Environmental Programs Implemented by Water Utilities in Japan

JWRC Study Group for International Comparison of Water Supply Services

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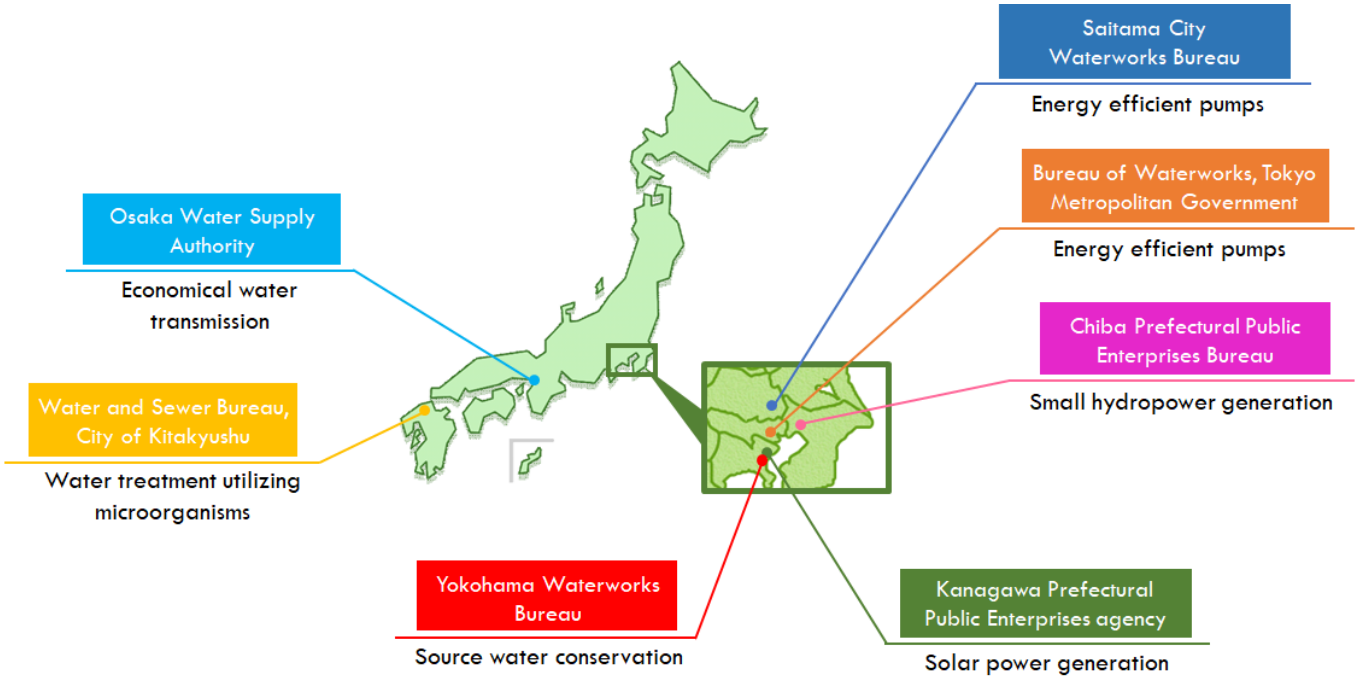
Contents

About this document

This document aims to present information on various environmental programs implemented by Japanese water utilities. It was compiled by the Study Group for International Comparison of Water Supply Services (Secretariat: Japan Water Research Center), and the information presented within was provided by the seven water utilities in Japan, that are also members of the Study Group.

Water utilities and environmental programs presented

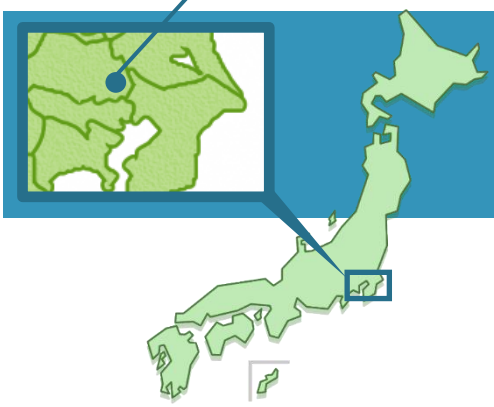
The map below shows the name of the seven water utilities and their environmental programs presented in this document. Please note that although only one type of program is presented per utility, any of them has implemented different environmental programs not presented in this report.



Environmental program at each water utility

Environmental programs implemented at each water utility are presented in the following pages.

