Industrial Energy Efficiency Project in South Africa

Case Study – EnMS

Company name	**Sappi Cape Kraft**
Sector	**Pulp and Paper**
Year joined IEE Project	**2012**
Year of interventions	**2013**
Contact person	**Crystal Adams**
Key focus areas of intervention	**Energy Management Systems Implementation**

1. BACKGROUND

1.1 Company profile

Sappi is a global company specialising in the manufacture of paper and paper based products. It has operations in Europe, North America and Southern Africa. It generates sales in excess of 7.4 million tons of timber and paper products per annum and has 13655 employees globally[1].

The Southern African operations have 6 mills, employing a total of 6,222 employees. All mills have achieved ISO9001 and ISO 18001 certification[2]. Sappi South Africa consumes 46.4 million GJ of energy per annum of which 37% (17.4million GJ) is generated in house using bark and black liquor.[3] However, because of the plantations that absorb CO_2, Sappi Southern Africa had a net annual absorption rate of 0.7 million tons of CO_2 in 2013[4].

Plant profile

Sappi Cape Kraft is participating in the Industrial Energy Efficiency Project's training component for the purposes of implementing an Energy Management System (EnMS). This plant is a paper mill based in Montague Gardens, Cape Town, Western Cape and is the only South African plant that specifically uses 100% recycled paper as the input raw material. It manufactures liner board and fluting that is mainly used in the packaging industry.

The mill was commissioned in 1981 and has been upgraded in 1989 and 1995. In 2003 a coater plant was added to the operations. The mill has a gross capacity of 56,000 tons of paper per annum and employs approximately 180 people including contractors.

SAPPI Cape Kraft contribution to the group's emissions was 120,832 tons CO_2 for 2013, based on a total energy equivalent consumption of 128,140 MWh.

[1] Sappi Group Sustainability Report 2013, downloaded from www.sappi.com, January 2014, p15
[2] ibid., p15
[3] Sappi Southern Africa Sustainability Report 2013, downloaded fr0m www.sappi.com, February 2014, p7
[4] Ibid. p41

1.3 Nature of challenges

As part of its drive towards sustainability, Sappi has committed to reducing energy consumption by 15% using 2000 as a base year (from a specific energy of 8.81GJ/ADT[5] in 2000 to 6.73 GJ/ADT in 2015), with overseas operations having already introduced interventions to conform to this requirement.

Higher utility costs, specifically electricity had driven down profit margins at all plants in South Africa. This provided further impetus to the need to reduce energy consumption and to improve operational efficiency.

Using these two challenges, the drive towards energy efficiency was re-initiated by the Senior Process Engineer at the mill following attendance of an Advanced level course on Energy Management Systems Implementation.

The course provided the framework for the implementation of an energy management system within an organisation. Using this framework, Sappi Cape Kraft embarked on a programme to implement an energy management system at its plant in Montague Gardens. The main objectives of this programme were to:

- Identify and realise energy savings within the plant in the short to medium term, and to
- Build skills and capacity within the plant to manage energy in a sustainable manner in the long term.

1.4 IEE capacity building programme

In 2012, Sappi Cape Kraft volunteered to be a candidate plant in the Western Cape for the purposes of implementing an Energy Management System. This programme was conducted under the training component of the Industrial Energy Efficiency (IEE) Project in the custody of the National Cleaner Production Centre of South Africa (NCPC-SA), hosted by the Council for Scientific and Industrial Research (CSIR).

Delegates from the mill have attended various courses presented under this programme. In addition, two external consultants were appointed as part of the training to realise the implementation of an energy management system.

Course Attended	Position
Advanced Energy Management Systems (2 day)	• Process Engineer • Senior Process Technician
Energy Management Systems Implementation Expert Level – 3day	• Senior Process Technician • SHEQ Manager
Energy Management Systems Implementation – Module 2	• Senior Process Technician • SHEQ Manager
Advanced Steam System Optimisation (2day)	• Senior Process Technician • Electrical Foreman • Instrument Technician • Fitter x 3 • Improvement Engineer
Advanced Pump Systems Optimisation (2 day)	• Maintenance Manager
Pump System Optimisation Expert Level – 4 day	• Maintenance Manager

[5] GJ/ADT Gigajoules of energy per air dried ton of paper produced. An industry wide measure that is used to determine specific energy consumption at pulp and paper plants

Sappi Cape Kraft delegates have derived benefit from attending these various courses. Some of the specific benefits include:

- Creating awareness that energy savings opportunities do exist within the host plant
- Sharing energy related knowledge with delegates from different plants and different industries
- Providing a framework from which to conduct energy assessments on various plant processes and utilities in a structured and systematic way
- Gaining an appreciation of measurement of energy in its various forms
- Gaining a basic understating of energy metrics and its applications
- Enabling the integration of energy management system into existing management systems

A major benefit of implementation of an EnMS has been that senior management and process engineering personnel are now viewing the entire plant from a different perspective. They are now seeking to understand the operations better and then trying to develop more efficient solutions. This has been evident in the operation of the paper machine where operations management are investigating the validity of operating parameters that have been used at the plant.

