Feasibility Studies on Joint Crediting Mechanism Projects

towards Environmentally Sustainable Cities in Asia

JCM Large Scale Feasibility Project to Promote Water Saving and Energy Saving Products in Vietnam

March 2014

Mitsubishi UFJ Morgan Stanley Securities Co., Ltd.

Summary

1. Purpose

The primary purpose of this project (“Project”) is to establish a water-saving mechanism reducing the emission of carbon dioxide (“CO2”) in order to develop a large-scale nationwide Joint Crediting Mechanism (“JCM”) while solving water-related challenges faced by Vietnam including shortage, leakage and contamination of water.

In this Project we will verify two sub-projects of introducing water-saving equipments, and rainwater utilization / purification system, as well as discussing finance scheme to promote water-saving equipments.

2. Introduction and Verification of Water-Saving Equipments

<Background>

There are energy demands at water purification facility or sewage treatment facility for supply and treatment of water and water-saving showers and toilets will contribute to reducing energy and saving heating energy. In view of the study of 2012 conducted by the Ministry of Economy, Trade and Industry Japan (“METI”), Mitsubishi UFJ Morgan Stanley Securities (“MUMSS”) and TOTO (“TOTO”) came to a conclusion that promotion of water-saving equipments will certainly generate credits.

In the study of 2012, energy-saving was expected not only from the water and sewage system based on the credit methodology but also in the water supply system within the building. However, there was not enough insight on how to reflect such effect on the credit methodology.

In this Project, we established a water-saving credit methodology for hotels to estimate energy-saving effect not only from the water and sewage system but also from the water supply system within the building to discuss applicability of a large-scale JCM project.

<Outline of Project>

This Project is aimed at estimating the level of water and CO2 reduction through the introduction of water-saving equipments in hotels in Vietnam based on the quantified water-saving effect taken from various measurement devices (measurement of water and hot water, water pumps, heat sources etc).

We attempt water saving during the actual water-consumption scenes in each guest room using water-saving showers and toilets equipped with the advanced Japanese water-saving technology. Chronological shift of water consumption will be modeled using a measurement device installed in guest rooms and various pumps. Level of energy saved for hot-water shower will also be modeled. In addition, we will determine the default value in MRV methodology to estimate the volume of CO2 reduction upon analysis of the measurements taken and establish water usage patterns for water-saving showers and toilets.

Our study was conducted at Renaissance Riverside Hotel Saigon, a five-star hotel in Ho Chi Minh City ("HCMC") upon replacement of the toilet and shower facilities in 150 rooms out of 336 guest rooms in total with TOTO water-saving equipments.

<Outcome of Study>

Below is the annual volume of water saved per room based on this Study in consideration for the frequency of toilet and shower usage, duration per usage and hotel occupancy rate.

Table 1: Annual Volume of Water Saved per Room

<table>
<tr><th rowspan="2"></th><th colspan="2">Volume of Water Usage</th><th rowspan="2">Annual Volume of Water Saved per Room</th></tr>
<tr><th>Pre-Renewal</th><th>Post-Renewal</th></tr>
<tr><td>Toilet (Full Flush)</td><td rowspan="2">10.5L/Use</td><td>4.92L/ Use</td><td rowspan="2">14.5m^3/Room/Year</td></tr>
<tr><td>Toilet (Half Flush)</td><td>3.18L/ Use</td></tr>
<tr><td>Shower</td><td>11L/Minute</td><td>6.82L/ Minute</td><td>11.2m^3/ Room/Year</td></tr>
</table>

Table 2 shows the level of annual CO2 reduction per room based on the volume of water saved above. Upper column A indicates actual reduction in the target hotel while figures in lower column B indicate the volume of reduction when default value of emission factor regarding water heating (to be described below) is applied. Although heat pump is used as heat source at the target hotel, the default value is based on such heat sources as electricity, heavy oil and LNG which are more common at hotels in Vietnam.

Table 2: Annual CO2 Reduction per Room

<table>
<tr><th colspan="3"></th><th>Toilet</th><th>Shower</th><th>Total</th></tr>
<tr><td rowspan="2">A</td><td rowspan="2">Target Hotel Note</td><td>Fl. 16 and above</td><td>11.9kg-CO2/Year</td><td>63.4kg-CO2/Year</td><td>75.3kg-CO2/Year</td></tr>
<tr><td>Fl. 15 and below</td><td>10.5kg-CO2/Year</td><td>62.3kg-CO2/Year</td><td>72.8kg-CO2/Year</td></tr>
<tr><td rowspan="3">B</td><td rowspan="3">Default Value (By Heat Source)</td><td>Boiler (Electricity)</td><td rowspan="3">10.5kg-CO2/Year</td><td>87.4kg-CO2/Year</td><td>97.9kg-CO2/Year</td></tr>
<tr><td>Boiler (Heavy Oil)</td><td>42.5kg-CO2/Year</td><td>53.0kg-CO2/Year</td></tr>
<tr><td>Boiler (LNG)</td><td>32.6kg-CO2/Year</td><td>43.1kg-CO2/Year</td></tr>
</table>

Note: At the target hotel of this Project, water is pumped from the main water supply pipe up to the storage tank on the highest floor and distributed to each floor. CO2 reduction for 16th floor and above is higher than that of 15th floor and below due to additional pressure from the pump to supplement low water pressure.

The water-saving credit methodology advocated in the study of 2012 took up shower used in residential properties as model. In this study the methodology is renewed to target high-rise buildings such as hotels and include toilet in addition to shower. Emission factor derived from water supply within the building and emission factor by heat source are set as default value in response to such renewal.

Table 3: Emission Factor (Default Value of HCMC and Hanoi City)

Parameter		HCMC	Hanoi City
Emission Factor from Water and Sewage Treatment		0.00039 t-CO2/m3	0.00039 t-CO2/m3
Emission Factor from Water Supply in Building		0.000334 t-CO2/m3	0.000334 t-CO2/m3
Emission Factor by Heating Method	Boiler (Electricity)	0.00708 t-CO2/m3	0.00902 t-CO2/m3
	Boiler (Heavy Oil)	0.00307 t-CO2/m3	0.00390 t-CO2/m3
	Boiler (LNG)	0.00220 t-CO2/m3	0.00279 t-CO2/m3

In consideration for different temperature of tap water in each climate zone, Vietnam is categorized into 7 climate zones in the methodology to set each emission factor by heat source, and above shows data in HCMC and Hanoi City.

Below is the potential reduction estimated when water-saving showers and toilets are available in 5,000 hotel guest rooms in HCMC and Hanoi City based on Table 1 to 3 above.

Table4: Potential CO2 Reduction

		HCMC	Hanoi City
Climate Zone		R7	R3
Emission Factor by Heating Method	Boiler (Electricity)	493 t-CO2/Year	600 t-CO2/Year
	Boiler (Heavy Oil)	266 t-CO2/Year	313 t-CO2/Year
	Boiler (LNG)	217 t-CO2/Year	250 t-CO2/Year

Default value has yet to be finalized in this year's methodology due to a lack of study on heating efficiency and pipe heat loss within the hotel. For example, pipe heat loss is presumed to be zero under the prevailing methodology, however there estimated to be an actual heat loss of 50% or more. There will be a greater reduction to be justified under the methodology when the aforesaid is taken into account and we must focus on this issue.

3. Introduction and Verification of Rainwater Purification System

<Background>

Rainfall in Vietnam is characterized by squall-like downpour within short hours lasting several days resulting in frequent flood in urban areas paved with asphalt. HCMC is plagued by flood damages every year and response to climate change and corresponding rise in sea level and abnormal weather is urgently needed.

Collection and utilization of rainwater will significantly help to turn around the urban flooding issues among other things and reduce water consumption which will improve water supply in Vietnam after all. It will also decelerate the worsening urban environment caused by inundation or leakage of untreated sewage at the time of rainfall.

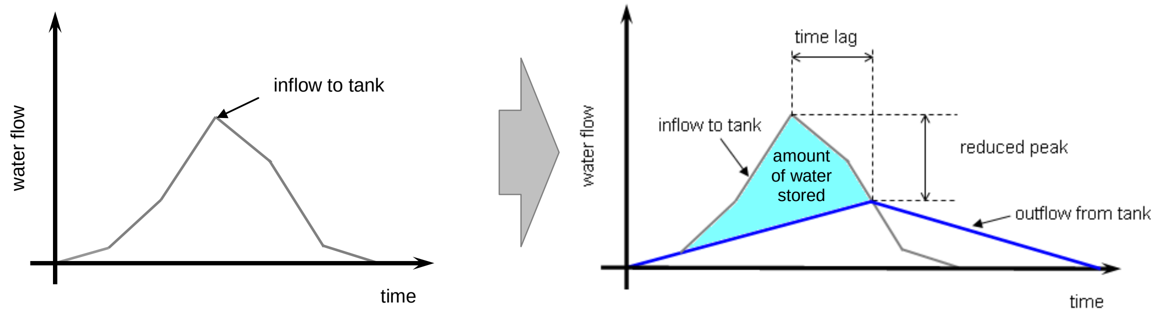
<Outline of Project>

In this Project, we calculated the level of water saving and CO2 reduction by use of rainwater collected from the rooftop of tenanted building, large hotel and parking space in HCMC to discuss the potential of rainwater utilization as well as level of water saving and CO2 reduction based on the precedents in Japan.

In addition, we verified the benefit and safety of Japanese water purification system when rainwater is used.

<Outcome of Study>

The method of curbing rainwater runoff is based on the concept of creating a delay in runoff through the temporary storage of rainwater during peak hours as illustrated below. Such delay in peak-hour runoff helps keeping the influx of rainwater into rivers within their capacity and mitigates urban flood.



Inflow of Rainwater in Storage Facility Runoff from Storage Facility and Control Effect

Illustration 1: Concept of Runoff Control at Storage Facility

Below is the estimated level of water saving and CO2 reduction by use of rainwater at 3 sites.

Table 5: Potential Level of Water Saving and CO2 Reduction

	Case 1	Case 2	Case 3
Type of Building	Multi-Tenant Building (5 floors)	Hotel (21 floors/2 basement floors)	Parking Lot (Office Building)
Location	District 1, HCMC	District 1, HCMC	District 3, HCMC
Floor Area/Roof Area	$284m^2$ / $51m^2$	$29,539m^2$ / $1,419m^2$	― / $60m^2$
Annual Water Supply*	$2,592m^3$	$132,241m^3$	NA
Annual Rainwater Usage Quantity**	$90m^3$	$2,524m^3$	$107m^3$
Water-Saving Ratio	3.5%	1.9%	NA
Annual CO2 Reduction***	21kgCO2	581kgCO2	25kgCO2

* Case 1and Case 2 are based on estimates and actual figures respectively.

** Annual Rainwater Usage Quantity [m3]＝Water Catchment [m2] × Annual Precipitation [mm] × Runoff Coefficient /1,000

Annual Precipitation :1,976mm Runoff Coefficient :0.9 (Roof)

*** Emission Factor : 0.23kgCO2/m3 (CO2 emission factor for water supply)

In Case 3 of Table 5, quality of the rainwater purified through the Japanese purification system is confirmed normal. Local counterparts also commented favorably that utilization of stored rainwater would certainly be effective in mitigating shortage of water supply. Although the quality is confirmed normal, the research team does not recommend taking purified rainwater directly from the clean water pipe.

Further studies are required to encourage more extensive use of rainwater and future use of greywater as supplementary water supply in order to make maximum use of water resources.

4. Consideration of Finance Scheme Promoting Water-Saving Equipments

First we considered the business feasibility of water-saving toilet and shower adopted in this Project. Payback period of water-saving toilet tends to be longer due to small saving effect per unit whereas investment may be recoverable in about 8 years for shower as energy can be saved not only from water but also heating power consumption.

Next we considered the feasibility of ESCO taking water-saving shower as example. Based on the estimation under the Guaranteed Savings scenario (initial costs to be borne by client) which is more common in emerging economies, it will take 13 years to recover investment if no financial help is offered. This outcome is derived from studying the investment return solely from the saving of water, fuel and electricity. A subsidy covering around 60% of the initial investment is required for ESCO to be recoverable within 5 years if relying solely on energy saving.

Due to the nature of product, other benefits are also considered when purchasing toilet or shower which are unrelated to energy-saving such as functionality, user-friendliness, brand image etc. Hence it is not appropriate to assess their benefits in view of the payout period alone. In case of commercial facilities including hotels, ESCO proposal based on the combination of such facilities as rather costly boilers and heat pumps will be more appealing where a great deal of energy can be saved.

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Chapter 1 Outline of Project

1.1 Purpose of Project

The primary purpose of this project (“Project”) is to establish a water-saving mechanism reducing the emission of carbon dioxide (“CO2”) in order to develop a large-scale nationwide Joint Crediting Mechanism (“JCM”) while solving water-related challenges faced by Vietnam including shortage, leakage and contamination of water.

1.2 Outline of Project

TOTO LTD., the leading partner in this Project ("TOTO") has evidenced through academic researches that CO2 emission can be reduced by means of water-saving showers and toilets designed for lower energy consumption in the water and sewage system as well as lower heat consumption through saving hot water.

In response to these researches, a method of converting saved water into CO2 reduction from the water facilities and equipments including showers and toilets has been adopted as the “(2010) New Installation of Water-Saving Type Residential Facilities (Methodology No. 43)” in the domestic credit business. This is the world’s first-ever credit business evolved from the correlation of water and CO2 emission and there has been much global response including invitation to present at the International Council for Research and Innovation in Building and Construction (“CIB”) and Waterwise Conference hosted by a British water-saving promotion agency, or solicitation to write on water-related English academic papers (“Water”). Such global reactions manifest worldwide attention gathered on the future development of this Japanese water-saving credit business.

This Project is designed to establish a water-saving credit methodology for buildings in Ho Chi Minh City, Vietnam, especially for hotels where significant volume of hot and cold water is consumed among other structures.

<<Particulars of Project>>

- Intended Target: Hotels in Ho Chi Minh City
- Reduction of Water Consumption: To attempt water saving during the actual water-consumption scenes in each guest room using water-saving showers and toilets equipped with the advanced Japanese water-saving technology. The water-consumption pattern will be modeled using a measurement device to record chronological shift of water consumption. Level of energy saved for hot-water shower will also be modeled. In addition, discussions will be held as to the setting of energy output unit at the time of water supply for the water-supply pumping system.
- Setting Default Value of MRV Methodology: To set the default value of MRV methodology in

estimating the volume of CO_2 reduction upon analysis of the measurements taken from guest rooms and illustration of the water usage patterns for water-saving showers and toilets.

In addition to verifying the widespread effect of these water and energy-saving equipments, water-saving technology and urban flood prevention measures of Japan will be evaluated to illustrate the validity of establishing a rainwater recycling system.

There are mandatory anti-inundation facilities installed in some areas of Japan such as river channels to prevent flood or rainwater reserves to prevent rainwater runoff. Measures taken by Yokohama City upon implementation of the Act on Countermeasures against Flood Damage of Specified City Rivers dated June 2003 has since contributed to curb flood damages significantly.

Furthermore, measures have been adopted by Yokohama City such as the grant of subsidy for the installation of rainwater storage tank in order to ensure favorable aquatic environment as well as reinforced water recycling and improved rainwater penetration ability. Water stored in the rainwater tank will be utilized not only to water plants and flowers as part of the water-saving initiatives but also to make up for shortage when water supply is disrupted upon emergency such as fire and earthquakes.

In our survey, quality of clean water in Ho Chi Minh City will be assessed in cooperation with Japanese company which has previously introduced water purification device to Vietnam as well as evaluating the level of improvement through the implementation of technology held by the company. We will also conduct experiments on rainwater recycling in cooperation with the Energy Conservation Center – Ho Chi Minh City ("ECC-HCMC") to submit practical proposals on rainwater usage.

1.3 Project Implementation Scheme

Mitsubishi UFJ Morgan Stanley Securities ("MUMSS"), as the consignee of this Project, will act as the overall project manager coordinating matters regarding water-saving and rainwater usage projects in cooperation with Sinet Corp. and ECC-HCMC. TOTO will be responsible for the verification of benefits gained upon installation of the water-saving equipments.

In addition, MUMSS will look for the most effective finance scheme for the Project.

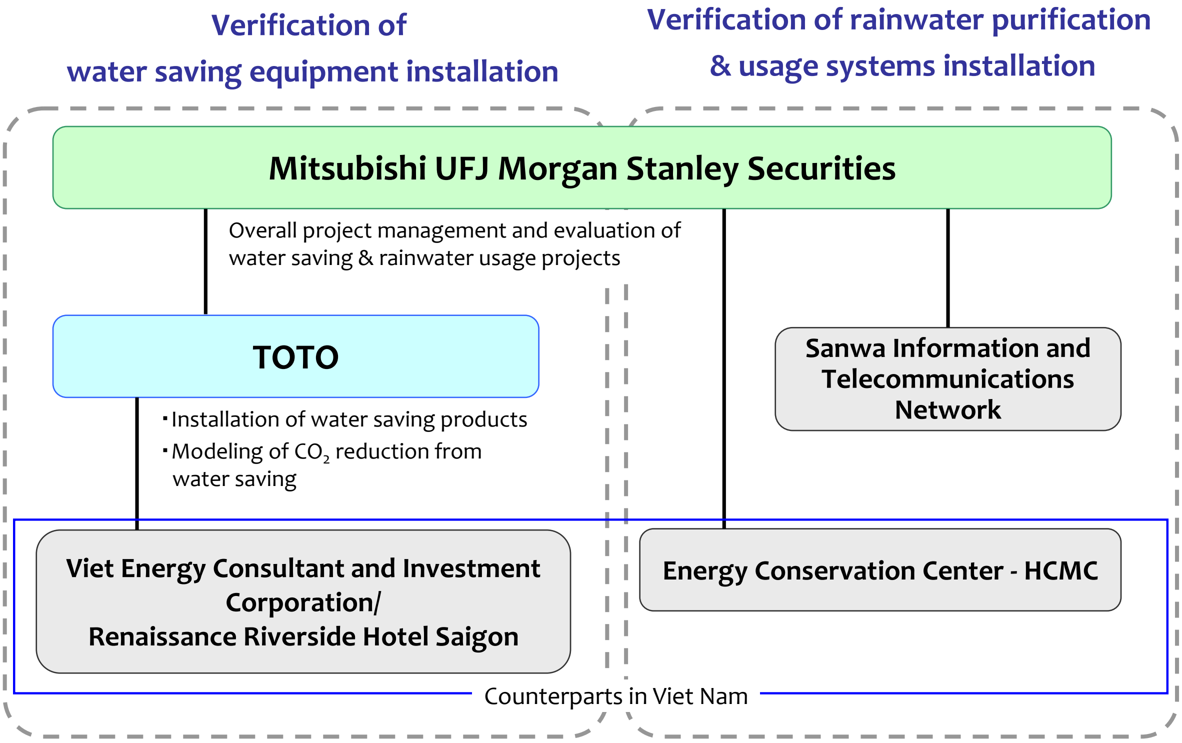


Figure 1.3-1 Project Implementation Structure

Chapter 2 Environment Surrounding Water Supply of Vietnam

Current environment of Vietnam surrounding water supply is described as follows including clean water and sewage conditions based on the “Survey on the Promotion of Global Contribution to Water Supply 2008” reported by the Ministry of Health, Labor and Welfare, Japan.

