MVV Environment Services Ltd

Energy from Waste Combined Heat and Power Facility, Forties Road, Dundee

Heat Plan

1 Introduction: The Energy from Waste Combined Heat and Power facility

The responsibility to manage waste generated by households in Scotland lies with local authorities. Through a competitive tendering process, MVV are the "sole bidder" the Dundee and Angus Residual Waste Treatment and Disposal contract.

MVV Environment Services Limited (MVV) propose to construct and operate an Energy from Waste Combined Heat and Power Facility (EfW CHP Facility) on land situated at Forties Road, Dundee. The proposed EfW CHP facility would replace the existing EfW facility at on the neighbouring site on Forties Road.

MVV is a wholly owned subsidiary of MVV Umwelt GmbH. It is a member of the German utility company MVV Energie AG. MVV Umwelt provides flexible solutions for waste disposal, producing environmentally sustainable energy.

In Germany, MVV Umwelt operates six Energy from Waste and biomass plants, managing 1.6 million tonnes of waste a year. With over 50 years' experience, MVV Umwelt is in the top three companies in Germany in its field.

In the UK, MVV aims to replicate the success of MVV Umwelt in the German EfW sector. Having been awarded a long term contract for the treatment of residual waste in an EfW CHP Facility in Plymouth, and developed a waste wood biomass EfW Facility in Kent, MVV is now using its extensive expertise in generating energy from residual waste to develop further projects in the United Kingdom market. The EfW CHP Facility in Plymouth has an annual incineration capacity of 245,000 tonnes and will achieve an energy efficiency of up to 49%, which is more than twice as efficient as the current norm at British plants.

A ban on biodegradable municipal waste going to landfill will be introduced from 1 January 2021 by the Waste (Scotland) Regulations 2012. All businesses, public sector and not-for-profit organisations have been required to present metal, plastic, glass, paper and card (including cardboard) for separate collection from 1 January 2014. Local authorities are required to provide a minimum recycling service to householders. These regulations seek to maximise the quantity and quality of materials brought to the market and minimise the residual fraction. Also these separately collected recyclables are banned from going directly to energy recovery or landfill.

The facility will sustainably manage waste arising primarily in the Dundee and Angus area, helping to minimise and control the adverse environmental effects of waste that will not be recycled or reused, including the release of greenhouse gases that contribute to climate change, which are currently generated by landfilling.

The authorities undertook an evaluation of alternative options for the management of residual municipal waste, which included forecasting the most likely quantities of residual waste that would require between 70,000 tonnes and 90,000 tonnes of Contract Waste per year management in the future, taking into account the need to meet the new recycling targets and forecast population growth. Each Partner Council aims to be able to recover for recycling approximately 55-60% of their total collected waste from its individual collection activities by 2016. The outcome of this evaluation process was that a replacement EfW facility was required to manage a range of residual waste inputs from the two authority areas, between 70,000 tonnes and 90,000 tonnes per year. In order to meet this objective an Invitation to Participate in Dialogue (ITPD) was published in the Official Journal of the European Union (Ref 2014/S245 – 432329) dispatched on 16 December 2014, which invited expressions of interest and PQQ submissions from Economic Operators in respect of the Project.

2 The Pollution Prevention and Control Regime

To build the EfW CHP development MVV will require a planning permission under the Town and Country Planning Act 1997, and, in order to operate, the EfW CHP Facility, will require an Environmental Permit under the Pollution Prevention and Control (Scotland) Regulations 2012. An Environmental Permit application for the MVV EfW CHP is been prepared in parallel with the planning application and EIA and will be submitted shortly after the planning application.

As part of the procedure to obtain the consents the the Scottish Environmental Protection Agency's (SEPA's) Thermal Treatment of Waste Guidelines 2014 require the preparation of a Heat and Power Plan at the time of submitting a planning application.

Annex 2 of the Guidelines sets out the format that SEPA would expect to be used for the preparation of the HPP. This comprises:

- Section 1: Description of the facility technology;
- Section 2: Description of the waste to be treated and its energy value;
- Section 3: Heat and power plan; and
- Annexes: Any supplementary information referred to in the submitted plans.

