JFE’s Holistic Approach for Waste Treatment

Hokubu Sludge Treatment Center, Yokohama

June, 2018
• Introduction of JFE Engineering

• WTE Technology (Incineration)

• WTE (Biogas/Sewage Sludge)

• Technology Comparison

• Business Structuring
JFE Group Structure

**JFE Holdings, Inc.** (est. 2002)

- **NKK**
  - Est. 1912
  - Est. 1951
  - JFE Holdings, Inc.
  - Equity-method affiliate

- **JFE Steel**
  - Net Sales (million $): 27,200
  - Employees: 44,400

- **JFE Shoji Trade**
  - Net Sales (million $): 9,300
  - Employees: 3,900

- **Japan Marine United**

- **JFE Engineering**
  - Net Sales (million $): 3,900
  - Employees: 9,300

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Global Network

**Europe**
- Duisburg (Germany)
- Rome (Italy)

**Asia & Oceania**
- Singapore
- Kuala Lumpur (Malaysia)
- Jakarta (Indonesia)
- Hanoi, Ho Chi Minh (Vietnam)
- Bangkok (Thailand)
- Yangon (Myanmar)
- Manila (Philippines)
- Delhi, Pune, Mumbai (India)
- Shanghai, Beijing (China)

**Middle East**
- Al Khobar (Saudi Arabia)

**America**
- Long Beach (USA)

CEO Mr. Oshita
Smart Infrastructure for Global Environment

JFE offers the world leading technology

Waste-to-Energy

Biogas (Sludge Treatment)

Waste Heat Recovery

Geothermal Power Plant
• Introduction of JFE Engineering

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• Technology Comparison

• Business Structuring
Total solution from EPC to O&M for Stoker furnace & Gasification

✔ No. 1 Market Share in Japan
✔ Possess both Stoker Furnace & Gasification technology

Market Share ('08-'17)

- JFE 24%
- Others 76%

Stoker Furnace  Gasification
Either technology is applied to 90% of WTE plant in Japan

Meguro WTE Plant
Kumamoto WTE Plant
Track Record in Japan

**EPC**

- 41,658.5t/d
- 366 Furnace
- (176 Plants)

**O&M**

- Operation: 79, Maintenance: 110

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Environmentally Conscious WTE in Tokyo

Completion: Nov 2015
Capacity: 500 tpd (250tpd×2 lines)
Power Gen.: 18.7 MW
Site Area: Approx. 15,000m²
Flue gas treat.: dry-type flue gas treatment system, bag filter, wet scrubber, deNOx reactor
Ignition Loss of Bottom Ash: ≤5%

<table>
<thead>
<tr>
<th>Design Calorific Value of Waste</th>
<th>Emission Performance</th>
<th>Regulatory Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. LHV</td>
<td>7,100 kJ/kg</td>
<td>1,700 kcal/kg</td>
</tr>
<tr>
<td>Ave. LHV</td>
<td>10,200 kJ/kg</td>
<td>2,400 kcal/kg</td>
</tr>
<tr>
<td>Max. LHV</td>
<td>14,300 kJ/kg</td>
<td>3,400 kcal/kg</td>
</tr>
<tr>
<td>HCl</td>
<td>10 ppm</td>
<td></td>
</tr>
<tr>
<td>DXN</td>
<td>0.1 ng-TEQ/Nm³</td>
<td></td>
</tr>
<tr>
<td>Hg</td>
<td>0.05 g/Nm³</td>
<td></td>
</tr>
</tbody>
</table>
Global Track Record

- EPC: 45,616.4t/d
- 134 Furnaces
- (81 Plants)

Europe: 63
Asia: 18

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First WTE in Myanmar

Counterpart: Yangon City Development Committee

Site: Mingalardon area, Yangon City, MYANMAR

Technology: Waste to Energy (WTE)
- Incinerator: 60ton/day
- Generator: 0.7MW

GHG Emission Reduction: 4,700t-CO₂/year

Facility Opening Ceremony on April 7th

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Expected GHG Emission Reductions

