Business Development

1. Activities of Our Municipal Solid Waste Treatment Plant Business

A leading company in the industry

Since completing Japan’s first fully continuous mechanical waste incineration plant in Osaka City in 1963, Takuma has built more than 350 waste incineration plants in the country, more than any other company in the industry. We have consistently led the municipal solid waste treatment industry, for example by starting operation of Japan’s first combined facility comprised of biological gasification plant and municipal solid waste incineration plant and building more than 80 bulk garbage and resource waste recycling plants.

Takuma will continue to contribute to the realization of a recycling-based society as the industry’s leading company.

From construction to after-sales service

Takuma’s municipal solid waste treatment plant business consists of four components: plant construction, primary equipment improvement, maintenance, and long-term turnkey operation.

In each area of operations, we draw on technological capabilities and expertise based on our extensive experience to precisely meet the needs of local governments, regions, and society, allowing us to offer facilities that are welcomed by their communities.

1. Plant construction

Stoker-type incinerators

Most Energy from Waste plants use stoker-type incinerators. Takuma has been delivering stoker-type incinerators to customers for half a century, allowing us to accumulate a variety of expertise in areas such as stable combustion, exhaust gas treatment, and waste-fueled power generation.

Based on this well-established base of technological capability, we build and supply highly efficient waste treatment systems by integrating the latest technologies, for example water-cooled stokers, real-time waste quality forecasting, exhaust gas recirculation systems, and furnace denitrification and urea decomposition systems.

Water-cooled stoker + high-temperature/high-pressure boiler

- This system uses a water-cooled stoker to ensure stable combustion, even of waste streams with high calorific values.
- The system uses a high-temperature/high-pressure boiler that operates at 4 MPa and at least 400° hot circulating gases in the incinerator.

Real-time waste quality forecasting

- The system checks the quality of waste in real time by measuring the concentration of methane in combustion gases with a laser NDIR meter.

Fly ash circulation system

- Fly ash captured by the filter-type dust collector is circulated, allowing effective use of unreacted chemical agents remaining in the fly ash.

Exhaust gas recirculation system

- Generation of NOx and dioxins is dramatically reduced by stirring and mixing exhaust gases with hot circulating gases in the incinerator.
- Combined with real-time waste quality forecasting, this system makes possible low-air-ratio combustion with an air ratio of 1.25.

Exhaust gas treatment system

- Ammonia is injected into the furnace at the optimal locations to enable highly efficient elimination of NOx.
- A system that generates ammonia from urea has been incorporated to reduce LCC.

Furnace denitrification and urea decomposition system

- The cost of catalyst maintenance can be dramatically reduced by regenerating catalysts without removing the catalyst from the associated equipment.

Biogas facilities

Recently the Ministry of the Environment has been encouraging the introduction of biogas facilities for use with municipal solid waste. This is an area where Takuma is helping further lower CO2 emissions with a combined system of methane fermentation and incineration for municipal solid waste to recover the maximum amount of energy from the waste treatment and utilize it in high-efficiency power generation. (The system received the New Energy Foundation’s Chairman Award at the FY2014 New Energy Awards.)
Annual maintenance is essential in order to ensure stable operation of waste treatment plants. However, maintenance demands both sophisticated technological capabilities and experience, both because waste treatment plants draw on a range of expertise and because the manner in which their equipment deteriorates over time varies with the properties of the waste they process. Takuma takes maximum advantage of its accumulated expertise to contribute to stable waste treatment and long-term facility operation by developing long-term repair plans, carrying out elaborate site investigations, and then performing maintenance that has been optimized in terms of both timing and content.

Ensuring stable waste treatment

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Safe, secure facility operation

In recent years, the number of long-term turnkey operation projects such as DBO* projects that involve long-term outsourcing of operation and maintenance management over 10 to 20 years has been increasing. The Takuma Group is pursuing this business actively, and as of June 30, 2016, we were operating 12 facilities and preparing for the start of operation of 4 more.

Against this backdrop, we are dedicated to pursuing safe, secure facility operation through initiatives that are designed to help establish a basis for future operations and to strengthen our capabilities in this area, for example by developing plant plans with a view toward operation, developing a turnkey operation and maintenance management support system, and strengthening self-monitoring.

* DBO projects: A business approach in which local governments secure funding and then place a single order encompassing facility design, construction, and operation.

