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THE NEXT GENERATION NSW PTY LTD
PROJECT DEFINITION BRIEF

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Table of Abbreviations

ACC	Air Cooled Condenser
APC	Air Pollution Control
BAT	Best Available Technology
BFR	Brominated Flame Retardants
C&D	Construction and Demolition
C&I	Commercial and Industrial
CCA	Copper, Chromium, Arsenic
CCTV	Common Camera Surveillance System
CEMS	Continuous Emissions Monitoring System
CEN	European Committee for Standardization
CMS	Control and Monitoring System
CRW	Chute Residual Waste
EfW	Energy from Waste
EPA	Environment Protection Authority
EPL	Environment Protection Licences
FGT	Flue Gas Treatment
HBr	Hydrogen Bromide
HCl	Hydrogen Chloride
IED	Industrial Emissions Directive
ISO	International Organization for Standardization
LOSP	Light Organic Solvent Preservatives
LP	Load Point
MCR	Maximum continuous flowrate
MRF	Material Recovery Facility
NCV	Net Calorific Value
NH_3	Ammonium Hydroxide
NO_x	Nitrogen Oxide
O&M	Operation and Maintenance
PAC	Powdered Activated Carbon
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PVC	Polyvinyl Chloride
SNCR	Selective Non- Catalytic Reduction
SO_2	Sulphur Dioxide
SWF	Specified waste fractions
TNG	The Next Generation
TWW	Treated Waste Wood
WEE	Electronic waste

1. INTRODUCTION

The purpose of this document is to define the key design parameters which are to be used in the documents for the new Waste-to-Energy plant owned by The Next Generation (NSW) Pty Ltd (hereafter TNG).

TNG, a stand-alone company, has been formed by Dial a Dump Industries and Genesis Xero Waste Facility to develop a low carbon electricity generating plant that will be fuelled by waste derived fuels.

The project can be divided into the following primary systems, which will be described below in this order:

- Delivery, tipping and feeding
- Furnace/boiler
- Flue gas treatment (APC)
- Turbine/Condensers
- Ancillary equipment
- Control and monitoring system
- Electrical systems
- Civil works and layout
- Operation

2. KEY FACTS OF THE PLANT

2.1 General

The proposed Development involves the construction and operation of an Electricity Generation Plant (the proposed Facility). The proposed Facility will generate electrical power from unsalvageable and uneconomic residue waste which would otherwise be land filled.

Regulatory Standards

The proposed Facility will be compliant with NSW Emissions Requirements and in line with the NSW EfW Policy.

Calorific Value of Fuel

The design fuel has been calculated based on the expected waste fractions and has a Net Calorific Value (NCV) of 12.3 MJ/kg (equivalent to 12,300 kJ/kg).

Based on the design fuel NCV the Facility will have a nominal capacity to treat 552,500 tpa (34.53 t/h, 2 streams, 8,000 h) of fuel.

Composition and NCV will vary for each individual fuel fraction. The Facility is designed to operate efficiently within an NCV range to maximise operational flexibility and high efficiency. The combustion diagram is based on an NCV range from minimum 8.5 MJ/kg to maximum 16.5 MJ/kg.

Electricity Generation output

To maintain the planned generating capacity with the proposed NCV range the fuel requirement can vary from approximately 405,000 to 675,500 tpa with an optimum expect throughput of 552,500 tpa when the fuel waste on an annualised basis has a Net Calorific Value (NCV) of 12.3 MJ/kg

The proposed Facility has a capacity to generate net 68.65 Mega Watts of electrical energy (MWe).

Fuel Source

The Fuel will be sourced from the neighbouring Genesis MPC, which will enter the proposed Facility via conveyor and the private connecting road under-pass culvert.

Fuel will be provided only by Facilities where bona fide resource recovery processes have been undertaken in accordance with the NSW EfW Policy guidelines and where fuel quality is consistently demonstrated.

In all cases quality control procedures engaged by the Genesis Recycling Facility will be employed to ensure,

(a) compliance with the NSW EPA Energy from Waste Policy in respect of the extent of the resource recovery required to have been carried out ,

(b) consistent fuel quality and the exclusion of unacceptable materials from the fuel residue waste stream.

Planning and Construction approval limited to Stage 1
Preliminary approval was previously sought for a two stage 4 line concept plan with the second stage [lines 3 and 4] having effectively 50% capacity of the two stages taken together.

The staged proposal based around a Facility engineered and designed to accommodate the second stage build met with community expressions of concern about size and scale.

In order to mitigate any confusion which may have had arisen in the community the proponent's response to submissions lodged in December 2016 made clear that the submission was in respect only of a stage 1 application for approval.

The supporting reports and modelling by expert consultants however continued to reflect potential impacts on the environment, on amenity, on health and upon the community *as if* both stages of the facility had had been completed and were operational.

Accordingly, the proponent makes a request pursuant to Regulations under the EPAA legislation to formally amend its application to limit it only to an application for development consent for stage 1 only.

Construction and operation will take place as follows:

- **Stage 1** will include the complete construction of the Tipping Hall and Waste Bunker and combustion Lines 1 and 2 comprising of two independent Boilers, Flue Gas Treatment (FGT) systems, Stack as well as one Turbine and one Air Cooled Condenser (ACC) and all other auxiliary equipment including two emergency generators.

The proponent will submit at a later time a fresh application in respect of two additional combustion lines [Lines 3 and 4].

The fresh application for a stage 2 build will only be submitted for assessment once the Department of Planning and Environment is satisfied that stage 1 is operating satisfactorily and the required additional amount of residual waste fuel is demonstrated to be available to the Stage 2 TNG facility.

Proposed Technology
The technology proposed for the Facility is a moving grate system with water and air cooled grate bars. This system offers the most flexible and cost effective solution for the fuel mix being considered.

The proposed turbine exhaust cooling system for the Facility is an Air Cooled Condenser. ACCs are considered to be the preferred option as they do not require water and do not generate an effluent discharge.

Except under exceptional and limited climatic conditions there will normally be no visual plume impact through the ACC, as there would be for an evaporative cooling tower.

The flue gas treatment system is designed to achieve the emission limits as required by the European Industrial Emissions Directive and complies with NSW emissions guidelines.

The flue gas treatment system will consist of a Selective Non- Catalytic Reduction (SNCR) of NOx, semi-dry system with hydrated lime and activated carbon reactor and fabric filter.

Without any changes to the main process, the Facility will be configured so that it will be possible to export electricity and heat to nearby consumers.

Operation of the Facility will generate three types of solid waste by-products:

- bottom ash;
- boiler ash; and
- flue gas treatment residues (APC residues).

The facility will produce no excess effluent during operation.

2.2 Fuels

A moving grate system offers TNG the greatest flexibility in the range of waste fuels that may be processed at the Facility.

The following fuel types have been identified as the main sources of fuel for the Facility;

- Chute Residual Waste (CRW) from the Genesis Plant Output
- General Solid Waste [non putrescible] after resource recovery- currently Landfill Facility Direct Input
- Material Recovery Facility waste (MRF) from bona fide resource recovery facilities [currently also Genesis Landfill Facility Direct Input]
- Floc waste from car and metal shredding and resource recovery carried out by others;
- Commercial and Industrial (C&I) residual after resource recovery carried out by Genesis or by others operating bona fide resource recovery facilities
- Other specified waste fractions (SWF) compliant with EFW Policy

As the NCV of waste fuels vary depending on type, the facility will operate within a range of NCVs to support operational flexibility.

2.2.1 Design Fuel

A number of elements have been taken into account in arriving at a Design Fuel.
These include,

(i) The availability within the Sydney Metropolitan area of wastes and residual wastes of the types which comply with the EFW Policy

(ii) The quantities of wastes and the relative proportions or fractions of residual wastes of the types which comply with the EFW Policy

(iii) The Calorific Values of the fractional components of the residual waste streams

The availability of appropriate waste streams is derived from an analysis carried out by MRA Consulting dated 13th July 2017.

MRA also modelled by reference to the NSW Energy from Waste Policy, the quantities in tonnes of qualifying waste streams either currently received by the Genesis Facilities or those that would be anticipated to be received by the Genesis Facilities if by the time the TNG project was approved and commissioned.

The constituent fractions of the fuel types were derived from the independently conducted audits of the waste streams currently managed by Genesis Facilities. The composition audits are found in Annex 1.

The calorific values of the fractional components of the waste streams were provided by Ramboll, based on the outcomes of the disposal based audit: C&I waste stream in the regulated areas of New South Wales, published May 2015, NSW EPA.

Based upon the fuel types listed above, a design fuel composition has been developed.
This is based on typical values for each of the proposed fuels and an estimated fuel mix.

Input fuel will always be mixed as part of the normal operational process to produce as homogenous an input as possible.

Design Fuel Content

During the assessment process attention was drawn to the differing nomenclature of waste categories used in NSW and those in parts of Europe and to the difficulties to which this could give rise when assessing inputs and outputs of facilities otherwise comparable in terms of size and engineering design.

Residual Waste [left over after resource recovery] forms the input fuel stream for the facility which is proposed.

The principal source of that fuel waste input stream has been identified as the adjacent Genesis Recycling Facility operated by a sister corporation to the proponent.

The Genesis Facility operated by the DADI Group is the holder of two Environment Protection Licences [EPLs].

The Genesis resource recovery Facility is licensed pursuant to EPL 20121 to accept the following material types:

- Wood waste
- Garden waste
- Building and demolition waste
- Waste tyres
- Soils
- General solid waste (non-putrescible)

In the NSW Waste Industry this type of waste is often described as Construction and Demolition (C&D) waste. It is one of the broadest categories of waste descriptions to be found in the Protection of the Environment Operations Act 1997 (POEO Act).

The Genesis Landfill operates pursuant to EPL 13426 and is licensed to accept
General Solid Waste

These types are more closely defined by reference to Part 3 Definition of Division 1 Waste Classifications.

> Part 3 - Definitions
> Division 1 Waste classifications
> 49 Definitions of waste classifications
>
> (1) In this Schedule:
> General solid waste (non-putrescible) means waste (other than special waste, hazardous waste, restricted solid waste, general solid waste (putrescible) or liquid waste) that includes any of the following:
> (a) glass, plastic, rubber, plasterboard, ceramics, bricks, concrete or metal,
> (b) paper or cardboard,
> (c) household waste from municipal clean-up that does not contain food waste,
> (d) waste collected by or on behalf of local councils from street sweeping,
> (e) grit, sediment, litter and gross pollutants collected in, and removed from, stormwater treatment devices or stormwater management systems, that has been dewatered so that it does not contain free liquids,
> (f) grit and screenings from potable water and water reticulation plants that has been dewatered so that it does not contain free liquids,
> (g) garden waste,
> (h) wood waste,
> (i) waste contaminated with lead (including lead paint waste) from residential premises or educational or child care institutions,
> (j) containers, having previously contained dangerous goods, from which residues have been removed by washing or vacuuming,

(k) drained oil filters (mechanically crushed), rags and oil absorbent materials that only contain non-volatile petroleum hydrocarbons and do not contain free liquids,
(l) drained motor oil containers that do not contain free liquids,
(m) non-putrescible vegetative waste from agriculture, silviculture or horticulture,
(n) building cavity dust waste removed from residential premises, or educational or child care institutions, being waste that is packaged securely to prevent dust emissions and direct contact,
(o) synthetic fibre waste (from materials such as fibreglass, polyesters and other plastics) being waste that is packaged securely to prevent dust emissions, but excluding asbestos waste,
(p) virgin excavated natural material,
(q) building and demolition waste,
(r) asphalt waste (including asphalt resulting from road construction and waterproofing works),
(s) biosolids categorised as unrestricted use, or as restricted use 1, 2 or 3, in accordance with the criteria set out in the Biosolids Guidelines,
(t) cured concrete waste from a batch plant,
(u) fully cured and set thermosetting polymers and fibre reinforcing resins,
(v) fully cured and dried residues of resins, glues, paints, coatings and inks,
(w) anything that is classified as general solid waste (non-putrescible) pursuant to an EPA Gazettal notice,
(x) anything that is classified as general solid waste (non-putrescible) pursuant to the Waste Classification Guidelines,
(y) any mixture of anything referred to in paragraphs (a)–(x).

In Europe it is common practice to refer to C&D Waste as being source separated on site.

The effect of this is to broadly separate out brick concrete and timber materials leaving the remainder as residue. This is generally a manual process carried out by unskilled labour.

The residue left over from that process is then added together with other waste streams as C&I waste to form the fuel waste for EfW plants.

By contrast in NSW, C&D waste is not source or site separated with those processes being highly mechanised and specialised and taking place at centralised waste collection facilities of which Genesis is one.

What in Europe is named C&D waste and that same named material in NSW does not yield a simple comparison. Descriptors of the residue waste by reference to their origin or source is to be eschewed.

The proponent also became aware during the public consultation process of a significant degree of concern by members of the public regarding what they considered might be the potential contents of the building and demolition waste given what appears to be a quite broad classification in Part 3 definitions in the POEO Act cited above.

In order to address community concern and also to ensure that any comparison of similar facilities was carried out on a like for like basis, the proponent undertook to identify not only the origin waste streams but more importantly the contents of the residue waste stream after resource recovery had been completed.

In order to do this the Genesis facility commissioned a series of independent Waste Audits carried out by NSW EPA accredited Waste auditors (audits are found in annex 1) to identify and establish with precision the physical compositional attributes of

- CRW
- MRF residual
- Floc Waste

In case of C&I waste Ramboll has used the fractional analysis according to "Disposal based audit: C&I waste stream in the regulated areas of New South Wales, published May 2015, NSW EPA" and existing data on the composition of these fractions to assess the composition of

- C&I
- SWF

Concurrently with the carrying out of the compositional analysis, samples from the audited waste were submitted to a NATA approved laboratory and analysed for a range of chemical constituents.

The Audit results and the Laboratory reports are appended at Appendix 1.

The residue waste streams which were audited were created as a result of resource recovery procedures and under the current configuration of sorting and processing were [as residue wastes] specifically destined to be landfilled.

Normally it would be expected that this process would concentrate any percentages of materials of concern.

Despite this the Audit reports note in particular, the absence of special wastes (asbestos) from the audited samples. The audit also demonstrates a general absence of a range of miscellaneous items of concern to the community such as car batteries gas cylinders and fire extinguishers.
The focus of the Genesis separation processes is to generate high quality recovered products meeting appropriate standards for safety and consumer use.

As a result the Genesis procedures are already very refined and are highly effective at removing all materials which are designated to be removed.

This result together with the Genesis, Quality Assurance measures provide a continuing high degree of confidence that unacceptable hazardous materials or electronic waste will be entirely excluded from the fuel waste stream.

CCA treated timber and painted wood were identified for the purposes of the audits of CRW and MRF residuals as hazardous. It is noted that in MRF residual the percentage of CCA treated and painted timber amounted to 0.16% to 0.44% by weight.

The audits were conducted of the residual waste streams (which are currently committed to landfill) and were therefore not subject to the exclusionary quality assurance processes which Genesis currently applies to its recovered wood-waste products – hence the detection of CCA timber in the waste stream.

There are two approaches to this issue,

(i) The first of these is to apply the quality assurance processes currently operated by Genesis in respect of its recovered wood-waste products to the residual fuel waste stream which would then be confidently expected to reduce even further in the CRW and MRF waste streams the fractional constituent of CCA treated or painted timber.
(ii) The second of these is to consider the fractional constituent present in the CRW and MRF residual streams as a component of the entire annual residual fuel waste stream of the TNG facility.

It should be noted that full scale tests have previously shown that processing up to 10% of CCA treated wood concurrently with other fuels had no deleterious effect on the quality of emissions[1].

[1] Ministry of Environment and Food of Denmark, Environmental Project No. 1654, 2015
"Vurdering af metalholdigt affald til forbrænding" (Abstract in English)
http://mst.dk/service/publikationer/publikationsarkiv/2015/mar/vurdering-af-metalholdigt-affald-tilforbraending/

In relation to the TNG proposal the proportions by weight of CCA treated and painted timbers are able to be identified in the CRW and MRF waste stream Audits. From this information the quantities of these materials expected to be present in the CRW and MRF streams on an annual basis is able to be calculated

These particular materials identified in small quantities in CRW and MRF are however expected to be absent from the balance of the eligible residual waste streams identified in the report by MRA Consulting.

When CRW, MRF and the balance of the eligible residual waste fractions are taken together the percentage by weight which the CCA components will be significantly less than 1% by weight. This presents as being of no consequence to the emissions output of the facility.

It was also noted that a high degree of homogeneity is evident in the sampled materials resulting from the extensive degree of processing to which the materials are subject during resource recovery.

The high degree of homogeneity present in the local waste fuel as a result of centralised process is not present in European residual waste fuels where sorting separating and processing is not centralised. To that extent European plants depend to a much greater degree on in-facility waste mixing which occurs as the waste is tipped and then fed to the incinerators. Nevertheless the same mixing procedures for waste delivered before feeding to the plant will be applied for this facility.

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	CRW	MRF	Floc Waste	Mixed C&I	Specified Waste	Design Fuel Mix
Fuel Mix	**19.90%**	**12.06%**	**14.73%**	**40.93%**	**12.37%**	**100.00%**
Compositional Analysis						
Paper/Cardboard	3.76%	22.00%	0.39%	20.42%	0.00%	11.82%
Wood/Timber	64.55%	3.09%	2.98%	16.87%	85.65%	31.16%
Plastic	7.38%	29.04%	21.42%	16.69%	0.00%	14.96%
Metal (Ferrous and non-ferrous)	1.88%	4.63%	1.41%	3.34%	0.00%	2.51%
Organic (not wood/timber)	11.78%	32.21%	15.71%	23.21%	14.35%	19.82%
WEE (electronic waste)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Hazardous	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Glass	0.11%	4.34%	0.00%	1.70%	0.00%	1.24%
Other* (including earth and building materials)	10.53%	4.69%	58.09%	17.77%	0.00%	18.49%
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

* Other defines earth and building materials including:
- Insulation
- Carpet/underlay
- Compounds (excl. plastic and metal)
- Asphalt
- Inert incl. non-hazardous building waste

	CRW	MRF	Floc Waste	Mixed C&I	Specified Waste	Design Fuel Mix
Chemical Analysis						
Carbon (C)	38.54%	44.18%	23.45%	25.66%	36.96%	31.53%
Hydrogen (H)	4.61%	6.09%	4.17%	3.32%	4.66%	4.20%
Oxygen (O)	25.20%	19.29%	7.99%	18.10%	33.09%	20.02%
Nitrogen (N)	0.77%	0.42%	0.96%	0.73%	0.56%	0.71%
Sulphur(S)	0.18%	0.07%	0.26%	0.16%	0.22%	0.18%
Chloride (Cl)	0.37%	0.32%	0.52%	0.06%	0.09%	0.23%
Ash	14.72%	19.04%	49.50%	21.04%	4.63%	21.70%
Water (H2O)	15.60%	10.59%	13.15%	30.92%	19.78%	21.43%
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
NCV MJ/kg	14.71	18.79	11.00	9.41	13.24	**12.30**

Table 1 Proposed design fuel analysis, as received basis

The analysis above defines the design fuel of the Facility. Suitable ranges for various key components such as the moisture, ash and energy content of the fuel are discussed in section 2.2.2. Based on the above design compositions, NCV of the nominal design fuel mix is calculated to be 12.30 MJ/kg.

2.2.2 Fuel Range

The homogenisation which results from the intense resource recovery processes together with the process of mixing fuels prior to incineration contributes to a more efficient burn process and an overall less chance of unexpected spikes during the incineration.

The minimum and maximum fuel ranges as basis for calculation and design of the plant are shown in Table 2 within this range the facility will still operate efficiently.

		Minimum	Maximum
Nitrogen(N)		0.42%	0.96%
Sulphur(S)		0.07%	0.26%
Chloride (Cl)		0.06%	0.52%
Ash		4.6%	49.5%
Water(H_2O)		10.6%	30.9%
NCV	MJ/kg	8.5	16.5

Table 2 Fuel range

2.3 CRW fractions and chemical analysis to be processed at TNG

The percentage components of CRW received at Genesis as indicated by the recent independently conducted audit is shown here.

To have a clear picture of the expected composition of the CRW waste to be processed at TNG (referred to as "DADI_CRW_Waste_Audit_Report_April_2017_050517_Draft"), 42 samples of the CRW waste stream were collected. These samples were then individually analysed to determine the macroscopic composition and the calorific value.[2]
In addition the chemical components were analysed (referred to "hrl 170505 Full Report"). [3]

The majority (64%) of CRW is wood timber. There are also substantial amounts of non-organic (12%), other (earth and building materials including insulation, carpet/underlay, compounds (excl. plastic and metal), asphalt and inert incl. non-hazardous building waste 11%) and Plastic (7%). These four materials make 94% of CRW. The rest is paper/cardboard (4%) and metal (2%).

