Solid Waste Management Office, Department of Public Works, Koror State Government

Summary Report

The Republic of Palau

Verification Survey with the Private Sector for Disseminating Japanese Technologies for Promoting Collection, Segregation and Reduction of Solid Waste by Recycling Plastic Waste to Oil

November, 2016

Japan International Cooperation Agency

Blest Co., Ltd.

1. BACKGROUND

The Republic of Palau (hereafter referred to as "Palau") is a chain of over 200 islands formed by uplifted coral reef and volcanic activities. The total population is approximately 21,000, and its 70% reside in Koror State where commercial activities are centered. Because of its geography and terrain, Palau has inconvenient access to international markets and limited domestic commercial activities between the islands. Natural disasters and climate changes add to the islands' vulnerability. Thus, the country has faced various challenges on the socio-economic development of the country. Moreover, the limited arable land available on the national territory makes agricultural activities at an industrial level almost impossible, resulting in that Palauan have high dependency on imported food products.

Market demands on modern products both from recently increasing tourists and changing lifestyle in the country accelerate import of household commodities as well as food. As a result, greater varieties and quantity of non-biodegradable wastes has been generated. The Integrated Solid Waste Management Plan (the Government of Palau, 2004) reports that the annual amount of municipal solid wastes disposed in the country is estimated to weigh 6,500 tons, of which 2,000 tons is plastic waste.

Palau, similar to her neighbouring island countries that have such a scarce national surface territory, faces difficulty to ensure enough land space for landfills. Securing soil for covering wastes over a landfill for such a country is also a serious issue. Environmental degradation and public health crisis triggered from inappropriate waste management have been important issues for islands countries like Palau and neighbouring countries.

Against this backdrop, the Department of Solid Waste Management, the Bureau of Public Works belonging to the Ministry of Public Infrastructure, Industries and Commerce (hereafter referred to as "SWM-BPW-MPIIC") plans and develops laws, policies and activities relating to solid waste management in Palau. The SWM-BPW-MPIIC is also responsible for operation and management of the largest landfill of Palau located in the Koror state.

In the Koror state, the Department of Public Works of Koror State Government operates the Solid Waste Management Office (hereafter referred to as "Recycling Center") which is the only recycling facility in Palau. The Koror state government has set out a target to increase recycling rate up to 50% of all recyclable wastes, and aims to reduce 30% of waste sent to the landfill compared to that of 2006 under the initiative of the Recycling Center by 2018. To achieve the target, the Recycling Center works on providing environmental education to the residents with a focus on the collection and segregation of recyclable wastes. The Recycling Center has successfully promoted segregation of recyclable wastes, especially organic wastes, glasses, valuable metals, and PET bottles; however, there is still a large quantity of plastic wastes other than PET bottles discarded to the landfill.

It is estimated the existing landfill will reach its maximum capacity within the next two to three years if the waste amount continues to rise at this pace. On the other hand, there is a big challenge to secure enough space for landfilling waste which is increasing constantly. In particular, reducing and recycling plastic waste, which is not bio-degradable, is an urgent issue in order to retain the economic activities and the livelihood of its population in Palau.

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

(1) Purpose

The Survey aims to verify the feasibility of a system for collection, segregation and recycling of plastic wastes by using product Blest will introduce: a machine that extracts oil from plastic waste (hereafter referred to as "plastic-to-oil machine") in the Koror state, with an overall goal of contributing to reduction of waste amount to be landfilled through dissemination of the machine in the country.

(2) Activities

1) Installation, operation and maintenance of a plastic-to-oil machine system

- Blest produced a NVG1000 plastic-to-oil machine and exported it together with two oil generators and other exterior components to the Koror State.
- Blest together with the Recycling Center installed the plastic-to-oil machine, other exterior components and one of oil generators at the Recycling Center. They installed the other oil generator at the Koror Capitol.
- Blest provided training for the operation and maintenance of the plastic-to-oil machine system to the staff of the Recycling Center.

2) Promotion of collection and segregation of plastic wastes

- The Recycling Center called on private organisations which dispose a large volume of plastic waste for establishing cooperation to segregate and collect plastic wastes on a regular basis.

3) Verification of feasibility of plastic-to-oil technologies

- Blest provided guidance and advices to the Recycle Center on how to improve skills for the machine operations through training.
- The Recycling Center checked performance and cleaned the machines and replaced consumable parts for the NVG1000 under consultation with Blest when necessary.
- The Recycling Center kept a record of plastic collection and compiled the data every month.