Opening facilities to the community

While waste treatment plants play an essential role in daily life for nearby residents, the facilities are also prone to be perceived as a nuisance. Takuma strives to spread understanding of the facilities it operates and the need to practice the 3Rs by hosting various events in an effort to open facilities to the surrounding community.
2. Activities of Our Energy Plant Business
—Transforming a variety of biomass resources into fuel

Since its founding, Takuma has enhanced its technological capabilities as a pioneering boiler manufacturer to deliver a total of more than 600 boilers designed to accommodate a wide variety of biomass fuels in Japan and overseas.

Going forward, we will continue to actively pursue development and improvement of technologies for effectively using energy in a way that gives priority to both humankind and the planet while simultaneously meeting customer needs.

**Technologies and experience in using a broad range of biomass fuels**

Since the Great East Japan Earthquake of 2011 threw the safety of nuclear power plants into question and led many to begin focusing on “renewable energy,” which is characterized by a low environmental impact, as an alternative source of energy. Biomass-fueled power generation in particular promises beneficial ripple effects such as redevelopment of the forestry industry and job creation as companies move to fill needs of fuel procurement, transport, and storage as well as chip processing and other operations. Compared to solar and wind power, biomass also has the advantage of being able to provide power in a relatively stable manner without being affected by weather. Currently, biomass-fueled power plants are being planned and built in locations across Japan.

**Renewable energy**

- Solar
- Wind
- Hydro
- Geothermal

**Biomass**

**Forestry-derived biomass fuels**
- Debris from demolition of wooden houses
- Thinned timber
- Waste from lumber plants

**Industry-derived biomass fuels**
- Paper sludge
- Miscellaneous plant waste

**Livestock-derived biomass fuels**
- Chicken manure
- Cattle manure

**Agriculture-derived biomass fuels**
- Bagasse
- Pruned fruit tree branches
- Rice husks

**Social landscape**

The introduction of Japan’s feed-in-tariff system for renewable energy is driving expectations for biomass power generation to new levels.

Anticipating these developments, Takuma has deployed numerous biomass power generation facilities and created a subsidiary with a wood biomass generation business to procure biomass fuels from various regions while operating, maintaining, and managing biomass power generation facilities.

**Delivery record of biomass boilers by area of Japan**

Takuma is working on facilities that use biomass fuel throughout Japan.

- We have constructed facilities that use forestry-derived biomass fuels such as thinned timber and waste from lumber plants and industry-derived biomass fuels such as plant waste and sludge from manufacturing plants in many regions.
- We have constructed many facilities in Japan that use livestock-derived biomass fuels such as chicken and cattle manure and agriculture-derived biomass fuels such as bagasse (fiber remaining after sugarcane is crushed and sugar extracted), particularly in Kyushu and Okinawa.

**Wood chip-fired power plant**

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**Subsidiary profile**

Subsidiary Biopower Katsuta Co., Ltd., operates a biomass-fired power generating plant located in Hitachinaka City in Ibaraki Prefecture. All the electricity the plant generates (with the exception of what is used to power the plant itself) is sold to the grid.
Biomass fired power plants comprise one of our most skilled product areas. Activity in the segment has been sparked by the prospect of stable profits made possible by the launch of Japan’s feed-in tariff system for renewable energy in July 2012, and Takuma has received orders for numerous plants. We have also received multiple orders for boiler fuel conversion projects to provide electricity and steam for internal plant use.

### Activities of Our Energy Plant Business

#### —Pursuing biomass power generation

Biomass fuel under the feed-in tariff program

<table>
<thead>
<tr>
<th>Generating output scale</th>
<th>General lumber</th>
<th>Unused lumber</th>
<th>Recycled timber</th>
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<tr>
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<td>4,000 kW</td>
<td>5,000 kW</td>
<td>2,000 kW</td>
<td>4,000 kW</td>
</tr>
</tbody>
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#### Proposing combustion furnaces that can accommodate the fuels customers use

- **Step grate stoker**
  - This combustion method, which derives from waste incineration technology, can be used to uniformly burn fuels with different calorific values, moisture content, shapes, and sizes. Another characteristic of this method is that it requires less power to operate (known as facility power) than other types.
  - **Installation example:** Sendai Factory, Chuetsu Pulp & Paper Co., Ltd.

- **Traveling stoker**
  - With a traveling stoker, fuel is distributed in the furnace so that longer combustion times are secured for fuel with larger volumes. As with a step grate stoker, combustion is comparatively gradual, and the system can accommodate a wide range of fuels with different calorific values, moisture content, and shapes.
  - **Installation example:** Maniwa Biomass Power Co., Ltd.

#### Converting biomass fuels under the feed-in tariff program

- **Bubbling fluidized bed**
  - Since sand that has been fluidized by high-pressure air burns away the surface of the chips, little unburned fuel remains, making high boiler efficiency a characteristic of fluidized bed systems. They can accommodate a variety of different fuels, including fuels with high moisture content.
  - **Installation example:** Gifu Biomass Power Co., Ltd.

