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MINISTRY OF ENERGY AND MINERAL RESOURCES THE HASHEMITE KINGDOM OF JORDAN INDUSTRIAL ENERGY EFFICIENCY PROGRAM

Final Report

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PROGRAM BACKGROUND

The Industrial Energy Efficiency Program for Jordan was undertaken during the period December 1989 through July 1990. The program was designed during a preliminary assessment of the need for an industrial energy conservation program in Jordan that was conducted under the Energy Conservation Services Program (ECSP) in January 1988. Based on the findings of that initial assessment, the USAID Office of Energy (S&T/EY) recognized the potential for meaningful energy efficiency improvements in Jordan's industrial sector and funded the present work jointly with the USAID Mission in Amman. The program was executed with the sponsorship and assistance of the Industrial Energy Conservation Section (IECON) of the Industrial Energy Department of the Ministry of Energy and Mineral Resources (IED/MEMR), the Hashemite Kingdom of Jordan.

A number of energy conservation activities had been undertaken with USAID and other foreign assistance in Jordan prior to the present program, including several training courses and seminars, the provision of energy audit instrumentation and equipment by USAID to the Ministry of Energy and Mineral Resources, and a series of energy audits of industrial facilities. These audits focused on 14 large industrial facilities, and indicated that the large plants operate at energy efficiency levels close to international standards.

In addition to these few large-scale factories, Jordan's industrial sector comprises over 1,500 small and medium-size enterprises, which operate at a lower level of energy efficiency. Of these, about 550 factories may be considered to be small and medium size plants; the remainder are small bakeries, restaurants, workshops and confectioners. The Industrial Energy Efficiency Program focused on the small and medium size plants, where the level of technical expertise is much lower, and where energy efficiency levels were also found to be much lower. This finding is reinforced by the results of energy audits conducted by IECON. In these factories, energy savings opportunities of up to about 30 percent or more of energy consumption were identified, mostly in the area of low cost/no cost projects. On an aggregate basis, broad application of the types of energy conservation projects identified is estimated to result in savings of up to 150,000 tonnes of fuel oil per year (4 to 5 percent of the nation's oil consumption).

During the initial project identification mission to Jordan in 1988 under the ECSP project, several key barriers to energy conservation in small and medium-size industrial enterprises were identified:

- The main barrier to the achievement of energy efficiency improvements was the lack of awareness of the problem and its solution.

- Partly through lack of awareness of the potential benefits of energy efficiency, there appeared to be an inability in small and medium-size units to define energy-related problems and to identify specific areas where savings could be achieved.

- Low-cost and no-cost housekeeping measures were frequently ignored in this industrial segment. Where capital investments for energy efficiency improvements were involved, there was a lack of the technical skills needed to examine the range of options available for improvement and to select the most cost-effective solution for a specific situation.

- Even when a decision was made to invest in energy efficiency improvement, project implementation experience was not available through in-plant personnel, or through such local outside resources as equipment vendors or consulting/engineering firms.

In order to assist the Kingdom of Jordan to overcome these barriers in achieving energy savings in small and medium-size industrial units, the Industrial Energy Efficiency Program was undertaken. Its objectives were to:

- Transfer knowledge and experience about industrial energy efficiency to the private sector in Jordan, through the local consulting/engineering firms and the industrial enterprises themselves

- Improve the current understanding of expected benefits and further potential for energy savings in Jordan's industrial sector, providing an adequate basis to develop a long-term and broader energy demand management activity

- Enhance the capability of IED/MEMR and IECON to promote energy awareness, to monitor energy efficiency, and to develop policy initiatives that will stimulate further gains in productivity.

PROGRAM COMPONENTS AND ACCOMPLISHMENTS

The Industrial Energy Efficiency Program consisted of the following components:

1. **Assessment of Local Capability.** The purpose of this task was to appraise the capabilities of the Jordanian private industrial sector with respect to energy conservation related services. The task involved assessments of both the market for these services and the ability of local

consulting/engineering (C/E) firms and/or individual consultants to provide the needed services. The task also included an assessment of IECON staffing needs, and an analysis of industrial energy conservation measuring ability in the private sector.

2. **Promotion and Training.** The purpose of this task was to increase the awareness of plant owners, managers, and engineers concerning energy-efficient industrial plant operation. The task included the delivery of two training courses. The first course was a one-day seminar on the importance and benefits of energy management. The audience was drawn primarily from plant managers. The second course was an intensive course on the principles of energy efficiency improvement, and was presented over a two-week period to plant engineers and local consultants. This task also included the preparation and distribution of several technical guidebooks concentrating on common aspects of energy conservation.

3. **Energy Audits and Technical Support.** Two major activities were originally included in this task. The first was the preparation of terms of reference for a study on the importance of energy in industrial production costs. The terms of reference were not prepared and the study was not carried out under this program because IED/MEMR had already collected and analyzed the data on their own and were in the process of preparing a report on their findings. The second activity was for the ECSP project team to support private firms in energy conservation related services. This included the conduct of three energy conservation studies by a local subcontractor firm with the assistance of the ECSP project team.

4. **Organization of Demonstration Projects.** The objective of this task was to provide two simple demonstration projects of industrial energy conservation equipment in the factories that were examined. Because the management of none of the factories were willing to commit to project implementation during the time frame of this program, it was agreed by the ECSP project team, USAID/Amman, and IED/MEMR to defer this activity and re-allocate the resources into the policy studies. It is expected that IED/MEMR will work with the plants after the end of this project to ensure that at least some of the energy conservation strategies identified in the previous task are implemented.

5. **Studies of Incentives and Regulations.** In this task, the ECSP project team prepared terms of reference for six policy studies related to industrial energy conservation. Three of the six policy studies were carried out by a

local subcontractor. The studies included analyses of tax and import policies related to investment in energy conservation equipment, and a study of the technical options for demand-side load management in small and medium-size industrial enterprises.

PROGRAM FINDINGS

As indicated in the initial study carried out by USAID's Office of Energy under the ECSP contract and reinforced by the present project, there is a large "latent" market for energy conservation related services in Jordan, particularly in small and medium-size industrial enterprises. The market is characterized by the word "latent" because of the lack of awareness of the need for the services on the part of plant owners and operators, and the lack of private sector consulting/engineering (C/E) firms to provide the necessary services. Because there is no demand for the services on the part of the industrial plants, the services are not offered by the local C/E firms. And because the local C/E firms do not market the services, industrial managers are unaware of their benefits. This problem is compounded by a lack of locally manufactured energy conservation equipment in Jordan (with the exception of insulation products), and a lack of access to and assistance in specifying imported energy conservation equipment.

Consulting/engineering firms in Jordan are well established and numerous. However, these companies specialize in civil, mechanical, and electrical engineering related to infrastructure and new building construction. During the course of the program, the ECSP team was unable to identify a single C/E firm with experience in energy conservation project identification and implementation. Indeed, there appears to be no local C/E firm capability in Jordan for industrial plant and process design. While many of the C/E firms contacted for this assessment expressed interest in offering energy conservation related services in order to expand their business portfolios, few were willing to set up a practice area for these services unless they were certain of the demand for such services, implying that they are unwilling to help develop the market on their own.

Further, vendors of imported equipment (including energy conservation equipment) act as little more than agents for foreign suppliers, and are unable to provide an appropriate level of assistance in the selection, installation, or operation and maintenance of the equipment that they sell. For energy conservation related projects, this has caused local industry to rely either on their limited in-house resources or on the advice of their foreign technology licensors or foreign partners. These factors have resulted in little being done in Jordan to identify energy conservation opportunities that can be easily and inexpensively implemented.

The potential for energy conservation in Jordan's small and medium-size industrial segment is great. Energy audits carried out by IECON have indicated that energy savings within the range of 5 to 25 percent of energy consumption (and more in a few cases) could be achieved at little or no cost to the industrial facilities examined. Visits to small and medium-size industrial enterprises under the present program have resulted in similar savings estimates, based on walk-through audits. In addition, energy audits carried out during the course of this program in two typical medium-size manufacturing facilities resulted in energy savings estimates of about one-third of consumption in the limited areas of the factories included in the scope of the audits (boiler combustion efficiency and steam distribution systems). For the two factories, annual savings of close to 1,500 tonnes of fuel oil per year were identified, with an annual cost saving of over JD 70,000. The aggregate simple payback period for the projects identified is about 9 months.

In addition to the thermal energy savings identified in the energy audits, a study was conducted of the potential and technical options for demand-side load management in the small and medium-size industrial units. This study indicated that in the approximately 130 industrial enterprises classified as small and medium-size under electric utility tariffs, at least 22 MW of peak load reduction could be obtained, primarily through peak shifting (changing operating hours to avoid utility peak periods). This represents about 5 percent of the maximum peak demand experienced by the interconnected distribution company network. Additional uniform demand savings (at all times) could be achieved by the use of more efficient electrical equipment (e.g., electric motors and lighting systems).

Given these findings, the previous estimate of potential energy savings in the small and medium-size industrial enterprises of 150,000 tonnes of fuel oil per year is still valid. Additionally, over 22 MW of peak load reduction can be obtained through demand-side load management (DSM) strategies implemented in these industries. Taking into account the cost of imported oil saved through the implementation of energy efficiency improvement strategies, and the avoided cost of new generation, transmission and distribution systems due to the implementation of DSM strategies, the net present value of all of the savings to Jordan is estimated to be on the order of $100 million[1].

There appear to be few barriers on the part of the government related to energy conservation investments. Studies conducted under this program indicate that the

[1] The net present value figure includes both the energy cost savings to industry and the avoided cost of new electricity generation facilities that could be achieved over a 10 year period of time through the implementation of energy conservation and load management in the small and medium size industrial segment.

opposite is true: the Government of Jordan actively encourages industrial development (including energy conservation) through the use of tax holidays and low import duties and taxes.

In summary, the main barrier to industrial energy efficiency in Jordan's small and medium-size industrial sector appears to be the lack of awareness of the benefits of energy conservation on the part of industrial plant managers, and the limited access to and knowledge of energy-efficient equipment. In order to overcome this barrier, a major outreach, information and training activity is required, to include both the potential "users" of energy conservation equipment and techniques (the industrial plant personnel) and the potential "suppliers" of energy conservation equipment and services (C/E firms, contractors, and equipment vendors).

RECOMMENDATIONS FOR FUTURE ACTIVITIES

In order to promote and coordinate industrial energy efficiency improvement in Jordan, the staff of IECON should be expanded. The current staff includes only three engineers devoted to energy conservation on a full-time basis; staffing should be increased by two or three experienced engineers. The increased staffing in the short term will allow IECON to provide a more appropriate level of technical assistance and follow up to small and medium-size industrial units in identifying and solving their energy-related problems and in promoting energy efficiency and load management through the development and dissemination of additional information and outreach materials. A suggested activity to be carried out by IECON in the near future is a workshop to disseminate the findings of the work conducted under this program to other small and medium-size industrial enterprises and to further increase their awareness of energy efficiency improvement potential.

Another short-term activity that should be considered is assistance to the Jordan Electricity Authority (JEA) in developing a demand-side load management program targeted to small and medium-size industrial units. As noted previously, a reduction in peak demand of more than 22 MW could be achieved through demand-side load management activities in these industrial units. This potential saving could be achieved through the implementation of "load management audits" of small and medium-size industrial facilities to determine the magnitude of potential demand reduction and to develop strategies for achieving peak load reduction.

A number of alternative approaches to institutionalizing energy efficiency in Jordan's small and medium-size industrial sector were considered. Based on the ECSP team's experience, it is recommended that a two-tier approach be taken, with technical

assistance provided both to IECON and to private sector C/E firms. The technical assistance would be provided by a team of two resident expatriate specialists:

- one energy conservation engineer to assist in the development and provision of technical services -- this specialist will work directly with C/E firms in Jordan to support them in performing energy conservation related services and provide further "on-the-job" training for the C/E firms' engineers in the conduct of energy conservation related services

- one training and outreach coordinator to assist in the training, outreach and information areas -- this specialist will work with IECON and other Ministry staff to help develop information and outreach materials in order to promote the concept of energy efficiency, especially to the small and medium size industrial units

As and when required, the skills and abilities of the resident specialists would be supplemented for specific tasks by short-term specialists.

Since the Government of Jordan's responsibility should be as a coordinating and promotion body, most of the actual work related to identifying and implementing energy conservation opportunities would be accomplished by Jordanian C/E firms and contractors.

In order to create an initial impetus and market for the firms' activities, the project should provide funding to allow the C/E firms to conduct energy conservation related services to the industrial establishments on an initially subsidized basis. As the C/E firms become more experienced in providing the services, and as the market for the services becomes more developed and mature, the subsidy will be reduced and finally eliminated. Under this subsidy program, the industrial plants would pay a reduced rate for the services provided and the difference between the "commercial" rate and the subsidized rate would be reimbursed to the C/E firms under the technical assistance program.

Rather than take the scattershot approach to provide a wide range of energy conservation related services, it is recommended that the "targeted services" approach be taken in this project. This approach focuses on specific and limited energy conservation services that are applicable to almost every industrial sector. These services can be provided to industrial establishments at little cost, but can result in almost immediate and significant energy efficiency improvements and energy cost savings. Two of the most needed types of targeted services that should be offered are:

- Boiler/furnace combustion efficiency analysis and tune-ups. This service focuses on optimizing combustion efficiency, and introducing the use of flue gas analysis and other fixed and portable instruments to industrial plants. The service can be provided in about one-half person-day per boiler or furnace to be tuned up, with expected average combustion efficiency improvements of 5 to 10 percent.

- Steam supply and condensate return system survey. This service focuses on identifying and quantifying the energy waste due to losses in the steam system. It includes identification of steam leaks, missing or damaged insulation, failed steam traps, areas where clear condensate could be returned to the boiler, and other problems related to the steam system. The manpower requirement for providing the service depends on the size of the industrial plant. Based on observations in industrial plants, average energy loss reductions of 5 to 10 percent could be achieved through this service.

Other areas of specific technical assistance that could be developed include demand-side load management surveys and analysis, lighting system surveys, and electric system analysis. While these technical services are being offered by the Government of Jordan agency, the other project components (e.g., training, outreach) should also focus on these specific subjects, with short training courses and outreach materials being prepared and delivered to develop awareness and interest in the areas.

In summary, there is a significant potential for energy savings in the small and medium-size industrial segment in Jordan. In order to achieve these savings, the Government of Jordan must take a more aggressive and coordinated role in promoting energy conservation through awareness and training programs. At the same time, the local market for C/E firms to provide energy conservation services can and should be developed. USAID and/or other donor agencies should assist the Government of Jordan through the funding of a medium-term technical assistance program, to help establish an autonomous or semi-autonomous energy conservation agency.

This chapter presents an overview of the Jordan Industrial Energy Efficiency Program. The sections below briefly describe the program's background, objectives, scope of work, and accomplishments. The chapter concludes with a brief outline of the remainder of this report.

