

9. Social Impact Analysis

9.1 Social background of Kiribati

(1) Natural resources and industries

There are only a few natural resources in the Kiribati coral islands. Kiribati has an oceanic, equatorial climate. Life in Kiribati is comparatively comfortable from March to October where wind blows from the west, but is hard from October to March during the rainy season. However there is no clear separation of rainy season and dry season, because it sometimes happens that there is little rain a year around. The soil is sandy and poor, and it has high permeability of water, so there is no standing agriculture production. And production of plants and animals is low per unit land area.

In Kiribati taro, pandanas, coconuts, bananas, papaya, breadfruits and sugar cane are planted as the main foods. Pumpkin, sweet potato, green vegetables and tobacco recently have been planted under the leadership of Kiribati government. However, rice, flour, sugar, frozen meat and all kinds of canned foods are imported from foreign countries, causing a worsening Kiribati trade balance. The government therefore tries to promote self-sufficiency in food supply.

Kiribati has large marine resources such as bonito, tuna, crayfish which are a major part of the local diet. The Government tries to control development and protection of their marine resources by declaring 200 sea miles exclusive economic zone. In Tarawa, the people are attempt to protect their fishing grounds by regulating lights and over fishes through self control. But the system is often broken due to the current rise in population. Also the quality of the fishing grounds in the lagoon is being lowered year by year due to pollution from the dense population.

Phosphorus ore was mined in Banaba island until the end of the 1970s, which gave a large boost to the Kiribati economy. But the phosphorus ore ran out in 1979. According to a resource survey in Kiribati, it is said that phosphorus ore, manganese nodules, cobalt craft and calcium carbonate exists on the bottom of sea in Kiribati territory. But these resources

have not been developed yet.

(2) Population

Kiribati people belong to the Micronesian race, but they have mixed with Chinese, European and Polynesian races area a long time. Population of Kiribati is 72,000 in 1990 up from 56,000 in 1978. The growth rate of the population in the same term was 2.1% per year.

The age structure of Kiribati people is young, the population lower than 15 years old is 40% of the whole population, the population lower than 50 years age is 90%. this means that Kiribati will probably have a rapid increase in population for the next few decades.

Table 9.1.1 Distribution of population by resident islands

	Area Km ²	Population		Population density	
		1978	1990	1978	1990
Gilbert Island (South Tarawa)	285.5 (15.8)	54,000 (18,000)	69,000 (25,000)	189 (1,140)	242 (1,580)
Line Islands	431.7	2,000	3,000	5	7
Phoenix Islands	9.1	-	50	-	5
Total	726.3	56,000	72,000	77	99

Kiribati has non resident area, they are 19.5 in Line Islands and 64.9 in Phoenix Islands.

The population of Kiribati is concentrated in South Tarawa because many people immigrate from outer islands into South Tarawa. In the past 10 years, the population of the outer islands changed little, but concentration of the population to South Tarawa increased to 35% of the total population in 1990 instead of 5% of the total population 1945 at the end of World War II.

The population density grew to 1,580 persons per km² from 1,140 persons per km² in the same period. The population density of South Tarawa is much

higher than the other islands.

(3) Political background

The Republic of Kiribati became independent from Great Britain in 1979. The President is elected from candidates selected by the Assembly. Kiribati adopts a single chamber parliamentary system, where the members of the Assembly consist of 38 representatives and a representative appointed by the Law minister.

The government which is based in South Tarawa consists of Ministry of finance, Office of interior & decentralization, Ministry of natural resources, Ministry of communication, Ministry of works & energy, Ministry of trade, industry & labor, Ministry of education and Ministry of health & family planning.

The structures of the local governments consist of seventeen island councils and two town councils (Betio Town Council, Teinainano Urban Council). The island councils consist of representatives elected from each village have responsibilities in the administration of the villages, certification and implementation of their projects, construction and maintenance of roads and other rural administrative.

Kiribati has no embassies in foreign countries but keeps friendly relations with international agencies. Kiribati is a member of the British Commonwealth, the South Pacific Forum and the Asian Pacific Economy and Social Committee. Kiribati does not participate in United Nations, but grants and observes the Chapter of United Nations. Also Kiribati takes part in the World Bank, IMF (International Monetary Fund) and Asia Development Bank.

(4) Social background

A monetary economy in South Tarawa and a subsistence economy in the outer islands are characteristics of Kiribati economy. The subsistence economy of the outer islands is based on fishing and agriculture. The main farm products supplied for their subsistence are Taro, Pandanas, Coconuts,

Bananas, Papaya, Sugar cane, Breadfruits, Pumpkins, Sweet potatoes, and green vegetables. There are some which are exported to South tarawa such as coconuts, but the most consumed locally. The foods which are not supplied locally are rice, sugar, flour and canned foods, these are imported mostly from Australia and New Zealand. Also fishing is a major subsistence activity with chickens and pigs in North Tarawa.

House construction materials have been obtained locally up to now. Recently cement, steel panels, metal roof materials and saw timbers are been used as construction materials for houses and these materials are imported from abroad. And fuel, clothes, soap, tobacco, matches, utensils, ceramics and so on are used as daily necessities and radios, bicycles, motorbikes and outboard engine are desired as durable products. All of these are imported.

The monetary economy is comparatively large in South Tarawa and public enterprises such as electric company, fossil fuel company and cooperative stores accomplish a major of the monetary economy. There are also bus transportation companies, road side vendors, rental cars, gasoline stands, restaurants and video stores as private economy activity as well as the public enterprises in South Tarawa.

There are several languages and customs in Kiribati and the Kiribati people tend to revert to places which their ancestors were born. It has been one and half centuries since Europeans came to Kiribati. Since that time, Kiribati has experienced many changes. To change their life styles and to accept Christianity are typical examples. But Kiribati people in the outer islands still keep faith to their religion before Christianity came to the region.

The extended family system of Kiribati accomplishes important roles in their lives. For example, maintaining the knowledge and technology for their lives and rules to administer their villages have passed down from parents to their children through the extended family system. In the village society of Kiribati, the people cooperative within villages and be-

tween villages, at the same time, roles, responsibilities, and the right of the people are regulated. In rural areas such as North Tarawa, the traditional customs are still kept, but in urbanized area such as South Tarawa, modern administrative power is managing their lives instead of the old custom.

9.2 Social background of North Tarawa

(1) Outline of villages in North Tarawa

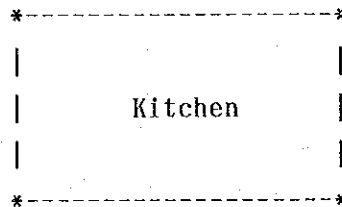
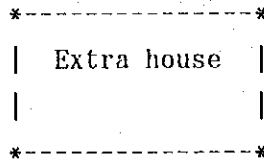
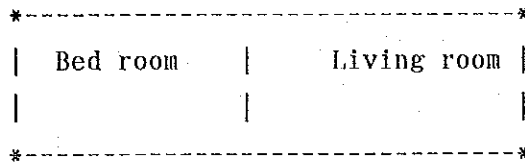
North Tarawa is a group of coral islands which has a total length of 35 km. In the islands, there are unelectrified villages such as Buariki, Tearinibai, Nuatabu, Tebangaroi, Tabonimata, Taratai, Notoue, Abaokoro, Marenauka, Tabonibara and Kainaba. Also there are Nabeina, Tabiteuea and Buota to the south of Kainaba which have been reached by grid electricity. The Public Utility Board(PUB) supplies 11kv electric power to Nabeina.

Abaokoro is the seat of the Government station in North Tarawa and has a VHF radio telephone which is able to communicate with South Tarawa. Most of People in Abaokoro work for the Government and get salaries from the Government, but the other people in North Tarawa live through self-sufficiency. Their main production activities are fishing and planting of taro, coconut and breadfruit. They earn some money with selling dried fishes, copra and roof thatching materials. There are several small shops in North Tarawa villages and items like canned foods and beverages are sold in the shop along with clothes, soap and other household goods.

People in North Tarawa delightfully wear T-shirts, but there is not a factory to produce T-shirts in Kiribati. The T-shirts are imported from Australia and New Zealand. Most of the people in North Tarawa live with no shoes as same as South Tarawa. Their lives without shoes are predicted to continue in future because even young people in North Tarawa live with no shoes.

A household has two or three buildings, each of which is about 20 square meters. the room space is separated by a curtain or woven wall, one space is used as living room, another space as bed room. another building is used as kitchen. There is a house having a high floor without walls called an extra house. The extra house is used as working place and resting area. An example plan of a family compound is shown in Figure 9.2.1.

Figure 9.2.1



(2) Population and households

Although an objective of the JICA mission is to electrify the villages in North Tarawa (excluding villages with electrification by PUB such as Nabeina, Tabiteuea and Buota) was targeted for a survey of population, number of households, life styles and so on. The objective of the survey is to determine the characteristics of the villages and their life styles.

Councilors and their families in ten villages were interviewed. In addition, all households in six villages around Abaokoro were surveyed using the APPENDIX 2.2 questionnaire. After the survey carried out under the said methods, Table 9.2.2 on the population and households was developed.

The period of the survey was April, 1992. The population per household was found to be 6.3 persons, it was 5.8 persons in 1988's survey.

Table 9.2.2 The population and households in
un electrified 10 villages in North Tarawa

Villages	Households	Population
Buariki	100	600
Tearinibai	63	450
Nuatabu	30	220
Tabonimata	39	240e
*Taratai	41	195
*Notoue	54	324
*Abaokoro	32e	218e
*Marenauka	10	60
*Tabonibara	43	300
*Kainaba	21	150
Ten villages total	433	2,757
Six villages total	201	1,247

e : Estimated value because they are not answered.

Installation of PV systems are planned in the six
villages signed (*)

(3) Life style

Bicycles, motorbikes and trucks are used in North Tarawa for transportation. A small ferry boat runs between Abaokoro and Buairiki and Betio twice a week. Most of the households in North Tarawa have canoes without engines, but they can not go to any port in South Tarawa by the canoes. For them a truck goes on the coastal reef to South Tarawa at low tide. Some of the people in North Tarawa go to South Tarawa by the truck for working and the trucks carry products to South Tarawa.

People in North Tarawa positively receive new culture and products, foods, clothes and electric appliances which are imported via South Tarawa.

to North Tarawa. Most of the households in North Tarawa have radios and cassette tape recorders, also video or movie promoters sometimes come from South Tarawa and show video with charge in Maneabas.

Some of the results of the survey on the life style in unelectrified ten villages in North Tarawa are the following:

Table 9.2.3 Number of workers by industries

Fishery & Agriculture	Government & Villages	Work away from homes	Total
421	103	58	582
179	71	32	282

The upper is total of 10 villages, the lower is the six villages to be installed PV systems by the mission.

Table 9.2.4 Number of durable products to be kept by people in North Tarawa

Automobile & Truck	Motorcycle	Canoe with Engine	Video	Radio & Tape Rec.
5	44	20	12	292
1	9	10 (3)	5	112

The upper is the total number in unelectrified ten villages in North Tarawa. The lower is the six villages targeted to be installed PV systems. (3) of canoe column is the number of private canoes with engine

Table 9.2.5 Life style of housewives

a. Time to get up	am 6:00 - 7:00
b. Work in the morning	Breakfast, Cleaning house, Washing and Harvesting
c. Work in the afternoon	Weaving mats and Preparing dinner
d. Hours for preparing dinner	One hour
e. Hours for washing	One hour
f. Desire to use electric light in daytime	Almost do not use
g. Desire to use electric light in nighttime	Want to use electric light
h. Time to go to bed	pm 9:00 - 10:00

These responses were from families of councilors in ten villages.
The above summarizes the responses.

Table 9.2.6 Life style of men in North Tarawa

a. Time to get up	am 6:00 - 7:00
b. Works in morning	Fishing, Collecting coconuts Cutting Toddy
c. Hours for fishing and agriculture	3 - 4 hours/day
d. Time to take meals	Breakfast 7:00 - 9:00 Lunch 12:00 -14:00 Dinner 19:00 -21:00
e. Desire to use electric lights in daytime	None
f. Desire to use electric lights	Want to use electric lights
g. Time to go to bed	pm 10:00 - am 1:00

These responses are from families of councilors in ten villages.
The above summarizes the responses.

Table 9.2.7 Life style of children in North Tarawa

a. Time to get up	am 6:00 - 7:00
b. Time to go to school	am 8:00
c. Time to return from school	pm 13:00 - 13:30
d. Homework	They sometimes have homework
e. Desire to use electric light in daytime	Need light for study at rainy time
f. Desire to use electric light in nighttime	Want to use electric lights
g. Time to go to bed	pm 9:00 - 10:00

These responses are to get from families of councilors in ten villages. The above summarizes the response.

(4) Organization of villages

a. Maneaba

The Maneaba is a unique house to Kiribati and neighboring Tuvalu. The old men which are representatives of their families gather in the Maneaba and hold a meeting (Unimane association). They reconcile problems among families in the meeting. The decision of the meeting in the Maneaba becomes a regulation of the village and persons who violate the regulation are punished.

Seats which the families in the village take are decided in the Maneaba, and visitors always have to take their seats at the side of the lagoon. The roles of persons in the meeting such as chairman or messenger are given to each family, that is, the role structure in the Maneaba shows social structure in the villages.

But today, modern laws have spread to the rural villages and punishment against theft and near relation incest are decided by justices instead of the meeting.

