

ECON3220/7740 Case Study Assignment in Applied Cost-Benefit Analysis, Semester 2 2019

Comparative Levelized Cost of Electricity: Renewables vs Coal

1. Introduction: The task at hand

A private mining company, Rio Blanco Corporation (RBC), which is a major electricity user, needs to decide whether to enter into a new contract with one of the State's main electricity retailers for the supply of its electricity needs for the next 20 years. The dilemma it faces is that the State's power grid is sourcing its electricity exclusively from existing, black coal-fired power stations at a supply price, equal to the marginal cost of electricity generation, of \$60/MWh (constant 2020 prices).

It is widely acknowledged that the external costs of carbon emissions from coal-fired electricity generation are extremely high relative to other technologies, especially renewables. It is estimated that for every MWh of electricity generated by a black coal-fired power station, 0.8 tonnes of carbon is emitted. There is growing recognition of the need for electricity regulatory authorities to factor in the Social Cost of Carbon (SCC) in comparative cost calculations. To internalize such external costs the State Government is planning to introduce of a carbon price/tax. For coal-fired electricity generation this additional cost, over and above the current contracted supply price, could be significant. Although there is some uncertainty as to how much and when the carbon charge will be implemented, the prevailing view among most stakeholders is that this will happen 'sooner rather than later'. For the purpose of this study it should be assumed that a carbon tax, initially set at \$20/tCO₂ (constant 2020 prices) will be introduced at the beginning of 2024 and will increase by \$2/tCO₂ per annum until it reaches a level of \$40/tCO₂ (constant 2020 prices), and remains at \$40/tCO₂ to the end of the project life-pan of 20 years (ie. to 2040).

The alternative to sourcing its electricity from the grid is for RBC to invest itself as producer/consumer (a '*prosumer*') in a new electricity generation plant, using a renewable technology. The two options under consideration are onshore wind turbines *versus* solar photovoltaic (PV). The construction and management of the preferred option is to be contracted to a private supplier: for the solar option, Sunshine Solar (SS), a local State-based company, and for the onshore wind option, Deutsche Onshore Wind (DOW), a Germany-based multinational company. Both companies have existing operations in the state are considered world leaders in renewable electricity generation and will be paid a project management fee (equal to 10% of, and included in, the estimated fixed operating and maintenance costs in Table 1). In the case of DOW the full amount of this fee will be remitted to its parent company in Germany.

If RBC switches to become a *prosumer* with one of the renewable options, it will avoid having to purchase any electricity from the grid at the current price, and avoid paying the additional carbon charge from 2024 onwards. This will also reduce the amount of electricity generated by the coal-fired power stations by an amount equivalent to the MWh generated by RBC.

You are required to undertake a cost-benefit analysis and prepare a report for RBC, comparing the costs and benefits to RBC of sourcing electricity over the next 20 years from either onshore wind- or solar-powered generators, *vs* continuing with supply from the grid using coal-fired generation sources. Your comparison of the two options should be based on their Levelized Cost of Electricity (LCOE).

As the proposed investment has wider social and economic implications, your analysis and report should also compare the costs and benefits from the social perspective of the State, using your estimates of the appropriate Social Cost of Carbon (SCC) and any other external costs or benefits, to be included in the

Efficiency CBA.

You will also need to show in the Referent Group CBA, the distribution of all costs and benefits among the various stakeholders affected, and discuss other social and environmental costs not quantified in the CBA, which could impact on RBCs final decision. Your conclusions and recommendations should also include a discussion of the policy implications your analysis raises from the State Government’s perspective.

2. Details of renewable options

Both proposed plants, if adopted, are to be constructed in 2020 and will begin production in 2021. They both have an economic life of 20 years, with an end value equal to 10% of the initial capital cost.¹

Your analysis should consider the options both with and without the carbon tax in the Market and Private CBA, and with the Social Cost of Carbon (SCC) in the Efficiency and Referent Group CBA. You are required to research and justify the range of values used in your analysis for the SCC, and, the level at which the Government sets its carbon charge.

Due to gradual wear-and-tear of the installed capacity, it should also be assumed that the efficiency of the onshore wind option will decline by 0.5% per annum and the solar option by 0.75% per annum. This means that the calculated annual MWh sent out per annum will decline at this rate.

In the Private CBA you will be analyzing the projects from the viewpoint of RBC. Your recommendation to RBC will be either to accept one of the renewable *prosumer* options, or to reject them in favour of continued supply from the grid. Net Present Values and Levelized Cost of Electricity (LCOE) in the Market and Private CBA are to be estimated at a discount rate of 10% (real), with sensitivity testing at 8% and 12% (real). For the Private CBA you should report the IRRs.

For the Efficiency and Referent Group CBAs you are required to report Net Present Values (NPVs) using a real social discount rate of 5% with sensitivity testing at 3% and 7%, given that the public sector traditionally uses a ‘social’ discount rate somewhat lower than that used by private investors.

