Smart Energy and Reclaimed Water Systems of Hokubu Sewerage Center in Yokohama

10th June 2015
Toshiaki YOSHIDA
Mikio TAKANO
Haruhiko KUMAGAI
Environmental Planning Bureau
City of Yokohama, Japan
Contents

- About Hokubu Sewerage Center
- Energy recovery from digestion gas
- Digestion gas generation
- Integrated power system and FIT
- Solar power generation
- Reclaimed water system
- At the end
Contents

• About Hokubu Sewerage Center
• Energy recovery from digestion gas
• Digestion gas generation
• Integrated power system and FIT
• Solar power generation
• Reclaimed water system
• At the end
Yokohama City

City Information

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Area</td>
<td>435 km²</td>
</tr>
<tr>
<td>Population</td>
<td>3.69 million</td>
</tr>
<tr>
<td>Household</td>
<td>1.6 million</td>
</tr>
</tbody>
</table>
# Current State of Sewage Works

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>City Population (A)</td>
<td>3.69mil.</td>
</tr>
<tr>
<td>Sewered Population (B)</td>
<td>3.68mil.</td>
</tr>
<tr>
<td>Sewerage Service Rate (B/A)</td>
<td>99.8%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated Wastewater</td>
<td>1.6mil.m³/day</td>
</tr>
<tr>
<td>Treatment District</td>
<td>9</td>
</tr>
<tr>
<td>Wastewater Treatment Plant</td>
<td>11</td>
</tr>
<tr>
<td>Sludge Treatment Center</td>
<td>2</td>
</tr>
<tr>
<td>Pumping Station</td>
<td>26</td>
</tr>
<tr>
<td>Total Sewer Length</td>
<td>11,600 km</td>
</tr>
</tbody>
</table>
Flow of Wastewater Treatment

Activated Sludge Process

Grit Tank / Pump Facility → Primary Sedimentation Tank → Final Sedimentation Tank → Disinfection Facility

Reaction Tank

Primary Sludge and Excess Sludge

Sludge Treatment (digestion, dewatering, incineration, etc.)

Effluent into rivers/ocean

Wastewater Treatment Plant

Sewerage System

Collecting Pipes
Centralized Sludge Treatment System in Yokohama City

Generated Sludge at 11 WTPs is transported to 2 STCs and treated.
Process of Sludge Treatment

Thickening
Concentrates and thickens sludge mechanically in order to improve digestion efficiency.

Digestion
Biological decomposition of the organic substances. Digestion gas is produced.

Dehydration
Removes water from sludge and produces dewatered sludge cake.

Incineration
Stabilizes its property by incineration and reduces the volume.
Contents

• About Hokubu Sewerage Center
• Energy recovery from digestion gas
• Digestion gas generation
• Integrated power system and FIT
• Solar power generation
• Reclaimed water system
• At the end
Flow of Digestion Gas

- Gas Power Generator
- Gas Power Generator Facility
- Digestion Gas
- Digestion Tank
- Desulfurization System
- Gas Compressor
- Low Pressure Gas Holder
- Moderate-Pressure Gas holder
- Incinerator
Composition of Digestion Gas

- **CH₄**: 60%
- **CO₂**: 35%
- **Others**: 5%
Quantity of Heat [/m³]

<table>
<thead>
<tr>
<th>Gas Type</th>
<th>Quantity of Heat [/m³]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Town Gas</td>
<td>46 MJ/m³</td>
</tr>
<tr>
<td>Digestion Gas</td>
<td>25 MJ/m³</td>
</tr>
</tbody>
</table>

- Utilize:
  - Generator (Electric Power)
  - Incinerator (supplemental fuel)
Contents

• About Hokubu Sewerage Center
• Energy recovery from digestion gas
• Digestion gas generation
• Integrated power system and FIT
• Solar power generation
• Reclaimed water system
• At the end
Scheme of Digestion Gas Generation Project

**Project summary:**  SPC replaced existing biogas engine system with highly efficient one and has been managed operation and maintenance of the system after ownership transfer (Build-Transfer-Operate)

**Operation/Maintenance Period:**  20 years (until March 31\textsuperscript{st}, 2030)

**Concession Agreement:**  Private Finance Initiative (PFI) Project
Yokohama city purchases electric power and hot water produced by gas engine using biogas which is supplied to the SPC by Yokohama city without compensation.

