# FY2013

# Feasibility Studies on Joint Crediting Mechanism Projects towards Environmentally Sustainable Cities in Asia

## Project Report: Demonstration Project for Introduction of Low-Carbon Clean Water Supply Systems

March 2014

Pacific Consultants Co., Ltd.

# Summary

## Outline of Study

The introduction of renewable energy power generation and energy-efficient technologies for water supply systems in developing countries can potentially make a significant contribution to reductions in greenhouse gas emissions. Based on those points, this study the examined and verified the feasibility of a project scenario designed to reduce power consumption from the electricity grid, thereby reducing $CO_2$ emissions, by introducing a combination of technologies for renewable energy power generation and energy-saving technology to existing water supply facilities in developing countries.

## Components of Study

- Study of Water Supply Facilities in Target Countries
- Evaluation of GHG Reduction Potential
- Evaluation of Potential for Introduction at Model Sites
- Calculation of GHG Emission Reductions
- Consideration of Financing Schemes for Project Implementation
- Consideration of Possible Co-Benefits of Project Implementation
- Consideration of Framework for Implementation of Demonstration Projects

## Summary of Water Purification Facilities in Target Areas

(1) Iskandar District

Based on our survey results below, we have selected Gunung Pulai Plant as the model site that both of micro hydroelectric power amd solar power can be installed, and Pulai Reservoir as the model site that high power micro hydroelectric power I can be installed.

Table　Survey results for the plants in Iskandar district

| Name | Gunung Pulai Plant | Pulai Reservoir | SG Layang Plant |
|---|---|---|---|
| Operator | SAJ Holdings | SAJ Holdings | SAJ Holdings |
| Availability for introducing micro hydroelectric power | ○ | ○ | × |
| | Surplus pressure for generation available | Surplus pressure for generation available | Too little space to install the machineries. Water level of the dam is liable to change and the fall, is |

| | | | |
|---|---|---|---|
| | | | unstable. |
| Availability for introducing solar power generation | △<br>Enough space to install solar power generator | ○<br>No space to install solar power generator | △<br>Enough space to install solar power generator |
| Availability for introducing wind power generation | ×<br>Wind condition in not good | ×<br>Wind condition in not good | ×<br>Wind condition in not good |
| Availability for introducing energy-saving equipment | ×<br>Already introduced | ×<br>Already introduced | ×<br>Already introduced |

- Gunung Pulai WTP

Table: Information for the micro hydropower generator (Gunung Pulai Plant)

| | |
|---|---|
| Location | Gunung Pulai Forest Park |
| Operator | SAJ Holdings Sdn Bhd |
| Generation form/system | Replacement with pressure reduction unit (utilizing surplus water pressure in the duct) |
| Details for water turbine generator | Available head: 18m<br>Water volume : 0.21$m^3$/s<br>Output : 27kW (total efficiency: 72%)<br>(details of the efficiency: 80% by water turbine, 90% by generator) |
| Outline of the equipment | Water turbine : 1 Linkless Francis Turbine<br>Generator : three-phase squirrel-cage induction motor<br>Grid connection: connect with 400V to the system in the plant |
| Comments | - |

Table: Information for solar power generation system (Gunung Pulai)

| | |
|---|---|
| Location | Available space inside the plant |
| Specification | Area: 225 $m^2$<br>Output: approx. 20kW |
| Generation form/system | Solar power module produced by domestic manufacturer<br>Supplementary equipment: （power conditioner, trestle, etc.） |
| Details for the | Captive consumption |

| | |
|---|---|
| equipment | |
| Comments | Total output (number of the panels to be installed) will be decided by the domestic operator based on business evaluation. |

- Pulai reservoir

Table: Information for micro hydropower generator (Pulai Reservoir)

| | |
|---|---|
| Location | Jalan Ulu Choh Johor Malaysia Pulai Service Reservoir |
| Operator | SAJ Holdings Sdn Bhd |
| Generation form/system | Replacement with pressure reduction unit (replacement with pressure reduction unit (utilizing surplus water pressure in the duct) |
| Details for water turbine generator | Available head: 85m<br>Water volume : 0.30m$^3$/s<br>Output : 186kWtotal (efficiency: 74%) |
| Details for the equipment | Water turbine : 1 Linkless Francis Turbine<br>Generator : three-phase squirrel-cage induction motor<br>Grid connection : connect to the lamp line of the power company by low pressure |
| Comments | Sell the electricity to the power company |

(2) Ho Chi Minh

We have selected Thu Duc B.O.O as the model site based on the survey results below.

Table: Survey results for the plant in Ho Chi Minh

| Name of the plant | Thu Duc | Thu Duc B.O.O | Tan Hiep | Tan Phu |
|---|---|---|---|---|
| Operator | Saigon Water Co. | Thu Duc Water B.O.O Co. | Saigon Water Co. | Saigon Ground Water Ltd. Co. |
| Availability for introducing micro hydropower generator | △ | ○ | × | × |
| | Low merit for installation for low fall and little amount of water flow | Surplus pressure for generation available at the plant | No surplus pressure for generation available at the plant | No surplus pressure for generation available at the plant |
| Availability for introducing solar power generator | ○ | ○ | △ | △ |
| | Enough space to install the | Enough space to install the | Space to install the equipment | Space to install the equipment |

| | | | | |
|---|---|---|---|---|
| | equipment | equipment | available | available |
| Availability for introducing wind power generator | × | × | × | × |
| | Bad wind condition | Bad wind condition | Bad wind condition | Bad wind condition |
| Availability for introducing energy-saving equipment | × | × | × | × |
| | Already introduced | Already introduced | Already introduced | Already introduced |

- Thu Duc B.O.O WTP

Table: Information for the micro hydropower generator (Thu Duc B.O.O)

| | |
|---|---|
| Generation form/system | Water receiving tank at the plant（utilizing surplus water pressure in the duct） |
| Details for water turbine generator | Available head : 5.45m<br>Water volume : 3.94m3/s<br>Output : 139kW（total efficiency: 66%） |
| Details for the equipment | Water turbine : 2 Cross-Flow Turbines<br>Generator : three-phase squirrel-cage induction motor<br>Grid connection : connect with 3,300V to the grid inside the plant |
| Comments | Adopt incessant water installation method as it is impossible to stop treated water supply. |

Table: Information for solar power generation system (Thu Duc B.O.O)

| | |
|---|---|
| Location | Available space inside the plant |
| Specification | Area : 21,550 $m^2$<br>Output : approx. 2,250kW |
| Generation form/system | Solar power module produced by domestic manufacturer<br>Supplementary equipment:（power conditioner, trestle, etc.） |
| Outline for the equipment | Grid connection: connect with 3,300V to the system in the plant |
| Comments | Total output (number of the panels to be installed) will be decided by the domestic operator based on business evaluation. |

(3) Medan

We have selected Cemara Reservoir as the model site based on the survey results below.

