Project Code:	12015	**Document Reference:**		**Version:**	3

Preliminary Energy Balance for

Rössing Uranium Ltd

Expansion, including

Acid Plant, Ore Sorter Plant and Extension of Mining Activities into SK4

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		Issue Date:	21 February 2007
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SECTION 1 - EXECUTIVE SUMMARY

Project Purpose

Rössing Uranium Ltd (RUL) would like to expand its operations beyond the previously agreed 2016 closure plan. Given the significant increase in uranium prices since 2005, RUL has now agreed sales to 2026 and is looking at ways of expanding beyond its name plate capacity. As part of the proposed expansion, RUL has commissioned a Social and Environmental Impact Assessment (SEIA) to investigate the possible implementation of three projects, namely:

- A sulphuric acid plant with associated storage and transport of sulphur;
- A radiometric ore sorter and prescreening plant with an associated waste rock storage facility; and
- The mining of a satellite ore body known as SK4.

This report outlines the energy balance undertaken to determine the incremental energy consumption and greenhouse gas (GHG) emissions of the proposed expansion projects. The purpose of the study was also to calculate the impact these changes will have on RUL's overall energy balance and assess how this change will affect RUL achieving its energy consumption and GHG emission targets.

Major Findings

The energy consumption and GHG emissions for each of the expansion projects have been estimated and compared against the energy balance determined for 2006 (Table 1). Although mine production will increase by the time these projects come on-line, it was decided that the 2006 energy balance would form the base case for comparison given that it was the latest data formally completed and submitted to Rio Tinto. The increases in uranium oxide (U_3O_8) production due to the development of SK4 and the ore sorter have been included in the total tonnes produced. The acid plant will not lead to an overall increase in U_3O_8 product.

Table 1 – GHG Emissions and Energy Use per product for the Expansion

	SK4		Ore sorter		Acid Plant		Expansion	
	E/Prod (GJ/t)	**GHGe/Prod (t CO_2-e/t)**	**E/Prod (GJ/t)**	**GHGe/Prod (t CO_2-e/t)**	**E/Prod (GJ/t)**	**GHGe/Prod (t CO_2-e/t)**	**E/Prod (GJ/t)**	**GHGe/Prod (t CO_2-e/t)**
Total	44	3	103	11	-84	-12	63	2
Total for 2006							378	50
Total 2006+ Expansion							441	52
Increase from 2006							17%	3%
2007 target rolled over to 2008							**297**	**43**

The development of the expansion could result in an overall unit increase of 17% in energy use and 3% in GHG emissions from 2006 values with a total GHG emission of 52.0 t CO_2-e/t U_3O_8 and an energy use of 441 GJ/t U_3O_8.

The study found that the most significant contributor to the increase was the ore sorter energy requirements. The acid plant, on the other hand, due to its power generating capacity was shown to have a substantial offsetting effect on the overall energy balance and the outcomes and impacts of the expansion could have been significantly different had it not been for this effect. The mining of the higher grade SK4 and operation of the ore sorter will have a positive effect on product output and will contribute to offset the impacts of the expansion in respect of unit energy and GHG emission performance.

However, it should be noted that this comparison is hypothetical and limited as it is based on 2006 values. According to the approved 2016 mine plan, the mining and operational conditions are likely to be different by the time the expansion projects come on-line. Similarly, it is anticipated that the individual project components of the expansion will not come on-line within the same year. Subject to their approval, SK4 is likely to come on-line in mid 2008 and the acid plant and ore sorter in 2010.

The study showed that energy consumption and GHG emissions achieved in 2006 were not within the RUL targets for 2008. Given that the mine plan went from closure at the time the targets were set to the present situation of a mine life to 2016, exceeding the targets was expected. The contribution towards energy usage and GHG emissions from the expansion is thus expected to widen the gap between current levels and Rio Tinto targets. From 2009 a new target setting process will be rolled out throughout Rio Tinto and the new targets should reflect more closely the current expansion environment.

Recommendations

Exceeding the current Rio Tinto 2008 targets due to the expansion projects was predicted given that the targets were based on a closure scenario for the mine. Nevertheless, RUL is still pursuing the achievement of its 2008 targets within the current implementation of the life of mine extension and a number of ongoing measures are being investigated. These measures are likely to reduce the energy consumption and GHG emissions associated with the expansion.

