Calculation of the 2009-10 Cost of Energy

Calculation of the Cost of Energy using the same methodology and data as CRA in their 2009 report

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Economics Policy Strategy

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1 Introduction

The calculation of the 2009-10 Cost of Energy component of the BRCI has replicated as closely as possible the methodology and data selection used by CRA in their last calculation described in the report "Calculation of the Benchmark Retail Cost Index 2009-10" dated 8 June 2009 (the CRA Report).

The main purpose of this calculation by ACIL Tasman is to use the same data and methodology as that used by CRA so that any difference between the two results can be identified as arising from the use of different models. While the models used by the two firms in calculating the Cost of Energy are intended to produce the same thing, there are differences in the way they manage and process the data.

The report sets out a description of the calculation of the LRMC and energy Purchase Cost components of the BRCI.

2 Long Run Marginal Cost (LRMC)

2.1 Introduction

In developing a LRMC component of the BRCI ACIL Tasman has used a similar approach to that employed by CRA in their successive calculations of the BRCI for QCA. This has involved

- Developing forecasts of fuel, capital and O & M costs for the range of power stations in use in Australia,
- Taking into account state and Commonwealth programs that add or subtract to energy costs, such as the RET and GEC schemes,
- Using these inputs in a least cost supply model which minimizes both short run and long run marginal costs in meeting future market demand.

For the 2009-10 Cost of Energy calculation we have used the same data inputs and sources as CRA used in their calculation, namely the report by Concept Economics undertaken for the 2009-10 BRCI calculation. This report was itself a review of the cost forecasts undertaken by ACIL Tasman for the 2009-10 calculation.

ACIL Tasman used its own least cost optmising model, *PowerMark LT*, to calculate the LRMC for the Queensland region of the Australian NEM.

2.2 PowerMark LT

PowerMark LT is a long term planning and analysis tool. It is a dynamic least cost model, which optimises existing and new generation operation and new investments over the selected period, given a range of input assumptions concerning demand growth, plant costs, interconnectors, new development costs and government policy settings. *PowerMark LT* utilises a large scale commercial LP solver. The LP matrix itself is reasonably large with approximately 1 million variables, 1.4 million constraints and 2.5 million non-zero coefficients. *PowerMark LT* solves efficiently providing the solution for a single long term scenario (technology, policy settings etc.) within a few minutes.

PowerMark LT utilises a sampled 50 point sequential representation of demand in each year, with each point weighted such that it provides a realistic representation of the demand population. The sampling utilises a tree clustering process with a weighted pair-group centroid distance measure.

The NEM is modelled on a regional basis with interconnectors represented as bidirectional linkages between regions with defined capacity limits and linear (as opposed to quadratic) loss equations.

In relation to new entry, *PowerMark LT* provides an optimal expansion program which takes into account all generation costs (which can include carbon costs) and constructs new generation facilities under the assumption of perfect foresight of future costs.

A range of new entrant technologies are available for deployment in each region, with defined fixed and variable costs. Fixed costs are in the form of an annual charge (specified in $/kW/year), covering capital, fixed O&M and tax. Variable costs (specified in $/MWh), represent fuel, variable O&M and carbon costs. For each technology constraints may be applied to construction limits in any one year or in aggregate.

2.3 Methodology

In calculating the 2009-10 Cost of Energy the model has been run in so-called "greenfields" mode. This mode assumes that no plant already exists (that is, the existing plant in the NEM have been removed from the PowerMark LT database) and the model builds from zero the most efficient (least cost) combination of plant to meet the demand duration curve. It builds a combination of base load, mid merit and peaking plant and uses the market's modelled price duration curve to govern the entry of different types and costs of new investment. The calculated regional reference prices (RRPs) for a given year are therefore the LRMC in each region of the market as they are the prices that support the least cost combination of new plant. The model is multi-regional and temporal and therefore includes the effects of regional differences in input assumptions (such as different fuel costs in each state) and changes in the input assumptions during the model horizon. For example, the lower fuel costs in Queensland result in the model finding a solution which includes Queensland generators exporting electricity into NSW.

