Coal cost projections DRAFT

Approach to coal cost projections

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Trusted Intelligence

AEMO AUSTRALIAN ENERGY MARKET OPERATOR

woodmac.com

Background and Objectives

Coal cost projections

The Australian Energy Market Operator (AEMO) is responsible for operating Australia's largest gas and electricity markets and power systems, including the National Electricity Market (NEM), the interconnected power system in Australia's eastern and south-eastern seaboard; and Wholesale Electricity Market (WEM).

AEMO's planning functions rely on an underlying set of input assumptions that govern the behaviour of existing generation assets, and the economics/location of future investment and retirement decisions.

The dataset includes projections of fuel costs for both existing and emerging generation technologies. Updated coal cost projections are required for upcoming market simulation studies that will be conducted by AEMO. To this end, AEMO engaged Wood Mackenzie to provide an update to the work done on the delivered cost of coal for both existing and upcoming power projects.

Wood Mackenzie has provided a separate excel document including the coal cost projections under different scenarios, and a high level approach and risks to the coal cost projections in this document.

Agenda

We adopted a stepped approach for the projection – Step 1 involved identifying the contracts and supply options each power station.

Scope

Step 1: Identify the type of contracts and other supply options

Key issues & assumptions

- **Approach for existing power stations:**
  - » We identified the type of coal procurement arrangements for the existing power plants based on Wood Mackenzie research and the publicly available data:
    - » Contracted vs uncontracted coal supply arrangements
    - » Commercial terms under the contracts
  - » We also identified possible future mine to power plant coal flows in case of uncontracted volume or as existing contracts expire. This is based on:
    - » Coal qualities at existing mines and upcoming projects, distance from power plant, production profile over 2020/21 to 2042/43
    - » Remaining reserves, etc.
  - » The following details related to the existing power stations were provided by AEMO:
    - » Capacity
    - » Station heat rates
    - » Plant load factors
    - » Plant life
- **Approach for new (upcoming) power projects:**
  - » We identified the coal sourcing options for the following locations based on the resource potential of upcoming coal projects:
    - » North Queensland
    - » Central Queensland
    - » Southwest Queensland
    - » Northern NSW
    - » North-Central NSW
    - » Latrobe Valley

Source: Wood Mackenzie

Step 2 involved applying different pricing approaches based on the type of contracts to arrive at the delivered costs of coal.

