



Australian Government

Department of Resources, Energy and Tourism

Energy Efficiency Opportunities

CASE STUDY

NYRSTAR PORT PIRIE SMELTER

THIS CASE STUDY LOOKS AT THE ENERGY EFFICIENCY OPPORTUNITIES (EEO) ASSESSMENT UNDERTAKEN AT NYRSTAR'S LEAD AND ZINC SMELTING PLANT IN PORT PIRIE.

Though challenged by the complexity of a one hundred year old plant and a lack of detailed energy data the company viewed the EEO program's legislative requirements as an opportunity to better understand energy use and energy waste. Nyrstar undertook a comprehensive Energy Mass Balance across all its eight key processes. The assessment and the significant business benefits resulting are detailed below.

NYRSTAR PORT PIRIE SMELTER

Nyrstar's Port Pirie smelter undertook an energy efficiency assessment during 2007 and 2008 to meet requirements under the Energy Efficiency Opportunities (EEO) program. While Nyrstar had reported its energy and greenhouse gas emissions through its global Sustainability Report its understanding of energy use at the site level was less well understood. Saving energy, though important, had not been seen as a critical priority. The EEO assessment provided a rigorous framework that allowed Nyrstar Port Pirie to transform its understanding of the value of saving energy.

An Energy Mass Balance (EMB) for Port Pirie was crucial to this transformation. Recognising there was limited monitoring of energy use at the site, Nyrstar Port Pirie devoted considerable time and resources to developing a comprehensive and detailed EMB. For the first time the EMB showed Nyrstar Port Pirie exactly where it used energy and where it could be more efficient. Drawing on the EMB Nyrstar identified 27 opportunities to save energy, reduce costs and improve material productivity and product quality.

BUSINESS BENEFITS ACHIEVED SO FAR

Nyrstar has identified 27 energy saving opportunities at Port Pirie and intends to implement or undertake further investigation of 17 opportunities in the short-term. The 17 opportunities to be implemented or investigated are expected to achieve:

- total annual financial savings of \$5.5 million,
- total annual energy savings of 0.21 petajoules, and
- a reduction in greenhouse gas emissions of 3,800 tonnes CO₂-e per year.

The process changes required to capture these benefits will also deliver non-energy benefits, including:

- more efficient use of raw materials and greater process stability in the blast furnace,
- better product quality from the sinter plant, and
- a reduction of other air emissions.

Three other factors were critical to the success of the EEO program at Nyrstar Port Pirie. First, the Business Improvement Team took responsibility for the assessment, which meant that assessment and opportunity identification were fully integrated into existing business decision-making processes.

Second there was a strong focus on workforce and leadership engagement. People were invited to awareness sessions, peer reviews and workshops. Regular program updates were provided through internal publications and through existing leadership forums including the Board. Lastly, the Business Improvement Team made good use of EEO resources that are available to all companies. These resources included liaison with EEO staff and use of materials such as the EEO *Industry Guidelines* and the EEO *Assessment Handbook*.

The outcome of the detailed analysis provided site management with evidence and data to make the business case for financial managers. It has also assisted Nyrstar Port Pirie in its preparation for introduction of the Carbon Pollution Reduction Scheme (CPRS) by generating a list of cost effective opportunities to reduce energy use and emissions.



ABOUT THE COMPANY

Nyrstar is a publicly owned Belgian company. It is a global supplier of zinc metal and alloys, lead metal and alloys, copper, acid, cadmium, gold and silver. The company operates facilities in Australia, Europe, China, the United States and the Middle East.

In Australia, Nyrstar operates an integrated lead and zinc smelting facility at Port Pirie, zinc smelting and alloying in Hobart and lead battery recycling facilities in Sydney and Melbourne.

The Port Pirie Smelter commenced operations in 1889. The Smelter employs about 670 direct employees and 110 full-time contractors. It is the largest employer in Port Pirie and a crucial part of the regional economy.



Nyrstar Port Pirie



Operator attending the blast furnace

ENERGY USE AT PORT PIRIE SMELTER

The Port Pirie smelter is an integrated multi-metal smelter and refinery that processes metal concentrates and residues. It can produce 245,000 tonnes of lead and 45,000 tonnes of zinc per year. Energy is needed to fuel a sinter plant, blast smelter and refinery for lead production and an acid plant that extracts sulphuric acid from the lead ore and slag fumers, kilns and electrolysis for zinc production.