2.1 Clean water

2.1.1 Coverage of Water Supply Network

WHO/UNICEF data illustrates that coverage ratio of the nationwide water supply network (including water supply per household, public water supply, well, spring and rainwater) stands at 85% as at 2004. The urban area has almost been fully covered with the ratio of 99%. Despite relatively low coverage of 80% in rural areas where 20% of the entire household is still faced with water supply issues, the country has already reached the United Nations Millennium Development Goals regarding clean water.

The challenges are that there remain strong funding demands for infrastructure in response to the recent urbanization of rural areas prompted by population growth. Hearing from the Ministry of Construction Vietnam reveals that local governments have no choice but to count on the central government budget for infrastructure development and therefore they are faced with sluggish progress.

2.1.2 Water Tariff

The nationwide average clean water tariff stands at around VND3,500/ m^3(JPY20/ m^3) as at 2008. The revenue dips below the cost of clean water project as it only covers 3/4 of the entire costs, causing another issue of covering shortfall with taxes. While halting the increase of water tariff to tide over the financial crisis of 2008, the central government has upheld its policy of imposing optimal tariff to support the financial conditions of project and the tariff has gradually been raised in line with such policy.

The tariff has been raised for the fourth consecutive year in Ho Chi Minh City since 2004 based on the decision made by the City People’s Council. The prevailing tariff rate following the last hike of around 10% in January 2013 is shown below.

Table 2.1-1 Water Tariff in Ho Chi Minh City

		Water Tariff (VND/m3) (Before Tax)	Water Tariff (VND/m3) (incl. 5% VAT and 10% Environment Conservation Charge)
Commercial and Business			
	Manufacturing	9,600/m3	11,040/m3
	Management, Service	16,900/m3	19,435/m3
Private			
	up to 4 m^3	5,300	6,095/m3
	4-6 m^3	10,200	11,730/m3
	above 6 m^3	11,400	13,110/m3

Source: JETRO Website

SAWACO comments that an investment of USD2.5billion is required to develop water supply system by 2025. The investment project has been stalled due to insufficient funding from national budget and own capital. Reports say the prevailing minimum monthly tariff of VND5,300/ m^3 needs to be raised to VND8,000/ m^3.[1]

2.1.3 Standards and Management of Water Quality

Quality of drinking water in the urban area is measured by the prescribed quality standards set out by the Ministry of Health Vietnam which conforms to that of WHO whereas more lenient criteria is applied to the quality of drinking water in some rural areas where daily consumption of drinking water stands at 500 m^3 and below.

However such standards are adopted for the management of water purification facilities and the quality of water supplied in such urban areas as Hanoi or Ho Chi Minh City is not always ensured. Hearing from the Ministry of Construction Vietnam reveals their standpoints that poor quality is not attributable to the water purification facilities but water pipe network.

2.2 Sewage

Ho Chi Minh City, the largest city in Vietnam, has the population of 6.11million (2006), or over 7million if unregistered migrants added. Furthermore the city is said to show the annual population growth of 200,000. Rapid urbanization and industrialization prompted by such population growth and corresponding influx of untreated water from households and factories have accelerated

[1] "Saigon Water Authority plans tariff hike in Ho Chi Minh City" by Viet Jo Vietnam News (http://www.viet-jo.com/news/life/130810011443.html)

contamination of rivers and channels. In addition, inundation of town areas caused by the combination of high tide and rainfall during the rainy season results in personal and collateral damages while simultaneous gush of murky water adversely affects health and life of the residents.[2]

2.3 Flood Countermeasures

Urban cities of Vietnam are frequently suffering from flood damages including road inundation caused by heavy rainfall during the rainy season.

Flood Prevention and Management Center of Ho Chi Minh City plans to carry out 13 anti-inundation works in the city in 2012 to get rid of 10 most-frequently inundated sites. The entire investment stands at VND1,743billion (USD836.6billion or JPY6.4billion).

The city has another 21 sites which are frequently inundated by rain or high tide. They are believed to be caused by blocked flow of canals and poor drainage systems in newly developed residential districts or main roads.


Source: Poste[3]

Figure 2.3-1 Road Inundation

In addition, Ho Chi Minh City has been faced with progressive land subsidence which is spreading into large areas in strips based on the survey conducted from 1996 to 2010.

Act of pumping groundwater on account of poor water supply network is said to be a cause of land subsidence. Besides land subsidence, greater flood risks are feared caused by high tide.

Such initiatives as extensive introduction of water-saving equipments, utilization and storage of rainwater advocated in this Project contribute to solving water-related issues posing serious threats to the Vietnamese society.

[2] "Sewage Management Capacity Development Project in Ho Chi Minh City" by JICA (http://www.jica.go.jp/project/vietnam/005/)

[3] Poste（http://www.poste-vn.com/vietnamesediary/2012/11/17.html）

Chapter 3 Verification test of water saving equipment implementation

3.1 Project overview

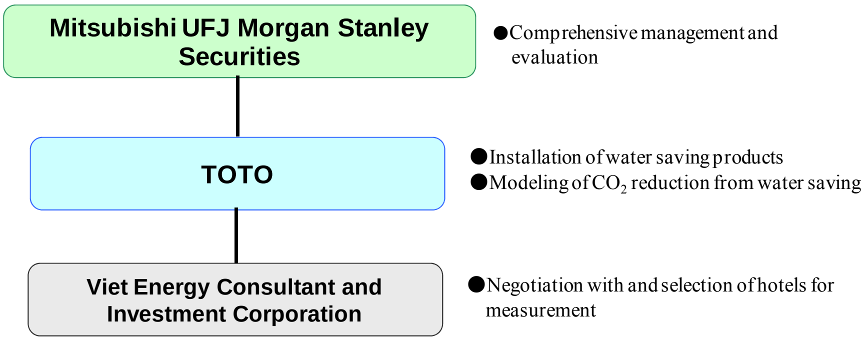
Mitsubishi UFJ Morgan Stanley Securities (MUMSS) and TOTO have investigated the feasibility of creating water saving credits under the Ministry of Economy, Trade and Industry's '2012 Global warming prevention promotion project'. It was found that conditions in Vietnam are conducive to the creation of carbon credits from the spread of water saving products; however, in residences conditions are limited by poor infrastructure that lessens water pressure. Nevertheless, large buildings such as hotels and apartments (hereinafter referred to as buildings) use a temporary water storage tank, which mitigates low water pressure from water leakage. In this case, the verification test was able to confirm that there is a large potential to reduce CO2.

Also, it was predicted that if a water saving project was carried out in buildings, not only would energy be reduced from the water and sewerage systems as per existing credit methodology, but also reduced from the buildings internal water supply system. However, the knowledge required to integrate this into the existing methodology is currently not available. Nonetheless, analysis of past reports show that energy costs from internal water supply systems have a potential reduction increase of 1.5-2 times using domestic credit methodology.4

Accordingly, water saving credit methodology for the internal water systems of hotels was created, and demonstrated that energy reductions could be made from not only water and sewerage systems, but also the internal water supply systems of buildings. The feasibility of a large-scale JCM project was then explored.

In this project, water saving products were introduced into Vietnamese hotels and the various water saving effects were measured (cold water/hot water volume measurement, pumps involved in water usage, heat sources) and then quantified – with the outlook of water and CO2 reduction. The administrative structure of this project is outlined in Figure 3.1-1

[4] Yasutoshi Shimizu et al(2013)：CO_2 emission factor for rainwater and reclaimed water used in buildings in Japan, Water, ,5,394-404



Source: prepared by the investigating group

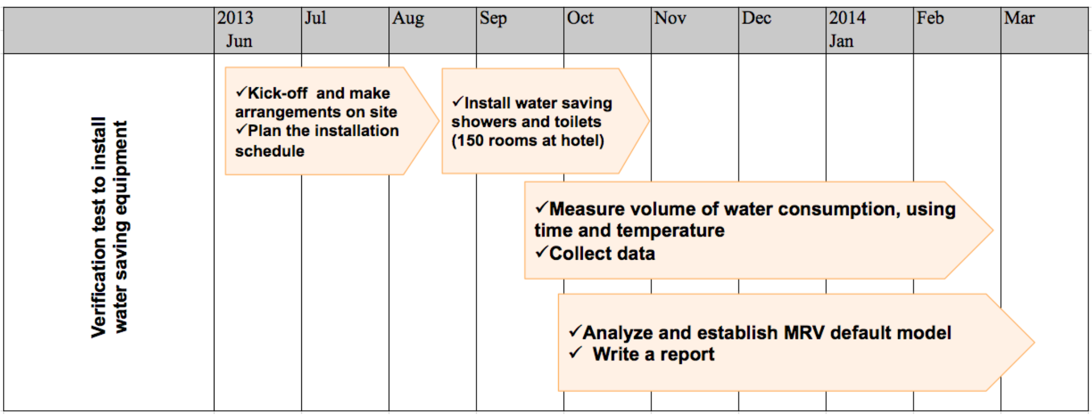
Figure 3.1-1 Project Structure

＜Project Outline＞

Project site: 1 hotel (Scale: 150 rooms)

Reduction in water consumption: Japan's most advanced water saving toilets and showers will be installed in guests' rooms, and the water reduced measured. To measure water usage reduction, a water gauge will be installed, and it will measure the changing times of water consumption to create a model. For the showers, a model will also be made of the reduction in energy to heat hot water. Also, the standard amount of energy used by the pumping system when water is being supplied will be investigated.

Setting default value for MRV methodology：Analyze the data for each room, and create a model for the usage of water saving showers and water saving toilets. Establish a default value for CO2 reduction calculation using MRV methodology. The above was carried out as outlined in Figure 3.1-2.



Source: prepared by the investigating group

Figure 3.1-2 Yearly Schedule

3.2 Hotel Overview

- Hotel name Renaissance Riverside Hotel Saigon
- Location 8-15 Ton Duc Thang Street, District.1, Ho Chi Minh City
- Ranking 5 stars
- Room total 336 rooms
- Structure 21 floors above ground, 2 below ground
- Opening 1998
- Facilities Guest rooms, restaurant, café, bar lounge, fitness club, business center, outside pool

The chosen hotel, Renaissance Riverside Hotel Saigon, is in the center of Ho Chi Minh City and affiliated with Marriott hotels. Because it is near to the business and entertainment districts, guests are often staying on business or site-seeing trips.

The average occupancy rate for 2012 and 2013 was 69.4%. This is very close to the average rate of 73% for Marriot hotels. Further, each room had an average occupancy of 1.44 guests.

3.3 Baseline water usage and energy consumption analysis (input and output model)

The aim of this project is to quantify the water saving impact of water saving products, and to calculate the associated CO2 emissions. The 2012 Global warming prevention promotion project is also meeting this aim.[5] However, it is necessary to contemplate the unique usage model required for industrial materials like plumbing fittings located at hotel.

There is research that has been done in Japan on a city hotel in relation to the volume of cold and hot water used in hotels.[6] However, that research was conducted in Japan – the conditions of a hotel in Vietnam located in a subtropical zone and mostly used by overseas tourists are different. As such, it is not appropriate to utilize the Japanese model in this case. Accordingly, this project endeavored to deduce hotel usage circumstances from measured data, cold and hot water usage and associated energy consumption.

In this project, 150 out of the overall 336 rooms had their toilets and showers changed to water saving toilets and showers. The function of the toilets and showers before the upgrade was used as the baseline function value.

3.4 Overview of existing facilities (baseline function)

The existing facilities of the hotel included 11 L/flush toilets without a half-flush (American Standard brand), and overhead showers (Grohe brand) (Figure 3.4-1).

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5 Ministry of Economy, Trade and Industry, 2012 Global Warming Mitigation Technology Promotion Project (Vietnam/preparing to set up a BOCM by CO2 reduction from water saving shower popularization)

6 Takada et al. (2007) “An Analysis on the Hot and Cold Water Usage of the Guest Rooms in a City Hotel” Architectural Institute of Japan Journal of environmental engineering (611) pp.53 - 58

Testers carried out a limited range of actions: toilet use, shower use, faucet use, and measured the amount of water used. The average baseline was, shower flow rate: 11.0 L/min, toilet water usage: 10.5 L（no half-flush).

Source: Prepared by the investigating group

Figure 3.4-1 Existing facilities (toilet and shower)

3.5 Overview of the installed fittings (Project function)

The newly installed fittings were a TOTO brand toilet, CST761DRS (full flush 4.8 L, half-flush 3.0 L), a TOTO brand Air-in-shower DB200CAF_V1 (optimum flow rate 6.5 L/min), which were made ready for use（Figure 3.5-1).

Source: Prepared by the investigating group

Figure 3.5-1 Facilities after upgrade (toilet and shower)

3.6 Method of measuring energy and water saved

3.6.1 Understanding the overall hotel water volume usage

Data regarding the overall water usage: the total hotel water usage, the ratio of water used by rooms, and water pricing, was acquired by receiving information on the hotel's water meter. The results are shown in Table 3.6-1.

Table 3.6-1 Overall hotel water usage and ratio of water used by guest rooms

	2013.07	2013.08	2013.09	2013.10	2013.11	2013.12
Total hotel water usage (m^3)	9,467	9,219	9,026	8,734	9,809	9,918
Ratio of water used by rooms (%)	58.84	64.22	64.22	67.98	85.23	68.87
Water cost (VND/m^3)	16,900					
Water usage fee (VND)	159,992,300	155,801,100	152,539,400	147,604,600	165,811,336	167,614,200
Value added tax (5%)	7,999,615	7,790,055	7,626,970	7,380,230	8,290,567	8,380,710
Environmental preservation tax (10%)	15,999,230	15,580,110	15,253,940	14,760,460	16,581,134	16,761,420
Cost (VND)	183,991,145	179,171,265	175,420,310	169,745,290	190,683,036	192,756,330
Cost (\)	859,772	837,249	819,721	793,202	891,042	900,731

Source: prepared by the investigating group

3.6.2 Measurement of electricity consumed by the lifting pump and pressure pump

In this hotel, water passes from the water supply pipes to a lifting pump; the water is supplied to a water tank on the 21st floor by lifting pump. The water is then distributed to each floor using potential energy. However, from the 16th floor upwards a pressure pump is used due to poor water pressure. Accordingly, the electricity used by rooms from the 16th floor upwards differs from other rooms. It was thus necessary to carry out different calculations. As such, the electricity used by the hotel lifting pumps and the pressure pumps used for the rooms above the 16th floor, was measured using a clamp meter.

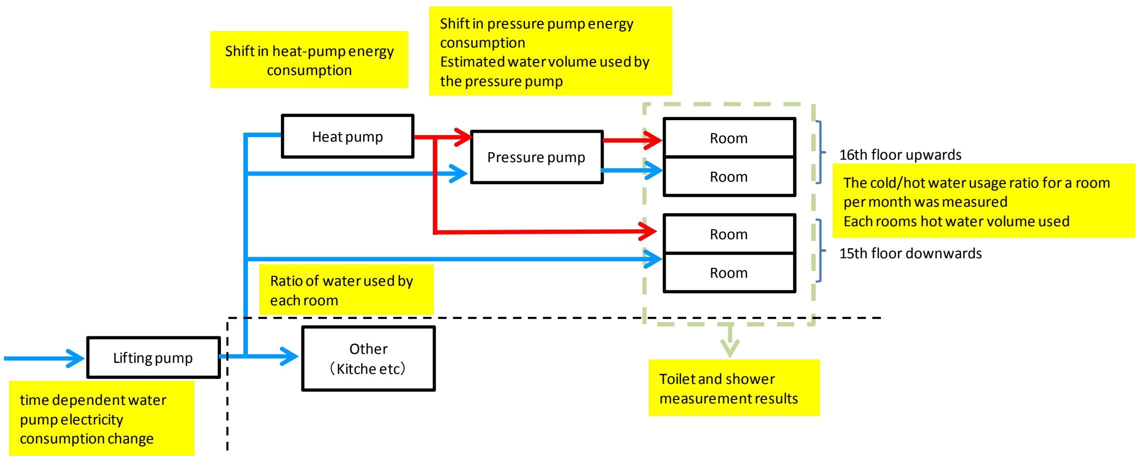
3.6.3 Measurement of electricity consumed by the heat pump

It was necessary to measure the hot water supplied to the hotel's guest rooms by three heat pumps to calculate the energy used by the hot water supply. In this case, clamp meters were used, as they were in previous pump measurements.

Chapter 4 Test results of water saving equipment implementation

4.1 Analysis based on input and output model of total water volume and energy reduction amount (water supply meter value, electricity amount value)

The input and output of the hotel, necessary to calculate the water and CO2 emission amount, is outlined in figure 4.1-1.



Source: prepared by the investigating group

Figure 4.1-1 Energy input and output model of the hotel's total water usage

Water is supplied to hotel facilities by pumping water from the lifting pump to a rooftop water tank, which then uses gravitational force to distribute the water. The measurement of electricity consumption by the lifting pump is outlined in Table 4.3-1. It was also possible to determine the water used in guest rooms from data acquired from the hotel (Table 3.6-1). Hot water is supplied using a heat pump and it consumes 707kWhr of electricity a day. However, for the floors above the 16^{th} floor a pressure pump is used to supply cold and hot water. For this reason, it is also necessary to comprehend the amount of electricity consumed by the pressure pump (Table 4.3-2). The water usage of six rooms was measured and the hot water volume consumed (Table 4.4-2) deduced from the ratio of cold water to hot water usage (Table 4.4-1). Further, the amount of cold and hot water used by the toilet and shower was calculated using measurements from the chosen rooms.

The volume of water used by each room was calculated based on the building's water usage and the ratio used by each room. Also, data on the toilet and shower usage (frequency and flow rate) was collected for the rooms included in the measurement tests. In regards to the CO2 emissions from water usage, the hotel's electricity consumption associated with water use is presented by calculating the electricity consumption of the lifting pump, heat pump and pressure pump.

4.2 Analysis based on measurements

4.2.1 Water usage behavioral modeling based on measurements

A measuring system, for the water saving products installed under this project, was created using a flow rate sensor, temperature sensor and programmable logic controller (hereinafter PLC).

Product upgrades took place in 150 rooms of the hotel, and the ensuing measurement took place in 6 rooms (group sample).

The water usage model was created from quantifying the data collected by a group of testing participants in the guest rooms.

4.2.2 Calculating the effects from the measurement model

For one person in one day, their frequency of toilet full flush/half-flush usage and flush volume, and shower usage (flow rate, flow speed, time, and temperature) are outlined in Table 4.2-1 after the upgrade of the facilities.

Table 4.2-1 Toilet and shower measurement results

	Toilet				Shower			
Room	Full (Flush/Day/Person)	Full (L/Flush)	Half (Flush/Day/Person)	Half (L/Flush)	Water usage (L/Day/Person)	Flow rate (L/min)	Time (min:Sec)	Temperature (℃)
1506	1.69	4.51	2.82	2.77	41.25	5.92	0:06:31	37.84
1507	2.76	5.22	3.70	3.22	55.56	6.90	0:07:35	38.56
1606	1.73	4.70	3.42	3.44	44.89	7.46	0:06:04	38.67
1607	2.93	4.75	3.69	3.32	44.26	6.27	0:07:44	38.01
1706	5.16	4.74	2.21	3.06	53.69	6.25	0:08:51	37.48
1707	4.86	5.61	1.91	3.27	50.13	8.12	0:06:43	37.17
Average	3.31	4.92	2.91	3.18	49.89	6.82	0:07:19	37.95
Standard deviation	2.86	0.41	2.46	0.24	37.64	0.84	0:05:47	2.72

Source: prepared by the investigating group

4.3 Analysis of the water supply pumps' power

In the hotel, water is passed from the water supply pipes to a rooftop water tank using a lifting pump. From the 15th floor downwards potential energy is used to transport the water. From the 16th floor upwards, a pressure pump is used to distribute the water. To calculate the emission factor of when water is being supplied, it was necessary to calculate the power energy of the pumps used to supply water.

