A Waste-to-Energy Plant for Auckland City?

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INTRODUCTION AND OVERVIEW TO AUCKLAND'S SOLID WASTE ISSUES

The Local Government Act 2002 identifies solid waste collection and disposal as one of Auckland City Council's five core services to the community

Management of the waste stream at the City level is a major concern because it involves per year about a million and a half tons of refuse and hundreds of millions of dollars.

What is the long-term plan for Auckland's waste stream? The goal of strategic planning for Auckland City must define achievable objectives, both short and long term which will improve the residents' quality of life.

The Waste Minimisation Act (WMA) 2008 is purposed to, "encourage waste minimisation and a decrease in waste disposal". This White Paper addresses key concerns with achieving WMA objectives. It introduces the next-generation technology for New Zealand's waste management strategy, to provide 'environmental, social, economic and cultural benefits' under the WMA.

The key to good waste management is source separation into three categories:

1) Recyclables for recycling
2) Organic waste into food and green waste for composting and anaerobic digestion
3) Residual waste to landfill OR for Energy from Waste (EfW)

Landfills remain NZ's predominant solution to waste management but they represent the disposal methods of the past. Landfills are now associated with Third World countries, for modern economies upgrade their management systems and employ advanced technologies to recycle resources and recover energy from their waste stream.

The conversion of waste to energy by thermal treatment yields valuable electricity. It also provides a 90% reduction in the waste volume, so there is less reliance on landfills. Most of the solid residue produced has uses. A small component, about 10% will require landfill.

Is Auckland ready to recover valuable energy from its waste?

WASTE GENERATION, LANDFILLS AND ENERGY FROM WASTE

New Zealanders generate a significant amount of waste. The landfill statistics from 2016 disclose 1.05 tonnes of domestic, commercial and industrial waste annually generated per person in Auckland. The consequences of landfill disposal include ecological impacts on land, waters and air. Other issues involve neighbourhood safety, public health, potential for disease and of course exposure to toxins and pollutants.

Current NZ best practice for the municipal waste stream is landfill yet the Waste Management and Minimisation Plan advocates reducing Auckland's reliance on landfills. A small portion of the waste is recovered, reused and recycled. Nevertheless the amount going to landfill represents a lost resource for it could be converted to energy, to supply resident's homes and businesses with electricity.

Composition by weight (2010 figures) of an average Auckland refuse bin contents which mostly goes to landfill is:

- 15% recyclables
- 35% refuse
- 40% food waste
- 10% green waste

Domestic kerbside refuse per capita in Auckland is 146Kg/capita/annum. Landfills are the final resting place for this waste. They become lasting monuments to the stored materials. Buried organic wastes generate methane, the most worrisome of the greenhouse gases and landfills also produce an ongoing liquid leachate of toxins and pollutants. Should a landfill containment membrane suffer a breach, the dump will leak pollution into the surrounding environment and trigger significant regulatory clean-up costs for all concerned.

In contrast with landfills the waste to energy plant consumes waste to produce power and a small amount of dry solids. Power generated by a municipal waste to energy plant saves consumption of equivalent amounts of other fuels e.g. coal and natural gas. The energy recovered represents a reduction in the total greenhouse gas emissions from organic components of the waste stream, because untreated waste releases significant quantities of methane. In contrast, when waste is converted to energy, the main gas released is carbon dioxide (a gas of lesser greenhouse concern than methane) and according to Emissions Trading Scheme criteria, much of this CO_2 is acceptable, for it comes from organics classified as renewables.

AUCKLAND CITY'S STRATEGIC OPPORTUNITY FOR MANAGING ITS WASTE

Auckland City is facing the burden of an increasing population which generates significantly more waste than days past, when landfill seemed the best option. The Government's policy framework on waste management provides territorial authorities with the powers to charge for the services to implement a city-wide waste minimisation plan.

The waste to energy solution is recognised by EfW engineers as the next step for NZ's cities. The good news is that the proven technology, the moving grate process, has decades of history in hundreds of plants across Asian, Europe and the USA. Countless millions of tons of municipal waste have been safely and efficiently converted to energy for city use and dry solids produced are used in roading and construction.

