UNFCCC Secretariat
Martin-Luther-King-Strasse 8
D-53153 Bonn
Germany

Att: CDM Executive Board

DET NORSKE VERITAS
CERTIFICATION AS
*International Climate Change Services*
Veritasveien 1
NO-1322 Høvik
Norway
Tel: +47-6757 9900
Fax: +47-6757 9911
http://www.dnv.com
NO 945 748 931 MVA

| Your ref.: | Our ref.: | Date: |
|---|---|---|
| CDM Ref 0872 | ETEL/KCHA | 17 April 2007 |

# Response to request for review
# "4.0 MW Power Plant Using Clinker Cooling Gas Waste Heat" (0872)

Dear Members of the CDM Executive Board,

We refer to the requests for review raised by five Board members concerning DNV's request for registration of the "4.0 MW Power Plant Using Clinker Cooling Gas Waste Heat" (0872) and would like to provide the following initial response to the issues raised by the requests for review.

***Comment 1:***

*Even acknowledging that this is a SSC project activity, the arguments for substantiating additionality raise questions on the IRR calculations. In applying the investment – benchmark analysis the calculations of the project IRR were based on the actual (2006?) costs for purchase of electricity from the grid of Rs 2,50. However at the time of decision making on this project (May 2005, followed by order placing on 7th September 2005) it is reported that the purchase price of electricity from the grid was Rs 3,50. This would result in an IRR being higher than the applied benchmark. Hence there are serious doubts on the additionality of the project activity.*

*The IRR calculation to demonstrate that the project is less attractive than the applicable benchmark has most probably used too pessimistic data on the price of electricity and this makes the additionality claimed questionable.*

**DNV Response:**

We reiterate that the project utilises the waste heat from clinker cooling gas from a granulator for generating electricity, which again displaces <u>an equivalent mix of grid power as well as captive electricity generation from fossil fuels.</u> Since the project replaces power, equivalent to weighted average of both the grid power and captive generation, the energy charges considered are therefore the average cost of purchase from the grid and captive generation from the previous two years (i.e., 2002-03 and 2003-04) from date of project conceptualization. This weighted average of energy cost has been determined to be INR 2.51 per kWh as indicated below:

| Year | From Grid | | | | From Captive | | | | Avg. Cost, Rs/kWh |
|---|---|---|---|---|---|---|---|---|---|
| | % of Power | Units, kWh | Cost, Lakh | Cost, Rs/kWh | % of Power | Units, kWh | | Cost | |
| 2002-03 | 41.5 | 81192471 | 146.8 | 1.81 | 58.5 | 114465499 | 329.3 | 2.88 | 2.43 |
| 2003-04 | 60.79 | 117196787 | 290.17 | 2.48 | 39.21 | 75589166 | 211.69 | 2.80 | 2.60 |
| **Average Power cost to the company, INR/kWh** | | | | | | | | | **2.51** |

It is also established and verified by DNV that:

- The cost of electricity purchase from the grid at INR 2.50 is cheaper than any other source of generation in the plant, and it is also the prevailing practice in the industry to import the cheaper power from the grid than having own captive power generation for regular usage, as indicated in our validation report
- The Government of Andhra Pradesh has been encouraging HT (high tension) consumption of grid power instead of captive generation by offering subsidies and incentives for HT consumers. This is evident from decrease in captive generation for the past three years and an increase in grid power consumption. With this trend it was expected that the cost of grid power would come down to INR 2.80 per unit and get further reduced to INR 2.50 with the deduction of incentives for power intensive industries of the size of the cement plant, during the year the project was planned to become operational and starting to yield returns. Hence, a combination of the arguments for using INR 2.50 per kWh in the IRR calculations was considered realistic and conservative and was accepted by DNV during validation.

We also reiterate, that nowhere in the PDD or in DNV's validation report, has it been reported that the purchase price of electricity from the grid was INR 3.50.

Given the above, a value of INR 2.50 considered as the average power cost to the company is deemed to be appropriate and justified.

