

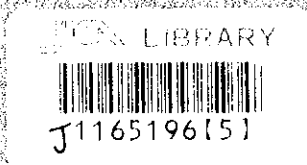
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THE SYRIAN ARAB REPUBLIC

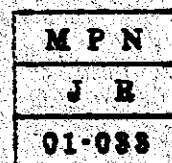
**THE STUDY
FOR
THE INTRODUCTION OF INTEGRATED
PHOTOVOLTAIC SYSTEM
INTO
THE SYRIAN ARAB REPUBLIC**

FINAL REPORT



MARCH 2001

**SHIKOKU RESEARCH INSTITUTE, INC.
THE INSTITUTE OF ENERGY ECONOMICS, JAPAN**



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SCINTIFEC STUDIES AND RESEARCH CENTER (SSRC)
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JICA STUDY TEAM

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THE INSTITUTE OF ENERGY ECONOMICS, JAPAN**



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Preface

In response to a request from the Government of the Syrian Arab Republic, the Government of Japan decided to conduct the Study for introduction of integrated photovoltaic systems into the Syrian Arab Republic and the study was implemented by the Japan International Cooperation Agency (JICA).

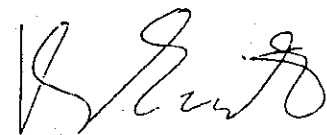
JICA sent a study team, led by Mr. Yoshinori Minato of Shikoku Research institute Inc. and organized by Shikoku Research institute Inc. and The Institute of Energy Economics, Japan, to the Syrian Arab Republic 16 times from December 1995 to February 2001.

The team held discussion with the officials concerned of the Government of the Syrian Arab Republic, and conducted related field surveys. After returning to Japan, the team conducted further studies and compiled the final results in this report.

I hope this report will contribute to the promotion of the utilization of photovoltaic systems and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Syrian Arab Republic for their close cooperation throughout the study.

March 2001



Kunihoko Saito
President
Japan International
Cooperation Agency



March 2001

Mr. Kunihiko Saito
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. Saito,

Letter of Transmittal

We are pleased to submit you the Final Report on The Study for the Introduction of Integrated Photovoltaic (PV) System into the Syrian Arab Republic.

The report contains the results of this study such as monitoring of introduced PV systems, the advice and suggestion of the Authorities concerned of the Government of Japan and your Agency as well as the formulation of the above-mentioned project. Also comments made by the Scientific Studies and Research Center and the related organization of the Government of Syria are reflected to make this Final Report including recommendation and the future introduction plan.

This report presents ①Social / village survey ②Installation of meteorological facility and technical transfer for PV village electrification and PV water pumping / desalination system ③Utilization of the surplus electricity in summer for cottage industry from the centralized system ④System management ⑤Economic analysis for the various PV systems ⑥ Evaluation of rural development effect after introduction of PV system ⑦ Recommendation and future plan for introducing various PV system into Syrian Arab Republic.

This country has large arid area like as Syrian Desert and there are rural areas, which do not have electricity and water because of economical difficulty. On the other hand, this country has a plenty of solar energy. Therefore, PV system will be introduced smoothly and utilized based on the outcome of this study and expected to contribute for the rural area development.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs and the Ministry of Economy, Trade and Industry. We also wish to express our deep gratitude to the Scientific Studies and Research Center, UNDP and the related organization of the Government of Syria.

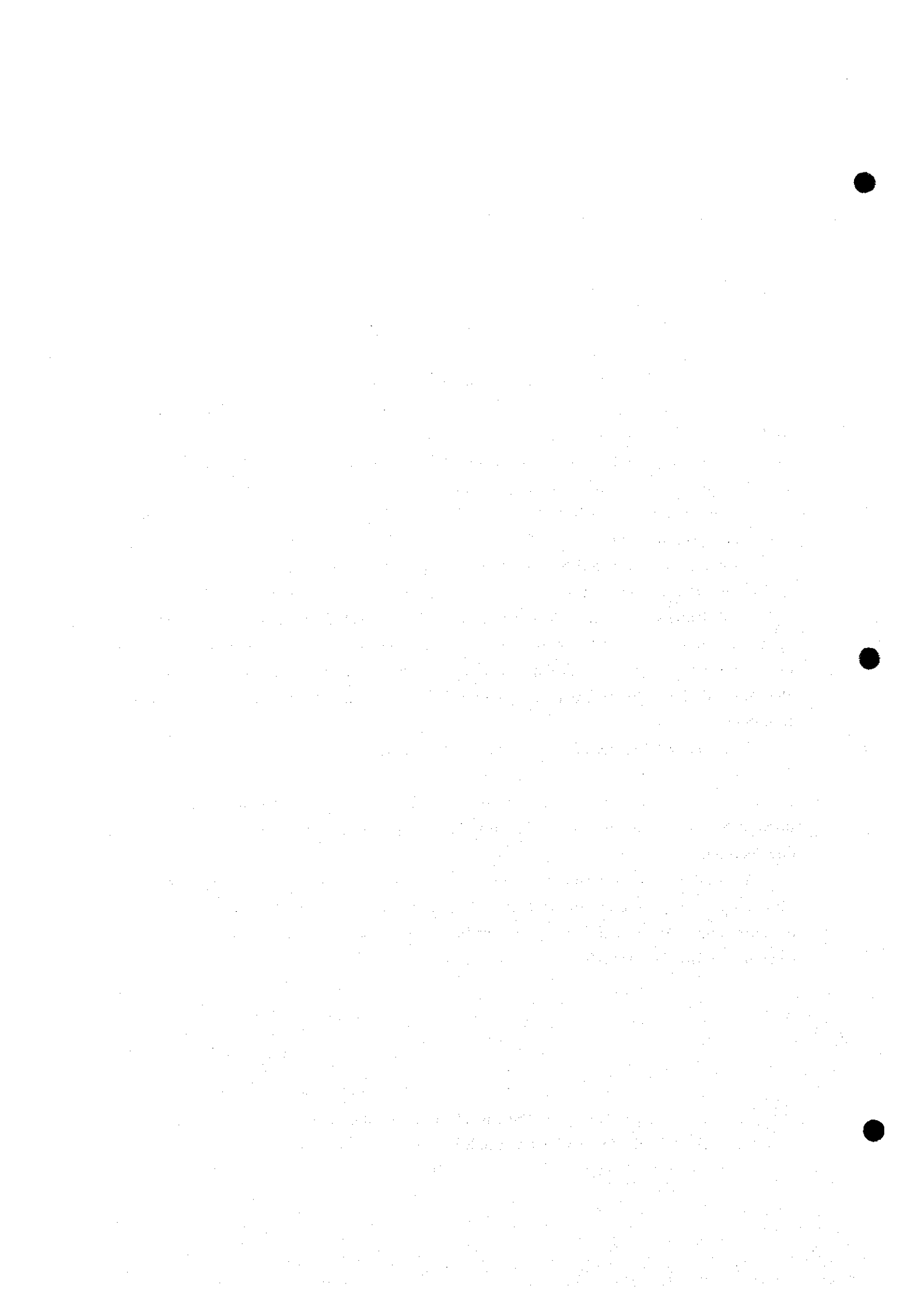
Very truly yours,

Dr. Yoshinori Minato

湊 嘉 徳

The Leader of the Study Team

The Study for the Introduction of Integrated Photovoltaic System into
the Syrian Arab Republic



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ABBREVIATION

AC	Alternating current
Ah	Ampere hour
CPU	Central processing unit
CRF	1/capital recovery factor
DC	Direct current
ED	Electro-Dialysis
FAO	Food and Agriculture Organization
FDD	Floppy Disc Drive
GDP	Gross domestic product
HDD	Hard Disc Drive
HIAST	Higher Institute of Applied Science and Technology
Hz	Hertz
IEA	International Energy Agency
IGBT	Insulated Gate Bipolar Transistor
I _{op}	Current at Optimum Power
I _{sc}	Short Circuit Current
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standard
LAN	Local Area Network
LED	Light Emitting Diode
Lx	Lux
MPPT	Maximum Power Point Tracking
OC	Overcurrent
OJT	On the job training
PEDEEE	Public Establishment for Distribution & Exploitation of Electrical Energy
P _{max}	Maximum Power
POD	Programmable Operationing Display
PV	Photovoltaic
PVC	Polyvinyl Chloride
PWM	Pulse Width Modulation
RAM	Random Access Memory
REDO	the Renewable Energy Development Organization
RO	Reverse Osmosis
SHS	Solar Home System
SP	Syria Pound
SPC	State Planning Commission
SSRC	Scientific Studies and Research Center
S/W	Scope of Work
UNDP	United Nations Development Program
UV	Undervoltage
V _{oc}	Open Circuit Voltage
V _{op}	Voltage at Optimum Power
VVVF	Variable Voltage Variable Frequency
WHM	Watt Hour Meter

