DSM CASE STUDY

- AngloGold
- South African Breweries
  - SAPPI Mandini

Introduction

The objective of the project, financed by European Commission and co-financed by the DME, the Dutch Government and TSI, was to develop and package information on energy efficiency in South Africa using three case studies in different industries. SAPPI, the largest pulp and paper manufac- turer in South Africa,South African Breweries (SAB), the largest beer brewer in Africa and AngloGold,the largest gold mining company in Africa, agreed to participate in the project and generously provided relevant information and access to their different premices. An energy audit, and its recommendations, form a vital part of a bussiness '3E1 (Energy Efficiency Earnings) Strategy.

The energy audit at SAPPI, SAB and AngloGold was a collaborative effort involving NOVEM (Representing the European Union), the Energy Research Institute (ERI) at the University of CapeTown and Energy Consulting Services (ECS), a division of Technology Services International (TSI). Prior to execution of this energy audit, SAPPI Kraft had embarked on an energy savings drive to reduce consumptions and improve its environmental performance. Current ongoing programmes include large scale steam consumption studies and general efficiency practice in 'operation clinker'.

The energy audit at these three companies was conducted as follows:-

1. A typical one day 'walk through' to survey the plant, gather informa- tion and identify areas for further analysis.
2. A comprehensive review of energy consumption and production records over a twelve month period to determine total energy costs, overall consumption of various fuels, energy intensities and seasonal variations. Most of the historic energy data surveyed came from the client.
3. Monitoring current key energy flows directly from the plant, including electrical energy audits and boiler efficiency tests where applicable.

Throughout the project the prime concern was to improve energy performance without compromising the operation. Care was taken to make sure this exercise was supplementary to companies efforts, and therefore much infor- mation relating to cost savings was extracted from the companies data. Following these initial investigations, which included approxi- mately a month of electrical monitoring and a week of boiler testing, the team proceeded to a process of detailed monitoring during which several key areas came under the spotlight. The detailed investigation included the analysis of several key areas outlined below.

Key Areas of Investigation

REFRIGERATION
AngloGold has a scheduled maintenance plan requiring refrigeration machines to be inspected and heat balanced at regular intervals. A typical finding is an insufficient heat transfer across some of the condensers and therefore efficiency losses. It is possible to cost the effects of scale build- up by a heat-balance and hence determine the optimal time to clean this equipment to minimise costs. AngloGold have already established a pilot plant testing the feasibility of automatic on line efficiency monitoring and in-line tube cleaning at their Great Noligwa mine. A further potential saving is to insulate these vessels.

- **COMPRESSORS**
  At AngloGold's Kopanang and Tshepong mines, hot water from compressor coolers is successfully being used for supplying hostel change houses with hot water requirements. The same could be investigated for Elandsrand. This is an effective use for waste heat. Additionally the cost of losses caused by the pressure drop across compressor inlet air filters can be calculated. This will give an indication of the best time to change the filters.
- **COMPRESSOR COOLING TOWERS**
  There appeared to be room for some efficiency improvement here. The cooling towers were returning water above design temperature to the compressor station. This issue was taken up with mine staff.
- **ENERGY RECOVERY**
  Elandsrand mine recovers energy from water supplied to the lower levels via pelton wheel turbine driven generators. AngloGold is similarly investigating alternative energy saving methods of pumping water, namely a three pipe chamber feed system, operational at Tshepong, and a water transformer being installed at Moab Khotsong. **ENERGY MANAGEMENT**
  While energy is currently accounted to macro processes, as far as the metering allows, the next level of accounting would be to individual end users, for charging direct utility costs. This is in line with current AngloGold policy to distribute energy costs as close as practicable to the end user. Elandsrand appears to be on the most cost effective tariff, currently using the Eskom Real Time Pricing option on tpo of their previous Nightsave KVA tariff.

Having highlighted the potential cost areas, the team proceeded to evaluate and categorise their benefit.

Evaluation Criteria

The following table identifies some of the key areas where energy saving could be achieved. These include: a cost estimate, the projected benefit to the company (in monetary terms), duration of the proposed project, the estimated return on investment, as well as the category of expenditure.
Type of expenditure was categorised as follows:

- IMPROVED HOUSEKEEPING (1) Covered by maintenance budget.
- LOW-COST MODIFICATION (2) Covered by maintenance budget.
- MEDIUM COST MODIFICATION (3) A one-off investment, which is expensive in relation to the value of existing equipment.
- HIGH COST MODIFICATION(4) Substantial capital outlay on new equipment.