Table: Survey results for the plants in Medan

| Plant | Sibolangit Plant | Delitua Plant | Sunggal Plant | Limau Manis Plant | Cemara Plant |
|---|---|---|---|---|---|
| Operator | PDAM | PDAM | PDAM | PDAM | PDAM |
| Availability for introducing micro hydropower generator | × | × | × | × | ○ |
| | No surplus water pressure for generation | No surplus water pressure for generation | No surplus water pressure for generation | No enough output produced for the little fall | Surplus water pressure for generation confirmed |
| Availability for introducing solar power generator | ○ | ○ | ○ | ○ | ○ |
| | Space for installation available | Space for installation available | Space for installation available | Space for installation available | Space for installation available |
| Availability for introducing wind power generator | × | × | × | × | × |
| | Bad wind condition | Bad wind condition | Bad wind condition | Bad wind condition | Bad wind condition |
| Availability for introducing energy-saving equipment | × | ○ | △ | ○ | △ |
| | Already introduced | Introducing high efficient pump available | Energy-saving by controlling a number of pumps under practice | Introducing high efficient pump available | Energy-saving by controlling a number of pumps under practice |

- Cemara Reseorvoir

Table: Information for micro hydropower generator (Cemara)

| Location | Cemara Reservoir |
|---|---|
| Operator | PDAM TIRTANADI |
| Generation form/system | Inhalant siphon of the reservoir (utilizing surplus water power in the duct) |
| Outline for water | Available head : 18m |

| | |
|---|---|
| turbine generator | Water volume : $0.17 m^3/s$<br>Output : 22kW（total efficiency: 72%） |
| Outline for the equipment | Water turbine : 1 Linkless Francis Turbine<br>Generator : three-phase induction generator<br>Grid connection : connect with 400V to the system in the plant |
| Comments | - |

Table: Information for solar power generation system (Cemara)

| | |
|---|---|
| Location | Available space inside the plant |
| Specification | Area: 1,100 $m^2$<br>Output : approx. 98kW |
| Generation form/system | Solar power module produced by domestic manufacturer<br>Supplementary equipment:（power conditioner, trestle, etc.） |
| Outline for the equipment | Grid connection |
| Comments | Total output (number of the panels to be installed) will be decided by the domestic operator based on business evaluation. |

Proposed Project Implementation Scheme

The Japanese side is proposing a private-sector business model centering on the concept of the energy service company (ESCO), which provides comprehensive services, from pre-evaluation and formulation of power generation plans, to operations, management, and verification of the effectiveness of power generation activities.

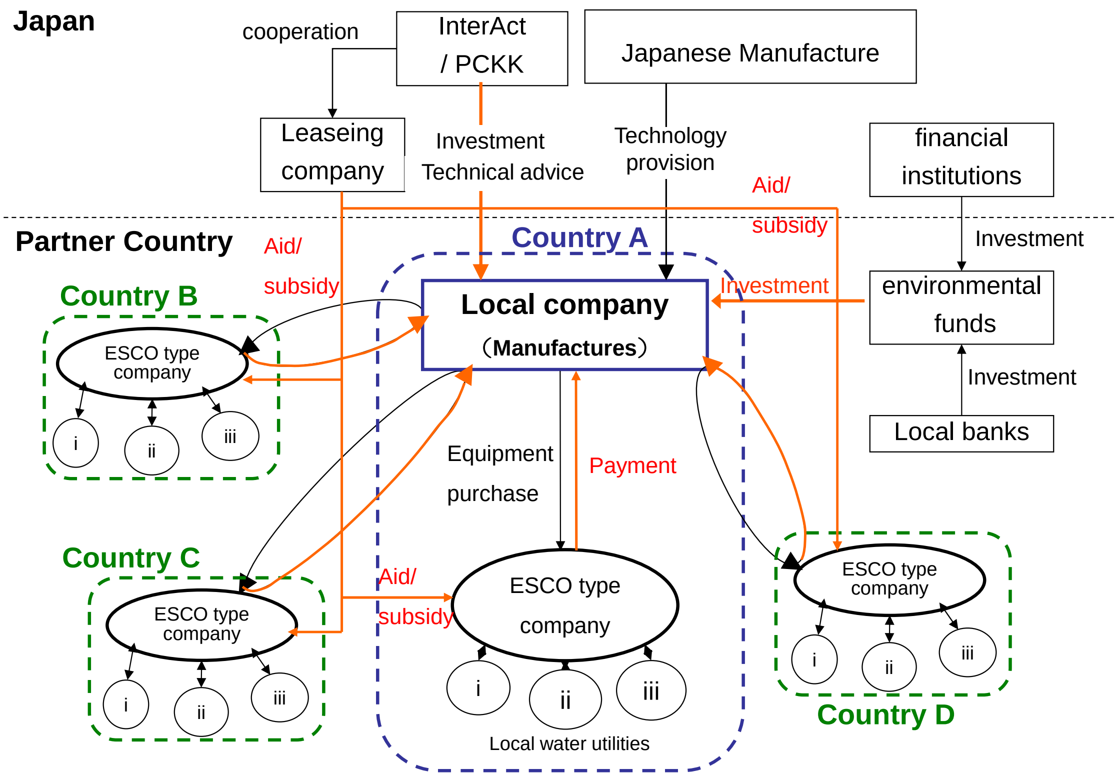


Figure: Image of Proposed Project Implementation Scheme

GHG Emission Reduction Potential

Notes: the following are estimated values, not precise figures

(1) Malaysia

| | |
|---|---|
| Micro-hydro | 46,255t$CO_2$ |
| Photovoltaic | 87,000t$CO_2$ |
| Windpower | Less potential |
| Energy-efficient technology | 180,522 t$CO_2$/year |

(2) Vietnam

| | |
|---|---|
| Micro-hydro | 20,435t$CO_2$ |
| Photovoltaic | 37,071t$CO_2$ |
| Windpower | 584 t$CO_2$ |
| Energy-efficient technology | 84,315 t$CO_2$/ year |

(3) Indonesia

| | |
|---|---|
| Micro-hydro | 14,941t$CO_2$ |
| Photovoltaic | 50,297.7t$CO_2$ |
| Windpower | Less potential |
| Energy-efficient technology | 170,312 t$CO_2$/ year |

## Next Steps

| Implementation item | | 2014 | | | | 2015 | | | | 2016～ |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | |
| Phase 1 | Detailed discussion of model project | | | | | | | | | |
| | Prepare project plan, funding plan | | | | | | | | | |
| | Cooperate with water utilities | | | | | | | | | |
| | Detailed design of equipment to be introduced | | | | | | | | | |
| | Prepare schedule for equipment assistance project | | | | | | | | | |
| Phase 2 | Implement model project | | | | | | | | | |
| | Manufacture equipment to be introduced | | | | | | | | | |
| | Equipment delivery, installation, trial | | | | | | | | | |
| | Launch equipment operation | | | | | | | | | |
| | Verify equipment installation benefits | | | | | | | | | |
| | Verify achievement status of project plan | | | | | | | | | |

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Chapter 1 Outline of Study

## 1.1 Outline of Projects Being Considered

The introduction of renewable energy power generation and energy-efficient technologies for water supply systems in developing countries can potentially make a significant contribution to reductions in greenhouse gas emissions. Based on those points, this study the examined and verified the feasibility of a project scenario designed to reduce power consumption from the electricity grid, thereby reducing $CO_2$ emissions, by introducing a combination of technologies for renewable energy power generation and energy-saving technology to existing water supply facilities in developing countries.