- Blest provided guidance to the Recycle Center on how to utilize oil extracted from plastic waste for electricity generation, boiler operation, diesel fuel extender, and so on.
- Blest checked the conditions of the machines every three months, and verified the compliance inspection result based on national regulations for safety and environment protection by the Environmental Quality Protection Board of Palau.

4) Improvement of the sustainability of the Survey (power generation from plastic waste oil)

- The Recycling Center generated electric power with a DCA-300ESK generator from plastic oil extracted by the NVG1000 plastic-to-oil machine and in return use the electricity to power the NVG 1000 system.
- The Recycling Center took an operation record of the plastic oil generators.

5) Formulation of a plan to disseminate the plastic-to-oil technologies

- The Recycling Center visited related governmental offices, private organisations, residents and etc., and promote the concept and importance of environmental protection through educational programmes including demonstration of oil extraction from plastic waste by utilising Be-h plastic-to-oil machines.
- Blest made results of the Survey available to the public through its official website, magazines, newspapers and etc. from time to time.
- Blest analysed and made considerations on how to replicate the system to other neighboring developing countries based on the information collection and analysis.
- Blest together with the Recycling Center collected data to update the user's operation manual which introduces on how to adopt a plastic-to-oil machine, improve its oil extraction rate, analyze the cost-benefit, and refer key points of operations for prospective users.

(3) Information of Product/ Technology to be Provided

The items in the following table are provided.

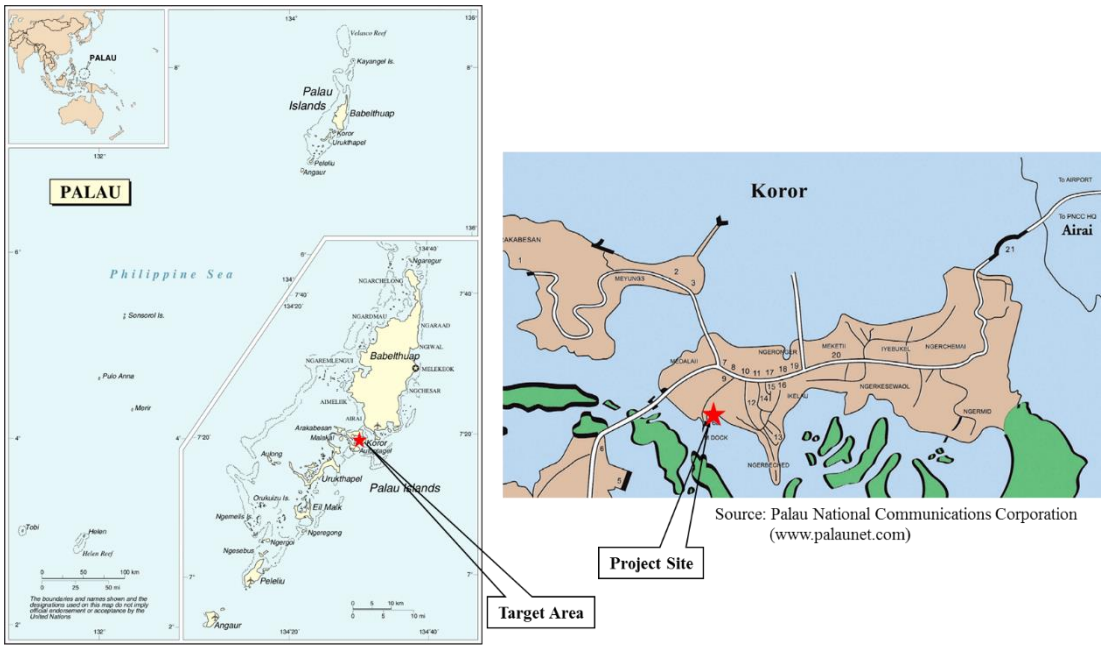
	Specification and Usage	Image
1	**NVG1000 plastic-to-oil-machine (1 unit)**: A machine that extracts 1,000 liter of oil from 1,000kg of plastic per 24hours continuously. Two types of plastics are accepted as ingredient for the machine: polypropylene (PP) and polyethylene (PE). Produced oil with the machine can be	