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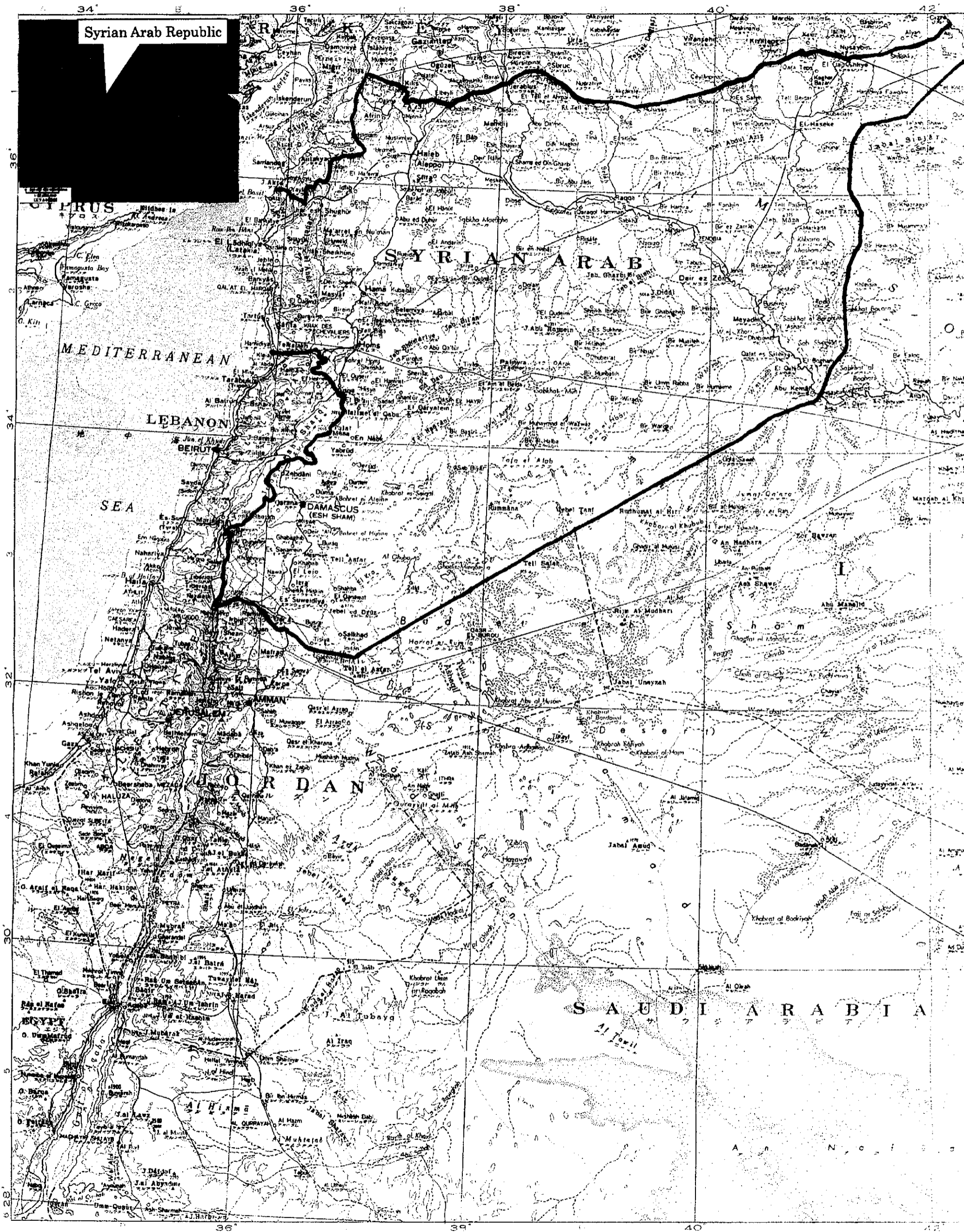
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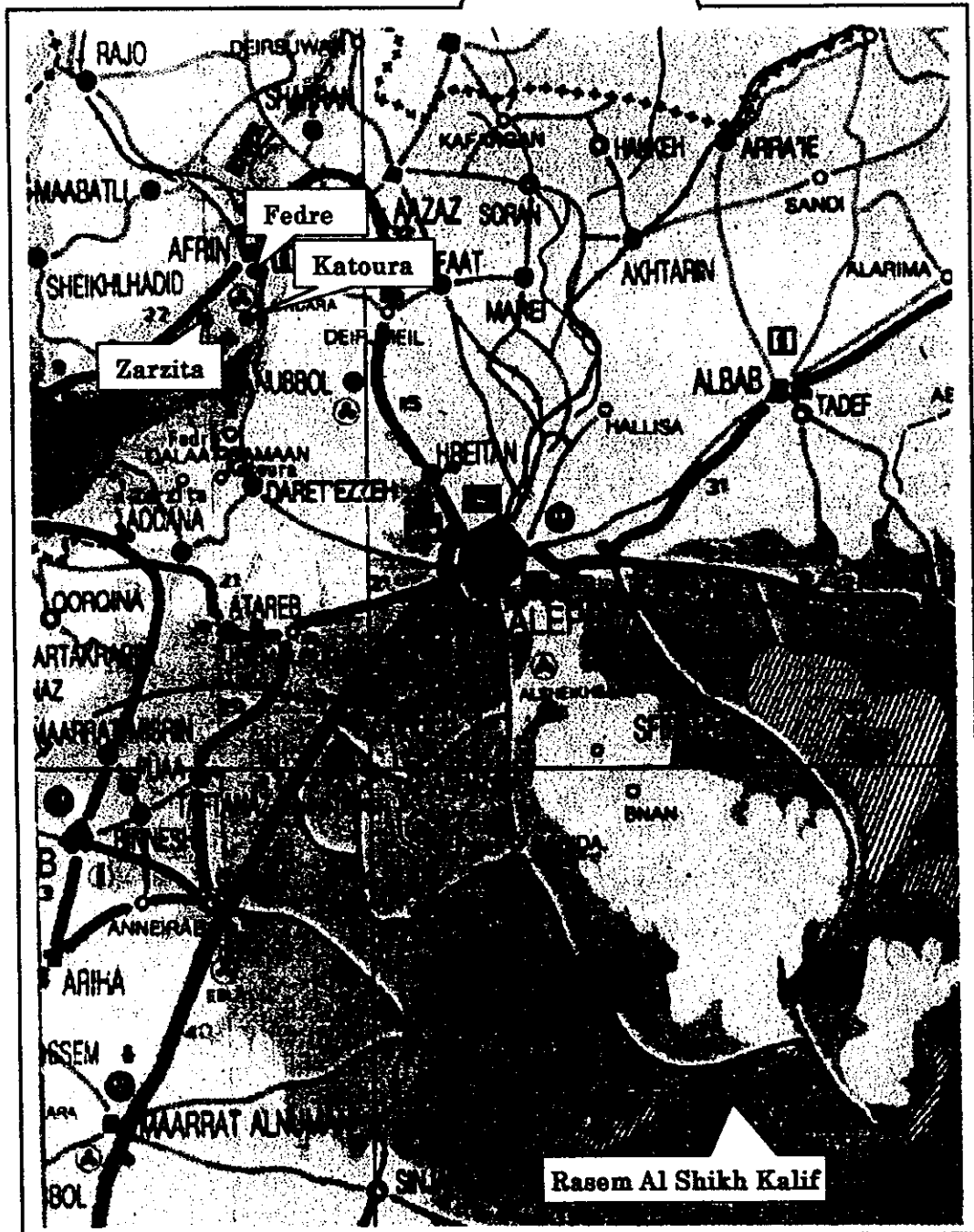
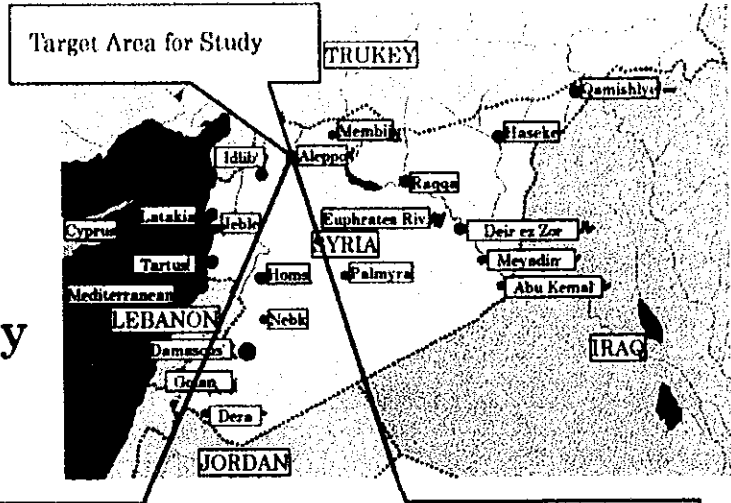
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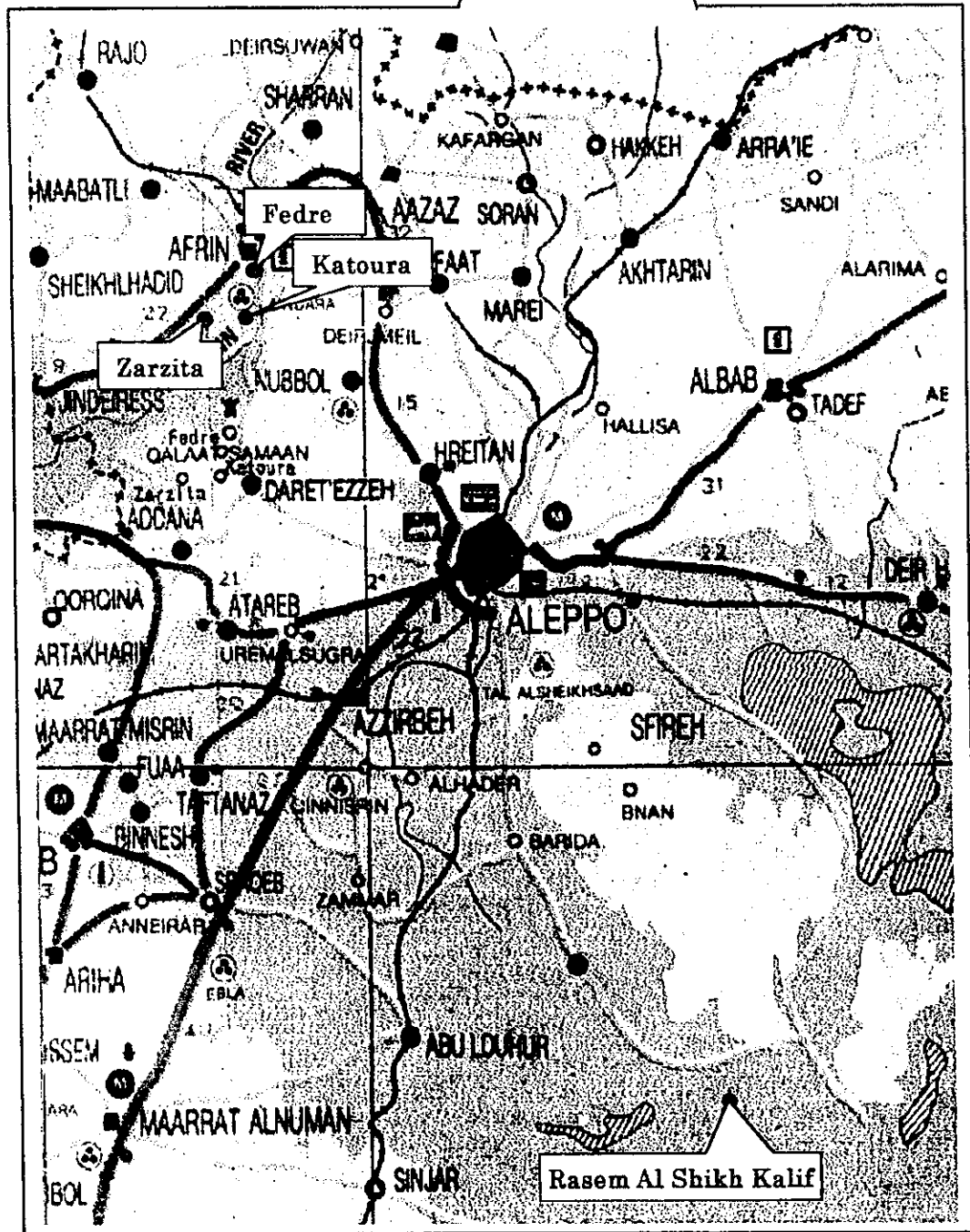
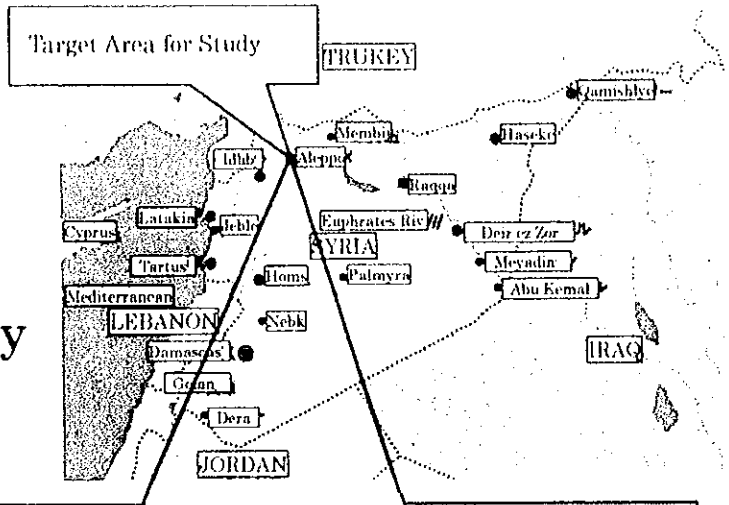
Target Country for Study