## 1.2. Organizational Structure for Project Implementation

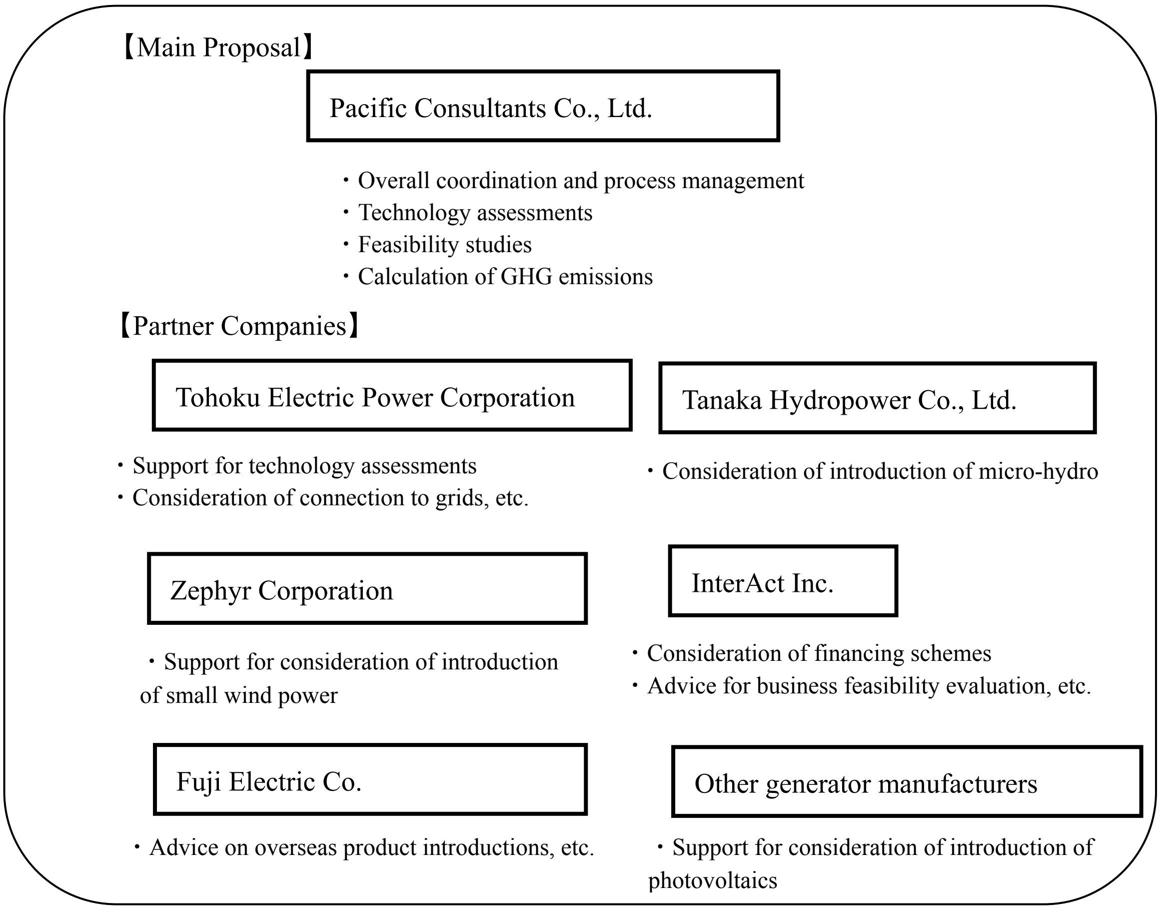


Figure: Organizational structure for project implementation

## 1.3 Components of Study

(1) Study of Water Supply Facilities in Target Countries

We gathered information about water supply facilities in the Iskandar Development Region (Malaysia), Ho Chi Minh City (Vietnam) and Medan (Indonesia). Specifically, missions were conducted to gather local information and related drawings/blueprints needed in order to identify sites that would be suitable for introduction of Japanese technologies.

(2) Evaluation of GHG Reduction Potential

We evaluated the GHG emission reduction potential in a scenario in which renewable energy power generation and energy-efficient technologies were rolled out nationwide in the three target countries.

(3) Evaluation of Potential for Introduction at Model Sites

We identified the suitable sites for introduction of the technologies (electricity generation from renewable energy including hydro, wind, and solar power; and energy-efficient technologies), and then conducted technical and economic evaluations of the feasibility of such technology introduction projects.

(4) Calculation of GHG Emission Reductions

We considered the necessary parameters, activity levels, and formulas needed for calculation methodologies of GHG emission reductions associated with implementation of this project.

(5) Consideration of Financing Schemes for Project Implementation

We considered approaches to resolve issues of securing stable and continuous funding, including the initial investment, that are likely to become the largest challenges in terms of implementing the projects being considered.

(6) Consideration of Possible Co-Benefits of Project Implementation

We considered the possible co-benefits associated with implementation of the projects being considered.

(7) Consideration of Framework for Implementation of Demonstration Projects Starting Next Fiscal Year

We considered the financing schemes and frameworks that included them, required for implementation of the projects being considered.

## Chapter 2 Japanese Products and Technologies Considered for Introduction

### 2.1 Project Benefits from Introduction of Technology

These technologies for renewable energy (micro-hydro, photovoltaic, and wind power) and energy efficiency can contribute to the target countries in the following ways:

- Achieve targets for energy use and expansion of the share of renewable energy
- Alleviate the tight electricity demand market

Ancillary decentralized power and load control systems—which are technologies to mitigate the impacts on the grid caused by instability in electrical sources from the output of photovoltaic and wind power, etc.—can support the deployment of renewable energy in the target countries.

### 2.2 Technologies for Electricity Generation from Renewable Energy

Micro hydro technology generates electricity by driving a turbine using water flow arising from a difference in water levels. To supply water efficiently over a wide area, water supply facilities are generally designed to store clean water temporarily in elevated location, and then for distribution to customers, take advantage of the vertical drop to supply water at an appropriate pressure. The pressure is reduced by the use of pressure-reducing valves and also distribution ponds. The concept behind the projects considered by this study is to generate electricity by installing micro-hydro power plants at these pressure-reduction points, and then make effective use of the electricity by selling it to the grid and using it as a captive power source for in-house consumption.

Photo: Linkless Francis Water Turbine Generator

Credit: Tanaka Hydropower Co., Ltd.

The compact Airdolphin high-performance wind power generator being considered by this study was developed through cooperation of Japanese industry, research institutions, and government agencies. It is light, easy to move, and can operate at low speeds. At a total weight of 18 kilograms, this unit is light enough to be easily moved and it can be installed in various locations, so installation costs can be low. We will also consider the introduction of the Zephyr9000, which with a larger blade diameter than the Airdolphin model can catch more wind, to generate more electricity.