This HPP has been prepared in accordance with the required format.

3 Description of the facility technology

The primary purpose of the EfW CHP facility is to treat the waste from the Dundee and Angus area that has not been recycled, reused or composted. The facility will primarily deal with Household Waste provided by the Dundee and Angus Councils under the Dundee and Angus Residual Waste Treatment contract. The remaining processing capacity will be used to process similar Commercial and Industrial (C&I) waste from local businesses in the surrounding area.

The EfW CHP facility is designed to treat 110,000 tonnes of waste per annum at the thermal design point of 39.9 Megawatts thermal (MWth) (hourly throughput of 13.725 tonnes per hour (tph) with a Lower Calorific Value (LCV) of 10.5 Megajoules per kilogram (MJ/kg) and an availability of 91.3% (equal to 8,000 full load operational hours per year).

The waste will be combusted and the heat will be used to generate steam. The steam will drive a steam turbine and generate renewable electricity for use at the facility, to supply the Michelin tyre factory and for export to the grid. Steam will also be extracted from the turbine and fed into the Michelin tyre factory steam network to be used for process and heating purposes. The EfW CHP Facility will therefore incorporate Combined Heat and Power (CHP) technology.

3.1 Waste Delivery

Waste will be delivered to the EfW facility in enclosed refuse collection vehicles, roll-on/roll-off vehicles with enclosed containers, and sheeted or enclosed bulk transfer vehicles.

Waste will be unloaded in an enclosed tipping hall. The tipping hall will have a “negative air pressure” system to ensure that all odours are contained within the building and treated so that they do not give rise to nuisance. The malodourous air will be used as primary combustion air in the furnace. The tipping hall will also be provided with a single entrance and exit roller shutter door that will be closed outside of the facility opening hours. Delivery vehicles transfer waste directly into the waste bunker via one of four available tipping bays.

The waste bunker consists of the reception bunker (750m^3) and the storage bunker (4,200m^3). The storage bunker serves space for fuel required for six days continuous plant operation (or ten days, if only contract waste is considered)

3.2 Waste Combustion

Waste will be fed from the waste bunker into the furnace using a grab crane. Prior to being loaded into the furnace, waste will be stored and mixed within the waste bunker. The crane operator will mix the waste to maximise homogeneity and calorific value so as to optimise the combustion of the waste.

The combustion technology will incorporate an inclined reciprocating grate. Ash generated from combustion will drop off the end of the grate directly into a water bath equipped with a mechanical ash discharge conveyor. Combustion air will be drawn from the waste bunker and fed into the combustion chamber.

Combustion gases will pass into a secondary combustion chamber. The chamber is sized so that the products of combustion, after the injection of secondary air, remain at a temperature of at least 850°C for a minimum of two seconds. This is to ensure the efficient destruction of organic compounds and carbon monoxide. In the unlikely event that the temperature arising from the combustion of the waste on its own is not sufficient (e.g. when burning very low calorific value waste), auxiliary burners are used to maintain this temperature. In addition flue gas will be circulated from behind the fabric filter into the firing chamber in order to enhance the incineration process and lower the formation of oxides of nitrogen (NOx).

The waste feed rate, the supply of primary and secondary combustion air and the grate speed will be regulated by an advanced combustion control system which measures steam flow rate, flue gas oxygen content and combustion temperature, and controls the plant to keep the rate of steam generation constant. This ensures that:

- The boiler and generator operate at their optimal efficiency; and
- Over firing of the boiler with the consequent increase in thermal stress and corrosion as well as the risk of increased CO emissions is avoided.

The amount of heat released by the waste will vary according to its net calorific value (NCV). The automatic control system will respond to this variation by modifying the waste feed rate and the grate speed to maintain a constant heat release from combustion and hence a constant steam flow rate.

In addition to this, the combustion control will record and control the fire location and thus the burnout on the grate.

