BUDAPEST WASTE-TO-ENERGY PLANT

FKF

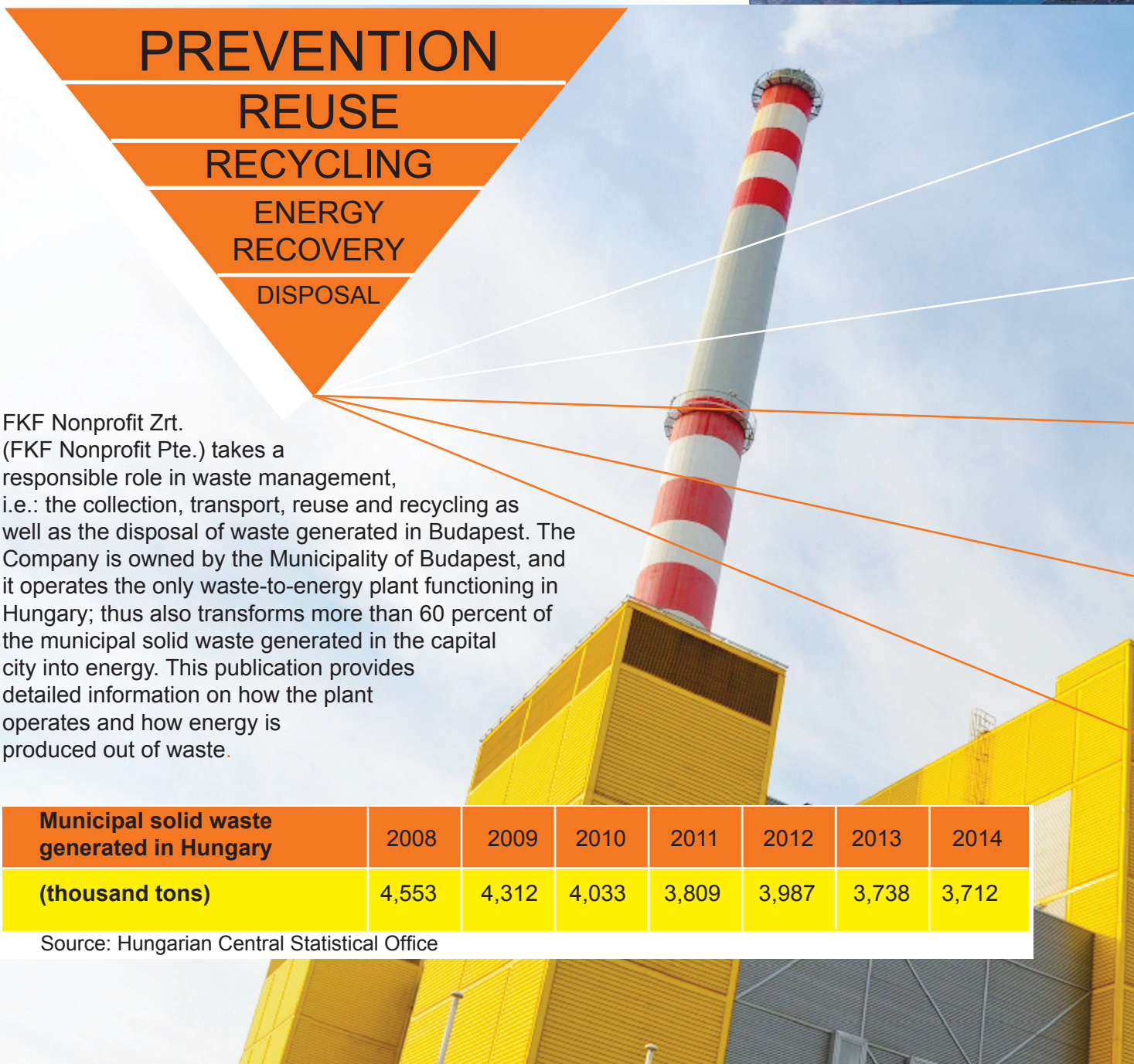
WASTE BUNKER

THE WASTE HIERARCHY

In a consumer society, people are continuously urged to buy more. With the accumulation of the different goods, more and more waste is generated, putting a heavy burden on our environment. The negative impact of waste on the environment can be reduced significantly if waste is treated with the right processes.

Waste is a material or an object that is or is to be discarded by its owner. Waste is different from garbage as – although it becomes useless where it was generated (households, factories, offices, agriculture, institutions, etc.) – it can be used as secondary raw material if collected separately according to different material types. **Garbage**, however, is a material or object that becomes useless and cannot be used further, thus it is removed from the cycle of economy.

Waste procession, disposal and recycling is a complex task since the different types cannot be treated in a unified way. Waste hierarchy which is defined in five steps provides help concerning the proper order in which waste should be treated.



FKF Nonprofit Zrt. (FKF Nonprofit Pte.) takes a responsible role in waste management, i.e.: the collection, transport, reuse and recycling as well as the disposal of waste generated in Budapest. The Company is owned by the Municipality of Budapest, and it operates the only waste-to-energy plant functioning in Hungary; thus also transforms more than 60 percent of the municipal solid waste generated in the capital city into energy. This publication provides detailed information on how the plant operates and how energy is produced out of waste.

Municipal solid waste generated in Hungary	2008	2009	2010	2011	2012	2013	2014
(thousand tons)	4,553	4,312	4,033	3,809	3,987	3,738	3,712

Source: Hungarian Central Statistical Office

1. The first and most important element of the hierarchy is prevention. Everyone should strive to minimise waste production. Nowadays it is a challenging task as almost every product one buys is pre-packed. Nevertheless, a conscious consumer does have a possibility to purchase goods with little or recyclable or reusable packaging.

2. The second step of waste hierarchy covers the preparation for reuse. It means that not every object which seems useless should be thrown out. These can be reused in their original forms after cleaning and repair. A machine part, for example, can function in another machine as well, or an outgrown piece of clothing can be given away or sold, and recyclable plastic bottles can be refilled after cleaning or used as an ornament.

3. The third step includes the recycling of waste materials. It makes separate waste collection inevitable. In the course of this process, materials sorted get reprocessed and resold.

4. The fourth step of waste hierarchy is energy recovery. Waste is incinerated in Budapest Waste-to-Energy Plant where district heating and electric energy is produced out of it. There are waste types from materials not to be recycled but their energy content can still be utilised in this plant.

5. The fifth and least environment-friendly solution is waste disposal in landfills. In the course of this process, waste is disposed of in a landfill site meeting environmental and environmental health regulations. Waste loses significant material and energy contents here. Efforts should be made so that only those waste types get disposed of in landfills which can be utilised in neither of the abovementioned steps of the hierarchy.

