Energy Balance for Phase I Expansion

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

Rössing Uranium Limited

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1. Project Background

Rössing Uranium Limited (RUL) would like to expand its operations beyond the previously agreed 2016 closure plan. Given the significant increase in uranium prices over the last few years, RUL is considering a 2026 mine plan. As part of the proposed Phase 1 expansion, RUL has commissioned a Social and Environmental Impact Assessment (SEIA) investigating the possible implementation of three projects, namely:

- A sulphuric acid plant with associated storage and transport of sulphur;
- A radiometric ore sorter 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 Greenhouse gas (GHG) emissions and energy usage of the proposed Phase 1 expansion projects. The findings will be included and assessed as part of the SEIA.

2. Rio Tinto Energy Use and GHG emissions

2.1 Rio Tinto and Rössing Uranium Limited

Rio Tinto, RUL's parent company, is a signatory to a number of international projects to reduce global Greenhouse Gas emissions, including the Carbon Disclosure Project. In addition a range of standards and policies have been put into place by Rio Tinto to reduce GHG emissions and energy usage and all Rio Tinto operations, including RUL, are committed to adopting and maintaining these standards.

2.2 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. These issues 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.

2.3 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 findings in 2006 for the entire Rio Tinto group were as follows:

- Total GHG emissions from Rio Tinto operations was 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. No emissions of SF_6 or HFCs were reported.
- 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. Forty percent of energy used in 2006 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 nuclear primary energy than the international average.
- It is worth noting that RUL is an insignificant contributor of GHG emissions and energy usage to the over Rio Tinto group (0.0002% of total GHG emissions can be attributed to RUL operation).

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 makes up 92% of the inventory and methane emissions, predominately from coal seam gas, contributed a further 7%.

3. RUL Uranium Energy Use and GHG emissions

Group performance targets for greenhouse gas 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.

3.1 RUL Uranium Targets

For RUL, the baseline GHG emission of 53.7t CO2-e/t U_3O_8 was established using actual emissions data from 2003. Based on this value, energy and GHG emission targets were set in 2003, and approved in 2004. The target was to reduce energy consumption by 23% and GHG emissions by 20% by the end of 2007. Although the Rio Tinto targets were set for a 5 year period, Rössing's targets were set for the end of the operational period, anticipated to be end of 2007. However, with the life of mine being extended, the target was rolled over to 2008.

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

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

Table 1 – Annual Total GHG Emissions and Energy Usage

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

The following aspects might influence the achievement of the end 2007 target:

- 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.
- Increase in number of mining equipment purchased and used on site, i.e. shovels, drills, haul trucks etc.
- Increase in haulage distances from increased depth of the open pit.
- Mining of low grade ore affecting the 2007 production target and therefore influencing the per unit of U production performance negatively.

All these factors were not included in the target setting in 2004 as the original mine plan was to close the RUL operation by end 2007. Given the increases in uranium price, the mine plan was significantly revised subsequently and given that energy use and GHG emission levels would significantly increase, it was predicted that these targets could not be met.

3.2 Revision of RUL Uranium Targets

A review of targets was requested 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.

3.3 Implementation and Monitoring of Targets

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.

4. Energy Use and GHG emissions from Phase I Expansion

The GHG emissions and energy usage for each of the projects within the Phase I expansion have been calculated. These values have been compared against the energy balance determined for 2006. 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 is the latest data formally completed and submitted to Rio Tinto.

4.1 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. However, the current mining of low grade ore from these areas and the placement of this material onto waste rock stockpiles will continue. This is it 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 trolley assist and no provision of electricity to the SK4 area, the main energy consumer will be associated with fuel usage. The following is a list of proposed vehicles that will be used:

Table 2 – Mobile Equipment Requirements for SK4

Equipment	Fuel Diesel (D) Petrol (P)	Utilisation (%)	Units	Fuel (l/h)	24 hour operation	Total fuel usage per annum (l/a)
994 Front end loader	D	50	1	180	2160	788400
Blast Hole Drill (pit viper)	D	85	1	72	1469	536112
Haul truck Kamatzu 730 (180t)	D	85	2	180	7344	2680560
Track dozer	D	85	1	35	714	260610
Grader	D	10	1	21	50	18396
Tyre dozer	D	85	1	25	510	186150
Wheel dozer 926	D	10	1	20	48	17520
Support vehicles	P	50	2	15	360	131400

Diesel is consumed in the makeup of explosives and it is anticipated that 4600 t of explosives per annum will be used. 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'. The GHG emissions and energy use associated with the development of SK4 are summarised in the following table.

Table 3 - Annual GHG Emissions and Energy Use for SK4

	Total Emissions per annum (t CO_2-e/a)	Total Energy per annum (GJ/a)
Diesel consumption	12463	177351
Electricity consumption	0	0
Process sinks & other sources	822	0

Total forSK4	**12463**	**177351**
Transport to site	0	0
% Increase from 2006	**7%**	**13%**

As seen from the table, the development of SK4 will result in a 7% increase in GHG emissions and a 13% increase in energy use compared to 2006.

