Chapter 9

Overall Evaluation

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In this project, village electrification, water pumping and desalination by PV system is introduced around Aleppo and a study were made to improve the human life of rural area through the installation, management of these systems and cottage industry. In here, based on the outcome of this project, the feasibility of PV system etc is evaluated by the aspect of technology, economics, social, management and environment.

9.1 Technical evaluation of the introduced PV system

The centralized PV system and the individual small-scale PV system was started operation in September 1997, and the water pumping system in Zarzita was started in March 1998. On the other hand, the individual medium-scale PV system and the water pumping/desalination system in Kalif was started there operation in August 1998 as well. The technical evaluation was executed on the introduced system based on the analysis of operation data, the situation of maintenance and troubleshooting.

9.1.1 Village electrification by PV system

(1) Centralized PV System

①State of power supply and consumption

After commissioning, noticeable issue was the addition of 100W and 10W incandescent lamps by villagers. The fluorescent lamp and incandescent lamp is brighter than kerosene lamp and these lamps are safety and convenient. Therefore, at first stage, demand for lighting was increased. When villagers understood the convenience of electricity, an electric appliances of the amusement usage that is radio-cassette, B&W or color TV was purchased. Continuously, electric appliance to reduce women's daily work, which is the washing machine and the iron, has increased.

The increasing of appliances is evidenced by a sharp rise in power consumption from approx. 2,600kWh/2months in the beginning and about 70% of the design load (approx. 4,000kWh/2months) to 4,700kWh/2months. Moreover, on Jul to Aug 1999, consumption was 7,200kWh/2months. Trend of average consumption is increasing, but system has some move margin. However, even in winter season that insolation is low, night demand can be covered. Therefore, initial design is satisfied.

②Battery Capacity

Based on the actual power consumption, the ratio of total consumption is assumed to divide into 20% for daytime and 80% for night. According to this assumption, the battery operation of centralized PV system was studied.

20% of depth or less of discharge of power consumption is acceptable for daily cycle services and about seven years life is expected. However, depth of discharge is over 20%, this depth is slightly deep for daily cycle services.

Especially, during two months of Jul to Aug/1999, power consumption recorded the maximum of [about 7,200kWh/2months →120.0kWh/day], [depth of discharge : 120.0kWh/day x 0.8/336kWh≒28.6%].

Battery life was affected by the condition of battery management. Therefore, the battery characteristics should be understood to sustain the battery life as long as possible.

③Inverter Capacity

The installed capacity of inverter for the centralized PV system is 35kW, which seems to have an ample margin against the current instantaneous peak load of about 20.5kW. According to SSRC/HIAST's inventory survey of electric appliances in Zarzita, refrigerators, washing machines and other electric rotating machinery are on the rise. These rotary machines ask rush current 7 to 10 times as much rated values during startup. Namely, the inverter must have capacity enough to take up these instantaneous peak loads. The installed inverter has capabilities to connect to the commercial grid if it extended to Zarzita in the future. Namely, if the inverter has capacity comparable to the total capacity of PV array, it will be able to send power in excess of demand to the grid system, maximizing the capacity utilization. While the inverter is seemingly given an ample margin at present, it is justifiable considering the future expandability.

From the viewpoint of the centralized PV system power consumption since the start of operation, the transition of power demand and the situation of electric appliances is necessary to watch continuously in case of the village which is close as the electrified village by the grid and which is supplied same power as the grid. Moreover, to keep sustainability as long as possible, the enlightenment and education are necessary to utilize the introduced system and to reduce power consumption for long life of battery.

(2) Individual PV System

①State of power consumption

On Fedre, based on the situation of electric appliances, the number of light, radio-cassette and TV were not increased and the other appliances were not introduced. The villagers of Fedre has followed the guidance of SSRC/HIAST and used their load appropriately. Some demand to use washing machine is there, but the villagers were satisfied to use lighting, radio and TV for the time being.

On Katoura, radio cassette and B&W TV is slightly increased, but particularly, the installation of 18(W) fluorescent lamp that is mainly used for livestock house are sharply increased. Therefore, Katoura villagers understand a convenience of electricity. It is estimated that the introduction of appliances and the amount of consumption is increased and it is necessary to check carefully.

On Kalif, the system passed about two year since start of operation. During this period, the equipment has no noticeable trouble. This system is AC system, however, the electric appliances is not increased like Zarzita. Only 5(W) incandescent is increased. In Kalif, about half of the houses become vacant in the dry season (summer) as people work away from their houses. During their absence, the system continues to charge the batteries without discharge. This is one of reason to accelerate water evaporation from the battery. At present, regarding these vacant houses, the inspection cycle was made short to once a month during the summer season same as the other system and it is correspond that charge circuit is off. Also, small roof was installed on top of battery box to make a shade.

②Point for utilizing system

Every individual PV systems were not stopped operation even in winter season. Thus, the scale of introduced system is reasonable. However, these systems will be utilized effectively to pay attention to the following issues.

a. Individual small-scale PV system

In winter, power supply and demand is balanced, but the power generated beyond power consumption sometime in the daytime of summer. Therefore, if small-scale inverter is introduced to operate washing machine etc and power generated is utilized effectively. It is useful to improve rural area development.

b. Individual medium-scale PV system

From the viewpoint of balance of supply and demand, the scale of the introduced system was adequate. However, in Kalif, about half of the houses become vacant in the dry season (summer) as people work away from their houses. Thus, if more effective plan, which separates a part of this system and convert to the portable system is studied, this PV system is useful to introduce for Bedouin in the Badia area.

(3) Situation of technology transfer

Situation of maintenance through this project was checked since commissioning. Based on check result, technology level of SSRC/HIAST is quite high and the outcome of technology transfer, which is system designing, installation and trial operation is utilized effectively. Thus, maintenance technology and procedure is excellent and the result arrangement and analysis of collected data is smooth. Therefore, in future, if all of system management activity is transferred to both Authorities, sustainability of the introduced system will be kept by both Authorities under the supervision of SSRC/HIAST.

(4) Future introduction of PV system

In case of a village, which is close to electrified town by grid line, people are well aware of the utility of electricity, and their holdings of electric appliances are rapidly increasing both in variety and quantity and demand is also large. Therefore, in case of these villages, it is difficult to control the demand of the villagers.

On Fedre, which is far from the grid line and few of cultural exchange comparatively, the number of electric appliances and demand were not increased through this project. Under these condition, some demand to use washing machine is there, but the basic needs of the villagers were satisfied to use lighting, radio and TV for the time being. In future, it seems unlikely that the electric appliances and power demand increase sharply, though it is necessary to watch carefully.

In Syria, the electrification of rural area has been promoted, as one of national project and the number of electrified villages is 8,158 out of 12,263 in this country. At present, the villages, which are located in the desert area, and the small-scale village, which is quite far from the grid line, are only remained. In this case, some of these areas have economical advantage for individual PV system. In future, PV system is

studied to introduce such as the small-scale un-electrified villages and to satisfy the basic human needs.

9.1.2 PV water pumping/desalination system

(1) PV water pumping

The design of this system, installation, technology transfer, selection and operation by the field operator proceeded very smoothly. The system starts its operation from April 1998 and no serious troubles occurred. Such PV water pumping system as is used in this project is completely developed and standardized, so the provision and support systems of manufacturers are well defined. Therefore, technically, the further dissemination of PV water pumping in Syria will go fairly well. To make the further dissemination more smoothly, following experiences will be used effectively.

①System capacity

Usually, water quantity and total head determine the system scale of PV water pumping. Total head is determined by the well to be introduced PV water pumping. Water quantity is determined by one day's water demand per person and population of the village. Therefore the most important factor for sizing the system is one day's water demand per person. Generally, the least one day's water demand per person is considered only 10 liter. But for some advanced villages or possible to be advanced villages as Zarzita, the value of 10 liter is too small. Villages near some towns like Zarzita will possibly be advanced and people use more water for cooking and washing. For this project the water demand is set to be 20 liter. At present, people use more water because people do not know the real ability of the system and effective use of limited water. In near future the demand will be lessened and it will come to the designed value, but for such villages some margin, 20 liter or more, will be preferable. Current standard of the Water Authority for facilitating water supply system is 125 liter for one person one day. The standard for rural water supply will depends on the situation of the villages and so not definitely determined but from this experience 9～30 liter is the most recommended value.