Saitama City Waterworks Bureau



Inverter Pumps to Reduce Energy and CO2 Emission

Water Utility

Saitama City Waterworks Bureau

Type of Water Supply

Retail water supply (public)

Population Served

1.29 million (FY2017)

Service Area

217.43 km² (FY2017)

Environmental Program

Inverter pump

Outcome

- Improved distribution control
- Reduced energy consumption and CO_2 emission

Background/Outline

The electricity consumption involving Saitama City's water supply costs JPY 3.71 per cubic meter. This number is relatively small among the largest water utilities in Japan, yet due to its rather plain terrain in the service area, water must be pumped for distribution and that results in a large amount of electricity consumption and CO_2 emission.

Given the situation, the city has been replacing the pumps with those with inverter motors to reduce the energy involved in distribution.

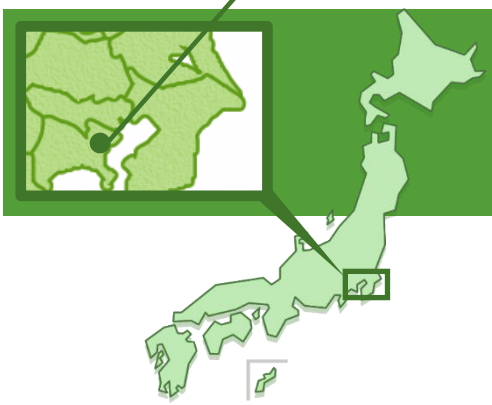
Program/Outcome

The city has been replacing five pumps per year. Of the 89 pumps now in service (breakdown: 25 at water treatment plants and 64 at distribution reservoirs), 61 pumps have been replaced with inverter types by FY2017. Through the replacement program, the city has promoted a more efficient water management by reducing the energy consumption required for water distribution. The table below shows the CO_2 reduction at three distribution reservoirs as a result of the pump replacement program.

Estimated CO_2 reduction from adopting inverter pumps

Name of distribution reservoir	Number of pumps	Estimated CO_2 reduction (t) per year
Shirahata	6	242
Minami Shimoarai	5	207
Omagi	4	69

Kanagawa Prefectural Public Enterprises Agency



Solar Power Generation Utilizing Facility Space Efficiently

Water Utility

Kanagawa Prefectural Public Enterprises Agency

Type of Water Supply

Retail water supply (public)

Population Served

2.8 million (FY2017)

Service Area

809 km^2 (FY2017)

Environmental Program

Solar power generation

Outcome

- Making the best of available facility space
- Reduced CO_2 emission

Background/Outline

The Agency had put covers over the filtration basins and other structures at its Samukawa Water Treatment Plant to prevent potential water contamination by foreign substances. In FY2004, they installed a solar power generation system on top of these covers by utilizing the available space efficiently.

Program/Outcome

The solar power generation system, which can produce power of 120 kW, started operation in February 2005. The covers on which the solar panels are placed are arch-shaped and movable, and made of fiber reinforced plastics, which are light and very good in strength. All the power produced from the system is consumed at Samukawa Water Treatment Plant.

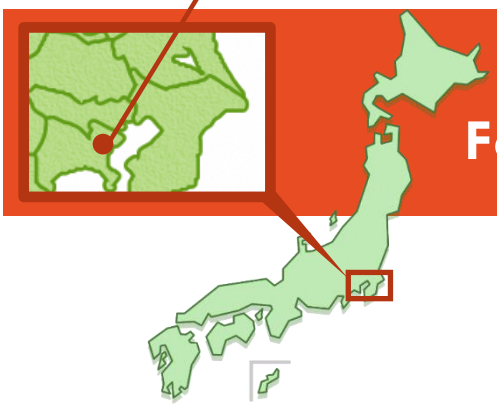
For general visitors to the plant, the Agency has installed electronic panels showing in real-time the amount of power being produced from the system. This is a public relations effort to show the Agency's environmental consciousness and to raise public awareness about solar power generation. The construction cost of the system was subsidized by central government through its new energy use promotion program.

In FY2017, the solar power system reduced approximately 48,000 kg of CO_2 emission and the amount of power generated from the system was around 98,000 kWh, which corresponds to the power use at about 26 residential houses.

Another solar power generation system is installed at some water related facilities just outside of the Samukawa plant's premises. Their generated power is sold to a local electronic company.

