East Rockingham Waste to Energy and Material Recovery Facility

Capacity
102 MW / 300,000 tpy

EPC Information Package

Project Nr	Project Name	Issue	Supplier	Rev_
YE-3324	**East Rockingham WtE and MRF**	**9 Feb 2017**	**HZIA**	**1.0**

Hitachi Zosen INOVA

Issued by

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Table of contents

1 Introduction

1.1 Rationale

New Energy reinvestigated the selection of the most appropriate waste to energy (thermal processing) technology for its permitted site in East Rockingham. This assessment included the following:

- The most appropriate energy conversion technologies to convert carbonaceous energy to electrical energy; and
- Identification of a proven thermal conversion technology capable of delivering optimal commercial and environmental sustainability for the waste feedstocks available.

Figure 1 shows the overall Waste to Energy system that is independent of technology selected. Whatever technology, there is always the same waste flow, the same statutor required emissions, inert materials will end up as ash, residues from cleaning the flue gas need to be properly disposed, and heat (if consumers are available) and power are produced. The overall differences are mainly the purity grades of the different products and the efficiency of producing power.

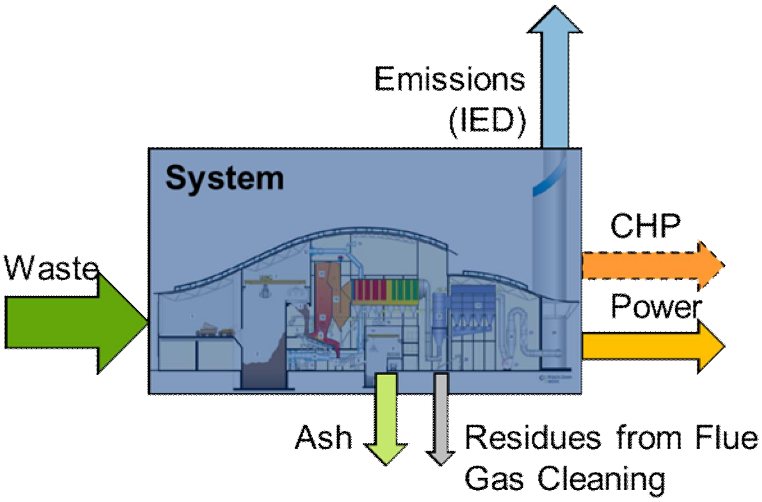

Figure 1: Waste to Energy System with entering and exiting streams

Of all technologies investigated grate combustion scored highest based on its long and large track record in Europe, Japan, and the US, as well as on its superior power conversion efficiency. It also allows for the proven recovery of metals and inert aggregates from the bottom ash.

This result comes in line with the observation that grate combustion is the current technology of choice around the world due to the same rational as employed here.

2 Grate Combustion

New Energy has chosen grate combustion and bottom ash recovery as the preferred technology based on the considerations listed above.

2.1 HZI Grate Combustion Technology

New Energy have identified Hitachi Zosen Inova (HZI) as the preferred technology provider due to their well-proven technology and their long international track record of supplying WtE plants. HZI bases its success on proprietary technology in combination with state-of-art project management. A collaboration agreement underpins the intention of NEC and HZI to bring this project to a success.

The reference list of HZI Waste to Energy Facilities shows that they have realized numerous similar, as well smaller and larger sized plants in recent years. Figure 2 shows the schematic of an equally sized WtE plant in Buckinghamshire (UK). The proposed plant will have similar features adapted to the specialties of the location in East Rockingham.

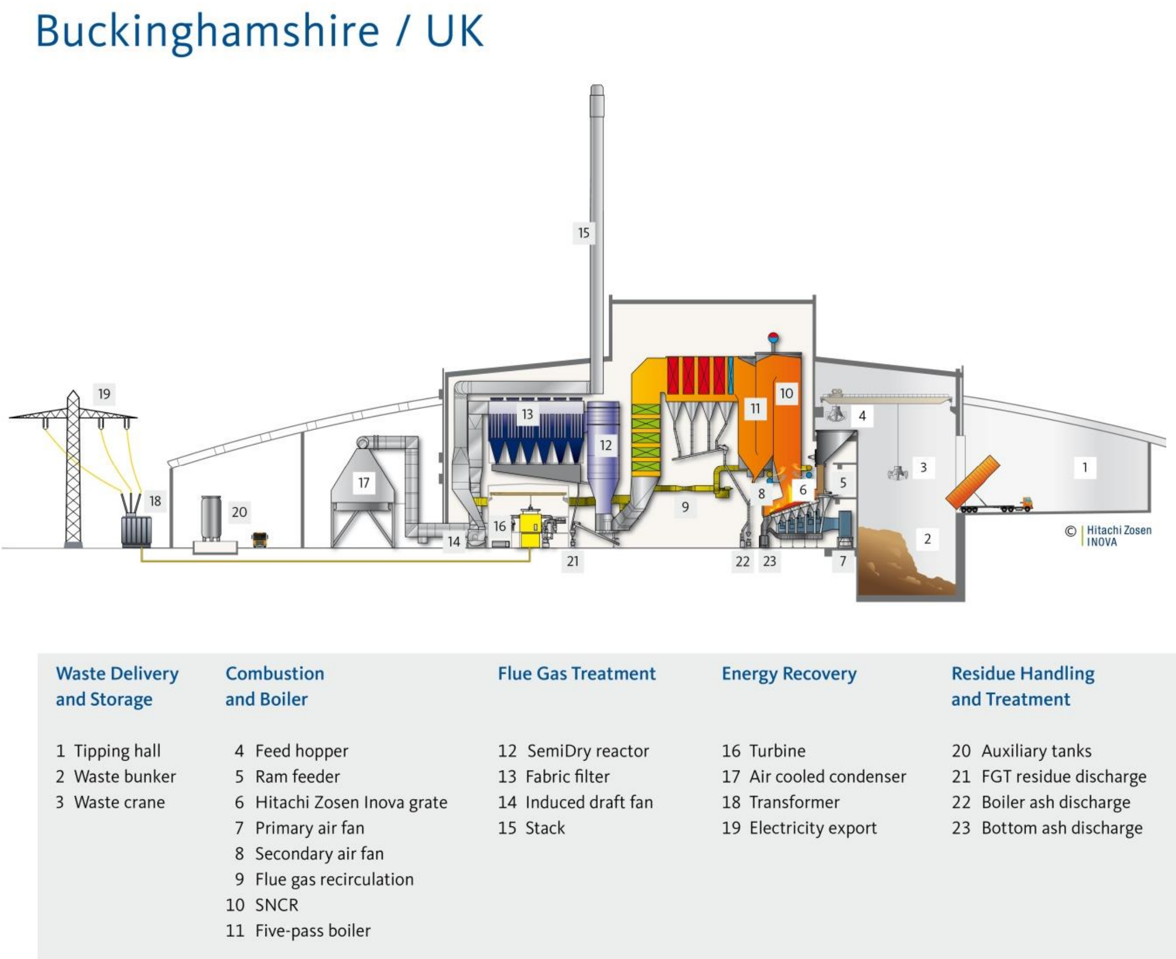

Figure 2: Schematic of Waste to Energy plant in Buckinghamshire recently completed by Hitachi Zosen Inova

2.2 References

Worldwide more than 500 Energy from Waste (EfW) plants are in successful operation with HZI technology.

All of the offered components of the plant are well proven and have successfully demonstrated their reliability in many years of operation in numerous of the reference plants mentioned above.

Newly developed systems for improved combustion or flue gas treatment performance have been tested in reference plants before being offered to the market.

Hitachi Zosen Inova has integrated several technical features in their design, which recognize the need for high reliability, economic solution, and low lifetime cost. Out of the overall concept, we would like to point out the following highlights in this summary:

- The R-grate, HZIôs most reliable moving grate system, has a long and successful history all over the world.
- The optimized swirl injection of secondary air is in operation since 1996 at the EfW plant Darmstadt (Germany). Today this system has become a standard in all new plants.
- The additive dosing (activated carbon, lime) was first applied by Hitachi Zosen Inova AG in 1988 for adsorption of organic compounds and mercury in the flue gas of the EfW plant St. Gallen (Switzerland). This system has been continuously optimized and is now in operation in various thermal waste treatment plants throughout the world.
- HZI first installed Semi-Dry or Dry FGT system with high recirculation rate in 1998 in the EfW plant Châteaudun (France). It has since been installed in various thermal waste treatment plants, with the newest generation (Xerosorp dry system) in Hinwil (Switzerland, commissioned 2012).
- The DeNOx SNCR-system was first installed by HZI in 1987 and is now in use in more than 200 combustion lines in thermal waste treatment plants. Many of those plants control NOx to < 150 mg. The ñnew generationò DyNOR is a further improvement of the DeNOx performance, in particular towards low Ammonia slip while operating at low NOx levels. HZI installed DyNOR first in plants located in Vaasa (Finland) and Vantaa (Finland).

3 Project Details

3.1 Plant Capacity

The maximum capacity of the plant is 102 MW (thermal power of waste). The electricity generated by the power station operating at 102 MW is approximately 31.4 MW. Of this, approximately 3.6 MW is parasitic electricity, required to operate the plant. Hence approximately 27.8 MW is exported to the grid when the power station is operating at maximum continuous capacity. The grate combustion plant can accept a wide range of municipal solid waste (MSW) in an unprocessed form.

3.2 Waste Types and Volumes

The facility is designed to receive MSW and waste similar to MSW including residuals from point of origin collection programs and off-site facilities processing MSW, C&I and C&D waste. Such waste will be collected, stored and mixed in a closed waste pit. The updated proposal will also incorporate an on-site Materials Recycling Facility in or adjacent to the waste reception hall for processing C&I and C&D waste delivered directly to site. The final design for this facility is yet to be determined. The MRF will separate out inert materials, recyclable metals and potentially hazardous items such as batteries to produce a fit for purpose feedstock that will be directed to the waste storage pit. The updated proposal may also incorporate facilities for receiving and drying (using waste heat from the boiler) sludges from the adjacent East Rockingham Wastewater Treatment Facility or others to produce dry sludge. The use of the waste heat from the boiler increases overall energy efficiency.

The combustion diagram of the East Rockingham Resource Recovery Facility (Figure 3) shows the flexibility on the calorific value of the waste that can be accepted.

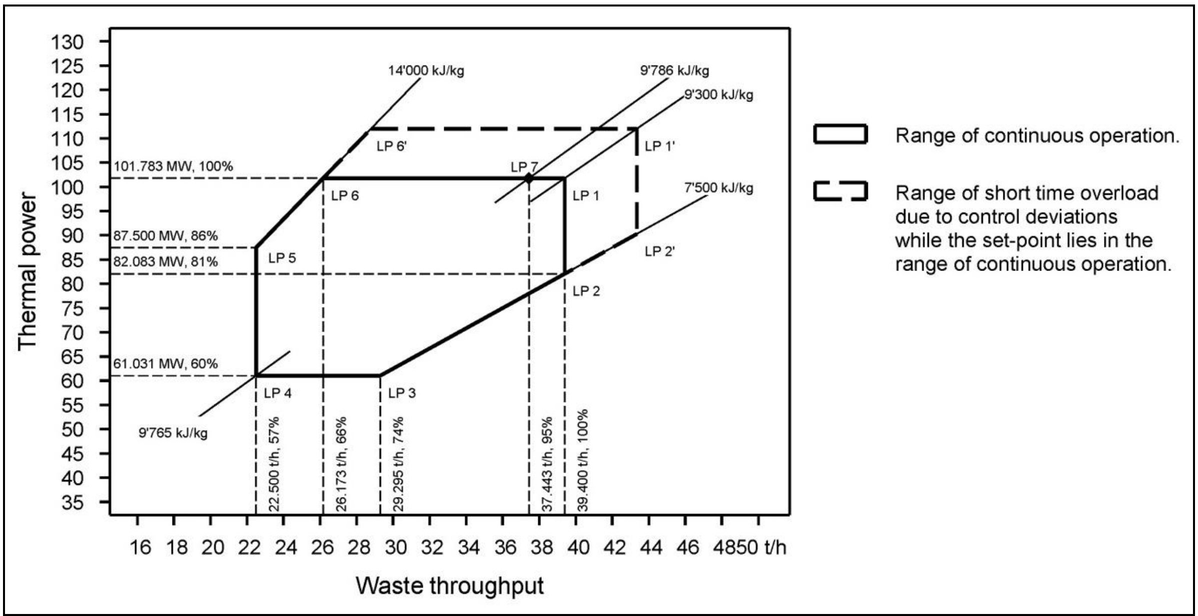

Figure 3: Combustion Diagram of East Rockingham WtE Facility

3.3 Operation Times

Combustion operation will be seven days per week, 24 hours per day. It will be staffed with permanent employees based on a rotating shift pattern.

The operating hours for the Site are summarised in Table 1.

Waste Reception (weighbridge)	06:00-16:00 Mon-Sat and as needed outside these hours
Combustion	Continuous (24 hours/day, 7 days/week)
Bottom Ash Treatment	06:30-16:30 Mon-Fri and as needed outside these hours
Administration	08:00-17:00 Mon-Fri

Table 1: Site Operation Hours

3.4 The Site Plan

The proposed site and the facility layout are shown in Figure 4.