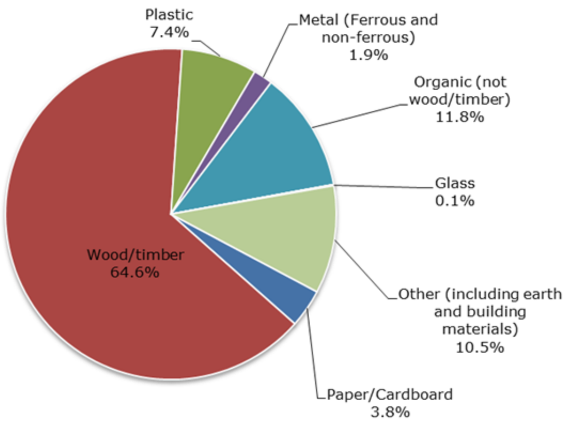


Figure 1 Average macroscopic composition of "CRW" TNG

The net wet calorific value were analysed for each material (referred to "hrl 170505 Full Report", table 3, part 1). The calculated NCV is 14.7 MJ/kg.

Chemical Analysis of CRW TNG

The chemical profile of CRW TNG is summarised in Table 3.

	unit	TNG
Carbon (C)	%	38.5
Hydrogen (H)	%	4.6
Nitrogen (N)	%	0.8
Sulphur (S)	%	0.2
Chloride (Cl)	%	0.4
Oxygen (O)	%	25.2
Ash	%	14.7
Water (H_2O)	%	15.6
NCV	**MJ/kg**	**14.7**

Table 3 Chemical Analysis CRW TNG

2 Reference Chute Residual Waste: Composition Audit for Dial A Dump Industries, by ec Sustainable, dated April 2017
3 Reference Analysis of waste samples, Report No. 170505 for Environ Consulting Services, by HRL Technology Group Pty Ltd, dated 01 June 2017, see Appendix 1

2.4 MRF fractions and chemical analysis to be processed at TNG

The percentage components of MRF Residual Waste received at Genesis as indicated by the recent independently conducted audit is shown here.

To have a clear picture of the expected composition of the MRF waste to be processed at TNG (referred to as "DADI_MRF_Residuals_Audit_Report_April_2017_120517_Draft"), 31 samples of the CRW waste stream were collected. These samples were then individually analysed to determine the macroscopic composition and the calorific value.[4]
In addition the chemical components were analysed (referred to "hrl 170505 Full Report"). [5]

There are three major materials in MRF. These are Organic (32%), plastic (29%) and paper/cardboard (22%). These three materials make 83% of MRF. The rest is other (earth and building materials including insulation, carpet/underlay, compounds (excl. plastic and metal), asphalt and inert incl. non-hazardous building waste), glass, HEEE and metal (each about 4.5%) and wood (3%).

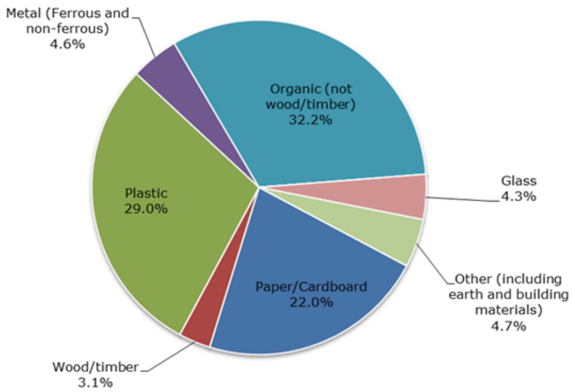


Figure 2 Average macroscopic composition of "MRF" TNG

The net wet calorific value were analysed for each material (referred to "hrl 170505 Full Report", table 3, part 2). The calculated NCV is 18.8 MJ/kg.

Chemical Analysis of MRF TNG

The chemical profile of MRF TNG is summarised in Table 4.

	unit	TNG
Carbon (C)	%	44.2
Hydrogen (H)	%	6.1
Nitrogen (N)	%	0.4
Sulphur (S)	%	0.1
Chloride (Cl)	%	0.3
Oxygen (O)	%	19.3
Ash	%	19.0
Water (H_2O)	%	10.6
NCV	**MJ/kg**	**18.8**

Table 4 Chemical Analysis MRF TNG

[4] Reference MRF Residual Waste: Composition Audit for Dial A Dump Industries, by ec Sustainable, dated April 2017
[5] Reference Analysis of waste samples, Report No. 170505 for Environ Consulting Services, by HRL Technology Group Pty Ltd, dated 01 June 2017, see Appendix 1

2.5 Floc Waste fractions and chemical analysis to be processed at TNG

The percentage components of Floc Waste received at Genesis as indicated by the recent independently conducted audit is shown here. To have a clear picture of the expected composition of the floc waste to be processed at TNG (referred to as "floc waste TNG"), 17 samples of nearby floc waste producers were collected. These samples were then individually analysed to determine the macroscopic composition, the chemical components and the calorific value. [6]

The following results refer to dry basis (db): The majority (58%) of shredder floc is inert material. There are also substantial amounts of non-polystyrene plastics (21%) and textiles (11%). These three materials make 90% of shredder floc. The rest is rubber/leather (5%), wood waste (3%), metal (1%), polystyrene (1%) and paper/cardboard (0.4%).

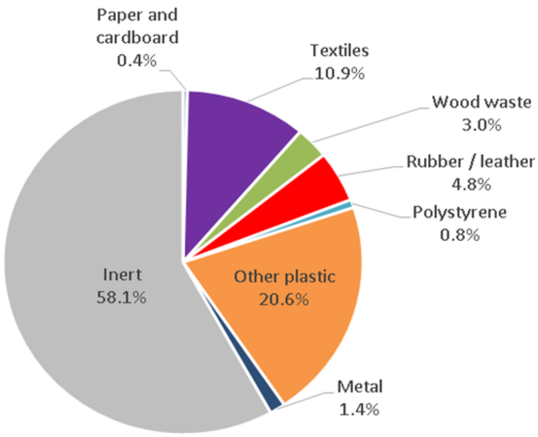


Figure 3 Average macroscopic composition of "floc waste TNG" (dry basis)

The analysed net calorific value of the 17 samples varies from 7.8 to 15.7 MJ/kg (as received). The average value is 11.0 MJ.

Chemical Analysis of floc waste TNG

The chemical profile of "floc waste TNG" is summarised in Table 5.

	unit	TNG
Carbon (C)	% (db)	27.0*
Hydrogen (H)	% (db)	4.8
Nitrogen (N)	% (db)	1.1
Sulphur (S)	% (db)	0.3
Chloride (Cl)	% (db)	0.6
Bromine (Br)	% (db)	0.01
Oxygen (O)	% (db)	9.2
Ash	% (db)	57.0
Water (H_2O)	% (ar)	13.2
Total PAH	mg/kg (db)	20
Total PCB	mg/kg (db)	14
NCV	**MJ/kg**	**11.0**

Table 5 Comparison of "floc waste TNG"

*Note: Value corrected to allow for uncertainties of the chosen analytical method

[6] Reference Audit of potential feedstock for The Next Generation energy-from-waste facility for Dial A Dump Industries, by apc waste consults, dated August 2016, see Appendix 1

2.6 C&I fractions and chemical analysis to be processed at TNG

The percentage components of C&I received at Genesis is shown here.

There are five major materials in C&I. These are Organic (23%), paper/cardboard (20%), plastic (17%), other (earth and building materials including insulation, carpet/underlay, compounds (excl. plastic and metal), asphalt and inert incl. non-hazardous building waste 18%) and wood/timber (17%). These three materials make 95% of C&I. The rest is glass and metal (total 5%).

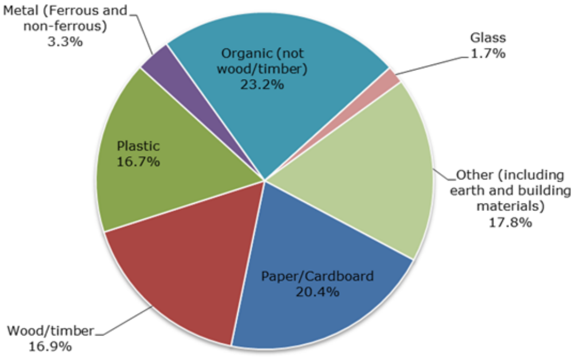


Figure 4 Average macroscopic composition of "C&I" TNG

The calculated NCV is 9.5 MJ/kg.

Chemical Analysis of C&I TNG

The chemical profile of "C&I TNG" is summarised in Table 6.

	unit	TNG
Carbon (C)	%	25.66
Hydrogen (H)	%	3.32
Nitrogen (N)	%	0.73
Sulphur (S)	%	0.16
Chloride (Cl)	%	0.06
Oxygen (O)	%	18.10
Ash	%	21.04
Water (H_2O)	%	30.92
NCV	**MJ/kg**	**9.4**

Table 6 Chemical Analysis C&I TNG

2.7 Special waste fractions and contaminants

2.7.1 The effect of waste separation and the resultant waste homogenisation

The Genesis Quality assurance processes are demonstrably effective at largely excluding PVC from C&D resources recovered for re-sale. Currently those quality assurance processes separate and remove PVC from recovered materials and the separated PVC forms part of CRW.

Despite this concentration of PVC in CRW, the PVC component by weight was shown in the recent audits to be only approx. 0.65% by weight, resulting in a chlorine content of 0.37% in the CRW. If the same PVC separation process was applied to the CRW as are currently applied to resource recovery then even this small component could be reduced significantly.

In all other waste fractions the chlorine content is between 0.06% and 0.52%. There is therefore a high degree of confidence that any single waste fraction and the waste in total as an average will not contain more than 1% chlorine.

2.7.2 Treated Waste Wood (TWW)

TWW can be defined as wood that has been treated with at least one of the following:

- Copper, Chromium, Arsenic (CCA)
- Copper Organics
- Creosote
- Light Organic Solvent Preservatives (LOSP)
- Micro-emulsion
- Paint / stain
- Varnish

Several studies are available on the impact of processing TWW in an EfW plant. The most important results are summarized below:

- Thermal treatment is suitable for all types of TWW as there is an effective control of the emissions.
- Co-incinerating of wood with the above mentioned substances along with the basic waste brings an increase of the average arsenic content in the waste, whereas the concentrations of copper and chromium do not differ significantly from the basic waste. Full-scale tests with co-incineration of impregnated wood, has not shown significant increase of arsenic emissions to air. Air emissions of arsenic (and trace metals in general) are mainly dependent on the Air Pollution Control technology and only to a small degree on the input concentration.

Nevertheless,

TWW represents a significant proportion of the waste wood received at Genesis and which is then separated and excluded during the processes of resource recovery currently operating there.

The Genesis Quality assurance processes described in Appendix 2 produce a recovered wood-waste for the purposes of reprocessing and then sale.

TWW is absent from the materials recovered for re sale. This is verified by independent laboratory analysis routinely carried out at Genesis attesting to the chemical profile of the wood. Typical reports are shown at Appendix 2.

Diversion of TWW [when it is separated from re-usable wood-wastes] away from the residual waste fuel stream will ensure that TWW will continue to be disposed of at landfill.

In the event that a quantity of TWW is not recognised and therefore not removed from the waste stream before the fuel waste enters TNG given the very low overall percentage of TTW in the fuel waste stream it is probable that the concentration of arsenic overall will not measurably increase.

If there was to be any increase in arsenic content this would primarily be evidenced in the residues from the flue gas cleaning process, and to some extent the concentration in the bottom ash

2.7.3 Shredder residue (floc waste/shredder floc)

Processing floc waste in EfW facilities is widespread and a preferred recovery option in Europe.

According to the Australian Federal Chamber of Automotive Industries the reuse and recovery rate of end-of-life vehicles in Australia is 75% (data published 2011) which obviously represents the metals.

In Australia the current recycling practice for the end-of-life vehicles is to drain fluids and to dismantle for saleable parts (wheels, batteries, engines, alternators, body panels, etc.). Approximately 65-75% of the rest of the vehicle are ferrous and nonferrous metals.
The percentage components of Floc waste received at Genesis as indicated by the recent independentl audit is shown below.

Chemical analysis of European floc waste
The composition of floc waste can vary widely depending on the input to the shredder, on the shredder process, the floc removal (wet or dry) as well as the amount of water-spray used for dust abatement. The following table shows the variation of the composition of European floc waste.

Parameter		Average	Range
Moisture	%-Weight	6.7	0.1 - 18
Ash	%-Weight	52.7	25 - 80
NCV	MJ/kg	13	7 - 20
C	%-Weight	32.6	20 - 47
H	%-Weight	4.1	2 - 6
N	%-Weight	0.9	0.2 – 1.8
O	%-Weight	7	3 - 11
S	%-Weight	0.6	0.1 – 1.4
Cl	%-Weight	1.8	0.5 - 3

Table 7 Range and average chemical composition of Floc Waste Europe

As the above table shows, the variation in composition is significant. The main factors contributing to the variation are the water and the ash content. The water content depends on the process (as described above) or the transport conditions (open containers, rain).

The measured ash depends on two factors: the sampling and the material fed to the shredder. The feed material often contains sand/dirt or is very rusty. As a result the ash of floc waste always has a very high SiO_2 (quartz sand) and Fe_2O_3 (rust) content.

[7]The effects of co-processing floc waste with other waste streams/sources have been evaluated in several European studies. These studies have concluded the following benefits:

- By incinerating 10% shredder residue along with the basic waste, there is an increase of metals in bottom ash when compared to incinerating basic waste only. The primary increase can be assigned to the elevated metal content in the incoming waste, which, to a large degree, can be extracted and recycled. There is a slight increase of trace metal content, even after the sorting process, but actual full scale tests show no indication of increased concentration of trace metals.

[7] Ministry of Environment and Food of Denmark, Environmental Project No. 1654, 2015
"Vurdering af metalholdigt affald til forbrænding" (Abstract in English)
http://mst.dk/service/publikationer/publikationsarkiv/2015/mar/vurdering-af-metalholdigt-affald-til-forbraending/

- The concentration of trace metals in flue gas cleaning residues is increased when co-combusting shredder residue. But full scale tests show, that there is no increase of trace metal in the emissions compared to incinerating basic waste only.

Comparison of "floc waste TNG" with European values

The chemical profile of "floc waste TNG" is summarised in Table 8 and compared with the European values.

	unit	TNG	Europe
Carbon (C)	% (db)	27.0*	32.6
Hydrogen (H)	% (db)	4.8	4.1
Nitrogen (N)	% (db)	1.1	0.9
Sulphur (S)	% (db)	0.3	0.6
Chloride (Cl)	% (db)	0.6	1.8
Bromine (Br)	% (db)	0.01	0.02
Oxygen (O)	% (db)	9.2	7.0
Ash	% (db)	57.0	52.7
Water (H_2O)	% (ar)	13.2	6.7
Total PAH	mg/kg (db)	20	-
Total PCB	mg/kg (db)	14	120
NCV	**MJ/kg**	**11.0**	**13.4**

Table 8 Comparison of "floc waste TNG" and average European values

*Note: Value corrected to allow for uncertainties of the chosen analytical method

In general the chemical profile of the "floc waste TNG" and European values are considered to be comparable. The main difference is that the chlorine and sulphur contents are lower. The average PCB value for TNG is substantially lower than in Europe, however the European value is based on only one source in the 1990ies.

Subject to the following,

(a) the concentration of chlorine and sulphur of "floc waste TNG" being substantially lower than European floc; and

(b) the chlorine content is below 1% and even lower than assumed in the design fuel;

The results of the NATA laboratory analysis of 17 samples of floc waste carried out following a recent compositional floc audit [8] (and which could be considered as typical of floc waste being processed in the TNG facility) show, that "floc waste TNG" is comparable to European floc waste.

There is a long-term positive experience in processing floc waste in Europe in EfW plants. Having a comparable composition of this waste in Australia supports the utilization in the TNG facility.

Conclusion

There is no evidence of any compounds present in the TNG Floc which is not otherwise catered for in the facility design.

[8] Reference Audit of potential feedstock for The Next Generation energy-from-waste facility for Dial A Dump Industries, by apc waste consults, dated August 2016,, see Appendix 1

2.8 Waste mixing

The mixing and homogenisation of the different waste streams remains an important aspect of the operation of a waste-to-energy plant and therefore it is given a very high importance. When the waste is tipped in to the bunker it has to be picked up by the crane grab so to keep the delivery area free and allow further waste deliveries. During times with low delivery it is the duty of the crane driver (or in the case of an automatic crane of the automation system) to thoroughly mix the waste by picking it up and dropping it in a different place of the storage area in the bunker. This ensures a thorough mixing of the different waste fractions. To be fed to the combustion system the waste is again picked up by the crane grab.

As a result any waste is picked and offloaded at least 2 to 3 times before being fed into the combustion process and therefore is well mixed. As a conclusion it is reasonable to assume that the contaminant concentrations of the different waste streams will be well homogenised when being fed to the combustion process.

2.9 Performance

The Facility is designed to have a thermal input of 235.96 MW (117.98 MW for each combustion line) at the design point. The Facility has an assumed net average annual electrical efficiency of 29.1%. The Facility is designed to export 68.66 MWe (29.1% x 235.96 MW). High net electrical efficiency is a priority for TNG and there are a number of options which have been incorporated to maximize the efficiency.

The export voltage will be set to match the requirements of the local high voltage electricity grid.

		Stage 1	
Items	**Units**	**Total**	**Per stream (based on 2 streams)**
Gross Power	MW_e	76.0	
Auxiliary load	MW_e	7.3	
Power Export	MW_e	68.7	
Net Efficiency	%	29.1%	
Fuel NCV	MJ/kg	12.30	
Thermal load	MW_{th}	235.96	117.98
Availability	%	91.3%	
Waste Throughput (based on assumed availability)	t/h	69.06	34.53
	tpa	552,500	276,250

Table 9 Overall Facility Performance (LPN, Design point)

2.10 Combustion Diagram

A combustion diagram is used to show the correlation of throughput in tons/hour, the calorific value in kJ/kg and the thermal output in MW for the plant. Combustion diagrams are a useful tool to identify the operational area where all guarantees, environmental and functional requirements are fulfilled.

Continuous operation shall preferably be at loading points near the nominal loading point to have an efficiently operating plant. Continuous operation outside the limits of the diagram is not possible.

Figure 5 shows the combustion diagram for one line of the proposed TNG facility.

As shown in the diagram the nominal design point (Load Point, LPN) is 34.53 tons per hour at a NCV of 12,300 kJ/kg (which is equivalent to 117.98 MW).

The line (LP6) – (LP1) represents 100% thermal load and the plant will mostly be operating along this line, in practice done by operating the boiler on a fixed steam flow rate set point (MCR: 144.7 t/h steam flow at boiler outlet). This implies that the amount of waste is reduced if the calorific value exceeds 12,300 kJ/kg and similarly increased if the calorific value decreases.

The diagram allows a range for the calorific value between 8,500 kJ/kg (line between (LP2) and (LP3)) and 16,500 kJ/kg (line between (LP5) and (LP6)). This allows variations between +34% and -31% of the nominal value of 12,300 kJ/kg.