The energy consumption of the lifting pump in the hotel is outline in Table 4.3-1. The total stored water volume from August to December was 46, 705 m^3, and the total electricity consumption was 27,078 kWh. From these totals it can be calculated that the lifting pump's energy consumption is 0.580 kWh/m^3 per cub meter. If the emission factor of electricity in Vietnam[7] is considered, this can

[7] Ministry of Economy, Trade and Industry (Mitsubishi UFJ Morgan Stanley Securities), FY2012 Global Warming Mitigation Technology Promotion Project, "Study on Development of an Environment for Launching a BOCM Project for CO2 Emissions

be outlined as follows:

$$\text{Hotel's lifting pump emission factor} = 0.580\left(\frac{\text{kWh}}{\text{m}^3}\right) \times 0.5764\left(\frac{\text{kg}-\text{CO2}}{\text{kWh}}\right)$$

$$=0.334\ (\text{kg-CO2/m}^3)$$

Formula 4-1

Table 4.3-1 Energy consumed by the lifting pump

Month	Water Usage (m3)	Energy Comsumption (kWh)	Energy Comsumption (kWh/m3)	Energy Comsumption (MJ/m3)
8	9,219	5,346	0.580	2.087
9	9,026	5,226	0.579	2.084
10	8,734	5,187	0.594	2.138
11	9,808	5,669	0.578	2.081
12	9,918	5,651	0.570	2.051
Total	46,705	27,078	0.580	2.087

Source: prepared by the investigating group

Conversely, the water usage of rooms using the pressure pump cannot be measured directly. 103 rooms use the pressure pump, and from the water usage ratio of rooms (Table 3.6-1) the pump's water volume use was calculated, and further calculations were conducted in the same way as for the lifting pump (Table 4.3-2).

Table 4.3-2 Pressure pump estimated water use

Month	Energy Comsumption (kWh)	Overall hotel Water Usage (m3/Month)	Ratio of water usage per room (%)	No. of rooms using a pressure pump	Pressure pump water volume estimate (m3)	Energy Comsumption (kWh/m3)	Energy Comsumption (MJ/m3)
8	344.92	9,467	58.84	103	1,708	0.202	0.727
9	326.62	9,219	64.22		1,815	0.180	0.648
10	265.34	9,026	64.22		1,777	0.149	0.538
11	270.98	8,734	67.98		1,820	0.149	0.536
12	338.57	9,918	68.87		2,094	0.162	0.582
Total	1,546	46,364	64.826		9,214	0.168	0.604

Source: prepared by the investigating group

$$\text{Hotel's pressure pump emission factor} = 0.168\left(\frac{\text{kWh}}{\text{m}^3}\right) \times 0.5764\left(\frac{\text{kg}-\text{CO2}}{\text{kWh}}\right)$$

$$=0.0968\ (\text{kg-CO2/m}^3)$$

Formula 4-2

4.4 Analysis of the heat pump's power

The heat pump is used to supply hot water to the hotel rooms. As such, it is necessary to determine the rooms' ratio of cold/hot water usage. The cold/hot water usage ratio of each month

Reduction by Reducing Water Consumption through Promotion of Water-saving Showers in Vietnam" was calculated for the selected rooms and the results are outlined in Table 4.4-1.

Table 4.4-1 Hot water usage ratio of selected rooms' measurements

Room	1506		1507		1606		1607		1706		1707		Total		
Month	Cold water use (L)	Hot water use (L)	Cold water use (L)	Hot water use (L)	Cold water use (L)	Hot water use (L)	Cold water use (L)	Hot water use (L)	Cold water use (L)	Hot water use (L)	Cold water use (L)	Hot water use (L)	Cold water use (L)	Hot water use (L)	Hot water ratio (%)
9	712.99	258.89	679.78	366.93	839.96	600.82	1036.84	826.08	672.54	305.96	678.3	477.77	4620.41	2836.45	0.380
10	1968.23	860.32	3162.42	2014.7	2594.65	1898.48	3576.48	2416.25	3818.48	1974.76	3405.16	1855.98	18525.42	11020.49	0.373
11	3956.49	2428.79	3322.02	1563.42	4194.67	2921.18	2644.63	1614.54	3130.71	1621.99	3508.59	1398.86	20757.11	11548.78	0.357
12	3488.98	2078.03	3307.03	2397.44	4980.5	3338.68	1643.38	934.36	3972.2	2837.43	2307.11	1337.97	19699.2	12923.91	0.396
Total	10126.69	5626.03	10471.25	6342.49	12609.78	8759.16	8901.33	5791.23	11593.93	6740.14	9899.16	5070.58	63602.14	38329.63	0.376

Source: prepared by the investigating group

According to Table 4.4-1, the ratio of hot water usage to cold-water usage is 37.6%. Also, using the values from Table 3.6-1, the volume of hot water used by each room was calculated as follows: (Table 4.4-2).

Table 4.4-2 Hot water volume usage estimation for rooms

	9	10	11	12
Total hotel water usage (m3)	9,026	8,734	9,809	9,918
Ratio of cold/hot water usage per room (%)	64.22	67.98	85.23	68.87
Ratio of hot water use (%)	37.6			
Ratio of hot water use (m3)	2,179	2,232	3,143	2,568

Source: prepared by investigating group

From Table 4.4-2, the average hot water usage per room is 2,531m^3, and per day it is 84.4 m^3. Because the electricity consumption for one day is 707 kWhr, the electricity consumption per 1m^3 is 8.4 kWhr/m^3.

$$\text{Hotel's heat pump emission factor} \quad = 8.4\left(\frac{\text{kWh}}{\text{m}^3}\right) \times 0.5764\left(\frac{\text{kg}-\text{CO2}}{\text{kWh}}\right)$$

$$=4.84(\text{kg-CO2/m}^3)$$

Formula 4-3

The CO2 emission factor arising from hot water supply is based on the actual heat pump measurements of formula 4-3. Accordingly, this is appropriate for determining the hotel's CO2 emission factor of hot water supply. However, careful investigation is necessary when introducing the project to different facilities.

For example, it is important to consider the differing maximum temperatures for different climatic zones, and the location of facilities. Also, the influence of the fuel source for heating must be considered.

Previously covered project[1] in Vietnam, the formula 4-4 is used to determine the emission factor of the hot water supply for showers.

$$(\mathrm{T}_2 - \mathrm{T}_1)\ \times 4.189\ \left(\frac{\mathrm{kJ}}{\mathrm{kcal}}\right) \times 0.5764\left(\frac{\mathrm{t-CO2}}{\mathrm{MWh}}\right) \times 1\left(\frac{\mathrm{MWhr}}{1000\mathrm{kWh}}\right) \div 3600\left(\frac{\mathrm{kJ}}{\mathrm{kWh}}\right)$$

Formula 4-4

T_1: Average water temperature in locations where the project was enacted (selected from Table 4.4-3)

T_2: Average shower's hot water temperature according to this investigation (Table 4.2-1: 37.95 degrees centigrade)

CO2 emission factor of electricity: 0.5764 t-CO2/kWh

Table 4.4-3 Average water temperature in Vietnam

	Measured water temperature	1	2	3	4	5	6	7	8	9	10	11	12	Average
R1	Lao Cai	17. 80	18. 51	21. 58	24. 86	26. 12	26. 78	26. 35	26. 44	25. 56	24. 16	21. 14	18. 48	23. 15
R2	Haiphong	18. 73	19. 73	21. 76	25. 18	27. 86	29. 53	29. 35	28. 70	28. 63	27. 13	24. 63	20. 63	25. 16
R3	Hanoi	19. 84	19. 92	21. 11	24. 31	27. 16	28. 18	27. 41	27. 70	27. 64	26. 44	24. 16	21. 01	24. 57
R4	Hue	21. 44	22. 10	24. 86	27. 16	27. 66	28. 29	28. 41	28. 02	26. 12	24. 46	22. 87	21. 20	25. 22
R5	Da Nang	22. 98	25. 20	26. 56	29. 52	31. 02	31. 02	30. 98	30. 44	29. 20	26. 80	25. 10	18. 92	27. 31
R6	Buon Ma Thuot	23. 43	25. 03	26. 67	28. 10	28. 39	27. 82	27. 22	26. 81	26. 52	26. 18	25. 16	23. 34	26. 22
R7	Ho Chi Minh	26. 25	27. 65	29. 27	30. 14	29. 33	27. 97	27. 02	26. 62	26. 50	26. 44	26. 07	25. 39	27. 39

Source: prepared by the investigating group

Accordingly

$$(37.95 - 27.39)\ \times 4.189\ \left(\frac{\mathrm{kJ}}{\mathrm{kcal}}\right) \times 0.5764\left(\frac{\mathrm{t-CO2}}{\mathrm{MWh}}\right) \times 1\left(\frac{\mathrm{MWhr}}{1000\mathrm{kWh}}\right) \div 3600\left(\frac{\mathrm{kJ}}{\mathrm{kWh}}\right)$$

= 0.00708 t-CO2/m^3) = 7.08(kg-CO2/m^3)

Formula 4-5

Compared to other systems using an electric hot water supply, this hotel's heat pump has a relatively low CO2 emission factor.

Chapter 5　Evaluating CO2 reduction potential

The aim of this project was to undertake the reduction of a hotel's thermal energy consumption through water saving. This was in order to ultimately reduce CO2 emissions.

The emissions reduction was achieved by reducing the amount of energy used, which is outlined below.

・The energy used by the water supply system and sewage works
・The energy used by the lifting pump and pressure pump inside the building (hotel)
・The energy used for heating by the hot water supply

The effect of water saving on CO2 reduction has been recognized in reports, such as the December 2012 domestic credit methodology papers "Water saving household fixtures' upgrade(Methodology 43)[8]" and "Water saving household fixtures' new installation (Methodology 43-A)[9]". In this way, the energy used by water supply and treatment has been garnering a lot of attention.

Also, the UN recognizes the calculation this project has used for determining the GHG emissions reduced from thermal energy by water-saving showerheads as small scale CDM methodology ASM-II.M "Demand-side energy efficiency activities for installation of low-flow water saving devices"[10].

The investigation to determine the varying amounts of energy reduced is explained in the following section.

5.1　Reduction CO2, water resources and energy in the project

Table 5.1-1 shows the emission factors calculated in Chapter 4.

Table 5.1-1 CO2 emission factor

CO2 emission coefficient of waterworks	Water supply CO2 emission coefficient	0.23	kg-CO2/m3
	Sewerage CO2 emission coefficient	0.16	kg-CO2/m3
CO2 emission coefficient of building's internal water supply	Water pump CO2 emission coefficient	0.334	kg-CO2/m3
	Pressure pump CO2 emission coefficient	0.0968	kg-CO2/m3
CO2 emission coefficient of the electric hot water system ※contains heat pump		7.08(4.84)	kg-CO2/m3

Source: prepared by the investigating group

The amounts reduced per room are calculated by applying the hotel's usage model and,

8 Domestic Clean Development Mechanism website http://jcdm.jp/process/data/043.pdf
9 Domestic Clean Development Mechanism website http://jcdm.jp/process/data/043-A.pdf
10 United Nations website: http://cdm.unfccc.int/methodologies/DB/HHDWO5LV9PEG6N3Y8X7J63I801N079

baseline and function of the products used in the project (Table 5.1-2).

Table 5.1-2 Amounts reduced per room

	Water use reduction (m3/room/year)			CO2 reduction (kg-CO2/room/year)		
	Toilet	Shower	Total	Toilet	Shower	Total
16th floor upwards	14.5	11.2	25.7	11.9	63.4	75.3
15th floor downwards				10.5	62.3	72.8

Source: prepared by the investigating group

In relation to the CO2 emissions factor, this project is furnishing the default data as the emission factor from the waterworks, the building's internal water supply emission factor, and the hot water supply's emission factor. However, it must be taken into consideration that the emission factor of the building's internal water supply was modeled on a residential house, and as such does not take into account the special characteristics of a tall building's water supply system. Furthermore, it was presumed that the CO2 emission factor of the hot water supply would be based on the use of electricity for heating. The site of this project was the large-scale facilities of a hotel – hence it was not the case that electricity was always used as a heat source. Accordingly, the project used MRV methodology to ensure the installations were appropriately carried out.

■ Appropriate project application

The MRV methodology developed in this investigation is applicable to the following project. A project in a large scale building in Vietnam that has toilets and hot water showers and that achieves the reduction of GHG emissions by installing water-saving products; the resulting reduction in water usage has the associated effect of reducing the consumption of electricity and fossil fuels needed to run the hot and cold water supply systems.

■ Appropriate standards

The methodology for this project was made to fulfill the following conditions.

Condition 1: A facility in Vietnam into which water saving products are installed

Condition 2: A project that changes the existing plumbing fittings or installs new products

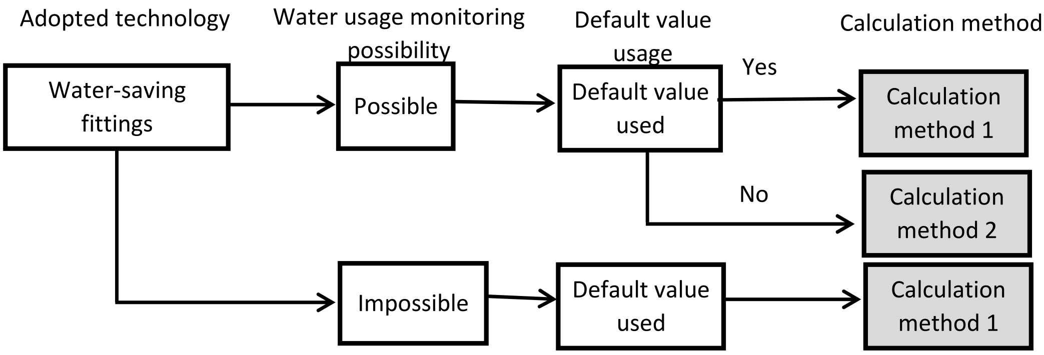
Condition 3: The water heater for the showers' hot water supply has the ability to reach a set temperature

Condition 4: The water saving showers provide the same level of comfort as the showers which were previously installed

Condition 5: The water saving toilets fulfill the same level of waste discharge as the toilets which were previously installed

■ Calculation method of reference emissions amount and relevant data

Those involved in the project can use the flowchart in Figure 5.1-1 to calculate the reference emissions.



Source: prepared by the investigating group

Figure 5.1-1 Flowchart of calculation method selection

■ The formula for calculating emissions reduction amount

The formula for calculating the emissions reduction amount is the same for both reference scenario calculation methods, but the acquisition of the water consumption reduction amount ($Q_{w,total,pj,y}$) differs according to the water saving products installed by the project.

$$ER_y = RE_y - PE_y$$

ER_y: Emissions reduction amount [tCO2/y]

RE_y: Reference emissions amount [tCO2/y]

PE_y: Project emissions amount [tCO2/y]

Formula 5-1

$$RE_{shower,y} = PE_{shower,y}/(1 - EER_{shower,pj})$$

$$RE_{toilet,y} = PE_{toilet,y}/(1 - EER_{toilet,pj})$$

$$RE_y = RE_{shower,y} + RE_{toilet,y}$$

$RE_{shower,y}$:	Reference shower emissions amount	[tCO2/y]
$PE_{shower,y}$:	Project shower emissions amount	[tCO2/y]
$EER_{shower,y}$:	Water-saving impact of the project's water-saving showers	[%]
$RE_{toilet,y}$:	Reference toilet emissions amount	[tCO2/y]
$PE_{toilet,y}$:	Project toilet emissions amount	[tCO2/y]
$EER_{toilet,y}$:	Water-saving impact of the project's water-saving toilets	[%]

Formula 5-2

$$PE_y = PE_{shower,y} + PE_{toilet,y}$$
$$= (Q_{shower,pj,y} \times EF_{w,y}) + (Q_{shower,pj,y} \times EF_{wp,y}) + (Q_{shower,pj,y} \times EF_{wh,y})$$
$$+(Q_{toilet,pj,y} \times EF_{w,y}) + (Q_{toilet,pj,y} \times EF_{wp,y})$$

$Q_{shower,pj,y}$:	Water volume used by showers installed by the project	[m^3/year]
$Q_{toilet,pj,y}$:	Water volume used by toilets installed by the project	[m^3/year]
$EF_{w,y}$:	CO2 emission factor of waterworks processing	[t-CO2/m3]
$EF_{wp,y}$	CO2 emissions factor of building's internal water supply	[t-CO2/m3]
$EF_{wp,y}$	CO2 emission factor of water heater	[t-CO2/m3]

Formula 5-3

■ Data necessary for calculating the emissions reduction amount

By selecting the reference emissions amount calculation method, the below default values are established for this methodology. Nonetheless, the emission factor of the hot water supply differs according to the heat source. The site we used based the emission factor on the use of electricity, but in this methodology there is a choice of physical means, which applies to the heat source factor.

Calculation method 1: Water-saving default value

Parameters	Value	Unit
CO2 emission factor of waterworks processing (default value)	0.00039	t-CO2/m^3
CO2 emissions factor of building's internal water supply (default value)	0.000334 0.000431* (0.000398) Average load	t-CO2/m^3
CO2 emission factor of water heater (default value)	0.00708	t-CO2/m^3
Water-saving impact of project's installed showers (default value)	38.0[11]	%
Water volume used by one shower installed by the project (default value)	18.2	m^3/product/year
Water-saving impact of project's installed toilets (default value)	60.9[12]	%

[11] Calculation of shower's water-saving impact
Showers' water-saving impact = (11.0 - 6.82)/11.0 = 0.380
[12] Calculation of toilets' water saving impact
Reference : (10.5) (L/a time) × (3.31＋2.91) (a time/person/day) × 1.44 (person/room) = 94.05 (L/room/day)
After the project was finished :
full flush) (4.92) (L/a time) × 3.31 (a time/person/day) × 1.44 (person/room) = 23.45 (L/room/day)
half flush) (3.18) (L/a time) × 2.91 (a time/person/day) × 1.44 (person/room) = 13.33 (L/room/day) Total:36.78 (L/room/day)
Toilet's water saving impact = (94.05-36.78)/94.05 = 0.609

Water volume used by one toilet installed by the project (default value)	9.3	m^3/product/year
Number of showers installed by the project	Monitoring	product/year
Number of toilets installed by the project	Monitoring	product/year

Calculation method 2: Water-saving project's eigenvalue

Parameter	Value	Unit
CO2 emission factor of waterworks processing (default value)	0.00039	t-CO2/m^3
CO2 emission factor of building's internal water supply (default value)	0.000334 0.000431* （0.000398） Weighted average	t-CO2/m^3
CO2 emission factor of the water heater (default value)	0.00708[13]	t-CO2/m^3
Water-saving impact of project's installed showers （default value）	38.0	%
Water volume used by one shower installed by the project	Monitoring	m^3/product/year
Water-saving impact of project's installed toilets （default value）	60.9	%
Water volume used by one toilet installed by the project	Monitoring	m^3/product/year

* In the case where a pressure pump is present: the below calculations are based on the site of investigation, which was divided into two types of rooms where water saving fittings were installed (16th floor upwards, 99 rooms, and 15th floor downwards, 51 rooms). These calculations use the weighted average.