Measures and recommended actions proposed by RUL and T&I respectively are summarised as follows:

- Undertake a Climate Change Risk Assessment as per Rio Tinto guidelines and follow up with an Energy Efficiency Review;
- Promote energy efficiency through training and awareness campaigns. Prepare a clear and easy-to-understand awareness training module aimed at both employees and contractors;
- Investigate options for using renewable energy sources;
- Undertake workshops to stimulate energy reduction initiatives;

- Investigate the use of chemical additives to fuel to reduce overall consumption;
- Upgrade the 11kV ring power supply to reduce downtime of pit equipment;
- Include energy considerations during purchasing of mine equipment;
- Use of energy efficient motors in haulage trucks;
- Revisit the energy balance of the two options for waste rock removal for the ore sorter (conveying or trucking) and ensure that the most energy efficient waste rock handling scenario is considered in the final design;
- Ensure measures to minimise energy consumption in the acid plant design, including the use of a variable speed drive on the main blowers to allow for changes in production demands and the provision of water cooling over the more energy intensive air cooling.

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SECTION 2 - MAJOR FINDINGS & ACTIONS

1 INTRODUCTION

Rössing Uranium Ltd (RUL) plans to expand its operations beyond the previously agreed 2016 life of mine plan. Given the significant increase in uranium prices since 2005, RUL is considering a 2026 mine plan. As part of the proposed expansion, RUL has commissioned a Social and Environmental Impact Assessment (SEIA) to investigate the possible implementation of three projects, namely:

- A sulphuric acid plant with associated storage and transport of sulphur;
- A radiometric ore sorter and prescreening plant with an associated waste rock storage facility; and
- The mining of a satellite ore body known as SK4.

This report outlines the energy balance undertaken to determine the incremental energy consumption and greenhouse gas (GHG) emissions of the proposed expansion projects. The purpose of the study was also to calculate the impact these changes will have on RUL's overall energy balance and assess how this change will affect RUL achieving its energy consumption and GHG emission targets.

Where appropriate, management actions have been recommended to mitigate any increases in energy usage and GHG emission levels. The findings will be included as part of the SEIA.

T&I wishes to acknowledge the valuable input from Achmet Abrahams, Tisa Chama and Dave Garrard without whose help the compilation of this report would not have been possible.

2 METHODOLOGY - RIO TINTO ENERGY USE AND GHG EMISSIONS

Rio Tinto, RUL's majority shareholder, is a signatory to a number of international projects to reduce global greenhouse gas (GHG) emissions, including the Carbon Disclosure Project. In addition a range of standards and policies have been put into place by Rio Tinto to reduce energy consumption and GHG emissions at all Rio Tinto operations. RUL is committed to adopting and maintaining these standards.

2.1 Rio Tinto Policy

Rio Tinto accepts that the activities of human beings and companies are contributing to climate change, through the emission of greenhouse gases (GHG). These gases include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perflurocarbons (PFCs), sulphur hexafluoride (SF_6) and hydroflurocarbons (HFCs). It is agreed that there are financial, social and environmental issues associated with the supply and consumption of energy, including the release of GHG emissions, which can be minimised by reducing consumption through more efficient energy use. Energy use covers the consumption of fuels in stationary (e.g. power generators) and on-site mobile equipment, the use of purchased electricity and the use of carbon and coals for anodes and reductants.

Rio Tinto has a number of documents relating to its management and reporting of GHG emissions, namely:

- Greenhouse Gas Emission Standard
- Rio Tinto Climate Change Policy
- Environmental Management System Standard
- Air Quality Control Standard
- Biodiversity Guidance Note
- Greenhouse Gas Emission Guidance Note

RUL has adopted these standards and policies as part of their current management system. A copy of the Rio Tinto Greenhouse Gas Emission standard is provided in Appendix 1.

2.2 Emission Inventory and Reporting

Rio Tinto has adopted the World Business Council for Sustainable Development (WBCSD) and World Resources Institute (WRI) Greenhouse Gas Protocol and has been reporting its GHG emissions publicly since 1996. The emissions inventory is presented as:

- On-site emissions – emissions from fuel use, on-site electricity generations and reductant use, process emissions and land management;
- Total emissions – on-site emissions plus purchased electricity and steam emissions minus exported electricity emissions; and
- Other indirect emissions – emissions associated with third party product transport, offsets external to inventory boundary and emissions linked to product use.

External consultants to Rio Tinto have, on two occasions, reviewed the methodology it uses against the standards set by the Intergovernmental Panel on Climate Change (IPCC) and WBCSD. In addition to the annual external verification of health, safety and environmental data, Rio Tinto has participated in the Australian Greenhouse Challenge verification programme.