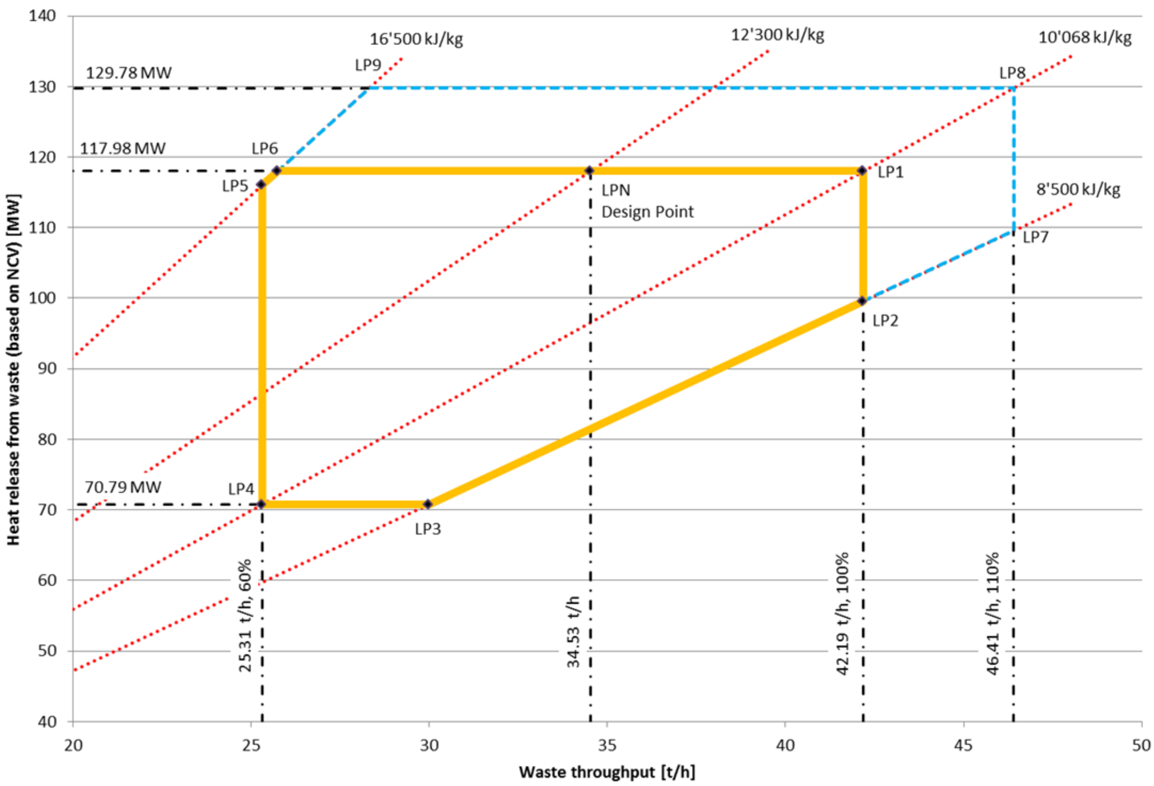


Figure 5 Combustion diagram for 1 Line

For short time overload (during less than one hour) a throughput of 46.41 tons per hour, corresponding to 110% of the nominal throughput is allowed.

The minimum amount of waste throughput is 25.31 tons per hour represented by the line (LP4) – (LP6), corresponding to 60% of the nominal throughput (mechanical load).

To maintain the planned generating capacity with the proposed NCV range the fuel requirement could vary from approximately 405,000 tpa ((LP4), (LP5): 2 streams, availability 8,000 h) to 552,500 tpa ((LP1), (LP2): 2 streams, availability 8,000 h).

However, it must be noted that operation on either the maximum or the minimum amount of waste is only possible during a very short period of time in order to absorb variations in the amount of waste and the calorific value of the waste. Continuous operation outside the limits of the diagram is not possible.

Inside the area made up by the lines (LP1), (LP2), (LP3), (LP4), (LP5) and (LP6) the plant shall be able to be in continuous operation.

The line (LP8) – (LP9) is the maximum short time thermal overload (129.78 MW), which is 110 % of the nominal thermal load. The area constituted by the lines (LP1), (LP8), (LP9) and (LP6) represents a thermal load of 100–110 % of the nominal load, is designed to manage inevitable fluctuations from the preferred operational line (LP1) – (LP6). Continuous operation at thermal overload is <u>not</u> possible.

The line (LP3) – (LP4) is the minimum allowable thermal input (fuel firing) where all guarantee values have to be fulfilled without use of the auxiliary gas burners. The line is representing 60 % of the nominal thermal load (70.79 MW).

2.11 Reference facilities

In order to compare technology, size and feedstock composition of the TNG facility several European reference plants have been chosen. The following table lists the chosen reference plants with their location, size and technology.

Facility/Location	Country	Commission year	Capacity t/a	NCV MJ/kg	Furnace/Boiler	Supplier Furnace/Boiler	APC	Supplier APC
TNG	AU	-	2 x 276'250	12.30	Grate	HZI	Semi dry (lime)	-
Grossräschen	DE	2008	1 x 246'000	12.50	Grate	AEE	Semi dry (lime)	LAB
Heringen	DE	2009	2 x 148'500	12.60	Grate	AEE	Semi dry (lime)	LAB
Premnitz	DE	2008	1 x 150'000	13.00	Grate	AEE	Semi dry (lime)	Lühr
Hannover	DE	2005	2 x 140'000	13.50	Grate	AEE	Semi dry (lime)	LAB
Knapsack	DE	2009	2 x 150'000	15.00	Grate	AEE	Semi dry (lime)	Lühr
Ferrybridge	UK	2015	2 x 256'500	13.50	Grate	HZI	Semi dry (lime)	HZI
Riverside	UK	2011	3 x 195'000	9.60	Grate	HZI	Semi dry (lime)	HZI
TIRME Mallorca	ES	2009	4 x 104'000	10.00	Grate	HZI	Semi dry (lime)	HZI

Table 10 Reference Facilities

The reference plants in Europe process a wide variation in their feedstocks, despite these variations the emissions profile show both consistency and a stable profile. This demonstrates a technological capacity of the EFW plants to withstand a wide range of variance.

The moving grate technology and semi dry flue gas treatment which is proposed for TNG is judged to be most suitable for the fuel waste composition which has been identified by the audits and is proposed

Following several key design parameters are listed and discussed in relation to the design parameters of TNG.

Plant capacity

The mechanical throughput of TNG is comparable with the plant in Grossräschen (DE). The plant capacity proposed for TNG being the thermal capacity (throughput x CV) is identical with Ferrybridge (UK). TNG therefore is in no way an exceptionally large plant.
The waste fractions comprising the design fuel at Ferrybridge UK and identified for TNG as a result of the waste Audit procedure demonstrate comparable fuel streams.

In terms plant size, of fuel capacity and waste fraction components Ferrybridge UK and the TNG proposed plant are directly comparable.

Calorific value

The calorific value defines the combustion characteristics of the waste. Generally it can be said that - except for very low CV below 8 MJ/kg - the higher the CV, the more difficult to maintain an ideal combustion process. With a CV of 12.3 MJ/kg TNG falls in the medium range between i.e. Knapsack with 15 MJ/kg or Riverside with 9.6 MJ/kg.

Chemical waste composition

Within the waste composition the most important parameters are:

- Moisture (limits the controlled ignition of the waste)
- Inert (ash) content (limits homogenous combustion and burnout)
- The larger of Chlorine or Sulphur content (is the limiting factor for the APC system)
- C/O ratio (high C/O ratio is an indicator for high plastic content which limits homogenous combustion and burnout)

The chemical waste composition of TNG design waste is shown below in stock diagram to demonstrate that TNG operates well within the range of comparable facilities, namely the listed reference plants.

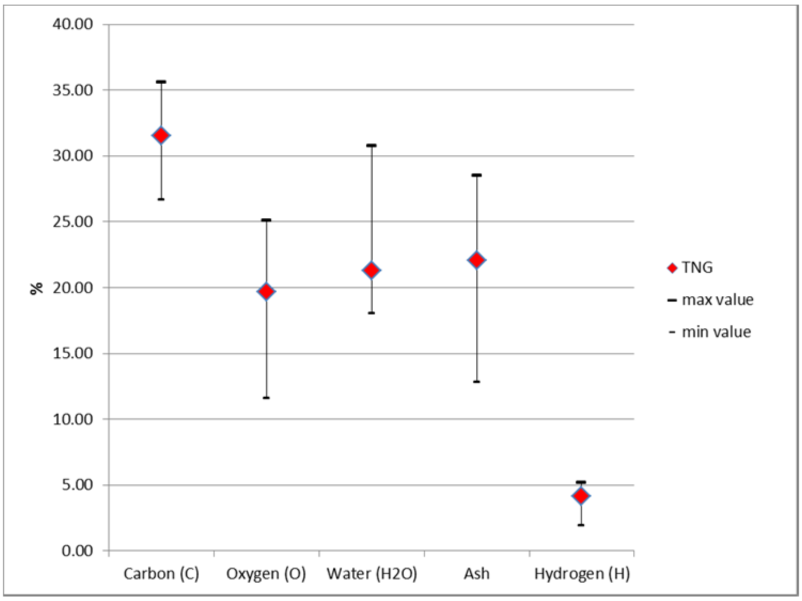


Table 11 Chemical composition of the facilities

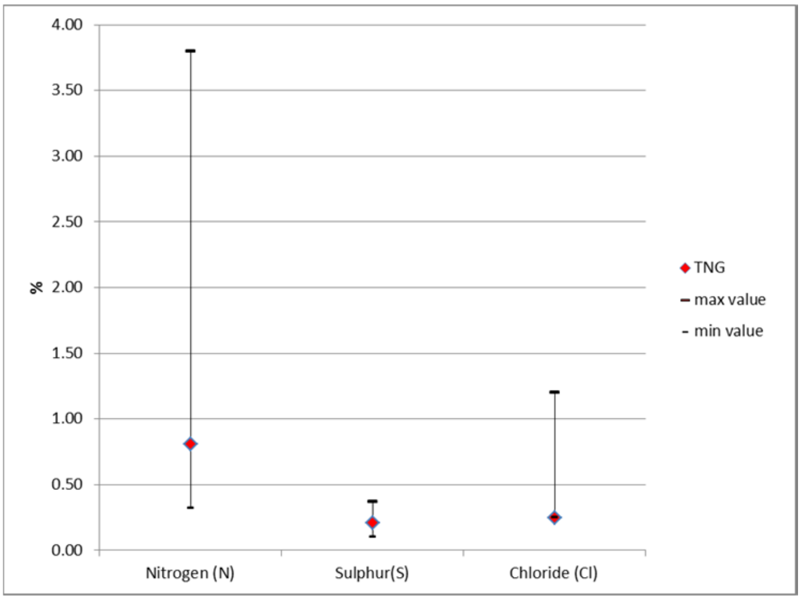


Table 12 Chemical composition of the facilities

For all these aspects TNG is well within the range of all the reference plants.

Feedstock composition

The following table compares the feedstock of the TNG facility with the reference plants.

	Specified Waste						Mixed C&I						MRF	MSW
		paper/card	plastic	textile	vegetation	wood		paper/card	plastic	textile	flock waste			
TNG	**12.0%**	-	-	x	-	x	**76.0%**	x	x	x	x	**12.0%**	x	-
Grossräschen	**9.8%**	x	x	-	x	x	**83.2%**	x	x	x	x	**7.0%**	x	x
Heringen	**13.6%**	x	x	x	x	x	**62.4%**	x	x	x	-	**24.0%**	x	-
Premnitz	**14.3%**	x	x	x	x	x	**57.0%**	x	x	x	x	**28.7%**	x	-
Hannover	**9.0%**	x	x	x	x	x	**75.3%**	x	x	x	x	**15.7%**	x	x
Knapsack	**10.0%**	x	x	x	x	x	**90.0%**	x	x	x	-	**0.0%**	x	-
Ferrybridge	**10.0%**	n.a.	n.a.	n.a.	n.a	x	**30.0%**	n.a.	n.a.	n.a.	n.a.	**60.0%**	x	x
Riverside	**n.a.**	x	x	x	x	x	**n.a.**	x	x	x	-	**n.a.**	x	-
TIRME Mallorca	**n.a.**	n.a.	n.a.	n.a.	n.a	n.a.	**n.a.**	n.a.	n.a.	n.a.	n.a.	**n.a.**	x	x

Table 13 Reference Facilities – Fuel Mix

In summary it can be said that the feedstock composition of the TNG facility is well within the range of the reference plants.

Summary

All relevant design parameters of TNG are well within comparable plants which are successfully in operation. As a result it can be said that the technology option pursued, being moving grate technology with semi dry flue gas treatment, was selected based on its capacity to handle a wide range of fuel types and variation of feed stock and is fully suitable for this application.

2.12 Availability Requirement

The plant is designed to ensure operation minimum availability of 8,000 h/a. 8,000 h/a is a usual availability standard within the EfW industry and a Standard guarantee required in EfW contracts. This allows for 760 hours a year of operational management that may include inspection stops, a maintenance period and some hours of unplanned stop of main components. The total number of hours per year is divided as follows:

Plant availability:	8,000 h
Scheduled plant stop, 14 days:	336 h
Scheduled inspection, 2 days:	48 h
Unplanned stops:	376 h
Total:	8,760 h

To meet the overall availability of 8,000 h/a, each system/component in the plant will have a significantly higher availability or redundancy.

The operator will ensure that fully redundant solutions are developed and implemented for all relevant equipment/components, in particular the components that lead to plant shut-down, in case of failure of the particular component. This also includes appropriate consideration of redundancy in relation to electrical and control and monitoring system. To a high extent all parts will be able to be maintained without stopping the plant / boilers, this is achieved by applying process bypass options (for example turbine bypass), and/or duplicate components (for example feed water pumps or multiple fabric filter chambers).

3. ENVIRONMENTAL STANDARDS

3.1 Background

The Facility design has been developed to align with the relevant environmental, operational and safety requirements of Australian and NSW Regulatory Framework. Key performance requirements have been used to inform the development of the design and operation of the TNG Facility.

The main statutory instruments are summarised in Table 14:

FRAMEWORK LEVEL	PLANNING INSTRUMENT
Legislation and Regulations	▪ Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth) ▪ *Environmental Planning and Assessment Act 1979* ▪ Environmental Planning and Assessment Regulation 2000 ▪ *Protection of the Environment Operations Act 1997* ▪ Protection of the Environment Operations (Waste) Regulation 2014 ▪ Protection of the Environment Operations (Clean Air) Regulation 2010 ▪ Waste Avoidance and Resource Recovery (WARR) Act 2001 ▪ Water Management Act 2000
Environmental Planning Instruments – State	▪ State Environmental Planning Policy (State and Regional Development) 2011 ▪ State Environmental Planning Policy (Infrastructure) 2007 ▪ State Environmental Planning Policy (Western Sydney Employment Area) 2009 ▪ State Environmental Planning Policy No. 33 – Hazardous and Offensive Development ▪ State Environmental Planning Policy No. 55 – Remediation of Land ▪ State Environmental Planning Policy No. 64 – Advertising and Signage.
Environmental Planning Instruments – Local	▪ Blacktown LEP 2015
Local Planning Policies	▪ Blacktown DCP 2006

Policies and Guidelines – State	▪ NSW State Rivers and Estuary Policy (1993); ▪ NSW State Groundwater Policy Framework Document (1997); ▪ NSW State Groundwater Quality Protection Policy (1998); ▪ NSW State Groundwater Dependent Ecosystems Policy (2002); ▪ NSW Energy from Waste Policy Statement 2015 ▪ Waste Avoidance and Resource Recovery Strategy (WARR) 2014 – 2021 ▪ Aquifer Interference Policy (2012); ▪ Department of Primary Industries Risk Assessment Guidelines for Groundwater Dependent Ecosystems (2012); and ▪ Guidelines for Controlled Activities (2012). ▪ Waste Classification Guidelines (EPA, 2014) ▪ Environmental guidelines: Composting and Related Organics Processing Facilities (DEC) (2004) ▪ Environmental guidelines: Use and Disposal of Biosolid Products (NSW EPA)

Table 14 Legislative Framework

The implementation of the relevant legislative and policy framework is achieved through the following key processes:

- Environmental Impact Statement (and supporting documents) and the associated Development Approval (granted under the *Environmental Planning and Assessment Act 1979*).
- Environment Protection Licence (issued under the *Protection of the Environment Operations Act 1997*)

The granting of Environment Protection Licences (EPL's) for Waste-to-Energy plants would be carried out by the Environment Protection Authority (EPA). The EPL requirements effectively drive key performance design decisions, and the EPL itself sets out operational requirements in respect of the environmental performance of the process, including the process emissions.

The starting point for the environmental performance of the Facility has been the compliance with legislative standards which are required of Waste-to-Energy plants in Europe. The European Industrial Emissions Directive IED 2010/75 EC has also been used as the basis for the development of the NSW Energy from Waste Policy, which is the legislative framework for the proposed Facility.

Furthermore the environmental permits sets out which waste types can be treated and gives directions to the reception, handling and storage of waste.

3.2 Proposed basic design parameters

The NSW EfW policy states "The process and air emissions from the facility must satisfy at a minimum the requirements of the Group 6 emission standards within the Protection of the Environment Operations (Clean Air) Regulations 2010". The EU regulations for EfW plants (part of the Industrial Emission Directive) is generally considered to be the most stringent requirements for EfW plants worldwide. Therefore the IED standards, including emissions, process performance and design and emissions monitoring will form the starting point for the process design along with the current Best Available Technology (BAT) reference note.

3.2.1 Process guarantees

In accordance with the decision to commence design on the basis of achieving compliance with the IED (above), process guarantees will be set to ensure compliance with the IED, as a minimum.
These will be expected to be included in the EPL issued in respect of the Facility and form licence conditions.

3.2.2 Emissions monitoring requirements

The Facility will be designed to meet the emission limits contained within the Chapter IV and Annex VI of the Industrial Emissions Directive (Directive 2010/75/EU) for waste incineration and waste co-incineration plants.

3.2.3 Continuous emission monitoring

Emissions from the stack will be monitored continuously by an automatic computerised system and reported in accordance with NSW EPA protocols.

Sampling and analysis of all pollutants will be carried out to NSW Approved Methods, European Committee for Standardization (CEN) or equivalent standards (e.g. International Organization for Standardization (ISO), national, or international standards). This ensures the provision of data of an equivalent scientific quality.

This monitoring has four main objectives;

1. to provide the information necessary for the facilities automatic control system to ensure safe and efficient facility operation;
2. to warn the operator if any emissions deviate from predefined ranges; and
3. to provide records of emissions and events for the purposes of demonstrating regulatory compliance.
4. to provide information and reassurance to the community that environmental and health standards are not being compromised. This is critical in maintaining a social licence to commence and continue operation.

The following parameters will be monitored and recorded continuously at each stack using a Continuous Emissions Monitoring System (CEMS);

(1) oxygen;
(2) carbon monoxide;
(3) hydrogen chloride;
(4) sulphur dioxide;
(5) nitrogen oxides;
(6) ammonia;
(7) VOCs (volatile organic compounds);
(8) Particulates; and
(9) Flue gas volume

In addition, the water vapour content, temperature and pressure of the flue gases will be monitored so that the emission concentrations can be reported at the reference conditions required by the IED or as required by the NSW EPA.

The continuously monitored emissions concentrations will also be checked by an independent auditor at regular interval or as required by NSW EPA.

The following parameters will be monitored by means of spot sampling at frequencies agreed with the relevant regulator.

(1) dioxins and furans;
(2) mercury;
(3) cadmium and thallium; and
(4) heavy metals.

The methods and standards used for emissions monitoring will be in consistent with the IED or as directed by NSW EPA.

There will be duty CEMS (one per line) and one hot stand-by CEMS per two lines. This will ensure that there is continuous monitoring data available even if there is a problem with one of the duty CEMS systems.

Over time sampling methods and technology will advance and will be updated. It is expected that the EPL issued in respect of the facility by the NSW EPA will reflect ongoing obligations to update both technology and methodology in line with these advances.

3.2.4 Noise

There will be a general sound pressure level requirement of max. 85 dB(A) for noise emissions inside the plant.

Most equipment within the plant will fulfil the 85 dB(A) requirement without further measures, except for the turbine during bypass operation, some larger pumps and fans and possibly conveyers for bottom ash transport, air coolers and steam condensers.

Where possible such equipment shall be place in dedicated noise areas (rooms) or be acoustically insulated/covered by noise hoods.

Item No.	Noise Source	Assumed Noise Level SWL dB(A)
1	Stacks	91
2	Turbine Hall	88
3	Tipping Hall	85
4	Air Cooled Condenser (ACC)	102
5	Transformer	102
6	Compressor	97
7	Boiler Area	85
8	Flue Gas Treatment	98
9	ID Fans	100
10	Silo's & Bag Storage	85
11	Bottom Ash Handling	93

Table 15 Noise requirements in various areas and development zones

4. WASTE AND RESIDUE LOGISTIC

4.1 Reception Hall and Bunker Storage Capacity

Checking and auditing the various fuels forms are critical in ensuring consistent fuel quality.

General Solid waste [non putrescible] comprising building and demolition waste and commercial and industrial waste received first at the Genesis Facility is generally described as being either,

(a) Unprocessed and therefore subject to Genesis resource recovery processes and quality assurance measures
(b) Pre- processed [resource recovery by others] upon receipt subjected to Genesis quality assurance measures

Unprocessed waste or waste which has not been subject to resource recovery will **not** be delivered direct to the EfW Facility.

Processed waste which has been subjected to resource recovery at Genesis and relevant quality assurance processes will be delivered to the EfW Facility from Genesis via an electrically driven covered conveyor system or by truck via the internal road network connecting Genesis with the EFW Facility.

