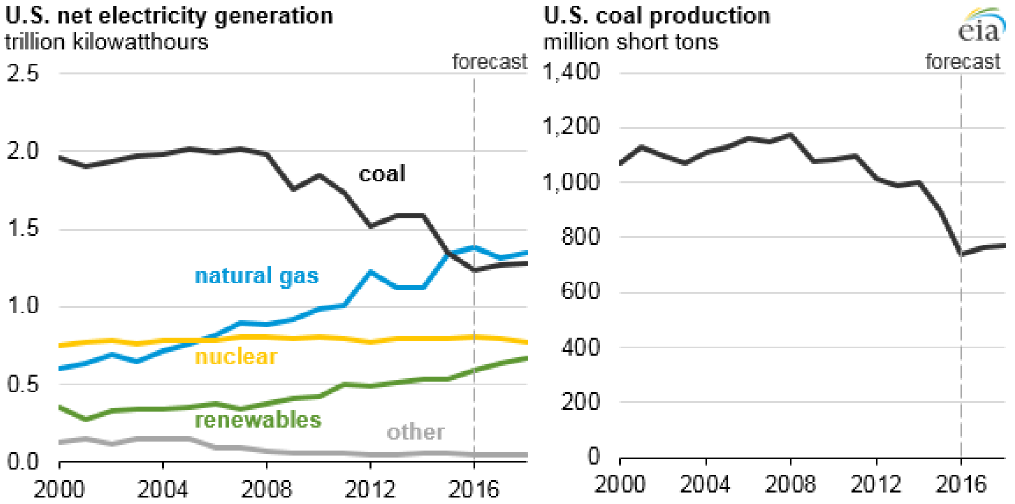
| | | |
|---|---|---|
| Alpha Coal West, Inc. | Belle Ayr Mine | 18,318,629 |
| Alpha Coal West, Inc. | Eagle Butte Mine | 19,649,723 |
| Black Butte Coal Co. | Black Butte Mine | 2,735,308 |
| Bridger Coal Co. | Bridger Surface Mine | 2,073,197 |
| Bridger Coal Co. | Bridger Underground | 3,090,175 |
| Buckskin Mining Company | Buckskin Mine | 13,601,471 |
| Cloud Peak Energy | Antelope Coal Mine | 22,871,977 |
| Cloud Peak Energy | Cordero Rojo Mine | 35,167,152 |
| Peabody Energy | Caballo Mine | 11,402,155 |
| Peabody Energy | Rawhide Mine | 15,167,996 |
| Peabody Energy | North Antelope Rochelle | 109,343,913 |
| Thunder Basin Coal Co. | Black Thunder Mine | 99,452,352 |
| Thunder Basin Coal Co. | Coal Creek Mine | 7,840,491 |
| Western Fuels of Wyoming | Dry Fork Mine | 6,369,206 |
| Westmoreland Coal | Kemmerer Mine | 4,470,864 |
| Wyodak Resources | Wyodak Mine | 4,140,386 |
| **Total Production (Converted to Metric Tonnes)** | | **341 Million Tonnes** |

Source: 2015 Annual Report of the State Inspector of Mines of Wyoming

Most of the coal produced in the United States is thermal coal used to generate electricity. Demand for thermal coal has been reducing due to conversion to natural gas and renewables. Coal may regain some market share of the electricity generation mix if the pricing of alternative energy fuels (e.g. natural gas) increases.

The recent decline in coal production has not been uniform across the three major coal-producing regions in the United States. Driven by extraction costs, transport costs and proximity to power stations, declines in the Western region (i.e. Powder River Basin) has fallen 36% since 2008 which has been consistent with the average decline in the industry.