As GHG emissions are largely dependent on how well energy use is managed, a comprehensive programme of energy audits was undertaken by Rio Tinto operations to identify energy saving opportunities. In 2004, Rio Tinto set a five year target to reduce GHG emissions by 4% per tonne of product by 2008 (using the 2003 baseline) and to reduce energy use by 5% per tonne of product over the same period.

The 2006 emissions for the entire Rio Tinto group were reported as follows:

- Total GHG emissions from Rio Tinto operations were 28.3 Mt CO_2-e. This was 5.8% higher than 2005 levels. Most of the change was due to continuing expansions and new developments.
- Energy use was 258 PJ. This was an increase of 5% from 2005 energy use levels. This increase was similarly attributed to development and general increases in production. In 2006 40% percent of energy used was in the form of purchased electricity. Of this, 79% had a fossil fuel as a primary energy source. This compares favourably with the international average for fossil fuel sourced primary energy, with Rio Tinto using a significantly greater proportion of hydroelectric and nuclear primary energy than the international average.

The conclusion was that Rio Tinto is not on track to meet its target to improve total emissions efficiency by 4% by 2008. However, there was a 0.3% improvement in efficiency compared to 2003. The result was affected by both production interruptions and changes in the emission intensity of purchased electricity. Carbon dioxide made up 92% of the inventory and methane emissions, predominately from coal seam gas, contributed a further 7%.

It is worth noting that RUL is an insignificant contributor of energy use and GHG emissions to the overall Rio Tinto group (0.0002% of total GHG emissions can be attributed to the RUL operation).

2.3 Rio Tinto Energy Use and GHG Emissions Targets

Group performance targets for GHG emissions, occupational noise exposure, occupational disease, energy use and fresh water withdrawal were approved by Rio Tinto in January 2004. In order to achieve the Group targets each business and/or operation needed to meet their targeted performance as stated and submitted in their 2004 business plans (based on 2003 actual values).

The progress of implementation against these targets is assessed by Rio Tinto twice a year and reported in the annual Social and Environmental Survey. Operations are asked to provide energy use and production data in accordance with their own calculation methodology following Rio Tinto guidelines. Assessment of performance is undertaken at the business level, progress is tracked and business units and operations receive biannual updates of progress against their targets.

2.4 RUL Targets

For RUL, the baseline energy usage of 385.4GJ/ t U_3O_8 and GHG emission of 53.7t CO_2-e/t U_3O_8 was established using actual emission data from 2003. Based on these values, energy consumption and GHG emission targets were set in 2003, and approved in 2004. The targets were to reduce energy consumption by 23% and GHG emissions by 20% by the end of 2007. Although significantly higher than the overall Rio Tinto targets, the reduction targets were in line with the RUL mine plan to cease operation by the end of 2007. However, with the significant improvement in uranium prices the life of mine plan was revised.

The following table outlines the annual total GHG emissions and energy use achieved for the years 2003 to 2006.

Table 2 – Annual Total Energy Use and GHG Emissions for RUL

Year	Product Produced U_3O_8 (t)	Total Energy Use (GJ)	Total Emissions (t CO_2-e)	Total Energy Use/product	Total Emissions/ product
2003	2374	914846	127504	385.4	53.7
2004	3582	1096349	155626	306.1	43.4
2005	3711	1151889	161015	310.4	43.4
2006	3617	1365648	181158	377.5	50.0
2007 Target				**296.8**	**43.0**

As seen from the above table, RUL was able to make some reductions in its total energy use and GHG emissions in line with their 2007 targets. However, the following life of mine activities are likely to have contributed to the lack of achievement of the 2007 targets by 2006, namely:

- o Initiation of work in the Phase 2 pioneering area to remove material and clear areas for the extension of the open pit, as part of the approved 2016 Life of Mine Plan, i.e. increased strip ratio[1].
- o Increase in the amount of mining equipment purchased and used on site, i.e. shovels, drills, haul trucks etc.
- o Increase in haulage distances from increased depth of the open pit.

None of these factors were included in the target setting in 2004 as the original mine plan was to close the RUL operation by the end of 2007. Given that energy use and GHG emission levels would significantly increase due to the revised mine plan, it was predicted that the 2007 targets could not be met. As the mine plan went from a closure plan at the time the targets were set to the present situation of a mine life in excess of 2020, exceeding the 2004 targets was expected.

Within RUL, energy consumption and GHG emissions are reported in a monthly internal OHSE report and a comparison is made against the targets to determine any improvements.

[1] Strip ratio is the ratio of waste rock to ore.