Photo: Small Wind Power Generators

Credit: Zephyr Corporation

There are likely to be many possible places to install photovoltaic generation equipment on the water supply facilities and grounds considered by this study, the roofs of facilities' building, top covers of water tanks, empty spaces on the grounds, and so on.

Various types of solar panels have been developed in Japan. Panasonic Corporation, for example, has developed its own design for the HIT Series of solar panels, which are in the world's top class in terms of power generation efficiency. The HIT Series is expected to be highly economical in the long term, thanks to its high generation efficiency and durability.

## 2.3 Energy-Efficient Technologies

Energy-efficient technologies for water supply facilities can be grouped into two major categories: technologies to improve pump efficiency, and control technologies for the overall water distribution system. This study examined the former.

Figure. Example of water pump and inverter

## 2.4 Ancillary Decentralized Power and Load Control Systems

Ancillary Decentralized Power and Load Control (ADC) systems were developed with the aim of minimizing the impacts of renewable energy on the electrical grid system. This study examined the benefits of introducing ADC systems on actual sites, by estimating the variations in grid voltage and frequency at the water purification plant in the event of introducing photovoltaic power generation equipment.

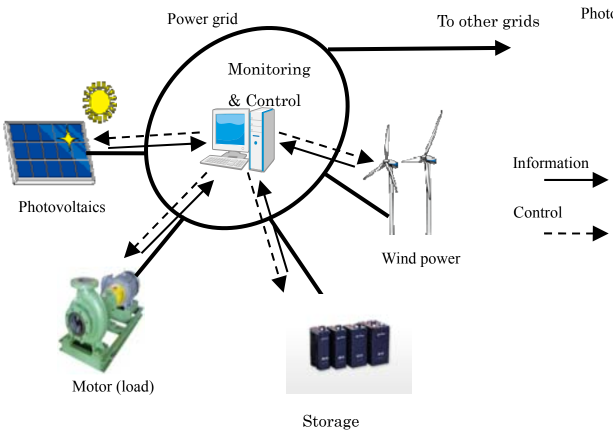


Figure: Grid stabilization technology based on centralized monitoring and control (concept)

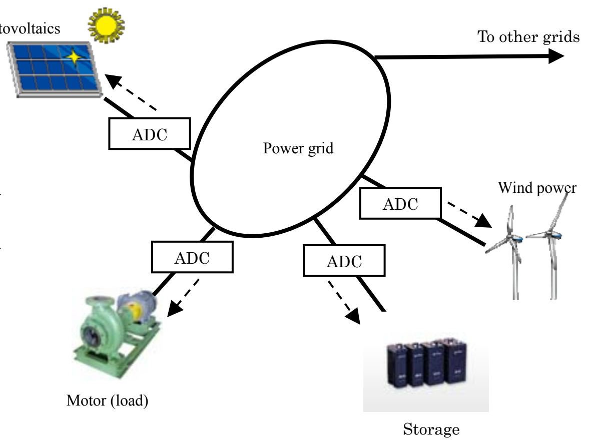


Figure: Grid stabilization technology based on ADC (concept)

## Chapter 3 Information Collection about Water Purification Facilities, and Summary

We have researched several water treatment plants in Iskandar District, Ho Chi Minh, and Medan and found some plants (model sites) that we can introduce Japanese technology.
Also, we have investigated our technology and products that we can introduce for the model sites.

### 3.1 Summary of Water Purification Facilities in Target Areas

(1) Iskandar District
Based on our survey results below, we have selected Gunung Pulai Plant as the model site that both of micro hydroelectric power amd solar power can be installed, and Pulai Reservoir as the model site that high power micro hydroelectric power I can be installed.

Table Survey results for the plants in Iskandar district

| Name | Gunung Pulai Plant | Pulai Reservoir | SG Layang Plant |
|---|---|---|---|
| Operator | SAJ Holdings | SAJ Holdings | SAJ Holdings |
| Availability for introducing micro hydroelectric power | ○ | ○ | × |
| | Surplus pressure for generation available | Surplus pressure for generation available | Too little space to install the machineries. Water level of the dam is liable to change and the fall, is unstable. |
| Availability for introducing solar power generation | △ | ○ | △ |
| | Enough space to install solar power generator | No space to install solar power generator | Enough space to install solar power generator |
| Availability for introducing wind power generation | × | × | × |
| | Wind condition in not good | Wind condition in not good | Wind condition in not good |
| Availability for introducing energy-saving equipment | × | × | × |
| | Already introduced | Already introduced | Already introduced |


Figure: Investigated plants in Iskandar

Credit: MAPBOOK OF MALAYSIA

(2) Ho Chi Minh

We have selected Thu Duc B.O.O as the model site based on the survey results below.

Table: Survey results for the plant in Ho Chi Minh

| Name of the plant | Thu Duc | Thu Duc B.O.O | Tan Hiep | Tan Phu |
|---|---|---|---|---|
| Operator | Saigon Water Co. | Thu Duc Water B.O.O Co. | Saigon Water Co. | Saigon Ground Water Ltd. Co. |
| Availability for introducing micro hydropower generator | △ | ○ | × | × |
| | Low merit for installation for low fall and little amount of water flow | Surplus pressure for generation available at the plant | No surplus pressure for generation available at the plant | No surplus pressure for generation available at the plant |
| Availability for introducing solar power generator | ○ | ○ | △ | △ |
| | Enough space to install the equipment | Enough space to install the equipment | Space to install the equipment available | Space to install the equipment available |

| | | | | |
|---|---|---|---|---|
| Availability for introducing wind power generator | ×<br>Bad wind condition | ×<br>Bad wind condition | ×<br>Bad wind condition | ×<br>Bad wind condition |
| Availability for introducing energy-saving equipment | ×<br>Already introduced | ×<br>Already introduced | ×<br>Already introduced | ×<br>Already introduced |