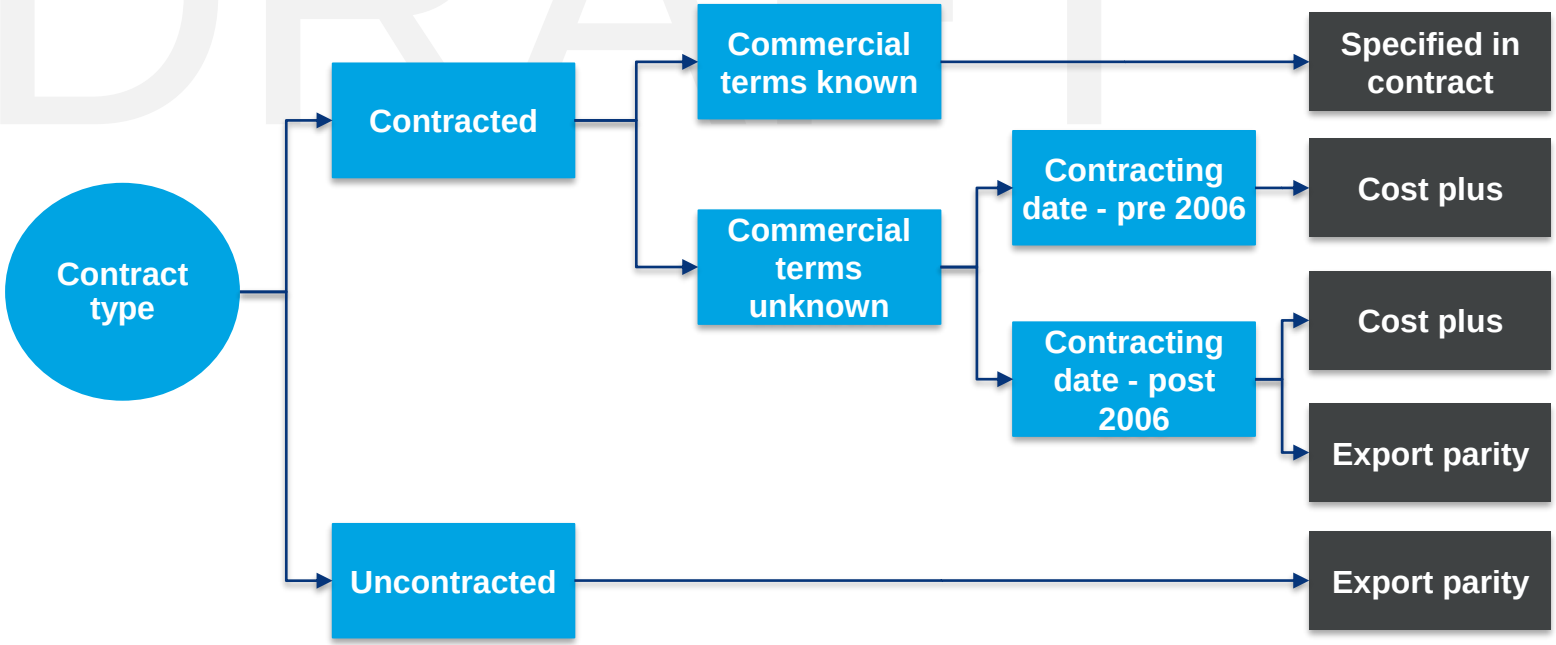
Scope

Step 2: Analyse the delivered cost of coal (Forecast for 2020/21 to 2042/43)

Key issues & assumptions

- **The pricing approach for existing power stations has been shown in the diagram below.**
  - » Contract-related information is based on information available in the public domain.
- **The pricing approach for new power projects is based on the marketability of coal in the export market and access to export infrastructure:**
  - » In case of existing access to export infrastructure and suitable coal quality, we adopted export parity pricing. Otherwise, we adopted a cost plus approach.
  - » Although there may be some lead time to the development of new projects, we have provided projections starting from 2020/21 for the modelling purpose (as requested by AEMO).

Coal pricing approach – Existing power stations



Source: Wood Mackenzie

Approach to cost plus and export parity pricing.

Scope	Key issues & assumptions
Cost plus approach	• **Forecast cost plus estimates are based on the Wood Mackenzie research information related to various cost elements, including:** » Mining cost » Sustaining capex » Processing & Overheads » Margin » Royalties » Transportation
Export parity approach	• **Export parity estimates involved the following steps:** » Identify the contracted mines or the least cost mine options » Establish products that can be sold from the mine » Estimate price based on the specific type of product required and the price forecast » Estimate cost for each type of product » Arrive at margin earned from each type of product on ROM tonne basis » Select the product based on optimum margin » Calculate the ex-mine price based on the optimum margin » Add transportation distance and cost to power station » Allow discount on account of comparatively lower risk of supply to domestic supply

Source: Wood Mackenzie

Agenda

We have developed three scenarios consistent with the scenarios (Central, Step Change and Slow Change) defined by AEMO (1/3).

- **We have modelled the cost of coal projections for different scenarios defined by AEMO:**
  - » Step Change – a future where there is strong action on climate change that leads to a step change reduction of greenhouse gas emissions. In this scenario, aggressive global decarbonisation leads to faster technological improvements, greater electrification of the transport sector with increased infrastructure developments, energy digitalisation, and consumer-led innovation.
  - » Central – a future where transition of the energy industry continues under current policy settings and technology trajectories, and where the transition from fossil fuels to renewable generation is generally led by market forces and supported by current federal and state government policies.
  - » Slow Change – a future with lower levels of decarbonisation ambitions both internationally and domestically. Australia's economic activity and population growth is low, with a greater proportion of households and commercial businesses installing rooftop photovoltaic (PV) systems, particularly in the short-term in response to a number of incentives. There are lower levels of electrification and the rate of technological development and cost reductions stagnates, as falling private investment reduces the speed of cost reductions in technologies.
- **We have modelled the scenarios for delivered cost of coal to the power stations based on the assumptions consistent with the scenarios defined above:**
  - » Forecast price of thermal coal traded in seaborne market is one of the key assumptions for estimating delivered cost of coal.
  - » Seaborne thermal prices are in turn based on a set of macroeconomic assumptions (GDP growth rates) and power generation fuel mix for the thermal coal importing countries.
  - » While these assumptions were not provided by AEMO, we used assumptions which are generally consistent with the definition of above scenarios.
  - » The approach has been explained further in the subsequent pages.