②Design method

Design method of PV water pumping system is provided by the manufacturers so it is not difficult to design under various conditions. The important factor for designing is well condition and water demand described above and insolation as well. In Aleppo, it is 6～6.5kWh/m^2 in summer season, 3.5～4.0kWh/m^2 in winter

season. Insolation of winter season is relatively small, compared with summer season but in this season people can use rainwater, so it will not limit the design condition. The critical point is the end of dry season because the saved rainwater runs short and insolation is getting small. The insolation of the season is considered to be 5kWh/m^2. Sometimes water level of the well varies according to seasons. Therefore insolation and well condition of this season is preferable to use. SSRC/HIAST learned to design PV water pumping system using these values through this project. From now, the design method should be transferred to the related organizations such as the Water Authority, which will play a key role in further rural water supply.

③Installation

Installation of PV array was done according to the standard of the manufacturer recommendation. This method can be used for future PV water pumping system installation. About an installation of inverters, there were 2 inverters and flow optimizer in Zarzita system, so a control box was installed separately and inverters were installed in the box. Usually one inverter is used for one system, so no control box is needed. Some small box containing an inverter is installed under PV array to avoid direct sunlight. Kalif system use only one inverter, therefore it is installed as is mentioned above. This method is recommended for standard method for future installation.

④Water distribution method

Water distribution method implemented in this project connecting plastic hose during scheduled time is meaningful and can be used in the future rural water supply. This method is also useful to make solidarity feeling and sharing philosophy among villagers. In this project, extra work of monitoring is needed and an operator is selected separately from a contractor. But for normal system, these two activities should be conducted by one person. The charge of water should be determined considering the reward for the work.

(2) Desalination system

①Power source

Adopting PV system as a power source for the desalination system, the system does not operate continuously, because of weather condition. PV system has no

influence from this condition, but for preventing desalination system from sudden output fluctuation the battery was installed.

②Validity of technology

Although the power supply by PV system is non-continuous by the state of insolation, it will not have much adverse effect on the desalination system. However, power supply to the desalination equipment is request to be constant and apply to the emergency case, minimum capacity of battery was installed.

The desalination performance of the system decreased by 3-4% in less than one year after commissioning, though at first the system performed the desalination rate of 99% or more as originally designed. This is attributable to that the equipment was put into complete stop for about two weeks when the first water leak is detected at the activated carbon filter tank as above-mentioned, and also after that period, the chemical cleaning of RO membrane was not adequate. There is a good reason to believe that these caused the decrease in desalination performance of RO membrane at too early stage.

As long as appropriate maintenance of the desalination system is conducted, a stable operation should be established. The machine parts of the desalination equipment are thought to last for a long term as long as the equipment is adequately maintained. Technical applicability of RO membrane method with PV system has been proven through the performance at Kalif. The RO membrane method has been widely used for seawater desalination. Because seawater is of much higher salinity than brackish water, it is expected that the method would be suitable for brackish water desalination in Syria's arid area, where a lot of solar energy exists and well water salinity is much higher than that in Kalif. In that case, however, adequate maintenance and management as above-mentioned is necessary.

③Validity of scale of desalination unit

In the original design of the system, sunshine hours each day was assumed to be about 5.5 hours, and accordingly fresh water production quantity was set to 2.3m^3/day. However, actual fresh water production quantity was about 20% more. The operation results of the desalination system at Kalif, the average production quantity of desalinated water was about 1m^3/day in winter and about 4m^3/day in summer. This is because the process of the desalination system was changed at the onset of the operation in accordance with local request for producing as much fresh

water as possible. The request was based on the fact that the Syrian standard for drinking water quality is less severe than that of Japan. As mentioned above, the demand and supply for fresh water change dramatically from summer to winter. The fresh water distribution of about six liters per person per day is secured in winter when the fresh water supply gets stringent. As for this amount, the desalination system of larger scale is preferable as long as there is room in budget in order to provide enough fresh water for drinking and cooking use. Measures against disproportionate demand and supply in summer are as already described in Chapter 5.

④Influence to environment

- As for desalination system, desalinated water is produced by separating impurity such as salinity. On the other hand, high salinity condensed water is produced as well. In Kalif system, this condensed water mix with raw well water and use for multi-purpose. Salinity contents of this multi-purpose water is seasonally fluctuated but yearly average is 3,000 to 7,000 μ S/cm. In Kalif, yearly rainfall is about 300mm, therefore, this multi-purpose water is available to use for irrigation, because diluting effect by rainfall is expected. Thus, no salinity contents problem will be happened for soil.

  However, in case of few rainfall seasons, when this water is considered to use for irrigation, some attention is necessary to keep reasonable salinity contents by controlling mixture ratio with raw water etc.

- RO membrane is necessary to wash by chemical product. On Kalif system, waste fluid is discharged near facility. This waste fluid is solution of alkaline and acid and no toxic liquid is mixed. Therefore, whenever, waste fluid is neutralized by alkaline and acid, this fluid is no influence to environment. Therefore, on Kalif system, this fluid is discharged to waste water pit and neutralized in soil. However, in case of large desalination system, wastewater mixture tank is necessary.

9.2 Evaluation of system management

The objective of systems management is to make proper maintenance of respective systems of village electrification and water pumping/desalination, to maintain their proper functions over their useful lives or more and to keep system sustainability as long as possible. To this end, proper system management should be executed and necessary fees should be collected. The study team considered jointly with SSRC/HIAST the issues of systems management well before implementation of electrification of three villages in the mountainous areas with PV system.

SSRC/HIAST are research organizations for the country and public establishment and cannot collect fees because of their functions. Hence it was decided that systems management for electrification was transferred to the Electric Authority and systems management for water to the Water Authority, respectively. SSRC/HIAST concluded agreements on systems management with the Electric Authority and the Water Authority, respectively. SSRC/HIAST considered various tasks of implementing this transfer of duties and eventually implemented the transfer.

Since then the Water Authority has been collecting fees. On the other hand, it took much more time for the Electric Authority to consider setting of fees. Recently, it was decided to collect fees. Now both Authorities are ready to make full-scale systems management. During this period, in response to the requests of the study team, SSRC/HIAST persistently negotiated with both Authorities and accomplished the initial objective.

(1) Items executed in relation to the transfer of systems management

①Operation, maintenance and inspection of systems after completion of installation

SSRC/HIAST executed operation, maintenance and inspection of the systems in the initial stage. Technical level of the engineers of SSRC/HIAST is excellent, and there were no problems.

②Training of engineers of the Electric Authority and the Water Authority

After the agreements concerning systems management were concluded, both Authorities sent their engineers to SSRC/HIAST. In SSRC/HIAST, they received education and training with necessary teaching materials and practical training at the sites of systems.

③Present state of operation, maintenance and inspection

With participation of engineers of SSRC/HIAST, the engineers of the Electric Authority mainly executed operation, maintenance and inspection of village electrification systems, and the engineers of the Water Authority mainly executed operation, maintenance and inspection of the systems of pumping/desalination. The study team examined the state of such operation, maintenance and inspection. There were no problems. During this period, periodic inspections were jointly made many times. We are sure that there will be no problem after the transfer of systems management.

(2) Grounds of delays on the Electric Authority in accepting system management and in setting fees

Initially the Electric Authority positively engaged in the preparation for systems transfer. However, on the following grounds, it took much time to consider the issue:

① In the regulation of power supply of the Electric Authority, there are no provisions regarding DC supply whereas individual PV systems supply DC power.

② Power used measures by electric counter. However, counters have not been installed on the systems except in Zarzita.