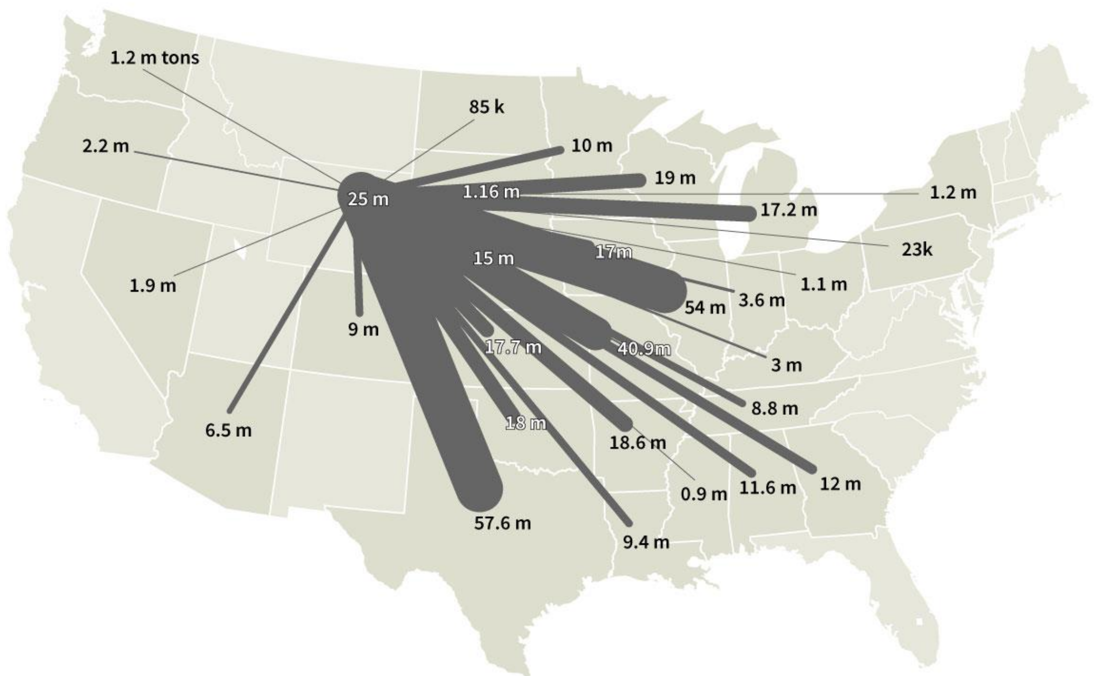
## Figure 18: US Energy Sources for Generation and Coal usage Trend -2000 to 2016.




Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, February 2017

The Powder Basin coal is an attractive product for power generation given its ease of mining. Despite a relatively long distance to some internal markets, it has the advantage of low mining costs through seams having low overburden ratios and substantial seam thickness. With seams that can be 30 metres thick or more, the mining cost makes the regions coal very competitive to extract. It also is attractive in terms having a low sulphur content of less than 1.0% and a relatively low ash content. These product advantages are offset by its lower calorific value of 8,800 BTU/lb compared to 12,000BTU/lb in other coal producing basins, meaning it produces less energy during combustion.

## Figure 19: Destination of Coal Production from the Powder Basin 2014




Source: Bill Lane Centre – Stanford University website.

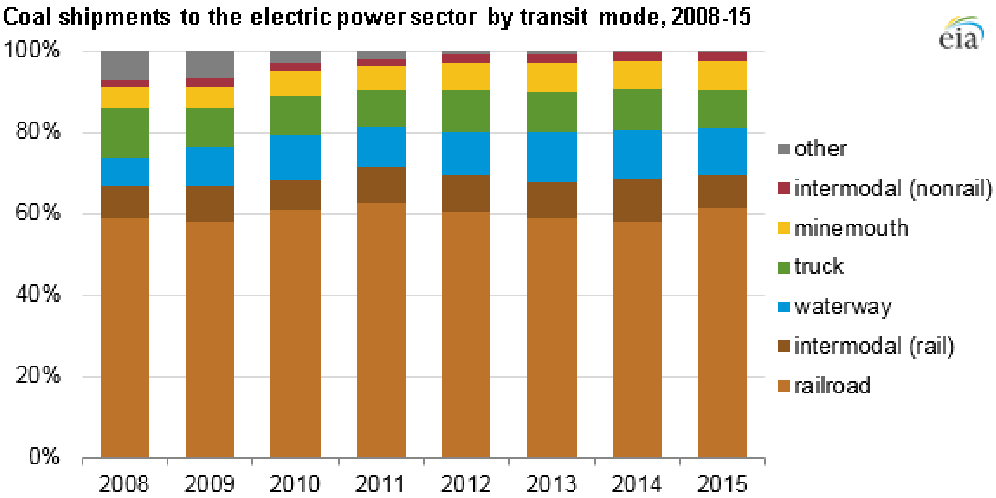
In 2016, the electric power generation sector consumed circa 92% of total U.S. coal production. Coal exports from the USA in 2016 were only 60.3 million tons (8.1%) of which