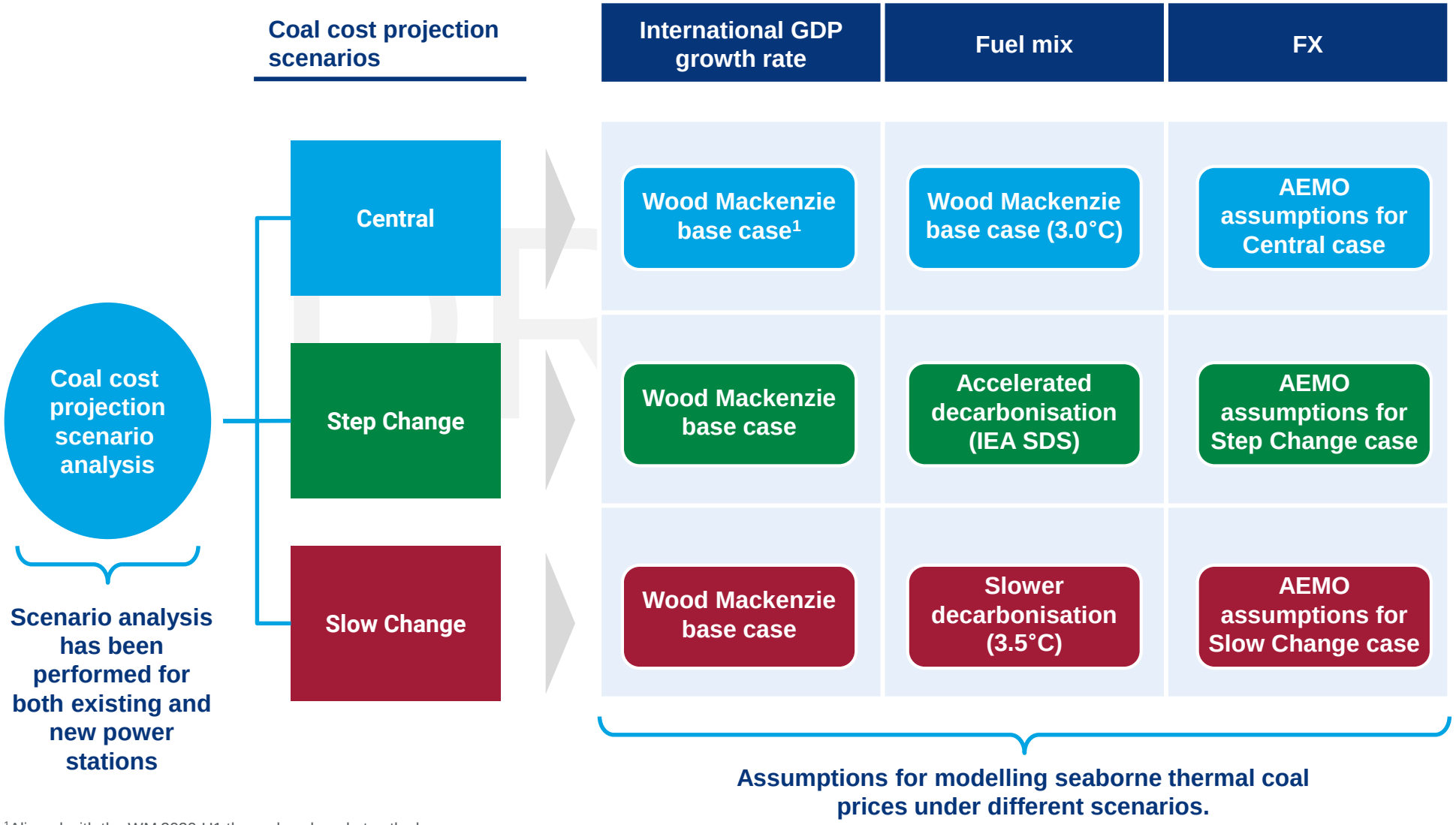
Source: Wood Mackenzie

We have developed three scenarios consistent with the scenarios (Central, Step Change and Slow Change) defined by AEMO (2/3).

