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PROGRESS MADE IN THE IMPLEMENTATION OF THE WORK PROGRAMME

**ENERGY CONSERVATION IN THE CEMENT INDUSTRY
IN ESCWA COUNTRIES**

(IRAQ - JORDAN)

Note by the Secretariat

BACKGROUND AND INTRODUCTION

This summary report has been prepared in implementation of programme element 3.3 on "Energy conservation in the cement industry in ESCWA countries" of the ESCWA work programme for 1984-1985. It is one of the components of subprogramme 3 on Energy conservation and efficiency of the work programme of the Division of Natural Resources, Science and Technology for 1984-1985 dealing with energy issues in Western Asia.

The main report consists of two parts. The first part covers two selected cement factories in Iraq, namely the cement factories of Badush and Hammam Al-Alil. This part of the report is presented in the form of energy audit undertaken jointly by the French Agency for Energy Management (AFME) and ESCWA to meet the request of the Iraqi National Energy Commission to undertake an in-depth analysis of energy consumption in the cement factories of Badush and Hammam Al-Alil and to investigate the potential of energy saving.

The second part is a study on energy conservation in the cement industry in Jordan. In this study emphasis is placed on energy consumption and the potential for conservation in the Jordan Cement Factories Company. The study is mainly aimed at reviewing the Jordanian experience in this field, indentifying the obstacles to energy conservation, and providing recommendations for more efficient use of energy in the cement factories under consideration to be submitted to the authorities concerned. For this purpose, the study is designed to include three substantial chapters. Chapter I traces the development of the cement industry in Jordan, with special reference to technological improvements and energy efficiency. In this chapter emphasis is placed on the development of the Jordan Cement Factories Company. the newly established "Cement of the South" has been given little attention due to lack of required information(*).

Chapter II comprises three sections. The first one is devoted to energy conservation in the cement industry in Jordan, particularly the Jordan Cement Factories Company. The second is aimed at assessing the Jordanian experience in the field of energy conservation and the potential of other sources of energy than fuel oil. In the third section, the main obstacles to energy conservation in the cement industry are identified and efforts deployed to overcome these obstacles are reviewed.

In Chapter III, the findings of the study are summarized, along with proposals and suggestions in the form of concluding remarks.

It is to be noted that the findings of this report are based primarily on information contained in official publications and whenever data were not available various secondary sources were consulted.

(*) It has been reported that the two cement companies have been merged.

PART I OF THE REPORT

Energy audit for the cement factories of Badush and Hammam Al-Alil (Iraq)

Initially the cement factory at Badush was chosen as a case-study for an energy audit. However, the project was extended to cover the cement factory at Hammam Al-Alil which is the cement plant most likely to reduce considerably its specific energy consumption. There follows a brief description of the two chosen cement factories.

Badush Cement Factory

The Badush Cement Plant has a production capacity of more than 2 million tons of clinker. At present, it consists of three lines of highly advanced technologies. All three lines use the dry process. There are two lines with a capacity of 1,500 t/day each and one line with a capacity of 3,000 t/day. One of the two old lines which used the wet process has already been shut down and the other is scheduled to cease production by 1985.

Hammam Al-Alil Cement Factory

The Hammam Al-Alil Cement Plant has a capacity of about 750,000 t/year of clinker. This plant still uses the wet process. It consists of three production lines: the first two lines, operating since 1958 and 1964, have a 400 t/day capacity; the third more recent line (1978) is designed to produce 1,500 t/day of clinker.

Energy consumption varies according to the production type used (dry or wet process). Therefore, the thermal energy consumed, expressed in Kcal/Kg of clinker is as follows:

- At Badush, 780 to 1,000 kcal/kg;
- At Hammam Al-Alil from 1,480 to 1,720 kcal/kg.

The electric energy consumed in these two cement plants reaches the usual average of electric consumption, i.e.:

- 85 KWh/ton by the wet process;
- 105 KWh/ton produced by the dry process.

