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INTEGRATION OF AN ENERGY FROM WASTE FACILITY INTO AN URBAN ENVIRONMENT

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ABSTRACT

The maximum environmental benefits from a new Energy from Waste (EFW) facility may require locating the new plant close to both the source of the waste and the potential energy customers. This paper will present design features that were incorporated into several new EFW facilities to allow them to be located directly into urban environments while minimizing their impact on the community and often improving the quality of life for the surrounding communities. Locating the EFW facility directly into an urban community:

- Minimizes the cost and the environmental impact of waste transport.
- Allows electrical power to be generated at the point of consumption.
- Provides thermal energy for district heating and cooling.
- Reduces the dependence on imported fossil fuel for electrical generation and for heating / cooling.
- Provides secure and well paying jobs for members of the community.
- Reduces the carbon foot print of the community.
- An EFW plant typically leads to higher recycling rate, both pre and post combustion.

Some of the specific measures that have been considered for EFW plants in urban environment have included architectural enhancements, more stringent noise and odor control, significant reduction or even elimination of visible plumes. The two case studies included in this paper will be the new Isséane EFW plant in Paris and the recently awarded Riverside EFW plant in London.

Keywords: Energy-from-Waste (EFW), green house gases, distributed energy generation, thermal treatment.

1. INTRODUCTION

EFW is getting growing acceptance worldwide as an important part of the waste treatment hierarchy (reduce, reuse, recycle, recover and dispose, with EFW being considered part of "recover") [1][2]. However, the traditional approach in North-America has been to locate EFW plants away from urban environment to either remote locations or to heavily industrialized areas. This approach tended to limit the potential of energy recovery to the production of electrical power. In Europe on the other hand, EFW plants were often built closer to the communities to take advantage of the potential for thermal energy sale (in the form of heating or cooling) in addition to electrical power generation. This paper will look at two recent projects, the new Isséane EFW plant in Paris that entered service in December 2007, and the Riverside EFW plant in London that is currently under construction and is expected to enter into service at the end of 2010. This paper will review the benefits obtained by locating an EFW facility in an urban area, as well as the additional challenges that come with this type of location.

2. BENEFITS OF LOCATING IN AN URBAN AREA

Locating an EFW plant in an urban area as compared to the more traditional approach of locating it in a remote or industrialized area (often close to a former or still active landfill) brings several additional challenges, the most important being acceptance by the community surrounding the proposed new EFW plant.

Locating the new EFW plant in the urban area has the potential to bring significant benefits to the community. Some of these benefits are:

- Minimizing the cost and the environmental impact of transporting the waste over long distances by treating the waste where it is produced. This contributes to a reduction in the number of trucks on the roads, a reduction in emissions from these trucks, a reduction in Green House Gas (GHG) emissions with reduced transport fuel requirements, a reduction in the potential for odors and spills with shorter transport distances.
- Providing electrical power generation at the point of consumption, offering more supply security to the community since they are not as exposed to the potential for breakdown of the transmission grid. An EFW plant can easily be designed to operate in island mode to maintain power in the neighborhood

around the plant in the event of supply disruption on the transmission grid. Generating power at the point of consumption significantly reduces transmission losses compared to using electricity produced by power plants located far from the point of consumption.

- Providing thermal energy for district heating and cooling. Typical district heating systems rely on non-renewable fossil fuels (natural gas, oil) that are imported into the community. Using residual thermal energy from the EFW plant for this purpose provides financial and environmental benefits (by reducing fossil fuel consumption and GHG emissions). If not used for district heating and cooling, this residual heat would likely end up being rejected to the environment (cooling tower, air or water cooled condenser).
- Reducing the dependence on imported fossil fuel for electrical power generation and for heating / cooling. Roughly two thirds of the combustible material in municipal solid waste (MSW) can be classified as biomass, a renewable resource. Using MSW to produce electricity will often displace natural gas, oil or coal. As discussed above, using the residual heat from the EFW plant for district heating and cooling further reduces fossil fuel usage.
- Providing secure and well paying jobs for member of the community. Regardless of the location of the treatment facility, the community pays for the costs to handle and treat the MSW. Having the facility located within the boundaries of the community keeps the economic value associated with these costs within the community.
- Reducing the carbon foot print of the community. In addition to the reduction in GHG listed above (transportation, electrical power generation, district heating and cooling), an EFW plant is also considered a carbon sink compared to landfilling MSW [2].
- An EFW plant typically leads to higher recycling rates, both pre and post combustion. It is well documented in both Europe and North-America that communities that have EFW plants also tend to have a higher level of recycling. The development of a new EFW plant is typically combined with an overall waste management plan which includes more separation at the source. In addition, embedded ferrous and non-ferrous metals that are not practical to recycle prior to combustion of the associated organic material, are easily recovered from the ash stream, increasing the total portion of the waste recycled.

