Solomon Islands

Ministry of Mines, Energy and Rural Electrification (MMERE)

Solomon Islands Electricity Authority (SIEA)

Summary Report

Solomon Islands

Pilot Survey for Disseminating SME's Technologies for Introduction of Utility Interactive Grid-Connected Photovoltaic Generation System Possessed in Okinawa Prefecture for Small Island Regions

May, 2015

Japan International Cooperation Agency

Okinawa Kobori Electric Co., Ltd

1. BACKGROUND

The National Development Strategy compiled by the Solomon Islands (Solomon) Government (2011-2020) states that one source of tribal conflict is regional economic disparities and that one of its goals is to reduce poverty and address economic disparities through economic growth. However, a delay in key industrial and social infrastructures such as transportation, water, power, and telecommunications has become a major obstacle in promoting economic activities and industrial development.

The power supply also has structural and geographical disadvantages, and the rates for electricity, which is indispensable in a daily life, has become very expensive (Solomon: approx. 100 ¥/kWh, Japan: approx. 22 ¥/kWh as of May, 2015. * rate 15.35 ¥/SBD). Currently, most of the power in the Solomon Islands is dependent on diesel generated power which uses imported fuel. This volatile energy supply structure is susceptible to soaring fuel prices, and the people want it to be rectified as soon as possible. Solomon has natural conditions suitable for solar power, and they are promoting renewable energy, but the grid-connected photovoltaic power generation system (hereinafter referred to as "grid-connected PV system") has not been introduced. On the other hand, in 2012, research conducted by relevant ministries such as the Ministry of Environment Climate Change, Disaster Management & Meteorology confirmed that there is a need for a grid-connected PV system to be installed.

On these backgrounds, Okinawa-Kobori Electric Co., Ltd. which has the technology of the grid-connected PV system combined with commercial small-capacity power conditioner (PCS), implemented the Survey with the aim to further promote the introduction of renewable energy and assist in improving the power situation in the Solomon Islands by transferring Okinawan technology as well as explore the possibility of Japanese small and medium enterprises expanding business overseas with the transfer of grid-connected PV technology through this Survey.

Current development issues for the target field

- Promotion of Renewable Energy deployment：The suitable natural conditions for solar power are existed in Solomon, but currently most all power is produced by imported diesel fuel.
- Revision of expensive electric rates：Since power is produced by imported fuel, electric rates are very expensive.
- Revision of the vulnerable energy supply structure：It is susceptible to high prices of imported fuel.

2. OUTLINE OF THE PILOT SURVEY FOR DISSEMINATING SME'S TECHNOLOGIES

(1) Purpose

In this Dissemination and Demonstration Project, Okinawa Kobori Electric aims to use its technology of a grid-connected PV system which combines commercially available small-capacity power conditioners (PCS) to further promote the deployment of renewable energy and demonstrate a model to improve the power situation in the Solomon Islands. At the same time, we aim to build a

model which will serve as a foothold for our business development as well as for small and medium enterprises in Japan by transferring grid-connected PV technology.

(2) Activities

① Investigation of PV system

(a) To examine the optimal specs and layouts of grid-connected PV system Based on the situation of electric power demand (14MW) and power-supply equipment in Solomon,

(b) To design an outline of grid-connected PV system for the first field survey.

(c) To collect relevant information such as general electricity conditions, regulations, location details, etc. from MMERE and SIEA.

② Field survey

(a) To explain the entire Survey to the counterparts and consult about the installation.

③ Structural calculation and detailed design

(a) To design the details of system such as structural calculation based on information from the first field survey.

④ Spec finalization

(a) To finalize the spec of PV system.

(b) To start selection of contractors in Solomon.

⑤ Conclusion of contract and equipment procurement

(a) To sign the contract between Okinawa-Kobori Electric Co., Ltd. and the contractor in Solomon.

(b) To set procure and transport the equipment.

⑥ Installation work and test run

(a) To carry out the installation work (foundation work, steel frame assembly work and electric work) supervised by Okinawa-Kobori Electric Co., Ltd.

⑦ Training and Dissemination activities

(a) To confirm the pilot grid-connected PV system of several dozen kW and training

(i) To confirm the local adaptability about the combination technology of multiple PCS.

(ii) To prepare the maintenance manual.

(iii)To provide lectures on operation and maintenance as below for the counterparts and the PV-related companies.

・Principles and basic knowledge of PV power generation system

・Features of a grid-connected PV system

・Facility planning method for grid-connected PV system

・Consideration issues of grid-connected PV system during implementation:
・Operation methods (inspection, operation)
・Maintenance
・Troubleshooting

(b) Verification of year-round power generation

(i) To monitor the amount of power generated by the grid-connected PV system and the reduction of fuel used by diesel power generators based on this data.

(c) Business model consideration

(i) To collect information of the go-going plan for a large-scale PV system implementation to seek the future business opportunities.

(ii) To appeal the results and advantages of the technology to the counterpart and PV-related companies, etc.