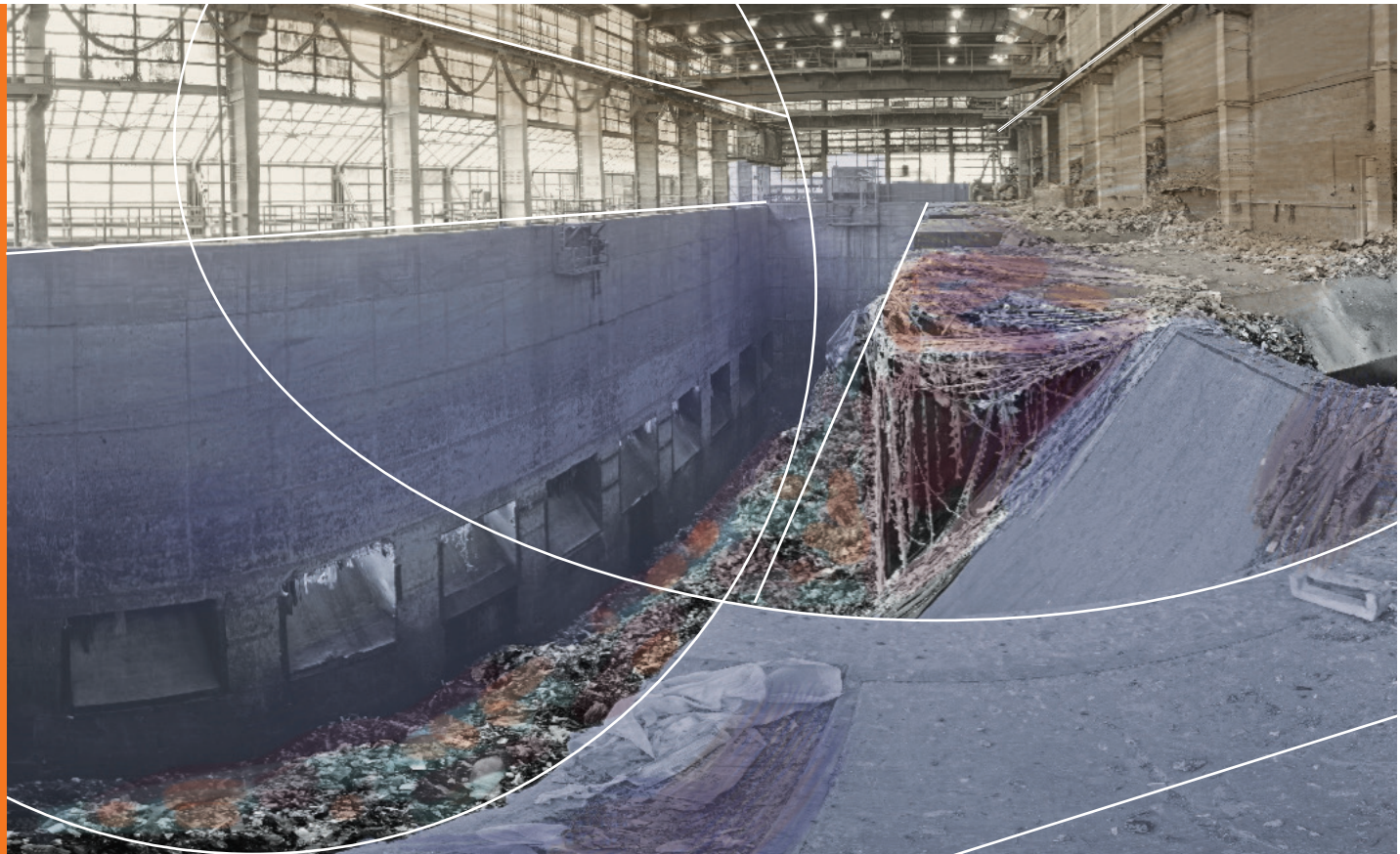
INTRODUCTION

FKF Nonprofit Zrt. goes back more than 120 years in its history (year of foundation: 1895). Its core activities include waste management which is partly based on Budapest Waste-to-Energy Plant as one of its main pillar.

Nearly 4 million tons of municipal solid waste is generated in Hungary every year, and 25 percent of it is generated in Budapest alone.

The waste-to-energy plant plays a significant role in utilising waste generated in Budapest. Only non-separately collected waste coming from the household dustbins is disposed here. Additionally, most of the bulky waste placed out to the streets during clearouts by residents is transported here as well. Nearly 60 percent of the municipal solid waste generated in Budapest is taken to Budapest Waste-to-Energy Plant where waste is incinerated and in this way district heating and electric energy is produced. Approximately 400,000 tons of waste is incinerated here a year, and more than 1 million GJ of energy is sold. This amount covers the electricity needs of some 140,000 people and the district heating needs of 25,000 people.

Several notes were recorded about the idea of the construction of the waste-to-energy plant already at the beginning of the past century, but the decision of the Council of Ministers was made only in 1976. Construction works started in 1977, and the plant was put into operation at the end of 1981.



The waste-to-energy plant was continuously reconstructed based on the experience gathered from practice. The biggest changes took place in 2002-2005 when a complete overhaul of the furnaces was made in line with European Union regulations and a flue gas cleaning facility was also put in place.

Due to the modern flue gas cleaning facility, the waste-to-energy plant puts far less burden on the environment than a landfill or an electric power generating plant utilising solid fuel. The process to generate energy out of waste is better for the environment as this way a significant amount of fossil energy carriers can be saved. 50 percent of municipal solid waste is of biological origin (e.g.: paper, organic food residues, wooden waste), and the carbon dioxide generated by incinerating them is climate-neutral.

The purpose of this publication is to dispel misconceptions in connection with Budapest Waste-to-Energy Plant and to provide reliable information to those interested in the thermal utilisation of waste.

1976

1977

1981

1988-1991

1991

HISTORY

2002-2005 installation of the new flue gas cleaning facility and overhaul of the boilers to increase energy efficiency

2005 the reconstructed plant is fully operational

2011 commissioning of the second turbine-generator

decision of the Council of Ministers on the construction of the waste-to-energy plant