Key issue	Description
GDP	• GDP growth rate assumptions for the seaborne import countries were not provided by AEMO. We assumed GDP growth assumptions for all cases to be in line with the Wood Mackenzie's base case assumption.
Fuel mix	• Fuel mix related assumptions for seaborne import countries were not provided by AEMO. Considering the Central case as defined by AEMO and the Wood Mackenzie base case are both business as usual scenarios, we assumed the fuel mix assumptions for the Central case scenario to be in line with the Wood Mackenzie's base case assumption. This is consistent with 3°C warming. • In line with the scenario defined by AEMO, the Step Change scenario assumes rapid decarbonisation of global economy. This case assumes rapid increase in renewables resulting in rapid decline in the demand for imported coal, and is consistent with 2°C warming. • For the Slow Change scenario, we have assumed a higher proportion of coal than that of the Central case. This case is equivalent to 3.5°C warming.
Foreign exchange rate (A$/US$)	• Foreign exchange rates for Central, Step Change and Slow Change scenarios were provided by AEMO.
Operating costs of mines	• We have applied same costs (base case) for all scenarios.

Source: Wood Mackenzie

We have developed three scenarios consistent with the scenarios (Central, Step Change and Slow Change) defined by AEMO (3/3).



[1]Aligned with the WM 2020 H1 thermal coal market outlook
Source: Wood Mackenzie