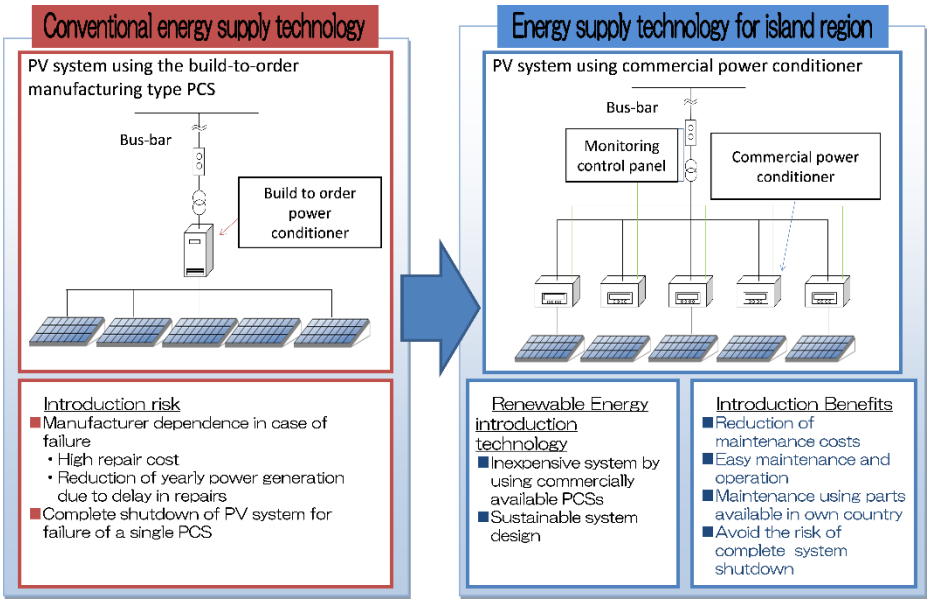
⑧ Final report

(a) To conduct a seminar for the counterparts, related ministries and PV-related companies to demonstrate the utility of the grid-connected PV system with the conclusion and date of the Survey.

(b) To draw up the final report and share it with MMERE and SIEA

(3) Information of Product/Technology to be Provided

Name	Grid-Connected PV System for Small Island Regions	
Specifications	Solar cell	Thin-film Silicon multijunction solar cells JET model U-ZE115 (Output 115W)
	Power conditioner for PV system	PV1000 : Yasukawa Electric With autonomous operation, connection box 10 kVA 50A JET certified product, 10 year warranty
	Power collection and transformer board	3-phase 3-wire 200V and 5-circuit 75kVA 3-phase 3-wire 200V/3-phase 4-wire 415V

<table>
<tr><td>Features</td><td>Our technology combines multiple commercially available small capacity PCSs creating a system that can be sustainably operated and maintained by the owners of grid-connected PV system without depending on manufacturers.
 
</td></tr>
<tr><td>Size</td><td>123.435 m²/10 kW system</td></tr>
<tr><td>Quantity of equipment installed</td><td>
<table>
<tr><th>No.</th><th>Equipment name</th><th>Model</th><th>Qty</th><th>Delivery date</th><th>Installation site</th></tr>
<tr><td>1</td><td>Solar cell</td><td>U-ZE115</td><td>450 panels</td><td>06/2014</td><td>SIEA parking lot</td></tr>
<tr><td>2</td><td>PCS</td><td>PV1000</td><td>5 units</td><td>06/2014</td><td>SIEA parking lot</td></tr>
<tr><td>3</td><td>Power collection and transformer board</td><td>100 × 600 × 1900</td><td>1</td><td>06/2014</td><td>In substation</td></tr>
<tr><td>4</td><td>Steel frame</td><td></td><td>1 set</td><td>06/2014</td><td>SIEA parking lot</td></tr>
<tr><td>5</td><td>PC</td><td>6300 Pro</td><td>1 unit</td><td>06/2014</td><td>In SIEA office building</td></tr>
<tr><td>6</td><td>17-in. monitor</td><td>LCD-AS172-BK</td><td>1 unit</td><td>06/2014</td><td>In SIEA office building</td></tr>
<tr><td>7</td><td>Actinometer</td><td>LP PYRA03</td><td>1 unit</td><td>06/2014</td><td>SIEA parking lot</td></tr>
<tr><td>8</td><td>Thermometer</td><td>HD9008</td><td>1 unit</td><td>06/2014</td><td>SIEA parking lot</td></tr>
<tr><td>9</td><td>42-in. LCD display</td><td>LCD-V423-N</td><td>1 unit</td><td>06/2014</td><td>In SIEA office building</td></tr>
<tr><td>10</td><td>Nuts and bolts</td><td>Various</td><td>1 set</td><td>06/2014</td><td>SIEA parking lot</td></tr>
<tr><td>11</td><td>Cables</td><td>Various</td><td>1 set</td><td>06/2014</td><td>SIEA parking lot</td></tr>
</table>
</td></tr>
<tr><td>Price</td><td>Manufacturing cost/unit (1 system) = 27,172,000 ¥ (228,413US$) *
Selling price/unit (1 system) = 30,322,000 ¥ (254,892US$) *
Total equipment cost for project 42,621,000 ¥** (358,280US$) *
*1US$ = 118.96¥ (exchange rate at May, 2015)
** Including transportation costs and customs duties, etc.</td></tr>
</table>

(4) Counterpart Organization

Ministry of Mines, Energy and Rural Electrification (MMERE)

PO Box 6 Honiara Solomon Islands

Solomon Islands Electric Authority (SIEA)

PO Box G37 Honiara Solomon Islands

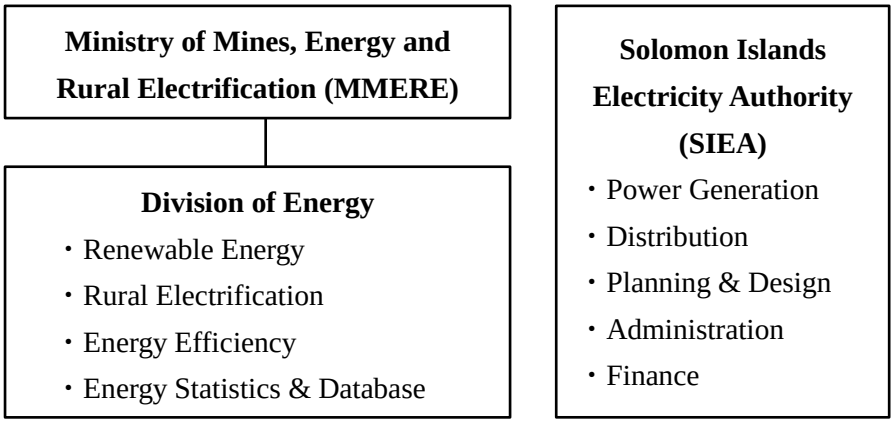


Figure 1 Organization Departments (MMERE and SIEA)

(5) Target Area and Beneficiaries

① Target Area：Honiara, the Solomon Islands

② Direct beneficiaries：MMERE, SIEA, and enterprises dealing with the grid-connected PV systems.