③Fees for electricity by PV system should be set, together with fees for electricity by wind power generation, as a part of renewable energy fees.

(3) Relationship between fees set and direct management cost

①Setting of electricity fees

For fee of electricity, the unit price of 0.75SP/kWh, which is three times as existing electric fee was decided by PEDEEE for all of the introduced PV systems. Specially, in Syria, public utility fees are set very low under the government subsidy. Therefore, if this unit price is continued to use, direct cost, which is replacement of battery, controller, and inverter of the introduced system cannot cover. Therefore, it is necessary to adjust this unit price to appropriate price.

②Setting of water fees

The Water Authority sets the fees for water pumping and desalination at same level as conventional water fees. RO membranes can be used, with spares, for about 20 years. Maintenance of the other equipment and procurement of almost chemicals are available in Syria.

(4) Evaluation of system management by both Authorities

①The Electric Authority experienced systems management of village electrification systems for about a year. The evaluations of the systems made by responsible persons of the Electric Authority are as follows:

- The Director General of the Aleppo Electric Authority judges, on the basis of actual performance of the system, that the systems are highly reliable and have been operating smoothly without problems, but at the present stage, PV system needs more flexibility for expansion.
- The manager of the Aleppo Electric Authority Dartazze Branch judges that the systems have high reliability. However, he finds it difficult to respond to complaints that when compared with the conventional power supply from grid lines, power generated by the systems are small and the residents cannot use refrigerators or washing machines.

②The Director General of Aleppo Water Authority showed very keen interest in water pumping and desalination with PV system and exerted efforts to develop a system for promoting such technologies.

(5) Future tasks

①SSRC/HIAST will analyze and examine technical tasks such as secular changes and troubles of the installed PV systems. SSRC/HIAST will give advices to both Authorities if a trouble occurs on any of the installed systems.

②As the systems are reliable and their maintenance and inspection are easy, both Authorities are planning to give technical training to some residents of the villages so that systems management can be partly managed by these villages.

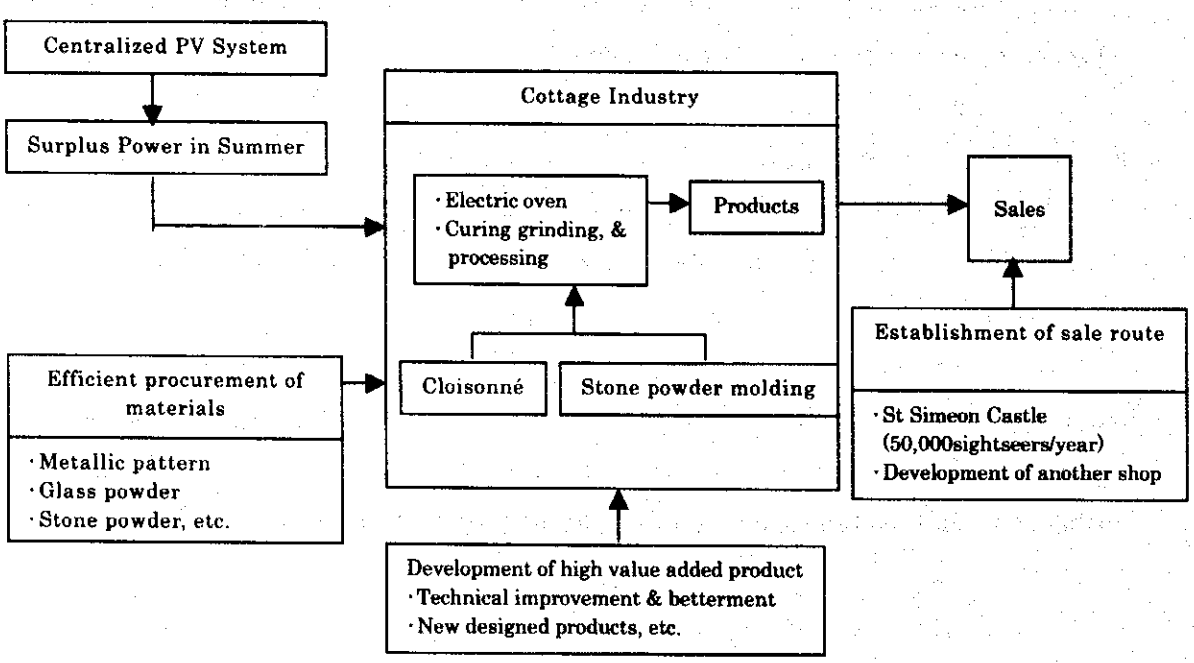
③Katoura is close to the city and grid lines run along the road in front of the village. If the Electric Authority has an electrification plan of Katoura, it is advisable to implement the plan. To use its PV systems effectively, shifting of the systems to another village should be considered.

9.3 Livelihood improving effects

As a specific livelihood improving effect, we will consider the development of a cottage industry through the utilization of surplus electricity in summer of centralized PV system in Zarzita. Next, we will assess the effects, on the residents, of electrification of three villages in mountainous areas and one village on the plain and water pumping/desalination in the village on the plain all with PV systems.

9.3.1 Development of a cottage industry

Conventional souvenirs of tourist spots in Syria include picture postcards and mosaics. Their variety is not abundant. The study team proposed production and sales of cloisonné and stone powder products, which are popular in Japan as handicraft. The study team produced such products on a trial basis and made technology transfer of these arts to our counterpart. The products were evaluated as souvenirs at St. Simeon Castle and some other places. As they were found to be popular, efforts were made to find retail outlets.



Production and sales of cloisonné and stone powder products were un-experienced fields for the residents of Zarzita. Fortunately, the welfare division of SSRC was operating the cafeteria and shop in St. Simeon Castle. The welfare division was ready to extend its direct cooperation to us in production and sales management. The project was set on its path by obtaining understanding from the Ministry of Tourism and the Tourist Bureau of the city and submitting the necessary documents to the

General Directorate of Museums and Antiquities who controls the licensing system of sales.

Moreover, UNDP experts on promotion of cottage industry participated in the survey of channels of procurement of materials and sales of products. UNDP constructed and presented a workshop. Thus the overall foundations were formed, and opportunities of employment and cash earning were opened to the residents of the village. In future, it is desirable to make sustainable development of the project by efficiently implementing the items indicated on the flowchart.

Zarzita which cottage industry was executed in this project can take advantage of its proximity to St. Simeon Castle where many tourists visit. Therefore, sales of handicrafts for these tourists are considered. Key holder and stone powder product, which are popular in Japan as handicraft is proposed. Trial production and technology transfer of these arts to our counterpart was executed in cooperation with UNDP. Sales of products, which produced by SSRC/HIAST and villagers, got good result. However, from the viewpoint of cottage industry, it is difficult to find suitable spot, which has good condition like Zarzita. Therefore, it is necessary to consider new expansion that is utilized the characteristics of respective areas.

9.3.2 Effects of introduction of PV systems

(1) Changes in lifestyles due to PV electrification

①Changes in the respective hours of rising, meals and sleeping

Changes in the respective hours of rising, three meals and sleeping, which give a large framework of daily living, after the installation of the systems were surveyed. Both men and women showed no change in the hour of rising and the hours of meals. However, the hour of sleeping of men was postponed by 1.5 hours, and the hour of sleeping of women was postponed by 1.2 hours after the installation of the systems. These changes were caused by the use of radios and TVs and the changes in luminance of lighting.

②Changes in other times of daily activities

Changes in other times of daily living after the introduction of the systems were surveyed. The largest change was the increases in the time of viewing TV by about three hours a day for both men and women. The next largest change was the increase in the time of listening to the radio. These changes indicate that the quantity of information that the residents of the villages receive increased rapidly.

- With the increase in the information received, conversations among the family members increased after the installation of the systems.
- As lighting of rooms got brighter, the time of reading and the time of study of children increased.