19.4 million tons were thermal coal. Demand between 2008 and to 2016, for thermal coal for electricity generation has decreased. In 2016, natural gas-fired generation exceeded coal's share of the U.S. electricity mix on an annual basis for the first time (Figure 18). Although the relative prices of coal and natural gas influence fuel use, demand is also increasingly impacted by generation from renewables (e.g. wind, solar, and hydropower).

# 2 Transport in the US Coal Industry.

The transport of coal output from mines to customers is dominated by rail in the USA. This is particularly the case with coal used for domestic power generation where almost 70% of all transport of coal for electricity was delivered by rail to customers.

**Figure 20: Coal Transport Mode Share**




Source: U.S. Energy Information Administration, Form EIA-923, Power Plant Operations Report
Note: Other includes pipeline, other waterway, barge, and coastal ports. Intermodal covers multiple modes of delivery.

The US rail industry is dominated by the major Class one rail companies. There are seven Class one companies in the USA. Historically, coal haulage has been a mainstay of railroad operations in the US. Each major rail operator provides an integrated rail service for customers through management of both the above rail train operations and below rail network infrastructure. The rail companies effectively manage the network area as their core franchise and have to strike commercial agreements to use or access routes beyond their core territory.

In the Powder River Basin, two major rail companies own network and provide services for customers. These are Union Pacific (UP) and BNSF who are the largest service rail providers in the USA. Over recent years as electricity generation has diversified away from coal, coal production has reduced which in turn has reduced the volumes transported by rail. While volumes transported by rail are still significant, it is a high volume bulk commodity that has a lower relative revenue yield compared to other commodities in the US. The UP coal haul task is 94% domestic coal, with 77% of all coal hauled sourced from the Powder River Basin.

The size and length of the standard gauge diesel hauled train consists hauling coal will be determined by network infrastructure constraints such as axle loads, track configuration, load/unload facilities, etc. Generally, the US networks can accommodate a much larger structure gauge (train envelope) than Australia that enables the deployment of larger locomotives and wagons. The train length can be in the order of 2.4 km long and have between 120 and 150 wagons. It is likely that four to five locomotives would be required to haul a train of this length and weight. The motive power required would be determined by the trailing load (payload plus wagon tare) and the ruling grades on the various routes.

In addition, the coal haulage routes in the US are much longer than the rail haulage undertaken in Australia. Haulage from the Powder River Basin to customers in the Chicago

Region would involve a one way haul distance on this route of 1650 km and New Orleans would be 2600 km. In comparison, Australian haulage tasks from mines in the Bowen Basin (e.g. Goonyella Mine) to export coal terminals at Mackay would involve a one way route distance of 200 to 300 km.