5.2 The projected potential CO2 reduced in hotels

There was an investigation of the potential amount that could be reduced if the project was spread to other hotels in Vietnam. However, the input and output of energy used by the hot water supply is influenced by its heat source and climatic zone, and this must be kept in mind for the investigation.

■ Setting up a model for expansion

It is envisaged that water saving products will be installed into 5000 rooms in both Ho Chi Minh City and in Hanoi City, with the consideration of the climatic zone's influence on energy input and output. Also, the heat sources are determined as electricity, heavy oil and gas. Accordingly, there are 6 possible patterns as outlined below.

The emission factor of each pattern is outlined below in Table 5.2-1.

[13] The default value differs according to the region in which the project was carried out – average water temperature and water supply systems are different. For example, those derived from electricity in Ho Chi Minh City are given.

Table 5.2-1 Emission factor of climatic zone/heat source variation

		City	
		Ho Chi Minh City	Hanoi City
Climatic zone		R7	R3
Hot water supply type (heat source fuel)	Electric hot water heater	0.00708	0.00902
	Boiler (heavy oil)	0.00307	0.00390
	Boiler (LNG)	0.00220	0.00279

Unit : t-CO2/m3

Source: prepared by the investigating group

■ An example of potential reduction calculation

The aforementioned 6 patterns of potential CO2 emissions reduction are outlined in Table 5.2-2 below.

Table 5.2-2 potential CO2 emission reduction

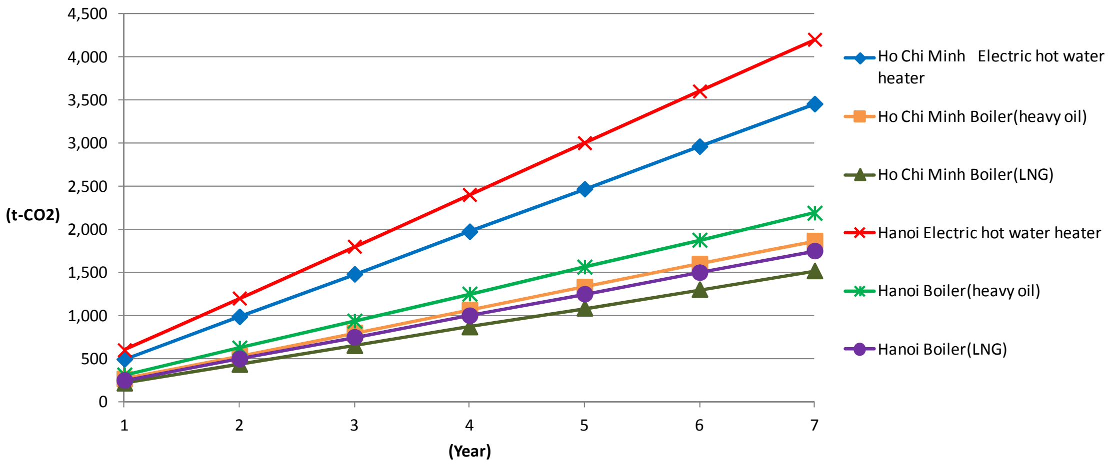
		City	
		Ho Chi Minh City	Hanoi City
Climatic zone		R7	R3
Hot water supply type (heat source fuel)	Electric hot water heater	493	600
	Boiler (heavy oil)	266	313
	Boiler (LNG)	217	250

Unit: t-CO2/Year

Source: prepared by the investigating group

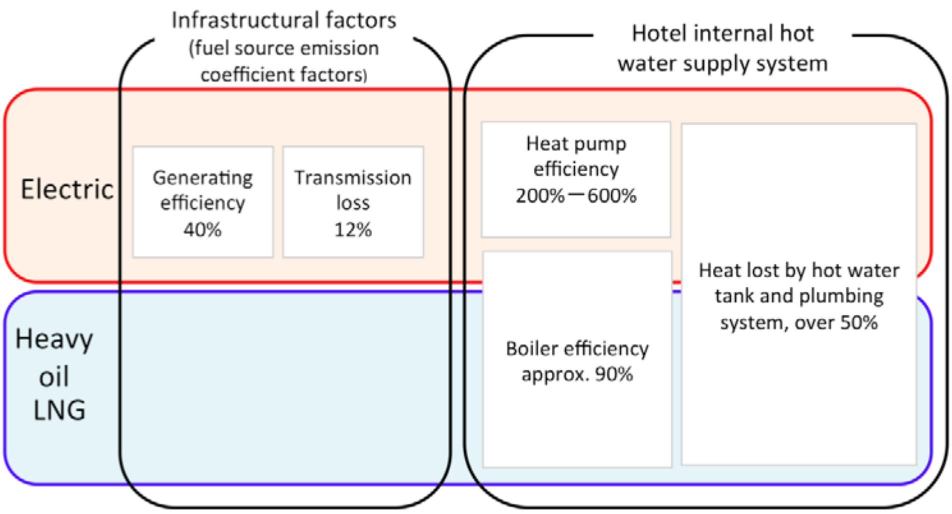
It is demonstrated that a reduction from 217 to 600 t-CO2 can be achieved by installing a set of 5,000 water saving products. The greatest reduction can be made in Hanoi City's electric water heaters – over the course of 7 years a reduction of over 4000 t-CO2 is predicted. Conversely, the lowest reduction predicted is in Ho Chi Minh City's boilers (LNG) – the reduction is predicted at 1500 t-CO2 (Figure 5.2-1). This difference is based on the two factors outlined below.

Firstly, as a default value it will vary according to the CO2 emission factor of the hot water supply. The result is that the CO2 emission factor of each hot water supply's heat source differs greatly (Table 5.2-2). This comes back to the fact that if the heat source is electric then the actual energy invested is only 40% electricity; this is an infrastructural factor (Figure 5.2-2). The CO2 emission factor of an electrical heat source, used to supply hot water, is very high in comparison to other heat sources.



Source: prepared by the investigating group

Figure 5.2-1 CO2 reduction potential cumulative amount



Source: prepared by the investigating group

Figure 5.2-2 Outline of differing heat source's energy efficiency

Secondly, the climatic zone influences the energy input and output. The main reason for this is that the CO2 emission factor of the heat source for the hot water supply is much larger than the CO2 emission factor of the waterworks and internal water supply infrastructure. Resultantly, it was found that the default CO2 emission factor of a shower is high. Hence, regions of higher latitudes, which have lower average water temperatures, have a much greater potential of CO2 reduction.

■ Further investigation for formula of the reduction potential

MRV methodology was advanced at the hotel, with an understanding of the influence of differing emissions factor of heat sources for hot water supplies, and the variation in average water temperature according to climatic zone. Accordingly, it was possible to estimate the water and CO2 reduction impact in the Vietnamese hotels, however, the hotel's internal hot water supply system is an area of further investigation due to the affect of the hot water heater's energy input and output on the CO2 emissions amount. The emission factor of the hot water heater was 4.84kg-CO2/m3, based on the actual measurements of the hotel's heat pump. (Formula 4-3), conversely, shows the electric water heater's emission factor is 7.08kg-CO2/m3 based on the default value of the aforementioned project formula (Formula 4-5). This differentiation is derived from two factors related to the hotel's internal hot water supply system.

The first factor is the difference in thermal efficiency of the hot water supply. The hotel's heat pump has a COP (Coefficient of Performance) of 3.5, and this is theoretically an efficiency of 350%. This is not taken into account by the aforementioned project formula, which sets the efficiency at 100%. In addition, it is widely stated that in many hotels in Vietnam, the heavy oil and electric boilers have a thermal efficiency of 90%, and this must also be taken into account.

The second factor relates to the loss of heat through the plumbing system. According to Masuda et al.[14] over 50% of heat is lost through the internal plumbing system of a hotel. These issues did not apply to the aforementioned project's investigation into residential homes, and also because many hotels have hot water heaters with a large capacity and were part of a central hot water supply system.

The differing energy efficiencies of the heat sources included in the issues mentioned above are outlined in figure 5.2-2. Infrastructural factors of electricity efficiency and electricity transmission loss are incorporated into the discussion on methodology. Conversely, there is insufficient knowledge on the hotel hot water heater's energy efficiency and heat loss of the plumbing system, to incorporate these into the methodology. Nevertheless, as mentioned previously, the hotel's internal hot water supply system impacts greatly on the hot water heater's CO2 emissions amount. Hence, the efficiency of the hotel's internal hot water supply system is considered when calculating the reduction potential. In this case, the electric hot water system can be divided into a heat pump and electric boiler. It is widely stated that the heat pump's efficiency in a majority of cases is from 200% to 600%. However, this investigation's formula sets it at 350%, which is specified in the catalogue for the heat pump used in the Riverside Hotel. Furthermore, the electric boiler is set at 90%, the same as heavy oil and gas boilers. Also, the heat lost from the plumbing system is set at 50%. The results are outlined in Table 5.2-3.

The yearly CO2 emission reduction of a room that does not use a pressure pump is 72.8kg-CO2 as shown in Table 5.1-2. If that is applied to 5,000 rooms it becomes 364t-CO2. This

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[14] Masuda et al. (2012) "Measurement of heat loss from hot water supply system in a budget hotel".

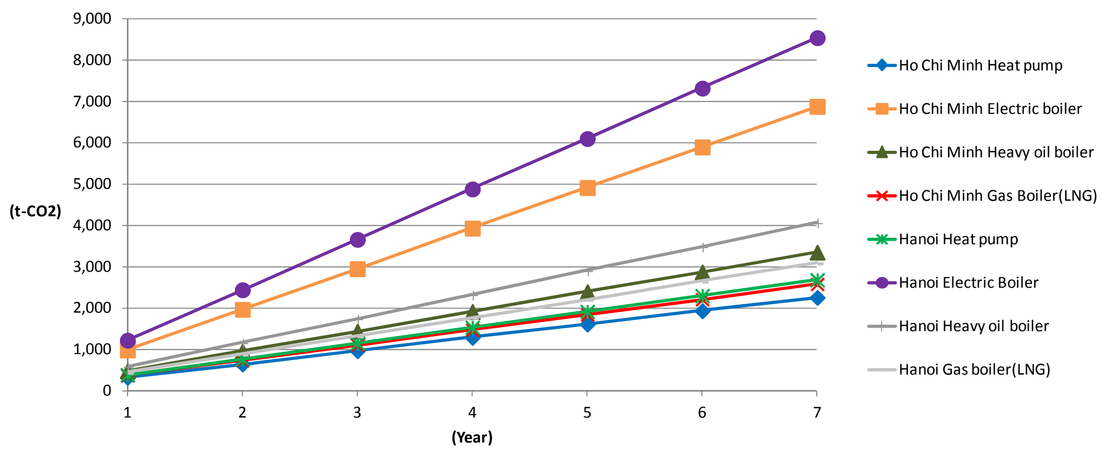
Architectural Institute of Japan: environment group (52), 301-304, 2012-05-25 value is close to the case of Ho Chi Minh City hot water supply, which uses a heat pump, and is 322t-CO2.

Table 5.2-3 CO2 emissions reduction potential based on the hotel's internal hot water supply system

		City	
		Ho Chi Minh City	Hanoi City
Climatic zone		R7	R3
Hot water supply type (heat source fuel)	Heat pump (electric)	322	383
	Electric boiler	982	1,219
	Heavy oil boiler	478	581
	Gas boiler(LNG)	368	441

Unit： t-CO2/Year Source: prepared by the investigating group

The CO2 reduction potential shown in Table 5.2-3 is portrayed as a cumulative reduction of CO2 levels over 7 years in Figure 5.2-3. Electric boiler hot water supplies in Ho Chi Minh and Hanoi have a CO2 reduction potential of over 6,000 t-CO2 across 7 years, which is much greater than other types of hot water supplies. Also, the CO2 reduction potential of heavy oil boiler hot water supplies adopted mostly in Vietnam is predicated to be over 3,000 t-CO2. Vietnamese hotels' main types of hot water supply are heavy oil boiler, and electric boiler. Thus, the seven-year reduction potential is over 3,000t-CO2 for heavy oil boilers and over 6000t-CO2 for electric hot water supplies.



Source: prepared by the investigating group

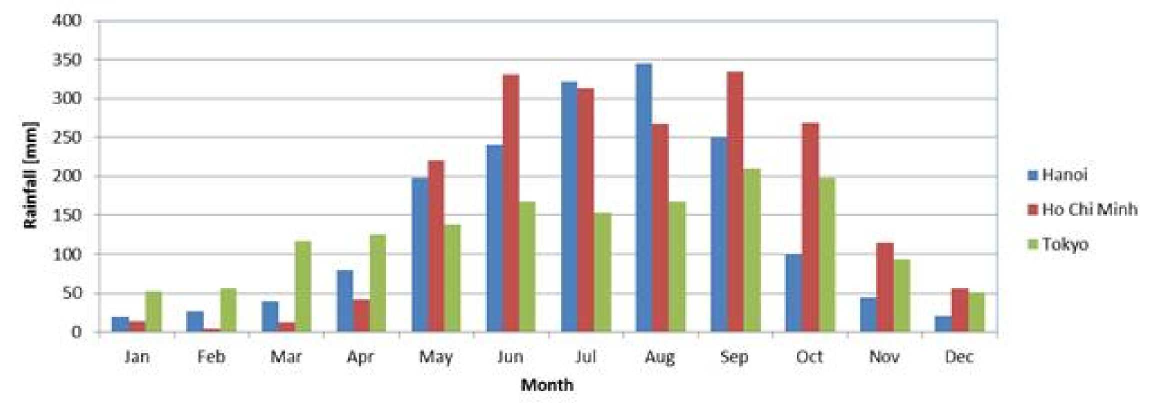
Figure 5.2-3 CO2 reduction potential: cumulative amount based on hotel's internal hot water supply system

Chapter 6 Environmental Benefit of Rainwater Utilization

6.1 Rainfall Situation in Vietnam

There is a clear distinction between rainy season and dry season in Vietnam and May to October falls into rainy season. Rainfall in Vietnam is characterized by squall-like downpour within short hours for several days resulting in frequent flood in urban areas paved with asphalt.

Collection and utilization of rainwater will undoubtedly contribute to the settlement of urban flood issues and clean water is saved simultaneously together of which will turn around the water supply situation and aggravating urban environment caused by flood in Vietnam.



Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hanoi	Average monthly	19	27	39	80	198	240	322	345	250	99	44	21
	Ave no of days with 1mm	8	13	14	15	16	14	16	17	13	9	8	7
Ho Chi Minh	Average monthly	14	4	12	42	220	331	313	267	334	268	115	56
	Ave no of days with 1mm	3	2	2	5	15	22	23	20	21	20	12	8
Tokyo	Average monthly	52	56	117	125	138	168	154	168	210	198	93	51

Source: The Embassy of the Socialist Republic of Vietnam in the United Kingdom

30-Year Average Figures Monitored From 1981-2010, Japan Meteorological Agency[15]

Figure 6.1-1 Rainfall in Hanoi, Ho Chi Minh and Tokyo

6.2 Outline of Rainwater Utilization

6.2.1 Benefit of Rainwater Utilization

Followings are the key benefits of utilizing rainwater.

[15] Japan Meteorological Agency（http://www.data.jma.go.jp/obd/stats/etrn/index.php）

・ Lower tariff rates of clean water and sewage through the saving of clean water
・ Alternative water source at the time of disaster
・ Mitigation of urban flood damages
・Conservation of underground water through the curb in release of water into rivers

These benefits are categorized by water management and disaster prevention, water utilization, environmental aspect, comfort and amenity (see Table 6.2-1 below).

Table 6.2-1 Particulars and Benefit of Rainwater Utilization

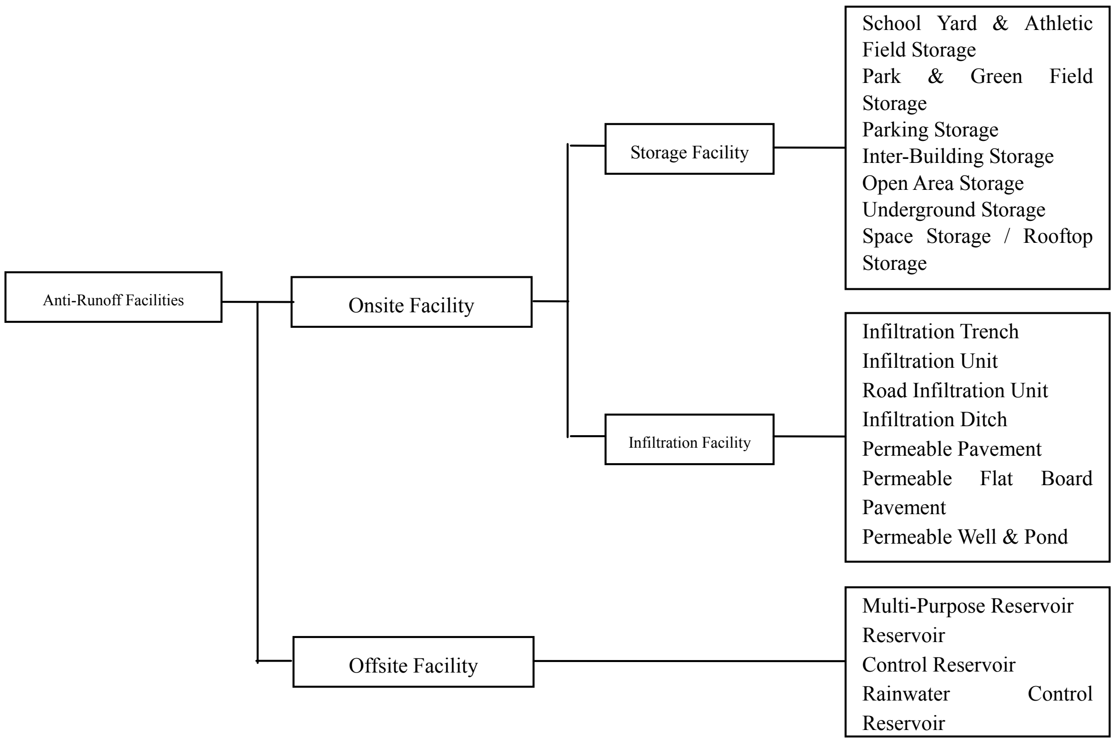
Assessment	Function/Benefit
Water Management/Disaster Prevention	Runoff control, Peak flow reduction, Mitigation of load in rivers and drains －Prevention of inundation, Reduction of water disasters, Reduction of drain and pipe maintenance costs
Water Utilization	Water supply at the time of disaster, for environmental management and landscaping, for miscellaneous purposes, for field/road/snow sprinkler －Reduction of tap water demands, Water-saving, Raising awareness of water resource utilization
Environmental Aspect	Secured water volume in rivers, Groundwater recharge and control of land subsidence, Conservation and restoration of spring water, Preservation and rejuvenation of aquatic ecosystem, Water supply to green areas, Mitigation of urban heat-island effect, Reduction of nonpoint load, Reduction of combined sewage contamination load －Conservation of aquatic environment, Preservation of ecosystem, Improvement of micrometeorological conditions, Conservation of water quality
Comfort/Amenity	Construction of waterfront and amenity (Sound of stream, Nature-friendly waterfront, biotope etc) －Formation of urban landscape, Enhanced recreational function

Source: Page 3, Latest List of Rainwater Storage and Immersion Facilities

6.2.2 Runoff Control Facilities

Runoff control facilities must be utilized as part of the measures to settle urban flood issues which are classified into offsite and onsite facilities. The former refers to the reservoirs of rainwater upon collection from rivers and sewage, whereas the latter refers to the facilities to prevent runoff of rainwater by means of minimizing movement of rainwater, storage and immersion on the site of rainfall.