3. CHALLENGES OF LOCATING IN AN URBAN AREA

Like any other power generation facility, an EFW plant located close to residential, office and retail areas should only have a minimal impact on the surrounding community. The main additional challenges involved in locating an EFW facility directly in an urban area fall under the categories of disrupting elements (traffic, noise, odors and emissions) and respect of the character of the neighborhood (architecture, visual impact of operations).

The reduction of potentially disrupting elements includes traffic management in and around the facility, noise abatement at the process equipment level and using more sound absorbing materials in the building construction, insuring that all potential odors are destroyed in the thermal treatment process by taking the combustion air from inside the building and maintaining the building under negative pressure. Respecting the character of the neighborhood may involve building and stack height restrictions, enhanced architecture and additional space inside the building for maintenance activities.

4. ISSEANE

The first case study reviewed will be the new Isséane EFW facility from SYCTOM in Paris, France. Founded in the 80's, SYCTOM is the organization looking after the municipal waste from 85 communities in the Paris area. It is Europe's largest such cooperation, meeting the needs of 5,48 Million inhabitants in the cooperation area and handling 2,67 Million t (metric) of MSW disposed (2006, without glass recycling). SYCTOM's budget for 2007 was 424 Million € [3].

SYCTOM started planning the new Isséane EFW facility in the late 1990's [4]. This new facility was required to replace an older EFW facility which had been in operation since 1965 and was located a few miles away from the new site. The new plant is located on a former production site of Peugeot that needed remediation work and the design of the plant was part of an effort to improve the waterfront of the Seine river. The cost of the civil portion of the project is in large part due to this objective of restoration of the site.

Figure 1, Aerial view of Isséane[1]

Figure 2, Rear of the plant looking at the Eiffel Tower[1]

[1] AA'E Architect: Jean-François Capeille

Some key facts from the project [1]:

- Investment:
  - Total: approx. 580 M€ (777 M$)
  - EFW part: approx. 150 Mio. € (200M$)
- Civil:
  - Architectural consideration of the location at the Seine river
  - Stacks not visible
  - O&M truck traffic not visible
- Technology:
  - 2 lines MSWI, 460,000tpy (metric), Grate, dry flue gas cleaning, SCR
  - Turbine 52MW / District heating
  - Sorting- and Recycling plant consisting of 2 lines for totally 55,000 tpy (metric)

The thermal waste treatment capacity at Isséane is actually about 17% less than the capacity of the plant it replaced. This is in large part due to the new recycling plant built within the same facility that can treat 55,000 tpy of curb side recycling and large bulky waste.

In large part, the location of the new plant was dictated by the desire to minimize the impact of handling the waste and maximize the benefit for the community [5]. This central location means that the maximum distance for transport of the waste is 10 km (6 miles) with the center servicing the needs of 1.1 million people. Proximity to the river also permits shipment of the ash and recycled metals by boat, reducing truck traffic around the plant by 25%. In addition to the 52 MW of electricity, the plant provides district heating for more than 70,000 housing units. Using energy from the plant for district heating displaces the equivalent of 110,000 tons of oil per year.

The location of the plant in a neighborhood that contains a mix of offices, apartments and commercial buildings, with the site facing the waterfront on one side and the commuting trains passing right behind the plant, made the design and architecture of the building housing the plant a significant factor on the overall project. Due to the character and style of building in the immediate vicinity, the height of the building was restricted to 21 meters (69 ft). As a result of this restriction, roughly 2/3 of the plant is actually underground.

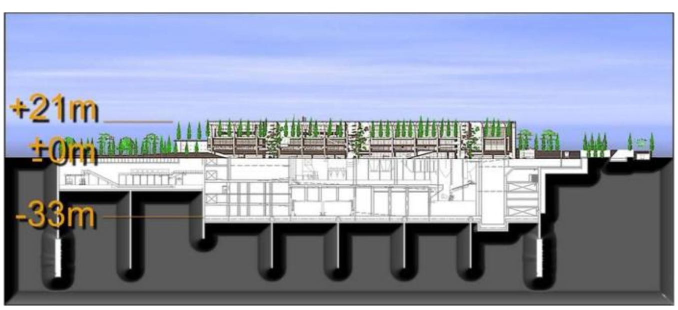

Figure 3, cut away view of the plant showing overall building, above and below grade.

