Identification of opportunities for Pacific Island countries and Japan to collaborate through the Clean Development Mechanism (CDM) of the Kyoto Protocol

February 2002

Pacific Consultants Co., Ltd.

Contents

1. Background and objectives of study 1
2. Details of study..... 1
3. Study results
    3.1 Collection of data and documentation..... 3
    3.2 Preparation and distribution of questionnaire to countries in the study..... 3
    3.3 Meeting of related parties during COP-7 4
    3.4 In-country research..... 4
4. Potential CDM projects in each country 7
5. Estimating GHG emission reduction and enhancement of sinks from CDM projects 14

1. Background and objectives of study

Pacific Island Countries (PICs) are among of the most vulnerable to global warming, although they among the world's lowest emitters of greenhouse gases. The aim of this study is to help in the selection of Clean Development Mechanism (CDM) projects to be implemented for those countries in the region, to identify which are the highest in priority and most feasible, and to prepare detailed project proposals.

2. Details of study

The following steps were implemented in this study.

a. Collection of data and documentation

Existing data and documentation were collected and organized relating to each of the 14 countries in the study, including, among other things, the National Communications to the UN Framework Convention on Climate Change; national-level developmental and environmental plans; statistical materials relating to greenhouse gas (GHG) emissions and sinks; past assistance from international and bilateral aid organizations, including Japanese organizations; and the organizational status of potential host organizations. Information collection was carried out in cooperation with the South Pacific Regional Environment Programme (SPREP), the University of the South Pacific (USP) and the South Pacific Applied Geoscience Commission (SOPAC), in addition to the questionnaire survey described in 'b.' below.

b. Preparation and distribution of questionnaire to 14 countries in the study

A questionnaire was prepared to obtain basic information and data relating to the items shown below, with a particular focus on information that would be otherwise difficult to gather elsewhere. It was distributed through SPREP and other organizations with a request for cooperation in providing the information.

c. Analysis of potential GHG emission reductions and mitigation options

(a) Analysis of characteristics of GHG emissions and reduction potential in 14 countries

Based on an analysis of the GHG emissions from each country studied, an effort was made to quantify the emission reduction potential if certain measures were introduced to reduce emissions. Existing literature, the questionnaire and in-country research formed the basis for this analysis.

(b) Analysis of mitigation option potential

For each country in the study, existing literature, the questionnaire survey and in-country research were used to determine the potential resources that could be utilized with the introduction of technologies to address global warming. The capacity to implement them (the potential and actual utilization of renewable

energies such as solar and wind power) was also considered.

d. Consideration of contribution to sustainable development

An assessment was also made regarding numerous topics in the context of development programs at the national level, including the status of sustainable development; environmental problems considered to be the most critical; the environmental conservation issues; and the status (results, problems, etc.) of global warming-related projects already underway through international and bilateral assistance institutions.

e. Consideration of possible host organizations

An effort was made to collect the necessary basic information for the selection of host organizations for CDM projects, including the international and regional organizations and national governmental organizations as well as private organizations in the study region and countries. In addition consideration was given to organizations (governmental, private sector, and joint public-private venture) or networks that might be appropriate as hosts for CDM projects.

f. Preliminary selection of possible CDM projects

Based on the findings of ‘a.’ to ‘e.’ above, a preliminary selection was made of between 6 and 19 potential CDM projects for each of the 14 countries, for a total of 157 projects.

g. Consideration of the potential for technology transfer and capacity building

With the cooperation of SPREP and other organizations, an analysis was made relating to the main industries thought to be the largest emitters of GHGs in each of the study countries, as well as the relevant technologies in those industries. Particular attention was given to identify technology transfer and capacity building projects in which Japan could be expected to make a major contribution, and which could be expected to have the greatest effect.

h. Identification of issues and problems

Consideration was given to the issues and problems that might arise if the above CDM projects were implemented.

i. Second selection of priority CDM projects in the 14 countries

A comprehensive assessment of the above study findings was carried out, and then 3 to 8 projects for each country were selected as the top priority CDM project candidates in the region, for a total of 80 projects.

k. Estimation of potential GHG emission reduction and enhancement of sinks as a result of CDM projects

The highest priority CDM project candidates were designated from among the projects selected above,

and estimates were made of their potential GHG emissions reduction and enhancement of sinks.

3. Study results

3.1 Collection of data and documentation

In total 123 items (88 publications, 35 website sources) were collected from sources including the target countries and international organizations. From this collection, information about environmental conditions, GHG emissions and sinks, and quantitative data was compiled for each country. In addition, quantitative data relating to the items shown in the questionnaire below were collected from a database held by SOPAC relating to the Pacific Island Countries.

3.2 Preparation and distribution of questionnaire to countries in the study

A questionnaire survey was conducted in order to study the potential in each target country for global warming countermeasures and CDM projects, the main sectors or fields to apply the countermeasures, and the situation or capacity of possible host organizations, etc.

The study included two types of questionnaires—one that focused on qualitative information (including a partially quantitative checklist) relating to global warming countermeasures overall, and a second one that sought more detailed and quantitative answers. The details of the studies are shown below.

Questionnaire topics: Global warming countermeasures in general

- Existing plans, initiatives and activities for sustainable development
- Existence and availability of statistical information relating to GHG reduction potential (the proportion of GHG emissions that could technically be reduced through the introduction of certain countermeasures)
- Existence and availability of statistical information relating to potential for global warming countermeasures (potential resources that could be used if technologies are introduced to address global warming)
- Impacts of global warming
- Issues relating to contribution to sustainable development
- CDM project candidates in each sector (evaluation using three categories for levels of significance)

Questionnaire topics: Quantitative data

(1) Energy supply sector
- Renewable energy: output of existing and planned facilities
- Energy efficiency improvement (power generation capacity of fossil fuel power plants, power transmission and distribution systems)

(2) Industrial sector
- Major factories: fuel/power consumption for each
- Fishing motor boats: number of boats, consumption by type of fuel
- Cold storage: number of facilities, consumption by type of fuel
- Major hotels: number of annual guests, consumption by type of fuel

(3) Transportation sector
- Vehicles: number of each type, consumption by type of fuel

(4) Household and business sector
- Non-electrified households, population
- Major buildings: total floor space, consumption by type of fuel

(5) Land use, land use change, and forestry sector
- Planned mangrove plantation area
- Planned coconut plantation area
- Planned reforestation area
- Planned land rehabilitation area (including rehabilitation of sugarcane fields, cropland, grazing land)

(6) Waste management sector
- Landfill area
- Landfill sites: present number
- Garbage: quantity per year

Responses were received from four countries for the general questionnaire (Fiji, Kiribati, Niue, and Papua New Guinea). Their details are shown in the sections on each respective country. The response from Tuvalu stated that there was no active interest in the project at this time. With the exception of these five countries, no response was received.