- **Circulating fluidized bed**
  - Heated, fluidized sand burns fuel as it circulates, keeping temperatures inside the furnace uniform to enable stable combustion. Since little waste remains unburned, boiler efficiency is high, and the system can accommodate a broad range of mixed fuels with different calorific values.
  - **Installation example:** Hyuga Factory, Chugoku Mokuzai Co., Ltd.

#### Waste products

- **Unused timber [JPY 22 per kWh]**
  - Unused timber with a moisture content of 25,000 to 30,000 kW can be used as biomass fuel.

- **Recycled timber [JPY 17 per kWh]**
  - This category includes construction waste, for example from the demolition of houses. Construction waste has been used as a primary fuel in wood biomass boilers for some time, and at present it constitutes the most commonly used wood fuel.
3. Activities of Our Water Treatment Plant Business

Takuma contributes to the preservation of the water environment by providing a variety of water treatment facilities. In addition, we are working to develop new technologies to accommodate ongoing changes in society, for example, by utilizing renewable energy and reducing emissions of greenhouse gases.

1. Reaction tank facility

The reaction tank facility consists of an aerobic tank that supplies oxygen (aeration) and oxidizes and breaks down organic matter through the action of microorganisms known as activated sludge. Anaerobic and anoxic tanks are also provided for the purpose of biologically eliminating nitrogen and phosphorus.

Takuma has developed energy-saving stirring machines to stir the contents of the anaerobic and anoxic tanks. We have commercialized a low-power stirring machine in which two specially shaped stirring blades are powered by an above-water drive unit. We have delivered 68 of these machines, which provide stirring capacity of about 1.0 W per cubic meter at about 1/10 the power of a conventional machine, to sewage treatment plants and other sites in Japan.

2. Advanced treatment facility

Measures undertaken to improve the quality of public water sources and the need to reuse treated sewage are spurring demand for more advanced water treatment. In order to reuse treated water, it is necessary to reduce the biochemical oxygen demand and suspended solid concentration in that water. Sand filtration is typically used as a technology for eliminating suspended solids, and both fixed-bed and moving-bed systems are available. Takuma has delivered a cumulative total of more than 2,500 upflow moving-bed sand filtration systems (uniflow sand filters).

Since the filtration differential pressure can be kept low in upflow moving-bed filtration ponds thanks to a purification mechanism that continuously purifies the sand, the amount of power used by lifting pumps can be reduced. In addition, Takuma has developed a high-speed sand filtration system that allows filter speeds of up to 1,000 meters per day, about three times that of conventional systems, while simultaneously using less space than those systems. There are already five of these facilities in operation.

3. Sludge incineration

Sewage sludge is a type of biomass, and it is expected to be used as a form of renewable energy. Past sludge incinerators have required auxiliary fuel and used large amounts of electricity, making them net consumers of energy. Takuma has developed a sludge incineration system based on a new concept that shifts operation to an energy-saving and energy-yielding footing, and we are working to develop a broad range of businesses using the system as a technology that can lower costs at sewage treatment plants while simultaneously reducing energy use and greenhouse gas emissions.

- Demonstration Study of Power Generation System with Sewage Sludge Incineration
  This energy-yielding system consists of three technologies: sludge dehydration using an inside double coagulation type centrifugal dehydrator, energy recovery using an innovative step gate (with boiler), and energy conversion using steam generators (both centrifugal and binary-type).

  The technology was adopted by the Ministry of Land, Infrastructure, Transport and Tourism's Breakthrough by Dynamic Approach in Sewage High Technology Project (B-DASH) in FY2013, and we constructed a full-scale demonstration plant capable of incinerating 35 tons (wet) per day at the Wakayama Municipal Central Sewage Treatment Plant. Based on data obtained from the plant’s operation, we were able to conclude that it delivered the target level of performance that we had envisioned at the outset, that operation is stable even without auxiliary fuel, that it generates electricity using heat recovered by means of steam, and that it generates more power than the incineration facility uses. The results from the demonstration project were published in September 2015 by the Ministry of Land, Infrastructure, Transport and Tourism National Institution for Land and Infrastructure Management in the form of a series of “Guideline for Introducing a Technology (draft).”

- High-temperature energy-saving sludge incinerator
  As a result of joint research, we were able to verify that stoker furnace-based sludge incineration technology satisfies the standards for high-temperature energy-saving incinerators as put forth by the Tokyo Metropolitan Government Bureau of Sewerage (for Generation 2.0 and 2.1 incinerators), which require incinerators to address global warming, improve energy savings, and reduce maintenance and management costs. Consequently, the incinerator was approved as a compliant facility.