4,732 tCO$_2$/ year
(2,358 tCO$_2$ accounts for the energy-originated CO$_2$)

✓ The calculation is based on the condition of 60t of waste treated per day and operation of 310 days per year, 24 hours per day (operating ratio: 85%).
✓ The emission factor refers to the latest CDM project in Myanmar (0.8 tCO$_2$/MWh).
Superiority of JFE Hyper Stoker

Secondary Combustion Zone
- For unburned gas: Oxidation reaction
  \[ 2\text{CO} + \text{O}_2 \rightarrow 2\text{CO}_2 \]
- For combustion gas: Reduction reaction
  \[ \text{NO}_x + \text{NH}_3 \rightarrow \text{N}_2 + \text{H}_2\text{O} \]

Complete Combustion Achieved

Unburned gas
\[ \text{CO, H}_2, \text{NH}_3 \]

Intermediate ceiling

Drying Zone

Combustion and post-combustion Zone

Combustion gas
\[ \text{O}_2, \text{NO}_x, \text{CO}_2 \]
Anti-DIOXINs Technology

1. Dioxin reduction control
2. Inhibit Dioxin re-generation by quenching flue gas temp.
3. Dioxin removal by Activated Carbon
4. Dioxin decomposition by SCR

- Homogenizing wastes by Crane
- Sufficient capacity of waste pit
- Temp of Flue gas: ≥ 850 deg.C
- Time of Residence: ≥ 2 sec.
- Turbulence

Dioxin conc. < 0.1ng-TEQ/Nm³
Waste incinerators are identified in the **MINAMATA Convention** as one of the major industrial sources of mercury emissions.

**JFE’s High Efficiency Activated Carbon Absorber “Gas Clean DX”**

*Inlet: 65μg/m³*

*Outlet: below detection limit of 5μg/m³*
• Introduction of JFE Engineering
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• WTE (Biogas/Sewage Sludge)
• Technology Comparison
• Business Structuring
Discussions Purpose Only

Utilizing Sludge with ZERO Emission

**RESOURCE**

Dewatered Sludge

Organic Solid Waste

**Biogas Power Generation**

Digestion Tank

Digested Sludge

Gas Engine

**Biogas Power Generation**

Bio-fuel

4,000 kcal/kg

Fertilizer

Sludge Dryer

Sludge-to-Fuel (carbonization)

Bio-fuel

Cement

Sludge Incineration

Power
## Largest Sludge Biogas Power Generation

<table>
<thead>
<tr>
<th>Client</th>
<th>Yokohama City</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>12,500 m³/day (wet sludge)</td>
</tr>
<tr>
<td>Output</td>
<td>4,500kW (900kW x 5)</td>
</tr>
<tr>
<td>Scheme</td>
<td>BTO (Build Transfer Operate)</td>
</tr>
<tr>
<td>O&amp;M</td>
<td>20 years</td>
</tr>
<tr>
<td>Remarks</td>
<td>CO2 reduction (588ton/day)</td>
</tr>
<tr>
<td></td>
<td>Volume reduction: 100%</td>
</tr>
</tbody>
</table>

**Diagram:**
- **Sewage Sludge** → **Digestion Tank** → **Biogas** → **Gas Engine** → **Electricity 80MWh/day**
- **Digested Sludge** → **Incinerator**
Multi Processing/Utilization in Bio-treatment in Nagaoka

Burnable Waste (Collect Separately)
- Food Waste
  - Diaper (65t/day)
- Non-Fermentable Waste (10t/d)
- Sorting Unit
- Incineration Plant

Methane gas 8,900m³/d
- Methane Level 60%

Deodorizing Unit
- Gas Holder
- Heat Emission
- Gas Engine Power Generator
  - Max 12,300kWh/d
- Electricity