Target Area for Study



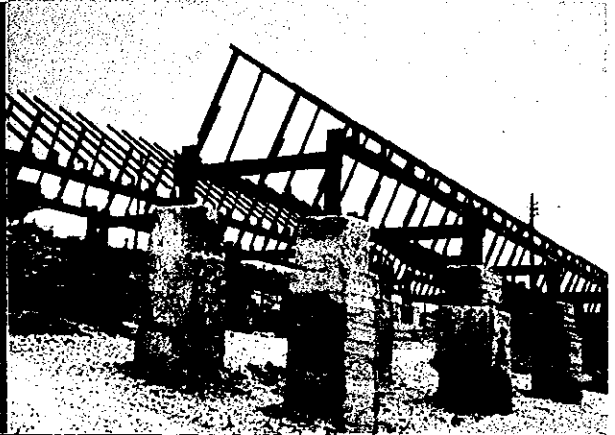
Target Area for Study



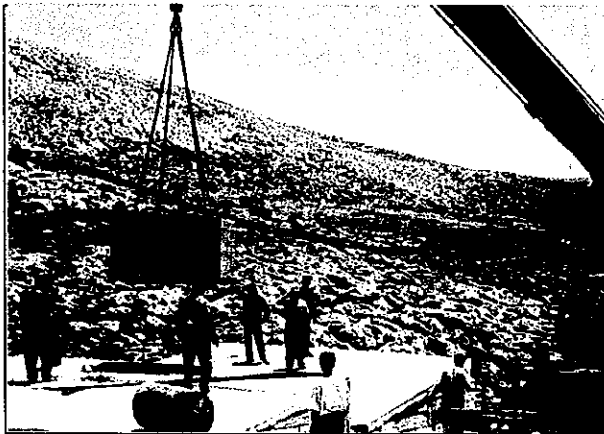
Centralized PV system in Zarzita Village



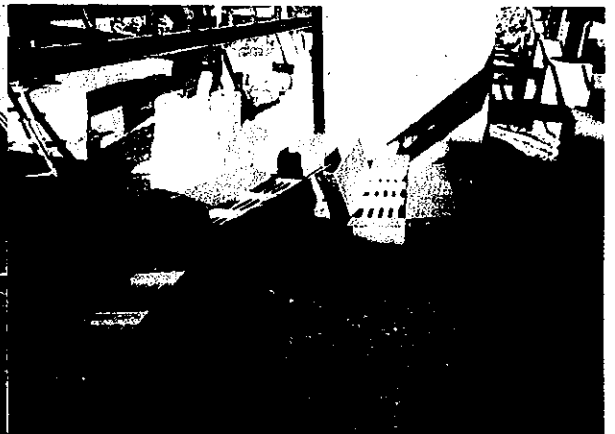
Site arrangement for centralized PV array
Mar/1997



Installation of PV array structure
Jun/1997



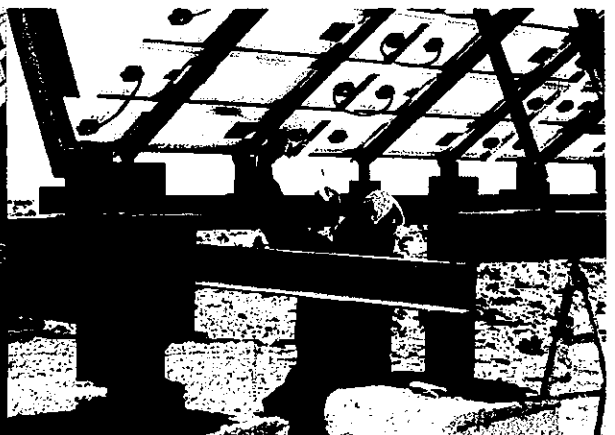
Material transportation
Jun/1997



Inspection of transported materials
Jun/1997



PV module mounting on PV array structure
Jun/1997

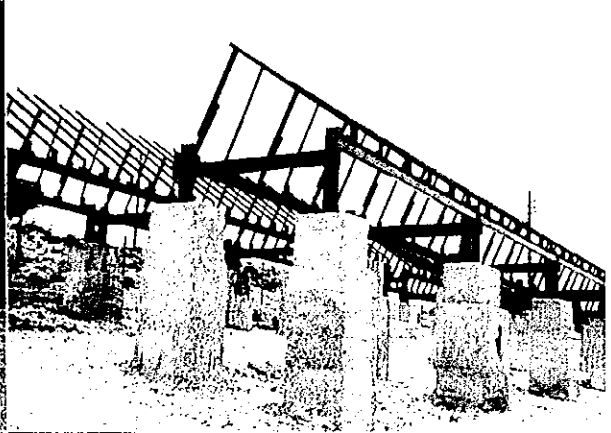


Interconnection among PV module
Jun/1997

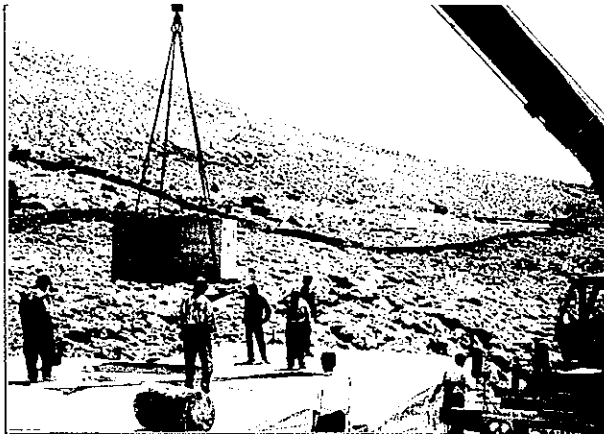
Centralized PV system in Zarzita Village



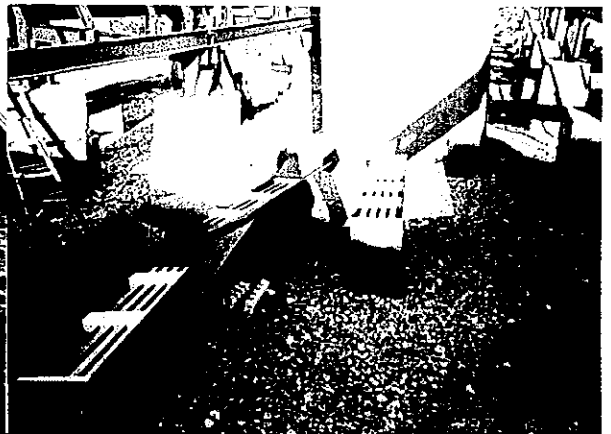
Site arrangement for centralized PV array
Mar/1997