1.1 PROGRAM BACKGROUND

The Kingdom of Jordan imports nearly all of the energy it uses, in the form of crude oil and other petroleum products. Jordan's industrial and power generating sectors account for over 40 percent of its energy consumption (1988 statistics). Energy imports represent a large portion of the country's total imports, and place a great burden on Jordan's foreign exchange reserves. In response to this situation, various activities related to energy efficiency improvement have been undertaken in Jordan in recent years.

Of particular relevance was a series of industrial energy audits carried out as part of a World Bank project in 1985-1986. The audits covered 14 large plants, which represented the 10 largest subsectors of energy use: petroleum refining, fertilizers, steel, cement, potash extraction, phosphates, glass, bricks, ceramics, and power generation. The implementation of energy conservation measures recommended as a result of these audits were estimated to reduce Jordan's oil consumption by some 3 percent, with an average simple payback period of less than three years. The study concluded that the large industrial sector in Jordan was reasonably efficient and self-sufficient in terms of energy efficiency, and that most of the plants examined operated with specific energy consumptions that were close to international standards.

Aside from the few large industrial units in the subsectors identified above, Jordan's industrial sector comprises a much larger number of smaller enterprises in other subsectors. Nearly 1,500 small and medium-size industrial enterprises (employing between 5 and 25 employees) exist, mostly in the chemicals, paper and carton, food processing, mining and quarrying, furniture and wood products, mineral products, machinery, and textile and apparel subsectors. Of these 1,500 industrial units, about 550 can be considered to be small and medium industrial plants, while the rest are mostly small bakeries, restaurants, confectioners, and workshops.

The energy efficiency of small and medium-size industrial enterprises had not been studied to any great extent, although the Industrial Energy Conservation Section of the Industrial Energy Department of the Ministry of Energy and Mineral Resources (hereafter referred to as IECON) has conducted a series of about 40 industrial audits in the past few years. The potential for savings identified in those audits reaches up to 35 percent of energy consumption, with simple payback periods of generally less than one year.

The potential energy savings in small and medium-size industrial units, through broad application of the types of energy efficiency improvement strategies identified, is estimated to be in range of 4 to 5 percent of national oil consumption, amounting to some 150,000 tonnes of fuel oil per year.

In view of these significant potential benefits to Jordan, MEMR requested technical assistance through USAID's Office of Energy and the USAID Mission in Amman to develop an industrial energy conservation plan. This assistance was provided under the Energy Conservation Services Program (ECSP), which sent a mission to Jordan in early 1988, with the following objectives:

- To review the energy conservation and efficiency activities in Jordan to date and confirm the potential for energy savings in Jordanian industry
- To identify the main barriers to energy efficiency that must be addressed by any conservation program
- To develop specific recommendations for such a program
- To identify priorities for ECSP involvement and corresponding budgets for technical assistance.

During the course of this mission, discussions were held in and around Amman, concentrating on the particular problems of Jordan's small and medium-size industrial units. The mission resulted in the preparation of a report outlining the type of program required for the target industrial subsector and the program's components.[2] The main findings of the mission were as follows:

- The main barrier to the achievement of energy efficiency improvements was the lack of awareness of the problem and its solution.
- Partly through lack of awareness of the potential benefits of energy efficiency, there appeared to be an inability in small and medium-size industrial units to define energy-related problems and to identify specific areas where savings could be achieved.

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[2] *The Hashemite Kingdom of Jordan: Recommendations for an Industrial Energy Efficiency Program*, prepared by RCG/Hagler, Bailly, Inc. for USAID/STEY under the ECSP program, May 1988, ECSP Report Number 88-09.

- Low-cost and no-cost housekeeping measures were frequently ignored. Where capital investments for energy efficiency improvement were involved, there was a lack of the technical skills needed to examine the range of options available for improvement and to select the most cost-effective solution for a specific situation.

- Even when a decision was made to invest in energy efficiency improvement, project implementation experience was not available through in-plant personnel.

- Outside support, through consultants or local equipment vendors, was not available. There were no consulting/engineering firms in Jordan with process design, industrial process, or energy engineering capability. Similarly, equipment vendors acted solely as agents for foreign equipment suppliers and were not able to provide any assistance in selecting equipment or estimating its performance.

- In many cases, the contribution of energy costs to the total cost of production was not known or recognized by plant owners or managers.

Based on these findings, an energy efficiency improvement program targeted to small and medium-size industrial units was developed. The program incorporated the following major components:

1. Appraisal of local capability and needs

2. Conducting promotional activities

3. Delivery of training courses

4. Conducting energy audits and providing technical support

5. Conducting policy studies related to barriers and incentives for energy efficiency improvement

The suggested activities to be carried out under each of these components were described in some detail in the original mission report. Based on the findings of that initial mission, the USAID Office of Energy recognized the potential for meaningful energy efficiency improvements in Jordan's industrial sector and funded the present work jointly with the USAID Mission in Amman. After discussions with USAID/W and

USAID/Amman, and with MEMR, the original program, as described in the mission's report, was reduced slightly in scope.

The program's objectives are stated in the following section, and the actual work that was performed is described in Section 1.3 below.

1.2 PROGRAM PURPOSE AND OBJECTIVES

The purpose of the Jordan Industrial Energy Efficiency Program was to provide assistance to the Industrial Energy Conservation Section (IECON) of the Industrial Energy Department of the Ministry of Energy and Mineral Resources (Hashemite Kingdom of Jordan) and to local subcontractors in the establishment and conduct of an energy efficiency improvement program for small and medium-size industries. The objectives of the technical assistance were to:

- Transfer knowledge and experience about industrial energy efficiency to the private sector in Jordan, through the local consulting/engineering companies and the industrial enterprises themselves

- Improve the current understanding of expected benefits and further potential for energy savings in Jordan's industrial sector, providing an adequate basis to develop a long-term and broader energy demand management activity

- Enhance the capability of IECON to promote energy awareness, to monitor energy efficiency, and to develop policy initiatives that will stimulate further gains in productivity.

1.3 SCOPE OF WORK AND PROJECT TEAM

The scope of work undertaken in this project includes the following tasks and activities.

1. **Assessment of Local Capability.** The purpose of this task was to appraise the capabilities of the Jordanian private industrial sector with respect to energy conservation related services. The task involved assessments of both the market for these services and the ability of local consulting/engineering (C/E) firms and/or individual consultants to provide the needed services. The task also included an assessment of IECON staffing needs, and an analysis of industrial energy conservation measuring ability in the private sector.

2. **Promotion and Training.** The purpose of this task was to increase the awareness of plant owners, managers, and engineers concerning energy-efficient industrial plant operation. The task included the delivery of two training courses by the ECSP project team. The first course was a one-day seminar on the importance and benefits of energy management. The audience was drawn primarily from plant managers. The second course was an intensive course on the principles of energy efficiency improvement, and was presented over a two-week period to plant engineers and local consultants. This task also included the preparation and distribution of several technical guidebooks concentrating on common aspects of energy conservation.

3. **Energy Audits and Technical Support.** Two major activities were originally included in this task. The first was the preparation of terms of reference for a study on the importance of energy in industrial production costs. The terms of reference were not prepared and the study was not carried out under this program because IECON had already collected and analyzed the data on their own and were in the process of preparing a report on their findings. The second activity was support to private firms in energy conservation related services. This included the conduct of three energy conservation studies by a local subcontractor firm with the assistance of the ECSP project team.

4. **Organization of Demonstration Projects.** The objective of this task was to provide two simple demonstration projects of industrial energy conservation equipment in the factories that were examined. Because the management of none of the factories were willing to commit to project implementation during the time frame of this program, it was agreed by the ECSP project team, USAID/Amman, and IECON to defer this activity and re-allocate the resources into the policy studies. It is expected that IECON will work with the plants after the end of this project to ensure that at least some of the energy conservation strategies identified in the previous task are implemented.

5. **Studies of Incentives and Regulations.** In this task, the ECSP project team prepared terms of reference for six policy studies related to industrial energy conservation. Three of the six policy studies were carried out by a local subcontractor. The studies included analyses of tax and import policies related to investment in energy conservation equipment, and a study of the technical options for demand-side load management in small and medium-size industrial enterprises.

The activities described above were carried out by a team of four experts. The ECSP project manager was responsible for overall program coordination and implementation. He was also responsible for conducting the assessment study, identifying factories for participation in the audits, conducting the one-day energy management seminar and portions of the two-week industrial energy efficiency course, preparing terms of reference for the technical studies, preparing technical guidebooks, and hiring local consultant firms. The ECSP policy analyst was responsible for preparing the terms of reference for the studies of incentives and regulations. The ECSP training coordinator was responsible for adapting existing materials and presenting the major portion of the two-week principles of energy efficiency course. The ECSP energy conservation engineer was responsible for providing technical support to the local subcontractors in the execution of the three technical studies.

1.4 PROJECT ACCOMPLISHMENTS

The accomplishments of the project are summarized as follows:

- **Support provided to a local consulting/engineering firm.** A local firm was subcontracted to conduct energy conservation studies in three industrial plants. Technical support was provided by the ECSP project team in the collection of field data and use of portable instruments, data analysis, development of recommendations for achieving energy efficiency improvements, and preparation of final reports.

- **Conduct of energy efficiency improvement studies.** As noted above, three energy conservation studies were conducted in local plants by the subcontractor firm. Two of the studies were related to energy conservation in boiler and steam systems; the third was a technical and financial feasibility study of fuel switching.

- **Conduct of policy studies.** Three policy studies were conducted by a local management firm. Two of the studies were related to aspects of energy conservation investments (tax policies and import policies); the third study examined the potential for demand-side load management in small and medium-size industrial plants.

- **Delivery of an intensive two-week course on the principles of energy efficiency.** This course was presented to about 25 industrial plant engineers, each of whom received a copy of the three-volume training and reference manual from which the course was derived.

- **Delivery of a one-day seminar on industrial energy management principles.** This seminar was presented to an audience of industrial plant owners, managers, technical personnel, and other persons from financial institutions and the Government of Jordan.

- **Provision of portable instruments.** The project funded the supply of portable energy conservation instruments to the Government of Jordan, to be used in this program and for future energy conservation activities. Instruments included those used for combustion analysis, flow measurement, and electric power analysis.

- **Printing of energy conservation technical guidebooks.** Three technical guidebooks related to efficient boiler plant and steam system operation and waste heat recovery were reproduced (250 copies of each) for distribution by IECON.

- **Preparation of an assessment of the capability for energy conservation in Jordan.** This memorandum report, included as part of the present document, appraised the capabilities of the private sector in Jordan with respect to energy conservation related services. The appraisal included an assessment of the market for energy conservation related services and of the ability of local consulting/engineering firms to provide the needed services. It also included an assessment of IECON's staffing needs and an appraisal of industrial measurement capability as related to energy conservation.

1.5 ORGANIZATION OF THIS REPORT

This report summarizes the activities carried out under the Jordan Industrial Energy Efficiency Improvement Program. The following chapters describe the activities and accomplishments of each of the major tasks of the project. Chapter 2 contains an assessment of the need for energy efficiency improvement in Jordan. It also describes the ability of local government personnel, private consulting/engineering firms, and plant engineers to carry out energy efficiency improvement programs and projects.

Chapter 3 describes the promotion and training activities carried out under this assignment, while Chapter 4 includes a description of the project's audit and technical support activities. Chapter 5 describes the energy efficiency improvement related policy studies conducted under the project. Chapter 6 provides recommendations for future activities to be carried out in Jordan to increase energy efficiency awareness and the implementation of energy conservation projects.

This chapter describes the assessment of local capability in Jordan to deliver energy conservation related services. Four aspects of local capability are covered in this chapter:

- an appraisal of the energy conservation related services market in Jordan
- an assessment of private sector consulting/engineering (C/E) firms' capability to provide energy conservation related services to industrial establishments
- an assessment of staff needs at IECON
- an assessment of industrial energy efficiency measurement capabilities existing in Jordan.[3]

In order to analyze and assess these areas, the ECSP project team held numerous interviews with principals of the larger C/E firms, with industrial plant managers and engineers, and with representatives of IECON and other Ministry of Energy and Mineral Resources personnel and with USAID/Jordan staff. A list of the people interviewed for this assessment and their affiliations is provided in Exhibit 2.1. The sections below cover each of the four areas of consideration.

2.1 THE MARKET FOR ENERGY CONSERVATION RELATED SERVICES IN JORDAN

In order to assess the market for energy conservation related services in Jordan, interviews were conducted by the ECSP project team with the principals of a number of the leading C/E firms in the Amman area. These interviews were held at the same time as those conducted for the C/E firm capability assessment described below. Interviews were also held with industrial plant managers and engineers to attempt to identify the types of services most required. The industrial plant interviews were supplemented by quick walk-through "energy audits" of their facilities to verify the information provided on the potential for energy conservation in their facilities.

In 1986, a series of energy audits were performed by Bechtel International in a number of the larger industrial establishments in Jordan. Bechtel found that factories in this industry segment were operating at or close to international standards of efficiency. Few,

[3] This task was carried out by IED/MEMR.

Exhibit 2.1 Persons Interviewed for Assessment Study

Date	Company Name	Person's Name and Position
12/11/89	IED/MEMR	Rashad Aburas, Dept Head Jamal Shweikeh, IECON Section Head
12/13	Yeast Industries, Inc.	Reman B. Halteh, General Manager also the plant technical engineer and production manager
	Pepsi Cola Bottling Plant	Mr. Fawzi, Plant Manager Ayman Farouqi, Electrical Engineer
12/14	Arab Chemical Detergents Co.	Hania Saadi, Production Manager Nahla Baara, Plant Manager Jamil I. Muasher, General Manager
12/16	Jordanian Consulting Engineering Co.	Marwan Zureiqat, General Manager Hani Obeid, Electrical Engineer
	Arab Aluminum Industry Co.	Khalil Sawalha, Technical Manager Fouad Ayoub, General Manager
12/17	USAID/Jordan	Farid Salahi, Project Officer Richard Rousseau, Project Officer Lyle Weiss, Chief, Engineering Office
	Jordan Sulfo-Chemical Co.	Bassam Samir Ahmad, Managing Director
	National Cable and Wire Co.	Factory manager and chief engineer
12/18	Sigma Consulting Engineers	Ghassan Ghanem, Director, Engineering Dept.
	Mohammad A.R. Jardaneh & Partners	Bisher Jardaneh, Projects Coordinator
12/19	PLANS/Hakim and Associates	George Charles Hakim, General Manager
	Arabtech Consulting Engineers	Ibrahim Abu Ayyash, Partner
12/20	Paper and Cardboard Company (Zarqa)	Technical Manager and Maintenance Engineer
	Jordan Rock Wool Industries Co.	Hazem Asfour, Factory Manager
3/11/90	Consulting Engineering Center	Izzat Aziz Sajdi, Vice President/General Mgr
3/25	I.C.A. Company	Ahmad Y. Kassim, Plant Manager

if any. audits were conducted during this series in small to medium-size industrial facilities, which comprise the bulk of the Jordanian industrial sector, in number at least.

