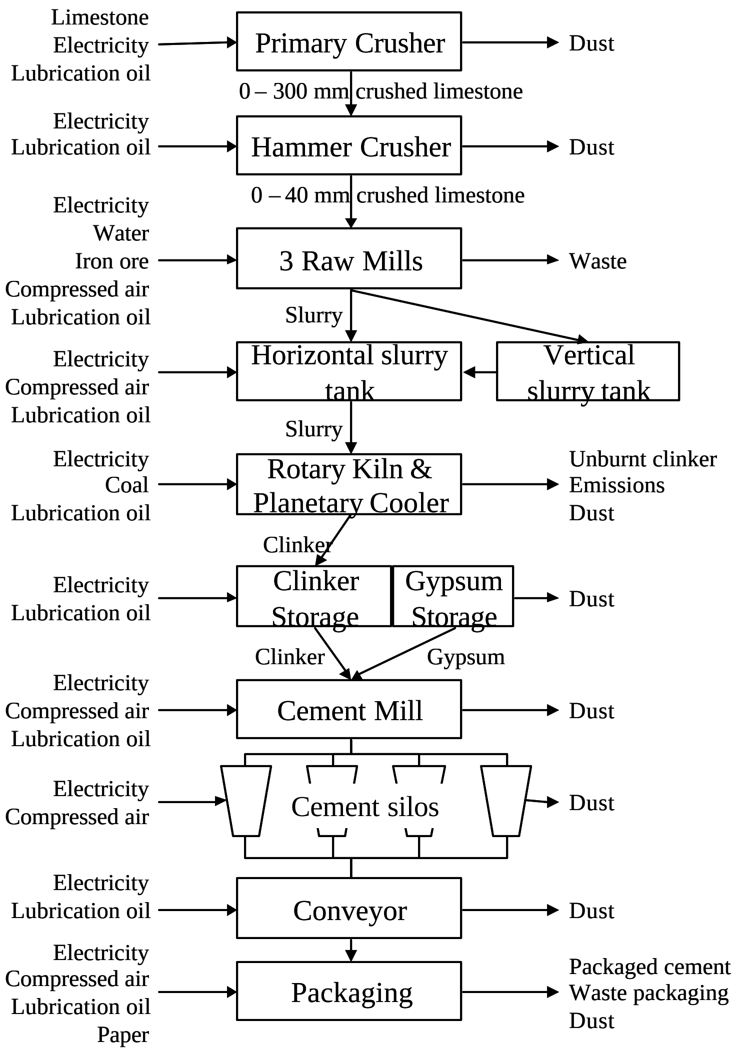
EREL CEMENT LTD

COMPANY DESCRIPTION

Erel Cement is a cement producer in Darkhan, Mongolia. The Darkhan Cement plant was established in 1967 and was privatized and renamed as the Erel Cement in 1998 and has 365 employees. The plant operates between 10 pm and 6 am to benefit from lower electricity tariffs, but the kiln operates 24 hours per day. The plant is closed between December and February because of the cold Mongolian winters. The company's annual production capacity is 200,000 tons and actual production is 80000 tons cement per year. The company participated in the GERIAP project because energy costs are a high portion of production costs, and therefore significant financial savings can be made through energy efficiency.

PROCESS DESCRIPTION

The production process is illustrated below. Most important inputs include limestone, electricity, coal, water, and iron ore and gypsums. Most important outputs include cement, dust, waste, and emissions.



The draft *Company Energy Efficiency Methodology* was used as a basis for the plant assessment to identify and implement options to reduce energy and other materials and wastes. Because this plant was visited several times by the external facilitator and UNEP consultants to trial the methodology, there are many interesting experiences to report:

- ***Task 1a – Meeting with top management***

The company had not previously participated in energy efficiency or cleaner production process. Nor had any other (internal/external) assessment for energy and environmental conservation been conducted to date. However, an assessment of conversion from wet process to dry process was undertaken in the past, but costs were estimated at US$ 20 million, which is considered too high. Therefore the team could start from scratch.
Lesson learnt: For companies that have not been involved in energy efficiency or cleaner production projects before and that have not undertaken formal energy assessments in-house, the *Company Energy Efficiency Methodology* can be applied without having to consider past activities.