The technology for waste to energy plants has reduced flue emissions of dioxin (the principal class of combustion-generated toxins) by over a thousand times, to a safety level way below all recommended limits. Such plants are operating now in the midst of Japanese cities such as Tokyo, with no health and safety issues: and the Japanese are among the most health and safety conscious of people.

Note: Some twenty years ago an international company called Olivine had plans for a waste to energy plant at Meremere. Opponents feared the plant would emit toxins and greenhouse gases into the atmosphere, so they successfully opposed Olivine's proposal. However the current generation of energy from waste plants can pass every challenge in terms of emissions and environmental safety.

In fact landfills with their significant releases of methane are the worst offenders of greenhouse gas emissions. They are repositories of toxins, pollution and represent the problems we are passing on to future generations.

What is the 'Energy from Waste' project proposal?

Energy Resource Situation

The Coalition Government's energy policy calls for a termination of off-shore oil and gas exploration. The anticipated ten-year production decline from the Taranaki gas fields means alternative sources of power will be required to fill the energy gap before 2028. Auckland City's most accessible and feasible energy resource is the presently untapped potential of thermal Energy from Waste (EfW).

Auckland City Waste Situation

The Strategic Arguments around implementing EfW:

1) Auckland's Waste Minimisation Management Plan states (P. 111), 'Opportunities to maximise reduction, reuse or recycling still need to be prioritised before EfW'. These

other activities are already underway. However the proposed EfW plant would be sized to use that portion of the waste resource presently landfilled, which cannot otherwise be accessed by reduction, reuse or recycling strategies.

2) From Auckland's 2018 waste stream volume of some 1.5 + million tonnes, the EfW plant will be sized to recover energy from a baseline of 300,000 tonnes.
3) The feared situation of locking the City into an expensive long-term contract to supply waste feedstocks to the detriment of reduce, reuse, recycle **cannot occur**, as the magnitude of the waste stream available for those other strategies far exceeds the proposed EfW feedstock requirement.
4) In fact the EfW plant will use the resources which are rejected by the City's reduction, reuse and recycling programs, keep them from landfill and produce much needed energy.
5) The EfW plant will be designed with the potential for expansion should the waste stream management demand additional production of energy from waste to meet the city's electricity demand.
6) Behaviour change is a major issue for city residents implementing the reduce, reuse, recycle strategies for waste. The EfW plant does not require behaviour change, so it can readily absorb the significant portion of resident's waste which escapes waste reduction strategies.

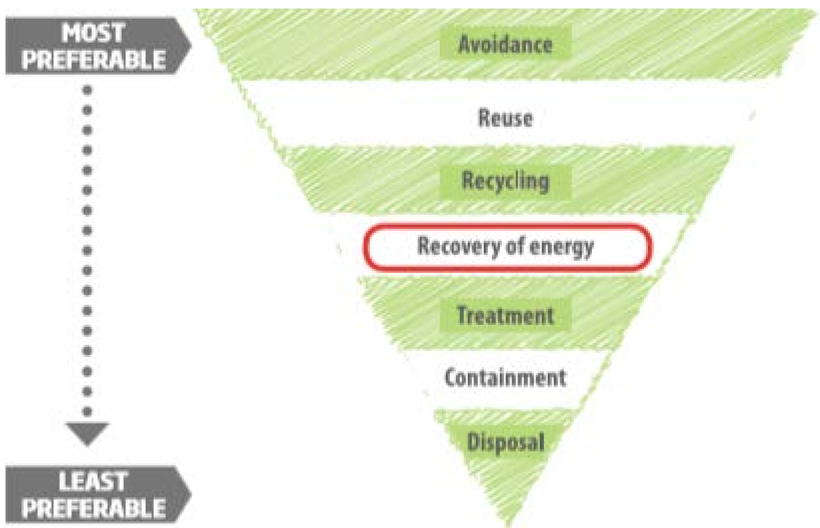


Figure 2: Waste Hierarchy showing the order of preference and where EfW is placed (Environment Protection Act 1970, p.4)

(above chart courtesy of Hitachi Zosen Inova Pty. Ltd, Australia)

The Proposed EfW Plant Size, Feedstocks and Productive Advantage

Auckland City Council has the opportunity to turn waste into useful resources by developing a thermal Energy from Waste (EfW) plant at a strategically located 6 – 10 hectare site in the region. The aim of the proposed $400M over 20 years EfW plant is to allow the Council to attain a sustainable, long-term and stable alternative base load energy source, to support the city's power supply. This plant would consume a significant portion of the municipal residual solid waste which otherwise would go to landfill.

