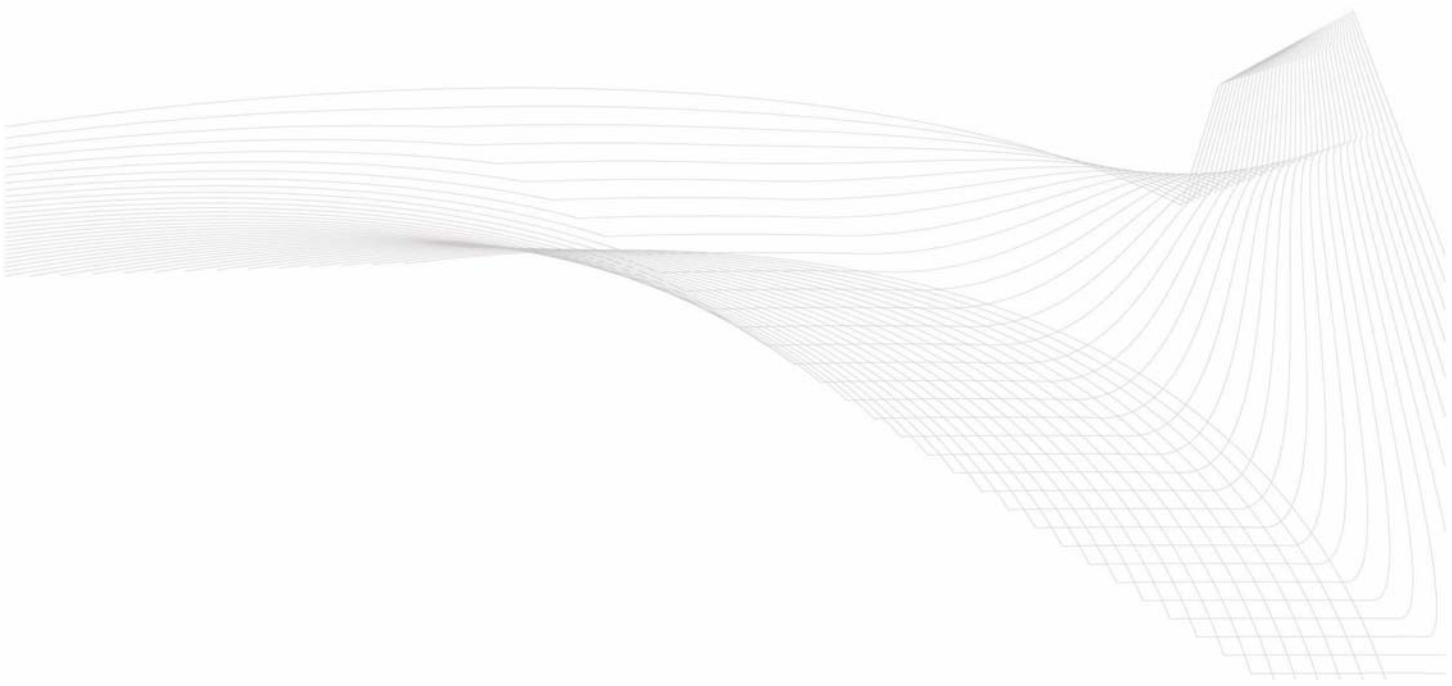
Abel Mine Energy Savings Action Plan

Donaldson Coal



Abel Mine Energy Savings Action Plan

Donaldson Coal

Prepared For:

Donaldson Coal

PO Box 2275,
Greenhills 2323

Contact:

Phillip Brown

Environment Manager
Telephone: 0439 909 952
Email: phil@doncoal.com.au

Prepared By:

Advitech Pty Limited

1 Elizabeth Street, Tighes Hill NSW 2297
PO Box 207, Mayfield NSW 2304
Telephone: 02 4961 6544
Facsimile: 02 4969 3530
Email: mail@advitech.com.au
Web: www.advitech.com.au

Report Details:

File Name: 6208 Abel Mine DOP ESAP rev i.doc

This report has been prepared and collated by:

December 2007

Jim Kelty — **Date**
Senior Consultant

This report has been checked and authorised by:

December 2007

Steven Smith — **Date**
General Manager

Job No: 6464
Folder No: 6208
Draft Report
December 2007

EXECUTIVE SUMMARY

The Abel Mine currently under construction at Black Hill will use a substantial amount of energy in the production of black coal using the bord and pillar method with secondary extraction. Preparing an Energy Saving Action Plan (ESAP) for a green-fields site where the detailed design and equipment selection has not been finalised in many areas has proved somewhat difficult. However it has given Donaldson Coal the opportunity to specify equipment, designs and procedures that are cost effective and energy efficient from day one.

This report is a summary of a more detailed analysis which has attempted to audit the proposed equipment and processes to identify potential improvements in energy performance. Electricity is by far the largest energy source.

A significant number of opportunities have been identified and analysed for cost effectiveness.

A number of difficulties were encountered in obtaining information due to the site still being some months away from commencement. Actual data from Donaldson Coal's Tasman Mine was analysed in order to try to estimate future baseline energy use and KPI's for the much larger Abel Mine. Lessons learned regarding energy efficiency issues from opening and operating the Tasman Mine have also been incorporated into the planning of the Abel Mine. This includes the recommendation to measure energy inputs by sub-metering of the major processes.

The Management Review revealed a number of areas where Donaldson Coal could improve the organisation's energy management system (EMS) including the proposed EMS for the Abel Mine. An improved EMS should also benefit other Donaldson Coal sites.

The obvious commitment of Senior Management to the review process bodes well for a successful process of implementation leading to significant benefits to Abel Mine, both commercially and environmentally.

Unfortunately at the time of writing this report (December 2007) the Abel Mine construction has been placed on hold and an actual commencement date is unknown. Hence many of the opportunities identified cannot be progressed and the completion dates for management's agreed actions will be dependent on an actual commencement of production.