	Costs	Return	Payback	Category
Rigorous Compressed air saving programme	R192 000 pa	R384 000 pa	6 months	(1)
Rigorous inter-stage cooling maintenance/retrofit for surface air compressors	R500 000 pa	R1 200 000 pa	5 months	(2/3)
Rigorous after-stage cooling maintenance/retrofit for surface air compressors	R500 000	See knock effects	13 months	(2/3)
Knock on effect on refrigiration from improving after-cooler performance		R308 000 pa (Value of additional heat input to mine)		

**All costs indicated above are 'high cost' estimates. In most cases actual costs will be lower.(Similar low savings estimates were chosen.)*

Selected Results & Other Activity

Selected Results

After having completed the more detailed analysis, new energy saving opportunities, as well as those listed in the walk through, were identified. The table below highlights some of the main recommendations from this study, and includes projects identified by AngloGold and the team.

INVESTMENT VS ANTICIPATED PERIOD OF PAYBACK

ALL MEASURES:

- The total investment required for the execution of all the above listed projects was R 1.293m.
- The total annual energy earning for the above is: R1.99 m per annum
- The overall payback is approximately eight months

MAINTENANCE & LOW COST MEASURES:

- The total investment required for the execution of all the above listed maintenance and low-cost (category (1) & (2)) projects was R692 000
- The total annual energy earning for this is: R1 584 000 pa
- The payback for these measures (class 1 & 2) is approximately five months

ENVIRONMENTAL CONSIDERATIONS:

- GLOBAL ENVIRONMENT: Reduction in CO2 emissions: 9 700 000 tons pa
- NATIONAL ENVIRONMENT: Reduction in SO2, emissions: 70 000 tons pa

Reduced environmental emissions from coalfired power stations providing less power.

Other Areas of Activity

ETA AWARDS:

- The Eta awards, sponsored by Eskom and SABS, are awards to the year's most outstanding energy efficiency initiatives. The Energy monitoring and accounting system used on AngloGold won this award in 1997 by the developers - IST Otokon.
- This year AngloGold is one of the finalists for this year's award. Their entry involves the implementation of a comprehensive real time monitoring and control scheme to respond to real time pricing signals received daily from Eskom. The investment was 0.33 million Rand and the payback an impressive 7.2 million rand per annum.

MONITORING AND TARGETING:

- AngloGold monitors and benchmarks the energy performance of each operation. Elandsrand has formed an energy management team lead by the "utility" engineer.

RETHINKING REFRIGERATION PRACTICES:

- The current utilities' engineer at Elandsrand initiated the pre-cooling of underground hot water dams directly. This gives a better cooling thermal efficiency than conventional cooling from the hot to the cold dam.
- Another initiative included decreasing condenser water solids by changing the existing configuration of the existing plant, improving heat transfer and therefore achieving higher efficiencies and savings.

Recommendations

- **PAYBACK OPPORTUNITY**
  By addressing the issues identified, the exercise indicated that savings of R 2 million per year, at a capital payback of less than a year, are achievable.
- **COMPRESSED AIR GENERATION**
  The Elandsrand team has implemented several excellent energy efficient initiatives. They are currently improving surface compressor control. Moore Controllers will optimise compressor sequencing thus ensuring the most efficient combination of operating the five surface compressors.
- **COMPRESSOR INTER-STAGE COOLING**
  Ensuring that inter-stage and after-cooling for the compressors run as close to design conditions as practicably can make further savings possible. A saving of about R100 000 a month could be derived from the decreases in the input work to the compressor due to correct isothermal operation. By ensuring that compressed air is cooled before leaving the compressors would contribute to minimising the heat input to the mine. This would have further spin off in improving environmental conditions underground. In some cases savings in capital equipment could be achieved.
- **COMPRESSED AIR DISTRIBUTION**
  For compressed air distribution, it was recommended that a rigorous leak detection and repair program should be implemented and that the responsible staff should have more authority to enforce repair when this is feasible. This finding has confirmed previous work by AngloGold in this area. Some of the air system may be rationalised by removing or isolating dead legs and minimising pressure drops, as well as isolating certain legs during non-productive hours to prevent leakage. A saving of about R 32000 per month can be achieved by implementing an effective campaign against leaks.
- **LIGHTING**
  AngloGold is investigating the potential for upgrading lighting, and have produced a set of performance criteria for lighting replacements. Upgrading T12 fluorescent lighting systems to T8 (including electronic ballasts) and replacing incandescent lights with compact fluorescent lighting (CFLs) should be considered at Elandsrand. Group replacement of lights based on 70% of the lamp's rated life should also be considered.
- **ENERGY MANAGEMENT TEAM**
  The commitment of the engineering staff to the efficient use of energy on the mine was evident. The possible savings in any plant are directly proportional to the commitment of those who apply these principles. Elandsrand mine is to be commended in this regard.
- **CHARGING USERS FOR CONSUMPTION**
  AngloGold believes end-users should be held accountable for energy efficiency. This should assist in curtailing wastage.
- **REWARDING INITIATIVES AND PROVIDING INCENTIVES FOR STAFF**
  Energy efficiency often requires extra effort from engineers , as it is not yet a high priority issue in South Africa. Rewarding initiatives will go some way in motivating staff to encourage efficiency.

