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SKM

Garnaut Climate Change Review Update 2011

Advice on Change in Merit Order of Brown Coal Fired Stations

- Amended Final
- 28 March 2011

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1. Introduction

As part of the modelling associated with the impact of a carbon price on behaviour of individual generating businesses in the Australian Electricity Market, the Garnaut Climate Change Review – Update 2011 has engaged Sinclair Knight Merz to provide advice on the technical capability of three Latrobe Valley stations to operate in a lower merit mode. The facilities involved and their scheduled capabilities are:

- Morwell Briquetting and Power 164 MW,
- Hazelwood 1600 MW
- Yallourn 1487/1420 MW (winter/summer).

The scheduled capability above is in accordance with that listed by the Australian Energy Market Operator (AEMO).

The revised operating regime proposed involves operation only in the months of December to March inclusive and only intermittent operation in those months in order to accommodate the high demand days usually associated with periods of hot weather. During the autumn-winter-spring period the plant would be shutdown and in preservation mode, with the expectation of no requirement for a immediate return to service.

The background to the proposed change of merit order, the proposed trading arrangements and the questions to be answered in respect of the technical capability of the stations to accommodate the revised operational role, is contained in DCCEE's brief, a copy of which is included as Appendix A to this report.

2. Description of Facilities

2.1. Morwell

The Morwell facility was established for the manufacture of briquettes, a form of compressed dried brown coal. The facility was progressively commissioned in the years 1958 to 1962. It was re-named Energy Brix Australia (EBA) when it was corporatised in the early 1990s. It is currently owned by HRL Limited and is operated by an associated company.

Coal for the boiler is supplied by conveyor from the adjacent Morwell open cut. SKM understands that coal for briquetting is supplied predominantly from the Loy Yang open cut and is delivered by road. Previously coal was supplied from Yallourn open cut but SKM is not aware if any coal continues to be obtained for briquetting from that source.

The Morwell facility consists of an integrated power station and briquette factory with the power station supplying low pressure steam to the factory for the production of briquettes. There were 8 boilers and 5 turbines installed on a steam range system. It is understood that currently not all 8 boilers are available for service.

In the initial design concept the plant was to be a pure cogeneration plant with all power generation being a natural consequence of the production of the necessary steam at low pressure for the briquetting process. However, as actually configured today, the plant is a mix of a co-generation facility and a power station meaning that only a portion of the power that is currently generated is an essential part of briquette production. It is very likely that the demand for briquettes will extend for at least another 20 years and hence the power generated in the production of low pressure steam for the briquette factory will also continue for at least that length of time.

Energy Brix Australia would need to be consulted as to the extent of power generation that occurs as part of its integration with briquette production. This amount is likely to vary depending on the amount of briquettes produced. When operating as a pure co-generation facility, where only that power that is generated in order to produce low pressure steam for supply to the briquette factory, the GHG emission intensity of the Morwell facility will be reduced significantly[1] and will be below that of other brown coal fired stations and possibly below most black coal fired stations.

However, the portion of power generated in a pure power generation mode would have a GHG emission intensity above all other brown coal generators in the Latrobe Valley

2.2. Hazelwood

Hazelwood (actually Hazelwood Power) is owned and operated by International Power Hazelwood. It consists of eight 200 MW boiler/turbine units and was commissioned progressively between 1964 and 1971. Coal is supplied from the adjacent Morwell open cut mine, which is owned and operated by International Power Hazelwood. The coal supply to the EBA boilers also comes from the Morwell open cut mine.

2.3. Yallourn

Yallourn (actually TRUenergy Yallourn) is owned and operated by TRUenergy. It was constructed in two stages - Stage 1 consisting of 2 x 350 MW boiler/turbine units, commissioned in 1973 and 1974, and Stage 2 consisting of 2x 375 MW units commissioned in 1981 and 1982. It is fed by

[1] For the calculation of the emission intensity for co-generators, the carbon emissions attributed to the heat supplied to 'industry' are subtracted from the total carbon emissions. The methodology for calculating the emission intensity for a co-generation facility is given in the AGO Technical Guidelines for the Generator Efficiency Standards, 2006, Section 9.

coal from the adjacent Yallourn open cut mine which is owned by TRUenergy but operated under contract by RTL.