As mentioned above, political power of the meeting (Unimane association) in Maneaba gradually changes, but the basic function of the meeting does not change now. Today, Maneaba is the place where people gather for chatting, relaxing, play games, dancing and enjoying their society.

The following table shows the number of public houses such as Maneaba, Church and School in the ten villages of North Tarawa.

Table 9.2.8 The number of public houses in the ten villages of North Tarawa

VILLAGES	MANEABA	CHURCH	SCHOOL
BUARIKI	6	2	1
TEARINIBAI	3	2	1
NUATABU	3	2	1
TABONIMATA	3	1	1
TARATAI	5	2	1
NOTOUE	9	1	1
ABAOKORO	3	3	1
MARENAUKA	1	1	
TABONIBARA	1	1	1
KAINABA	1	1	1
Ten village total	35	16	9
Six village total	20	9	5

There are also public houses such as Government offices, Clinics and Guest houses in Abaokoro not included in the above table.

Table 9.2.9 Frequency of meeting in Maneaba in the ten villages of North Tarawa

VILLAGES	F R E Q U E N C Y
BUARIKI	1 per month
TEARINIBAI	No answer
NUATABU	2 per month
TABONIMATA	2 per month
TARATAI	2 per month
NOTOUE	1 per month
ABAKORO	Depend on frequency of visitors
MARENAUKA	4 per month
TABONIBARA	5 per month
KAINABA	No answer

b. Unimane and the island council

In the traditional, sanctified Maneaba, an older man who is called 'Unimane' is the most powerful in the village. Landowners traditionally were inaugurated 'Unimane', but recently persons who retired and government officer are often inaugurated Unimanes.

Unimane has no public position but he deals with problems in the village through the Maneaba and also decides whether people in the village accept projects in the village. Unimanes in each village regularly gather to hold Unimane association meetings and to discuss problems in the islands.

There is an island council in the village, which is the public rural administration agency. the Unimane association is an informal organization which rural villages autonomously administrate and they fulfill the role which is different from the Government policy which is set outside the people.

Unimane does not become a member of an island council. And a person who is supported by the Unimane association is sent to the island council. The power of Unimane association is stronger than one of an island council in the rural villages now. Unimane fulfills the role of administration of justice. It sometimes happens that Unimane are elected as a member of land justice because they are well informed about possession situation of their land, and their proposal in the land justice has considerable influence over the judgment. Recently, the traditional cooperative society which Unimane association is based on is wavering. It is said that Unimane power is becoming weaker.

c. The church in Kiribati

Christianity has been accepted in Kiribati society since the arrival of the missionaries from the American Board of Commissioners in 1852 and from the Sacred Heart Mission in 1888. Pioneering religious organizations have been followed by religious groups including the Seven-Day Adventists, the Baha'i, the Church of God and the Mormons.

A strong factor which keeps people in favor of the churches was their early involvement in education and community development. Before the complete absorption of the churches' Primary schools into the state education system in 1977, the Catholic Church maintained its own Primary and Secondary schools. While the Protestant Church had already yielded control of Primary education but continued its Secondary schools. It has often been remarked that the church schools, in particular the Catholic schools which were run by the expatriate missionaries, were relatively superior in quality to other schools in Kiribati. Secondary schools are still being operated by church organization.

The association of the villages with church Primary schools was a crucial factor of negotiation at the time of the Government take-over. The villagers were opposed to government administration of Primary education as it might mean the cancellation of all religious instruction. They would not agree to the amalgamation unless religious instruction became an integral part of the public school curriculum and the pastors and catechists were allowed to teach the Scriptures. Only on these conditions was the merger of the church schools into a unified system considered

possible.

d. Island Council

The Island Councils are regarded in the outer islands, including North Tarawa as agents of the national government. There is a case where the councilors of the Island Councils are elected by the island dwellers and another case where the councilors are nominated by national government. The main role of the Island Councils is to collect land taxes from the dwellers and to manage and promote projects which the national government has planned. As most of the Island Councils have no financial resources, they depend on the national government. Then in reality, the promotion of projects in rural villages is carried out by the national government.

Though the social position of chairman of the Island Council has been gradually increased, the position is lower than that of Unimane. Also houses of the Island Councils are not more sanctified than Church and Maneaba houses.

(5) Occupation of the people in North Tarawa

In the electrification feasibility study for North Tarawa, the targeted villages were limited around Abaokoro since the maintenance supplies and persons are to be in Abaokoro. Taratai, Notoue, Abaokoro, Marenauka, Tabonibara and Kainaba were selected from the ten unelectrified villages of North Tarawa to receive the detailed survey. Occupations of the people in the six villages shown from Table 2-10 to Table 2-16. The survey was carried out to the all households in the six villages, and there were 167 responses from about 200 households (estimation) in the six villages. The details of the survey are described in APPENDIX 9.2.1.

Regarding of the 167 households, the 103 households engage in Agriculture and fishing. And it can be assumed that most of the respondents without any occupation carry on agriculture and fishing. The number of respondents without any occupation are 16 households, then when adding 16 households to 103 households, the number of the households which engage to agriculture and fishing is 119 households. These households are 71% to the

total 167 households. The rate of workers engaged to agriculture, fishing and occupation away from home in Table 2-3 is 75%, the rate agrees with the result, that is 71%, which is obtained from the six village survey.

More than 70% of people in North Tarawa are estimated to be engaged in agriculture and fishing and less than 30% people engaged as salary workers or government workers.

Table 9.2.10 Occupation of the people in the six villages

OCCUPATION	NUMBER OF FAMILY	PERCENTAGE
Agriculture & Fishing	96	57%
Seaman	7	4%
Salary & Government worker	48	29%
No answer	16	10%
Total	167	100%

Table 9.2.11 Occupation in Taratai

OCCUPATION	NUMBER OF FAMILY	PERCENTAGE
Agriculture & Fishing	12	38%
Seaman	4	12%
Salary & Government worker	9	28%
No answer	7	22%
Total	32	100%

Table 9.2.12 Occupation in Notoue

OCCUPATION	NUMBER OF FAMILY	PERCENTAGE
Agriculture	37	69%
Seaman	1	2%
Salary & Government worker	12	22%
No answer	4	7%
Total	54	100%

Table 9.2.13 Occupation in Abaokoro

OCCUPATION	NUMBER OF FAMILY	PERCENTAGE
Agriculture & Fishing	7	27%
Seaman	1	4%
Salary & Government worker	17	65%
No answer	1	4%
Total	26	100%

Table 9.2.14 Occupation in Marenauka

OCCUPATION	NUMBER OF FAMILY	PERCENTAGE
Agriculture	7	78%
Seaman	0	0%
Salary & Government worker	2	22%
No answer	0	0%

Total	9	100%
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Table 9.2.15 Occupation in Tabonibara

OCCUPATION	NUMBER OF FAMILY	PERCENTAGE
Agriculture & Fishing	20	80%
Seaman	1	4%
Salary & Government worker	3	12%
No answer	1	4%
Total	25	100%

Table 9.2.16 Occupation in Kainaba

OCCUPATION	NUMBER OF FAMILY	PERCENTAGE
Agriculture & Fishing	13	62%
Seaman	0	0%
Salary & Government worker	5	24%
No answer	3	14%
Total	21	100%

(6) Income of the villages

According to 'The Energy Demand survey of South Pacific Countries' conducted by Pacific Energy Development Programme (PEDP) in October, 1985, cash income per household was A\$3,045 in South Tarawa, A\$624 in Abaiang island, A\$520 in Tamana island. The cash incomes of Abaiang and Tamana island are a typical pattern in the outer islands. It is said that there are rich villages and poor villages in North Tarawa, for example, Buariki is one of the rich villages because the village has good fishing grounds. But

it is considered that differences of cash income among the villages in North Tarawa is not greatly different between South Tarawa and Abalang island.

The people in North Tarawa get money by means of selling fish, copra, roof thatching materials and handicraft of pandanas leaves, working in South Tarawa, and receiving remittance from family members working overseas. They use the money for purchasing clothes, electric appliances, bicycles, motorbikes, motorboat, fossil fuel and donating to church and school.

According to the six villages survey, the average annual income in the six villages is A\$2,152. And the number of households which get the annual income of more than A\$2,150 are 55 (37%) in the 150 available respondents. (it can be estimated that there are 200 households in the six villages). And households which get the annual income of more than A\$3,000 are 37 (25%), the number of households with income from A\$1,000 including A\$1,000 to A\$3,000 excluding A\$3,000 are 76 (50%), the number of households with income lower than A\$1,000 are 37 (25%).

Analyzing the average income by the villages, Taratai is A\$1,900, Notoue is A\$1,900, Abaokoro is A\$2,200, Marenauka is A\$1,800, Tabonibara is A\$3,200 and Kainaba is A\$2,000. The highest average income is Tabonibara, A\$3,200; The lowest average income is Marenauka, A\$1,800. Abaokoro occupies the average position in the six villages.

Analyzing the income of the six villages by their income sources, they get 58% of their income by means of salaries, selling handicraft products and remittance from relatives and also get 42% of their income from agriculture and fishing activities. This means that the people in the six villages have not only agriculture and fishing activities but also other source of income.

The households which desire PV systems have to pay an installation fee of A\$50 and a maintenance fee of A\$10 per month. The households which sign with 'RANK A' have willingness to pay the fee, the households which sign with 'RANK B' are willing to pay a fee lower than installation fee of

A\$50 or maintenance fee of A\$10, the households which do not desire a PV system are signed with 'RANK C'.

Analyzing the average annual income by the RANK A, B and C, the households with RANK A are average annual income of A\$2,830, the households with RANK B are of A\$1,930 and the households with RANK C are of A\$1,650. The difference among the average annual incomes by the RANK are recognized. But as there are some households who have a low income in RANK A and B, it can not be said that all of the households in RANK A or B have the ability to pay the fee.

Table 9.2.17 Average annual/month income of the six villages

INCOME	NUMBER OF FAMILY	AVERAGE INCOME	
		Annual	Month
Upper 25%	37	A\$4,865	A\$405
Middle 50%	76	A\$1,714	A\$143
Lower 25%	37	A\$ 419	A\$ 35
Total	150	A\$2,152	A\$179

The samples are 167 households, non-respondents are 17.

Table 9.2.18 Income of Taratal

INCOME	NUMBER OF FAMILY	AVERAGE INCOME	
		ANNUAL	MONTH
Upper 25%	6	A\$4,743	A\$396
Middle 50%	13	A\$1,405	A\$117
Lower 25%	6	A\$ 279	A\$ 23
Total	25	A\$1,938	A\$162

The samples are 32 households, non respondents are 7.

Table 9.2.19 Income of Notoue

INCOME	NUMBER OF FAMILY	AVERAGE INCOME	
		ANNUAL	MONTH
Upper 25%	13	A\$4,198	A\$350
Middle 50%	25	A\$1,409	A\$117
Lower 25%	12	A\$ 333	A\$ 28
Total	50	A\$1,876	A\$158

The samples are 54 households, non respondents are 4.

Table 9.2.20 Income of Abaokoro

INCOME	NUMBER OF FAMILY	AVERAGE INCOME	
		ANNUAL	MONTH
Upper 25%	6	A\$4,577	A\$381
Middle 50%	13	A\$1,852	A\$154
Lower 25%	6	A\$ 433	A\$ 36
Total	25	A\$2,165	A\$180

The samples are 26 households, non respondents are 1.

Table 9.2.21 Income of Marenauka

INCOME	NUMBER OF FAMILY	AVERAGE INCOME	
		ANNUAL	MONTH
Upper 25%	2	A\$4,730	A\$394
Middle 50%	5	A\$1,134	A\$ 95
Lower 25%	2	A\$ 355	A\$ 30
Total	9	A\$1,760	A\$147

The samples are 9 households.

Table 9.2.22 Income of Tabonibara

INCOME	NUMBER OF FAMILY	AVERAGE INCOME	
		ANNUAL	MONTH
Upper 25%	6	A\$5,827	A\$486
Middle 50%	11	A\$2,825	A\$235
Lower 25%	6	A\$1,319	A\$110
Total	23	A\$3,215	A\$140

The samples are 25 households, non respondents are 2.

Table 9.2.23 Income of Kainaba

INCOME	NUMBER OF FAMILY	AVERAGE INCOME	
		ANNUAL	MONTH
Upper 25%	4	A\$4,793	A\$399
Middle 50%	10	A\$1,589	A\$132
Lower 25%	4	A\$ 385	A\$ 32
Total	18	A\$2,033	A\$169

The samples are 21 households, non respondents are 3.

Table 9.2.24 Composition rate by Income sources

INCOME	Salary	Fish.	Agricul.	Handl.	Remit.	Other	Total
Six vill.	23.5	17.7	24.0	14.2	10.7	9.7	100.0
Taratai	48.5	13.9	10.8	6.1	15.1	5.7	100.0
Notoue	17.2	18.6	20.7	16.2	13.6	13.7	100.0
Abaokoro	37.8	10.9	21.2	5.5	13.8	10.8	100.0
Marenauka	11.2	14.6	54.1	16.9	0.0	3.2	100.0
Tabonibara	5.0	19.9	35.9	26.5	4.3	8.3	100.0
Kainaba	28.2	27.2	17.2	6.7	11.9	8.8	100.0

9.3 Lighting equipment and electric appliances in North Tarawa

(1) Lighting equipment in the six villages

There are 340 lamps consisting of 173 kerosene wick lamps(51%), 145 kerosene pressure lamps(43%) and 22 other types of lighting equipment (PV light, diesel generator) in the six villages. A household has an average of 2.0 (=340/167) kerosene lamps.