The estimated costs and other input data are detailed in Table 1. (All costs reported are in A\$2020 prices.)

Table 1: Available Input Data on Costs and Benefits of Renewable Electricity Generation Options

Plant Specific Input Data	Onshore wind	Solar PV	
Installed (Nameplate) Capacity (MW)	150	200	
Capacity Factor	40%	30%	
Initial Capital Costs (\$mn/MW)	\$2.00	\$1.75	
Fixed O&M Costs (\$/MW of nameplate capacity, per annum)*	\$30,000	\$20,000	
Variable O&M Costs (\$/MWh sent out per annum)*	\$12.00	\$2.00	
Productivity Drop-Off (% output pa)	0.50%	0.75%	

* Including GST of 10%

** Increasing by \$2 per annum for 10 years, then fixed at \$40/t

¹ The same end-value calculated for the Market and Private CBA should be used in the Efficiency CBA. The end-value should not be deducted from capital costs when calculating depreciation.

3. Financing

To finance the investment RBC will need to take out a commercial loan in 2020 of \$200mn at a 6% real rate of interest with a consortium of overseas financial institutions, to be repaid in equal annual amounts as an annuity, over the life of the project starting in 2021. (In the Private CBA enter the loan repayments in Rows 55 & 56 from RBCs perspective) but keep the interest cost in Row 53 as a positive amount.)

Private companies pay 30% business company tax on profits net of operating costs, interest payments and depreciation allowances. RBC can deduct any losses against taxable profits from their other Australian projects.

Depreciation allowances can be claimed as tax deductible costs using the straight-line method over a period of 10 years starting in the year 2021; ie. no depreciation beyond year 2030.

4. External Costs and Benefits

Both prosumer projects can be expected to involve significant external benefits relative to electricity sourced from coal-fired generation in terms of reduced carbon emissions. The reductions in carbon emissions are expected to amount to 0.8 tons of carbon per MWh of electricity generated. However, both the renewable project options are expected to result in other external social and environmental costs to the local communities which have not been quantified. These need to be identified and discussed in your report.

5. Sensitivity and Scenario Analysis

5.1 You are required to undertake sensitivity testing on at least 4 of the variables individually (apart from the discount rates) that can be considered most uncertain and with significant implications for the results and recommendations. These should include the Social Cost of Carbon, and the Capacity Factor of the two plants, plus 2 other key variables selected and justified. Your report should also explain and substantiate the range of values selected for sensitivity testing. (For the purpose of this study it should be assumed that the nameplate capacities of the two plants cannot be varied.)

5.2 Your sensitivity analysis should also include derivation of the threshold values for: (i) the carbon tax at which the wind and solar options become at least as cost-effective as coal-fired generation from the grid in the Private CBA; and, (ii) the SCC at which the wind and solar options become at least cost-effective as coal-fired generation from the grid in the Efficiency CBA. (You are encouraged to derive threshold values for other variables such as the Capacity Factors.)

5.3 You should also report the results of a scenario analysis based on the most optimistic, best guess, and most pessimistic, sets of values for the combination of variables included in your sensitivity analysis

6. INSTRUCTIONS

On behalf of RBC you are required to undertake and report the findings of a cost-benefit analysis of the solar and onshore wind proposals as possible alternatives to continued supply from the national grid using coal-fired electricity generation.

The analysis is to be reported in millions of 2020 Australian dollars, to two decimal places, with PV of

costs and LCOEs in year 2020 to be calculated. *It is highly recommended that all costs and revenues/benefits are entered as positive values in the spreadsheets and the net values are derived by subtracting costs from revenues/benefits in the corresponding formulae. The loan payments receipts should be calculated from RBCs perspective.*

In your report you should also indicate if there are any omitted costs and benefits that could be of potential significance to the decision-maker and might warrant further investigation

Format: Two Files to be submitted – (i) CBA Analysis in Excel Workbook; and,

(ii) CBA Report for RBC and State Government in PDF

Excel Workbook

In constructing your CBA spreadsheets you are required to use the template Excel Workbook downloadable from Blackboard. You should not change the structure of the template tables in the spreadsheets unless requested by an instructor to do so, with the exception of the *Summary Results* and the *Sensitivity Analysis* sheets to which you need to add additional summary tables. Precise details of the assumed values for variables in the sensitivity and scenario analyses should be clearly stated alongside the results tables to allow the markers to replicate your reported results. (Any additional tables and working space for your sensitivity analysis results should be added to the additional, unformatted spreadsheet labelled “*Sensitivity Analysis*” in your Workbook.)

NO ADDITIONAL EXCEL FILES SHOULD BE SUBMITTED.

All Excel analysis and reporting of results should be conducted in 2020 prices in millions of dollars to two decimal places. (A ‘Conversion Factor’ to convert \$ to \$mn should be included in your Input Data spreadsheet as indicated.)

You are required to enter your name and student ID number in the space provided at the top of the ‘*Summary Results*’ sheet in the template Excel Workbook.