3.3 Meeting of related parties during COP-7

A meeting was held during COP-7 (on 8 November 2001) and attended by representatives from some organizations and target countries that are participating in this study (SPREP, as well as the Cook Islands, Niue, Samoa, Papua New Guinea and Vanuatu). At the meeting, SPREP explained the background of the initiative of the Global Environment Centre Foundation (GEC) and main purpose of the present study. Pacific Consultants provided an explanation of the questionnaire survey and made a request for cooperation, as well as an opportunity for questions and answers.

3.4 In-country research

A visit was made to SPREP, which is serving as a counterpart in this study, for discussions on implementation of the study, collection of materials, and outcomes of the preliminary selection of CDM project candidates. In addition, face-to-face meetings were held with experts in fields relevant to the potential CDM projects. Interviewees included the person in charge of climate change office at the Samoa Ministry of Environment, the resident representative of the Japan International Cooperation Agency (JICA) office in Samoa, the manager in charge of solid waste and landfill management at SPREP, and a key person in the tourism industry (hotel manager).

Below are the main points that arose in the interviews.

(1) Current status of environmental problems in Samoa and potential for CDM projects: Main points of interview with Ministry of Environment, Samoa

With regard to climate change, there is a recognition that adaptation is a more important and necessary

step than mitigation. In particular, the impacts of extreme weather event on the country are severe, and these are the most important immediate priorities to address.

As regards initiatives relating to CDM projects, plans are being developed with funding from Australia for projects connected with renewable energy and GHG reductions. In addition, the Pacific Island Renewable Energy Project is being considered as a UNDP pilot project.

The lack of data is a serious problem, and for the preparation of accurate GHG inventories, it is important to improve collection and quality of data. With regard to capacity building, a community-based project is under way with funding from CIDA.

(2) Energy supply and demand in Samoa: Main points of interview with JICA office manager

Electrical demand and the number of vehicles on the roads have increased in recent years. Electrical power consumption has grown by 5 percent per year, and electric charges are quite expensive. The question of how to secure sources of energy supply to meet the demand has become an issue lately. In the mid-1980s JICA started a development studies for rural electrification projects, and the rate of rural electrification has since risen to about 93 percent. However, various problems exist today, such as the power plants being poorly networked with each other, and frequent breakdowns of the turbines. The electrical supply depends on diesel generators. It will be essential to solve the problems with electrical power in a way that does not become a burden on the country's economy. Two hydroelectric plants now operate on Upolu Island, but local people frequently oppose new construction plans. In addition, there are no other rivers in the country that are suitable for hydropower; water flow volume is inadequate and the variation between dry and wet season is large. Research has also been conducted on solar power generation, but it was judged to be impractical, as it can supply enough to play a only supplementary role to meet current energy demand.

Urbanization is progressing in the capital city of Apia. The national economy has continued to experience rapid growth, at 3.1 percent in 1991, 7.3 percent in 2000, and 6.0 percent during the first half of 2001. A middle class has been emerging in Apia, and the use of cars and electrical products has been growing in pace with the westernization of lifestyles.

Tourism, nationals working overseas, and foreign assistance are supporting the huge gap that exists between imports and exports. However, there is not a large number of people working in the tourism business, and little desire exists to bring large capital into this industry. Half of the exports are comprised of fisheries products, but a number of problems exist in this industry; for example, the fishing boats are not energy efficient, and the quality of tuna sold is poor due to the absence of cold storage facilities.

(3) The state of waste management in Samoa and other Pacific Island Countries: Main points of interview with solid waste and landfill management project officer of SPREP

Some characteristics of the countries in this study are that the dependence on imports is high, they are remotely located, and the population is concentrated in urban areas. In each of the countries, a number of problems have been emerging along with changes in the socio-economic conditions in recent years,

including an increase in the amount of waste (in the amount generated as well as changes in the nature of the waste); illegal dumping (in back yards, mangroves and lagoons); inadequate management of landfills and difficulty in acquiring more land for landfills; increases in the imports and disposal (abandonment) of used cars; lack of adequate handling of medical (contagious) and hazardous waste (persistent organic pollutants); poor economic viability of recycling (small market, difficulty of transport); and contamination of groundwater and seawater from waste and domestic effluent.

Samoa has a relatively large land area, and landfill sites have been secured inland, but garbage is simply piling up and only a few hospitals possess the needed small-scale incinerators. Although Fiji is the most advanced country in the region in terms of recycling and separating garbage, few others are actually separating their garbage. In Samoa garbage is not being separated, and on outer islands in some areas garbage collection is not even being done.

In the smaller island states, garbage is being dumped along the seashores with the intention of expanding the land area. This practice leads to the loss of mangroves in some places. In addition, housing is built soon after landfilling, leading to concerns about health and safety.

(4) Conditions of the tourism industry: Main points of interview with manager of Hotel Kitano Tusitala

The hotel's utility costs are comprised of electricity (80 percent), LPG (15 percent, of which 5 percent is used for dryers) and water (5 percent). About ten years ago the hotel installed a solar water heater, which provides all of the hot water needed in guestrooms for showers, etc.

Due to certain factors, including the fact that diesel is a cheaper energy source than electricity from the grid, many buildings the size of this hotel, including large office buildings, use their own generators. They are already implementing feasible measures to conserve energy. These include converting lights bulbs to energy efficient types, setting the air conditioners to turn off when the guest is not in the room, and training staff about energy conservation, etc.