Installation of PV array structure
Jun/1997



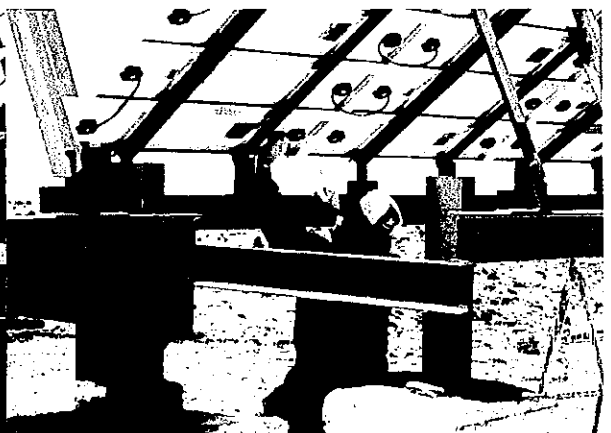
Material transportation
Jun/1997



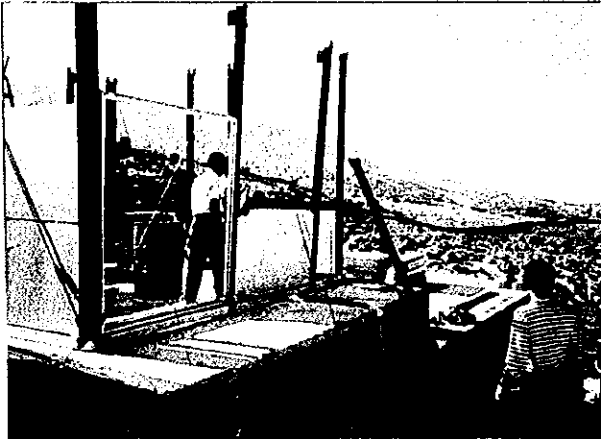
Inspection of transported materials
Jun/1997



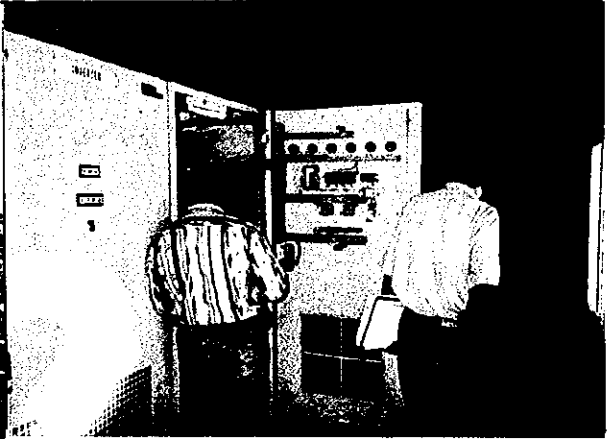
PV module mounting on PV array structure
Jun/1997



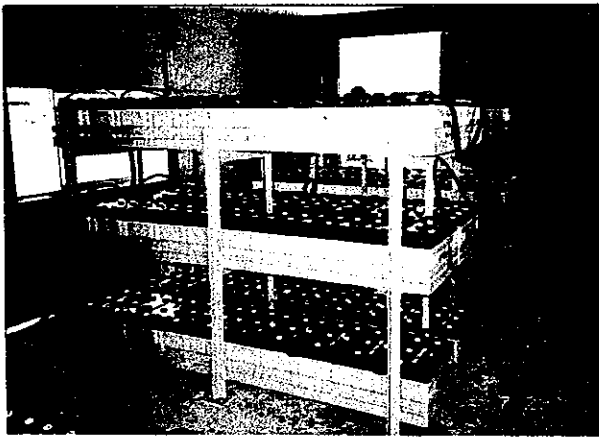
Interconnection among PV module
Jun/1997



Construction of rooms for control equipment and battery
Jun/1997



Equipment installation in control room
Jun/1997



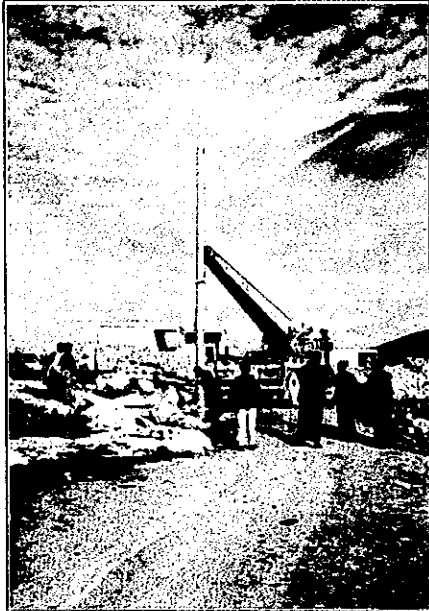
Installation of battery
July/1997



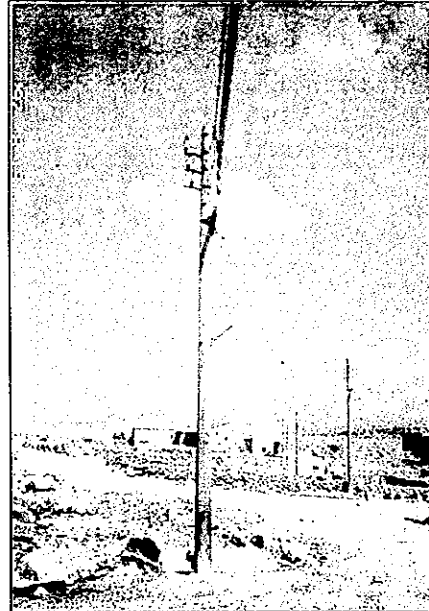
Battery solution filling up
July/1997



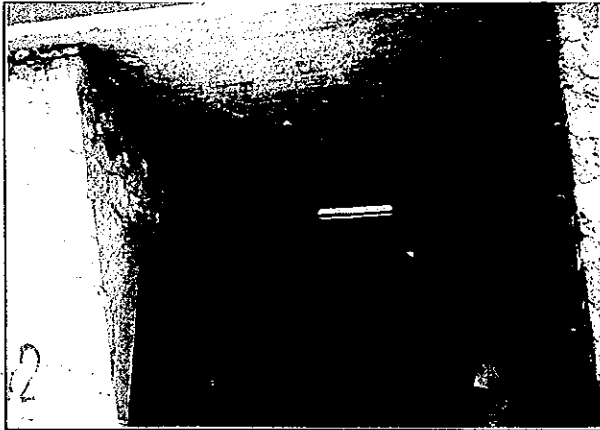
Hole view of centralized PV system
July/1997



Grid line facility (pole erection)
Feb/1997



Grid line facility (pole attachment)
Feb/1997

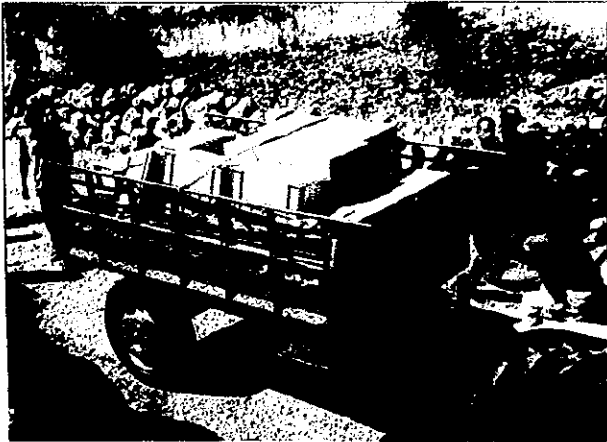


In-house wiring
July/1997

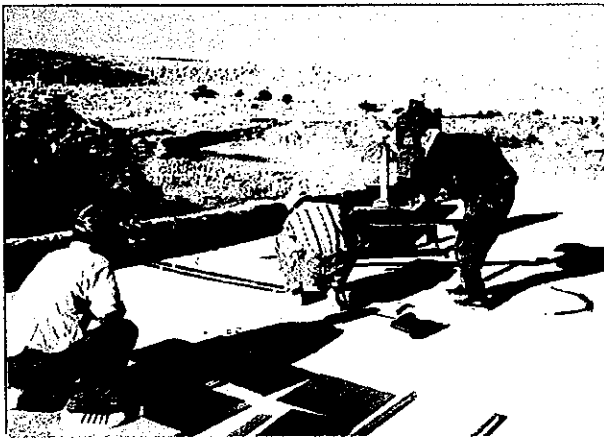


Inspection of commissioning
July/1997

Individual small scale PV system



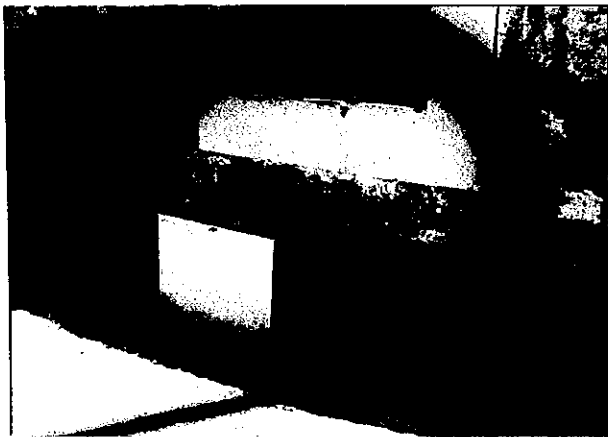
Material transportation and separation
Jun/1997 (Fedre)



Fabrication of PV array
July/1997 (Fedre)



Interconnection among PV module
July/1997 (Fedre)



Setting up storage box for battery
July/1997 (Fedre)



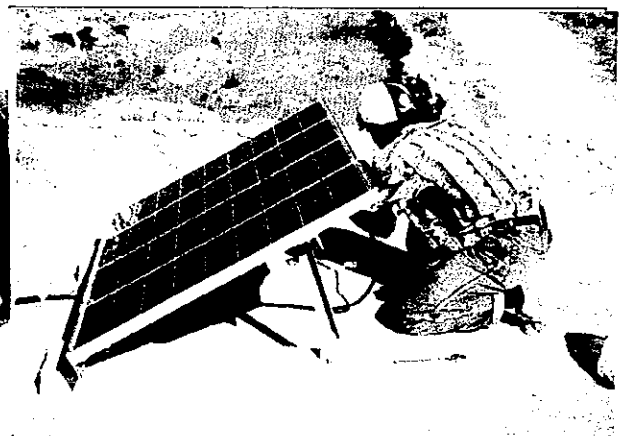
Battery solution filling up
Aug/1997 (Fedre)