	used for boilers, diesel fuel extender and so on. The motor of this machine is powered by electricity only.	
2	**Be-h plastic-to-oil-machine (2 units)**: A Be-h extracts 1 liter of oil from 1kg of plastic per 3 hours. This machine is handy, light (50kg), and compatible with home power supply (100-110V, type A outlet). It is useful in experimental activities, educational programme, and demonstration, because the process of extracting oil is observable over the transparent part (grass bottle) of the machine.	
3	**DCA-300ESK and DCA-150ESK power generators (1 unit each)**: DCA-300ESK is a 300kVA generator to install at the Recycling Center, and a DCA-150ESK of 150kVA at the Koror Capital. The both are produced by Denyo Co., Ltd. The power factor is 0.8, and it is connected to a three-phase power supply. The both generators run at 60Hz frequency.	
4	**CS-36 crusher (1 unit)**: A machine that crushes 250 kg of plastic per hour. Size and shape of plastic to load can vary from light to heavy and small to large. Plastic films can be cut too. This machine is produced by Japan-Cim Co., Ltd.	
5	**Pelletizer and a belt conveyor (1 unit)**: A pelletizer is produced by Earth Co., Ltd. This machine re-shapes plastic into pellets to make the flow of light plastic falling into the plastic-to-oil machine smoother and faster. A belt conveyor is attached to the NVG1000 to transport plastic automatically into the entrance of the NVG1000.	 (belt conveyor)
6	**Consumable goods for NVG1000:** A gasket, rubber seals, heat-resistant bolts, a glass tube, anti-seize lubricating compound and so on are provided for training on maintenance.	No Image

(4) Counterpart Organization

Solid Waste Management Office (the Recycle Center), Department of Public Works, Koror State Government, the Republic of Palau

(5) Target Area and Beneficiaries



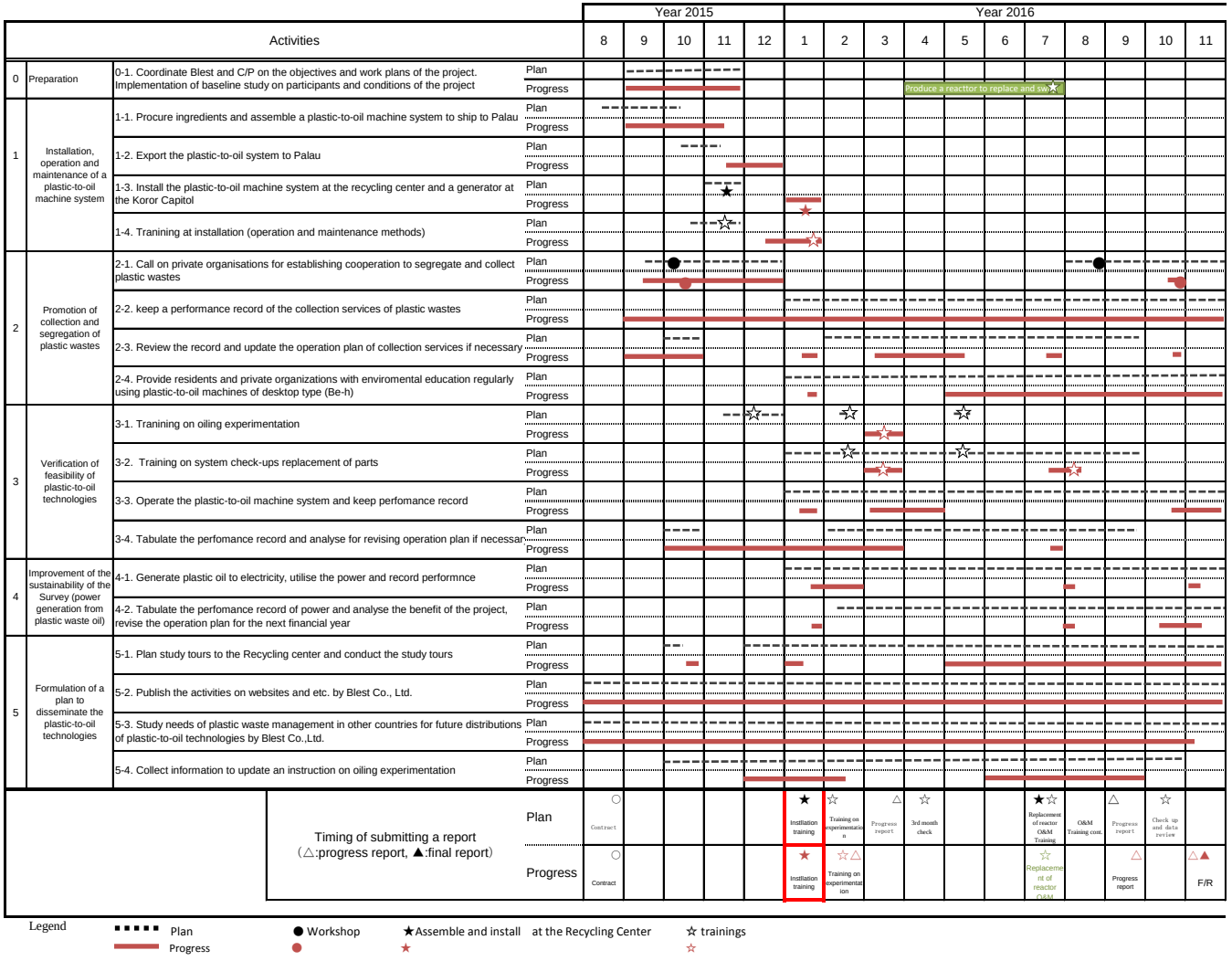
Target area: Koror State　　Project site: Koror State Government Recycle Center