PowerMark LT is run for 2009/10 to 2017/18 inclusive (nine years) – the same as the projection horizon adopted by CRA.

2.3.1 Demand

In a similar process to that employed by CRA, we have taken actual half-hourly demands for calendar year 2008 from the NEMMCO/AEMO website. These demands include electricity delivered from the transmission system to the distribution system <u>as well as demand of end-users directly connected to the transmission system</u>.

A sample of 50 regional demands is selected from the set of half-hourly demands to represent the entire year. This sample set is selected to best represent the distribution of demands in each region on an annual basis as well as to best represent the relationship between demands across the regions (that is, the coincidence of demands).

This appears to be similar to the approach taken by CRA although they used a sample of 40 regional demands instead of 50. We do not think this results in a material difference and simply reflects the different models.

Each of the 50 regional demands in the sample set has a weighting and weightings sum to 8,760.

The sample demand set is then grown for each of the years between 2009/10 and 2017/18 inclusive based on the demand projection parameters published in the 2008 NEMMCO SOO (the demand parameters being the annual energy and peak demand). The selection of the 50 regional demands is not stratified by season and therefore the sample set does not explicitly distinguish between summer and winter. As a consequence the sample set is grown to a single peak demand in each region and not both the summer and winter peaks. The peak selected is the maximum of the two seasonal peaks published in the SOO. Based on our reading of the various CRA reports, we understand this is to be similar to their approach.

PowerMark LT uses "as-generated" demands, not "sent-out" (after internal usage has been deducted). Therefore, the energy parameter in the SOO (which is reported on a sent-out basis) is increased to "as-generated" by using the scaling factors is provided in the 2008 APRs. Again, this is similar to the approach used by CRA.

2.3.2 Supply

We have used the same supply input assumptions as CRA, namely capital costs of plant and fuel costs for coal and gas fired plant have been sourced from the Concept Economics report. These input costs are set out in Tables 8 to 16 of the CRA Report and the same numbers were used in the ACIL Tasman calculation of LRMC.

2.3.3 Transmission

PowerMark LT includes the existing interconnectors and optimises the use of the interconnectors. However, intraregional transmission is not modelled. Again, this appears consistent with the CRA approach

2.3.4 Other factors

The modelling excludes the CPRS.

The modelling assumes the GEC scheme continues with GEC prices fixed at the penalty and the GEC target as published in the CRA report. One point not discernable in the CRA report is whether the modelling takes into account any oversupply of GECs in the CCGT/OCGT revenue streams. PowerMark LT subtracts the GEC price from the LRMC of gas-fired plant in Queensland – this deduction increases the attractiveness of these plant which results in more CCGT/OCGTs being included in the optimal plant mix of Queensland. However, if there is an oversupply of GECs then only the proportion of GECs able to be sold is included in the revenue streams. This has the effect of decreasing the amount of the reduction from the LRMC due to the GECs. For example, if there are twice as many GECs as required then the model will only reduce the LRMC of the CCGTs/OCGTs by 50% of the GEC penalty. The model undertakes several iterations to find a stable solution of gas-fired penetration. We believe CRA have taken a similar approach.

The MRET scheme is included with the REC price fixed at the penalty as per the CRA report. We assume the MRET target is satisfied and, similar to GECs, the REC price is taken off the LRMC of the renewable plant in all regions.

The LRMC is modelled at the Queensland regional reference node (RRN). This understates the LRMC as it assumes all load and supply is at the RRN and that there are no transmission losses. Therefore, we have assumed that the resulting LRMC is increased to include transmission losses of 3.99%. We assume CRA took a similar approach although this is not clear from a reading their report.