③ Indirect beneficiaries：All people in the Solomon Islands.

(6) Duration

From October, 2013 to May, 2015

(7) Progress Schedule

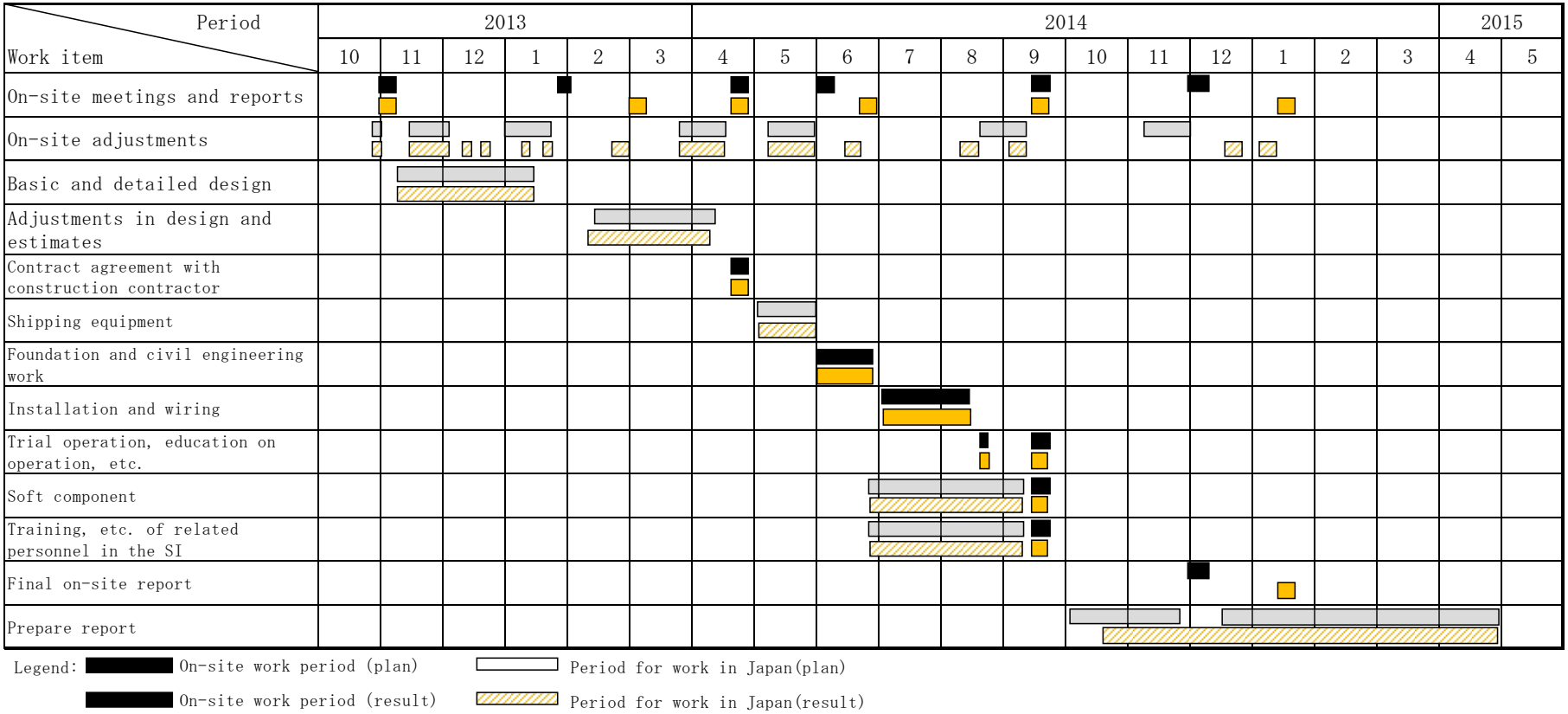


Figure 2 Work process

(8) Manning Schedule

In charge	Name	Company		2013						2014												2015		人・日計	
				10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	現地	国内
Chief of Operations	TOMORI KATSUHIRO	okinawa koboridenki	plan	2 8		18							25		10				5	5				1.10	2.00
			result	2 9	3	1	2	1		2	1 1 1 1	1	3 24	1	2 9 3	5	1	2	4	2	2			1.40	2.00
Chief of Operations(deputy)	UNE YOSHIHIKO	okinawa koboridenki	plan																					0.00	0.00
			result																7					0.23	0.00
Field survey, system design, purchasing, etc.	IKEHRA KAORU	okinawa koboridenki	plan	2 8	5		2 8	3		7	5	25	5	25	7	10		8	8					2.93	2.00
			result	2 9	5	1 1	4	9 3		2 9	10	4	24	6	2 16 1 9 1	2	2		5 4 7	2	2			2.77	2.95
Field survey, system design, and on-site construction	KAMIDA HIDEAKI	okinawa koboridenki	plan	2 8		30				25				25	7	10			8					2.17	2.50
			result	2 9	3	1	2	1		4	10	4	24		1 16 1		1	1	1	1	1	1		1.63	1.75
on-site construction	KINA YOSHITOMO	okinawa koboridenki	plan										25											0.83	0.00
			result								2	1	1 24 2											0.80	0.30
Chief Advisor	KAKEFUKU RUIS	okinawa enetech	plan	2 8		2	2	2 8	4	7		7		12			8	8						1.27	1.50
			result	1 9	3	1	2	9 3		9	4	2			4	3	2	3	2 7					1.13	1.50
Survey, soft component, etc.	FURUKI SATOSHI	okinawa enetech	plan	3 8	10		1 8	2			15				7	5	8	15						1.03	2.75
			result	2 9 2	2 2	1	2 2 9	5		2	2	2 9	4	4	1 9 2	2	2	6	7 1	4				1.43	2.50
Design work	TOUBARU TIHIRO	okinawa enetech	plan						10			7												0.23	0.50
			result					2 1		1 1		1 3	1		1									0.00	0.55
Field and grid survey	UEZU YUMA	okinawa enetech	plan											5	7	6								0.23	0.55
			result					3 1			1	1 9	1		9 1		2	1						0.60	0.55
Grid-connection system design review	MTUMOTO TOORU	okinawa enetech	plan		5				5																0.50
			result			2	4	4																	0.50
On-site coordination, assistant for system design	SIMABUKU MASANORI	okinawa enetech	plan						6																0.30
			result					2 2 2												4					0.50
																								order company Man・Month(plan)	7.03	6.50
																								order company Man・Month(result)	6.83	7.00
																								outside order Man・Month(plan)	2.76	6.10
																								outside order Man・Month(result)	3.16	6.10
																								Man・Month(plan)	9.79	12.60
																								Man・Month(result)	9.99	13.10