- Energy self-reliant sludge incinerator
  As a result of joint research, we were able to verify that our system combining stoker furnace-based sludge incineration technology with steam-driven power generation technology satisfies the standards for energy self-reliant sludge incinerators as put forth by the Tokyo Metropolitan Government Bureau of Sewerage (for Generation 3.0 incineration systems), which require that incinerators to generate more power than they use, that incinerators do not require auxiliary fuel (with the exception of special operations such as incinerator startup and shutdown[^1]), and that incinerators help reduce the CO2 emissions associated with power use. Consequently, the incinerator was approved as a compliant facility.
4. Activities of Our Overseas Business
—Sales of biomass-fired power plants, municipal solid waste incineration plants, and Energy from Waste plants overseas

For more than half a century, Takuma’s biomass boilers have contributed to industrial growth and economic development in Southeast Asia. In addition, our power plants help materialize coexistence of both environmental protection and energy supply.

Biomass-fired power plant sales in the Southeast Asian market

In the Southeast Asian market, the sugar industry in Thailand is undergoing a transition from a sector that focused on expanding sugar production volume to an energy-supplying industry in which sugar production is joined by electricity sales and bioethanol production as core business operations. Specifically, companies are combining bagasse (fiber remaining after sugarcane is crushed and sugar extracted) as a main fuel with eucalyptus wood chips, rubber wood chips, cane leaves, rice husks, and other materials as auxiliary fuels to effectively generate electricity, using comparatively high-temperature, high-pressure steam on the order of 10 MPa and 520°C, for sale to the grid.

Furthermore, impetus to this major change is being given by programs that give exemptions on import duties for building power plants using biomass and other renewables, that lower corporate taxes for operators during a specific period and that maintain advantageous purchase prices for power by means of feed-in-tariff (FIT) mechanisms. As a result, there continues to be a voracious appetite for investment in the Thai sugar industry despite the recent decline in sugar prices on international markets.

There is also a noteworthy trend on the part of other countries in Southeast Asia toward using the Thai programs as a model in the use of biomass and other renewables. Takuma will continue to draw on its extensive experience and outstanding technology to meet market demand by supplying highly reliable power plants that deliver efficient and stable combustion of biomass.

In addition, we are confident that we will be able to make an even broader contribution by building on our record of success through delivery of biomass-fueled high-efficiency, high-temperature/high-pressure boiler power plants to the sugar industry in Thailand and thereby earning praise in the market so that we can supply highly reliable plants to the markets in nearby countries such as Indonesia, Myanmar, Vietnam, Cambodia and Laos.

Overseas Energy from Waste plant business

Through its overseas market research, Takuma has become aware that demand for Energy from Waste (EfW) plants is growing rapidly worldwide against the backdrop of urbanization and growing environmental awareness. Particularly in developing countries where urbanization is occurring, there is pressure to take environmental factors into consideration along with infrastructure development (for example by preventing global warming through the use of renewable energy), and interest in building EfW plants is rising rapidly.

At the same time, most developing countries need appropriate diagnostic information, advice, and guidance concerning this type of facility, and due to the need to understand waste treatment in each of these markets, it will be essential for Takuma to strengthen partnerships with stakeholders in each country and obtain more accurate information in order to pursue its business.

Takuma has been able to take advantage of its extensive experience and track record, coming from the holding top market share in Japan and the high praise that the nine EfW plants delivered overseas have earned for stable operation and other performance, to provide optimal proposals in response to each country’s unique needs while exchanging detailed information with stakeholders. We are interested in working with Japanese local governments to help the public and private sectors in overseas countries come together to resolve waste-related issues, and we expect our expertise in areas such as waste sorting and collection, EfW technology popularization and awareness-raising, environmental education, and consensus-building with local residents to play an important role. We are confident that we can provide safe, secure, and stable plants to the people of these countries and regions by pursuing these initiatives.

Although the market and competitive environment worldwide are becoming more challenging as Asian and European companies join their domestic counterparts in competing for project orders, Takuma will conduct feasibility studies to gauge the viability of building optimal business models that will enable it to take advantage of its strengths as the first step after choosing target markets. In this way, we plan to contribute to environmental protection by building overseas EfW plant businesses that are optimally suited to each country and region.

**EFW plants delivered by Takuma overseas**

- U.K.: 1 plant
- China: 2 plants
- U.S.A.: 2 plants
- Taiwan: 4 plants