2.4 Results

The results from the LRMC modelling are shown in Table 1

Table 1 **ACIL Tasman LRMC results**

	SRMC	LRMC	MW	GWh	Capacity factor (%)	Market share (%)	Capacity share (%)
Coal	$11.91	$45.40	5,059	39,889	90.00	64.40	49.50
CCGT	$24.56	$50.15	4,038	21,551	60.90	34.80	39.50
OCGT	$71.25	$415.23	1,128	504	5.10	0.80	11.03
Total			10,226	61,944		100.00	100.00

Data source: ACIL Tasman modelling

The CRA results for new plant mix are shown in Table 2

Table 2 **CRA results for the 2009-10 LRMC calculation**

	MW	GWh	Capacity factor (%)	Market share (%)	Capacity share (%)
Coal	5562	44196	90.7	59.1	71.5
CCGT	3741	16818	51.3	39.8	27.2
Biomass	107	799	85	1.1	1.3
Total	9410	61813		100.0	100.0

Data source: CRA, Calculation of the Benchmark Retail Cost Index 2009-10 (8 June 2009),

ACIL Tasman achieved a result of $53.63 compared to the CRA results of $53.28. The following table indicates where differences have arisen.

Table 3 **LRMC methodology and key inputs, variations from the CRA report**

Component of LRMC calculation	Reference to original methodology	Key inputs used in ACIL Tasman's replication of the LRMC	Variation on the CRA June 2009 report
Least cost supply model	Page 35, CRA report	AT used *PowerMark LT*, which probably has differences in the optimising (least cost) routine as well as other parts. There were differences in plant mix	Different coal, CCGT and OCGT, mix, AT got no biomass and CRA got biomass but no OCGT.
Data sources for LRMC, SRMC, heat rates etc	CRA used the Concept Economics report	AT used the Concept Economics Report.	No variation.
Load forecast used	Page 39, CRA report	The 2008 calendar year half hour loads were used and split into 50 segments (each with a weight totaling 8760) and grown to 2016-17 using the SOO peak and energy growth rates	CRA used 40 rather than 50 segments but there appear to be no other differences
Treatment of RET, GEC schemes	Pages 39 to 43, CRA report	GECs and RECs reduce LRMC and SRMC by the respective penalty amounts BUT these certificate values are reduced in proportion to any oversupply (see 2.3.4)	CRA have included GECs and RECs at penalty values but not clear whether they reduced these in response to oversupply

Data source: ACIL Tasman analysis, CRA data provided by QCA and CRA report *Calculation of the Benchmark Retail Cost Index 2009-10,* 8 June 2009.

3 Energy purchase costs (EPC)

ACIL Tasman has replicated CRA's model of energy purchase costs using the methodology described in Section 3.3 of CRA's final report on *Calculation of the Benchmark Retail Cost Index 2009-10, 8 June 2009* (CRA report). The methodology and key inputs are briefly summarised below using references from the CRA report.

Where possible, we have used the same data inputs as CRA, with the exception of the NEM pool prices, for which we have used prices from our own electricity market simulation modelling.

3.1 Hedging strategy

The volume of hedge contracts has been determined using the criteria in Table 19 and the calculations on page 65 of the CRA report.

The half hourly load data used for the purposes of constructing the hedging strategy represents an estimate of the 50%POE Queensland load excluding the load associated with directly connected customers. This load is called the 'little' load.

The little load was estimated by ACIL Tasman using the methodology outlined in a previous paper that ACIL Tasman prepared for the QCA[1].

Table 4 compares our estimates of swap contract volumes with those calculated by CRA[2]. Our estimates are reasonably close to CRA's estimates. The reason for the slight difference in Q3 contract volumes is unknown. However, the difference has an insignificant (<$0.02/MWh) impact on the final energy purchase cost estimate.

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[1] The paper can be viewed at http://www.qca.org.au/files/ER-NEP910-ACIL-ConsPapNEMLoad-0509.pdf

[2] Contract volumes were not published in the CRA report but the swap contract volumes were provided to us by QCA. No cap contract volumes were provided.