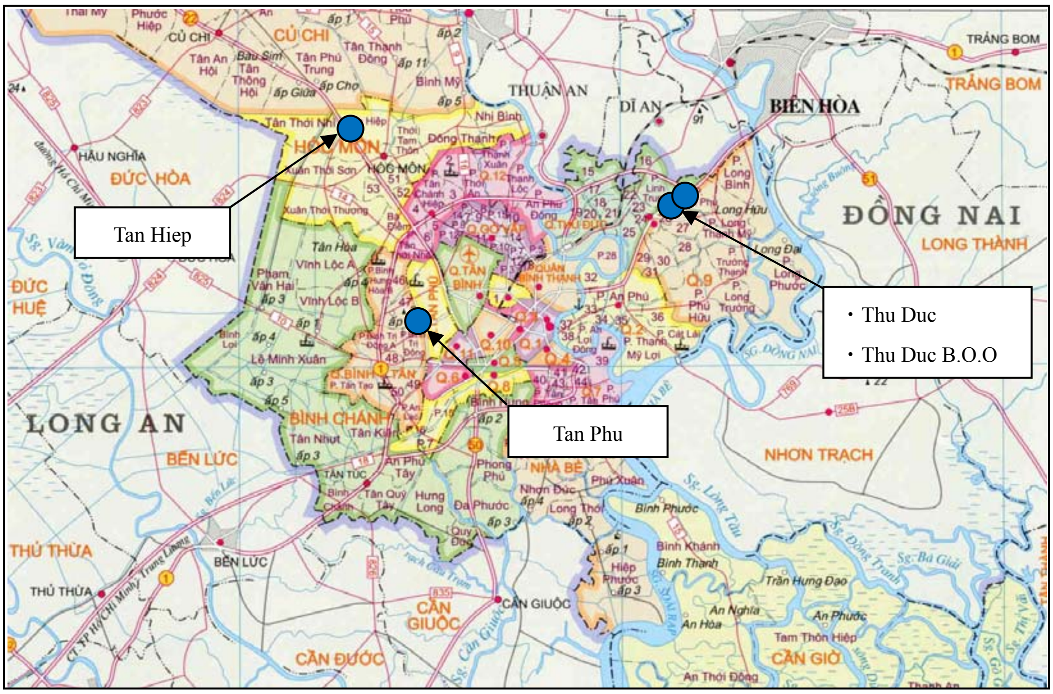


Figure: Investigated plants in Ho Chi Minh

Credit: Vietnam Administrative Atlas

(3) Medan

We have selected Cemara Reservoir as the model site based on the survey results below.

Table: Survey results for the plants in Medan

| Plant | Sibolangit Plant | Delitua Plant | Sunggal Plant | Limau Manis Plant | Cemara Plant |
|---|---|---|---|---|---|
| Operator | PDAM | PDAM | PDAM | PDAM | PDAM |
| Availability for introducing micro hydropower generator | ×<br>No surplus water pressure for generation | ×<br>No surplus water pressure for generation | ×<br>No surplus water pressure for generation | ×<br>No enough output produced for | ○<br>Surplus water pressure for generation |

| | | | | | |
|---|---|---|---|---|---|
| | | | | the little fall | confirmed |
| Availability for introducing solar power generator | ○ | ○ | ○ | ○ | ○ |
| | Space for installation available | Space for installation available | Space for installation available | Space for installation available | Space for installation available |
| Availability for introducing wind power generator | × | × | × | × | × |
| | Bad wind condition | Bad wind condition | Bad wind condition | Bad wind condition | Bad wind condition |
| Availability for introducing energy-saving equipment | × | ○ | △ | ○ | △ |
| | Already introduced | Introducing high efficient pump available | Energy-saving by controlling a number of pumps under practice | Introducing high efficient pump available | Energy-saving by controlling a number of pumps under practice |

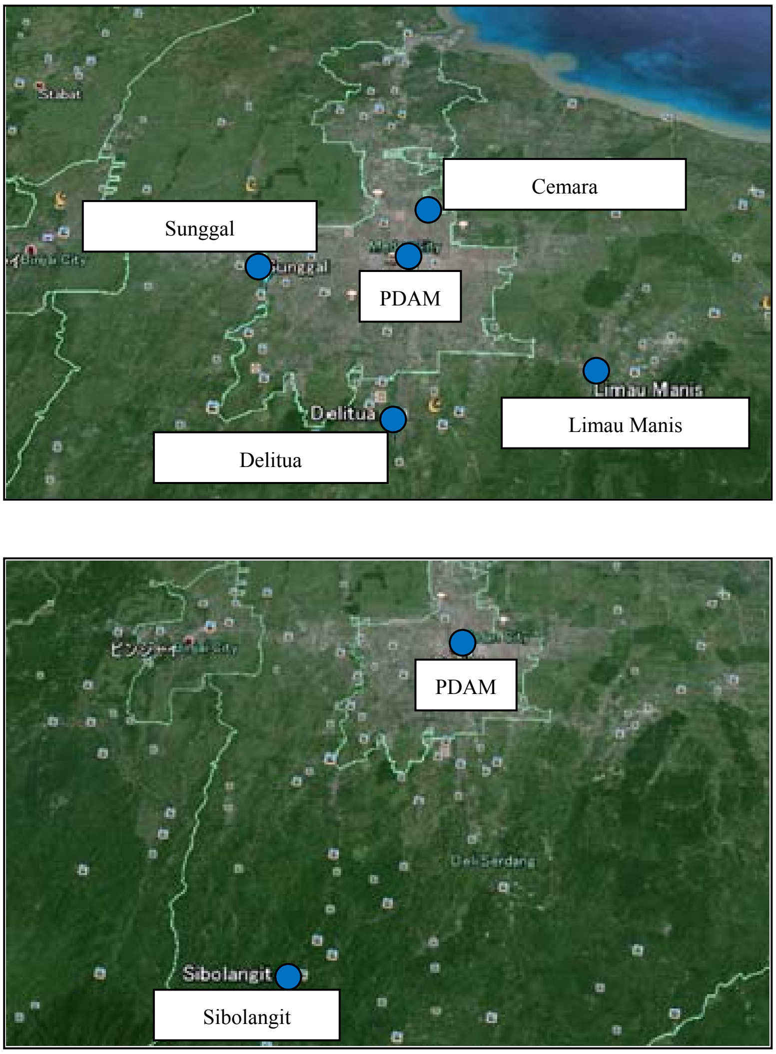


Figure: Investigated plants in Medan

Credit: Google Earth

## 3.2 Technical Potential for Introduction of Technology

(1) Iskandar resion

We have investigated capacity of micro hydropower generator and solar power panel for Gunung Pulai water treatment plant and micro hydropower generator for Pulai service reservoir.

a) Gunung Pulai water treatment plant

Table: Information for the micro hydropower generator (Gunung Pulai Plant)

| | |
|---|---|
| Location | Gunung Pulai Forest Park |
| Operator | SAJ Holdings Sdn Bhd |
| Generation form/system | Replacement with pressure reduction unit (utilizing surplus water pressure in the duct) |
| Details for water turbine generator | Available head: 18m<br>Water volume : $0.21m^3/s$<br>Output : 27kW (total efficiency: 72%)<br>(details of the efficiency: 80% by water turbine, 90% by generator) |
| Outline of the equipment | Water turbine : 1 Linkless Francis Turbine<br>Generator : three-phase squirrel-cage induction motor<br>Grid connection: connect with 400V to the system in the plant |
| Comments | - |