Solar power generation system on the rooftop of a water treatment plant

Yokohama Waterworks Bureau



Management of Water Resource Forest and Water Source Protection

Water Utility

Yokohama Waterworks Bureau

Type of Water Supply

Retail water supply (public)

Population Served

3.7 million (FY2017)

Service Area

436 km^2 (FY2017)

Environmental Program

Water source protection

Outcome

- Improved water recharge function of a forest
- Water quality protection of a river
- CO_2 reduction

Background/Outline

In 1916, Yokohama City purchased from Yamanashi Prefecture what is now known as "Doshi Water Resource Forest", a forest area where one of Yokohama's water supply sources, Doshi River, begins. The purchase was made to protect and conserve the river's water quality. As of 2019, the Doshi Water Resource Forest stretches 2,873 hectares of land and comprises 36% of Doshi Village, which is located approximately 55 km west of Yokohama City.

Doshi River

Program/Outcome

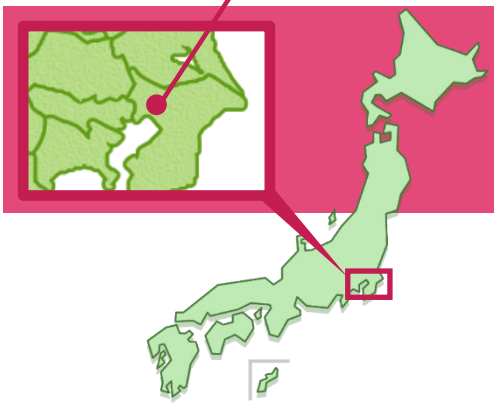
Soil protection is a key to forest conservation. The Doshi forest has many different types of trees, and accumulated fallen leaves help its soils keep high water holding capacity, which enriches the source water. Therefore, the city has regularly thinned out conifers such as cedars and cypresses and kept the forest mixed with both conifers (needle-leaved trees) and broad-leaved trees.

On the other hand, approximately 60% of the forest area that the city does not own had not been managed as well as it would have been desired, having raised concern over the forest's water recharge function being adversely affected. This led the city to initiate a special volunteer program in 2004, and to this day as many as 17,000 volunteers have helped conserve 70 hectares of the privately-owned portion of the Doshi forest. To support volunteer activities, the city created a fund in 2006 to receive donations from citizens and private companies and to relocate some of the revenues generated from selling its official bottled water.

The city and Doshi Village have also co-founded another fund to help with the conservation efforts and to stimulate local economies in Doshi area. Other conservations efforts by the city include financial support to Doshi Village for treating its residential wastewater and a collaborative conservation program for the Doshi forest in cooperation with private companies and other stakeholders.

Volunteers thinning out trees

Chiba Prefectural Public Enterprises Bureau



Hydropower Covers 2.3% of Entire Energy Requirements

Water Utility

Chiba Prefectural Public Enterprises Bureau

Type of Water Supply

Retail water supply (public)

Population Served

3.03 million (as of March 2018)

Service Area

566 km^2 (as of March 2018)

Environmental Program

Small hydropower generation

Outcome

CO_2 reduction

Background/Outline

The Waterworks of Chiba Prefectural Public Enterprises Bureau installed small hydropower generators on the Makuhari Pump Station (Chiba City) and the Myoden Pump Station (Ichikawa City) in 2008. This is an effort to reduce the electricity required to operate the two stations. Two more generators were also installed in 2014 on the Kita-Funabashi Pump Station (Funabashi City).

Hydropower generator at the Makuhari Pump Station

Program/Outcome

The hydropower generation program is cooperated by the Waterworks, which has provided hydro energy, and The Tokyo Electric Generation Company, which has built and operated relevant power plants. The electricity generated from the program is supplied to the pump stations where the generators were installed.

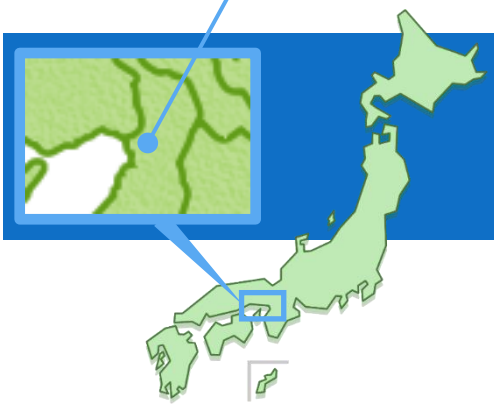
The annual amount of energy produced from the three pump stations is approximately 3.3 million kWh, which accounts for 2.3% of the annual electricity consumption by the Waterworks. In total, the hydropower generation contributes to approximately 1,600 t of CO_2 reduction a year.

CO_2 reduction from the hydropower generation

Pump station	Output (kW)	Annual power generation (kWh)	Annual reduction in CO_2 (t)
Makuhari	350 kW	1.37 million kWh[*1]	666 t
Myoden	300 kW	1.05 million kWh[*2]	510 t
Kita-Funabashi	235 kW	0.92 million kWh[*3]	447 t

* Equal to the consumption of 380[*1], 290[*2], or 260[*3] households.