***Comment 2:***
*The technology is widespread in the world, so that the project activity would be common practice in the sector, while the PP has indicated that the project is the first of its kind in the cement sector in the region. The PP should clarify how the region was defined.*

**DNV Response:**

We reiterate that it is not a common practice to generate power from low quality waste gases in the cement industry using ORC (organic Rankine cycle) technology. It has been clearly addressed in DNV's validation report that (section 3.4): *It has been demonstrated through data from the CMA (Cement Manufacturer's Association of India) that most of the cement plants in the state of Andhra Pradesh are either connected to the grid or have generating sets that meet the total or part of their power requirements. Of the 21 cement plants in the state there is only one other cement plant that generates power from waste heat recovery based captive power plant, although not by adopting the ORC technology. It has also been established through a report by National*

*Council for Cement and Building Materials (NCCBM), that there exists a total recovery potential of about 200 MW in the 45 Indian cement plants with a capacity greater than 1 MTPA (Attachment 1). Till date not a single plant in the cement industry in India has implemented ORC technology. UTCL is the first plant to use pentane based ORC technology. The validation team witnessed a declaration from the technology supplier Ormat, Israel as a support for this argument. Hence, it is deemed confirmed that generation of power from low quality waste gases in the cement industry using ORC technology it is not representing common practice in India.*

DNV was able to verify that the waste heat recovery project using organic Rankine cycle technology for generation power is a first of its kind in India. A letter from the technology supplier ***Ormat-Israel*** that was presented for DNV verification is attached for your perusal (Attachment 2)

We sincerely hope that the Board accepts our aforementioned explanations and we look forward to the registration of the project activity.

Yours faithfully
for DET NORSKE VERITAS CERTIFICATION AS

Einar Telnes
*Director*
International Climate Change Services

C Kumaraswamy
Manager – South Asia
Climate Change Services

Attachments:

Attachment 1: Energy efficiency improvement in Indian cement industry

Attachment 2: Letter from the technology supplier ORMAT.

Attachment 1:
Energy efficiency improvement in Indian cement industry

# ENERGY EFFICIENCY IMPROVEMENT IN INDIAN CEMENT INDUSTRY

## 1.0 INTRODUCTION

The escalating costs of cement manufacture over the years and increasing competitiveness have resulted in a focused approach by the cement industry in India to maximise the operational efficiency with respect to retrofitting of energy efficient equipment/systems, technology upgradation, process optimisation, effective maintenance management and above all, energy management including energy monitoring and energy audit. This comprehensive approach has resulted in significant reduction in specific energy consumption levels in cement plants. NCB's perspectives in the context of energy conservation include energy auditing and management, technological support, research & development, training, consultancy and policy planning. NCB has carried out about 120 studies in the areas of energy management, monitoring and audit during the past two decades. These studies have helped the industry in a variety of ways such as: formulation of policy guidelines for managerial and structural changes in the industry, formulation of specific guidelines for improving energy efficiency in individual / group of plants, as well as for implementation of energy conservation measures in individual plants.

## 2.0 INDIAN CEMENT INDUSTRY

India is the second largest producer of cement in the world. The Indian cement industry is a unique combination of very large to very small capacity and very modern to very old technology plants. The share of installed capacity of energy inefficient wet process plants had slowly decreased from 94% in 1960 to 61% till 1980 and thereafter as a result of quantum jump in production capacities through modern dry process plants as well as conversion of some of the wet process plants, the share of old wet process has been reduced to just 5% today. The changing process profile of the Indian cement industry over the years is given in Fig.1.

The Indian cement industry comprises of 124 large/medium size cement plants including grinding units and about 300 mini cement plants. The annual installed capacity of the industry is about 146 million tonnes and production was about 106 million tonnes during 2001-02. The current trend is to install large size single stream cement plants of 1.2-2.5 million TPA capacity.

Cement plays a vital role in infrastructure development, especially in a developing country like India. The industry also provides direct and indirect employment to people. Economic liberalisation and favourable industrial policies, including decontrol of cement, has resulted in enormous growth in cement production capacities in India. The growth of cement industry in India is likely to be sustained at the rate of 8% and the cement demand is likely to reach about 164 million tonnes by 2006-07.