Target beneficiaries: Staff of the Recycle Center, residents and private organisations disposing plastic wastes in the Koror state.

(6) Duration

August 2015 - February 2017（1 year 6months）

(7) Progress Schedule

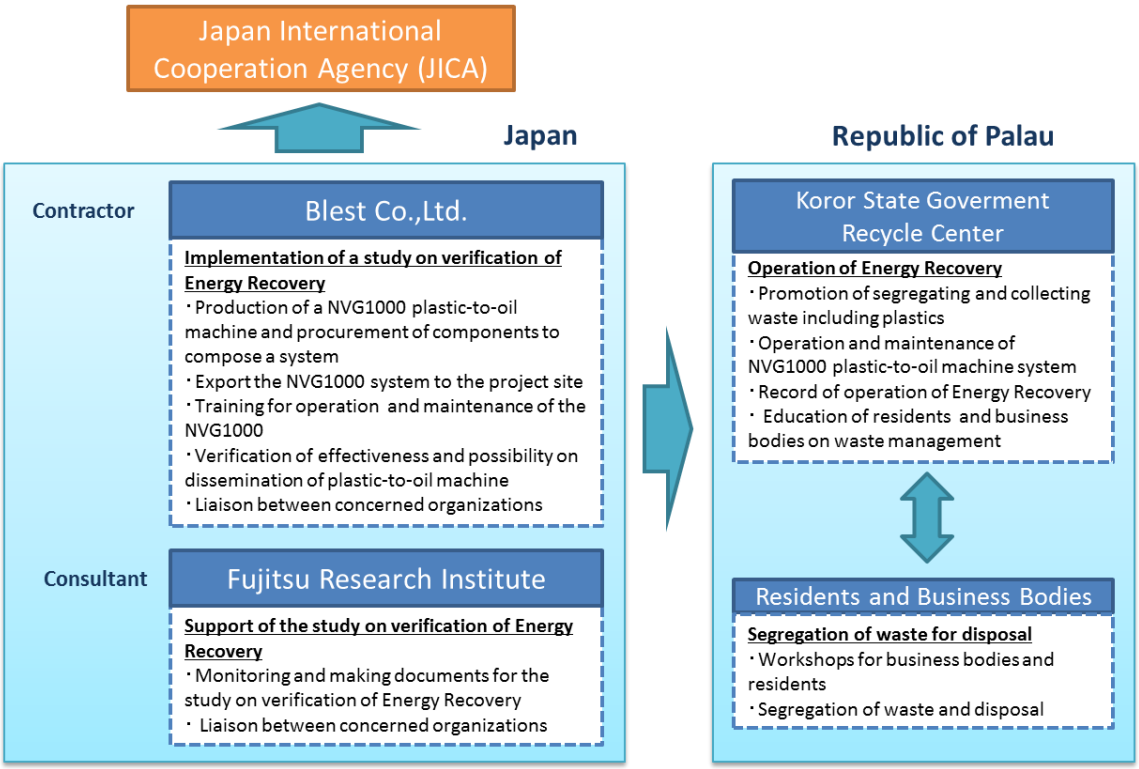


(8) Manning Schedule

Role	Name	Organization	Plan / Result	Year 2015 Aug	Sep	Oct	Nov	Dec	Year 2016 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Palau	Total Japan
Project Leader/Analysis of the Energy Recovery project	Mr Akinori, ITO	Blest Co.,Ltd	Plan	1 6 1	1	1	1	1	1	2	2	1	2	1	1	1	1	1	1 7	1	0.43	1.00
			Result	1 6 1	1	1	1	1	1 5	4	2	3.5	0.5	1	1	1	1.5	1	0.5		0.37	1.10
Vice project leader / Plan of bubiness development	Mr Makoto, TAKIZAWA	Blest Co.,Ltd	Plan	2 6 3	5	1	1		1	2	2	1	3	1	1	1	1	1	1 7	1	0.43	1.40
			Result	2 6 3	5	2	1		1	4	6	5	2	4	4	4	2	1	1		0.20	2.35
Installation and monitoring the plastic-to-oil machine system (Design of plastic-to-oil	Mr Minoru, AOYAMA ⇒from Dec 2015 Hitoshi, ITAGAKI	Blest Co.,Ltd	Plan				2	Changed to Hitoshi, ITAGAKI from Dec													0.00	0.10
			Result																		0.00	0.00
Monitoring and maintenance of the plastic-to-oil machine system	Mr Hidetaka, ITAGAKI	Blest Co.,Ltd	Plan	5	5	15	7		7			1	7								1.20	0.55
			Result	5	5	20	2		1 16	2	1	1	1	9	1	1	0.5				0.53	2.48
Installation and monitoring (Electric circuit)	Mr Kaoru, NAGAI ⇒from Feb 2016 Akihisa, ISHIGAMI	Blest Co.,Ltd	Plan	5	5	7				Changed to Akihisa, ISHIGAMI from Feb											0.23	0.50
			Result	5	5	10	1														0.00	1.05
Verification and Analysis of plastic-to-oil machine	Mr Yoshikazu, EDO ⇒from Jan 2015 Teruyoshi, WATANABE	Blest Co.,Ltd	Plan	2 10 3	5	15 5	3 10		Changed to Teruyoshi, WATANABE from Jan												1.17	0.90
			Result	2 10 3	5	10	10		4												0.33	1.50
Chief advisor/ Assistance on verification of plastic-to-oil machine	Ms Yoshimi, HAYASHI	Fujitsu Research Institute	Plan	2 10 2	5 10	2 15	1 15		10	5 15	10	2	1 15	10	10	1 15	10	5	1 15	2	3.67	3.95
			Result	7 2 10 1 1	5 10	11	7.5		1 22	19.5	11	10	5	2	3	2 9	11.5	8	0.5 11.5 6	5 6.5	2.43	4.50