With regard to the water supply and sewerage system, during the rainy season there is a problem with muddy water, and during the dry season the problem is disruptions in the water supply. Although they do continue for about a week in some areas, neither of these problems is serious enough to disrupt business.

About four or five years ago, the hotel upgraded to its own treatment facilities for its wastewater, and today the hotel treats almost all of the wastewater it generates. However, most people generally discharges all of their sewage without being treated. The hotel is not separating its garbage. A waste management company has been contracted to collect it.

4. Potential CDM projects in each country

The following pages provide a summary of the natural and socio-economic conditions, state of GHG emissions and sinks, and outline of potential priority projects for each country in the study.

Summary of Potential CDM Projects

	Cook Islands	Samoa	Fiji	Solomon Islands	Kiribati
Area	- 240 km^2	- 2,935 km^2	- 18,333 km^2	- 29,785 km^2	- 717 km^2
Population	- 18,904	- 172,000	- 772,655	- 421,000	- 94,149
Geography	- Volcanic islands and atolls (highest elevation 652 m)	- volcanic islands (Upolu and Savai'i)	- Volcanic islands and atolls (332 islands, the largest of which are Viti Levu and Vanua Levu, highest elevation 1,324 m)	- Volcanic islands (highest elevation 2,447 m)	- 32 atolls and one uplifted limestone island (elevation about 5 m)
GHG emissions (tCO_2/year)	- 32,000	- 102,000 (20,220 after subtracting sinks)	- 726,000	161,333	- Not provided
Energy situation	- 85% of total energy supply is from fossil fuels (diesel) - Electricity generation and transportation each account for 50% of consumption - Solar power (129 units)	- Coconut husks and fuelwood provide 65% of total energy supply - Electricity generation is by thermal power (diesel), and hydro - Solar power	- Hydroelectric, thermal power, fuelwood, bagasse, etc. - There are 6 supply systems for electricity generation - Electrical power reaches 67% of the population - Solar power (332 units)	- 70% of total energy is from biomass - Diesel is used for electricity generation - Transmission loss is 14% - Solar power (4.1 kW)	- 70% of total energy is from biomass - Diesel is used for electricity generation - Transmission loss is 15% - Solar power (304 units)
Industry	- Tourism (37% of GDP) - Agriculture (fruit, vegetables) - Marine resources - Black pearl culture	- Agriculture, including copra, coconut, etc. - Tourism is expanding rapidly - Beer brewing, copra processing - Japanese corporations: - Yazaki Corporation (automotive parts factory) - Kitano Construction Corp. (Hotel Kitano Tusitala)	- Tourism (main industry) - Sugar production - Copra production - Mining (gold) - Japanese corporations: - YKK	- Timber production - Fishing (tuna), agriculture (palm oil) - Mining (gold) - Japanese corporations: - Kitano Construction Corp. (Kitano Mendana Hotel) - Maruha Corporation (tuna canning factory)	- Agriculture (copra) - Fishing (sea cucumber)
Transportation	- Automobiles - Inter-island ferries, barges - Aircraft	- Buses, automobiles - Inter-island ferries, barges	- Buses, automobiles - Inter-island ferries, barges - Aircraft	- Details not available	- Inter-island ferries, barges - Aircraft
Forests	- Forest area: 22,120 ha	- Forest area: 115,000 ha (40% of land area)	- Forest area: 935,000 ha	- 2,535,634 ha (relatively high proportion by international comparison)	- 28.2 ha
Priority projects (Bold indicates top priority projects from second selection)	(1) Introduction of solar power and solar heating equipment at the village level (2) Effective utilization of biomass such as coconut residue (3) Methane fermentation and biogas utilization from livestock waste **(4) Improving the efficiency of fossil fuel power plants (2 plants)** **(5) Global warming countermeasures in black pearl culture industry, including energy efficiency** (6) Global warming countermeasures in tourist hotels (7) Improving energy-use efficiency of vehicles by upgrading fuel efficiency, etc. **(8) Improving energy-use efficiency**	(1) Introduction of solar power and solar heating equipment at the village level **(2) Effective utilization of biomass such as coconut residue** (3) Methane fermentation and biogas utilization from livestock waste **(4) Improving the efficiency of fossil fuel power plants (Upolu, Savai'i each have 1 plant)** **(5) Improving the efficiency of electricity generation by upgrading operating efficiency of existing hydroelectric plants** (6) Reducing power transmission and distribution loss (Upolu, Savai'i) (7) Choosing low CO_2-emitting fuels for new electricity generating plants, introduction of low CO_2-emitting	**(1) Introduction of solar power equipment at the village level** (2) Improving efficiency of biomass fuel utilization at household level (3) Effective use of biomass such as coconut residue **(4) Improving the efficiency of fossil fuel power plants** (5) Improving the efficiency of electricity generation by upgrading operating efficiency of existing hydroelectric plants **(6) Reducing power transmission and distribution loss (Viti Levu and Vanua Levu)** (7) New installation of small-scale hydroelectric plants **(8) New construction of cogeneration facilities that use**	**(1) Introduction of solar power and solar heating equipment at the village level** **(2) Improving efficiency of biomass fuel utilization at household level** (3) Improving the efficiency of fossil fuel power plants **(4) New construction of small-scale hydroelectric plants** **(5) Reducing power transmission and distribution loss** **(6) Improving energy efficiency and productivity of canning factories** (7) Improving energy efficiency and use of renewable energy at gold mines **(8) Increasing energy efficiency and use of renewable energy in hotels** (9) Improving energy-use efficiency	**(1) Introduction of solar power and solar heating equipment at the village level** **(2) Improving efficiency of biomass fuel utilization at household level** **(3) Improving efficiency of fossil fuel thermal power plant (Tarawa)** **(4) Reducing power transmission and distribution loss** (5) Use of coconut husks in place of diesel (6) Reducing CO_2 emissions from energy conservation and use of renewable energy in hotels (7) Improving energy-use efficiency of vehicles by upgrading fuel efficiency, etc. **(8) Improving operating efficiency**