**Figure 21: UP Powder River Basin Haulage and Corridor Haulage Density Map.**

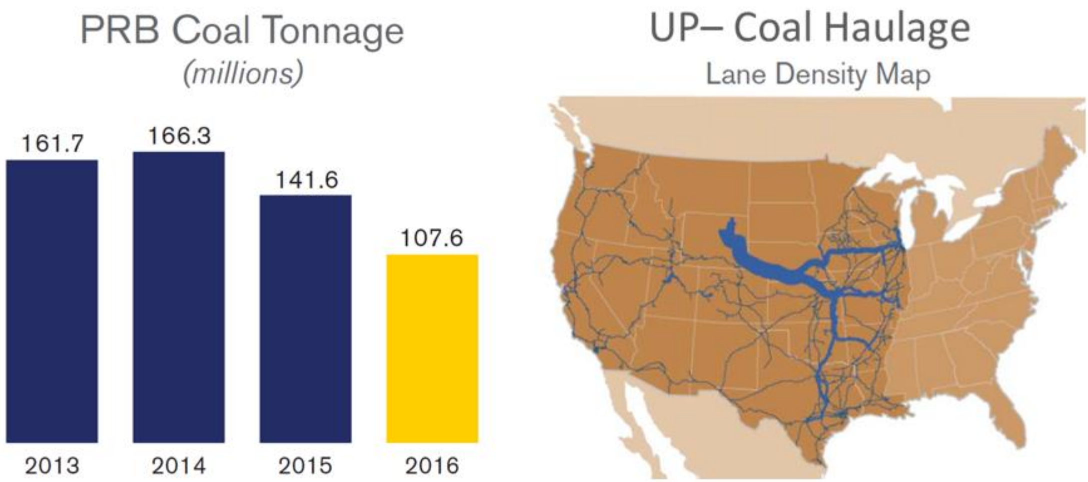