TABLE OF CONTENTS

APPENDICES

1. INTRODUCTION

Advitech Pty Limited was engaged by Donaldson Coal to prepare an Energy Saving Action Plan (ESAP) for the proposed Abel Mine at Black Hill, NSW as directed by the Director General of the NSW Department of Planning (DoP).

The mine will have a production capacity of approximately 4.5 million tonnes of coal per annum over 20 years. All underground mining south of John Renshaw Drive will use continuous miners with secondary extraction and coal will be transported to the Bloomfield Coal Preparation Plant.

It should be noted that this report does not cover transportation of coal to the Bloomfield Coal Preparation plant or the upgrading of this plant.

Advitech have audited the proposed gas and electricity systems using the guidelines and templates recommended by the NSW Department of Environment and Climate Change (DECC). The findings and recommendations for energy reductions are summarised in this report. Advitech sub-contracted Specialty Air to assist in some areas.

The objectives of the ESAP are to:

- Ensure compliance with the project approval conditions;
- Reduce the mine's greenhouse gas emissions; and
- Ensure annual reporting of greenhouse gas emissions and tracking of energy saving opportunities.

It should be noted that this report was prepared by Advitech Pty Limited for Donaldson Coal ("the customer") in accordance with the scope of work and specific requirements agreed between Advitech and the customer. This report was prepared with background information, terms of reference and assumptions agreed with the customer. The report is not intended for use by any other individual or organisation and as such, Advitech will not accept liability for use of the information contained in this report, other than that which was intended at the time of writing.

2. METHODOLOGY

Site visits were conducted by Advitech on 14th, 22nd and 24th of August 2007 involving management team meetings and inspections of the equipment and electricity system at the nearby Tasman Mine. Proposed equipment lists and specifications were examined for usefulness in providing energy-related data. Information was also obtained from company management and operational personnel regarding the policies and procedures to be implemented.

3. BASELINE ENERGY USE

A baseline energy audit is normally undertaken as part of the Energy Savings Action Plan. This was unable to be undertaken as the Abel Underground Mine is a green-field's site. The Company proposes to undertake a Base Line Energy Audit following twelve months normal operation of the underground mine.

4. MANAGEMENT REVIEW

4.1 DEUS Management Team Review Template

A facilitated management meeting was held on 14 August 2007 at the Donaldson Coal head office.

The management team used the DEUS ESAP template to rate various categories of current energy management performance for the Donaldson Coal organisation as a whole. Rating the Abel Mine management team specifically was not possible as the team is yet to be finalised.

As can be seen in Appendix 1, the current energy management performance is generally in the moderate category with "informal management systems" the normal practice.

Compliance with legal and/or regulatory requirements was not scored as the Abel Mine has not commenced construction. The team did note that Donaldson Coal as a group had an excellent track record in this area to date.

Actions to improve the Donaldson Coal group's general energy management performance are noted in Table 1 which again is based on the DEUS ESAP template.

It will not be possible to commence some actions until the mine has commenced production (scheduled for Feb 2008) and many actions will not be able to be completed for another 12 months when the mine is operating at a reasonable production level.

Donaldson Coal management is committed to achieving level 3 compliance (Minimum Sustainable) within two years of commissioning the mine by following the action plan detailed in Table 1 below.

Prior to this date Donaldson Coal aim to undertake an audit on actual energy usage for the Abel mine following twelve months of normal operations to verify if the opportunities already identified have been implemented and are effective and to look for further energy saving opportunities.

Table 1: Energy Management Actions (DEUS Template 3) for Abel Mine

Energy Management Action	Management Review Area	Responsibility	Start Date	Completion Date
Formalise an energy management program that details objectives and targets	Senior Management Commitment	Mine Manager	01 Sep 07	01 April 09
Report annually on progress with energy management program (EMP) to DoP as part of Annual Environment Management Report	Senior Management Commitment	Environment Manager	01 Sep 07	01 April 09
Appoint person to be responsible for coordinating EMP	Accountabilities for energy management	Mine Manager	01 Sep 07	01 April 09
Appoint energy manager to prepare and implement a training program	Training and awareness procedures	Environment Manager	01 Sep 07	01 April 09
Document operating and maintenance procedures to ensure that energy usage is a factor when scheduling decisions are made	Operating and maintenance procedures	Mine Manager	01 Sep 07	01 April 09
Review current energy procurement procedure to ensure that request for prices includes energy management initiatives	Energy supply management	Mine Manager	01 Sep 07	01 April 09
Ensure that equipment purchasing procedures comply with the company energy management policy	Energy supply management	Purchasing Officer	01 Sep 07	01 April 09
Achieve Minimum Sustainable reporting level by 12 months from commencement	Energy management reporting	Financial Controller	01 Feb 08	01 April 09
Target is to achieve Informal Management Practice level within 6 months from commencement then achieve Minimum Sustainable level within 12 months of commencement	Energy targets and key performance indicators	Manager Electrical Engineering	01 Feb 08	01 April 09
Instigate an energy audit after 12 months of operation to determine actual consumptions and savings potentials	Understand energy saving potential	Manager Electrical Engineering	01 Feb 08	01 April 09
Maintain organisation's current excellent compliance record	Compliance with legal and regulatory	Environment Manager	01 Sep 07	01 April 09

Notes to Table 1: The completion dates are all dependent on the mine commencing operation in March 2008. At the time of writing the report the project has been placed on hold and an actual commencement date is unknown. Responsibilities may be changed by the operation at any time.

4.2 Development of an Energy Savings Culture

4.2.1 Present Culture

The present corporate culture at Donaldson Coal embodies a strong focus on production, safety and environmental management. This is highly commendable, but this can be in conflict with energy efficiency which tends to be a "hidden cost". Lack of awareness and a strong motivation to restore or maintain maximum production can mean that energy saving (or even maintaining energy efficiency) opportunities are missed or are given such a low priority that the issue is "forgotten" over time.