In this respect, a dry process cement plant requires approximately 1/45 Toe (ton oil equivalent) electric and 1/12 thermal Toe to produce 1 ton of cement whereas a wet process cement plant requires 1/56 Toe (electric) and 1/6 Toe (thermal).

The research for a minimum energy consumption in connection with the cement industry, which has a high energy consumption, gave rise to the development of new processes. In the lapse of 20 years, it revealed that

energy consumption -thank to technological contributions- decreased from 1,500 kcal/kg of clinker to 800 kcal/kg.

The development is shown in the figure below, which indicates, for the periods included between 1955 and 1983, the average consumption of the cement plants constructed.

The consumption in cement plants decreased slightly owing to the perfecting of apparatus and the use of sophisticated production lines.

The new progress to be expected in this field would consist in developing the study of shorter conveying lines through the use of heavy-duty machines. In this connection, one should mention the use of very expensive heavy duty fans or the increase of the research on the output of material fragmentation apparatus (mills, crushers, etc.) using, at present, substantial portion of the electrical energy consumed by the cement plant.

Major actions identified for improving energy efficiencies

The Badush Cement Plant

Appreciable saving could be achieved in the thermal energy consumption of the 3000 t/d kiln at a low investment cost through establishing some sort of balances in the energy consumption between this kiln and the two 1500 t/d kilns.