The Port Pirie smelter is an energy intensive business, with energy representing approximately 30% of operating costs. In 2005-06, the site used 5.23 PJ at a cost of around \$50 million and released 725,000 tonnes of greenhouse gas emissions.

The largest energy source for the site is coke used in the blast furnace and sinter plant (35% of total energy use), followed by black coal used in the slag fumers (28%), purchased electricity used for electrolysis (18%), natural gas used in the acid plant, kilns and refinery (18%) and smaller amounts of diesel, LPG, wood, petrol, acetylene and fuel oil.

THE ASSESSMENT PROCESS

CORPORATE LEADERSHIP

Saving energy and reducing greenhouse gas emissions fits well with Nyrstar's core values, one of which is preventing harm to the environment. Nyrstar recognises it has a responsibility to reduce its carbon footprint while at the same time meeting society's need for zinc, lead and other products.

Nyrstar's previous parent company Zinifex had participated in Greenhouse Challenge Plus. The company has publicly reported greenhouse and energy data in its sustainability reports. Prior to the assessment there were limited energy management systems in place. The requirement to undertake a legislated assessment increased the focus of senior management and the Board on energy use and climate change.

THE PROJECT TEAM

The EEO assessment prompted a much stronger focus on energy efficiency in Nyrstar's Australian operations as reflected in the resources allocated to the project team.

Nyrstar's Port Pirie Business Improvement Team led the response to the EEO program. This ensured integration with standard business improvement and communication processes. It enabled assessment of all opportunities according to standard business criteria before approval and included consideration of the full range of business benefits – not just the energy and greenhouse benefits.

The Senior Business Analyst, reporting to the Deputy General Manager Port Pirie, facilitated the EEO program. The Site Energy Management Committee comprised a Steering Group responsible for ensuring that opportunities identified were consistent with Nyrstar’s strategic objectives while a Working Group focused on analysis and delivery. Managers and operational staff were involved in the Site Energy Management Committee which met quarterly. During the EEO assessment monthly meetings were the norm.

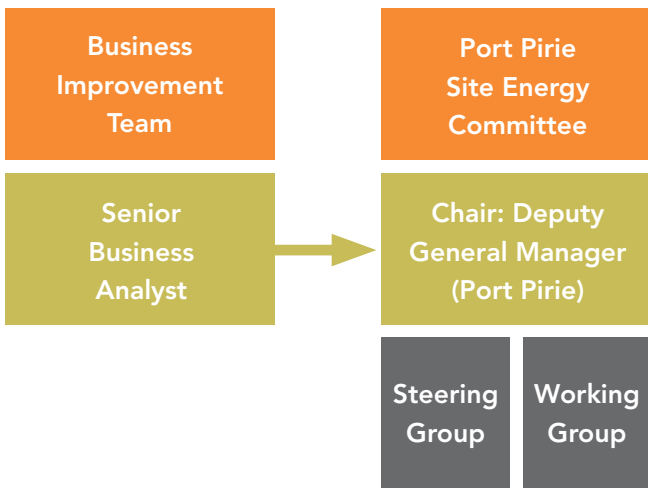


Figure 1: The structure that facilitated activities for the EEO and Greenhouse Challenge programs at Port Pirie.

DATA COLLECTION AND ANALYSIS

As a facility that commenced operations more than 100 years ago, the Port Pirie smelter lacked metering and process control systems to track energy use in some parts of the smelter. This factor made it very difficult to identify which processes had the most potential for energy savings. The Business Improvement Team began to investigate energy use at the site by mapping key production processes to understand where

energy was used. It quickly became apparent that the development of a detailed Energy Mass Balance (EMB) by key processes rather than at the high site level would be vital to get a good understanding of where energy was used and where it could be saved in the unique and complex smelter processes. Nyrstar commissioned an energy consultancy to develop a detailed EMB.

The Site Energy Management Committee identified champions to guide the consultants through different parts of the plant during their site visits and to help them find the right people to get the data they needed. Due to the lack of existing metering, the consultants needed to install temporary sub-metering and used data from the SCADA system to gather essential information. The consultants collected physical, thermodynamic and energy use data and used these to develop separate EMBs for eight key processes at the site. The EMBs were developed in an Excel spreadsheet with a summary diagram showing how mass and energy moves between different components within each plant.