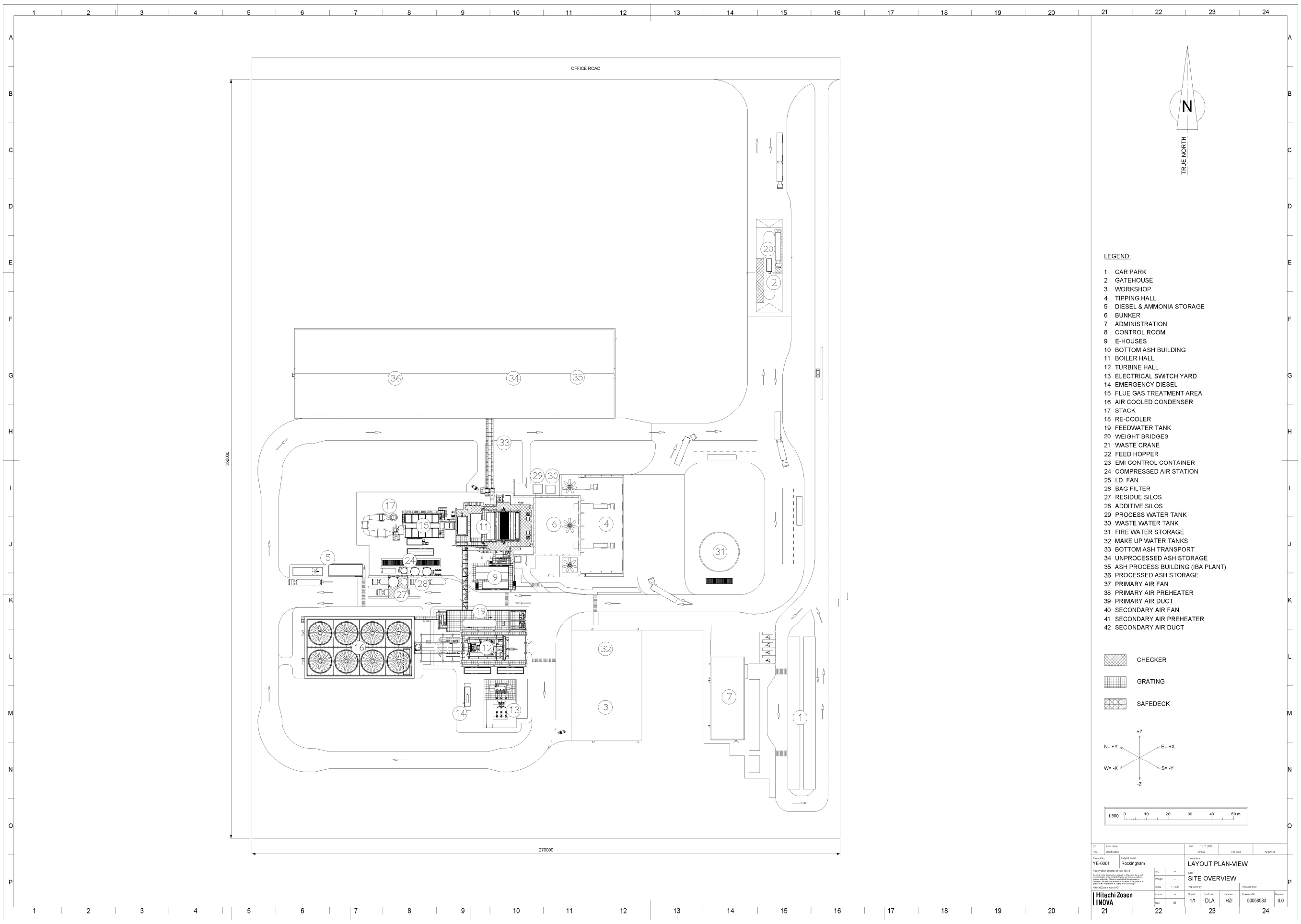

Figure 4: Layout of the proposed facility (preliminary)

4 The Process

Years of experience in engineering, construction and operation of energy from waste plants by HZI form the basis for the concept of the offered plant considering the following objectives:

- Compliance with all regulations
- Proven technology
- Economical concept regarding investment and operation costs
- High flexibility to accommodate changing future demands

The plant proposed comprises the Hitachi Zosen Inova reciprocating grate, the Hitachi Zosen Inova heat recovery boiler with an SNCR-DyNORÊ process for NOx control and the Hitachi Zosen Inova flue gas treatment system (evaporation cooler and fabric filter), including all necessary consumables storage and the residue handling systems. An efficient turbine-generator set for the heat utilisation is integrated. The balance of plant includes electrical and auxiliary systems.

Figure 5 shows the main process as in a bloc flow diagram. A more detailed bloc flow diagram that includes a mass balance is attached.

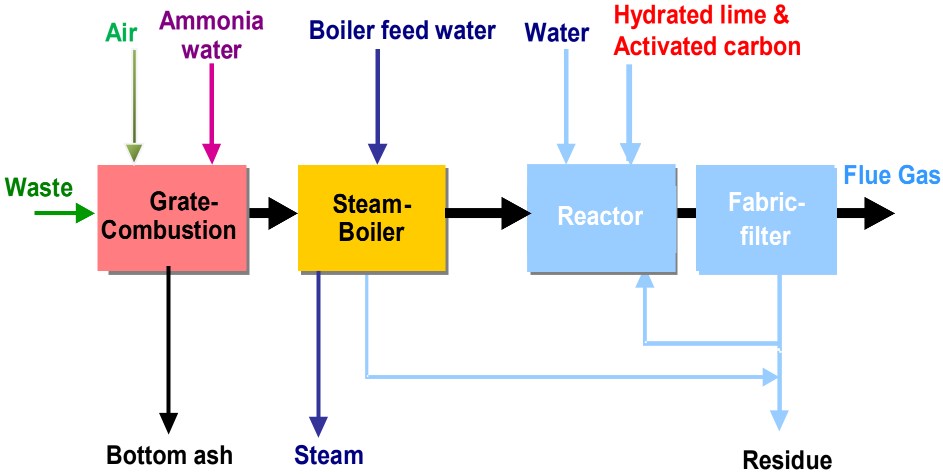

Figure 5: Bloc Flow Diagram of grate-combustion, steam boiler and flue gas cleaning system

4.1 Cooperation, Integration and main features

Hitachi Zosen Australia Pty Ltd (HZIA) is a fully owned subsidiary of Hitachi Zosen Inova AG. HZI is a world-wide leading Engineering Procurement & Construction (EPC) supplier of turn-key Energy-from-Waste and services. See our attached Company Brochure.

HZI has at its disposal a wide array of treatment technologies to choose from. HZI prides itself in its abilities to select the treatment methods most suited for the application at hand.

Years of experience in integration of these technologies into the design of energy from waste solutions make the Hitachi Zosen Company uniquely qualified to meet all the needs of this project. HZI combines the skills of all the professional disciplines that are required to coordinate, construct, install and commission a project of this complexity. HZI therefore offers a turn-key solution for the complete project, inclusive of all civil work, rather than a selection of individual supplies.

The Plantôs main features are:

- Waste Reception and Handling;
- Combustion and Heat Recovery;
- Bottom Ash Handling and Treatment;
- Energy Utilization;
- Flue Gas Cleaning;
- Auxiliaries; and
- Maintenance and Administration.

The following sections detail the East Rockingham facility.

4.2 Buildings and Surroundings

Hitachi Zosen Inova has shown its experience as an EPC contractor in similar plants with comparable capacity and fuel range. One of the greatest tasks is to provide an entire solution for all logistic requirements. The offered concept takes care about all truck drive and loading/unloading zones, allows for enough flexibility in the waste reception area and waste bunker as well as in all other storage capacities for consumables and residues and the bottom ash management.

Figure 6: Impression of the East Rockingham WtE Plant extracted from the preliminary 3D model

4.3 Waste Reception and Handling

4.3.1 Weighbridge

The weighbridge operator will receive and process all commercial vehicles entering the site, including those vehicles for the following purposes:

- Waste delivery;
- Chemical delivery;
- Ash collection;
- Recyclables collection;
- Spare parts delivery; and
- Off-site contractors for maintenance or specialist jobs.

All vehicles will be checked (using video cameras in the roof of the weighbridge) for identification of the load, and will be weighed in and out of the weighbridge. Appropriate paperwork will be required to prove identity/source of waste and identify the waste carrier. Only licenced carriers will be allowed to bring waste to the facility. The waste will be directed in one of the following two ways:

- Rejected waste which is outside the facility's licence conditions will be rejected by the weighbridge operator. Rejected waste will be ordered to enter site and by-pass the facilities, exiting the site without offloading. This will be checked by a weighing in and weighing out; or

- Sent to the Reception hall direct to the waste reception pit for unloading and inspection and further processing in all other cases.
- Sent to the Reception hall for pre-processing in the Material Recycling Facility prior to placement in the waste reception pit.

Non-commercial vehicles, such as visiting members of the public, will not be allowed through the weighbridge. They will be directed to the separate entrance road and parking area in front of the administration building.

Private vehicles arriving for waste deliveries will not be accepted onto the site due to the heavy industrial nature of the operations.

The tonnages and relative percentages of waste streams accepted at site will vary on a daily, weekly, seasonal and annual basis.

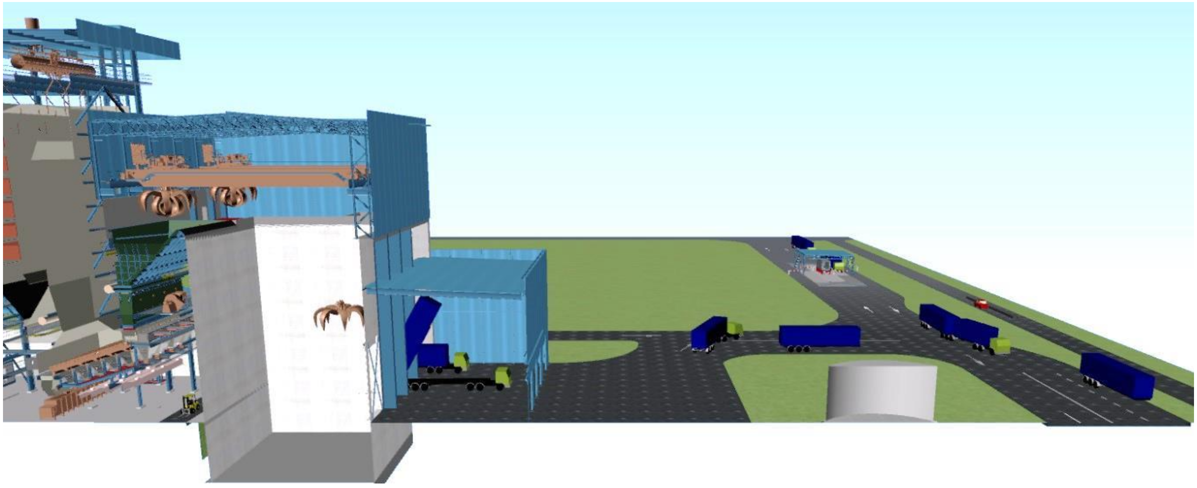

Figure 7: Cut through model showing weighbridge, reception hall and bunker.

4.3.2 Reception hall

In view of the significant volume of MSW proposed for acceptance at the facility and the potential for odour emissions to cause off-site impacts, the waste entering the site will be offloaded within a building (the reception hall) specifically designed and ventilated to contain odours.

Figure 8: Waste trucks discharging their load into waste bunker in a WtE plant.

The reception hall will be connected to the waste bunker but isolated from any other buildings. The combustion air will be drawn from the bunker hence creating an under-pressure in bunker and reception hall. When any automatically fast acting door to the reception hall is open to enable trucks going in or out, this under-pressure will make ambient air flow into the reception hall and avoid odour containing air escaping from the reception hall.

4.3.3 Waste Bunker with Overhead Crane

One duty and one standby waste crane with integrated weighing cells will be installed capable of operating in automatic as well as manual mode. Full redundancy will be secured via two identical waste cranes that each alone is sufficient for feeding the hopper. The cranes shall be able to operate in automatic mode, feeding/mixing/moving, thus programmed for random homogenisation and mixing of waste when feeding is not required. The cranes shall be fitted with automatic weighing cells that feed data on the amount of waste placed in the hopper to the control system. A spare grab shall be present to ensure a high degree of reliability.

Figure 9: Photo of overhead crane in a WtE plant

4.4 Combustion

The combustion system grate is designed for municipal waste. It is also capable of treating industrial and commercial waste and shredded bulky waste with similar characteristics. The specific thermal and static surface loads are important design parameters of any combustion unit, which is expected to demonstrate low wear and long life time. For the given calorific values the Hitachi Zosen Inova AG air-cooled grate serves best with its well proven design.

The furnace is designed for continuous waste combustion in the range between 60% and 100% of the thermal design load. Short-term peaks caused by the non-homogeneity of the waste are absorbed by the system.

4.4.1 Hitachi Zosen Inova Combustion Grate

Since 1938 HZI has built waste combustion grates, which were steadily optimised until today, in regards of reliability, life time of the grate blocks, burn out of bottom ash and flue gas, maintenance, changing heating values of the waste etc.

The inclination of the grate in combination with its moving grate block rows guarantees a good mixing of the waste and thus an excellent burn out of the bottom ash. The grate block movement in co-flow to the waste makes the combustion process smoothly and therefore easier to control. Furthermore, it reduces dust deposits in the boiler.

The moving grate consists of 5 individually driven zones that allow acting on the different phases of the combustion process (drying, ignition, gasification and combustion of volatiles, char burn-out).

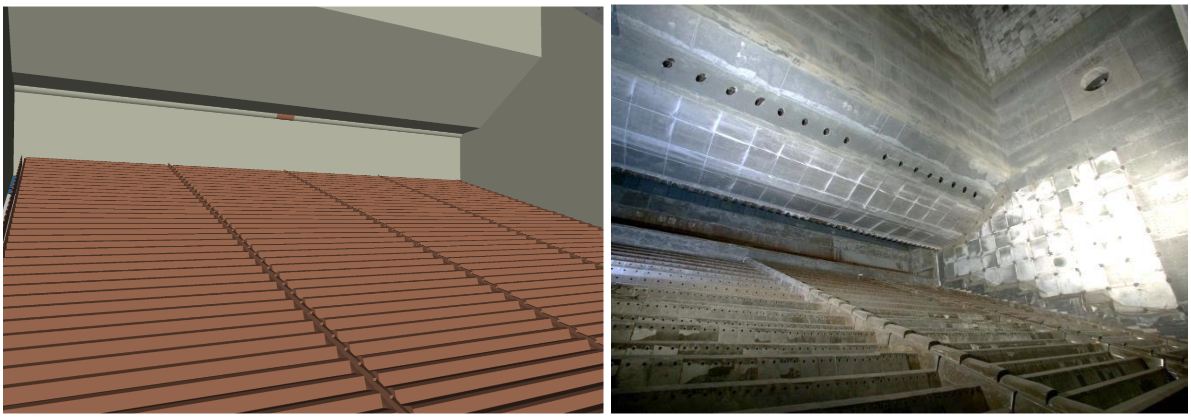

Figure 10: Model of HZI grate for East Rockingham WtE (left); and photo of existing grate (right)

The process reduces the waste volume received by up to 90%. The burnt out ash passes through the ash discharger.