Agenda

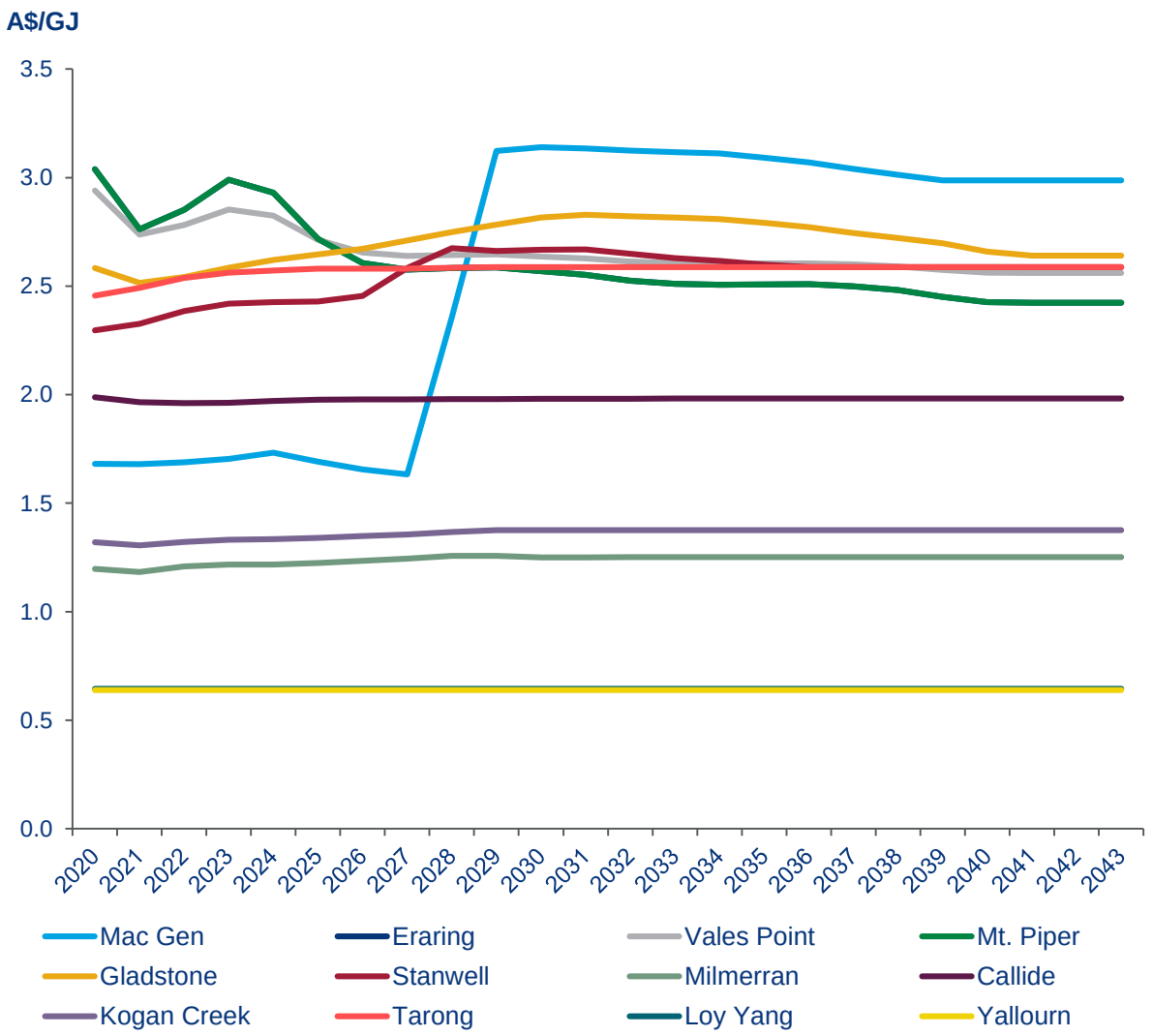
1 Approach

2 Scenario development

3 Results

Forecast delivered costs of coal follow different patterns based on the arrangement of the coal supply and the type of coal.

Delivered cost of coal – Central scenario

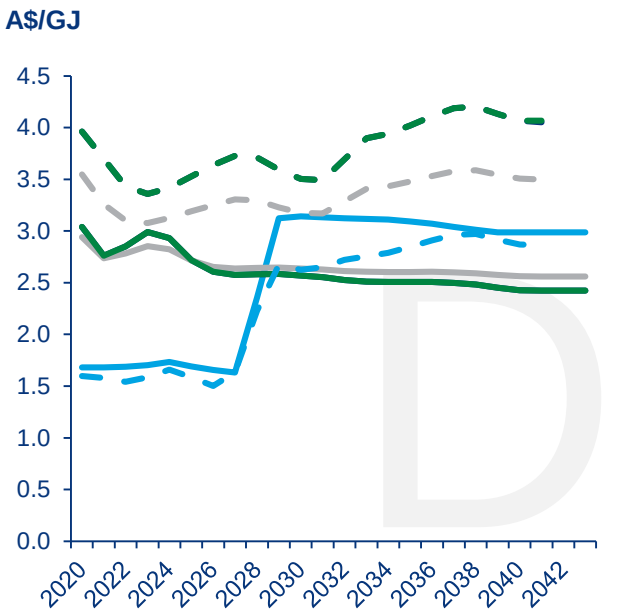


- **Power stations with a captive coal supply**
  - » For the power stations with a captive supply of coal, delivered costs of coal are generally flat are reflective of mine operating costs. Apart from the captive supply, there are a few power stations where the supply has been contracted at a fixed rate. These power plants also have a relatively flat delivered cost of coal through the contract period.
- **Power stations contracted on export parity basis**
  - » For the power stations with coal supplied on export parity based costs, delivered costs generally follow the Wood Mackenzie base case view of thermal coal prices. The delivered costs differ between the stations due to the type of coal being assumed for estimating costs. For instance, a power station sourcing coal with low value in use in the export market will pay a lower price on an export parity basis compared to a power station sourcing coal with high value in use. The location of the power station also impacts costs due to the transport netback mechanism.