Kerosene wick lamps are mainly used for lighting the bed room, kitchen and living rooms. Kerosene pressure lamps are mainly used as portable lights, fishing lights and lighting for bed rooms, living rooms and kitchens. Generally speaking, a kerosene pressure lamp is brighter than a kerosene wick lamp and the price of a kerosene pressure lamp is higher than that of a kerosene wick lamp. Thus it is a tendency that the people who have saved some money buy kerosene pressure lamps while keeping these kerosene wick lamps.

Analyzing the average number of lamps kept by the villages, the village keeping the most number of lamps is Kainaba which averages 2.4 kerosene lamps (wick lamp and pressure lamps) per household, the second is Abaokoro which has 2.2, the third are Marenauka and Taratai which each have 2.1. The village in the lowest average number is Tabonibara which has 1.9.

The average lighting hours in the six villages are 4.9 hours for bed rooms, 4.4 hours for kitchens, 4.6 hours for living rooms, 5.5 hours for extra rooms and 4.8 hours for walking lights. There are only two households to use light equipment in the extra room, most of the households in the six villages do not use lamps for the extra room. The number of households which use lamps more than ten hours in a day is 12 households for bed rooms, 7 households for kitchens, 7 households for living rooms and 3 households for walking lights. There are very few households using lamps almost all night like the above, but there are doubts that the respondents give accurate answers.

When recalculating the average lighting hours except the households having abnormal lighting hours (they are defined such that lighting hours

less than 6 hours are normal), they are 3.9 hours for bed rooms, 3.7 hours for kitchens, 3.8 hours for living rooms, 5.5 hours for extra rooms and 4.3 hours for walking light in the averages. And the rate of the respondents selected for the calculation out of the all respondents is 89% in the calculation for bed rooms, 91% for kitchens, 91% for living rooms, 100% for extra rooms and 95% for walking lights.

Therefore, it appears sufficient that the PV system can provide for 6 hours of light for most of the households.

Table 9.3.1 (1) Lighting equipment in North Tarawa
(Six Villages)

Village	Equip- ment	Bed room	Cook area	Living	Extra	Portable
Six Villages	KWL	67	59	39	1	7
	KPL	33	19	29	1	63
	Others	8	4	7	0	3
	Total	108	82	75	2	73
	Rate	65%	49%	45%	1%	44%

Average lighting equipment per household is 2.0

The number of households surveyed is 167

KWL : Kerosene Wick Lamp

KPL : Kerosene Pressure Lamp

Other : Engine Generator, Benzine Pressure Lamp,
Battery Lamp, PV system

Table 9.3.1 (2) Lighting equipment in Taratai

Village	Equip- ment	Bed room	Cook area	Living	Extra	Portable
Taratai	KWL	13	16	6	1	1
	KPL	8	1	5	0	9
	Others	1	1	2	0	3
	Total	22	18	13	1	12
	Rate	69%	56%	41%	3%	38%

Average lighting equipment per household is 2.1

The number of households surveyed is 32

Table 9.3.1 (3) Lighting equipment in Notoue

Village	Equip- ment	Bed room	Cook area	Living	Extra	Portable
Notoue	KWL	17	16	10	0	5
	KPL	10	5	8	1	24
	Others	2	3	3	0	
	Total	29	24	21	1	29
	Rate	54%	44%	39%	2%	54%

Average lighting equipment per household is 1.9

The number of households surveyed is 54

Table 9.3.1 (4) Lighting equipment in Abaokoro

Village	Equip- ment	Bed room	Cook area	Living	Extra	Portable
Abaokoro	KWL	16	9	1		0
	KPL	4	10	5		6
	Others	4	0	1		1
	Total	24	19	7		7
	Rate	92%	73%	27%		27%

Average lighting equipment per household is 2.2

The number of households surveyed is 26

Table 9.3.1 (5) Lighting equipment in Marenauka

Village	Equip- ment	Bed room	Cook area	Living	Extra	Portable
Marenauka	KWL	6	3	2		0
	KPL	2	2	2		1
	Others	0	0	0		0
	Total	8	5	4		1
	Rate	89%	56%	44%		11%

Average lighting equipment per household is 2.1

The number of households surveyed is 9

Table 9.3.1 (6) Lighting equipment in Tabonibara

Village	Equip- ment	Bed room	Cook area	Living	Extra	Portable
Tabonibara	KWL	7	6	13		1
	KPL	3	0	6		7
	Others	1	0	0		0
	Total	11	6	19		8
	Rate	44%	24%	76%		32%

Average lighting equipment per household is 1.8.

The number of households surveyed is 25.

Table 9.3.1 (7) Lighting equipment in Kainaba

Village	Equip- ment	Bed room	Cook area	Living	Extra	Portable
Kainaba	KWL	8	9	7		0
	KPL	6	1	3		16
	Others	0	0	1		0
	Total	14	10	11		16
	Rate	67%	48%	52%		76%

Average lighting equipment per household is 2.4

The number of households surveyed is 21

Table 9.3.2 (1) Lighting hours in North Tarawa (Six villages)

Village	Items	Bed room	Cook area	Living	Extra	Portable
Six villages	Average (1)	4.9	4.4	4.6	5.5	4.8
	H.H. (1)	103	77	72	2	63
	Average (2)	3.9	3.7	3.8	5.5	4.3
	H.H. (2)	91	70	64	2	59

Average (1): Average hours in all households surveyed

H.H. (1): The number of households surveyed (167)

Average (2): Average hours in households excluding abnormal data

H.H. (2): The number of households excluding abnormal data

Table 9.3.2 (2) Lighting hours in Taratai

Village	Items	Bed room	Cook area	Living	Extra	Portable
Taratai	Average (1)	3.8	2.8	5.1	6.0	4.8
	H.H. (1)	22	18	13	1	12
	Average (2)	3.0	2.8	3.1	6.0	4.8
	H.H. (2)	20	18	10	1	12

Table 9.3.2 (3) Lighting hours in Notoue

Village	Items	Bed room	Cook area	Living	Extra	Portable
Notoue	Average (1)	4.8	4.8	4.8	5.0	5.3
	H.H. (1)	29	23	18	1	27
	Average (2)	4.5	4.5	4.4	5.0	4.2
	H.H. (2)	28	22	17	1	23

Table 9.3.2 (4) Lighting hours in Abaokoro

Village	Items	Bed room	Cook area	Living	Extra	Portable
Abaokoro	Average (1)	5.1	4.3	3.5	0	5.6
	H.H. (1)	23	19	7	0	5
	Average (2)	3.7	3.6	3.7	0	5.6
	H.H. (2)	19	18	7	0	5

Table 9.3.2 (5) Lighting hours in Marenauka

Village	Items	Bed room	Cook area	Living	Extra	Portable
Marenauka	Average (1)	6.4	6.2	6.0	0	5.0
	H.H. (1)	8	5	4	0	1
	Average (2)	4.3	3.7	4.3	0	5.0
	H.H. (2)	6	3	3	0	1

Table 9.3.2 (6) Lighting hours in Tabonibara

Village	Items	Bed room	Cook area	Living	Extra	Portable
Tabonibara	Average (1)	4.8	6.6	4.4	0	4.3
	H.H. (1)	11	6	19	0	7
	Average (2)	3.8	3.3	4.0	0	4.3
	H.H. (2)	10	4	18	0	7

Table 9.3.2 (7) Lighting hours in Kainaba

Village	Items	Bed room	Cook area	Living	Extra	Portable
Kainaba	Average (1)	5.9	5.2	4.5	0	3.6
	H.H. (1)	10	6	11	0	11
	Average (2)	4.4	3.8	3.0	0	3.6
	H.H. (2)	8	5	9	0	11

(2) Lighting fuel cost in the six villages

Most of the Lamps in the six villages are kerosene wick lamps or kerosene pressure lamps. Then the cost of the lighting fuel is equal to the consumption cost of kerosene in the six villages. In the survey, the average kerosene consumption is 2,300 liter per month in 160 households surveyed. Assuming a price of kerosene is 75 cents per liter, the kerosene consumption value is A\$1,700 per month in the six villages. the consumption and the value of all households (including non surveyed households) in the six villages are 2,900 liter per month and A\$2,100 per month.

The kerosene consumption per household in the six villages is 14.1 liter per month, the value is A\$10.58 per month under 75 cents of the kerosene price. Tabonibara is the highest value with A\$13.69 per month, Abaokoro is the least value with A\$7.86 per month.

The households with kerosene consumption value more than A\$10 per month are 62 households in 160 households surveyed, or 39% of the 160 households. In the case of a kerosene consumption value more than A\$6.0 per month, the number of the households is over 50% of the 160 households.

The number of households with kerosene consumption value more than A\$10	62 H.H.	39%
The number of households with kerosene consumption value more than A\$9	65 H.H.	41%

The number of households with kerosene consumption value more than A\$6 84 H.H. 53%

The number of households with kerosene consumption value more than A\$3 139 H.H. 87%

Table 9.3.3 Kerosene consumption and the value per month in the six villages

VILLAGES	H.H. surveyed	Respon- dents	Consump- tion (liter)	Per H.H. (l/HH)	Value (A\$)	Per H.H. (A\$/HH)
Six villages	167	160	2,256.5	14.1	1,692.4	10.6
Taratai	32	30	446.0	14.9	334.5	11.2
Notoue	54	54	681.5	12.6	511.1	9.5
Abaokoro	26	23	241.0	10.5	180.8	7.9
Marenauka	9	8	85.0	10.6	63.8	8.0
Tabonibara	25	24	438.0	18.3	328.5	13.7
Kainaba	21	21	365.0	17.4	273.8	13.0

(3) Audio equipment and batteries use in North Tarawa

One third of the household in the six villages has a radio and a cassette tape recorder. If the households which hold the radio or the tape recorder are not the same, two households in three are considered to keep a radio or a tape recorder. Also two households in three keep electric torches.

Active hours of the radio and the tape recorder are respectively 4.6 hours and 5.6 hours per day. The power sources of the equipment are mostly D type batteries. The average number of the batteries per household in the six villages is 5.8 batteries. The average number is a figure to be divided the total number all households surveyed (160) in the six villages.

Assuming batteries for a radio are changed once in two months, batteries for a torch and a tape recorder are changed once a month, a household in

the six villages buy 5 batteries per month in the average, the value is estimated A\$2.2 per month. Actually, it is considered for them to use chargeable batteries or to get power from automobile batteries. Then the expenditure for batteries of a households is less than A\$2.2 per month.

Table 9.3.4 Quality of audio equipment and electric torches

VILLAGES	Number of H.H.	Radio	Active Hours per day	Torch	Used Hours per day	Tape Rec	Active Hours per day
Six villages	167	56	4.6	114	1.1	56	5.6
		3.0		1.5		3.0	
Taratai	32	12	3.1	24	2.4	13	5.3
		2.7		1.3		2.5	
Notoue	54	17	4.4	39	1.1	21	5.9
		3.2		1.4		2.6	
Abaokoro	26	14	3.9	21	2.3	11	4.9
		1.9		1.2		2.4	
Marenauka	9	6	7.9	9	1.8	3	6.0
		1.5		1.0		3.0	
Tabonibara	25	2	7.0	9	0.8	7	6.4
		12.5		2.8		3.6	
Kainaba	21	5	5.9	12	0.7	1	4.0
		4.2		1.8		21.0	

Upper : The number of components and average hours of use

Lower : Rate = all households / the number of components

Table 9.3.5 Consumption of batteries in the six villages

VILLAGES	Number H.H.	D type (pcs)	C type (pcs)	AA type (pcs)	Total (pcs)	Per H.H. number (pcs/H.H.)
Six villages	167	874	39	49	962	5.8
Taratai	32	186	14	5	205	6.4
Notoue	54	293	19	28	340	6.3
Abaokoro	26	213	0	6	219	8.4
Marenauka	9	45	6	8	59	6.6
Tabonibara	25	72	9	2	83	3.3
Kainaba	21	65	0	0	65	3.1

Table 9.3.6 Cost of battery consumption in the six villages

VILLAGES	Number H.H.	D type (A\$)	C type (A\$)	AA type (A\$)	Total (A\$)	Per H.H. (A\$/H.H.)
Six villages	167	393.3	15.6	14.7	423.6	2.5
Taratai	32	83.7	5.6	1.5	90.8	2.8
Notoue	54	131.9	7.6	8.4	147.9	2.7
Abaokoro	26	95.9	0	1.8	97.7	3.8
Marenauka	9	20.3	2.4	2.4	25.1	2.8
Tabonibara	25	32.4	3.6	0.6	36.6	1.5
Kainaba	21	29.3	0	0	29.3	1.4

The prices of D type battery, C type battery and AA type

battery are 45 cents, 40 cents and 30cents respectively

Table 9.3.7 Consumption Value of batteries per month
in North Tarawa (Six villages)

VILLAGES	Number H.H.	Total battery number (pcs)	Battery number for radio (pcs)	Consump. value for total (A\$/M)	Monthly average for Bat. purchase. (A\$/M)	Per H.H. (A\$/M)
Six villages	167	962	242	423.6	370.3	2.2
Taratai	32	205	52	90.8	79.3	2.5
Notoue	54	340	83	147.9	129.8	2.4
Abaokoro	26	219	63	97.7	83.6	3.2
Marenauka	9	59	18	25.1	21.3	2.4
Tabonibara	25	83	8	36.6	34.8	1.4
Kainaba	21	65	18	29.3	25.2	1.2

Torches and tape recorders are changed the batteries once a month,
radios are changed once in two months

(4) Durable equipment in six villages

In the six villages, there is no grid electricity which is supplied by PUB, but some diesel generators and some PV generators have already been installed. Especially Taratai, Notoue and Abaokoro have some diesel generators. When the mission visited on June, 1992, the diesel generators did not work at Abaokoro, but a PV generator was used in the Maneaba. The PV generator was funded by the South Pacific Commission.