Pre-processed Waste streams which have been subjected to resource recovery by others will in all cases also be subjected to Genesis quality assurance measures designed to ensure that unacceptable, inappropriate or hazardous materials are excluded from the fuel waste stream.

Upon arrival at a Genesis Facility, all waste fuels delivered by truck will be weighed, visually checked with CCTV and if necessary sampled. During unloading, facility operators will carry out further visual checks of the fuel waste.

Fuel waste will be emptied onto the floor where it will visually inspected for the presence of any nonconforming material specific approved work practice directions.

Any deviation from the fuel specification will be noted. If the non-conformance is minor and can be rectified immediately then it will be, in accordance with specific work directions.

If the non-conformance is significant, the nonconforming or unacceptable materials will be segregated and isolated within the Tipping Hall later being removed to the Genesis Plant for further resource recovery or for disposal by landfilling as may be appropriate.

In order to avoid payment of the higher costs of disposal by landfill and a continuing suspension of a right to supply there will be significant commercial pressure upon suppliers to conform to published standards.

Cleared waste will be stored inside the bunker. Sufficient storage for 5-7 days at full load will be provided to provide a buffer to cater for disruptions in fuel supply or with unplanned outages of the Facility. The fuel will be mixed in the bunker using the overhead cranes to ensure maximum homogeneity in the fuel.

The EfW facility will operate continuously, 24 hours a day and 7 days a week, however waste Fuel will only be delivered to the site within the operators' specified times during the week days.

The tipping hall which will be kept at negative air pressure ensuring a constant inward flow of fresh air.

The types of waste proposed to be used as fuel at the TNG facility are known to have a low propensity for odour but the negative air pressure will ensure that any risk of odour escape is obviated.

The bunker is an important component of any Waste-to Energy plant as it functions as the recipient and storage of the waste supply. The waste will be delivered by trucks (rear tipping).

The tipping hall will provide adequate space, to accommodate access and queuing areas able to accommodate any variation in the flow of vehicles, including during periods with adverse weather. The tipping hall will also be of sufficient width to ensure easy access for all types of trucks.

The bunker and tipping hall are significant civil works items and therefore the volume of the bunker and the area of the reception hall and number of unloading bays need to be balanced against costs and with due attention to the need to minimise queuing and waiting time for vehicles.

There will be one bunker with one compartment serving two incineration lines. The bunker will have a maximum capacity of approximately 34,475 m^3. Each bunker will have an approximate footprint of 30 m x 48.5 m, with a stacking height up to 30 m. Even at the maximum throughput the bunker size described in Table 16 is sufficient to provide 11.9 days storage. Fill and removal of material will be via the waste cranes.

Facility & Fuel parameters			
		LP1	LPN
Fuel flow (2 combustion lines)	t/day	2,025	1,657
Assumed Fuel Density	t/m^3	0.35	
Volumetric fuel flow	m^3/day	5,786	4,734
Bunker parameters			
Length	m	30	
Width	m	2 x 48.5 = 97	
Height	m	30	
Maximum fuel stacking height	m	30	
Bunker capacity (with stacking), waste volume	m^3	68,950	
Maximum number of days storage	days	11.9	14.6

Table 16 Bunker Design Data (Parameter for the 2 bunkers together)

4.2 Number of unloading bays

It is assumed that all trucks will be walking floor type, although it may be possible to take tipping bulkers if required. It is assumed that the average unloading time for a 22 tonne load is 12 minutes, which is the total time occupying a bay, including reversing and leaving.

Table 17 indicates that in case of the maximum fuel throughput NCV (10 MJ/kg) and accounting for variability and peak flows, there would be a short term maximum of 17 deliveries per hour, requiring a minimum of 4 delivery bays.

Parameter	Unit	Design fuel, average flow	Maximum fuel throughput peak flow
Fuel NCV	MJ/kg	12.3	10
Peak hourly fuel	t/h	132	374
Delivery capacity	t/h	22	22
Peak deliveries	Deliveries /h	6	17
Unloading time per bay	minutes	12	12
Minimum bays required	(rounded up)	2	4

Table 17 Unloading bays requirement

To provide flexibility in operations (i.e. bunker management) the design layout has allowed for 16 delivery bays.

4.3 Trucks (size and frequency)

The waste will be transported to the plant in predominately semi-trailers, trucks and dog trailers. Likewise, the bottom ash and the residual products from the flue gas cleaning will be picked up in semi-trailer trucks.

Trucks are anticipated to carry an average load of 22 tonnes. The plant will operate 24 hours a day, seven days a week. The proposed plant is to have a maximum total capacity of 675,000 tonnes per annum. The planned nominal operational input of 552,500 tonnes per annum will result in 69 trucks per day with capacity for a peak of a maximum of up to 84 truck deliveries per day associated with input waste material.

Tonnes p.a.	Weeks per Year	Days per Week	Truck Capacity (t/veh)	No. of Trucks (per day)	Truck Movements (per day)	Hours per Day (hrs)	Truck Movements per Hour (veh/hrs)
675,000	52	7	22	**83**	166	24	7
552,500	52	7	22	**69**	138	24	6

An additional 20 truck movements per week are expected for miscellaneous deliveries such as hydrated lime, activated carbon and other materials required for the various processes involved in the power generation. Assuming these will be trucks with an average load of 22 tonnes, delivered over a standard 5 day week, results in a demand for up to 2 additional trucks per day.

Tonnes p.a.	Weeks per Year	Days per Week	Truck Capacity (t/veh)	No. of Trucks (per day)	Truck Movements (per day)	Hours per Day (hrs)	Truck Movements per Hour (veh/hrs)
12,150	52	5	22	**2**	4	24	0.2

The total ash residue waste (APC Residues and Bottom ash) for worst case fuel will be in the order of 225,870 tonnes per annum (please refer to Chapter 6.10.5, table ash production). As a worst case, it is assumed that this waste is to be carried on trucks with an 18 tonne capacity, removed over a 12 hour period, 6 days a week. On this basis, the removal of ash residue equates to an additional 40 ash truck per day, as outlined in Table below.

Tonnes p.a.	Weeks per Year	Days per Week	Truck Capacity (t/veh)	No. of Trucks (per day)	Truck Movements (per day)	Hours per Day (hrs)	Truck Movements per Hour (veh/hrs)
225,850	52	6	18	**40**	80	12	6.7

Table 18: shows the estimated average and peak road deliveries by type, assuming the worst case scenario that all fuel and consumable deliveries, and residue removal from site takes place by road.

		Fuel (NCV 10MJ/kg)	Consu-mables	APC Residues	Bottom Ash	Total
Average mass flows	t / a	675,000	12,150	25,850	200,000	913,000
	t / week	12,981	234	497	3,846	17,558
	t / d (Mon-Sun)	1,855	46	83	641	2,625
	per h	77	1.9	3.5	26.7	109
Average deliveries	per a	30,682	552	1436	11,111	43,781
	per week	590	10.5	27.5	214	842
	per day	**84**	**2**	**4.5**	**35.5**	**126**

Table 18 Total Traffic Flows on worst case fuel

4.4 Effluent discharge

Under normal operating conditions, no effluent is disposed of to the sewer or stormwater systems but returned to the Facility for re-use.
In this way, the liquid effluent produced on site will either be evaporated or absorbed into the bottom ash discharger via the process water system.

Liquid effluent will consist of boiler blow down, boiler water treatment, swilling down water, occasional maintenance discharges and drain water from contaminated areas.

The re-use of the different water streams within the process results in a liquid effluent free EfW facility during normal operation.

5. BOILER/FURNACE

5.1 EfW grate technology

The EfW plant is based on advanced moveable grate mass burn technology.

A moving grate EfW incineration facility has been preferred due to the robustness and its proven ability to treat a very wide range of wastes. EfW grates show little technical processing sensitivity to the vast majority of variations normally seen in wastes e.g. physical dimensions and chemical composition.

5.2 “Vertical” and Horizontal “Tail-End” Boiler

An important consideration is the fundamental boiler concept. The Facility will use of a 5-pass horizontal boiler incl. vertical economiser pass as shown in Figure 6**.**

Below the most important topics with regard to the design of the boiler/furnace are discussed.

In principle, the boiler is either designed as a so-called “vertical boiler”, i.e. a boiler with vertical passes in both the radiation and the convection parts (incl. the economiser), or as a so-called horizontal, “tail-end” boiler where the boiler has one or more vertical radiation passes followed by a horizontal convection pass with pre-evaporator, superheater, evaporator and economiser sections, see Figure 6.

The horizontal boiler type (the “tail-end”) is characterised by the radiation pass being followed by a horizontal convection pass and economiser.

The “vertical” boiler is characterised by the radiation pass being followed by one or two vertical convection passes and an economiser.

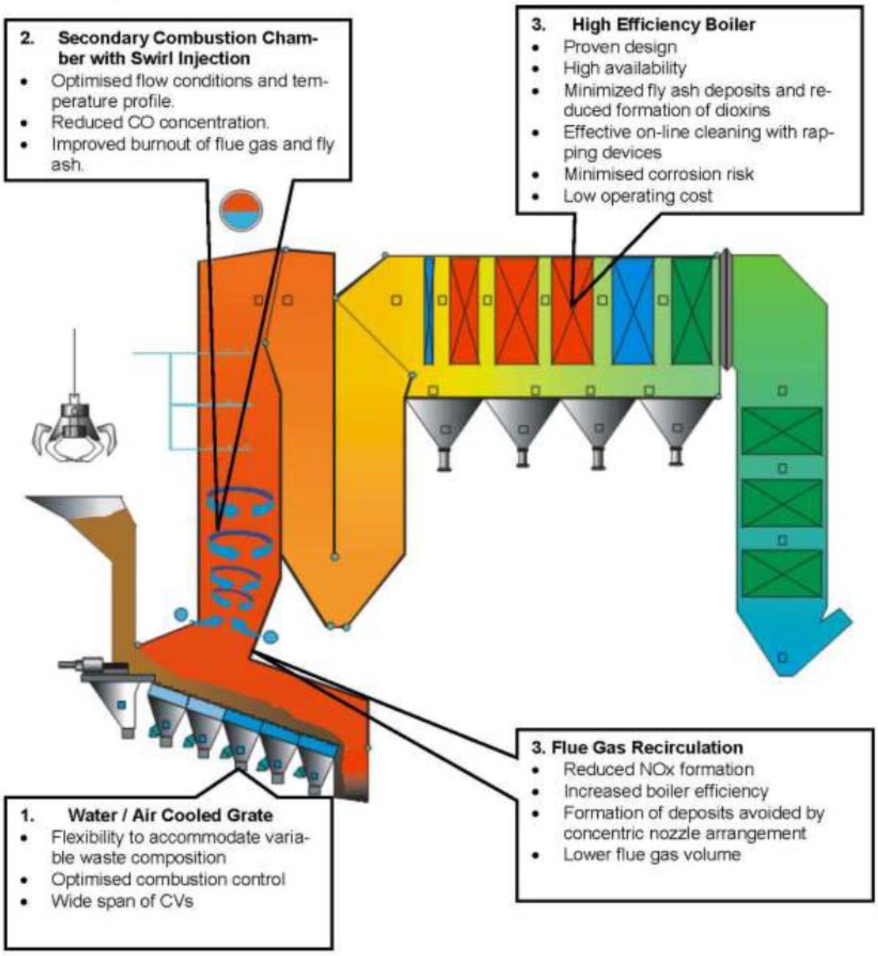


Figure 6 5-pass boiler configuration

Cleaning, Operation and Maintenance
The horizontal convection pass is equipped with a mechanical rapping device, which at a pre-set frequency (typically 4-6 cleaning sequences of 2-5 minutes per day) raps the tubes in the convection pass and thereby removes dust and ash from the tube bundles which fall into the collection hoppers.

A water spray cleaning system is installed in the vertical radiation parts. The radiation part is without baffle walls as it ensures a more conservative or spacious design of the boiler. The boiler is dimensioned for moderate flue gas velocities (3.5 – 5.5 m/s, lowest in the first pass).

The temperature in the cross section at the inlet to the convection part is an important factor and should not exceed 625°C at the beginning of the operation time after manual boiler cleaning.

The convection part consists of superheater sections, the evaporator and the economiser. In between the superheater sections water injections are used to control the temperature of the live steam.

The economiser, evaporator and superheater sections are designed as fully de-mountable tube bundles dedicating special attention to easy replacement of the super heater section subject to the highest thermal load.

The following maintenance and operating conditions speak in favour of selecting a horizontal convection pass:

- A smaller extent of fouling due to more effective cleaning. Soot blowing and shot ball cleaning generally do not result in a uniform cleaning of entire tube sections.
- With the horizontal "tail-end" boiler very long operating intervals between manual boiler cleanings can be achieved. Thus, a guaranteed, continuous operating time of up to 8,000 hours for horizontal boilers against 4,500 hours for vertical boilers leads to less downtime.
- Mechanical cleaning with rapping devices is a considerably gentler and effective and also simpler method compared to steam or compressed air soot blowing. Maintenance of the rapping devices is primarily limited to replacement of parts, which are accessible from the outside of the boiler.
- The horizontal boiler will have a better working environment at the manual cleaning process of the pipe bundles. In a horizontal boiler, the manual cleaning can be performed in an up-right position, whilst in a vertical boiler; the cleaning must be made lying down, thereby exposing the worker to dust and ashes.
- There is no steam consumption for the cleaning and hence no reductions in the power production or operational problems with the turbine due to momentary relatively large steam consumption for soot blowing.
- Generally, fewer corrosion and erosion problems can be expected of a mechanically cleaned horizontal convection pass, mainly because of a smaller extent of fouling and ash deposition and because the protective oxide coating of the tubes is not damaged when using this cleaning method.
- Future replacement of tube bundles in the superheater is easier.

Thermal Conditions
A higher thermal efficiency (0.5-1 %) can be expected of the horizontal boiler as the smaller extent of fouling leads to a better heat transfer of the super-heater tubes of the boiler.

Construction and Operating Costs
A boiler with a horizontal convection pass is more expensive than a boiler with a vertical convection pass.

As, however, the average annual operating and maintenance costs during the life time of the facility are normally expected to be lower for the horizontal boiler the full life cost of the horizontal is generally expected to be lower than the vertical boiler.

Summary

From the above it can be concluded that the horizontal boiler is technically the best and most efficient solution and also the most environmentally beneficial. It requires, however, a bigger up-front investment than a vertical boiler solution

As a result of these considerations the Facility will use of a 5-pass horizontal boiler incl. vertical economiser.

5.3 Combustion control system

Given the thermal output increases with greater waste throughout (see Figure 7 combustion control system), a cooling system is used to condense the steam from the turbine exhaust for re-use. Large variations of the calorific value (CV) may require an adaptation of the parameters of the different control loops. The adaptation of all control parameters is executed manually by the adjustment of one single input value. This is the so called 'CV- correction'; a feature that is fully integrated in the control system. The CV-correction effects an automatic adjustment of up to ten parameters of the combustion control system.

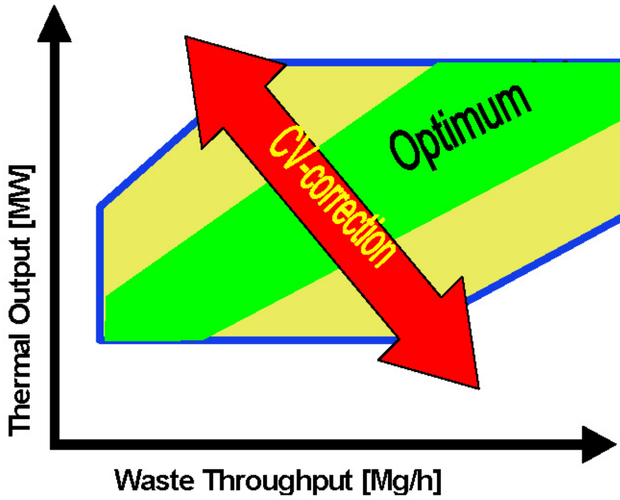


Figure 7 Combustion control system

5.4 Furnace and Secondary Combustion Chamber

The furnace and secondary combustion chamber shall comply with the 2s retention time and 850°C temperature requirements of the IED and be equipped with auxiliary burners.

5.5 Steam Parameters and Corrosion

Steam parameters have been fixed at 70 bar/430ºC, as this allows for high energy efficiency and at the same time keeping the risk of corrosion at an acceptable level.

Corrosion is a significant issue in waste fired boilers. Corrosion increases with higher temperatures. Steam parameters for boilers are therefore determined to achieve the optimal balance between boiler corrosion and plant efficiency.

In addition to the risk of high temperature corrosion in the superheaters, experience has shown that there is a risk of corrosion in the evaporator part of the boiler, particularly where the unprotected membrane tube walls in the first and second passes of the boiler are exposed. Therefore Inconel[9] cladding are foreseen at some parts of membrane walls furnace, membrane walls top of pass 1 and 2 and some tubes of superheater 3.2

[9] Inconel alloys are oxidation and corrosion resistant materials well suited for service in extreme environments subjected to pressure and heat.

5.6 Combustion Air Excess (λ)

All systems are designed for all load situations according to the combustion diagram, Figure 5. The combustion air systems are designed to ensure a correct amount of excess air in the flue gas, both in order to ensure high combustion efficiency and to avoid a reducing (corrosive) atmosphere, incomplete burnout of the flue gases etc.

5.7 Primary Air Intake

Maintaining a negative air pressure in the tipping hall is critically important to avoid odour problems from the waste bunker. Therefore, all primary air required for the combustion process are drawn from the bunker. During stand still negative air pressure is maintained and air goes directly to stack.

5.8 Secondary Air Intake

Secondary air shall be drawn from the top of the furnace/boiler hall, and will be injected into the furnace and at the inlet to the first boiler pass through 2 rows of nozzles.

5.9 Flue Gas Recirculation

To increase the overall efficiency of the boiler and reduce NO_X formation (by reducing the amount of excess air) it is beneficial to recirculate the flue gas. Further by flue gas recirculation the flue gas treatment plant will have to treat less flue gas increasing the removal efficiency.

5.10 Feed Water Pumps

The feed water pump is a critical component that secures operation and needs redundancy in case of failure. It is especially important to avoid boiling off all water in the water-steam system, thus avoiding damaging the pressure part in worst case conditions. The Facility will have 2 x 100% feed water pumps for each line (one pump in operation, one in stand-by mode).

5.11 Make-up Water System

A water treatment plant, producing the make-up water for all combustion limes, is able to fill the tank in 72 hours with all combustion lines in operation whilst maintaining Plant supply at MCR.
The capacity of the make-up water tank shall be 125% of the volume required to completely fill one boiler including superheaters.

5.12 Proposed Design Data

For proposed overall design data refer to table below.

Waste-to-Energy with waste utilization Preliminary Process and Design Data Boiler/Furnace		
Plant Component / Parameter	**Value / Description**	
Input and Output		
Gross Heat Release	117.98 MWth	
Throughput nominal	34.53 t/h	
Calorific Value nominal	12.30 MJ/kg	
Steam flow 100 %, at 70 bara, 430 °C	144.7 t/h	
Steam pressure nominal	70 bara	
Steam temperature nominal	430 °C	
Flue gas Temperature		
Flue gas temperature exit boiler	Nom 170 °C	
Bottom ash Handling System		
Water content bottom ash nominal	19 %	
Max. Ignition loss bottom ash	5 %	
Max. TOC bottom ash dry	3%	
Bottom ash Bunker parameters (per stage)		
Length	m	13
Width	m	47
Height	m	9 (included 7m below ground level)
Maximum ash stacking height	m	9
Ash bunker capacity	m^3	5,499
Bottom ash flow (2 combustion lines)	t/day	641 (see Table 18)
Assumed Bottom ash Density	t/m^3	1.8
Volumetric Bottom ash flow	m^3/day	356
Maximum number of days storage (at LP1)	days	15.5

6. FLUE GAS TREATMENT

6.1 Flue Gas Cleaning System

The flue gas will be cleaned in the Flue Gas Treatment plant to control emissions of acid gases, particulates, dioxins and furans and heavy metals.

The semi-dry flue gas cleaning process is designed to remove acidic gaseous contaminants by chemical absorption with hydrated lime. Heavy metals and organic contaminant compounds (i.e. dioxins and furans) are reduced by adsorption on activated carbon. Features of this system are illustrated in Figure 8.