Small-sized onsite storage facilities will be studied in this report through the analysis of their impact upon extensive application.



Source: Page 1 of Technical Guideline of Rainwater Storage and Immersion Facilities Tokyo

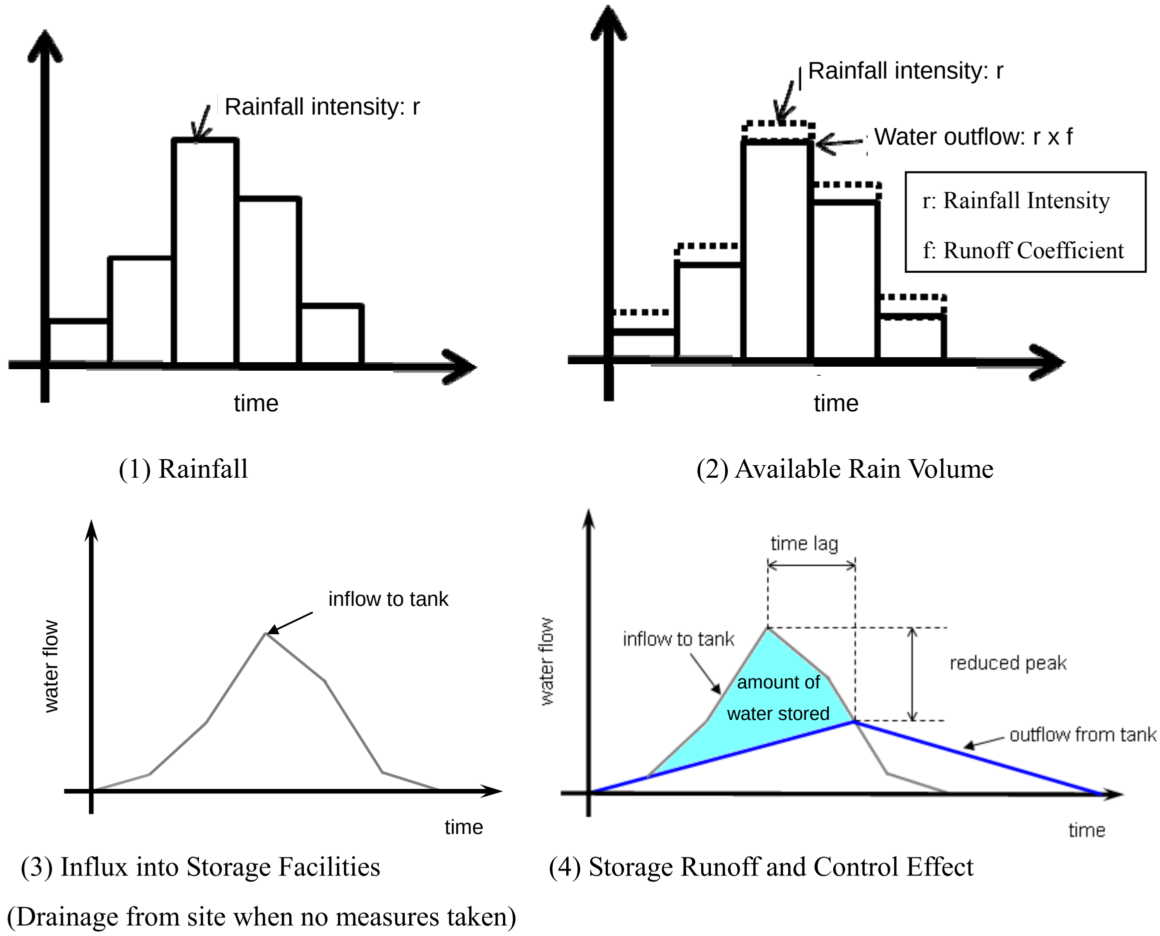
Tokyo General Water Management Council, February 2009

Figure 6.2-1 Classification of Storage and Immersion Facilities

6.3 Urban Flood Mitigation Mechanism

In mapping out effective flood countermeasures, it is crucial to understand the flood cause and establish the mechanism that fits the actual situation outlined as follows.

The method of curbing rainwater runoff is based on the concept of creating a delay in runoff through the temporary storage of rainwater during peak hours as illustrated in Table 6.3-3 below. Such delay in peak-hour runoff helps keeping the influx of rainwater into rivers within their capacity and mitigates urban flood.



(1) Rainfall

(2) Available Rain Volume

(3) Influx into Storage Facilities

(Drainage from site when no measures taken)

(4) Storage Runoff and Control Effect

Figure 6.3-1 Concept of Runoff Control at Immersion and Storage Facilities

6.4 Rainwater Utilization Technology and Verification Method

Having said that causing a delay in peak-hour rainfall through runoff control effectively alleviates urban flood issues, technology of utilizing rainwater and method of verification are described below to achieve the goal.

6.4.1 Calculation of Collected Rainwater

Annual volume of collectible rainwater is to be calculated based on the following formula.

Annual Volume of Collectible Rainwater [m^3] = Collection Area [m^2] x Annual Rainfall [mm] x Runoff Coefficient ÷ 1,000

Runoff coefficient above refers to the percentage of rainwater running off the ground surface against rainfall. Runoff coefficient of rooftop rainfall stands high at 0.85~0.95 due to high collectability whereas that of the unpaved ground surfaces stands low at 0.3 and below on account of greater infiltration.

Table 6.4-1 Standard Figures of Fundamental Runoff Coefficient By Work Type

By Work Type	Runoff Coefficient
Roof	0.85～0.95
Road	0.80～0.90
Other Non-Permeable Surface	0.75～0.85
Surface of Water	1.00
Unoccupied Ground	0.10～0.30
Green Park	0.05～0.25
Low-Pitched Mountain	0.20～0.40
Steep Mountain	0.40～0.60

Source: Sewage Facility Planning/Designing Guideline and Explanatory Notes

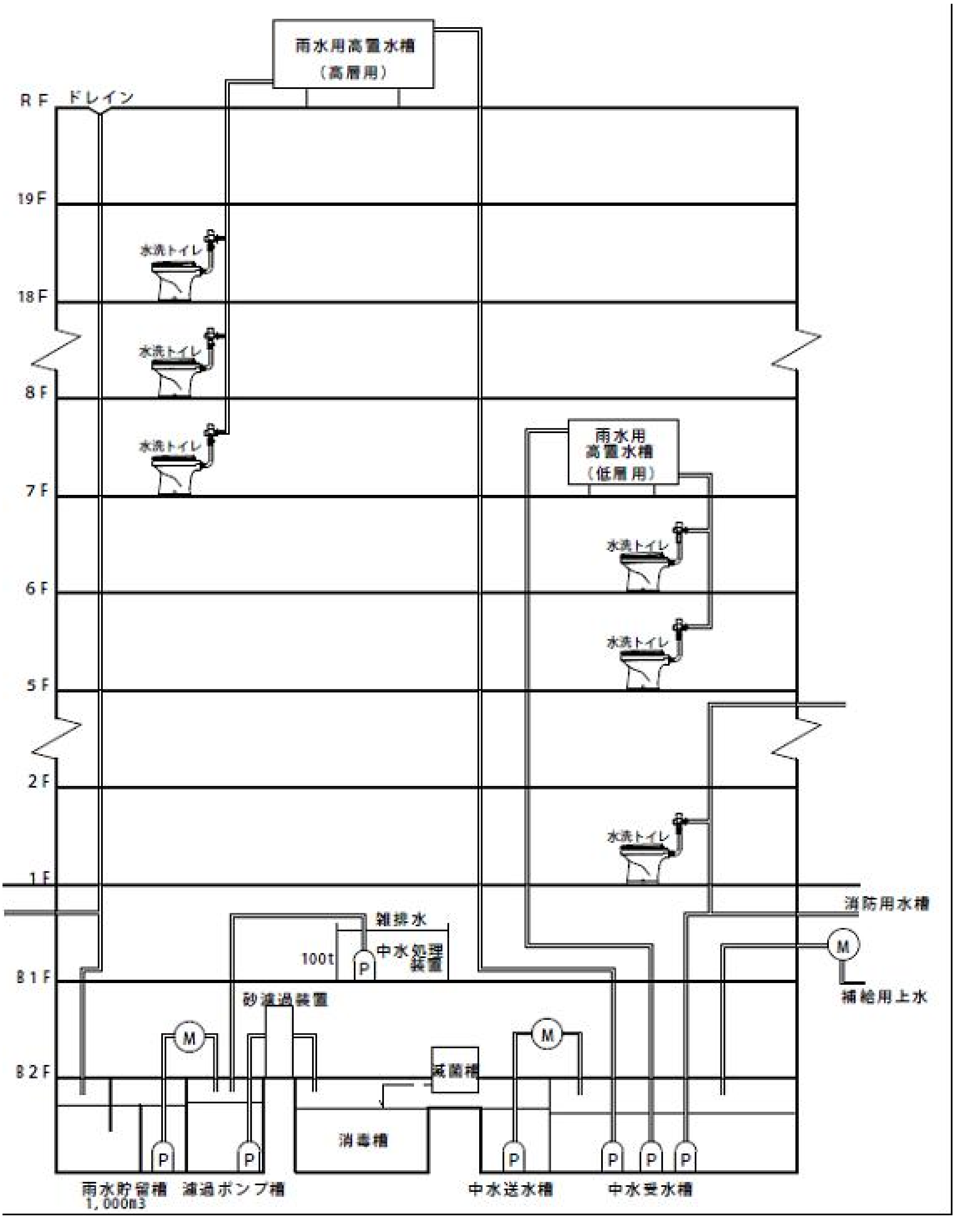
Amount of collectible rainwater refers to the maximum available volume. In general, supplementary water supply system needs to be installed at the same time as the actual availability may vary subject to the storage capacity and usage situation.

6.4.2 System Showcase

The system adopted in large-sized construction is illustrated in Figure 6.4-1 below. Rain water is collected into the underground rainwater tank through the drain pipes and flown into the semi-clean water tank through the filtering and sterilization process. The water is then mixed with semi-clean water treated to rid of household sewage excluding toilet sewage and used for toilet flushing and fire extinguishing. Clean water supplements semi-clean water should there be any shortfall.

On the other hand, small-sized facilities usually collect only rainwater for sprinkling.

Below is the showcase of actual structure in Japan (Koto-Ward Education Center). The structure is equipped with rainwater utilization facilities in its educational facility and library which spread into the gross floor area of 9,000m^2. The scale of rainwater utilization stands at the water collection area of 1,800m^2, rainwater storage capacity of 360m^2 and rainwater availability of 1,326m^3/p.a. and 47% of miscellaneous water and 40% of total water supply are covered with rainwater all the year around.



Source: Environment Conservation Office, Sumida-Ward Tokyo

Figure 6.4-1 Showcase of Rainwater Utilization System

Table 6.4-2 Particulars of Structure

Address	2-3 Toyo, Koto-Ward Tokyo
Purpose of Site (Purpose of Facility)	Educational Center, Library
Commencement	April 1985
Mission	Water Resource Utilization, Sewage Load Reduction
Site Area	5,628m^2
Floor Area	9,088m^2
Water Collectible Area	Building Roof and Balcony of 1,800m^2
Rainwater Storage Tank	Building Underground of 360m^2
Purpose of Rainwater Usage	Toilet Flushing, Pond Water, Coolant Water, Sprinkling, Cleaning, Car Washing, Fire Extinguishing
Water Volume	1,326m^2/Year
Water Processing	Deposit Treatment, Crushed Stone Filtration, Strainer
Source Supply	Clean Water

Source: Rainwater Utilization Handbook

6.5 Reduction Effect of Clean Water Consumption

According to the Rain Water Storage and Infiltration Facility Installation Manual for Landed Property, privately-owned household may enjoy saving of clean water consumption by 6.8m^3/month through the utilization of rainwater which is equivalent to about 21% of the total water consumption and is converted into the annual saving of around JPY11,000 with the pumping cost of stored water included (calculation based on the household of five, water collection area of 116.1m^2, capacity of 2.12m^3 and water used for toilet flush).

Benefit of lowering water bill through the use of rainwater is illustrated below.

Table 6.5-1 Use of Rainwater and Reduction of Water Bill

Items	Unit	No Rainwater	With Rainwater	Notes
Rainwater Usage	m^3/ Month	0.0	6.8	Monthly Average of 16 Years
Water Consumption	m^3/ Month	32.0	25.2	Average Water Consumption of 5-Member Household for "No Rainwater" Category

Water Tariff	Yen/Month	4,710.0	3,440.0	Estimation From Tariff of 23 Wards of Tokyo
Electricity Consumption	kwh/Month	300.0	315.7	Average Electricity Consumption per Household for "No Rainwater" Category
Electricity Tariff	Yen/Month	6,372.0	6,724.0	Estimation on 30A Contract with TEPCO
Water + Electricity	Yen/Month	11,082.0	10,164.0	
Saved Amount	Yen/Month	-	918.0	
	Yen/Year	-	11,014.0	

Source: P25-26 of Rain Water Storage and Infiltration Facility Installation Manual for Landed Property

6.6 Important Notes of Planning Rainwater Utilization

While clean water can be saved, planning of rainwater utilization shall be based on such points as a) Elimination of early rain, b) Full capacity countermeasures and c) Flood countermeasures.

Quality of early rain is subject to the interval of rainfall, season, air pollution and organic pollutants of the collection site (bird droppings, oil etc). Dust on the rooftop or collection pipe may also affect the quality of water and therefore measures should be taken to eliminate early rainwater when collected.

As part of the full capacity countermeasures, anti-overflow function needs to be considered in order to prevent overflow from the storage tank at the time of downpour. Furthermore, a method of automatic drainage can also be considered by closing the rainwater influx valve upon detection of full capacity of the storage tank.

One of the key purposes of rainwater utilization in Vietnam is to prevent floods and it is necessary to ensure the influx capacity of storage tanks at the time of rainfall to this end.

Besides clarifying the purpose of rainwater utilization, much attention shall be given when planning the system to ensure optimal benefit.

6.7 Importance and Benefit of Rainwater Storage

As is the case of Vietnam, Japan has coped with flood issues along with urbanization. Local governments have taken the initiatives for extensive use of rainwater storage facilities and some residential complexes are equipped with storage functions between the blocks or underground of car parks. Similar methods have also been adopted in public and commercial facilities where open spaces or parking areas surrounded by buildings can be converted into storage facilities upon emergency.

Such all-out efforts made by the entire community have helped reducing flood damages in big cities.

Chapter 7 Verification of Rainwater Utilization Benefits at model buildings in Vietnam

Possibility and benefit of rainwater utilization are verified in this survey based on the model case of a building considering introduction of water purification facilities in the entire building.

7.1 Particulars of Surveyed Building

Purpose of Building: Tenanted Building (Complex of Café, Aesthetic Salon, Hair Salon and other services with high water consumption)

Location: District1, Ho Chi Minh City, Vietnam

Gross Floor Area: 284m^2

Floor: Ground to 5th Level

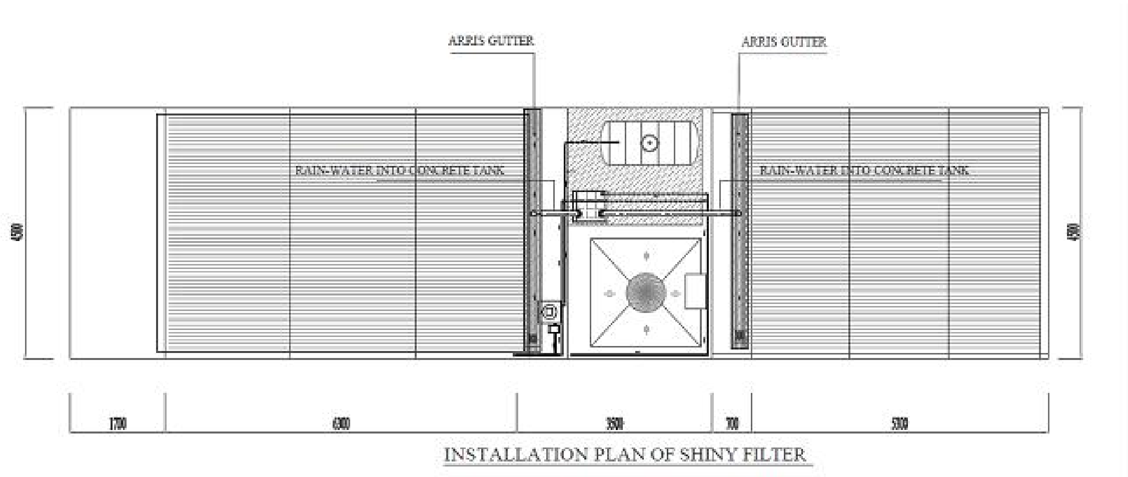


Figure 7.1-1 Rooftop Floor Plan

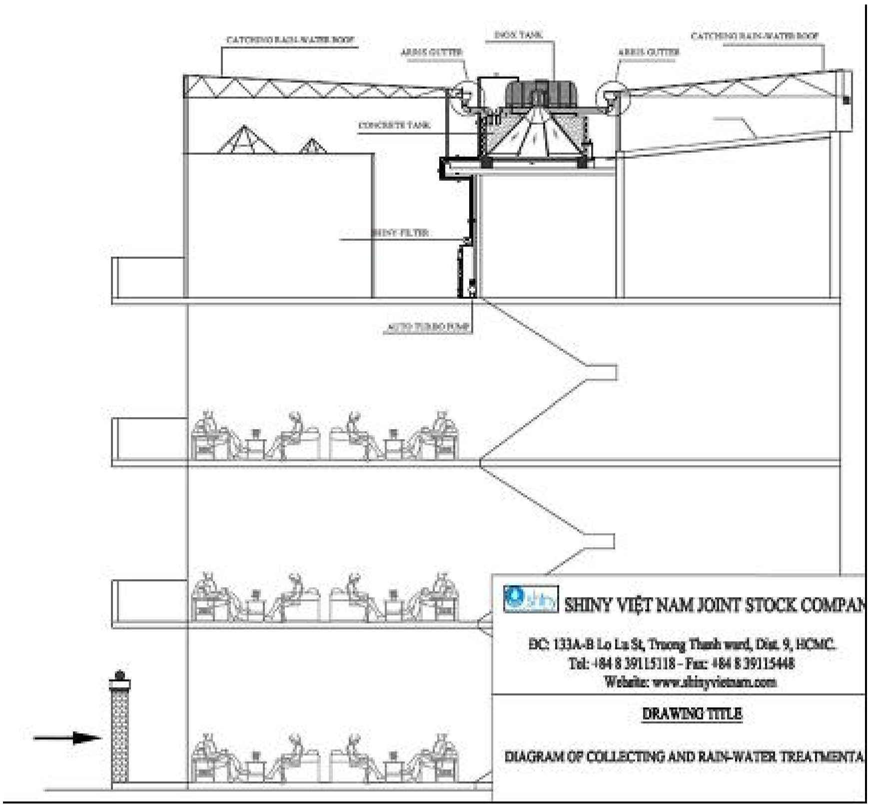


Figure 7.1-2 Cross-Sectional View

7.2 Estimated Rainwater Usage and Water-Saving Effect

The target is a complex building where water consumption per unit area is estimated at 25 L/day which is translated into the average hourly consumption of 2.5L/hour per m^2 based on the daily business duration of 10 hours.