Figure 11: Photo of waste being combusted in an existing facility

4.4.2 Combustion Control System

The combustion control is fully automatic. The operator only selects the desired power and all control devices are handled by the system. This secures that the plant operates at all time at an optimum regarding efficiency, environmental protection and life time of the equipment.

4.5 Boiler for heat recovery

The flue gas passes through a water tube boiler where it is cooled while the water of the closed water-steam cycle is transformed into superheated steam.

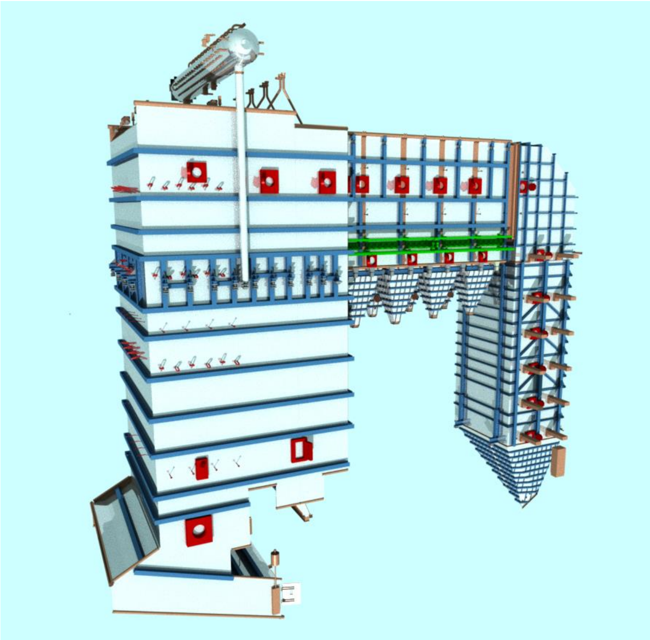

Figure 12: 3-D Rendering of Boiler

The furnace and secondary combustion chamber shall comply with the 2s retention time and 850°C temperature requirements of the Industrial Emissions Directive (IED) of the EU and be equipped with auxiliary burners. Auxiliary fuel is used only for start-up yet the burners are kept shut-off but ready to ensure compliance with the IED.

4.6 Bottom Ash Handling and Treatment

The bottom ash is conveyed to and storage and treatment plant on site.

By means of a wheel loader, the material is loaded into the vibrating feeder where the material > 250 mm is separated and sent to a box. Material with size < 250 mm goes on in the process. The material is separated in three fractions using a polygon trommel, fraction 0-32 mm, fraction 32-150 mm and fraction > 150 mm. The fraction > 150 mm passes by an overband magnet, where ferric parts are extracted and driven to a box. The fraction 32-150 mm is transported by vibrating conveyor to a magnetic drum where also ferric parts are extracted. Following the fraction enters an air-conditioned and heated hand-sorting cabin where stainless-steel, composite metals (e.g. coils), other metals and unburnt parts are separated. The fraction 0-32 mm first passes a magnetic drum to extract the ferric parts, and goes to a screening machine afterwards. In the screening machine, the fraction is divided in a 12-32 mm fraction and two 0-12 mm fractions. The two 0-12 mm fractions are necessary because it is the biggest fraction with about 60% of total bottom ash (see Figure 14 below and diagram attached).

Figure 11 gives an overview of a typical arrangement including transport of the bottom ash to the unprocessed bottom ash storage (middle), bottom ash treatment (left), and storage of the different fractions of the bottom ash (different sizes of aggregates, ferrous metals, non-ferrous metals).

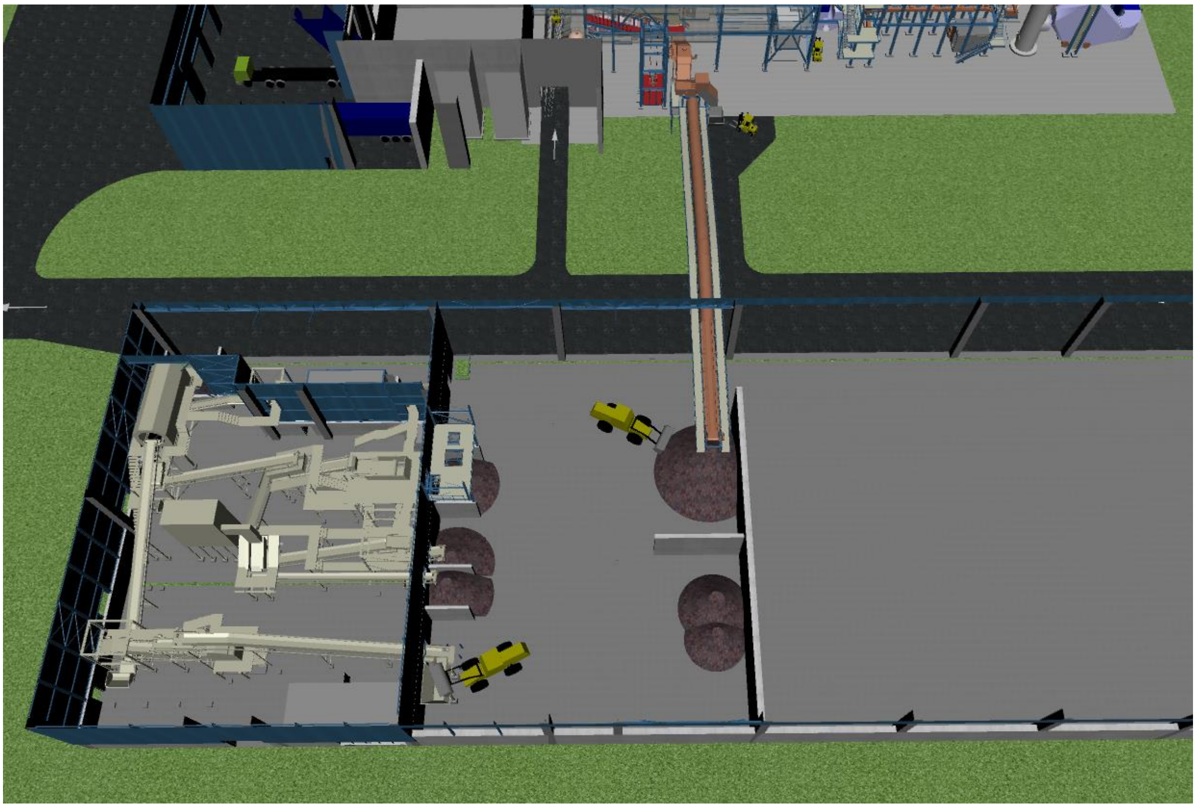

Figure 13: Bird's view of bottom ash transport and treatment plant

Both the 0-12 mm fraction and the 12-32 mm fraction first pass a Fe-separator each before they go to two serially connected Eddy current separators. The separated Fe- and NF-material is stored in boxes inside while the treated bottom ash leaves the bottom ash-treatment building by belt conveyors and goes to storage boxes outside.

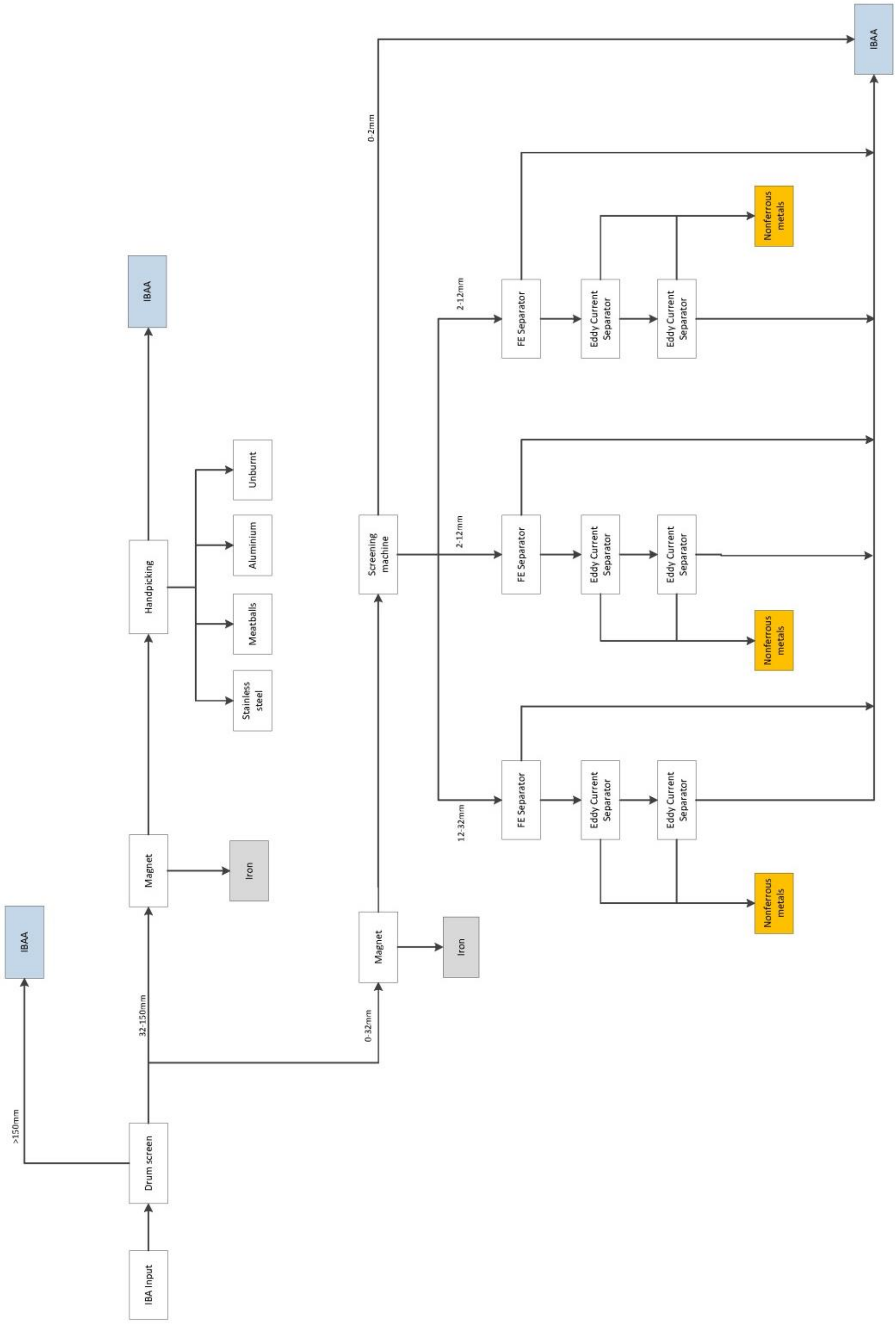

Figure 14: Bottom ash treatment diagram (typical)

4.7 Energy Utilisation

The generated steam is transformed into electrical energy in a turbo-generator set that is used to cover the plantꞌs own electricity needs and to feed the public electrical grid.

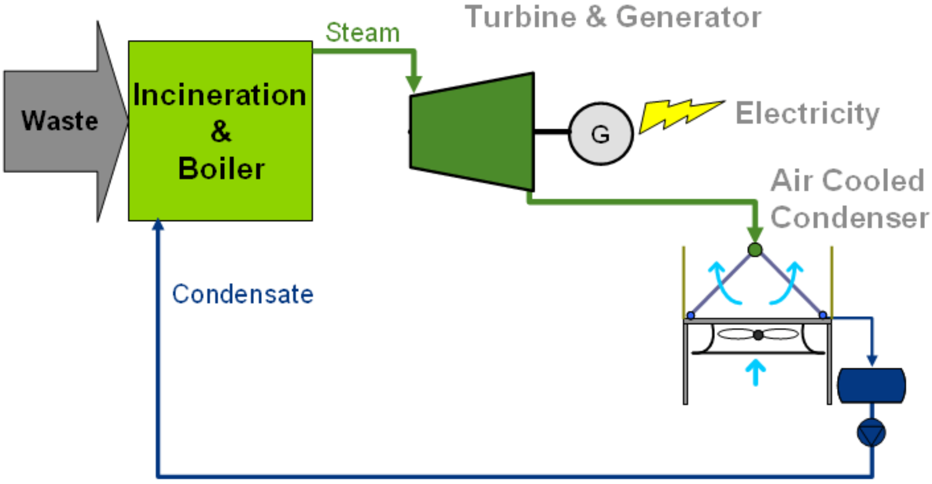

Figure 15: Schematic of Water-Steam-Cycle

4.7.1 Steam Turbine

The superheated steam is expanded in the turbine that drives a generator producing 31 MW of electricity. Over 88% of the produced electrical power is exported to the national grid.

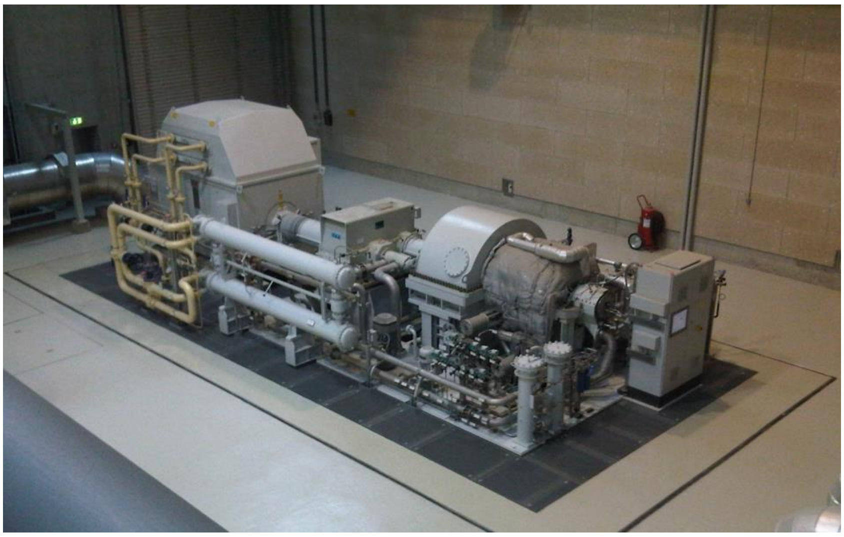

Figure 16: Photo of turbine used in a WtE plant

4.7.2 Air Cooled Condenser

The exhaust steam from the turbine condenses in the air-cooled condenser.