3. KEY ACHIEVEMENTS

Key Findings

Implementation Period	**2012 – 2013**
Total Number of Projects	**5**
Monetary savings in ZAR	**R894,000 per annum**
Energy savings in KWh	**3,436 GJ (944,445 kWh) - Electricity 3.0% of annual electricity consumption 1946 GJ (540,553 kWh) - Steam 0.6% of annual steam consumption**
Total investment made ZAR	**R70,000**
Payback time period in years	**2 Months**
GHG Emission Reduction (ton CO_2)[6]	**1,416 tons per annum**

Following the introduction of the EnMS candidate programme to Sappi Cape Kraft, the energy team embarked on a programme of identifying low cost opportunities for savings. In addition the team were also looking for opportunities that required a minimum of monitoring and measurement and a minimum in design.

These projects were thus based on optimising existing operational processes. Five projects were identified through the EnMS energy planning process and these are:

1. Switch off Frotapulper when making certain grades of paper
2. Switch off Top Line Refiner when making certain grades of paper
3. Switch off Rewinder in the Paper Machine when not required
4. Switch off Cameron Winder in the Coater Plant when not required
5. Implement a steam trap maintenance programme

[6] SA Grid kWh to CO_2 Conversion Factor set at 0.957 as per the 'Journal of Energy in South Africa' – Vol 22 No 4; November 2011.
Low Grade Coal CO2 factor of 1.844kg CO2/kg of coal. From UNIDO Steam System Optimisation Expert Manual: Dr Greg Harrel, Riyaz Papar and the US Climate Registry Default Emission Factors released January 6 2012

Specific changes were introduced in the processes for the preparation of the paper fibre before being formed into rolled sheets. This included the Frotapulper and Top Line Refiner. It was discovered that these machines were not required when producing certain grades of paper. Operators were trained and their work procedures were amended to include these energy saving measures. As result, operators now switch off these machines when certain grades of paper are being produced. Savings have been calculated based on typical production volumes for the various grades of paper. Similar process changes were introduced for the Rewinder in the Paper Machine as well as the Cameron Winder in the Coater Plant.

Two of these projects are described in more detail in Section 5. Other projects involve more detailed investigation and capital requirements and are currently being investigated or implemented. This includes the installation of equipment to optimise plant power factor and an energy efficient lighting retrofit programme for the plant.

One of these projects involves an investigation into the use of alternate steam reticulation technologies. This investigation is still ongoing, but has resulted in many plant stoppages and special production test runs to determine steam consumption base load for existing technologies and savings achieved for newer technologies. Establishing a base load provides a baseline from which to determine the effectiveness of future projects and would also facilitate the development of energy consumption prediction models for capacity expansion. It is assumed that absolute steam consumption has increased in 2013 as a consequence of these tests.

Figure 1 below shows the recent energy consumption in relation to production for the same period. In Sappi's Financial Year 2013 (October 2012 – September 2013), production increased by 4.8% whilst absolute electrical energy consumption remained relatively constant, only increasng by 0.2%. In contrast, steam energy consumption increased by 13.2% despite the steam trap saving.

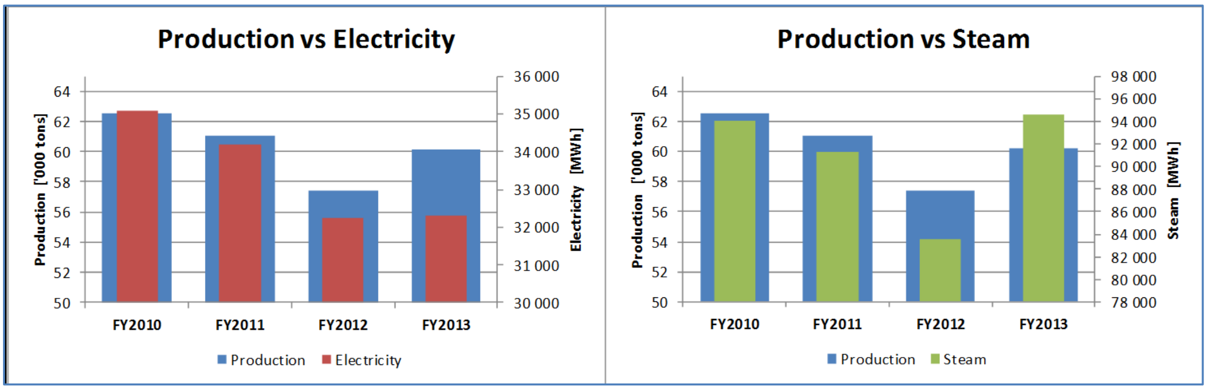

Figure 1: Production vs Energy

3. IMPLEMENTATION OF AN ENERGY MANAGEMENT SYSTEM

Sappi Cape Kraft has demonstrated its commitment to change by participating as a candidate EnMS company. The EnMS has provided the platform to re-launch Sappi Cape Kraft's drive towards energy efficiency and ultimately sustainability, to meet Sappi Corporate objectives. The EnMS Tool developed by UNIDO has been used extensively as a guide to achieve this desired outcome and is described through the following points.