Based on the calculation above, the average hourly consumption for the entire building will be 2.5 $L/hm^2 \times 284m^2 = 710$ L/hour.

(1) Water-Saving Effect

・Annual Rainfall: 1,976mm (Section 6.1 of Ho Chi Minh City Meteorological Data)

・Runoff Coefficient: Roof 0.9 (Subsection 6.4.1 of Runoff Coefficient Data)

・Roof Area: $51m^2$

・Annual Rainwater Utilization: $1{,}976mm \times 51m^2 \times 0.9 \div 1{,}000 = 90m^3$

・Annual Consumption of Supplied Water: $25\ L/day \times 284m^2 \times 365day \div 1{,}000 = 2{,}592m^3$

Based on the above, the water-saving ratio is estimated to be <u>90÷2,592=3.5%</u>. (If 90% of rainfall all flows into storage tank and the entire influx is treated for use.)

(2) Benefit of Rainwater Storage

According to the data taken from a local water purifier merchandiser, the intensity of rainfall in Ho Chi Minh City is derived as follows.

$$Q=A\times(1+C\times\log(P))/(T+b)^{n}$$

Followings are definitions of the formula above.

Q: Intensity of Rainfall [L/ses.hr]

A: Index at Tan Son Nhat Meteorological Observatory, Ho Chi Minh City =11,650

C: Index at Tan Son Nhat Meteorological Observatory, Ho Chi Minh City =0.58

n: Index at Tan Son Nhat Meteorological Observatory, Ho Chi Minh City =0.95

b: Index at Tan Son Nhat Meteorological Observatory, Ho Chi Minh City =32

P: Rainfall Cycle (Average Simulation Year) [year]

T: Duration of Rainfall [hour]

According to the formula above, the probable intensity of rainfall for 5 years stands at 601.03 L/s.ha (extremely heavy rainfall equivalent to 216mm/h) which translates into the runoff of 4.14m^3 from the roof of 51m^2 after downpour in 25 minutes. A storage tank with a capacity of around 4m^3 sufficiently prevents runoff of rainwater from roof even at the time of first-ever downpour in five years to last 25 minutes (see Table 7.2-1 below).

Table 7.2-1 Calculation of Rainfall and Collected Water (Tenanted Building)

Continued Rainfall T hr 0.42

TT	**Calculation Items**	**Value**	**Unit**
	Index taken at Tan Son Nhat Meteorological Observatory in Ho Chi Minh City		
1	A =	11,650	
2	C =	0.58	
3	n =	0.95	
4	b =	32	
5	Period: P =	5	Year
6	Runoff Coefficient: Ø =	0.90	
7	Rainfall Area: S =	0.0051	ha
		51	m2
8	Rain Intensity: q =	601.03	L/s.m2
9	Rain Flow Volume: Qtt =	2.76	L/s
10	Average Rainfall Duration per Rainfall: t =	**25**	Minute
11	Volume of Heavy Downpour Once in Five Years: Qtt =	**4.14**	m3

7.3 Analysis of Other Cases

In addition to the building in the previous section, analysis is conducted in a much larger building, namely the Renaissance Riverside Hotel Saigon, as the model.

(1) Particulars of Building

・Location: Ho Chi Minh City, Vietnam

・Gross Floor Area: 29,539m^2

・Floor: Basement 1 to 21st Level

・Usage: Hotel

Source: Google, DigitalGlobe

Figure 7.3-1 Aerial Photo of Renaissance Riverside Hotel Saigon

(2) Consumption of Supplied Water

・Actual consumption of 2008 based on the survey: 132,241m^3/year

・(Ref.) Annual consumption of supplied water estimated from the standard consumption at hotels in Japan (reference material): 24.2 L/day×29,539m^2×365day÷1,000=260,918m^3

(3) Estimated Rainwater Usage and Water-Saving Effect

・Annual Rainfall: 1,976mm

・Runoff Coefficient: Roof 0.9

・Roof Area: 1,419m^2 (incl. swimming pool)

・Annual Rainwater Usage:1,976mm×1,419m^2×0.9÷1,000=2,524m^3

・Annual Usage of Supplied Water: 132,241m^3

Based on the above, the water-saving ratio is calculated to be 2,524÷132,241=1.9% (if 90% of rainfall is all treated and used).

(4) Benefit of Rainwater Storage

As stated above, the probable intensity of rainfall for 5 years stands at 601.03 L/s.ha (extremely heavy rainfall equivalent to 216mm/h) which translates into the runoff of 115m^3 from the roof of 1,419m^2 after downpour in 25 minutes. A storage tank with a capacity of around 115m^3 sufficiently prevents runoff of rainwater from roof even at the time of first-ever downpour in five years to last 25 minutes.

Table 7.3-1 Calculation of Rainfall and Collected Water (Renaissance Riverside Hotel Saigon)

Continued Rainfall T hr 0.42

TT	**Calculation Items**	**Value**	**Unit**
	Index taken at Tan Son Nhat Meteorological Observatory in Ho Chi Minh City		
1	A =	11,650	
2	C =	0.58	
3	n =	0.95	
4	b =	32	
5	Period: P =	5	Year
6	Runoff Coefficient: Ø =	0.90	
7	Rainfall Area: S =	0.1419	ha
		1,419	m2
8	Rain Intensity: q =	601.03	L/s.m2
9	Rain Flow Volume: Qtt =	76.76	L/s
10	Average Rainfall Duration per Rainfall: t =	**25**	Minute
11	Volume of Heavy Downpour Once in Five Years: Qtt =	**115.14**	m3

7.4 Ripple Effect across Ho Chi Minh City

We will verify the ripple effect of rainwater utilization and storage across Ho Chi Minh City based on the analysis of the model cases above.

The verification is based on the occupancy analysis data of Tokyo to supplement the lack of data on the building floor ratio (occupancy rate) of Ho Chi Minh City.

Google Map in Figure 7.4-1 shows the vicinity of Ho Chi Minh City and Sumida-Ward Tokyo which indicates that both are densely mixed with business, commercial and residential complexes.

Source: Google

Figure 7.4-1 Central District of Ho Chi Minh City (Left) and Sumida-Ward Tokyo (Right)

(1) Prerequisite

・Area of Ho Chi Minh City: Town area of494km^2

・Building Occupancy: 36% (based on the data taken from similar city)

・Roof Area: 492km^2×0.36=177km^2

・Availability: 20%

・Rainwater Collectible Area: 177km^2×0.2=35.4km^2

(2) Estimation of Rainwater Usage and Water-Saving Effect

(i) Saved Water Volume

・Annual Rainfall: 1,976mm

・Runoff Coefficient: Roof 0.9

・Roof Area: 35.4km^2

・<u>Annual Rainwater Usage: 1,976mm×35.4km^2×0.9÷1,000×10^6=63×10^{6}m^3</u>

63million ton of water can be saved annually based on the data above.

(ii) Reduction of Greenhouse Gas (GHG)

Based on the emission factor of the clean water derived from this survey of 0.00023tCO2/m^3, followings are applied:

<u>Total Reduction of GHG Emission = 14,490tCO2,</u>

meaning a potential GHG reduction of 14,500tCO2 annually.

(iii) Lowering Water Tariff

Based on the water tariff of VND13,250/m3(about JPY65/m3) which is the average commercial tariff of VND9,600/m3(Manufacturing Industry) and VND16,900/m3(Management and Service Industry) following amount can be cut from the water tariff.

<u>Water Tariff Reduction = JPY4.1billion/year</u>

Water tariff will be reduced by as large as JPY4.1billion annually.

(iv) Disaster Prevention and Safety Effect

As stated above, promotion of rainwater utilization contributes significantly to save water and energy across Ho Chi Minh City. At the same time it is extremely crucial and beneficial in protecting people's lives and assets to solve flood issues by means of rainwater storage in addition to its utilization.

Chapter 8 Rainwater Utilization Test

As part of the survey, we conducted rainwater utilization test using Japanese water purification system in cooperation with ECC-HCMC. Based on the outcome of this test, we will pursue the optimal method of rainwater utilization and finalize safe and workable proposals in accordance with local applicable laws and regulations.

8.1 Particulars of Test Building

Purpose of Building: Parking Space of ECC-HCMC

Location: District 3, Ho Chi Minh City Vietnam

Rainwater Collectible Area: $60m^2$

Rainwater Tank Capacity: 1,000L

System Structure: Preliminary Treatment Device, Water Purification Device, Outlet Pump

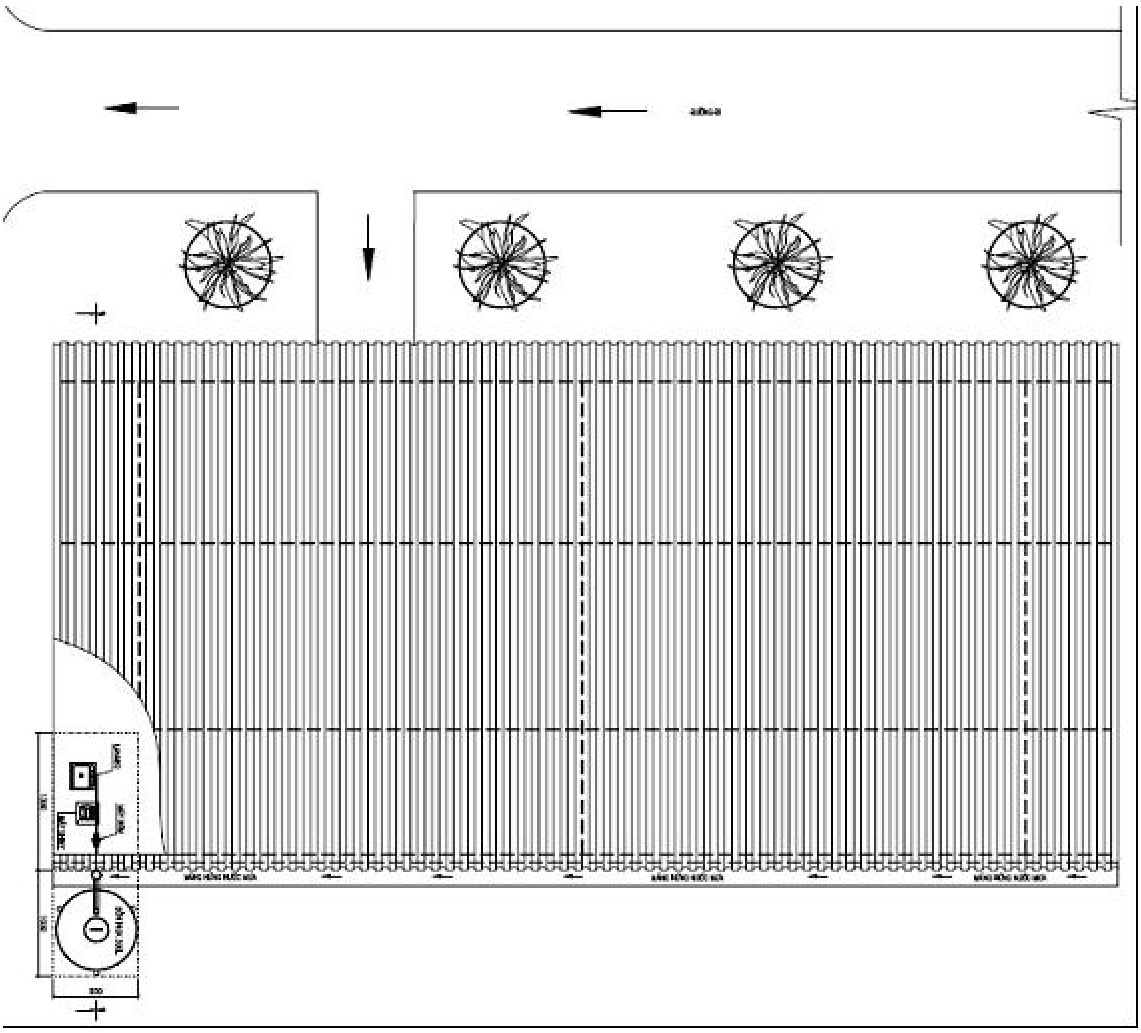


Figure 8.1-1 Rooftop View

Figure 8.1-2 shows cross-sectional view of the system installed. Rainwater will be collected from the parking roof for storage in the rainwater tank through the drainage pipe, go through the preliminary treatment in the outlet pump, purified in the purification device and provided to office. Purified water will also be provided under this system to supplement water supply. The actual system implementation is shown in Figure 8.1-3 below.

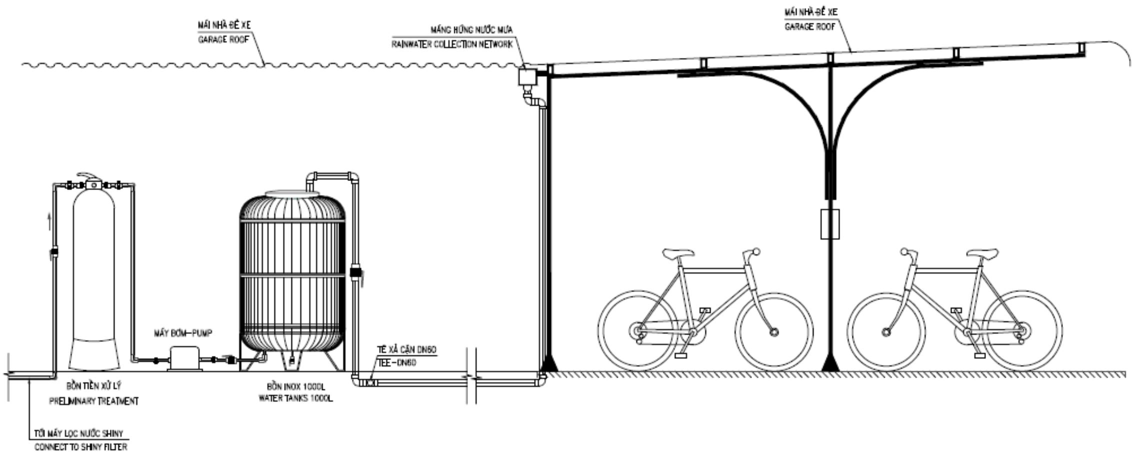


Figure 8.1-2 Cross-Sectional View of System

Rainwater Collection Roof

Water Purifier

Water Collection Tank

Figure 8.1-3 Actual Implementation of Water Purification System

8.2 Applicable Laws and Regulations

Followings are the applicable laws and regulations of Vietnam to be complied with in implementing the system under the test.

- National Standard of tap-water QCVN 02: 2009/BYT.
- National Standard of drinkable water QCVN 01: 2009/BYT.
- TCXDVN 33:2006: Water supply – Pipe net – Design Standard
- Other standards of pipes and materials.

The system herein is confirmed to meet these standards. As stated above, clean water in Vietnam is not fit for drinking in many areas and the system supplier in this test has the record of providing safe drinking water for schools and hospitals through purification of their clean water using the system herein. In addition sewage from hotels and hospitals is increasingly recycled for business as semi-clean water for toilet flushing and sprinkling.

8.3 Result of Water Quality Check

Table 8.3-1 shows the outcome of water quality check in the rainwater utilization test conducted at ECC-HCMC and the quality is confirmed normal after the adoption of Japanese water purifier system.

Table 8.3-1 Result of Rainwater Quality Test upon Treatment

No.	Parameter	Unit	No.	Limit
1	pH	-	7,53	6,5 – 8,5
2	Turbidity	NTU	1	< 2
3	Colour	Pt – Co	13	< 15
4	Odour	-	Odourless	No strange taste & odour
5	Permanganate	mg/l	ND (<2)	< 2
6	$N\text{-}NH_4^+$	mg/l	ND (<0,5)	< 3
7	$N\text{-}NO_2^-$	mg/l	ND (<0,003)	< 3
8	$N\text{-}NO_3^-$	mg/l	0,37	< 50
9	Hardness	$mgCaCO_3/l$	168	< 300
10	SO_4^{2-}	mg/l	6	< 250
11	Fe	mg/l	0,074	< 0,3

12	Mn	mg/l	0,008	< 0,3
13	Cl^-	mg/l	12	< 250
14	Ecoli	CFU/250mL	ND (<1)	0
15	Coliforms	CFU/250mL	ND (<1)	0
16	Pseudomonas aeruginosa	CFU/250mL	ND (<1)	0
17	Fecal Streptococcus	CFU/250mL	ND (<1)	0
18	Clostridium Botulinum	CFU/250mL	ND (<1)	0

* ND: not detected

Although the quality is confirmed normal, the research team does not recommend taking purified rainwater directly from the clean water pipe to prevent potential health damages caused by mixture of clean water and unsuccessfully treated rainwater due to inadequate piping, failure or malfunction of the purification system. The Water Supply Act of Japanese prohibits direct cross-connection of tap water pipes and pipes for other purposes in order to prevent contamination. Having said that, it is not common for people in Vietnam to drink directly from the tap and hotels usually indicate their clean water is not fit for drinking.

Having the rainwater utilization test done including the verification of Japanese water purifier system in this survey, local counterparts comments favorably that utilization of stored rainwater is certainly effective in mitigating shortage of water supply. Further studies shall be conducted to encourage more extensive use of rainwater and future use of household sewage as semi-clean water in order to make maximum use of water resources.

Chapter 9 Consideration of Finance Scheme in Promoting Energy & Water-Saving Equipments

Vietnam has been faced with shortfall of energy, especially electricity due to rapid economic growth and the Government of Vietnam has encouraged energy-saving initiatives t such issues. It is urgently needed to set up a finance scheme to support energy-saving initiatives.

Despite cash-out from new energy-saving facilities, absence of direct cash flow from facility investment makes it difficult to visualize energy-saving effect and such difficulty is probably one of the obstacles to establishing a workable payout scheme. Taking such issues into account, we will study energy-saving finance schemes including ESCO which makes apparent the monetary advantage of energy-saving.

9.1 What is ESCO?

ESCO (Energy Service Company) is a scheme where all the principle energy-saving renovation costs (including facility expenses, renovation fees and interests) are offset by the saving of utility costs achieved through such renovation and ESCO provider offers funding-related services as well as assessment of energy-saving effect, designing and construction, operation and maintenance of energy-saving facilities. Clients (property owners etc) and ESCO provider sign a energy-saving service agreement based on which the entire utility savings upon contract expiry shall belong to the client.

Furthermore, ESCO project is characterized by the practice that ESCO provider guarantees the effect of energy-saving to its client (performance guarantee). ESCO provider is consigned to manage the entire process of construction, operation and management of the contract facility based on the renovation plan drawn up upon energy-saving assessment. Should ESCO provider fail to achieve the scheduled energy-saving effect at the time of contract and perform the expected utility saving ESCO shall indemnify the client for losses based on the performance guarantee agreement. In this way ESCO is a scheme of promoting energy-saving equipments through visualization of energy-saving effects based on performance guarantee.

ESCO scheme is based on two types of contracts: Guaranteed Savings Agreement where client (property owner) bears the initial renovation costs and Shared Savings Agreement where the initial renovation costs are borne by ESCO provider. The latter enables client to save facility investment in the first business year as it is borne by ESCO provider which is to be paid out from energy-cost savings.

ESCO projects have been adopted in Japan since 1990’s and the entire project size reached JPY30billion in FY2011 (214 projects) evidencing assurance of ESCO in Japan as effective method of promoting energy-saving equipments.