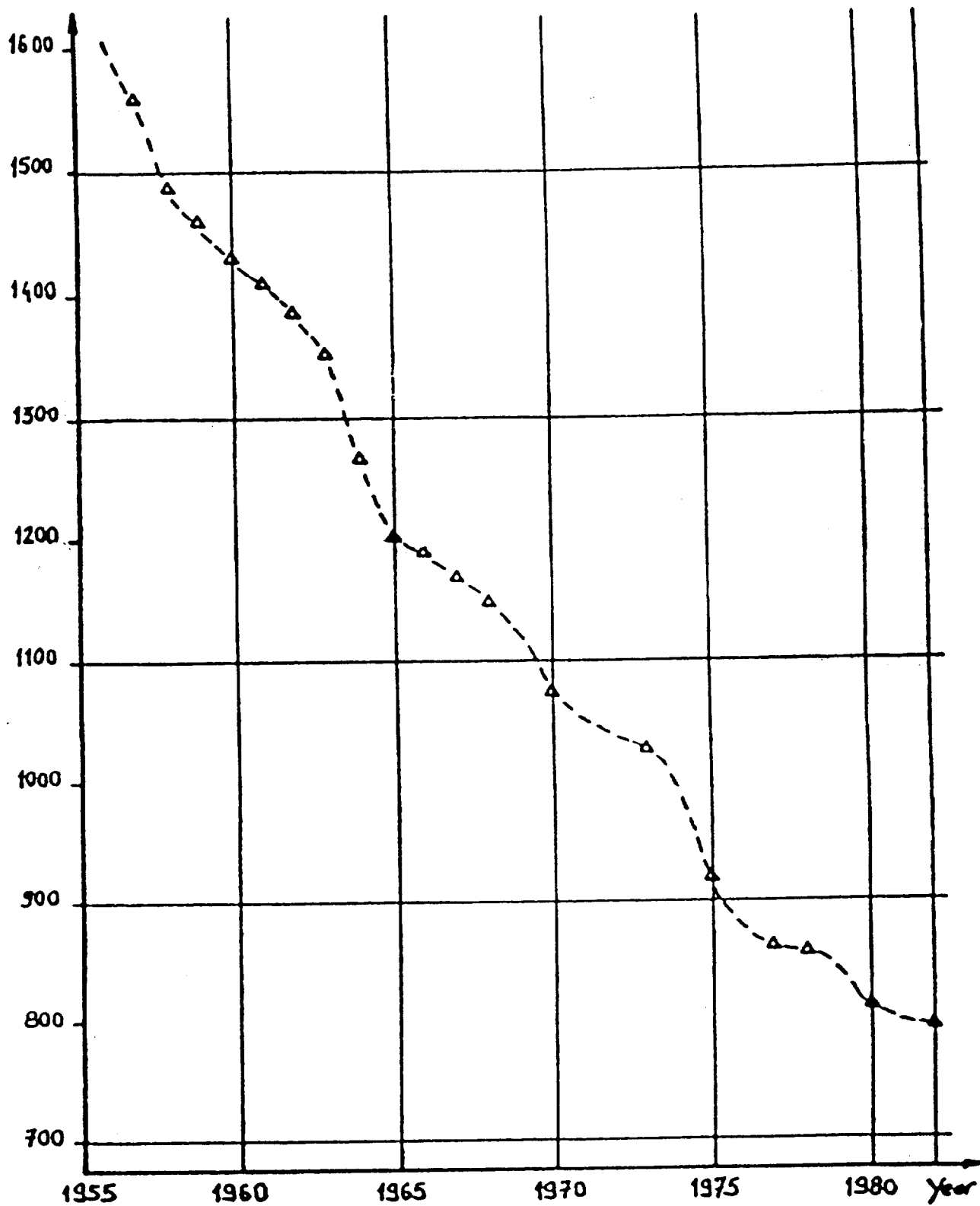
The Hammam Al-Alil Cement Plant

An option to be examined (in the research for energy saving) is the transformation of the last wet process kiln (1,500 t/d) into a dry process unit. This method would make it possible to increase the kiln capacity to suppress the two old consuming lines. The expected saving in the thermal field may reach 40 per cent. The benefit will be a fuel consumption of 55,000 m³/year compared with a present consumption of 140,000 m³/year.

In addition to the above, more attention should be paid to the following:

- Systematic maintenance of mechanical and electrical equipment is to be undertaken;
- Training of personnel on modern equipment;
- Organization of data processing should be undertaken by a team to cover all three cement plants of the State Enterprise for Cement at Ninevah instead of separate data processing for each cement plant;
- Ensuring operation of the equipment next to the rated capacity and limiting as much as possible breakdowns, shutdowns and blocking up of the workshops;
- Reviewing completely all the operation and control elements in both the cement plants (Polysius kilns) as the present state of instrumentation accounts for, in part, the low output.

Heat Consumption (Kcal/kg Clinker)



Examples of small savings to be achieved

- 1 per cent of excess oxygen in the smoke consumes 3 to 5 kcal/kg (estimated on the 2 polysius kilns, 3 per cent of excess oxygen observed in the burning workshop THI);
- The lack of thermal insulation of the duct pre-heater outlet of Gepol. A drop of 30° (for a few metres) increases the consumption by 14 kcal/kg;
- One unexpected shutdown of one 1,500 t/d Polysius kiln:
during 1 hour - Consumption: 10 m³ of fuel oil;
during 1 day - Consumption: 70 to 80 m³ of fuel oil;
- An unsteady operation of a burning line involves thermal shocks, bad outflow of not enough prepared material, premature wear-out of equipment and affects the quality of the clinker produced.

Adverse Effects of production at below or beyond rated capacity

It is of particular importance to note that production below rated capacity results in significant waste of energy. If production is 30 per cent below rated capacity, the specific energy use is 10 to 20 per cent higher.

On the other hand, a kiln operated beyond its nominal capacity consumes more due to the insufficient thermal efficiency of the exchangers, too high outlet temperature, etc.

PART II OF THE REPORT

Energy conservation in the cement industry in Jordan

Cement is a highly energy intensive product. Consequently, attention has been devoted for a long time to the issues related to the use of energy in the cement industry.

It is to be noted that with the exception of some industries such as steel and chemicals, the total energy consumption for cement manufacture is higher than most other industries on account of the high tonnages of cement produced. This has special significance for a country like Jordan where cement industry is relatively more prominent compared with other manufacturing industries.