A motorbike is useful in North Tarawa. the roads in the six villages are narrow and rough, An automobile with four wheels is unable to go through some bridges. And a motorbike is more effective than an automobile at the time traveling over coastal reefs. A motorbike is used more than an

automobile in North Tarawa. Therefore there are a few automobiles in North Tarawa. The common means of land transportation is by bicycle or motor-bike. There are 9 motorbikes in the six villages, these are used for transportation among the villages in North Tarawa.

Each household in the six villages have canoes, but most of them do not have outboard engines. There are only three canoes with outboard engines in the six villages.

Table 9.3.8 Durable equipment in the six villages

VILLAGES	Number H.H.	Auto mobile	Truck	Outboard engine	Motor bike	Diesel generator
Six villages	167		(1)	3	9	6
Taratai	32			1	3	2
Notoue	54				3	2
Abaokoro	26		(1)		1	2
Marenauka	9					
Tabonibara	25			1	1	
Kainaba	21			1	1	

The number of trucks in () is possessed by Island council. There are 7 outboard engines which are possessed by village administrators.

9.4 Households desiring PV systems in the six villages

(1) The number of households desiring PV systems

When surveying for the installation of PV systems, 124 households in 167 indicated their willingness to install PV systems. It is given 'RANK A' for the households who desire to install PV systems and willing to pay the installation fee of A\$50 and the maintenance fee of A\$10, 'RANK B' is for the households who desire to install PV systems with an installation fee of less than A\$50 or a maintenance fee of less than A\$10, and RANK C' for the households not desiring to install PV systems.

The number of households in RANK A is 55 households out of total 167. Then the ratio of RANK A to the total is 33%. The number of households in RANK A and RANK B is 124, so the ratio of RANK A and RANK B to the total is 74%.

The village desiring the highest ratio of PV systems is Tabonibara, its rate is $64\% (=16 \div 25)$ in RANK A, the next is Kainaba, its ratio is $48\% (=10 \div 21)$ in RANK A. In RANK A and RANK B, the highest ratio is $96\% (=25 \div 26)$ in Abaokoro, the second is $80\% (=20 \div 25)$ in Tabonibara and the third is $78\% (=7 \div 9)$ in Marenauka.

There are 167 respondents to the survey and total number of households in the six villages can be estimated to be 200 households. Therefore the number of the households which desire to install PV systems in the six villages is to $150 (=200 \times 74\%)$.

Table 9.4.1 The number of the households to desire to install PV systems in the six villages

VILLAGES	Number of H.H.	R A N K			A+B	A ratio	A+B ratio
		A	B	C			
Six villages	167	55	69	43	124	33%	74%
Taratai	32	5	15	12	20	16%	63%
Notoue	54	11	27	16	38	20%	70%
Abaokoro	26	10	15	1	25	38%	96%
Marenauka	9	3	4	2	7	33%	78%
Tabonibara	25	16	4	5	20	64%	80%
kainaba	21	10	4	7	14	48%	67%

(2) The number of subscribers to desire PV systems

After understanding that 124 households desire PV systems in the six villages of the survey, The SEC announced to the six villages that it would hold a lottery to select households to install PV systems 22nd June 1992. At the same time, the SEC said that the desiring households had to bring A\$50 for the installation fee at the day of the lottery. Consequently, 40 persons gathered to the lottery at Maneaba of Abaokoro from the six villages, then all of the persons were certified as the elected candidates for installation of PV systems. In addition to them 12 council workers in Abaokoro also certified to install PV systems on condition that the installation fee of A\$50 was to be paid by the Government. The other desiring households came to the SEC after 22nd June. The households numbered more than 50 gather as of 8th August.

There are 10 households with an the annual income less than A\$1,000 in the subscriber group. And the subscribers do not pay A\$50 as the installation fee as of 30th June 1992. The subscribers who are the low income households can not be considered to pay A\$50 in the future. When the subscribers do not pay the installation fee, the SEC has a policy to install

PV systems to other households which desire PV systems.

Table 9.4.2 Subscription of installation of PV systems
in the six villages

VILLAGES	Number of H.H.	Number of Subscribers (A\$/H.H.)	Average income of Subscript. (A\$/H.H.)	Average income of villages (A\$/H.H.)	H.H. less than A\$1,000
Six villages	167	60	2,187	2,151	10
Taratai	32	6	2,890	1,938	0
Notoue	54	12	1,357	1,876	4
Abaokoro	26	20	2,409	2,165	3
Marenauka	9	6	2,298	1,760	1
Tabonibara	25	5	2,493	3,215	0
kainaba	21	11	2,108	2,033	2

(3) Lottery for installation of PV systems

There were 20 persons at a Maneaba in Abaokoro at 11:00 am 22nd June 1992. They gathered from the six villages in North Tarawa for the lottery which opened at 2:00 pm in the Maneaba. At noon, they were a 40 person group. The lottery opened at noon, because the appointed people came to the lottery meeting. After Mr. Konta who is the I.C. president in North Tarawa explained purpose of the lottery, he heard the attendant names and addresses and wrote them in his paper.

The mission and the counterparts were considering installation of 50 PV system sets in order to stabilize management of Solar Energy Company (SEC). However according to the survey on installation of PV system for the six villages in North Tarawa such as Taratai, Notoue, Abaokoro, Marenauka, Tabonibara and Kainaba, 121 households in 200 households in

the total of the villages desired installation of PV systems. Therefore SEC decided to select 50 households from the 121 households a lottery since they had a custom to settle such problems by lottery in North Tarawa.

The lottery was to be held in Abaokoro. But the number of the people attending to the lottery was not 121, but only 40. The reasons which the entry number is so small was that the people had to pay A\$50 as installation fee at the same time as they were to be selected by the lottery, and that the people say they did not have enough time to decide about the installation of PV systems.

At completion of the meeting, Mr.Konta wrote the names of 46 persons. The number of the names was more than the number of participants in Maneaba, because there were some persons who relied on the entry to the lottery. However the persons who paid A\$50 as the installation fee at the meeting time was only 19, the remainder could not immediately pay the fee, they want to pay the fee by December 1992 or else A\$10 as the fee every month from this July.

Then SEC promised them that they would accept their payment by July. Also SEC decided that they would install PV systems for North Tarawa Island Council staffs after consulting with Mr. Konta. The situation as of 30th June is as follows;

Table 9.4.3 Components of installation of PV systems

Councilor's staff households	Paid up households	Unpaid up households	Total households
12 H.H.	27 H.H.	21 H.H.	60 H.H.

At first, the mission had a plan to install a PV system to a Maneaba in Abaokoro, however a PV system was already installed for the Maneaba in Abaokoro. Then the mission and the counterpart decided to install a PV system to some Maneaba except Abaokoro. All villages except Abaokoro desired the PV system. Therefore a lottery for installing a PV system to a Maneaba in the five villages was held. Mr. Konta went out of the Maneaba to take 5 grass from ground and one of them had a flower, but others had cut their flowers off. The village representative drawing the grass stem with the flower was the "Winner". By the lottery, Kainaba was selected as village in which the PV system was to be installed.

The lottery meeting started at 12:00 noon and finished at 1:00 pm.

9.5 People's needs and responsibility for the PV system

Rural electrification can be separated into economic development and social development. The purpose of the social development is to improve the quality of life of people through improving housing, health, water supply, communications and medicine. Rural electrification is intended to supply electricity for private houses, public houses, pumps, communications and health centers. The electrification of North Tarawa, which is for the social development, though install electric lights into private houses. The following conditions must be present for the plan to succeed.

- ① Electrification must agree with consensus of the people.
- ② The people have to have a willingness to pay recurrent cost.
- ③ A technician who can maintain and manage the equipment must be stationed in the rural area.
- ④ Monetary, administrative and technical support must be available from the villages, the Government or overseas.

(1) Requirement of the people on PV systems

The main lighting equipment in North Tarawa are now the kerosene lamps, but the people in North Tarawa have problems getting kerosene for their lamps, because it is not only problems of transportation between South Tarawa and North Tarawa which depend on canoes, but also the oil supply system is not completely organized in the country. Also the maintenance of kerosene lamps is an annoyance to their daily lives.

Under the circumstances, electric light is strongly desired in North Tarawa. 124 households in 167 in the survey want and they will pay for PV systems. When the number of the households desired PV systems is estimated for all ten villages in North Tarawa, we can take the number of the households surveyed in the six villages which is 167 and the number of households in the ten villages which is estimated at 430 households. Then the number of the households desiring PV systems in the ten villages in North Tarawa can be estimated to be 320 households ($=430 \times 124 / 167$). Therefore it appears that the requirement for PV systems from the people in North Tarawa is strong.

(2) Burden of the people for the cost of PV system

The annual average income per household is A\$2,150 in the six villages. A\$10 per month is estimated as the maintenance fee for the PV system, so the fee occupies 5.6% of the average income in North Tarawa. It is therefore not considered that the fee gives a heavy burden to the households getting income more than the average, particularly since expenditures for kerosene will be reduced.

The rate of the households having income more than the average is 37%, the number is 74(=200*37%) households. And the number of the households having income more than the average in the ten villages in North Tarawa is 160(=430*37%). According to the economic analysis of the mission, 50 households which desire PV systems require one maintenance technician in the field. Then 160 households which desire PV systems can distribute will require 3 maintenance technicians.

(3) Cost of kerosene lamp

Most of the households in North Tarawa use kerosene wick lamps or kerosene pressure lamps and kerosene is rarely used for anything else. Then the fuel cost for light is equal to the kerosene consumption value in North Tarawa. According to the survey, if the kerosene price would be 75 cent per liter, the kerosene consumption value per household would be A\$10.58 per month. And the number of the households which pay more than A\$6.0 per month is 85(=160*53%). Therefore it is reasonable that the maintenance fee of the PV systems is set the range of A\$6~10 per month when considering a PV system is a substitute for kerosene lamps.

(4) Willingness to pay the cost of PV system

The number of the households which desire PV systems which have an installation fee more than A\$50 and maintenance fee more than A\$10 is 55 households in 167, a ratio of is 33%. the number in the whole of the six villages can be estimated with 66(=200*33%) households and the number in the whole of the ten villages can be estimated with 140(430*33%) households. Considering their willingness to pay the installation cost and the maintenance cost, it is possible to retain 1~3 maintenance technicians in North Tarawa.

(5) Environmental impact and control

Having the PV systems include problems of disposing of failed batteries and electric lamps, it is not good for the environment to dispose them outside of their houses. A collection system of these wastes is required to protect the environment. At the same time, cooperation of the people is required too. The survey asked about this cooperation, and most of the respondents answered that they would cooperate in the collecting the wastes.

9.6 Evaluation of the PV systems after installed

(1) Households installing PV systems

Households which the PV systems would be installed have to pay A\$50 as initial charge by December 1992. Also the households have to pay A\$9 instead of A\$10 every month as maintenance fee for the PV system.

Consequently, the 55 PV systems were installed in households in Taratai, Notoue, Abaokoro, Marenauka, Tabonobara and Kainaba. Also the one PV system was installed in Maneaba of Kainaba. The household name which were installed the PV systems and household codes which were surveyed before installation of the PV systems in 1992 are as the following tables. And the PV system were installed with installation fee of A\$50 and maintenance fee of A\$9.

Table 9.6.1 (1) Households installing PV systems in Taratai

NO	CODE	NAME	NO	CODE	NAME
TARATAI					
1	R-17	TETIKA			
2	R-28	TABOBO			

Table 9.6.1 (2) Households installing the PV systems in Notoue

NO	CODE	NAME	NO	CODE	NAME
1	N-1	AREBONTO	9	N-37	IOTEBWA
2	N-3	BENTARA	10	N-	AIRIN
3	N-10	KEITI	11	N-38	RONIITI TETABO
4	N-16	MIKAERE TIMAIA	12	N-06	TAUKABAN IOANE
5	N-30	TERIRIAKI	13	N-54	TAMUERA KAREBANGA
6	N-32	TIKANRO	14	N-37	TEBIKE NENEIA
7	N-35	UTIMAWA	15	N-	TIIBAU
8	N-36	WAIRE			

Table 9.6.1 (3) Households installing PV systems in Abaokoro

NO	CODES	NAMES	NO	CODES	NAMES
1	A-1	ABAKUKA	14	A-33	TIOTI
2	A-4	BEIA TOARA	15	A-35	ABAU
3	A-5	EKEIETA ITITAKE	16	A-36	BWENAWA
4	A-9	LOUI NAMANE	17	A-37	MATIOTA
5	A-10	NAITIRA TAMTON	18	A-	AMBOU
6	A-11	OBETA	19	A-	BAURO(TICA)
7	A-16	IERUBAARA	20	A-07	KAOBUNANG
8	A-17	TEBUAKA	21	A-19	TEKATAU(TEKATAO)
9	A-18	TEKAKIABO	22	A-	TEKERAOI
10	A-21	TEMARAWA	23	A-	TENAGIMAU(TEACHER)
11	A-26	MAKIN NGATAU	24	A-22	TETAKE
12	A-29	TAUKABAN	25	A-	BIITA
13	A-32	RIBATI(KPC)			

Table 9.6.1 (4) Households installed the PV systems in Marenauka

NO	CODES	NAMES
1	M-1	BEIA RRUAIA
2	M-4	MOAUEA
3	M-7	TEN TATERAKA

Table 9.6.1 (5) Households installing the PV systems in Tabonibara

1	T-6	RANANGAKI MAITINNARA	4	T-	MAEUEA
2	T-18	TOANII TAKAITO	5	T-	TABEIA
3	T-23	TEAOTI NGAIA	6	T-	TUTU TITIBO

Table 9.6.1 (6) Households installing the PV systems in Kainaba

NO	CODES	NAMES	NO	CODES	NAMES
1	K-4	BIRIKAUA TABOKAI	3	K-11	TEBUATEI ABIETE
2	K-10	TAAKE TETAUA	4	K-14	UEANNA TEMANIAKAAI

(2) Factors of Social Impacts to family life and village life

Electricity once installed to an unelectrified village will have an impact on social conditions. We can separate these impacts into two categories: family life and village life.