There is no doubt that energy efficiency comes at a cost - both in time as well as money. Targeted actions can and should bring attractive commercial returns and staff play an important role in identifying and practicing energy efficiency.

4.2.2 Development of an Energy Management System

Energy management should preferably be incorporated into existing quality, environmental and OH&S systems. Donaldson Coal currently operate an ISO 14001 environmental management system and energy management can readily be built into the key objectives and criteria of this system. The overall objective is to understand and gain control over the use of energy. The system will consist of a number of planned actions to achieve this objective.

4.2.3 Energy Management Reporting

Advitech's interviews with the management team have provided ample evidence of commitment and understanding. In most cases (as demonstrated by Template No 2 of the DEUS ESAP) this is put into practice informally. To some extent, as noted above, the focus on getting the mine into production dominates the corporate culture and future reporting systems have not yet been defined.

The most obvious cause of lack of focus on energy efficiency in any organisation is the difficulty in detecting any change in energy performance particularly when there are changes to production levels. The only solution to this difficulty is to put in place an effective energy reporting system.

Such a system should produce timely, targeted reports to each level of the organisation as well as to external stakeholders. To this end, a significant amount of effort has gone into preparing an effective foundation for reporting electricity usage – by far the most significant energy input at Abel Mine. When this is coupled to an effective SCADA monitoring and control system in the future, efficiency levels could be continuously monitored via the SCADA system and management reports will be facilitated.

These reports will provide verification for actions taken as part of this review and will enable more accurate assessment of longer term energy saving proposals.

4.2.4 Appointment of an Energy Manager

Donaldson Coal will spend approximately $4 to 5 million pa. on electricity for the Abel Mine alone when it is in full production in coming years. An effective Energy Management System has the capacity to influence downwards both quantity and cost. To ensure success, the system needs a Coordinator or Energy Manager. The role would be to manage current energy needs and to develop a future strategy embracing opportunities to improve energy performance. The role would involve communication with management, staff and external stakeholders as well as project management of the opportunities identified in this Review.

The role can be assigned to more than one person, but experience has demonstrated that the best results are achieved when a person is clearly accountable and given clear objectives and adequate resources.

5. TECHNICAL REVIEW

The Technical Review document is appended to this report. It should be noted that this review has been undertaken in line with the Abel Underground Mine being a green-field's site. The Technical Review has been formulated on the Company's experience with the Tasman Mine (a smaller underground mining operation).

The following table lists opportunities that were identified during the Technical Review and at a brainstorming workshop conducted with Donaldson Coal representatives.

Table 2: Energy Opportunities for Abel Mine

Area	Opportunity	Responsible Officer	Completion Date
Bulk Electricity Supply	Investigate purchase rather than hire of diesel generator sets for future safety and financial reasons.	Mine Manager	01 April 2008
Cost of Supply	As part of energy supply negotiations consider purchase of electricity for both Tasman and Abel underground mines from suppliers who can offer assistance with Donaldson's energy management program.	Mine Manager	01 July 2008
Transformer Efficiency	Investigate the efficiencies of the specified transformers and look at cost/benefits of upgraded equipment. Select transformers that offer the highest efficiency for a reasonable cost.	Mine Manager	01 April 2008
Power Factor Correction	Install appropriately sized power factor correction equipment to achieve a power factor of 0.95 (minimum 0.9).	Manager Electrical Engineering	01 April 2008
Typical Peak Day Load Profiles	Maximise production during the off peak electricity hours and avoid operating during peak afternoon NSW system load periods.	Manager Mechanical Engineering	01 April 2009
Underground Machinery	Conduct an energy awareness program for underground staff to reinforce the need to shut down equipment that is not in use.	Manager Electrical Engineering	01 April 2009
Conveyor Systems	A SCADA system that has the capacity to monitor and remotely control underground conveyors and other equipment will be installed and could be used to identify unloaded equipment and shut them down when safe and practical to do so.	Manager Electrical Engineering	01 April 2008
Water Pumping	Investigate recycling of underground water for continuous miner sprays at Abel mine. The practicality of this opportunity cannot be established until management gain experience with actual water ingress flow rates.	Manager Mechanical Engineering	01 April 2009
Hot Water Supply to Bath House	Investigate the installation of heat pump hot water systems instead of standard electric hot water systems. As the bath house will consist of hired relocatable buildings for the first 12 months it would not be practical to install high efficiency equipment until a permanent facility has been established.	Manager Mechanical Engineering	01 April 2009
Heating of Bath House	Investigate the installation of heat pump air conditioning systems boosted by gas heaters instead of standard electric heaters and incorporate timers and/or control systems. As the bath house will consist of hired relocatable buildings for the first 12 months it would not be practical to install high efficiency equipment until a permanent facility has been established.	Manager Mechanical Engineering	01 April 2009
Surface Facility Lighting	Install high efficiency lights with photo-sensors and timers.	Manager Electrical Engineering	01 April 2009
AC Variable Speed Drives (VSDs)	The investigation and analysis of potential applications of variable speed drives should be continued.	Manager Mechanical Engineering	01 April 2009

Area	Opportunity	Responsible Officer	Completion Date
Heat Recovery from Air Compressors	Investigate the practicality of reclaiming waste heat from the air compressors to provide hot water and heating for the surface facilities once the type and location of the air compressors is known and the permanent surface facilities are established.	Manager Mechanical Engineering	01 April 2009
Compressed Air	Investigate further cost/benefits of single stage VSD versus two stage air compressors depending on projected mine air consumption.	Manager Mechanical Engineering	01 April 2008
Data Restraints	Abel Mine management develop an energy reporting format which can be incorporated into the management reporting system enabling both maintenance of existing levels of efficiency **and** verification of improvements through energy savings initiatives.	Mine Manager	01 April 2009
Energy Data	To be able to allocate total energy consumption to major pieces of equipment or facilities will require sub-metering of electricity at various points around the site. Advitech have recommended a number of proposed locations for sub-metering including surface and underground facilities.	Mine Manager	01 April 2009
Development of Energy KPI	Following twelve months of operation, Abel Management will develop Key Performance Indicators (KPI) as a reporting tool for measuring energy efficiency	Mine Manager	01 April 2009

Notes to Table 2:

1. The completion dates are all dependent on the mine commencing operation in March 2008. At the time of writing the report (December 2007) the project has been placed on hold and an actual commencement date is unknown.
2. Until a firm commencement date has been set all ordering of equipment and investigations have been suspended and hence many of the actions above cannot be completed.