Fermentation Tank
- Refuse-Derived Fuel (RDF)
- Electricity

Blending Tank
- Dehydration Unit
  - Drying Unit
  - Sludge 10t/d
  - Drain 500t/d

Sewage Plant
World’s First Multi-Bio Waste Treatment

<table>
<thead>
<tr>
<th>Client</th>
<th>Toyohashi City, Aichi Pref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>472 m³/d (sewage sludge) 59 t/d (kitchen waste)</td>
</tr>
<tr>
<td>Output</td>
<td>1,000 kW</td>
</tr>
<tr>
<td>Scheme</td>
<td>BTO</td>
</tr>
<tr>
<td>O&amp;M</td>
<td>20 years</td>
</tr>
<tr>
<td>GHG Reduction</td>
<td>3,900 CO₂-t/year</td>
</tr>
</tbody>
</table>

Sewage sludge: 351 m³/day
Human waste: 121 m³/day
Garbage: 59 tons/day

Methane fermentation
5,000 m³ x 2 units
Residue after fermentation

Biogas power generation
24,000 kWh/day
Conversion to fuel
Carbonized fuel
6 tons/day
**Food Waste Biogas Power Generation**

**Scheme**

- JR-East Group restaurant, food factory, etc.
- another food factory, etc.

**Location**
- Yokohama City

**Facility Area**
- 6,900m² (approx.)

**Capacity**
- 80t/d (max.), 1,800kw

**Power Generation**
- 11 mil. kWh/year
  - *equiv. 3,000 households*

**GHG Reduction**
- 5,500 t-Co2/year

**CAPEX**
- 3 bil. JPY (approx.)

**Operation Start**
- August 2018

**Electricity Recycle Co. (Biogas Plant)**

- **Gate Fee**
- **39 JPY/kWh**
  - (=35USc/kwh)

**Purpose**

- DISCUSSION PURPOSE ONLY

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• Introduction of JFE Engineering
• WTE Technology (Incineration)
• WTE (Biogas/Sewage Sludge)
• Technology Comparison
• Business Structuring
## Comparative assessment of WTE Technology

<table>
<thead>
<tr>
<th>Stoker</th>
<th>Fluidized bed</th>
<th>Gasifying and Direct Melting</th>
<th>Plasma Gasification</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="Image" alt="Stoker Fluidized bed Gasifying and Direct Melting Plasma Gasification" /></td>
<td><img src="Image" alt="Stoker Fluidized bed Gasifying and Direct Melting Plasma Gasification" /></td>
<td><img src="Image" alt="Stoker Fluidized bed Gasifying and Direct Melting Plasma Gasification" /></td>
<td><img src="Image" alt="Stoker Fluidized bed Gasifying and Direct Melting Plasma Gasification" /></td>
</tr>
</tbody>
</table>

- The conventional and reliable system in the world
- Large capacity of a furnace (400-500 t/d) is widespread.

- No movable part inside furnace
- Pretreatment is required for stable combustion.
- It is difficult to meet waste fluctuation due to rapid combustion.

- Slag can be utilized.
- Coke is necessary for ash melting.
- High GHG emission and High Operation cost due to coke usage.

- No commercial operation
- Slag can be utilized.
- Synthesis gas can be introduced to gas engine.
- Large amount of self electric consumption
## Comparative analysis of the solutions (1/3)

<table>
<thead>
<tr>
<th></th>
<th>Incineration and Power generation “WTE=Waste to Energy”</th>
<th>Non Incineration MBT (mechanical composting)</th>
<th>Bio-gasification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste to be treated</td>
<td>Municipal solid waste, industrial waste</td>
<td>Mainly for organic wastes such as kitchen wastes or night soil treatment residue</td>
<td>Mainly for organic wastes such as kitchen wastes or night soil treatment residue</td>
</tr>
<tr>
<td>Sorting and selections</td>
<td>Not necessary</td>
<td>Careful sorting and selection necessary</td>
<td>Careful sorting and selection necessary</td>
</tr>
<tr>
<td>Recoverable Resource</td>
<td>Electric power</td>
<td>Compost</td>
<td>Biogas (can be used as fuel)</td>
</tr>
<tr>
<td>Final residue</td>
<td>Bottom ash, fly ash</td>
<td>Residue after selection</td>
<td>Residue after selection</td>
</tr>
</tbody>
</table>