At first, a family generally installs lights, but the family gradually adds radios, televisions, pumps and refrigerators ultimately using the full benefit of electrification to the limit of the family's economic capability. Therefore, the family's direct benefits from electrification depends on the family's income and the availability of appliances.

There is social impact when public facilities such as school, hospitals, churches, communication centers, etc. are electrified. Then the social impact was evaluated for electrification for each public facility. Of course, the public facility has to exist prior to electrification for such an evaluation to be appropriate.

The electric appliances expected to be placed into use after installation of the PV system in North Tarawa include the following:

- ① Electric light for households, schools, hospitals, churches and Maneabas
- ② Electric fans for households, schools, hospitals, churches and Maneabas
- ③ Electric water pumps
- ④ Refrigerators, freezers and/or ice makers
- ⑤ Radios, tape recorders, televisions and video cassette recorders
- ⑥ Medical equipment
- ⑦ Street lamps, public address systems
- ⑧ Telecommunication equipment

This electrification can be described as the "Primary impact" "Secondary impact" is determined by people's reactions and attitudes towards the appliances. It will take several years to realize the "Secondary impact" and we will have to wait that time to evaluate them.

The following data was collected to evaluate the social impact of the installed PV systems after 8 months in North Tarawa. The 55 families receiving PV systems were targeted.

(3) Methods of the survey and number of responses

a. Targeted households

55 households receiving the PV systems

b. Date of the survey

The survey was carried out in September 1993, that is, eight months after the installation of the PV systems.

c. The number of the responses

Table 9.6.2 The number of the households

	Households surveyed	Households installed the PV system
Taratai	1	2
Notoue	13	15
Abaokoro	19	25
Marenauka	2	3
Tabonibara	5	6
Kainaba	4	4 + 1 (in Maneaba)
Total	44	55 + 1 (in Maneaba)

(4) Satisfaction with the PV system and perceived convenience of the PV system

a. The fee charged for the PV system

The households responded that the fee for the PV system is lower than the cost of the kerosene lamps and the PV system is more convenient than kerosene lamps. It is considered that all households are pleased with the installation and the cost of the PV system is acceptable. The maintenance fee (A\$9/month) of the PV system is about equal to the kerosene cost per month for the kerosene lamps.

b. The users of the PV system are pleased with the brightness color and convenience of use. The PV system now lights for 4 hours a day though the PV system is designed for lighting up to 6 hours. Most of the households are satisfied with this arrangement and also they are pleased that there have been no technical problems.

c. Problems and Desires

Though there have been no significant technical problems, the users have complained that many insects gather around lights. On the other hand, they ask to have 2 to 3 more lights and a power outlet for radio and tape recorder attached to the PV system.

d. SEC's service

The people are satisfied with SEC's maintenance service. The PV systems have been working well since they were installed and there has not been problems trouble caused by SEC's maintenance and technical capability except for two instances of delays in the lights coming on and there being insufficient charge in the battery when the weather had been very cloudy.

e. Kerosene lamp and Torch

At first the kerosene lamps were used for room light. After the PV systems were installed, they mainly use their kerosene lamps for fishing and cooking at night. Also they have decreased the use of their battery powered torches after the PV systems were installed.

Table 9.6.3 Q3. Regarding the fee of the PV systems: What is your family's feeling about it compared with kerosene lamp?

	HH	a.Cheaper	b.About the same	c.Expensive
Taratai	1	1		
Notoue	13	13		
Abaokoro	19	19		
Marenauka	2	2		
Tabonibara	5	4		1
Kainaba	4			
Total	44	43	0	1

Table 9.6.4 Q4.How about the convenience of the PV lighting system? What is your family's feeling about it compared with kerosene lamp.

	HH	a.More convenient	b.About the same	c.Less convenient
Taratai	1	1		
Notoue	13	13		
Abaokoro	19	19		
Marenauka	2	2		
Tabonibara	5	5		
kainaba	4	4		
Total	44	44	0	0

Table 9.6.5 Q5.What complains does your family have about the PV lighting system?

	HH	a.Not enough lighting	b.Time	c.Technical trouble	d.Insect	e.Others
Taratai	1					1
Notoue	13			8		5
Abaokoro	19	2		14		3
Marenauka	2					2
Tabonibara	5			3		2
Kainaba	4			1		3
Total	44	2	0	1	25	16

Table 9.6.6 Q6.What kind of additional functions does your family want from the PV system?

	HH	a.More light (How many)	b.Power outlet (What purposes)	c.Others
Taratai	1	1	1	
Notoue	13	13	13	
Abaokoro	19	19	19	
Marenauka	2	2	2	
Tabonibara	5	5	5	
Kainaba	4	4	4	
Total	44	44	44	

Table 9.6.7 Q7.What kind of services does your family need from the SEC that your family does not get now?

	HH	a.Quick Repair	b.Move equipment	c.Add equipment	d.Others
Taratai	1	1			
Notoue	13	2	2	2	8
Abaokoro	19				19
Marenauka	2				2
Tabonibara	5				5
Kainaba	4	2			2
Total	44	5	2	2	36

Table 9.6.8 Q8.How does your family use its Kerosene lamps after installing the PV lighting system?

	HH	a.Not change from before	b.Changed
Taratai	1		1
Notoue	13		13
Abaokoro	19		19
Marenauka	2		2
Tabonibara	5		5
Kainaba	4		4
Total	44	0	44

Table 9.6.9 Q9.Has use of your family's torch decreased after installing the PV lighting system?

	HH	a.Not change from before	b.Decreased	c.Others
Taratai	1		1	
Notoue	13		13	
Abaokoro	19		19	
Marenauka	2		2	
Tabonibara	5		4	1
Kainaba	4		4	
Total	44	0	43	1

(5) Impact to the family installed with PV system

a. Effectiveness of work at night

Work in North Tarawa is fishing, harvesting and maintenance of fishing nets for men with cooking, washing and handicrafts for housewives. Most of the village people listen to radios in their houses and watch videos in the Maneaba at night. By having a PV system, they can continue to work on the maintenance of fishing nets and/or handicrafts at night. Then it is believed that they can increase their income by increased nighttime production activity.

b. Satisfaction among family members

The housewife's work was completed faster and with less effort after the PV system was installed. They also increased the time they had available to spend with children and other family members.

c. Doing homework

The children in North Tarawa sometimes have homework assigned by their school teacher. They have increased the amount of time spent for studying their homework after the PV system was installed. Also their time to go to bed was later than before having the PV system.

d. Use of radio and tape recorder

Some households (29 households) increased the time spent listening to their radios and tape recorders, but the rest responded (11 households) that there was no change.

Because PV systems do not have any power outlet for a radio or tape recorder, it is expected that the use of radios and tape recorders has not changed. The reason that the time for listening to radios and tape recorders increased is result of their going to bed later than before the PV systems were installed.

e. Other electric appliances desired by the households

Households having PV systems desire other electric appliances such as solar pumps and power outlets for radios, tape recorders and videos.

Table 9.6.10 Q10. Has time of production activity increased at night or in your house after installing the PV lighting system?

	HH	a. Not change	b. Activity time increased for fishing and agriculture	c. Activity time increased for handicrafts	d. Other
Taratai	1			1	
Notoue	13		8	13	3
Abaokoro	19		17	19	1
Marenauka	2		2	2	
Tabonibara	5		5	5	
Kainaba	4		3	4	
Total	44	0	35	44	4

Table 9.6.11 Q11. What kind of change has it caused for housewife's works after installing the PV system?

	HH	a. Not change from before	b. Some of the works are done faster or easier	d. Others
Taratai	1		1	
Notoue	13		13	1
Abaokoro	19		19	2
Marenauka	2		2	
Tabonibara	5		5	
kainaba	4		4	
Total	44	0	44	3

Table 9.6.12 Q12. Has the time which the housewife spent with her children and other family members changed?

HH	a.Not change from before	b.Increased	c.Decreased	d.Do not Know
Taratai	1	1		
Notoue	13	13		
Abaokoro	19	19		
Marenauka	2	2		
tabonibara	5	5		
kainaba	4	4		
Total	44	44	0	0

Table 9.6.13 Q13.Has the time to for homework by your children increased after installing the PV lighting system?

HH	a.Not change	b.Increased	c.others
Taratai	1	1	
Notoue	13	13	
Abaokoro	19	17	2
Marenauka	2	1	1
Tabonibara	5	4	
kainaba	4	3	1
Total	44	39	4

Table 9.6.14 Q14.Has the time to go to bed changed
in your house after installing the PV
lighting system?

	HH	a.Not change from before	b.Later (before: after)	c.Others
Taratai	1		1	
Notoue	13		13	
Abaokoro	19		19	
Marenauka	2		2	
Tabonibara	5		5	
Kainaba	4		4	
Total	44	0	44	0

Table 9.6.15 Q16.Has the time spent listening to radio
or tape recorder changed in your house
after installing the PV system?

	HH	a.Not change from before	b.Increased	c.Decreased	d.Others
Taratai	1	1			
Notoue	13	5	8		
Abaokoro	19	1	18		
Marenauka	2		1		1
Tabonibara	5	1	2		2
Kainaba	4	3			1
Total	44	11	29	0	4

Table 9.6.16 Q17. What kind of electric appliances does your family now want to be powered from the PV system?

	HH	a.Solar pump	b.Solar refrigerator	c.Radio/Record/Video	d.Fan	e.Washing machine
Taratai	1	1	1			1
Notoue	13	13	6	1		
Abaokoro	19	19	8	5	1	
Marenauka	2	2		1		
Tabonibara	5	5	1	3		
Kainaba	4	1	2	5		
Total	44	41	18	15	1	1

(6) Impact to the villages with PV systems installed

a. Outdoor social activities at night

In the villages having many PV systems such as Abaokoro, the PV system illuminates not only in the houses but also nearby roads and the neighborhood area. The PV system therefore allows the people to have increased social enjoyment outdoors at night.

b. Increasing their productivity in the Maneaba

After installing the PV systems, the people were surprised to see that the fluorescent lights with the PV system were brighter than they expected. The result was especially that housewives came to the Maneaba to make handicrafts and do weaving every night. That increase their productivity and will bring their villages increased income and help preserve their material culture.

c. More PV systems desired

The households having PV systems believe that households not having the PV system are jealous of them. And households not having PV system desire to install a PV system.

d. Participation of meetings in their villages

There is no evidence that the households have changed their participation in meetings held in their villages.

e. Negative social impact due to the PV system

At present, there is no sign that the PV system particularly impacts leaders of the villages, and there has been no trouble which arose among the people due to economic differences and feelings of unfairness between the families with the PV systems and those without. Also there was some discontent due to the fact that the existing PV system can not supply power of any electric appliances except lights.

Table 9.6.17 Q15. Has social activity changed between neighbors in your house after installing the PV lighting system?

	HH	a. Not change	b. Increased	c. Others
Taratai	1		1	
Notoue	13		13	
Abaokoro	19	2	15	2
Marenauka	2		1	1
Tabonibara	5		5	
Kainaba	4		2	2
Total	44	2	37	5

Table 9.6.18 Q18. Has the vigor of your village changed after having the PV system?

	HH	a. Not change from before	b. Increased	c. Do not know
Taratai	1		1	
Notoue	13		13	
Abaokoro	19		19	
Marenauka	2		2	
Tabonibara	5		5	
Kainaba	4		4	
Total	44	0	44	0

Table 9.6.19 Q19. What kind of change has occurred between households having the PV system and households not having the PV system?

	HH	a.No change from before	b.Households not having the PV system are jealous of households having the PV lighting system	c.Others
Taratai	1		1	
Notoue	13		13	
Abaokoro	19		19	
Marenauka	2		2	
Tabonibara	5		5	
Kainaba	4		4	
Total	44	0	44	0

Table 9.6.20 Q20. Do some of the households not having the PV system now want to install a PV lighting system?

	HH	a.Yes,they want to	b.No, they do not want to	c.Do not Know
Taratai	1	1		
Notoue	13	13		
Abaokoro	19	19		
Marenauka	2	2		
Tabonibara	5	5		
Kainaba	4	4		
Total	44	44	0	0

Table 9.6.21 Q21. Has there been any change in your participating in meetings held in your village?

