Local Success Stories	
Country	Italy

The Initiative

The District Heating plant in Ferrara is an integrated system of geothermal, waste incineration and reserve boilers. The system mainly uses the heat energy coming from the geothermal fluid extracted from the subsoil by means of two wells. The secondary source is depicted by the waste-to-energy plant, and another tertiary source of production is a thermal plant made up of 7 natural gas-powered boilers to produce hot water. The production system is composed by:

1. geothermal renewable source;
2. waste to energy plant;
3. four storage tanks of 1.000 m3 individual capacity;
4. thermal power station in S. Anna Hospital, built to balance water flow in the water distribution network;

At the end of the 1960s, an underground hot water basin was found, deep 2.000m in Casaglia. After 1970s energy crisis, the Joint Venture AGIP-ENEL made up the Geothermal Project, to use the geothermal basin for district heating.

Geothermal fluid is pumped towards the surface through two wells. The fluid releases energy to the district heating network through a heat exchanger, and finally re-injected in the underground through an intake well.

Today, with a water flow of 400 m3/h (at a temperature of 100°C), geothermal source contributes with 14MWt of the total power required.

The waste-to-energy plant in Ferrara is located inside the site called "geothermal power", where the district heating plant of the city of Ferrara is also situated. In operation since 1993 with a 150 t/day capacity treatment line, the plant attains heat recovery generated in the waste incineration process for the combined production of electricity and heat. Based on the season and needs, a part of the steam can be bled from the turbine to transfer energy to the adjacent district heating plant through a dedicated heat exchanger.
The waste-to-energy plant is being upgraded and redeveloped, and today is in the final completion stage. Two new waste-to-energy lines are planned in its final configuration. The two new lines have been in the start-up stage since November 2007.

District Heating Ferrara Plant (2008)		
Total thermal energy delivered	165	GWht
Geothermal energy	66,54	GWht
Waste energy	19,59	GWht
boilers	79,07	GWht
Served buildings volume	5.170.000	m3
residential sector	*2.364.000*	m3
tertiary sector	*2.802.000*	m3
industrial sector	*4.000*	m3
Length of network	130	km
Number of users substations	530	
Geothermal source		
Total capacity	400	m3/hour
Geothermal fluid temperature	100-105 °C	
Fluid supply temperature	90-95 °C	
Fluid return temperature	60-65 °C	
Nominal thermal power	14	MWt
Max energy generated	75.000	MWht/year
Continuous availability		
Waste to energy plant		
Treatment capacity	130.000	t
Electric power	13	MWe
Electric energy to network	87.000	MWhe
Max thermal power for DH	29	MWt
Thermal energy for DH	80.000	MWht
Thermal Power Plant		
Boilers power	84	MWt
Storage tank capacity	1000	m3
Integrative boiler power	12	MWt
Environmental energy benefits		
TEP spared	8100	
NOx avoided	27.400	kg
SO2 avoided	33500	kg
CO2 avoided	23300	kg

A. TECHNOLOGY

1. Waste receiving, storage and feed section

The plant has two ditches (a main and an auxiliary) for storing incoming waste.

Total usable capacity is 5000 m3 to allow the furnaces to operate normally and with a continuous infeed, even if there are consecutive days without any receipt of waste. Two orange-peel buckets on a bridge crane run alternatively inside the building housing the main ditch, one as stand-by to the other, to perform the waste homogenizing functions in the ditch and to load them into the furnace hopper.

2. Combustion line with moving grate furnace

The combustion chamber is the moving grate type with a water cooling system, able to treat waste with a **calorific value ranging from 6700 to 16,750 kJ/kg**.

To achieve utmost flexibility, the system supplying the material onto the grate is fitted with a double feed-pusher. The material is transported onto the grate by a sloping chute, also water-cooled. The slope of the grate is 14 degrees, and it is sized in such a way as to adequately handle the changes in calorific value.

The combustion air system includes a primary air system with a total of 5 fans, three air/steam pre-heating exchangers with adjustable bypass for the air, and a secondary air system with 2 fans. All of the fans have speed adjustment with inverters, and the primary and secondary air flows for each zone and for each lane of the grate are automatically measured and adjusted. The primary air is blown in underneath the material through the cracks in the plates of the grate surface.

In all, there are 5 air inlet zones, the first and last of which have 4 steps each, whereas the zones in the middle have 6 steps each. The rows of moving steps, totalling 13, are operated separately by two hydraulic cylinders installed on the sides. Every step of a single lane of the grate consists of two plates forming a joined chamber structure, built so that the cooling water can go through the steps and cool the metal surface of the grate.

A fumes recirculation system is envisaged to control the combustion temperature and reduce the production of undesirable emissions, such as NOx. These fumes are withdrawn downstream of combustion fumes neutralisation. The combustion control system developed by the grate manufacturer provides better control and management via PLC.

Ten hoppers connected to a wet collection system (Redler) are envisaged to remove the ash underneath the grate. The system transports and releases the material into the various zones to the waste extractor. Water also plays the role of a seal, preventing air from getting into the combustion system. The extractor is driven by two hydraulic cylinders connected to the main hydraulic station that controls the infeed system and grate system.