In case of start-up, shutdown, overload or trip of the turbine, all or a part of the live steam flows into the air-cooled condenser via the turbine bypass system. The thermal capacity of the air-cooled condenser is high enough so that it is able to condense the saturated steam that bypasses the turbine.

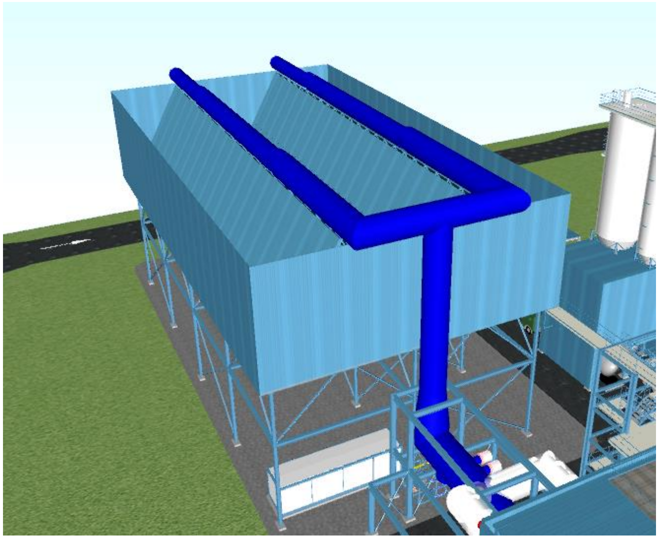

Figure 17: Model of ACC to be used for East Rockingham WtE

4.8 Flue Gas Cleaning

4.8.1 DeNOx System

The plant will be provided with a non-catalytic deNOx system (SNCR) that uses injection of a reactant, i.e. aqueous ammonia or urea, to convert oxides of nitrogen to nitrogen and water. The main reaction that takes place can be briefly described as follows:

$$NH_2CONH_2 + 2\,NO + 1/2\,O_2 \rightarrow 2\,N_2 + CO_2 + 2H_2O$$

The reduction takes places within a temperature range of 850 to 950 °C. This range exists in the secondary combustion chamber of the furnace (the first pass of the boiler). In this area an aqueous urea solution is injected into the flue gas.

Temperatures higher than 1000 °C trigger undesired secondary reactions according to the above formulas and are responsible for higher ammonia consumption. At temperatures below 800 °C the efficiency of NOx separation declines considerably and a large portion of the injected reactant is routed to the flue gas treatment system without having been used.

Due to the changing temperature profile in the boiler several injection levels are required.

Figure 18: View of SNCR injection lances

4.8.2 Dry Flue Gas Cleaning

The proposed development would use a dry or semi-dry flue gas cleaning system downstream of the boiler to control the air emissions. Hydrated lime is injected into the flue gas where it neutralises acidic components such as hydrogen chloride, hydrogen fluoride and sulphur dioxide. At the same injection point activated carbon is added to the flue gas that adsorbs dioxins and furans, gaseous mercury, and other components. In case of using a semi-dry system some water is injected to quench the flue gas down to a temperature range where the chemical reactions proceed favourably whereas in case of a dry system the cooling is down by heat exchanger.

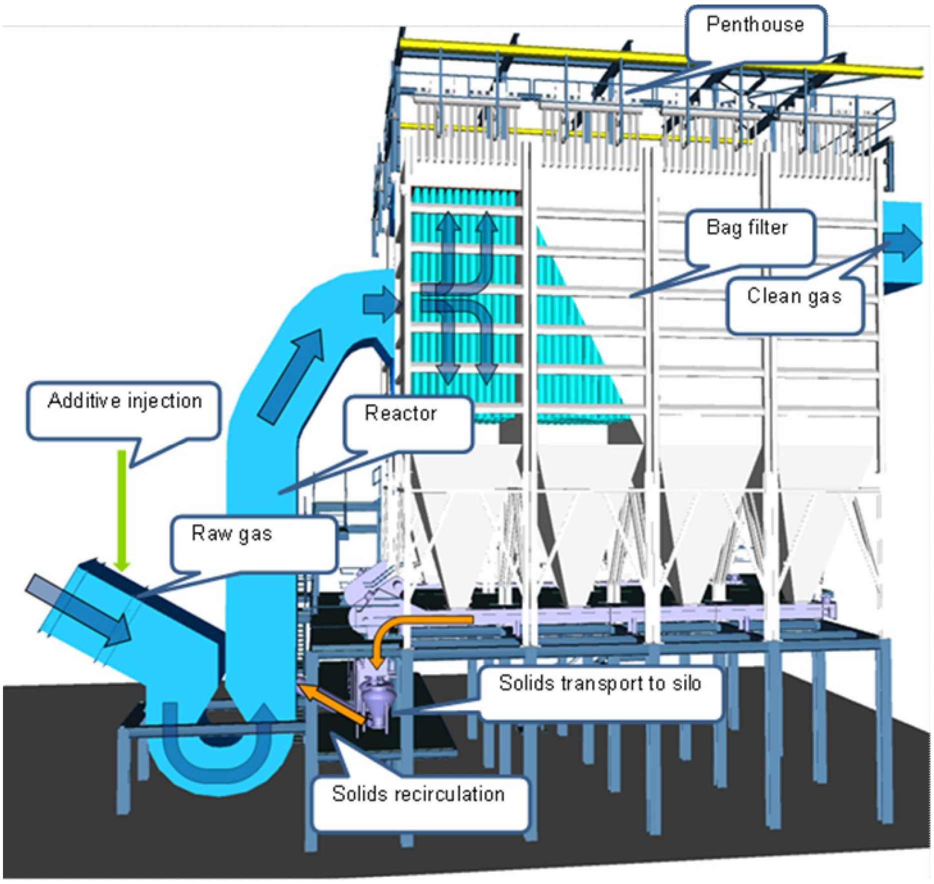

Figure 19: Dry Flue Gas Cleaning

Downstream the injection of the reactants the flue gas passes through a fabric filter (bag filters) which trap fine particulates. Some of the spent lime is recycled to optimize the consumption of the reactants. Periodically, the fabric filters are cleaned by a reverse pulse of air, and the flue gas residues collected for disposal.

An induced draught fan maintains the flue gas flow through the process overcoming the pressure loss through the system. Before the cleaned gas is released to the atmosphere at the stack the emissions are monitored in the continuous emission monitoring system (CEMS).

4.9 Plant emissions

The EfW process is required to meet the Industrial Emission Directive (IED), for concentrations of pollutants in the exhaust gas in the following substances:

- total particulates (dust) PM_{10}
- carbon monoxide (CO), acid and corrosive gases - hydrogen chloride (HCl), hydrogen fluoride (HF), sulphur dioxide (SO_2) and oxides of nitrogen (NOx);
- heavy metals - cadmium (Cd), mercury (Hg), lead (Pb) and other heavy metals;
- organic compounds - dioxins, furans and volatile organic compounds (VOCs).

Emissions Monitoring

Emissions from the stack will be monitored using certified Continuous Emissions Monitoring Systems (CEMS) for: particulates, carbon monoxide (CO), sulphur dioxide (SO_2), hydrogen chloride (HCl), oxygen (O_2), nitrogen oxides (NOx) and Volatile Organic Compounds (VOC).

In addition to the continuous monitoring, periodic sampling and measurement will be undertaken for nitrous oxide (N_2O), hydrogen fluoride (HF), cadmium (Cd), thallium (Tl), mercury (Hg), antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn), nickel (Ni), vanadium (V), dioxins and furans and dioxin like PCBs.

Periodic measurements will be carried out typically four times in the first year of operation and twice per year thereafter.

The Facility will include a dedicated certified duty CEMS for each line and a further hot standby CEMS which will ensure that there is continuous monitoring data available even if there is a problem with a duty CEMS system.

The process is supervised from the Control Room, with continuous process and emissions monitoring to ensure satisfactory operation and performance. The site staff will be fully trained in the use of the selected technology.

A list of projects for the last 10 years for plants built by HZI in compliance with the IED (Industrial Emissions Directive), the successor of WID, is attached.

The CEMS offers the option to stream the live data to the regulator and compile reports over any chosen time period.

4.10 High efficient EfW plants, the R1 calculation

HZI has built high efficient EfW plants in Europe fulfilling the R1 criteria of Directive 2008/98/EC and its link to the Best Available Techniques for Waste Incineration (BREF WI). Plants with a R1 value of >0.65 (>0.58 for plants at locations with low heating degree days HDD such as Perth) qualify as recovery plants in Europe. An overview with examples of high efficient EfW plants recently built by HZI and currently in operation is attached.

For the Rockingham WtE facility, despite a much higher yearly average ambient temperature (Perth area) compared for example to the UK plants, thus negatively affecting the cooling potential of the air cooled condenser (ACC) and decreasing the steam turbine power output, we would still expect a highly efficient R1 factor in the range of ~0.77. Thus, Rockingham WtE would qualify as a recovery plant according European regulation.

A preliminary R1 calculation for the East Rockingham WtE plant is attached.

Combined with the metal and aggregate recycling from bottom ash, the East Rockingham WtE and MRF project will be exactly what its name says ï a highly efficient Waste to Energy and Material Recycling Facility operation.

5 Attachments

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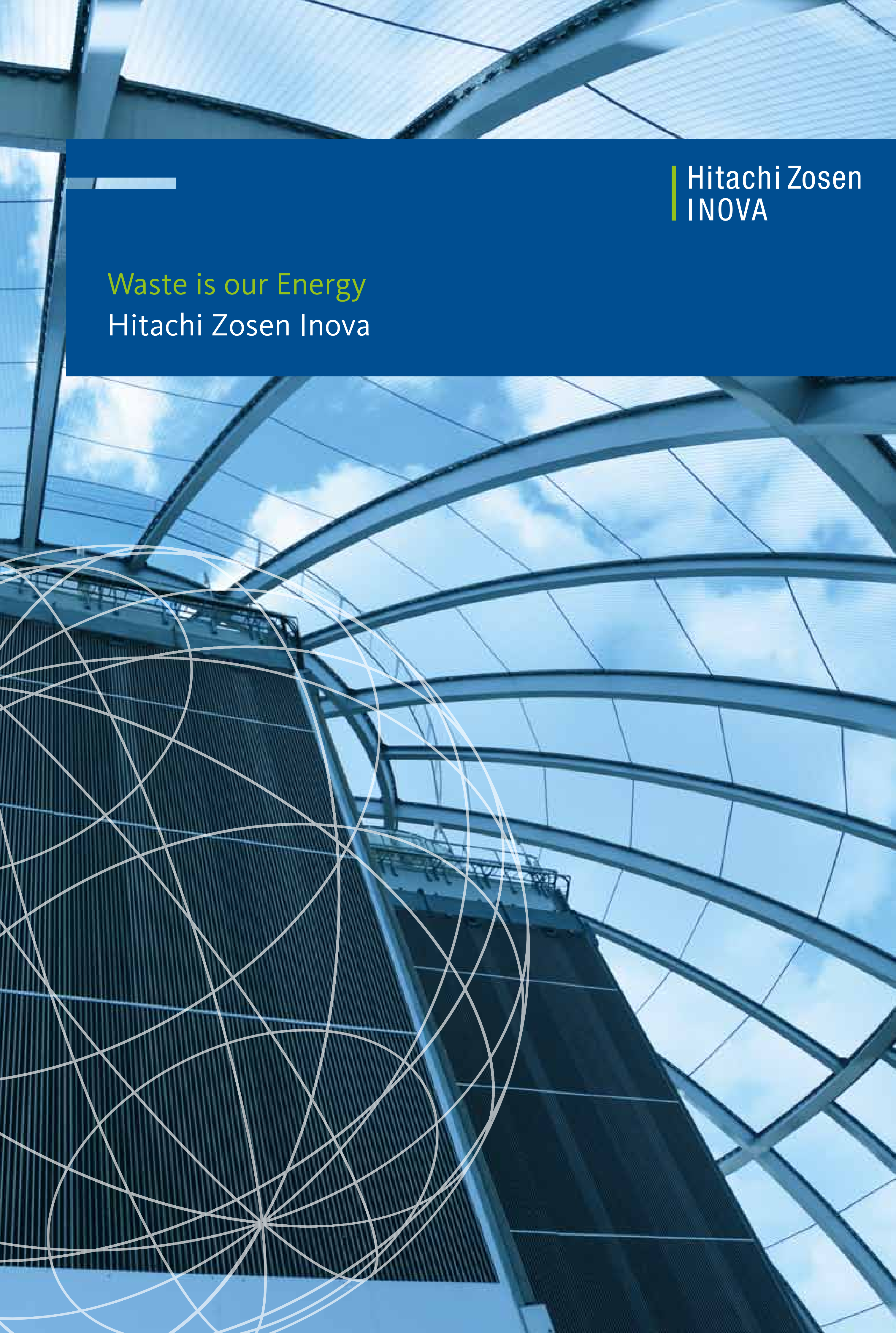
- HZI Company Brochure
- Reference Plants complying with IED since 2007

Hitachi Zosen INOVA

Waste is our Energy

Hitachi Zosen Inova



Waste is our Energy.
Engineering is our Business.
Sustainable Solutions are our Mission.