The differing relationships that exist between the power stations and the mines that supply the coal to fuel them may impact on the degree of flexibility of operation of the power generation facilities under the proposed future operating regime.

3. Answer to Questions

3.1. Technical Factors in Changed Operational Regime

Q1 Are there likely to be any technical reasons that would make it impossible to operate the plant, open cut or coal bunker to meet these trading parameters?

The operating regime required is as follows:

- Full station shutdown for autumn, winter and spring.
- Station to be available on three days notice (or if possible, shorter) for intermittent duty ranging up to full output for the months of December to March inclusive.

The following discussion relates only to Hazelwood and Yallourn. There is a need for the Morwell facility to continue operating throughout the year in order to continue the production of briquettes and hence it would not be able to conform fully with the proposed revised operating regime.

Both Hazelwood and Yallourn are capable of operating in a non base-load role which would involve more start-ups/shutdowns and operation at reduced load.

While Hazelwood and Yallourn Stage 1 units were not specifically designed to undertake a nominated number of start-ups and shutdowns (SU/SD), however at the stress levels that were used in the design of the plants they would be capable of undertaking a moderate increase in frequency of start-ups with no significant adverse impact on plant integrity. Yallourn Stage 2 was designed for a given number of start-ups and shutdowns - nominally 600. The number of SU/SD cycles undertaken to date is well below the design number.

Hence it is expected that all units can undertake a moderate number of additional start-ups in the next 10 years or so, in the range of perhaps 20 per year, without the need to replace major items due to the fatigue effects of such additional SU/SD cycles.

During the 8 month shut down period some measures would need to be taken to preserve the plants. In particular corrosion protection is required on the inside surfaces of the boiler tubes, headers, piping, vessels and steam turbine. With respect to the electrical generator, it would need to be protected against moisture ingress. In both cases protection can be afforded by the recirculation of dried air throughout the systems. Special tapping points may need to be installed on the plant to admit air and for air exit and equipment for the production of dried air would need to be purchased and installed and some dismantling of smaller components such as turbine valves may be required.

Preservation of the cooling water side of the turbine could be achieved by either draining and applying dried air or maintaining a small circulation of treated water.

During the shutdown, some of the rotating machinery may need to be operated periodically in order to limit moisture ingress and minimise corrosion.

Some preservation measures would also be required on the major mine equipment.

The preparations for a return to service in December may take of the order of two weeks. This length of time is in part determined by the need to simultaneously prepare all units for return to service, ie, 8 at one station and 4 at the other.

The first start-up after the prolonged shutdown is likely to have a low probability of meeting its scheduled start-up time. It would be prudent to have a trial start-up of all units before they are required for system demand purposes.

The expenditure on the equipments for the preservation of the plant and the necessary modification of the plant may cost in the range of a million dollars for each station.

During the summer period, when intermittent operation will be required, some preservation measures are probably also advisable. Being the summer months with usually a low relative humidity, the measures against moisture ingress can be less rigorous than over the winter period. It may be sufficient to ensure the minimisation of water retention in the circuits on shut down. Some dried air admission may also be preferred but reduced dismantling of the plant for its connection would need to apply in order to achieve the 3 day deadline required. During this 4 month period some corrosion may occur but with the limited time in this mode, perhaps a maximum of 10 years, a small amount of corrosion may be acceptable.

Because of the spontaneous combustion properties of mined brown coal, and also because of compaction concerns, it is standard practice to not store coal in hoppers and bunkers for long periods. The hoppers and bunkers would need to be emptied for the long outage and also for the period between the intermittent operation times. In order to empty the bunkers, some notice would be required of the need to shutdown in order to enable the coal to be run-out of the storages. The notice time is likely to be in the range of 3 to 10 hours.