SOUTH AFRICAN BREWERIES plc

Key Areas of Investigation

- **ELECTRICAL ENERGY**
  An audit of all electrical consumption from each substation was completed to obtain a clearer picture of electricity consumption. It was found that the power factor could be improved.
- **BOILERS AND STEAM SYSTEM**
  A comprehensive investigation touched on these aspects: steam flow rate equipment: continuous boiler control; flash steam-, wort kettle vapour-, and condensate recovery from the brew house: use of steam accumulator; and condensate recovery from the packaging hall.
- **COMPRESSED AIR**
  This is an expensive form of energy and it was important to determine the efficiency and application.
- **REFRIGERATION**
  Streamlining the energy usage would include rescheduling of refrigeration loads, compressor sequencing and control, as well as cooling towers.
- **AIR CONDITIONING**
  It was noticed that small single units, which are not efficient in energy use, are used rather than efficient centralised units.
- **ENERGY MANAGEMENT**
  It appeared that the timing of production schedules was made arbitrarily. With little or no effect on the final product, these schedules could be changed to make a significant reduction in utility consumption and eventually costs.

Having highlighted the potential saving in energy costs, the team proceeded to evaluate these key issues according to succinct evaluation criteria.

Evaluation Criteria

The following table identifies some of the key areas where energy saving could be achieved resulting from this work and selected examples of other SAB initiatives. Where possible, these include: a cost estimate (which was a 'high-end cost' where a range was considered), the projected benefit to the company (in money terms), duration of the proposed project (time frames), the estimated return on investment (months) as well as the category of action required.
Proposed action for the case studies evaluated in this program were categorised as follows:

- IMPROVED HOUSEKEEPING (1) Covered by maintenance budget or required changes in behaviour and/or schedules
- LOW-COST MODIFICATION (2)
- RETROFIT (3) Refers to a significant one-off invest ment which is expensive in relation to the value of existing equipment
- SUBSTANTIAL CHANGE INVOLVING SIGNIFICANT INVESTMENT (4) Similar to retrofit, costs may be substantial and it usually requires capital outlay on new equipment

	Costs	Return	Payback	Category
Improved power factor correction	R60 000	R120 000 pa	6 months	(3)
Refrigiration load management	R650 000	R650 000 pa	1 year	(1 & 4)
Spent grain removal Load management	Zero	R6 000 pa	Immediate	(1)
Rigorous program for Saving compressed air	R75 000	R150 000 pa	6 months	(1)
Rigorous program for Saving steam	R100 000	R200 000 pa	6 months	(1)
Boiler automation	R100 000	R132 000 pa	9 months	(3)
Use of waste biogas	R32 000	R52 000 pa	9 months	(2)
Efficient lighting upgrades	R165 000	R165 000 pa	1 year	(3)

**All costs indicated above are 'high cost' estimates. In most cases actual costs will be lower.There are*

There are of course many more.

Selected Results & Other Activity

Selected Results

After having completed the more detailed analysis, new energy saving opportunities, as well as those listed in the walk through, were identified. The table below highlights some of the main recommendations from this work, and some other key SAB energy and money saving programs.