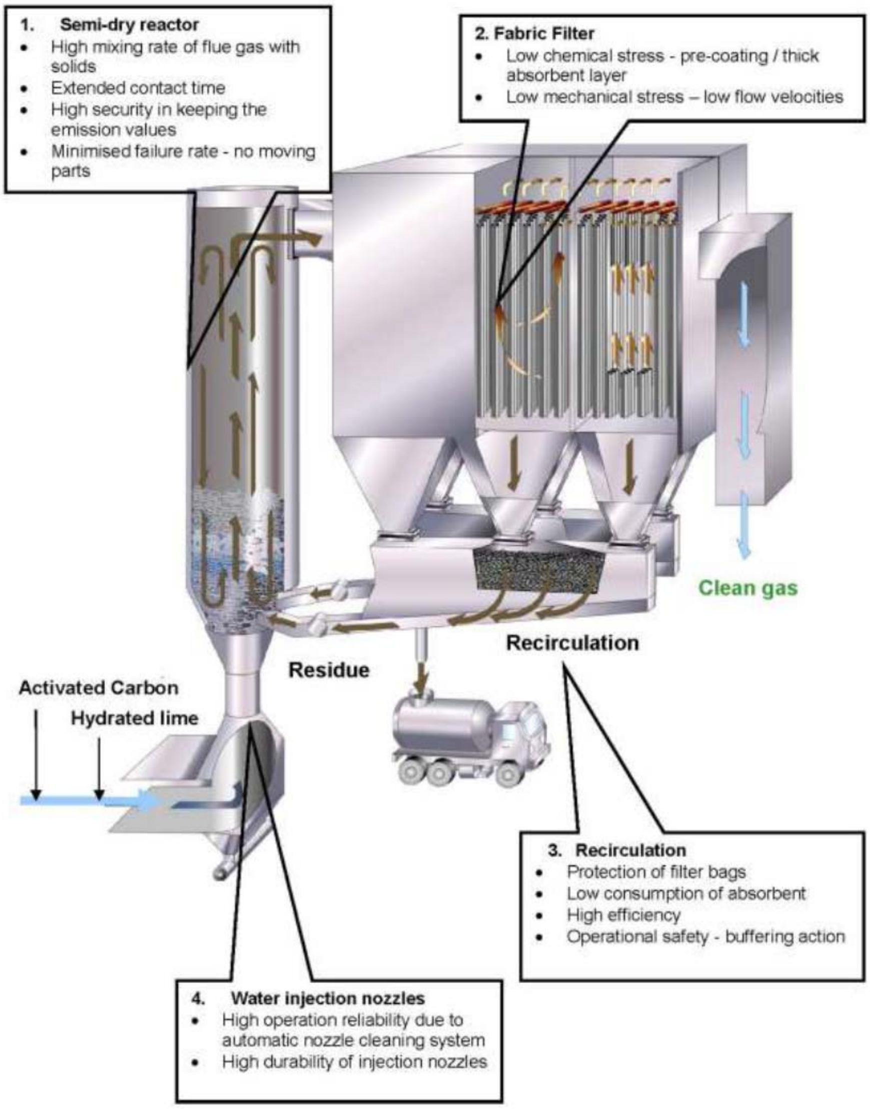


Figure 8 Semi-dry Flue Gas System

In this process the flue gas and solids move turbulently through the semi-dry reactor with partial inversion of the solid flow. The pollutants react with the injected hydrated lime and the activated carbon at a temperature of approximately 145 °C.

The separation of solids from the flue gas takes place in the fabric filter downstream of the reactor. Precautions are considered for water contacted parts, generally water-proof insulation is applied. All maintenance and inspection areas are encased in order to protect against rain during maintenance work.

The flue gas cleaning process is characterised by the following features:

- Flexible to load changes and changes in gas contaminant concentrations;
- Efficient use of adsorbent and minimised residue quantities;
- Designed for high Hydrogen Chloride (HCl) and Sulphur Dioxide (SO_2) inlet concentrations;
- Dry injection of Calcium Hydroxide ($CaOH_2$) and Powdered Activated Carbon (PAC);
- Separate injection of water for conditioning and reactivation of recycled lime particles;
- Compact design; and
- Low manpower requirement.

6.2 Nitrogen Oxide (NO_x) Removal System

The NO_x Removal system is a selective non-catalytic reduction**.**

With an SNCR system, ammonia water is injected into the first pass of the boiler at a temperature level of approximately 900°C. Here the chemical reaction takes places, converting NO_X to harmless N_2 and water.

The system requires 2-3 levels of injection nozzles in the first pass of the boiler and a system based on water or air to atomize ammonia water into the boiler. With a SNCR system the requirement of 200 mg/Nm^3 NO_x can be comfortably reached.

The SNCR technology can be optimised to reach 120 mg/Nm^3 for a sophisticated SNCR (as daily average). The increased efficiency comes with a modest increase of CAPEX and additional consumption of ammonia.

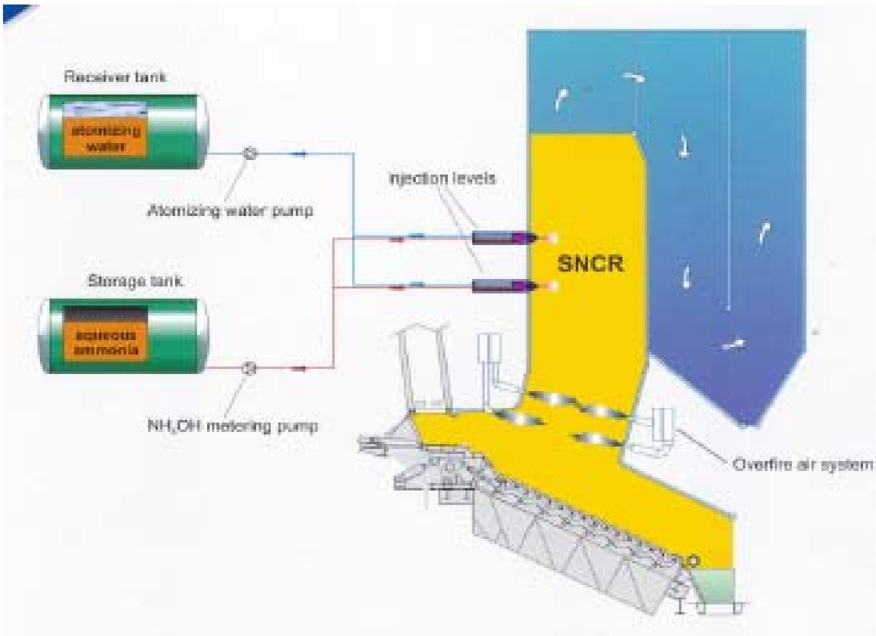


Figure 9 Schematics, SNCR system.

6.3 **Acid Gas Management**

6.3.1 Chlorine

In view of the APC design the chlorine content of the waste is a relevant consideration.
The main contribution to the chlorine content of the waste is PVC. PVC (C_2H_3Cl) itself contains approx. 57% of chlorine.

In municipal waste typically approximately 50% of the chlorine comes from PVC, in C&I waste the contribution of PVC to the overall chlorine content can be expected to be higher.

The Audit reports note in particular a low percentage of PVC from the audited samples notwithstanding that the Audits were carried out in respect of the residue from mixed waste processing [which is material which is currently landfilled].

Genesis Quality Assurance measures already target the removal of PVC from the waste stream during the production of recovered wood-waste and timber products.
The Audit result together with the Genesis, Quality Assurance measures provide a continuing high degree of confidence that PVC will be almost entirely excluded from the fuel waste stream.

In the EU regulation the following is stated: "*If **hazardous waste** with a content of more than 1 % of halogenated organic substances ...".*

The NSW EfW Policy states: "*If **a waste** has a content of more than 1% of halogenated organic substances...*". In NSW, PVC is **not** considered a hazardous material.

The waste composition proposed for the Facility is well within the range of other facilities operating in Europe. Many facilities in Europe have average chlorine concentrations of above 1% (some even 1.7%) and all categorised as facilities with a necessary furnace temperature of 850°C according to EU regulation.

During the combustion process PVC is fully decomposed to CO_2, hydrogen chloride and water vapour. HCl is an acid gas which has been given specific design attention in the proposed Facility.

The HCl will be eliminated by the Air Pollution Control system which is designed, controlled and operated to capture such substances even when occurring as a spike. The chosen APC technology for this facility is standard in modern WtE plants with comparable feedstock and with continuously very low emissions.

6.3.2 How the Acid Gas treatment works.

The flue gas treatment plant is a semi-dry process consisting of a reactor and a downstream bag filter. The reactor is a cylindrical vessel with a Venturi-like inlet nozzle and lateral outlet at the top.

The raw gas enters the reactor centrally from below through the inlet nozzle. Just above the nozzle hydrated lime, activated carbon, recycled solids and water are injected. The water evaporates and cools the flue gas to approx. 145°C, which is an optimum reaction temperature for the absorption of the acid gases and adsorption of mercury and organic compounds (poly-aromatic hydrocarbons, dioxins, furans, etc.). The gas entrains the solids thus forming a fluidised bed. Due to the intensive gas solids contact within the fluidised bed the acid gases are effectively removed. The gas and solids then leave the reactor at the top of the vessel and enter the subsequent bag filter where the solids are removed. For an optimum use of the hydrated lime the solids separated in the bag filter are recirculated into the reactor.

According to the following chemical reactions the hydrogen chloride (HCl), hydrogen fluoride (HF) and the sulphur oxides SO_2 and SO_3 are chemically absorbed.

$$Ca(OH)_2 + H_2O + SO_2 + \tfrac{1}{2} O_2 = CaSO_3 + 2\,H_2O$$

$$Ca(OH)_2 + H_2O + SO_3 = CaSO_4 + 2\,H_2O$$

$$Ca(OH)_2 + 2\,HCl = CaCl_2 + 2\,H_2O$$

$$Ca(OH)_2 + 2\,HF = CaF_2 + 2\,H_2O$$

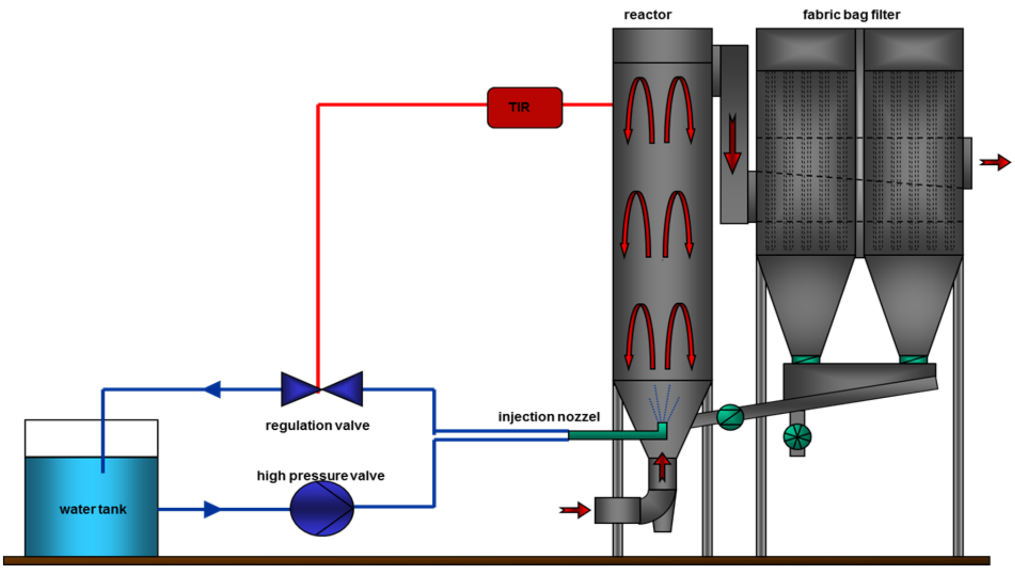
The semi-dry process therefore allows removing the acid gases and simultaneously neutralizing them. The resulting products are well known and harmless salts as $CaSO_4$ (gypsum), CaF_2 (Calciumfluorid) and $CaCl_2$ (sea salt).

These salts as well as the activated carbon are removed in the baghouse filter, recirculated to the process and partly removed for disposal.

6.3.3 Control loops of the flue gas treatment system

The **four following control loops** ensure constantly low emissions:

- The first loop controls the amount of circulated solids in order to maintain a stable fluidised bed. The density of the fluidised bed is monitored by means of the pressure drop.
- The second loop controls the flue gas temperature at the exit of the reactor by means of the process water injection
- A third loop controls the injected amount of fresh absorbent based on measurements of the clean gas concentrations (feed backward) and the raw gas concentrations (feed forward)



With the raw measurement upstream the reactor analyses the following parameters:

- HCl (hydrochloride acid)
- SO_2 (sulphur dioxide)
- Gas flow

Based on the measured values and the gas flow the feed-forward controller calculates the necessary hydrated lime. The concentrations of HF and SO_3 are very small compared to HCl and SO_2 and necessary for the calculation.

Following further values from the continuous measurement system at in the stack are used for the hydrated lime dosing

- HCl
- SO_2

Based on these values at the stack, the feed-back part of the hydrated lime dosing is calculated by comparing the current emission values with the target values. In case of deviations an adjustment of the hydrated lime dosing is activated.

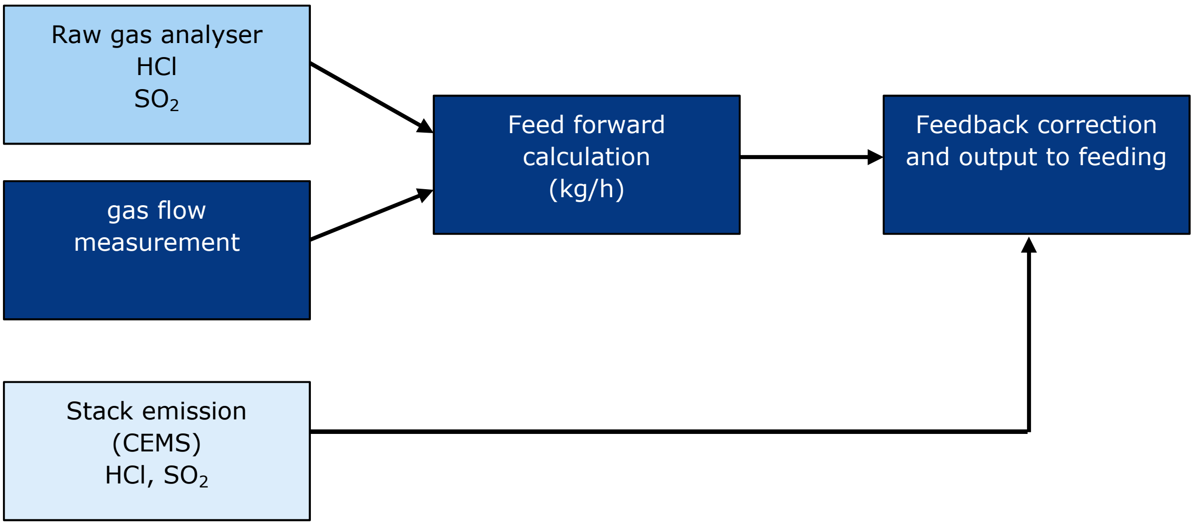
- The fourth loop ensures a constant dosing of the activated carbon according to the current flue gas flow.

6.3.4 Control logic for hydrated lime

Raw gas analyses allow a faster and smother control of the additive feeding compared to plants with simple feedback control. The aim of the feedforward control is to dose the additive according to the incoming pollutant load. The raw gas input includes the main pollutants HCl and SO_2; other components in minor concentrations (e.g. HF, HBr, SO_3) are not measured since they count not significantly for the additive consumption.

The feedforward calculation is an addition for the calculated lime consumption for HCl and SO_2 (included the expected stoichiometric factor for excess lime). This value (in kg/h of lime) is converted into the set point (speed) of the dosing screw considering the dosing capacity of the feeding device.

The set point for the feeding device is than corrected with the output of the feedback controller; in case the set point for stack emissions (e.g. 8 mg/m^3 if the ELV is 10) is exceeded, the feedback control requires more additive until the emission is again below the set point.



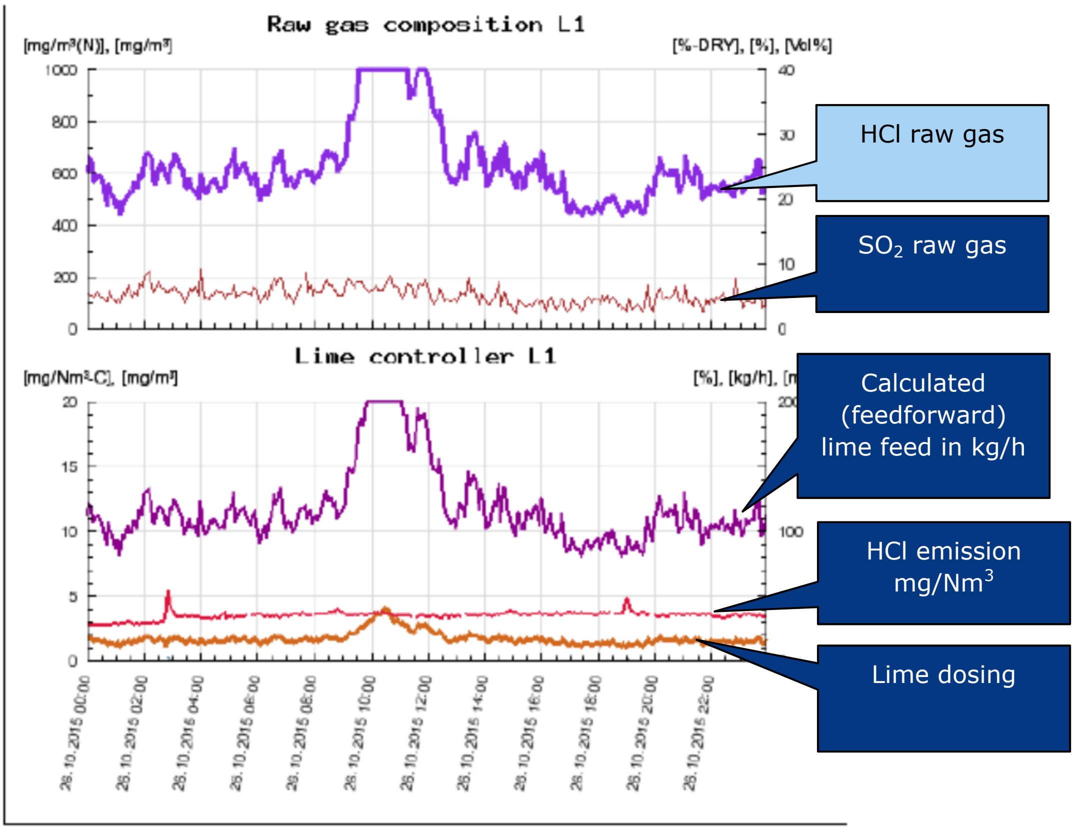
In case of a malfunction of the raw gas analyser, the operator can either run the plant with a default value for the raw gas concentration (e.g. the observed average) or without the feedforward part of the control logic (just using the feedback controllers). With this setup the emissions are maintained below the required limits, but there might be slightly higher lime consumption.

6.3.5 Achieved emission quality

An example from a EfW plant semi-dry FGT in UK shows the result of the combined feedforward – feedback additive control logic. All data points are 5 min average values

Turbulent day with an HCl raw gas peak

- At approx. 9 am, a huge HCl raw gas peak occurs
- The feedforward logic adds simultaneously more lime into the system
- The HCl emission value is nearly not affected by this raw gas peak; HCl and SO_2 emissions are "low as normal"



6.3.6 Separation of heavy metals

During the combustion process metals with a high evaporation temperature like chromium, nickel or copper mainly remain in the bottom ash. Metals with a low evaporation temperature as mercury, cadmium and arsenic evaporate in the combustion chamber and partly condensate at lower temperatures in the boiler area. When entering the Air Pollution Control System (at a temperature of below 150° C) all heavy metals except mercury are predominantly present as particulates and therefore easily removed by the baghouse filter.

6.3.7 Separation of mercury and other volatile heavy metals

Mercury completely evaporates at a temperature of 357°C and remains gaseous in the flue gas even at lower temperatures. All other heavy metals have a much higher evaporation temperature (arsenic 613°C (sublimation), cadmium 765°C, zinc 907°C, lead 1740°C, etc.) and therefore are present as particulates. Mercury and any other traces of volatile heavy metals are adsorbed on the activated carbon and are thereby effectively removed from the flue gas.