- ***Task 1c – Pre-assessment to collect general information***

As part of the in plant assessment, an overview of what is currently measured at each section was prepared, that is provided in the table below. Based on the review it was recommended to

  - Increase the measurement of energy-related indicators (column "Additional data required" in the table)
  - Purchase monitoring equipment (column "Instruments required" in the table)
  - Include energy-related Key Performance Indicators (KPIs) in daily and monthly reports to management

<u>Lesson learnt: Making an overview of what is already measured at the plant can help identify gaps in measurement and what monitoring equipment is needed to measure key performance parameters in the future. This in turn will help with continuously identifying new options for resource efficiency improvements</u>

- ***Task 1c – Pre-assessment to collect general information***

It was found that there is very limited information on energy usage or factors that influence energy usage (e.g. dust), and this is mostly available at plant level only (and only partly at process or section level). Reasons are:

  - This plant level energy information (coal, electricity) is collected for billing purposes but not for managing/reducing the amount of energy used
  - Measurements are made for legal purposes only (e.g. an outside contractor monitors dust levels outside the plant. Erel Cement takes action if measurements are different from normal / legally allowed levels. Dust levels are only monitored visually inside the plant boundaries, for example at the kiln stack and cement silos)
  - Meters at individual processes / equipment do not exist (e.g. compressors) or meters are not used and/or accuracy of existing meters is not known (e.g. cement mills)
  - Measurements are made at section level but not recorded in the company's information system (e.g. coal consumption for sub areas in the Kiln Section)

Analytical and monitoring equipment is not available at the plant for energy-related measurements (e.g. to measure the temperature and composition of exhaust gas in the kiln and to measure power consumption). During the assessment monitoring instruments on loan to the Ministry of Nature and Environment were used.
<u>Lessons learnt: Plants in developing countries often do not have detailed information on energy consumption or other materials consumption and wastes</u>

Table 2. Information currently measured at Erel Cement and suggested improvements related to energy

No	Section	Data Measurements – existing situation					Additional data required	Instrument required
		Information	Who measures	Where measured	When measured	Information receivers		
1.	Crusher (primary and hammer)	Number of dumpers	Receiver	Weighing point	Every time when it arrives	Shift supervisor-economist-chief engineer	- Electricity consumption: kWh - Specific consumption: kWh/tonne - Dust loading in exhaust: grams/m3 of exhaust	Energy meter Portable SPM Analyzer[1]
2.	Raw mill	Weight of 1litre of slurry, particle size, titration, moisture of slurry Produced slurry Iron ore: Moisture, content, chemical content, quantity received	Shift laboratory staff Analytic chemist Receiver	Raw mill Vertical slurry tank Every dumber	Every hour In each shift Every time when it arrives	Machinist-shift supervisor-economist-chief engineer Technology engineer Shift supervisor-Economist-accountant	- Electricity consumption: kWh - Specific electricity consumption: kWh/tonne crushed - Ball wearing rate for each mill separately: Grams/ tonne of raw meal - Dust loading: grams/m3 of exhaust	Energy meter exists but must be calibrated Portable SPM Analyzer
3.	Coal mill	Moisture and of coal Particle size and moisture of coal before mill Moisture of coal after mill Average moisture and particle size of the day Chemical composition of coal	Shift laboratory staff Analytic chemist	Each wagon In each input Each output Mixture of masterpiece Average of mixture	Every 2 hours Daily Monthly	Shift supervisor-technology manager-master-machinist-director of kiln section-economist-chief engineer-director Technology engineer-chief engineer-economist Technology engineer, Mining Company, chief engineer	- Electricity consumption: kWh - Specific electricity consumption: kWh/tonne coal crushed - Coal consumption: tonnes - Ball wearing rate for each mill separately: Grams/ tonne of raw meal - Dust loading: grams/m3 of exhaust	Energy meter exists Tachometer at screw feeders Portable SPM Analyzer
4.	Kiln	Weight, CaCO3, moisture, and water content of slurry Weight of clinker, Stability, mark and coagulation of slurry Chemical component of slurry	Shift laboratory staff Mechanic Laboratory staff Analytic chemist	Horizontal slurry tank Kiln, cooler	Every 2 hours Daily	Shift supervisor-technology manager-machinist-director of kiln section Technology engineer-chief engineer	- O2 before and after cyclone: percentage (1) - Surface temperature: oC (2) - Electricity consumption: kWh - Specific electricity consumption: kWh/tonne clinker (3) - Specific coal consumption: kg / tonne clinker - Dust loading at clinker section (drag chain conveyor)	(1) Portable combustion analyzer & Orsat apparatus at lab (2) Non-contact surface temp indicator (3) Energy Meter (4) Portable

[1] Only two Portable SPM Analysers are needed. One at the kiln, and a second one for other areas.