<table>
<thead>
<tr>
<th>NOx Reduction for Emission</th>
<th>Lean burn and catalytic reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Power Generation</td>
<td>900 kW</td>
</tr>
<tr>
<td>Gas Consumption</td>
<td>378 Nm3/h</td>
</tr>
<tr>
<td>Recovered Heat</td>
<td>804 kW as hot water</td>
</tr>
</tbody>
</table>
Scheme of Digestion Gas Generation Project

The city of YOKOHAMA
- Wastewater Treatment Plant
- Sludge Treatment Plant
- Digester
- Gas Holder

PFI Business Operator
- Electricity & Heat Supply
- Payment of the charge
- Digestion Gas Generation System

- Digester
- Sludge Treatment Plant
- Gas Holder

Giving license to business operator
Checking of business operator’s management

Financing, Renewal of the system and O&M
Contents

• About Hokubu Sewerage Center
• Energy recovery from digestion gas
• Digestion gas generation
• Integrated power system and FIT
• Solar power generation
• Reclaimed water system
• At the end
Transmission line of power company

66[kV]

VCT

Power selling

No.1TR
10,000[kVA]
66[kV]/6.3[kV]

No.2TR
10,000[kVA]
66[kV]/6.3[kV]

Hokubu-Daini WWTP

Hokubu Sludge Treatment Plant

Tsurumi Garbage Incineration Plant

Steam turbine power generation facility

22,000[kW]

Digestion gas power generation facilities

900[kW] × 5

1,100[kW] × 1

Power selling

Power generation
Feed-In Tariff Law for Renewable Electric Energy

- Solar energy
- Wind energy
- Water energy
- Biomass energy
- Geothermal energy

- Sell electric power
- Buy electric power
- Supply electric power
- Surcharge

Power company

- Government
- User

Self-generated electric power
Steam turbine power generation 77%

Digestion gas power generation 23%

The shortage

The inner use

(The shortage)

The surplus electric power

The inner use
Steam turbine power generation 77%

Digestion gas power generation 23%

The inner use

The shortage

23% over the surplus electric power

The surplus electric power

The inner use
Steam turbine power generation 77%

Digestion gas power generation 23%

The surplus electric power FIT is applied.

The inner use

The shortage

The surplus electric power

The inner use
Contents

- About Hokubu Sewerage Center
- Energy recovery from digestion gas
- Digestion gas generation
- Integrated power system and FIT
- Solar power generation
- Reclaimed water system
- At the end
Solar power generation facilities

- Solar panel
- Junction box
- Power conditioner
- Power company
- Electric room

Existing facilities
Only connected during emergencies.

- Industrial Power Panel board (For accidents)
- Industrial Power Panel board (Existing)
- Displaying device
Considerations for a location (First)
Considerations for a location （Decision）
Normality
Emergency power source

Electric transmission stop by blackouts

Transformer

Power conditioner

Displaying device

Actinometer

Thermometer

Power company

Emergency power source

Industrial power Panel board
Contents

• About Hokubu Sewerage Center
• Energy recovery from digestion gas
• Digestion gas generation
• Integrated power system and FIT
• Solar power generation
• Reclaimed water system
• At the end
Reclaimed water system

Biological treatment → Sand filtration → Public works contractors

Inner use
Reclaimed water supplying site
Contents

• About Hokubu Sewerage Center
• Energy recovery from digestion gas
• Digestion gas generation
• Integrated power system and FIT
• Solar power generation
• Reclaimed water system
• At the end
Scheme of Sewage Sludge Fuelization Project

The city of YOKOHAMA

- Digestion Tank
- Sludge Digestion
- Sludge Cake Dehydration
- Sludge Cake
- Wastewater Treatment Plant

PFI Business Operator

- Business contract
- Sludge Cake
- Payment of the charge
- Sludge Cake
- Fuel
- Thermal power plant

Carriage
Nocturnal View of Yokohama Harbor