A review of targets was initiated by Rio Tinto for 2008, the last year of the first 5 year period in which performance is tracked against targets between 2003 and 2008. From 2009 a new target setting process will be rolled out throughout Rio Tinto. Although a new target for 2008 has been proposed, the 2007 targets remain in place for 2008 until the new targets have been approved.

As part of achieving these targets, various energy conservation projects are under consideration in the mining, plant processing and engineering areas and will potentially be implemented in future if found feasible.

3 ENERGY USE AND GHG EMISSIONS FROM EXPANSION

The energy consumption and GHG emissions for each of the projects within the expansion have been estimated. It was determined that the 2006 energy balance would form the base case for comparison given that it is the latest data formally completed and submitted to Rio Tinto. The cumulative effect of the expansion on the overall 2006 RUL energy balance has been considered.

3.1 Extension of Mining Activities into SK4

The higher grade ore from SK4 will replace low grade ore currently being mined from the SJ pit. Consequently, there will be no changes to the operation from the primary crusher downstream which will continue to process 14 Mtpa. However, the current mining of waste rock from the SJ pit and the placement of this material onto dumps will continue at the same rate to ensure that stripping activities are not delayed due to the mining of SK4.

Energy use and GHG emissions for SK4 will be associated with drilling, blasting, loading, hauling and dumping activities. Given that there will be no provision of electricity to the SK4 area, the main energy consumer will be associated with diesel usage. The following is a list of proposed mining equipment that will be used:

Table 3 – Mobile Equipment Requirements for SK4

Equipment	Fuel Diesel (D) Petrol (P)	Utilisation (%)	Units	Fuel (l/h)	24 hour operation	Total fuel use per annum (l/a)
994 Front end loader	D	50	1	180	2160	788,400
Blast Hole Drill (pit viper)	D	85	1	72	1469	536,112
Haul truck Komatsu 730 (180t)	D	85	2	180	7344	2,680,560
Track dozer	D	85	1	35	714	260,610
Grader	D	10	1	21	50	18,396
Tyre dozer	D	85	1	25	510	186,150
Wheel dozer 926	D	10	1	20	48	17,520
Support vehicles	P	50	2	15	360	131,400

Diesel is also consumed in the makeup of explosives and it is anticipated that 4,600 t of explosives per annum will be used at SK4. The contribution of diesel in the explosive makeup has been accounted for under ‘diesel consumption’. Similarly, the provision of a further 40 personnel to mine SK4 will contribute towards GHG emissions from the sewage plant. These additional sources of GHG emissions are accounted for under ‘process sinks and other sources’ (Table 4).

Given that diesel is railed in from Walvis Bay, this contribution to the overall energy balance was also considered. However, the contribution was below the recommended Rio Tinto 1000t CO_2-e limit for reporting and therefore no GHG emissions or energy usage are listed under 'transport to site' (Table 4).

The GHG emissions and energy use associated with the development of SK4 are summarised in the following table.

Table 4 – Annual Energy Use and GHG emissions for SK4

	Total Energy Use per annum (GJ/a)	**Total Emissions per annum (t CO_2-e/a)**
Diesel consumption	177,351	12,463
Electricity consumption	0	0
Process sinks & other sources	0	822
Total for SK4	**177,351**	**13,285**
Transport to site[2]	0	0
% Increase from 2006	**13%**	**7%**

As seen from the table, the mining of SK4 will result in an absolute increase of 7% in GHG emissions and 13% in energy use compared to 2006. This result was to be expected given that under the current mining plan, SK4 will not remove any capacity from current mining activities within the SJ pit and therefore associated energy consumption and GHG emissions will not be offset by reductions elsewhere.

3.2 Development of the Radiometric Ore Sorter and Prescreening Plant

Energy use and GHG emissions for the ore sorter will be associated mainly with the high pressure air used in the radiometric ore sorter and the transporting of reject material to the waste rock disposal site. The method of transporting reject material to the waste rock disposal site is still under consideration and two scenarios were proposed, namely:

Scenario 1 - the reject material is conveyed 2.2 km to a disposal site where the material will either be graded into an appropriate shape or loaded into a haul truck and taken to a nearby waste rock disposal site. The energy requirement for the conveyor is 0.64 MW. Anticipated cycle time[3] is 20 minutes for the haul trucks.

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[2] Given that diesel is obtained from Walvis Bay and railed to site, the overall contribution to GHG emissions and energy use due to its transport was estimated to be insignificant. Similarly, the quantities of ammonium nitrate prill used in the makeup of the blast are such that they do not contribute significantly to the overall energy balance. As a general rule, Rio Tinto does not quote figures below a 1000t CO_2-e.