(2) Survey of other effects

The study team prepared a list of expectations related to the introduction of PV systems and asked the residents to evaluate the state of realization of each expectation with ratings of high, intermediate and low. In parallel with this evaluation of the degree of satisfaction with the use of the system by the residents, the study team also investigated the state of use of various appliances. The results are summarized in the following table.

Table 9.3-1 State of realization of expectations

System introduced	Expected effects	Degree of realization(1
PV electrification (Zarzita,Fedre, Katoura,Kalif)	Improvements of living environment, improvements of sanitary conditions (from lamp to fluorescent lamp)	Medium (2
	Installation of street lighting / improved safety at night	High
	Improved safety and convenience inside the house	High
	Communication within a family and among families / increased inflow of external information	High
	Increased time of education / improved rate of literacy and ratio of students who go on to schools of higher grade	Low(3
	Use of electric appliances / lightened labor of women (increased free time, increased time spent with children)	Medium ~ low (4
Water supply system (Zarzita, Kalif)	Improved sanitary environment for residents (supply of water for living)	Medium
	Improved productivity of agriculture and stock farming (increased yield, number of stock, etc.)	Low
	Increased variety of food (cooking) (Increased products of kitchen garden)	Low
	Reduced labor for women and children (Reduced work of drawing water)	Medium
	Saving of money for purchasing water (Reduced expenditure by residents)	High

(1 :Degree of realization: High : 90~80 % of residents indicated satisfaction; Medium : 79 ~50 % of residents indicated satisfaction; Low : 49 % or under of residents indicated satisfaction.

(2 :Energy for lighting has been switched to electricity. Fuels for heating and cooking are conventional kerosene, gas oil, wood and animal excretion.

(3 :It takes time before effects of the system appear in the form of improved rate of literacy and increased ratio of students who go on to schools of higher grade.

(4 :Degree of realization differs between villages in which AC 220 V can be used and villages in which only DC 12 V can be used.

9.3.3 Overall evaluation of the introduced PV systems

The study team investigated the degree of satisfaction of the residents of the four villages with the overall performance of the systems; three ratings (satisfied / fairly satisfied / somewhat dissatisfied) were used. The results were as follows:

Irrespective of generations, a little over 60% indicated satisfaction. About 25% was fairly satisfied. Remaining less than 9% were dissatisfied. When examined by generation, the degree of satisfaction is higher in senior generations and women, and the degree of satisfaction of men and the junior generation was low. Evaluation of the systems introduced in the respective villages was as follows:

(1) Zarzita

Centralized PV system has been installed in Zarzita, and power is distributed through grid network. At present, as power used is not high, the services of this system does not differ at all from those of the grid lines of the Electric Authority. Accordingly, the level of satisfaction of the members of the respective households with electricity is very high. As for water supply, $8m^3$/day of water is filled in the water supply tank, and water is conveyed from the tank by a water supply pump to three taps located in the village. In comparison with the conventional water drawing, the labor of water carriage of women and children has been reduced.

(2) Fedre

In Fedre, each house has been electrified with DC200W individual PV system. Each household uses electricity for lighting, TV and radio. The degree of satisfaction of the residents is lower than that of residents of Zarzita. Responses of fairly satisfied" and somewhat dissatisfied" increased to 13%. Such tendencies are particularly strong among women. Immediately after installation, a village senior expressed deep gratitude by saying with lighting and TV, it is more convenient now."

(3) Katoura

In Katoura, like Fedre, DC300W PV systems have been installed and power is mainly used for lighting, TV and radio. Of the three villages, this village is closest to the city and the residents have many opportunities to visit the city, and in turn, have abundant knowledge of electricity. Young couples of teachers of a school spent their university days in Damascus and are familiar with the electrification conditions of cities. The gap is large for them and they have strong desires to use refrigerator and

washing machine. Transmission lines have been extended to a trunk road 1 km ahead of the village. Their initial expectation was that the electricity supplied by PV system should be comparable to that of grid lines.

(4) Kalif

In Kalif, AC200V PV systems (500W each) have been installed to supply power to one to three houses. In contrast to the three villages of the mountainous areas, women of the village, such as housewives and daughters, are very satisfied with the systems. As for men, the indications of fairly satisfied". increased. There is no dissatisfaction.

When grass is not available around the village, the residents of the village will move, together with all the members of their households and sheep and goat, to make nomadic herding in mountains and fields after harvest of wheat by contracting with the farmers. Hence in summer the population markedly drops to about 20 persons. The supply of drinking water at $3m^3$/day by the desalination system has a sufficient margin after meeting the demands of the residents. The surplus is used to supply water to other villages where water is needed.

9.4 Economic analysis of PV systems

On the basis of the findings of the present demonstrative study of various PV systems and the recent trends of technical development of PV system, for reference in considering introduction and promotion of PV systems in Syria, we have conducted one economic analysis of PV systems and two proposal of planning materials of PV systems. The target time is set at 2005.

9.4.1 Economic analysis of PV systems

We analyzed economics by comparing the cost of kerosene lamp and battery-powered TV, which is widely practiced in un-electrified villages in Syria, and the cost of 60W individual PV systems as an alternative to the former.

①Cost required for kerosene lamp and battery-powered TV is very expensive in comparison with the electricity fees. The living environment of the residents in un-electrified villages is worse and they are forced to bear a greater burden in comparison with the city dwellers and the farmers who live near cities and use electricity of the Electric Authority.

②If PV system is used as an alternative, thanks to the recent decrease in prices of PV system components, the cost of PV system, which is bases on the prices estimated for 2005, is one fourth of the cost of kerosene lamp and battery-powered TV and power supply of PV system is much stable.

③EIRR of PV system is as high as about 70% and meets the condition of receiving overseas loans.

④PV system is not restraint much by geographical limitations like wind power generation, and can be installed anywhere.

⑤Electrification of un-electrified villages through grid extension lines will be continued in future. However, the number of households within the scope of electrification is smaller and the distances to such villages are greater than before. Thus economics will decrease extremely. Accordingly, introduction and development of PV systems is a very important issue for the Electric Authority.

9.4.2 Proposal of planning materials of PV systems

The study team consulted with SSRC/HIAST concerning the promotion of introduction of PV systems in Syria in future. Setting the target start year of such efforts at 2005, the study team compared the economics of various applications of PV system with the economics of alternatives, in terms of power generating cost and water cost, in Chapter 8.

(1) Electrification with PV system

As for electrification with PV system, the costs of

①Individual PV systems	5 cases of scales
②Mini-centralized PV systems	3 cases of scales

were compared with costs of electrification through grid extension and diesel power generation. Moreover, in cases of mini-centralized PV systems, the water pumping cost through the use of surplus power was examined.

(2) Water pumping with PV system

Head and quantity were used as parameters, and water cost of PV water pumping and that of diesel pumping were compared. The advantageous range of PV water pumping was clarified.

(3) Desalination with PV system

To secure drinking water for Bedouins in Badia in the southeast of Hama, and to secure drinking water at another point, water production costs of PV water pumping and desalination by RO membrane method or ED method were examined.

As a result, the following can be recommended as fields for PV system in Syria:

①Electrification of un-electrified villages

- When the distance from grid lines to the village is 5 km or over, if the number of households is about 40, electrification with PV system is more economical. Electrification with grid lines can be more economical than that with PV system only when the village size is large and consumptions of the respective households are large.
- When about nine houses are adjacent to each other in the village, if mini-centralized PV system is introduced, the residents can use conventional household electric appliances. Moreover, surplus power may be used, for example, pumping of drinking water economically.
- PV system is optimal to electrification of houses of Bedouins who live in Badia. If PV system is partly modified to a portable system, it can be used during their nomadic herding. In the case of electrification with grid lines, as they leave the village during the nomadic period of summer, the installed systems are not used.