Assessment of Small and Medium-Size Industries

Visits to small and medium-size factories during this project indicated that while many firms had taken some actions to try to improve energy efficiency, much more needed to be done in those same factories. Most of the energy efficiency improvements were achieved by simple housekeeping and implementation of other low cost/no cost

measures (e.g., repair of steam leaks, repair or replacement of missing or damaged insulation, installation of steam traps or repair of existing steam traps, combustion optimization, repair or recalibration of instruments, purchase of low-cost portable instruments). In addition, it was felt that substantial further electricity cost savings could be achieved through demand-side load management and through the installation of power factor correction devices.[4] These findings were reinforced by a series of about 40 energy audits undertaken by IECON in small and medium-size industrial enterprises.

Most simple energy conservation opportunities in industrial factories are identified and implemented by the firm's in-house engineering and maintenance staff. While the intention is good, the execution often suffers from poor workmanship or a "cheaper" approach to solving the problem. In many cases, this approach does little to solve the problem over the long term.

In the plants visited by the ECSP project team during the course of the interviews, potential energy savings are conservatively estimated at 5 to 25 percent of current use. This does not include additional potential energy cost savings due to implementation of power factor correction or demand-side load management projects. In the factories examined in detail in this project, energy savings opportunities of close to one-third of consumption were identified in the limited plant areas audited. Given the large potential for energy savings in this industrial segment, two questions arise:

- Why aren't the factories improving their energy efficiency?
- Why are there no local energy conservation services companies operating in Jordan?

To a large extent, the answers to these questions are related to attitudinal and awareness aspects of the way the small and medium-size factories are managed and operated. Energy costs are generally a very small percentage of the total cost of production in these factories: typically less than 10 percent and generally less than 7 percent. In addition, companies using heavy fuel oil and producing product for export also enjoyed a

[4] IECON is currently following up a survey of about 500 industrial factories to provide information and assistance to those identified as having a particularly low power factor. The Jordan Electricity Authority (JEA) is planning a survey of industrial customers for the purpose of helping to implement demand-side load management programs (DSM). One of the policy studies undertaken under this project includes a preliminary identification of both the barriers to DSM and technical options available to small and medium-size industrial factories.

fuel subsidy of up to 50 percent.[5] Hence, energy cost was not considered to be a major cost that needed to be managed or controlled.

Another consideration is that factory management appear to be more interested in making sure that the plant operates and meets production targets, than making sure that the plant operates at its optimum efficiency. This was clearly observed during the walk-through surveys undertaken at the time of the plant visits. Preventive maintenance programs rarely exist,[6] and equipment is generally maintained only when and if it fails. This has a major impact on energy efficiency systems installed as part of the original plant installation. If insulation is removed to repair pipe work, it is not replaced; steam traps that fail are not repaired and in many cases steam traps were never installed according to prudent steam system practice; instrumentation that is considered "non-critical" is not repaired or replaced upon failure; and portable instrumentation or diagnostic equipment[7] is not available for spot-checking operating conditions or process efficiency. In an extreme case, in one factory which boasted that all their furnaces were equipped with heat recovery systems, it was found that all of the heat recovery duct work had been removed some time ago and that the furnace flames were shooting out into the work area.

Conversations with plant managers and engineers indicated that they do have some awareness of the need for energy conservation, but that energy conservation is not a major concern. When an energy conservation opportunity is found, it is identified and (if considered useful) implemented by in-house engineering and maintenance staff. None of the plants visited have employed local C/E firms for anything other than the original civil and layout design and construction supervision of the factories. Technical and management personnel in all of the plants visited felt that they know their process and equipment sufficiently well to maintain production levels, or if they do have problems that can't be solved in-house, rely upon their foreign affiliates or technology licensors.

A further problem is the lack of energy conservation equipment in Jordan. With the exception of locally manufactured insulation material (mineral wool and fiberglass), all other energy conservation equipment must be imported. While there are agents for

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5 This subsidy of up to 25 Jordanian dinars (JD) per ton of heavy fuel oil, prorated on the amount of production for export, was eliminated in 1990.

6 This was also confirmed through informal interviews with the engineers attending the 10 day energy efficiency training course presented under this project.

7 A possible exception is instruments and chemicals for measuring the quality of water used in the boilers.

foreign manufacturers of these types of equipment in Jordan, the equipment is not available in stock in Jordan, and must be imported specifically for the factory. Also many of the agents are said to be unfamiliar with the equipment that they sell[8], and are not able to provide technical assistance in the specification, sizing, installation, operation or maintenance of the equipment. Because of this, when a factory does require imported equipment, they will import it directly rather than go through an agent.

Hence, little is being done in Jordan to identify energy conservation opportunities that may require imported equipment, because of the lack of information about the equipment required and the lack of after-installation support for that equipment. When energy conservation opportunities are identified and implemented in small and medium-size factories, they are usually very simple projects that use the limited locally manufactured equipment (e.g., insulation). Even the use of instrumentation is kept to a minimum because of the lack of information available and lack of access to spare parts and expendables.

Summary and Recommendations

A market does exist for energy conservation related services in Jordan, not only for consulting/engineering services, but also for contractor services. Because of the lack of awareness of the benefits of energy conservation in small and medium-size plants, and the limited access to and knowledge of energy efficient equipment, little is being done to take advantage of the large energy conservation potential in this industrial segment and no demand exists for these services. In any event, none of the local C/E firms are currently able to provide the services required (see Section 2.2).

A suggested solution to the problem involves a major outreach and information campaign targeted to small and medium-size industrial plant managers and engineers. This outreach campaign must address a number of different information voids, including techniques for the identification and quantification of energy conservation opportunities; and the equipment, instruments, or operating and maintenance techniques required to achieve the benefits of the energy efficiency improvements (including operating characteristics, and capital and maintenance and operating costs). At the same time, a similar effort needs to be undertaken to train local C/E firms and future generations of engineers in the theoretical and practical principles and techniques of energy

[8] A common comment expressed by industrial plant personnel about local suppliers of imported equipment is that they are selling equipment without being sure of its suitability for the particular application and without being able to guarantee its performance after the sale.

conservation (see Section 2.2). International donor agencies could directly support these activities through a longer-term commitment to energy efficiency improvement in Jordan.

2.2 PRIVATE SECTOR C/E FIRMS' CAPABILITY TO PROVIDE ENERGY CONSERVATION RELATED SERVICES

In order to assess the capability of private sector C/E firms to provide energy conservation related services, interviews were conducted with the principals of a number of the leading C/E firms in the Amman area. The firms were identified from a list provided by the Jordan Association of Engineers, a professional society. These interviews were supplemented by a mail survey to approximately 10 firms (some of which were interviewed prior to the mailing of the survey). The contacts were further supplemented by interviews with industrial establishments in the Amman area to seek out their experiences with and views on the use of outside consultants.

C/E Assessment

The main finding of this assessment is that none of the C/E firms contacted has had any prior experience in the energy conservation services area, and none of the persons interviewed were aware of any other local firm that could or had provided these services in Jordan.[9] To appreciate this finding, a brief description of the consulting/engineering services market in Jordan is in order.

Most of the C/E firms in Jordan are registered with the Jordan Association of Engineers. Among other activities, the Association registers C/E firms as capable of working in a number of disciplines (e.g., civil engineering, sanitary and sewage, electrical engineering, mechanical engineering). In order for a firm to be registered, it must have on its full-time staff at least one senior engineer and one junior engineer qualified in the particular field ("senior" and "junior" are defined in terms of years of experience).

Most of the C/E firms in Jordan are dedicated to civil and/or building design and construction work. These firms work almost exclusively in the area of infrastructure (e.g., roads and highways); water supply, sewage, and waste water treatment; and building design (including architectural, mechanical and electrical). Of the few firms registered by Association of Engineers to work in the industrial area, most of the work

[9] Several short-term energy conservation projects were undertaken with foreign assistance in Jordan prior to the current Industrial Energy Efficiency Program: a series of energy audits conducted by Bechtel International of large industrial units, and a series of energy efficiency training courses organized by the European Commission, World Bank, UNDP and others. None of these projects involved the use of Jordanian consultants.

actually accomplished has been in the area of plant layout and civil, mechanical and electrical work related to the construction of new industrial plants or the expansion of existing plants.

Another finding is that there appear to be no local firms with consulting or engineering capability for the design or adaptation of industrial processes. In fact, none of the C/E firms contacted had a chemical engineer on staff.

Of the many factories visited, all were of European, British or American design and were purchased as "packages." Local C/E firms and contractors were used only in the design of plant layout and design of mechanical and electrical services. When factories experience operating problems, they either rely on in-house engineering capability, or on contacts with the licensors of the plant technology. On a very limited basis, the problems are sometimes referred to the engineering staff at one or two of the large- scale industrial establishments (e.g., the petroleum refinery) for assistance.

This has resulted in a vicious circle. The factories do not call upon local C/E firms for solutions to problems, since they feel that the local C/E firms do not have a track record in being able to provide assistance. The local C/E firms do not (and cannot) offer the services, because it is felt that there is no demand for them. Another major limitation faced by local C/E firms is that they are forbidden by regulation from engaging in any "contracting" type work. While they are allowed to perform design and technical studies, and can supervise project implementation, they are not allowed to actually do any of the installation work themselves. Hence, a C/E firm would need to work in a joint venture relationship with a local contractor in order to provide "turnkey" services.

A further barrier to the provision of energy conservation related services is the lack of instruments available for use by the C/E firms. While the firms have instruments that are used in their primary areas of business (e.g, surveying, hydrology), they do not own or have ready access to the types of instruments needed for energy efficiency related measurements. Indeed, the instruments required are not found anywhere in Jordan outside of the Ministry of Energy and Mineral Resources.

With the recent economic problems facing Jordan, local markets for C/E services have become more limited. C/E firms have thus started marketing their expertise in other Arab and non-Arab countries (and have been rather successful). Several of the firms interviewed had a number of foreign contracts and expected this trend to continue since the devaluation of the Jordanian dinar has made them more competitive with other foreign firms.

While none of the firms interviewed has had any prior experience in providing energy conservation related services in Jordan, several expressed an interest in developing this service as a means to diversify and expand their domestic practices. Several of the companies sent at least one of their employees to the training courses presented under the Industrial Energy Efficiency Program to receive some training and background in the area. However, it became clear from other comments made by the principals of the C/E firms, that in general they were not willing to set up a practice area related to energy conservation services unless they were certain of the demand for the services. The firms are not eager to hire and train employees unless a definite market for the services was already in existence, implying that they were not willing to help develop the market on their own.

In order for the local firms to expand into this area, however, additional staff or staff with different backgrounds and experience would be required. Of the firms interviewed, all employed at least one mechanical and one electrical engineer. The mechanical engineers were employed mostly in the areas of building heating, air conditioning and ventilation systems (including boilers and chillers). Their role, however, is limited to system sizing and specification from catalogs. The electrical engineers are responsible primarily for design of building electrical services and many of them have previous experience in the design of electrical networks. While these capabilities provide some of the necessary background for energy conservation related services, few of the mechanical engineers have actual operating experience with combustion systems (industrial boilers, kilns, furnaces, dryers, heaters) and few of the electrical engineers have actual operating experience with industrial electrical systems and equipment.

Summary and Recommendations

The potential capability to provide energy conservation related services does exist in Jordan. It must be developed, however, through enhancement of the particular skills required (by means of expanded outreach, training, and education at the university level). A suggested approach is to incorporate energy conservation principles into bachelor's and advanced-level engineering curricula, and to provide intensive short-term training to a wider audience of practicing engineers than could be reached under the Industrial Energy Efficiency Program.

Local C/E firms must be encouraged to develop the capability and market for their services (the firms do not seem to be willing to develop the market on their own) through a mechanism that will allow the services to be provided with little risk to either the C/E firm or the industrial establishment requiring the services. A suggested approach could be the complete or partial subsidy of the services either by the Government of Jordan or through longer-term support and commitment by international

donors. The subsidy could take one of many forms: direct subsidy by means of rebate or all or part of the cost of the services or of the equipment actually installed as a result of the study; or tax incentives for energy conservation investments (including the technical analyses).

It should be noted at this point that the Industrial Energy Department of the Ministry of Energy and Mineral Resources has conducted energy audits of many small and medium-size industrial factories at no cost to the factories. However, the Department's resources do not allow for substantial follow-up of the studies' findings or support for the encouragement of energy efficiency project implementation. As is clear, conducting an energy audit does not in itself save energy; the energy efficiency improvement strategies identified must be properly implemented and maintained in order to achieve the energy cost savings.

2.3 IECON STAFF NEEDS

The Ministry of Energy and Mineral Resources is a fairly new institution in Jordan, having been established in 1984. The Ministry itself consists of about 80 persons. While the Jordan Electricity Authority (JEA) is part of the Ministry (the Minister is the Chairman of the JEA), it operates as an autonomous body.

MEMR's Industrial Energy Department is staffed by about seven engineers and economists working in four major areas: industrial energy conservation (IECON), the transportation sector, fuel distribution, and energy monitoring (national energy inputs and outputs). Three engineers are working in the Industrial Energy Conservation Section on a full-time basis. Of the three, one is a relatively new employee with limited experience in the field. The other two have had more direct experience and training: one of the engineers has attended the USAID/TVA sponsored energy conservation course in the U.S., while the other has attended training courses and seminars in Jordan, England, Spain and other countries.

Despite its small size, over the past few years IECON has been engaged in a number of important activities. In 1986, Bechtel International conducted a series of industrial energy audits of large industrial factories, with the cooperation of IECON. The Department also sponsored technical training courses in energy conservation with the assistance of the European Commission, the World Bank, UNDP and other organizations. USAID is one of the leading international donor agencies in Jordan which has supported and provides technical training in energy conservation to IECON staff in the United States.

On their own, IECON's engineers have conducted about 40 energy audits of small and medium-size industrial establishments at no cost to the factories, and have conducted a number of energy conservation workshops and seminars. Due to the IECON's limited resources, however, little follow-up of these audits has been undertaken to track or assist in the implementation of the recommended energy efficiency improvement measures. IECON has also recently begun to provide industrial plant engineers with information and outreach materials to encourage the identification and implementation of energy efficiency measures such as peak load management and combustion efficiency improvement.

Also recently, IECON has undertaken a survey of about 500 industrial establishments to determine their energy consumption and energy costs, production figures, costs of production, production processes employed, and other parameters. These data have been entered into a computer data base and some of the data will be published as a report in the near future. The data are currently being used to identify factories with low power factor, in order to make direct contacts with the factories to assist in the implementation of power factor improvement projects.

Assessment of IECON's Resources

Prior to the Industrial Energy Efficiency Program, IECON had limited access to energy audit instruments: a combustion gas analyzer, digital thermometer, air velocity meter, and electrical measurement equipment (power factor and demand). The department has access to instruments owned by EEIAC (see below). Under the Program, a more complete range of portable instruments was purchased for the Department. IECON does own a number of personal computers and standard software, and has access to the JEA mainframe computer.

