PROJECT FUNDING FOR ENERGY

Piet Heersche and Dr Hans Wilhelm Meyer, Cemcon AG, Switzerland, outline the benefits of dedicated funding plans for cement plant projects, including energy conservation and CO_2 reduction projects.

Introduction

Project funding and financing through private, developmental or commercial financial institutions has become a critical part of an overall large capital project development and approval in the cement industry.

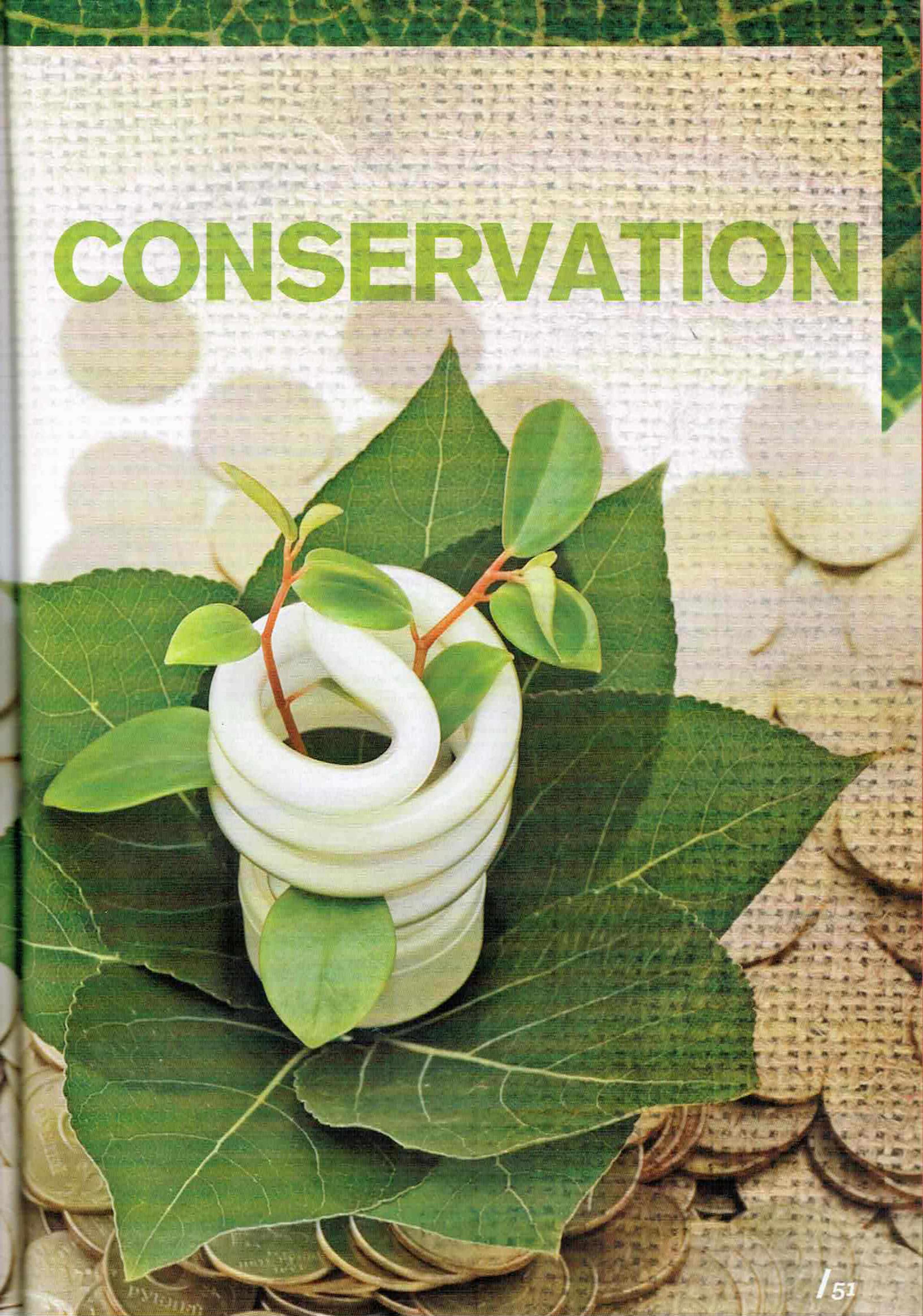
Funding criteria depend on a variety of factors, including the commercial situation of a cement manufacturing company, the project location, as well as the actual situation of plant technology and the overall financial performance of the large capital project. Moreover, attractive long-term loans could supplement the project feasibility.