②Pumping of drinking water and pumping for other purposes

- For example, when the head is 60m and quantity is 20m^3/day, PV water pumping is more economical than diesel pumping. PV water pumping is almost maintenance-free whereas diesel pumping requires labor for replenishing oil, startup and shutdown, and periodical inspection.
- PV water pumping is optimal for pumping drinking water for livestock kept in extensive glazing land. As it makes no excessive pumping, it is effective in conserving the underground veins.
- If PV water pumping and drip irrigation are combined, agriculture can be practiced even in rural areas in summer. This leads to enhanced productivity of farmers.

③Desalination

- Under the present conditions, the unit cost of water production is high and

drinking water cannot be supplied economically. However, for example, in the case of RO membrane method, all components and chemicals, except RO membrane, can be procured in Syria. Hence if efforts are made to prototype and improve a desalination system of Syrian design, it can be an economical system that is suited to brackish water of Syria. When this is realized, it will have many applications.

9.5 Future tasks concerning the introduced systems

Three years have passed since the start of operation of village electrification systems and water pumping/desalination systems in the four villages. With the course of time, due to changes in social environment and experiences of the use of such systems, changes can be observed in the views of the residents. On the basis of the actual records, the study team will consider such changes in views of residents and the following tasks, with focus on the systems operation in future. SSRC/HIAST, the Electric Authority and the Water Authority are requested to make appropriate responses in future.

(1) Tasks related to PV electrification systems

①Problem of complaints from residents of Katoura

The conditions of power supply have been improved significantly when compared with the conditions six years ago when the project was started. At the time, the residents of Katoura judged that no electrification with grid lines would take in the village in at least ten years to come, and they earnestly requested the installation of PV systems. They accepted the prior explanation and were satisfied with the systems immediately after the installation. Recently, however, residents have expressed such complaints even after transfer of systems management to the Electric Authority. They would like to use refrigerators and washing machines. Grid lines run along the road that is 1km away from the village. Therefore, if the Electric Authority has a plan of electrification of this village, it is electrified by grid lines and considers this PV system to shift in another un-electrified village in rural area. The other option is considered to change this system to grid connection type, together with SSRC/HIAST.

②Problems of rapid increase of new houses in Zarzita

Zarzita was a village with 40 households and 400 persons. More than two years

have passed since electrification with 35kW centralized PV system and the start of supply of drinking water at 8m³/day by PV water pumping. During this period, a total of thirteen new houses were built, and this trend of building new houses seems to develop more in future. The capacity of PV system was planned for the initial number of the houses plus natural increase of demand, and it will be difficult in future to maintain the balance between demand and supply. Therefore, we would like to ask the Electric Authority to extend grid lines to this village at an appropriate time and consult with SSRC/HIAST to connect this PV system with grid line. The existing inverter has a function of grid connection.

③Effective use of PV systems in Kalif

In summer, many residents of Kalif leave the village to make nomadic herding with their livestock. Hence PV systems are not used while they are away. To promote more effective use of this systems, the study team recommend SSRC/HIAST to consult with the Electric Authority and partly modify the system into a portable one so that the system can be used during nomadic herding.

④Improving efficiency of systems management with cooperation of residents

Considering high reliability of PV systems, the Ministry of Electricity has been trying to reduce the costs by conducting some works, such as replenishment of battery liquid, with the cooperation of residents. The study team recommends the Ministry of Electricity to extend range of such cooperation while supervising such works to secure technology and safety.

⑤Adjustment of electric fees of PV system

We understand the existing electricity fees are provisional. We request review and resetting of fees for renewable energy to ensure efficient management.

(2) Water pumping/desalination systems with PV system

①Water pumping

The Water Authority has been giving greatest consideration to the management of the water pumping system in Zarzita and for extra insurance it has been appointing one dedicated person. As water fees are set low, even the administrative expenses cannot be covered. The study team would like to ask the Water Authority to grasp the properties of the system and consider more efficient management through the

cooperation of residents like the case of the Electric Authority.

②Desalination

- As we have already experienced, once the desalination system is shut down over a long period, if proper measures are not taken, its membrane will deteriorate quickly. Hence it is important to have close contact regarding accidents and other interruption of system operation.
- Acquisition of management technologies of the desalination system

  Water is a precious resource in Syria where water conditions are bad as expressed by saying "water is life." In view of the rises in the standard of living and increases in population in future, it is a very important task to secure drinking water efficiently. To prepare for the future, it is very important to acquire desalination technology while constantly keeping the sustainability of the demonstration systems. To this end, the operation and maintenance manuals should be followed strictly to accomplish the initial objective of the demonstration systems.
- Collection of information and development of prototype on desalination systems

  As the water demand and supply conditions are getting tight in the world, technical development is in progress and a variety of desalination systems have been proposed. It is important to collect and properly analyze information on such development and, in turn, select and develop systems that are suited to Syria and reduce their costs. All components and chemicals, except RO membranes, can be procured in Syria. The study team suggests that the Water Authority make an experimental facility using local materials and promote research and development for desalination system.

(3) Miscellaneous

- Development of cottage industry in Zarzita

  In Zarzita, surplus power of centralized PV system in summer has been used to produce cloisonné and stone powder products. These products are sold as souvenirs to foreign tourists at St. Simeon Castle near Zarzita. At present there are several kinds of products. The business, however, cannot be continued without successively developing and marketing new attractive products. The study team suggests development of new products in cooperation with the department of arts of the University of Aleppo.

Chapter 10

Recommendations on the use of PV systems to the Government of Syria and Organizations Concerned

Chapter10 Recommendations on the use of PV systems to the government of Syria and Organizations Concerned

Assurance of a stable supply of energy and food is the greatest policy task for developing countries as well as the advanced industrial countries. Having farseeing wisdom, all of the countries are striving to accomplish this task through positive promotion of technical development and improvement. The PV system is a part of the use of renewable energy sources and is an effective means for diversifying them. Hence the advanced industrial countries, facing difficulties in finding new sites for nuclear power plants have been positively promoting the introduction of PV systems and wind power generation to tackle the environmental problems and reduce the consumption of fossil fuels. Under such circumstances, it is quite a timely event that the Syrian and Japanese governments have jointly conducted a demonstrative study of the use of various PV systems in four un-electrified villages in Syria. In the following, we will discuss the trends for responding to energy issues around the world, matters which should be considered for using PV systems in Syria that are a part of the results of this study, and make recommendations to the government of Syria and the organizations concerned regarding promotion of the use of PV systems in Syria.

10.1 Energy trends of the world and the need for the diversification of energy sources

- Economic development and the consumption of petroleum have a close relationship. In the future, with the economic growth of the developing countries including those of the Southeast Asia, the world's demands for petroleum are expected to grow markedly. Hence the demand and supply conditions of petroleum are getting tighter and there are trends towards increasing prices.
- Because the increase in fossil fuel consumption results in an increase in CO^2, many countries have been promoting diversification of energy sources while still ensuring a stable supply of energy. As a part of such efforts, the use of renewable energy sources including PV systems has been positively promoted.
- Syria is an oil producing country and the domestic demands for energy have been met by its own petroleum and natural gas reserves. However, considering economic growth and industrialization in the future, it is necessary to use petroleum and natural gas as chemical materials for producing higher value added products. From such a viewpoint, it is now the time to promote expansion of renewable energy including PV systems so as to diversify the energy demand and supply conditions.

10.2 Matters to be considered in the use of PV systems in Syria

In this project, we have conducted village electrification and pumping/desalination by PV systems. On the basis of the findings of this study, we believe that electrification and pumping/desalination in the future can be promoted smoothly by observing the following matters:

(1) Electrification with PV systems

①Careful explanation to residents at the time of the installation of PV systems

Residents tend to think that electricity from PV systems is similar to grid lines. The people who have DC PV systems tend to complain that they cannot use refrigerators or washing machines because there is a large difference in the available power. It is therefore important to fully explain and convince the residents that rational usage is needed according to the installed capacity of the systems.