The estimated 104 Megawatts of thermal energy (MWth) to be generated by the EfW plant would provide base load power sufficient to support some 35,000 homes. Currently the city is experiencing unprecedented population growth, which increases requirements for electricity supply, and correspondingly contributes more refuse to the waste stream.

Ongoing rises in electricity charges reflect substantial cost increases in the market price of natural gas and electricity. This situation provides for the long term suitability of the EfW strategy to support the City's power demand as an alternate baseload energy source. Local energy generation projects which replace demand for natural gas will conserve the nation's natural gas assets and contribute to the New Zealand's long-term energy sustainability.

Most importantly, EfW facilities would generate power on a continuous basis. This benefit of EfW technology overshadows the intermittent performance of renewable energy sources such as solar and wind technologies,

For Auckland's proposed EfW plant the operating waste feed requirement is calculated at a minimum 300,000 tonnes per annum (tpa) of non-hazardous municipal residual waste which would otherwise be sent to landfill. The proposed use of the city's Municipal Solid Waste (MSW) will supply approximately 80% of the fuel input to the EfW plant. MSW is waste from household rubbish collections (not recyclable collections). Some Commercial and Industrial (C&I) waste (approx. 20% of fuel input) would also be used. The non-hazardous C&I waste is similar to MSW, but sourced mostly from manufacturing facilities, shopping centres and office buildings.

Introducing the EfW Technology and Plant

Diagram of a typical EfW plant layout

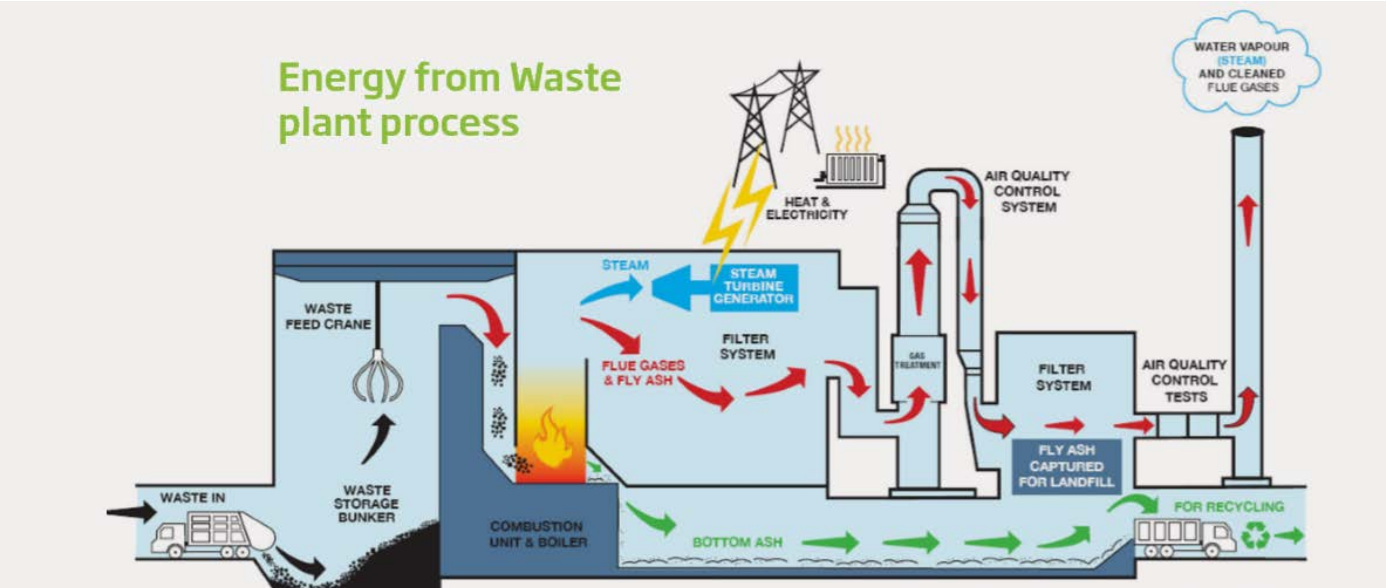


Figure 1. Typical Process overview of an EfW Plant
(Ref: http://www.arc21.org.uk/opencontent/?itemid=27&section=Residual+Waste+Project)