Many loaning institutions and banks, in particular those that support sustainable development such as the World Bank, the European Investment Bank (EIB), the Deutsche Investitions-und Entwicklungs Gesellschaft (DEG), etc., have established dedicated funds for energy conservation projects. These funds have not been recognised and utilised by owners, although many cement plant modernisation and/or upgrading projects are directly related to energy conservation. CEMCON has identified that the key to applying for such funds is a standardised energy conservation assessment (ECA) to validate the proposed energy savings relevant to the loaning application.

CEMCON, based in Switzerland, is specialised in the cement, mineral and environmental industries and is an independent partner for the development of large capital projects and energy conservation assessments. The company provides technical and strategic expertise and access to its global project and energy databases.

CEMCON has successfully completed various energy conservation assessments. Recently, two projects in Myanmar, one of the fastest growing cement markets in Southeast Asia, were the subject of these assessments and ECA. Both plants were operated on low capacity 500 tpd, wet process technology but are subject to modernisation, utilising a dry process system, and a capacity increase to 2100 tpd. The projects have been selected as a background to this article, as most major

CONSERVATION



aspects of potential energy savings in relation to application for energy conservation funds were incorporated in this ECA. The outcome of the assessments resulted in general considerations in addition to the particularities of each project, and these are presented below.

Systematic of an ECA

An energy conservation assessment considers all aspects of energy savings. Strategic energy conservations can be categorised as follows.

Technology/machinery related energy savings included:

- Thermal energy conservation.
- Electrical energy (MV as well as LV) conservation.
- Alternative energy generation (e.g. waste heat recovery, wind energy, solar energy, etc).
- Alternative heating by waste gas utilisation or air conditioning by solar energy.

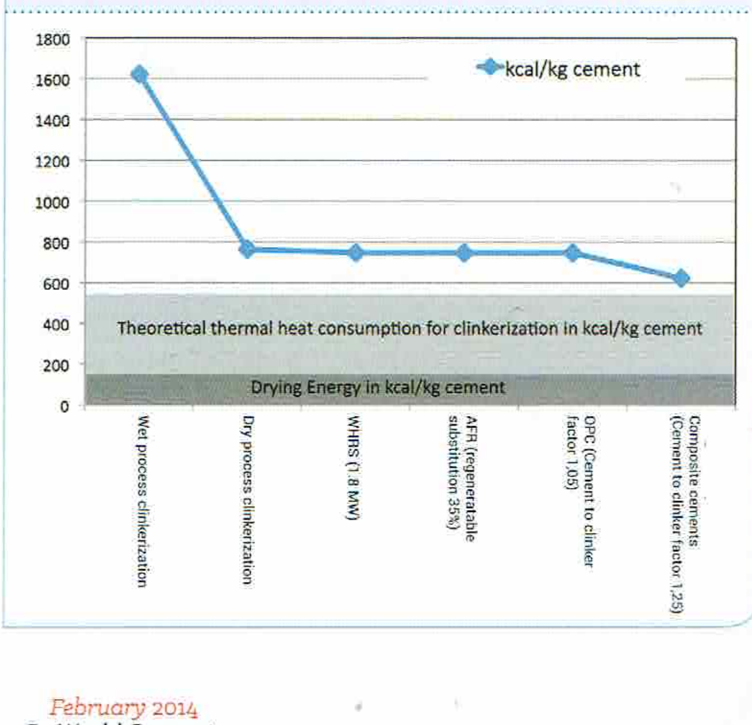
Product related energy savings included:

- Optimisation of raw mixture and clinker composition.
- Utilisation of alternative fuel and raw materials (AFR).
- Substitution of clinker component in cement and improvement of the cement product portfolio.

Table 1. **Schematics of categorisation of energy conservation measures and its effects**

+	Low priority: low conservation potential, economically unfeasible or low application potential.
++	Medium priority: medium conservation potential, acceptable economical feasibility or medium application potential.
+++	High priority: high conservation potential, good economical feasibility and/or high application potential.

Figure 1. Major measures and related saving of thermal energy per tonne of cement.