Energy conservation information resources and reference materials available to IECON are limited. IECON does not have a formal library, and materials are scattered throughout its offices. The materials available consist primarily of product literature from Europe and the U.S. (mostly dated); a number of technical brochures, booklets, and handbooks prepared by energy conservation agencies in other countries (e.g., U.S., U.K., Ireland, Japan); and copies of training course materials (USAID/TVA manuals, ECSP manuals, EC manuals, and manuals related to other international training courses, seminars, and workshops). While JEA has a formal library located in the Ministry building, the reference materials there are not directly related to energy conservation (although many standard technical handbooks are available).

A potential problem related to the MEMR's energy conservation efforts is a lack of coordination among agencies concerned with energy conservation. Recently, the Jordan

Electricity Authority established a load management unit to investigate demand-side load management potential and strategies in a number of end-use sectors. This unit was established partly in response to recommendations from two studies conducted for JEA.[10] While the unit is planning to conduct a survey of load management strategies for the industrial sector later this year, there has been little or no coordination with MEMR on this study. It should be noted that the load management unit does plan to follow up the study on industrial demand-side load management conducted under this Program.

Within the Ministry of Energy and Mineral Resources is a second agency that deals with energy conservation: the Energy and Electricity Information and Advisory Center (EEIAC), located in the Renewable Energy Department of MEMR.[11] The objectives of the EEIAC, as stated in its brochure, are to provide "services to public, as well as technical, academic and industrial institutions in the following sectors: energy audit, thermal insulation, passive [solar] design, building orientation, solar heating, HVAC systems, lighting, electricity and electrical equipment, electrical services." The EEIAC has been rather successful in its efforts, and has established permanent offices in at least two cities in Jordan. EEIAC advertises its advisory services, promotes energy conservation through newspaper advertisements (albeit on a limited basis), and has undertaken a number of activities geared more towards residential and commercial consumers. As with the load management unit set up within JEA, although the EEIAC and IECON are part of the same Ministry, there is little coordination of the efforts and activities of the two departments.

Summary and Recommendations

IECON has accomplished a great deal with limited manpower and financial resources. However, in order for IECON to be able to provide the functions necessary to promote, coordinate, and monitor energy conservation activities in the industrial sector, it is imperative that additional funding and staffing of IECON be provided by the Government of Jordan. While the core staff of three energy conservation engineers has done a good job in the past few years, their efforts have not been as successful as they could have been because of lack of follow-up and wide-ranging dissemination of technical and promotional information.

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[10] One study was conducted by Gilbert/Commonwealth under USAID funding in 1986; the other more recent study was conducted by Ontario Hydro under a CIDA program.

[11] USAID has supported this agency through the purchase of instruments and equipment for energy efficiency measurement and analysis.

At a minimum, the energy conservation activities in IECON need to be staffed by at least an additional two or three experienced engineers. The increased staffing will allow IECON to more effectively pursue and accomplish a number of critical functions:

- development and dissemination of materials and information promoting the concept of energy efficiency improvement to the managers and owners of small industrial units
- development and dissemination of technical materials in the form of booklets, brochures, case studies and technical reports describing to plant engineers and technicians the more common energy conservation technologies and techniques required
- development of policy initiatives to promote energy conservation
- coordination and follow-up of energy conservation activities in Jordan's industrial sector
- development and organization of a central technical library on energy conservation, efficiency, equipment and technologies[12]

As can be inferred from the staffing recommendations above, funding beyond that currently available to IECON would be required, not only for manpower, but also for such support services as transportation, photocopying and printing, development and maintenance of a technical library, and the purchase and maintenance of additional energy audit equipment and instrumentation.

As can also be inferred from the staffing recommendations above, IECON should be more involved in the coordination and promotion of a national industrial energy conservation campaign, rather than being responsible for conducting the technical studies. This is consistent with one of the objectives of the Industrial Energy Efficiency Program: to create a market for energy conservation services among Jordanian consulting engineering firms.

Energy efficiency is a new field in Jordan and it is unlikely that new staff hired by IECON would have much prior experience or expertise in the area. It is strongly recommended that foreign training of the newly hired staff be undertaken either on a

[12] This function could be undertaken jointly with one or more of Jordan's universities granting engineering degrees.

short-term basis (e.g., attendance at overseas training seminars and workshops, trade shows and equipment expositions), or on a longer-term basis (e.g., Government of Jordan sponsorship of master's degree programs in energy conservation, energy management, energy planning, etc.)[13]. Because of the potential problem of trained personnel leaving, the training should be provided only after contractual agreement by the employee of a certain fixed employment period (say, up to two years) after return from the overseas training.

2.4 INDUSTRIAL ENERGY CONSERVATION MEASUREMENT CAPABILITY

The information leading to this assessment was obtained by IECON during January and February 1990. The data were obtained by visits or telephone contacts with the relevant institutions.

Test instrumentation for energy conservation purposes is rare in Jordan. Private sector companies do not have access to any but the most basic instruments, generally for electrical measurements. Combustion flue gas analyzers (either chemical or electronic) are not used outside of the large scale industrial plants (e.g. refineries, cement, electric power plants).

Even the Royal Scientific Society (RSS), which undertakes specialized measurements for industry and the government, does not have the specific types of instruments needed for energy conservation work.[14] The universities offering engineering degrees have a significant amount of test instrumentation, but this is primarily of the bench-test variety and no portable instruments are available.

Because of the almost complete absence of the appropriate types of instruments for energy conservation measurement and analysis, this assessment can only conclude that Jordan's current energy conservation measurement capability is extremely limited.

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[13] Under the Industrial Engineering Program Project, USAID is providing substantial technical assistance to the Government of Jordan in establishing a master's degree program in industrial engineering at the University of Jordan.

[14] It is interesting to note, however, that the RSS does have instruments for analysis of solar energy, and recently received instruments for use in air pollution studies.

This chapter summarizes the promotion and training activities carried out under the Jordan Industrial Energy Efficiency Program. The promotion activities consisted of the reproduction of three technical guidebooks on common energy conservation problems encountered in Jordan, while the training activities consisted of two training courses presented in Amman during the project.

3.1 PROMOTION ACTIVITIES

Under the scope of work for this project, two or three energy conservation related technical guidebooks were to be adapted and reproduced for distribution by IECON. The guidebooks were to be adapted from existing materials and provide useful information to the target audience of industrial plant engineers and operators.

During the project, materials available in IECON's collection of technical books were reviewed. As a result of this review, it was decided by the ECSP Project Team and IECON that three of the booklets in the U.K. Energy Efficiency Office's *Fuel Efficiency Booklet Series* would be included. The three booklets chosen were:

- *Recovery of Heat From Condensate, Flash Steam and Vapor* (#6)
- *The Recovery of Waste Heat From Industrial Processes* (#13)
- *Economic Use of Oil-Fired Boiler Plant* (#14)

These three booklets were chosen for the following reasons:

- The three booklets addressed common energy efficiency problems encountered in small and medium-size industrial plants in Jordan.
- The booklets were written in simple English and included both the theoretical and practical aspects of the problems being addressed.
- The booklets included practical applications and examples, with procedures outlining the computation of energy and energy cost savings through application of the energy conservation strategies; in many cases, simple charts and nomographs were presented.

Copies of the booklets were distributed to engineers attending the 10-day Principles of Energy Efficiency Improvement course (see below). Additional copies will be distributed to other engineers by IECON in the future.

3.2 TRAINING ACTIVITIES

Two training courses were presented under the Industrial Energy Efficiency Program. Each of the courses is described in turn in the sections below.

3.2.1 Energy Management Seminar

The first course presented was a half-day seminar on energy management. The course was held in the training center of the Ministry of Energy and Mineral Resources in Amman on Tuesday, March 6, 1990. The ECSP project manager was the lecturer for this seminar.

Seminar participants were invited by IECON, and approximately 28 persons attended. The participants included industrial plant managers and engineers, local engineering consultants, IECON and Jordan Electricity Authority staff, and representatives from the Industrial Development Bank and the Chamber of Industries. A partial list of the participants is shown in Exhibit 3.1.[15] As can be seen from the attendance list, many of the participants represent the upper management of industrial establishments, while some of participants were plant engineers. While the target audience for the seminar was upper management, some of the industrial facilities invited were unable to send upper management personnel, and hence lower-level personnel attended.

The seminar was opened by the Undersecretary-General of the Ministry. Also in attendance for the opening were representatives of USAID and IECON. Both television and press coverage of the opening were provided, and articles about the seminar were published in both the Arabic and English language newspapers. A copy of an article appearing in the Jordan *Times* is shown in Exhibit 3.2.

The seminar lectures ran for about four hours; the seminar outline is presented in Exhibit 3.3. The seminar was based on a similar training seminar developed by RCG/Hagler, Bailly for use in Pakistan, but revised to reflect the situation in Jordan. A seminar manual was developed as a reference for the course and it was to be photocopied and distributed to seminar participants by IECON.

The seminar was well received, with numerous questions and comments put forth by the participants during the session and the breaks. Many of the questions related to specific energy management problems encountered in the participants' own factories. While

[15] Some of the participants left without providing the registration information.

Exhibit 3.1 Partial List of Energy Management Seminar Participants

Name	Affiliation	Position
Moh'd Shaaban	Arab Co. for White Cement	Plant Manager
Moh'd Mousa Bani-Hani	Jordan Cement Factory	Works Manager
Ahmad Abu-Naim	Sigma Consulting Engineers	Head, Electrical Dept.
Abdul Rahman Khalil	Jordan Cement Factory	Manager, Engineering Services Dept.
Mustafa Shaher Muheisin	Jordan Cement Factory	Asst. Works Manager
Turki Abu Kassab	Jordan Electricity Authority	Engineer, Planning Dept.
Farid Salahi	USAID/Amman	Project Officer
Remon Halteh	Yeast Company	General Manager
Sulieman Atyeh Mahfouz	Consulting Engineering Center	Mechanical Engineer
Ahmed S. Jalal Kayyal	Jordan Pipe Manufacturing	Head, Electrical Dept.
Hani M. Nofal	IED/MEMR	Engineer
Jamal F. Schweikeh	IED/MEMR	Head, IECON Section
Khalil T. Halaseh	Al-Hikma Pharmaceuticals	Maintenance Engineer
Fadi Nassar	Al-Hikma Pharmaceuticals	Chemical Engineer
Dr. Ahmad Kassim	I.C.A.	Technical Manager
Moh'd. Frehat	Jordan Electricity Authority	Power Engineer, Planning Dept.
Randa Y. Taher	Industrial Development Bank	Project Engineer
Adnan M. Abu Shaar	National Industry Paper Mill	Maintenance Manager
Ali Al-Zoubi	Jordan Electricity Authority	Load Management Unit Head

Exhibit 3.2 Text of an Article Appearing in the Jordan Times Describing the Energy Management Seminar

Seminar studies ways to conserve energy

Amman (J.T.) — A seminar opened in Amman Tuesday to study means of reducing cost of industrial production through rationalizing energy consumption and boosting national industries.

The seminar, which was organized by the Ministry of Energy and Mineral Resources in cooperation with the United States Agency for International Development (USAID), also aims to improve methods of energy consumption by Jordanian industries in order to reduce cost and improve product quality to compete in foreign markets, according to a ministry official.

The official said rationalizing energy consumption will result in a reduction of the amount of imported fuel. It will also save hard currency.

According to the official, the ministry has begun a series of studies on model industries to be selected by the Chamber of Industries as case studies. Several engineers will be trained on energy consumption rationalization.

The seminar, which was opened by ministry Secretary-General Ibrahim Badran, was attended by representatives of several public and private institutions and industrial concerns in Jordan.

Under the terms of a three-year agreement signed by the Jordanian government and USAID, the latter pledged to provide assistance in helping Jordan's exports both regionally and throughout the world.

Jordan *Times*, March 7, 1990

some of the questions were very specific and not entirely relevant to the materials presented in the seminar, many of the questions were related to the establishment of

Exhibit 3.3 Outline of Energy Management Seminar

1. **Introduction to Energy Management**
   Background
   Benefits of Energy Management

2. **Energy on the Company Level**
   Why is Energy Conservation Important?
   How is Energy Measured?
   How Much Does a Unit of Energy Cost?

3. **Energy Management Organization and Approach**
   Linking Energy Consumption to Costs
   Where to Start?
   Top Management Commitment
   The Energy Committee
   The Energy Manager
   Setting Goals and Targets
   Staff Training and Motivation
   Use of Internal and External Resources

4. **Energy Accounting, Monitoring and Targeting**
   Introduction and Definitions
   Energy Accounting: A Simple First Step
   Monitoring
   Evaluation and Analysis
   Establishing Targets

5. **Technical Approaches and Analyses**
   The Energy Survey Process
   Checklisting

6. **Energy Conservation Opportunities**
   Classification of ECOs
   Typical Energy Conservation Opportunities

7. **Project Evaluation and Financial Considerations**
   Project Evaluation Report
   Detail of Cost and Savings Estimates
   Financial Analysis Techniques

energy management programs and to establishing and monitoring energy performance.

At the end of the seminar, all of the course materials prepared (e.g., manuals, overhead transparencies) were turned over to IECON for use in presenting this seminar on their own in the future.

3.2.2 Principles of Energy Efficiency Improvement Training Course

This training course was presented in Amman from March 11 through March 21, 1990. An outline of the topics presented is shown in Exhibit 3.4. The course was based on the existing three-volume ECSP energy audit training manual.[16] Two topics, environmental problems related to energy conservation, and economic feasibility techniques, were added to the course at the request of IECON. Copies of the three-volume manual were printed in Jordan under this project and distributed to the course participants at no charge.

The bulk of the course was presented by the ECSP team training coordinator, with some of the sessions presented by the ECSP team project manager. A special session on power factor engineering was presented by a guest lecturer from the Jordan Electricity Authority.

In regular attendance were some 16 engineers representing local industry (11 from 8 different companies), consulting/engineering firms (2), and local universities (4). An additional nine engineers were occasional participants. The course was held at the MEMR auditorium during a 6-hour period on each of the ten days. A list of participants is presented in Exhibit 3.5.

In addition to regularly scheduled lectures as indicated in the course outline, two other activities were included in the training course:

- Case studies were presented by participants, involving energy conservation projects already implemented or planned for implementation at their own plants. A total of five case studies were presented. Of these, three appropriately addressed energy usage and conservation at the manufacturing facilities, and were well presented. One presentation did little more than describe an existing plant heat recovery problem in an attempt to elicit possible solutions from the audience and lecturers.

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[16] *Energy Audit Manual, Volume I: Introduction to Industrial Energy Management, Energy Audit Manual, Volume II: Unit Operations,* and *Energy Audit Manual, Volume III: Equipment, Materials and Systems*, prepared by RCG/Hagler, Bailly, Inc., January 1989, for USAID/STEY under the ECSP program.