**Material transportation and separation
Jun/1997 (Katoura)**



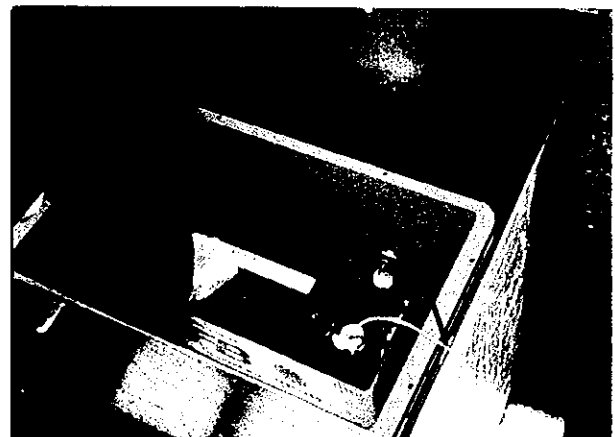
**Fabrication of PV array
July/1997 (Katoura)**



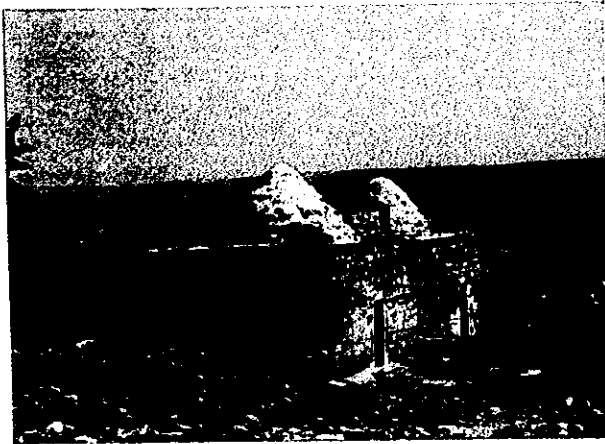
**Interconnection among PV module
July/1997 (Katoura)**



**Setting up storage box for battery
July/1997 (Katoura)**



**Battery solution filling up
Aug/1997 (Katoura)**



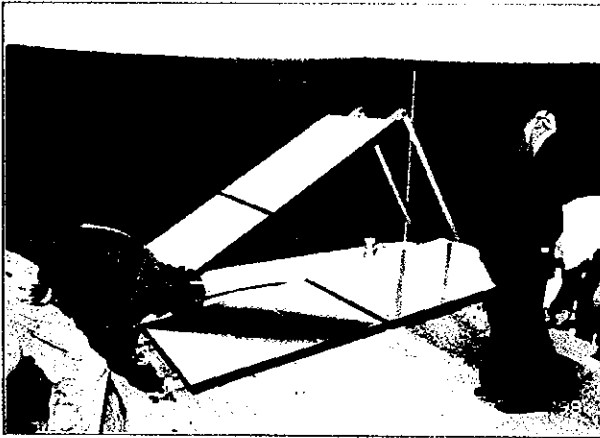
Fedre Village



Katoura Village

View of individual PV small scale system

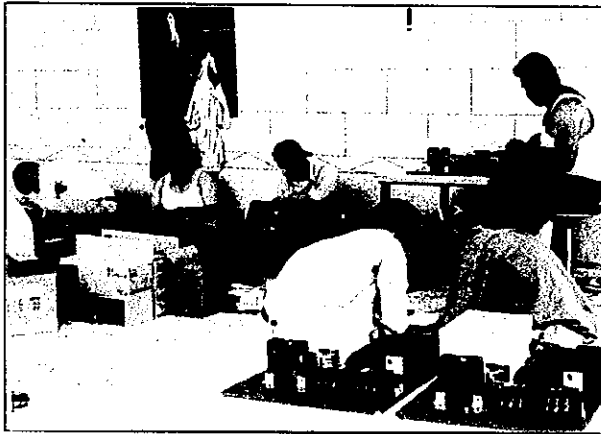
Individual middle scale PV system in Kalif Village



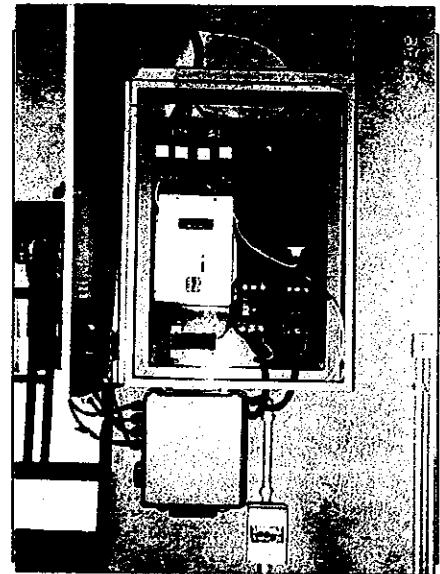
Fabrication of PV array
July/1998



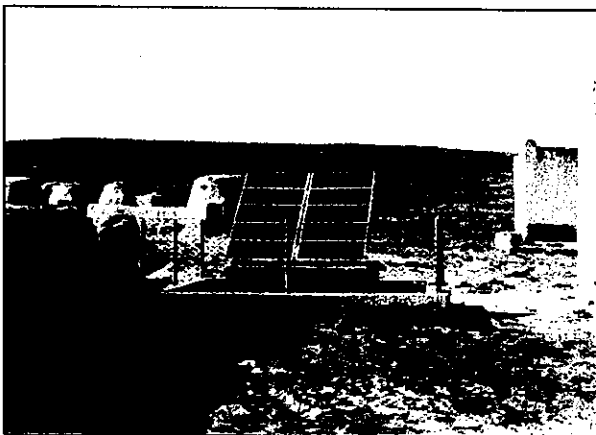
Interconnection among battery
July/1998



Fabrication of SW board
July/1998



View of SW box
July/1998

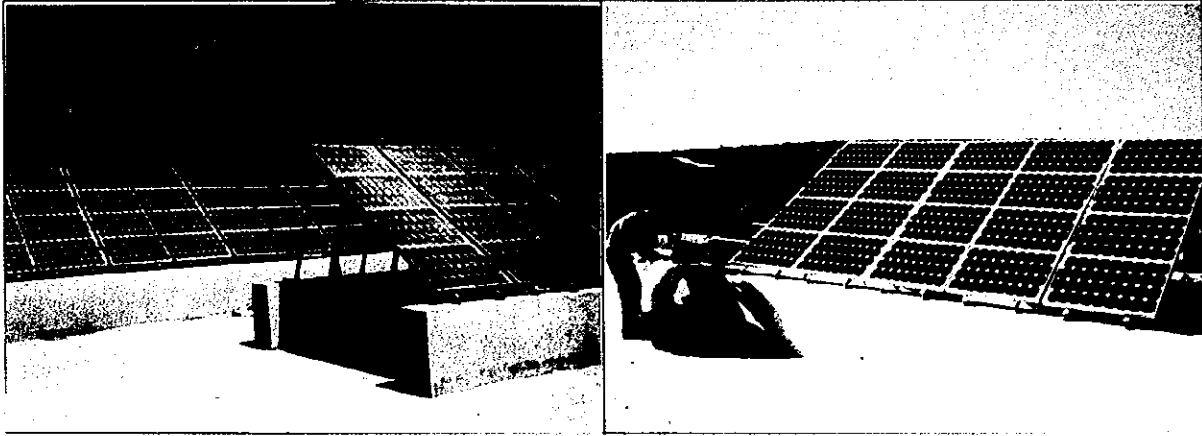


View of PV array
(ground type)



View of PV array
(Roof mount type)

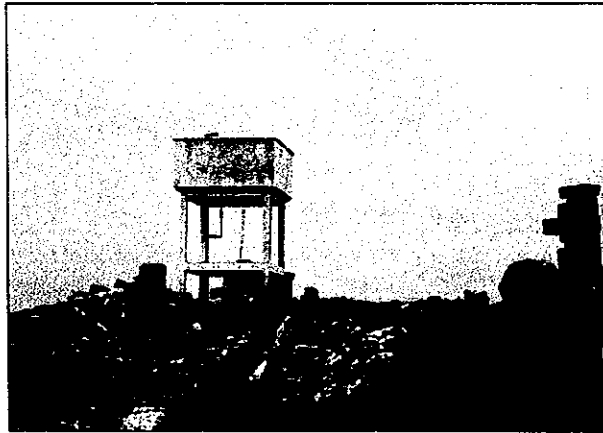
PV water pumping and water supply facility in Zarzita



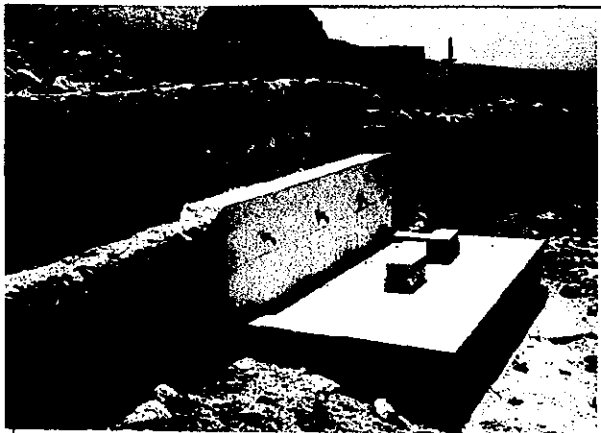
PV module mounting on PV array structure
Mar/1998