An energy conservation assessment not only includes direct savings in energy and related commercial benefits, but also has environmental benefits. A major requirement is also the tracking and reduction of the CO_2 emissions as a result of a particular energy conservation project/measure.

All energy savings and CO_2 reductions are then transferred into an energy conservation passport, a standardised format allowing the direct comparison and effect of each energy conservation measure. The effect of each energy conservation measure is categorised according to its priority and indicated in the passport as per the schematics shown in Table 1.

According to this standardised categorisation in the energy conservation passport, a decision on the feasibility (on a stand-alone basis) and priority of each conservation measure can be concluded.

Example: Myanmar cement plant

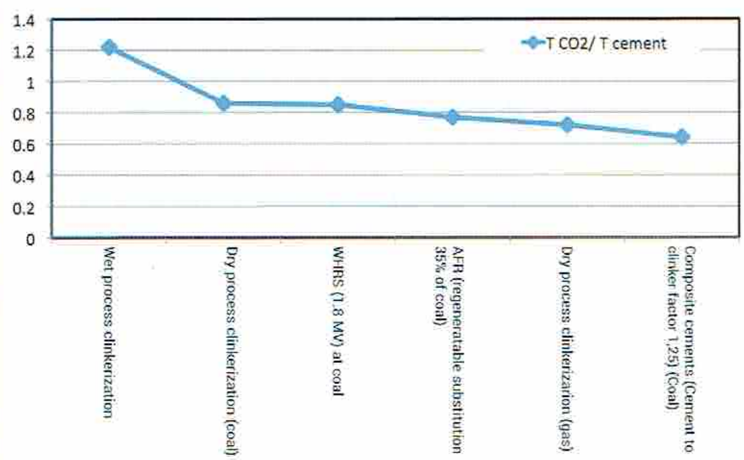
Cemcon completed an ECA as an impartial expert on behalf of an internationally active loaning institution for a cement producer in Myanmar. The cement industry in Myanmar is still in the process of privatisation from public ownership (state, governmental bodies and communities). The client, a major industrial conglomerate in the country, operates two almost identical wet kiln lines, each with a 500 tpd rated production capacity. Although both plants were commissioned recently (within the past 3 years) they have a small capacity and are based on wet process kiln technology. The plants were supplied by a contractor on an EPC (turnkey) basis. The technology and equipment quality is below international industrial standards and operational benchmarks are not achieved. In order to retain profitability, and as a direct result of the high thermal and electrical energy demand and coal prices in Myanmar, the plants are subject to upgrading/modernisation to dry process technology and a capacity increase to 2100 tpd.

Wet to dry process

The major thermal energy savings of the project are listed in Figure 1. It is obvious that the change from wet to dry process technology will achieve the most significant saving on thermal energy. Compared to an energy consumption of approximately 1620 kcal/kg of OPC cement, a reduction to approximately 762 kcal/kg of OPC cement will be achieved. This is equivalent to 60% of energy conservation. To do so, a 5-stage preheater, a calciner and a tertiary air duct will be installed. The 3.5 m dia. kiln is cut at approximately 86 m and the existing grate cooler is extended but will not reach BAT recuperation figures. For this reason, 762 kcal/kg of OPC cement (cement-to-clinker factor = 1.05) equates to heat consumption of approximately 800 kcal/kg clinker. The calciner is designed with a gas velocity of approximately 14 m/s and a retention time of 5 seconds.

Figure 2. Sugar cane cultivation in the vicinity of the Myanmar cement plants. Sugar cane is processed in two sugar mills near the cement plants.

Figure 3. Major measures and related saving of CO_2 per tonne of cement.



In addition, the following new equipment relevant to energy and CO_2 conservation will be installed during the upgrading/ modernisation project:

- New two-stage limestone crushing system (300 tph).
- New clay/laterite crushing system (100 tph).
- Replacement of the existing wet ball mill with a modern vertical roller mill (170 tph, 1600 kW).
- Installation of two raw meal silos (23 000 t).
- Installation of a 1.8 MW waste heat recovery system (WHRS).
- Installation of an additional ball mill system for cement grinding (4.2 m dia. x 14 m, 100 tph at 3400 Blaine, 3350 kW).
- Installation of an additional 7000 t cement silo.
- Installation of an additional cement packing station.