3.2. Arrangements for Staffing

Q2 Presuming there is adequate economic incentive, is it likely that staffing can be arranged for this kind of periodic operation?

Under the proposed operating regime the staffing numbers required should be capable of being lower compared to current levels as full manning on a continuous basis would be hard to justify.

The arrangement for staffing the station and mines becomes one of restructuring the operating arrangements, re-negotiation of manning agreements with the staff and unions, and, not least, one of economics.

There are few examples in Australia of major coal fired stations shutting down for a major portion of the year and then operating in an intermittent mode over the remaining portion of the year. There are however examples of a portion of a station operating in this mode. This occurred at Hazelwood in the late 1980s/early1990s when the expected increase in Victorian system demand did not eventuate at the time when the units at the Loy Yang power stations were progressively commissioned. At times one stage (2x200 MW) at Hazelwood was put in cold storage whilst one other stage was operated in an intermittent mode. The manning level was reduced and flexible staff operations enabled the Stage that was operating in an intermittent mode to be staffed from the remaining resources.

There are two stations known to SKM where intermittent operation is undertaken. One of these is a gas fired station and the other a coal fired station. Unlike the Latrobe Valley stations the coal fired station is not associated with a dedicated adjacent coal mine and it has been refurbished and automated so as to allow remote automatic operation. Consequently there is minimal operational manning at the station. This station also tends to be operated on a seasonal basis.

The gas fired station is on a very short recall throughout the year. The short recall is achieved by maintaining the boiler in a warm state by periodically firing. Again this station, because it is gas fired and has a high level of automation, has minimal operational and maintenance manning.

The dissimilarity of the coal supply arrangements, level of automation and level of manning mean that the operational flexibility of these two stations, cannot be readily replicated at Hazelwood or Yallourn.

With respect to staffing of stations in which all units operate for only a (small) portion of the year this would represent a very challenging management issue. The difficulties are made more so because of the additional changes in staff numbers at the associated dedicated mines.

The number of staff at each of Hazelwood and Yallourn facilities, including the mines, would be in the order of 400. Of these a major portion would be trained operational staff. It is the management of the operational staff during the cyclical nature of the operation which will present the major challenge.

Since in the summer period the operation will only be intermittent, some 60 to 70% of the current operating staff only are likely to be required. Leave entitlements can be taken during the prolonged shutdown and reduced manning levels in the periods between the intermittent operations should be possible. To achieve this, re-negotiation of the manning agreements would be required.

During seasonal shutdowns one approach would be to lay-off the majority of the staff, but only retaining some core staff. When the station is de-manned there would be a loss of trained staff such that when re-hiring, training of many of the new personnel would be required before the station could become fully operational again. This is considered by SKM to be a non-feasible arrangement.

We consider that the one of the following arrangements may be feasible

- Retain a large proportion of the staff (perhaps 50% of current staff) during the seasonal shutdown period. It would then be necessary for some casual rehiring or contracting-in around November or overtime used to top–up.
- Shutdown only a portion of the station, not greater than 50%, with reduction to say 50% of operating staff. Again it may be necessary for some casual rehiring or contracting-in around November or overtime used to top–up.

In the first case there would be a morale issue during the off season, with perhaps significant staff losses. In both the above cases manning agreements would need to be re-negotiated incorporating a greater degree of flexibility.

Where a plant is progressively changing its operating regime over a number of years in response to the ever increasing carbon constraints, as would appear likely to occur for the two stations, the acceptance of change by the staff is more likely than if there were to be a sudden change in the operating regime.

The management of the maintenance staff would be less of an issue than for the operating staff. Much of the current maintenance is done under contract which allows more flexibility of staffing. A significant core of maintenance staff would need to be retained to, amongst other things, manage the maintenance contracts. Most of the planned maintenance work would be undertaken during the long shutdown.