[3] Cycle time is the time it takes for a haul truck to load material, transport it to its disposal site, offload and then return to the loading point.

Scenario 2 – the reject material is loaded into a haulage truck via a storage bin and then transported to the waste rock disposal site. Given that a number of sites are being considered, the worst case with respect to energy use was assumed, i.e. the furthest waste rock disposal site, Waste Dump 5, with an anticipated cycle time of 37 minutes. The following equipment requirements and diesel consumption were determined:

Table 5 – Annual Mobile Equipment Diesel Requirements for Reject Material Disposal

Equipment	**Scenario 1 (l/a)**	**Scenario 2 (l/a)**
Track Dozer	1,533,001	260,610
Haul truck Komatzu 730 (180t)	946,080	2,059,411
994 Front end loader	788,400	-
Total	**1,887,780**	**2,320,021**

The proposed radiometric ore sorter and prescreening plant will replace the current prescreening plan and will require the input of purchased electricity. As per the Order of Magnitude study an overall electricity requirement of 4.3 MW is anticipated. Currently the existing prescreening plant uses 1,842 MWh of electricity and will be decommissioned following the construction of the new prescreening and ore sorter plant. The offset in energy use due to the replacement of the existing prescreening plant has been accounted for in the energy balance.

The provision of a further 50 personnel to operate the ore sorter, prescreening plant and transporting activities associated with the waste rock disposal site will contribute towards GHG emissions from the sewage plant. This additional source of GHG emissions is accounted for under ‘process sinks and other sources’.

The energy consumption and GHG emissions associated with the development of the ore sorter and prescreening plant are summarised in Table 6.

As seen in table 6, scenario 2 (trucking) is estimated to be a slightly better option from an energy balance perspective. Subject to whether scenario 1 or 2 is selected, the development of the ore sorter will result in an absolute increase of 29% in energy use and 22 to 23% in GHG emissions compared to 2006.

Due to the fact that the ore sorter is expected to increase the U_3O_8 production, the unit energy and GHG emissions are likely to reduce. This is considered under section 4.5.

Table 6 – Annual Energy Use and GHG Emissions for the Ore Sorter and Prescreening Plant

	Scenario 1		Scenario 2	
	Total Energy Use per annum (GJ/a)	Total Emissions per annum (t CO_2-e/a)	Total Energy Use per annum (GJ/a)	Total Emissions per annum (t CO_2-e/a)
Diesel consumption	222,830	15,685	239,471	16,856
Electricity consumption	175,306	25,760	155,952	22,916
Process sinks and other sources	0	6	0	6
Total for Ore Sorter	**398,135**	**41,451**	**395,423**	**39,779**
Transport to site[4]	0	0	0	0
Absolute % Increase from 2006	**29%**	**23%**	**29%**	**22%**

3.3 Development of the Acid Plant

The main source of energy usage and GHG emissions from the acid plant will be associated with energy consumption, i.e. the use of blowers and the provision of cooling circuits. The plant will require an electricity supply of 4.5 MW. However, as the process is exothermic, the generated heat will be converted into thermal energy in the order of 14.5 MW. Hence, the overall energy balance indicates that there is a net benefit from the acid plant.

3.3.1 Cooling Arrangement

Three options were considered with respect to the determining the optimum cooling arrangement for the acid plant and turbo generator set, namely utilising water cooling, air cooling or an advanced heat recovery system. The various cost/benefit considerations for the different options are listed below:

Water Cooling -

- This form of cooling is technically the least risky given the climatic conditions at the mine, i.e. high ambient temperatures.
- Water cooling has one of the lowest energy requirements of all three cooling options.
- It was found to be financially the least expensive option but requiring the most water.

Air Cooling -

[4] Given that diesel is obtained from Walvis Bay and railed to site, the overall contribution to GHG emissions and energy use due to its transport is insignificant. As a general rule, Rio Tinto does not quote figures below a 1000t CO_2-e. No other chemicals will be required for the ore sorter operation.

- o Air cooling has a greater capital expenditure than water cooling given that specially designed electric fans need to be utilised.
- o It has a higher power load than water cooling but consumes lower quantities of water.
- o Given the ambient temperatures at the mine, this operation was predicted to be more technologically demanding than water cooling.

Advanced Heat Recovery System (HRS) -

- o Advanced HRS is technically the most advanced of all three cooling options due to the need for very tight operational controls. Major failure would cause complete shutdown of the acid plant.
- o This technology requires 4MW of additional power.
- o It has a capital cost of US$10M.