DISCUSSION PURPOSE ONLY

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### Comparative analysis of the solutions (2/3)

<table>
<thead>
<tr>
<th>Incineration and Power generation “WTE=Waste to Energy”</th>
<th>Non Incineration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Merit</strong></td>
<td></td>
</tr>
<tr>
<td>- It can treat various types of wastes</td>
<td></td>
</tr>
<tr>
<td>- flexibly adapt to waste characteristics changes</td>
<td></td>
</tr>
<tr>
<td>- Large amount of waste can be treated in large-scale plants</td>
<td></td>
</tr>
<tr>
<td>- Technology is mature as many plants have been constructed and operated</td>
<td></td>
</tr>
<tr>
<td>- The power for operation can be self-supplied</td>
<td></td>
</tr>
<tr>
<td>- Power generation efficiency can be improved by simple pre-treatment for some waste quality</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MBT (mechanical composting)</th>
<th>Bio-gasification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Merit</strong></td>
<td></td>
</tr>
<tr>
<td>- It can be introduced in a small scale</td>
<td></td>
</tr>
<tr>
<td>- treat wastes that are not adaptable for incineration such as those with high water content</td>
<td></td>
</tr>
<tr>
<td>- does not generate combustion exhaust gas</td>
<td></td>
</tr>
<tr>
<td>- If an independent facility for this technology is to be constructed, its CAPEX would be lower than incineration facility</td>
<td></td>
</tr>
</tbody>
</table>
### Comparative analysis of the solutions (3/3)

<table>
<thead>
<tr>
<th>Incineration and Power generation “WTE=Waste to Energy”</th>
<th>Non Incineration</th>
<th>Bio-gasification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demerit</strong></td>
<td><strong>MBT (mechanical composting)</strong></td>
<td><strong>Bio-gasification</strong></td>
</tr>
<tr>
<td>• If it is introduced in a small scale, the cost-effectiveness will lower</td>
<td>• Facility to treat residue after selection must also be constructed.</td>
<td>• Facility to treat residue after selection must also be constructed.</td>
</tr>
<tr>
<td>• Cost is relatively high</td>
<td>• If an independent facility for this technology is to be constructed, it must be equipped with odor prevention facilities.</td>
<td>• If an independent facility for this technology is to be constructed, it must be equipped with odor prevention facilities.</td>
</tr>
<tr>
<td></td>
<td>• Production of high-quality product will require high quality pre-treatment.</td>
<td>• Safe operation will require high-quality pre-treatment</td>
</tr>
<tr>
<td></td>
<td>• If an independent facility for this technology is to be constructed, as there would be no power generation facility, power would have to be purchased.</td>
<td>• If biogas is to be sold instead of electric power (as selling biogas is generally more profitable than selling electric power), the bio-gasification plant would have to purchase electric power for its operation</td>
</tr>
<tr>
<td></td>
<td>• The market price of compost will largely affect the revenue.</td>
<td></td>
</tr>
</tbody>
</table>
Introduction of JFE Engineering

WTE Technology (Incineration)

WTE (Biogas/Sewage Sludge)

Technology Comparison

Business Structuring
## Business Scheme of WTE in Japan

### Scheme Form

<table>
<thead>
<tr>
<th>Scheme</th>
<th>Public-build and Public-operate</th>
<th>DBO (Design Build Operation)</th>
<th>PFI (Private Finance Initiative)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Public</td>
<td>Public</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Public</td>
<td>Public</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Equity</td>
<td>Equity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subcontracting</td>
<td></td>
</tr>
</tbody>
</table>