Exhibit 3.4 Outline of Principles of Energy Efficiency Improvement Training Course

Date	Day Number	Topics
March 11	1	Course Opening Course Objectives and Outline Introduction to Energy Management
March 12	2	Process Principles: Combustion Heat Transfer
March 13	3	Insulation Fuel Burners
March 14	4	Boilers Furnaces
March 15	5	Steam Distribution Drying
March 17	6	Evaporation Refrigeration/Chillers
March 18	7	Cooling Towers Electricity
March 19	8	Electric Motors Lighting
March 20	9	Instrumentation Environmental Aspects
March 21	10	Engineering Economics Course Closing

- A field trip to a local company (Arab Aluminum -- Aral) was organized to examine an energy-intensive facility and see a successfully completed energy conservation project.[17] Logistical support for transporting the participants to the factory was provided by IECON.

[17] One of the case studies was presented by the chief engineer of this factory.

Exhibit 3.5 Attendance List for Principles of Energy Efficiency Training Course

Name	Affiliation	Position
Zuhair Simonian	Arab Aluminum Company	Electrical Services Manager
Ali Ahmad Hyajneh	Mutah University	Mechanical Engineer
Isam E'-Holoul	Mutah University	Mechanical Engineer
Hisham Ahmad	National Industries	Mechanical Engineer
Afif Shomali	Jordan Dairy Company	Mechanical Engineer
Hisham Al-Aloul	Jordan University	Mechanical Engineer
Mohammad Khalil	Arab Steel Pipes Mfg. Company	Electrical/Maintenance Engineer
Hamid Abu Touk	Industrial Development Bank	Project Evaluation Engineer
Ahmed Abu Zeid	Jardaneh Consulting Engineers	Head, Mechanical Dept.
Jalal Saleh	I.C.A.	Mechanical Engineer
Deifellah Dajeh	Yarmoub University	Assistant Professor
Moh'd Nasser-eddin	Arab Pharmaceuticals Mfg. Co.	Chemical Engineer
Yaser Al-Abbadi	Jordan Ceramic Company	Chemical Engineer
Moh'd Rezeq	Sigma Consulting Engineers	Electrical Engineer
Nasri Dogom	Sigma Consulting Engineers	Mechanical Engineer
Hisham Ahmad Sulaiman	National Industries (Paper)	Mechanical/Maintenance Engineer
Ayman Farouqi	Pepsi Cola	Electrical Engineer
Fathi Abo Abdoh	Yeast Industries	Electro-mechanical Engineer
Fatima Al-Azam	I.C.A.	Chemical Engineer
Ali Mosleh	Arab Aluminum Company	Mechanical/Maintenance Engineer
Sulieman Abu-Mahfouz	Consulting Engineering Center	Mechanical Engineer
Munif Hijazi	Jordan Technical Consultants	General Manager
Nasri Rabadi	Jordan University	Lecturer, Mechanical Eng. Dept.
Moh'd Frehat	Jordan Electricity Authority	Power Engineer
Tahir Hamid	N/A	N/A

The mix of course participants included a range from young and relatively inexperienced engineers employed in local enterprises, to consulting engineers who were older and more experienced, and engineers from academic institutions. While most participants had only a bachelor's degree, a few had advanced degrees, up to the PhD level. This mix of experience and background produced some problems in the conduct of the course, especially related to an understanding of the physical and engineering basics for energy conservation methods. Less experienced participants would ask questions about the fundamentals during the breaks rather than during the lectures themselves.

Hence, it was difficult to decide whether to spend more time on the fundamentals or on the technical applications during the presentations. If more time was spent on the technical fundamentals, the more experienced engineers became inattentive. If more time was spent on the technical applications, the less experienced engineers were unable to fully grasp the concepts being conveyed. It is recommended that more careful screening of the participants be undertaken in the future, to make sure that the group is more homogeneous in terms of background and experience, or that the course be expanded to include separate sessions on fundamentals for a more limited audience.

Many of the course participants were specifically interested in finding solutions to problems related to their own work and only casually concerned with the broad approach to energy efficiency principles covered in this course. While these problems were occasionally distracting and time consuming, the presentation of individual problems to the participants as a group did allow some of the principles of the course to be applied in the solution of what appeared to be rather common problems.

The last session of the course included the display and description of the portable energy auditing instruments purchased under this project (see Chapter 4 below). The session was of great interest to the audience, with many questions addressed to the cost and use of the instruments.

At the conclusion of the course, all course materials prepared were turned over to IECON for use in presenting this course on their own in the future. The materials included copies of the manuals, hand-out materials prepared for the different lectures, and overhead transparencies.

A major element of the Industrial Energy Efficiency Program for Jordan was the provision of technical support in the conduct of energy audits by local consulting/engineering firms. This task area accounted for a major portion of the resources of the entire project and is described in this Chapter.

A major finding of the preliminary ECSP study of the need for an energy conservation program in Jordan was that there was no capability within the private sector to provide energy conservation related services. A more thorough examination conducted during the present project (described in Chapter 2 above) confirmed this finding. Although consulting/engineering firms in Jordan can and do provide design services related to energy consuming equipment, these services were limited to the building heating, ventilating, and air conditioning areas. There were no consulting/engineering firms in Jordan with any experience in providing energy conservation related services in industry or buildings.

To try to overcome this barrier to energy efficiency in Jordan, one of the objectives of this program was to transfer knowledge and experience in energy efficiency project identification and quantification to Jordanian consulting/engineering firms. This objective was to be accomplished by providing training and technical support to local firms in the execution of energy conservation related studies under the aegis of the project.

The major steps in the accomplishment of this task were as follows:

- identification and hiring of a local consulting/engineering firm to carry out the energy audits and feasibility studies
- identification of small and medium-size industrial units willing to participate in the energy audit and feasibility study program
- purchase of portable energy audit instruments and equipment
- identification of the areas of examination of each of three industrial plants and preparation of terms of reference
- provision of specialized training of the local consulting/engineering firm's personnel in energy audit techniques and the use of portable instruments
- provision of ongoing technical support to the local consulting/engineering firm in the conduct of the energy audits and feasibility studies, analysis of data, and report preparation

This chapter includes a summary of the work accomplished under this task.

4.1 IDENTIFICATION AND SELECTION OF CONSULTING/ENGINEERING FIRM AND INDUSTRIAL PLANTS TO BE STUDIED

4.1.1 Selection of Consulting/Engineering Firm

During the course of the local capability assessment (see Chapter 2 above), interviews were held with the principals of numerous consulting/engineering firms in the Amman area. These interviews were supplemented by a mail survey to about 10 additional firms, representing the country's larger C/E firms. All of the firms contacted were identified from a list of registered C/E firms prepared by the Jordan Association of Engineers. Despite extensive inquiries, it became evident that there were no firms in Jordan with previous experience in conducting energy related studies.

From the interviews, a short list of C/E firms to be considered for training to carry out the technical studies under this project was developed. Inclusion of a firm on the short list was based on a number of factors, including:

- interest of the firm in developing the capability to provide energy related services in the future
- commitment of the firm, as evidenced by their willingness to send engineers to attend the training programs conducted under this project
- the range of experience of the company and its personnel in areas related to energy efficiency improvement.

After completion of the terms of reference for the three technical studies (see below), firms were invited to bid on the work to be accomplished. The work was awarded to Mohammad A.R. Jardaneh & Partners, an Amman consulting/engineering firm, on the basis of price, ability to complete the work within the specified time frame, and qualifications of proposed personnel.

4.1.2 Identification of Industrial Plants

A preliminary identification of industrial firms willing to participate in this program was made by IECON, based on their knowledge and previous experience in working with the factories. A list of about 10 companies was prepared. These companies were visited during the course of the project by the IECON personnel and the ECSP team project manager. The purpose of these visits was to identify potential areas of study for energy

efficiency improvement strategies, and to gauge the willingness of the companies' management to implement the strategies identified.

Because of the economic situation in Jordan, and the particular problems facing small and medium-size industrial enterprises, none of the plant management contacted during these visits would commit firmly to implementation of projects. Most said that economically and technically viable projects would be given due consideration, but that no promise could be made that any project would definitely be undertaken.

After visits to the plants, terms of reference were developed for technical studies in six industrial units. These terms of reference were discussed with IECON and USAID/Amman to identify three studies that could be undertaken. The criteria for selection included the replicability of potential energy efficiency improvement strategies identified in other small and medium-size industrial units and the ease of implementation, short time frame required, significant energy savings achievable, and low cost of potential measures in the plants where studies were to be conducted. A further consideration was the ability of the C/E firm to carry out the work. Because this would be a new area for the firm, it was decided to limit the scope of work to certain well defined portions of the entire industrial plant, and to concentrate on areas where the local firm could identify significant savings without the development of complex solutions.

Based on these criteria, three plants were chosen for inclusion in the technical study portion of the project. Studies of boiler combustion efficiency improvement and improved operation and maintenance of the steam distribution and condensate return systems would be carried out at the Industrial, Commercial, and Agricultural Company (I.C.A.) and at the Jordan Paper and Cardboard Company. An additional study of fuel substitution of diesel by lower-cost heavy fuel oil would be carried out at the Jordan Rock Wool Company.

4.2 PURCHASE OF PORTABLE ENERGY AUDIT INSTRUMENTS

In order to carry out the technical portion of this program, portable energy audit instruments were purchased and transferred to IECON. The instruments were made available for use by the local consulting/engineering firm hired to conduct the technical studies. In the future, the instruments will be used by IECON staff in the conduct of energy audits, and it is expected that the instruments will also be made available to industrial plant engineers and consulting/engineering firms on a loan basis.

The portable instruments purchased include those commonly used for combustion analysis, temperature and flow measurement, and electrical measurements and

monitoring. The instruments are listed in Exhibit 4.1. The cost of the instruments (including shipping to Amman) was approximately $15,000.

Exhibit 4.1 Portable Energy Audit Instruments Purchased for the Program

Description of Instrument	Quantity
Digital Photometer	1
Clamp-on Power Factor Meter	2
Clamp-on Volt-Ohm-Ammeter	2
Electric Power Demand Analyzer and Spares	1
Digital Thermocouple Readout	4
Thermocouple Probes (assorted)	12
Infrared Pyrometer	1
Velometer and Probes	1
Slack Tube Manometers	4
Aspirated Psychrometer	2
Total Dissolved Solids (TDS) Meter	2
Chemical Combustion Gas Analyzer and Spares	1
Smoke Tester and Spares	1
Electronic Combustion Gas Analyzer and Spares	1

4.3 TERMS OF REFERENCE FOR TECHNICAL STUDIES

The work provided by the local consulting/engineering firm included analyses of existing energy efficiency and recommendations for improvements of the boiler and fuel handling systems and steam supply and condensate recovery systems for two factories located in the Amman area: the Paper and Carton Manufacturing Company in Zarqa, and the Industrial, Commercial and Agricultural Company (I.C.A.) in Ruseifa. The C/E firm also provided technical assistance to the Jordan Rock Wool Industries Company (Zarqa) in the area of substitution of heavy fuel oil for the currently used diesel fuel.

The analysis of existing energy efficiency and recommendations for improvements was accomplished through on-site instrumented measurements of the relevant systems; computation of annual energy loss and energy savings potential; development of strategies for reducing the energy loss; estimation of the cost of implementation (for both the equipment itself and its installation) of each of the strategies identified; estimation of the energy cost savings of each of the strategies identified; identification and estimation of possible additional operating and maintenance costs associated with each of the strategies; and estimation of the return on the investment. The series of steps outlined below was followed for each of the three factories.

4.3.1 Energy Efficiency Improvement in Boiler and Fuel Handling Systems and Steam Supply and Condensate Return Systems for the Paper and Carton Company and I.C.A.

The work under this task involved the measurement, analysis, and formulation of recommendations for improvement in energy efficiency of the boiler and fuel handling systems and the steam supply and condensate return systems at two factories: the Paper and Carton Factory in Zarqa, and the Industrial, Commercial and Agricultural Company (I.C.A.) in Ruseifa. The steps followed in the accomplishment of the work for each of these companies are detailed in the following paragraphs.

- Task 1: Establish Schedules. Based on analysis of the requirements of this scope of work, the local C/E firm was responsible for setting up a schedule for visiting the factories in order to make the necessary measurements and investigations required to complete the work.

- Task 2: Energy Related Data Base Development. During the first visit to each of the factories, the local C/E firm developed a data base of relevant energy-related information in the factory. This data base included information concerning annual energy consumption and costs, and the characteristics of major energy consuming equipment in the factory.

- Task 3: Preliminary Energy Survey. The local C/E firm conducted a Preliminary Energy Survey (PES) of the boiler and fuel handling system, and steam supply and condensate return systems of each of the two factories. This enabled the local C/E firm to determine the overall condition of the facility and plan resources to cover those areas needing the greatest amount of data collection during the Detailed Energy Survey (DES) stage of the work (described below).

- Task 4: Detailed Energy Survey of Boiler and Fuel Handling System. The local C/E firm conducted instrumented measurements of the boilers in each factory to determine their operating efficiencies. The measurements included the following:

  - analysis of boiler flue gas composition, smoke/particulate content, and temperature (including the temperature of combustion air) for each operating boiler in the factory over a range of burner firing rates (for burners with multiple firing rates); these data were used to compute the average combustion efficiency of each boiler in the factory

- analysis of the total dissolved solids (TDS) of boiler water, feed water, make-up water, and condensate water; these data were used to estimate both the blowdown heat losses and the fractional amount of steam produced that is returned as condensate to the boiler

- measurement of the temperature of the boiler shell at a number of locations; these data were used to determine the boiler shell heat losses.

- Task 5: Analysis of Energy Savings Opportunities for Boiler and Fuel Handling System. Using the data collected above, the local C/E firm identified areas where energy losses are occurring in the boiler and fuel handling system, quantified these losses on an annual basis, and developed strategies for reducing or eliminating these losses. Annual savings in energy and energy cost by energy type through implementation of these strategies was also estimated. For each energy saving measure requiring a capital cost, the local C/E firm estimated the capital and installation cost of the measure. Return on investment for each energy conservation strategy identified was estimated using simple payback period:

$$\text{Simple Payback Period (years)} = \frac{\text{Total Installed Cost of Strategy}}{\text{Net Annual Cost Savings}}$$

The general strategies considered for the boiler and fuel handling system included:

- repair, adjustment or replacement of heavy fuel oil heat exchangers and insulation to ensure proper fuel temperature and viscosity at the burner

- improvement in boiler plant operating efficiency by repair or replacement of burners; improvement in fuel/air ratio control or other boiler control systems (including automatic control systems); reduction in conduction, convection and/or radiation heat losses through improved boiler shell insulation or operating conditions

- heat recovery from the boiler exhaust gases or boiler blowdown to be used for combustion air preheating or make-up, or feed water heating or preheating

- other operating and maintenance (low cost/no cost) measures that may reduce fuel consumption, such as elimination of leaks in the fuel delivery

system, reduction of boiler operating hours, reduction of boiler operating pressure, improved boiler loading, elimination of hot stand-by boilers

- purchase and installation of fuel and/or steam metering instruments, or other fixed or portable instrumentation that could be used by the factory engineers to monitor and maintain optimum boiler efficiency.