The close proximity to the river meant that the water table on the site was only a few meters below grade. Special excavation methods and foundations were used to make it possible to have most of the building volume below grade. Having most of the building underground made it simpler to reduce the impact of truck traffic to the plant by locating the waste receiving area inside the building. The waste delivery trucks enter the building using down ramps from the main arterial road that runs parallel to the bank of the river. A cut away view of the plant showing the truck receiving area and the main process equipment is shown at the top of the next page. To make the stack not visible from street level, it was located almost completely inside the building with less than 5 meters above the roof. The stack velocity and exit gas temperature were selected to meet the requirements of the air permit and to almost completely eliminate any visible plume.

The location of the plant and the lack of space around the building, i.e. the building was taking nearly the whole available space, posed special difficulties with erection and site logistics. Very little preassembly space was available, truck deliveries (if unavoidable) had to be "just in time", barge delivered goods had to be transported across a main road without interruptions and large lifting distances. Crane capacity had to be shared by various site players.


Figure 4, showing the congestion on the site

Due to the lack of space, the process equipment was mostly pre-assembled in larger modules at a secondary location outside Paris and brought to site by barge.

Figure 5, large components delivered to site

On site, the components were placed on special trucks and transported over a temporary bridge over the road and into the building.

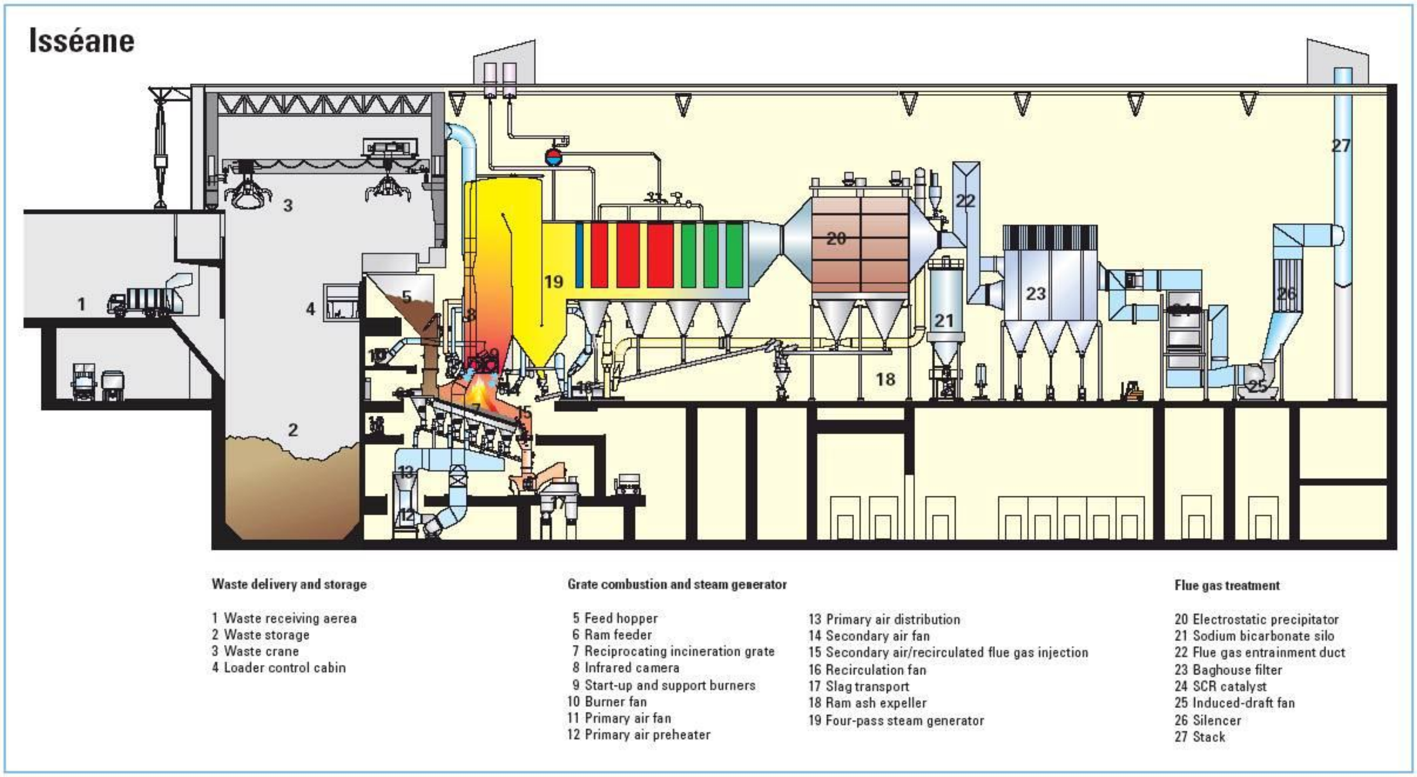

Figure 6, side view of the building showing the process equipment.

Figure 7, boiler module being transported

As seen on figure 6 above, the two separate waste thermal treatment lines at Isséane share a common waste receiving area, waste storage pit, and control room. From that point, Inova France, a subsidiary of Von Roll Inova and part of the AE&E Group, provided the two thermal treatment lines. Each line consists of the feed hopper, ram feeders, the combustion grate, water-cooled combustion chamber and radiant section, convective heat transfer section, combustion air system, flue gas treatment system, bottom ash extraction and fly ash system. The flue gas treatment system for each line consists of an electrostatic precipitator that removes most