

Industry Case Study

XSTRATA COPPER

Xstrata Copper's refinery in Townsville conducted a trial assessment over a period of six months for the Energy Efficiency Opportunities program. Savings captured far outweighed the cost of the trial, and additional savings will be achieved over time. The trial assessment highlighted the importance of developing an energy-mass balance so that energy flows through processes could be understood and optimised. It also demonstrated the value of using expertise from outside the site to apply 'fresh eyes' to the search for energy efficiency.

Xstrata Copper saw the trial assessment as an opportunity to learn about the practical issues involved in implementing the program. It also wanted to create systems that could be applied across the organisation and in other Xstrata businesses. This trial complemented a similar trial assessment conducted in Xstrata Coal's mining operations in New South Wales.



BUSINESS BENEFITS ACHIEVED SO FAR

The assessment identified a number of cost-effective energy efficiency opportunities, many of which have been or are now being implemented. Four of these measures have simple payback periods of less than two years, and collectively offer the potential to:

- provide total annual savings of \$200,000;
- reduce greenhouse gas emissions by 3,500 tonnes of CO₂ equivalent per year; and
- reduce site energy costs by 3 per cent.

In addition, these opportunities also offer the following non-energy benefits:

- improved temperature control and reduced maintenance costs through the use of a smaller variable drive pump to circulate water for the re-melt furnace;
- improved reliability of plant and equipment through fixing steam leaks; and
- improved understanding of processes at the site and stronger relationships between different functional groups.



About the company

Xstrata is a global metals and mining business whose operations are broken into several largely autonomous groups including Xstrata Copper.

Xstrata Copper has its global headquarters in Brisbane, with regional offices in Chile, Peru, Argentina and Canada. In Australia, the company operates Mount Isa Mines copper mining and processing operations, Ernest Henry Mining, and the Townsville Copper Refinery and port operations.

Globally, the company manages production of over a million tonnes of copper each year, 20 per cent of which is processed at the Townsville refinery.

e at the Townsville refinery

A copper refinery uses electrolysis to purify crude copper from a copper smelter. Crude copper anodes, separated by stainless steel cathodes, are immersed in baths of electrolyte. When an electrical current is passed through the system, copper ions are released from the copper anodes and deposited on the cathodes. The pure copper is stripped from the cathodes, bundled and sold.

Electricity for the electrolysis process is the major component of energy cost and comprises around 85 per cent of the site's electricity use. Significant amounts of natural gas are also used to heat the electrolyte and to run a re-melting furnace. The furnace melts residual copper from spent anodes and outside-specification anodes, producing new anodes for processing.

g the assessment

Designing the Townsville Copper Refinery assessment

Xstrata Copper selected the Townsville Copper Refinery to conduct the trial assessment, because the facility is relatively small (using around 0.5 PJ of energy per annum) and its refinery process is relatively simple. The site is not new and, hence, provided a good opportunity to take another look at energy use. Staff members have many years of experience and substantial expertise in their specialised fields.

The project team

The site's Refinery Manager, Ken Draffen, assumed leadership of the assessment. This sent a strong message to staff that the assessment was an important activity, reinforced by Ken's enthusiastic participation in all stages of the project. Ken also liaised with corporate management, building support for the assessment and providing feedback on progress.

Line managers also participated in the assessment, as well as selected shop floor staff and specialists from other sites. External consultants were engaged to provide support on energy efficiency, an energy mass balance, and workshop facilitation.

Site visit and data collection

The site visit allowed key stakeholders to familiarise themselves with the site, to meet staff, and to collect relevant energy and production data.

The consultants then prepared a background paper on the site's operations and a description of the energy aspects of the refinery. Basic analysis identified data gaps and anomalies and raised questions to be discussed in the workshop.

The background paper also listed a range of possible energy saving opportunities, including some 'left field' ideas intended to free up discussion. The interaction between consultants with their 'fresh eyes' and experienced site staff during this process meant that some misconceptions were resolved and staff began to look at site processes through an 'energy lens'.