NAMWATER has committed to providing desalinated bulk water to industrial users. All expansion options for RUL have been based on the assumption that the desalination plant will be constructed and that water will be available. Given that the desalination plant is dependent on power to operate, power is the critical aspect of the power/water discussion. Currently power availability within southern Africa is at a premium given inadequate infrastructure planning and maintenance. Therefore, when considering which of the three cooling options were to be selected, RUL gave due consideration to the process that resulted in the greatest power output, in this case water cooling.

The option of directing part of the superheated steam into the process was also considered to improve uranium recovery. This would use in the order of 3MW of the available power generating steam. Although, this would allow some recovery of water through recycling of process water, it was determined that at this stage, all of the superheated steam would be converted into thermal power. The main reasons for this decision were:

- o The technology to utilise the superheated steam within the leach process is complex and prone to operational difficulties, namely clogging of injection jets and scaling of heat exchangers.
- o Given the power crisis, the emphasis should be on utilising all the available power generating capacity within the RUL operation.

Nevertheless, the option of directing steam to the leach circuit has not been discarded and could be revisited at a later stage.

Following the review of the above options, the RUL management team determined that the optimum cooling arrangement would be water cooling due to it having the greatest power output at the lowest capital investment even though it uses the most water. It was determined that all the available superheated steam would be converted to thermal power, in this case estimated to be 14.5 MW. Given a predicted acid plant energy requirements of 4.5MW, a net power output of 10MW was estimated[5].

[5] It should be noted that 10MW is approximately one third of the current power requirements of RUL. A reduction of 10MW from the national grid due to the acid plant power output would equate to an approximate 1% increase in Namibia's installed capacity.

3.3.2 Acid Plant Energy Balance

Currently sulphuric acid is imported to site and contributes 26,116 tCO_2-e to the overall GHG emissions from transport (32,285 tCO_2-e). These values include the GHG emissions from both ship and rail transport. Given that the importation of sulphur will replace that of sulphuric acid, a revised transportation energy balance was required. Based on the design capacity of the acid plant, i.e. 150,000 t of sulphur required per annum, the importation of sulphur will result in the emission of 19,304 tCO_2-e, i.e. a 26% reduction in current GHG emissions due to the transport of sulphuric acid. The contribution of transport related GHG emissions are accounted for under 'Transport to Site'.

The acid plant will not result in an increase in U_3O_8 product. The following table provides total emissions output and energy consumption.

Table 7 – Energy Use and GHG Emissions for the Acid Plant

	Total Energy Use per annum (GJ/a)	**Total GHG Emissions per annum (t CO_2-e/a)**
Diesel consumption[6]	-	-
Electricity consumption	136080	19996
Process sinks and other sources	0	4
Electricity generation	**-438,480**	-64,432
Total for Acid Plant	**-302,400**	**-44,432**
Transport to site[7]	0	19304
% Increase from 2006	**-22%**	**-25%**

As seen from the table, the development of the acid plant will result in an absolute decrease of 22% in energy use and 25% in GHG emissions compared to 2006.

3.4 Expansion

Rio Tinto reports its GHG emissions and energy usage as a unit per tonne of product, i.e. in the case of RUL per tonne of uranium oxide (U_3O_8). The 2008 targets for determining efficiency are similarly stated as unit per tonne of product. To compare the energy consumption and GHG emissions for the expansion against 2006 values and Rio Tinto targets, the values were divided by the production of U_3O_8 for that year, i.e. 3,617 t.

The development of the ore sorter and SK4 are expected to increase the overall U_3O_8 production for the mine. These increases were included in the unit calculations, i.e. the U_3O_8 production for 2006 was increased by the respective product contributions due to SK4 or the ore sorter. The findings are noted in table 8.

[6] Diesel will be used in the start-up of the Acid Plant. However, this is likely to occur infrequently and quantities to be used are insignificant relative to the tonnages quoted. As a general rule, Rio Tinto does not quote figures below a 1000t CO_2-e.

[7] Sulphur will be transported from Daman, Arab Emirites via ship and rail to site. The total GHG emissions due this transport have been accounted for under 'transport to site'.