	HH	a.Participate as much as before installing the PV lighting system	b.Decreased in partici- pation	c.No change and always attend meetings
Taratai	1			1
Notoue	13	2	1	10
Abaokoro	19	1		18
Marenauka	2	1		1
Tabonibara	5			5
kainaba	4	3	1	
Total	44	7	2	35

(7) Evaluation in general

a. Evaluation of the PV system

a-1. Comparison with kerosene lamp

As the evaluation survey has been carried out only eight months after installation of the PV systems, we could not completely determine the details of the impact of the systems to family life style, village leadership and other various aspects.

The PV system has the outstanding points that its lights are brighter than kerosene lamps and there is a constant fee without respect to hours used. It is clear that the PV systems are welcomed by the families and villages of North Tarawa.

a-2. Function of the PV system

For a modern life style, even in remote areas of a developing country, it is not enough for people to have only lighting. The people in North Tarawa also use radios and tape recorders and they want to get power for these appliances from the PV system. For the next stage of electrification, we should consider much more useful and convenient PV system for the people of Kiribati.

b. Evaluation of the life of families having PV systems

This section analyzes how the life style of families or North Tarawa has been affected by the PV systems.

b-1. Impact to housewives

In North Tarawa, housewives can cook without any light until 6:30 pm, but they need lights after 7:00 pm. Thus most of the housewives in North Tarawa wish to finish cooking by 7:00 pm. Generally they cook both inside and outside their houses. They sometimes do cooking in the house with torches after 6:00 pm, since after 6:00 pm there is not enough light to work in the house. The PV system is very useful for such housewives' works. By using the PV lights, they were able to work much later in the night.

Also the PV systems impact housewives' life styles after dinner. Before having the PV system, they usually went to the Maneaba to weave mats and

sew clothes under kerosene pressure lamp or electric lights powered by a generator. But they could not use kerosene pressure lamps and diesel powered lights in their houses since they were too expensive.

To meet in the Maneaba at night and work while talking with one another is one of their pleasures. Therefore installation of the PV system to the Maneaba is more effective than installing PV systems for each household in the impact on village life styles for women.

b-2. Impact to men

Men in Households having a PV system were able to prepare for fishing even at night. This is a great improvement for the men. Before having a PV system, They could not have work at night and spent their time listening to radio or watching video. Without having a PV system, they had to been work under a kerosene lamp or a torch at night. As the PV light is brighter than these lights and it does not have any additional cost for longer use, they can increase their production activity and need not worry about any additional cost for their lights.

b-3. Impact to children

Most of children in North Tarawa do not do their homework in their homes though there are some children who study their homework in the Maneaba, but it is rare. Most of them are watching a video in their neighborhood or playing with each other around the Maneaba at night. The children having a PV system were able to study their homework in their homes at night. That is a great advance in their life.

Also the children in the six villages desire electric lights in their schools even in the daytime when it rains. This is a very serious problem. Rain in North Tarawa can be very heavy and the sky become very dark. So at this time the children can not read their books or study. Therefore, it would be best the future PV systems installed in Kiribati can be lit both in daytime and at night.

As a result, the housewives having PV systems received the most advantages from the PV systems, the next are the men, third are the children.

c. Impact to the household economy

Most of the households in North Tarawa used to use kerosene lamps and pressure kerosene lamps as their light. According to the survey before installing the PV systems in North Tarawa, kerosene consumption per household in North Tarawa was averaging 14.1 liter per month. The number of households which consume more than A\$10.00 per month of kerosene was 62 households out of 160 households of North Tarawa. the number spending more than A\$9.00 was 65 households, or 41% of 160 households in North Tarawa. Also the share of households which consumed more than A\$6.00 per month was about 50% of the whole.

The number of households which consumed more than A\$10.00 per month of kerosene	62 HH	39%
The number of households which consumed more than A\$9.00 per month of kerosene	65 HH	41%
The number of households which consumed more than A\$6.00 per month of kerosene	84 HH	53%
The number of households which consumed more than A\$3.00 per month of kerosene	139 HH	87%

As mentioned above, the maintenance fee (A\$9/month) of the PV system approximately equals the kerosene cost per month paid by households in North Tarawa. So there is no complaint from households having PV systems up to now. household members believe that the PV system is a better source of light and its effectiveness is good value when compared with the cost of kerosene lights.

d. Social problems caused by PV system and measures

Up to now there has been no trouble between households having a PV system and households not having one. It can be supposed that the following problems may become social problems in the future.

d-1. Difference of income between households having a PV system and those not having

Initially the Difference in individual income was assumed to divide households in North Tarawa into a group having the capability to install the PV system and another group not having that capability. Since households to receive the PV systems were selected through a drawing held in the Maneaba at Abaokoro, there are households having a PV system and households not having a PV system with the same income.

The PV systems installed in North Tarawa do not have any power outlet for radio, tape recorder and refrigerator. The difference in household income has not caused a difference in their life style. But as the PV lights are liked by the households having the PV system, It is supposed that if only 55 households have the PV system for a long time, there will be a bad effect upon the villages. Then it is desired that in the near future additional PV systems are installed in households not presently having them.

There are 200 households in the targeted six villages of North Tarawa. Only 55 PV systems are now installed in the households and it was shown by the april 1992 survey that there exists about more 70 households desiring to have PV system. Therefore after the feasibility study survey finishes, the Kiribati government and the SEC need to make plan for installing additional PV systems to the households desiring them. Otherwise, it is feared that in the near future trouble will occur between households having a PV system and households not having a PV system.

d-2. Impact of the PV system to the Maneaba

By the social impact survey, it appears that installation of the PV system for the Maneaba gives the greatest impact on village life. Therefore installation of PV systems should be carried out in Maneaba immediately after discussing with councilors of villages in North Tarawa.

d-3. Electric appliances powered by PV systems

Refrigerators and water pumps are desired by some people in North Tarawa as equipment for economic activity. This equipment can be used for fish storage and is useful to improve the villager's storage of food. At the

same time the people can store and sell fresh fishes by using this equipment. By doing so they will be able to increase their income as a result. It is believed that an improvement of village life and complete electrification of the villages will be realized after installation of such equipment.

d-4. Accomplishing maintenance of the PV systems and adopting a flexible payment system for the PV system fee

It is expected that the people will become used to having electricity and will be very angry when their systems stop operating. It will be important that the SEC provide prompt repairs and maintenance, otherwise people will be unwilling to pay the fee.

As there is a money economy in North Tarawa only at the primitive level, the households having the PV system are not yet accustomed to periodically pay for the fee for the PV system every month. Then it is appropriate that the SEC prepare some kind of the fee collecting system such as a prepayment system or deferred payment system for the households having the PV system.

(8) Future improvement of North Tarawa

a. Secondary impact and the measures for it

There is benefit gained by using electric appliances and equipment which is the primary impact. Also it is found that the PV systems have an impact on the mentality and the environment of people using them. The impacts are defined as "Secondary impacts", and the types of secondary impact are pointed out as follows:

- ① The young generation staying in the villages and resulting revitalization of the villages
- ② Increased productivity of their housework at night
- ③ Increased study time for children
- ④ Increased literacy rate
- ⑤ Increased security in villages at night
- ⑥ Decreased birth rate

It will be necessary to increase the family income on North Tarawa in order to realize the benefits of electrification and maximize to beneficial impact. The increased income will be needed for adding appliances and tools for productive use of electricity and for expanding the solar systems to allow more productive electrical use. Some measures are needed to accomplish this increased use of productive electricity on North Tarawa.

It is necessary to diversify occupations in North Tarawa. Now they get cash income by producing dried fish and copra. Also, recently, housewives in North Tarawa attain a higher level of skill for handicraft year by year and they want to sell their products to visitors in Kiribati. For to support their productivity, it is considered to establish a local cooperative society to sell their products. Also occupations such as selling tools for agriculture and fishing and repairing canoe engines, bicycles and automobiles in North Tarawa are desired.

b. Measures for maximizing to the effectiveness of the PV systems

There are positive impact and negative impacts of the PV systems to family life and social life. The details are as follows:

Table 9.6.22 Impact of the PV systems for family and social life

	Positive impact	Negative impact
Family life	<ul style="list-style-type: none"> • Increase in productivity • No additional fee for the PV system 	<ul style="list-style-type: none"> • To desire to buy electric appliances • To pay constantly fee of the PV system
Social life	<ul style="list-style-type: none"> • To keep younger generation in the villages and increased vigor in villages • Increased literacy rate and security 	<ul style="list-style-type: none"> • The contrast between a Maneaba having lights and other Maneabas not having lights may cause friction

b-1. Increased positive impacts for family life in North Tarawa

Positive impacts for family life are increasing their productivity and their children's studying time and so on. These are primary impact and the main effectiveness of the PV systems. As the PV systems are achieving these purposes, the Kiribati government and SEC are advised to install as many PV systems in North tarawa as the people desire.

b-2. Increased positive impact for social life in North Tarawa

Positive impacts on social life include increased retaining of the young generation in villages and revitalizing the villages in North Tarawa. For keeping the phenomenon, it is needed to have more occupations for the young generation to be able to get income in the villages. If this can not be realized in the villages, the families in North Tarawa need to get more income through sending family members overseas or to South Tarawa to work for money for their homes. To achieve this purpose of increasing retention of young people by using the PV systems, they need to have outlets for radios and other small electric appliances. Also there will be social improvement in villages where the PV lighting systems are installed in their Maneabas, PV water pump systems are added, PV telecommunication systems are used and PV refrigeration systems are available for food storage.

b-3. Decrease of the negative impact against family life in North Tarawa

It is a fear that the people will expend much money to buy electric appliances causing a negative impact in family life when they have PV systems. Additionally every month they have to pay the fee of A\$9. It is supposed that the payment is a heavy load for households having the PV system, because their income is not constant. To decrease the negative impact, it may be necessary to stabilize their income. At the same time, the SEC needs to arrange some kind of payment systems such as prepayment or deferred payment systems for collecting the fee of the PV systems.

b-4. Decrease of negative impact against social life in North Tarawa

There are often several Maneabas in a village. A Maneaba having a PV system will be used every night, but Maneabas not having PV systems are hardly used at night. As ceremonies of the villages are almost always hold in daytime, then it is no problem to the leaders of the villages whether a Maneaba has a PV system or not.

But meetings for discussing improvements in their lives and improving their skills are frequently held in the Maneaba at night. Therefore it is considered to give a top priority to installing future PV systems in Maneabas which the women use frequently.

(9) Kiribati Human Development Index

The human development index (HDI) is constructed in three steps. The first step is to define a measure of deprivation that a country suffer in each of the three basic variables (life expectancy, literacy rate and real GDP per capita). A maximum and a minimum value is determined for each of the three variables given the actual values. The deprivation measure then places a country in the range of zero to one as defined by the difference between the maximum and the minimum.

Thus I_x , I_y and I_z are the deprivation indicators for the country.

Life expectancy	X
Literacy rate	Y
GDP per capita	Z

$$I_x = (\text{Max } X - \text{Ave } X) / (\text{Max } X - \text{Min } X)$$

$$I_y = (\text{Max } Y - \text{Ave } Y) / (\text{Max } Y - \text{Min } Y)$$

$$I_z = (\text{Max } Z - \text{Ave } Z) / (\text{Max } Z - \text{Min } Z)$$

The second step is to define an average deprivation indicator (ADI).

$$\text{ADI} = (I_x + I_y + I_z) / 3$$

The third step is to measure the HDI as one minus the average deprivation index.

$$\text{HDI} = 1 - \text{ADI}$$

What a HDI is zero indicates that the country is set her position in the lowest level in aspect to human development. What a HDI is one indicates that the country reaches to the highest level. In 1987, Bangladesh's HDI was 0.318 and Japanese HDI was 0.996 calculated by Asia development Bank.

a. Kiribati Human Development Index in 1987

a-1. Life expectancy

Max life expectancy	58.0 age (South Tarawa)
Min life expectancy	50.0 age (Rural area in Kiribati)
Ave life expectancy	52.9 age (25,000p=Max, 45,000p=Min)
Deprivation	$(58.0 - 52.9) / (58.0 - 50.0) = 0.638$

a-2. Adult literacy rate

Max adult literacy rate 70.0 % (South Tarawa)
 Min adult literacy rate 50.0 % (Rural area in Kiribati)
 Ave adult literacy rate 57.1 % (25,000p=Max, 45,000p=Min)
 Deprivation $(70.0-57.1)/(70.0-50.0)=0.645$

a-3. GDP per capita

Max GDP per capita $(A\$3100*1.2)/6.3 = A\590 $\log 590 = 6.38$
 Min GDP per capita $(A\$2150*1.2)/6.3 = A\410 $\log 410 = 6.02$
 Ave GDP per capita $(A\$2489*1.2)/6.3 = A\474 $\log 474 = 6.16$
 Deprivation $(6.38-6.16)/(6.38-6.02)=0.611$

C.F. GDP per Capita = cash income per household * 1.2 (self sufficiency)

/ 6.3 (average number of family member)

a-4. Kiribati HDI

Average deprivation $(0.638+0.645+0.611)/3 = 0.631$
 Kiribati HDI $1 - 0.631 = 0.369$

a-5. Comparison of HDI

Table 9.6.23 Human Development Indices in 1987

COUNTRIES	HDI	COUNTRIES	HDI
Bangladesh	0.318	Indonesia	0.591
*Kiribati	0.369	Viet Nam	0.608
Pakistan	0.423	China	0.716
India	0.439	Thailand	0.783
PNG	0.471	Sri Lanka	0.789
Kampuchea	0.529	Malaysia	0.800
Laos	0.506	Australia	0.978
Myanmar	0.561	Japan	0.996

b. The case study

PV systems improve productivity, literacy and life expectancy in the area installing them. In future, when many PV systems are installed into most of the rural area in Kiribati, it is considered that average productivity, average literacy and average life expectancy of Kiribati will go up as much as five percent.