**Figure 22: UP Coal Customers**

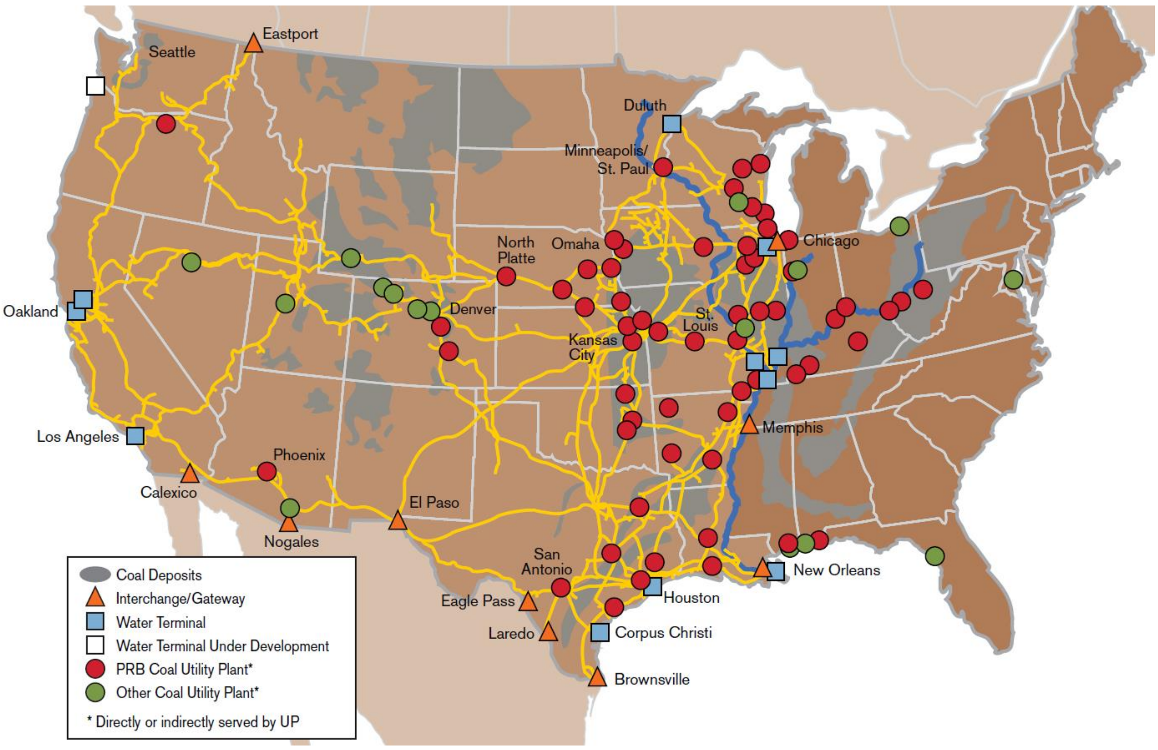
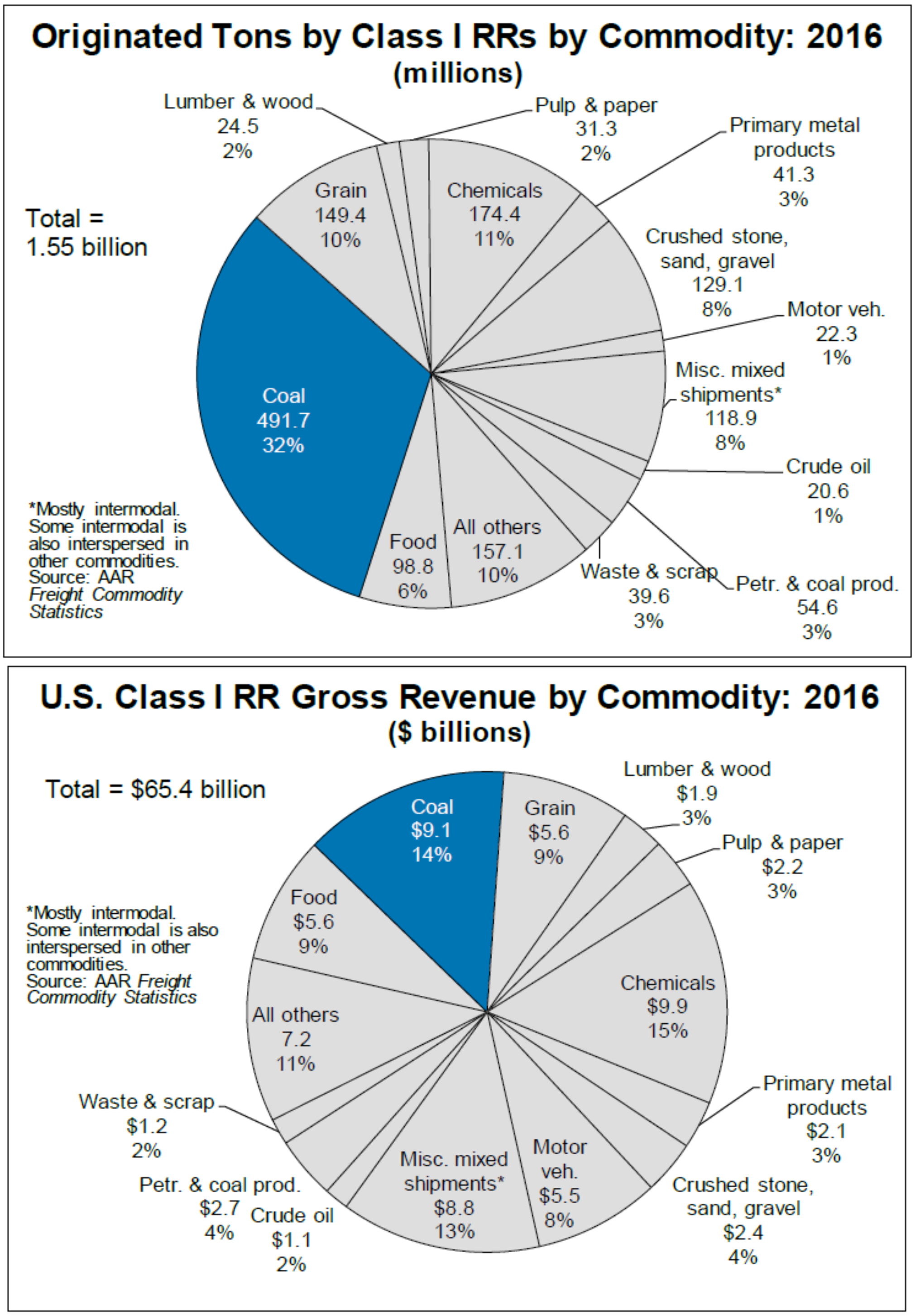