6. RECOMMENDATIONS

6.1 Energy Saving Action Plan

Donaldson Coal management have committed to investigate each of the opportunities identified in this report. Many are already in progress as part of the normal process of selecting the best equipment for the project. Other items such as staff training and investigation of underground water recycling cannot be commenced until the mine starts operating.

Progress on actioning of these opportunities will be reported in the first Annual Environment Management Report (AEMR).

Progressing these opportunities listed in Table 2 is in addition to, and will be enhanced by, establishing an energy management program as detailed by the actions and responsibilities listed in Table 1.

6.2 Greenhouse Reporting

The DoP Consent Condition requires Donaldson Coal to report annually in the AEMR the total amount of greenhouse gas emissions from the Abel Mine and the effectiveness of the measures implemented under the ESAP.

The Environment Manager has the responsibility to "report annually on progress with the energy management program (EMP) to DoP as part of Annual Environment Management Report"

The reporting of the effectiveness of measures implemented under the ESAP will be greatly enhanced by the installation of sub-metering systems, SCADA monitoring systems, monthly reporting of energy KPI and other initiatives proposed in this ESAP.

7. CONCLUSION

Advitech Pty Limited has prepared a first pass Energy Savings Action Plan for the green-field's site – Abel Underground Mine.

The review has identified a number of areas that can be implemented by Donaldson Coal initially which would give benefits both financial and environmentally and areas that may give future benefits.

The report also identifies Management's commitment to undertake an audit following twelve months of operation of the Abel Underground Mine.

8. REFERENCES

The following information was used in the preparation of this report:

1. Department of Energy Utilities and Sustainability (DEUS), 2006, Guidelines for Energy Saving Action Plans.
2. Templates, tools and conversion factors provided by DEUS (now incorporated in the Department of Environment and Climate Change – DECC)
3. Rheem Hot Water Manual, 1997

Appendix I

Energy Management Review-14 August 2007

Organisation: Donaldson Coal Pty Ltd

Site: Abel Mine - Black Hill

Management Team

Phillip Brown	Environment Manager
Mansell Williams	Manager Electrical Engineering
Ross Middleton	Manager Mechanical Engineering
Mark McPherson	Project Manager, Abel Mine

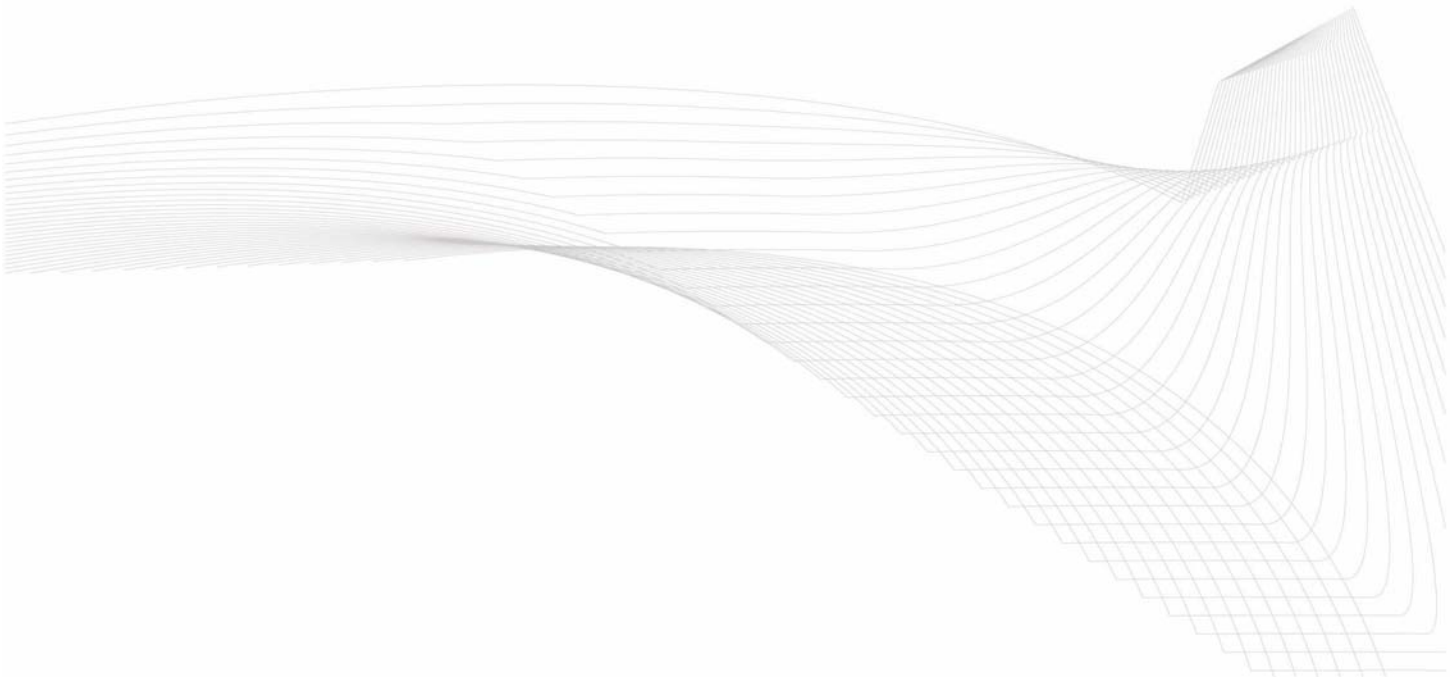
Key Areas

		Low	Moderate	Minimum Sustainable	Industry Leader	Best Practice
A	Senior management Commitment		**X**			
B	Understanding of energy savings potential			**X**		
C	Energy targets and key performance indicators	**X**				
D	Energy metering and monitoring	**X**				
E	Energy management reporting	**X**				
F	Energy supply management		**X**			
G	Operating and maintenance procedures		**X**			
H	Accountabilities for energy management		**X**			
I	Training and awareness procedures		**X**			
J	Compliance with legal and/or regulatory requirements			**X**		