	Cook Islands	Samoa	Fiji	Solomon Islands	Kiribati
	of barges, by upgrading fuel efficiency, etc.	(high-efficiency) equipment **(8) Reducing CO_2 emissions through increased productivity by energy efficiency and use of waste from beer brewery** **(9) Energy-efficient utilization of renewable energy at auto parts factories** **(10) Increasing energy efficiency and use of renewable energy in hotels** (11) Improving energy-use efficiency of vehicles by upgrading fuel efficiency, etc. (12) Reducing CO_2 emissions improving operating efficiency and fuel efficiency of public bus systems (13) Improving operating efficiency and fuel efficiency of inter-island ferries (14) Improving fuel efficiency of boats (fishing and other) (15) Introducing energy-efficient equipment in governmental and commercial buildings, etc. **(16) Reforestation on commercially logged and weather-damaged forest sites**	**biomass (bagasse)** **(9) Reducing CO_2 emissions through increased productivity by upgrading energy efficiency and use of waste from beer breweries** (10) Reducing CO_2 emissions through improving productivity of fastener factory by upgrading energy efficiency **(11) Increasing energy efficiency and use of renewable energy in hotels** (12) Improving energy-use efficiency of vehicles by upgrading fuel efficiency, etc. **(13) Reducing CO_2 emissions improving operating efficiency and fuel efficiency of public bus systems** (14) Introduce energy-efficient cars (15) Improving operating efficiency and fuel efficiency of inter-island ferries (16) Improving fuel efficiency of boats (fishing and other) (17) Introducing energy-efficient equipment in governmental and commercial buildings, etc. **(18) Promoting new tree-planting based on plantation-creation policy** (19) Mangrove planting	of vehicles by upgrading fuel efficiency, etc. (10) Improving operating efficiency and fuel efficiency of inter-island ferries (11) Improving fuel-efficiency of boats (fishing and other) **(12) Reforestation on commercially logged sites** (13) Mangrove planting	**and fuel efficiency of inter-island ferries** **(9) Improving fuel-efficiency of boats (fishing and other)** (10) Improving operational management, fuel efficiency of aircraft (11) Promoting intensive agroforestry systems using local species

	Marshall Islands	Micronesia	Nauru	Niue	Papua New Guinea
Area	- 181 km^2	- 702 km^2	- 22 km^2	- 259 km^2	- 462,840 km^2
Population	- 63,230	- 105,500	- 11,500	- 2,040	- 5,130,000
Geography	- 29 atolls and 5 low-lying islands (highest elevation 10 m)	- 607 scattered islands (highest elevation 791 m)	- Uplifted coral reef (only one island, highest elevation 71 m)	- Uplifted coral reef (only one island, highest elevation 68 m)	- Island of New Guinea (has mountain range with average height of 3,000 m, highest elevation 4,706 m)
GHG emissions (tCO_2/year)	- Not provided	- Not provided	- 28,000 (19,000 after subtracting sinks)	- 4,412	- 1,140,570 (sinks are 413,000)
Energy situation	- 90% of total energy use is from petroleum, 10% from coconut husks, fuelwood, etc. - Diesel is used for electricity generation - Electricity generation loss: 22%, 12.6% - Solar power (366 units) - Potential for wind-powered electricity generation	- 80% of total energy consumption is supplied by petroleum, 11% from biomass, 1% from hydroelectric - Of electrical generation, 96.3% is from diesel, 3.7% from hydroelectric - Solar power (486 units)	- The island is 100% electrified by diesel-fired electricity generation from Nauru Phosphate Corporation - Biomass resources have not been utilized to date	- Diesel is used for electricity generation - Construction plans exist for wind-powered electricity generation (450kW, 3 plants)	- Of total energy supply about 50% is from imported petroleum, 42% from biomass, 7% from hydroelectric, 2% from solar electric - 26 towns are electrified by 18 systems - Solar electric generation (332 units) - Transmission loss is 13%
Industry	- Agriculture (copra, oils and fats) - Fishing (tuna) - Tourism	- Fishing (tuna) - Agriculture (copra, oils and fats) - Manufacturing (coconut oil products) - Tourism (growing in recent years)	- Phosphate mining (phosphate is the only export). However, phosphate stocks are nearly depleted - No tourism	- Agriculture (honey, root vegetables, lime) - Fishing - Tourism	- Mining (oil, gold, copper) - Agriculture (coffee, copra) - Forestry (timber)
Transportation	- Inter-island ferries, barges - Aircraft	- Automobiles (30% of fossil fuels) - Inter-island ferries, barges (15%) - Aircraft (15%)	- Automobiles - Motorboats	- Unconfirmed	- Automobiles - Shipping - Aircraft (Transportation sector accounts for about half of fossil fuel consumption)
Forest	- 60% of land area covered by coconut and breadfruit trees	- 15,146 ha	- 20% of land area is forested (coconut palm, etc.)	- 50% of land area is forested	- 30,601,000 ha (67.6% of land area)
Priority projects (Bold indicates top priority projects from second selection)	(1) Introduction of solar power and solar heating equipment at the village level (2) Improving efficiency of biomass fuel utilization at household level **(3) Improving the efficiency of fossil fuel power plants** **(4) Reducing power transmission and distribution loss** (5) Increasing energy efficiency and use of renewable energy in hotels **(6) Improving energy-use efficiency of vehicles by upgrading fuel efficiency, etc.** **(7) Improving operating efficiency and fuel efficiency of inter-island ferries** **(8) Improving fuel-efficiency of boats (fishing and other)** **(9) Improving operational management, fuel efficiency of aircraft**	(1) Introduction of solar power and solar heating equipment at the village level (2) Improving efficiency of biomass fuel utilization at household level **(3) Improving the efficiency of fossil fuel power plants** (4) Improving efficiency of hydropower plants **(5) Reducing power transmission and distribution loss** **(6) Improving energy efficiency and productivity of coconut oil processing plants** (7) Increasing energy efficiency and use of renewable energy in hotels **(8) Improving energy-use efficiency of vehicles by upgrading fuel efficiency, etc.** **(9) Improving operating efficiency and fuel efficiency of inter-island ferries**	**(1) Introduction of solar power and solar heating equipment at the village level** (2) Promote the use of biomass fuels at the household level **(3) Improving the efficiency of fossil fuel power plants** (4) Reducing power transmission and distribution loss **(5) Improving energy-use efficiency of vehicles by upgrading fuel efficiency, etc.** (6) Improving fuel-efficiency of boats (fishing and other) **(7) Reforestation on former phosphate mining sites**	**(1) Introduction of wind power electricity generation facilities** **(2) Improving the efficiency of fossil fuel power plants** (3) Reducing power transmission and distribution loss **(4) Improving energy-use efficiency of vehicles by upgrading fuel efficiency, etc.** **(5) Improving fuel-efficiency of boats (fishing and other)** **(6) Reforestation (plantation) on logged forest sites**	**(1) Introduction of solar power and solar heating equipment at the village level** (2) Effective utilization of biomass such as coconut residue (3) Methane fermentation and biogas utilization from livestock waste **(4) Improving the efficiency of fossil fuel power plants** (5) Improving the efficiency of electricity generation by upgrading operating efficiency of existing hydroelectric plants (6) Reducing power transmission and distribution loss (7) Choosing low CO_2-emitting fuels for new electricity generating plants, introduction of low CO_2-emitting (high-efficiency) equipment (8) Seeking energy efficiency and use of renewable energy in sugarcane factories