The complexity of the processes at Port Pirie smelter made validation of the EMBs by employees critical. To assist in communicating each EMB to employees, the consultants developed Sankey diagrams for each plant. A Sankey diagram is a flow chart used to assist in visualisation of material and energy flows. The size of the boxes in the flow chart is proportional to the size of the flow. An example for the Sinter Plant is provided in Figure 2. The Sankey diagram shows how energy is used in a process and where energy could potentially be recovered.

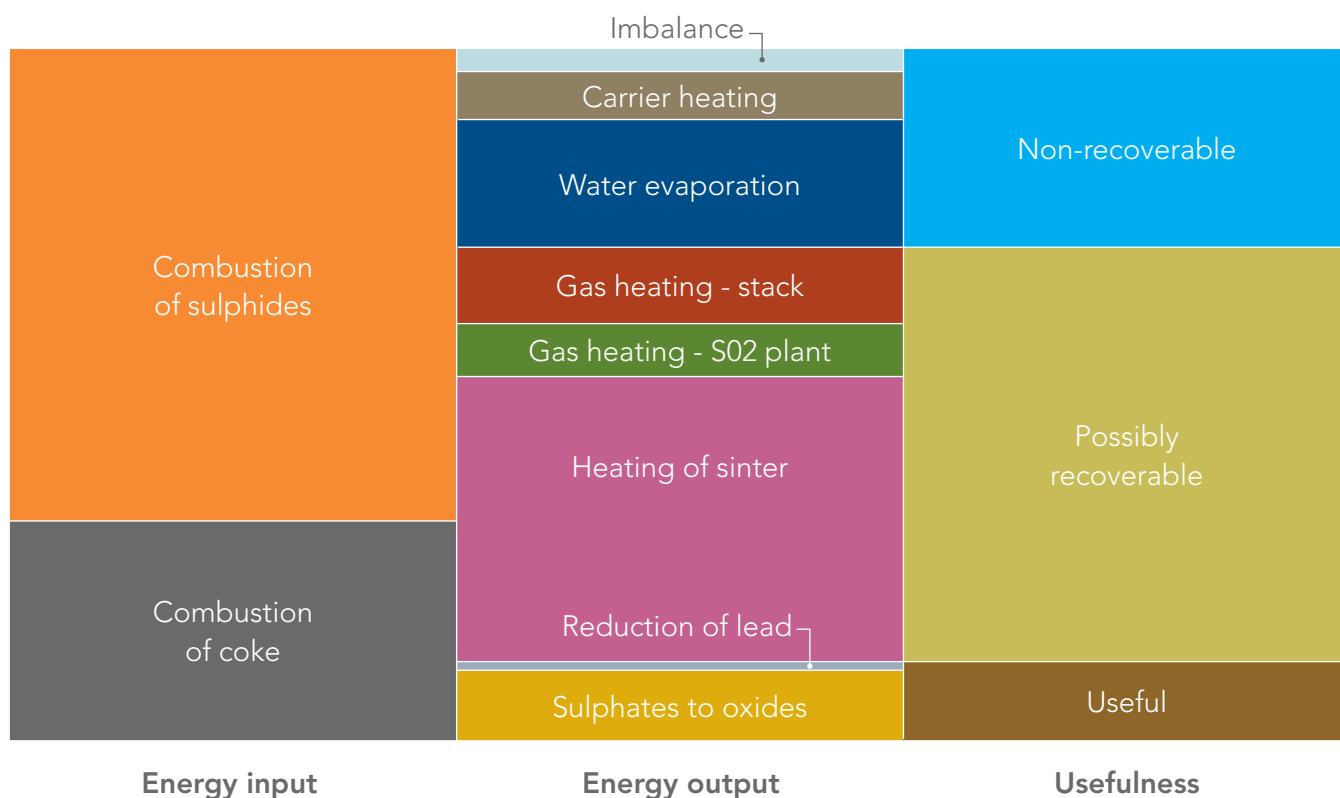


Figure 2: Sankey diagram for the sinter plant at Port Pirie smelter.

The sinter plant removes sulphur from lead-rich concentrates through a roasting process. The diagram shows that the energy for the process is derived from combustion of sulphides and coke. Some of this energy is used to convert lead sulphates to lead oxides and fusion of the lead into sinter (reduction of lead). This energy is considered 'useful'. Some energy use cannot be recovered. Water in the lead concentrate evaporates as steam and cannot be readily captured. The remaining energy use could potentially be recovered. For example, hot gases and sinter that leave the plant contain energy that could be captured using heat exchangers.