Figure 1: Energy Management Review (DEUS Template 2)

Appendix II

Technical Review



TECHNICAL REVIEW

1. Bulk Electricity Supply

Electricity supply to the Abel Mine will be initially provided by diesel generators until a dedicated customer power line (DCPL) high voltage supply is connected by Energy Australia. The permanent 33 kV/ 11 kV switchyard and metering enclosure will be located on John Renshaw Drive. The 33 kV substation will be owned by Donaldson Coal and the metering is proposed to be located on the high voltage side of the main transformer.

Given that up to 2 MVA of diesel generating capacity will be required for up to 3 months until grid connection is arranged, it may be worth investigating the purchase of diesel generator sets which could be used in future as standby power for running essential equipment such as ventilation fans during prolonged blackouts and for voluntary load shedding during times of high NSW pool prices.

Capital off-sets could be obtained by avoiding the cost of hire of generators and also by avoiding the cost of buying a standby diesel fire fighting water pump engine.

Opportunity: Investigate purchase rather than hire of diesel generator sets for future safety and financial reasons.

2. Cost of Supply

Supply costs consist of two major parts: network or delivery charges which are regulated, and energy charges which are competitively sourced from the market. Wholesale contract electricity price volatility has increased by an order of magnitude since January 2007 and NSW contract electricity prices have increased markedly.

At the time of preparing this report, future retail contract prices are pointing to an increase of approximately 21% in electricity prices compared to the current Tasman Mine contract price. Given that the Abel Mine's price has not been locked in, Advitech has used an average projected price for Calendar Year 2008 of 9 c/kWh (excluding GST but including all network and market charges), for all cost and payback calculations.

3. Internal Supply Arrangement

The incoming supply will be transformed to 11 kV for distribution around the site by means of one 33/11kV transformer. This transformer is rated at 10-12.5 MVA. The 11 kV distribution system will feed twenty smaller substation transformers with output ratings from 2 MVA to 750 kVA at either 1 KV or 415 V.

4. Transformer Efficiency

Although there are minimum standards for the efficiency of new transformers it is known that there is a wide range in efficiencies within some manufacturer's ranges and between manufacturers. The evaluation method for determining the optimum transformer for a job will depend on the shape of the customer load i.e. percentage of time at various load levels.

Opportunity: Investigate the efficiencies of the specified transformers and look at cost/benefits of upgraded equipment.

5. Power Factor Correction

The Abel Mine will have power factor correction equipment fitted from commencement which will aim to achieve a power factor of 0.95 (0.9 minimum). Management will investigate the possibility of relocating the oversized Tasman Mine power factor correction equipment to the Abel site to reduce costs and achieve improved power factor at Tasman by installing equipment better suited to the current loads.

6. Typical Peak Day Load Profiles

The Abel Mine is expected to operate in a similar fashion to the Tasman Mine ie. 24 hours per day for seven to ten day cycles separated by a 24 hour maintenance shutdown. Additional maintenance shutdowns regularly occur on two afternoon shifts per week - generally Mondays and Thursdays. This pattern was chosen to maximise production during the off peak electricity hours and avoid operating during peak afternoon NSW system load periods.

A typical peak operating day load profile for the Tasman Mine is shown below. Abel Mine is expected to have a similar but flatter profile as more mining equipment will mean less impact of starting and stopping of individual continuous miners and shuttle cars.

As can be observed, the load is relatively flat during production periods with little variation expected between winter and summer.

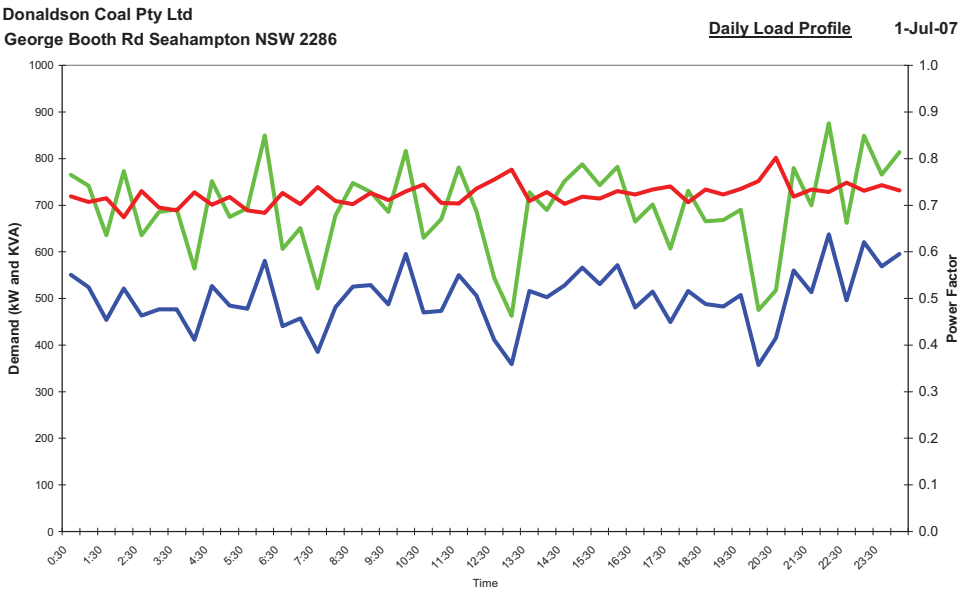


Figure 1: Typical Daily Load Profile

kW demand is shown in blue kVA demand is shown in green Power factor is shown in red

7. Major Plant Items

Figure 2 shows the expected break up of electricity use according to the maximum demand rating of the proposed equipment.