	Marshall Islands	Micronesia	Nauru	Niue	Papua New Guinea
		(10) Improving fuel-efficiency of boats (fishing and other) **(11) Improving operational management, fuel efficiency of aircraft** **(12) Reforestation on logged sites** (13) Protection of mangrove forests (14) Promoting intensive agroforestry systems using local species			(9) Seeking energy efficiency and use of renewable energy in palm oil factories **(10) Increasing energy efficiency and use of renewable energy in hotels** (11) Improving energy-use efficiency in the mining sector (12) Improving energy-use efficiency of vehicles by upgrading fuel efficiency, etc. (13) Introducing energy-efficient equipment in governmental and commercial buildings, etc. **(14) Reforestation on commercially logged sites** (15) Reforestation of logged mangrove forests

	Tonga	Tuvalu	Palau	Vanuatu
Area	- 697 km^2	- 26 km^2	- 458 km^2	- 12,189 km^2
Population	- 99,700	- 10,050	- 17,225	- 183,000
Geography	- Volcanic islands and atolls (highest elevation about 70 m)	- Atolls and uplifted islands of limestone coral (average elevation 3 m)	- Volcanic islands and uplifted coral reefs (over 200 islands)	- Volcanic islands with elevated land of uplifted coral reef, and atolls (highest elevation 2,000 m; has some active volcanoes)
GHG emissions (tCO_2/year)	- 31,000 (only includes CO_2)	- Not provided	- Not provided	- 56,708 (sinks are 1,153)
Energy situation	- About 60% of total energy consumption is from biomass (fuelwood and coconut residue - 25% of petroleum is used for electricity generation (all electricity generation uses petroleum) - Transmission and distribution loss is between 7.5% and 17% - Solar power (582 units)	- All electricity generation is from diesel power generation plants (in the capital Funafuti and on outer islands) - Solar power (397 units)	- 98% of total energy consumption is from imported petroleum, 2% from biomass - Electricity generation: 85.6% from diesel thermal and 14.4% from hydroelectric - 48% of petroleum consumption is for electricity, 47% for transportation - Electrification reaches 96% of households - Solar power (196 units)	- About 70% of total energy consumption is from biomass - 25% is from petroleum fuels (mostly consumed by the transportation sector) - All electricity generation is by thermal (diesel) - Solar power (196 units) - Agricultural sector consumes 26% of energy (fuel for crop drying)
Industry	- Agriculture (squash, bananas, copra, coconut, vanilla) - Manufacturing (meat products, lumber) - Tourism	- Agriculture (copra, taro root, bananas) - Postage stamp sales	- Tourism (now expanding) - Fishing (tuna, button shells) - Agriculture (copra)	- Agriculture (copra, cava) - Tourism (growing in recent years)
Transportation	- Unconfirmed	- Inter-island ferries, barges - Aircraft	- Automobiles - Inter-island ferries, barges	- Aircraft
Forest	- 4,000 ha (5.3% of land area)	- Coconut palm is most common tree species	- 34,521 ha (75% of land area)	- 446,924 ha (80% of land area)
Priority projects (Bold indicates top priority projects from second selection)	**(1) Introduction of solar power and solar heating equipment at the village level** **(2) Improving efficiency of biomass fuel utilization at household level** **(3) Improving the efficiency of fossil fuel power plants** **(4) Reducing power transmission and distribution loss** **(5) Increasing energy efficiency and use of renewable energy in hotels** (6) Improving energy-use efficiency of vehicles by upgrading fuel efficiency, etc. (7) Improving fuel-efficiency of boats (fishing and other) **(8) Reforestation on commercially logged sites** (9) Mangrove planting	**(1) Introduction of solar power and solar heating equipment at the village level** **(2) Improving efficiency of biomass fuel utilization at household level** (3) Improving the efficiency of fossil fuel power plants **(4) Improving efficiency of small-scale (household) diesel generators** (5) Reducing power transmission and distribution loss (6) Improving energy-use efficiency of vehicles by upgrading fuel efficiency, etc. **(7) Improving operating efficiency and fuel efficiency of inter-island ferries** (8) Improving fuel-efficiency of boats (fishing and other) **(9) Reforestation (agroforestry) on former coconut palm plantations**	**(1) Introduction of solar power and solar heating equipment at the village level** **(2) Improving efficiency of biomass fuel utilization at household level** **(3) Improving the efficiency of fossil fuel power plants** (4) New construction of wind power electricity generation facilities (5) New construction of small-scale hydroelectric plants (6) Reducing power transmission and distribution loss **(7) Increasing energy efficiency and use of renewable energy in hotels** (8) Improving energy-use efficiency of vehicles by upgrading fuel efficiency, etc. (9) Improving operating efficiency and fuel efficiency of inter-island ferries **(10) Reforestation on former plantations**	**(1) Introduction of solar power and solar heating equipment at the village level** **(2) Improving efficiency of biomass fuel utilization at household level** **(3) New construction of small-scale hydroelectric plants** **(4) Improving the efficiency of fossil fuel power plants** (5) Reducing power transmission and distribution loss **(6) Increasing energy efficiency and use of renewable energy in hotels** (7) Improving energy-use efficiency of vehicles by upgrading fuel efficiency, etc. (8) Improving operating efficiency and fuel efficiency of inter-island ferries (9) Improving fuel-efficiency of boats (fishing and other) **(10) Reforestation on degraded forest land and burned land**

	Tonga	Tuvalu	Palau	Vanuatu
				(11) Mangrove planting

5. Estimating GHG emission reduction and enhancement of sinks from CDM projects

From among the CDM project candidates in the 14 Pacific Island Countries, five were selected as examples of projects considered to be important by the respective host countries, and for which quantitative estimates of GHG emission reduction or enhancement of sinks are possible. For these examples, the amount of certified emission reduction (CER) units that could be obtained is estimated using the Project Case and a Baseline Case.