**Figure 23: Rail Task – Relative Coal Share by Volume and Revenue**

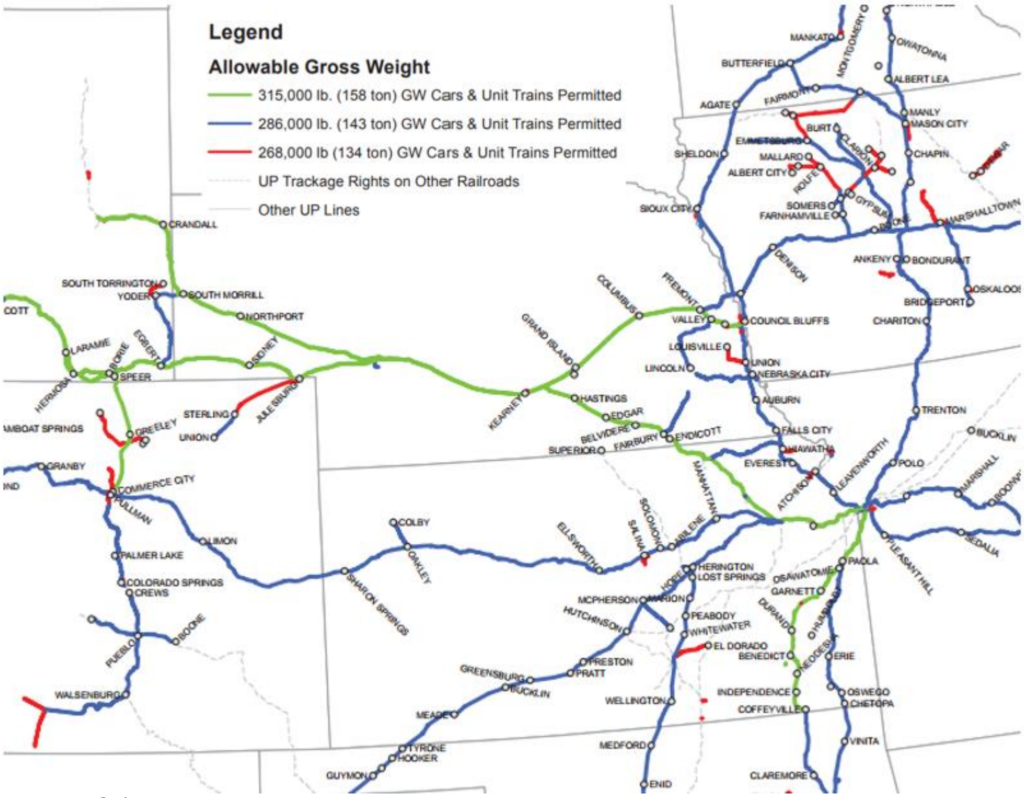



# 3 *Rail Network Infrastructure*

The major rail companies when providing integrated rail transport services to customers, have a dual commercial challenge of matching both track and operating capacity to customer requirements. Revenue generated from customers must cover operating costs including a margin and a ROIC for all of network, rollingstock fleet and support facilities. UP achieved a 12.7% ROIC in 2016.

Rail companies must also undertake continual network investment to optimise operational efficiency or connect the network to new customers and trade opportunities. The networks have required capacity upgrades to accommodate larger rollingstock capacity. The axle loads operating on the major networks have progressively expanded to accommodate the larger more efficient rollingstock essential for long distance hauls. The 100 ton car (22 TAL wagon) was introduced in the 1970's and in 1991, the 286,000 lb gross vehicle weight ("286k GVW") equal to 30 TAL in Australia was accepted as the interchange standard across the major networks. For heavy haul rail tasks such as coal haulage or double stacked intermodal services, networks have been upgraded to 39 tons (36 TAL).

**Figure 24: United Pacific Network Limitations East and South East of Powder River Basin**




Source: UP website.