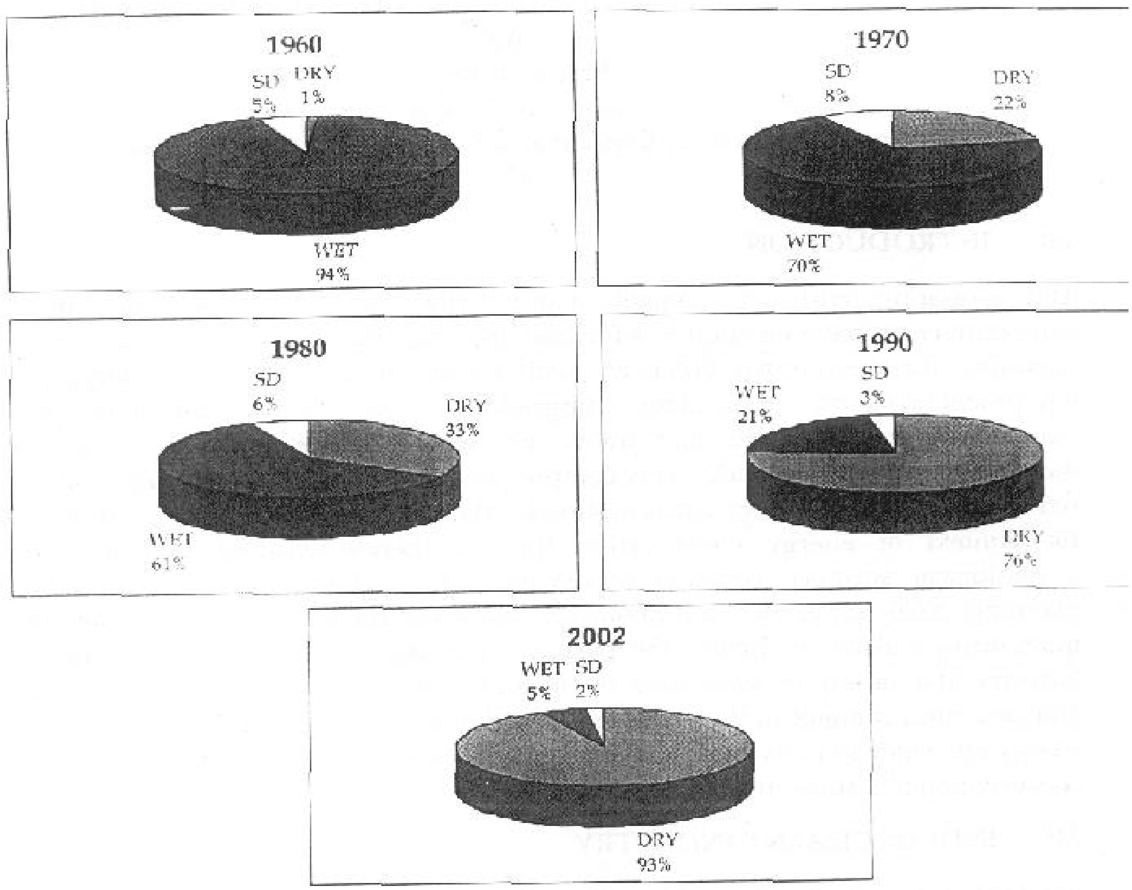



Fig. 1: Changing Process Profile of Indian Cement Industry

## 3.0 ENERGY CONSUMPTION IN CEMENT INDUSTRY

Indian cement industry is one of the core industries of the country consuming about 16 million tonnes of coal and 11 billion electric units annually. Cement industry is highly energy intensive, requiring on an average about 0.80 Mil.K.Cal of thermal energy per tonne of clinker production and about 100 kWh of electric energy per tonne of cement production.

NCB's energy monitoring studies indicate reducing thermal and electrical energy consumption trend of the dry process plants from 876 to 734 kcal/kg clinker and 120 to 89 kWh/t cement respectively from the year 1990 to 2001 (Fig. 2). Another significant fact is that the best operating levels of energy consumption in cement plants in India are 663 kcal/kg clinker and 69 kWh/t cement which compare well with world best levels of 650 kcal/kg clinker and 65 kWh/t cement. Moreover, the older plants can be modernised/ expanded by technology upgradation and retrofitting with energy efficient equipment/systems. Some of the cement plants by their pioneering efforts have reduced energy consumption by 25-30% by incorporating/retrofitting energy efficient equipment/systems during the last 7-8 years giving them competitive advantage over others.