Table 4 **Swap contract volume comparison MW**

	Flat swap volume MW			Peak swap volume MW		
	CRA	ACIL Tasman	Variation	CRA	ACIL Tasman	Variation
Q3 2009	4,436	4,422	-14	967	998	31
Q4 2009	4,981	4,981	0	1,630	1,630	0
Q1 2010	5,265	5,265	0	1,566	1,566	0
Q2 2010	4,415	4,415	0	778	778	0

Data source: ACIL Tasman analysis and CRA data as provided by QCA

3.1.1 Contract prices

The cost of the swap and cap contracts have been estimated under the assumption that the retailer spreads its purchases of contracts evenly over the two year period prior to the beginning of the 2009-10 BRCI period.[3]

Data by d-cypha Trade was used to estimate the cost of electricity swap and cap contracts using the averaging methodology described on pages 61- 62 and page 66.

Our estimates of the cost of contracts match those estimated by CRA in Table 26 of the CRA report.

3.2 Settlement

Settlement is modelled for three load scenarios – the 10%POE, the 50%POE and the 90%POE. These load forecasts were estimated by ACIL Tasman using the methodology outlined in a previous paper that ACIL Tasman prepared for the QCA[4].

Half hourly NEM prices were used to calculate the energy purchase cost under the three load scenarios. NEM prices have been estimated by ACIL Tasman's proprietary electricity market simulation model (PowerMark) and are based on the same load scenarios mentioned above.

Table 5 shows ACIL Tasman's quarterly pool prices used in the energy purchase cost calculation.

[3] CRA, *Calculation of the Benchmark Retail Cost Index 2009-10* (8 June 2009), page 66.

[4] The paper can be viewed at http://www.qca.org.au/files/ER-NEP910-ACIL-ConsPapNEMLoad-0509.pdf

Table 5 **ACIL Tasman quarterly pool prices ($/MWh)**

	10%POE	50%POE	90%POE
Q3 2009	$47.76	$39.27	$41.29
Q4 2009	$83.79	$55.68	$51.86
Q1 2010	$118.62	$56.03	$38.86
Q2 2010	$22.08	$22.07	$22.05

Data source: ACIL Tasman PowerMark modelling

Table 6 shows the CRA modelled pool price forecasts that were used to calculate the cost of purchasing energy in the CRA report.

Table 6 **CRA quarterly pool prices ($/MWh)**

	10%POE	50%POE	90%POE
Q3 2009	$37.17	$38.76	$39.30
Q4 2009	$44.99	$41.79	$40.02
Q1 2010	$93.55	$78.95	$64.30
Q2 2010	$32.18	$33.05	$33.35

Data source: CRA report *Calculation of the Benchmark Retail Cost Index 2009-10,* 8 June 2009

The projected spot prices are different from the two models. The ACIL Tasman spot prices for the 50%POE are generally lower than those of CRA on average. However, ACIL Tasman's prices do exhibit more volatility – particularly in the 10%POE case. It is difficult to identify the reasons for the differences in projected prices as the modelling requires a large number of inputs and the models themselves use different IP. ACIL Tasman has internally reviewed the projected spot prices produced by PowerMark and is satisfied with the projection.

Table 7 is a summary of the key components of the energy purchase cost calculation and includes references to the CRA report for the methodology, the key inputs used in ACIL Tasman's estimate of energy purchase cost and any variations on the CRA estimate.

The spot prices are the only significant variation from CRA's inputs.

Table 7 **Energy purchase cost methodology, key inputs and variations from the CRA report**

Component of EPC calculation	Reference to original methodology	Key inputs used in ACIL Tasman's replication of the EPC	Variation on the CRA June 2009 report
Hedging strategy	Table 19, CRA report	50%POE forecast half hourly load trace for 2009-10 for the little load in Qld based on the methodology outlined in the paper provided to QCA (see table note).	Small (insignificant) variation in Q3 contract volumes.
Contract prices	Pages 61- 62 and page 66, CRA report	d-cyhaTrade daily settled prices for flat and peak swaps and $300 caps.	No variation.
Load forecast used for the purpose of settlement	Page 62, CRA report	10%POE, 50%POE and 90%POE forecast half hourly load traces for 2009-10 for the little load in Qld based on the methodology outlined in the paper provided to QCA (see table note).	No variation.
Spot prices used for the purpose of settlement	Page 63, CRA report	Half hourly electricity spot prices modelled by ACIL Tasman based on the 10%POE, 50%POE and 90%POE load forecasts.	Variation - we have used our own modelled spot prices, whereas CRA used spot prices from its own modelling.