Table 9.1-1 ESCO Contract Types

<table>
<tr><th></th><th>Guaranteed Savings Agreement</th><th>Shared Savings Agreement</th></tr>
<tr><td>Initial energy-saving costs borne/owned by:</td><td>Client (Property Owner etc.)</td><td>ESCO Provider</td></tr>
<tr><td>ESCO service fees paid from:</td><td colspan="2">Prescribed amount or percentage of energy-saving effect (utility saving)</td></tr>
<tr><td>Principle expenses covered by ESCO service fees</td><td>Assessment, Maintenance, Miscellaneous Expenses (excl. Facility and Interest Fees)</td><td>Facility Installment, Interest, Assessment, Maintenance, Miscellaneous Expenses</td></tr>
<tr><td>Profit sharing upon expiry of ESCO agreement</td><td colspan="2">Energy-saving effect (utility saving) all belongs to client</td></tr>
<tr><td rowspan="2">Other highlights</td><td colspan="2">・Secured energy-saving effect through performance guarantee
・Visual energy-saving effect through assessment</td></tr>
<tr><td>・Lower risk of ESCO provider as compared to Shared Savings as initial investment and interest fees are borne by client</td><td>・Initial investment and interest fees are borne by ESCO provider using service fee paid by client
・ Client can exclude energy-saving facilities from balance sheet</td></tr>
</table>

9.2 ESCO in Vietnam and Obstacles

9.2.1 ESCO in Vietnam

Although ESCO has yet to gain popularity in Vietnam with poor social recognition, Viet Energy Service and Consulting Joint Stock Company (Viet ESCO) was established in March 2012 as the first full-fledged ESCO in Vietnam in response to heightening energy-saving awareness. Viet ESCO is not only funded by the local companies interested in ESCO project but also by Veglia Laboratories Inc., a Japanese ESCO company which also provides technical expertise.

In emerging economies including Vietnam, plant purchase tends to be discussed based more on initial cost than life cycle cost not only due to financial difficulty of client (property owner etc) but also poor assurance for energy-saving effect gained upon installation and operation of high-performance facility or insufficient understanding of current energy consumption which in all make it hard to visualize cost-saving effect. Although property owners in Vietnam admit cost-saving effects of high-performance equipments, they are uncertain of investment payout of such unfamiliar new technology and therefore they tend to refrain from making huge investments and seek alternatives with low initial costs.

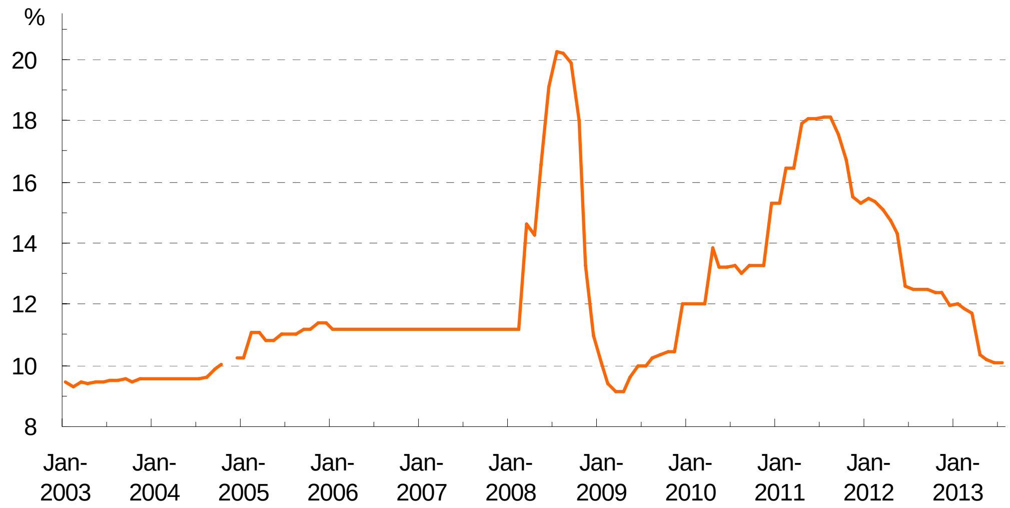
ESCO will certainly encourage property owners to make investment decisions by providing clear energy-saving effects evidenced through energy-saving assessment and verification of effects as well as performance guarantee and (in case of Shared Savings Agreement) exemption from initial costs which in all enable property owners to better visualize cash flow.

9.2.2 Expansion of ESCO and Finance Related Obstacles

While ESCO is a finance scheme expected to promote energy-saving equipments, procurement cost borne by ESCO provider gives rise to financial obstacles to the full-fledged growth of ESCO due to two major reasons. Bank interest rates in Vietnam are historically high and there is additional financial burden for ESCO providers to procure funds due to short business track record.

i) High Interest Rates in Vietnam

Under the Shared Savings Agreement, ESCO provider shall bear the initial costs on behalf of property owner and bank loans may be taken out should there be shortfall in own capital. Given the permanently high loan interest rate of over 10% in Vietnam, ESCO provider needs to set high service charge which reflects on the loan procurements costs. Similarly in case of Guaranteed Savings Agreement, client itself bears high interest rate which poses financial hurdle to purchasing energy-saving equipments.



Source: Bloomberg (Original Source: IMF)

Figure 9.2-1 Historic Performance of Loan Rates in Vietnam[16]

[16] Average Short-Term Loan Rates of Four Major National Commercial Banks of Vietnam

ii) Poor Funding Capacity of ESCO Provider

In many emerging economies including Vietnam, it is hard to take out bank loans for ESCO project and procurement cost is high due to very little recognition or reputation of ESCO resulting in insufficient track record and lack of corporate strength and credibility of ESCO provider.

Ordinary costs of energy-saving facilities primarily consist of service and maintenance fees and interest charges in both cases of plant investment using client's own capital or Shared Savings Agreement. Provided that there is no significant difference in service and maintenance costs, difference in procurement costs affect client's burden which means success of ESCO proposal is heavily dependent on offering as favorable finance scheme as possible.

Keeping the above in mind, it is crucial to support in procuring favorable finance terms and build on the track record in order to clear the obstacles to fund procurement faced by ESCO provider, raise awareness of ESCO model and put it on smooth track.

9.3 Japanese Government's Assistance

There are various schemes provided by the Japanese Government for private companies to promote the Joint Crediting Mechanism. We will take up finance-related assistance provided by the Japanese Government contributing to raise awareness of ESCO and energy-saving equipments other than direct assistance for JCM project.

9.3.1 Support Program to Respond to Climate Change (JICA)

The Support Program to Respond to Climate Change advocated by JICA is aimed at strengthening approach taken by the Vietnamese Government to cope with climate change in consideration for the policies advocated under the "National Target Program to Respond to Climate Change (2009~2015): NTP-RCC" by the Vietnamese Government in 2008. The Program consists of three terms; 1st term of 2010, 2nd term of 2011 and 3rd term during which Yen Loan Agreement was signed between JICA and the Vietnamese Government in March 2013 disbursing scheduled JPY15billion.

Table 9.3-1 Support Program to Respond to Climate Change for Vietnam

	Date of Loan Disbursement	Loan Amount (JPY)	Interest Rate	Repayment (Deferment) Period	Procurement Terms
Term 1	June 2010	100	0.25%	40(10) Years	Untied
Term 2	Nov. 2011	100	0.3%	40(10) Years	Untied
Term 3	March 2013	150	0.3%	40(10) Years	Untied

Source: JICA

The loan procured on general untied conditions under the Program may hinder direct assistance for bilateral JCM project of Japan and Vietnam. However following ESCO promotion program may be feasible to encourage use of energy-saving equipments.

Table 9.3-2 Energy-Saving Equipments Promotion Program (idea)

Support Measures (Draft)		Similar Structure in Japan
Financial Support	• Low-Interest Loan for Purchase of Energy-Saving Equipments	• Low Interest Loan by Japan Finance Corporation • "Interest Support for Environment-Friendly Management" by MOEJ
Subsidy	• Prescribed Subsidy for Purchase of Energy-Saving Equipments	• "Support Program for Rational Energy Business" by METI • "Net Zero Energy Building Evidence Project" by METI
	• Partial Subsidy of ESCO Provider Service Fees	• Eco Lease Promotion Project
Taxation	• Accelerated Depreciation for Acquisition of Energy-Saving Equipments	• Tax Cut for Green Business
	• Preferred Corporate Tax Rate for ESCO Provider	

Under the Energy-Saving and Promotion of Renewable Energy Program conducted by JICA in 2010~2012, a medium-to-long term loan of JPY4.7billion was disbursed through the two-step loan scheme via the Vietnam Development Bank (VDB) for the purpose of promoting energy-saving and utilization of renewable energy by domestic companies of Vietnam. The Program, under which JICA imposed an interest rate of 0.75% to VDB and VDB charged 11% to companies, was overwhelmingly welcomed with over 100 applications due to its low rate of 11% as compared to prevailing average domestic loan rate of 20%. Technology was adopted overseas given the untied conditions of the Program expertise but the fact illustrates validity of low-interest loans provided through the two-step loan scheme of Japan as effective financial assistance.

9.3.2 Funding Support (Fund) for "Leap Frog"-Style Development

The Ministry of the Environment Japan advocates in its draft budget of FY2014 as principle new agenda of establishing "Fund for Promoting Low Carbon Technology", a scheme supporting developing countries to leap into advanced low carbon society through the application of low carbon technology of Japan.

Project Outline	A fund is established to assist highly-effective projects in reducing emission among the projects supported by JICA and other Japanese organizations. The fund is aimed to raise awareness of Japan's advanced low-carbon technology despite high initial costs which are highly effective in reducing emission, as well as achieving low-carbon structure in more diverse fields than before across cities and regions to establish workable crediting mechanism through JCM.
Project Period	FY2014 ~ 2020
FY2014 Claimed Amount	JPY6,000million

Under the Scheme, part of the project funds is provided by private organizations as project leader and the remaining fund procurement will be subsidized by the Fund. JICA will provide investment loan program. Subsidy from the Fund is expected to lower the percentage of debts and procurement costs.

When applying this Fund for Promoting Low Carbon Technology to the promotion of Japanese low carbon technologies, an idea to provide two step loans through Vietnamese financial institutions can be thought of. Under this scheme, an ESCO Facility will be set up within local financial institutions which would provide low-interest loan to ESCO project based on the funding from JICA and the Fund. The Facility, backed by financial support from Japan, covers ESCO/energy-saving projects and local banks provides loan for advanced energy-saving project that meets certain criteria. The Facility provides opportunity for local banks to accumulate expertise on ESCO benefit through the loan examination of each energy-saving project which will be effective in promoting ESCO model.

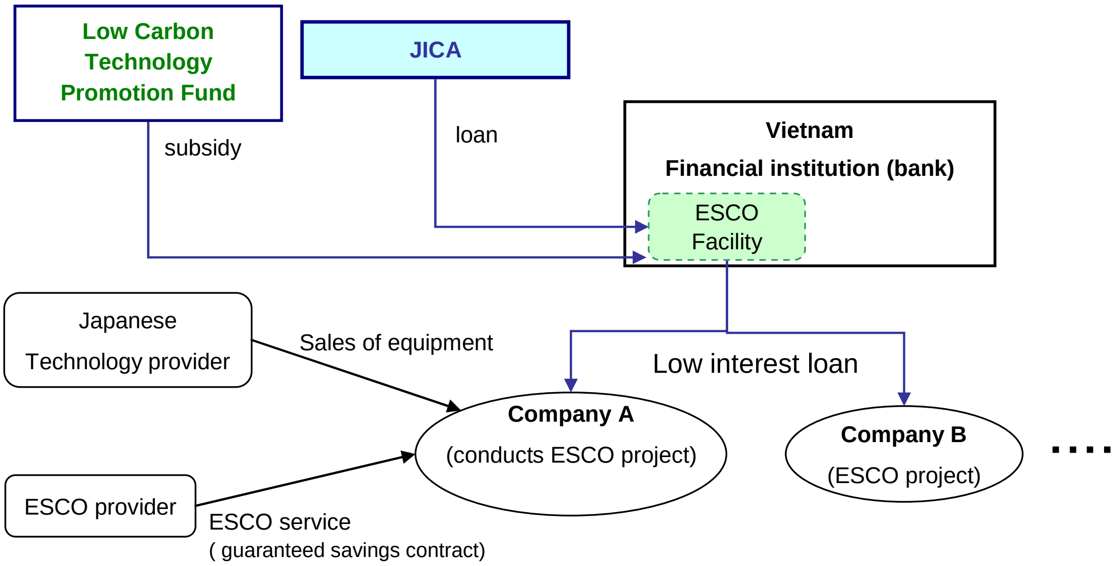


Figure 9.3-2 Example of an ESCO Support Program: Two-Step Loan

9.3.3 ADB Trust Fund

As part of the "Leap Frog"-style funding support advocated by the Ministry of the Environment Japan, funding from ADB Trust Fund is discussed in addition to the above fund idea in order to subsidize advanced low carbon technology which is yet to be adopted due to high initial cost.

Project Outline	The contribution to ADB trust fund will be used to encourage advanced technology currently unpopular due to high costs to be adopted in ADB projects by supplementing additional costs. The project is aimed at a leap transition into low-carbon society through ADB development support as well as establishment of JCM crediting scheme.
Project Period	FY2014~2020
FY2014 Claimed Amount	JPY3,000million

There are 50 over facilities provided by ADB including trust and other funds, among which is the Clean Energy Financing Partnership Facility (CEFPF) set up in 2007 aiming at strengthening energy guarantee in developing countries and combating climate change. The Facility is utilized for promotion of clean energy development and covers ESCO. On top of this Facility, newly-established trust fund will help supporting ESCO project promoting advanced energy-saving initiatives.

9.4 Finance Scheme for Water-Saving Equipments

In this section, we will study the potential availability of ESCO and business feasibility of water-saving equipments (toilets and showers) using the measurement of the Project.

9.4.1 Business Feasibility of Water-Saving Equipments

Showers and toilets are usually picked out considering not only energy-saving effect but functionality, user-friendliness, design, brand image and other non-price factors for personal use in private space. However we will figure out returns from saving water and energy in this section. Service and maintenance costs are excluded and period of investment return is simply calculated without consideration for monetary value of currency.

(1) Toilet

Return of investment from water-saving toilet is as follows.

Particulars	Unit	Notes
Initial Cost	JPY60,000	Unit Price + Installation Fees
Annual Saving Effect per Room	JPY1,463/Room/Year	Annual Water Saving per Room JPY1,375/Room/Year Annual Power Saving per Room JPY88/Room/Year
Payout Period	41 Years	Initial Cost ÷ Annual Saving Amount

* Prerequisite: Commercial Water Tariff: JPY95/m3(VND 19,435/m3)
Electricity Tariff: JPY10.5/kWh(VND 2,148/kWh)
FX Rate: VND1.00=JPY205

(2) Shower (Heat Source: Heavy Oil Boiler)

Return of investment from water-saving shower designed for saving cold and hot water is as follows (Hot water is supplied from heavy oil boiler).

Particulars	Unit	Notes
Initial Cost	JPY20,000	Unit Price + Installation Fees
Annual Saving Effect per Room	JPY2.481/ Room/Year	Annual Water Saving per Room JPY 1,058/Room/Year Annual Fuel Saving per Room JPY 1,355/Room/Year Annual Power Saving per Room JPY 68/Room/Year
Payout Period	8.1 Years	Initial Cost ÷ Annual Saving Amount

* Prerequisite: Commercial Water Tariff: JPY 95/m3(VND 19,435/m3)
Kerosene Unit Price: JPY107/L(VND 22,000/L)
Electricity Tariff: JPY 10.5/kWh(VND 2,148/kWh)
FX Rate: VND1.00=JPY205

(3) Shower (Heat Source: Electric Boiler)

Return of investment from water-saving shower designed for saving cold and hot water is as follows (Hot water is supplied from electric boiler).

Particulars	Unit	Notes
Initial Cost	JPY20,000	Unit Price + Installation Fees
Annual Saving Effect per Room	2,563/Room/Year	Annual Water Saving per Room JPY 1,058/Room/Year Annual Power Saving per Room (Electric Boiler) JPY 1,437/Room/Year Annual Power Saving per Room (In-House Water Supply) JPY 68/Room/Year
Payout Period	7.8 Years	Initial Cost ÷ Annual Saving Amount

* Prerequisite: Commercial Water Tariff: JPY 95/m3(VND 19,435/m3)
Electricity Tariff: JPY 10.5/kWh(VND 2,148/kWh)
FX Rate: VND1.00=JPY205

Payout period of water-saving toilet tends to be longer due to small saving effect per unit gained mainly from saving water consumption whereas greater saving effect is expected for shower from heating power cut. Figures derived from our calculation indicates that there is little difference in the period of collection for both heavy oil boiler widely used at hotels in Ho Chi Minh City and electric boiler which is less common as compared to heavy oil boiler.

9.4.2 Business Feasibility of ESCO

Considering the fitness of ESCO as effective finance scheme to promote water-saving facilities, we will study the potential of its application to water-saving equipments. Setting aside the toilet due to extremely prolonged payout period from water-saving, we will take up the shower from which energy-saving should be achieved from heat-saving as well. ESCO is presumed to be in the form of Guaranteed Savings Agreement (under which initial costs shall be borne by clients) which is more common in developing economies.

In addition to the base case estimation where no financial subsidy is available for ESCO project, another case will be studied based on the assumed financial assistance.

(1) Base Case Estimation

Followings are the prerequisites for the base case.

Particulars	Terms and Conditions
Subject Facility	Water-Saving Shower (Heart Source: Heavy Oil Boiler)
ESCO Contract Type	Guaranteed Savings (Initial Costs borne by Client)
ESCO Service Period	3 Years
Annual Service, Maintenance & Other Costs	3% of Initial Costs (Equipments and Installation)
Profit Rate of ESCO Provider	After-Tax Profit Rate: 10%
Corporate Tax Rate	22%
Client's Payment	30% of Initial Costs (Equipments and Installation)
Client's Bank Loan	70% of Initial Costs (Equipments and Installation)
Repayment Period	3-Year Equal Repayment
Bank Loan Rate	12% (Prevailing Loan Rate of 10% + Risk Premium of 2%)

Profit and loss of the ESCO provider during ESCO contract period are shown in 9.4-1 below.

Table 9.4-1 Profit and Loss of ESCO Provider (Per Shower Unit)

(JPY)

		1	2	3
revenue:	ESCO fee	688	688	688
cost:	O&M/other costs	600	600	600
profit before tax		88	88	88
corporate income tax		19	19	19
profit after tax		69	69	69

Profit, loss and cash flow for 15 years of the client based on the ESCO fees under the base case is shown in Table 9.4-2 whereas cash flow performance is shown in Figure 9.4-1.

Profit overrides loss throughout the contract period except the first business year upon replacement with water-saving shower which reduced annual energy costs. ESCO and interest fees are also covered through energy-saving. However cash flow is expected to turn negative for the first 4 years on account of initial costs and loan service burdens. The base case is proven to be unfavorable for clients given the fact that their cash flow and accumulated cash flow turn positive only in the 5th and 13th years respectively. Equity IRR for the period of 15 years stands at 4.0%.