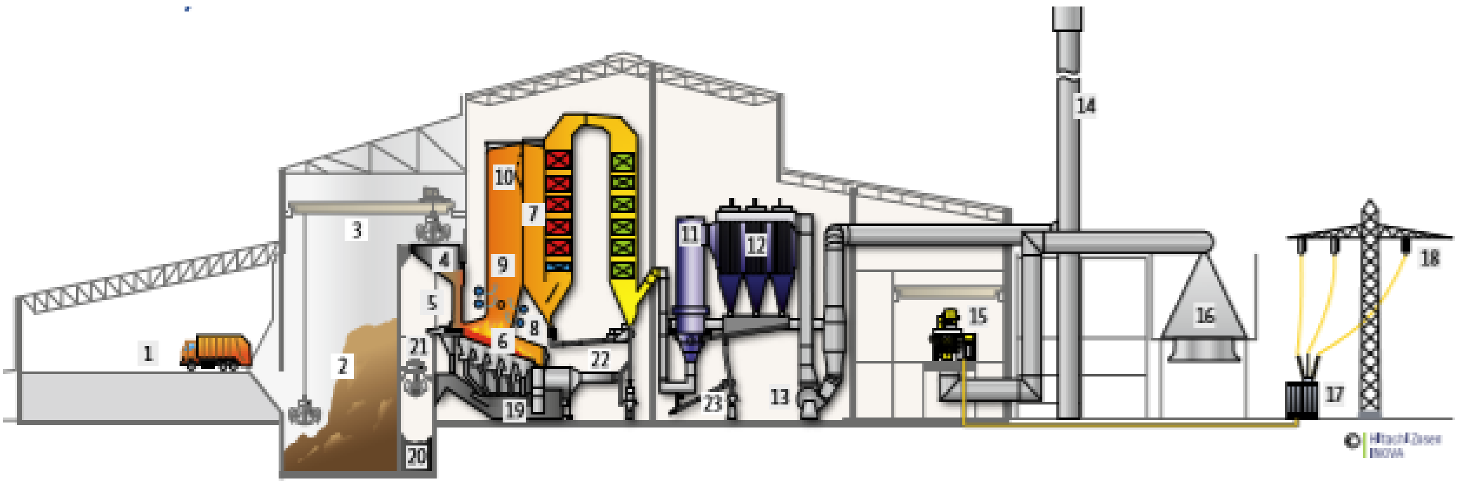
Image of a typical EfW plant

Outline of the EfW process

The key steps in the EfW process are as follows:

- Waste is transported to the EfW plant via (train and) truck
- Waste is combusted in a boiler (or boilers)
- The boiler(s) produce heat generated by the combustion of waste which produces steam
- Steam is used in generators to produce electricity to feed into Auckland's power grid
- Air from the combustion process is treated to very high cleaning specifications, through gas treatment and filter bags
- Cleaned combustion air is discharged through the stack, while being continuously monitored
- Ash residues from the boiler and filter bags are collected and disposed to approved landfill or commercial uses

Schematic of the EfW Plant Operations



Waste Delivery and Storage	Combustion and Boiler	Flue Gas Treatment	Energy Recovery	Residue Handling and Treatment
1 Tiping hall 2 Waste pit 3 Waste crane	4 Feed hopper 5 Ram feeder 6 Hitachi Zosen Inova grate 7 Four pass boiler 8 Secondary air injection 9 Start-up burner	10 SNCR injection levels 11 Semi-dry reactor 12 Fabric filter 13 Induced draft fan 14 Stack	15 Extraction-condensation turbine 16 Air cooled condenser 17 Trafo 18 Electricity export	19 Bottom ash extractor 20 Bottom ash bunker 21 Bottom ash crane 22 Boiler ash conveying system 23 Residue conveying system

Waste is transported to the site via (train and) truck and placed within the waste bunker, which is enclosed in a large building. To minimise the escape of odour to the outside environment air is drawn into the building and fed through the boiler.

The thermal process occurs on a moving grate floor, to allow for mixing and more complete combustion by providing air flow directly through the grates. As the combustion occurs, temperatures will reach over 850°C for at least two seconds. The combustion gases then cool slightly before entering the boiler tubes section to generate steam.