beginning of construction and installation works

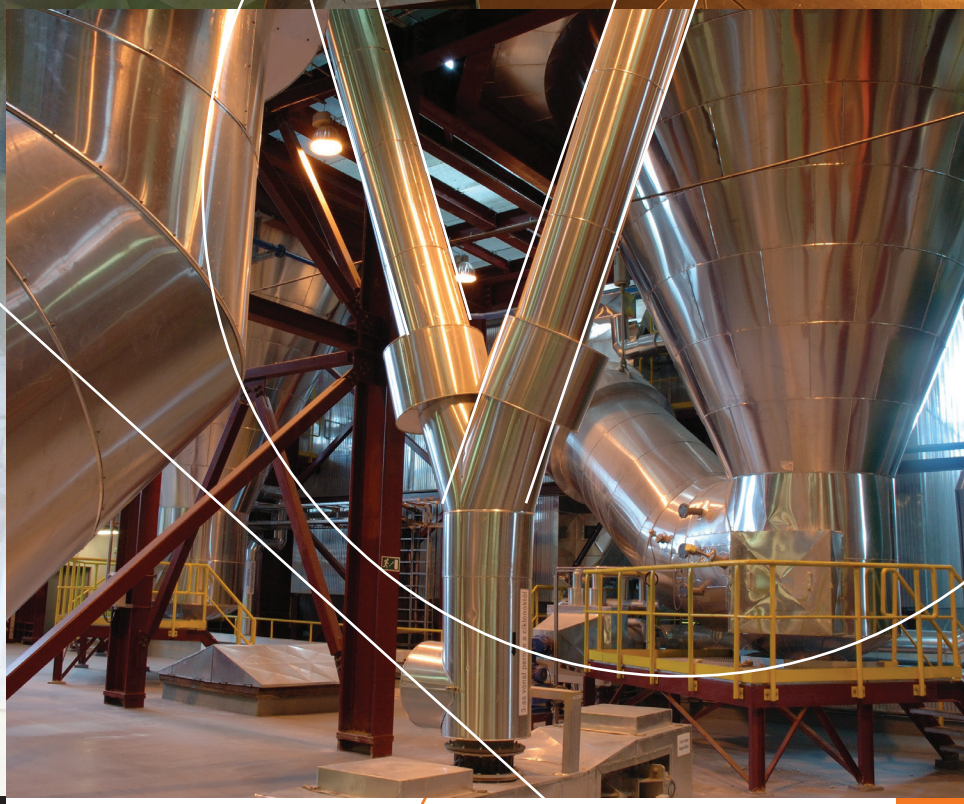
operations start

partial reconstruction of the boilers

due to legal regulations, reducing the emission from the plant becomes necessary

TECHNOLOGICAL DATA

number of boilers	4
combustion system	roller grates
incineration output per boiler	15 t/h
steam output per boiler	40 t/h
boiler type	single drum, natural circulation, membrane wall, four passes
steam parameters	40 bar, 405 °C
flue gas cleaning	semi-dry system
solid residue of combustion	slag



slag treatment	electromagnetic separation of scrap metal
residue treatment	slag, fly ash and other flue gas cleaning residues separately
energy recovery	electric power generation and district heating services
turbine-generator output	27 MW
temperature of flue gas leaving via the stack	130 C°
height of the stack	120 m

I. Waste incineration

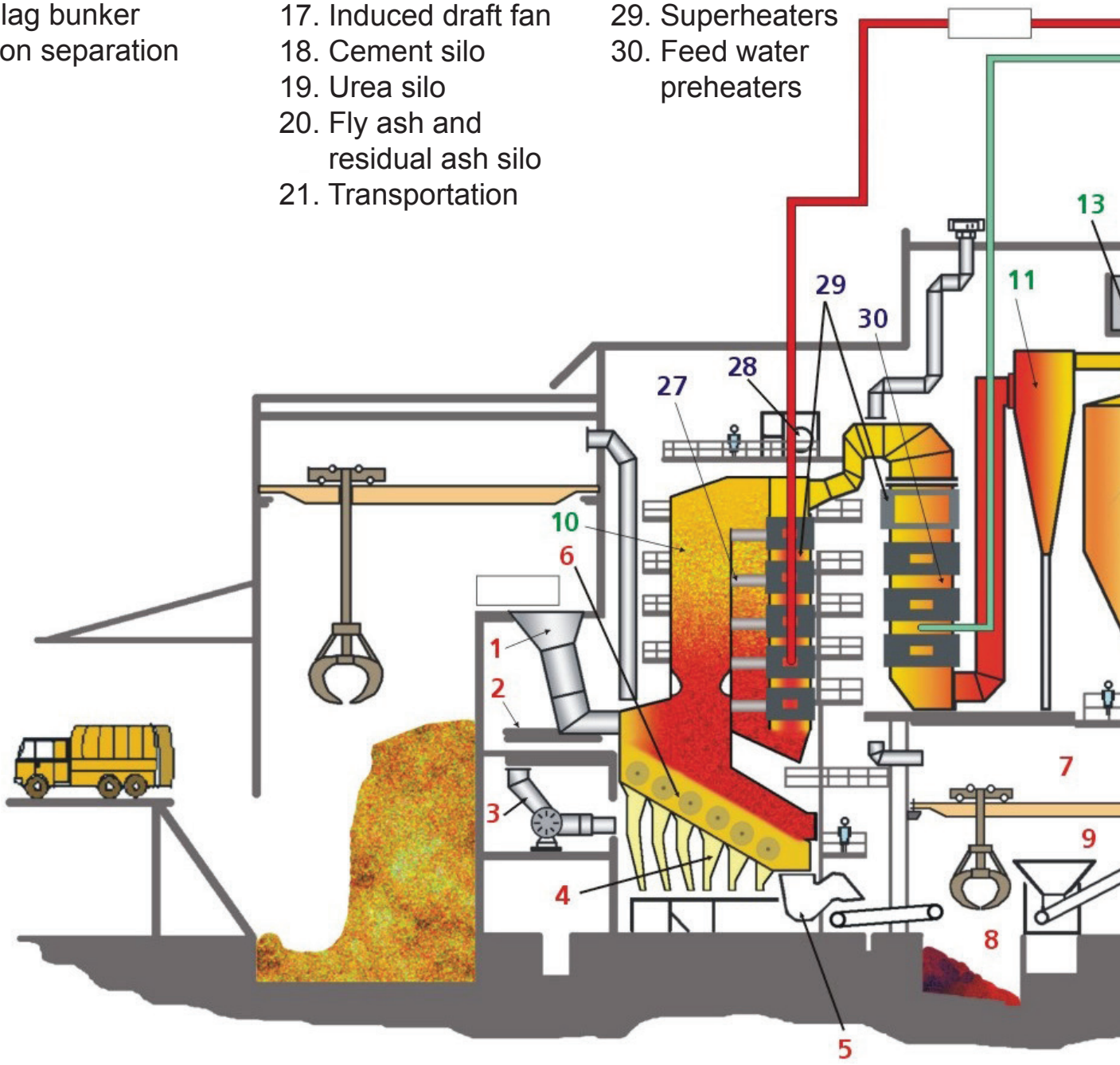
1. Feed chute
2. Waste feeder
3. Primary air fan
4. Air distribution chambers
5. Slag pusher
6. Roller grates
7. Slag treatment building
8. Slag bunker
9. Iron separation

II. Flue gas cleaning

10. Urea injection
11. Cyclones
12. Lime milk atomizer
13. Hydraulic unit
14. Absorber
15. Active coke blowing
16. Bag filter
17. Induced draft fan
18. Cement silo
19. Urea silo
20. Fly ash and residual ash silo
21. Transportation