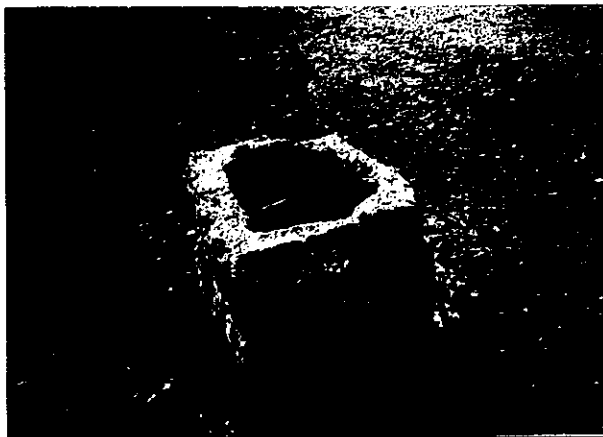
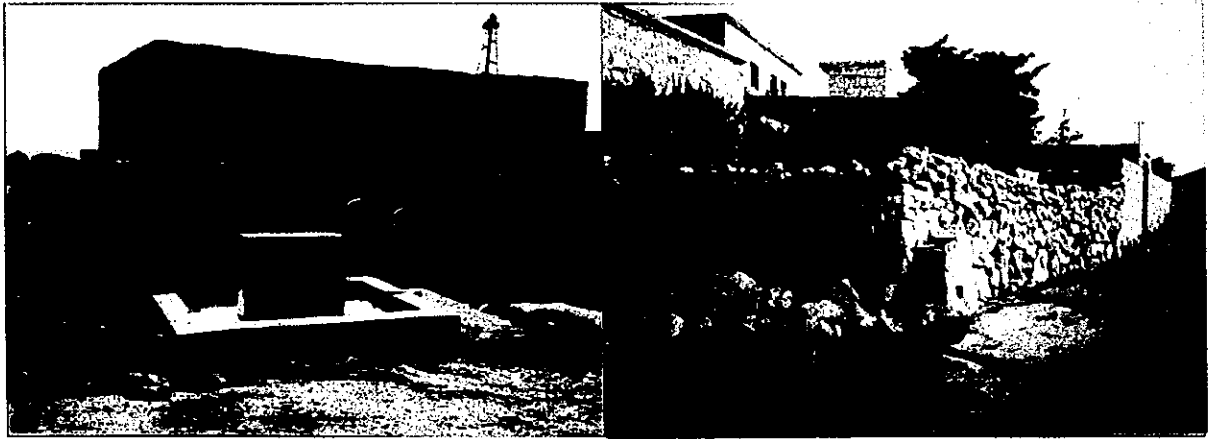
Installation of Inverter
Mar/1998



Water reservoir in Zarzita
(High Tank)

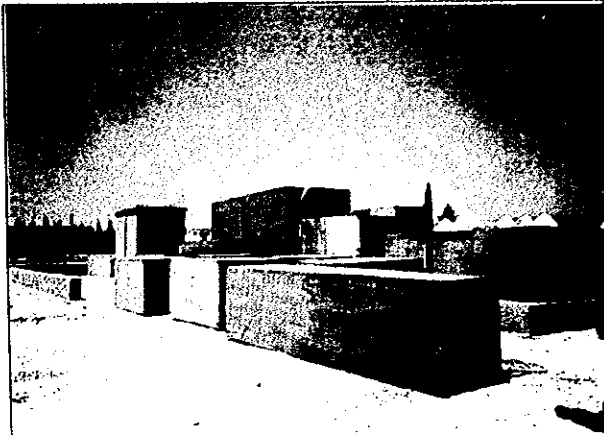


Water tap in Zarzita

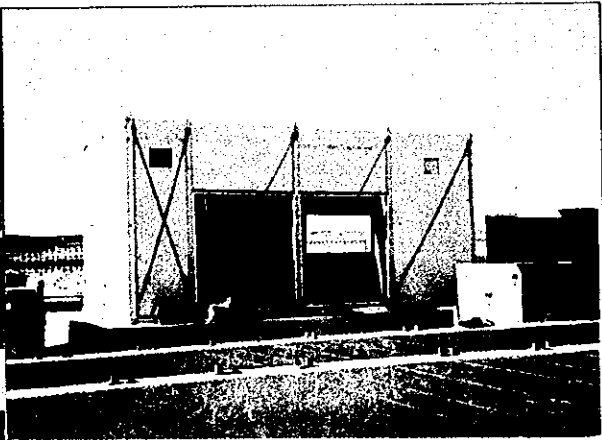


Each water tap in Zarzita

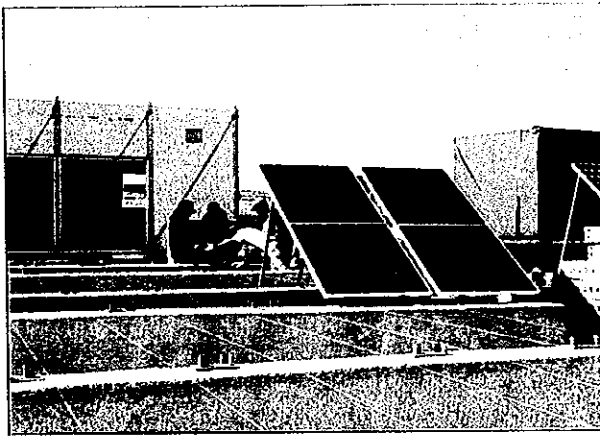
Water pumping and desalination by PV system in Kalif



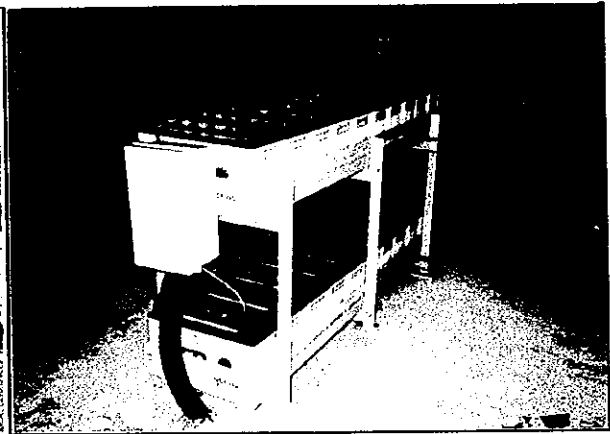
Transported materials
July/1997



Fabrication of control and battery room
July/1997



PV module mounting on array structure
July/1998



Battery installation
July/1998



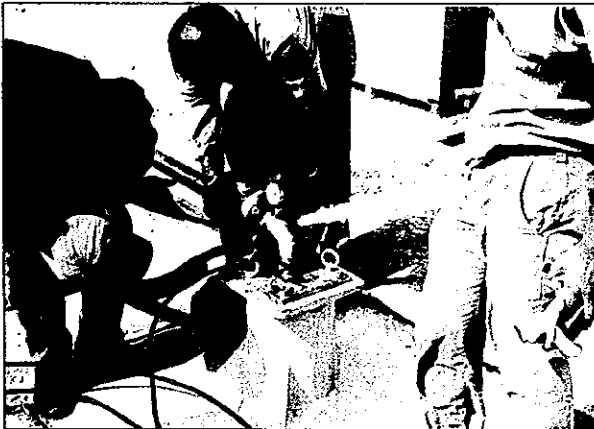
Inspection of main equipment
July/1998



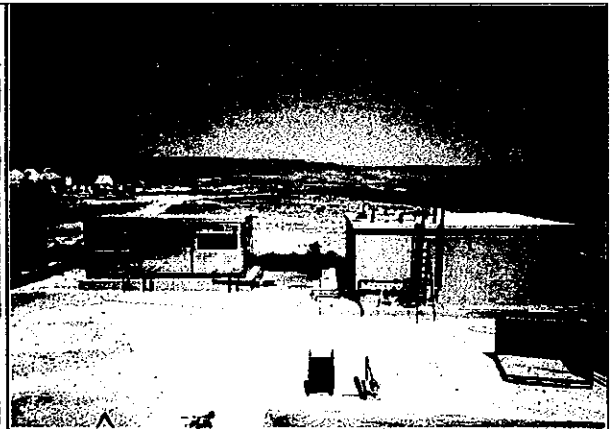
**Pumping test for checking underground water quantity
(Before installation) Jun/1997**



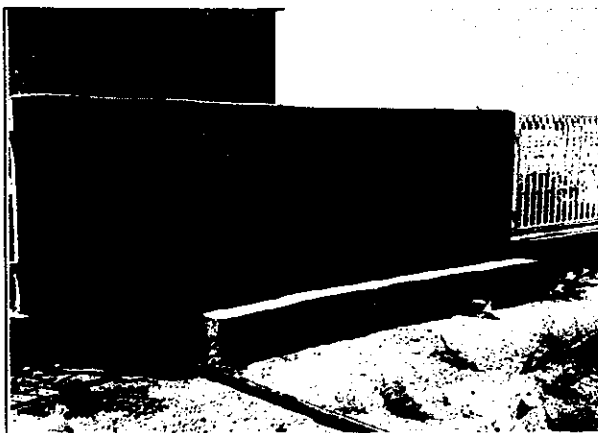
**Installation of water pump
July/1998**



**Pumping test (after installation)
Aug/1998**



**View of desalination facility
Aug/1998**



Water tap

Main parts of desalination facility



Control panel

Chemical tank

Filter



High pressure pump

RO membrane

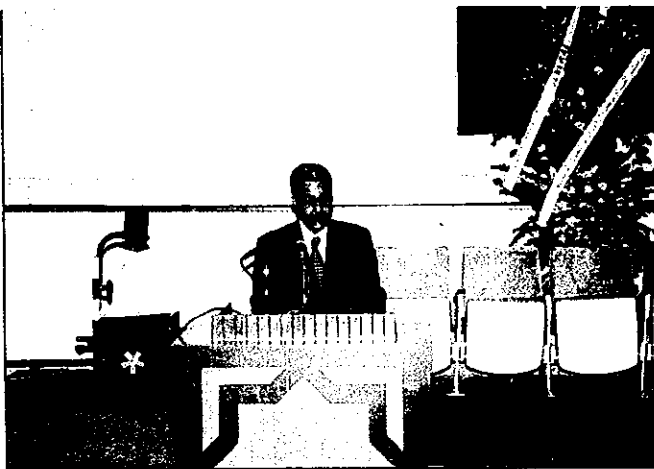
Work Shop



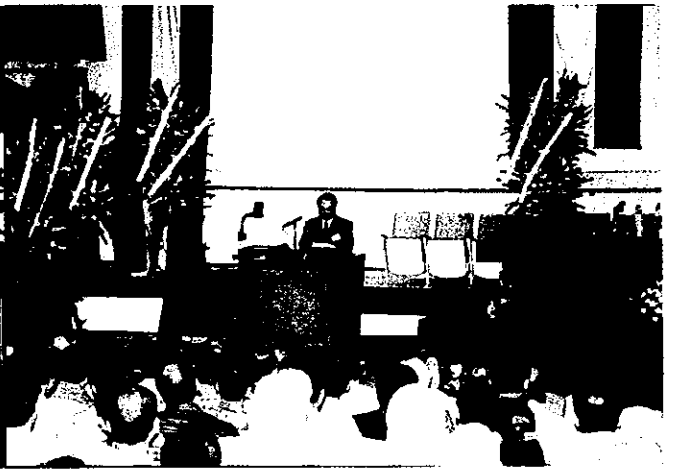
Banner for Workshop in front of Aleppo University