The networks developed by the rail companies also reflect the capacities required in individual regions for specific customer demand and products. While the majority of the network is single line track with passing loops, sections of the network has been expanded and augmented over time to meet capacity requirements. Exchange agreements exist between different rail operators to facilitate the transport of rail freight across the networks of competitor operators as required.

**Figure 25: UP Network Capacity – Single to Quadruple Network**


Source: UP Investor Fact Book 2016.

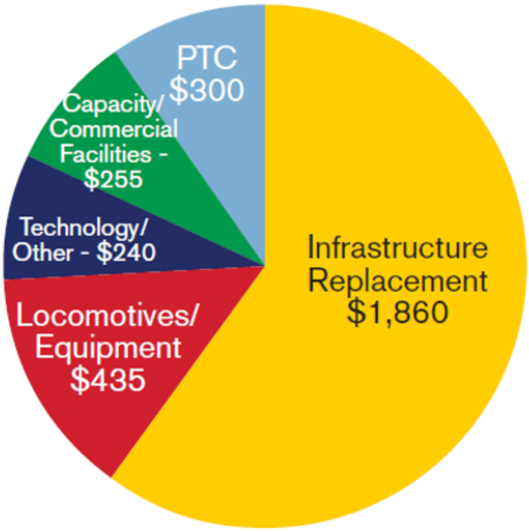
# 4 *Capital Investment*

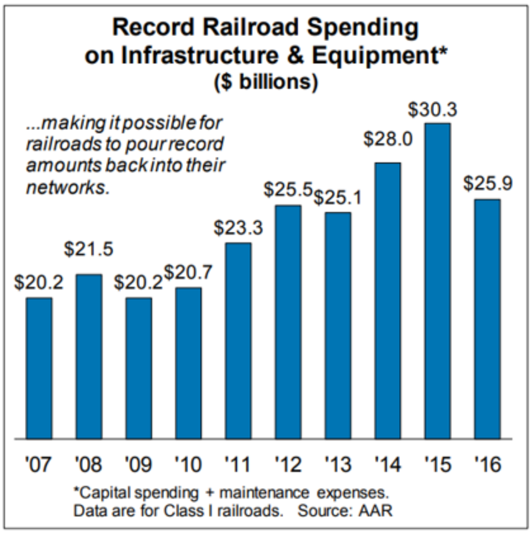
Maintenance of these large network systems combined with the upgrades, capacity expansion and adoption of new technology requires significant ongoing investment. The networks are large with UP having 82,000 km of track and BNSF having 52,000 km. Both the rail companies have over 8,000 locomotives in their fleet. UP transported 8.4 million wagons of freight and BNSF transported 9.7 million wagons of freight per annum. The BNSF split between major freight categories were:

- Consumer products – 5.2 million p.a.;
- Industrial products – 1.8 million p.a.;
- Agriculture products – 950,000 p.a.; and
- Coal – 1.8 million p.a.

The Capital Programs for UP and BNSF are significant. BNSF are planning to spend $3.4 billion in 2017 which is a $500 million reduction compared to 2016. Major components are network replacements and upgrades ($2.4 billion), rollingstock and equipment expenditure ($400 million), expansion projects ($400 million) and positive train control (PTC) implementation ($100 million). The 2017 Capital Plan for UP was identified as $3.1 billion. The components are outlined in Figure 26.

**Figure 26: UP Capital Plan Composition 2017 - $3.1 billion / Class one Capital Spending 2007 - 2016**




# 5 Regulation

The Federal Railroad Administration (FRA) oversees the regulation of the rail industry in the USA. The FRA through inspections undertake compliance and enforcement activities including:

- hazardous Materials;
- motive Power and Equipment;
- operating Practices;
- signal and Train Control; and
- track.