of the particulates from the gas, followed by bicarbonate injection and a fabric filter. Finally, the flue gas passes an SCR (Selective Catalytic Reduction) to reduce NO_x emissions and is evacuated through the stack. Silencers are installed on the equipment as required to minimize the noise generated by the process and combustion air is drawn from inside the building at the top of the waste storage pit to eliminate any odors. The first firing of waste took place in December 2007.

Due to the location of the plant, SYCTOM placed a great emphasis on minimizing the emissions from the plant.

	Isséane permit	European regulation 2005
Dust	3 mg/Nm^3	10 mg/Nm^3
HCl	5 mg/Nm^3	10 mg/Nm^3
SOx	17 mg/Nm^3	50 mg/Nm^3
HF	0.8 mg/Nm^3	1 mg/Nm^3
Hg	0.03 mg/Nm^3	0.05 mg/Nm^3
Cd	0.04 mg/Nm^3	0.05 mg/Nm^3
NOx	40 mg/Nm^3	200 mg/Nm^3
Dioxins+Furans	0.07 ng-TE/Nm^3	0.1 ng-TE/Nm^3

Figure 8, Isséane emissions compared to EU Regulations [5]

The emission limits for the plant were set at typically 50% or less of the European limits that came into force in 2005. SYCTOM made significant efforts to inform the community about the project and worked with them to insure acceptance of the project. In 2000, an Environmental Quality Charter was signed with the town of Issy-les-Moulineaux, where the plant is located, that details the requirements for environmental quality, safety and protection that will be followed during the life of the plant. The plant is now in full operation serving the needs of the surrounding communities with thermal treatment of the waste, electricity and energy production. As shown by the plant pictures, the new Isséane EFW plant made a significant contribution to the redevelopment and restoration of the waterfront of the Seine River.

4. RIVERSIDE

The second case study is the Riverside EFW plant in London currently being constructed for Riverside Resource Recovery Ltd [RRRL], a subsidiary of Cory Environmental, one of UK's leading waste management companies. After a lengthy permitting process planning was finally achieved 2006. In the course of the following bidding process, RRRL selected Von Roll Inova as the turn-key plant contractor including O&M services for the first four years. In an open book process with RRRL, Von Roll Inova selected the civil subcontractor based on a competitive tender process. Preparatory work started early 2008, before financial close was finally achieved in July 2008. Site work then started immediately on this new EFW plant, located within 10 miles from the center of London. The new Riverside Plant is scheduled for first waste fire in 2010.