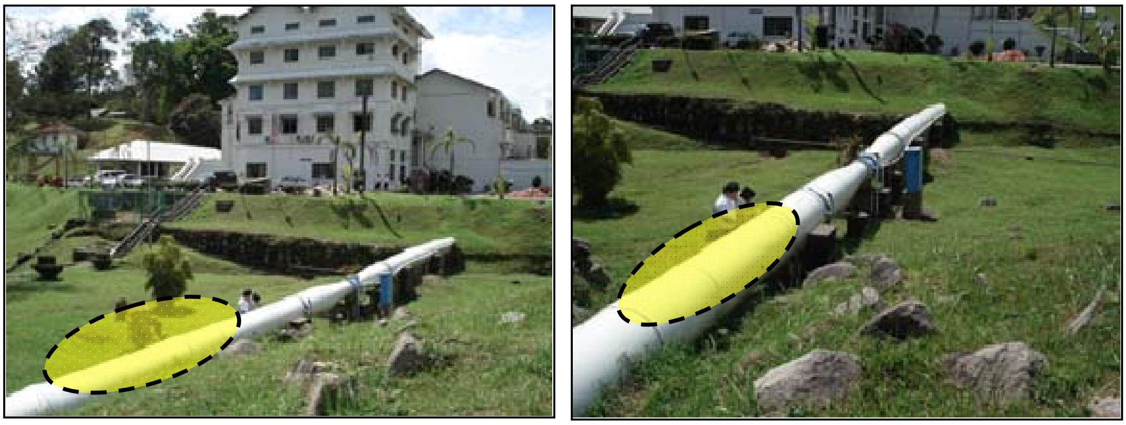

Figure: Expected place to install micro hydropower equipment

Table: Information for solar power generation system (Gunung Pulai Plant)

| | |
|---|---|
| Location | Available space inside the plant |
| Specification | Area: 225 $m^2$<br>Output: approx. 20kW |
| Generation form/system | Solar power module produced by domestic manufacturer<br>Supplementary equipment: （power conditioner, trestle, etc.） |
| Details for the equipment | Captive consumption |

| | |
|---|---|
| Comments | Total output (number of the panels to be installed) will be decided by the domestic operator based on business evaluation. |

b) Pulai Reservoir

Table: Information for micro hydropower generator (Pulai Reservoir)

| | |
|---|---|
| Location | Jalan Ulu Choh Johor Malaysia Pulai Service Reservoir |
| Operator | SAJ Holdings Sdn Bhd |
| Generation form/system | Replacement with pressure reduction unit (replacement with pressure reduction unit (utilizing surplus water pressure in the duct) |
| Details for water turbine generator | Available head: 85m<br>Water volume : 0.30m$^3$/s<br>Output : 186kWtotal (efficiency: 74%) |
| Details for the equipment | Water turbine : 1 Linkless Francis Turbine<br>Generator : three-phase squirrel-cage induction motor<br>Grid connection : connect to the lamp line of the power company by low pressure |
| Comments | Sell the electricity to the power company |

Estimated area to install micro hydropower equipment

Mechanical water control bulb

Figure: Estimated place to install micro hydropower equipment

(2) Ho Chi Minh

We have investigated capacity of micro hydropower generator and solar power panels to install in Thu Duc B.O.O Water Treatment Plant.

Table: Information for the micro hydropower generator

| | |
|---|---|
| Generation form/system | Water receiving tank at the plant (utilizing surplus water pressure in the duct) |
| Details for water turbine generator | Available head : 5.45m<br>Water volume : 3.94m3/s<br>Output : 139kW (total efficiency: 66%) |
| Details for the equipment | Water turbine : 2 Cross-Flow Turbines<br>Generator : three-phase squirrel-cage induction motor<br>Grid connection : connect with 3,300V to the grid inside the plant |
| Comments | Adopt incessant water installation method as it is impossible to stop treated water supply. |


Inside of the pit: butterfly bulb


Estimated location to install micro hydropower generator

Figure: Estimated place to install micro hydropower generator

Table: Information for solar power generation system

| | |
|---|---|
| Location | Available space inside the plant |
| Specification | Area : 21,550 $m^2$<br>Output : approx. 2,250kW |
| Generation form/system | Solar power module produced by domestic manufacturer<br>Supplementary equipment: (power conditioner, trestle, etc.) |
| Outline for the equipment | Grid connection: connect with 3,300V to the system in the plant |
| Comments | Total output (number of the panels to be installed) will be decided by the domestic operator based on business evaluation. |

Figure:　Estimated place to install the solar power generator

(3) Medan

We have investigated capacity of micro hydropower generator and solar power panels for Cemara Reservoir.

Table: Information for micro hydropower generator

| | |
|---|---|
| Location | Cemara Reservoir |
| Operator | PDAM TIRTANADI |
| Generation form/system | Inhalant siphon of the reservoir (utilizing surplus water power in the duct) |
| Outline for water turbine generator | Available head : 18m<br>Water volume : $0.17m^3/s$<br>Output : 22kW (total efficiency: 72%) |
| Outline for the equipment | Water turbine : 1 Linkless Francis Turbine<br>Generator : three-phase induction generator<br>Grid connection : connect with 400V to the system in the plant |
| Comments | - |

Figure: Estimated place to install micro hydropower generator

Table: Information for solar power generation system

| | |
|---|---|
| Location | Available space inside the plant |
| Specification | Area: 1,100 $m^2$<br>Output : approx. 98kW |
| Generation form/system | Solar power module produced by domestic manufacturer<br>Supplementary equipment: （power conditioner, trestle, etc.） |
| Outline for the equipment | Grid connection |
| Comments | Total output (number of the panels to be installed) will be decided by the domestic operator based on business evaluation. |

Figure: Estimated place to install the solar power generator

Installation costs of micro hydropower system and solar power system has were estimated for each model site chosen in chapter 3. Besides, this chapter 4 assessed the feasibility of each installation project.

(1) Iskandar region

a) Gunung Pulai water treatment plant

Following tables shows the approximate cost for installation of micro hydropower and solar power at Gunung Pulai. An accurate price will be calculated in the next detail study.

Table: Installation cost of micro hydropower (Gunung Pulai)

| Item | Cost | | Remark |
|---|---|---|---|
| Construction cost | | | - |
| Water wheel | 46,400 | Thousand JPY | Linkless Francis Turbine |
| Generator | 39,100 | Thousand JPY | Connect to the grid inside the plant |
| Others (pipework etc.) | 6,500 | Thousand JPY | - |
| Shipping | 3,000 | Thousand JPY | - |
| Installation | 27,000 | Thousand JPY | Include incidental works |
| Total | 122,000 | Thousand JPY | - |
| O&M cost | | | - |
| Operation & Maintenance | 464 | Thousand JPY | - |
| Total | 464 | Thousand JPY | - |

Table: Installation cost of solar power (Gunong Pulai)

| Item | Cost | | Remark |
|---|---|---|---|
| Construction cost | | | - |
| Panel system | 4,200 | Thousand JPY | - |
| Land preparation | 0.33 | Thousand JPY | - |
| Shipping | 150 | Thousand JPY | - |
| Grid connection | 257 | Thousand JPY | Interview experts |
| Total | 4,612 | Thousand JPY | - |
| O&M cost | | | - |

| | | | |
|---|---|---|---|
| Operation & Maintenance | 67 | Thousand JPY | - |
| Administration | 9 | Thousand JPY | - |
| Total | 76 | Thousand JPY | - |
| Insurance | 11 | Thousand JPY | - |
| Total | 297 | Thousand JPY | - |
| Clearance | 211 | Thousand JPY | - |
| Total | 221 | Thousand JPY | - |

b) Pulai reservoir

Following tables shows the approximate cost for installation of micro hydropower at Pulai reservoir. An accurate price will be calculated in the next detail study.