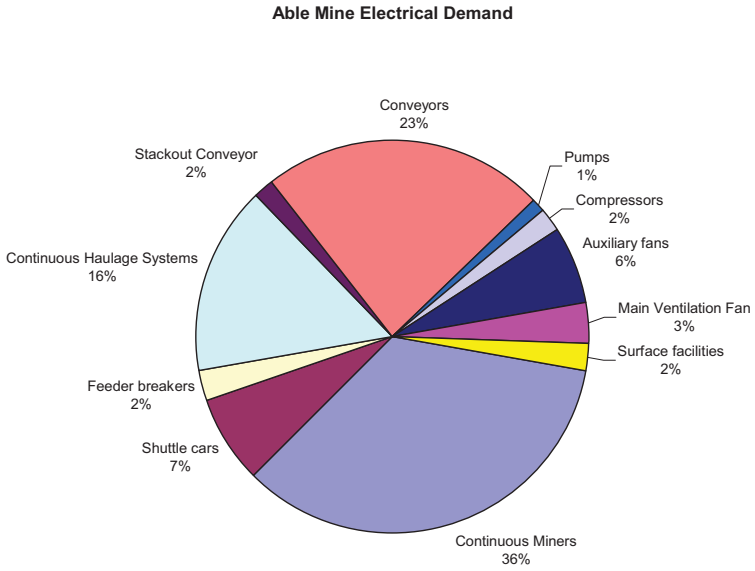


Figure 2: Abel Mine Electrical Demand by Equipment

8. Underground Machinery

The majority of the sites energy consumption will be in the underground equipment. Unfortunately there appears to be little opportunity for energy reductions in the main mining equipment such as the continuous miners, shuttle cars, auxiliary fans and feeder breakers. These will be the latest technology specialist equipment that cannot be easily modified. The only opportunities for energy reductions are in optimising usage patterns which generally correspond to good compliance to mine operating standards and optimising production as per the mine plan.

Opportunity: Conduct an energy awareness program for underground staff to reinforce the need to shut down equipment that is not in use.

9. Conveyor Systems

Conveyor systems will constitute the next largest group of energy using equipment. Mine management have been diligent in specifying conveyor systems that are not oversized and with low friction rollers.

The main conveyors will have two drive motors and there is an opportunity to shutdown one motor at low loads. This is discussed further in Section 16. Unloaded Motors.

There is also potential to turn off some conveyors when not in use for extended periods. Unfortunately mining regulations that require conveyors to be manually inspected prior to restarting after a short period restrict the opportunity to shutdown conveyors repeatedly for brief periods.

Opportunity: A SCADA system that can monitor and remotely control underground conveyors and other equipment could be used to identify unloaded equipment and shut them down when safe and practical to do so.

10. Main Ventilation Fans

Abel Mine will commence with one Variable Speed Drive (VSD) controlled fan which will be gradually ramped up with increased mine production and when at capacity a second VSD fan will be installed, probably at a different location. It is the Mine Ventilation Officer's responsibility to maintain appropriate fan speeds to ensure minimum specified air flows to the workers. Good compliance with mine standards will minimise fan energy use.

11. Water Pumping

Water pumps specified for the Abel Mine are VSD controlled surface pumps to maintain adequate flows and pressures to underground and above ground facilities. These actual units have not been specified at the time of writing this report however the mine engineering staff understand the importance of specifying correctly sized pumps and motors to optimise energy efficiency.

Underground air operated and electric pumps are used to control water ingress. The continuous miners require around 114 L/min of water for dust suppression and lubrication for the cutting head. At 50% average utilisation this equates to 246 ML pa for 10 miners. Using recycled water collected in underground pits for use on the continuous miners will avoid the cost of importing water and the cost of the energy required to transport it underground.

Opportunity: Investigate recycling of underground water for continuous miner sprays at Abel Mine.

12. Hot Water Supply to Bath House

Hot water for the mine bath house was proposed to be supplied by electrically heated storage heaters. The heaters are connected continuously and controlled only by thermostats. Two tanks of 1,000 L capacity each fitted with three 8.4 kW elements were originally proposed by the equipment supplier.

There is no natural gas available in the vicinity so a comparison has been made of the relative costs and benefits of various combinations of electric, heat pump, LPG and solar hot water systems.

There is no doubt that significant energy and greenhouse gas reductions could be achieved by specifying LPG or solar hot water systems but unfortunately the high running cost of LPG and the high capital cost of solar systems makes economic justification of either difficult. However a Heat Pump hot water system coupled with electric boosters could give a reasonable pay back and still reduce energy and greenhouse gas emissions significantly (up to 110 tonnes CO_2 pa).

Opportunity: Investigate the installation of heat pump hot water systems instead of standard electric hot water systems.

13. Heating of Bath House

The equipment suppliers originally proposed the installation of six domestic style 8 kW output reverse cycle air conditioners similar to the existing Tasman Mine bath house. Mine bath houses traditionally are set at 30^{o} C to provide drying for the wet clothes that are hung in mesh steel lockers.

Advitech's analysis revealed that, in theory, the reverse cycle air conditioners are more cost effective and greenhouse friendly than electric fan heaters, however experience at the Tasman Mine has shown that they cannot maintain a reasonable temperature and that the fan heaters are required to supplement the air conditioners in cold conditions. Although marginally more expensive to run, gas heating is much less expensive to install and offers good greenhouse gas savings. CO_2 savings of up to 84 tonnes pa. have been identified.

Whether gas or electric fan heaters are chosen as the back up for the air conditioners it is recommended they be fitted with a timer so that they operate only for short periods just prior to shift changeover during cold periods.