### Division of Roles

<table>
<thead>
<tr>
<th></th>
<th>Public</th>
<th>Public</th>
<th>Public</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic planning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financing</td>
<td>Public</td>
<td>Public</td>
<td>Private</td>
</tr>
<tr>
<td>Design and Construction</td>
<td>Public</td>
<td>Public / Private</td>
<td>Private</td>
</tr>
<tr>
<td>Operation and Maintenance</td>
<td>Public</td>
<td>Private</td>
<td>Private</td>
</tr>
<tr>
<td>O&amp;M monitoring</td>
<td>—</td>
<td>Public</td>
<td>Public / Private</td>
</tr>
</tbody>
</table>

Source: Japan Environmental Facilities Manufacturers Association (JEFMA)
Business Structure (Nagaoka Biogas & Bio Fuel)

Nagaoka City

Lender: JFE Engineering

Concession Contract

Invest

SPC
Nagaoka Bio Cube

Repayment

Loan

Dividend

Consultant
Consultant Contract

Construction Contract

Design・Construction SV

JFE Engineering

Original Engineering

Construction JV

Construction JV

JFE Engineering

Echigo Kotsu Kogyo

O&M Contract

O&M JV

JFE Engineering

Echigo Kotsu Kogyo

JFE Environment Service

JFE Engineering

Echigo Kotsu Kogyo

JFE Environment Service
## WTE PPP Projects by JFE in Japan

<table>
<thead>
<tr>
<th>Name of Facility</th>
<th>Seibu Incineration Plant</th>
<th>Clean Ene-Park Nanbu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner/Employer</td>
<td>City of Kumamoto</td>
<td>Southern Fukuoka Region Environment Enterprise</td>
</tr>
<tr>
<td>Contract Scheme</td>
<td><strong>DBO</strong></td>
<td><strong>DBO</strong></td>
</tr>
<tr>
<td>Contract amount</td>
<td>15.9B JPY (159M USD)</td>
<td>29.1B JPY (291M USD)</td>
</tr>
<tr>
<td>Construction period</td>
<td>01/2012 – 02/2016</td>
<td>04/2013 – 03/2016</td>
</tr>
<tr>
<td>Operation period</td>
<td>03/2016 – 03/2036 (20 years)</td>
<td>04/2016 – 03/2041 (25 years)</td>
</tr>
<tr>
<td>Type of furnace</td>
<td>JFE HYPER Stoker 280t/d (140t/d,2units)</td>
<td>JFE HYPER Stoker 510t/d (170t/d,3units)</td>
</tr>
<tr>
<td>Power Generation</td>
<td>5.7 MW</td>
<td>16.7 MW</td>
</tr>
</tbody>
</table>
## Cost Structure of Yangon WTE

### Outline of the Project

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Owner</strong></td>
<td>Yangon City</td>
</tr>
<tr>
<td><strong>Scope</strong></td>
<td>Construction: JFE (EPC)</td>
</tr>
<tr>
<td></td>
<td>O&amp;M: Yangon City</td>
</tr>
<tr>
<td><strong>Finance</strong></td>
<td>CAPEX</td>
</tr>
<tr>
<td></td>
<td>50%: Yangon City</td>
</tr>
<tr>
<td></td>
<td>50%: JCM Subsidy Scheme</td>
</tr>
<tr>
<td><strong>Specification</strong></td>
<td>Waste-to-Energy Plant</td>
</tr>
<tr>
<td></td>
<td>Waste: Municipal</td>
</tr>
<tr>
<td></td>
<td>Furnace: Stoker</td>
</tr>
<tr>
<td></td>
<td>Capacity: 60 tons/day</td>
</tr>
<tr>
<td></td>
<td>Power Gen.: 760kW</td>
</tr>
<tr>
<td><strong>Completion</strong></td>
<td>31st May 2017</td>
</tr>
</tbody>
</table>