No	Section	Data Measurements – existing situation					Additional data required	Instrument required
		Information	Who measures	Where measured	When measured	Information receivers		
							and at chimney: grams / m3 in exhaust gas (4)	SPM Analyzer
5.	Cement mill	Particle size, coagulate, mark Average particle size, stability, volume Quantity of produced cement Chemical composition of cement Coagulation + SO3 Moisture content and chemical content, received quantity of gypsum	Shift laboratory staff Mechanic Laboratory staff Shift technology engineer Analytic chemist Receiver	Masterpiece point Vertical tank of cement At wagons	Every hour Daily Every time	Technology engineer O-Shift Supervisor-Technology engineer-Chief engineer Technology engineer-economist-Chief engineer-Director-EREL company Technology engineer-economist-accountant	- Electricity consumption of each mill: kWh - Specific electricity consumption of each mill: kWh/tonne cement - Ball wearing rate for each mill separately: Grams/ tonne of cement - Time between ball charge of each mill: operating hours - Dust loading: grams/m3 of exhaust	Energy meter exists but must be calibrated Portable SPM Analyzer
6.	Packaging	- Coagulation - Stability of cement - Chemical composition of cement - Accounting of dispatched cement	Shift laboratory staff Analytic chemist Shift Supervisor	At each transport Cement reserve	Daily	Shift supervisor-Marketing manager-economist -chief engineer-director-EREL company	- Electricity consumption: kWh - Specific electricity consumption: kWh/tonne dispatched - Dust loading: grams/m3 of exhaust	Energy meter Portable SPM Analyzer
7.	Compressor	- Pressure of oil - Air generator pressure - Voltage - Current - Cooling period	Operator	Control board	Hourly	Shift supervisor-Energy manager-chief engineer	- Electricity consumption of each compressor: kWh - Operating hours of each compressor	Energy meter Hour meter
8.	Electricity	- Quantity of electricity consumed as per the bill - Allocation of electricity consumption to the different sections	Energy Engineer	Monitor station Electrical sub-station	Monthly	Shift supervisor-economist-chief engineer-director	- Electricity consumption of each section: kWh - Power factor of each transformer - Electricity consumption at three billing periods (10pm-6am; 6am-5pm; 5pm-10pm): kWh / day	Energy meter Power factor meter & portable power analyzer
9.	Accounting Section	- Produced cement and cement sales - Cost allocation to sections - Capacity utilization - Remaining material stock report - Monthly balance sheet - Lime stone mined - Cost accounting report - Price change information - Annual report of production by unit (AU 7)	Economist		Monthly Quarterly Yearly	Economist-EREL corporate office	- Specific electricity consumption (kWh) per tonne of clinker and cement - Specific coal consumption (kg) per tonne of clinker	

- ***Task 2e – Quantify losses through a material energy balance***

Because the kiln is the largest energy consumer in the plant it was selected as a focus area. A material energy balance was established for the kiln, which is much easier than for the entire plant. The results showed that the kiln efficiency is only 20% and therefore there is an enormous potentia l for energy efficiency

Lesson learnt: If a material energy balance is too difficult to establish for the entire plant then it can be established for a specific production section or equipment, such as the kiln

Material balance around kiln

1. Basic operation data on necessary raw materials for 1 ton clinker production is as follows:

Lime stone:	1.704 ton
Iron ore:	0.02 ton
Refractory:	0.005 ton
Ash recycles:	0.01 ton
Coal:	0.5 ton (average)
	0.44 ton (at 4500 kcal/kg)
	0.6 ton (at 3500 kcal/kg)

2. Operation data:

Clinker production:	12.5 ton/h
Slurry feed:	33.8 ton/h
Dry material:	21.6 ton/h
Water (36% of slurry)	12.15 ton/h
Coal:	6.25 ton/h (12.5 x0.5)

Heat balance around kiln

Heat input	*kcal/kg.cl.*	*(%)*
1. Heat of combustion of fuel (coal)	0.5 x 4132 = 2066	100
2. Sensible heat of fuel =	0 (ambient temperature)	
3. Heat of combustion of raw material		
4. Sensible heat of raw material	0 (ambient temperature)	
5. Sensible heat of primary air	0 (ambient temperature)	
6. Sensible heat of cooling air of clinker cooler	0 (no heat recovery)	
Total heat input	**2066**	**100**

Heat output	*kcal/kg.cl.*	*(%)*
7. Heat for clinkering	421	20.3
8. Sensible heat of clinker entering cooler	not applicable	
9. Sensible heat taking away by clinker (130 ^{0}C)	21.7	1.1
10. Sensible heat taking away by exhaust from clinker cooler	not applicable	
11. Heat of water in slurry taken away a y taken away as steam in exhaust gas	679	32.9
12. Sensible heat taking away by exhaust gas		
a. Sensible heat of steam emanating from raw material	0	
b. Sensible heat of CO_2 emanating from raw materials	24.0	1.2
c. Sensible heat of combustion gas	400	19.4
d. Sensible heat of leaking air	not applicable	
13. Sensible heat taking away by dust	1.88	0.1
Heat loss due to radiation	518	25.0
Total heat output:	**2066**	**100**
Burning efficiency	**421/2066 =**	**0.2 (20%)**