The bath house design also specifies 24 off 250 L/s wall mounted exhaust fans similar to those installed at the Tasman Mine bath house. As these are installed at a high level they are effectively removing the heat supplied by the heating system. The fans are on a single manual control switch and are routinely left on continuously or for long periods all year round. A timer is recommended to control the operation of the exhaust fans so that they operate only as long as required to remove excess moisture. This time will vary from season to season and will require fine tuning after experience.

Heat retention would also be greatly improved if the bath house entrances were fitted with a simple air lock to prevent warm air from escaping every time the door is opened.

Opportunity: Investigate the installation of heat pump air conditioning systems boosted by gas heaters instead of standard electric heaters and incorporate timers and/or control systems.

14. Surface Facility Lighting

The cost of providing surface lighting of buildings is expected to represent only approximately 0.13% of total energy use. However a visit to the Tasman Mine which has a similar surface facility arrangement proposed for the Abel Mine showed numerous areas where lighting was being left on 24 hours per day. Ninety nine standard 36 W double T8 fluorescent tubes have been specified for Abel with no sensor controls to turn off lighting in daylight hours or when rooms are unoccupied for long periods.

Advitech's analysis shows that energy savings of 250% and payback periods of less than one year are possible by installing the more efficient T5 lights and simple control systems. Greenhouse gas savings of 30 tonnes pa are possible.

Opportunity: Install high efficiency lights with photo-sensors and timers.

15. AC Variable Speed Drives (VSDs)

It has been well documented that both productivity and energy consumption can be improved by using variable speed drives on applications such as pumps, compressors and fans. By adjusting the motor speed in proportion to the load, the VSD can reduce energy costs by as much as 30% if the fan or pump speed is reduced by, say 15%.

Several drives are already proposed to be fitted with VSDs and Advitech's assessment is that generally, the company has been diligent in identifying VSD opportunities. Even so, further opportunities may exist where the cost effectiveness has now become attractive in light of increasing electricity prices.

Opportunity: The investigation and analysis of potential applications of variable speed drives should be continued.

16. High Efficiency AC Motors

As from 1 April 2006, there are new mandatory standards for motors so that minimum efficiency levels are achieved. These higher efficiency levels apply to both new motors and to rewinds. This means that all motors repaired or replaced in the future will automatically have higher efficiency and lower running losses.

17. Unloaded Motors

As discussed previously, it will be difficult in a continuously operating mine to identify motors that continue to operate after their loading has been removed. Company staff have mentioned that such situations may exist in areas associated with conveyors. It should be possible to use SCADA logging (where motor input current is monitored) to identify motors that spend a portion of their time idling. Further investigation of this matter is warranted.

For example it is understood that some conveyors have two drive motors for periods of high loads but do not automatically switch one motor off when the load decreases.

Opportunity: A procedure should be developed to identify unloaded motors and then install control systems and/or VSDs to minimise the energy wasted in keeping unloaded motors spinning.

18. Compressed Air

A specialist report was commissioned to review the use of compressed air and to identify opportunities for increased energy efficiency.

The principal finding of the report was a recommendation to install a two stage compressor rather than a single stage compressor such as the Atlas Copco currently proposed. Although the VSD controlled Atlas Copco is more efficient at low loads, the two stage machines are much more efficient at higher loads so the decision on which to buy will depend on how long the mine will take to ramp up production and compressed air consumption.

Comparing single stage and two stage 250 kW compressors operating at 1500 CFM (42.5 m^3/min), the two stage compressor would operate approximately 232,000 kWh per annum more efficiently, saving the mine 228 tonnes per annum of CO_2.

Opportunity: Investigate further cost/benefits of single stage VSD versus two stage air compressors depending on projected mine air consumption.

The projected break-up of equipment energy costs shows that the three proposed air compressors should contribute around 2% of the total final energy consumed. Abel propose to install the VSD controlled air compressor first to allow for the progressive increase in load as the mine expands.

When the VSD machine is bearing full load a second fixed speed compressor will be installed along with a control system to ensure that the fixed speed machine operates as a base load unit and the VSD compressor acts to top up the required air.

Given the comments from Specialist Air the two stage compressor type should be chosen as the base load machines provided that reliability and cost issues are satisfied.

19. Heat Recovery from Air Compressors

In addition to the recommendations identified in Specialty Air's report, other areas have been identified for potential heat recovery options. Up to 81° C hot water is available by installing air / water heat exchangers to replace existing fan driven air / air cooler.

This could be used to heat the bath house hot water if the compressors were located reasonably close to the bath house. From the previous section on the bath house the proposed capacity of the hot water and heating systems totalled 92 kW.

The proposed air compressor can supply up to 195 kW of hot water continuously at full load so should be more than capable of supplying the bath house demand. This could potentially save up to 302 tonnes pa of CO_2. Unfortunately the mine plan dictates that the air compressors will be located remotely from the bath house for the first three years of operation so an alternative hot water and heating system must be installed initially.

Opportunity: Investigate the practicality of reclaiming waste heat from the air compressors to provide hot water and heating for the surface facilities once the type and location of the air compressors is known.

20. Opportunities to Reduce Peak Electricity Demand

A number of initiatives identified in the review could contribute to a reduction in peak electricity demand. A summary of these initiatives and the relevant impact is shown in Table 3.

Table 3: Opportunities to Reduce Peak Electricity Demand

Initiative	Peak Reduction Winter kW	Peak Reduction Summer kW
Transformer Efficiency	**50**	**50**
Bath house hot water	0	70
Bath house heating	0	0
Surface lighting	20	20
Air compressor heat recovery	165	165
Lightly loaded motors	105	105

21. Total Energy Use Analysis

a) Data Restraints

The absence of sub-metering or SCADA systems for electricity at the Tasman Mine has necessitated a significant amount of engineering assessment of energy flows which has then been extrapolated to the proposed Abel Mine situation. It is recommended that Abel Mine management develop an energy reporting format which can be incorporated into the management reporting system enabling both maintenance of existing levels of efficiency and verification of improvements through energy savings initiatives.

b) Energy Data

To be able to allocate total energy consumption to major pieces of equipment or facilities will require sub-metering of electricity at various points around the site. Advitech have recommended a number of proposed locations for sub metering including surface and underground facilities.

c) Production Data

The Abel Mine is expected to produce up to 4 million tonnes pa of raw coal when in full production. However there will be a gradual ramp up of production as has been the case with the smaller Tasman Mine.