Estimates were done using an energy-related database from SOPAC and other materials. They were carried out with reference to methodologies that arise in the questionnaire findings, to discussions at the COP meetings of the UN Framework Convention on Climate Change, and to examples used in past studies relating to the CDM.

5.1 Project to improve the efficiency of fossil fuel plants (Tonga)

(1) Background and objectives of project

The island of Tongatapu, where the capital city (Nuku'alofa) of the Kingdom of Tonga is located, has one operating fossil fuel power plant (the Tongatapu generation plant) supplying power to the capital area. The aim of this project would be to reduce the GHG emissions (i.e., CO_2) emitted from operation of the Tongatapu plant by increasing its efficiency.

(2) Project outline

The Tongatapu plant has the following specifications and operating results (data from the SOPAC database).

Capacity:	17 MW
Fuel:	heavy oil
Fuel consumption (1999):	40,300 kl/year
Electricity generated (1999):	127,000,000 kWh/year
Power generation efficiency:	29%

This project would upgrade the Tongatapu generation plant (install the latest diesel-fired generation equipment) and improve operational management in order to raise the power generation efficiency to 40 percent. Fuel conversion from crude oil to natural gas to increase electricity generated or efficiency was not considered for this project.

(3) Approach to the Baseline Case

In selecting the Baseline Case, the options initially considered include the following: (a) construction of a new power generation plant (crude oil-fired), (b) new construction of a renewable energy (wind power,

biomass, etc.) generation plant, (c) continued operation of the existing plant, and (d) efficiency improvements of the existing plant.

Information obtained for this report suggested there were no existing plans for construction of a new power plant or for improving the efficiency of the existing plant. In addition, the potential for renewable energy cannot compare with the 17 MW output of the existing plant. Thus, for the Baseline Case, the following option was selected.

Baseline Case: Continuation of the current fuel type, amount of fuel consumption, amount of electrical generation, and operations at the Tongatapu power generation plant.

(4) Estimated GHG emission reductions due to the project

GHG emissions of the Baseline Case

40,300 kl/year * 1,000 * 2.96 kgCO_2/l / 1,000 = 119,288 tCO_2/year
(crude oil consumed) (kl/l) (emission factor: C crude oil) (kg/t)

GHG emissions of the Project Case

40,300 kl/year * 1,000 * 2.96 kgCO2/l / 1,000 * 29/40 = 86,484 tCO2/year
(crude oil consumed) (kl/l) (emission factor: C crude oil) (kg/t) (generation efficiency)

Reduction of GHG emissions

119,288 tCO_2/year - 86,484 tCO_2/year = 32,804 tCO_2/year

Reduction of GHG emissions, assuming a project period of 10 years: 328,040 tCO_2

Assuming a price of 375 yen/tCO_2 (US$3/t$CO_2$, US$1=125 yen), CERs worth about **12.3 million yen per year, or 123 million yen over 10 years,** can be obtained.

(5) Other points to consider

Because this project will result in annual emission reduction exceeding a small-scale project, it is important to carefully consider the baseline setting and the monitoring program. As shown above, the estimate indicates the possibility of obtaining CERs amounting to about 10 million yen per year. It would be desirable to conduct a feasibility study (FS) on the economic impacts of obtaining these CERs.

5.2 Project to improve efficiency of electrical power transmission and distribution network (Tonga)

(1) Background and objectives of the project

The aim of this project would be to improve the efficiency of the electrical transmission and distribution system, in order to reduce the GHG emissions (i.e., CO_2) emitted from power generation at the Tongatapu

plant. The system is currently experiencing a transmission and distribution loss of 17 percent.

(2) Project outline

By carrying out the following measures, the project would reduce the power transmission and distribution loss from the current 17 percent down to 7 percent:

(1) increase the number of and replace substation facilities
(2) extend and replace transmission lines
(3) replace aging transformers

(3) Approach to the Baseline Case

In formulating the Baseline Case, it is assumed that in the absence of this project, efficiency-improvement projects similar to these would be postponed, for various reasons (lack of funds, technology and expertise). Thus, the Baseline Case was set as shown below.

Baseline Case: Continuation of the current power transmission and distribution system.

(4) Estimated GHG emissions reduction due to the project

GHG emissions of the Baseline Case

For the GHG emissions of the Baseline Case, the CO_2 emissions are taken to be the amount of emissions from the generation of the electricity that is now lost through the existing power transmission and distribution system.

127,000,000 kWh/year * 0.17 * 0.317 l/kWh * 2.96 kgCO_2/l / 1,000 = 20,258 tCO_2/year
(annual electricity generation) (power transmission and distribution loss) (crude oil used per unit of electricity) (emission factor: C crude oil) (t/kg)

GHG emissions of the Project Case
127,000,000 kWh/year * 0.07 * 0.317 l/kWh * 2.96 kgCO_2/l / 1,000 = 8,342 tCO_2/year
(annual output) (power transmission and distribution loss) (crude oil used per unit of electricity) (emission factor: C crude oil) (t/kg)

Reduction of GHG emissions

20,258 tCO_2/year - 8,342 tCO_2/year = 11,916 tCO_2/year

Reduction of GHG emissions, assuming a project period of 7 years:* 83,412 tCO_2

* It is assumed that without the CDM, this project would be postponed by 7 years.