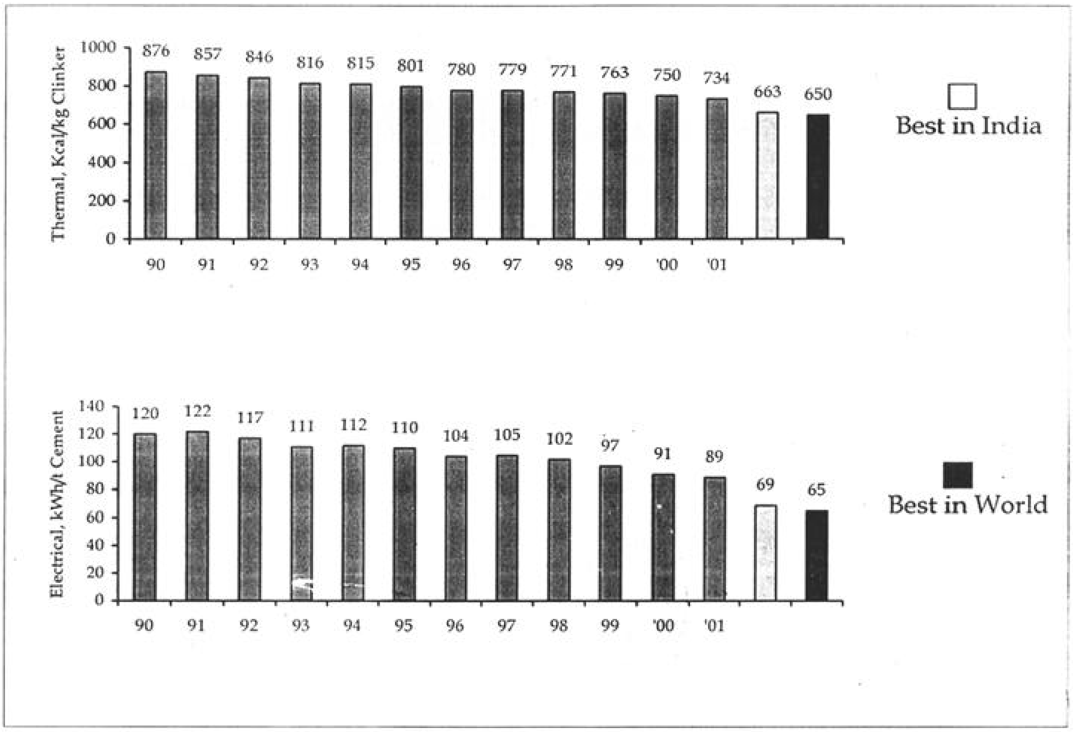


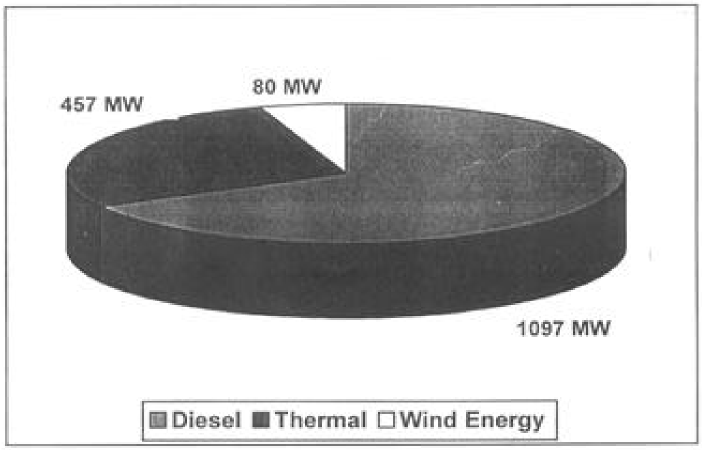

**Fig. 2 : Energy Consumption Profile (Dry Process Plants – Weighted Average)**

The main energy inputs to the cement industry are coal and power. A brief discussion on these energy inputs is as follows:

### 3.1 Coal

Coal is predominantly being used in the Indian cement industry. The quality of indigenous coal supplied is poor with high ash content (30 to 35%) which affects the efficiency of kiln apart from increasing the fuel consumption leading to higher specific Green House Gas emission. Deteriorating and inconsistent quality of coal has become a limiting factor in improving energy efficiency, productivity and dinker quality. The use of these coals results in a number of operational problems such as improper and inefficient burning and higher per unit consumption of coal as well as lower operational efficiencies which tend to further increase the emission of green house gases.

The frequent variations in the quality of coal, inadequate supplies and transportation bottlenecks have rendered it imperative to import coal from countries like Africa, China, Indonesia etc. besides going for substitute fuels like lignite, rice-husk petroleum coke etc. However, import of coal is costly and a drain on our national exchequer even though it has helped cement industry getting quality coal. Cement plants located in the south are using nearby available lignite. Cement plants bcated in Tamil Nadu are already using lignite along with coal. The opening of new lignite mine at Neyveli and exploitation of lignite in Gujarat and Rajasthan have further heightened the hopes of cement plants for using more and more lignite. Many cement plants are utilising lignite blended with coal to the extent possible. Pet coke, which has proved to be an excellent alternate fuel to coal, is a residual product from oil refinery with high calorific value and insignificant ash content but often with high sulphur content as compared to coal. A number of cement plants have attempted successfully using pet coke in varying proportions upto 50% alongwith coal. Pet coke has been used 100% in kiln firing and a few cement plants are using it in the precalciner, too.