Technology

Service

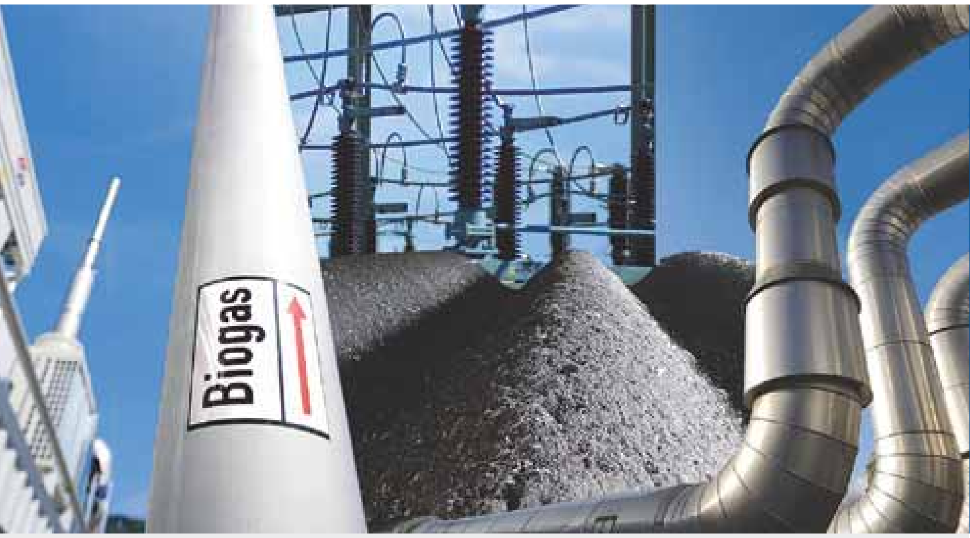
Hitachi Zosen Inova

We Build Turnkey EfW Plants with Our Own Technologies

Swiss clean-tech company Hitachi Zosen Inova (HZI) is a global technology leader for energy and material recovery from MSW, RDF, and organic waste. HZI acts as an engineering, procurement, and construction (EPC) contractor delivering complete turnkey plants. Our solutions are based on efficient and environmentally sound in-house technology, are thoroughly tested, can be flexibly adapted to user requirements, and cover the entire plant life cycle. HZI's portfolio is rounded off with strong operation and maintenance (O&M) capabilities.

HZI's customers range from experienced waste management companies and municipalities to up-and-coming partners in new markets worldwide. Our innovative and reliable solutions for grate combustion, anaerobic digestion, flue gas treatment, and material and energy recovery have been part of over 600 reference projects delivered since 1933.

Waste – A Global Challenge We Take On



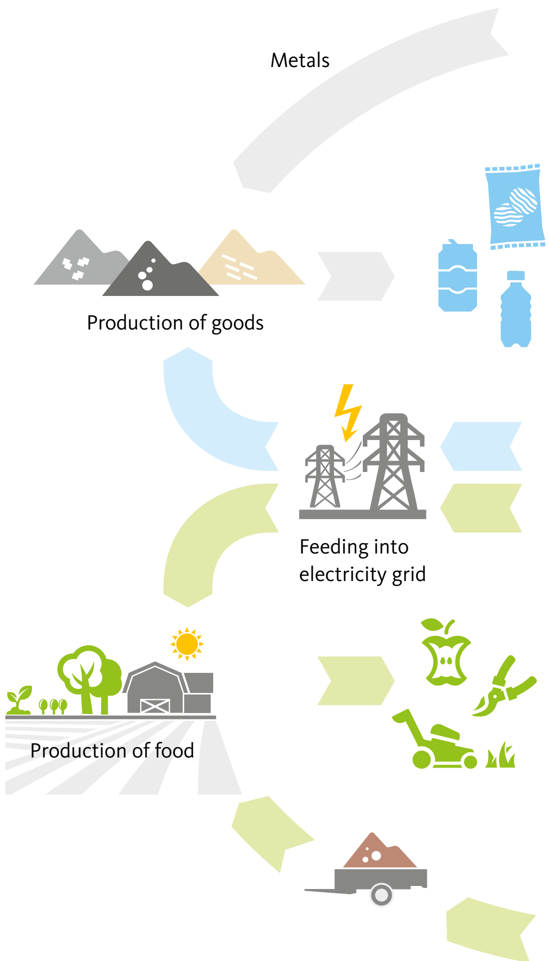
More Waste
The amount of waste worldwide is growing faster than the global population, with the production of municipal solid waste set to rise from 1.4 billion tons at present to 2.2 billion tons by 2025.

Less Landfill Capacity
A lack of landfill capacity, the negative environmental impact, urban hygiene, increasing costs, and tighter regulations require alternative solutions.

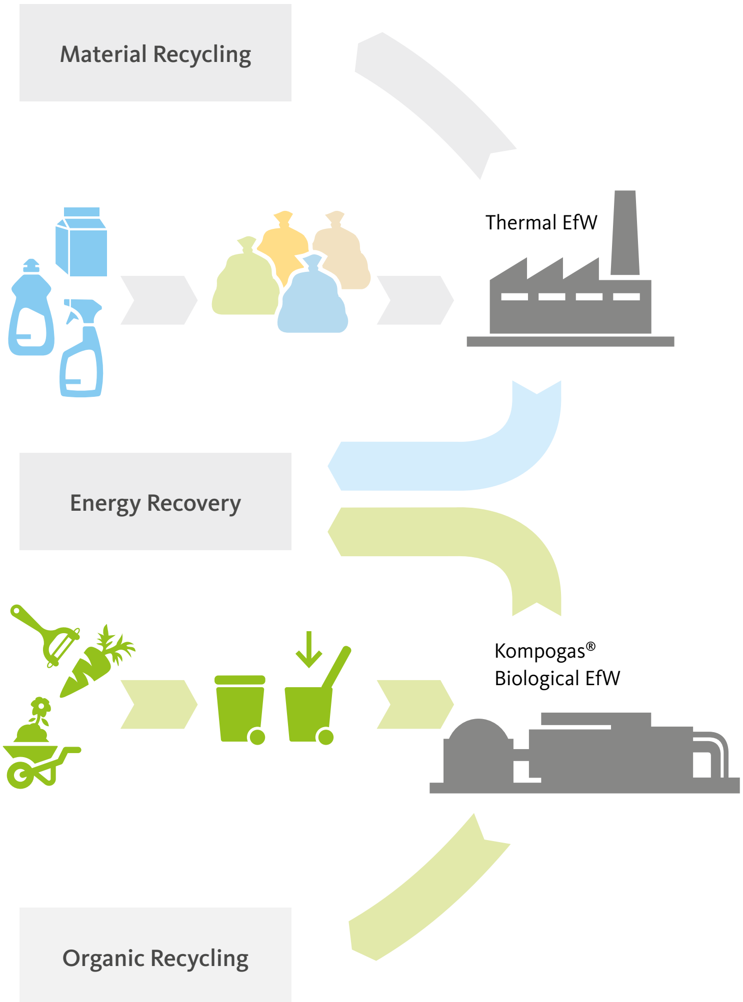
Demand for Energy and Resources
As natural resources become scarcer, the recovery of energy and raw materials from waste becomes more important.

Away from Landfill…
Landfills account for eight percent of the total greenhouse gas emissions. The negative impact on human habitat and the environment would be substantially reduced by replacing landfills. Landfill taxes and bans are supporting changes in waste management.

…to a Circular Economy.
Separate collection of direct recyclables and organic waste allows for material and energy recovery. Thermal treatment is used to recover energy and material from waste that cannot be recycled directly.



> “Converting non-recyclable waste materials into electricity and heat generates a renewable energy source and reduces carbon emissions by offsetting the need for energy from fossil sources and reduces methane generation from landfills.“
>
> | The United States Environmental Protection Agency



Collection, Separation …

The first steps of a sustainable waste management system are the reduction and complete collection of waste, as well as the separation of waste fractions that have a market value for recycling.

… and Energy from Waste …

Recovery of materials and energy from waste using thermal and biological waste treatment is an integral part of any modern waste management system focused on maximizing utilization of all resources contained in the waste and minimizing the adverse impact on society and the environment.

… Serve to Protect Human Habitat …

EfW not only decreases the volume of waste, it saves natural resources such as land and water. It also protects the air and climate because EfW plants reduce the greenhouse gases coming from landfill.

… and Ensure Sustainable Recycling.

A modern waste management system not only focuses on protecting health and the environment, it also makes maximum use of waste to reduce the exploitation of our limited natural resources. Hitachi Zosen Inova has two first-class in-house technologies for sustainable waste management aimed at bringing the world closer to a circular economy.

Hitachi Zosen Inova – Portrait

We deliver. Check our 600 references worldwide.

"Hitachi Zosen Inova's success is characterized by the combination of a pioneering spirit, long-term technological expertise, and a global focus. This is as true today as it was in 1933."

| Koichiro Anzai, Chairman of the HZI Supervisory Board

Pioneer in Thermal Waste Treatment

Hitachi Zosen Inova's roots go back to the foundation of "L. von Roll Aktiengesellschaft" in 1933, set up to focus on thermal waste treatment. Six years later, it delivered its first plant for the Dutch city of Dordrecht.

Emphasis on Technology

From the very beginning, the Swiss company developed proprietary and improved technologies, including the reciprocating grate, advanced methods for flue gas cleaning, and processes for the recovery of materials from residues.

Global Expansion

In 1960, Von Roll entered into a long-term license agreement with Hitachi Zosen Corporation, and opened its first offices in Germany and Japan. Subsidiaries were founded in France and Sweden in 1966, and in 1975 the company established a presence in the US. Since 2011, the renamed company and its subsidiary KRB have been part of Hitachi Zosen Corporation.

Reliability as a Commitment

As a licensee of the Von Roll technology, Hitachi Zosen Corporation implemented HZI's core technology in more than 200 energy-from-waste plants in Japan, China, and other countries throughout East Asia. Hitachi Zosen Inova and Hitachi Zosen Corporation combine the competencies of two strong partners in the EfW sector.

First-Class Waste Management Technologies and Services

In addition to the HZI grate combustion technology, the Kompogas® and BioMethan® technologies enhance Hitachi Zosen Inova's portfolio, allowing the company to extend its position as one of the world's leading providers of EfW plants and solutions. Offering both thermal and biological treatment of waste, Hitachi Zosen Inova is able to address the specific market requirements stemming from the separate collection of organic waste. HZI's portfolio is completed with HZI KRB's manufacturing capabilities and the construction and maintenance services of HZI Deutschland.

We Deliver Turnkey Plants

Engineering, Procurement and Construction
Hitachi Zosen Inova acts as a global EPC contractor for thermal and biological energy-from-waste plants. We are committed to delivering to our clients on schedule and within budget, and with a keen focus on safety and quality. We execute turnkey projects in international markets based on our wealth of experience in managing a wide range of projects, from equipment supply through to complete plant delivery.

Turnkey Plants
Hitachi Zosen Inova assumes overall responsibility for the construction of complex EfW plants. The concept and plant design for integrated solutions are based on our highly reliable technologies. Our success comes from decades of experience in planning and building turnkey plants around the world. Our turnkey capabilities cover all relevant EPC tasks, ranging from engineering to plant commissioning. Leveraging its innovative spirit and project management competence, Hitachi Zosen Inova guarantees highly efficient, forward-looking solutions that fully meet customer needs. Our project teams assure smooth project progress, timely coordination of suppliers and subcontractors, and compliance with technical, commercial, and regulatory requirements.

Health and Safety
Our health and safety strategy focuses on providing a safe and healthy working environment for all our employees and partners, with the aim of zero incidents.

Quality Management
The quality of our products and services is a key element in implementing our vision, mission, and related strategy. As quality is so essential to the success of our company, HZI introduced a comprehensive quality management system in accordance with the ISO 9001 standard back in 1992, and the system has been certified ever since.

All from a Single Provider
With us, your energy-from-waste projects are in good hands. We are capable of performing virtually any task relating to thermal and biological EfW. Our services include plant design and construction, plant operation, and maintenance and equipment servicing. We are there for you.

"Hitachi Zosen Inova is one of the major players on the market and has in house proven technologies and relevant capabilities for the supply of Turnkey EfW plants. We are operating EfW plants that Hitachi Zosen Inova has delivered as a professional and reliable EPC contractor."

| Jean Erkès, Senior Vice President Recycling and Recovery Projects, Suez

EfW plant under construction in Zorbau (Germany)



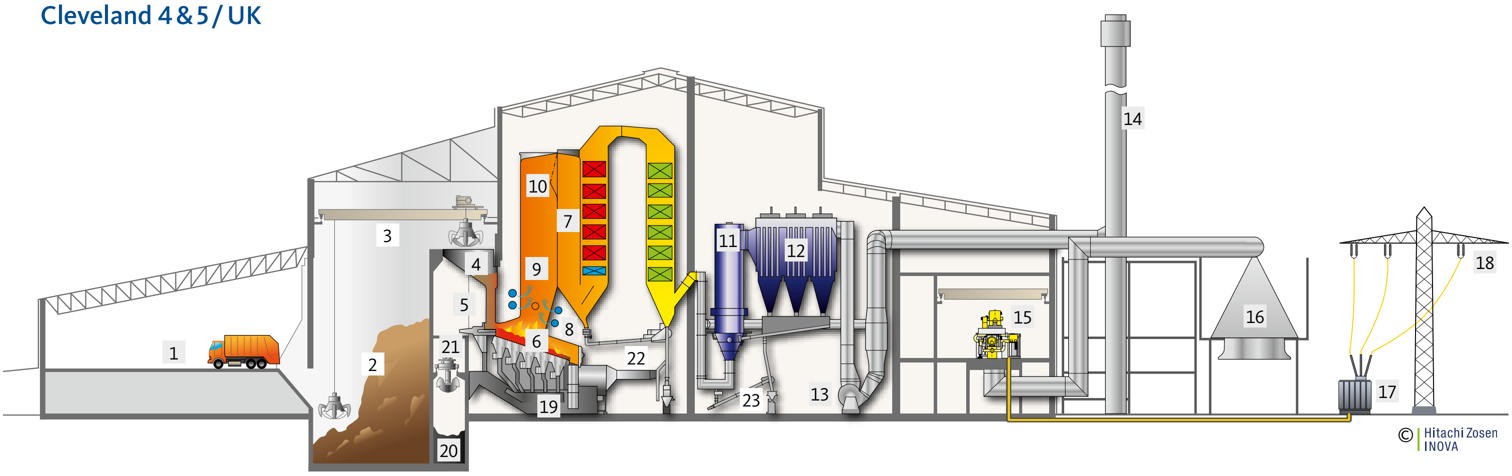
We Recover Energy and Material from MSW and RDF

Hitachi Zosen Inova's Thermal EfW Technology

Long-term, proven EfW solution with grate combustion, energy utilization, flue gas treatment, and material recovery.