legard On-site work
work in Japan

Figure 3 Personnel plan

(9) Implementation Structure

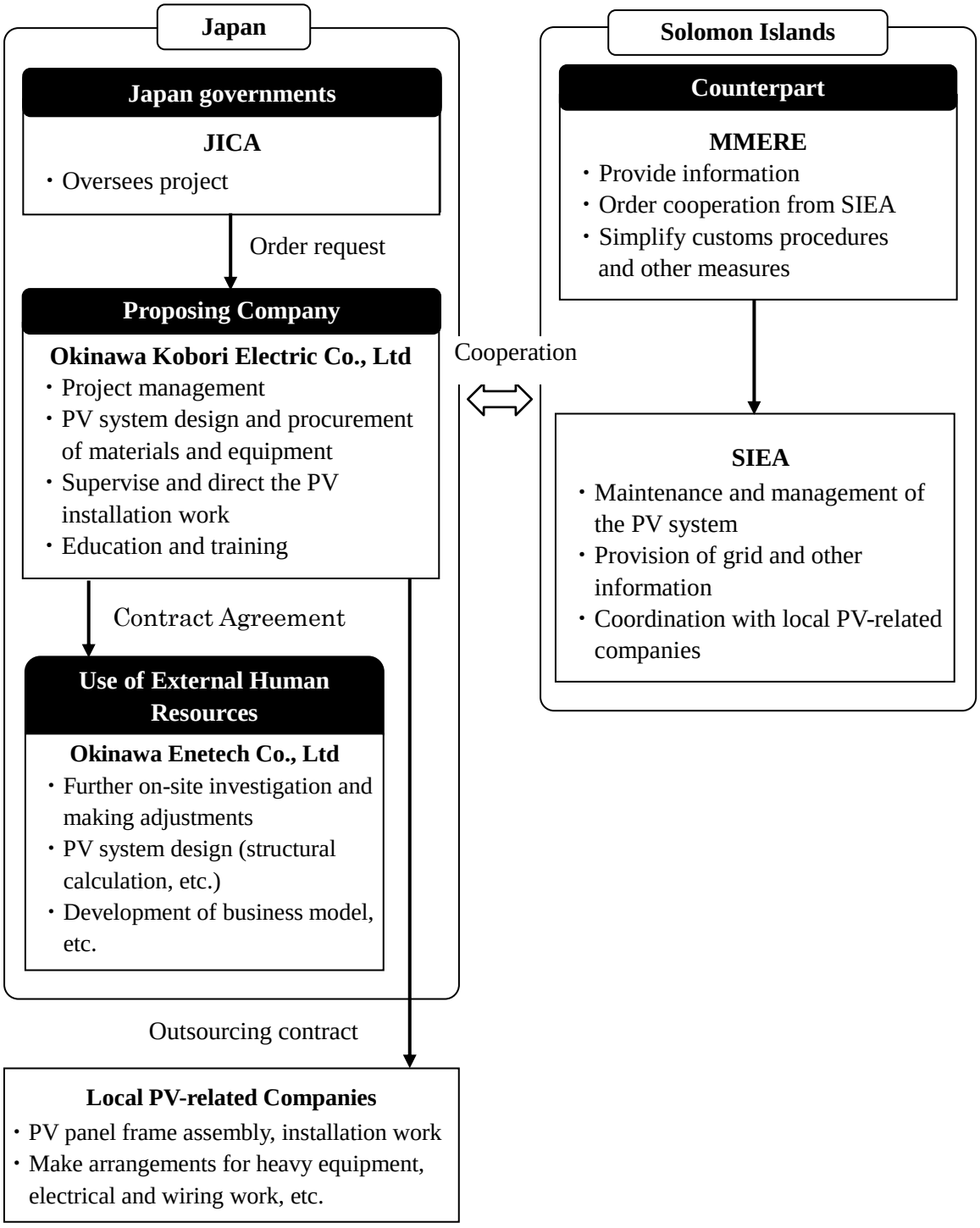


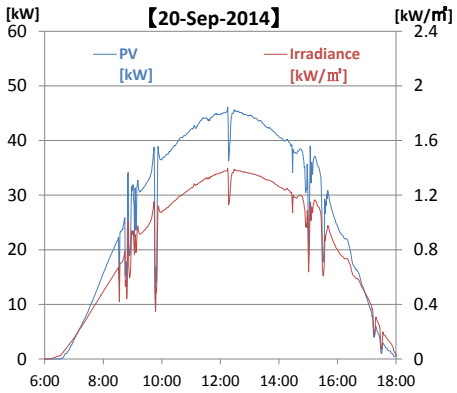
Figure 4 Implementation structure

3. ACHIEVEMENT OF THE SURVEY

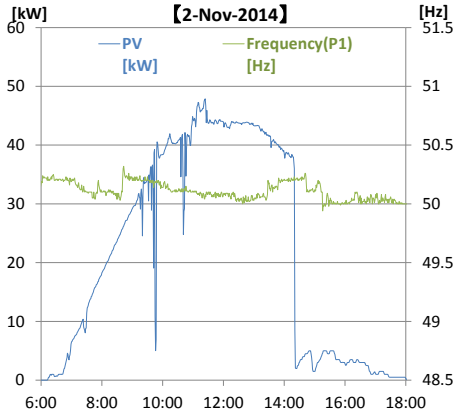
(1) Outputs and Outcomes of the Survey

① Generation status

In this project, the first grid-connected PV system in the Solomon Islands was installed, and Okinawa Kobori Electric demonstrated that its technology is effective in Solomon as well. Figure 5 shows the power generation status during operation.



Comparison of generation output and solar radiation intensity



Comparison of generation output and frequency

Figure 5 Generation status

As can be seen from the comparison of generation output on the left of Figure 5, output follows the pattern of solar radiation intensity, and the system is operating smoothly. In addition, from the comparison of frequency and generation output on the right, steep fluctuations in output have almost no impact on frequency. For these reasons, it is confirmed that this system, which uses JET certified products, is operating effectively on the Solomon grid.

② Amount of power generated

The amount of power generated annually by the 50 kW system deployed will be predicted. Solomon (Honiara) has about 1.3 times the amount of solar radiation (horizontal plane) than Japan, so the environment is optimal for PV installation.

Table 1 Comparison of average solar radiation per month (Honiara and Okinawa) [kWh/m^2/day]

Average solar radiation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Solomon (Honiara)	5.25	4.99	5.05	4.91	4.39	4.19	4.12	4.67	5.21	5.67	5.64	5.35	4.95