After steam generation, the cooled gases pass through the flue gas treatment system where lime and activated carbon absorb any trace heavy metals, acid compounds and trace dioxins and furans. Captured pollutants are then removed through a process of filtration as solid residues, then the cleaned air is checked by emissions monitoring equipment before being released to atmosphere from the stack.

Should there be a nearby demand for steam, the EfW plant could supply both steam and electricity to its neighbours.

The best use for the bottom ash from the combustion process is recycling into road base and construction materials such as concrete.

A Proven Technology - Why Energy from Waste (EfW)?

EfW is recognised by managers of modern cities as a proven and reliable technology which has been used in Europe, North America and Japan for decades. There are over 500 operational EfW plants in Europe alone, many of which are in and around major cities such as Paris, Zurich, Vienna and London. Germany, Austria and Sweden support EfW as a key component in the waste management hierarchy thereby reducing their landfill requirements almost to zero.

The technology generates energy from the controlled combustion of non-hazardous residual waste materials otherwise consigned to landfill. EfW plants consume wastes and convert the released heat into steam and electricity. Sophisticated filtering technology ensures the systems comply with stringent EPA stack emissions standards. EfW plants have the flexibility to provide energy as steam or electricity and can switch between the two during the plant's operation, to provide for market needs. Onsite waste bunkering of five days volume ensures an EfW plant can operate continuously as a reliable baseload energy supply.

The proposed Auckland City plant would process MSW as well as C&I waste sourced from the greater Auckland metropolitan area. This would significantly reduce pressure on existing landfill sites which in 2016 received some 1.646 million tonnes. Sites at Redvale, Hampton Downs, Puwera, Whitford and Claris at current rates of use will reach capacity within ten years and will have to close.

EfW Plants Extend Landfill Life and Management Options

The EfW plant would divert an estimated 300,000 tonnes of waste from landfill each year. The plant is designed to maintain a steady energy output despite the variable nature of the residual waste stream.

Air quality modelling will be evaluated based on the maximum continuous rated thermal capacity of the plant.

According to the Environment Protection Act (1970) Waste Hierarchy, the recovery of energy from waste is the next preferred method after recycling. Disposal to landfill is the least preferred method of waste management, yet it is the most widely used in Third World countries, and is current best practice in New Zealand.

Leading countries such as the UK have identified EfW technology as their key waste solution in conjunction with recycling, to significantly reduce MSW volumes sent to landfill. Germany's use of EfW technology has almost completely eliminated its dependence on landfill. Countries with EfW have developed significant secondary industries to process the bottom ash and capture the value of that resource.

(Note that the Auckland City proposed EfW project will be of the same description and specification type as has recently been approved in Victoria, Australia for the Maryvale Mill EfW plant. The Australian Works Approval Application has been considered by the Metropolitan Waste and Resource Recovery Group (MWRRG) and the Gippsland Waste and Resource Recovery Group (GWRRG). The proposal broadly meets the intent of their respective Implementation Plans.)

Why Auckland City and Why Now?

Our city faces rising power prices, increasing energy demand and the eventual closing down of the natural gas supply which provides baseload power. Also the MSW burden increases with every new resident.

In 2017 Auckland's Vector power company had 551,700 customers who use up to 1722MW and in 2010-2011 consumed 8679 GWh.

Auckland City's strategic planning needs to evaluate EfW for its suitability to provide a baseload energy source from the presently untapped resource of the residual waste stream. Key points to consider for the EfW plant are:

- Total potential cost (capital and operating)
- Best fit technology for generating significant and variable volumes of steam to generate electric power
- Minimising environmental impacts
- Maximising social benefits