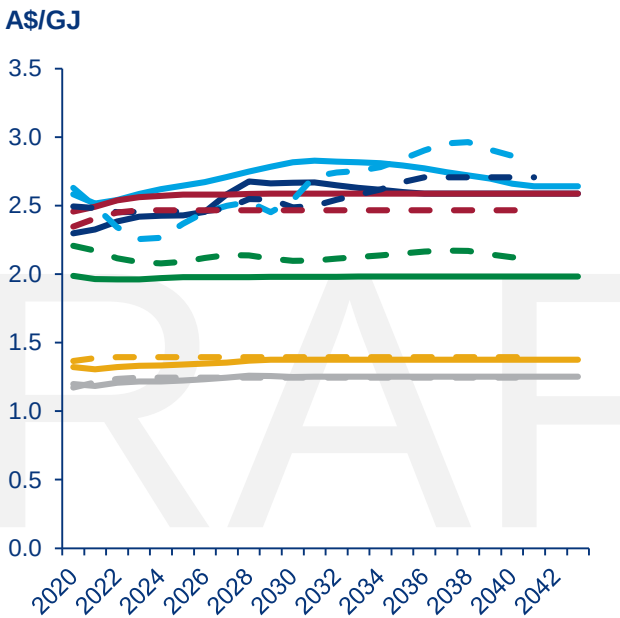
Source: Wood Mackenzie

Differences between the updates are as a result of changes in views related to export price, operating cost of mines and quality of coal.

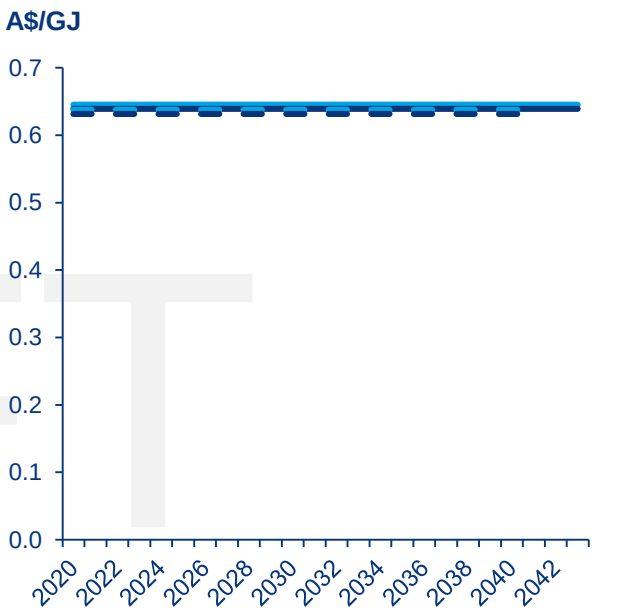
New South Wales

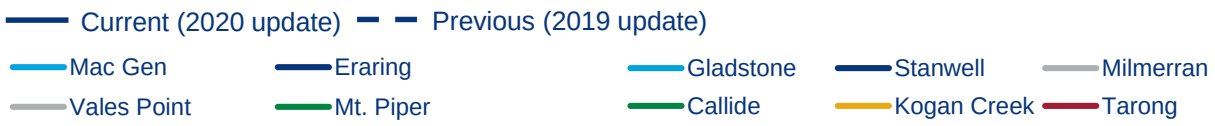


Queensland



Victoria





Key drivers of changes – current (2020 update) vs Previous update (2019 update:

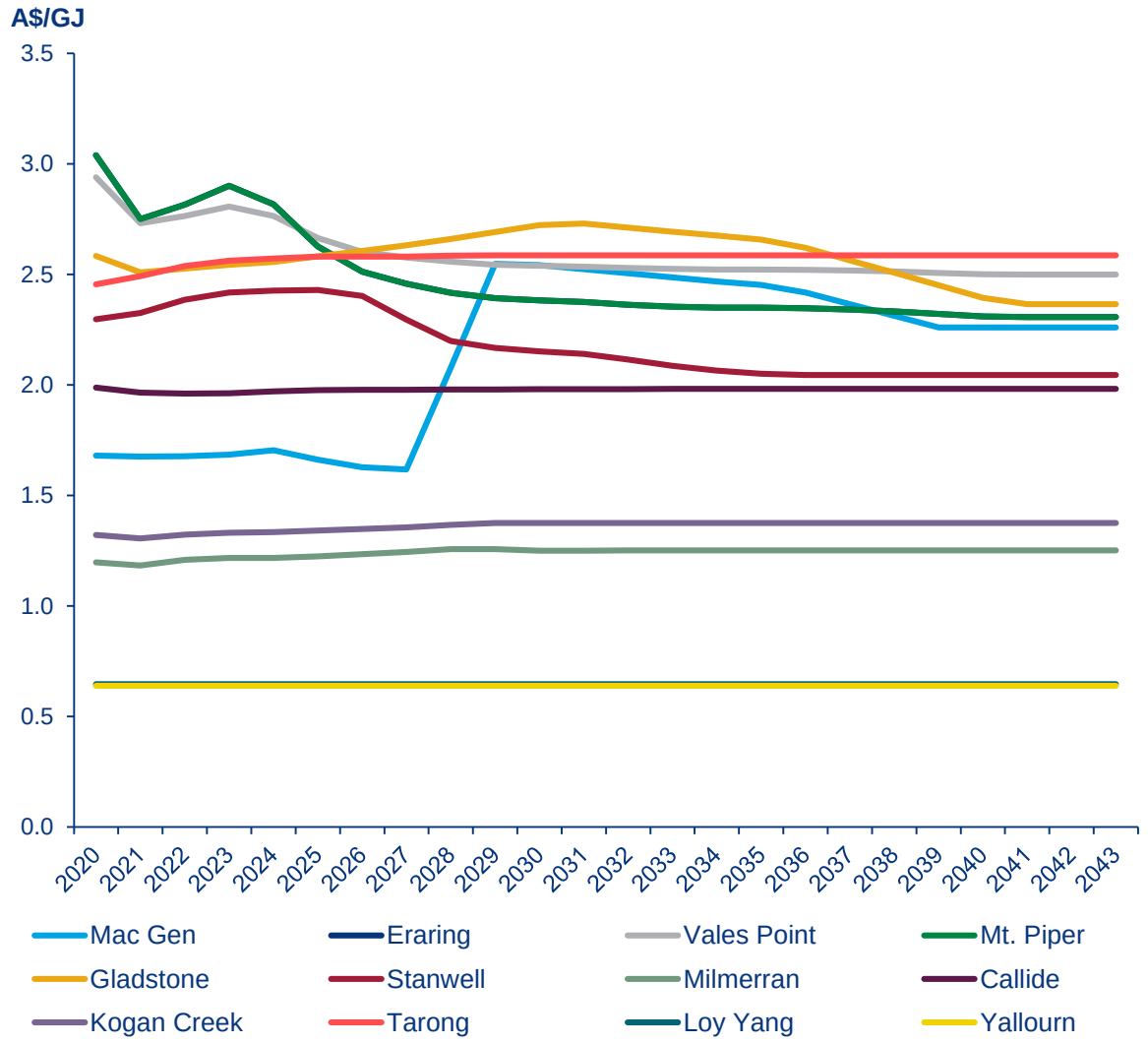
- **Minor change in view on export price of coal**
- **Change in assumptions related to quality of coal**
- **Minor change in view on the operating cost of mines, particularly for the power stations with captive mines or contracts based on cost recovery**

- **Minimal change to previous outlook, mainly related to inflation.**

Source: Wood Mackenzie

Delivered costs of coal in the Step Change scenario are lower compared to the Central scenario due to fuel mix assumptions.