- Task 6: Detailed Energy Survey of Steam Delivery and Condensate Return System. The local C/E firm conducted a visual inspection and instrumented measurements of the steam delivery and condensate return system of each factory to determine the sources of energy losses. The examination and measurements included the following:

  - surface temperature measurements of both insulated and uninsulated steam pipe surfaces (including valves and flanges) on all of pipework feeding major steam consumers in the factory and the dimensions (diameter of bare pipe, thickness of insulation on the pipe, length of the pipe run) of the section of pipework under measurement; the local C/E firm identified all areas of uninsulated steam pipework, flanges and fittings, or areas where existing insulation was damaged or insufficient

  - identification of steam leaks through broken pipes, flanges, or valves and fittings, and an estimation of the quantity of live steam being lost

  - identification of production or other areas in the factory where clean condensate is being sent to drain and could be collected and connected to an existing condensate recovery system, along with the temperature and quantity of the condensate being wasted; the examination included the estimated length and size of pipework required to connect to an existing condensate recovery system, or identification of the need for a condensate return system where one does not exist in the factory

  - identification of areas in the process where condensate could be used to generate flash steam for process or other heating purposes

  - identification of failed steam traps allowing steam to pass directly into the condensate return system or to drain, or causing condensate flooding in the steam lines.

- Task 7: Analysis of Energy Savings Opportunities for Steam Delivery and Condensate Return System. Using the data collected above, the local C/E

firm identified areas where energy losses are occurring in the steam delivery and condensate return system, quantified those losses on an annual basis, and developed strategies for reducing or eliminating these losses. Annual savings in energy and energy cost by energy type through implementation of these strategies were also estimated. For each energy saving measure requiring a capital cost, the local C/E firm estimated the capital and installation cost of the measure. Return on investment for each energy conservation strategy identified was estimated using simple payback period as defined above.

The general strategies considered for the steam delivery and condensate return system included:

- reduction in steam losses through repair of steam leaks

- reduction in steam system heat losses through the insulation of bare pipes, flanges, valves, and fittings, or through the replacement of missing, damaged or inadequate insulation

- recovery of the sensible heat in lost condensate by either returning it to the boiler or reusing the condensate for process heating or preheating

- recovery of the latent heat in condensate by using it for the generation of flash steam

- repair or replacement of failed or inadequate steam traps which result either in loss of steam to the condensate system (traps failed open) or flooding of steam mains (traps failed closed or traps of inadequate capacity).

- Task 8: Prepare Report of Findings, Conclusions and Recommendations. For each factory, the local C/E firm prepared a report containing a summary of the measurements conducted, the major findings concerning the energy efficiency of the areas investigated, conclusions concerning areas for improvement, and recommendations of technically and financially viable energy efficiency improvement measures that should be implemented by the factory. The report outline used is shown in Exhibit 4.2.

Exhibit 4.2 Report Outline: Boiler and Fuel Handling System and Steam Delivery and Condensate Return System Energy Efficiency Improvements

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   Background to the Study
   Current Energy Consumption and Costs
   Summary of Energy Efficiency Improvement Measures Identified
   Summary of Energy and Energy Cost Savings Possible

2. Findings, Conclusions and Recommendations Related to the Boiler and Fuel Handling System
   Overall Condition of the Equipment
   Major Areas of Potential Energy Efficiency Improvement
   Energy Efficiency Improvement Measures Recommended for Implementation
   Energy Efficiency Improvement Measures Not Recommended for Implementation
   Energy Efficiency Improvement Measures Recommended for Further Study

3. Findings, Conclusions and Recommendations Related to the Steam Delivery and Condensate Return System
   Overall Condition of the Equipment
   Major Areas of Potential Energy Efficiency Improvement
   Energy Efficiency Improvement Measures Recommended for Implementation
   Energy Efficiency Improvement Measures Not Recommended for Implementation
   Energy Efficiency Improvement Measures Recommended for Further Study

4. Action Plan for Implementation of Energy Efficiency Improvement Measures

Annex 1: Energy and Equipment Data Base
Annex 2: Test Data Collected During Site Visit
Annex 3: Calculations

4.3.2 Substitution of Heavy Fuel Oil for Diesel Oil at Jordan Rock Wool Industries

The purpose of this work was to determine the technical and financial feasibility of using heavy fuel oil in the production equipment at Jordan Rock Wool Industries. Although the process equipment at the factory was designed for the use of heavy fuel oil, the factory is using higher-priced diesel oil. The work included an analysis of the present situation in the factory, identification of the reasons for the current use of diesel as fuel,

and identification of the requirements for new burners, fuel handling equipment, and possible process modifications required to use heavy fuel oil. The costs and benefits of equipment and changes in current factory operating practices required to accommodate the new fuel system were also determined. The steps followed in the accomplishment of the work for this company are detailed in the following paragraphs.

- Task 1: Establish Schedules. Based on an analysis of the requirements of this scope of work, the local C/E firm was responsible for setting up a schedule within the time frame for this work for visiting the factory in order to make the necessary measurements and investigations required to complete the work.

- Task 2: Conduct Investigation of Current Fuel Use and Operating Practices. The local C/E firm visited the factory for the purpose of obtaining detailed information concerning the current use of diesel at the factory: consumption, cost, and production for the most recent 12-month period. At the same time, discussions were carried out with the engineering and management staff of the factory to determine why diesel is currently being used instead of heavy fuel oil. An equipment inventory of the relevant existing process equipment was developed, including all of the necessary equipment characteristics required to analyze the potential for heavy fuel oil use or to recommend the replacement of certain equipment in order to accommodate heavy fuel oil.

- Task 3: Determine Technical Options for Heavy Fuel Oil Use. Based on the investigations carried out in the factory, the local C/E firm determined the technical options available to the factory for converting from diesel oil to heavy fuel oil use. This analysis included identification of equipment that would replace existing equipment, identification of new equipment or facilities that would be required, and identification of new factory operating procedures required to accommodate the change in fuels. The analysis also determined if fuel switching will have any negative impact on the quality of the product, or on the production capacity.

- Task 4: Determine Financial Feasibility of Heavy Fuel Oil Use. Having identified the technical options and feasibility of switching from diesel to heavy fuel oil in the previous step, the local C/E firm carried out a financial analysis of the technical options identified. This analysis included the estimation of the capital and installation costs of the required equipment, estimation of increased operating and maintenance costs, estimation of decreased energy costs, and estimation of the costs associated with the possible negative impacts of the project. Return on investment for each

energy conservation strategy identified was estimated using simple payback period as defined above.

- Task 5: Develop Action Plan for Project Implementation. For the fuel switching option recommended, the local C/E firm prepared a plan of action to be taken by the factory in order to implement the project. This step-wise plan outlined, in sequence, specific actions to be taken by the factory personnel; contacts to be made with vendors, local agents, and/or local contractors; and gave an overall general time schedule for each of the actions required by the factory to implement the project.

- Task 6: Prepare Report of Findings, Conclusions and Recommendations. The local C/E firm prepared a report containing a summary of the measurements conducted and data collected, and the major findings and recommendations concerning the technical and financial feasibility of converting from diesel to heavy fuel oil. The report outline used is shown in Exhibit 4.3.

4.4 TECHNICAL STUDY RESULTS

This section presents the findings of the technical studies conducted in each of the three factories.

4.4.1 I.C.A. Company

The Industrial, Commercial and Agricultural Company (I.C.A.) is located in Ruseifa, a short distance from Amman. The company is engaged in the production of a wide variety of products, including soaps and detergents, toiletries, biscuits and crackers, ice cream, and paints.

The major consumer of heavy fuel oil in the factory is the boiler plant, which consists of two boilers. One of the boilers is rated at 15 tonnes per hour, while the other (used for standby or peak steam demand periods) is rated at 7 tonnes per hour. Steam is raised at 15 bar. Heavy fuel oil consumption in 1989 was found to be 534 tonnes, for a cost of JD 26,700.

The major findings of the study were as follows:

- The fuel oil storage and handling system uses both steam and electric heaters to maintain the proper handling temperature. This system is uninsulated,

Exhibit 4.3 Report Outline: Substitution of Heavy Fuel Oil for Diesel Oil

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List of Exhibits

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1. Introduction and Summary of Recommendations
   Background to the Study
   Current Energy Consumption and Costs
   Summary of Equipment Required to Convert from Diesel to Heavy Fuel Oil
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   Discussion of Recommended Technical Options
   Justification for Recommendation
   Identification of Equipment and Facilities Required
   Identification of Changes in Operating Practices Required
   Expected Impact on Product Quality and Production Capacity
   Discussion of Options Examined and Not Recommended

3. Financial Viability of Recommended Fuel Switching Options
   Discussion of Overall Financial Viability of the Project
   Analysis of Capital and Installation Costs for Necessary Equipment
   Analysis of the Impact on Operating and Maintenance Costs
   Analysis of the Impact on Product Quality and Production Capacity

4. Action Plan for Implementation of Fuel Switching Project

Annex 1: Energy and Equipment Data Base
Annex 2: Data Collected During Site Visit
Annex 3: Calculations Related to Technical Analysis
Annex 4: Calculations Related to Financial Analysis

resulting in reduced fuel oil temperature and heat losses. Insulation can be installed at minimum cost to reduce this source of heat loss.

- The boilers are operating with excessive levels of excess air: up to 100 percent excess air was observed during the boiler tests. Part of the reason for this is the poor condition of the existing automatic air-fuel ratio controls on the boilers. This can be remedied by repair or replacement of the

controls and proper boiler combustion efficiency monitoring and maintenance.

- Boilers currently operate on 100 percent make-up water, with no condensate return. The water treatment equipment on the boiler is not effective and total dissolved solids levels in the boilers are high, resulting in a long-term decrease in boiler efficiency and steam quality.

- The steam delivery system was poorly constructed, with improper gradients and elevations. This results in condensate settling in parts of the steam mains, and a reduction in overall steam flow. As the steam system is repaired, proper steam system practices should be observed. Other major losses in the steam system include bypassing of steam traps and a lack of condensate return. The practice of bypassing steam traps during plant start-up should be modified so that bypasses are closed off after start-up. Clean condensate from several process areas can be recovered and returned to the boiler, with minimum cost.

- Approximately 400 meters of steam lines are uninsulated in the factory. The heat loss due to the lack of insulation represents the equivalent of about 15 percent of the total fuel oil consumed in the factory. Insulation can be installed at a low cost to reduce this significant heat loss.

In summary, the study identified potential savings of heavy fuel oil in the range of 170 tonnes per year, or about 32 percent of present consumption. A summary of recommendations, potential energy and energy cost savings, implementation costs, and simple payback period is shown in Exhibit 4.4.

4.4.2 Paper and Carton Factory

The Paper and Carton Factory is located in Zarqa, a short distance from Amman. The company is engaged in the production of paper and cardboard, and assembles cardboard boxes from the paper and corrugated materials it produces internally.

The major consumers of heavy fuel oil in the factory are the two boiler plants. The main boiler is rated at 10 tonnes per hour, while the auxiliary boiler is rated at 5 tonnes per hour. Steam is raised at 10 bar. Heavy fuel oil consumption in 1989 was 3,475 tonnes, for a cost of JD 175,500. Fuel oil is used exclusively for raising steam in the boilers.

Exhibit 4.4 Summary of Energy Savings Recommendations for I.C.A.

Measure	Fuel Savings tonne/year	Fuel Savings JD/year	Implementation Cost (JD)	Simple Payback (years)
Reduce boiler excess air	20.4	1006	(1)	—
Implement boiler monitoring program	(2)	—	600	—
Improve boiler water quality	5.3	268	(3)	—
Isolate shut down boiler from steam system	2.7	135	0	immediate
Insulate steam oil preheater	2.4	133	28	0.2
Insulation of steam system	72.5	3660	1693	0.5
Close steam trap bypasses	47.5	2400	0	immediate
Recover condensate	20.1	1015	2981	2.9
TOTALS	**170.9**	**8617**	**5302+**	**0.6 (4)**

Notes
(1) Further analysis of this measure is required to determine whether existing controls can be repaired or must be replaced. Implementation cost not estimated.
(2) No savings claimed directly for this item, but simple performance monitoring is recommended to ensure that boiler combustion efficiency is maintained at optimum level.
(3) Existing equipment was not in operation and could not be assessed. Hence, it was not possible to determine if equipment required repair or replacement. Implementation cost not estimated.
(4) Actual aggregate payback period may vary because implementation costs of two of the projects are not included.

After the factory was selected for inclusion in this program, it became known that a new boiler is to be added to the site in order to support a major production expansion program. In addition to the boiler, a new steam distribution and condensate return system is expected to be installed. Because this information was provided literally on the day that the study commenced, it was decided to proceed with the study, but to modify the terms of reference somewhat. Hence, the findings and recommendations given here are related to the design and operation of the new systems. The expectation is that the management of the factory will take into account the losses experienced through improper operation and maintenance of the existing system in planning the operation and maintenance of the new system.

The major findings of the study were as follows:

- The fuel oil storage and handling system is poorly insulated, resulting in reduced fuel oil temperatures and heat losses. Insulation can be installed at minimum cost to reduce this source of heat loss. This recommendation for insulation also applies to the condensate return tank in the boiler house and the steam separator.

- Boiler combustion efficiency is not at optimum levels, and excess air levels were observed to be on the order of 100 percent. This level is much too high for the type of burner employed. Improvement of boiler combustion efficiency can be achieved by adjustment of the air-fuel ratio controls and by the implementation of a boiler combustion efficiency monitoring program.

- Approximately 650 meters of steam and condensate return lines were found to be uninsulated in the factory. Combined with the numerous steam leaks observed, these losses represent the equivalent of nearly 1,000 tonnes of fuel oil annually, or nearly 30 percent of fuel oil consumption.

In summary, the study identified potential savings of heavy fuel oil in the range of 1,300 tonnes per year, or about 38 percent of present consumption. A summary of recommendations, potential energy and energy cost savings, implementation costs, and simple payback period is shown in Exhibit 4.5.

4.4.3 Jordan Rock Wool Company

The Jordan Rock Wool Company is located in Zarqa, a short distance from Amman. The company produces mineral wool insulation products by melting basaltic rock and spinning it into mineral wool fibers. The fibers are formed into blankets, batts, and other forms. The process equipment in the factory was originally designed for use with heavy fuel oil, but since the plant was commissioned, diesel oil has been used for all of the plant's combustion processes. Diesel oil is much more expensive than heavy fuel oil. The plant currently consumes about 1.75 million liters of diesel oil annually, of which about 1.36 million liters (77 percent) are used in the melting furnaces.

The purpose of this study was to determine the technical viability of conversion to heavy fuel oil, and if the conversion was viable, to determine its costs and benefits. The study found that the four rock melting furnaces could be converted to heavy fuel oil with the continued use of the existing burners. Hot air generators in the factory could probably be converted to heavy fuel oil as well, but it was felt that there might be an adverse effect on product quality due to the soot in the combustion gases.