Other Areas of Activity

- Electrode Boilers (CT) SAB in Newlands, Cape Town, have recently switched from using coal and oil fired boilers to electrode boilers. This change has resulted in a boiler efficiency improvement of close to 15%, and the reduction of thousands of tons of local pollutants, a sensitive and scenic area.(4)
- Monitoring and targeting SAB has a national monitoring targeting program fostering competition and comparison between plants.(1)

Costs	Return	Payback	Category	
Improved power factor correction	R60 000	R120 000 pa	6 months	(3)
Refrigiration load management	R650 000	R650 000 pa	1 year	(1 & 4)
Spent grain removal Load management	Zero	R6 000 pa	Immediate	(1)
Rigorous program for Saving compressed air	R75 000	R150 000 pa	6 months	(1)
Rigorous program for Saving steam	R100 000	R200 000 pa	6 months	(1)
Boiler automation	R100 000	R132 000 pa	9 months	(3)
Use of waste biogas	R32 000	R52 000 pa	9 months	(2)
Efficient lighting upgrades	R165 000	R165 000 pa	1 year	(3)

Recommendations

- **POWER FACTOR CORRECTION**
  Existing power factor correction equipment could be upgraded to a power factor of greater than 0.97 to achieve a saving of approximately R120 000 per annum.
- **COMPRESSORS**
  Suggestions included: a riqorous leak detection and repair program, shifting compressed air loads (such as for the removal of spent grains) and investigating the most efficient compressor loading.
- **REFRIGERATION**
  The SAB plant at Prospecton had moved some of the load to off peak tariff times at night and this practice should be continued. Additionally, it may be possible to produce some, or all of the chilled liquor at night, and to store it for daytime use. Large quantities could be partially cooled or small quantities could be completely cooled. This would require a short optimisation exercise to determine the best practice with a projected desired payback.
- **BOILER PLANT OPERATION AND STEAM USAGE**
  Installing an in-situ oxygen probe at the ID fan outlet for real-time monitoring would help optimise combustion air to fuel ratios. A digital gauge for stoker speed measurement should be used and all measuring equipment calibrated.

A further energy saving is possible using biogas. Biogas produced in the purification plant could be piped to the boiler plant and introduced directly to the combustion chamber at the forced draft fan inlet. This should be viewed as an interim measure due to its short payback. The process could result in quicker (more energy and cost efficient) start-ups and, due to the large storage of biogas, help meet 'spikes' in steam demand. Approximately one km of HDPP pipe feeding the gas to the boilers, with the right pressure regulation, would act as a 'gas storage vessel'.
There is scope for a rigorous steam leak and trap repair program. This is ongoing at SAB and could be further encouraged via an energy management team.

ENERGY MANAGEMENT TEAM

TO ACHIEVE THE DESIRED RESULTS, THESE KEY ISSUES HAD TO BE ADDRESSED

- **ENERGY MONITORING AND TARGETING**
  (M&T). Prospecton currently has a well run utilities department and the minor adjustments required would not pose any difficulty. SAB has a national energy monitoring scheme, which allows different plants to 'compete' and be compared. Generic suggestions, for M & T as well as the topics that follow, are outlined in more detail in the 'How to' booklet of the 3E program.
- **RESPONSIBILITY AND ACCOUNTABILITY**
  (The following is a common theme in plants audited.) Due to the desegregated nature of 'utilities' consumption, not one particular division assumes responsibility for planning and cost effective utilisation. Significant savings can be achieved by introducing basic constraints to these various consuming sectors. These should be cost driven with final accountability resting with the accounts department and management. Incorporating a summary to an existing regular report could facilitate this. This would also provide a forum for recommendations and innovation.
- **CHARGING USERS FOR CONSUMPTION**
  This is recommended to improve maintenance and curtail wastage.
- **REWARDING INITIATIVES AND PROVIDING INCENTIVES FOR STAFF**
  'Energy efficiency' often requires engineers 'go the extra mile', as it is not yet accepted practice in South Africa. This might be adjusted by rewarding initiatives and creating incentives to motivate staff.

Bottom Line

INVESTMENT VS ANTICIPATED PERIOD OF PAYBACK

ALL MEASURES:

- The total investment required for the execution of all the above listed projects was R 1.18 million.
- The total annual energy earning for the above is: R1.37 million per annum
- This represents a saving of 8% of the total energy consumption
- The overall payback is approximately ten months

MAINTENENCE & LOW COST MEASURES:

- The total investment required for the execution of all the above listed maintenance and low-cost (category (1) & ((2))projects was R175 000
- The total annual energy earning for this is: R258 000 pa
- The payback for these measures (class 1 & 2) was about six months

ENVIRONMENTAL CONSIDERATIONS

- The adoption of all of the efficiency measures will result in a saving of 1 600 tons of coal pa with an associated reduction in emissions.