View of conference room (about 250of attendee)



Greeting of Dr. Ali Al Marahfji
(Director General of SSRC)



Greeting of Mr. Yasunobu Akimoto
(Vice president of JICA)



Chairman Dr. M. R. Sabouni



VIP invited guest for workshop

Form Left

(Minister of Electricity, Minister of Industry)

(Director General of SSRC, Vice President of JICA)

(Governor of Aleppo)



Tea break

Preparation of SW On ceremony in Zarzita



View of Villagers in Zarzita on ceremony

SW On ceremony by Vice President of JICA and Director General of SSRC



Villager's celebration for commissioning centralized PV system in Zarzita

Chapter 1
Outline of Study



Chapter 1 Outline of Study

Recently, the concern for environmental issues has been rising in the world such as global warming and breaking of ozone barrier by exhausting carbon dioxide (CO²) and Fluor. On December 97, Kyoto Conference on Climate Changes (COP3) was held. On the developed country, the agreement was concluded to reduce at least 5% amount of the exhaust of Green House Gases compared with year 1990 by year 2012. In the background of such situation, photovoltaic system (hereinafter called PV system) for utilizing clean and renewable energy was highlighted to contribute very much against the global warming prevention. Japan and the other developed countries began to accelerate the introduction of PV systems.

On the other hand, to contribute the electrification of rural area with a small power demand, PV system, which is independent and easy installation, is positively introduced at the developing country in Southeast Asia and the Middle East nations. This introduction is together with advancing the extension of transmission and distribution line. Among the developing countries of the Middle East, the Syrian Arab Republic (hereinafter called Syria) is characterized as follows:

- With long duration of bright sunshine, it is possible to utilize plenty of solar energy in these regions.
- Due to rapid urbanization and underdeveloped social infrastructure, the conditions of electric services were not necessarily favorable at the time of start of this project. It was necessary to restrict the power consumption.
- Un-electrified villages of these regions in Syria comprise gatherings of dwellings of several families engaging in both stock farming and agriculture and these gatherings are scattered over a wide area. Many of such villages are subjected to severe natural conditions. Such villages are in sharp contrast with the agricultural collective villages of Asian countries.
- There are many arid regions in Syria. In such regions, important issues are how to secure precious water and how to use it effectively.
- Syria has many capable persons who received well-developed university education of Europe and America.

In the light of these characteristics, we can expect that when Syria successfully introduces PV systems that can effectively utilize plenty solar energy and

accomplishes satisfactory results in rural electrification and supply of water, the project will serve as an effective model for other countries of the Middle East. In this chapter, the background that led to the establishment of this project, its objectives and the progress of the study are described.

1.1 Background of the study

Syria has vast arid and semiarid regions, including the Syrian Desert, mainly in its southeast. There are about 12,000 villages in these regions and many rural areas in Syria. Of these villages, about 4,000 villages have not been electrified yet to receive the benefit of electricity. Moreover, nearly 3,000 villages are not supplied with water. Most of such villages are small-sized villages located far away from grid lines and wells. As for supply of electricity, from the viewpoint of economy, one cannot expect installation of grid line that requires a large investment. As for supply of water, it is not economically feasible to install a water service installation that requires a large initial investment.

Ever since the fifth five-year plan (1981~), the government of Syria has been pursuing elimination of interregional differences as one of the general objectives of the national development plan. Positively promoting its electrification plan to increase the standard of living of the people of the villages of rural areas. The government of Syria has been having a strong interest in and great expectations of research and development on effective use of renewable energy sources including plenty solar energy as a means of promoting rural electrification. If it can be demonstrated that the introduction of PV systems, which utilizes plenty solar energy in Syria, is feasible as means for supplying energy for rural electrification and water pumping/desalination systems, the government will be able to supply electricity and water to vast semiarid and unelectrified regions stretching over the land. Supply of electricity and water will enhance and stabilize the livelihood of the residents of the villages and, in turn, will contribute to the stabilization of the entire Middle East.

Under such circumstances, the government of Syria requested the government of Japan in August 1994 to make this development study. The list of the requested study was a demonstration, around Aleppo, the second largest city in Syria, of introduction of rural electrification with PV systems, introduction of groundwater pumping systems and pumping/desalination systems, and enhancement of the livelihood of the

residents of rural areas through the use of electricity and such systems. In response to the request of the government of Syria, the government of Japan made the first and second preliminary surveys in February and June 1995 to confirm the background and contents of the request of the government of Syria and the potential of cooperation and the scope of work of the government of Japan.

As a result of the preliminary surveys, it was confirmed that the introduction of rural electrification systems and water pumping/desalination systems through the use of PV system would enhance the livelihood of the residents of the rural areas and, in turn, reduce the interregional differences. It was also confirmed that, in view of the effective use of plenty solar energy and availability of talented people who can acquire the technology, Syria would become an excellent model country of introduction of PV systems in the Middle East. In short, it was confirmed that the introduction of PV system could be an effective means of promoting regional development in Syria.

On the basis of these findings, the government of Japan held conference with the Scientific Studies and Research Center (SSRC) of Syria and its subordinate organization, the Higher Institute of Applied Science and Technology (HIAST) and made field surveys. Then the government of Japan and the government of Syria reached full agreement and concluded a Scope of Work on "The Study for the introduction of integrated photovoltaic system into the Syrian Arab Republic" on June 24, 1995. In December 1995, the study team for "The Study for the introduction of integrated photovoltaic system into the Syrian Arab Republic" was sent to Syria.

1.2 Objectives of the study

The objectives of this developmental study are as follows:

PV system is introduced in areas around Aleppo, Syria to promote rural electrification and introduce groundwater pumping systems and brackish water desalination systems for demonstration. Installation, operation and management of these demonstration facilities and development of a cottage industry are executed to enhance the livelihood of the people of the rural areas. Through this study, it is intended to verify the feasibility of PV systems in terms of technology, economy, finance, society, organization, management and environment. It is also intended to establish measures for enhancement of livelihood of the people of rural areas through

the use of PV systems that can be effective and applicable in enhancement of livelihood of semi-arid and un-electrified areas. Furthermore, it is intended to make technology transfer to the Syrian counterpart during the study. Cooperation is made with UNDP to assist development of a cottage industry and technology improvement of the counterpart.

To accomplish these objectives of the study, a social and economic survey of un-electrified villages around Aleppo, including Zarzita, Fedre, Katoura and Rasem Al Shikh Kalif (Kalif for short), is conducted. On the basis of the findings of the survey, a centralized village electrification system and a water pumping system are installed and operated in Zarzita. In Fedre and Katoura, individual small-scale electrification systems are installed and operated. In Kalif, individual medium-scale electrification systems and a water pumping/desalination system are installed and operated.

Next, through the experiences of operation and management, maintenance and inspection, and collection of fees of these systems, efforts are made to develop a plan as much as practicable, concerning the sustainability of the introduced facilities, method of operation and management, organizational system, methods of setting and collecting fees for electricity and water that are appropriate in comparison with the conventional public utilities fees.

At the same time, in the villages in rural areas of Syria, changes in the livelihood of the residents after the introduction of the demonstration facilities are monitored on a continuous basis to grasp the livelihood-enhancing effects of rural electrification with PV systems and introduction of water pumping/desalination systems. Further, it is expected that development of a cottage industry that utilizes surplus electricity generated by the centralized PV system in the daytime in summer will have livelihood-enhancing effects on the residents of the village. The study team considers the kinds of products, establishes production technology, executes production control, financial management, etc., conducts demand research and market research, and give guidance on development of sales network, etc.

Furthermore, the study team analyzes the introduced PV systems in terms of technology and economy, considers and recommends future introduction plans of such

systems and the roles of the government of Syria so that the introduction of such systems meets the present conditions of Syria and is rationally integrated into the electrification plan and the water supply plan of Syria.

1.3 Progress of the study

In this study, surveys were made in Syria and Japan, as described below, in the period of six years from November 1995 to March 2001. All of the project outcome including fees collection were compiled in Draft Final Report and submitted to SSRC/HIAST. At February 2001, the final survey was carried out to discuss the project outcome and reported to the government of Syria and the related organization through seminar. Comments from SSRC/HIAST and result of seminar were taken into account to make Final Report. As a result, Final Report was submitted in March 2001.

- 1) In December 1995, the first field survey was made. The Inception Report was submitted, and the objectives and overall plan of the project were explained to the Syrian side. Then site surveys in Syria were made. The findings of these surveys were compiled in the Progress Report 1 and submitted in March 1996.
- 2) In 1996, arrangements were made for engineering of the facilities to be introduced and procurement of equipment and materials. In July 1996, prior to the delivery of the actual facilities to be introduced, meteorological observation system were introduced to Zarzita and SSRC laboratory building, and a battery performance evaluation system was introduced to SSRC laboratory to collect data. At the same time, baseline surveys of the respective villages prior to the introduction of the facilities were made. The findings of these surveys were compiled in the Progress Report 2 and submitted in March 1997.
- 3) From May to August 1997, the centralized PV system of Zarzita and the individual small-scale systems of Fedre and Katoura were installed, and testing and trial operation of these systems was conducted. Continuous operation of these systems was started in September to supply electricity in the respective villages. Taking this opportunity of the commencement of continuous operation, SSRC and the study team jointly held a workshop in Aleppo University. About 300 persons including the Minister of Electricity and the Minister of Industries, the Director General of SSRC, the Mayor of Aleppo City, and the Vice President of

JICA Headquarters attended the workshop. After the workshop, celebrations were made in the respective sites, and a lighting-on ceremony was held in Zarzita. With the commencement of the continuous operation of the centralized PV system, the residents of the village, the counterpart and the study team started joint efforts of trial manufacture of cloisonne wares as a part of development of a cottage industry.