Osaka Water Supply Authority



Economical Water Transmission Based on Demand Estimation

Water Utility

Osaka Water Supply Authority

Type of Water Supply

- Wholesale water supply (public)
- Retail water supply (public)

Population Serviced

6.1 million (FY2016)

Service Area

1,680 km^2 (FY2015)

Environmental Program

Efficient water management

Outcome

- Control of water pressure fluctuation
- Cost reduction for electricity consumption
- Reduction of contracted electricity rates

Background/Outline

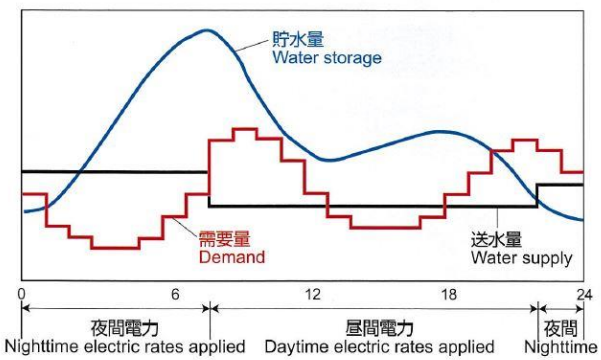
The Water Transmission Management Center of the Authority has stably operated and monitored its pumping stations for water transmission. This has been enabled by a prompt and accurate analysis of various facilities' operational data through the use of wireless data transmission units, supervisory control devices, and other IT equipment. Also, the Center has operated in a financially economical manner by increasing the amount of transmission during evening hours and thus taking advantage of cheaper night tariffs of electricity.

Program/Outcome

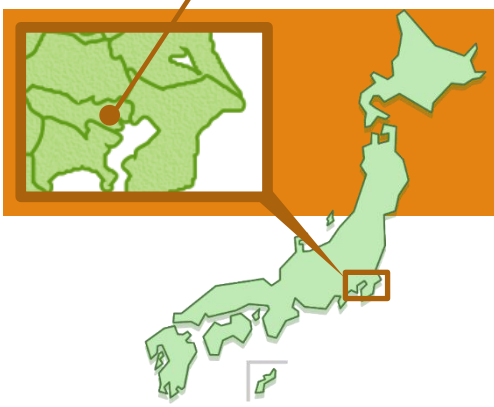
Normally, the operation of transmission pumps requires a large amount of electricity. The Center has estimated daily water demand based on various indicators including historic demands, weather patters, days of the week, air temperature, and utilizes the estimates for efficient and economical water transmission. More specifically, they have transmitted water to clear water reservoirs during evening hours and using the stored water to meet the day time demand which is normally larger than that of night time. This enables the Center to not only reduce the electricity cost required to operate transmission pumps but to minimize the number of turning-on/ff of the pumps and thus better control water pressure fluctuations and stabilize the amount of transmission, all of which contribute to an ecnomical and reliable water supply.

In case there are multiple routes for transmission, they calculate how much each route would cost based on the characteristics of relevant transmission pipes and pumping stations, and take the calculation results into consideration in order to operate in the most efficient way possible.

Example of estimated daily water demand



Bureau of Waterworks, Tokyo Metropolitan Government



Energy Efficient Pump Cut 20% of Electricity Use

Water Utility

Bureau of Waterworks, Tokyo Metropolitan Government

Type of Water Supply

Retail water supply (public)

Population Served

13.4 million (FY2017)

Service Area

1239.27 km^2 (FY2017)

Environmental Program

Energy efficient pump

Outcome

Reduced electricity consumption

Background/Outline

The amount and pressure of water distributed from water treatment plants and water supply stations are normally controlled by adjusting pump speed. Traditionally, Tokyo Metropolitan Government has used liquid resistors to adjust pump speed, but because their energy efficiency drops in the low speed range, the utility has been replacing aged pumps with more energy efficient ones such as those with inverter controls. This way, the utility has reduced the amount of electricity required to operate pumps.