Opportunities identification workshop

The workshop was held off-site, and ran over an afternoon and the following morning. On the first evening, workshop participants met for dinner to further discuss the initial workshop sessions. The workshop structure encouraged engagement and built relationships, while also allowing time for people to generate new insights by 'sleeping on it'.

The workshop began with the rating of the site against the Energy Efficiency Opportunities' diagnostic tool (see the Energy Efficiency Opportunities assessment handbook). This helped participants to identify areas of strength and weakness with regard to energy management. The external consultants then presented some of their initial findings, and this led to extensive discussion which raised many questions and ideas for opportunities.

The next day the focus was on brainstorming possible energy efficiency opportunities. A total of 61 potential technical projects and 21 management projects were identified. These ideas were then grouped together into logical categories and prioritised by the group. The 13 highest priorities were then identified and assigned to individuals for further investigation, evaluation and discussion.

The group recognised that it could have productively spent more time prioritising projects. Lack of detailed information (some of which emerged later during the development of the energy-mass balance) also limited the validity of the prioritisation process.

Detailed investigation

Regular site meetings to monitor the progress of opportunity evaluations were organised by Ken Draffen. Some opportunities were considered so attractive that substantial progress was made on their implementation during this stage.

Participants conducted laboratory experiments to determine the practicality of some proposals, and to better understand existing practices. Some project proposals were reviewed and options closed or opened up for further action. This stage highlighted the importance of tracking and monitoring energy performance as changes to the production process were investigated or implemented. It also demonstrated the need for flexibility in defining the opportunities.

Review workshop

Workshop participants conducted a review as the next step in finalising the assessment. The results of completed evaluations and business cases were presented by workshop participants to the assessment team. Lessons learned were also discussed. Overall, the group agreed that there had been a substantial increase in awareness and understanding of energy use at the site. Improved systems for monitoring energy use and the impacts of efficiency initiatives had been introduced. The site had achieved substantial cost-effective energy savings, and more were expected over time.



The workshop to identify opportunities encouraged engagement, built relationships, and allowed people to generate new insights



The Townsville Copper Refinery uses electrolysis to purify crude copper. The electrolysis process accounts for around 85 per cent of the site's electricity use.

Opportunities identified

The assessment identified cost-effective energy efficiency opportunities. Specific examples include:

Reduced contact resistance between cathodes and busbars

The lower the voltage drop across the cells for a given current flow, the more energy-efficient the copper electrolysis process is. While most factors affecting voltage drop are constrained by the plant design, it was found that improved cleaning of the contacts reduced the overall voltage drop by 2 per cent, directly resulting in a saving in electricity use worth over \$100,000 per year.

Pump for cooling water

A large pump circulates coolant water continuously for the re-melt furnace, even though the furnace operates intermittently. Tests involving switching the pump off showed that corrosion and fouling of the pipes occurred. It is now proposed to install a smaller pump with a variable speed drive. This will:

- allow the pump to operate at very low speed during the majority of operating times;
- provide a reduction in energy use of up to 80 per cent;
- reduce energy costs by approximately \$19,000 per annum for an initial cost of \$20,000 – a payback period of just over 12 months; and
- improve temperature control during operation and reduce maintenance costs.

Compressed air audit

A compressed air audit was conducted with the following results:

- audit cost \$1600;
- air leaks found and repaired cost \$5000;
- running costs reduced by an estimated \$22,000 per annum – a payback period of 3.6 months; and
- improved systems for tracking performance.

Consideration is also being given to annual checks being conducted by a specialist to implement preventative maintenance.

Steam usage

An audit of steam usage showed that steam traps were leaking. Fixing the leaks would:

- cost \$120,000;
- potentially save \$60,000 per annum – a payback of 2 years; and
- potentially provide further maintenance savings and reliability benefits.