Japan (Naha)	2.41	2.77	3.33	4.18	4.52	4.93	5.71	5.25	4.71	3.91	2.94	2.51	3.94

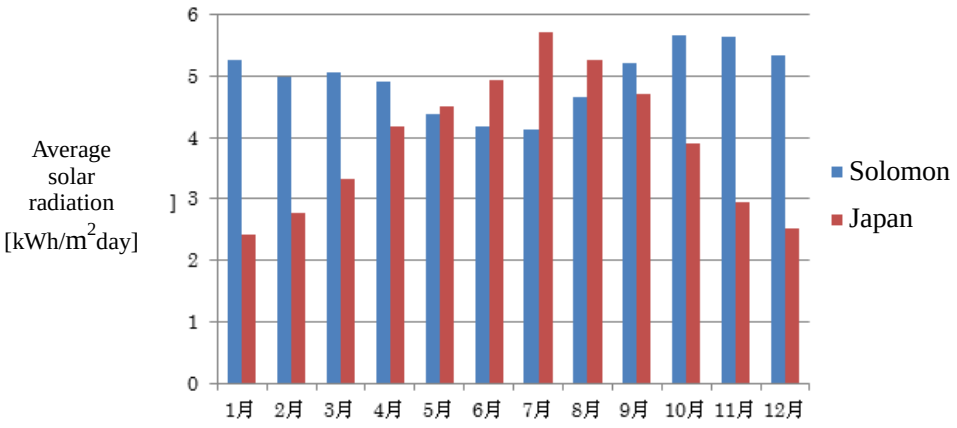


Figure 6 Comparison of average solar radiation per month (Honiara and Okinawa)

Using the following calculation method, the amount of power generated annually was calculated based on this solar radiation data.

Annual power generation $E_P = (P_{AS} \cdot H_A \cdot K)/Gs = P_{AS} \cdot H_A \cdot K \times 365$ days

P_{AS}: solar array output (kW)

H_A: amount of solar radiation based on location and installation conditions (kWh/ m^2/day)

K: Overall design coefficient (0.65~0.8 = about 0.7)

Gs: solar radiation intensity (kW/m^2) in the standard state = 1 kW/m^2

Using the following calculation method,

■Solomon : 50kW calculation results

Power generation $E_P = (P_{AS} \cdot H_A \cdot K) / Gs = P_{AS} \cdot H_A \cdot K \times 365$days

=50 kW × 4.95 kWh/m^2・day × 0.7×365days = <u>63,236 kWh</u>

■Okinawa : 50kW calculation results

=50 kW × 3.94 kWh/m^2・day × 0.7×365days = <u>50,334 kWh</u>

<u>*Comparing the 2 results above, Solomon generation is about 1.3 times of the amount of Okinawa</u>

Measurement data for the amount of power generated in October and November 2014 shows a greater value than the above estimated value. Therefore, assuming the amount of power generated per unit of solar radiation is equivalent to that of October and November throughout the year, it can be expected that the amount of power generated annually will be 74,458 kWh. At this time, the penetration rate for renewable energy is approximately 0.13%.