III. Energy

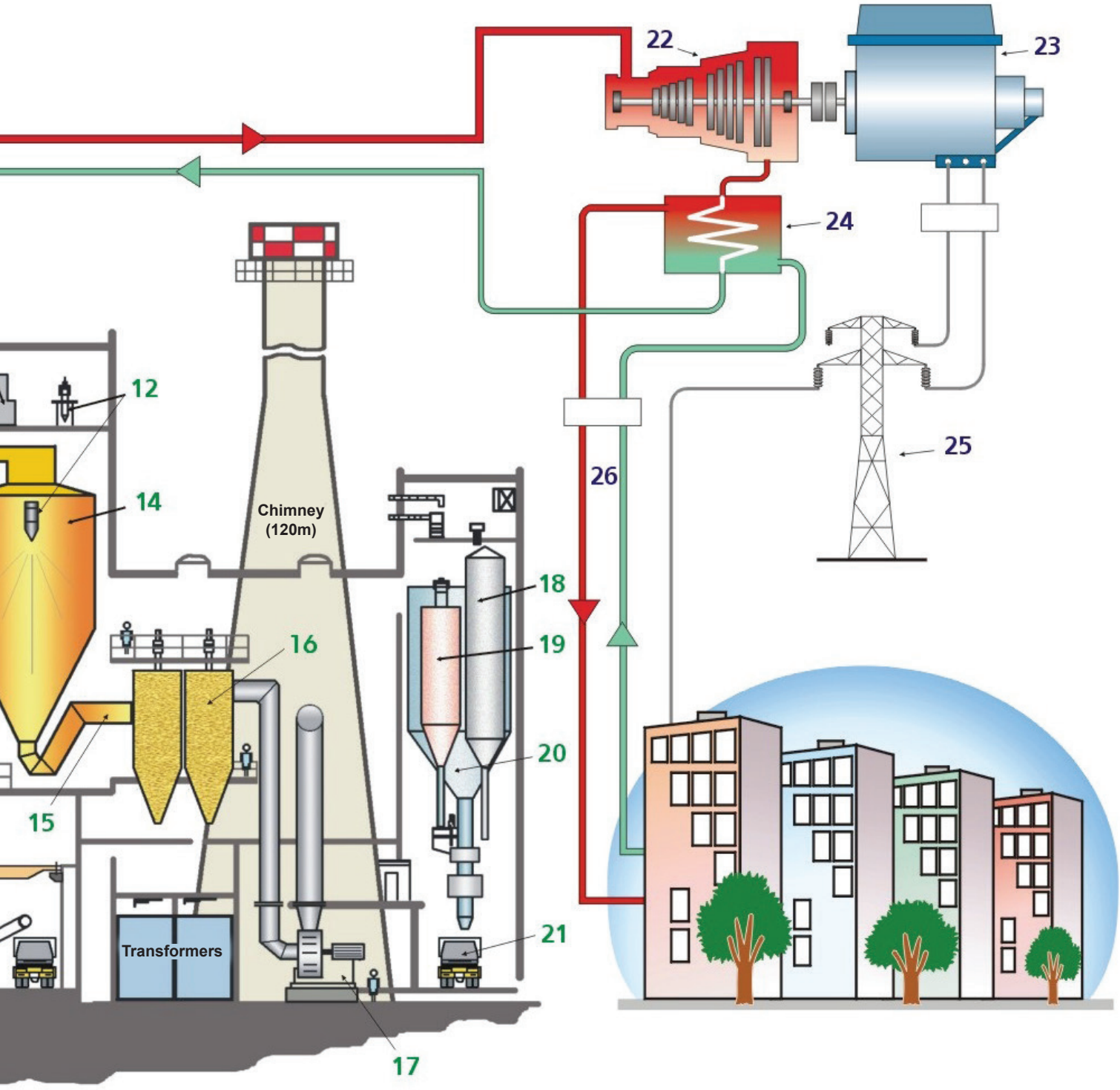
22. Turbine
23. Generator
24. Heat exchanger
25. Electric power transmission line
26. District heating system
27. Evaporator
28. Steam drum
29. Superheaters
30. Feed water preheaters



The flow chart of Budapest Waste-to-Energy Plant depicts the three pillars of the

TECHNOLOGICAL SYSTEM I-II-III.

Budapest Waste-to-Energy Plant Operational Flow-Chart



waste-to-energy technology: waste incineration, flue gas cleaning and power generation.

I. WASTE INCINERATION

Waste collecting vehicles entering the plant are weighed at the cargo gate on a weighbridge. The dead weight of all transportation vehicles is registered by the system, so it is easy and fast to determine the weight of the waste brought in.

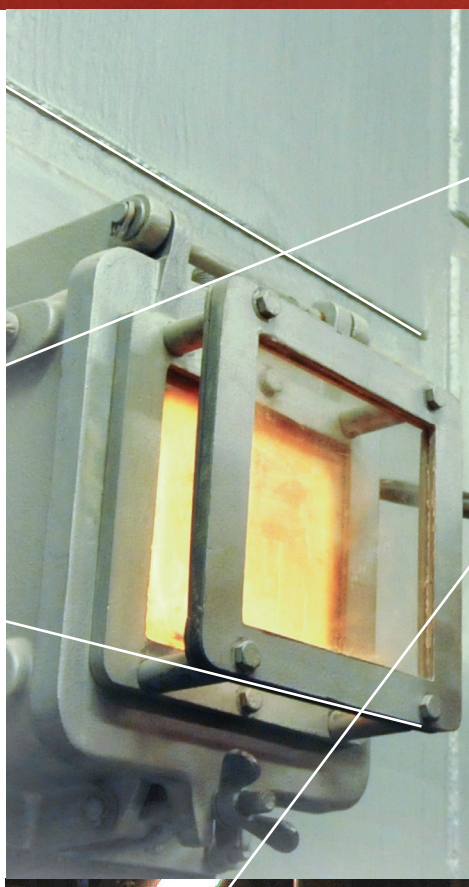
Did you know that on weekdays some 1100-2200 tons of waste a day is brought to the Budapest Waste-to-Energy Plant? This means that 250-300 waste collecting vehicles arrive every day, each of which collects waste equal to household waste from about 600 homes. The volume of the waste brought in every day would cover a football field 20 meter high, if not compressed.

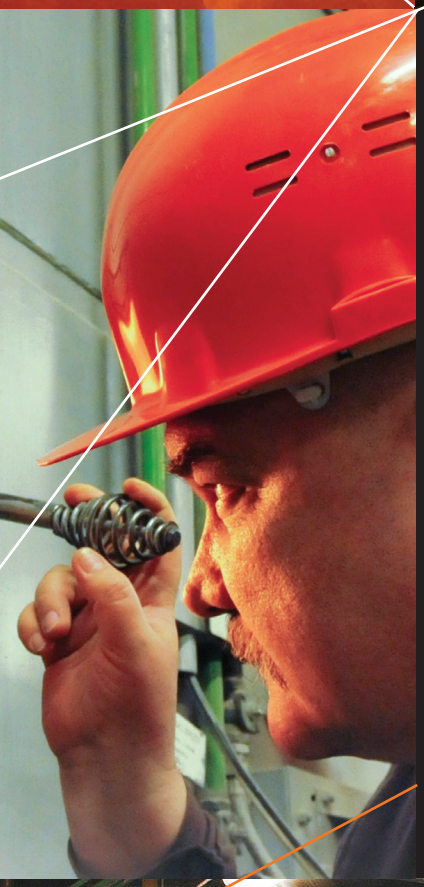
After determining the amount of waste brought in, the vehicles drive onto the ramp, then unload the waste into the waste bunker of a capacity of 10,000 m^3. Vehicles transporting bulky waste empty their load not directly to the waste bunker but into boxes dedicated for this purpose so that bulky waste items are placed in the waste bunker only after being grinded to a suitable size for incineration. The bulky waste grinder was purchased by the Municipality of Budapest by means of EU funding to avoid the disposal of bulky waste with high-calorific value in landfills. Instead of landfilling, these can be used for energy recovery.