(Total Captive Power Capacity : 1634 MW)

Fig. 3 : Captive Power Generation Capacity Installed (MW)

### 3.2 Power

Production of cement being a continuous manufacturing process, requires stable and reliable power supply. Any power interruption leads to kiln stoppage resulting in loss of production, additional fuel consumption to attain requisite thermal profile and a lot of idle running of equipment leading to wastage of electrical energy. The present power scenario in India is dismal due to shortage of power generation capacity, transmission and distribution losses, poor management of power distribution and low frequency and voltage fluctuation. These factors lead to scheduled power cuts as well as unscheduled power interruptions.

It is estimated that, in a one million tonne per annum capacity cement plant, a one-hour power cut (equivalent to 4% downtime) will result in loss of production of about 7% (200 tonnes). Apart from the production loss, the additional coal requirement would be about 4 tonnes for a one-hour power cut, amounting to the mere wastage of coal.

To augment the power requirement, many plants today have their own captive power generation stations. Total capacity of captive power generation in the industry at present is 1634 MW. The capacities of various types of captive power systems are shown in Fig. 3.

## 4.0 ENERGY CONSERVATION EFFORTS BY THE INDUSTRY

The energy monitoring studies carried out by NCB have revealed that the efforts made by the industry towards energy conservation are mainly directed towards:

### 4.1 Target Setting and Energy Monitoring

NCB studies have revealed that while most plants have been setting standard/benchmarks, the success in achieving the targets have been found varying. It is worth noting that the plants are setting targets not only for overall energy consumption levels, but also for section-wise energy consumption levels. The monitoring of energy performance by the plants has improved a lot during the last few years. This has also helped in continuous improvement in setting targets and monitoring actual performance.

## 4.2 Operational Control and Optimisation

Process optimisation, load management and operational improvement generally involve marginal financial investment and yet found to have produced encouraging results in energy saving. These aspects have been accorded high priority by the plants. The different aspects explored in this direction by the plants are given hereunder:

- Plugging of leakages in kiln and preheater circuit, raw mill and coal mill circuits
- Reducing idle running
- Installation of Improved insulating bricks/blocks in kilns and preheaters
- Effective utilisation of hot exit gases
- Optimisation of cooler operation
- Optimum loading of grinding media/grinding mill optimisation
- Rationalisation of compressed air utilization
- Redesigning of raw mix
- Installation of capacitor banks for power factor improvement
- Replacement of over-rated motors with optimally rated motors
- Optimisation of kiln operation
- Changing from V-belt to flat belt

## 4.3 Energy Efficient Equipment

Use of energy efficient equipment gives very encouraging results even at the cost of some capital investment. More and more plants are now going for these available energy saving equipment to improve the energy performance of the units. The energy efficient equipment being used by the cement industry are highlighted below:

- Slip Power Recovery System
- Variable Voltage & Frequency Drive
- Grid Rotor Resistance
- Soft Starter for Motors
- High Efficiency Fans
- High Efficiency Separators
- Vertical Roller Mill
- Pre-Grinder/Roller Press
- Low Pressure Preheater Cyclones
- Multi-channel Burner
- Bucket Elevator in place of pneumatic conveying
- Fuzzy Logic/Expert Kiln Control System
- Improved Ball Mill Internals
- High Efficiency Grate Cooler

## 4.4 Active Participation of Employees and Manpower Training

The cement plants are realising the need for active participation of employees in energy conservation efforts. The suggestions box schemes, quality circles, brain-storming sessions and cash rewards for good suggestions etc are some of the schemes, the plants are adopting for ensuring active participation of employees.

Setting up of an energy conservation cell for monitoring and controlling energy performance of the plant is gaining its significance in the plants.

Cement units are also giving importance to manpower training by deputing their employees at different levels; for seminars, workshops, training courses to enhance their knowledge and to create awareness among the employees towards energy conservation.

## 5.0 TECHNOLOGICAL DEVELOPMENTS

The last two decades have experienced major technological advances in cement plant equipment /systems such as single stage crushers, On-line- Bulk Material Analyzers, Vertical Roller Mills, High Pressure Roller Presses, High Efficiency Grate Coolers and 5/6 Stages Low Pressure Cyclone Pyroprocess Systems. The economic necessity for high productivity and energy efficient plants has been the motivating force for their development/ adoption. The declining trend in heat and power consumption as achieved by incorporation of these technological improvements is discernible from Figs. 4 & 5.