Exhibit 4.5 Summary of Energy Savings for Paper and Carton Factory

Measure	Fuel Savings tonne/year	Fuel Savings JD/year	Implementation Cost (JD)	Simple Payback (years)
Reduce boiler excess air	125	6313	3000	0.5
Improve boiler water quality	66	3333	(1)	—
Insulate and cover condensate tank	32	1618	617	0.4
Insulate fuel oil piping and tank	101	5086	3357	0.7
Insulate steam separator	13	636	100	0.2
Insulation of steam system	224	11322	3107	0.3
Repair steam leaks	757	38229	(2)	—
TOTALS	**1318**	**66537**	**10181+**	**0.2 (3)**

Notes
(1) Existing equipment was not in operation and could not be assessed. Hence, it was not possible to determine if equipment required repair or replacement. Implementation cost not estimated.
(2) No implementation cost estimated for this item, since the steam system is to be replaced in its entirety. Savings figures shown to demonstrate impact of lack of repair of existing steam system.
(3) Actual aggregate payback period may vary because implementation costs of two of the projects are not included.

Of the technical options examined, it was felt that the most flexible and desirable system would allow the existing furnaces to fire both diesel and heavy fuel oil (parallel fuel delivery systems). The project involves conversion of existing diesel storage tanks to handle heavy fuel oil (including installation of tank heaters and electric tracing of the heavy fuel oil delivery pipework), installation of a smaller storage tank to handle remaining diesel oil needs, and the installation of the associated pumps and pipework to accommodate the new system. The total installed cost of the required equipment was estimated to be JD 18,243. This would result in an offset in oil costs due to substitution of heavy fuel oil for diesel in the amount of JD 38,670 per year. Increased operating and maintenance costs of approximately JD 2,070 annually were estimated, resulting in a net annual cost savings of JD 36,600. Hence, the simple payback period for the project is estimated to be 0.5 years.

It should be noted that the factory had already purchased the required electric heaters for the oil storage tanks at the time the factory was built. In addition, the manufacturer

of the burners indicated that the existing burners could be converted to heavy fuel oil firing without modification, if certain operating practices were observed. These factors have resulted in a more favorable payback period than would have resulted if the burners needed to be replaced and the oil heaters purchased. On the other hand, the factory is expecting to operate at higher production levels in 1990 and subsequent years. This will result in a more rapid payback period than the 0.5 years estimated above (which was based on 1989 actual production levels).

4.5 APPRAISAL OF LOCAL CONSULTING/ENGINEERING FIRM PERFORMANCE

As has been stated earlier in this report, none of the C/E firms in Jordan have had any prior experience in providing energy related services. Hence, it was necessary to provide specialized training to the C/E firm hired to conduct the studies under this program.

This factor was taken into account by the ECSP project team in developing the terms of reference for the technical studies. Since there was no prior experience in carrying out these studies, it was decided to limit the scope of services provided to the industrial enterprises. This would serve two purposes. First, it would allow the C/E firm to gain competency and experience in areas where it was known that there are common problems in small and medium-size industries: boiler combustion efficiency and steam system operation and maintenance. The feasibility study conducted on fuel substitution also presented a rather straightforward problem, with a limited number of potential solutions. Second, it would enable the C/E firm to provide the management of the three industrial plants with simple and useful studies of readily implementable energy efficiency improvement projects.

The Mohammad A.R. Jardaneh and Partners engineers assigned to this project received their initial training during the 10-day Principles of Energy Efficiency Improvement course conducted under this project. Additional assistance was provided to them by the ECSP team energy conservation engineer during his three visits to Jordan under this project. This assistance consisted of the following activities.

Preliminary discussions were held between Jardaneh personnel and the energy conservation engineer during his first visit to Amman (March 23 to 30, 1990). These discussions served to define the general approach to the scope of work laid out in the terms of reference for each of the three factories. The discussions also included a review of the relevant theoretical principles, and instruction in the use of the portable instruments.

An initial one-day visit to each factory was made by the Jardaneh engineers accompanied by the ECSP energy conservation engineer. The visits included meeting relevant plant personnel, inspecting the equipment to be studied in each of the plants, and further instruction in the use of the portable instruments. Areas where the energy conservation engineer could facilitate Jardaneh's work by collecting information outside of Jordan were also identified at this time. Following the plant visits, detailed work schedules were developed jointly between the energy conservation engineer and Jardaneh personnel.

The second visit to Jordan by the ECSP energy conservation engineer was from May 11 to 24, 1990. During the interim period, Jardaneh engineers had carried out the basic site work and data collection in each of the three factories. The assistance provided during this visit was essentially related to the analysis of the collected data and the technical calculations. Areas where additional data were required were also identified. Work was also initiated during this visit on the preparation of the draft reports.

The third and final visit of the ECSP energy conservation engineer was from June 8 to 15, 1990. During this time, assistance was given primarily in the final checking of calculations, a review of the findings and conclusions of the three studies, and preparation of the draft final reports. During this period, a meeting to review the work completed and study findings was held with Jardaneh, IECON, and USAID/Amman.

It was felt by the ECSP energy conservation engineer that the Jardaneh personnel performed their work in a professional manner. Although they had no previous experience in conducting energy studies, they learned the site data collection techniques and calculation procedures well. It was also felt that they have the potential to carry out similar work independently in the future and to progress to broader energy efficiency studies that were outside the scope of the present studies (e.g., process analysis and examination of plant electrical consumption).

The contents of the technical studies prepared under this program should prove to be of practical value to the respective industrial plants. Indeed, during the conduct of the study carried out at the Paper and Carton Factory, the management of the plant requested Jardaneh to assist them in the preparation of terms of reference for contractors wishing to bid on the engineering of the new steam system; this assistance was provided outside of this program. This was encouraging, as it showed that there was an awareness of the need to work to proper standards. Jardaneh subsequently was one of the bidders on this work, but the contract was awarded to another firm on the basis of price. This is not as encouraging, however, since there is substantial evidence that price, rather than quality, is the main factor in the selection of services and energy equipment.

In addition to the promotion, training, and technical support components, the Industrial Energy Efficiency Program included a component to study energy efficiency barriers, incentives, and regulations. These studies were to be carried out by Jordanian consultants. The ECSP team prepared terms of reference for six studies:

- Costs and Procedures for Importing Energy Efficiency Equipment
- Licensing Procedures for Industry and the Role of Energy Efficiency
- Tax Barriers and Incentives for Investments in Energy Efficiency
- Financial Barriers and Incentives for Energy Efficiency Investments
- Analysis of Efficiency of Rewound Motors and Recommendations for Improvement
- Potential and Strategies for Demand-Side Management in Jordan.

These terms of reference were discussed with and approved by IECON. With assistance from USAID, IECON, and officials of the Ministry of Industry and Trade, three qualified Jordanian consulting firms were identified. Each company received a set of the terms of reference along with guidelines for preparing proposals to carry out the studies. The proposals were reviewed by ECSP and IECON staff, and the Jordan Technical Consultants Group (JTCG) was selected to carry out the studies.

After selecting the Jordanian consultants, the ECSP team and IECON staff ranked the six studies according to the following criteria:

- Level of interest of IECON
- Perceived importance and potential energy efficiency impact of the study
- Ease of implementation of potential study results and recommendations.

ECSP staff and IECON used this ranking to select three studies that would actually be carried out by the Jordanian consultants:

- Costs and Procedures for Importing Energy Efficiency Equipment
- Tax Barriers and Incentives for Investments in Energy Efficiency

- Potential and Strategies for Demand-Side Management in Jordan.

The purpose, methodology, findings, and recommendations of the three studies are presented below.

5.1 COSTS AND PROCEDURES FOR IMPORTING ENERGY EFFICIENCY EQUIPMENT

5.1.1 Study Background, Purpose and Methodology

Energy efficiency projects in developing countries generally have a high foreign currency content because of the need to import specialized equipment and engineering services. At the same time, because energy efficiency projects reduce the consumption of imported fuels, they have high foreign currency returns. However, governments often impose high tariffs and strict import controls on durable goods, including energy efficiency equipment, and such policies are a serious barrier to increased energy efficiency. One way to encourage energy efficiency investments is to eliminate or reduce tariffs, import duties, and import restrictions on energy efficiency equipment. Because it was not known whether current import policies act as a barrier to energy efficiency investments in Jordan and because import incentives are not explicitly offered for energy efficiency equipment, a study on the costs and procedures for importing energy efficiency equipment was undertaken.

The purpose of this study was to review and assess the current procedures and costs for importing energy efficiency equipment and materials and to analyze whether changes in these policies are necessary and feasible to encourage investments in energy efficiency. The methodology for this study entailed:

1. Obtaining information about the existing tariff/customs duty system and import procedures in Jordan, and how they affect the financial attractiveness of industrial energy efficiency projects.

2. Holding discussions with government officials (e.g., Customs Department), industrial managers, and local suppliers of energy efficiency equipment to determine the need, feasibility, and likely impact of offering incentives to encourage importation of energy efficiency equipment and materials.

3. Analyzing current import policies and procedures to determine whether they pose a barrier to industrial investment in energy efficiency.

4. Analyzing import incentives that could be offered to increase the financial attractiveness of energy efficiency projects.

5.1.2 Study Findings and Recommendations

The principal finding of this study is that existing import policies and procedures in Jordan do not represent a barrier to investments in energy efficiency. On the contrary, the existing system offers incentives for the importation of most energy efficiency equipment. Most energy-related equipment is already exempt from import duties, with the exception of small motors (20 percent), discharge lamps (1 percent), and refractories (5 percent), which account for a very small share of energy-related equipment imports. Although an additional 20 percent surcharge is generally levied on imports, those imports that are exempt from import duties are subject to only a 5 percent surcharge. Therefore, the total import charge on most energy efficiency equipment is only 5 percent.

The study did find that there are bureaucratic/administrative barriers in the existing import system. However, these barriers are related to the poor working relationship and lack of trust between the private sector and customs officials, and are not specific to energy efficiency equipment.

The study did not recommend any changes in current import procedures and policies. The study concluded that the main barriers to industrial investment in energy efficiency are a lack of awareness about energy use and efficiency, a lack of information about energy efficiency equipment, a lack of capabilities to identify and implement energy efficiency measures, and investor skepticism about the cost-effectiveness of energy efficiency investments. The study recommended that immediate action be taken to correct these problems through information and promotion programs, technical assistance, and training. The study also identified a lack of standards for energy efficiency equipment.

5.1.3 Next Steps

No specific next steps were recommended. The study concluded that it would be premature to make any changes in import policies and procedures until promotional campaigns have been implemented to increase industry awareness, and technical assistance has been provided to increase energy efficiency capabilities. The need for additional import incentives should be re-evaluated if it becomes clear that projects are being identified but not implemented due to a lack of financial incentives.

5.2 TAX BARRIERS AND INCENTIVES FOR INVESTMENTS IN ENERGY EFFICIENCY

5.2.1 Study Background, Purpose and Methodology

Another option available to governments to encourage energy efficiency is to increase the financial attractiveness of energy efficiency projects by offering tax incentives, such as tax credits, accelerated depreciation, and reduced tax rates, for investments in energy efficiency. These types of tax incentives have been offered in several industrialized and developing countries, but they have not been offered in Jordan.

The purpose of this study was to examine the existing tax system in Jordan as it applies to small and medium-sized industries, and to analyze and recommend tax incentives that could be offered to encourage investments in energy efficiency. The methodology for this study entailed:

1. Obtaining information about the existing tax system and how it affects the financial attractiveness of energy efficiency projects.

2. Holding discussions with government officials (e.g., Tax Department) and industrial managers to determine the need, feasibility, and impact of offering tax incentives.

3. Analyzing the current tax system to determine whether it poses a significant barrier to industrial investment in energy efficiency.

4. Analyzing potential tax incentives that could be offered to increase the financial attractiveness of energy efficiency projects.

5.2.2 Study Findings and Recommendations

The principal finding of this study is that the current tax system in Jordan does not pose a barrier to investments in energy efficiency projects. Tax incentives are already offered through existing laws such as the Encouragement of Investment Law, which grants tax holidays, and the Income Tax Law, under which energy efficiency projects qualify for tax deductions. The study concluded that the most immediate barriers to investment in energy efficiency by Jordanian industry are the lack of awareness of potential savings, the lack of information and capability to identify and implement energy efficiency measures, and skepticism about the cost-effectiveness of energy efficiency projects. The consultants recommended that immediate action be taken to correct these problems through information and promotion programs, technical assistance, and training.

Special tax holidays strictly for energy conservation investments were not recommended due to the administrative difficulties in assessing energy savings and monitoring the projects. Under existing law, public companies are required to allocate 1 percent of their annual net profits for research and development and manpower training. The study recommended that companies be encouraged to use these funds for energy conservation studies and services, although no specific guidelines were provided. In addition, the study recommended that accelerated depreciation for energy efficiency investments be considered in the future once sufficient energy efficiency awareness and capabilities have been developed within Jordanian industry, especially if it is clear that projects are not being implemented due to a lack of fiscal incentives.

5.2.3 Next Steps

No specific next steps were recommended. As with the study on import policies and procedures, this study concluded that it would be premature to make any changes in the tax system. The top priority should be to address the awareness and capabilities problems.

5.3 POTENTIAL AND STRATEGIES FOR DEMAND-SIDE MANAGEMENT IN JORDAN

5.3.1 Study Background, Purpose and Methodology

The industrial sector is the largest consumer of electricity in Jordan, accounting for 38 percent of the country's total electricity consumption in 1988. Two recent studies carried out for Jordan's MEMR on load management identified a need to develop load management programs.[18] However, only one of the studies examined the load management potential in the industrial sector, and this entailed only a cursory survey (three plants were visited). In 1989, the Jordan Electricity Authority established a special unit for load management; it is currently conducting a load research program and plans to carry out surveys of industrial and commercial customers. A more detailed study of the potential and appropriate strategies for load management in a sample group of industrial customers would assist MEMR in its efforts to design and implement an effective load management program.

The purpose of this study was to assess and quantify the potential for electricity load management in the industrial sector in Jordan, identify technical and other barriers to

[18] Gilbert Commonwealth International, Inc., funded by USAID/Amman, in 1986; Ontario Hydro, funded by CIDA, in 1989.

achieving this potential, determine industry's interest in participating in a load management program, and identify and recommend the most viable load management strategies for industry. This information would help MEMR work with other industrial companies to reduce the peak load in the industrial sector. The study would also provide the load management unit of JEA with input in developing their survey of small and medium-size industry, to be initiated later in 1990.

The methodology for this study entailed:

1. Identifying, selecting, and visiting a representative sample of medium-sized industrial customers (maximum demand exceeding 200 kW) in order to identify the potential for load management, the barriers to achieving this potential, the most effective load management strategies, and the customers' interest in participating in a load management program.

2. Based upon the load management potential estimated for the customer sample, estimating the total load management potential in the industrial sector.

3. Identifying, assessing (including conducting cost-benefit analyses), and recommending strategies for load management in the industrial sector.

5.3.2 Study Findings and Recommendations

The study identified a potential for reducing the industrial sector's peak load by 22 MW, primarily through peak shifting (changing operating hours to avoid utility peak periods). This represents about 5 percent of the maximum peak demand experienced by the interconnected distribution company network. Additional uniform demand savings (at all times) could be achieved by the use of more efficient electrical equipment (e.g., electric motors and lighting systems).