The above manning considerations relate to the power stations. Similar considerations would also apply to the mines but there would be some differences due to the ability to store coal, and in the case of Yallourn, because the mine is operated under contract to the owner.

For the Morwell facility where the supply of steam to the briquetting facility continues throughout the year there will be a lesser change in the staffing levels between the off-season and summer time. Hence staffing arrangements should be easier to manage.

3.3. Maintenance Costs

Q3 Is it likely that maintenance costs in the plant and mine would decline roughly in proportion to operating hours?

Maintenance costs are a complex function of operating time (or Service Factor, SF), energy generated (Capacity Factor (CF))[2], the number of start-ups/shutdowns and elapsed time. For some portions of the plant, such as the coal milling plant the wear rates will be close to proportional to the energy generated as would the mill maintenance costs. Other costs such as the cost of major inspection and maintenance outages, usually undertaken every 4 to 6 years will have costs more closely related to elapsed time. In addition because of the change in the operating regime there is likely to be a more rapid deterioration in plant condition due to additional corrosion associated with the out-of service period, and increased rate of metal fatigue due to the changes in stress levels associated with start-ups and shutdowns. Also there will be extra labour required for installing and removing the preservation equipment and undertaking periodic preservation activities during the off-season shutdown.

With a shutdown for 8 months and then intermittent operation over 4 months the plant may only operate at a CF in the range of 3 to 8% (ie, discontinuous operation of from 10 to 30 days during the 121 day period) compared to current values generally in the range 80% to 90%. The future overall maintenance costs might be in the range of 10 to 20% of current costs, ie, the maintenance costs are expected to be the order of three times the proportional line between costs and energy generated (CF) for the above range of Capacity Factors.

Another cost component which is normally addressed separately in the station and mine cost structure is capital expenditure. With a reduction in the operating horizon of these stations the current capital expenditure profile, which was originally targeted for a shutdown somewhere around 2030 on both stations, would be ramped down.

The above considerations relate to the power stations. Similar maintenance considerations would also apply to the mines but there would be some differences.

3.4. Short Time Re-call

Q4 Could a recall time shorter than 3 days be reliably supported by any plants?

During the autumn-winter-spring period with the plant in a preserved condition preparations for the return to service is likely to take the order of two weeks, noting that all units at each station (8 in one case, 4 in the other) need to be worked on simultaneously for return to service.

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[2] A non dimensionally expression of energy generated - energy generated over a given period, usually a year, divided by 'scheduled capability' of the plant and divided by hours in the period.

During the summer period some modified form of the preservation measures used during the longer preservation period is envisaged. If a shorter than a 3 day return to service time is required there would be some compromise on the level of preservation measures taken or an alternative operating mode employed.

For example a short time for return to service can be achieved if the boiler is kept warm by intermittent firing.   This type of operation is likely to be economic only if there was a high probability that operation was again required within a week or two of the pervious time. This type of practice is known to be adopted on a conventional gas fired station. Higher costs would be involved associated with auxiliary fuel and make-up water usage.

4. Another possible operating mode

Another possible operating mode is for only some of the units at a station to be shut down and other units to operate at reduced load.   This mode of operation has the advantage of minimising the difficulties of changes in station staffing but with the disadvantage of achieving less than the desired reduction in emissions.

The current operating practice, based on the economics associated with fuel costs, is to not operate the units below a load range of around 50 or 60% of full output. This is the limit at which a reliably stable flame can be maintained without the use of auxiliary fuel (briquettes at Hazelwood and fuel oil at Yallourn).

The reduction in flame stability at lower loads is due to a lower flame temperature and other adverse firing conditions including the change from optimum excess air conditions and an increase in burner inert loading.

Some plant testing and possible plant improvements may enable safe operation to be achieved at a load range of 40-50% without the use of auxiliary fuel.