Table: Installation cost of micro hydropower (Pulai reservoir)

| Item | Cost | | Remark |
|---|---|---|---|
| Construction cost | | | - |
| Water wheel | 56,000 | Thousand JPY | Linkless Francis turbine |
| Generator | 48,000 | Thousand JPY | Connect to the grid outside the plant |
| Others (pipework etc.) | 7,000 | Thousand JPY | - |
| Shipping | 3,500 | Thousand JPY | - |
| Installation | 34,000 | Thousand JPY | - |
| Total | 148,500 | Thousand JPY | - |
| O&M cost | | | - |
| Operation & Maintenance | 560 | Thousand JPY | - |
| Total | 560 | Thousand JPY | - |

(2) Ho Chi Minh

Following tables shows the approximate cost for installation of micro hydropower and solar power at Thu Duc B.O.O. plant. An accurate price will be calculated in the next detail study.

Table: Installation cost of micro hydropower (Thu Duc BOO)

| Item | Cost | | Remark |
|---|---|---|---|
| Construction cost | | | - |

| | | | |
|---|---|---|---|
| Panel system | 136,000 | Thousand JPY | Cross flow turbine |
| Land preparation | 79,500 | Thousand JPY | Connect to the grid inside the plant |
| Shipping | 17,000 | Thousand JPY | - |
| Grid connection | 7,500 | Thousand JPY | - |
| Total | 50,000 | Thousand JPY | - |
| O&M cost | 290,000 | Thousand JPY | - |
| Operation & Maintenance | | | - |
| Administration | 1,360 | Thousand JPY | - |
| Total | 1,360 | Thousand JPY | - |

Table: Installation cost of solar power (Thu Duc BOO)

| Item | Cost | | Remark |
|---|---|---|---|
| Construction cost | | | - |
| Panel system | 402,267 | Thousand JPY | - |
| Land preparation | 158 | Thousand JPY | - |
| Shipping | 14,367 | Thousand JPY | Interview experts |
| Grid connection | 21,525 | Thousand JPY | - |
| Total | 438,317 | Thousand JPY | - |
| O&M cost | | | - |
| Operation & Maintenance | 6,439 | Thousand JPY | - |
| Administration | 901 | Thousand JPY | - |
| Total | 7,340 | Thousand JPY | - |
| Insurance | 1,006 | Thousand JPY | - |
| Total | 9,486 | Thousand JPY | - |
| Clearance | 20,121 | Thousand JPY | - |

(3) Medan

Following tables shows the approximate cost for installation of micro hydropower and solar power at Cemara reservoir. An accurate price will be calculated in the next detail study

Table: Installation cost of micro hydropower (Cemara reservoir)

| Item | Cost | | Remark |
|---|---|---|---|
| Construction cost | | | - |

| | | | |
|---|---|---|---|
| Panel system | 43,400 | Thousand JPY | Linkless Francis turbine |
| Land preparation | 39,100 | Thousand JPY | Connect to the grid inside the plant |
| Shipping | 6,500 | Thousand JPY | - |
| Grid connection | 3,000 | Thousand JPY | - |
| Total | 27,000 | Thousand JPY | - |
| O&M cost | 119,000 | Thousand JPY | - |
| Operation & Maintenance | | | - |
| Administration | 434 | Thousand JPY | - |
| Total | 434 | Thousand JPY | - |

Table: Installation cost of solar power (Cemara reservoir)

| Item | Cost | | Remark |
|---|---|---|---|
| Construction cost | | | - |
| Panel system | 20,533 | Thousand JPY | - |
| Land preparation | 11 | Thousand JPY | - |
| Shipping | 733 | Thousand JPY | Interview experts |
| Grid connection | 1,132 | Thousand JPY | - |
| Total | 22,409 | Thousand JPY | - |
| O&M cost | | | - |
| Operation & Maintenance | 329 | Thousand JPY | - |
| Administration | 46 | Thousand JPY | - |
| Total | 375 | Thousand JPY | - |
| Insurance | | Thousand JPY | |
| Total | 51 | Thousand JPY | - |
| Clearance | 1,027 | Thousand JPY | - |
| Construction cost | 1,078 | | |

## 5.1 Proposed Project Implementation Scheme

The Japanese side is proposing a private-sector business model centering on the concept of the energy service company (ESCO), which provides comprehensive services, from pre-evaluation and formulation of power generation plans, to operations, management, and verification of the effectiveness of power generation activities.

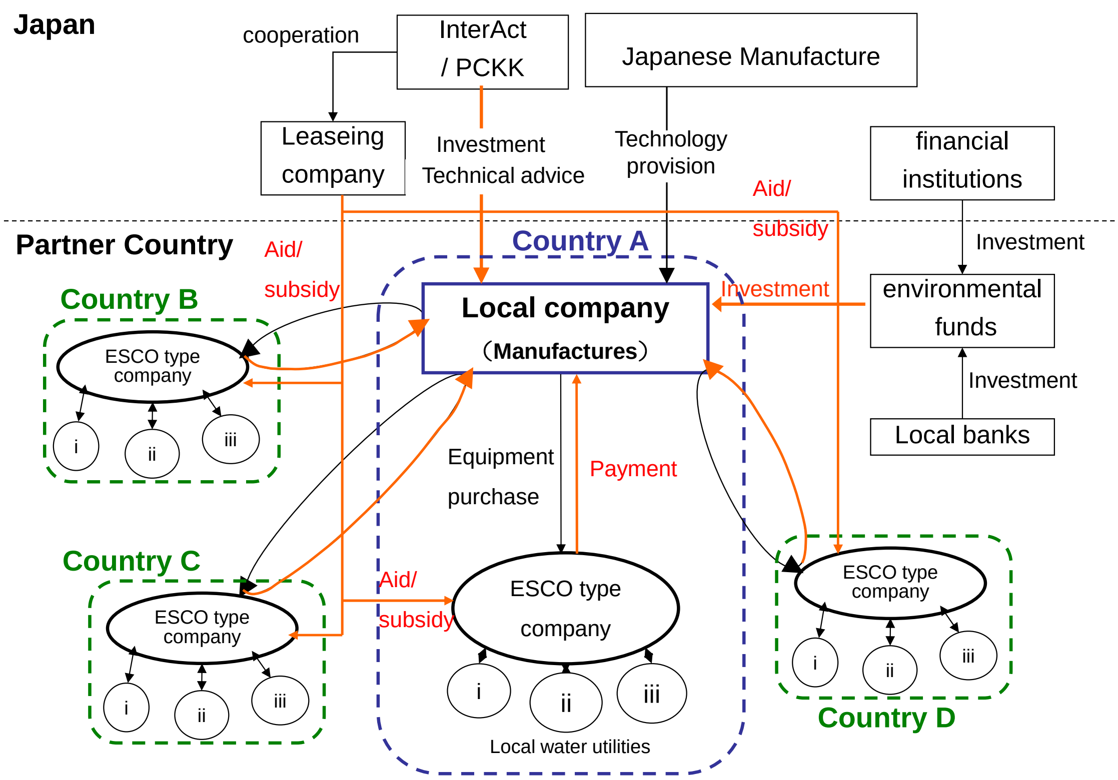


Figure: Image of Proposed Project Implementation Scheme

The central concept, the "ESCO type services company" is a service company that provides comprehensive support including the formulation of power generation plans, capital investment and equipment holdings, operations management, handling procedures on related legislation, and verification of the power generation effects. Because it takes the form similar to the profit-making system of ESCO[1] businesses, which receive a return for reducing energy consumption, we use the

[1] An energy service company (ESCO) is a business model in which the business provides comprehensive services to introduce energy-efficient technologies, guarantees the energy savings, and then receives in return a payment for a

term "ESCO-type services" company.