Indeed, special attention has been paid to the development of the cement industry in Jordan. This particular interest in the cement industry is mainly due to the following:

- Availability of significant and good quality of raw materials for cement manufacturing;
- Increasing demand for cement;
- Potential of export to the neighbouring countries.

Unlike several countries of the region, Jordan is deprived of significant oil resources. This fact, combined with the expansion of the industrial sector, in particular the cement industry, makes of energy conservation an issue of particular importance.

The Jordan Cement Factories Company (JCFC) has been chosen to be the focus of this part of the ESCWA report on energy conservation in the cement industry because this Company has been functioning for quite a while and has undergone substantial modifications with the objective of improving energy use and introducing more efficient methods for energy conservation. A draft study on the "Cement of the South" was excluded from this report because of incomplete data.

The Jordan Cement Factories Company (JCFC)

This Cement Plant is located in Fuhais area, some 20 kms north-west of Amman. The Fuhais area was chosen as the site of the plant for the following reasons:

- Suitability of the soil of the Fuhais for cement manufacture;
- Availability of water in the nearby village of Mahis.

Production was first started in 1954 with one kiln. This kiln started producing cement clinker at the rate of 200 t/d. Five additional expansion

lines were introduced. Two lines with a capacity of 300 t/d each were commissioned in 1960 and 1963 respectively. Two other lines were commissioned in 1968 and 1979, with capacities of 700 and 2,000 t/d respectively. In 1982 a kiln with precalciner and a capacity of 3,000 t/d was commissioned.

Until recently, the JCFC functioned with six production lines. The first three lines utilize the semi-dry process. Despite the fact that the technology used in these three lines is not an advanced one, production capacity could be raised from 200, 300 and 300 to 250, 350 and 350 t/d respectively, following technical modifications in the cooling system and introduction of a dust filter.

Significant decrease in the production capacity of line four, which utilizes dry process, has been noticed, apparently owing to faults in the design and lack of maintenance. It is to be noted, however, that following substantial technological changes the production capacity of line four reached 800 t/d in 1983.

On the other hand, the three old production lines were decommissioned owing to the fact that "their rehabilitation or upgrading as well as their operational production cost were not economically feasible". Work on a project to construct a seventh production line was suspended owing to uncertainty of additional demand for cement from neighbouring countries.

It was noted, in the 33rd annual report of the JCFC Board of Directors that "the produced quantity of clinker during 1984 totalled (1,520,973) tons, which represents the highest figure recorded in the history of this Company".

At present, only one type of cement is produced, which is Pozzolana Portland Cement.

Energy conservation issues

As indicated earlier cement ranks among the principal energy-consuming industries. It may be of interest to recall that "the energy sources in a cement plant are classified as primary sources such as oil, gas, coal and electricity, and secondary sources consisting of waste heat from one phase of the process which can be recovered and utilized in another phase of the process". The most energy-intensive phases in cement manufacturing are pyroprocessing and grinding. Energy consumption in cement production is, however, directly affected by the type of process used.

The JCFC has been aware of the direct correlation between energy consumption and the technologies used. It is, however, worth mentioning that the JCFC has encountered serious difficulties in connection with the policy of technology transfer. The following remarks based on published information and data collected during a fact-finding mission may be of particular interest:

- It seems that the JCFC in using highly advanced technologies has been faced with the continued problem of highly advanced technology and lack of know-how. It has also been indicated that "due to the fact that the level of development in Jordan cannot permit locally produced technological inputs,

the Company has been dependent on industrialized countries even for the development of its own technological capacities";

- The second remark relates to training policy. According to some specialists in this field the pattern of training has been a static one, particularly with regard to training for maintenance. It is to be noted, however, that the training centre established by the JCFC has played an important role in improving the professional capabilities of the employees and increasing the number of trainees.

