Wood Mackenzie
A Verisk Analytics Business

Coal cost projections

Approach and risks to coal cost projections

May 2016

AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Strategy with substance
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Background and Objectives

Coal cost projections

AEMO oversees system security of the National Electricity Market (NEM) electricity grid and the Victorian gas transmission network. In addition, AEMO operates the retail and wholesale electricity and gas markets of eastern and south-eastern Australia.

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 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.

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We adopted a stepped approach for the projections – Step 1 involved identifying the type of contracts and supply options for the power stations.

Scope

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

Key issues/assumptions

- **Approach for the existing power stations:**
  - **We identified the type of coal procurement arrangements for the existing power plants based on the 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 2016/17 to 2040/41,
    - 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(1) based on the resource potential of upcoming coal projects:
    1. North Queensland
    2. Central Queensland
    3. Southwest Queensland
    4. Northern NSW
    5. North-Central NSW
    6. Latrobe Valley

Note: 1) We have not included SW NSW region in the projections due to a lack of adequate coal resource development in the region.

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

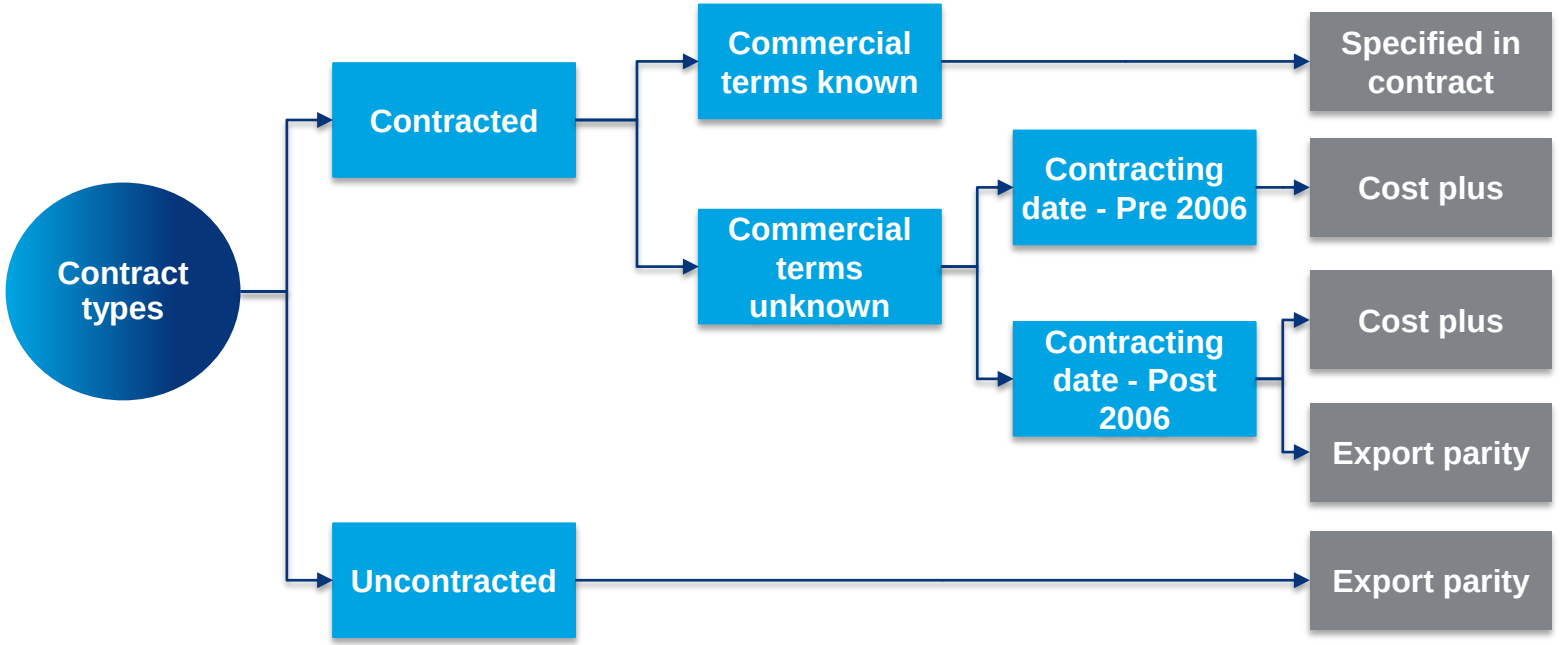
Scope

Step 2: Analyse the delivered cost of coal (Forecast for 2015/16 to 2040/41)

Key issues/assumptions

- **The pricing approach for the existing power stations have been shown in the diagram below.**
  - The contract related information is based on the 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 the access to export infrastructure:**
  - In case of existing access to export infrastructure and suitable coal quality, we adopted export parity pricing. Otherwise, we adopted cost plus approach.
  - Although there may be some lead time to the development of new projects, we have provided projections starting from 2016/17 for the modelling purpose (as requested by AEMO).