There are two grabs each with a capacity of ten tons, mounted on a bridge crane in the waste bunker. These mix all the wastes up and feed them into the feed chute (1).

Did you know that in summer about 20-30% more waste is generated than in winter?

After the waste is fed into the feed chute by the grabs, gravitation slides it down to the waste feeder (2) from where a hydraulic cylinder pushes it into the furnace chamber. The waste is incinerated on a special roller grate consisting of six rolls, with a slope of 30 degrees (6). The rotation of each roll can be set individually by grades.
Primary air preheated to 140 °C is pushed from the bunker into the furnace chamber by a separate fan (3) through the roller grate. The air necessary for the individual rolls for incineration can be regulated separately with the help of the air distribution chambers belonging to the rolls of the roller grate.
Waste going through the roller grate during thirty minutes burns out completely, its combustible matter content decreases below 3%. Ferrous metals get selected from the slag amounting to 20wt% of the waste by means of electromagnets after it is being cooled. These ferrous metals are suitable for smelting, thus their materials are recyclable.





Did you know that the grab can lift 5 tons of waste at a time? (The machine itself weighs 5 tons) This means that it can feed two waste collector truckfuls of waste into the furnace by two grips.

Incineration is controlled automatically from the control room. The slag produced, which is about 23 per cent of the original mass, is dropped from the last roller grate into a water bath, where it is cooled and granulated.

A hydraulic arm pushes the slag from the bath into the slug bunker (7-8). The slag remover has a closed condensator type of water cooling system from where the waste water cannot escape.

Did you know that waste burns perfectly in the furnaces at 1000-1100 °C in 30 minutes?

Did you know that a large amount of iron can be found in waste? The slag treatment system selects some 5000 tons of iron a year with the help of electromagnets, which is sold for re-smelting. The slag from which iron had been removed is taken to the Dunakeszi landfill, where it is used as cover material.

II. FLUE GAS CLEANING

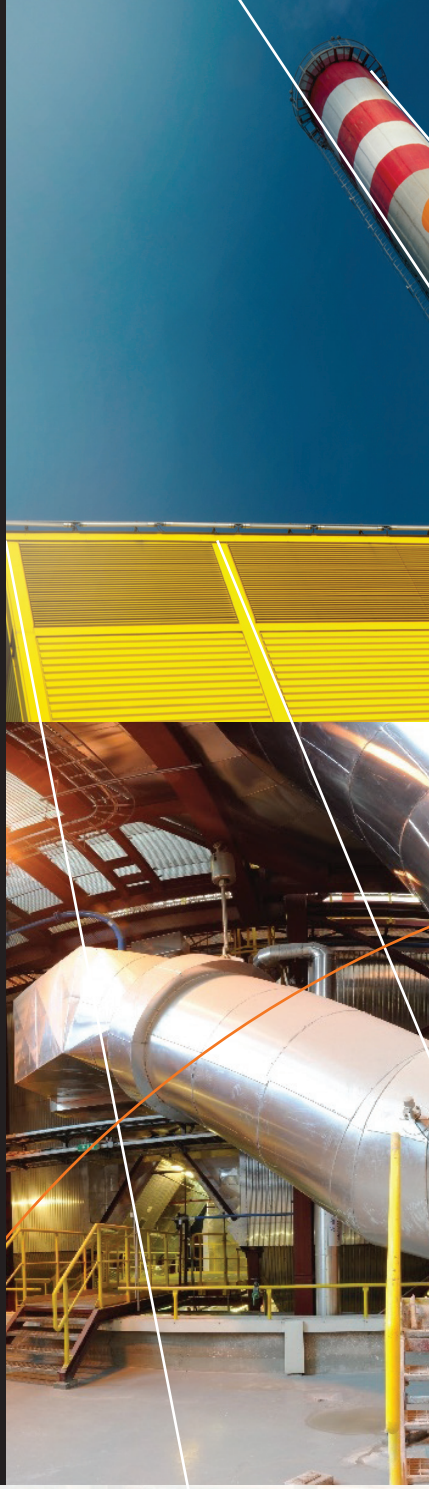
In line with environmental regulations, a flue gas temperature of at least 850 °C must be maintained for 2 seconds. Natural gas needs to be burnt to heat up the furnaces. A furnace needs an average of 12 hours to heat up. In case of wastes with lower heating value, 2 stabilizing natural gas burners each with a capacity of 2.6 MW can be used, and in the first phase also two natural gas burners each with a capacity of 16 MW can be used in the furnace chamber, as necessary, to reach the required flue gas temperature.

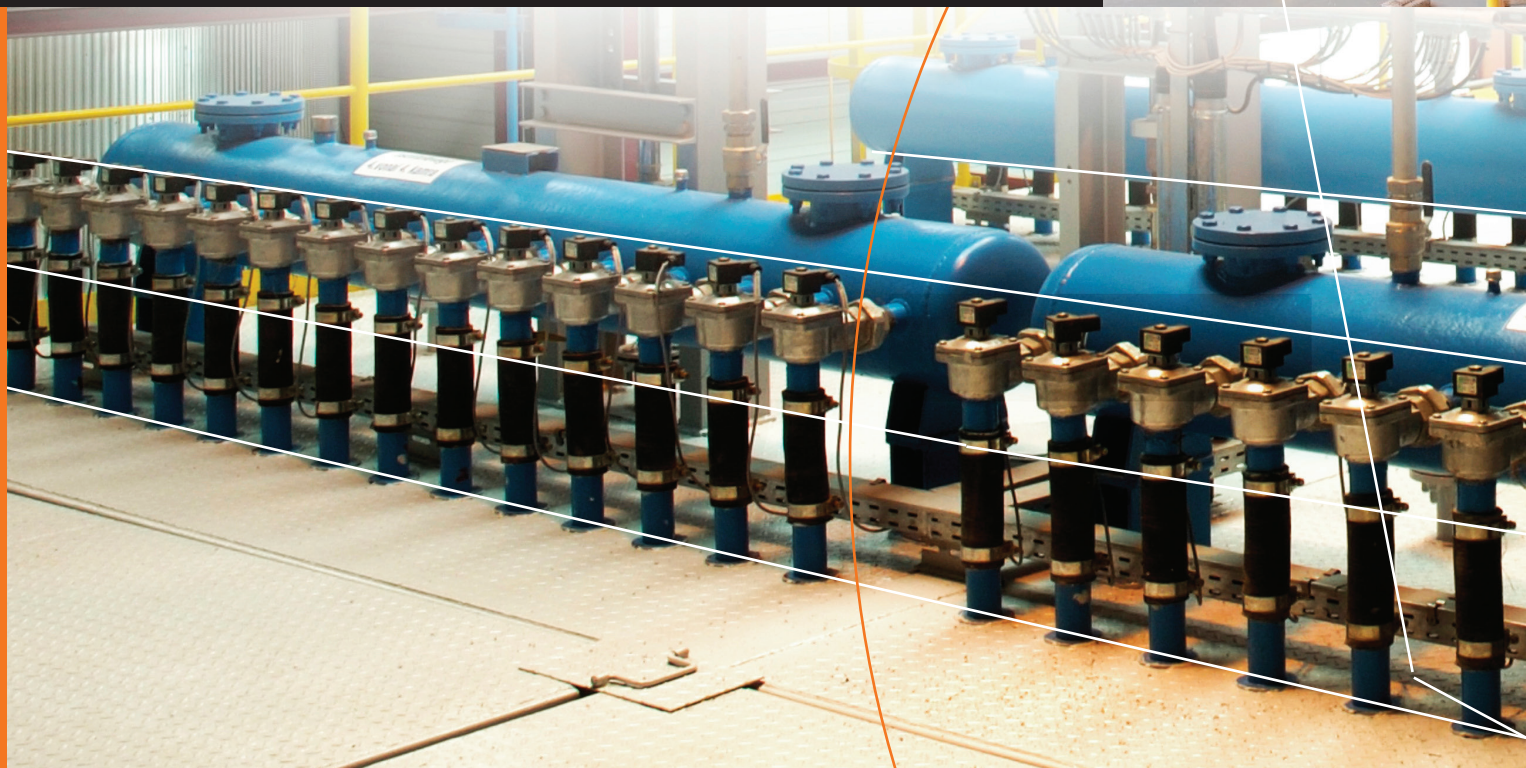
The first step of flue gas cleaning takes place already in the furnace by injecting urea-water-solution into the furnace chamber (10). This process is called the SNCR (Selective Non Catalytic Reduction) denox system, and the point is to reduce nitrogen oxides (intermediate in the industrial synthesis of nitric acid, indirect greenhouse gas). Urea is in the form of granulates when delivered to the waste-to-energy plant, and a 40% concentration solution is made there, using water.