In addition to its training programmes, the JCFC has held training programmes in co-operation with the Arab Union for Cement and Building Materials. Contacts have also been initiated with UNIDO "with the objective of developing the Company's training centre".

- An important remark can be advanced with regard to the lack of a unit responsible for research and development. The JCFC is a leading industry in Jordan and a unit of research and development can considerably improve its performance and technological capacities.

Energy cost may exceed 50 per cent of the total cost of production in the JCFC. However, it seems that little attention has been paid to energy conservation and efficiency. As the cement industry is one of the most important industries in Jordan policy measures for energy conservation have a particular role in this country. The main components of policy for energy conservation and efficient use of energy may be summarized as follows:

- Technological improvements and maintenance. Recent technologies provide various ways and means for saving energy. Efficient use of equipment and systematic maintenance also result in substantial saving of energy use.

- Pricing policy. In the case of a country like Jordan where energy prices are subsidized, energy pricing has a particularly important role in energy saving. Energy prices in Jordan are fixed at 75 per cent of the world price. The main problem is, therefore, to reconcile the necessity of encouraging the cement industry to meet the local needs and eventually to export the surplus and create additional sources of foreign exchange earnings with the requirements of demand restrictive energy pricing system.

- Regulations and legislation. It goes without saying that direct control of energy consumption is carried out through a number of regulations and pieces of legislation. The execution of such regulations and legislation often requires that existing laws be amended or supplemented correspondingly. In some cases a specific law for energy conservation is to be enacted.

- Government support. Such support which may be provided through financial incentives such as low-interest loans, subsidies, favourable taxes and special depreciation treatment constitutes an important part of energy conservation policy. In Jordan, the JCFC is exempted from import customs for its equipment and installations. But this privilege has been granted to encourage the cement sector and not for the sake of energy conservation. It can therefore be stated that no substantial support is provided by the Government for energy conservation in the cement industry in Jordan.

- Direct investment for R and D activities. With the exception of a few examples, such as the publication of technical papers, R and D activities for energy-saving technologies in the cement industry in Jordan are virtually inexistent. It is to be recognized, however, that some energy-saving technologies involve risks and "require a long lead time to develop". In the developing countries the main role in this field is to be taken up by the Governments. In Jordan, this role is still limited.

- Education and training. It is of utmost importance that staff be educated on the efficient use of energy through circulation of handbooks and pamphlets on energy conservation issues. It is also important to conduct seminars, workshops and training courses on various aspects of energy use. Such practices have not been used so far in the cement sector in Jordan. In 1981 the JCFC established a training centre which also serves the "South Cement Company". This Centre has played an important role in improving the technical ability of the staff and in providing as much as possible the required know-how to cope with the highly advanced technology recently introduced. However, training activities in this Centre do not include technologies for energy conservation and efficiency.

- Institutional arrangements. Needless to say that proper institutional arrangements are to be established in order to promote energy conservation and efficiency according to the various means indicated above. These institutional arrangements may take the form of an energy service or agency within the Government. After the establishment of the Ministry of Energy and Minerals, it is expected that a system will be established to co-ordinate activities related to energy conservation and efficiency.

The above-mentioned remarks are of particular importance to Jordan. This country has chosen industrialization as a main path for economic development. Emphasis has been placed on the cement industry for its role in the development of the economic infrastructure of the country. Cement has played a role in saving substantial foreign exchange needed for the development of other economic sectors. Owing to the fact that the cement industry is a great consumer of energy in a country deprived of significant sources of energy, the issue of energy conservation is of utmost importance. The following remarks reflect the shortcomings detected with regard to efficient use and conservation of energy:

- Some of the production lines are not operating at their rated capacities. As a result a substantial part of the energy consumed is lost "because of the low efficiency";

- Lack of systematic maintenance. Although maintenance is given special attention, this maintenance is not systematic. It goes without saying that this shortcoming may cause significant waste of energy and reduce the efficiency of the energy used for the various operations of the plant;

- Lack of a unit concerned with research and development for energy-saving technologies. There are plans to organize courses for training in the field of energy conservation. However, so far, issues related to energy conservation or efficient use of energy have not been seriously

stressed and no measures have been taken for the establishment of a unit or department to undertake research in the field of energy conservation.