Research of new market /Asistance of planing business development	Mr Kotaro, FUJIMOTO	Fujitsu Research Institute	Plan		5 10	10		15	10		5		15	5	10		5	5		15	1.83	2.85
			Result	0.5	5 10	5.5	4.5		6 8	7	9	3	2.5		1	3.5	1	1.5 6			1.10	2.05
Installation and monitoring the plastic-to-oil machine system (Design of plastic-to-oil	Hitoshi, ITAGAKI	Blest Co.,Ltd	Plan	Changed from Minoru, AOYAMA from Dec 2015				2				1	3 7							1	0.23	0.35
			Result						5 12	4	23 5	8.5	1.5	1.5	5 20	11 2	0.5	0.5			2.20	1.68
Analysis of verification	Teruyoshi, WATANABE	Blest Co.,Ltd	Plan		Changed from Kazuyoshi, EDO from Jan 2016				5	3 10	5	2	10	2	5	5	3	2	2	1	0.33	2.25
			Result						5 11	7	4	3.5	0.5	1.5	1	0.5	2	1			0.37	1.30
Verification and Analysis of plastic-to-oil machine	Akihisa, ISHIGAMI	Blest Co.,Ltd	Plan			Changed from Kaoru, NAGAI from Feb 2016						1									0.00	0.05
			Result							2	23 6	3.5	1.5	4	5 20	11 2	0.5				1.80	1.23
Research of new market	Yashiaki, SASAKI	Fujitsu Research Institute	Plan													Added on Oct 2016					0.00	0.00
			Result															3.5	3		0.00	0.18
Asistance of planing business development	Masazumi, ANDO	Fujitsu Research Institute	Plan													Added on Oct 2016					0.00	0.00
			Result															4.5	10		0.00	0.23
																				Contractor's Man Months (Plan)	4.02	7.10
																				Contractor's Man Months (Result)	5.80	12.69
																				Consultant's Man Months (Plan)	5.50	6.80
																				Consultant's man months (result)	3.53	6.96
																				Total Man Months (Plan)	9.52	13.90
																				Total Mon Months (Result)	9.33	19.65

Work in Palau
Work in Japan
number in red Cost contributed by each organization

(9) Implementation System



3. ACHIEVEMENT OF THE SURVEY

(1) Outputs and Outcomes of the Survey

The Survey was successfully verified. The collected plastic waste compatible with the Products was and is going to be converted to fossil oil and used to run the NVG1000 plastic-to-oil-machine.