Table 8 – GHG Emissions and Energy Use per product for the Expansion

	SK4		Ore sorter[8]		Acid Plant		Expansion	
	E/Prod (GJ/t)	GHGe/Prod (t CO_2-e/t)	E/Prod (GJ/t)	GHGe/Prod (t CO_2-e/t)	E/Prod (GJ/t)	GHGe/Prod (t CO_2-e/t)	E/Prod (GJ/t)	GHGe/Prod (t CO_2-e/t)
Total	44	3	103	11	-84	-12	63	2
Total for 2006							378	50
Total 2006+ Expansion							441	52
Increase from 2006							17%	3%
2007 target rolled over to 2008							**297**	**43**

If the total energy consumption and GHG emissions of the individual project components for the expansion were combined, the following could be predicted:

- The development of the expansion would result in an overall unit increase of 17% in energy use and 3% in GHG emissions from 2006 values.
- The combined 2006 and expansion would equate to a total GHG emission of 52.0 t CO_2-e/t U_3O_8 and an energy use of 441 GJ/t U_3O_8.
- The most significant contributor to the increases is the ore sorter energy requirements.
- The acid plant has had a substantial offsetting effect on the overall energy balance.

The table 8 shows that energy consumption and GHG emissions achieved in 2006 were not within the Rio Tinto targets for 2008. Given that the mine plan went from a closure plan at the time the targets were set to the present situation of a mine life of 2016, exceeding the 2004 targets was expected. As shown table 8, the contribution towards energy usage and GHG emissions from the expansion is thus expected to widen the gap between current levels and Rio Tinto targets.

It should be noted that this comparison is hypothetical and limited as it is based on 2006 values. According to the approved 2016 mine plan, the mining and operational conditions are likely to be different by the time the expansion projects come on-line. Similarly, it is anticipated that the individual project components of the expansion will not come on-line within the same year. Subject to their approval, SK4 is likely to come on-line in mid 2008 and the acid plant and ore sorter in 2010.

The projected mining targets are 50 Mt for 2008 and 58 Mt for 2009 against the current 36 Mt for 2007 and a large proportion of the mined material will be associated with pioneering work. Pioneering work requires significant inputs of diesel but does not necessarily result in proportional increases in uranium oxide production. Therefore, there is a high likelihood that GHG emissions and energy use per tonne of uranium oxide will continue to increase and that Rio Tinto 2008 targets will be exceeded. On the other hand, mining of the higher grade SK4 and operation of the ore sorter will have a positive effect on product output and will contribute to offset the impacts of the expansion in respect of unit energy and GHG emission performance.

[8] The worst case with respect to energy usage was selected for the ore sorter.

4 MAJOR FINDINGS

In 2004, Rio Tinto established a five year target to reduce GHG emissions by 4% per tonne of product by 2008 (using the 2003 baseline) and to reduce energy use by 5% per tonne of product over the same period. Each Rio Tinto operation determined their individual targets based on their actual 2003 values.

RUL's 2003 baseline energy usage was 385.4GJ/ t uranium oxide (U_3O_8) and its GHG emission was 53.7t CO_2-e/t U_3O_8. The target was to reduce energy consumption by 23% and GHG emissions by 20% by the end of 2007. Although significantly higher than the overall Rio Tinto targets, the reduction targets were in line with the RUL mine plan to cease operation by the end of 2007. However, with the significant improvement in uranium prices the life of mine plan was revised.

A review of targets has been initiated by Rio Tinto for 2008 and from 2009 a new target setting process will be rolled out throughout Rio Tinto. Although a new target for 2008 has been proposed, the RUL 2007 targets remain in place for 2008 until the new targets have been approved.

The energy consumption and GHG emissions for each of the expansion projects have been estimated and compared against the energy balance determined for 2006 (Table 9). Although production will increase from 2006 by the time these projects come on-line, it was decided that the 2006 energy balance would form the base case for comparison given that it was the latest data formally completed and submitted to Rio Tinto. The increases in U_3O_8 production due to the development of SK4 and the ore sorter have been included in the total tonnes product. The acid plant will not lead to overall increase in U_3O_8 product.

Table 9 – GHG Emissions and Energy Use per product for the Expansion Projects

	SK4		**Ore sorter**		**Acid Plant**		**Expansion**	
	E/Prod (GJ/t)	**GHGe/Prod (t CO_2-e/t)**	**E/Prod (GJ/t)**	**GHGe/Prod (t CO_2-e/t)**	**E/Prod (GJ/t)**	**GHGe/Prod (t CO_2-e/t)**	**E/Prod (GJ/t)**	**GHGe/Prod (t CO_2-e/t)**
Total	44	3	103	11	-84	-12	63	2
Total for 2006							378	50
Total 2006+ Expansion							441	52
Increase from 2006							17%	3%
2007 target rolled over to 2008							**297**	**43**

This evaluation shows that energy consumption and GHG emissions for 2006 were higher than the Rio Tinto targets for 2008. Given that the mine plan went from a closure plan at the time the targets were set to the present situation of a mine life in excess of 2020, exceeding the targets was expected. In addition, the inclusion of the cumulative expansion energy consumption and GHG emissions is expected to widen the gap between current levels and the Rio Tinto targets.