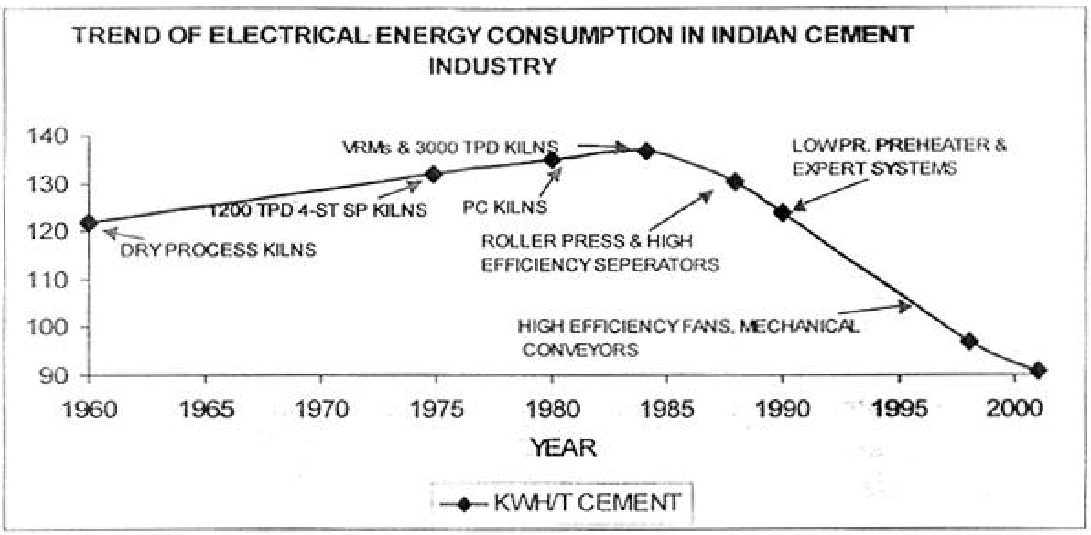



Fig. 4

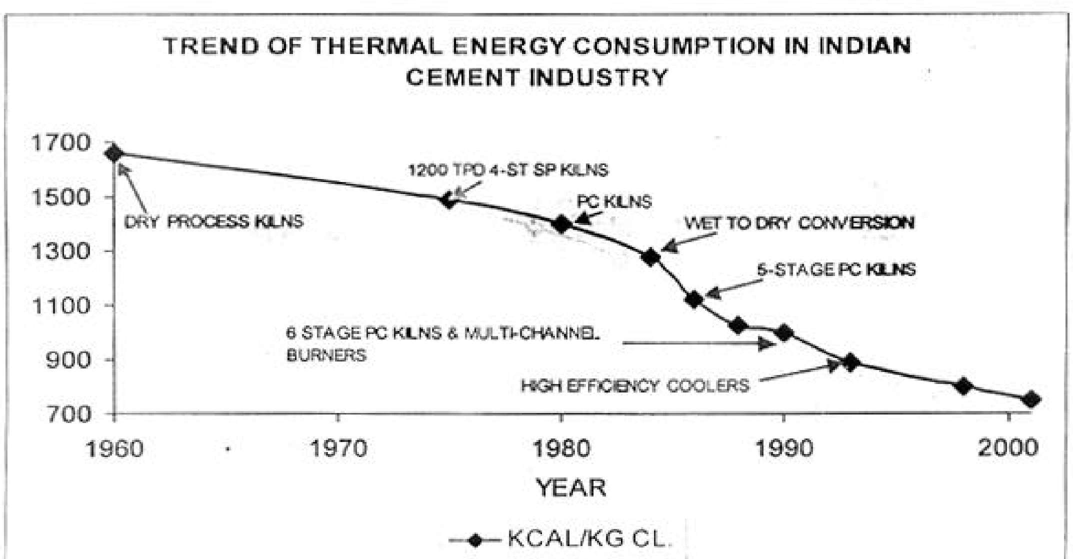



Fig. 5

The existing cement plants which have inherent peculiarities of energy inefficient process/systems and disadvantage of scale economy can achieve major productivity enhancement and energy conservation by adopting energy audit and management systems. In this connection, National Council for Cement and Building Materials (NCB) has taken major initiatives towards developing an integrated approach for assisting the industry in energy conservation through technological support and R&D base. Energy audit has emerged as a potent tool for identification, analysis and implementation of energy conservation measures and overall energy management.