Thermal EfW: Grate Combustion

Cleveland 4 & 5 / UK



Waste Delivery and Storage

1 Tiping hall
2 Waste pit
3 Waste crane

Combustion and Boiler

4 Feed hopper
5 Ram feeder
6 Hitachi Zosen Inova grate
7 Four pass boiler
8 Secondary air injection
9 Start-up burner

Flue Gas Treatment

10 SNCR injection levels
11 Semi-dry reactor
12 Fabric filter
13 Induced draft fan
14 Stack

Energy Recovery

15 Extraction-condensation turbine
16 Air cooled condenser
17 Trafo
18 Electricity export

Residue Handling and Treatment

19 Bottom ash extractor
20 Bottom ash bunker
21 Bottom ash crane
22 Boiler ash conveying system
23 Residue conveying system

> “Reliable, well proven technology and innovative solutions from HZI ensure highly efficient energy recovery combined with optimal material recycling, and minimize the adverse impact on the environment. We see this every day in our plant delivered by Hitachi Zosen Inova”
>
> | Olli Alonhiemi, Managing Director, Westenergy Oy Ab

Thermal Treatment of Waste – an Efficient, Environmentally Sound Solution for Modern Cities

Mixed municipal solid waste or RDF from sorting plants is delivered to the site and stored in a bunker. A crane both thoroughly mixes and feeds the waste into the feed hopper. From there it is pushed onto the grate by a ram feeder. A fully integrated control system ensures stable and efficient staged combustion, and optimized burn-off loss on the grate. Upon completion of the combustion, the residual ash falls into the wet or dry bottom ash extractor, from where it can be taken to a treatment facility for metal recovery and reuse of the inert material for road construction.

The flue gases from the combustion are cleaned to strictest standards in the downstream flue gas treatment system and are continuously monitored before being released into the atmosphere via the stack.

The energy in the flue gases is used to produce superheated steam, which is expanded in a turbine generator to generate electricity. Alternatively, the heat can be used for process steam supply, or also combined with the heat from flue gas condensation for district heating purposes.

Hitachi Zosen Inova’s thermal EfW plants are designed custom fit, for a big variety of heating values, throughputs, and methods of energy recovery. With HZI, you can rely on the experience we have gained in over 500 reference plants over more than 80 years, using our own technologies to deliver the highest energy efficiency and lowest residue production.

1 t of Waste

Up to 3.4 MWh heat

Up to 1.1 MWh electric power

Up to 200 kg recyclables

Thermal energy is extracted as steam or hot water, and can be converted into electricity.

Combustion Systems

Reliable Technology – Continuously Improved and Optimized

Grate combustion is the best-proven thermal waste treatment technology and has been successfully deployed in well over 1,000 plants. Thanks to continuous optimization, today's grate combustion is the most advanced technology with regard to environmental friendliness, operating reliability, flexibility, and cost effectiveness. The grate combustion technology we have developed in-house is specially designed for the thermal treatment of municipal solid waste and RDF.

Well-Proven Combustion Technology

A fully integrated control system ensures stable and efficient staged combustion, and optimized burn-off loss on the grate. The gases released from the waste in the bunker serve as primary air. Secondary air is mixed with recirculated flue gases above the grate. This assures complete combustion and lowest CO, NOx, and VOC emissions. Flue gas recirculation and low excess air enhance the energy efficiency of the plant.

Inova® Grate

The rugged construction of the grate and the heterogeneous waste fractions explain why grate combustion remains the most widespread method for thermal treatment of residual waste today. In fact, it forms the very heart of EfW plants, and is the technology of choice not only for untreated municipal and industrial wastes, but also for RDF and for pre-treated wastes.

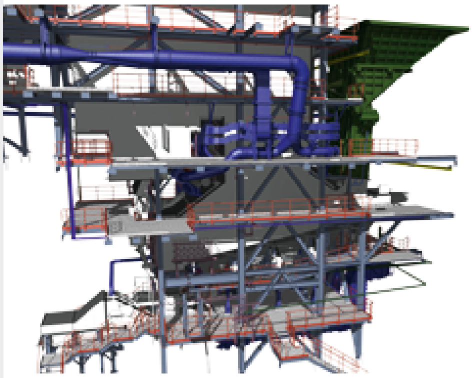
Conveying and Stoking to Perfection

From the feed hopper the ram feeder doses the waste onto the grate in a controlled way. The grate is composed of individual grate modules with alternating fixed and moving grate block rows. The hydraulically-driven moving grate blocks stoke the waste and convey it through the combustion chamber for optimum burn-out.

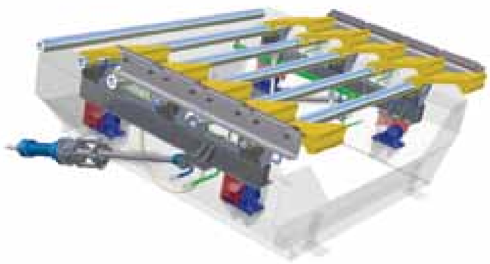
Individually Adapted Design

The number of grate modules depends on the specific throughput, the properties, and the calorific heating value of the waste. Various grate modules are assembled in rows and lines to suit each specific situation, with a capacity of between 4 and about 44 tons per hour. The air-cooled grate with its robust design has proven to be very reliable. Depending on the properties of the waste, it is the most favorable solution in terms of capital and maintenance costs. For high thermal loads with higher calorific values, water-cooled grate bars ensure optimum burn-out and an increased lifetime. They also offer a decisive advantage: In every zone, the airflow can be adjusted precisely to the combustion requirements.

HZI grate combustion



HZI grate element



Flue Gas Treatment

Clean Air Thanks to HZI Technologies
Emission limits for EfW plants are more stringent than for any other thermal power or process plant. This requires best available technologies (BAT) for pollution control. The pollutants introduced by the waste include combustion products like SOx, NOx, HCl, and HF, as well as substances such as heavy metals, dioxins, and dust. HZI offers a range of flue gas treatment processes that ensure complete cleaning in full accordance with the legal requirements.

Xerosorp® Dry Scrubbing – High Efficiency and Small Amounts of Residues
Our Xerosorp® process removes acidic gases by adsorption with sodium bicarbonate. In addition, activated carbon or coke can be injected for the removal of volatile organics and metals. Our Xerosorp+® process combines the advantages of the dry scrubbing process and the low temperature SCR DeNOx system for cases where highest removal efficiencies are required for fly-ash, acid gas, and NOx. Both the dry scrubbing and the SCR DeNOx processes operate at the same temperature, thus avoiding energy and heat losses. Maximum heat can be recovered prior to and after the Xerosorp+® process.

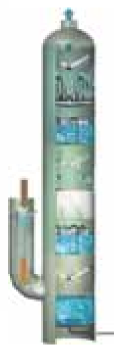
HZI Semi Dry – Economic and Reliable
The HZI Semi Dry process employs the principle of the circulating fluidized bed for efficient removal of acid gases by adsorption with hydrated lime. Recirculation of the reagents maximizes their use and provides excess reagent to capture contaminant peaks. In addition, activated carbon or coke can be injected for the removal of volatile organics and metals.

HZI Wet Scrubber – Pollutant-Free, Step by Step
Wet scrubbing is the most effective method for removing acid gases from even heavily burdened flue gases, and achieving lowest emission levels. The contaminants are captured by providing intensive contact between the flue gases and water, or by adjusting the pH through the addition of reagents.

HZI Condensing Scrubber – Higher Energy Efficiency
In addition to the advantages of the Wet Scrubber, the Condensing Scrubber allows for additional heat recovery by means of condensation of the water vapor contained in the flue gas. This delivers overall EfW plant energy efficiencies of up to 100% or more with the use of the heat for district heating.

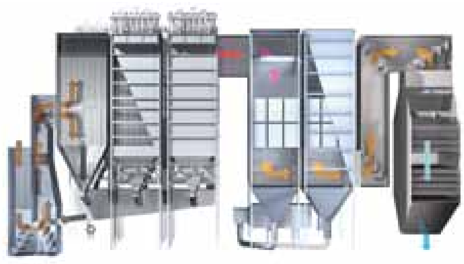
DYNOR® SNCR – Efficient NOx Removal
DYNOR® is the answer to Europe's tightened nitrogen oxide limits. Simple in design and easy to install, our non-catalytic DYNOR® process closes the gap between the costly SCR process and the conventional SNCR process. It is an investment which pays off.

HZI semi dry technology



HZI wet scrubbing technology

Xerosorp+® technology



Energy Recovery

Economical, Reliable, and Efficient
Recovering the energy content of waste is the key aspect in EfW plants. As the thermal EfW process is low in emissions and renewable to a great extent, it contributes to the reduction of greenhouse gases. The recovered energy is used in the way that best meets the needs of the client. Cogeneration, the simultaneous production of electric power and heat, offers high efficiency and maximum energy yield.

Electric Power – Proven Base-Load Power
The electric power plant concept is reliable and easy to operate, and has been optimized continuously. Superheated steam from the boiler drives a steam turbine connected to a generator. The electricity produced by the generator is fed into a public electricity network. Within the turbine, the steam expands and cools down. Thereafter it is condensed in an air or water-cooled condenser. To close the cycle, the condensate is pumped back into the boiler as feedwater and converted to steam again.

Thermal Power – District Heating or Industrial Facilities
If there is a beneficial use for heat, the steam cycle can be adjusted in various ways depending on the amount and temperature level of the required heat. The heat may be supplied directly as process steam for industrial use, or transferred as hot water to public district heating networks.

Combined Heat and Power – Multipurpose Energy Recovery
While a higher heat demand reduces electricity production, it increases the total energy efficiency of the complete plant. A fully redundant system ensures safe and reliable supply of heat and power around the clock and throughout the year.

Combined Cold and Power – Feeding Public Networks
The combined cold and power plant concept allows the use of heat in countries where rather air conditioning is required than heating. The electricity produced by the generator is fed into a public electricity network. Part of the steam is extracted from the turbine at a higher pressure. It drives an adsorption chiller that converts the heat into cold water, which reaches the consumers via a district cooling network.

Electricity from waste

1 t of Waste

Up to 4.6 t steam

Up to 3.4 MWh heat

Up to 1.1 MWh electric power

Thermal energy can be converted into electricity or extracted as steam or hot water for district heating.

Material Recovery

Reusing Most Materials
Thermal waste treatment plants produce bottom ash and flue gas treatment residues which can be either reused or landfilled. The bottom ash consists mostly of non-combustible waste components such as glass, minerals or scrap metals. The volume and nature of the residues produced in the flue gas cleaning depend mainly on the composition of the waste. With an intelligent secondary treatment process, large parts of these materials are reused.

InovaRe by HZI – Efficiently Recovering Metals from Waste
Maximum metal recovery to high standards of purity, less need for landfill, and a reduced burden on the environment: InovaRe enables valuable metals to be recovered from waste. Thermal treatment in the furnace is followed by a dry discharge of bottom ash, which is then processed. This allows metals such as iron, aluminum, zinc, copper, silver, and gold, to be recovered – all while maximizing energy efficiency and without additional emissions. The high level of purity achieved by this process means large volumes of precious materials can be recovered, creating a source of substantial earnings over the long term. InovaRe also makes a major contribution to saving resources and protecting the environment.

Fly Ash Washing – Stabilization and Product Recovery
If fly ash is collected separately from bottom ash and flue gas cleaning residues, two different methods may be applied to remove or immobilize fly ash contaminants. Acid washing of fly ash using acidic scrubber blowdown removes heavy metals in a recyclable form, and produces a fly ash which can be disposed of with the bottom ash. Neutral washing is followed by solidification to condition the fly ash into a leach-resistant matrix, which can then be used for construction purposes.

Effluent Treatment – Capture and Recycle Contaminants
The effluent treatment process neutralizes blowdown from wet flue gas scrubbers or from fly ash washing, and removes contaminants such as heavy metals, ammonia or persistent organic pollutants (POPs). Depending on the plant configuration, some contaminants such as mercury or zinc can be recovered for recycling. The only remaining components in the cleaned effluent are naturally occurring salts such as sodium and calcium chlorides and sulfates.

Metals and minerals for recycling recovered from bottom ash.

1 t of Bottom Ash:

Up to 27 kg of aluminum 

Up to 12 kg of nonferrous heavy metals 

Up to 100 kg of ferrous metals 

Up to 150 kg of inerts 

Metals and inerts for reuse recovered from bottom ash.



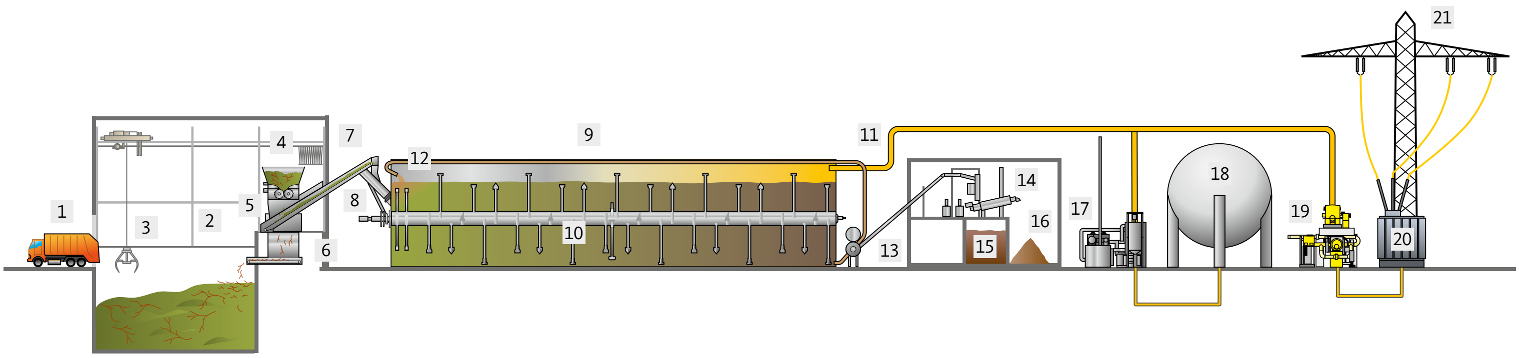
We Recover Energy and Material from Organic Waste

Kompogas® Biological EfW Technology

Dry fermentation with steel or concrete digesters for energy and material recovery and upgrading biogas to be fed into the natural gas grid.