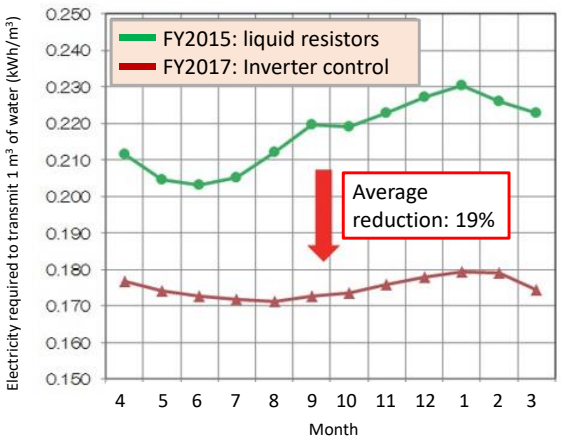
Distribution pump at Kamiigusa Water Supply Station

Program/Outcome

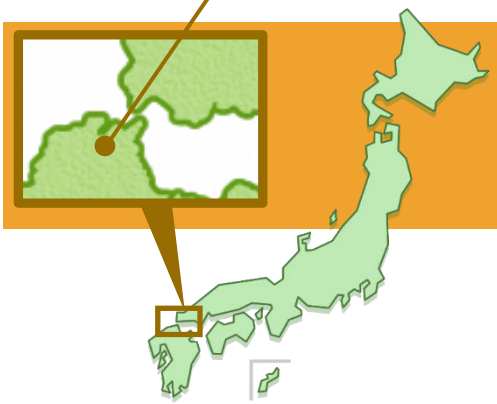
The 2nd Inagi Pump Station, built in 1980 in the southern part of Tokyo, is a water transmission facility to send water up to water supply stations located on high land from water treatment plants located on low land.

When the pump station underwent a facility renewal in 2016, the utility replaced the existing pumps with new ones of inverter controls in order to raise energy efficiency. After the replacement, the amount of electricity required to transmit one cubic meter of water was reduced by 19%. The graph below compares the electricity requirements before and after the pump replacement.

Energy reduction before and after pump replacement at the 2nd Inagi Pump Station



Water and Sewer Bureau, City of Kitakyushu



Water Treatment Utilizing Microorganisms

Water Utility

Water and Sewer Bureau, City of Kitakyushu

Type of Water Supply

- Retail water supply (public)
- Wholesale water supply (public)

Population Served

1.0 million (FY2017)

Service Area

270.16 km^2 (FY2017)

Environmental Program

Upward Biological Contact Filtration System (U-BCF)

Outcome

- Reduced chemical use
- Improved stability of water treatment
- Removed pollutants and odor

Background/Outline

The water quality of Onga River, the city's primary water source, has been adversely affected by the urbanization occurring in upstream regions. Increased pollutants due to the wastewater have resulted in algae bloom and intensified musty odor.

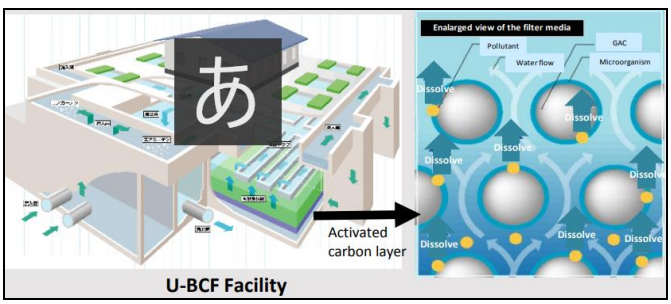
These pollutants and musty odor are difficult to remove by the traditional water treatment process, hence City of Kitakyushu has developed an original counter measure called Upward Biological Contact Filtration System (U-BCF) and installed that system at its Honjyo Water Treatment Plant in 2000 and Ano Water Treatment Plant in 2003. The U-BCF can be installed easily as it can be installed at the beginning of existing water treamtnet processes.

City of Kitakyushu has activeily promoted the U-BCF outside of Japan, and in 2013 the Haiphong Water Supply One Member Company Limited - the water utility supplying Haiphong City in Vietnam - installed a U-BCF at their Vinh Bao Water Treatment Plant.

Program/Outcome

The core function of the U-BCF is to artificially reproduce - in a more efficient manner - a natural environment in which aquatic microorganisms decompose micropollutants. The U-BCF uses granular activated carbon as filter media, and due to its porus, rugged, uneven surfaces, the granular activated carbon provides a much better environment for microorganizams to live in, than, for example, pebbles in a riverbed. The U-BCF's upward water flows prevent the filter layers from getting clogged while making the granular activated carbon being moved by the flow and contact with much more water, enhancing the decomposition process by microorganisms.

The U-BCF can remove, without using chemicals or large electircity, ammonia nitrogen, dissolved manganese, and musty-odor causing substances like geosmin existing in raw water. This feature contributed to less chemical use and more stable treatment process at the existing process.



U-BCF Facility

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JWRC
Japan Water Research Center

T +81-3-5805-0264
W www.jwrc-net.or.jp/english/index.html
A K.I.S Iidabashi Bldg. 7F, 2-3-28 Koraku, Bunkyo-ku, Tokyo 112-0004 Japan