Mercury is present in the flue gases in two forms: The majority is present as ionic mercury (mainly as a chloride after reacting with HCl) and a small part as elemental mercury. Both ionic as well as elemental mercury are easily adsorbed by activated carbon and removed from the flue gas via the downstream fabric filter. It is known that sulphur impregnated of the activated carbon improves the adsorption of elemental mercury. The reaction is known as chemisorption (chemical absorption) according to the following reaction: Hg + S → HgS

Long term experience in Waste to Energy facilities has shown that there is no visible effect using sulphur impregnated of the activated carbon under normal operating conditions. The reason is that the proportion of elemental mercury is small compared to ionic part and additionally the SO_2/SO_3 content in the flue might have an impregnating effect on the carbon.

6.3.8 Separation of dioxins and furans

Dioxin and furans are omnipresent in urban environment. Dioxins and furans are mainly formed during combustion (residential heating's, fireplaces, open burning of waste, motors, and industrial processes) and emitted to the environmental. As a result dioxins are also present in waste. The average concentration in Municipal solid waste is 50 ng/kg (as toxic equivalent).

Dioxins and furans are not thermally stable and fully destroyed at temperatures above 400°C. During waste combustion dioxins and furans therefore are fully destroyed as a result of the high temperature (over 1'000°C) in the furnace. However they can be reformed (so called "de novo synthesis") at temperatures between 200 and 350°C in in the final part of the boiler. Necessary conditions for this de-novo synthesis are solid products of incomplete combustion (soot) and relevant accumulation of fly ash to enable "breeding" of dioxins and furans over an extended period (hours) in these solid deposits.

As a result the following measures have been chosen for TNG to reduce the reformation of dioxins and furans:

- Combustion with sufficient residence time above 800°C in order to destroy these compounds
- Combustion control to reduce products of incomplete combustion and therefore limit reformation
- Boiler design to minimize accumulation of fly ash
- filter systems operating at a temperature below 200 °C

Any remaining traces of dioxins and furans are removed from the flue gas by injection of activated carbon. Dioxins and furans are absorbed on the activated carbon simultaneously with the volatile heavy metals. The necessary quantity of carbon is determined by the necessary mercury removal and therefore available in high excess ratio for the adsorption of dioxins and furans.

Dioxin and furan removal by activated carbon injection has been applied in WtE facilities for over 20 years with excellent results, enabling the facilities to remain well below the required limit of 0.1 ng/Nm³ any time.

6.3.9 Bromine

Bromine is most commonly use in brominated flame retardants (BFRs) in building materials, textiles and electronic supplies. Waste has a bromine content of 0.003% and 0.006%. In WtE plants BFRs will decompose and form mainly hydrogen bromide (HBr).

HBr is removed from the flue gas in the same way as HCl, i.e. by absorption and neutralization by lime. In case of TNG the in stack concentrations for gaseous bromine can be assumed to be below 2 mg/Nm³.

6.3.10 Asbestos

Asbestos is a natural fibrous mineral used as construction material with good insulating and fire resistance properties. Asbestos has melting point of > 1500°C and is chemically resistant to acids. For technical applications the fibres typically have a length of 10-20 mm and a diameter of approx. 3 micrometres. When Asbestos is processed the fibres tend to break and release fine fragments with a fibre length above 5 micrometres. The health hazard of asbestos lies in the inhalation of these particles, not in the chemical properties of asbestos.

Materials containing asbestos will be separated during the recycling process and will go to landfill. In case some material should remain in the waste stream and end up in the furnace it will not burn, vaporize or vitrify due to its high melting temperature. Depending on the form of asbestos following will occur:

- Tightly bounded asbestos (i.e. in concrete bound materials) will remain bonded and leave the furnace via the bottom ash in larger pieces.
- In case of non- or only slightly-bonded asbestos materials most of the material will remain on the grate and then also leave the furnace with the bottom ash. In the bottom ash extractor it will be quenched with water and embedded in the clay-like matrix of the bottom ash and not be further released.
  A minor part of fibres might be entrained with the flue gas. Larger fibres will deposit in the boiler and be removed with the boiler ash. Very fine particles will be entrained to the flue gas treatment and then fully removed by the baghouse filter. Baghouse filters in semi-dry systems have excellent removal efficiency of near to 100% for particles larger than 0.1 micrometre. As asbestos particle will never have a diameter below 3 micrometres it will be fully removed and leave the plant via the APC residues.

As a result it can be said that even if asbestos enters the facility by mistake it will be fully removed and leave the plant either with the bottom ash or APC residues.

6.3.11 Start-up procedure after a shut-down of the semi-dry system

The kind of applied procedure depends on the duration of the interruption. In case of short interruptions only the filter bags cleaning and the residues recirculation are stopped

In case of interruptions that are not longer than approx. 3 days (to be checked with the designer) the residues remain inside the filter hoppers and in the pneumatic recirculation line. In case of longer shut-downs the residues must be discharged completely and replaced by fresh hydrated lime before the next start-up.

6.4 ID-fan

The ID-fan is designed for boiler operating at 110 % MCR in a fouled condition after 8,000 hours of operation. In order to keep the wear and noise level down the air fan speed shall be below 80% of the maximum speed for which the fan is designed for sustained operation. The ID-fan is electrically driven.

Spare capacity of air and flue gas systems with respect to flow rate is necessary for several reasons. The ID-fan shall always have sufficient capacity to ensure negative pressure in the furnace, also during short term variations. During the life time of the plant the waste composition, quality and quantity might change, leading to different requirements of air and flue gas flows.

6.5 Stack

Neutralised flue gases will be emitted to atmosphere via a stand-alone stack for each line.
The final stack height was selected based on a combination of compliance of ground level concentrations and reference to the US EPA document "Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations)" (US EPA Good Engineering Guideline).

Treated flue gases will be emitted to the atmosphere via-flues within a standalone stack, located to the south of the Flue Gas Treatment Areas.

The stack will be built to the minimum height necessary to ensure adequate dispersion of the emissions and excessive concentrations of any air pollutant in the immediate vicinity of the stack (as defined through air quality dispersion modelling). The US EPA Good Engineering Guideline states the general rule of thumb for good engineering practice stack height is 'Height of building + 1.5 times the lesser of building height or projected width'.

With height being the less of these two dimensions; a stack height of 125 m was initially identified. Dispersion modelling was then used to refine and identify a project specific stack height, based on achieving compliance with ground level concentrations. Dispersion modelling found that a stack height of between 80m and 100m would be suitable. A final stack height of 100m was selected due to consistency with the good engineering practice guide and modelled emissions concentrations at ground level.

6.6 Potential upset conditions

Upset operating conditions can occur for a limited number of reasons each of them resulting in the increase of certain emissions. The following table identifies potential incidents the root cause, the consequence in emissions and the possible remedy.

Incident	Root cause	Consequence in emission	Indication	Remedy
Failure of lime dosing	Dysfunction of the dosing device, the pneumatic conveying system or clogging of lime in the silo or ducts.	Gradual increase of HCl and SO2 emissions over time (within 15-20 minutes). Due to the remaining lime in the system and the in system there is sufficient time for the operator to take necessary actions.	Alarm caused by increased HCl and SO_2 emission in stack.	- Restart lime dosing system - actuate anti-clogging system in silos - Switch to the reserve dosing and conveying system
Failure of activated carbon dosing	Dysfunction of the dosing device, the pneumatic conveying system or clogging of activated carbon in the silo or ducts.	Gradual increase of mercury emissions over time (within several hours). No relevant increase of dioxins and furans emissions due to remaining active carbon in the system and high recirculation rate.	Alarm caused by no usage of activated carbon	- Restart lime dosing system - actuate anti-clogging system in silos - Switch to the reserve dosing and conveying system
Failure of filter bags	Gradual wear of bags (mainly seam), wrong installation, manufacturing defect(s) of bags or cages.	Gradual increase of dust and heavy metals during in short spikes whenever cleaning of bags is in operation (note: the complete rupture of a bag is in extremely rare incident)	Dust peaks during online cleaning, alarm as a result of increasing dust emissions in stack	- Monitoring the emission to detect relevant filter compartment - replacement of damaged bag (possible during continuous operation of the plant)
Failure of SNCR system	Breakdown of pumps, failure of piping, clogging of nozzles	Increase of NOx emission	Alarm due to increased NOx emissions	- Change to standby pump - repair piping - Unblock nozzles (possible during continuous operation of the plant)
Insufficient combustion conditions	Low combustion temperature, dysfunction of the primary or secondary air system, of the grate or the pusher, blockage in the feed hopper	Increase of CO and VOC emissions	Alarm due to low furnace temperature and/or increased CO/VOC emissions	- Start auxiliary burners - if root cause cannot be solved during operation then normal shutdown of plant

As mentioned above, during upset conditions certain emissions will increase, sometimes even above the required emission limit. While during normal operation the emissions remain well below the required limit an increase will be immediately detected by the emission monitoring or other monitoring systems system.

The evaluation of operational results shows that in case of upset operation conditions there might be an increase of the emissions above the required limit by a factor of 2 to 3. In case the upset condition remains for more than 4 hours, the plant has to be shut down. For further evaluations a conservative approach assuming a factor of 10 for every individual emission during upset condition has been chosen.

6.7 Chosen Emission Standard

Under the EfW Policy Statement the stack emissions from the facility are required, as a minimum, to meet the Group 6 standards of concentration set out in the *Protection of the Environment Operations (Clean Air) Regulation 2010* ("the Clean Air Regulation"). The Clean Air Regulation sets emission standards for various industrial activities and those that are applicable to an EfW facility are outlined in Table 19.

Pollutant	Standard (mg/Nm^3)	Source	Activity
Solid Particles (Total)	50	Electricity generation	Any activity of plant using liquid or solid standard fuel or non-standard fuel
HCl	100	General standards	Any activity or plant
HF	50	Electricity generation	Any activity of plant using liquid or solid standard fuel or non-standard fuel
SO_2	No applicable standard		
NO_2	500	Electricity generation	Any boiler operating on a fuel other than gas, including a boiler used in connection with an electricity generator that forms part of an electricity generating system with a capacity of 30 MW or more
Type 1 & 2 substances (in aggregate)	1	Electricity generation	Any activity of plant using non-standard fuel
Cd or Hg (individually)	0.2	Electricity generation	Any activity of plant using non-standard fuel
Dioxins or furans	$1x10^{-7}$ (0.1 ng/m^3)	Electricity generation	Any activity of plant using non-standard fuel that contains precursors of dioxin or furan formation
VOC	40 (VOC) or 125 (CO)	Electricity generation	Any activity of plant using non-standard fuel
Cl_2	200	General standards	Any activity or plant
H_2S	5	General standards	Any activity or plant

Reference conditions defined as dry, 273.15 K, 101.3 kPa and 7% O_2 for all air impurities when burning a solid fuel, with the exception of dioxins and furans where the required O_2 concentration is 11% for waste incineration.

Table 19: POEO Clean Air Regulation Standards of Concentration

However, the proposed flue gas treatment will be designed to employ Best Available Technology and achieve the emission limits specified by the European *Industrial Emission Directive IED 2010/75/EU*. The IED emissions limits (refer Table 20) are generally more stringent that the Clean Air Regulation limits. The proposed technology is based on existing facilities operated throughout Europe, which are designed to meet the IED limits.

The European limit values for emissions in waste incineration plants are defined within the IED. The specific emission limits for WtE are found in Annex VI, part 3 of the Directive.

Parameter	Daily Average	Half Hour Average	Units
Continuous measuring			
Total Dust	10	30	mg/Nm^3
Total Carbon (TOC)	10	20	mg/Nm^3
Inorganic chlorine compounds (HCl)	10	60	mg/Nm^3
Inorganic fluorine compounds (HF)	1	4	mg/Nm^3
Sulphur dioxide (SO_2)	50	200	mg/Nm^3
Oxides of nitrogen (expressed as NO_2)	200	400	mg/Nm^3
Carbon monoxide (CO)	50	100	mg/Nm^3
Discontinuous measuring			
Dioxins and Furans	0.1	ng/Nm^3	average of 6-8hours
Hg	0.05	mg/Nm^3	average of 0.5-8hours
Cd+Tl	0.05	mg/m^3	average of 0.5-8hours
Total of heavy metals	0.5	mg/m^3	average of 0.5-8hours

All emissions are dry basis, 11% O_2 and at normal temperature and pressure.

Table 20 IED Emission Limits for an Incineration

6.7.1 Continuous Emission Monitoring System (CEMS)

Consistent with the requirements of the EfW Policy Statement, there will be continuous measurements of NO_x, CO, particles (total), total organic compounds, HCl, HF and SO_2. This data will be made available to the EPA in real-time graphical publication and a weekly summary of continuous monitoring data and compliance with emissions limits will be published on the internet.

Further, the emission monitoring shall comply with the requirements of European Industrial Emissions Directive. Continuous monitoring is therefore installed for the pollutants CO, HCl, SO_2, NOx, NH_3, VOC and particulates. Auxiliary parameters are also measured: Flue gas flow rate, temperature, pressure, moisture content and oxygen.

6.7.2 Shut down of plant in case of non-compliance with emission limits

The facility will be designed and operated in accordance with the IED directive. The directive states in § 46.6 that "*... the waste incineration plant ... shall under no circumstances continue to incinerate waste for a period of more than 4 hours uninterrupted where emission limit values are exceeded. The cumulative duration of operation in such conditions over 1year shall not exceed 60 hours. In according to the IED in case of non-compliance with the emission regulations the plant can only be operated a maximum*."

The plant will further be equipped with an automatic shutdown procedure in case of non-compliance with the emission limits according to the IED § 50.4c which states: "*Waste incineration plants ... plants shall operate an automatic system to prevent waste feed ...*

whenever the continuous measurements show that any emission limit value is exceeded due to disturbances or failures of the waste gas cleaning devices."

6.8 Plume Visibility

For the proposed semi-dry flue gas treatment, a stack exit temperature of around 120 °C and moisture of the flue gas of 15-18% is expected. Calculations show that that plume formation will not occur at ambient temperatures above 12 °C and a relative humidity of 75%.

The mean relative humidity (9am) is between 65 and 75% all year. In the months May to October the mean maximum temperature is 17-23 °C, which is well above the 12 °C threshold. The mean minimum temperatures of May-Oct are 7-11 °C, indicating that there will be a number of hours where plume visibility is possible.

It can be concluded from the temperature and humidity data that a plume will not be visible the vast majority of the time.

Even under the most adverse weather conditions any water vapour which is visible will be light (not dense) and it will disappear quickly.
Visible water vapour will most likely occur only at night and in early morning hours in the coldest 6 months of the year and have very limited height.

6.9 Consumables Handling

The Facility will use various raw materials during operation. Primarily, these include hydrated lime, ammonium hydroxide, activated carbon, Low Sulphur gas oil and water. These will be delivered to the Facility in bulk transportation vehicles (except for water, Low Sulphur gas oil and oil). The minimum on site storage capacity will be set to reflect the process requirements and local delivery capability. Table 22 shows the approximate consumable requirements.

Various smaller amounts of materials are used for the operation and maintenance of the Facility. These are:

- hydraulic oils and silicone based oils;
- low Sulphur gas oil emptying and filling equipment;
- boiler water dosing chemicals.

All liquid chemicals stored on site will be kept in bunded controlled areas with a volume of 110% of stored capacity.

6.10 Residue Handling

The facility will generate the following residues:

- Bottom ash
- Boiler ash
- APC residue;
- Ferrous material residue;
- Staff waste;

6.10.1 Bottom ash

Bottom ash is the burnt-out residue from the combustion process. Bottom ash from the grate is quenched with water and moved by conveyor to the enclosed ash storage bunker where it is stored prior to being transported off-site. The conveyor passes under a magnetic separator to remove ferrous materials.

6.10.2 Boiler ash

The characterisation of boiler ash is dependent upon in which boiler pass it is accumulated in. Boiler ash of the horizontal pass will be conservatively disposed of with the APC residues. The composition of the ash from the first vertical passes is similar as the bottom ash and can be disposed of with the latter.

6.10.3 Air pollution control (APC) residue

Flue Gas Treatment residues, also known as APC residues, comprise fine particles of ash and residues from the FGT process. APC residue is collected in bag filters and will contain fly ash and reaction products from the hydrated lime scrubber and spent activated carbon. Due to the heavy metals involved in FGT, this material is classified as restricted solid waste. It will be stored in dedicated enclosed silos located adjacent to the flue gas area before being transported via a sealed tanker to an appropriate offsite disposal facility.

6.10.4 Ferrous material residue

Ferrous metals will be removed from the bottom ash by means of magnetic separators and discharged to into bins which are then transported offsite to metal recycler.

6.10.5 Mass Balance

The residue production from the Facility has been estimated and presented within Table 21:

Parameter	Units	Design fuel	Worst case fuel
Fuel NCV	MJ/kg	12.30	10
Ash content	%	21.49	24
Fuel Flow	tpa	552'500	675'000
Bottom ash (dry)	tpa	118'732	162'000
Bottom ash (wet)	tpa	146'583	200'000
FGT/APC residue	tpa	21'900	25'850
Combined ash and residue	tpa	168'483	225'850

Table 21 Residue production

Raw material	Process	Typical usage (tpa)
Hydrated Lime	Flue gas treatment – acid gases	9,900
Ammonium hydroxide (25% solution)	Flue gas treatment – NO_X reduction	1,100
Activated carbon	Flue gas treatment – dioxins/ heavy metal	210
Low Sulphur gas oil [10]	System firing	950

Table 22 Consumable requirements

[10] Based on 10 starts per year per boiler (assuming 2 boilers), each start using 43 t gasoil. 10% has been added to the total figure to account for other uses e.g. maintaining the temperature above 850°C. Delivery size is nominal.

6.11 Water Balance

Based on the water balance from a typical EfW facility, the average process water requirement is likely to be 11.63 m^3 per hour for the overall plant. Based on 8,000 operating hours a year this equates to approximately 93,000 m^3 per year for the overall plant. The primary requirement for water is to provide make-up for the boiler and steam cycle (to replace that which is blown down) and the FGT plant.

6.12 Proposed design data

For proposed overall design data please refer to table below.

Waste-to-Energy with waste utilization Preliminary Process and Design Data Flue Gas Treatment	
Plant Component / Parameter	**Value / Description**
Raw Flue Gas	
Referring to flue gas downstream the boiler.	
Nominal data 1)	
Flue gas flow rate, dry flue gas at 11% O_2	279,900 Nm^3/h
Temperature	170 °C
Pressure	– 1,000 Pa
H_2O	14.5 % vol.
O_2	7.4 % vol., dry
Dust	1,850 mg/Nm^3, 11% O_2, dry
Σ Cd + Tl	3 mg/Nm^3, 11% O_2, dry
Σ Sb+As+Pb+Cr+Co+Cu+Mn+Ni+V	70 mg/Nm^3, 11% O_2, dry
HCl	900 mg/Nm^3, 11% O_2, dry
SO_2 and SO_3 (as SO_2)	530 mg/Nm^3, 11% O_2, dry
HF	20 mg/Nm^3, 11% O_2, dry
NO_x as NO_2 3)	200 mg/Nm^3, 11% O_2, dry
NH_3 3)	3 mg/Nm^3, 11% O2, dry
N_2O	~ 0 mg/Nm^3, 11% O_2, dry
Hg	0.7 mg/Nm^3, 11% O_2, dry
Dioxins and furans (tox. equivalent 2,3,7,8 TCDD) 3)	5 ng/Nm^3, 11% O_2, dry
1) Nominal values to be used as reference for guarantee values (at nominal) of consumables, residues, and energy production and consumption etc. Values apply at boiler exit 2) Wet flue gas at actual O_2 content 3) after SNCR-deNOx	
Emission limits, Outlet stack	
Emission limits	Clean Air Regulation Group 6, and where more stringent, IED 2010/75/EU (Please refer to Chapter 3)
Absorbents/adsorbents silos	
Minimum capacity, lime	7 days' consumption + 30 tonnes
Minimum capacity, activated carbon	20 days' consumption + 30 tonnes
Silo for Flue gas Treatment residue	
Minimum capacity	5 days' production at nominal conditions

7. TURBINE/CONDENSERS

7.1 Energy recovery, water steam cycle

The Facility will be capable of exporting approximately 68.65 MW of electricity, amounting to about 549,200 MWh per annum of electricity. For the export of electricity there will a separate connection to the electricity distributed network.

The Substation will be designed for both stages by taking into account two connection points for each turbine generator and also ability to make a new connection for the second turbine generator in readiness for any stage 2 build without shutting down the stage 1 facility.

The Facility will have one turbine for each stage which will serve two streams each. The principle of water steam cycle is sown below in Figure 10.