(Amount of power generated in 2013 in Honiara: About 57,000,000 kWh)

Table 2 Amount of power generated by 50 kW PV system in Solomon per month (actual and predicted)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Solar radiation [kWh/m^2/day]	5.25	4.99	5.05	4.91	4.39	4.19	4.12	4.67	5.21	5.67	5.64	5.35	
Amount of power generated [kWh] (Actual and predicted)	6,526	6,203	6,278	6,104	5,457	5,209	5,122	5,805	6,477	7,616 *	7,011 *	6,651	74,458

*Actual value

Other than the actual values are estimated based on the amount of power generated in November per 1 kWh / m^2/ day solar radiation (7,011/5.64≒1243)

③ Fuel reduction effect

(a) In case of 50kW system

The fuel consumption and fuel cost when the existing diesel generators in Solomon are used to generate 70,000 kWh of power was estimated. The results are shown in Table 3. (Considering 74,458 kWh/year will decline due to some factors, the approximate value is 70,000 kWh per year.)

Table 3 Fuel required to generate 70,000 kWh and its cost

	Diesel generators	PV system
Fuel consumed [ℓ]*1	16,000	0
Fuel cost [US$]*2	17,000	0

* 1 Fuel consumption was estimated using the average fuel consumption rate of each diesel unit of the Honiara power system supplied by SIEA.

* 2 The fuel cost was estimated by multiplying fuel consumption by the unit fuel price provided by SIEA (8.26 SB$). 1SB$ = 0.135US$(average of 2014)

Calculation results show that a 17,000US$ reduction in fuel cost per year can be expected with a 50kW system.

(b) In case of future deployment plan

Based on Solomon's PV deployment goals, we conducted a study on the reduction of diesel fuel consumption for power generation on the following two facilities of different scales.

(ⅰ) 1.5 MW (= 1,500 kW): the capacity of installation plans underway after completing the field survey*

(ⅱ) 2.5 MW (2,500 kW): the maximum amount of PV that SIEA deems can be connected to the grid in its current state

* Draft of "LUNGGA SOLAR POWER STATION FEASIBILITY" conducted by SIEA

The power generation of a 1.5 MW PV system, which was predicted from the power data collected in this demonstration is about 2,200 MWh per year. Even if 2.5 MW of PV is deployed, the power generation expected will be about 3,700 MWh per year.

Economical comparison between existing diesel generators and the 1.5 MW and 2.5 MW grid-connected PV systems is show in the table 4. Fuel consumption and fuel cost when the existing diesel generators are used to generate the same amount of power generated by the PV

systems was estimated .

Table 4 Comparison of fuel consumption and fuel cost (existing diesel generators and PV)

	2,200 MWh		3,700 MWh	
	Diesel	PV	Diesel	PV
Fuel consumed[ℓ] *1	506,000	0	851,000	0
Fuel cost[US$] * 2	560,000	0	940,000	0

* 1 Fuel consumption was estimated using the average fuel consumption rate of each diesel unit of the Honiara power system supplied by SIEA (0.23ℓ/kWh).

* 2 The fuel cost was estimated by multiplying fuel consumption by the unit fuel price provided by SIEA (8.26 SB$). 1SB$ = 0.135 US$(average of 2014)

A fuel cost of 539,163 US$ is expected to generate the amount of power equivalent to the amount generated by a 1.5 MW grid-connected PV system (2,200 MWh) and 906,774 US$ to generate the amount of power equivalent to the amount generated by a 2.5 MW grid-connected PV system (3,700 MWh).

It should be noted that this is a simple calculation, and does not consider stopping operation of the system for failures and parts replacements that occur over the course of 20 years, so fuel costs may not necessarily be reduced by the amounts stated above. However, if the system operates smoothly for 20 years, a reduction in fuel cost on a scale of several billion ¥ to over ten billion ¥ can be expected.

(c) Examples of return on investment

[In the case of a power company (SIEA)]

Recovering the cost of PV installation by reducing such fuel costs is also being implemented in SIEA's field survey. Based on the field survey, SIEA estimated the (approximate) investment payback period when a system made in Japan of the same size as this system is purchased at the cheapest market price and installed. The results are shown in Table 5 and Table 6.

Table 5 Conditions for estimating investment payback period for a 50 kW PV system

System capacity	50	kW
Expected annual power generation	74,000	kWh/year
Initial cost *1	312,000	US$
Maintenance cost *2	84,000	US$/20 years
Total cost	396,000	US$
Fuel cost *3	1.27	US$/ℓ
Generator efficiency *3	3.58	kWh/ℓ
Generation cost *3	0.355	US$/kWh

*1 Referring to materials of the Procurement Price Calculation Committee for Japan's FIT scheme (13th), set at 2,610 US$/kW.

*2 Referring to materials of the Procurement Price Calculation Committee for Japan's FIT scheme (13th), set at 83.86 US$/kW.

*3 Set referring to the draft of the “LUNGGA SOLAR POWER STATION FEASIBILITY" conducted by SIEA.

Table 6　Investment payback period for a 50 kW PV system (approximate reference value)

	Total power generated [kWh/year] *1	Reduction effect [US$/year] *2	Return on investment [US$] *3
Time of installation	0	0	-396,000
Year 1	74,000	26,251	-369,749
Year 2	73,778	26,173	-343,576
Year 3	73,557	26,094	-317,482
Year 4	73,336	26,016	-291,466
Year 5	73,116	25,938	-265,528
Year 6	72,897	25,860	-239,668
Year 7	72,678	25,782	-213,886
Year 8	72,460	25,705	-188,181
Year 9	72,243	25,628	-162,553
Year 10	72,026	25,551	-137,002
Year 11	71,810	25,474	-111,527
Year 12	71,594	25,398	-86,129
Year 13	71,380	25,322	-60,808
Year 14	71,165	25,246	-35,562
Year 15	70,952	25,170	-10,392
Year 16	70,739	25,095	14,703
Year 17	70,527	25,019	39,722
Year 18	70,315	24,944	64,666
Year 19	70,104	24,869	89,536
Year 20	69,894	24,795	114,331

*1 Total power generation was calculated by decreasing the guaranteed panel power generation value by 0.3% per year.