4.2 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 ore sorter and prescreening plant will require the input of purchased electricity. As per the Order of Magnitude study for the ore sorter plant, an overall electricity requirement of 4.3 MW for the plant is anticipated. Currently the prescreening plant uses 1,842 MWh of electricity and will be decommissioned following the construction of the new prescreening and ore sorter plant. The change in energy requirements due to this replacement have been accounted for in the energy balance.

The method of transporting reject material to the waste rock disposal site is still under consideration and two scenarios were considered, 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 requirements for the conveyor are 0.64 MW. Anticipated cycle time is 20 minutes.

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 usage was assumed i.e. the furtherest waste rock disposal site, Waste Dump 5 with an anticipated cycle time of 37 minutes.

The following equipment usage and diesel consumption were determined:

Table 4 – Annual Mobile Equipment Diesel Requirements for Reject Material Disposal

Equipment	Scenario 1 (l/a)	Scenario 2 (l/a)
Track Dozer	1533001	260610
Haul truck Kamatzu 730 (180t)	946080	2316838
994 Front end loader	788400	-
Total	**1887780**	**2577448**

The provision of a further 50 personnel to operate the ore sorter, prescreening plants and the 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 GHG emissions and energy use associated with the development of the ore sorter are summarised in the following table.

Table 5 – Annual GHG Emissions and Energy Use for the Ore Sorter Plant

	Scenario 1		Scenario 2	
	Total Emissions per annum (t CO_2-e/a)	**Total Energy per annum (GJ/a)**	**Total Emissions per annum (t CO_2-e/a)**	**Total Energy per annum (GJ/a)**
Diesel consumption	5116	72680	6985	99232

Electricity consumption	21951	149386	19107	130032
Process sinks and other sources	6	0	6	0
Total for Ore Sorter	**27074**	**222065**	**26099**	**229264**
Transport to site	0	0	0	0
% Increase from 2006	**15%**	**16%**	**14%**	**17%**

As seen from the table, subject to whether scenario 1 or 2 is selected the development of the ore sorter will result in a 14 to 15% increase in GHG emissions and a 16 to 17% increase in energy use compared to 2006.

4.3 Development of the Acid Plant

The main source of GHG emissions from the acid plant is associated with its energy usage. 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 11.8 MW. Hence the overall energy balance indicates that there is a net benefit from the acid plant. The following table provides total emissions and energy usage.

Table 6 - GHG Emissions and Energy Use for the Acid Plant

	Total Emissions per annum ($t\ CO_2$-e/a)	**Total Energy per annum (GJ/a)**
Diesel consumption[1]	-	-
Electricity consumption	19996	136080
Process sinks and other sources	4	0
Electricity generation	52434	356832
Total for Acid Plant	**-32434**	**-220752**
Transport to site	19304	0
% Increase from 2006	**-18%**	**-16%**

As seen from the table, the development of the acid plant will result in an 18% decrease in GHG emissions and a 16% decrease in energy use compared to 2006.

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.

4.4 Phase I 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. The 2008 targets for determining efficiency are similarly stated as unit per tonne of product. To compare the GHG emissions and energy usage for the Phase 1 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 findings are noted in the following table.

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[1] 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 CO2-e.

Table 7 – GHG Emissions and Energy Use per product for the Phase I Expansion

	SK4		Ore sorter[2]		Acid Plant		Phase 1 Expansion	
	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)	E/Prod (GJ/t)
Total	4	46	7	63	-9	-61	**2**	**51**
Total for 2006							**50**	**378**
Increase from 2006							**4%**	**14%**
Total 2006+Phase I Expansion							**52**	**429**
2007 target rolled over to 2008							**43**	**296.8**

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

- o The development of the Phase 1 projects would result in an increase in GHG emissions of 4% and energy usage increase of 14% from 2006 values.
- o The most significant contributor to the increases is the ore sorter energy requirements.
- o The combined 2006 and Phase 1 expansion would equate to a total GHG emission of 52.0 t CO2-e/t U_3O_8 and an energy usage of 429 GJ/t U_3O_8.

This evaluation shows that the GHG emissions and energy usage achieved in 2006 were within the Rio Tinto targets for 2008. However, the inclusion of the GHG emissions and energy usage of the proposed expansion with 2006 is likely to result in Rio Tinto targets being exceeded.

It should be noted however 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 Phase I expansion projects come on-line. Similarly, it is anticipated that the individual project components of the Phase I expansion will not come on-line within the same year. Subject to the individual projects obtaining financial approval, SK4 is likely to come on-line in mid 2009 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 very good likelihood that GHG emissions and energy usage per tonne of uranium oxide will continue to increase and that Rio Tinto 2008/2009 targets will be exceeded. On the other hand, mining of SK4 will have a positive effect on product output and might contribute to offset the impacts of the expansion in respect of unit energy and GHG performance.

RUL will continue to investigate and implement measures to reduce GHG emissions and energy usage in line with its policies and standards.

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