Waste heat recovery system

The raw material moisture at both plants is very low. During dry season the raw mix moisture reaches figures below 1%, and in the monsoon season the value increases to 2.9%. However, a low grade (<4500 kcal/kg) lignite coal with a high moisture content of up to 35% during wet season needs to be dried. Due to the low moisture content of the raw materials, the thermal energy content of the preheater exhaust gas is sufficient for drying both the raw mixture and the coal. For this reason the major part of the cooler exhaust air is available for a WHRS, creating 1.8 MW of electrical energy. This energy recuperation/regeneration results not only in a reduction of specific thermal energy consumption of 17.8 kcal/kg clinker, but also provides sufficient energy for continuous operation of the core processing machinery of the plant (the kiln line, in case of electrical power "brown outs" of the public grid).

AFR utilisation

Because of the design of the calciner, and the multi-channel main burner, the utilisation of alternative fuel and raw materials (AFR) is applicable. There are tremendous amounts of biomass materials (rice husk and sugar cane bagasse) available in the areas surrounding the cement plant (Figure 2).

Sugar cane bagasse is a waste product from sugar milling with a specific calorific value of up to 3000 – 3200 kcal/kg (dependent on process and moisture). Rice husk usually indicates a stable calorific value of 3200 kcal/kg. Only 20% of the available sugar cane bagasse and the rice husk are currently used for energy generation in Myanmar. Hence sufficient material is available to substitute up to 35% of the primary thermal fuel, which at present is lignite coal. This substitution does not result in a further decrease in thermal energy consumption, but provides significant environmental benefits in reducing the CO_2 emissions of the plant (Figure 3). Biomass is qualified to reduce the CO_2 emissions of the plant by 0.31 t CO_2/t of OPC cement, as rice husk and sugar cane bagasse are considered carbon neutral fuel sources. Based on the future capacity of 2100 tpd, the emission savings accumulate to 246 078 tpa of CO_2 for each plant.

Not only does the use of biomass AFR result in improved environmental performance, it also results in a significant improvement in financial performance of the production plant through the substitution of the primary fuel coal with AFR, as well as potential emission credits for reduced CO_2 emissions.

Change from coal to natural gas

There is a natural gas pipeline available in the direct vicinity of the plant site. Due to the extremely high transportation costs for the low quality lignite coal over a distance of 560 km, natural gas could be an alternative source of primary fuel. However this is dependent on the agreed terms and rate of the natural gas. Utilisation of natural gas, instead of the lignite coal, does not reduce the thermal energy consumption but will lower the CO_2 emissions by 0.15 t CO_2/t of clinker, and provide an improvement in environmental performance. At a production capacity of 2100 tpd this would result in savings of 97 650 t of CO_2 for one plant.

Change of product portfolio (OPC to composite cements)

Currently only OPC according to EN 197–1 is produced at the plants. The actual cement-to-clinker factor is 1.05 due to the addition of only 5% gypsum to the cement. The cement has a fineness of 3400 Blaine and its compressive strength still remains below 59 MPa at 28 days. At present, the products are produced in accordance with the current market requirements in Myanmar.

A change in the cement product portfolio, reducing the production of OPC cements and increasing the production of composite cements, results in a reduction in specific CO_2 emissions. A reduction in the specific production cost per tonne of cement produced a direct financial benefit. Such changes in the product portfolio are directly linked to the sales and marketing strategy of the owner. In this example the owner is vertically integrated downstream and as such can channel a significant portion of the plant's production capacity within their own value chain and define product requirements. The conservation potential of specific CO_2 emissions by each major conservation measure is listed in Figure 3.

Trass is available in the vicinity of the plants. The initial target is to produce a composite cement with 15% trass addition. Furthermore, limestone could be added as another additive in the range of 5% according to EN 197–1. The resulting composite cement would have a cement-to-clinker factor of 1.25. This will result in indirect energy consumption and a CO_2 conservation of 20% of actual specific thermal energy and CO_2 emission. Compared to OPC production of the upgraded/modernised plant at 2100 tpd and coal firing, thermal energy savings of 160 kcal/t of cement and 0.18 t CO_2/t of cement (117 180 tpa CO_2) could be achieved. These savings are of a secondary character based on the "dilution" of the OPC, but are an efficient method of conserving energy and CO_2.