Rasem Al Shikh was initially planned to be the site for introducing individual medium-scale systems and a water pumping/desalination system. However, as fresh water well was successfully dug in Rasem Al Shikh, introduction of the water pumping/desalination system was not needed anymore. A survey was made to find an alternative site for installing the water pumping/desalination system together with the rural electrification systems. Eventually, Kalif was found to be an appropriate site, and it was decided to install all the systems there.

In March 1998, the findings of the study for the first three years were compiled in an Interim Report and the report was submitted. At the same time, the water pumping system of Zarzita was installed, and trial operation of the system was made. After the final inspection of the system, continuous operation of the system was started to supply water.

4) From July to August 1998, the individual medium-scale systems and the water pumping/desalination system in Kalif were installed and trial operations of these systems were made. Then continuous operations of these systems were started. As all the facilities started operation, the study team began full-scale consultation concerning organizations and methods for operation and management of these systems and collection of fees. As a result, it was agreed that for the time being, the Ministry of Electricity is in charge of operation and management of the village electrification systems, the Aleppo Water Authority is in charge of operation and management of the water pumping system in Zarzita, Jabal Al Hoss Development Office of the Ministry of Agriculture is in charge of operation and management of the water pumping/desalination system in Kalif, and SSRC/HIAST provides technological assistance covering related fields.

The study team conducted surveys of the respective villages into which the facilities were introduced in 1997 to find any changes in the life style of the residents after the introduction and their attitudes to electricity. These surveys were intended to grasp the conditions of enhancement of the livelihood of the

residents. As for the development of a cottage industry in Zarzita, with technical assistance given by the experts of UNDP, full-scale production of cloisonné wares was started, and trial sale of the products was started in St. Simeon Castle near Zarzita.

In March 1999, the findings were compiled the Progress Report 3 and submitted. At the time of the field survey made in March, consultation concerning operation and management of the systems was made again with the Aleppo Electric Authority, the Aleppo Water Authority and Jabal Al Hoss Development Office of the Ministry of Agriculture. The timing of commencement of management and the institutional framework were confirmed.

5) In the field survey from June to September 1999, a follow-up survey of the conditions of the operation, management, maintenance and inspection of the introduced facilities was made, and consultation concerning operation and management was made. As a result, Jabal Al Hoss Development Office of the Ministry of Agriculture gave up the idea of becoming the entity for the operation of the facilities of Kalif due to limitation of their budget, etc. It was confirmed that the Ministry of Electricity is in charge of operation and management of the village electrification systems, the Aleppo Water Authority is in charge of operation and management of the water pumping system in Zarzita and the water pumping/desalination system in Kalif. It was also agreed that both Authorities and SSRC/HIAST would conclude agreements concerning operation and management of the respective systems. The agreement with the Aleppo Water Authority was signed up in August, and the agreement with the Aleppo Electric Authority in November.

With transfer of system management, technical training was given by SSRC to the engineers and technicians of the both Authorities. After this training, system management activity was shifted to the both Authorities. Based on the outcome of technical and economical aspect, advantage and available area for PV system was discussed and organization and institution aspect was studied for the future expansion with the Ministry of Electricity, the Ministry of Housing and Utilities and the organization concerned.

In March 2000, the results of five-year's study were compiled in a Draft Final Report No.1 and submitted. Both parties discussed about contents of this report.

6) Comprehensive management including fee collection did not started in fifth project year (1999). Therefore, to make comprehensive evaluation including system management and recommendation including policy and management aspect toward future introduction, project period extended one year. During this year, fee collection for the Water Authority started in April 2000 and the Electric Authority set up temporary fee for PV electricity in January 2001. As a result, comprehensive system management by the both Authorities was started.

Draft Final Report No.2 that includes system management and recommendation is submitted to SSRC/HIAST. In February 2001, seminar was held at SSRC Damascus and the outcome of this project was reported to the Ministries and the organizations concerned of Syria.

Final Report that reflects results of seminar and comments of SSRC/HIAST will be submitted in March 2001.

1.4 Organization of the study team and counterpart

(1) Organization of the study team

The study team was organized as follows, and as the leader, Dr. Y. Minato, each member has been in charge of following jobs.

Name	Job	
Dr. Masahide Takahashi	Leader	(Nov. 1995~Mar. 1996)
Dr. Yoshinori Minato	Leader	(Apr. 1996~Mar. 2001)
Mr. Takayuki Tani	Deputy leader, Social survey & System management	(Nov. 1995~Mar. 2001)
Dr. Masanori Tanifuji	Social survey	(Apr. 1997~Mar. 1998)
Mr. Katsuhiko Otaki	Cottage industry development	(Nov. 1995~Mar. 2000)
Mr. Mitsuru Fujita	Planning of water supply	(Nov. 1995~Mar. 1997)
Mr. Toshinori Fujita	Planning of water supply	(Apr. 1997~Mar. 2000)
Dr. Hirofumi Yokouchi	Planning of water supply	(Apr. 2000~Mar. 2001)
Mr. Kazuo Miyata	Planning & water resources survey and pumping up/desalination	(Nov. 1995~Mar. 1998)
Mr. Kunio Asai	Planning & water resources survey and pumping up/desalination	(Apr. 1998~Mar. 2000)
Mr. Shinji Omoteyama	Economic analysis	(Nov. 1995~Mar. 2000)
Mr. Hideo Semba	Planning & Design of PV system(A)	(Nov. 1995~Mar. 2001)
Mr. Koichi Iwabu	Design of PV system(B)	(Nov. 1995~Mar. 2000)
Mr. Takehiro Komatsu	Construction management of PV system (A)	(Nov. 1995~Mar. 2000)
Mr. Masao Kurokawa	Construction management of PV system (B)	(Nov. 1995~Mar. 1997)
Dr. Hiromu Inoue	Construction management of PV system (B)	(Apr. 1997~Mar. 2000)
Mr. Toshinobu Takeuchi	Coordinator	(Nov. 1995~Mar. 1996)
Mr. Tsuyoshi Sogabe	Coordinator	(Apr. 1996~Mar. 1998)
Dr. Hirofumi Yokouchi	Coordinator	(Apr. 1999~Mar. 2000)

(2) Counterpart in Syria (SSRC/HIAST)

Name	Job	Position
Dr. Riad Sabouni	Leader	Head of PV Lab
Mr. Yaser Shahid	Social survey/system management	Engineer
Mr. Mohammed Dakkak	PV System	Engineer
Mr. Imad Abdosh	Economic /PV System	Engineer
Mr. Adel Hassan	PV System	Engineer
Mr. Ahamed Babelly	PV System (Design)	Engineer
Mr. Yousef Cryem	Water System	Technician
Mr. Zakaria Annes	PV System (Battery)	Technician
Mr. Salem Yousef	Maintenance	Technician
Mr. Ziad Moscow	Cottage Industry	Technician
Mr. Mohamad Zeno	Coordination	Administrator

(3) COORDINATION COMMITTEE

NAME	TITLE
Eng. ABED ALRAHMAN AMMER	Head of planning/ General directorate of Electricity/ Aleppo
Dr. MAMOUN MALAKANI	Director of water research center/ Ministry of Irrigation
Dr. HASAN AMMOURI	Researcher/ water research center/ Ministry of Irrigation
Eng. IHSAN SANDOUK	Director of Scientific and Technical Affairs/ Ministry of Industry
Eng. MUHEI ALDIN ABOUDAN	Deputy director of Agriculture and Agrarian reform/ Aleppo
Eng. MUSTAFA AL-SHEHABI	Member of the Executive Bureau for Province in Aleppo
Mrs. AUMAIMA ISSA	Assistant Director for Energy Planning/ SPC

The introduced facility for each village is described below.

(1) Village electrification system

Zarzita

Type of system	Quantity	Outline of main equipment
Centralized PV system (Start : Sep 1997)	For 40 houses	PV array 35kW Inverter 40kVA Battery 336kWh Distribution facility In-house wiring facility, Pre-fabricated house etc

Fedre

Type of system	No. of system	Outline of one system
Individual DC system (DC200W) (Start : Sep 1997)	15	PV array 200W Controller 300W Battery 2,400Wh(1 x 12V-200Ah) In-house wiring facility etc

Katoura

Type of system	No. of system	Outline of one system
Individual DC system (DC300W) (Start : Sep 1997)	24	PV array 300W Controller 300W Battery 2,400Wh(1 x 12V-200Ah) In-house wiring facility etc

Kalif

Type of system	No. of system	Outline of one system
Individual AC system (AC500W) (Start : Aug 1998)	17	PV array 530W Controller 500W Inverter 500W Battery 7,200Wh(6 x 12V-100Ah) In-house wiring facility etc

(2) Water pumping / Desalination system

Zarzita Water pumping system

Type of system	No. of system	Outline of main equipment
Water pumping system (Start : Mar 1998)	1	PV array 6kW Submergible Pump 2 x 0.55kW Transfer Pump 1 x 0.55kW Water reservoir tank x 2 Water transfer line etc

Kalif Water pumping / Desalination system

Type of system	No. of system	Outline of main equipment
Water pumping system (Start : Aug 1998)	1	PV array 1.9kW Inverter 1.5kW Submergible pump etc
Desalination system (Start : Aug 1998)	1	PV array 8.6kW Controller for Desalination system Inverter 10kW Battery 24kWh(20 x 12V-100Ah) Desalination unit Raw water tank Desalinated water tank Pre-fabricated house etc