## 6.0 ENERGY MANAGEMENT IN INDIAN CEMENT INDUSTRY – NCB'S INITIATIVES

NCB has been actively engaged in:

- Carrying out energy audit studies
- Monitoring of energy performance of cement plants
- R&D on conservation and rational utilization of energy
- Heat and gas balance studies
- Identification of leakages in kiln-preheaters and other gas/air circuits
- Identification of potentials for energy saving
- On-site study of process parameters, target-setting and monitoring
- Waste heat recovery for cogeneration of power
- Creating awareness and motivation through National Awards for Energy Efficiency in Indian Cement Industry
- Manpower training in energy management and auditing
- Bringing out publications/newsletter related to energy conservation aspects

### 6.1 Energy Audit Studies

NCB has so far carried out about 120 Energy Audit studies in cement plants. Jointly with the Bureau of Industrial Costs and Prices (BICP), NCB had conducted an energy use survey of Indian industry in 1983-84 and again ten year later. As part of its own Programmed Projects, NCB has been carrying out detailed energy audit studies in a number of cement plants, which in turn have strengthened its expertise and capabilities. Apart from these, similar studies were carried out at the request of individual plants and the Advisor Board of Energy (ABE). So far about 50 cement plants have benefited from sponsored Energy Audit studies. Saving of thermal energy upto 164 kcal/kg clinker and electrical energy upto 16.4 kWh/t cement were found possible in a typical case. The potential of saving in some of the individual plants from Rs. 4.40 million to Rs 66.20 million annually. **Empanelled as nodal energy audit consultancy organization with Petroleum Conservation Research Association (PCRA) and Industrial Development Bank of India (IDBI), for cement sector, NCB provides total consultancy services to the cement industry for improving its energy efficiency.**

### 6.2 R&D Support to Indian Cement Industry

Keeping in view Indian cement industry's unique problems, NCB has been pursuing mission-oriented R&D studies and some important studies in energy conservation are:

**Fuel**

- Characterisation of lignite and development of technique for desulphurisation of high sulphur lignite
- Utilisation of high ash coal through dry beneficiation in cement plants
- Coal washeries for upgrading coal quality
- Use of alternate fuels such as natural gas and pet coke
- Use of industrial and agricultural combustible wastes as supplementary fuel
- Improved burners for low grade coal and reduced primary air with low $NO_x$ emissions
- Coal sweetening
- Diagnostic studies for unstable burning in kilns

**Operational Aspects**

- Low pressure-drop preheater cyclones
- Expert System for kiln control
- Grinding aids and slurry thinners
- Blended cements and low energy cements, such as Belite cement
- Field testing of motor efficiency

**Systems**

- Waste heat recovery for cogeneration of power
- Effective power management
- Wet-to-dry/semi-dry conversion
- Kiln dust utilization

## 6.3 Waste Heat Recovery for Cogeneration of Power

Cogeneration of power utilizing waste heat is an attractive proposition for cement plants for energy conservation and minimizing dependence on the grid. Further, cogeneration of power will also help reduce environmental pollution as well as strain on the economy because of reduction in consumption of diesel oil. The present scenario therefore, warrants adoption of cogeneration systems in the Indian cement industry to make them more economical and to ensure cleaner environment.

Cogeneration systems are already in use in cement industry in Japan, China and other south-east Asian countries. Further, the cogeneration has been well established in paper, sugar and other chemical industries in India. However, in Indian cement industry, this technology has not been implemented so far owing to the following reasons:

- Non-availability of proven technology indigenously
- Non-availability of installation or their operating experience in India resulting in lack of confidence
- Design of waste heat boiler suiting to high dust load.
- Large capital requirement and financial constraints owing to depressed cement marketing scenario

Nevertheless, the cement industry is quite keen to adopt the cogeneration system provided its apprehension with regard to technology and economic risks are alleviated through installation of demonstration projects, and same financial assistance.

The Ministry of Commerce & Industry, Govt. of India, has identified NCB as the nodal agency for evaluation of various available cogeneration technologies. NCB is also making efforts to secure support from Global Environment Facility (GEF) for installation of a cogeneration system in a cement plant to serve as a demonstration Unit/Model.