The simple presentation of complex information through Sankey diagrams transformed Nyrstar's understanding of where energy was used and lost and clearly showed the scale and location of potential energy saving opportunities. The Business Improvement Team developed a summary of all the Sankey diagrams for the Port Pirie smelter, shown in Figure 3. This summary shows that as much as one third of the energy used at Port Pirie is potentially recoverable and that the biggest opportunities for saving energy were in the sinter plant, the slag fumer, the blast furnace, the acid plant and the refinery.

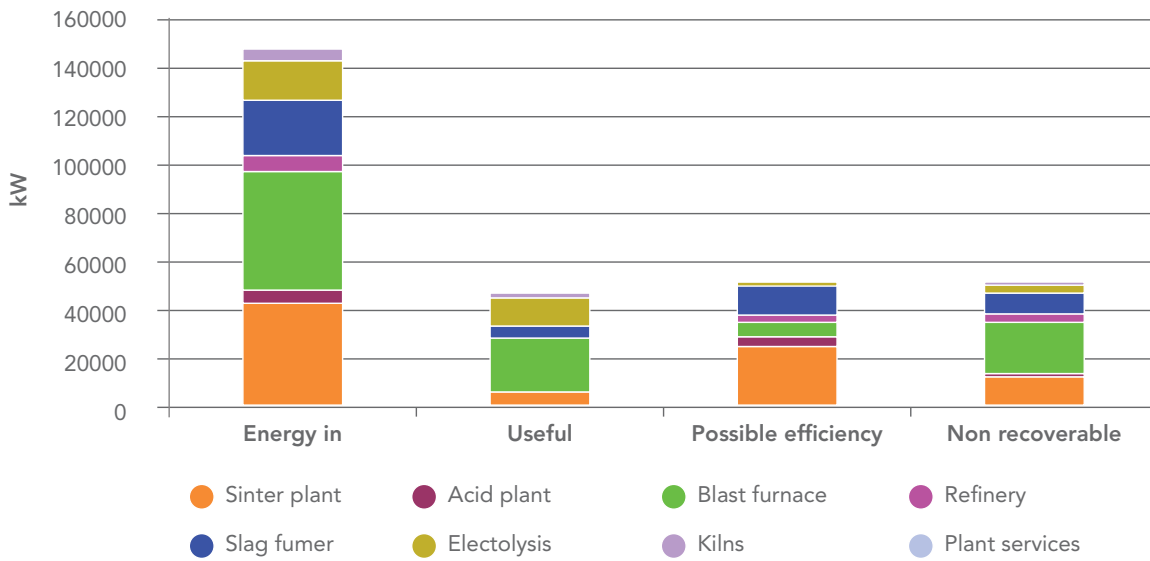


Figure 3: Summary of Sankey diagrams for Port Pirie smelter.

FINDING OPPORTUNITIES - IDEAS WORKSHOPS

Nyrstar held 16 workshops involving 180 personnel to generate over 300 ideas for saving energy. There were two general workshops, nine walk-through workshops in particular areas of the plant, and seven detailed workshops covering specific processes. The externally facilitated workshops brought together operational staff, maintenance staff and superintendents along with external experts from other sites, and process experts from other companies. External experts, from other resource processing competitor and non-competitor companies, provided valuable insight with an alternative and independent perspective on processes within the plant.

The objectives of the workshops were to:

- validate the energy data developed by the consultants for particular areas of the plant,
- identify trends, issues and anomalies that might reveal opportunities to save energy,
- generate ideas to address these issues, and
- undertake an initial assessment of these ideas according to their business value and ease of implementation.

The information prepared for the workshops, including the detailed EMB and the Sankey diagrams, helped workshop participants develop ideas, quickly focus on significant energy saving areas and identify those projects likely to have the greatest business impact.



Nyrstar employees operating the blast furnace from the control room

OPPORTUNITIES ASSESSED AND INVESTIGATED

Initial ideas were condensed to 190 possible opportunities of which 27 are still undergoing detailed investigation. The *Value Ease Model* (Figure 4 below) was one tool used to evaluate projects. Nyrstar believe 17 opportunities will be viable projects for future implementation. Collectively these could deliver an annual financial saving of \$5.5 million.