Coal pricing approach – Existing power stations



Approach to cost plus and export parity pricing.

Scope	Key issues/assumptions to be analysed and discussed
Cost plus approach	» **Forecast cost plus estimates are based on the Wood Mackenzie research information related to the various cost elements:** » Mining cost » Sustaining capex » Processing & Overheads » Margin » Royalties » Transportation » Carbon costs: Costs associated with fugitive emissions have been taken into account in the cost plus approach. The carbon tax(1) related assumptions were provided by AEMO.
Export parity approach	» **Export parity estimates involved the following steps:** » Identify the contracted mines or the least cost option mines » Establish products that can be sold from the mine » Estimate price based on the specific type of products and the Wood Mackenzie's base case price forecasts . » 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/ cost to power station » Allow discount (say 10% discount) on account of comparatively lower risk of supply to domestic supply

Note: 1) Start year: 2020, Assumed rate: A$25/t-Co2 in 2020 increasing linearly to A$50/t-Co2 by 2030.

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Content

There are certain upside and downside risks to our Base case coal price forecasts that may impact the coal cost projections.

Scope

Upside and downside risks to Base Case coal price forecasts

Key issues/assumptions to be analysed and discussed

» Our Base Case price forecast is based on the most likely view on the underlying assumptions. However, there are upside and downside risks associated with some of the demand side and supply side assumptions, particularly for the large demand growth countries such as India and China, and large supply countries such as Australia, Indonesia and Russia. We have performed a high level analysis taking into account the upside and downside risks to provide High Case and Low Case prices (See below).

Type	Key risk factors
Upside risk (High case price)	Reduced Chinese domestic protectionism
	India's GDP growth and power sector reforms
	Southeast Asian demand
	Delay in commissioning of Galilee basin projects
Downside risk (Low case price)	Climate change related policies

Upside and downside risks to coal prices (1/2).

Key issue	Description
Upside risks	» We considered the following upside risks to our Base Case: » **Reduced Chinese domestic protectionism** » Our base case assumes Chinese domestic protectionism policies resulting in reduced Chinese imports. » This is despite a majority of domestic coal is estimated to be cash negative but continuing to operate with direct and indirect support from the Chinese government. Moreover, the domestic supply is not suitable due to environmental concerns that would require using coal with relatively low ash content. » However, it is possible that the government will reduce protectionism earlier than our Base Case assumption to reduce its subsidy burden. This upside risk will have advantage in the short to mid-term. We have taken this into account in the Upside Case price. » **India's GDP growth and power sector reforms** » The biggest risk to India's demand outlook comes from the pace of reforms, both within the energy sector and the broader economy. The acceleration of broader economy wide reforms would result in relatively higher growth of GDP compared to our Base Case assumptions. This would have a positive impact on the growth in demand for electricity, provided the government can implement some of the reforms required in the Indian power sector. » **SEA demand** » The developing Southeast Asian (SEA) economies (particularly Malaysia, Thailand, the Philippines and Vietnam) are forecast to see the fastest growth of demand for imported thermal coal. The acceleration and implementation of reforms in these countries will have upside to our Base Case GDP growth assumptions for SEA countries. As SEA countries are largely dependent on the import of coal for power generation, an upside related to the growth of GDP will directly drive the demand for imported coal.

Upside and downside risks to coal prices (2/2).

Key issue	Description
Upside risks	» **Delay in commissioning of Galilee Basin coal projects** » In our Base Case, the Galilee basin coal projects in Australia are the single largest contributor of additional supply of seaborne thermal coal post 2020. However, the development of these projects is subject to funding risks due to large capital requirements for the below rail infrastructure, particularly in the low price environment. Therefore, we have delayed the commissioning of these projects in the Upside Case.
Downside risks	» We considered the following downside risk to our Base Case: » **Climate change related policies** » More restrictive targets agreed by the countries compared to Wood Mackenzie's base case as part of the global commitment would result in a significant decline in coal volume demand in the longer term. » This will have a significant impact on the coal prices as thermal coal based generation is one of the key contributors to the emissions and thermal coal demand growth. » We have performed a downside price sensitivity analysis taking this factor into account.