②Appropriate sites for electrification with PV systems

To consider the introduction of PV systems, economic comparison with the alternative method of grid extension and diesel generation was carried out, and an appropriate PV system and site to meet the village form was studied.

a. Small-sized villages distant from grid lines

If a village near grid lines is electrified with PV systems, the merits of the extension of grid lines cannot be obtained and the residents will not be satisfied due to the differences in usage of electrical appliances between the two methods. Firstly, electrification plans of the Electric Authority should be evaluated, and small-sized villages that are remote from the grid lines be considered appropriate candidate sites. Practical appropriate sites were studied by the economic analysis in Chapter 8. As a result, for example,

- When the distance from the grid to the village is 5 km or more, if the number of customers is about 40 and their power demands are small such as about 200Wh, electrification by a PV system is economical. When about nine houses are adjacent to each other in the village, if a mini-centralized PV system is introduced, the residents can use conventional electrical appliances. Moreover, surplus electricity may also be used, for example, pumping drinking water.

b. Electrification of houses of Bedouins living in Badia

The population of the Syrian Badia is about 600,000, and houses of the Bedouins are scattered all over Badia. It is very efficient to electrify these houses with PV systems rather than grid extensions. If PV systems are modified to be portable, they can use these systems during nomadic herding.

③Consideration of demands after electrification with PV systems

On the electrification of villages with PV systems the capacity of the PV system is determined according to the assumed demands. Natural increases in demand are considered in this assumption. However, when a mini-centralized PV system is installed, new houses may be constructed. It is necessary to consider in advance the expansion of facilities, grid extensions, etc. in order to cope with such increases in demand.

④Promotion of introduction of PV systems by revising power supply regulations of the Electric Authority

At the time of the system management transfer of electrification with PV systems from the SSRC/HIAST to the Electric Authority, it was determined that due to the power supply regulations of the Electric Authority they could not manage systems such as individual PV systems which supply DC power and have no meters. It is therefore necessary to modify regulations without delay so that PV systems as well as other forms of renewable energy generation systems can be managed smoothly.

⑤Early setting of renewable energy fees

According to the Aleppo Electric Authority, their initial intent was to set the electricity fees for systems management as part of the consideration of renewable energy fees at PEDEEE. However, recently, the fee for electricity was set to three times of the lowest rate price of the conventional fee by PEDEEE. Except for the capital costs, even the operation cost of PV systems could not be covered. It is therefore necessary to set and introduce renewable energy fees without delay so as to ensure smooth system management. This is also applicable to the case of supply with grid lines. Demands for electricity are estimated to grow by about 10 % per year in the future. It is necessary to consider measures for avoiding potentially tight financial conditions.

(2) Pumping/desalination with PV systems

①Effective use of water resources by PV systems.

Water demand in Syria has been increasing rapidly together with improvement of the standard of living. Since groundwater is salty in some areas, it is not easy to secure drinking water for un-electrified villages. On the other hand, there are many places where water is diesel-pumped for irrigation. In the case of diesel pumping, the following is pointed out.

a. Daily start and stop operation is necessary. In addition, in many cases, the diesel pumps are not operated properly and they are operated much longer than they are required to. Thus the quantity control of pumping water is quite difficult to achieve.

b. In the case of diesel engines, it is difficult to attach protection functions such as those for pump cavitations. Thus appropriate operations are not executed in many cases.

As a result, excessive water pumping destroys groundwater veins and wells must be bored deeper and deeper. To tackle this problem, it is effective to use pumping with PV systems. Although its quantity is limited the pumping of drinking water from freshwater wells, for livestock in extensive grazing lands and drip irrigation for agriculture can be done economically.

②Adjustment of water fee

The water fees for pumping/desalination in the two villages have been set to be the same current water fees of the Water Authority. The operation costs of the systems cannot be covered because the water fee is set too low. Therefore, it is very important to adjust the water fees for these systems. It should be noted that residents who purchase drinking water pay high costs for transportation and that this differential is great.

③Acceleration of development of desalination technology

The Water Authority has a keen interest in desalination and hopes to desalinate unused, brackish well water within its service areas. The estimated cost of desalination for the year 2005 is still high so the introduction of desalination is yet difficult. However, all of the components and chemicals for desalination, except reverse osmosis membranes, can be procured in Syria. It is an important task for Syria to reduce their costs by developing a desalination system on an experimental

basis and to improve it. We recommend further promotion of the development of desalination technologies in SSRC and the Authorities concerned.

(3) Maintenance management with participation of residents

The Electric Authority and the Water Authority evaluated high reliability in the electrification and pumping/desalination with PV systems. In using PV systems in the future the Water Authority is expected to establish a system like the one used by the Electric Authority wherein the maintenance management can be done in cooperation with the residents so as to reduce their maintenance management costs.

(4) Promotion of technical development and cost reduction

For the expansion of PV systems cost reduction is important. Technical development of PV modules and charge controllers and technology improvement in battery production is executed by the mutual cooperation of the public and private sectors in Syria. It is necessary to reduce the total costs of PV systems by shifting to domestic production. Moreover, improvement of technical levels is important by continuing collection of advanced technology information. On the other hand, at the present time it is necessary to import the main materials. Therefore the consideration of the institutional aspects such as import taxes for PV system materials and the simplification of customs clearances are necessary in order to promote material import.

10.3 Potential areas for application of PV systems

As for the method of use of PV systems, the study team consulted with its counterpart and examined desirable areas for the supply of electricity with PV systems. This examination was done by setting plural desirable capacities for both individual and mini-centralized PV systems and comparing their generating costs with that of electrification through grid extension and of electrification through diesel power generation. As for water pumping with PV systems, the head and the quantity were used as parameters, and the water cost was compared with that of diesel pumping. As a result the economical range where pumping with PV systems was clarified. Finally, as for desalination, two specific sites were selected and the desalination cost of the reverse osmosis membrane method and that of electro-dialysis method were analyzed. On the basis of these findings, the potential areas for application of PV systems were identified as follows:

①Electrification (the Ministry of Electricity)

The Ministry of Electricity has been measuring the electrification rates by using the administrative unit (village) as a unit. In 1998, of 12,121 units, 8,751 units have been electrified and the electrification rate was 72 %. The regions containing many un-electrified units were Aleppo (electrification rate = 53 %, number of un-electrified units = 1448), Homs (59 %, 412), Hassake (65 %, 850) and Raqqa (66 %, 433). A total of 3,370 units are left un-electrified in the country. Electrification of such a unit with PV systems is more economical when the village size is smaller and more distant from the grid lines.

②Pumping of drinking water (the Ministry of Housing and Utilities)

For example, the Aleppo Water Authority has many unused wells within its service area. Of such wells, freshwater wells close to un-electrified villages such as the well near Zarzita (classified as unused because the yield is 10 m^3/h or under) are candidates. New wells should be included within the scope of candidates by considering the characteristics of PV systems.

③Appropriate sites for pumping of drinking water for livestock and drip irrigation (the Ministry of Agriculture)

a. As for the pumping of drinking water for livestock, brackish water from wells near farm houses and in extensive grazing lands are within the scope. Because individual farmers are involved, the Ministry of Agriculture must conclude an agreement before implementation. A potential area within the scope is Hassake in the east of Syria.

b. As for drip irrigation, at first pumping should be made on an experimental basis in order to obtain water for high value added crops. Then the fields of application should be extended. Candidate areas are ones where the groundwater level is relatively shallow and the water quantity is high.

④Desalination (the Ministry of Housing and Utilities)

Around the Badia area south east of Syria it is very important to keep water for livelihood, because the underground water is salty. However, at present since the desalination costs are so high an emphasis should be placed on the survey of the technical development conditions of the reverse osmosis membrane method, electro-dialysis method and the evaporation method using solar thermal, as well as

on technical development such as prototyping and improvement. It is requested to reduce desalination costs based on those technical developments. On the other hand, candidate sites are investigated and the data collected is arranged. Extra care should be taken in the stage of future introduction.

10.4 Future implementation of PV systems

The study team consulted with SSRC/HIAST regarding this issue. The timeframe was estimated to be around 2005 from the viewpoints of the accumulation of experience in operation of the demonstration systems in the future and of increased understanding of PV systems on the part of the parties concerned. We recommend starting development of uses of PV systems by securing the understanding and cooperation from the parties concerned during the period up to 2005.