Assuming a price of 375 yen/tCO_2 (US$3/t$CO_2$, US$1=125 yen), CERs worth **about 5 million yen per year**, **or 31 million yen over 7 years,** can be obtained.

(5) Other points to consider

Because this would be defined as a small-scale CDM project, it is assumed that the simplified version of baseline-setting and monitoring would be used. Improving the efficiency of the power transmission and distribution system has a similar effect to installing one small-sized generating plant. Since the capital cities in many other Pacific Island Countries are known to be experiencing power transmission and distribution losses similar to this case, the need for action on this problem is urgent.

5.3 Project to construct a new wind plant (Niue)

(1) Background and objectives of the project

A 1.5MW fossil fuel plant is currently operating in Niue. Plans exist to introduce wind power using funding assistance from the European Union. Taking into consideration the EU assessment about the feasibility of wind energy on the island, this proposal also aims to introduce wind power generating facilities.

(2) Project outline

The following specifications were used for the introduction of wind power generating facilities:

Capacity:	150 kW
Units to be installed:	3
Capacity utilization:	10%

(3) Approach to the Baseline Case

The methodology is based on the guidelines[1] published by CERUPT of the Netherlands.

(4) Estimated GHG emissions reduction due to the project

GHG emissions of the Project Case

Because this project involves the installation of wind power generating facilities, it is assumed that the GHG emissions from the Project Case are zero tCO_2/year. The power generation from the project is estimated as follows:

150 kW * 3 * 24 * 365 * 0.1 = 394,200 kWh/year
(generating capacity) (number of units) (hours) (days) (capacity utilization)

1 "Standardised Baselines and Streamlined Monitoring Procedures for Selected Small-scale Clean Development Mechanism Project Activities, Volume 2c: Baselines studies for small-scale project categories—A guide for project developers, Version 1.0" (Ministry of Housing, Spatial Planning and the Environment of the Netherlands, December 2001).

GHG emissions of the Baseline Case

According to the CERUPT guidelines, for small-scale CDM projects one can use the hypothetical CO_2 emissions of diesel power generators as the Baseline Case, assuming the same amount of power generation and operating conditions as with the proposed renewable energy. Using the emission factor from those guidelines for 135 kW to 200 kW equipment, the CO_2 emissions of the Baseline Case would be as follows:

394,200 kWh/year * 0.9 kgCO_2/kWh / 1,000 = 355 tCO_2/year
(annual output) (emission factor) (kg/t)

Assuming that the electricity from wind energy would replace electricity from the existing power plants, the displacement of CO_2 emissions by the new wind power facilities would be as follows:

394,200 kWh/year * 0.78 kgCO_2/kWh / 1,000 = 307 tCO_2/year
(annual output) (emission factor*) (kg/t)

* Calculated from actual operating results of the existing fossil fuel plant.

Reduction of GHG emissions

355 tCO_2/year - 0 tCO_2/year = 355 tCO_2/year

Reduction of GHG emissions, assuming a project period of 10 years: 3,550 tCO_2

Assuming a price of 625 yen/tCO_2 (US$5/t$CO_2$, US$1=125 yen), CERs worth **about 222,000 yen per year, or 2.22 million yen over 10 years**, can be obtained.

(5) Other points to consider

This project would be considered a small-scale CDM project. Compared to projects involving fossil fuel plants, the estimated CERs that could be acquired here are very low. As indicated above, even if CERs were valued at US$5/t$CO_2$* this would amount to just around 200,000 yen per year (assuming US$3/t$CO_2$* for fossil fuel plants).

* Calculated with reference to initiatives of ERUPT/CERUPT of the Netherlands, which establish different purchasing prices for ERUs and CERs depending on the project type.

5.4 Project for new solar power installation at the village level (Kiribati)

(1) Background and objectives of the project

In Kiribati today, besides a 4.4 MW fossil fuel plant in operation the country also has 30.4 kW (304 units) of installed capacity of solar power generation. There are now plans for installation of an additional 1,800 units (900 kW) of solar power generation using funding assistance from the EU. The project proposed below also aims to install additional solar power generators, having taken into consideration the EU

assessment about the feasibility of solar power on the island.

(2) Project outline

The specifications of the solar power generation proposed for installation under this project are shown below:

Capacity (each unit):	0.5 kW
Units to be installed:	1,800
Hours of generation:	1,314 hours/year (at 15% capacity utilization)

(3) Approach to the Baseline Case

The Baseline Case is set according to the CERUPT guidelines described above.

(4) Estimated GHG emissions reduction due to the project

GHG emissions of the Project Case

Because this project involves the installation of solar power generating equipment, it is assumed that the GHG emissions from the Project Case are zero tCO_2/year. The power generation from the project is estimated as follows:

0.5 kW ***** **1,800** ***** **1,314** **=** **1,182,600 kWh/year**
(generating capacity of each unit) (number of units) (annual hours of operation)

GHG emissions of the Baseline Case

According to the CERUPT guidelines, for small-scale CDM projects one can use the hypothetical CO_2 emissions of diesel power generators as the Baseline Case, assuming the same amount of power generation and operating conditions as with the proposed renewable energy. Using the emission factor from those guidelines for 3 to 12 kW equipment, the CO_2 emissions of the Baseline Case would be as follows:

1,182,600 kWh/year ***** **1.4 kgCO_2/kWh / 1,000** **= 1,656 tCO_2/year**
(annual output) (emission factor) (kg/t)

Assuming that the electricity from solar power would replace electricity from the existing power plants, the displacement of CO_2 emissions by the new solar power generation would be as follows:

1,182,600 kWh/year *** 0.9 kgCO_2/kWh / 1,000** **= 1,064 tCO_2/year**
(annual output) (emission factor*) (kg/t)
* Calculated from actual operating results of existing fossil fuel plant.