*2 Reduction effect(US$/year) = total power generated(kWh/year)×generation cost(0.355US$/kWh)

*3 Sets as a return on investment of the total cost in Table 5.

According to our estimations, even if the Japanese system is adopted as is, SIEA could recover investments in about 16 years if it installs the PV system and continues operations. However, since further economic feasibility can be expected by using cheaper PV modules made in other countries, it should consider our enhanced system construction while considering negotiating with both Japanese and other manufacturers and confirming equipment specifications.

On the other hand, in order to further ensure the accuracy of such estimates, demonstrating quality through stable generation over a long period of time will be required. To this end, the deployment of our system for which adequate salt corrosion and waterproofing measures have been taken, and which has a proven track record of withstanding strong winds as those of typhoons is desirable.

[If the case of customers (public institutions other than SIEA and private enterprises)]

On the other hand, we estimate (rough estimate) the number of years expected to recover investment assuming a public institution other than SIEA or a private sector company installed the system deployed in this project.

When considering the cost of the system, delivery costs, construction costs plus maintenance costs (expected), the total cost is approximately 460,000 US$, and the estimation results based this are shown in Table 7 and Table 8.

Table7 Conditions for estimating investment payback period for a 50 kW PV system

System capacity	50	kW
Expected annual power generation	74,000	kWh/year
Initial cost *[1]	418,000	US$
Maintenance cost *[2]	42,000	US$/10years
Total cost	460,000	US$
Electric rates *[3]	0.905	US$/kWh

*1 Set in reference to the records of this project, includes the frame for the carport.

*2 Referring to materials of the Procurement Price Calculation Committee for Japan's FIT scheme (13th), set at 83.86 US$/kW.

*3 Set in reference to the average value of the three types of electrical charges in 2014 (approximately 6.7SB$/kWh).

Table 8 Investment payback period for a 50 kW PV system (approximate reference value)

	Total power generated [kWh/year]*1	Reduction effect*2 [US$/year]	Return on investment *3 [US$]
Time of installation	0	0	-460,000
Year 1	74,000	66,970	-393,030
Year 2	73,778	66,769	-326,261
Year 3	73,557	66,569	-259,692
Year 4	73,336	66,369	-193,323
Year 5	73,116	66,170	-127,153
Year 6	72,897	65,971	-61,182
Year 7	72,678	65,774	4,592
Year 8	72,460	65,576	70,168
Year 9	72,243	65,379	135,548
Year 10	72,026	65,183	200,731

*1 Total power generation was calculated by decreasing the guaranteed panel power generation value by 0.3% per year.

*2 Reduction effect(US$/year) = Total power generated(kWh/year)×generation cost(0.905US$/kWh)

*3 Sets as a return on investment of the total cost in Table 7.

With this simple estimation, it can be said that Solomon is so optimal for PV installation that investment could be recovered in seven years if the system operates smoothly. However, results differ when a Daily Standby charge is applied. This is a system where the amount the customer bears varies depending on the system's rated output and the customer's contracted electric rate. For instance, a system with a rated output of 50 kW and an electric rate of 0.905 US$/kWh the results are as follows.

Table 9　Daily Standby charge 50 kW PV system

Act rep [%]	kW rating in Times	Inverter Rating [kW]	Rates-Tariff [US$/kWh]	**Daily Standby Charge [US$]**
50%	4.4	4	0.905	**7.964**
50%	4.4	50	0.905	**99.55**

Annual payment amount:　99.55 × 365 ≈ 36,336 US$/year

If Daily Standby charge is considered, this would reverse the results, and recovering investment would not be possible in 10 years (Table10).

Table10　Investment payback period for a 50 kW PV system (approximate reference value)

	Total power generated [kWh/year][*1]	Reduction effect[*2] [US$/year]	Return on investment [*3] [US$]
Time of installation	0	0	-460,000
Year 1	74,000	30,634	-429,366
Year 2	73,778	30,433	-398,932
Year 3	73,557	30,233	-368,699
Year 4	73,336	30,033	-338,666
Year 5	73,116	29,834	-308,832
Year 6	72,897	29,636	-279,196
Year 7	72,678	29,438	-249,758
Year 8	72,460	29,240	-220,518
Year 9	72,243	29,044	-191,474
Year 10	72,026	28,848	-162,627

*1 Total power generation was calculated by decreasing the guaranteed panel power generation value by 0.3% per year.

*2 Reduction effect(US$/year) = Total power generated(kWh/year) × generation cost(0.905US$/kWh)

*3 Sets as a return on investment of the total cost in Table 9.

It is easy to see from these estimates that the dissemination of PV in the private sector would be slowed by the impact of the Daily Standby Charge and as a result, interfere with Solomon's national policy of promoting renewable energy.

(d) Future market research

A survey was conducted by interviewing six customers to probe their interest in a grid-connected PV-system. The interviews were conducted in the following 6 locations. According to the results of the customer survey, the maximum investment at one time for the average private company in the Solomon Islands is 200,000 SBD, so it was determined that deployment would be difficult with an initial cost similar the one for this project. On the other hand, there was less resistance to the initial costs from public institutions, and obtaining the approval of the budgeting authority was important.

Once PV system owners integrate their systems, they will not be able to sell any power that they feed back to the grid to SIEA as there is no FIT or any similar programs in place. However, in such

case, the owner will have to pay a "daily standby charge," so the terms and conditions of disseminating PV systems are not very favorable, and the creation of a better system by SIEA, MMERE, and other relevant officials in the future is desirable.

In addition, we will need to consider adherence to Australian standards in order to sell our system in the future.