The separation of solid pollutants of the flue gas is carried out in the double cyclones (11). In the course of the process, gravitation and centrifugal force separate the higher specific weight pollutants. The degree of efficiency is 80-90%.

The flue gas flows into the absorber (14), where milk of lime is injected in. A milk of lime atomizer injects the milk of lime with a speed of 8000 rotations/minute to neutralise acidic gases in the flue gas (hydrochloric acid and sulfur dioxide). The optimum temperature necessary for the absorption (around 140°C) is regulated by the amount of water injected. Due to the semi-dry nature of the process, no waste water leaves the system.

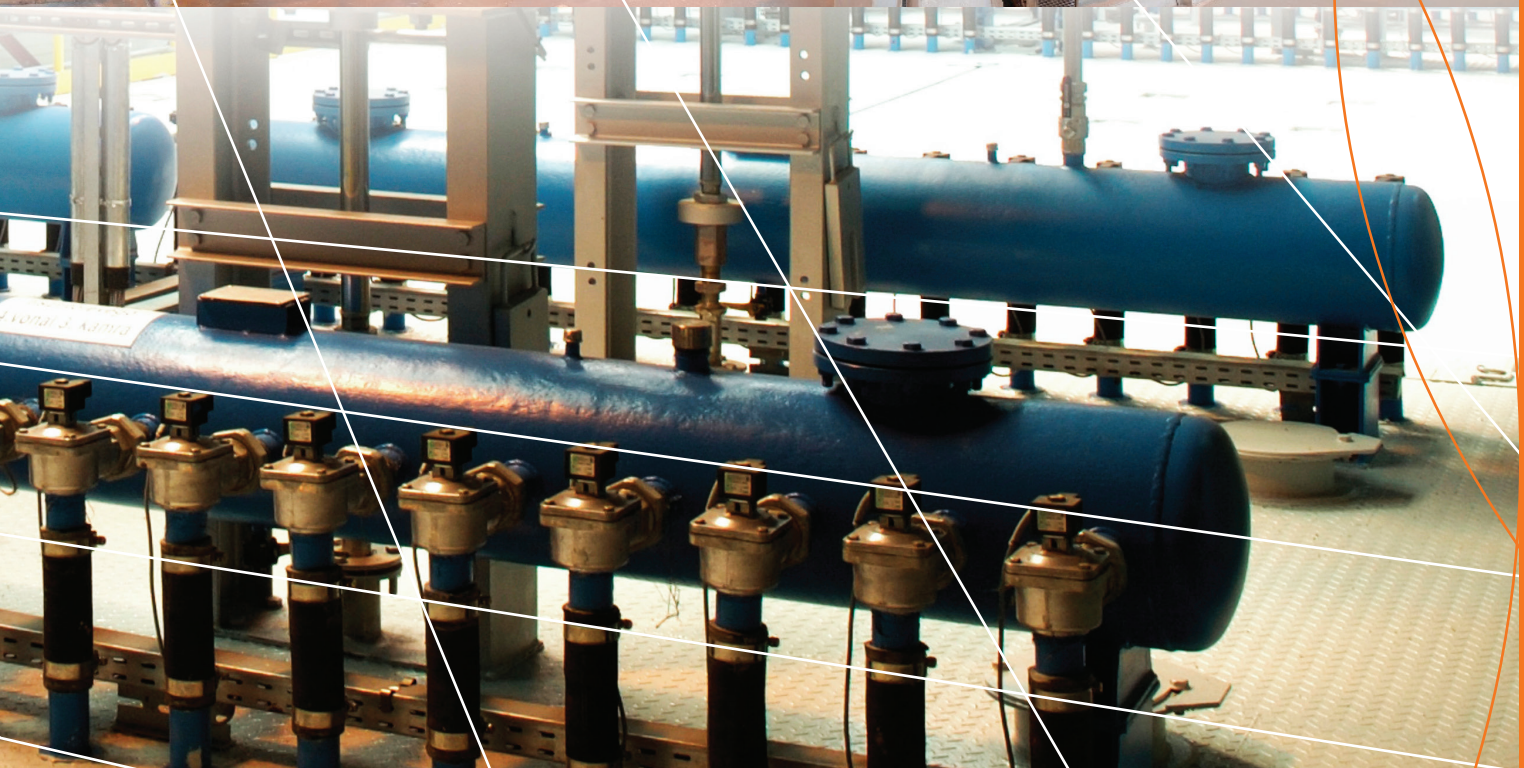
Active lignite coke is given into the flow of flue gas for binding by adsorption of dioxins, furans and vapour phase mercury (15). The large specific surface material can effectively separate the organic pollutants and heavy metals from the flue gas.