Further work will be undertaken to comprehensively evaluate potential projects, three of which are detailed below.

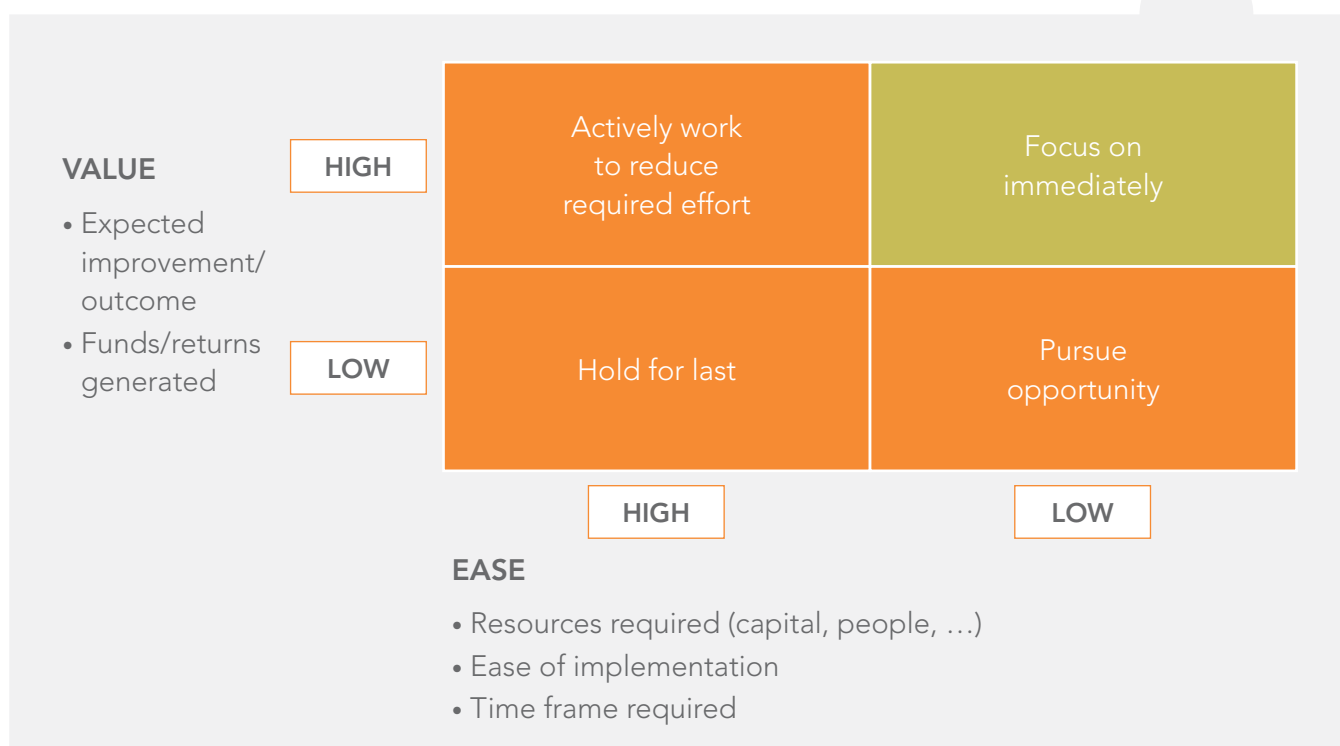


Figure 4: Value Ease Model

BLAST FURNACE STEAM INJECTION

At the Port Pirie smelter, zinc is recovered from slag in a slag fuming process. Two slag fuming furnaces, operating at very high temperatures, vaporise zinc from the slag and collect it. The slag fuming furnaces generate high-pressure steam. Some of this steam is currently used in the laundry and leach areas of the zinc plant but the excess is exhausted to the atmosphere. There is an opportunity to inject exhaust steam from the slag fuming furnaces into the blast furnace. This would increase efficiency either through increased lead production or reduced use of coke.

Nyrstar has already trialled steam injection to the blast furnace. The full project is expected to save more than 80,000 GJ of energy previously provided by coke, with an annual saving of \$890,000 and a reduction in greenhouse gas emissions of 10,000 tonnes of CO₂-e per year. The steam injection is also expected to improve process stability in the blast furnace, thereby reducing furnace emissions and adverse air quality impacts. The payback for this opportunity is less than 4 years.