NCB studies indicate that in the dry process cement plants, nearly 40 percent of the total heat input is rejected as waste heat from exit gases of preheater and grate cooler. The quantity of heat lost from PH exit gases ranges from 180-250 kcal/kg clinker at temperature range of 300-4000$^{o}$C. In addition, 80-130 kcal/kg clinker heat is lost at a temperature range of 200-300$^{o}$ C from grate cooler. This waste heat can be utilized for electric power generation. There can be many combinations to work out the best scheme suited to a given situation. In existing plants, cogeneration technologies based on bottoming cycles have potential to generate upto 25-30 percent of the power requirement of a plant.

The analysis of the data of 20 cement plants by NCB has indicated cogeneration potential ranging from 3.0 to 5.5 MW in different plants depending upon the temperature and quantity of waste gases from PH and cooler exhaust, number of PH stages, use of gases for drying of raw materials and coal etc. There is a total cogeneration potential of about 200 MW in 45 plants of 1 MTPA and more capacity.

### 6.4 Manpower Training

NCB till date has conducted more than 35 training courses on Energy Management, Energy Conservation, Energy Audit and other energy related topics, which have been attended by over 500 participants mostly from the cement industry. It has also organized sponsored training programmes specially for the Energy Management Centre (EMC), Ministry of Power, Govt. of India and individual cement plants. It has also been conducting training courses for overseas participants on energy conservation, modernization, process optimization etc. for UNIDO sponsored teams from overseas countries.

### 6.5 Energy Awareness

NCB has been creating awareness for energy conservation in cement industry through publications on energy management and auditing. Notable among these are success stories/case studies of plants, which have won National Awards for Energy Efficiency. These are widely circulated in the industry to help plants emulate the more efficient plants. NCB also brings out topical Technology Digests besides a quarterly Newsletter entitled "Cement, Energy and Environment" jointly with Cement Manufacturers Association (CMA) to keep the industry abreast of latest developments. Special mention may be made of the publication entitled, Guide Norms for Cement Plants Operations, which covers energy norms for various operations/processes to help cement plants set their own benchmarks.

### 6.6 Motivation for Competitive Improvement

Appreciating the need for creating awareness and motivating the industry for competitive improvement in energy performance, NCB instituted a scheme of National Awards for Energy Efficiency in Indian cement industry as far back as 1986-87. The scheme had the intended effect on energy performance of the Indian cement Industry. Based on the inputs from the industry National Awards have also been instituted by NCB for Environmental and Quality excellence from the year 2000-01.

## 7.0 CONCLUSIONS

Indian Cement Industry has been continuously striving to reduce energy consumption in cement manufacture at each step. The increased consciousness for energy conservation and the steps taken towards effective monitoring, better operational control & process optimization, retrofitting of energy efficient equipment etc have contributed greatly in energy conservation efforts. Energy conservation measures are cost effective and can bring about considerable improvement in cost-economics of cement manufacture. The government efforts can result in further large-scale rationalization in energy use efficiency of industry through a well-defined and judicious implementation of the provisions of the energy efficiency bill passed by the parliament recently.

Mr. Shiban Ji Raina
Director General, NCCBM
IIPEC Programme on
22nd September 2002 at
M/s Shree Cement, Beawar

Attachment 2:
Letter from the technology supplier ORMAT.

ORMAT®

August 2, 2006

Mr. V. Devi Prasad
Dy. General Manager (CPP)
UltraTech Cement Limited
AP Cement Works, Tadipatri - 515415
Dist. Anantapur, AP, India

Dear Mr. Devi Prasad

Re: 4.8MW ORMAT® Energy Converter ("OEC") for Clinker Cooler Heat Recovery

We refer to the project currently under construction at AP Cement Works for the installation of a heat recovery system for power generation by an ORMAT® Energy Converter ("OEC") of 4.8MW rated capacity utilizing the exhaust air from the clinker cooler.

We can certify that the AP Cement project is the first application of ORC technology for heat recovery in India in the cement or any other industry, and represents a major milestone for the development of energy efficiency and emissions reductions programs in the Indian cement industry, as pioneered by UltraTech Cement Ltd.

The OEC is an organic Rankine cycle (ORC) power system utilizing N-pentane as the working fluid of the power cycle. Due to its low boiling point, this organic liquid is able to efficiently exchange heat with the relatively low temperatures of the clinker cooler exhaust air to generate vapour to drive a turbine. This organic vapour is condensed (by air cooled condensers or water) and recycled to the heat exchangers.

Yours faithfully,

David Citrin
Vice President
Ormat Systems Ltd.


**ORMAT SYSTEMS LTD**

**New Industrial Area, P.O.B. 68 Yavne 81100, Israel • Telephone 972-8-9433777 • Facsimile 972-8-9439901**