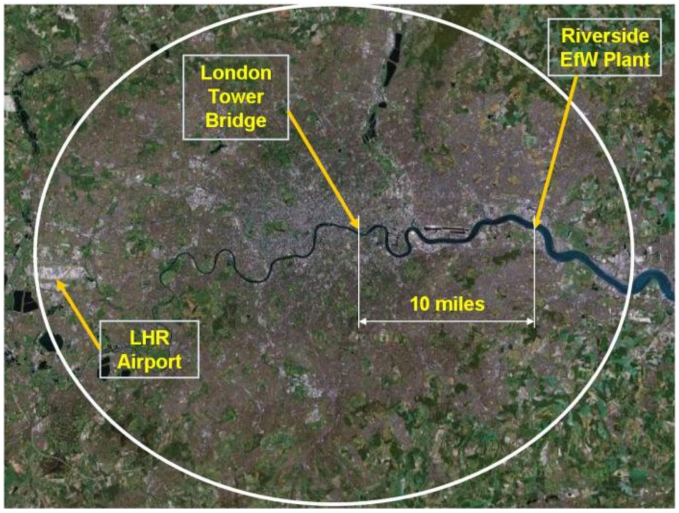

Figure 9, location of the Riverside EFW Plant

The following table shows the situation in 2007 for Waste Management in London [6]:

	MSW	C&I
Arisings	4.3mtpa	6.5mtpa
Recycling & composting	11%	44%
EfW	19%	5%
Landfill	70%	40%
London self-sufficiency	60% (70% of MSW goes to landfill outside London)	

Figure 10, Current Waste Management in London

Several factors led to the decision to treat a larger fraction of waste using EFW plants. More specifically, the EU directive that established target dates for the reduction of land-filling of untreated waste and the imposition of landfill taxes are key drivers to the project. The Riverside EFW plant, with its three thermal treatment lines, will have the capacity to treat 670,000 metric tpy of London residual waste, helping London achieve its self-sufficiency in waste handling, its landfill diversion and its resource recovery goals.

Its key location by the Thames River enables a delivery of the majority of the waste by barges with a consequential reduction of vehicle movements

Figure 11, Waste transportation by barge on the Thames River

The new Riverside EFW plant is being designed to have a net electrical output of 66 MW [4]. The electrical efficiency of the plant will be greater than 27%, making it one of the most efficient EFW plants in the UK for electricity production. The plant is also designed for future district heating capacity. As opposed to Isséane that was built in an existing community; Riverside is being built in an area that will see further residential and commercial development follow at a later date. With its key location along the Thames River and its proximity to the center of London, special consideration was also given in the design of the plant to its landscaping and architecture in harmony with an adjacent sewage sludge treatment plant.. An artist rendering of the plant is shown below:

Figure 11, artistic rendering of the new Riverside EFW plant

The arrangement of the Riverside EFW plant includes three parallel trains which share a common waste receiving area and waste storage pit. Each train consists of the feed hopper, ram feeders, the moving combustion grate, water-cooled combustion chamber and radiant section, convective heat transfer section, combustion air system, flue gas treatment system, bottom ash system and fly ash system.