CHANGE IN PRESHA BOILER OPERATION

Most of the time the leach plant at the Port Pirie smelter uses excess steam from two slag fuming furnaces. However, on Tuesdays and Thursdays one of these furnaces is shut down to allow for maintenance. On these days, additional steam is supplied to the leach plant from a Presha boiler. The EMB indicated that the steam from the Presha boiler is not actually needed during normal operation – the single slag fuming furnace can supply all of the steam needed by the leach plant. Steam from the Presha boiler is only needed when both slag fuming furnaces are not operating.

Currently, the Presha boiler operates at full capacity on Tuesdays and Thursdays, using 42,000 GJ of natural gas per year at a cost of \$140,000. For the rest of the year, it consumes 4,000 GJ at a cost of \$13,000 while idling. By operating the Presha boiler in idle mode all year, Nyrstar can save 41,000 GJ of natural gas and \$136,000 per year, reducing greenhouse gas emissions by 2,900 tonnes CO₂-e. By operating the boiler in idle mode, Nyrstar can still supply steam to the leach plant at short notice if steam supply from the slag fuming furnaces is lost. The cost to implement this change is \$30,000, giving a simple payback of less than a year.

TUNING AIR FLOWS IN THE REFINERY HEATING SYSTEM

The lead refining process at Port Pirie smelter uses more than 20 gas-fired holding pans to heat the lead and remove impurities. Some of these pans have good air control and sealing whereas older brick pans have more access ports, leaks and ingress. At present, some of the airflow to the pans is being heated unnecessarily from ambient temperature to 600°C then exhausted to the atmosphere. There is an opportunity to investigate the minimum airflow requirements for effective operation and then tune the air flow to match the requirements.

Nyrstar has estimated that this project would cost \$50,000 to implement and could save \$330,000 per year, giving a simple payback of less than a year. Natural gas savings are estimated at 75,000 GJ per year, with associated greenhouse gas savings of about 3,850 tonnes CO₂-e.

Several other opportunities under investigation include:

- use of waste oil for preheating in the slag fuming furnaces,
 - partial substitution of natural gas for coal in the slag fuming furnaces,
 - improved heat transfer in the burners in the copper dressing furnace,
 - a review of compressed air infrastructure to identify leaks and reduce these where possible, and
 - installation of a variable speed drive to a fan in the baghouse so that the fan operates only as needed.
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LESSONS LEARNED

THE VALUE OF A DETAILED ENERGY MASS BALANCE (EMB)

Due to its age, the Port Pirie smelter had limited measurement and monitoring of energy flows through its processes. This had made identification of opportunities to save energy and improve processes difficult in the past. Nyrstar was initially daunted by the level of rigour required by the EEO program and unsure how much to invest in improved measurement and monitoring.

After some internal debate and an external tendering process, Nyrstar concluded that a high-level energy review that failed to grapple with the detail and complexity of energy and mass flows through each process would be of little value in identifying new opportunities. A detailed and comprehensive EMB was the only way to make sense of energy use in the smelter processes.

This turned out to be the right decision. The development of a detailed EMB provided Nyrstar with an excellent understanding of energy flows through the Port Pirie smelter leading to the identification of numerous opportunities to save energy and optimise processes. The combination of an expert EMB consultancy and the site-specific knowledge of employees and independent experts was the key to identifying these opportunities.

The EMB helped Nyrstar to identify where additional measurement and monitoring would make sense and would actually help the business to improve efficiency. The information from the EMB supported internal decision-making by allowing accurate estimation of costs and benefits of identified energy efficiency opportunities. In fact one opportunity worth approximately \$1 million could only have been identified using the EMB and another worth \$1.5 million could only have been quantified using the EMB.

“One of the benefits of the EEO program was that it gave us the chance to look at our processes from a different point of view. The rigour required was very good for us because we hadn’t had a focus on the energy component of the process; it was always about the metallurgical side of the business. We decided that we had to invest in data collection up front so that we could work out where we could save the most energy. We learned a lot about how energy is used in different parts of the process.”