Note: The paper can be viewed at http://www.qca.org.au/files/ER-NEP910-ACIL-ConsPapNEMLoad-0509.pdf

Data source: ACIL Tasman analysis, CRA data provided by QCA and CRA report *Calculation of the Benchmark Retail Cost Index 2009-10,* 8 June 2009.

Table 8 compares ACIL Tasman's energy purchase costs estimates with those in the CRA report.

ACIL Tasman's weighted energy purchase cost is $2.88/MWh lower than CRA's weighted energy purchase cost estimate. The variation is mostly due to the differences in spot prices.

The reason for the lower energy purchase costs when using ACIL Tasman's prices is that the retailers are receiving more payments from their swap and cap contracts due to the over-contracted position assumed in the hedging strategy.

Table 8 **Energy purchase costs, 2009-10 – scenario results, weightings and weighted values ($/MWh)**

	Scenario weighting	ACIL Tasman	CRA	Variation
Energy purchase costs ($/MWh) - 10POE	30.40%	$53.18	57.88	-$4.70
Energy purchase costs ($/MWh) - 50POE	39.20%	$55.17	57.65	-$2.48
Energy purchase costs ($/MWh) - 90POE	30.40%	$56.02	57.59	-$1.57
Energy purchase costs ($/MWh) - Weighted		**$54.83**	**$57.70**	**-$2.88**

Data source: ACIL Tasman analysis

To test our model of energy purchase costs, we used half hourly inputs from the December 2008 second draft report, provided to us by QCA, as half hourly data from the final report was not available.

Table 9 shows a variation in the weighted energy purchase cost of $0.35/MWh.

Table 9 **Energy purchase costs, 2009-10 (using CRA data from the second draft report, December 2008) – scenario results, weightings and weighted values ($/MWh)**

	Scenario weighting	ACIL Tasman	CRA (second draft report, December 2008)	Variation
Energy purchase costs ($/MWh) - 10POE	30.40%	$58.26	57.89	$0.37
Energy purchase costs ($/MWh) - 50POE	39.20%	$57.41	57.06	$0.35
Energy purchase costs ($/MWh) - 90POE	30.40%	$57.47	57.14	$0.33
Energy purchase costs ($/MWh) - Weighted		**$57.69**	**$57.34**	**$0.35**

Data source: ACIL Tasman analysis using CRA half hourly data

The reason for the variation is unclear, but it is possible that there may have been some differences in the input data used by CRA in their draft report to that which was supplied to us.

4 Comparison of ACIL Tasman and CRA results

Table 10 shows the comparison between ACIL Tasman and CRA results for the LRMC and EPC components of the 2009-10 BRCI.

Table 10 **Summary of AT and CRA results for LRMC and EPC costs**

	2009/10			
Energy costs	**CRA**	**ACIL Tasman**	$ diff	% diff
LRMC	$53.28	$53.63	$0.35	0.66%
Energy purchase costs (EPC)	$57.69	$54.83	-$2.87	-4.97%
Energy - based on 50% weighting	$55.49	$54.23	-$1.26	-2.27%

The LRMC results are very close, which is to be expected given that the two approaches used the same data and similar modelling approaches. The variation almost certainly arises from the slight differences in the way the two least cost optimising models work. This was indicated in the differences in plant mix in the two sets of results.

The EPC modelling uses similar loads and the same contracting model but it is clear there are differences in the two pool simulation models as the major difference is the pool price projections at the three different POE levels which, even after the effects of the contracting model are taken into account, cause a difference of about 5% in the ACIL Tasman and CRA EPCs.