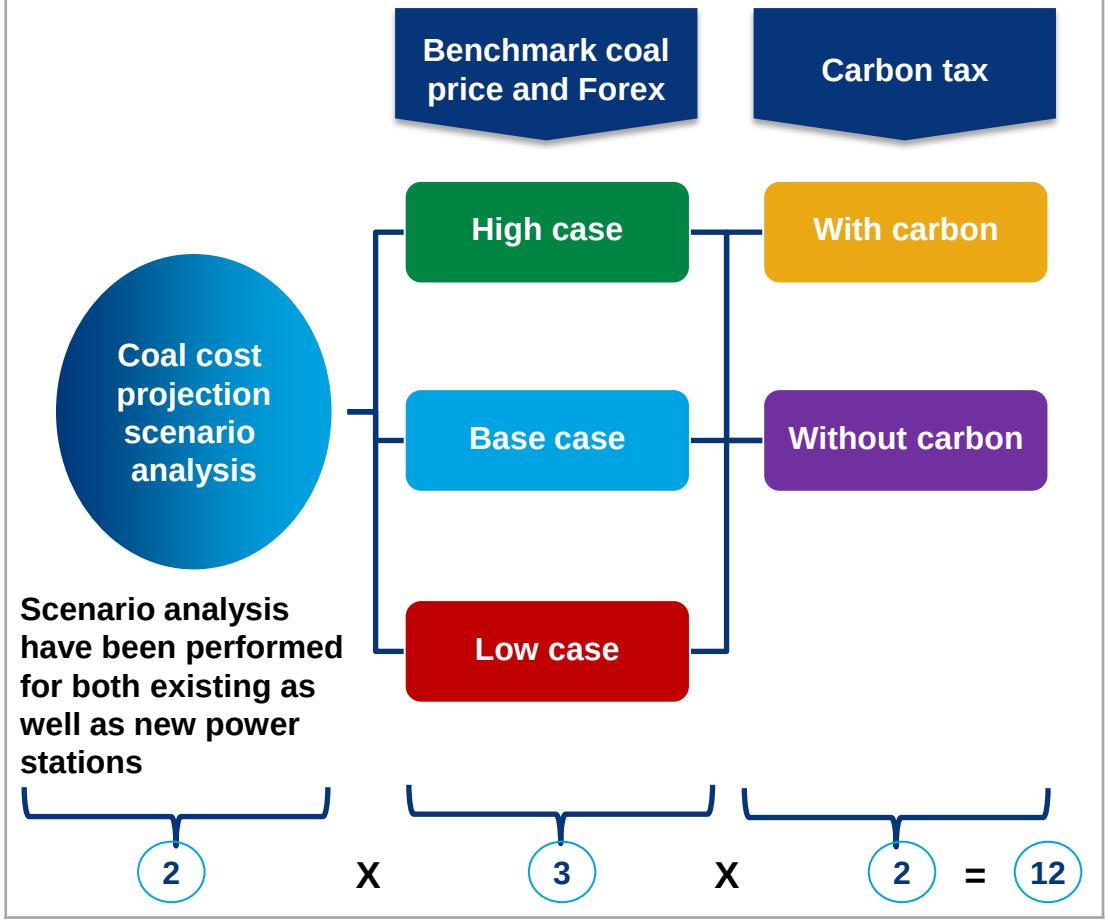
We have performed a number of scenarios based on the different inputs related to coal price, foreign exchange rate, and carbon tax.

Drivers	Description

Benchmark coal and Forex	» **Base case is based on the Wood Mackenzie's base case forecast of coal benchmark**
	» **High and and Low cases are based on:**
	  » potential upside and downside risks (discussed in previous slides) to the Wood Mackenzie's Base case coal price forecasts
	  » Strong (for High case) and Weak (for Low case) exchange rate related assumptions aligned with AEMO.
	» In the High case the impact due to Australian exchange rate related assumption outweighs the impact due to Upside risks to coal prices

Carbon tax	» **Scenarios have also been performed with and without carbon tax** » **Carbon tax related assumptions are based on the AEMO's inputs**

Approach to scenario analysis



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