**Moira Coffey,
Business Improvement Analyst.**

CHALLENGING ASSUMPTIONS

An important lesson from Nyrstar’s approach is the value of using external people who can look at energy-using processes from a different perspective and suggest alternative ways of doing things. In the ideas workshops, Nyrstar invited not just employees from other plants but also external process experts from other companies to participate. For example, a lead smelting expert from Xstrata was invited to participate in the workshops on the lead smelting processes. When a process has always been run in a particular way, it can be difficult for site employees to see how it might be changed to save energy.

WORKFORCE ENGAGEMENT AND COMMUNICATION

Nyrstar adopted a strong focus on workforce engagement in the EEO program and this paid dividends in raising awareness and generating ideas for saving energy. There were several innovative approaches to engagement, including:

- a formal launch of Port Pirie's participation in EEO to provide information and build momentum,
- provision of a *Launch Pack* to all employees containing an energy saving light bulb, an interactive brochure about ways to save energy and an Ideas Form to enable staff to actively participate,
- internal branding of the program with a logo and a clear set of take home messages,



Nyrstar developed its own EEO logo to increase internal program recognition

- energy efficiency update articles in Port Pirie smelter's internal publication, *Tall Stack Yak*, and
- for ease of understanding various communications, conversion of petajoules to household equivalents.

These initiatives contributed to generating more than 300 initial ideas through the workshops.

The use of Sankey diagrams to communicate messages from the EMB was also an important and successful workforce engagement initiative.

In an initial workshop that did not use Sankey diagrams, participants found it difficult to understand the size of the energy savings that might be achievable. The introduction of Sankey diagrams in subsequent workshops helped participants see at a glance the results of the EMB and enabled them to really understand potential savings and to more readily validate the underlying data.

BUSINESS INTEGRATION AND IMPROVEMENT

Another key lesson from Nyrstar's approach at Port Pirie is the value of integrating the EEO program into standard business improvement processes. From the beginning, Nyrstar viewed the EEO program as one likely to deliver a range of benefits not just energy savings. The task of meeting EEO requirements was therefore allocated to the Business Improvement Team. It was always clear that opportunities emerging from the process would be assessed according to Nyrstar's standard business criteria before approval.

As a result of the business improvement focus, Nyrstar undertook rigorous analysis to identify the full business case for each opportunity – not just the energy and greenhouse benefits. Nyrstar made use of existing communications channels and network structures within the business to drive the program forward, which further increased the integration of the program into Nyrstar's every day operations. Importantly, these structures are sustainable and will not disappear when the bulk of EEO assessment activities are complete, which increases the likelihood that opportunities will be taken through to implementation.

An example of a wider, non-energy benefit for Nyrstar is the successful trial of an ideas tracking database that will be applied across the whole business enabling *all* business improvement opportunities to be tracked and assessed.



Nyrstar Port Pirie

NEXT STEPS

For Nyrstar Port Pirie, the next step is to implement low cost opportunities and seek Board support for those investigations and projects that require more significant funding to implement. Those opportunities supported by the Board will be taken forward by developing a full business case for commitment of capital consistent with normal business processes.

Nyrstar completed the assessments for all its qualifying sites, including the Hobart smelter, in December 2008. Outcomes will be communicated to employees through an article in *Tall Stack Yak* and are made publicly available on Nyrstar's website: www.nyrstar.com/nyrstar/en/sustainability/energy

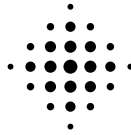
"The Energy Efficiency Opportunities program has been an invaluable opportunity for us to analyse how and where we use energy across the whole business with the view to identify and undertake improvements across a range of areas.

"Our employees have embraced the opportunity to have input into this innovative business improvement process, and understand that without this detailed and rigorous program to improve energy use, our business would not be ready for the many challenges that we face with emissions trading and escalating energy costs."

**Matt Howell, General Manager,
Nyrstar Port Pirie.**



Australian Government
**Department of Resources,
Energy and Tourism**



**National Framework
for Energy Efficiency**

ENHANCING AUSTRALIA'S ECONOMIC PROSPERITY

The Department of Resources, Energy and Tourism thanks Nyrstar for sharing the information in this case study. Readers should be aware that this case study outlines key learnings and does not necessarily mean that the Department has verified that the assessment has met all legal requirements.

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The aim of the Energy Efficiency Opportunities program is to increase the uptake of cost effective energy efficiency opportunities by Australian industry through improving the identification, evaluation and public reporting of energy efficiency opportunities by large energy using corporations.