### Budget (mil. USD)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CAPEX</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M &amp; E</td>
<td>16.3</td>
<td></td>
</tr>
<tr>
<td>C &amp; S.</td>
<td>3.7</td>
<td></td>
</tr>
<tr>
<td><strong>OPEX (15yrs)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation</td>
<td>10.5</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td><strong>Total Budget</strong></td>
<td></td>
<td>38.0</td>
</tr>
</tbody>
</table>

### Key for Materialization:

JCM Subsidy from Ministry of Environment, Japan
JCM Project Scheme

Myanmar Government

September 16, 2015

JCM Agreement

Japanese Government

GHG Reductions

Yangon City’s Budget

JCM Subsidy from G of Japan

Yangon City Development Committee

International Consortium

JFE Engineering Corporation

✓ Operation
✓ Maintenance
✓ Monitoring
✓ Reporting

✓ Construction
✓ Supervisor Dispatch

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### Why WTE fail in many countries?

<table>
<thead>
<tr>
<th>Stage</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Planning (pre-FS)</strong></td>
<td>Weak policy enforcement, public opposition, no financial source, no supporting regulations, etc.</td>
</tr>
<tr>
<td><strong>Design (FS)</strong></td>
<td>Reject of proposal by a competent authority, opposition from existing stakeholders, lack of budget, gap between proposal and needs, etc.</td>
</tr>
<tr>
<td><strong>PQ/Tender Stage</strong></td>
<td>Unsuccessful PQ/tender due to conflict of price (tipping fee, etc.), etc.</td>
</tr>
<tr>
<td><strong>Operation/Maintenance Stage</strong></td>
<td>Insufficient performance of facility, critical change of waste management policy, bankruptcy of operation company, etc.</td>
</tr>
</tbody>
</table>

Source: Created based on “Financing issue for a development of recycling and waste treatment facility”, Nov. 3rd 2016, Shiko Hayashi, IGES
Basic PPP Scheme of Waste Treatment

**DISCUSSION PURPOSE ONLY**

**Purpose**

1. **Central Government**
   - Subsidy

2. **Local Government**
   - Tipping Fee

3. **Waste Treatment Service**

4. **Electricity Company**
   - Tariff/FIT

5. **Special Purpose Company**
   - Engineering
   - Construction
   - O&M

6. **Investor (Local)** & **Investor (Foreign)**

7. **Loan, Grant** & **Investment**

8. **MDBs**

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## Standard Model for Cost Sharing in Japan

<table>
<thead>
<tr>
<th>Total cost</th>
<th>Total construction cost of WtE facility (CAPEX)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financing construction cost</td>
<td>* Local gov’t can issue bonds maximum 90% of the cost which is not covered by national government.</td>
</tr>
<tr>
<td>Subsidy from national government (33%)</td>
<td>Local government bond (60%)</td>
</tr>
<tr>
<td>amortized by local allocation tax (30%)</td>
<td>amortized by local government (30%)</td>
</tr>
</tbody>
</table>

* Local gov’t bares only about 10% of the total cost when it is constructed.

| Cost sharing national and local government | Cost burden on national government (63%) | Cost burden on local government (37%) |

Source: Japan’s Solid Waste Management Policy, Financing and Implementation, May 2017, World Bank

Public arrangement is Key for successful implementation of project.
## Public Finance for WTE (Yokohama Case)