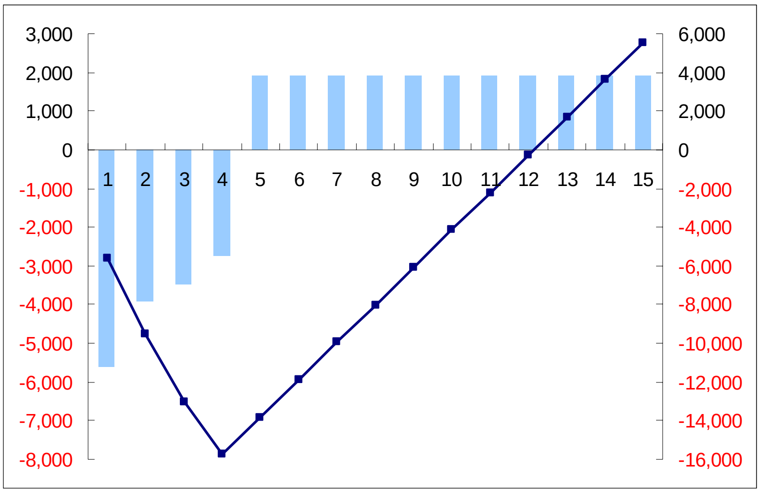
Table 9.4-2 Profit, Loss and ESCO Cash Flow of Client (Per Shower Unit)

(JPY)

Profit & Loss		current	1	2	3	4	5	6	7	8	9	10
	total energy cost	6,529	4,048	4,048	4,048	4,048	4,048	4,048	4,048	4,048	4,048	4,048
revenue	**energy savings**	**0**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**
cost	ESCO fee		688	688	688	0	0	0	0	0	0	0
	equipment purchase		20,000	0	0	0	0	0	0	0	0	0
	loan interest		1,400	840	280	0	0	0	0	0	0	0
profit before tax			-19,607	953	1,513	2,481	2,481	2,481	2,481	2,481	2,481	2,481
corporate income tax			0	210	333	546	546	546	546	546	546	546
profit after tax			**-19,607**	**743**	**1,180**	**1,935**	**1,935**	**1,935**	**1,935**	**1,935**	**1,935**	**1,935**
Cash Flow			1	2	3	4	5	6	7	8	9	10
profit after tax			-19,607	743	1,180	1,935	1,935	1,935	1,935	1,935	1,935	1,935
grant (subsidy)			0									
debt increase / repayment			14,000	-4,667	-4,667	-4,667	0	0	0	0	0	0
equity cash flow			**-5,607**	**-3,923**	**-3,487**	**-2,731**	**1,935**	**1,935**	**1,935**	**1,935**	**1,935**	**1,935**
accumulative cash flow			**-5,607**	**-9,530**	**-13,017**	**-15,748**	**-13,813**	**-11,878**	**-9,942**	**-8,007**	**-6,072**	**-4,136**

(JPY)

Profit & Loss		11	12	13	14	15
	total energy cost	4,048	4,048	4,048	4,048	4,048
revenue	**energy savings**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**
cost	ESCO fee	0	0	0	0	0
	equipment purchas	0	0	0	0	0
	loan interest	0	0	0	0	0
profit before tax		2,481	2,481	2,481	2,481	2,481
corporate income tax		546	546	546	546	546
profit after tax		**1,935**	**1,935**	**1,935**	**1,935**	**1,935**
Cash Flow		11	12	13	14	15
profit after tax		1,935	1,935	1,935	1,935	1,935
grant (subsidy)						
debt increase / repayment		0	0	0	0	0
equity cash flow		**1,935**	**1,935**	**1,935**	**1,935**	**1,935**
accumulative cash flow		**-2,201**	**-266**	**1,670**	**3,605**	**5,540**



Bar Graph: Cash Flow of Each Year (Left Axis)

Line Graph: Accumulated Cash Flow (Right Axis)

Unit: JPY

Figure 9.4-1 Client ESCO Cash Flow (Business Year/Accumulated)

(2) Estimation based on Financial Assistance

Based on the estimation in the scenario where client's bank loan is support by such preferential terms as low-interest loan, partial waiver of interest or subsidy, measures are to be discussed on how to improve profitability.

i) Preferential Interest Rate

Followings are the estimated ESCO cash flow of client after the application of preferential interest rate of 6% through such financial assistance as low-interest rate loan or partial waiver of interest from the prevailing domestic loan rate of 10% and above in Vietnam. Other conditions remain unchanged from the base case scenario.

Finance Terms and Conditions (Preferential Interest Scenario)

Particulars	Terms and Conditions
Client's Payment	30% of Initial Costs (Equipments and Installation)
Client's Bank Loan	70% of Initial Costs (Equipments and Installation)
Repayment Period	3-Year Equal Repayment
Bank Loan Ratio	**6%**

* Underscored is the difference from the base case scenario.

It turned out from the estimation that under the scenario where loan is available at a half rate of the prevailing loan interest, equity IRR stands at 5.1% and accumulated cash flow turns positive in the 12th year both of which evidence slight improvement in client's profitability.

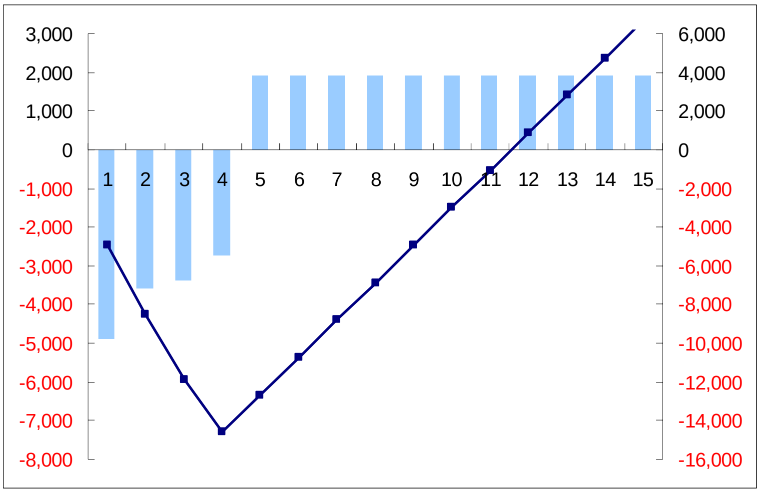
Table 9.4-3 Profit, Loss and ESCO Cash Flow of Client (Per Shower Unit)

(JPY)

Profit & Loss		current	1	2	3	4	5	6	7	8	9	10
	total energy cost	6,529	4,048	4,048	4,048	4,048	4,048	4,048	4,048	4,048	4,048	4,048
revenue	**energy savings**	**0**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**
cost	ESCO fee		688	688	688	0	0	0	0	0	0	0
	equipment purchase		20,000	0	0	0	0	0	0	0	0	0
	loan interest		700	420	140	0	0	0	0	0	0	0
profit before tax			-18,907	1,373	1,653	2,481	2,481	2,481	2,481	2,481	2,481	2,481
corporate income tax			0	302	364	546	546	546	546	546	546	546
profit after tax			**-18,907**	**1,071**	**1,289**	**1,935**	**1,935**	**1,935**	**1,935**	**1,935**	**1,935**	**1,935**

Cash Flow	1	2	3	4	5	6	7	8	9	10
profit after tax	-18,907	1,071	1,289	1,935	1,935	1,935	1,935	1,935	1,935	1,935
grant (subsidy)	0									
debt increase / repayment	14,000	-4,667	-4,667	-4,667	0	0	0	0	0	0
equity cash flow	**-4,907**	**-3,596**	**-3,377**	**-2,731**	**1,935**	**1,935**	**1,935**	**1,935**	**1,935**	**1,935**
accumulative cash flow	**-4,907**	**-8,503**	**-11,880**	**-14,611**	**-12,676**	**-10,741**	**-8,805**	**-6,870**	**-4,935**	**-2,999**

		11	12	13	14	15
						(JPY)
Profit & Loss		11	12	13	14	15
	total energy cost	4,048	4,048	4,048	4,048	4,048
revenue	**energy savings**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**
cost	ESCO fee	0	0	0	0	0
	equipment purchas	0	0	0	0	0
	loan interest	0	0	0	0	0
profit before tax		2,481	2,481	2,481	2,481	2,481
corporate income tax		546	546	546	546	546
profit after tax		**1,935**	**1,935**	**1,935**	**1,935**	**1,935**
Cash Flow		11	12	13	14	15
profit after tax		1,935	1,935	1,935	1,935	1,935
grant (subsidy)						
debt increase / repayment		0	0	0	0	0
equity cash flow		**1,935**	**1,935**	**1,935**	**1,935**	**1,935**
accumulative cash flow		**-1,064**	**871**	**2,807**	**4,742**	**6,677**



Bar Graph: Cash Flow of Each Year (Left Axis)

Line Graph: Accumulated Cash Flow (Right Axis)

Unit: JPY

Figure 9.4-2 Client ESCO Cash Flow (Business Year/Accumulated)

ii) Initial Cost Subsidy

Below is the estimation in the scenario where 30% of the initial costs are subsidized and bank borrowing is lowered from 70% to 40% while interest rates and other terms and conditions remain unchanged from the base case scenario.

Finance Terms and Conditions (Initial Cost Subsidy Scenario)

Particulars	Terms and Conditions
Client's Payment	30% of Initial Costs (Equipments and Installation)
Client's Bank Loan	40% of Initial Costs (Equipments and Installation)
Repayment Period	3-Year Equal Repayment
Bank Loan Ratio	12%
Subsidy Ratio	30% of Initial Costs (Equipments and Installation)

* Underscored is the difference from the base case scenario.

With the subsidy covering 30% of the initial investment, equity IRR significantly increases to 12.1%. There is a great leap from the base case scenario as accumulated cash flow turns positive in the 9th year. However a period of 9 years to break even is generally deemed unaccepTable in making investment decision.

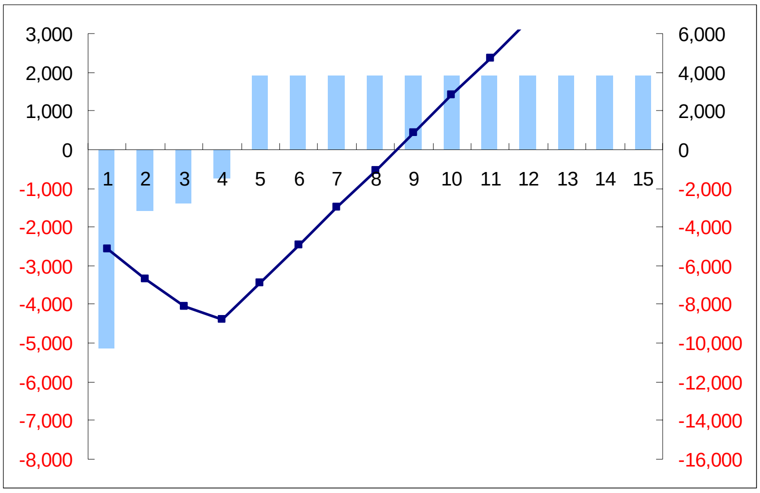
Table 9.4-4 Profit, Loss and ESCO Cash Flow of Client (Per Shower Unit)

(JPY)

Profit & Loss		current	1	2	3	4	5	6	7	8	9	10
	total energy cost	6,529	4,048	4,048	4,048	4,048	4,048	4,048	4,048	4,048	4,048	4,048
revenue	**energy savings**	**0**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**
cost	ESCO fee		688	688	688	0	0	0	0	0	0	0
	equipment purchase		20,000	0	0	0	0	0	0	0	0	0
	loan interest		800	480	160	0	0	0	0	0	0	0
profit before tax			-19,007	1,313	1,633	2,481	2,481	2,481	2,481	2,481	2,481	2,481
corporate income tax			0	289	359	546	546	546	546	546	546	546
profit after tax			**-19,007**	**1,024**	**1,274**	**1,935**	**1,935**	**1,935**	**1,935**	**1,935**	**1,935**	**1,935**
Cash Flow			1	2	3	4	5	6	7	8	9	10
profit after tax			-19,007	1,024	1,274	1,935	1,935	1,935	1,935	1,935	1,935	1,935
grant (subsidy)			6,000									
debt increase / repayment			8,000	-2,667	-2,667	-2,667	0	0	0	0	0	0
equity cash flow			**-5,007**	**-1,643**	**-1,393**	**-731**	**1,935**	**1,935**	**1,935**	**1,935**	**1,935**	**1,935**
accumulative cash flow			**-5,007**	**-6,650**	**-8,043**	**-8,774**	**-6,839**	**-4,903**	**-2,968**	**-1,033**	**903**	**2,838**

(JPY)

Profit & Loss		11	12	13	14	15
	total energy cost	4,048	4,048	4,048	4,048	4,048
revenue	**energy savings**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**
cost	ESCO fee	0	0	0	0	0
	equipment purchas	0	0	0	0	0
	loan interest	0	0	0	0	0
profit before tax		2,481	2,481	2,481	2,481	2,481
corporate income tax		546	546	546	546	546
profit after tax		**1,935**	**1,935**	**1,935**	**1,935**	**1,935**
Cash Flow		11	12	13	14	15
profit after tax		1,935	1,935	1,935	1,935	1,935
grant (subsidy)						
debt increase / repayment		0	0	0	0	0
equity cash flow		**1,935**	**1,935**	**1,935**	**1,935**	**1,935**
accumulative cash flow		**4,773**	**6,709**	**8,644**	**10,579**	**12,515**



Bar Graph: Cash Flow of Each Year (Left Axis)

Line Graph: Accumulated Cash Flow (Right Axis)

Unit: JPY

Figure 9.4-3 Client ESCO Cash Flow (Business Year/Accumulated)

iii) Initial Cost Subsidy + Preferential Interest Rate

Bearing in mind the fact that investment shall be recovered within 5 years at the longest in developing economies, percentage of subsidy required to turn around the accumulated cash flow within 5 years is estimated to be 60% of the initial costs as follows. Below is based on the preferential interest rate of 6% and equity IRR of 29.2%.

Finance Terms and Conditions (Initial Cost Subsidy + Preferential Interest Rate Scenario)

Particulars	Terms and Conditions
Client's Payment	30% of Initial Costs (Equipments and Installation)
Client's Bank Loan	11% of Initial Costs (Equipments and Installation)
Repayment Period	3-Year Equal Repayment
Bank Loan Rate	6%
Subsidy Ratio	59% of Initial Costs (Equipments and Installation)

* Underscored is the difference from the base case scenario.

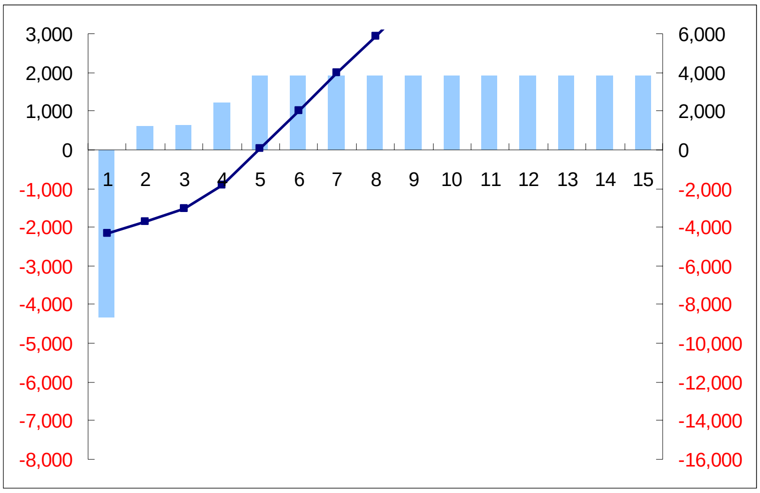
Table 9.4-5 Profit, Loss and ESCO Cash Flow of Client (Per Shower Unit)

(JPY)

Profit & Loss		current	1	2	3	4	5	6	7	8	9	10
	total energy cost	6,529	4,048	4,048	4,048	4,048	4,048	4,048	4,048	4,048	4,048	4,048
revenue	**energy savings**	**0**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**
cost	ESCO fee		688	688	688	0	0	0	0	0	0	0
	equipment purchase		20,000	0	0	0	0	0	0	0	0	0
	loan interest		110	66	22	0	0	0	0	0	0	0
profit before tax			-18,317	1,727	1,771	2,481	2,481	2,481	2,481	2,481	2,481	2,481
corporate income tax			0	380	390	546	546	546	546	546	546	546
profit after tax			**-18,317**	**1,347**	**1,381**	**1,935**	**1,935**	**1,935**	**1,935**	**1,935**	**1,935**	**1,935**
Cash Flow			1	2	3	4	5	6	7	8	9	10
profit after tax			-18,317	1,347	1,381	1,935	1,935	1,935	1,935	1,935	1,935	1,935
grant (subsidy)			11,800									
debt increase / repayment			2,200	-733	-733	-733	0	0	0	0	0	0
equity cash flow			**-4,317**	**614**	**648**	**1,202**	**1,935**	**1,935**	**1,935**	**1,935**	**1,935**	**1,935**
accumulative cash flow			**-4,317**	**-3,703**	**-3,055**	**-1,853**	**82**	**2,017**	**3,953**	**5,888**	**7,823**	**9,759**

(JPY)

Profit & Loss		11	12	13	14	15
	total energy cost	4,048	4,048	4,048	4,048	4,048
revenue	**energy savings**	**2,481**	**2,481**	**2,481**	**2,481**	**2,481**
cost	ESCO fee	0	0	0	0	0
	equipment purchas	0	0	0	0	0
	loan interest	0	0	0	0	0
profit before tax		2,481	2,481	2,481	2,481	2,481
corporate income tax		546	546	546	546	546
profit after tax		**1,935**	**1,935**	**1,935**	**1,935**	**1,935**
Cash Flow		11	12	13	14	15
profit after tax		1,935	1,935	1,935	1,935	1,935
grant (subsidy)						
debt increase / repayment		0	0	0	0	0
equity cash flow		**1,935**	**1,935**	**1,935**	**1,935**	**1,935**
accumulative cash flow		**11,694**	**13,629**	**15,565**	**17,500**	**19,435**



Bar Graph: Cash Flow of Each Year (Left Axis)

Line Graph: Accumulated Cash Flow (Right Axis)

Unit: JPY

Figure 9.4-4 Client ESCO Cash Flow (Business Year/Accumulated)

(3) Potential of ESCO for Water-Saving Equipments

Followings show the improvement of profitability in the base case scenario upon application of ESCO for the installation of water-saving shower as well as various financial supports.

Table 9.4-6 Improvement of Profitability of Water-Saving Shower by Form of Assistance

Benchmark	Base Case	Form of Assistance		
		Preferential Interest Rate	Subsidy (30%)	Subsidy (60%) + Preferential Interest Rate
PL Turnaround	2nd Year	2nd Year	2nd Year	2nd Year
Single BY CF Turnaround	5th Year	5th Year	5th Year	2nd Year
Accumulated CF Turnaround	13th Year	12th Year	9th Year	5th Year
Equity IRR	4.3%	5.1%	12.1%	29.2%

* PL: Profit and Loss Statement *CF: Cash Flow

The study above is focused only on investment payout from fuel and electricity saving. However given the nature of product, other non-energy saving factors are also considered in the actual choice of toilet or shower. Therefore it is not appropriate to assess the benefit of each equipment solely based on the payout period but a subsidy of around 60% of the initial investment is generally required for shower to be eligible for choice in a payout project through energy-saving. In case of commercial facilities including hotels, ESCO proposal based on the combination of such facilities as expensive commercial boilers and heat pumps will be promising where a great deal of energy-saving effect is expected.