The FRA can set maximum freight rates where no effective competition for rail services is possible. If rail companies exhibit unreasonable conduct or pricing, the FRA has authority to intervene on behalf of customers. The Staggers Rail Act of 1980, removed the many regulatory restraints on the railroad industry, providing the industry increased flexibility to adjust their rates and tailor services to meet shipper needs and their own revenue requirements. Prior to the Staggers Act, the rail industry in the USA was subject to economic regulation that impacted pricing flexibility and the ability to rationalise branch lines. The FRA has indicated that services have improved, haulage rates have decreased and safety performance in the rail industry has improved with accident rates reducing by around 65% (Palley 2011). Rail market share was in decline prior to 1980 reducing from 56% to 37% and has stabilised at circa 40% with improved ROIC levels between 1990 and 2009 of 8%. Investment in the industry has also increased, with approximately $500 billion of capital improvements undertaken up to 2009 (Paley 2011).

The Staggers Rail Act of 1980 limited the authority of the Surface Transportation Board (STB), to regulate rates only for traffic where competition is not effective to protect shippers. The STB estimates that roughly 20 percent of traffic is still regulated and circa 50% of all traffic based on a revenue basis is exempt from regulation. The exemption is based on

- market competition maintaining rates at levels below the statutory threshold (where the ratio of the revenue to regulatory variable cost of the move is less than 1.8);

- specific traffic has been explicitly exempted (e.g. traffic moving in boxcars or trailers or containers on flatcars); and
- freight traffic movements undertaken according to negotiated contracts /agreements between railroads and shippers that includes terms such as rates, service levels, equipment, and minimum annual volume of traffic which enables railroads to improve asset utilization through better planning of their freight tasks.

Some participants in the supply chains advocate for a more regulated model and open access on private networks for an access fee to increase competition. The rail industry believes this would inhibit network investment.

The rail industry has also experienced opposition to expansion projects, particularly where the projects proposed were export coal projects requiring the establishment of a new export coal terminal. A new export terminal was proposed at Cherry Point in Washington State to enable Powder River Basin Coal to be exported from the US west coast to Asian markets. The project commenced an environmental assessment and lodged an EIS for the proposed site in 2011. After a range of obstacles were encountered throughout the EIS process and community opposition to constructing a new coal terminal, the project was abandoned in 2017 with the withdrawal of the environmental approval application.

# 6 Key Facts and Relevant Issues

- The US coal industry is mainly focused on the provision of thermal coal for customers undertaking domestic power generation. Powder River Basin is the major supplier of thermal coal to customers.
- Rail is the major mode of transport used for the large scale transport of thermal coal to customers.
- There are 16 mines in the Powder River Basin. Two mines at Black Thunder and North Antelope Rochelle account for 190 million tonnes of the 341 million tonnes from the region in 2015.
- UP and BNSF are the major Class1 rail companies that are providing coal haulage services from the Powder River Basin to a diverse number of power generators spread across central USA on rail networks owned by the rail companies.
- Despite coal demand having reduced in recent years, coal remains the major freight commodity by volume in the USA.
- The US rail services from the Powder River Basin can run a large unconstrained diesel hauled standard gauge train configuration on major corridors that can be 2.4 km in length with up to 150 wagons and 36 TAL (metric). The payload can be in excess of 15,000 tonnes of coal per service.
- The rail haulage distances in the US required to deliver coal to customers involve much longer haulage distances than in Australia. The haul distance from the Powder River Basin to a customer located in Chicago and New Orleans would involve 1650 km and 2600 km routes for the respective destinations for a one way haulage task compared to a 200 to 300 km haulage task in Australia from a Bowen Basin mine to the export coal terminals at Mackay.
- The network configuration from the Powder River Basin region corridor east to major destinations including Kansas City and Chicago include dual, triple and quad track corridors. The network configurations to more remote destinations are invariably single or dual track corridors.

- The rail operations are vertically integrated where operators control the above and below rail operations. This model results in rail companies investing billions of dollars each year across their networks, rollingstock fleet, support facilities, technology applications, safety and expansion opportunities.

- The US system of regulation is light handed relying on the striking of commercial contracts and agreements between the rail companies and freight shipping companies. Regulatory action from the FRA can be used to protect freight customers where insufficient competition results in unreasonable conduct or pricing.

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