Key Areas of Investigation

- **ELECTRICAL ENERGY**
  An audit of all electrical consumption from each substation was completed to obtain a clearer picture of electricity consumption. It was found that the power factor could be improved.
- **BOILERS AND STEAM SYSTEM**
  A comprehensive investigation touched on steam flow rate equipment and continuous boiler control.
- **COMPRESSED AIR**
  This is normally a very expensive form of energy and it was important to investigate its efficiency and application.
- **ENERGY MANAGEMENT**
  It appeared that the timing of production schedules was made almost arbitrarily. With little or no effect on the final product, these schedules could be amended to reduce utility consumption, and eventually costs.

Having highlighted the potential saving in energy costs, the team proceeded to evaluate these key issues according to succinct evaluation criteria.

Evaluation Criteria

The following table identifies some of the key areas where energy saving could be achieved resulting from this work and selected examples of other SAPPI initiatives. Where possible, these include: a cost estimate (which was a 'high-end cost' where a range was considered), the projected benefit to the company (in money terms), the estimated return on investment (months) as well as category of action

required. Results were reviewed by the Mandini engineering staff.
Proposed action for the case studies evaluated in this program were categorised as follows:

- IMPROVED HOUSEKEEPING(1) Covered by maintenance budget or required changes in behaviour and/or schedules
- LOW-COST MODIFICATION (2)
- o RETROFIT (3) Refers to a significant one-off investment which is expensive in relation to the value of existing equipment.
- SUBSTANTIAL CHANGE INVOLVING SIGNIFICANT INVESTMENT (4) Substantial capital outlay on new equipment.

	Costs	Return	Payback	Category
Improved power factor correction	R270 000	R540 000 pa	6 months	(3)
Rigorous program for saving compressed air	R53 000	R106 000 pa	6 months	(1)
Rigorous program for Saving steam	R2 011 000	R4 020 000 pa	6 months	(1)
Efficient lighting upgrades	R888 000	R888 000 pa	1 year	(3)

**All costs indicated above are 'high cost' estimates. In most cases actual costs will be lower.There are of course many more.*

Selected Results & Other Activity

Selected Results

After having completed the more detailed analysis, new energy saving opportunities, as well as those listed in the walk through, were identified. The table below highlights some of the main recommendations from this work, and some other key SAPPI Mandini energy and money saving programs.

Other Areas of Activity

- STEAM OPTIMAISATION: SAPPI has an ongoing drive to rationalise the Mandini plants use of steam and formulate a co-ordinated approach to steam monitoring and targeting. This also included a recent extensive steam trap audit.(1)
- 'OPERATION CLINKER' is a program that has been started to try and identify the major energy losses in the Mandini plant and quantify potential energy losses.(1)

	Costs	Return	Payback	Category
Improved power factor correction	R270 000	R540 000 pa	6 months	(3)
Rigorous program for saving compressed air	R53 000	R106 000 pa	6 months	(1)
Rigorous program for Saving steam	R2 011 000	R4 020 000 pa	6 months	(1)
Efficient lighting upgrades	R888 000	R888 000 pa	1 year	(3)

Bottom Line

INVESTMENT VS ANTICIPATED PERIOD OF PAYBACK

ALL MEASURES:

- The total investment required for the execution of all the above listed projects is R3.22m.

- The total annual energy earning for the above is R5.55 m. (Following implementation, an amount of approximately R200 000 per annum should be included in budgets of future years to facilitate and motivate the required activities.)
- This represents a saving of more than 5% of the total energy consumption.
- The overall payback is approximately seven months.

MAINTENENCE & LOW COST MEASURES:

- The total investment required for the execution of all the above listed maintenance and low cost projects is R2.06m.
- The total annual energy earning for this is R4.13m.
- The payback for these measures (class 1 & 2) is about six months.

ENVIRONMENTAL CONSIDERATIONS

- **NATIONAL ENVIRONMENT**
  Reduction in CO_2,emissions: 65 200 tons per annum.
- **LOCAL ENVIRONMENT**
  Reduction in SO_2 emissions: 1185 tons per annum.