Delivered cost of coal – Step Change scenario

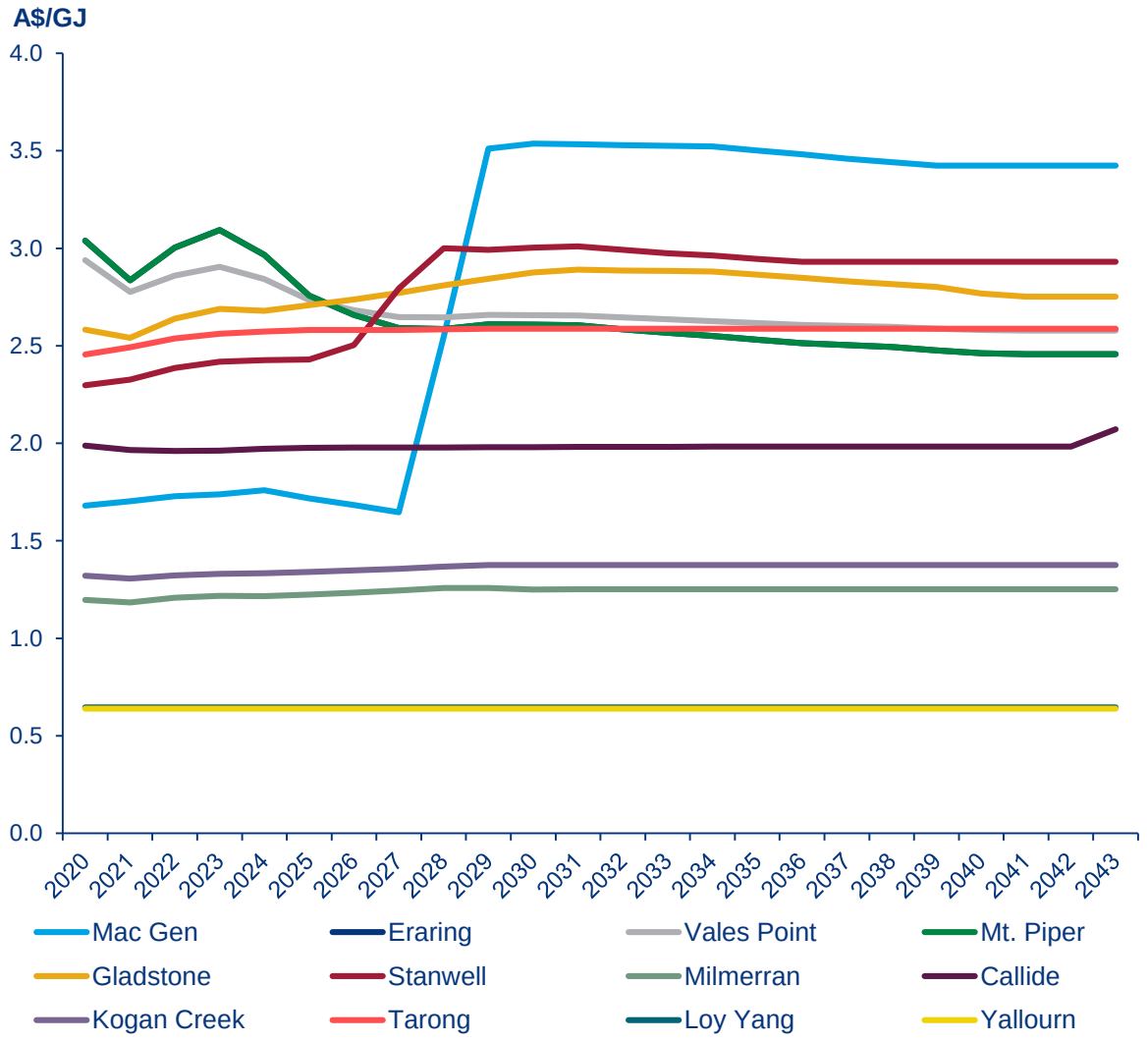


- **Delivered costs of coal for power stations not exposed to export parity prices are unaffected by the Step Change scenario.**
- **For the power stations exposed to export parity prices, delivered costs are lower due to the lower price of thermal coal in the export market.**
- **The lower export thermal coal price is derived from the fuel mix assumptions used in this scenario.**
  - » Under the Step Change scenario, an increase in renewables drives a rapid decline in demand for imported coal globally and results in a significantly lower thermal coal price despite stronger global economies. The fuel mix assumptions used are in line with the IEA Sustainable Development Scenario (SDS).
  - » The IEA SDS scenario assumes rapid decarbonisation compared to business as usual case. The IEA SDS is fully aligned with the Paris Agreement's goal of "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C".

Source: Wood Mackenzie, https://www.iea.org/reports/world-energy-model/sustainable-development-scenario

Forecast delivered costs of coal in the Slow scenario are higher than that in the Central scenario due to more coal in the fuel mix

Delivered cost of coal – Slow scenario



- **Delivered costs of coal for power stations not exposed to export parity prices are unaffected by the Slow scenario.**
- **For the power stations exposed to export parity prices, delivered costs are higher due to a higher seaborne thermal coal price.**
  - » Delivered costs are higher in the Slow scenario. Imported coal demand is higher due to a higher proportion of coal in the global generation mix with less global action on climate change, resulting in higher seaborne thermal coal prices.

Source: Wood Mackenzie

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