In many cases production of composite cements requires a higher electrical energy consumption due to an increase of cement fineness and increased material grindability of cement additives (e.g. industrial blastfurnace slags). Naturally occurring mineral components, such as pozzolan and trass, typically have lower material grindabilities as compared to clinker. When no specific data is available, and the grindability of trass normally

Table 2. **Thermal energy conservation passport**

		Machine/plant department		Priority/relevance	
Thermal energy conservation measure:		**Pyro line with operation on coal**		**+++**	
Modification from wet kiln process to dry kiln process with preheater, calciner and recuperation of tertiary air from the clinker cooler. Currently the water of the raw mixture slurry of the wet process needs to be evaporated before the sintering process. Raw mixture compostion and fuel (coal) will remain unchanged. The change in process technology results in a significant reduction of the specific thermal heat consumption from 1700 kcal/kg clinker to guaranteed 800 kcal/kg clinker.					
Actual situation			**Future situation**		
Calculation input			Calculation input		
Specific thermal power consumption	1700 kcal/kg		Specific thermal energy consumption	800 kcal/kg	
Rated production capacity	500 tpd	155 000 tpa	Rated capacity	2100 tpd	651 000 tpa
Calorific value per t coal	4500 kcal/kg		Calorific value per unit	4500 kcal/kg	
Energy price/unit	US$92/t		Energy price per unit	US$92/t	
Actual situation			**Future situation**		
Actual total energy consumption	850 000 Mcal/day 263.5 million Mcal pa		Future total energy consumption	1.68 million Mcal/day 520.8 million Mcal pa	
Conservation potential	**Energy savings**		**900 kcal/kg clinker**	**585.9 billion kcal pa**	
	Commercial savings		**US$38 640/day***	**US$11.978 million pa***	
Actual situation			**Future situation**		
Actual CO_2 emission (absolute)	645 tpd CO_2	199 950 tpa CO_2	Future CO_2 emission (absolute)	1890 tpd CO_2	585 900 tpa CO_2
Actual CO_2 emission (specific)	1.29 t CO_2/t of clinker		Future CO_2 emission (specific)	0.9 t CO_2/t of clinker	
Conservation potential	**CO_2 reduction**		**0.39 t CO_2/t of clinker**	**30.2% CO_2**	

*Savings based on upgraded production of 2100 tpd.

eaches similar figures compared to clinker, a 10% increase in ectrical grinding energy has been considered.

Frequency controlled MV motors

n many plants, including this case study, only fixed speed MV electro motors are installed at the major drives of the plant imestone crusher, raw mill, kiln fan, cement mill and coal mill). As part of the modernisation project, new equipment will be installed, including frequency controlled MV motors. This will result in a specific saving potential of electrical energy of 10%/t of cement for all MV drives.

Motor controllers at LV motors

LV motors typically run at a fixed speed under the provision of rated load requirement. In many applications in a cement plant (e.g. at bucket elevators, belt conveyors, etc.), fluctuations in material load could save electrical energy. To do so, LV motors could be equipped with power saving controllers. Such controllers could reduce the power consumption of selected LV motors by up to 20%.

Minor energy conservation measures

Besides the major energy conservation measures identified at this cement plant, a series of minor but mentionable energy saving measures have also been recognised:

- Optimisation of mining machinery could reduce transportation costs of raw materials.
- Optimisation of the composition and burnability of the raw mixture (LSF, SM) could result in savings of thermal energy.

Energy conservation passport

The ECA results in the issue of an energy conservation passport for qualified measures, or according to the relevant department of a cement plant.

The energy conservation passport of a specific energy saving measure (thermal and/or electrical) includes the existing energy consumption, the future energy consumption, the financial impact (saving potential of energy and cost, as well as the environmental impact) and the CO_2 emission balance, if applicable.

As an example of an energy conservation passport, the exchange from wet to dry process at one Myanmar plant is provided in Table 2.

Conclusion

An ECA and corresponding energy conservation passport(s) provide a basis for the application of energy conservation funds of loaning institutions. The given example of a large capital project does not include the complete spectrum of options of energy and CO_2 savings within a cement plant project, but it provides a clear and targeted overview of the environmental and financial performance possibilities.

The option to fund a large capital cement plant project (at least partially) through energy conservation funds should not be underestimated or neglected.