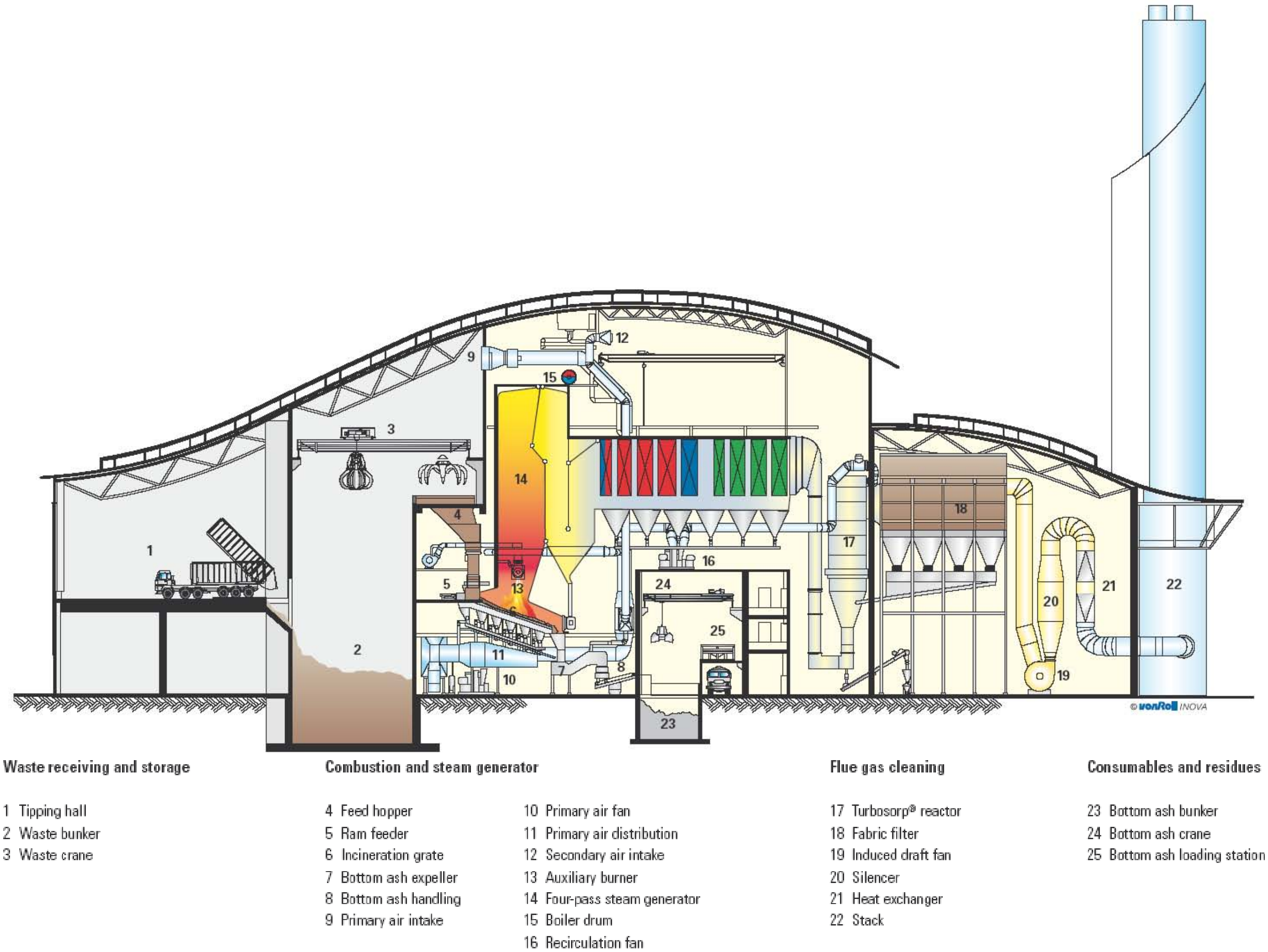

Figure 12, side view of the Riverside EFW plant showing the process equipment

The core of the flue gas treatment system is the Turbosorp® reactor where reagents are injected to control acid gases, heavy metals and dioxin/furan emissions. Thereafter, a fabric filter removes dust and reaction products before the clean gases are evacuated through the stack.

Silencers are installed on the equipment as required to minimize the noise generated by the process, and combustion air is drawn from inside the building at the top of the waste storage pit to eliminate any odors.

5. CONCLUSION

Several benefits can come from locating EFW plants in urban areas, close to the source of the waste. This approach has been used regularly in Europe and continues to be used in most large recently built EFW plants. Developments in emission control equipment in the last two decades and more stringent regulations for EFW plants means that they are often cleaner than the more traditional central power plant. As demonstrated in the case study presented, it is possible to locate an EFW plant within an urban area without negatively affecting the quality of life in the community, and sometimes actually improving it significantly (reclamation and restoration of contaminated sites). The main alternative to thermal waste treatment with energy recovery is landfilling and landfills cannot easily be located in close proximity to urban areas.

The approach taken in locating a new EFW plant to take advantage of district heating or other forms of cogeneration opportunities is largely dependent on the existing infrastructure and on the development plan for the community. Both of the cases presented in this paper took advantage of a waterfront location to reduce the environmental impact of transportation; Isséane by using water transport for the ash and Riverside for the transport of the waste to the plant. By being close to the community, both have also significantly reduced the volume of waste being transported to final disposal since an EFW plant reduces the volume of the waste by more than 95%. The bottom ash from both plants is expected to be reused as aggregate.

In both projects, efforts were made to work with the community to demonstrate the benefits of the project while taking into account the needs of the community to insure that the project would be successful. Each project also benefited from the realization at the political level that the status quo in the management of waste with a significant portion of it ending up untreated in landfills was both harmful to the environment and represented a significant loss of opportunity to use a valuable and largely renewable resource. Both were driven by the EU directive requiring the significant reduction of landfill disposal of untreated waste. Those two projects, as well as a large number of others throughout the world, clearly demonstrate that EFW is a good approach to reduce the dependence on fossil fuel for electricity and thermal energy production.

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