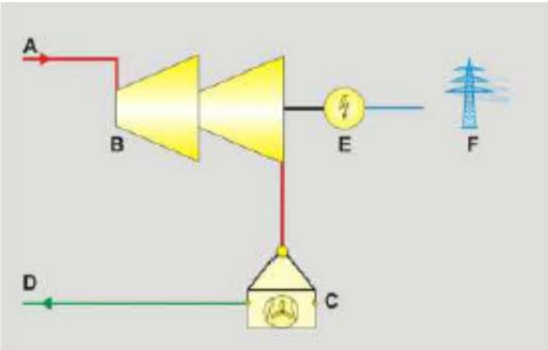


Figure 10 Steam Turbine set generating electricity

By means of a pressure controlled steam extraction, low pressure steam is taken for internal consumers in the plant. The expanded steam is then led to an air-cooled condenser to completely condensate the steam. Also part of this cycle are general steam and condensate systems, water treatment and feed water preparation systems as well as a closed-loop cooling system for all general cooling purposes of the plant.

7.2 Condensing System

The EfW plant will require a cooling system to condense the steam from the turbine exhaust for re-use. A BAT assessment has concluded that the use of ACC represents BAT for this installation based on its geographical location.

ACCs condense steam from the turbine exhaust by transferring heat to the air. The steam travels down the inside of finned metal tubes whilst air is blown by fans across the outside of the tubes. As the steam loses heat it cools and then condenses. The condensate is collected in a condensate tank below the ACC unit and then pumped to a feed water tank ready for recirculation back to the boilers.

7.3 Power Generation

As previously mentioned the steam parameters are 70 bar at 430ºC. With these parameters processing of 34.53 tonnes/hour with at a calorific value of 12,300 kJ/kg the plant has a thermal power of 117.98 MW per combustion line.

The estimated nominal steam turbine power output is 76 MW (gross power). The net power output is estimated at 68.7 MW.

The power generation from the Facility is presented within Table 9. The Facility will be designed to export 68.7 MWe in stage 1 and a further 68.7 MWe in stage 2 a total of 137.3 at full operation to the grid.

7.4 Turbine

The steam turbine shall be designed to swallow 110% of the maximum boiler steam production. This allows for sufficient turbine capacity for slight overshoots and variations in steam flow, as well as givens margin if the boiler is performing better than expected.

In order to achieve a flexible operation of the plant and for safety reasons and for start-up/shutdown it is necessary to provide the plant with a possibility of operation without passing the steam through the turbine: This is done with a turbine bypass system.

The turbine bypass system function is designed to allow operation of the combustion during maintenance on the turbine without having to shut down the complete Facility.

Bypass operation is used, when the turbine cannot receive the steam due to internal malfunction (turbine trip) and maintenance works or at start-ups and shut-downs, where the condition of the steam is outside the operational range.

The bypass is able to swallow steam corresponding to 20-110% boiler load. During bypass operation (that is, operation without the steam turbine), a live steam reduction valve shall provide the necessary steam for deaerator and air preheating.

The bypass station produces slightly superheated steam of such conditions, that the condenser works properly in the whole load range.

Typical load point of bypass operation could be: steam turbine producing only house load (~2 MW) or steam turbine completely out of operation.

7.5 Export of heat

Without any changes to the main plant design, the Facility is configured so that it is possible to export heat to nearby consumers for space heating or cooling or hot water.
The turbine is constructed to export up to 20MW heat per turbine.

TNG is very interested to use this technical possibility and is actively exploring potential heat export possibilities.

7.6 Proposed design data

The proposed overall design data is summarised in the table below.

Waste-to-Energy with waste utilization Preliminary Process and Design Data Turbine/generator/condensers	
Plant Component / Parameter	**Value / Description**
Turbine design steam data	
Nominal (100%) Steam flow	Maximum continuous flowrate (MCR) in boiler combustion diagram
Steam flow nominal	144.7 tonnes/h
Steam flow rates possible	Island mode – 110% of boiler MCR
Steam pressure (inlet of Emergency shut-off valve, controlled by turbine inlet nozzle group)	70 bara
Steam temperature nominal at boiler exit	430 °C
Swallowing capacity for turbine	Corresponding to operation at 110% MCR
Swallowing capacity for bypass system	Corresponding to operation at 110% MCR
Island mode	
Electricity demand, Island Mode (preliminary for tendering)	3,0 – 6,0 MW (final value to be given during detailed engineering)
Turbine bleeds (design)	
	Approx. 5 bara to supply steam to: - air preheater - de-aerator Further bleeds foreseen for heat export if later required.
Turbine bypass station	
Steam downstream turbine bypass station Temperature	[Saturation + 5-10 °C]
Air cooled condenser	
Operation pressure	0.1 bara at 22°C ambient temperature and turbine operating at 100% MCR
Temperature inlet / outlet	46/46°C

8. ANCILLARY EQUIPMENT

8.1 Waste Cranes

Two 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 CMS system. A spare grab shall be present to ensure a high degree of reliability.

The waste crane grabs size and the speed of operation shall be appropriately sized to service two process lines with the duty cranes operated in semi-automatic mode, the regime being:

- The Contractor will define the unproductive time in the bunker management procedure;
- Maximum 30 minutes per hour to remove mixed waste from the bunker and feed the waste hoppers to enable the plant to operate at 100% MCR at the maximum fuel throughput as defined on the firing diagram (waste CV of 10 MJ/kg).;
- During the lorry and conveyor delivery time period the remaining time shall be sufficient to allow clearing of the tipping area and stacking, such that waste deliveries are not disrupted.
- Outside the main delivery time period the remaining time shall be sufficient to allow sufficient mixing and stacking and clearing of the tipping area.

8.2 Bottom Ash Cranes

Three bottom ash cranes will be installed with integrated weighing cells for run and standby operation, with the facility to operate both cranes simultaneously in either manual or automatic modes.

8.3 Component Cooling System

The component cooling system will supply the necessary amount of cooling water (water/propylene glycol mixture) at a specified pressure- and temperature level to the cooling water consumers connected to the system, for example the turbine.

The cooling system and its components are dimensioned for the maximum cooling need in the entire system at the most critical supply conditions.

8.4 Cranes and Ancillary Hoisting Equipment

To ensure efficient lifting of main equipment during operation and maintenance, two permanent cranes are installed:

- Workshop Crane, load capacity 5 tonnes
- Turbine Hall Crane; load capacity 72 tonnes
- Lifting hoists in boiler hall

Ancillary hoists will be installed in such a way that all major pieces of equipment and plant can be serviced and replaced efficiently throughout the plant where major equipment and components are installed.

It is important that maintenance and repair can be carried out efficiently at any given time to maintain the high plant availability. For this reason, cranes as well as galleries etc. are planned and established throughout the facility to ensure that all components can be serviced and replaced quickly and safely.

8.5 Proposed design data

For proposed overall design data please refer to table below.

Waste-to-Energy with waste utilization Preliminary Process and Design Data Ancillary Equipment	
Plant Component / Parameter	**Value / Description**
Waste	
Waste density within closed grab to be used for crane cycle calculations.	500 kg/m^3
Average density of the waste in the bunker before compression to be used for calculation of capacity	350 kg/m^3
Crane construction for waste cranes (both stages)	
Number of cranes	3 semi-automatic waste cranes
Crane capacity (per crane in semi-automatic mode)	
Charging waste hopper (nominal)	34.53 t/h
Compressed Air (per stage)	
General	
Total installed compressor capacity for process and instrument air	4x37% or 5x28% of total demand of one stage
Process and Instrument air	
Maximum size of particles:	0.1 µm
Maximum concentration of particles:	0.1 mg/m^3
Dew point:	-40 °C
Maximum oil content:	0.01 mg/m^3

9. CONTROL AND MONITORING SYSTEM

In order to control and monitor all the processes and components and to support automatic operation of the EfW Plant, a Control and Monitoring System (CMS) is required.

The CMS is an automated system used to operate the plant and ensure the safety of personnel and equipment. The CMS operates the Facility processes, machinery, and drives. It also covers information management, quality control, and mechanical and field device condition monitoring.

The CMS replaces the following equipment:

- Operator Level
- Server stations
- Process stations
- System network (redundant Ethernet network)
- Bus systems to Remote I/O stations
- Communication to HV system
- Link to Turbine package unit

The CMS consists of the following levels:

- Plant level: Process equipment, sensors, actuators, probes and analysis devices
- Automation level: Process control, automated devices and autonomous systems, safety systems (SIL = Safety Integrated Level)
- Process control level: Monitoring and controlling of process, data acquisition, programming tools
- Plant control level: Management, maintenance and supervision
- Interface to management systems and the office network.
- Interface for remote access
    - CEMS (Continuous Emission Measuring System)
    - Remote maintenance
    - Data and trends

The CMS will perform the dedicated control and monitoring tasks for specific equipment in the plant and support operator control of the said equipment, and support full-automatic and semi-automatic operation and control of the various process sections of the plant, and support plant operation staff in operation, control and monitoring of the entire plant. Furthermore, the CMS shall support plant operation staff in reporting to internal as well as external parties (e.g. supervising authorities) and support plant maintenance staff in planning, organisation and performance of maintenance of the plant. The CMS shall also enable automatic generation of environmental reports and provide maintenance schedules in accordance with license requirements.

The CMS overall configuration is illustrated in the topology drawing, Figure 11.

The CMS-system will be constructed with a number of operator stations from where operation and monitoring of all the facilities are performed. The operator stations shall mainly be located in the control room. If a specific process demands a local operation, it should be possible to place local operator screens at the process. The operator stations shall communicate with the process control stations through a safe redundant process network.

The process control stations will be established as autonomous processor-based units, which independently of any fault in the overall process network or operator stations shall be able to control, monitor and protect the facility equipment.

An engineering station will be established for configuration, programming, analysing, etc. the system. Furthermore, a common report server for operational and environmental reporting shall be established. Printing facilities, including colour laser printer, shall be available in the control room, to be used for printing of reports and documentation. A connection to the operation and maintenance system (O&M system) will be established, to update the O&M system with plant information, information from electrical components of the facility, for scheduling of preventive maintenance work. Access to the O&M system shall be provided from the control room and administration areas.

All electronic equipment, except monitors, keyboards and printers, will be installed in a dust-free and temperature-controlled environment. It is common to have an air conditioned server room close to the control room, where all the electrical equipment can be located safely.

A redundant control network for communication between all process stations will be established. It must be possible to access all information from each operator station. This process network will also be the interface to the network of the administrative system. The network must be constructed with intelligent firewalls, routers and switches to separate the process network with the administrative network. The network must be constructed with optical cable or cobber cable. Wireless network is not allowed, except for maintenance purpose (Service Laptops). The routers and the components on the network shall be based on the technology Simple Network Management Protocol (SNMP), which entails that diagnosis and operational information from the individual (SNMP) components can be transferred to further processing in the O&M system.

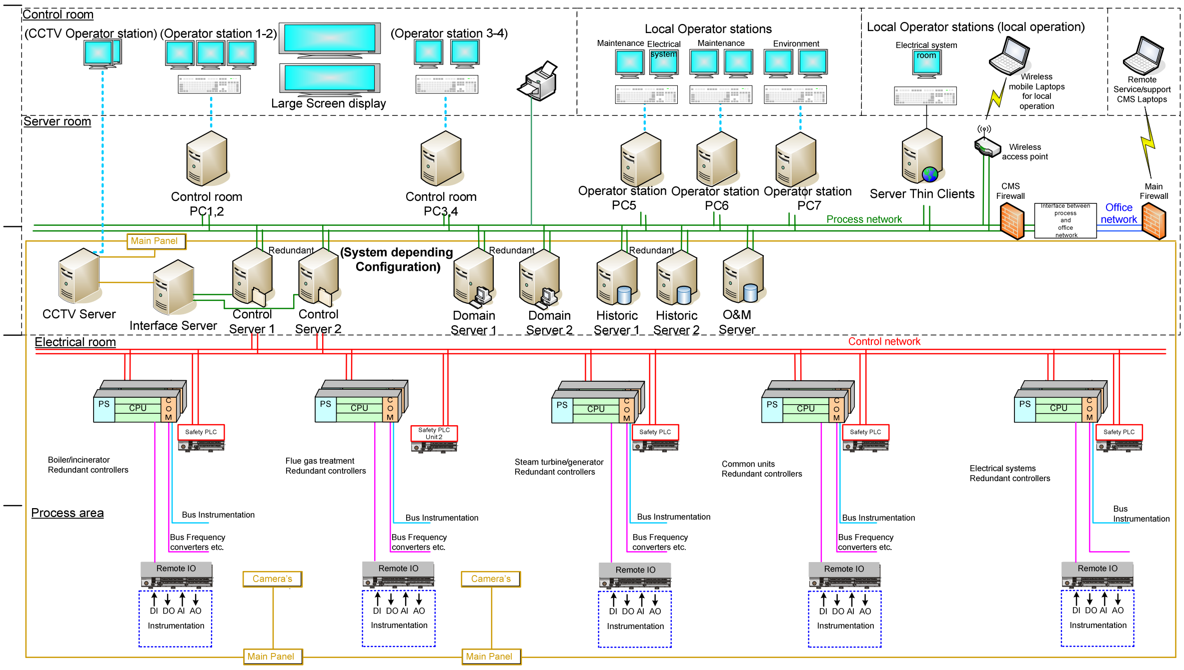


Figure 11 CMS configuration

9.1 Overall CMS Operation Philosophy

The following requirements regarding operation philosophy shall be observed:

- The total plant will be controlled and monitored from the operator stations in the control room. It shall be possible to carry out all control and monitoring functions by means of the operator stations. Under normal conditions it shall be possible for one operator to control and monitor the entire plant from the operator stations in the control room.
- Independent of the chosen level of operation and control, the CMS will ensure that the total plant can be controlled and operated in a secure and satisfactory manner. This includes personnel safety, plant safety and operational reliability. All operator actions shall be subordinate to the safety systems of the CMS. In case of faults in the plant, or in the CMS itself, partially or totally, the CMS shall ensure that the faulty part of the plant is brought into a controlled and secure condition.
- The operator will have full information from the entire plant available in the CMS, to help with decision making and issuing commands through the CMS. The operator is the person in charge and it is the obligation of the system to provide adequate and correct information, presented in an easily understandable manner. To do this, the CMS must be able to produce the following lists:
    - Presentation of the plant processes and object status
    - Indication of historical trends
    - Event and Alarm handling
    - Reporting system, for different reports.

Access shall be limited. It shall be possible to limit access to all or part of the system through the use of password protection.

9.2 CCTV

A common camera surveillance system (CCTV) with monitors in the control room, to which all cameras for the plant area are connected, shall be installed in the server room. It shall be possible to operate and select cameras from a position close to each operator stations in the control room.

10. ELECTRICAL SYSTEM

10.1 Electrical Installation

The following voltage levels shall be in use in the Facility:

Rated operating voltage	Maximum voltage of equipment	Neutral treatment	Purpose
11 kV AC	12 kV	Insulated high resistance earthing	Generator voltage and high voltage distribution.
710/415/240 V AC	+10%,-6%	Solidly earthed	Mains power distribution.
110 V DC	110 V	Isolated	Control voltage only where 24 V cannot be used and only available with the written approval of the Company's Representative.
24 V DC	24 V	Earthed negative	Control voltage, fire alarms.
24 V AC	24 V	Safety insulation	Safety voltage for lighting.

Table 23 Plant voltage levels

The steam turbine generator is expected to generate electrical power at 11 kV and will be connected on to the Facility 11 kV power distribution system and to the distribution network operator's network through a step-up transformer.

The turbine generator will provide the electricity to operate the rest of the Facility.

Electricity will normally be exported to the grid, but the grid connection will also allow for import of electricity back to the turbine halls for start-up of the whole Facility.
In addition, it shall be possible to supply power from one Power Island to the other via appropriate switching, including all necessary synchronisation and automatic controls. This should enable either Power Island to supply the other, whether operating in island mode, in the event of an emergency, or as desired during normal operation. An appropriate power management system shall be provided enabling all the necessary functionality.

All switchgear, control gear and fuse gear will be located indoors, in metal-clad sheet steel cubicles with front access doors. The equipment will be selected from manufacturers' standard product range and be fully type tested in accordance with relevant Australian, European and International Standards.
The equipment will be rated to withstand the mechanical forces and thermal effects of the maximum prospective fault current at the point of application.
In normal operating conditions, the power requirements of the Facility will be supplied by the steam turbine generator with the balance exported to the grid.

In the event of a breakdown of the steam turbine generator, the power for the site parasitic load will be supplied from the grid.

It is anticipated that the steam turbine will be capable of operating in island mode. In the event of a loss of grid connection, this would allow the Facility to continue processing fuel with the auxiliary load supplied form the turbine generator.
Emergency diesel generators will also be available for safe shut down of the Facility in the event of a loss of grid connection and failure of the steam turbine to transfer to island mode operation.

10.2 Transformers

Following transformers are used in the facility:

- Power transformers – 132/11 kV;
- Auxiliary transformers – 11/0.415 kV or 11/0.71kV;
- Unit transformers – 11/11 kV

10.3 Protection

The protection system will be designed that in the event of faults occurring, the faulty plant is safely disconnected, whilst continuity of supply consistent with system stability is maintained. The selection and setting of protection devices for the auxiliary system will be based upon the following major requirements:

- Faults on facility items will be disconnected as quickly as possible to minimise damage;
- Faults external to major power sources, e.g. unit transformers, will only open the circuit breaker controlling these power sources after all other protection nearer the fault has failed;
- Faults internal to major power sources shall cause their circuit breakers to open as fast as possible to ensure that the transmission system can restore itself within the limits of stability;
- The protection will be designed to be stable in transient conditions such as motor starting and will not operate for current surges caused by faults external to the auxiliary system, for which the main generator would recover and the item of plant protected would not be damaged; and
- Protection of plant is designed to match the plant operating characteristics and provide discrimination with other plant.

All circuits will have lockable isolating facilities so that they can be disconnected and worked upon in complete safety.

10.4 Electrical Works

The Facility will include standard electrical equipment, selected based upon safety, reliability and quality. No single failure of a major part of the auxiliary plant should result in the total shutdown of the main generating plant.

Essential supplies systems will be provided to maintain unit output and to protect plant from damage, due to a loss of supply. The systems will be sized to enable the station to be shut down in a safe manner on loss of transmission supplies and afterwards to allow normal supplies to be re-instated following reconnection. Suitable earthing and lightning protection will be provided.

10.5 Emergency Power/UPS

It is critically important that failure of the grid or other power failure does not result in either damage to the plant or in excessive emissions to the atmosphere. Therefore, uninterrupted power supply (shall be supplied in order to maintain control of the plant at power supply failure) and emergency diesel generator (the UPS can only supply power for smaller components - primarily the CMS) are installed in order to slowly run-down the plant at failure of the grid. The diesel generator will require suitable housing / positioning to limit the risk of noise impacts.

The main emergency power supply shall be from the emergency generators and shall be sufficient to permit the re-start of all necessary Plant control systems and equipment following a full Plant trip to permit the safe shut-down of the Facility. The emergency diesel generators are specified in chapter 10.5.1.
In addition battery back-up emergency systems (DC, UPS), as required for the safe shut-down of Plant components, shall be supplied.

10.5.1 Emergency Power

The two emergency diesel generators shall supply emergency power to the selected items of Plant as required by TNG for the four incineration lines. They will not be used for shutting down and starting up the plant in the case of planned (scheduled) outages, or forced (unscheduled) outages.
The emergency generators shall be designed for continuous operation. In addition to providing emergency power supplies to essential users, the generators shall be designed for operation when:

1. synchronised to the grid;
2. synchronisation of the diesel generation set with the Site distribution system for testing purposes; and
3. automatic switching of the diesel generation set to the Site electrical connection so that the Site supply can be restored without disruption of the essential services.
4. Black start of one incineration line

In case of a complete breakdown of the normal auxiliary power supply, the emergency generators shall be sufficient to meet the electrical demand of at least the following consumers:
1. essential air conditioning, including boiler house/turbine hall chiller equipment and air conditions units for all main LV/HV switchgear/distribution rooms, Plant control room, relay rooms, and the CEMS rooms;
2. all drives and electrical devices necessary for the safe control and shut-down of the entire Facility and its associated systems;
3. 110 V DC and 240/415 V UPS systems;
4. Plant control room lighting and air conditioning systems;
5. radiator fan, diesel oil transfer pump and all other drives required for diesel generator operation;
6. ventilation fan of diesel engine room;
7. oil pump and turning devices for turbine shut down;
8. generator shut down heaters;
9. emergency lighting system, including in all main LV/HV switchgear/distribution rooms, central control/relay rooms, escape routes, exits, etc;
10. essential task and access lighting systems;
11. HV and LV switch-gear and switch-gear rooms;
12. weighing systems in weigh-bridge area;
13. Site access barriers;
14. passenger lifts, goods lifts;
15. Site fire pumps and fire detection, protection and alarm systems;
16. all other essential services/equipment/areas.