- ***Task 3c – Screen options for feasibility analysis***

For each of the three focus areas (kiln section, compressor house, and cement mills) a number of possible high-level options were identified. But because data available was limited, the feasibility analysis stage included a number of monitoring tasks. These tasks were discussed among the team members and written down. For example, for the combustion process, the following tasks were identified:

- Purchase portable combustion analyser
- Purchase contact thermometer
- Monitor O2 every shift
- Trial reducing air supply (8%, 7%, 6%, 5%, 4%) and for each % monitor in exhaust before cyclone: O2, CO (CO max limit 80 ppm), Flue gas temperature, Black smoke (no black smoke condition allowed when reducing excess air!!)
- Calculate coal and cost savings for minimum successful O2 level (estimated at 100-200 tonnes for each % O2 reduction)
- Replace the chains and metal plates which are provided inside the kiln

<u>Lesson learnt: It is not always possible to immediately identify options for energy / resource efficiency improvement during the first visits of a plant. In this case it is important to identify tasks to obtain the right information that can be used to identify options for improvement</u>

- ***Task 4c: Prepare implementation and monitoring proposal for top management approval***

Three main options were identified for implementation. But there were several smaller good housekeeping options that required little or no investment and that could be easily implemented in combination with the three recommended options. As a result, a cluster of several options was recommended for the cement mill and for the kiln section.

<u>Lesson learnt: It is often more practical and efficient to select a cluster of options that can be implemented at the same time for a particular focus area</u>

OPTIONS

- Three focus areas were selected for an energy assessment: (1) kiln section, (2) compressor house and (3) cement mills
- The Team identified almost 30 possible energy and waste minimization options. Ten of these options were further investigated. Three main options were implemented, but several smaller good housekeeping options were implemented at the same time.
- For the three cluster options implemented, the total investment costs were US$ 58860, annual savings were US$ 96483 and the combined payback is 0.6 years
- For the four options implemented, the total coal reductions were 7900 tons, electricity reductions were 2 MWh (as some options reduced and other options increased electricity consumption) and net GHG reductions were 19831 tons CO2 per year

A summary of implemented options is given in the table below.

Table: EXAMPLES OF OPTIONS IMPLEMENTED AND INVESTIGATED

FOCUS AREA/ OPTION	CP TECHNIQUE	FINANCIAL FEASIBILITY	ENVIRONMENTAL BENEFITS	COMMENTS
Cement mills / Reduce dust by improved sealing of dust control system *(see case study)*	Good housekeeping Production process / equipment modification	▪ Investment: US$ 2210 ▪ Cost savings: US$ 14400 ▪ Payback period: 2 months	▪ Coal savings: 4500 t/yr ▪ Electricity increase: 302 MWh/yr ▪ GHG emission reductions (net): 11007 tCO2/yr	

FOCUS AREA/ OPTION	CP TECHNIQUE	FINANCIAL FEASIBILITY	ENVIRONMENTAL BENEFITS	COMMENTS
Kiln section / Reduce the number of kiln shutdowns and efficiency improvement *(see case study)*	New equipment / technology	▪ Investment: US$ 42350 ▪ Cost savings: US$ 60,000/yr ▪ Payback period: 0.7 yr	▪ Coal savings: 3000 t/yr ▪ Electricity savings: 450 MWh/yr ▪ GHG emission reductions: 7966 tCO2/yr	Four VSDs were installed Several good housekeeping options were also implemented to reduce energy losses
Kiln section / Reuse of cooling water from central motors and compressors *(see case study)*	Onsite reuse / recovery	▪ Investment: US$ 12500 ▪ Cost savings: US$ 29083/yr ▪ Payback period: 5 months	▪ Electricity increase: 150 MWh/yr ▪ GHG emission increase: 146 tCO2/yr ▪ Water savings: 72000 m3	Implemented
Compressor house / Improved sealing of dust control system *(see case study)*	Good housekeeping	▪ Investment: US$ 2210 ▪ Cost savings: US$ 14400 /yr ▪ Payback period: 2 months	▪ Coal savings: 4500 tons/yr ▪ GHG emission reductions: 11007 tCO2/yr	Implemented

FOR MORE INFORMATION

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