<table>
<thead>
<tr>
<th>Name of WTE</th>
<th>Total Construction Cost</th>
<th>Central Government</th>
<th>Prefectural Government</th>
<th>City Bond</th>
<th>City Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mil. JPY (%)</td>
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<td>Mil. JPY (%)</td>
</tr>
<tr>
<td><strong>TSUZUKI</strong> (1,200tpd, 12MW)</td>
<td>28,683 (100.0)</td>
<td>8,044 (28.0)</td>
<td>0 (0.0)</td>
<td>16,428 (57.3)</td>
<td>4,211 (14.7)</td>
</tr>
<tr>
<td><strong>TSURUMI</strong> (1,200tpd, 22MW)</td>
<td>51,778 (100.0)</td>
<td>12,450 (24.0)</td>
<td>0 (0.0)</td>
<td>27,532 (53.2)</td>
<td>11,797 (22.8)</td>
</tr>
<tr>
<td><strong>ASAHI</strong> (540tpd, 9MW)</td>
<td>27,289 (100.0)</td>
<td>4,633 (17.0)</td>
<td>96 (0.4)</td>
<td>13,911 (51.0)</td>
<td>8,649 (31.6)</td>
</tr>
<tr>
<td><strong>KANAZAWA</strong> (1,200tpd, 35MW)</td>
<td>62,594 (100.0)</td>
<td>11,030 (17.6)</td>
<td>47 (0.1)</td>
<td>43,344 (69.2)</td>
<td>8,173 (13.1)</td>
</tr>
</tbody>
</table>

Source: Resources and Waste Recycling Bureau, City of Yokohama
## Major Risks and Problems on WTE Project

<table>
<thead>
<tr>
<th>Item</th>
<th>Risk/Problem</th>
<th>Impact/Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Waste Volume</td>
<td>No guarantee for Waste Volume (insufficient volume)</td>
<td>Tipping fee will be increased</td>
</tr>
<tr>
<td>2 Feed in tariff (PPA: Power Purchase Agreement)</td>
<td>PPA is responsible for the bidder</td>
<td>Project is not financially feasible</td>
</tr>
<tr>
<td>3 Tipping Fee</td>
<td>Lower tipping fee</td>
<td>Project is not financially feasible</td>
</tr>
<tr>
<td>4 Sovereign Guarantee</td>
<td>No Guarantee from central government providing government guarantees for infrastructure Public-Private Partnership (PPP) projects.</td>
<td>Negative influence on project finance</td>
</tr>
</tbody>
</table>

**Guarantees and financial condition for a project are the most important**
### Appropriate Risk Allocation

| Phase                        | Land Availability | Infrastructure Risk | Opposition of the local residents | Cost and time over run | Accident and physical damage of facility and equipment | Credit risk of sub-contractor | Completion and Performance of facility | Quantity of Waste | Quality of Waste (LHV, components) | Tipping Fee | Feed in Tariff (unit price, Period) | Ash disposal | Waste disposal during planned maintenance of WtE facility | Accident and trouble of facility due to prohibited waste | Accident and physical damage of facility and equipment | Cost over run | Environmental emission risk | Political risk /Country risk (e.g. Change in policy of Myanmar/YCDC, Transfer of foreign currency) | Force Majeure (e.g. Disaster, Industrial dispute) | Market risk (e.g. Escalation, interest-rate, change in tax system) | |
|------------------------------|-------------------|---------------------|-----------------------------------|------------------------|--------------------------------------------------------|----------------------------|----------------------------------------|------------------|-----------------------------------|-------------|-----------------------------------|-------------|-------------------------------------------------------------|-------------------------------------------------|-------------------------------------------------------------|-------------|-----------------------------------|-------------------------------------------------------------|-------------------------------------------------------------|
| Preparation and Construction Phase | ✓                 | ✓                   | ✓                                 | ✓                      | ✓                                                      | ✓                         | ✓                                      | ✓                 | ✓                                 | ✓            | ✓                                 | ✓           | ✓                                                                           | ✓                                           | ✓                                                           | ✓            | ✓                                 | ✓                                           | ✓                                                           |
| Operation Phase              |                   |                     |                                   |                        |                                                        |                           |                                        | ✓                 | ✓                                 | ✓            | ✓                                 | ✓           |                                                        |                                                           |                                                            | ✓            | ✓                                 |                                                           |                                                             |
| Overall Phase                |                   |                     |                                   |                        |                                                        |                           |                                        |                   |                                   | ✓            |                                                        |             |                                                                                   |                                                             |                                                             |             |                                   |                                                             |                                                             |

DISCUSSION PURPOSE ONLY

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Thank you

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