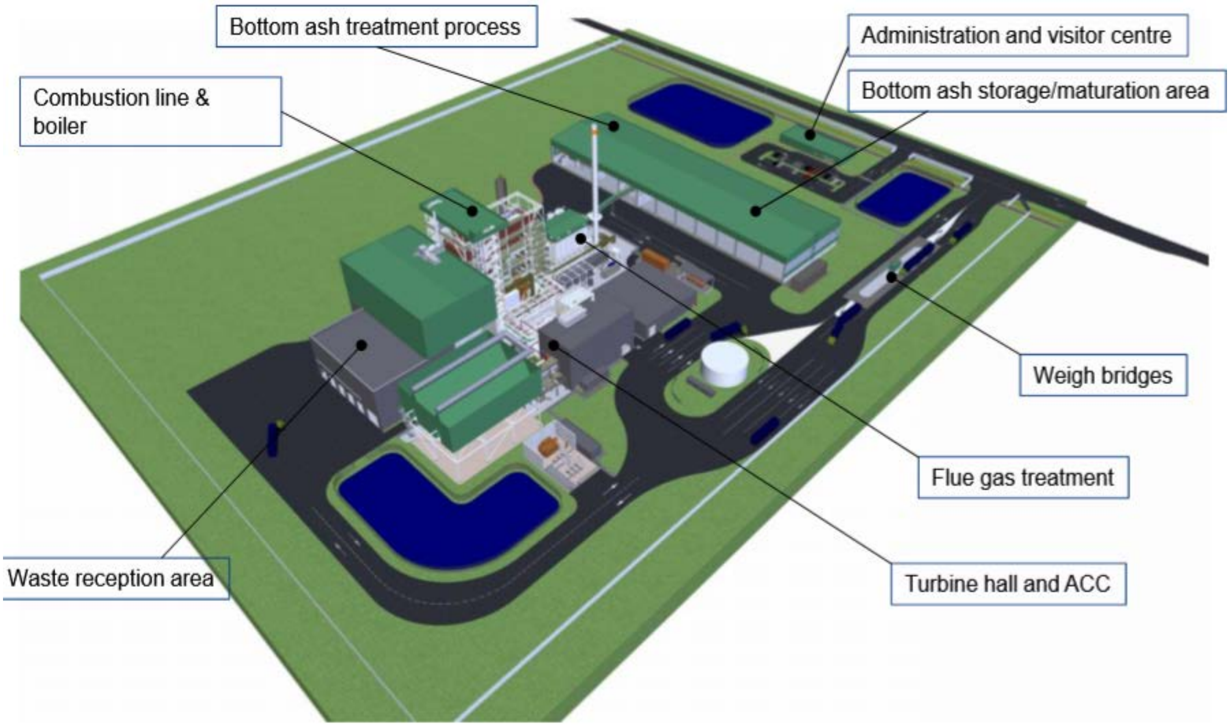
- Employment effects
- Plant performance and reliability, as compared with alternative energy sources
- Yield of superior energy efficiency (approximately 58%) due to the supply of Combined Heat and Power (CHP) over a standalone electricity generator (~27%)
- Selection of the EfW combustion technology suitable to use non-hazardous residual waste, which is successfully operating in cities with similar requirements to Auckland.

The project is expected to conserve NZ's natural energy resources equivalent to the 29 MWe per annum it will feed into the grid.

The Required Site

The site selected should be between 6 and ten hectares. The following practical considerations should inform the final decision:

- Best use of the steam and/or electricity generated by the EfW plant, to maximise the plant's efficiency
- The possibility of using existing or additional rail infrastructure to enable waste transport to the plant by train
- The road infrastructure to the EfW plant should be well organised for truck traffic with no residential areas along major arterials to the plant
- Grid electricity connections available on site with sufficient spare capacity
- Preferred location in an existing Industrial Zone (for planning) suited for this type of industrial development
- Provision for a suitable buffer around the plant
- Access to a skilled local workforce



What are the benefits of an Energy from Waste plant?

If successfully implemented, the project would provide a range of important benefits for the local community, region and nation including:

- Providing 29MWe of electrical energy directly to the grid
- Supporting an estimated 400 fulltime jobs for three years during the construction phase and 40-50 fulltime jobs for the operational phase.
- Diverting some 300,000 tonnes of residual waste from landfill each year, to a higher order use as per the Waste Hierarchy
- A net reduction in greenhouse gas emissions of approximately 254,000 tonnes per year, the equivalent of taking more than 46,0000 cars off the road
- Improving energy security by significantly reducing natural gas usage to generate power by approximately 102 MW thermal.

How would the plant be constructed?

Construction (as well as commissioning and operation) would adhere to the Auckland City Unitary Plan integrated Operations Management System (OMS) – a structured framework for effective environmental, health and safety practices and performance across all of Auckland City's activities and operations, including developing management plans and procedures for implementation during the development of the project.