3. Waste storage prior to disposal or recovery at authorised plants

The waste leaving the extractor of each furnace is conveyed on a vibrating table whose purpose is to uniform its flow, and from here to an iron removal system and then to the main conveyor belt that transfers it to the deposit area.

Separated ferrous materials are accumulated in a storage ditch. The waste is stored in heaps inside the building where the deposit area is located, whereas special doors allow lorries to enter to load it and then transfer it to the recovery/disposal plant.

4. Steam generator

The back boilers installed on the two new lines are the natural circulation type, with cylindrical body placed at the top of the structure. They can produce **32.4 t/h of steam each**. The exchange area consists of 4 vertical radiancy chambers and a horizontal convection channel containing the exchange banks. The saturated steam leaves the cylindrical body through several outlets that then flow into just one pipe connected to the inlet manifold of the superheater. The boiler is equipped with flat, insulated doors bolted to special frames so that the entire circuit of fumes and pipes can be thoroughly inspected.

Hoppers for collecting ashes the fumes deposit during reversal of direction or that have detached during mechanical cleaning are underneath both the radiancy zone and the convective zone. The maximum slope is 35° so as to make unloading the ashes easy and sure. Furthermore, a flange interfaces the lower part with the clapets so they can be scavenged.

5. Gas treatment line

A new, completely dry, gas treatment system has been designed for the two new lines (line 2 and line 3). Two reactor-filter systems installed downstream of the back boiler have been envisaged for each line, to then be followed by an ammonia-injection SCR system.

Lime hydrate and activated carbon will be injected into the first reactor-filter system to reduce acids via salification, and dioxins, organic substances and volatile metals via adsorption. The salts and adsorbent carbon will then be blocked and collected in the bag filter and sent to the three residual calcic product storage silos by a pneumatic system. Sodium bicarbonate and, if necessary, activated carbon will be injected into the second reactor-filter system to reduce, by salification, residual acids that have not reacted with the lime and, by adsorption, dioxins, organic substances and residual volatile metals. This second stage will also considerably reduce SO2. The salts and adsorbent carbon, if any (hereinafter called residual sodic product), are blocked in the bag filter in this case as well, and sent to storage in a silo.

A catalytic system with 24% ammonia solution (SCR) injected is envisaged downstream of the double filtration stage described above to reduce NOx, which also however contributes to reducing residual organic compounds, particularly the dioxins. The plant adopted in the project efficiently operates at low temperatures (no lower than 180°C) and ensures an annual mean concentration of NOx at the chimney lower than 100 mg/Nm3. The vaporized ammonia in the reactor is injected directly into the gaseous flow upstream of the catalytic converter, where the nitrogen oxides turn into molecular nitrogen and water.

6. Thermal cycle for the cogeneration of electricity and thermal energy (common to the two lines)

The steam coming from the new lines (line 2 and line 3) is sent to just one **turboalternator having a nominal electric power of 12.9 MW**. Based on the season and needs, a part of the steam can be bled from the turbine to transfer heat energy by adjusted withdrawal to the district heating system through a dedicated heat exchanger. **In the cogeneration layout, the turboalternator will be able to supply 8.4 MW of electric energy and 26 MW of heat energy.**

The steam leaving the turbogenerator is sent to an air condensation system. This system contemplates a geometric "saddle" configuration made up of four modules, arranged on two banks with two modules each.

B. MONITORING SYSTEMS

The two emissions points are monitored according to current regulations:

- Continuous monitoring of the concentration of macro-pollutants (total dust, hydrochloric acid, NOx, sulphur oxide, carbon monoxide, total organic carbon, hydrofluoric acid, mercury, ammonia) and the process parameters, such as the oxygen level, humidity level, fumes flow rate, fumes pressure and fumes temperature;
- Automatic continuous sampler for organic micro-pollutants, dioxins and furans.
- Periodic monitoring of the organic micro-pollutants and heavy metals with analytical campaigns.
- Periodic surveys concerning definition of the dimensional spectrum of the dust emitted, exploring the numeric concentration of particles (on every dimensional class) in the range between the manometres and 10 micrometres.

C. ENERGY SOURCES

1) Waste sources

Waste to Energy Ferrara Plant (2008)		
Number of Treatment Lines:	2	
Heat Capacity:	55,7	MWt
Combustion chamber tecnology:	Moving grate type with a water cooling system	
Waste treatment capacity:	420	t/day
Lower heating value	*2400*	*kcal/kg*
Number of operating hours per year:	8000	hours
Nominal electric power:	12,9	MWe
Environmental emissions consistent with laws:	D.Lgs. 133/05	
	D.Lgs. 152/06	
	D.Lgs. 59/05	

The waste-to-energy plant is ISO 9001 and ISO 14001-certified, and attained EMAS registration in 2004.

2) Other sources

Thermal energy system is completed by a thermal power station with 4 natural gas powered-boilers and 4 storage tanks, for the thermal energy daily-variability demand management.

District Heating Hera Spa		
Total thermal energy delivered	422.633	MWh
Served buildings volume	16.109.000	m3
Number of equivalent housing units served	53.696	
Length of network	312	km
District heating procurement mix		
Energy CCGT	*1%*	
Gas fired cogeneration plants	*17%*	
Geothermal	*13%*	
Energy recovery from WTE	*11%*	
Domestic gas fired system	*58%*	