This HDI calculation is the result of above case study under the following premises.

[Premises]

- ① PV systems are installed in the most of the rural area in Kiribati
- ② The HDI is at the time 5 years after installation of the PV systems.
- ③ Life expectancy, adult literacy and GDP per capita of Kiribati will improve 5 % more than current situation by the PV systems.

b-1. Life expectancy

Max life expectancy	No change to 1987	58.0 age
Min life expectancy	No change to 1987	50.0 age
Ave life expectancy	5% up to 1987	55.5 age
Deprivation	$(58.0-55.5)/(58.0-50.0)=0.313$	

b-2. Adult literacy rate

Max adult literacy rate	No change to 1987	70.0 %
Min adult literacy rate	No change to 1987	50.0 %
Ave adult literacy rate	5% up to 1987	60.0 %
Deprivation	$(70.0 - 60.0)/(70.0 - 50.0)=0.500$	

b-3. GDP per capita

Max GDP per capita	No change	
	$(A\$3100*1.2)/6.3 = A\590	$\log 600=6.38$
Min GDP per capita	No change	
	$(A\$2150*1.2)/6.3 = A\410	$\log 410=6.02$
Ave GDP per capita	5 % up	
	$(A\$2613*1.2)/6.3 = A\498	$\log 498=6.21$
Deprivation	$(6.38-6.21)/(6.38-6.02)=0.472$	

b-4. HDI

Average deprivation $(0.313+0.500+0.459)/3 = 0.428$

Kiribati HDI $1 - 0.428 = 0.572$

b-5. Comparison of HDI

Table 9.6.24 Image of Kiribati HDI after installation of PV systems

COUNTRIES	HDI	COUNTRIES	HDI
Bangladesh	0.318	Indonesia	0.591
Pakistan	0.423	Viet Nam	0.608
India	0.439	China	0.716
PNG	0.471	Thailand	0.783
Kampuchea	0.471	Sri Lanka	0.789
Laos	0.506	Malaysia	0.800
Myanmar	0.561	Australia	0.978
*Kiribati	0.572	Japan	0.996

10. Rural Electrification of KIRIBATI

10.1 Existing status of Kiribati

10.1.1 Outline of Kiribati

Kiribati is made up of thirty three(33) islands located in the Central Pacific Ocean, straddling the equator and the International Date Line. It is sub-divided into three main group:

(a) The Gilbert Group: a chain of 17 atolls spread over 680 kms in the western sector which includes Tarawa, the seat of Government.

(b) The Phoenix Group: a cluster of 18 atolls lying about half way between the Gilbert and Line islands.

(c) The Line Islands: a chain of 8 atolls spread over 2,000 kms located some 3,000 kms east of the Gilbert Group on the other side of the Date Line. They include Kiritimati which accounts for half the country's land area.

These atolls rarely rise more than five meters above sea level and the total land area is only 746 square km but Kiribati covers three million square kms of exclusive economic zones(EEZ).

The population has increased to 72,000(1991) from 64,000(1985), and the number of people in South Tarawa rose from 21,400 in 1985 to 25,400 in 1991.

Economic dualism is a characteristic of feature of Kiribati's production, where subsistence livelihood predominate in much of the outer islands while a monetary economy exists in urban Tarawa and Kiritimati island. GDP per capita was nearly US\$660 in 1988.

Public enterprise dominates the cash economy which is centered in urban Tarawa, the administrative seat of Government, and Kiritimati island which caters for a limited amount of tourism. Small scale industries has been encouraged and so far there are some slipper and chair makers. Most private enterprise is situated on South Tarawa in the service sector, such as taxis, buses, film showing and food vendors.

Exports are basically copra and marine products while import consist of a wide range of consumer and capital goods.

(1) ENERGY RESOURCES:

(a) Biomass, primarily in the form of coconut fronds, husk, spathe, sheathe and nut are historically the principal source of energy within Kiribati both in rural and the densely populated urban area of South Tarawa. Other tree species such as casuarina, te uri, iron wood, te mao, pandanus and breadfruit are also utilized.

(b) Coconut oil may provide a viable alternative as long term fuel supply for power generation and ground transport needs. However, there has been no work done or planned to determine its potential viability.

(c) Solar energy on South Tarawa is conservatively estimated to have an average of 5 KWh/m²/day available for utilization using various conversion technologies. On Kiritimati island average solar insolation is estimated at 5.6 KWh/m²/day.

(d) Wind, potential in the Gilbert group appears to be low and non-persistent averaging in the range of 4.0-6.0 m/s. However, on Kiritimati island it reported to average 6.6 m/s and is consistent over much of the year.

(e) Ocean energy may have a long term future potential for the utilization of sea water temperature differences and seawave energy but no assessment has been done or planned.

Table 10.1-1 Statistic Data for Each Island
Population and household

Name of Island	Area (km2)	Popuration			Household		
		1985	1991	+/-	1985	1991	+/-
Banaba	6	46	284	238	10	62	52
Makin	8	1,777	1,762	- 15	287	295	8
Butaritai	13	3,622	3,774	152	581	633	52
Marakei	14	2,693	2,863	170	464	443	- 21
Abaiang	17	4,386	5,233	847	648	743	95
North Tarawa	15	3,205	3,648	443	456	551	95
South Tarawa	16	21,393	25,380	3,987	2,907	3,297	390
Maiana	17	2,141	2,180	39	353	378	25
Abemama	27	2,966	3,218	252	492	534	42
Kuria	15	1,052	990	- 62	172	187	15
Aranuka	12	984	1,002	18	173	169	- 4
Nonouti	20	2,930	2,814	- 116	534	539	5
N. Tabiteua	26	3,171	3,201	30	591	586	- 5
S. Tabiteua	12	1,322	1,331	9	246	250	4
Beru	18	2,702	2,909	207	521	539	18
Nikunau	19	2,061	1,994	- 67	360	369	9
Onotoa	16	1,927	2,100	173	377	431	54
Tamana	5	1,378	1,385	7	267	263	- 4
Arorae	9	1,470	1,440	- 30	292	276	- 16
Washington	10	451	936	485	67	163	96
Fanning	34	445	1,309	864	69	244	175
Christmas	388	1,731	2,537	806	288	341	53
Canton	9	24	45	21	5	8	3
Total	726	63,877	72,335	8,458	10,160	11,301	1,141

Table 10.1-2 Statistic Data for Each Island
Economic data in 1985

Name of Island	(1,000A\$)				Total	(A\$)	(A\$)
	Sale of Fish	Sale of Copra	Salary, Wages	Remit- tance		Income/ person	Income/ house
Banaba	--	--	32	1	33	726	3,322
Makin	48	143	213	45	449	253	1,566
Butaritai	188	228	581	146	1,142	315	1,966
Marakei	144	222	319	65	749	278	1,615
Abaiang	127	243	591	29	990	226	1,528
North Tarawa	293	128	300	22	743	232	1,629
South Tarawa	1,738	--	10,924	986	13,648	638	4,695
Maiana	34	184	278	89	585	273	1,658
Abemama	235	296	456	109	1,096	370	2,228
Kuria	69	133	135	12	350	332	2,033
Aranuka	23	330	205	15	573	582	3,313
Nonouti	211	225	470	242	1,148	392	2,149
N. Tabiteua	54	274	408	55	790	249	1,337
S. Tabiteua	26	--	246	14	286	216	1,161
Beru	147	95	405	69	716	265	1,374
Nikunau	33	175	251	20	479	232	1,331
Onotoa	112	144	248	39	544	282	1,442
Tamana	20	96	186	14	316	230	1,185
Arorae	38	81	173	7	299	203	1,023
Washington	--	68	--	--	68	151	1,015
Fanning	--	22	--	2	24	53	343
Christmas	--	23	1,199	20	1,242	718	4,313
Canton	--	--	--	2	2	102	491
Total/Average	3,542	3,110	17,620	2,001	26,273	411	2,586

10.1.2 Electricity in Kiribati

The commercial electricity supply in Kiribati is provided by a state-owned organization, the PUB(Public Utility Board). The PUB covers only South Tarawa(and a small part of North Tarawa plus Kiritimati Island).

Table 10.1-3 Number of Electricity Customer (31 Dec. 1988)

Customer	Number
Domestic	1,992
Industrial	252
Commercial	259
Total	2,503 (on South Tarawa)

Table 10.1-4 Facilities for generation in Betio, South Tarawa

Maker & Model	Nominal Rating	Actual Rating	Date of Install.	Operation H. 1983	Operation H. 1987	Actual State
English Electric 4 SRK	300KW	260KW	1968	44,186	57,119	Working
English Electric 4 SRK	300	260	1968	--	--	Broken Down
English Electric 4 SRK	300	260	1968	43,209	45,050	Working
Ruston VCBAG	140	100	1968	17,021	22,917	Not Used
English Electric 4 SRK	300	260	1968	11,563	15,912	Broken Down
English Electric 6RK3C	750	600	1976	31,333	45,579	Overhaul
English Electric 6RK3C	750	600	1976	32,798	46,265	Working
Wartsila	1,000	1,000	1988			Working

10.1.3 Financial situation of PUB (from 1990/91 Annual Report)

As of the 1991 PUB annual report, the electricity tariff remained at 29 c/KWh for domestic customer and 33c/KWh for commercial and industrial consumers, with these rates coming into effect on 1 December 1988 based on the price of oil at 43 c/liters.

(In 1992, the tariff changed to 32 c/KWh for domestic customer and 39 c/KWh for commercial and industrial consumers)

Table 10.1-5 Budget summary 1990/91 Electricity Fund (A\$)

	1989/90	1990/91	(difference)
Total revenue	2,277,000	2,363,000	
Less Subsidy from Government	28,000	19,000	
Revenue generated from operation	2,249,000	2,344,000	(+95,000)
Less expenses	1,988,560	2,252,966	(+264,406)
Profit generated from operation	260,440	91,034	(-169,406)

Table 10.1-6 Electricity produced

	1989/90	1990/91	
Residential	1,638MWh	1,679MWh	
Commercial	1,500	1,536	
Industrial	3,500	3,773	
Total	6,638	6,988	(+350)

Table 10.1-7 Expense budget

	1989/90	1990/91	(difference)
Payroll cost:			
Generation & Mechanical	110,000	126,500	(+16,500)
Distribution & Transmission	178,000	186,000	(+ 8,000)
Shared cost:			
Finance & Accounting	83,100	137,400	(+54,300)
Personnel & Administration	149,460	201,066	(+51,606)
Other cost:			
Generation & Mechanical	1,156,500	1,262,000	(+105,500)
Distribution & Transmission	311,500	340,000	(+28,500)
Total	1,988,560	2,252,966	(+264,406)
Unit cost c/KWh sent out	29.95	32.24	(+2.29)
(Generation & Mechanical)	19.08	19.87	(+0.79)

10.1.4 Photovoltaic systems in Kiribati

In Kiribati, it is estimated that about 200 PV systems have been installed since the early 1980's but poor design combined with a low quality of system components, a lack of the proper installation technology and insufficient maintenance has left few systems working properly.

A partial survey of PV systems was conducted by the Solar Energy Company in 1990 on several villages and comprehensive survey was done in 1992. The preliminary summary is shown on Table 10.1-8 and Table 10.1-9.