Biological EfW:
Kompogas® – Dry Anaerobic Digestion

Vétroz Kompogas® plant / Switzerland



Waste Receiving and Storage

1 Waste receiving
2 Waste bunker
3 Waste crane

Anaerobic Digestion

4 Shredder
5 Sieve
6 Sieve rejects
7 Conveying system
8 Feeding system
9 Digester
10 Agitator
11 Biogas pipe

Discharge

12 Inoculation pipe
13 Discharge system
14 Dewatering press
15 Liquid digestate
16 Solid digestate

Energy Utilization

17 Biogas upgrading HZI BioMethan®
18 Gas storage
19 Combined heat and power plant
20 Transformer
21 Electricity export

"The Kompogas® technology allows us to transform organic waste energetically into biogas and energy, and to recycle the waste in the form of solid and liquid fertilizer. With this technology, we are contributing to sustainable waste management in the Botarell area."

| Hugo Urdaneta, Plant Manager, Kompogas® plant Botarell

Kompogas® is the Market and Technology Leader in Dry Fermentation Processes

The patented Kompogas® process is based on continuous dry fermentation of organic waste using a horizontal plug-flow digester. In this process the temperature in the digester is maintained at 55°Celsius. The average moisture of the fermenter's content is around 75 % and the retention time is approximately 14 days. The Kompogas® process ensures that the organic waste is fully converted to biogas and that the digestate is completely sanitized. The continuous, horizontal plug-flow digester allows a high biogas yield and assures highest operating reliability thanks to simple and efficient control systems. A low-speed agitator ensures the optimum biogas conversion. The special design of the agitator paddles prevents sedimentation of heavy and undesired matter in the substrate. Fermentation involves various upstream and downstream processes. In the feed unit, the organic waste is shredded and metals and other non-digestibles are removed. A discharge pump withdraws the digestate. Around one-third is pumped back for inoculation. The rest is either dewatered to produce compost and liquid fertilizer or mixed with green waste using the liquid fertilizer free partial flow process.

The Core Component of the Patented Kompogas® Process

Our digesters are available in two series as concrete or steel digesters. Both series are equipped with the same robust agitator components and can be deployed for all input materials, bio-waste, green waste and organic elements from the general waste collection. Two, three or more digester modules can be combined to form larger plants.

Bio Gas Upgrade for Feed-in

HZI BioMethan delivers gas treatment facilities, which can also be installed as an upgrade to Kompogas® plants. Two different processes are used to separate CO_2. One of these is pressure less amine scrubbing or alternatively a pressure controlled membrane process.

1 t Organic Waste

Up to 160 Nm³ biogas

Up to 390 kWh electric power

Up to 370 kg compost

Biogas can be converted into electricity, and after upgrading it can be supplied to the natural gas grid or used as fuel for engines.

We Take Care of Your Plant

Hitachi Zosen Inova Service Group

Operation, maintenance, retrofit, manufacturing, spare parts, and laboratory services

Hitachi Zosen Inova Service Group

Operation and Maintenance

For owners of EfW plants, the focus is on achieving maximum efficiency coupled with the highest economic benefit. HZI's clients are benefiting at the best from their invest. We work together with our clients to develop an efficient strategy that will ensure their EfW plant performs optimally in terms of availability, waste throughput, and energy recovery.

Remote support is possible with our special tool Pamela®. The plant can be monitored from our offices, giving us the full picture of all operational data. This allows us to make efficient decisions on interventions and optimizing the operating conditions. HZI's interactive training tool ITS simulates plant operations, and also covers health and safety aspects.

Retrofit

Tighter legislation and more stringent environmental and economic requirements are constantly presenting new challenges for plant owners. Together with Hitachi Zosen Inova Kraftwerkstechnik, we provide holistic solutions and the latest technologies to help tap the full potential for efficiency and performance gains at any plant. This includes modernization for extended service life, emission reductions for maximum ecological compatibility, and increased efficiency and higher steam output through constant supervision of heat exchangers. We focus on leveraging our resources to maximize your plant's performance.

"With the retrofit on the grate, boiler, bottom ash extractor, and flue gas treatment executed by HZI, we will be able to operate our plant for another 15 years with greater energy efficiency and a higher recycling rate."

| Romano Wild, CEO of the EfW plant in Horgen

Manufacturing
Hitachi Zosen KRB is specialized in manufacturing boilers parts and piping, and pride ourselves on maintaining long-standing partnerships with our customers. Since 1997, we have been providing products and services around thermal waste treatment to our customers in Switzerland and abroad. The spectrum includes manufacturing for steam generators, fabrication of membrane walls and tube bundles, cladding for boiler and combustion systems and constructing of standard or customized components.

Spare Parts Management
Spare parts management is complex, cost-intensive, and requires storage space. That is why it makes sense to entrust us with procuring and delivering wear components – we are quick, reliable, and experts in the field. Original spare parts are provided directly from stock. For our clients, this translates into savings in terms of expenditure and time.

Laboratory Services
HZI's laboratory is equipped to meet the demands of EfW plant operators. Our range of services is as broad as the variety of questions arising in connection with thermal and biological waste treatment. We check compliance with emission limits and performance guarantees, measure the relevant process parameters, and carry out root cause analysis in cases of operational problems. We bring together all the relevant EfW testing and analytical methods under one roof, including sampling, measurements and analysis on site, leading to very quick turn-around times.

Hitachi Zosen Inova – Our Commitment

Customers & Partners

Building on our long experience and in-depth know-how proven in numerous reference projects.

Culture

Focusing on reliability, and combining Swiss roots with Japanese tradition.

People

Fostering long-term relationships with a diverse mix of highly skilled employees.

Technology

Traditionally strong in optimizing energy extraction and flue gas treatment solutions based on state-of-the-art engineering.

Environment & Society

Committed to waste treatment as a social obligation, enhancing the waste sector with eco-friendly thermal treatment solutions for a better environment.

Health & Safety

We actively care for all our employees and partners so they return home safely every day that make us a successful and profitable business.

"What fascinates me about working at HZI is successfully tackling complex projects in interdisciplinary teams."

| Tobias Ruchty, project lead engineer, HZI

"Thanks to the implementation of Hitachi Zosen Inova's sophisticated HSE strategy, the incident statistics during the realization of the Renergia project were much lower than is usually the case."

| Ruedi Kummer, CEO, Renergia Zentralschweiz AG

HZI as Employer

Our employees come first: They are the key to our outstanding solutions. We offer our highly trained and qualified employees a rewarding environment where motivation, team spirit, creative involvement, and a philosophy of leadership are all actively fostered and encouraged. We value our people, and draw our strength from their drive, their passion for engineering, consulting and project management, and their in-depth expertise and experience.

HZI as Partner

We strive to be a trusted partner to our clients and stakeholders all over the world. With over 80 years of experience our aim is not only to build thermal and biological EfW plants worldwide, but also to be a fair partner towards our stakeholder Hitachi Zosen Corporation. The HZI commitment encourages us in the daily business and makes us a reliable partner for all kind of situations.

Code of Conduct

HZI will not tolerate discrimination, conflicts of interest, bribery and corruption, insider trading, political contributions, or non-compliance with the law. HZI and its employees respect the rules of fair competition and intellectual property rights. The business assets of HZI are used carefully and protected in accordance with good business practice.

Health Safety and Environment

HZI's HSE strategic and operational focus is on providing a safe and healthy working environment for all our employees and partners. HZI respects the natural environment, and we work to minimize our negative impact on it and our use of natural resources wherever possible. Built around our value of actively caring for our people and the environment, and coupled with our aim of zero incidents, our strategy is based on three core principles: **competence, compliance, and community.**

Our HSE strategy, policies, and procedures provide orientation, but it is our actions that demonstrate how we actively care for all our employees and partners, ensuring that they return home safely to their families every day.

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Hitachi Zosen INOVA

Energy from Waste Reference Projects

Plants complying with IED since 2007

in chronological order

GB, Ferrybridge Multifuel 2 (FM2)

Start of operation	2019	
Combustion	Concept	Air-cooled Grate
	Fuel	Municipal Solid Waste, Refuse Derived Fuel
	Number of Lines	2
	Throughput per line	42.26 t/h
	Thermal power per line	117.7 MW
Boiler	Concept	5-pass boiler
	Steam	148 t/h at 73 bar(a) and 430 °C
Flue gas treatment	Concept	SNCR, Fabric Filter, Semi-dry System
	Reactant	Calcium Hydroxide, Activated Carbon
	Throughput per line	238'866 m³/h (STP)
Energy recovery	Concept	Condensation Turbine
	Electric power output	79.17 MW (gross)
	Output	Electrical Power

GB, Edinburgh

Start of operation	2018	
Combustion	Concept	Air-cooled Grate
	Fuel	Municipal Solid Waste, Refuse Derived Fuel
	Number of Lines	1
	Throughput per line	24.00 t/h
	Thermal power per line	50.00 MW
Boiler	Concept	6-pass boiler
	Steam	66 t/h at 60 bar(a) and 400 °C
Flue gas treatment	Concept	Entrainment reactor, Fabric Filter
	Reactant	Calcium Hydroxide, Activated Carbon
	Throughput per line	103'178 m³/h (STP)
Energy recovery	Concept	Condensation Turbine
	Electric power output	12.49 MW (gross)
	Output	Electrical Power

IE, Dublin

Start of operation	2017	
Combustion	Concept	Air-cooled Grate
	Fuel	Municipal Solid Waste
	Number of Lines	2
	Throughput per line	41.00 t/h
	Thermal power per line	102.5 MW
Boiler	Concept	4-pass boiler
	Steam	125 t/h at 62 bar(a) and 443 °C
Flue gas treatment	Concept	SNCR, Fabric Filter, Scrubber, Semi-dry System
	Scrubber Reactant	Caustic Soda
	Reactant	Lignite Coke, Calcium Hydroxide
	Throughput per line	189'000 m³/h (STP)
Energy recovery	Concept	Condensation Turbine
	Electric power output	68.80 MW (gross)
	Output	Electrical Power, Hot Water

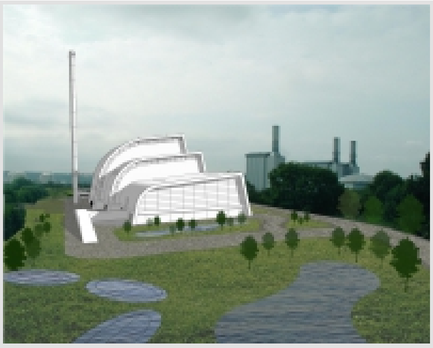
Hitachi Zosen INOVA

GB, Herefordshire and Worcestershire

Start of operation	2017	
Combustion	Concept	Air-cooled Grate
	Fuel	Municipal Solid Waste
	Number of Lines	1
	Throughput per line	30.55 t/h
	Thermal power per line	67.89 MW
Boiler	Concept	5-pass boiler
	Steam	89 t/h at 60 bar(a) and 415 °C
Flue gas treatment	Concept	SNCR, Fabric Filter, Semi-dry System
	Reactant	Calcium Hydroxide, Activated Carbon
	Throughput per line	126'000 m³/h (STP)
Energy recovery	Concept	Condensation Turbine
	Electric power output	20.00 MW (gross)
	Output	Electrical Power

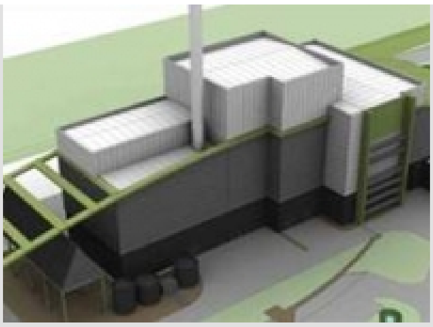
PL, Poznan

Start of operation	2016	
Combustion	Concept	Air-cooled Grate
	Fuel	Municipal Solid Waste
	Number of Lines	2
	Throughput per line	15.00 t/h
	Thermal power per line	31.50 MW
Boiler	Concept	4-pass boiler
	Steam	38 t/h at 62 bar(a) and 422 °C
Flue gas treatment	Concept	SNCR, Semi-dry System, Fabric Filter
	Reactant	Calcium Hydroxide
	Throughput per line	66'000 m³/h (STP)
Energy recovery	Concept	Condensation Turbine
	Electric power output	17.30 MW (gross)
	Output	Electrical Power, Hot Water



GB, Severnside L1, L2

Start of operation	2016	
Combustion	Concept	Air-cooled Grate
	Fuel	Municipal Solid Waste
	Number of Lines	2
	Throughput per line	24.24 t/h
	Thermal power per line	62.61 MW
Boiler	Concept	5-pass boiler
	Steam	78 t/h at 62 bar(a) and 422 °C
Flue gas treatment	Concept	SNCR, Semi-dry System, Fabric Filter
	Reactant	Calcium Hydroxide
	Throughput per line	127'000 m³/h (STP)
Energy recovery	Concept	Condensation Turbine
	Electric power output	37.40 MW (gross)
	Output	Electrical Power