- An energy policy was drafted and integrated into the existing quality management system policies. Roles and responsibilities for Energy Management were defined and assigned to various employees. These employees were then drafted onto Sappi Cape Kraft's energy team.
- As part of the EnMS energy review process the collection of the energy data initially proved onerous. Although Sappi use a central data repository, the data stored is much segmented and not always available in

useable formats. In addition utility data were stored in various formats using different time bases. These needed to be converted before being analysed and used effectively for the purposes of managing energy.
- Analysis of energy data over a number of time bases (monthly, weekly, daily) did not yield any strong driver correlations. This hampered the development of energy performance indicators (EnPIs) since suitable energy consumption extrapolation models could not be established. As an alternative, action plans were developed around significant energy users (SEUs) and local personnel's understanding of these SEU's.
- Further investigations of the identified SEUs were also hampered by the lack of sub-metering. This was most significant for the paper machine and the large machines in the noodle plant.
- The EnMS operational control section identified operational energy savings opportunities. Typically these opportunities required intervention from operators at certain points within the production process. Operators were trained and their work procedures were amended to ensure that the opportunities listed in Section 3 could be successfully implemented. In addition, automated signalling from the centralised control system has also been introduced to prompt personnel when an energy saving opportunity arises in the production process.
- The Design Team are also now required to incorporate energy efficiency into the design of new processes and operations, and equipment specifications. Although no specific criteria were established, the design approval process now requires the Design team to present the energy impact of designs as well as the life cycle cost implications of the various energy efficient alternatives.
- The Procurement Team has amended their purchasing specifications to include energy efficient criteria, specifically for electrical machinery. This required additional training for personnel to understand new energy specific criteria. External vendors were invited to demonstrate their energy efficient products. These vendors included the major motor suppliers as well as some vendors of new steam trap technology. Process engineers and maintenance personnel were included in these demonstrations.

4. IMPLEMENTATION CHALLENGES

Senior management were initially sceptical about how an EnMS could result in significant savings. The perception was that capital would need to be invested to realise significant savings. Energy was further perceived as an expense rather than a controllable cost driver. Reporting of energy data and relating consumption patterns to operational events has facilitated the change in this perception.

The significant bottleneck to implementation revolved around the installation of energy measuring instrumentation. No sub-metering for steam or electrical energy consumption existed. This was in part overcome by using information provided by the steam supplier as a starting point. Temporary electrical metering was installed to monitor SEU electrical consumption. In other areas, electrical consumption was estimated using instantaneous measurements of current (amps) taken at the point of supply. Inadequate labelling and cross-supply of machines from multiple electrical distribution boards made the summation of energy consumption of SEUs difficult, identifying the need for electrical system mapping. Instantaneous current readings were taken to reduce the SEU measurement errors.

Analysis of energy data collected by Sappi Cape Kraft did not yield any good correlations and hence no significant drivers of energy consumption were initially identified. Correlating energy consumption against weather conditions using heating degree days (HDD) and cooling degree days (CDD) did not yield any good relationships. It was found that the reporting periods for energy consumption and production did not match. Monthly production was reported in either 4 or 5 weekly periods, whilst energy consumption was reported for a calendar month. Normalisation of production data to a calendar month has significantly improved correlation between production and energy consumption, yielding an R^2 Value of around 0.5. This is however, still not significant as an energy driver. Variations in product type as well as small hourly variations in energy metered periods have not been accounted for in the model. Further investigation is required to determine suitable energy drivers. It has further been proposed to install a weather station inside the main hood of the paper machine to monitor the micro-climate in the plant as opposed to the general outdoor weather data used in the initial analysis.

The loss of key personnel at critical times during the implementation process has hampered the speed of implementation. The General Manager completed his term of office shortly after the EnMS programme was launched. Initial meetings regarding policy, scope and roles were then repeated with the new General Manager. The Senior

Process Engineer was promoted to a more senior position at the Head Office during the time when action plans were being developed. This person had been the initiator of the project and the senior driving force behind the implementation programme. Repeat meetings were then conducted with the new process engineer to enable the implementation to move forward. The benefit of having a documented process and a systemised approach has minimised the effect of personnel loss, illustrating the effectiveness and value of having an Energy Management System.