Reduction of GHG emissions

1,656 tCO_2/year - 0 tCO_2/year = 1,656 tCO_2/year

Reduction of GHG emissions, assuming a project life of 10 years: 16,560 tCO_2

Assuming a price of 625 yen/tCO_2 (US$5/$tCO_2$, US$1=125 yen) CERs worth **about 1.04 million yen per year**, **or 10.35 million yen over 10 years**, can be obtained**.**

(5) Other points to consider

Because this project is based on 1,800 small-scale solar power generators of 0.5 kW each being installed, a 3 kW to 12 kW diesel generator is used as the Baseline Case. If the total output of 900 kW from the 1,800 units is inserted in the above equation as the Baseline Case, the use of solar power reduces CO_2 emissions by less than 60 percent. If units calculated from actual operating results of the existing fossil fuel power plant are used, the CO_2 emissions decline by more than 60 percent. This shows that the CERs obtainable differ greatly depending on the methodology (CO_2 emissions units) for Baseline Case setting.

This project would be considered a small-scale CDM project. Compared to projects involving fossil fuel plants, the estimated CERs that could be acquired here are very low. As indicated above, even if CERs were valued at US$5/$tCO_2$* this would amount to just around one million yen per year (assuming US$3/$tCO_2$* for fossil fuel plants).

* Calculated with reference to initiatives of ERUPT/CERUPT of the Netherlands, which establish different purchasing prices for ERUs and CERs depending on the project type.

5.5 Project for reforestation on commercially logged sites (Solomon Islands)

(1) Background and objectives of the project

Logging on the Solomon Islands expanded rapidly since the end of the 1980s. It improved government revenues, but aid donor countries and environmental organizations expressed serious concerns about environmental destruction caused by the logging. The aim of this proposed project is to conduct reforestation for environmental conservation on sites that have been commercially logged.

(2) Project outline

This project involves replanting of commercially logged sites using native tree species, to form conservation forests able to sequester carbon. The outline of the project is as follows.

Species to be planted:	native species
Area to be planted:	4,000 ha
Proportion of area plantable: *	90%
Seedling survival rate:	70%

Above-ground annual growth:* 13 tDm/ha/year

Below-ground/above-ground ratio:* 22%

Carbon content of tree:* 0.5 tC/tDm

* Determined with reference to the World Bank's *Greenhouse Gas Assessment Handbook—A Practical Guidance Document for the Assessment of Project-level Greenhouse Gas Emissions*. The quantities shown as tDm are in metric tonnes of dry matter of the tree.

(3) Approach to the Baseline Case

The approach to setting the amount of carbon sequestration in the Baseline Case for afforestation or reforestation projects can be based on a number of methodologies, such as these: (a) determine a reference (control) site and determine the characteristic values by observation; (b) utilize documented values for locations with similar climate and land uses; or (c) predict future land uses based on the natural and social conditions as well as development plans for the target region. For the current estimate the documented value of 2.9 tC/ha/year (10.6 tCO_2/ha/year) was used (from *The State of Research on Scientific Assessment of Carbon Sequestration Functions of Terrestrial Ecosystems*, International Workshop Report, August 2001, Center for Global Environmental Research, National Institute for Environmental Studies, Japan).

(4) Estimate of GHG sequestration due to the project

GHG sequestration under the Project Case

The results of estimation of carbon sequestration in the case of reforestation using native tree species on the logged sites are shown below. Here the time period for the project is assumed to be 20 years, although it must be mentioned that discussions still continue in international negotiations and under the IPCC regarding the treatment of issues such as leakage and permanence.

	Item	Units		Basis (WB-GL: World Bank Guidelines)
A	Area of target site	ha	4000.0	From documentation
B	Proportion of plantable area	–	0.9	Assumed actual plantable area on target site
C	Planted area	ha	3600.0	A x B
D	Seedling survival rate	–	0.7	Assumed survival rate for seedlings
E	Area of surviving seedlings	ha	2,520.0	C x D
F	Aboveground annual increment	tDm/ha/y	13.0	WB-GL, p79, Exhibit 5-7, Asia, Insular, <20 years
G	Aboveground increment on area of surviving seedlings	tDm/y	32,760.0	E x F
H	Root-to-shoot ratio corresponding to G	–	0.2	WB-GL, p79, Exhibit 5-9, Tropical, Montane moist
I	Belowground increment	tDm/y	7207.2	G x H
J	Aboveground plus belowground growth	tDm/y	39,967.2	G + I
K	Growing period	years	20.0	Assumed project life
L	Increment for entire growing period	tDm	799,344.0	J x K
M	Carbon content	tC	0.5	WB-GL, p81, default value
N	Carbon accumulation	tC/tDm	399,672.0	L x M
O	Carbon accumulation	tCO2	1,465,464.0	
P	Carbon accumulation per year	tC/y	19,983.6	N ÷ K
Q	Carbon accumulation per year	tCO2/y	73,273.2	

GHG sequestration under the Baseline Case

The amount of sequestration under the Baseline Case is calculated as follows:

10.6 tCO_2/ha/year * 4,000 ha = 42,400 tCO_2/year

Enhancement of GHG sinks

73,273 tCO_2/year - 42,400 tCO_2/year = 30,873 tCO_2/year

Enhancement of sinks, assuming a project period of 20 years: 617,460 tCO_2

Assuming a price of 375 yen/tCO_2 (US$3/$tCO_2$, US$1=125 yen), CERs worth about **11.6 million yen per year**, **or 232 million yen over 20 years**, can be obtained. Average accumulation rates were used or CER accounting.

(5) Other points to consider

In the case of CDM projects involving afforestation or reforestation, the amount of carbon accumulation can have an enormous effect on the amount of CERs obtained. This estimate calculated the amount of carbon accumulation as follows: 10.6 tCO_2/ha/year × 4,000 ha = 42,400 tCO_2/year. However, this may be an overestimate, because the baseline amount of annual carbon sequestration (10.6 tCO_2/ha/year) is drawn from the results of a field study on Lombok Island in Indonesia, whereas under natural conditions recovery may be more difficult for vegetation on the Solomon Islands, which have steeper topography. Another factor that may result in overestimation is the fact that the Baseline Case is significantly simplified compared to the Project Case.

Some parameters in the Project Case may be overestimated, such as the proportion of plantable area, seedling survival rate, and aboveground annual increment, etc. In addition, in the Project Case it is essential to consider leakage and permanence (affected by forest fires, pests, etc.).

The 4,000 ha per year area for reforestation in this project was chosen to equal one year of the annual rate of deforestation that occurred from 1990 to 2000.