Figure 3 shows production and energy use to date at the Tasman Mine and shows a reasonably good correlation of energy use with production apart from the first month where there is obviously a substantial (say 13,000 kwh) non-production related energy use. This is thought to be fixed equipment that operates continuously such as ventilation fans, surface facilities (bath house, office etc), and power required to maintain compressed air pressure and water pressure.

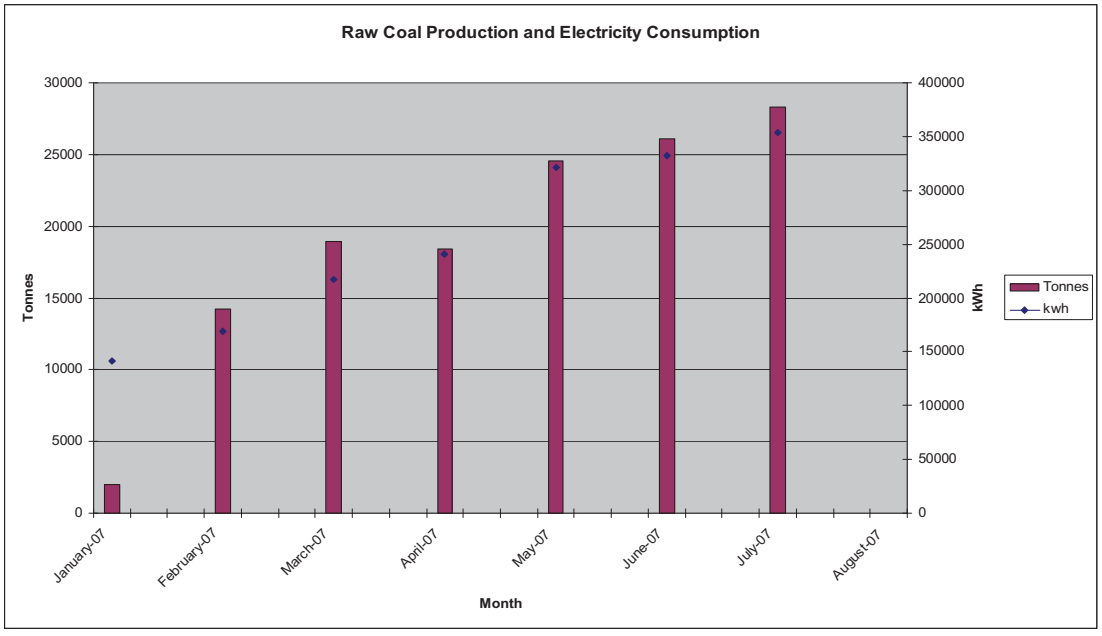


Figure 3: Production and Energy Use Since January 2008 for Tasman mine

d) Development of Energy KPI

The only Key Performance Indicator (KPI) that is relevant for an underground coal mine is kWh per tonne of raw coal produced.

A chart showing the variation of KPI over time for the Tasman Mine is shown in Figure 4 below:

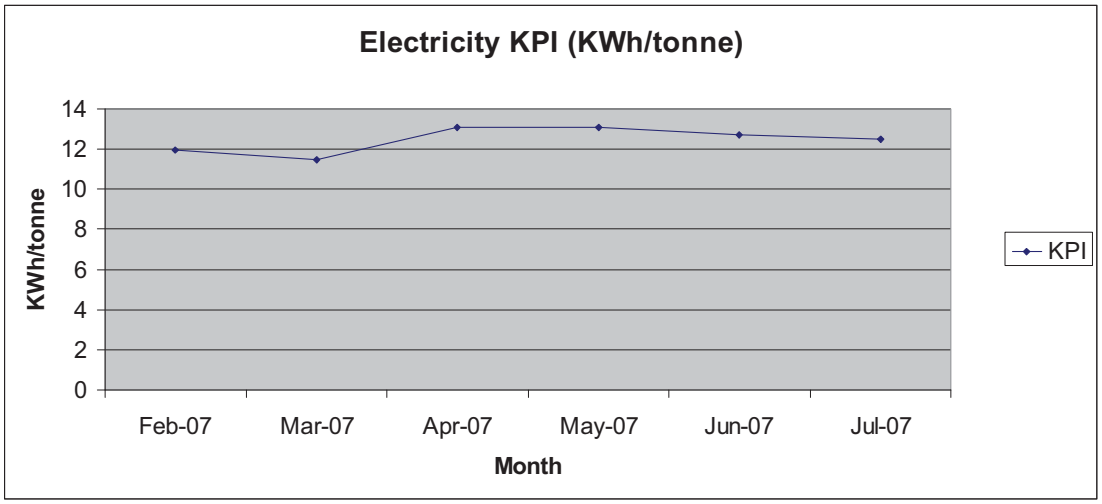


Figure 4: Tasman Mine KPI History

As data becomes more consistently available KPI's will be able to be refined and, as such, will become a valuable reporting tool for measuring energy efficiency. It should be noted that the Tasman Mine is only operating at 40% capacity at the time of writing this report so the accuracy of extrapolating these estimates to the much larger Abel Mine is questionable.

Abel Mine management were understandably reluctant to commit to baseline energy consumptions or KPI's until the Abel Mine was in operation at a reasonably steady state. The different scale, geography, geology and timing of the Abel Mine could well result in a higher KPI. For example Abel will be much deeper than Tasman and more water ingress is expected - both of which will require more expenditure of energy per tonne of coal.