The Counterpart Organization obtained new 37 business participants that contribute to segregating plastic waste from the other types of waste generated in the participant's facilities through a workshop, individual consultations by the telephone and visits, provisions of trash bins for segregating plastic waste. They also came to conduct educational sessions regularly twice a month using two Be-h plastic-to-oil-machines of desktop type with communities, schools and local governments and so on both inside and outside of the Koror State. Those activities resulted in collecting 19,396kg of plastic waste in total for 13 months from the October 2015 to the October 2016, which is estimated a size of 55.5 cubic meters saved in the M-Dock landfill.

(2) Self-reliant and Continual Activities to be Conducted by Counterpart Organization

The Counterpart Organization will continue to operate and maintain the Products: NVG1000 to save energy for the Koror State Government by using oil produced from plastic, Be-h to promote environmental education. When consumable parts stocked in the Counterpart Organization run out, these will be purchased and replaced by the Counterpart Organization.

4. FUTURE PROSPECTS

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

The Survey brought about developing a cooperative relationship between the Counterpart Organization and the private sector through approaches by the Counterpart Organization. There are individuals and business waste collectors who voluntarily brought in segregated plastic waste to the Counterpart Organization's facility at the contributor's costs. Counterpart Organization might want to collaborate more or contract with them to accelerate the collection of plastic waste, as the amount of plastic waste can be expanded from the perspective of the machine's capacity.

(2) Lessons Learned and Recommendation through the Survey

The members of staff working with the Products are equipped with fundamental skills and techniques for the operation and maintenance of the Products. There are some members working in the process of the Survey longer than the others, since there were relocations of staff at times, and therefore those became more skillful. Such staff is expected continuously to share his/her obtained knowledge and techniques with the others and new staff within the Counterpart Organization.

The Koror State Government kindly exempted the provided Products necessary for the Survey from customs duties and VAT imposed in Palau with respect to the import. Also, the Counterpart Organization generously provided the land, the cost for the labor and the building facilities to install the Products.

ATTACHMENT: OUTLINE OF THE SURVEY

The Republic of Palau

Promoting Collection, Segregation and Reduction of Solid Waste by Recycling Plastic Waste to Oil

Blest Co., Ltd（Kanagawa, Japan）

Concerned Development Issues in Palau

- Wastes discarded to the landfill is reduced - Remaining capacity of the landfill lasts 3 years as of 2014.
- Education methods well organized and easy to understand is introduced.
- Negative impacts with degraded national environment on the biggest industry, tourist is mitigated.
- Self-reliance rate of energy is improved.

Implemented Activities in the Survey

- Recycle plastic waste to fossil fuel.
- Establish a method to collect plastic waste.
- Promote environmental education conducted to residents, businesses and governmental organizations.
- Optimize the productivity in the operation of plastic-to-oil-machine system in a stable way
- Produced plastic oil is used to run not only the plastic-to-oil-machine itself but also other facilities.

Proposed Products and Technologies

Plastic-to-oil-machine:
Desktop types (Above) /NVG1000 (Bottom)

Plastic-to-oil-machine

– Converts plastic waste to fossil fuel (1kg of plastic→ 1L of oil)
– Environment-friendly and free from danger. It can reduce CO2 by ¼ in comparison to incineration
– Easy operation and maintenance
– A variety of capacities (1kg-8ton,6 types)

Survey Overview

Name of Counterpart:
Solid Waste Management Office, Department of Public Works, Koror State Government
Survey duration: 18months
Survey Area: Koror State

Impact on the Concerned Development Issues in Palau

- Waste discard to the landfill is reduced - approx. 90.7 tons/year.
- Size of the landfill is saved - 259.5㎥/year
- Importance of waste segregation is acknowledged better and it promotes further reduction of wastes.
- Self-reliance rate of energy is improved and it saves fossil fuel consumed and imported.

Outputs and Outcomes of the Survey

Present

- Plastic-to-oil-machines attract interests of policy makers and business but there is few practice.

Future

- The project will be a business model and its results can be introduced to countries/areas where plastic waste is an issue.
- Profits produced from more sales can be re-invested on educational activities and employment, which contributes to activate the local community and industry