Plating shop

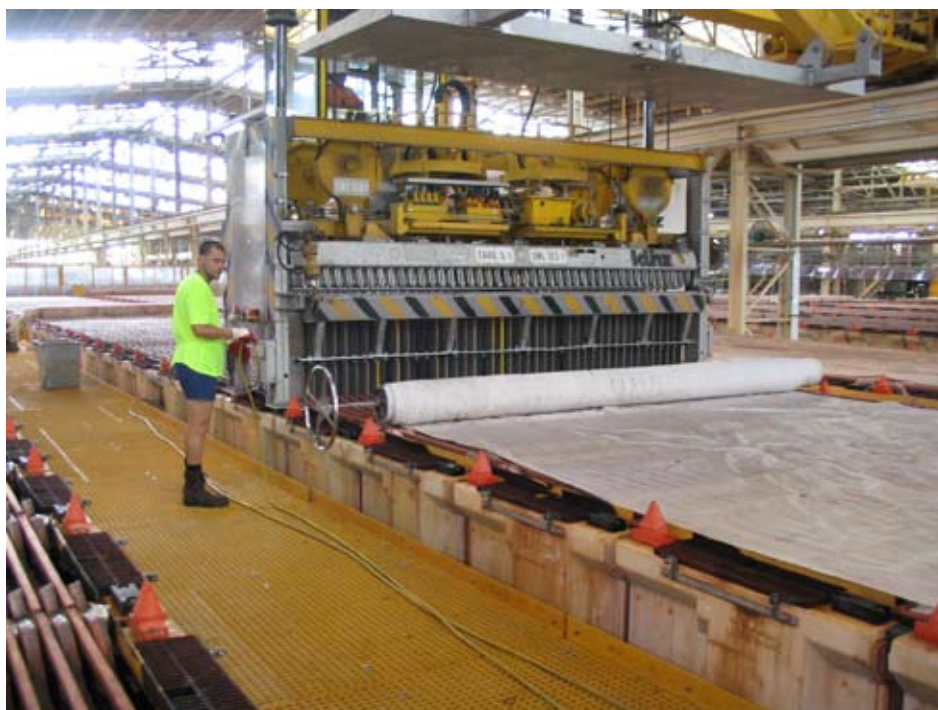
Energy waste at the plating shop was also identified as providing potentially significant savings. More specific energy monitoring will now be implemented to quantify how much energy is being wasted and identify where it is occurring. This in turn will generate a greater emphasis for operators on being aware of the potential for energy management and may lead to developing a user-pays scheme for energy to provide operators with an incentive to optimise energy performance.

Costs and benefits of the assessment

Efficiency measures that are being implemented offer potential annual savings of over 3 per cent of site energy costs with payback periods of less than two years. Further opportunities are being explored that could significantly increase these savings.

The total project cost of the assessment was estimated at around \$100,000, including the implementation of some projects. Annual savings identified and implemented so far will offset this cost in less than a year.

The assessment improved the company's understanding of a number of processes at the site, and has led to changes in operating practices in several areas. Although the staff at this site already worked cooperatively, the assessment also helped to strengthen relationships across functional groups.



Covering the refinery's tanks improves resource efficiency by reducing heat loss and water evaporation