10.5.2 UPS

Supplies for protection, tripping, alarm, control, instrumentation, emergency drives, emergency lighting, communication equipment etc. as defined, shall be maintained by means of batteries for a period of not less than 1 hour in the event of loss of all normal means of supply.

Each DC system shall be supplied by one 100% battery and one associated 100% charger. Each charger shall be capable of simultaneously float charging the battery and supplying the total load.

The UPS requirements are:

	Parameter	Requirement
i	Output voltage	As required by the particular application
	Static tolerance	+ 1
	Dynamic tolerance	+ 4% for 100% load change
ii	Output frequency	50 Hz
	Tolerance	+0.2 to + 0.3% adjustable, synchronised to mains
iii	Harmonic distortion	<2% for linear load
		<5% for non-linear load
iv	Overload capability	150% for 1 min, 125% for 10 min
v	Short circuit current	2 x rated current for 10 seconds
vi	Ambient temperature range	0-40^{0}C
vii	Cooling	Forced ventilation (redundant)
viii	Noise level	60dB (A) max

Table 24 UPS requirements

11. CIVIL WORKS AND LAYOUT

11.1 Background

The capacity of the Facility cannot be treated in a single combustion system. A single combustion system of the required size cannot be supplied. Therefore, the Facility will be configured as a two combustion line system.

The Facility will comprise of two combustion grates and two boiler systems housed in one building and each boiler has its own independent Flue Gas Treatment system and connecting to one turbine enclosed in the adjacent Turbine Hall, connecting to one air cooling system and one emission Stack and the other auxiliary elements connecting the process.

In stage 1 the entire tipping hall, waste bunker, administration and workshop will be constructed as well as full sized underground infrastructure, substation, detention basins and back-up systems, to ensures no synergies or efficiencies of the facility are lost with the two stage approach and the external appearance is not altered between the construction of the two stages.

The bunker is divided in to two parts, bunker 1 and bunker 2. Both bunker are used for receiving, mixing and storing of waste and are serviced by common waste cranes.
The size of the bunker provides sufficient volume to ensure thorough mixing in order to achieve best possible homogenization as well as volume to store waste during maintenance and shutdown.

The Development will include the following elements:

- Combustion lines and associated boilers;
- Cooling systems comprising air cooled condenser units;
- Flue gas treatment systems, including residue and reagent storage silos and tanks;
- Emissions stacks and associated emissions monitoring systems;
- Steam turbines and generator housed within a turbine hall;
- Auxiliary diesel generators.
- Buildings:
    - tipping hall and waste bunker;
    - boiler hall;
    - turbine hall;
    - substation;
    - bottom ash collection bay;
    - workshop;
    - stack; and
    - control room, offices and amenities.

- Hard-standing, internal vehicular access roads, vehicle turning and waiting areas;
- Fuel reception and storage facilities, consisting of a tipping hall and vehicle ramps,
- Fuel storage bunker and cranes;
- Consumable Materials Handling and Storage area for raw materials including hydrated lime, ammonium hydroxide, activated carbon, Low Sulphur gas oil , oil, and water, bottom ash handling systems, compressed air systems;
- Process effluent storage tanks;
- Demineralised water treatment plants;
- Fire water and fire protection facilities;
- Administration and control buildings; and substation.

Associated and supporting components of the development will include:

- Subdivision of the land;
- Pedestrian footpaths and routes;
- Internal roadways and weighbridges (x 2);
- Direct underpass connection (Precast Arch and Conveyor Culvert) between the proposed Facility and the Genesis MPC;
- Staff car parking for 40 vehicles (including 3 visitor parking spaces);

- Water detention and treatment basin; and
- Services (Sewerage, Water Supply, Communications, Power Supply);
- Signage;
- CCTV and other security measures;
- External lighting; and
- Hard and soft landscaping and biodiversity measures.

The proposed buildings have varying footprints and heights, with the maximum height reaching 52 metres above ground level, and the stacks reaching 100 m. The indicative dimensions of the buildings and various components of the facility are outlined in Table 26.

Building	**WIDTH (W)**	**LENGTH (L)**	**HEIGHT (H)**
Tipping Hall	108	50	20
Waste Bunker	98	31	46 (included 7m below ground level)
Boiler House	50	58	43
Flue Gas treatment	50	57	34
Stack with two inner flues	Outer diameter 3.1		100
Turbine Hall	34	46	25
ACC	51	51	24
Bottom Ash collection area	50	16	17
Sub Station (4000m^2)	63	50	20
Office Block	15	31	11
Workshop	32	35	16.5
Control Room	10	38	38
Weighbridge (in)	40	16	10
Weighbridge (out)	38	15	10
Fire water Tank	14.7	13.7	9
East Amenities	32	6.5	8
West Amenities	19	6	4.5

Table 25 Main Building Dimensions for the Facility (meters)

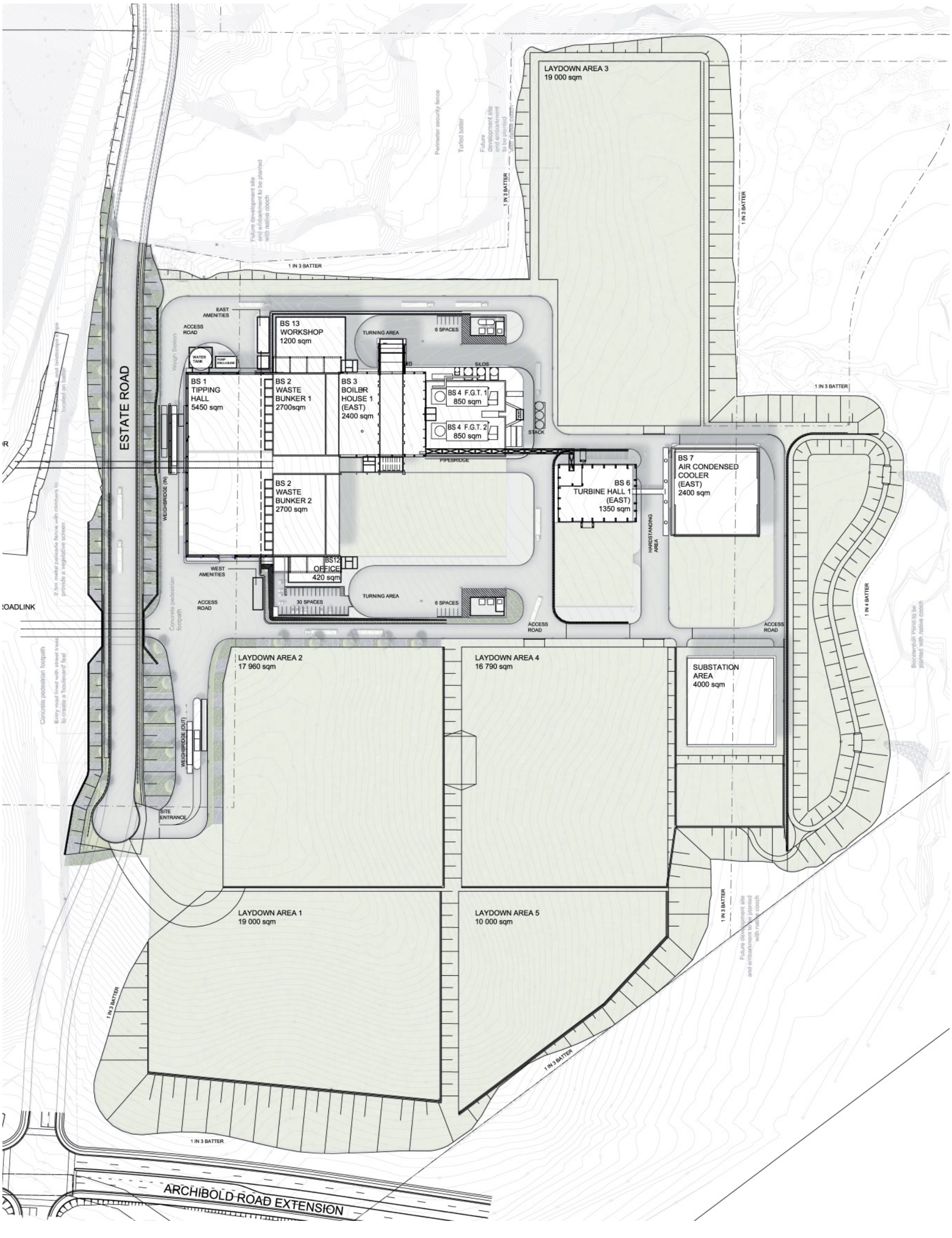


Figure 12 Site Layout

The above dimensions have been developed based in consultation with the technology provider (HZI) and the appointed construction company (Brookfield Multiplex) to ensure optimal functionality of the Proposed Development taking into consideration the unique site typography.

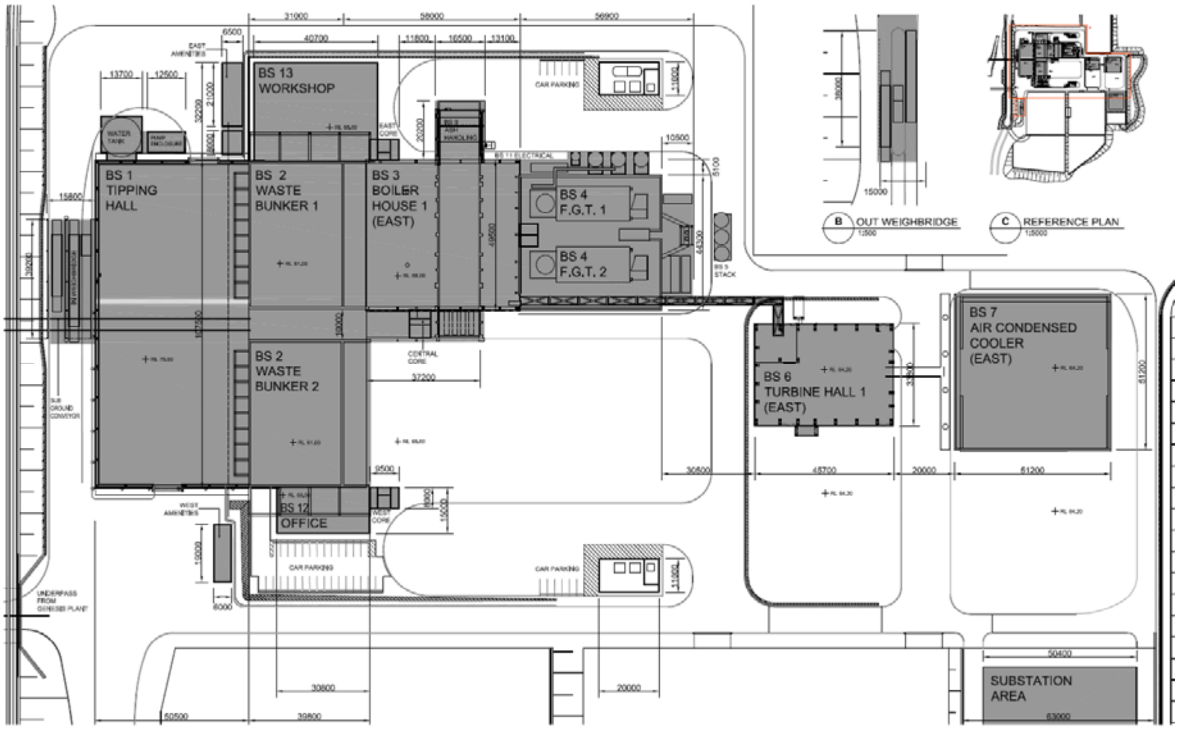


Figure 13 Building layout Stage 1

11.1.1 Site Layout

Traffic areas are designed in accordance with the national regulations. The design takes into account the peak vehicle movements and any associated queuing or standing time in order to avoid trucks/cars cueing onto the public road. Furthermore, the design will separate the heavy traffic from the light traffic for safety reasons.

11.1.2 Entrance/Weighbridge

The proposed Facility will provide two new weighbridges to be constructed within the boundary of the Site on Precinct Road (one on entry and one on exit).

Fuels from external transfer stations and recycling facilities will be delivered via road vehicle. These vehicles will enter the Site through the main entrance off Precinct Road which is being constructed as part of this proposal.

Once vehicles have entered the site they will proceed to the weighbridge where the quantity of incoming fuel is checked and electronically recorded. Vehicle loads will be inspected at the weighbridge to confirm the nature of incoming fuel and only authorised fuel will proceed to the fuel reception area.

Loads will be nominally 22 tonnes for all fuel types. Fuel can be sampled from the vehicle at the weighbridge. The weight of the outgoing vehicles will be recorded on a separate weighbridge as they leave the Site.

Fuel from the Genesis MPC will arrive at the proposed Facility in two ways as described below. The incoming fuel will be pre-weighed and its details recorded at the Genesis Xero Waste Facility before transported to the Facility:

- By a conveyor transport system which will carry the residual waste output of the Genesis MPC. It will travel via the culvert under Precinct Road and will eject directly into the storage bunker.
- Some vehicle transport from Genesis MPC will be required and when this occurs it will be via the archway under the Precinct Road (to be constructed as part of the DA consent). Vehicle transport via the culvert under Precinct Road will also be used in the event the conveyor is out of service.

Out bound movements along the road may include unrecyclable wastes that are extracted from mixed waste stream at the pre-sort stage prior to be feed into the recycling plant

11.1.3 Process Building

The layout of the facility has been informed by a range of operational requirements of key components including the furnace boiler and flue gas treatment that are required to have a linear arrangement.

Below a number of issues which have impact on the layout of the facility and which are reflected in the proposed layout of the plant:

<u>Tipping Hall:</u>

- Full enclosed tipping hall through individual tipping gates
- Number of tipping bays
- Width and geometry to allow for efficient use and safe traffic manoeuvring
- Inspection area

Waste Bunker:
- Volume (please refer to Chapter 4.1)
- Depth (ground conditions/foundation/required tipping height)
- Diversion (sorting)
- Direct view from control room into waste bunker
- Waste crane maintenance area

Boiler Hall:
- Boiler configuration (horizontal/vertical)
- Boiler support integrated in primary building structure
- Bottom ash storage below the horizontal part of the boiler
- Combustion equipment arrangement and accessibility

FGT area:
- Flue gas treatment equipment arrangement
- Consumables silos
- Residue silos

Turbine Hall:
- Arrangement of turbine and water-steam cycle equipment
- Crane accessibility
- Area needed for maintenance and laydown area for turbine casing/rotor etc.

Bottom Ash Handling:
- On-site storage
- Storage capacity
- Crane accessibility
- Safe loading

Workshops:
- Maintenance philosophy (own staff/external)
- Separate mechanical and electrical workshop
- Needed area (closely linked to philosophy)

General:
- Crane accessibility
- Area for operation and maintenance
- Escape routes

Control Room/Offices/Staff Rooms
- Reception area
- Toilet/welfare facilities
- Employee mess room and kitchenette area
- Lift and stair access to all floors of the plant
- Office areas and meeting rooms
- Control Room

12. OPERATION

12.1 Start-Up and Shut-Down

The Facility will be started and stopped automatically, but under the supervision of trained operators. This means that the control system will start the Facility in a controlled and safe manner, but the operator will have various "hold" points where checks are made before proceeding to the next stage.

The Facility will be started using fuel oil to reach safe combustion temperatures before any solid fuels are added. The flue gas cleaning system and emissions monitoring will be in operation before any solid fuel is added.

If the operator wishes to turn the Facility off, this is carried out in a controlled manner by reversing the start-up process. Solid fuel feeding is stopped, but the Facility continues to operate to ensure that all material is burnt and any flue gases are cleaned out of the system. Air flows are left on to allow the boiler to cool down before the Facility is fully shut off.

If any emergency condition is reached, or if a rapid facility shut down is required, the Facility will stop automatically in a rapid manner.

Fuel flows and air flows are stopped instantly which causes combustion to stop very quickly. The boiler can be depressurised via safety valves immediately if required. This system is fully interlocked to prevent manual intervention unless it is safe to do so.

The Facility is also protected in case of a complete loss of power, a "black plant" trip. In this case, the Facility will stop as under an emergency stop. The Facility will be provided with a secure electrical supply to provide power to essential consumers such as oil pumps, feedwater pumps, instrument air, fire pumps and emergency lighting. Control systems are supplied from a UPS system (Uninterruptable Power Supply) to ensure the operators are aware of what is happening.

12.2 Staff

The Facility will be operated and managed by suitably qualified and trained personnel. It is anticipated that a total of 55 staff will be employed of which 4 will be managers and 3 will be supervisors.

TNG is planning to entrust the operation to an internationally experienced EfW operator and has received bids from two world-wide respected EfW operators. As a conclusion there is no doubt that experienced experts are available and the plant will be run by an experienced and well trained operation team.

The shift teams will be led by experienced engineers who will have the responsibility for managing the operation of the Facility outside of office hours.

As detailed in Section 9 there will be a high degree of automation in the facility with the plant and key processes controlled from a central control room using a state of the art control system based on programmable logic controllers.

A fully automatic waste grab crane is to be installed which removes the need to man the grab crane except during peak waste delivery times. The weighbridge will also be fully automated with a vehicle recognition system and traffic barrier control system. Table 26 outlines the anticipated staff members required.

Role	**Number of staff (Indicative)**
	Overall Facility
Facility Manager	1
Operations Manager	1
Engineering Manager	1
Supervisor/Engineer – Mechanical	2
Supervisor/Engineer – Controls;	2
Supervisor/Engineer – Electrical;	2
Shift Engineers	6
Process Operatives	15
Day Team Supervisor	1
Weighbridge Operatives	2
Multi Skilled Labourers	9
Maintenance Technicians	10
Administrators	2
Compliance Manager	1
Total	**55**

Table 26 Staff required

13. R1 CALCULATION

The NSW Energy from Waste Policy Statement of Environment Protection Authority (EPA) states that:

"This Policy Statement is restricted in its scope to facilities that are designed to thermally treat waste for the recovery of energy rather than as a means of disposal. The net energy produced from thermally treating that waste, including the energy used in applying best practice techniques, must therefore be positive.
The R1 energy efficiency formula from the European Waste Framework Directive has been adopted with R1 to be ≥0.65 as the minimum total system efficiency threshold that must be met for a facility to qualify as an energy recovery facility.
Where these criteria are met, the facility will be licensed as 'Energy Recovery' under Schedule 1 of the Protection of the Environment Operations Act 1997, and therefore the waste and environment levy will not apply to waste received at the facility."

European Commission has produced a revised Directive on waste, which has replaced the old Waste Framework Directive (WFD) as of 20th October 2008. In this revised Directive, incineration facilities for municipal waste can be regarded as "Recovery" operations if the energy efficiency of the plant is greater than 0.65 for plants permitted after Jan 2009. Plants which do not meet this criterion are classed as "Disposal" operations and therefore lie on the same hierarchical level as landfill.
The definition of energy efficiency used in the revised Directive is:

$$\text{Energy Efficiency} = \frac{\left(E_p - \left(E_f + E_i\right)\right)}{\left(0.97 \times \left(E_w + E_f\right)\right)}$$

Ep — *means annual energy produced as heat or electricity. It is calculated with energy in the form of electricity being multiplied by 2.6 and heat produced for commercial use multiplied by 1.1 (units of GJ/yr)*

Ef — *means annual energy input to the system from fuels contributing to the production of steam (units of GJ/yr)*

Ew — *means annual energy contained in the treated waste calculated using the lower calorific value of the waste (units of GJ/yr)*

Ei — *means annual energy imported excluding Ew and Ef (units of GJ/yr)*

0.97 — *is a factor accounting for energy losses due to bottom ash and radiation.*

The interpretation of the R1 formula has proved to be difficult. Accordingly, the European Commission set up an expert panel to discuss this. The panel has prepared a guidance note "for the use of the R1 energy efficiency formula for incineration facilities dedicated to the processing of Municipal Solid Waste", which has now been adopted by the European Commission.

We have therefore used the formula, interpreted in accordance with the guidance, to assess the energy efficiency of the Facility. The calculation is based on predicted design figures and predicted levels of fuel consumption and electricity usage.

The R1 efficiency is predicted to be 0.86 (based on gross generated power) which is well above the threshold for new incineration plants. Therefore, the Facility will meet the definition of recovery.

APPENDIX 1
DADI WASTE AUDIT REPORTS

APPENDIX 2
TNG WASTE FUEL QUALITY ASSURANCE PROCEDURES