Table 10.1-8 1990 survey result

Island	Village	Building	Main object	Panel	Battery	Cont-roller	Condition year
N.Tarawa	Abaokoro	Island Council	Radio	35Wx1, 53Wx1	100Ahx1	?	6Y fair
ibid.	ibid.	SPC office	Radio	47Wx1	100Ahx1	none	1Y fair
ibid.	ibid.	Police station	Radio Bat.charger	47Wx2	80Ahx2	none	2Y fair
ibid.	ibid.	Medical clinic	Radio Light	35Wx1	none	yes?	4Y poor
Marakei	Rawannai	Co-op	Radio	40Wx1	200Ahx1	yes	3Y fair
			Lightx6	53Wx1	100Ahx1		
ibid.	ibid.	Store	LT15Wx5	53Wx1	90Ahx2	none	3Y fair
ibid.	ibid.	Store	LT20Wx1	40Wx1	100Ahx2	none	3Y poor
Nonouti	Matang	Store	Radio	47Wx1	100Ahx2	yes	1Y fair
			LT15Wx4				
ibid.	ibid.	Medical clinic	Radio	40Wx1	100Ahx1	yes	2y poor
			LT20Wx2				
ibid.	ibid.	Island Council	Radio	40Wx1	100Ahx1	yes	4Y fair
Abamama	Kauma	Church	Light Appliances	45Wx75	150Ahx42	yes	1988
						?	
ibid.	ibid.	Household	Light	40Wx1	120Ahx1	?	? fair
ibid.	Manuco	ibid.	Light Water pump	52Wx2	93Ahx4	?	1988 fair
ibid.	ibid.	Church	Light Water pump (0.5Hp)	28Wx70	93Ahx 70	yes	1982 fair
ibid.	Taria-tebike	Police station	Radio	30Wx2	? x12	?	? fair
ibid.	ibid.	Telecom	Radio	30Wx1	100Ahx1	?	1985 fair
ibid.	ibid.	Warehouse	Radio Light	30Wx1	93Ahx1	?	1983 fair
ibid.	ibid.	Household	Radio	30Wx1	93Ahx1	?	1987

Table 10.1-9 Comprehensive Survey Result of PV system in Kiribati

Name of Island	Number of PV systems	Utilization of PV system for:																		
		Lighting	Lighting+ Radio/Tape	Lighting+ CB	Lighting+ Radio	Lighting+ Pumping	Refrigerator	Communication	Pumping	Others										
① BANABA																				
② MAKIN	8	6									1		1							
③ BUTARITARI	12	7			3															2
④ MARAKEI	22	15			1		1				1		2							2
⑤ ABAIANG	22	13									1		4							4
⑥ NORTH TARAWA	11	6			2						1		2							
⑦ SOUTH TARAWA	--																			
⑧ MAIANA	33	16	6	4							1		2							4
⑨ ABEMAMA	51	41		3		1					1		2							3
⑩ KURIA	15	7		3							1		3							1
⑪ ARANUKA	11	4		2							1		1							3
⑫ NONOUTI	12	6		4							1		1							
⑬ TABITEUA NORTH	14	6		2							1		3							2
⑭ TABITEUA SOUTH	8	7		1																
⑮ BERU	7	2		3							1		1							
⑯ NIKUNAU	14	4									1		2							7
⑰ ONOTOA	13	11											2							
⑱ TAMANA	10	6									1		2							1
⑲ ARORAE	12	7	1								1		1							1
⑳ WASHINGTON	unsurveyed																			
㉑ FANNING	unsurveyed																			
㉒ CHRISTMAS	unsurveyed																			
㉓ CANTON (KANTON)	unsurveyed																			
TOTAL	275	164	7	28	2	14	29	11	20											

10.1.5 Outline of Electrification Projects

There are several electrification projects which have been or are being examined including Photovoltaic electrification, some of them are:

(1) Future Power System Expansion examined by New Zealand consultant Krta and Cooper & Lybrand. (March 1990)

This study has covered technical and economic aspects of immediate and future requirement for the Tarawa Power System.

Proposed extension in Fiscal Year 1990/91 of the 11KV cable system and associated distribution to Nabeina is assumed viable provided that due attention is paid to careful design to minimize equipment requirement for the system.

Electrification of North Tarawa to Nabeina and on-going load growth will increase peak demand to such a level that an additional 1 MW diesel generator will be required at Betio in 1994.

Electrification of the rest of North Tarawa from Nabeina to Buariki is viable if the principle of isolated small generating station is adopted, as the large transmission distances involved and low population density means that cable extension from the existing system is not justifiable in the near future.

(2) Kiribati Energy Conservation Project examined by Biomass Technology Group of University of Twente in Netherland (November 1988)

(a) Solar Photovoltaic Battery Charging, Kiritimati Island

The project originally was aimed at the installation of six individual solar photovoltaic radio battery charging kits and a central PV-system for charging automotive battery types on Kiritimati, Washington and Fanning Islands.

Due to the examination and consultation with the authorities involved the proposal was changed to "PV-systems for village community buildings Tabuaeran on Fanning Island. The project has been again changed to provide Photovoltaic power supply for telephone communication on Kiritimati Island.

(b) Solar Photovoltaic Lighting for Outer Island Communication Stations

The original project proposed was based on the assumption that all outer island communication stations are required to operate at night as well as during the day.

As presently lighting is provided with kerosene lamps, the project would make a substantial improvement by providing these stations (22 in number) with photovoltaic lighting systems.

The present communication between outer islands and South Tarawa, which uses HF radio stations owned by Telecom, will be replaced by VHF-telephone, which also will be owned by Telecom but operated by the Island Councils.

A project was suggested to change the communication system to be operated by a PV-system, so two parallel PV-systems may be installed.

The project would thus provide two PV arrays and two batteries, designed to work separately for radio communications and the lighting function.

Islands where systems should be installed with priority are:

1st. group; Marakei, Abaiang, N.Tarawa, Maiana, Abemama, Tabiteua

2nd. group; Kiritimati, Washington, Fanning, Canton

3rd. group; the rest

(3) Rural Electrification with stand-alone PV-system.

This project is one of the EC (European Community) support programmes for the developing countries (Lome II Regional energy project).

The project consists of 250 PV stand-alone systems for individual household lighting systems and they will be installed on Marakei, Nonouti and some are to be in North Tarawa along with those provided by JICA.

The system outline is:

PV panel	50W x 2
Battery	100Ah x 1
Controller	1
Light	11W FL x 1
	7W FL x 2
	night lamp x 1

10.2 Proposal of Rural Electrification Program

10.2.1 Objectives of Electrification

The objective of rural electrification of Kiribati is for all Islands except for South Tarawa and Kiritimati.

Table 10.2-1 The basic data for these Islands

Name of Island	village	Household	Maneaba	Clinics	School
Banaba	3	62	0	1	1
Makin	2	295	2	2	3
Butaritai	8	633	6	5	7
Marakei	8	443	7	3	5
Abaiang	18	743	15	6	7
N.Tarawa	14	551	10	3	9
Maiana	13	378	9	3	3
Abemama	8	534	6	4	4
Kuria	4	187	3	2	1
Aranuka	3	169	2	2	2
Nonouti	8	539	6	4	7
N.Tabiteua	12	586	10	5	8
S.Tabiteua	6	250	4	3	4
Beru	9	539	6	3	3
Nikunau	6	369	4	3	3
Onotoa	7	431	7	3	5
Tamana	3	263	2	1	1
Arorae	2	276	2	1	1
Washington	5	163	2	2	1
Fanning	8	244	4	2	3
Canton	1	8	1	1	1
Total	148	7,663	108	59	79

10.2.2 Procedure for PV rural electrification

(1) The first step target is to electrify about 20% of households on each Island plus the Maneabas, schools, clinics, churches and Island Council buildings that want and are able to pay the maintenance fee.

(2) Field technicians should be trained on each Island to maintain the PV systems to be installed and their fees should be met by the monthly payment of users.

(3) Field technicians will initially cover about 75 systems per person within the area they can easily visit on foot or bicycle.

After they become used to their job, the number of customer covered by them will increase to about 100.

(4) SEC is to be responsible for the installation of the systems, supply of spare parts, training of field technicians and the fund for replacing the battery and other failed parts.

(5) The basic concept of this rural electrification is as follows:

(a) Users are supplied electricity generated by a PV system installed close to their house.

(b) The systems belong to SEC and SEC is responsible to maintain these systems.

(c) Users pay the monthly fee for the service of supply of electricity.

(d) SEC installs the PV systems for which the investment will be covered by the Government or funded from overseas Aid or Grants.

(6) After the first stage electrification is finished, PV systems will have been introduced on each Islands and there will be field technicians for the maintenance of systems. Then new or additional installation of PV systems in Kiribati will be easily supported by the SEC and existing field technicians.

The estimated number of PV systems and field technician in the first stage of PV rural electrification is shown in Table 10.2-2.

Table 10.2-2 Estimated number of PV systems at first stage.

Name of Island	Household		Maneaba Clinic		School	Number of Systems	F.Tech
		20% of HH					
Banaba	62	12	0	1	1	14	0*
Makin	295	59	2	2	3	66	1
Butaritai	633	127	6	5	7	145	2
Marakei	443	89	7	3	5	104	2
Abaiang	743	149	15	6	7	177	3
N. Tarawa	551	110	10	3	9	132	2
Maiana	378	76	9	3	3	91	2
Abemama	534	107	6	4	4	121	2
Kuria	187	37	3	2	1	43	1
Aranuka	169	34	2	2	2	40	1
Nonouti	539	108	6	4	7	125	2
N. Tabiteua	586	125	10	5	8	148	2
S. Tabiteua	250	50	4	3	4	61	1
Beru	539	108	6	3	3	120	2
Nikunau	369	74	4	3	3	84	2
Onotoa	431	86	7	3	5	101	2
Tamana	263	53	2	1	1	57	1
Arorae	276	55	2	1	1	59	1
Washington	163	33	2	2	1	38	1
Fanning	244	49	4	2	3	58	1
Canton	8	2	1	1	1	5	0*
Total	7,663	1,543	108	59	79	1,789	31

* User maintained with annual visit by the SEC technician

10.2.3 Systems to be installed

The PV systems for rural electrification will be designed assuming the main purpose of electricity for households is for lighting while for other buildings is lighting, communication (CB radio) and radio/VCR use.

Table 10.2-3 Main component of PV system

	Household	Other buildings
PV array	50W x 2	50W x 10
Battery	100Ah x 1	100Ah x 4
Controller	1	2

Systems should be designed after the user's needs are surveyed thoroughly

Table 10.2-4 Materials to be required for the first stage electrification

	Household	Other building	Total
PV panel(50W)	1250 x 2 = 2500	250 x 10 = 2500	5000
Battery(100Ah)	1250 x 1 = 1250	250 x 4 = 1000	2250
Controller	1250	250 x 2 = 500	1750

10.2.4 Assumed installation schedule

The first stage electrification assumed to be installed in five years, work requirement for each year are as follows.

Table 10.2-5 Installation schedule

year	First	Second	Third	Fourth	Fifth	Total
Training of F.T*	6	6	6	6	6	30**
Installation of household system	250	250	250	250	250	1250
Installation of other building	50	50	50	50	50	250

* Field Technician

** including each one of Banaba and Canton

In the JICA's study experiences, it seems practical for the SEC to install 300 to 400 PV systems in each year with assistance from local labor.

If we suppose the cost of PV system as 20A\$/W for PV array output, the installation fund for the first stage electrification is estimated as follows:

Table 10.2-6 Installation cost (1,000A\$)

year	First	Second	Third	Fourth	Fifth	Total
Installation of household system	500	500	500	500	500	2500
Installation of other building	500	500	500	500	500	2500
Total	1000	1000	1000	1000	1000	5000

The total project cost will come to roughly five million Australia dollars including the labor cost for installation.

10.2.5 The case study of rural electrification

Under the several preconditions, the simulation results shows the first stage of electrification by PV systems is viable.

The preconditions are:

- (a) Initial investment is provided by government or foreign Aid.
- (b) Users pay installation fee(50A\$) and monthly maintenance fee(9A\$/M).
- (c) Degradation of system components is PV panel(2%/Y), battery(5Yrs) controller(10Yrs).
- (d) Exchange cost of system components is PV panel(350A\$), battery(150 A\$), controller(120A\$).

Through the first stage, neglecting depreciation, the income will cover the cost. (see the Table 10.2-7).

Table 10.2-7 Case study of rural electrification

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Profit & Loss Items	Cost	1	2	3	4	5	6	7--10	11	12	13--15	16	17	18	19	20	
Policy & Environment	Unit cost of H.H	2000.0															
	Unit cost of O.B	10000.0															
	Unit cost of panel	350.0															
	Unit cost of Battery	150.0															
	Unit cost of control	120.0															
	Wage of Field Tech.	2000.0															
	Inst. fee per Unit	50.0															
Maint. fee per year	108.0																
Sales	No. of Inst. Unit H.H		300	250	250	250	250	250									
	No. of Inst. Unit O.B		5	50	50	50	50	50									
	accum H.H		300	550	800	1050	1300	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550
	accum O.B		5	55	105	155	205	255	255	255	255	255	255	255	255	255	255
	Sales of Install		15,250	15,000	15,000	15,000	15,000	15,000									
	Sales of Maintenance		32,940	65,340	97,740	130,140	162,540	194,940	194,940	194,940	194,940	194,940	194,940	194,940	194,940	194,940	194,940
Total Income		48,190	80,340	112,740	145,140	177,540	209,940	194,940	194,940	194,940	194,940	194,940	194,940	194,940	194,940	194,940	
Variable cost	Number of panel	2.0 %		13	33	53	73	93	113	113	113	113	113	113	113	113	
	Number of Battery	5years						320	450	770	450	450	770	450	450	450	
	Number of controller	10years								310	350	350	350				
	Cost of panel		0	3,900	9,900	15,900	21,900	27,900	33,900	33,900	33,900	33,900	33,900	33,900	33,900	33,900	33,900
	Cost of battery		0	0	0	0	0	48,000	67,500	115,500	67,500	67,500	115,500	67,500	67,500	67,500	67,500
	Cost of controller		0	0	0	0	0	0	0	31,000	35,000	35,000	35,000	0	0	0	0
	Total Var. Cost		0	3,900	9,900	15,900	21,900	75,900	101,400	180,400	136,400	136,400	184,400	101,400	101,400	101,400	101,400
Fixed cost	Number of Field tech		5	11	17	23	29	35	35	35	35	35	35	35	35	35	
	Wages of Field Tech.		10,000	22,000	34,000	46,000	58,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000
	Administration	15.0 %	1,500	3,300	5,100	6,900	8,700	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500
	Total Fixed Cost		11,500	25,300	39,100	52,900	66,700	80,500	80,500	80,500	80,500	80,500	80,500	80,500	80,500	80,500	80,500
	Total cost		11,500	29,200	49,000	68,800	88,600	156,400	181,900	260,900	216,900	216,900	264,900	181,900	181,900	181,900	181,900
(Investment cost)		650,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	0	0	0	0	0	0	0	0	0	
Income from Opn.		36,690	51,140	63,740	76,340	88,940	53,540	13,040	-65,960	-21,960	-21,960	-69,960	13,040	13,040	13,040	13,040	
Net Present Value	r=10%	230,682															

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