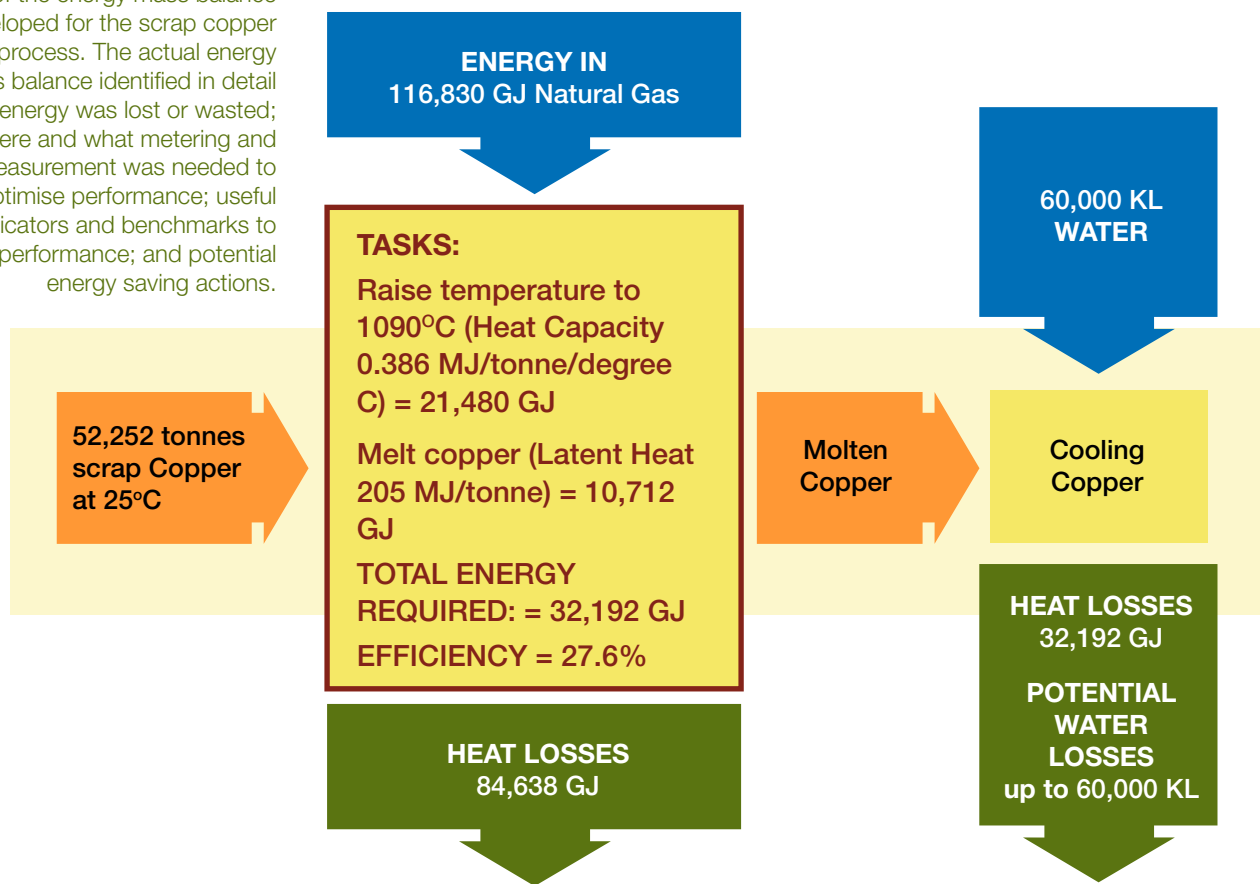
Lessons learned

The value of an energy-mass balance

The development of energy-mass balances for a number of processes during the assessment provided helpful insights into where energy flowed, how it was used, and how efficiently processes operated. Questions raised during collection of the necessary data highlighted where improved measurement was needed. It also provided a justification for the investment in new measurement systems by identifying the scale of possible savings.

An energy-mass balance developed for the scrap copper remelt process at the site is represented in Figure 1.

Figure 1: A simplified representation of the energy mass balance developed for the scrap copper remelt process. The actual energy mass balance identified in detail where energy was lost or wasted; where and what metering and measurement was needed to optimise performance; useful indicators and benchmarks to monitor performance; and potential energy saving actions.



A number of other energy mass balances were developed for other systems, including the heat delivery system. This work revealed that it was not possible, based on existing data, to establish the overall efficiency of the heat delivery system (boiler, steam distribution system etc), but that there seemed to be losses in the order of 30 per cent. The subsequent steam system audit found the potential for cost-effective savings through repair of steam traps and other equipment.

The participants indicated that it would have been most effective to do an energy-mass balance prior to the workshop, as it questioned their assumptions about where energy wastage and opportunities were to be found.

Measurement and monitoring systems

The assessment demonstrated that an iterative approach to data collection is required. Efforts to develop energy-mass balances highlighted some important data gaps, and the evaluation of specific opportunities also highlighted where improved data were needed to determine the potential for improvement.

Energy and related process measurement systems should be integrated into existing monitoring and reporting systems, so that information can be accessed at minimal cost and from a range of systems.

Prioritising opportunities

The priority initially placed on some opportunities identified at the workshops changed as a result of subsequent detailed investigation and the energy-mass balance. To some extent this reflected the reality that there had been too little time in the opportunities workshop for comprehensive discussion, and relatively simple criteria had been applied. The changes in priority also reflected the outcomes of trials, tests, more detailed analysis, consultation with specialists and quotes from suppliers. In some cases, new opportunities emerged that led to the rejection of some originally identified.