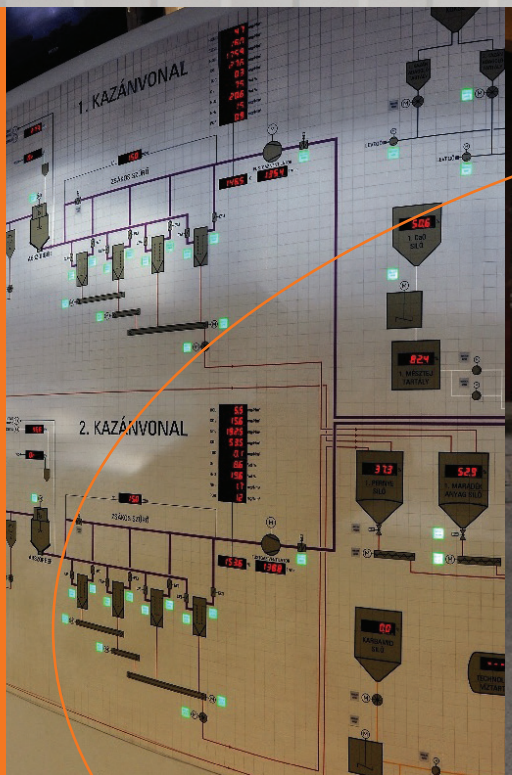


Did you know that the “visibility” of flue gases leaving the stack depends to a large extent on weather conditions because the white smoke is actually condensed vapour?

Bag filters (16) are used to separate the remaining fly ash and salt particles generated in the course of the process. The solid pollutants are separated with 99.99% efficiency with the help of the 896 bags located in the system. The dust collected on the surface of the bags is cleaned by compressed air blow impulses at regulated intervals. The solid residual materials collected in the hoppers of the bag filters are temporarily stored the same way as the fly ash. The transportation and disposal of the materials separated during flue gas cleaning may be performed by specialised licensed companies. A high power fan is used to convey flue gas into the stack and to provide draft in the furnace chamber.




Turbina gőz jellemzők mérése
Belépő gőzmennyiség
49,8 t/h
Szabályzott elvétel gőzmennyiség
22,7 t/h
Átömlő gőznyomás
3,57 bar
Belépő gőznyomás
35,37 bar
Szabályzott elvétel gőznyomás
9,5 bar
3-as megcsapolás gőznyomás
-0,22 bar
Vákuum a kondenzátorban
-0,932 bar
Belépő gőzhőfok
400,7 °C
Szabályzott elvétel gőzhőfok
298,8 °C
3-as megcsapolás gőzhőfok
109,6 °C
Kondenzvíz szint
7,01 cm
Turbina csonk hőfok A
37,3 °C
Turbina csonk hőfok B
33,7 °C
Ét. kilépő hőfok
45,4 °C
Hűtővíz belépő hőfok
30,1 °C


1. KAZÁNVONAL
2. KAZÁNVONAL

III. ENERGETICS

The hot flue gases generated in the course of the incineration process transfer most of the heat to the feed water.

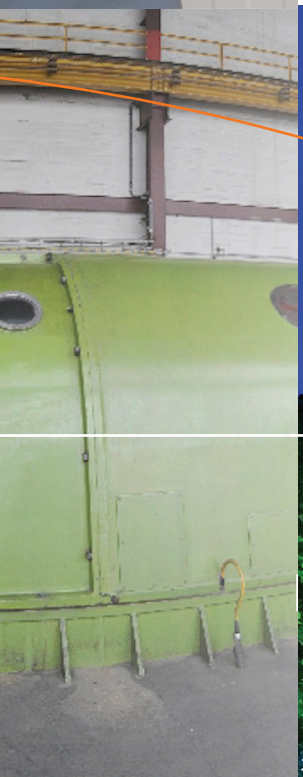
Did you know that the flue gas of a temperature of nearly 1000 °C is used in a boiler of the height of an 8 storey building?

The flue gases leave the furnace at a temperature of 200-220 °C and enter the flue gas cleaning facility. In this process, superheated steam of 405 °C with a 40 bar pressure is generated, which is fed into a turbine (22) and produce electric power.

Did you know that only 2-3% of the energy generated by Budapest Waste-to-Energy Plant originates from burning natural gas?

The extraction of the larger turbine releases steam suitable for district heating. The remaining amount of steam goes through the low pressure part of the turbine, revolving the generator, and this way it is used to generate electric power. The nominal output of the turbine-generator unit (23) is 24 MW. The steam released from the smaller turbine transfers the rest of its heat energy through a steam/hot-water heat exchanger after generating 3 MW electric power with the aid of the turned generator.

Did you know that currently Budapest Waste-to-Energy Plant covers the annual power needs of nearly 140,000 people and provides district heating through the Újpest heat exchanger to some 25,000 residents in the Káposztásmegyer housing estate? The Budapest Waste-to-Energy Plant provides disrtict heating and electricity from here to its own plant, and sells the rest.



ENVIRONMENTAL PROTECTION

FKF Nonprofit Zrt. is one of the major environmental providers in the capital city; it serves the preservation and the improvement of the Budapest environment and hygiene scene, and contributes to improving environmental culture as well. In order to maintain and improve competitiveness, and in line with environment management objectives, it aims to harmonise economic and environmental activities based on the principle of sustainable development and prevention.

FKF Nonprofit Zrt. owns the only waste-to-energy plant in Hungary which has undergone a lot of changes, bringing it up-to-date to environmental requirements. With the installation of the flue gas cleaning facility in the course of a general overhaul in 2002-2005, the emission of air pollutants of the plant remains well under the limit identified in the 29/2014 (XI.28.) Ordinance of the Minister of Agriculture, as shown on the figure below. Actual emission of several pollutants is much lower than the required limit. The Budapest Waste-to-Energy Plant fully complies with all environmental regulations.