Table11 Information on the customers interviewed

No.	Company/organization name	Type	Industry	Size	Investment possible	PV Needs	Business Possibility
1	Hardware Supplies Ltd	Priv	Construction materials Sales	Small	Small	Med	Small
2	Kwaimani Construction Ltd	Priv	Construction	Small	Small	Med	Small
3	GTL Holdings LTD	Priv	Gasoline Station	Med	Small	Med	Small
4	Solomon Islands Broadcasting Corporation	Gov	Radio broadcasting	—	*	Med	Lg
5	King George Ⅵ School	Gov	Education	—	*	Lg	Lg
6	Pacific Casino Hotel	Priv	Lodging	Lg	Med	None	None

*Since budgeting is under Government jurisdiction, it is unclear, but if approved, a sufficient budget can be obtained.

4. FUTURE PROSPECTS

(1) Impact and Effect on the Concerned Development Issues through Business Development of the Product/Technology in the Surveyed Country

For the objective of further promoting the deployment of renewable energy and demonstrating a model to improve the power situation in SB with the introduction of our system, since the installation of SB's first grid-connected PV system was completed, and we are sharing steady power data with SIEA after grid connection, it can be said that some results are being achieved. However, it is necessary to continue to verify PV output data and to have stakeholders in SB recognize the effectiveness of the system, as well as to share information on its effectiveness in reducing diesel fuel consumption with them.

The PV system can continue to generate power for a long time (20 years or more) with proper operation, inspection patrols, and regular maintenance. Also, defects can be detected early by monitoring the amount of power generated. Therefore, we would like the counterpart to continue to use the system over a long period of time by establishing a maintenance system.

Through implementation of the Survey, we expect the following risks in conducting business in Solomon.

- Deficiencies in contracts with local contractors
- Misunderstandings due to differences in business practices
- Incomplete execution due to differences in construction technology
- Theft of equipment

・Differences in land ownership and usage
・Competitors

(2) Lessons Learned and Recommendation through the Survey

① Lessons learned

Risks in conducting business in the future were described above, but the presence of foreign private consultants should also be noted. Foreign private consultants work at SIEA headquarters as their "owners engineers" and they are influential within SIEA. Considering this organizational structure, sharing information frequently among all the parties concerned is important for smooth implementation of surveys and projects. In our case, the construction work for the Survey was completed on schedule with the cooperation of JICA headquarters and JICA Solomon Island Office. We will maintain and further develop our relationship of mutual trust among MMER, SIEA and Kobori which was built through the Survey and seek a mutually beneficial way for both Solomon and Kobori. We believe that this will lead to our business development and the improvement of the power situation in Solomon.

② Recommendations

(a) **Measures to ease the requirement to get Australian certification**

It is desirable for MMERE, SIEA and other stakeholders of supplying power in Solomon to consider not limiting the installation of PV equipment to those that meet Australian standards. This is because although the PV equipment we deployed in this project has not obtained Australian certification, it has obtained JET certification and is operating smoothly. Although further study of operation status is needed, the installation should be allowed hereafter.

(b) Establishing an assistance scheme for the promotion of PV

Solomon does not have a FIT scheme like other countries or an assistance scheme for PV installation.

On the other hand, with additional fees such as the Daily Standby Charge, the situation is unfavorable for those who wish to install PV systems. To promote PV deployment, it would be desirable for MMERE, SIEA, and other stakeholders of supplying power in Solomon to cooperate and come up with an assistance scheme such as partial subsidization of the initial cost.

Attachment: Outline of the survey

THE PILOT SURVEY FOR DISSEMINATING SME'S TECHNOLOGIES

Solomon Islands Pilot Survey for Disseminating Small and Medium Enterprises Technologies for Introduction of Utility Interactive

Outline of the Survey

- Proposed by: Okinawa Kobori Electric Co., Ltd. (Uruma city, Okinawa Japan)
- Target area and Beneficiaries: Honiara, Solomon Islands (SB)
- Counterpart Organization: Ministry of Mines, Energy and Rural Electrification (MMERE), Solomon Islands Electricity Authority (SIEA)
- Duration: October, 2013 – May, 2015

Concerned Development Issues ⟷ Match ⟷ **Proposed Products / Technologies**

- Promotion of Renewable Energy deployment
  Has the natural conditions suitable for solar power, but currently almost all power is produced using imported diesel fuel.
- Revision of expensive electric rates
  Since power is produced using imported fuel, electric rates are very expensive. (As of 2015, assuming 15.35 ¥/SBD: Solomon approx. 100 ¥/kWh, Japan approx. 22 ¥/kWh)
- Revision of the vulnerable energy supply structure
  Susceptible to high prices of imported fuel.

- A PV generation system which combines multiple commercially available small power conditioners (PCS).
  ⇒ Large made to order PCS not required.
  ⇒Sustainable operation and maintenance not dependent on PCS manufacturer support.
  ⇒ Maintenance is quicker and cheaper.
- Measures for high winds and salt corrosion which incorporates experience and knowledge unique to Okinawa, which has environmental and other features similar to Solomon.

Implemented Activities in the Survey

- Deployment of a grid-connected PV system, which uses small PCSs of tens of kWh, suited to the local power demand and power supply equipment (transmission and distribution lines, transformers, etc.) .
- Training stakeholders on the basics of a PV system and its maintenance and preparation of a manual.
- Hold a seminar inviting relevant ministries, and introduce the proposed technology based on the results and data obtained through this project.

Outputs and Outcomes of the Survey

- Completed the installation of SB's first grid-connected PV system and began power generation.
- Share PV power generation data with relevant Solomon ministries, while collecting data on existing power generation facilities.

Business Expansion

- By taking part in SIEA's outline plan to connect the grid-connected PV system to the grid in this project, the proposing company pursues the possibility of business development in Solomon.

Impact on the Concerned Development

- A grid-connected PV system installed and operated as a model case to promote the deployment of Renewable Energy
- Share PV generation data with SB and support mega solar installation in order to address the energy supply structure