The assessment therefore needs to be sufficiently flexible to take into account the knowledge gained during the process. In some cases, it may be necessary to put opportunities 'on the back-burner' because they are best applied under certain circumstances, such as when a contract is re-negotiated, when there is a plant shut-down, or when equipment is being replaced. In other cases, it may be important to carry out further research or investigation, or to conduct trials before prioritising an opportunity. In this context, it is important to allocate sufficient funds and resources (based on the potential future benefits and likelihood of success) to carry out this work.

Low cost methods of evaluating opportunities

The Xstrata Copper assessment developed a number of innovative strategies for the evaluation of opportunities. These included:

- Defining projects for university students on summer vacation or as projects within their courses. For issues that were not particularly urgent, and required broad research and/or laboratory experiments, this can be a very effective way of achieving an outcome at low cost while training future professionals.
- Preparation of a brief describing a new product, system or material and the role it would be required to play. This brief can then be circulated to researchers and suppliers to see if a suitable solution is available.
- Identifying a sub-set of a task that can be easily defined (e.g. a lighting upgrade in part of the site that very obviously requires improvement) and calling for quotes for an energy-efficient installation. This can avoid the cost of an audit and deliver rapid savings. This approach may also establish a relationship with a supplier who could potentially form a partnership to carry out further work at the site.

“The assessment identified not only energy efficiency opportunities but also broader operational benefits.”

Ross Thompson
Principal Advisor
Energy and Utilities
Xstrata Copper



Xstrata Copper learned that it needed to encourage the development of creative solutions to gain the most out of the assessment

Finding creative solutions

Different types of opportunities involve different approaches and ways of thinking. It is important to define opportunities in ways that do not 'lock-in' specific approaches to solving them, but facilitate development of creative solutions. For example, an opportunity may be captured by a technical solution, a contractual solution, a marketing solution or a mix of these.

Xstrata Copper found potential for efficiency improvements at the associated plating works. Instead of taking a technical approach, the way that the unit paid for energy was changed to provide an incentive for greater energy efficiency.

It may also be easy to reject an opportunity assessment because of contractual restrictions or time issues. For example, Xstrata Copper's fork-lift fleet had just been replaced with vehicles unsuited to conversion to Compressed Natural Gas (CNG). However, Xstrata staff had discussions with the supplier, who saw market potential in developing a CNG option. Xstrata has included CNG as an issue to be considered at the time of replacement.

Cross-functional collaboration

Many opportunities involve interactions between elements of a site or different business units, and can open up additional opportunities or create new issues that have to be dealt with.

For example, Xstrata Copper found that reducing the voltage drop across the electrolytic cells reduces the amount of heat generated, and this would require more heat from an external source unless the heat loss from the cells was reduced. However, insulating the cells has implications for maintenance.

Before such complex opportunities can be evaluated, modelling of energy and material flows is needed so that the impacts of changes can be understood. The implications of changes in one area for other areas can then be explored using 'what-if' scenarios. Practical options for making changes and delivering the outcomes from the scenarios should be explored.

Next steps

The Townsville Copper Refinery is well on the way to establishing effective systems to identify and evaluate more energy efficiency opportunities, and the experience of the trial is being reported to corporate staff. Xstrata Copper is now developing its strategy to ensure it meets the objectives of the Energy Efficiency Opportunities program while capturing business benefits.

© Commonwealth of Australia
Energy Efficiency Opportunities
Department of Industry, Tourism and Resources, March 2007
Tel: 1300 799 186
E-mail: energyefficiencyopportunities@industry.gov.au
Website: www.energyefficiencyopportunities.gov.au

The Department of Industry, Tourism and Resources thanks Xstrata Copper for its involvement in the trial to test and develop aspects of the Energy Efficiency Opportunities program, and for sharing its results and the lessons learned. Readers should be aware that as this case study is based on a trial assessment and may not represent a complete assessment as required by legislation.