Large corporate business entities tend to follow a rigorous process for capital budget approval where all capital projects need to be approved by the Head Office. In general, financial criteria form the main basis of decision making. Here too the advantage of a systematic approach to energy management now allows energy project personnel to assess, qualify and quantify the impact an energy savings opportunity in a manner that will better facilitate the capital approval process.

5. HIGHLIGHTS OF OPERATIONAL/ESO INTERVENTIONS

The two interventions below represent some of the initial success that the plant has achieved with regard to energy savings. Further interventions that require capital investment and more detailed investigation have been planned and are in process.

Frotapulper

Summary of Initiative	
Process	Preparation of Fibre Pulp
Plant	Noodle Plant – Pulping
Energy Source	Electricity
Objective	Stop use of machine when not required
How	Training of operational personnel and process control signalling
Status	Successfully implemented

The Frotapulper is used in the Noodle Plant, where it plays a vital role in the development of the strength of the fibres that will be used in the formation of the paper. In the rotating zone of the Frotapulper, the mechanical work on the fibres is done through the strong shearing forces under high pressure. The combination of shearing, pressure and the heat from steam injection, involves twisting and torsion of the paper fragments followed by gentle de-fibration of the fibre bundles. Friction and rubbing will promote the loosening of fibres, therefore developing strength.

Investigation of operational processes found that the Frotapulper could be switched off when producing low grammage[7] products. Fibre specifications for these products could be achieved without the use of the Frotapulper. The shift foreman authorises this decision when the fibre properties are within specification. On change over to the lighter grammages, an automated notification is sent to the shift foreman and the operator that the machine needs to be stopped.

Frotapulper Savings	
Monetary savings	R 264,000 pa
Energy savings	2525 GJ pa
Energy savings	701,389 kWh pa
Cost of initiative	R 0
Payback period	Instant
Kg CO_2 savings	671,229 kg pa

[7] Grammage refers to the weight and ultimately thickness of the paper

Topline Refiner

Summary of Initiative	
Process	Final Preparation of Fibre
Plant	Noodle Plant - Stock Preparation
Energy Source	Electricity
Objective	Stop use of machine when not required
How	Training of operational personnel and process control signalling
Status	Successfully implemented

A part of the stock preparation phase of papermaking, refining is the most important aspect of the process. In this process the final characteristics of the fibres and the composition of the papermaking furnish that comprises paper are determined. It also determines how the fibres bind with each other during the formation of the paper web and what the various optical, structural, and chemical properties of the paper will be. Inside the refiner, the rotating motion of the stationary Stator Disc and the moveable Rotor Disc against the other rubs, rolls, cuts, frays, and softens the fibres.

Similar to the investigation of the Frotapulper, various trials were conducted to determine the impact of producing the low grammages successfully without operating the Refiner. For low grammages, the topline refiner is now no longer used in the stock preparation process.

Topline Refiner Savings	
Monetary savings	R 78,600 pa
Energy savings	752 GJ pa
Energy savings	208,890 kWh pa
Cost of initiative	R 0
Payback period	Instant
Kg CO_2 savings	199,907 kg pa

6. FUTURE PLANS

Sappi Cape Kraft has developed a list of energy saving opportunities and has outlined actions for them. Implementation of these required more detailed investigation and sound financial analysis. Opportunities currently being implemented include:

- Power factor correction upgrades
- Energy efficient lighting retrofit
- Steam trap maintenance
- Compressed air leak maintenance
- Steam reticulation system upgrade and optimisation

In addition, Sappi also continues to develop and enhance its EnMS. Energy awareness is promoted at selected meetings on a regular basis.

7. LESSONS LEARNED

Lessons learned by the company through the process

- Energy management needs to be introduced in a structured manner in order to derive the maximum benefit
- Specific targets and action plans cannot be developed in the absence of reasonable sub-metering of SEUs
- Accurate drawings of utilities are required in order to ensure safe and reliable measurement of SEUs

Lessons learned by the IEE Project for the company's future consideration

- Some companies in South Africa cannot implement EnMS at the speed proposed by expert training course.
- Companies do not always have the resources to set aside personnel specifically for energy management. The possible use of afull time intern as part of the implementation process may improve this.

How has the IEE project impacted on the company competitiveness and business culture?

- Perception has changed from regarding energy as an uncontrollable input to the process. EnMS implementation has changed the way senior management and process engineers view energy, regarding it as a valuable input to the process that needs to be controlled.
- There is better awareness of energy consumption at all levels within the plant
- Key personnel have gained skills in understanding and interpreting energy data that will inform key decisions and facilitate the development of actions plans to improve long term sustainability. These personnel include support services like Maintenance, Finance and Procurement.
- The EnMS implementation has also created an environment for Sappi personnel to understand their manufacturing processes better and to identify opportunities not only in energy but in other utilities as well as in process optimisation.