The ultimate customers of this scheme would be the local water utilities (water suppliers), which can be divided into two segments.

a) Water utilities that only wish to purchase power generators (Type A end customers)
   Businesses that only want to purchase (design/install) micro-hydro power generators.

b) Water utilities that want total support for electricity generation (Type B end customers)
   Businesses that want services other than the purchase of generators, including pre-evaluation of power generation projects, formulation of power generation plans, funds procurement, operations and management of power generation equipment, guarantee and verification of the power generation effects.

## 5.2 Proposed Management Structure for Project

Below is an outline of key roles of companies on the Japanese side of the project implementation scheme described above.

a) InterAct Inc./Pacific Consultants Co., Ltd.

InterAct Inc. is a company that participates in planning as both investor and expert service provider, and offers services throughout the project life-cycle, from the project concept stage to actual operations.

b) Tanaka Hydropower Co., Ltd.

Tanaka Hydropower will provide the technology, as it proposes to build local manufacturing capabilities for its cutting-edge, proprietary, micro-hydro power generation equipment.

c) Tohoku Electric Power Corporation

Offering the benefits of its know-how relating to the power generation and electricity sales sectors, and as one of Japan's leading power utilities, Tohoku Electric Power Corporation will play a role as a technical advisor on infrastructure development, in order to smoothly implement in host countries the deployment of renewable energy, and support the creation of feed-in tariff (FIT) systems.

d) J-team

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portion of the value of the customer's reduced energy consumption. Services provided include diagnosis of energy-saving potential, design and installation of equipment, managing of maintenance, and guaranteeing/verifying the actual energy savings realized.

J-team is an organization that works in cooperation with InterAct and Japanese small and medium enterprises that own advanced technologies. It offers a comprehensive package of services, from project finding and planning, to funds procurement, construction and operations management, for projects that will contribute to the creation of a low-carbon society in developing countries. In this project, it works as a problem-solver to address challenges bringing this project scheme to reality.

## Chapter 6 GHG Emission Reduction Potential

Notes: the following are estimated values, not precise figures

(1) Malaysia

| | |
|---|---|
| Micro-hydro | 46,255t$CO_2$ |
| Photovoltaic | 87,000t$CO_2$ |
| Windpower | Less potential |
| Energy-efficient technology | 180,522 t$CO_2$/year |

(2) Vietnam

| | |
|---|---|
| Micro-hydro | 20,435t$CO_2$ |
| Photovoltaic | 37,071t$CO_2$ |
| Windpower | 584 t$CO_2$ |
| Energy-efficient technology | 84,315 t$CO_2$/ year |

(3) Indonesia

| | |
|---|---|
| Micro-hydro | 14,941t$CO_2$ |
| Photovoltaic | 50,297.7t$CO_2$ |
| Windpower | Less potential |
| Energy-efficient technology | 170,312 t$CO_2$/ year |

# Chapter 7 Next Steps

## 7.1 Summary of This Study

This study interviewed water utilities in the Iskandar Development Region (Malaysia), Ho Chi Minh City (Vietnam) and Medan (Indonesia), selected model sites from among the water purification plants under their responsibility, and conducted a detailed review for the potential introduction of renewable energy and energy conservation facilities.

As our conclusion, we confirmed that there are no technical obstacles to the introduction of these technologies However, we discovered that there difficulties exist in ensuring project feasibility, from the economic perspective.

Nevertheless, project feasibility will improve if a number of factors change, including the possible expansion of feed-in tariff (FIT) systems in the host countries, the possible future introduction of subsidy programs, and cost reductions for equipment manufacturing in response to a more dynamic domestic market for renewable energy in Japan. Therefore, it is our finding that project feasibility can be sufficiently achieved if equipment manufacturing costs can be reduced based on the development of local manufacturing capabilities, and if local governments can be encouraged to introduce subsidy policies.

Based on these findings, and having considered Japanese corporations' strengths as well as weaknesses that must be overcome, based on discussion about project directions, this study proposes a "private-sector business model centering on the concept of the energy service company (ESCO), which provides comprehensive services, from pre-evaluation and formulation of power generation plans, to operations, management, and verification of the effectiveness of power generation activities"

This study also considered methodologies to calculate emission reductions from projects that introduce hydro, photovoltaic, and wind power generators, as well as high-efficiency pumps at water purification plants. We also estimated the potential GHG emission reductions if this project were to be deployed nationwide in Vietnam, based on the number of water purification plants around the country as well as their geographical and environmental parameters.

## 7.2 Future Schedule

We proposed a project plan based on the concept of implementation of a model project as part of the model installation project from the next fiscal year onward.

Phase 1 would consist of detailed discussions toward implementation of a model project. Specifically, discussions would be held with water utilities responsible for the model sites identified in the current year's study, and work to prepare a detailed project plan and funding plan. Based on that work, we would conduct detailed design of equipment to be introduced, in cooperation with Japanese generation equipment manufacturers, and develop a more detailed schedule of the overall project.

Phase 2 would be implementation of the model project. It would include advancing to manufacturing of equipment based on detailed designs from Phase 1, and when that was completed, proceeding next to export, delivery, installation, and trial operations, followed by regular operation and monitoring. However, for technologies and products for which overseas production arrangements are not yet established (e.g., micro-hydro generators), some difficulties may arise in relation to the preparation time for local production during this phase For that reason, the plan for the model project is to manufacture the relevant equipment in Japan, and deliver it to the local sites for installation. During the model project, by regularly verifying the benefits of equipment installation and checking the status of achievement of the project plan, we will verify the technical and economic usefulness of the Japanese products introduced.

Table: Model Project Plan (By Quarter)

| Implementation item | | 2014 | | | | 2015 | | | | 2016～ |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | |
| Phase 1 | Detailed discussion of model project | | | | | | | | | |
| | Prepare project plan, funding plan | | ━ | | | | | | | |
| | Cooperate with water utilities | | | ━ | | | | | | |
| | Detailed design of equipment to be introduced | | | | ━ | | | | | |
| | Prepare schedule for equipment assistance project | | | ━ | ━ | ━ | | | | |
| Phase 2 | Implement model project | | | | | | | | | |
| | Manufacture equipment to be introduced | | | | | | ━ | ━ | | |
| | Equipment delivery, installation, trial operation | | | | | | | ━ | | |
| | Launch equipment operation | | | | | | | | ━ | ━ |
| | Verify equipment installation benefits | | | | | | | | ━ | ━ |
| | Verify achievement status of project plan | | | | | | | | ━ | ━ |