The study also found that if industries were to shift 100 percent of their controllable load during peak hours, the annual savings would be JD 1.14 million (US$ 1.7 million) for industry, JD 2.57 million (US$ 3.8 million) for JEA, and JD 3.9 million (US$ 5.8 million) for the country. These figures apply to the 130 industrial units in Jordan with connected loads of greater than 200 kW.

An extremely important finding of the study is that of the 130 industrial plants with installed capacity of 200 kW or more, 70 plants are not classified as "large industrial" and therefore do not come under the demand tariff and do not pay the peak-load penalty. Hence, these companies are not receiving the correct pricing signals to encourage them

to undertake load management strategies. The study also found that there is a general lack of awareness in industry about load management strategies, techniques, and procedures. Discussions with industry management revealed that they are, in principle, willing to participate in a load management program, but that they require much more information before making a firm commitment.

The study recommended that the following strategies be implemented to help capture the load management potential in industry:

1. Apply the "large industry" tariff to all industrial plants with total installed capacity of 200 kW or more.

2. Implement a program to increase industry awareness of the need, potential, benefits, and strategies of load management.

3. Use the electricity tariff as a tool to alter consumer behavior and avoid electricity consumption during peak periods. In particular, the study recommended increasing the peak-load penalty rate.

4. Encourage plants with standby generators to use them during peak hours.

The study also suggested expanding the large-industry tariff to include all plants that consume 100 kW or more. However, since there is inadequate electricity use data for plants that fall into the 100 kW-200 kW category, a comprehensive study is required before this option can be pursued further.

5.3.3 Next Steps

The study concluded that at least two detailed studies are needed:

1. an analysis of amending the existing tariff

2. an analysis of the potential to use standby generators to reduce the peak load on utilities.

In addition, a promotion and education campaign should be launched to inform industry about the need, potential, benefits, and options for load management. This campaign should include providing detailed information with electricity bills, site visits by JEA experts and/or private consultants, seminars, pamphlets, brochures, articles and mass media reports.

In this chapter, recommendations for additional support of energy conservation activities in Jordan are presented. This is followed by a description of areas where further study and analysis are required.

6.1 RECOMMENDATIONS

An initial analysis of the need for an industrial energy efficiency program focussing on Jordan's small and medium-size industries was conducted under the USAID/STEY ECSP program in January 1988.[19] That study estimated that in a sample of 14 small to medium-size industries, average energy savings of about 15 percent were possible, with simple payback periods of less than one year. Extrapolating these savings to all of the small and medium-size industrial enterprises, energy savings on the order of 4 to 5 percent of national oil consumption, valued at about $20 million annually, could be achieved. Additional savings could be possible through the implementation of more capital-intensive energy efficiency improvement measures.

The findings of this study are still valid after two years. The previous estimate of potential energy savings in the small and medium-size industrial enterprises of 150,000 tonnes of fuel oil per year is still valid. Additionally, over 22 MW of peak load reduction can be obtained through demand-side load management strategies implemented in these industries. Taking into account the cost of imported oil saved through the implementation of energy efficiency improvement strategies, and the avoided cost of new generation, transmission and distribution systems due to the implementation of DSM strategies, the net present value of all of the savings to Jordan is estimated by the ECSP project team to be on the order of $100 million.

Hence, there is a vast, as yet untapped, energy conservation potential in Jordan. The local skills and resources needed to take advantage of this potential are in their infancy and need to be nurtured in order for energy conservation to reap its full benefit to the Jordanian economy.

To promote and coordinate industrial energy efficiency improvement in Jordan, the staff of the Industrial Energy Conservation Section (IECON) of the Industrial Energy Department of the Ministry of Energy and Mineral Resources should be expanded by two or three additional experienced engineers. The current staff includes only three engineers devoted to energy conservation on a full-time basis. The increased staffing in the short term will allow IECON to provide a more appropriate level of technical

[19] *The Hashemite Kingdom of Jordan: Recommendations for an Industrial Energy Efficiency Program,* prepared by RCG/Hagler, Bailly, Inc. for USAID/STEY under the ECSP program, May 1988, ECSP Report Number 88-09.

assistance and follow up to small and medium-size industrial units in identifying and solving their energy-related problems. It will also allow IECON to prepare and disseminate promotional and informational materials covering energy conservation topics to industrial plant owners, operators and engineering and technical staff. Other short-term activities should include a workshop in the next few months to disseminate the findings of the work conducted under this program to other small and medium-size industrial enterprises and to further increase their awareness of energy efficiency improvement potential.

Another short-term activity that should be considered is assistance to the Jordan Electricity Authority (JEA) in developing a demand-side load management program targeted to small and medium-size industrial units. As noted previously, a reduction in peak demand of more than 22 MW could be achieved through demand-side load management activities in these industrial units. This potential saving could be achieved through the implementation of "load management audits" of small and medium-size industrial facilities to determine the magnitude of potential demand reduction and to develop strategies for achieving peak load reduction.

In order to institutionalize energy conservation in Jordan, a number of approaches are available and have been implemented in other developing countries. A brief discussion of these approaches is presented below.

The first approach is based on a government agency, but one acting as a coordinating body rather than an implementing body. Such an approach has been taken in Pakistan, where the National Energy Conservation Center (ENERCON), supported by a USAID technical assistance program, is seeking to promote market-oriented solutions to energy waste. In this program, substantial resources are being provided to train private engineering firms to provide energy conservation services. Through a series of demonstration projects and energy conservation investment promotion efforts, ENERCON is working to create a situation where investment in energy conservation is sustained by basic market economics.

The second approach is one where a public sector or semi-public sector corporation is established to provide energy conservation related services. Such a corporation was established in Indonesia (the Energy Conservation Company of Indonesia -- KONEBA). KONEBA, initially funded under a loan from the World Bank, offers energy conservation services on a fully reimbursed basis through commercial contracts and through shared savings agreements with industrial enterprises. This approach represents a viable model for a national center that must operate on limited government funding. It also offers the advantage of better reception by local industry because the center is

freed from possibly burdensome government rules and operating procedures, allowing faster, more flexible, and more efficient operation.

A third approach is the establishment of a private sector or quasi-private sector implementing agency, similar to that established in Morocco under that country's energy demand management initiative (GEM). In this program, a quasi-private sector institution has been set up to sell its services to targeted subsectors at rates that will gradually increase to their full commercial value and therefore establish a market for self-sustaining consulting/engineering services.

In order to improve the energy efficiency of industrial units[20] in Jordan, an approach slightly different from these, but incorporating elements of all three, is recommended. This approach is two-tiered, drawing and expanding on the existing capabilities in the country.

In the first tier, IECON, through the expansion of staffing as recommended above, should focus on the promotion, information, outreach, and monitoring and coordination areas of industrial energy conservation. This includes the following critical activities:

- preparation and dissemination of outreach and information materials targeted to industrial plant owners and operators, informing them of the benefits of energy management and the concept that energy management can help reduce costs and increase productivity; these materials can take the form of brochures, booklets, and workshops and seminars which provide illustrative case studies of energy management successes in Jordan

- preparation and dissemination of outreach and information materials (brochures, booklets and technical reports) targeted to industrial plant engineers and technical staff describing energy conservation strategies, techniques and equipment, including case studies; the development and presentation of one-day workshops and seminars at the major industrial centers in the country should be included as part of this function

- provide follow-up and monitoring of the energy management activities undertaken by industrial energy consumers, and use this information to assist the Government of Jordan in developing policy initiatives which would make energy conservation a higher priority item in industrial plant investment

[20] This could also include large commercial buildings, which have a number of energy consuming systems that are similar to those found in industrial plants.

- act as a clearinghouse for energy conservation related information, through the establishment (possibly with the participation of one or more universities in Jordan) of an energy conservation library, with information and materials on energy conservation fundamentals, techniques, strategies, and equipment

In these activities, IECON would, in effect, "market" the concept of energy conservation to industrial energy consumers. Through aggressive promotion and coordination efforts on the part of the Government of Jordan, the existing "latent" market for energy conservation services could be developed.

The second tier of the program involves the further development of private sector C/E firms' capability to provide energy conservation related services. As noted previously in this report, the local C/E firms have the potential and qualifications to provide services in this area. Assistance is needed to help these firms refine the skills needed to market and provide energy conservation related services to industrial energy consumers.

In order to achieve these ends, a medium-term (up to two years) technical assistance program that could be funded by donor agencies is required. The technical assistance team should consist of two resident expatriate specialists. The areas of the expertise of the expatriate team should be as follows:

- one energy conservation engineer to assist in the development and provision of technical services -- this engineer would work directly with local C/E firms

- one training and outreach coordinator to assist in the training, outreach and information areas -- this coordinator would work directly with IECON staff

As and when required, the skills and abilities of the resident specialists would be supplemented for specific tasks by short-term specialists.

Since the Government of Jordan agency's responsibility is to be a coordinating and promotion body, the actual work related to identifying and implementing energy conservation opportunities would be accomplished by Jordanian C/E firms and contractors. Hence, the technical assistance project would include the participation of local C/E firms in much of the training and outreach activities.

To create an initial impetus and market for the local C/E firms' activities, the it is recommended that the project provide funding to allow the C/E firms to conduct energy conservation related services to the industrial establishments on an initially subsidized basis (as is the case in Morocco). As the C/E firms become more experienced in providing the services, and as the market for the services becomes more developed and

mature, the subsidy can be reduced and finally eliminated. Under this subsidy program, the industrial plants would pay a reduced rate for the services provided and the difference between the "commercial" rate and the subsidized rate would be reimbursed to the C/E firms under the technical assistance program.

Rather than take the scattershot approach to provide a wide range of energy conservation related services all at once, it is recommended that the "targeted services" approach be taken in this project. This approach focuses on specific and limited energy conservation services that are applicable to almost every industrial sector. These services can be provided to industrial establishments at little cost, but can result in almost immediate and significant energy efficiency improvements and energy cost savings. Two of the most needed types of targeted services that should be offered by the local C/E firms are:

- Boiler/furnace combustion efficiency analysis and tune-ups. This service focuses on optimizing combustion efficiency, and introducing the use of flue gas analysis and other fixed and portable instruments to industrial plants.[21] The service can be provided in about one-half person-day per boiler or furnace to be tuned up, with expected average combustion efficiency improvements of 5 to 10 percent.

- Steam supply and condensate return system survey. This service focuses on identifying and quantifying the energy waste due to losses in the steam system. It includes identification of steam leaks, missing or damaged insulation, failed steam traps, areas where clean condensate could be returned to the boiler, and other problems related to the steam system. The manpower requirement for providing the service depends on the size of the industrial plant. Based on observations in industrial plants, average energy loss reductions of 5 to 10 percent could be achieved through this service.

Other areas of specific targeted services that could be developed include demand-side load management surveys and analysis, lighting system surveys, and electric system analysis. While these technical services are being offered by the local C/E firms, the other project components supported by IECON (e.g., training, outreach) should also focus on these specific subjects, with short training courses and outreach materials being prepared and delivered to develop awareness and interest in the areas.

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[21] As noted previously, the use of fixed and portable instrumentation for energy measurement and analysis is not common in Jordan.

In summary, there is a significant potential for energy savings in the small and medium-size industrial segment in Jordan. In order to achieve these savings, the Government of Jordan must take a more aggressive and coordinated role in promoting energy conservation through awareness and training programs. At the same time, the local market for C/E firms to provide energy conservation services can and should be developed. Donor agencies should assist the Government of Jordan through the funding of a medium-term technical assistance program, to help establish an autonomous or semi-autonomous energy conservation agency.

6.2 AREAS FOR FURTHER ANALYSIS AND STUDY

The recommendations above for the establishment of a more aggressive energy efficiency improvement program in Jordan are based on a limited assessment of the situation in Jordan, and have not addressed the subject of sources or availability of donor funding to aid in the establishment of such a program. Nor have the recommendations taken into account the ability of the Government of Jordan to support such a program, especially in light of the other economic issues and priorities it faces.

Hence, it is recommended that additional analysis of the approach recommended in the previous section be undertaken. The analysis should include, but not be limited to, the following:[22]

- confirmation of the willingness and ability of the Government of Jordan to support a more aggressive energy conservation program
- identification of the economic sectors to be targeted by the energy conservation program[23]
- confirmation of interest on the part of the Government of Jordan to request donor assistance in the establishment of the recommended program
- preparation of a multi-year work plan for the proposed program
- preparation of a multi-year operating budget, terms of reference, and staffing plan for the proposed program

[22] The items are listed in a hierarchy of items to be cleared and resolved in order to establish the energy conservation program.

[23] It is more than likely that the energy conservation program will not be limited to the industrial sector, although such a focus is recommended in the early stages.

- identification of potential local firms (C/E firms and contractors) to be trained and to carry out the energy conservation services

- development of preliminary terms of reference and budget for foreign advisors.

The Office of Energy

The Agency for International Development's Office of Energy plays an increasingly important role in providing innovative approaches to solving the continuing energy crisis in developing countries. Three problems drive the Office's assistance programs: high rates of energy and economic growth accompanied by a lack of energy, especially power in rural areas; severe financial problems, including a lack of investment capital, especially in the electricity sector; and growing energy-related environmental threats, including global climate change, acid rain, and urban air pollution.

To address these problems, the Office of Energy leverages financial resources of multilateral development banks such as The World Bank and the InterAmerican Development Bank, the private sector, and bilateral donors to increase energy efficiency and expand energy supplies, enhance the role of private power, and implement novel approaches through research, adaptation, and innovation. These approaches include improving power sector investment planning ("least-cost" planning) and encouraging the application of cleaner technologies that use both conventional fossil fuels and renewable energy sources. Promotion of greater private sector participation in the power sector and a wide-ranging training program also help to build the institutional infrastructure necessary to sustain cost-effective, reliable, and environmentally-sound energy systems integral to broad-based economic growth.

Much of the Office's strategic focus has anticipated and supports recently-enacted congressional legislation directing the Office and A.I.D. to undertake a "Global Warming Initiative" to mitigate the increasing contribution of key developing countries to greenhouse gas emissions. This strategy includes expanding least-cost planning activities to incorporate additional countries and environmental concerns, increasing support for feasibility studies in renewable and cleaner fossil energy technologies that focus on site-specific commercial applications, launching a multilateral global energy efficiency initiative, and improving the training of host country nationals and overseas A.I.D. staff in areas of energy that can help to reduce expected global warming and other environmental problems.

To pursue these activities, the Office of Energy implements the following seven projects: (1) The Energy Policy Development and Conservation Project (EPDAC); (2) The Biomass Energy Systems and Technology Project (BEST); (3) The Renewable Energy Applications and Training Project (REAT); (4) The Private Sector Energy Technical Assistance Project (CETA); and (7) its follows-on Energy Technology Innovation Project (ETIP).

The Office of Energy helps set energy policy direction for the Agency, making its projects available to meet generic need (such as training), and responding to short-term needs of A.I.D.'s field offices in assisted countries.

Further information regarding the Office of Energy's projects and activities is available in our Program Plan, which can be requested by contacting:

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