10.5 Efforts of the government of Syria on energy problems

In April 2000, as a result of a proposal made by the Prime-Minister, the Higher Committee for Energy was established. This Committee responds to tasks such as the World Energy Conference and agreed to set up a national center of energy research. In view of such conditions, the study team proposes and recommends the following regarding renewable energy including PV systems. We hope that this proposal will be considered by the Committee and that measures will be taken to promote the development of renewable energy sources as national projects.

10.6 Roles of the government of Syria

Development of power sources requires a long time and a huge investment in plants and equipment. Hence, to diversify the energy sources in the future, Syria has been promoting demonstrative studies of the use of renewable energy sources such as wind power generation and PV systems. Since the development of such energy sources does not require a large sum of investment at one time, it is essential to establish a policy without delay and promote its development. As the use of renewable energy sources relates the various Ministries, it is hoped that a new organization will be established to unitarily develop and operate renewable energy systems. To this end, it is necessary for the government to enact a bill on promotion of the expansion of new energy sources without delay and implement national projects. The outline of the bill is as follows:

(1) Setting the target for development of renewable energy sources

It is necessary to develop the country's comprehensive energy demand and supply plan including renewable energy and to set rational targets for the development of renewable energy sources in that plan. This renewable energy includes PV systems, wind power generation, solar thermal heaters, etc. The Higher Committee for Energy can execute such considerations and efficiently make decisions.

(2) Establishment of advisory organizations for considering targets

To assist the government in effectively setting targets, the subcommittees of the Higher Committee for Energy may be asked to consider the following:

- Comprehensive energy demand and supply plan
- Renewable energy development plan
- Technical development plan.

(3) An organization for implementation

Once the development targets are set, the Renewable Energy Development Organization (hereinafter called REDO) that unitarily develops and operates renewable energy sources will be established. However, it is important to introduce renewable energy systems efficiently without any duplication of the activities of the Higher Committee for Energy.

[REDO]

The Renewable Energy Development Organization executes the following three items:

① Introduction of specific development plans for PV systems, wind power generation, solar thermal heaters, etc., commissioning of such plans and their evaluation.

The government determines the specific targets for development of renewable energy sources and related technologies every year. The organization considers plans that are desired by the public establishment (the Electric Authority → village electrification plans with mini-centralized systems, etc.; the Water Authority → plans for the pumping/desalination of villages; the Ministry of Agriculture → irrigation plan of an area), and effectively executes such plans within the framework of targets.

②Establishment of plans for implementing the development of related technologies (efficiency improvement, increase in domestic production rates), commissioning of such plans, evaluation, and application

The organization sets technical development tasks related to renewable energy and promotes such technical developments efficiently by nominating or publicly inviting some organizations (for example, candidates including SSRC/HIAST, Universities, the Electric Authority, the Water Authority, organizations of the Ministry of Agriculture and private sector screened and selected organizations are commissioned to do the tasks), then evaluates the results. Effective technologies are introduced and used.

③Enlightenment and introduction of renewable energy system

Regarding the promotion of the use of renewable energy systems such as PV systems, wind power generation, and solar thermal heaters, extensive publicity activities and education are carried out by the governmental organizations and the local authorities etc based on the project outcome which includes environmental issues as well as elements of rural development. Through these activities, the information regarding the introduction of renewable energy systems is collected and together with information from the local authorities and the governmental organizations is combined and considered in order to make plans for introduction.

④Mutual cooperation among the organizations concerned

Regarding the introduction of renewable energy systems, it is necessary to cooperate not only among the organizations concerned but also with the local authority for promotion. This expansion of renewable energy system includes both aspects. One is the technical aspect such as research and development and operations and maintenance. The other one is the software aspect such as systems management and the collection of fees. On the other hand, for future expansions, an engineer who can carry out operations and maintenance and a planner who can study introduction plans should be trained and located not only in the organization concerned but also at the local authority. Therefore, in order to execute various activities smoothly and efficiently by the organization concerned, REDO arranges and assists them in making the plans and educating capable people.

(4) Budgetary procedure

- Funds needed by REDO are collected as special taxes. For example, a renewable energy tax is collected together with an electricity tax or a petroleum tax. The yield of the renewable energy tax is used exclusively for projects related to renewable energy so as to promote such projects continuously.
- If foreign funds are desired, Japanese loans, etc will be taken into account for use.

Efforts of promoting the introduction of PV systems through the above-mentioned measures should advance the day when PV systems, which are making rapid technical progresses, will be competitive on a commercial basis.

10.7 Roles of the respective ministries and the organization concerned

The respective Ministries have electrical engineers and can fully manage the installation and operation of PV systems. On the other hand, in many cases, the local authority contacts the rural villages directly and collects information. Here, cooperation between the Ministries concerned and REDO is taken into account and the roles of each organization are described toward the future introduction.

(1) Roles of the Ministry of Electricity

The Ministry of Electricity should regard electrification with PV systems as a supplementary technology for reducing investment rather than a technology that competes with electrification through grid extension. The Ministry considers electrification of candidate un-electrified villages with plural mini-centralized systems and selects electrification plans of villages where economic results of electrification are greater than the investment for grid line. The plans are implemented in the following manner:

①Collection of information on PV system plans

The Ministry of Electricity asks the Electric Authority of the respective areas to identify in cooperation with the local authority un-electrified villages for which grid extension cannot be expected for the time being. The Electric Authority quantitatively analyzes and consider to what extent economic results of the installation of PV systems are greater than those of grid extensions. Then the Authorities submit plans to the Ministry. The Ministry analyzes and summarizes the results.

②Establishment and submission of plans

On the basis of the PV electrification plans of the respective Electric Authorities, the Ministry of Electricity considers effective ways of introduction of PV system all over the country, and submits plans of the Ministry itself to REDO.

③Implementation of plans

Based on the results of the screening of the plans by REDO, the Ministry of Electricity implements and operates the PV systems in the selected villages through the Electric Authorities concerned.

④Other items

a. Based on the plans of REDO, a practical education plan is drawn up with the assistance of SSRC/HIAST. An engineer, who carries out maintenance and operations and a planner who executes planning and systems management are educated and located in the Ministry, the Electric Authority and the Local Authority.

b. The Ministry implements the following through the respective Electric Authorities:

a. Education and training of electric work contractors

In view of the advancement of PV systems in the future, the Ministry provides electric work contractors of necessary areas with education and training on the installation and operations of PV systems.

b. Support to private customers who install individual PV systems

When private customers install an individual PV system, in response to a customer's request, the Ministry will help them find a contractor or will execute the installation work. To ensure safety, the Ministry executes inspection of the in-house wiring.

c. Responses to changes in situation

PV system will be installed in place where grid is unexpected, and the PV system will present higher priority method to provide power to these places and villages. However, after installation, if situations will be changed to grid power supply, the Ministry will consider to connect PV systems with the grid or to move the systems to another un-electrified village for utilizing effectively.

(2) Roles of the Ministry of Housing and Utilities

The respective Water Authorities under the control of the Ministry of Housing and Utilities bore many wells to secure drinking water. Of these wells, low quantity wells are left unused. For example, the well in Zarzita is not used, because the water quantity is 10 m^3/hr or less.

①Collection of information on plans of pumping with PV systems

The Ministry asks the respective Water Authorities in cooperation with the local authority to collect information on site surveys and plans (draft) for the use of existing freshwater wells of small water quantity in un-electrified villages where pumping with PV systems is expected to be useful for the residents of the villages. The Ministry analyzes and evaluates the information collected.

②Development and submission of plans ～ implementation of plans

The procedure is similar to that of the Ministry of Electricity.