- Lack of appropriate policy with regard to energy pricing. As indicated earlier, energy prices in Jordan are subsidized to boost the development of the industrial sector. However, a system of energy pricing taking into consideration the limited sources of energy on the one hand, and the efficient use of energy on the other hand is to be worked out.

- The problem of the rapid turn-over of skilled manpower. Highly advanced technologies have been introduced in the JCFC. However, the skilled staff needed to cope with these technologies leave the Company to the oil-rich countries and they are often replaced by new and inexperienced manpower. Lack of qualified staff results in substantial waste of energy.

Concluding remarks

On the basis of the above-mentioned issues, the following remarks can be made:

- The issue of substitution of fuels should be seriously considered. It is important to note that "energy conservation means not only reduction of specific energy consumption per unit of finished product, but also preservation of scarce fuels such as fuel oil".

- Many developing countries are reversing to coal and other alternative fuels. Opportunities to use low-grade fuels for clinker burning are now opened as a result of the development of systems with cyclone preheaters and precalciners. These technological developments opened the way to save high-grade fuel such as fuel oil, gas or high quality coal and to substitute in their place low-grade fuels and combustible industrial wastes such as wood chips and bark, waste tires and urban wastes. However, such a shift requires that in-depth studies should be undertaken to evaluate the use of imported coal and to assess the potential of urban and rural wastes and their use as fuels in the cement industry.

- It is advisable that clinker be reduced and additives be raised. This can result in significant saving of energy. The proportion of additives may be raised up to 30 to 35 per cent and this could save 20 per cent of energy cost. Corrective materials and additives are brought about from local sources. Good quality of pozzolana is available in Jordan and the percentage of its use can be raised substantially.

- More Government support is needed. Direct governmental investment for introducing energy conservation technologies can be an important factor for energy saving. It should be kept in mind that although energy prices are subsidized, cement prices are fixed by the Government. Therefore, high energy costs cannot be compensated by increasing the sale prices.

- Establishing a maintenance schedule is of particular importance. A systematic maintenance schedule is required to undertake statistical surveys of shutdowns caused by breakdowns the origin of which is often mechanical or

electrical. The importance and implications of these shutdowns should be calculated on the basis of shutdown time. In addition, the same practice should be undertaken with regard to shutdowns caused by human errors. These errors occur very often. It is therefore necessary to provide the staff "with equipment designed to measure and interpret the incidents to be controlled and hence to ensure the maintenance of the whole instrumentation".

- Specific training programmes should be undertaken with the objective of acquainting the staff with issues relating to energy conservation and efficient use of equipment.

- The JCFC should have the equipment operated at its rated or at least near its rated capacity. The present daily production capacity of the Company's production lines is less than their designed one. Operating production units at their rated capacity is an important means of eliminating energy waste.

- Strong incentives should be provided to the skilled manpower to reduce the rapid turn-over of the staff.

- Close co-operation should be established with the cement plants of the other countries of the region. Exchange of information on the measures to be taken for more efficient use of energy and on energy conservation policy may help to avoid mistakes and errors. Such co-operation is particularly recommended with countries facing similar difficulties and using similar technologies.

The above-mentioned remarks are far from being exhaustive. They are mainly aimed at opening more detailed discussions on appropriate measures for energy conservation and efficiency in the cement industry in Jordan. A more comprehensive review of issues related to energy conservation in the JCFC is included in the main body of the report entitled "Energy conservation in the cement industry in ESCWA countries" (E/ESCWA/NR/85/13).