This operating mode involving only partial closure is more manageable in respect of manning, than an operating mode involving a long seasonal total closure.

5. Summary of Answers to questions

Q1 Are there likely to be any technical reasons that would make it impossible to operate the plant, open cut or coal bunker to meet these trading parameters?

For Hazelwood and Yallourn facilities there are no known technical reasons which would make it impossible for the facilities to operate in the lower merit order regime as described. For the Morwell facility the need to continue to manufacture briquettes will prevent the plant being able to operate as proposed.

Q2 Presuming there is adequate economic incentive, is it likely that staffing can be arranged for this kind of periodic operation?

The operating regime as described would present a major challenge with respect to the management of operational manning. Retaining staff, training re-hired staff (if available) and the re-negotiation of long standing manning agreements will be some of the issues.

Q3 Is it likely that maintenance costs in the plant and mine would decline roughly in proportion to operating hours?

Maintenance cost are a complex function of operating time, energy generated, elapsed time, number of start-ups and the costs associated with preservation. For the operational regime proposed the maintenance costs might be somewhere in the order of a multiple of three compared to a proportional change of costs with a change in energy generated.

Q4 Could a recall time shorter than 3 days be reliably supported by any plants?

A shorter recall period than 3 days could be achieved if the preservation measures were not fully implemented, with a risk of a higher rate of plant degradation. Maintaining the boilers in a warm condition by intermittently firing could also be considered at the expense of added costs associated with auxiliary fuel and make-up water usage.

Appendix A Brief from Garnaut Climate Change Review – Update 2011

Question for Engineering Consultant regarding changed Merit Order Role of Brown Coal Plant

From Garnaut Climate Change Review - Update 2011

Background

Brown coal plant has historically had amongst the cheapest marginal costs in the NEM, and has therefore assumed a base-load position in the merit order. These units are only occasionally dispatched below full availability. The imposition of a carbon price will increase the marginal running cost of this style of plant, which is intended to result in a changed position in the merit order and ultimately earlier retirement of the plant.

It is expected that for some years the most emissions intensive stations, being Morwell, Hazelwood and Yallourn, even if energy output is reduced, will find market value in their capacity during the summer demand peak until lower emissions capacity emerges.

The Garnaut Update is receiving conflicting messages about the technical capacity of these three stations to operate in a mode that involves units being de-committed for long periods of time whilst providing capacity for short periods of time. It is understood that Hazelwood stage 4 operated under a short recall regime for several years in the early 1990’s. The Garnaut Update seeks a short statement from an expert engineering firm as to the physical capability of operating the plant in this manner, given a presumption that sufficient economic drivers to do so exist.

A new operating arrangement would be expected to emerge gradually, as marginal cost relativity gradually declines and the plant moves from base-load through to intermediate operation. The questions below relate to a more extreme, peaking role that might emerge after several years of intermediate operation.

Trading Arrangements

The consultant should assume that trading arrangements can be negotiated to support such an operation. These would have characteristics such that:

- The affected units would be uncontracted for all but the 4 peak months, i.e. Dec-March. The units may be placed in an unrecallable mothballed state for the rest of the year.

- The contractual arrangements would see it being expected to be recalled for one to five days operation at a time.
- A recall delay of up to 3 days would be acceptable.
- A start success rate of 80%.
- Periodical testing would be provided for.

Open Cut Operations

It is presumed that the mine is kept open with existing equipment in situ. The mine will become responsive to the variable demand of the station, subject to the requirements above.

Questions for Consultant

- Are there likely to be any technical reasons that would make it impossible to operate the plant, open cut or coal bunker to meet these trading parameters?
- Presuming there is adequate economic incentive, is it likely that staffing can be arranged for this kind of periodic operation?
- Is it likely that maintenance costs in the plant and mine would decline roughly in proportion to operating hours?
- Could a recall time shorter than 3 days be reliably supported by any plants?

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