The study found that the most significant contributor to the increase was the ore sorter energy requirements. The acid plant, on the other hand, due to its power generating capacity was shown to have a substantial offsetting effect on the overall energy balance and the outcomes and impacts of the expansion could have been significantly different if it had not been for this effect. In addition, the mining of the higher grade SK4 and operation of the ore sorter will have a positive effect on U_3O_8 product output and will contribute to offset the impacts of the expansion in respect of unit energy and GHG emission performance.

The two options for waste rock removal for the ore sorter (conveying or trucking) were examined from an energy balance perspective and Scenario 2 (trucking) proved the marginally better option. However, given further revision during the detailed design process, these findings may change and it is recommended that the energy balance be revisited to ensure that the most energy efficient waste rock handling scenario is considered in the final design.

5 RECOMMENDED ACTIONS

Exceeding the RUL 2008 targets due to the expansion projects was predicted given that the targets were based on a closure scenario for the mine. Nevertheless, ongoing measures are being investigated by RUL to reduce energy consumption and GHG emissions in line with its policies and standards.

5.1 Current RUL Management Actions

RUL is still pursuing the achievement of its 2008 targets within the current implementation of the life of mine extension[9]. As a result, there are a number of challenges that RUL is facing to achieve these targets and these include:

- Finding new ways to reduce energy consumption and GHG emissions;
- Achieving reductions within an environment of increased mining activity and production;
- Ensuring that energy use and GHG considerations are taken into account during all aspects of business during a time of expansion; and
- Providing for a changing electricity supply environment which could result in significant changes to the way RUL is able to manage its energy use and would result in a modification to the energy balance calculations.

A number of actions have been developed by the RUL HSE Sustainable Development Department to deal with these challenges and they include:

- Undertaking a Climate Change Risk Assessment as per Rio Tinto guidelines;
- Following up with an Energy Efficiency Review at RUL;
- Preparing an awareness training module laid out in layman’s terms to ensure all levels of staff understand the message;
- Using the module to train both employees and contractors; and
- Continuing with projects previously identified, namely:
    - Investigate the use of chemical additives to fuel to reduce overall consumption.
    - Upgrade an 11kV ring power supply to reduce downtime of pit equipment.
    - Include energy considerations during purchasing of mine equipment.

5.2 Expansion Actions

In conjunction with the initiatives noted above, a number of additional actions are recommended to reduce the likely energy use and GHG emissions associated with the expansion.

Due consideration should be given to the use of renewable energy sources and improvements in the way individuals and departments operate with respect to energy use. RUL intends undertaking

[9] Achmet Abrahams – Superintendent Environmental Technical Support - personal communication February 2008.

workshops to 'brain storm' ways of reducing energy use and promoting energy conservation awareness[10]. Such measures are likely to stimulate innovation and the development of initiatives that could result in reductions in energy use.

Given that diesel usage forms a significant component of energy consumption and GHG emissions, any measure to reduce its consumption is likely to have a positive effect on the energy balance. Measures that should be considered are:

- Use of energy efficient motors in haulage trucks;
- Promote energy efficiency through training and awareness campaigns, e.g. recommend that trucks and support vehicles are switched off when idle.

Given the two scenarios of the Ore Sorter design for waste rock removal (see section 4.2), it is recommended that further review of the ore sorter energy balance be undertaken during the finalisation stage of the design to:

- Update the balance with any new values; and
- Ensure that the most energy efficient waste rock handling scenario is considered in the final design.

For the acid plant, RUL has reviewed in detail a range of options to ensure that best energy versus cost design for the acid plant was obtained, in line with their goal to implement 'best practice design'[11]. The technology that has been adopted includes:

- Use of a variable speed drives on the main blowers to allow for changes in production demands;
- Choice of water cooling over the more energy intensive air cooling.

[10] Achmet Abrahams – Superintendent Environmental Technical Support - personal communication February 2008.

[11] Dave Garrard – Acid Plant Project Manager, RU – personal communication February 2008

APPENDIX 1

RIO TINTO GREENHOUSE GAS AND ENERGY USE STANDARD