③Other items

a. According to the plan of REDO, a practical education plan is drawn up in assistance with SSRC/HIAST. The engineer, who carries out maintenance and operations and the planner who executes planning and systems management are educated and located in the Ministry, the Water Authority and the Local Authority.

b. The Aleppo Water Authority has a keen interest in the pumping and desalination of groundwater (salty). For such organizations, we believe it is certainly effective for the assurance of drinking water in the future to seek funds for survey, research and development of desalination from REDO and to conduct a joint research program with SSRC/HIAST.

(3) Roles of the Ministry of Agriculture

The people related to the Ministry of Agriculture whom we have contacted have a deep interest in the use of PV systems and hope to utilize them in order to enhance the livelihood of the residents of the agricultural villages. Here, some examples are proposed by limiting the use of PV systems in the field of agriculture.

① Collection of information on plans for pumping with PV systems and drip irrigation

The Ministry of Agriculture asks the respective agricultural offices in cooperation with the local authority to collect such information. The Ministry analyzes and evaluates the information and then compiles plans that are most desirable to the Ministry. The important factors in screening are farms that can pump water with PV systems, types of crops, and their production. If the Ministry cannot directly implement the plans, the Ministry commissions the implementation of such plans.

②Submission of plans ～ implementation of plans

The procedure is similar to that of the Ministry of Electricity.

③Other items

According to the plan of REDO, practical education plans are drawn up with the assistance of SSRC/HIAST. An engineer who carries out maintenance and operations and a planner who executes planning and systems management are educated and located in the Ministry, the local office of the Ministry like as Jabal Al Hoss office and the Local Authority.

(4) Roles of SSRC/HIAST

As SSRC/HIAST have roles of conducting technical developments for national enterprises and responding to their technical tasks, SSRC/HIAST is capable of positively tackling various techniques of PV systems. Specific roles will be explained in the National Projects of Renewable Energy" that will be prepared in the future. For the time being, it seems to be necessary for SSRC/HIAST to tackle the following tasks:

①Collection of international technical information

As for PV systems technology, positive efforts are in progress in advanced industrial countries to reduce prices of cells through improvements in cell efficiency and thin film process and to mass-produce cells. It is therefore necessary to monitor the price trends and inform the respective organizations concerned of such developments in order to consider such information in their activities.

②Promotion of domestic production of PV systems components

SSRC/HIAST promote technical development for

- Controllers
- Inverters
- Improvement of batteries
- Improvements in efficiency and quality of the laminator process for PV module manufacturing

so as to efficiently produce them domestically while cooperating continuously with public and private sectors and universities.

③Standardization of PV systems

SSRC/HIAST promotes standardization, for example the structure of PV arrays, which are optimal to Syria, so as to reduce the costs.

④ Technical development for increasing the domestic production ratios of desalination systems

SSRC/HIAST jointly promotes technical development of desalination systems with the Water Authorities, etc. so as to increase the domestic production ratios and in turn reduce the costs.

⑤Other items

SSRC/HIAST assists to draw up the comprehensive education plans for REDO. SSRC/HIAST conducts and assists to make a practical plan for the Ministry concerned as well. Moreover, the execution of the actual training is supported and periodical training and technical improvements are planned and executed at the same time.

(5) Roles of the Local Authority

①Collection and arrangement of information

Regarding the present situation of water supply, the demand of power and water, the number and scale of un-electrified villages and the electrification plans by grid extensions at the areas managed by the Local Authority concerned, information is collected and analyzed. Finally, a database is built for future introduction.

②Planning for introduction plans

Using the collected data of villages, the type and scale of PV systems and water pumping systems is studied with the assistance of the local office of the Electric Authority and the Water Authority. Based on the results, an introduction plan is drawn up and submitted to the organization concerned. At this time, if social development factors are estimated by introducing PV systems like the cottage industry in this project, it is also taken into account.

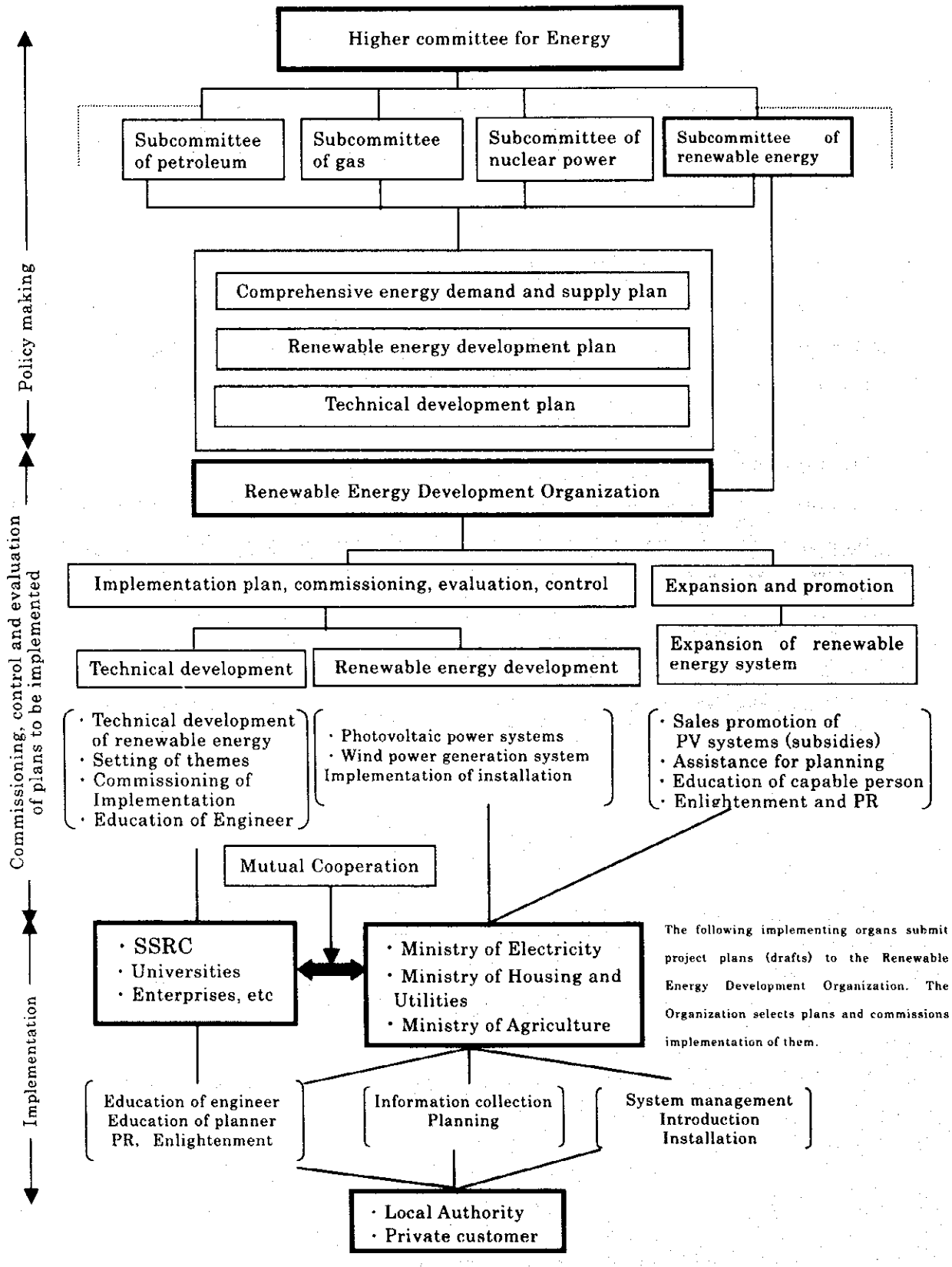
③Assistance for systems management

The activity of systems management, which is installation, maintenance and fees collection by the local office of the Electric Authority and the Water Authority is assisted by the Local Authority from the technical and software aspects.

④Other items

To carry out assistance of systems management and planning for introduction plans, a capable person is educated with the cooperation of the Ministry concerned and SSRC/HIAST.

System for Expansion and Promotion of Renewable Energy (Proposal)



Note) Special taxes are used for budgets of implementation of respective plans.