Site or phase specific management plans will be developed to describe how significant impacts will be addressed during specific project development phases (i.e. construction, commissioning and operation), including development of a Construction Environmental Management Plan (CEMP) and Operations Environmental Management Plan (OEMP).

Additionally, detailed risk assessments will have to be conducted to identify the key environmental risks for the construction and operational phases. These risks and associated controls and mitigation measures will be incorporated into the CEMP and OEMP as appropriate.

Environmental best practice

The proposed EfW plant will be designed with modern technology and best practice environmental techniques. These include:

- The adoption of environmental and sustainability principles and the use of multi-criteria assessments during the selection phase of the best options for the key processes
- The opportunity to review EfW industry best practice to examine boiler technology studies, which evaluate moving grate technology. Then to assess this as the proven technology with the greatest environmental and commercial benefit for treating Auckland's MSW and C&I waste.
- Comparative analysis of industry-accepted EfW technologies to establish which technology offers the lowest technical and environmental risk for Auckland City's EfW potential requirements.
- Design for an adequate buffer zone around the plant site
- Higher order use of wastes according to the Waste Hierarchy moving from "Disposal" to "Recovery of energy" and "Recycling" for metals and ash generated from the process
- Compliance with stringent European Union Industrial Emissions Directive (IED 2010/75/ EU) .

Flue Gas Treatment residues

The main source of Prescribed Industrial Waste PIW would be from the flue gas treatment residues (FGTr), which are the fly ash residues from the air treatment system. Typically these residues comprise 3-4% of the input fuel by weight.

This material would contain minor amounts of hazardous components such as heavy metals (e.g. cadmium, chromium, copper, magnesium) mixed with mostly unprocessed cleaning reagents such as lime and activated carbon.

FGTr would be contained and disposed of offsite to an appropriately engineered and licensed landfill by a licensed waste contractor, either directly after recovery or following treatment.

Noise

With reference to the Australian EfW plant (see notes below), their applicable EPA guideline is Noise for Industry in Regional Victoria (“NIRV”). A noise assessment was conducted in accordance with NIRV, which included the calculation of noise limits and design targets.

The assessment found that the noise contribution from the proposed EfW plant would meet EPA limits at recording stations, particularly the nearest residential recording points to the north, south, east & west of the site.

During the detailed design phase, there will be opportunities to consider additional mitigation measures to reduce potential noise impacts. This would include identifying dominant noise sources, including:

- Noise from the boiler house
- Water Cooled Condensers (WCCs)
- Train and truck noise

Greenhouse gas emissions

The EfW plant would result in a net reduction of approximately 254,000 tonnes of CO_2 emissions each year in comparison to the waste going to landfill. This is equivalent to removing over 46,000 cars from our roads each year.

Conclusion

The proposed 102 MWth EfW plant for Auckland is a significant $400 million project over 20 years that would provide a welcome contribution of baseload energy supply to the Auckland City grid of 29MWe, equivalent to powering some 35,000 homes.

The energy security established from the project would support the City's waste management operations in an economically viable manner. It would generate energy-related employment opportunities through the construction and the ongoing operational phases, and bring significant social and economic benefits to Auckland City and region.

A comprehensive set of environmental assessments would be conducted to ensure compliance with all regulatory constraints. It is anticipated that the Auckland EfW case will correspond to the Australian EfW case. The Australian assessments all concluded that potential environmental impacts from the project would be low. The Australian assessments also support claims for the numerous benefits that the project would provide at a local, regional and state level.

This White Paper has been prepared by Oceania Marketing Services Ltd for discussion purposes only and cannot formally represent the interests of Hitachi Zosen Inova Australia Pty Ltd or any of its affiliates.

The purpose of these discussions is to engage with the Auckland City Council and consider the case for an EfW plant for the city.

The next step would involve an educational workshop with Council representatives conducted by the Hitachi Zosen Inova Pty Ltd regional manager from Sydney. At that time, should the Council representatives consider advancing the City's interest in the EfW plant, those qualified authorities would join the City into a non-binding Memorandum of Understanding with Oceania Marketing Services Ltd to that effect.

(All illustrations courtesy of Hitachi Zosen Inova Pty Ltd,. Australia)