CBA Report

Your written report should not be more than 12 pages in length, including the Executive Summary and tables. It should be on A4 size pages (portrait orientation only) in PDF format, 12-point Times New Roman font, 1.5 spacing, 2.5 margins on all sides. Penalties apply for excessive length.

The report should provide a Front Page containing name, student number, etc. This not included in the page limit. The Report should begin with the Executive Summary of no more than one page. Results of both project options and sensitivity analyses should be reported in summary tables included in the text, and where necessary, in more detailed tables in an Appendix (not included in 12 page limit). Do not attach copies of spreadsheets (e.g. in PDF) to your main report, although sections showing summary results can be cut-and-pasted into the report.

Your report (in PDF format) plus your Excel Workbook file should be submitted electronically via Blackboard (Bb) by 4.00 pm 18 October 2019. For the report you have unlimited attempts to submit, but for the Excel Workbook submission a maximum of 2 submission attempts is allowed. Only the final submissions will be marked and graded.

You may submit only one Excel Workbook file, containing all relevant spreadsheets, which should be

formatted in landscape in normal view, and left unlocked so all calculations and sensitivity testing can be checked and verified against the results in your written report.

Your Excel file must be named: LCOE_[your family name]_[your student ID number]

PLEASE ALSO NOTE

A. Late penalties: See course profile for further details of the marking criteria and weights and the severe penalties for late submission.

B. Feedback on work in progress:

Electronic files containing work-in-progress in spreadsheets should not be e-mailed or brought to instructors for uploading to their PCs. We can provide assistance during the lab sessions or we can comment on spreadsheet files (in the template format only) which are printed out or are accessible on student's own laptops during consultation and lab times;

and,

We will not agree to read and comment on draft reports before the submission dates; however, general guidance on the direction and structure of the reports will be provided, including the lecture "Guidelines for Preparing a CBA Report" and through the Discussion forum in Bb.

C. Marking criteria

LCOE Case Study Report [80 marks]

1. Statement of approach and methodology [10 marks]

- a) Introduction
 - i. Length ($\frac{1}{2}$ to $\frac{3}{4}$ page)
 - ii. Describe project, importance
 - iii. Decision makers, stakeholders
- b) Methodology
 - i. Variables
 - ii. CBA
 - iii. Decision criteria (NPV, IRR, LCOE etc.)
- c) Assumptions
 - i. List assumptions – most already in project description;
 - ii. Marks will be subtracted for each incorrect or contradicting assumption.

2. Presentation and discussion of base case results [30 marks]

- a) Base Case
 - i. Accept/reject project, ranking and preferred option, discussion of results generally
 - ii. Distribution of costs/benefits among stakeholders within Referent Group
 - iii. Identify and discuss external costs and benefits of renewable project options
 - iv. Possibilities for improvement; what can make it more acceptable to stakeholders in RG?

3. Scenario and Threshold Analysis [30 marks]
- a) Basic sensitivity testing of individual variables with justification (and references if needed)
 - b) Scenario Analysis (Optimistic/Pessimistic)
 - c) Threshold Analysis and implications for ranking of options
 - d) Discussion of other unaccounted costs and/or benefits NOT included in CBA and possible implications for project ranking/choice.
4. Conclusions & Recommendations (including Executive Summary) [10 marks]
- a) Executive summary (1 page only)
 - i. Length and style
 - ii. Introducing the project
 - iii. Results/findings; sensitivity/scenario/threshold analysis
 - iv. Overall feasibility of project and preferred option?
 - b) Conclusion & recommendations
 - i. Length and style (1- ½ pages)
 - ii. Recommendations
 - iii. Base case & options
 - iv. Implications of Sensitivity and Threshold Analysis
 - c) General 'readability', overall coherence and style

LCOE Case Study Excel Files [20 marks]

Some basic instructions

1. 20 marks will be subtracted if no excel files are submitted. That is 10 marks for base case and 10 marks for sensitivity/threshold analysis.
2. We use 'negative marking' ie. Subtract marks for errors and/or omissions
3. Once a mistake has been penalised we do not subtract marks for it again.
4. We will also check to see if template structure has been altered in any way, with the exception of the *Summary Results* and *Sensitivity Analysis* sheets which you need to customise. Note changes in colour, highlighting adding comments etc. which are cosmetic will not be penalised.
5. We will check for consistency between numbers in excel file and those quoted in report.
6. Different formula that are logical and give same results will not be penalised.
7. Students are expected to save the full set of sensitivity/scenario/threshold analysis in the '*Sensitivity Analysis*' tab. Only those most pertinent to the overall analysis and the CBA results should be reported in the '*Summary Results*' tab.
8. We will be checking to make sure that the results of the sensitivity analysis can be verified using your Excel file. Therefore it is important that the values for the variables used in the sensitivity analysis should be shown clearly in the '*Sensitivity Analysis*' tables.