GB, Buckinghamshire

Start of operation	2015	
Combustion	Concept	Air-cooled Grate
	Fuel	Municipal Solid Waste, Industrial Waste
	Number of Lines	1
	Throughput per line	39.40 t/h
	Thermal power per line	101.7 MW
Boiler	Concept	5-pass boiler
	Steam	127 t/h at 52 bar(a) and 402 °C
Flue gas treatment	Concept	SNCR, Fabric Filter, Semi-dry System
	Reactant	Activated Carbon, Calcium Hydroxide
	Throughput per line	180'714 m³/h (STP)
Energy recovery	Concept	Condensation Turbine
	Electric power output	26.50 MW (gross)
	Output	Electrical Power

GB, Ferrybridge

Start of operation	2015	
Combustion	Concept	Water-cooled Grate
	Fuel	Municipal Solid Waste, Biomass, Refuse Derived Fuel, Wood
	Number of Lines	2
	Throughput per line	42.25 t/h
	Thermal power per line	117.4 MW
Boiler	Concept	5-pass boiler
	Steam	104 t/h at 72 bar(a) and 427 °C
Flue gas treatment	Concept	SNCR, Fabric Filter, Heat Exchanger, Semi-dry System
	Reactant	Activated Carbon, Calcium Hydroxide
	Throughput per line	208'000 m³/h (STP)
Energy recovery	Concept	Condensation Turbine
	Electric power output	75.00 MW (gross)
	Output	Steam, Electrical Power

CH, Lucerne Perlen

Start of operation	2015	
Combustion	Concept	Water-cooled Grate
	Fuel	Municipal Solid Waste
	Number of Lines	2
	Throughput per line	15.60 t/h
	Thermal power per line	47.00 MW
Boiler	Concept	4-pass boiler with external economizer
	Steam	57 t/h at 41 bar(a) and 410 °C
Flue gas treatment	Concept	Entrainment reactor, Entrainment reactor 2, Electrostatic Precipitator, Ext. Eco, Fabric Filter, Fabric Filter 2, Heat Exchanger, Heat exchanger 2, SCR
	Reactant	Sodium Bicarbonate, Lignite Coke, Calcium Hydroxide
	Throughput per line	78'000 m³/h (STP)
Energy recovery	Concept	Condensation Turbine
	Electric power output	28.10 MW (gross)
	Output	Steam, Electrical Power, Hot Water

Hitachi Zosen INOVA

GB, Cleveland L4, L5

Start of operation	2013	
Combustion	Concept	Air-cooled Grate
	Fuel	Municipal Solid Waste, Industrial Waste
	Number of Lines	2
	Throughput per line	19.00 t/h
	Thermal power per line	45.85 MW
Boiler	Concept	4-pass boiler
	Steam	56 t/h at 50 bar(a) and 410 °C
Flue gas treatment	Concept	SNCR, Fabric Filter, Semi-dry System
	Reactant	Activated Carbon, Calcium Hydroxide
	Throughput per line	95'400 m³/h (STP)
Energy recovery	Concept	Condensation Turbine
	Electric power output	26.00 MW (gross)
	Output	Electrical Power

CH, Hinwil

Start of operation	2012	
Flue gas treatment	Concept	Entrainment reactor, Fabric Filter, Heat Exchanger, SCR
	Number of Lines	2
	Fuel	Municipal Solid Waste
	Reactant	Sodium Bicarbonate, Activated Carbon
	Throughput per line	87'500 m³/h (STP)

GB, Newhaven

Start of operation	2011	
Combustion	Concept	Air-cooled Grate
	Fuel	Municipal Solid Waste
	Number of Lines	2
	Throughput per line	14.50 t/h
	Thermal power per line	35.85 MW
Boiler	Concept	4-pass boiler
	Steam	44 t/h at 50 bar(a) and 400 °C
Flue gas treatment	Concept	SNCR, Semi-dry System, Fabric Filter
	Throughput per line	75'600 m³/h (STP)
Energy recovery	Concept	Condensation Turbine
	Electric power output	19.25 MW (gross)
	Output	Electrical Power

NO, Oslo

Start of operation	2011	
Combustion	Concept	Water-cooled Grate
	Fuel	Municipal Solid Waste, Industrial Waste
	Number of Lines	1
	Throughput per line	24.00 t/h
	Thermal power per line	66.70 MW
Boiler	Concept	4-pass boiler
	Steam	78 t/h at 42 bar(a) and 402 °C
Flue gas treatment	Concept	Electrostatic Precipitator (3 Fields), Heat Exchanger, Scrubber, Heat exchanger, Heat exchanger 2, Heat exchanger 3, SCR, Heat exchanger 2
	Scrubber Reactant	Lye
	Throughput per line	130'000 m³/h (STP)
Energy recovery	Concept	Back-pressure Turbine
	Electric power output	12.80 MW (gross)
	Output	Hot Water, Electrical Power

GB, Riverside, London

Start of operation	2011	
Combustion	Concept	Air-cooled Grate
	Fuel	Municipal Solid Waste, Industrial Waste
	Number of Lines	3
	Throughput per line	32.44 t/h
	Thermal power per line	81.10 MW
Boiler	Concept	4-pass boiler
	Steam	99 t/h at 72 bar(a) and 427 °C
Flue gas treatment	Concept	SNCR, Semi-dry System, Fabric Filter
	Throughput per line	169'800 m³/h (STP)
Energy recovery	Concept	Condensation Turbine
	Electric power output	73.00 MW (gross)
	Output	Electrical Power

NL, Roosendaal

Start of operation	2011	
Combustion	Concept	Water-cooled Grate
	Fuel	Municipal Solid Waste
	Number of Lines	2
	Throughput per line	21.00 t/h
	Thermal power per line	62.00 MW
Boiler	Concept	5-pass boiler
	Steam	76 t/h at 62 bar(a) and 422 °C
Flue gas treatment	Concept	Entrainment reactor, Fabric Filter, SCR
	Reactant	Sodium Bicarbonate
	Throughput per line	127'000 m³/h (STP)
Energy recovery	Concept	Condensation Turbine
	Electric power output	28.70 MW (gross)
	Output	Hot Water, Electrical Power

Hitachi Zosen INOVA

DE, Neunkirchen EEW

Start of operation	2011	
Flue gas treatment	Concept	Spray Dryer, Fabric Filter, Scrubber
	Number of Lines	2
	Fuel	Municipal Solid Waste
	Throughput per line	50'000 m³/h (STP)

NO, Bergen L2

Start of operation	2010	
Combustion	Concept	Water-cooled Grate
	Fuel	Municipal Solid Waste
	Number of Lines	1
	Throughput per line	16.00 t/h
	Thermal power per line	44.80 MW
Boiler	Concept	4-pass boiler
	Steam	57 t/h at 43 bar(a) and 402 °C
Flue gas treatment	Concept	SNCR, Fabric Filter, Scrubber, Semi-dry System
	Scrubber Reactant	Caustic Soda
	Reactant	Lignite Coke, Calcium Hydroxide
	Throughput per line	92'000 m³/h (STP)
Energy recovery	Output	Hot Water, Electrical Power

LU, Leudelange TABA

Start of operation	2010	
Combustion	Concept	Water-cooled Grate
	Fuel	Municipal Solid Waste
	Number of Lines	1
	Throughput per line	22.00 t/h
	Thermal power per line	67.00 MW
Boiler	Concept	3-pass boiler
	Steam	79 t/h at 40 bar(a) and 400 °C
Flue gas treatment	Concept	Entrainment reactor, Fabric Filter, SCR
	Reactant	Sodium Bicarbonate, Lignite Coke
	Throughput per line	136'642 m³/h (STP)
Energy recovery	Output	Electrical Power

BE, Intradel

Start of operation	2009	
Combustion	Concept	Water-cooled Grate
	Fuel	Municipal Solid Waste, Sewage Sludge
	Number of Lines	2
	Throughput per line	23.63 t/h
	Thermal power per line	67.10 MW
Boiler	Concept	3-pass boiler with external economizer
	Steam	80 t/h at 40 bar(a) and 400 °C
Flue gas treatment	Concept	Electrostatic Precipitator, Ext. Eco, SCR, Spray Absorber
	Throughput per line	141'000 m³/h (STP)

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AT, Zistersdorf

Start of operation	2009	
Combustion	Concept	Water-cooled Grate
	Fuel	Municipal Solid Waste
	Number of Lines	1
	Throughput per line	19.79 t/h
	Thermal power per line	57.80 MW
Boiler	Concept	4-pass boiler
	Steam	68 t/h at 42 bar(a) and 405 °C
Flue gas treatment	Concept	Entrainment reactor, Fabric Filter, SCR
	Reactant	Sodium Bicarbonate
	Throughput per line	97'000 m³/h (STP)
Energy recovery	Concept	Condensation Turbine
	Electric power output	14.90 MW (gross)
	Output	Electrical Power

ES, Mallorca

Start of operation	2009	
Combustion	Concept	Water-cooled Grate
	Fuel	Municipal Solid Waste, Sewage Sludge
	Number of Lines	2
	Throughput per line	27.00 t/h
	Thermal power per line	70.00 MW
Boiler	Concept	3-pass boiler
	Steam	82 t/h at 52 bar(a) and 400 °C
Flue gas treatment	Concept	Semi-dry System, Fabric Filter, Heat Exchanger, Heat exchanger 2, SCR, Heat exchanger
	Throughput per line	142'000 m³/h (STP)
Energy recovery	Output	Electrical Power

GB, Cleveland L3

Start of operation	2009	
Combustion	Concept	Air-cooled Grate
	Fuel	Municipal Solid Waste
	Number of Lines	1
	Throughput per line	19.00 t/h
	Thermal power per line	45.80 MW
Boiler	Concept	4-pass boiler
	Steam	55 t/h at 43 bar(a) and 400 °C
Flue gas treatment	Concept	SNCR, Fabric Filter, Semi-dry System
	Reactant	Calcium Hydroxide, Activated Carbon
	Throughput per line	94'600 m³/h (STP)
Energy recovery	Concept	Condensation Turbine
	Electric power output	10.00 MW (gross)
	Output	Electrical Power

DE, Witzenhausen

Start of operation	2008	
Combustion	Concept	Fluidized Bed
	Fuel	Refuse Derived Fuel, Pulp Sludge
	Number of Lines	1
	Throughput per line	34.92 t/h
	Thermal power per line	125.3 MW
Flue gas treatment	Concept	SNCR, Semi-dry System, Fabric Filter
	Throughput per line	207'100 m³/h (STP)
Energy recovery	Output	Steam, Electrical Power

CH, Giubiasco

Start of operation	2008	
Flue gas treatment	Concept	Electrostatic Precipitator (3 Fields), Ext. Eco, Fabric Filter, Fly Ash Treatment, Heat Exchanger, Heat exchanger 2, Heat exchanger 2, Heat exchanger 3, Heat exchanger, SCR, Scrubber, PAC Entrainment
	Number of Lines	2
	Fuel	Municipal Solid Waste
	Scrubber Reactant	Caustic Soda
	Reactant	Lignite Coke
	Throughput per line	67'430 m³/h (STP)

NL, Moerdijk L4

Start of operation	2008	
Combustion	Concept	Water-cooled Grate
	Fuel	Municipal Solid Waste
	Number of Lines	1
	Throughput per line	38.33 t/h
	Thermal power per line	95.80 MW
Boiler	Concept	2-pass boiler
	Steam	121 t/h at 107 bar(a) and 400 °C
Flue gas treatment	Concept	SNCR, Fabric Filter, Ext. Eco, Scrubber
	Scrubber Reactant	Lye
	Throughput per line	199'200 m³/h (STP)
Energy recovery	Concept	Back-pressure Turbine
	Electric power output	13.47 MW (gross)
	Output	Steam, Electrical Power

NO, Trondheim L3

Start of operation	2007	
Combustion	Concept	Water-cooled Grate
	Fuel	Municipal Solid Waste
	Number of Lines	1
	Throughput per line	17.29 t/h
	Thermal power per line	45.80 MW
Boiler	Concept	2-pass boiler
	Steam	911 t/h at 16 bar(a) and 180 °C
Flue gas treatment	Concept	SNCR, Semi-dry System, Fabric Filter, Scrubber
	Scrubber Reactant	Lye
	Throughput per line	84'000 m³/h (STP)
Energy recovery	Output	Hot Water

FR, Dunkerque

Start of operation	2007	
Combustion	Concept	Air-cooled Grate
	Fuel	Municipal Solid Waste
	Number of Lines	1
	Throughput per line	12.00 t/h
	Thermal power per line	29.30 MW
Boiler	Concept	4-pass boiler
	Steam	35 t/h at 40 bar(a) and 380 °C
Flue gas treatment	Concept	SCR, Scrubber
	Scrubber Reactant	Caustic Soda
	Reactant	Lignite Coke
	Throughput per line	50'000 m³/h (STP)
Energy recovery	Concept	Condensation Turbine
	Electric power output	6.00 MW (gross)
	Output	Electrical Power

FR, Issy-les-Moulineaux

Start of operation	2007	
Combustion	Concept	Water-cooled Grate
	Fuel	Municipal Solid Waste
	Number of Lines	2
	Throughput per line	34.90 t/h
	Thermal power per line	85.23 MW
Boiler	Concept	4-pass boiler
	Steam	104 t/h at 50 bar(a) and 400 °C
Flue gas treatment	Concept	Entrainment reactor, Fabric Filter, SCR
	Reactant	Sodium Bicarbonate, Lignite Coke
	Throughput per line	151'000 m³/h (STP)
Energy recovery	Output	Electrical Power, Hot Water

DE, Stassfurt EVZA

Start of operation	2007	
Combustion	Concept	Water-cooled Grate
	Fuel	Municipal Solid Waste, Industrial Waste
	Number of Lines	2
	Throughput per line	22.50 t/h
	Thermal power per line	55.60 MW
Boiler	Concept	4-pass boiler
	Steam	64 t/h at 40 bar(a) and 400 °C
Flue gas treatment	Concept	SNCR, Semi-dry System, Fabric Filter
	Throughput per line	116'000 m³/h (STP)
Energy recovery	Concept	Condensation Turbine
	Electric power output	28.14 MW (gross)
	Output	Steam, Electrical Power

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