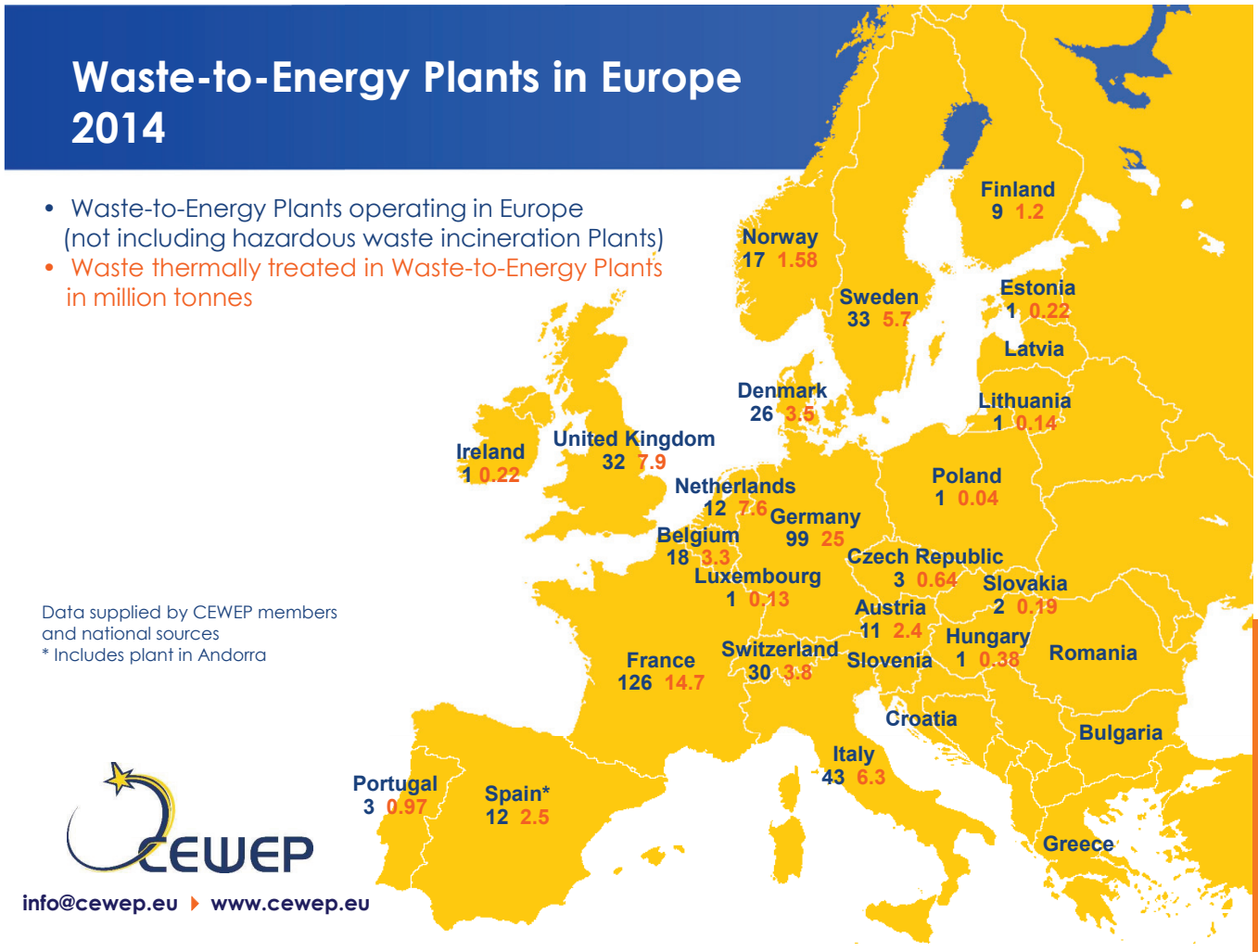
Pollutant	Measured daily average	Limit
dust	0-1	10
HCl	1-8	10
SO_2	10-30	50
NO_X	120-140	200
CO	5-20	50
C_xH_y	0-0.5	10
Pollutant	**Measured value from sample**	**Limit**
Hg	0.0055	0.05
Cd and Tl total	<0.005	0.05
Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V	<0.05	0.5
Dioxins and furans (2,3,7,8 - TCDD/F TE)	$<0.02 \times 10^{-6}$	0.1×10^{-6}

Flue gas emission data of the Budapest Waste-to-Energy Plant compared to the limit values identified in 29/2014 (XI.28.) Ordinance of the Minister of Agriculture: mg/Nm^3 for 11% O_2.

INTERNATIONAL RELATIONS

International relations play a vital role in the development of the services FKF Nonprofit Zrt. provides. The Company follows closely the development of international waste management organisations, and is in constant contact with them.

FKF Nonprofit Zrt. is the Hungarian member of the International Solid Waste Association (ISWA). The non-profit organisation wishes to promote high quality professional sustainable waste management. The role of FKF Nonprofit Zrt. is to contribute to the emergence of sustainable solid waste management, to the development of solid waste treatment processes, and to put modern waste recycling and disposal technologies into practice.



Waste incinerators in Europe. Data from 2014. Source: CEWEP
Total: 482

FKF Nonprofit Zrt. is also a member of the Confederation of European Waste-to-Energy Plants (CEWEP). About 390 waste-to-energy plants belong to this organisation. CEWEP membership means a commitment to environment friendly, low emission technologies.

SITE VISITS

Budapest Waste-to-Energy Plant is the only power plant fed by the incineration of waste in Hungary so far. Besides using modern technologies and focusing on environmental protection, the facility intends to contribute to the environmental education of the society as well as to provide people with proper information on the topic.

In the course of the site visits, visitors can gain practical experience in the subject of the thermal recovery of municipal solid waste and the modern methods of flue gas cleaning.

In addition, the Museum of Street Cleansing with its unique exhibition hall is located in the area of the Budapest Waste-to-Energy Plant. It gives visitors a great opportunity to learn about the history of the legal predecessor of our Company, Public Sanitation Agency, and view the different waste containers and waste transporting vehicles from the past (e.g.: a horse-drawn water wagon used at the beginning of the previous century or a Csepel-type waste collection vehicle from the '50s). A speciality of the museum is that the exhibited vehicles can be "tried out"; those interested can sit in them instead of just watching them from a certain distance.

The plant and the museum can be visited by groups of 10 people by previous appointment. The groups are welcome at 8-15 o'clock from Monday to Friday. It is altered only on special occasions.

The plant cannot be visited under the age of ten. Groups of 10-18 years can participate the site visits only accompanied by an adult.

Filling the form of the site visits does not mean automatic acceptance of the visit.

A visit takes 1.5 hours.

Please, carefully read the information leaflet with the title Labour and Fire Safety Information for Visitor Groups. It can be downloaded on our website: www.fkf.hu

Visits are accepted only after you have filled and sent us our site visit form and we have given you confirmation. The form can be downloaded from our website www.fkf.hu.

Appointment

Before filling the form of site visits, please, make an appointment with our colleagues via phone or email:

06 1 305 2458
marosfalviz@fkf.hu
or
06 1 305 2411
greskovicsnet@fkf.hu

We reserve the right to change the scheduled appointment. In case of any change, we inform the contact person indicated previously prior to the site visit. Please send us your filled site visit form to the email addresses listed above or to the following fax number filled and printed.

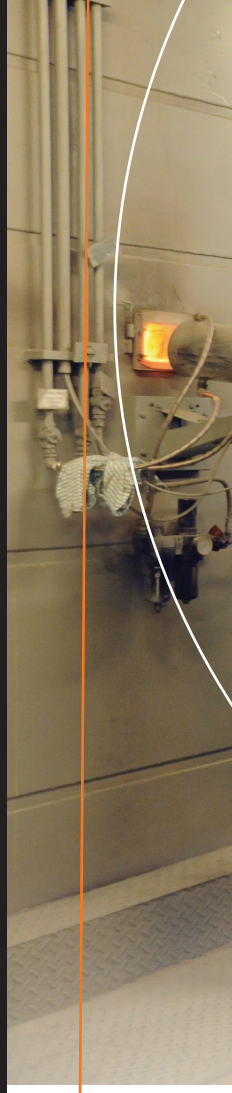
Fax number:
06 1 323 5867

Address:
Mélyfúró utca 10-12,
Budapest 1151

How to approach Budapest Waste-to-Energy Plant?

By public transport: you can take the 125 bus from Bosnyák Square and get off at the stop called Hulladékhasznosító Mű in Károlyi Sándor Street. After bypassing the Workers' Hostel, the entry can be found from Felsőkert Street.

By car: you can visit us if you exit M3 motorway at the rest stop called Szilas (in front of a Shell gas station) and turn to the left to Felsőkert Street, then turn to the left on Mélyfúró Street to the main entrance of the plant.

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