The combustion process generates NOx. In order not to exceed the emission limit for these substances, the Facility will be equipped with a NOx reduction system which will inject urea solution into the secondary combustion chamber of the furnace.

Urea acts as a reducing agent which decomposes during injection in the hot flue gas stream, initially to ammonia. The hydrogen in the ammonia then reacts with the oxides of nitrogen to produce molecules of water vapour and nitrogen. This is known as a selective non catalytic reduction process (SNCR), which is optimised at temperatures of between 850°C and 1,000°C.

3.3 Steam Generation

High pressure (43 bar) and temperature (405˚C) steam will be created by the evaporation of water in the boiler and the further heating of the saturated steam in the super-heaters.

The combustion gases will cool rapidly when passing through the boiler, maintaining heat transfer efficiency, minimising erosion and also minimising the presence of ash deposits on the tubes. The economiser sections of the boiler will reduce the gas exit temperature to the optimum required for the flue gas treatment process and preheat the boiler feed water for increased efficiency. The rapid cooling coupled with minimal ash deposits will help minimise the reformation of dioxins and furans.

3.4 Air Pollution Control

The process will use a dry APC system using hydrated lime, which will be delivered in sealed bulk powder carriers which are pneumatically emptied.

Acid pollutants HCl, SO_2 and HF will be removed by a dry scrubbing and filtration system, using hydrated lime as the reagent, to enable more energy to be recovered from the flue gas. A controlled amount of powdered activated carbon will also be injected into the flue gas upstream of the fabric filter.

The flue gases will pass through the fabric filter in which the entrained particles are trapped in the filter cake which covers the filter bags. The neutralisation reaction will be completed as the flue gases pass through the filter cake. The filter cake will be removed at regular intervals by reverse air pulses and fall into the filter discharge hoppers. A proportion of this residue will be re-circulated into the flue gas duct upstream of the fabric filter and reactivated by injection of water or steam. This increases the neutralisation reaction efficiency, thereby reducing the final quantity of un-reacted lime in the APC residue. The SO2 and HCl concentrations at the boiler outlet and at the emission monitoring points in the stack will be continuously monitored and the quantity of hydrated lime injected will be adjusted, in accordance with the difference in the concentrations of the acid gases at the two measurement points, to achieve the permitted emission limits.

The primary method of minimising the release of dioxins will be by careful control of the combustion conditions. The gas residence times and the temperatures in the combustion system are such that dioxins / furans are efficiently destroyed.

For additional removal of dioxins and furans an activated carbon injection system will be used. The activated carbon adsorbs mercury, and organic compounds including dioxins and furans. Other heavy metals such as copper and cadmium are filtered out as particulates by the fabric filter.

3.5 The Fabric Filter

The filter bags act as a foundation for the formation of a filter cake which serves as an additional reaction medium for both the acid gas neutralisation and the adsorption of heavy metals and organic compounds and provides particulate filtration. The filter cake will be periodically removed from the bags by the automatic cleaning system.

3.6 Turbine Generator and Air Cooled Condenser

The steam turbine will generate electricity from the superheated steam produced in the boiler. The superheated steam from the boiler will be expanded in a steam turbine. The expansion of the steam will deliver energy in the form of shaft power which, in turn, will be used to drive an electrical generator. Provision will be made in the design of the steam turbine for steam extraction to the existing Michelin Tyre factory network.

The Facility will use a finned-tube ACC to condense the exhaust steam from the steam turbine. In the ACC the steam will be condensed under vacuum to extract the maximum practical mechanical energy from the expansion in the steam turbine.

The ACC will consist of several sections as follows:

- Tube bundles in carbon steel with aluminium fins;
- A cooling fan system including adjustable blade pitch, frequency regulated electric motors, and direct drive reduction gear;
- Screening of the air exit openings to reduce visual impact; and
- A steel support structure.

3.7 Emissions to Water

In normal operation, the production and consumption of liquid effluent will be balanced. Boiler blowdown water or backwash water from the boiler water treatment plant will be returned to the ash quench water seal system on the boiler. During plant shut down, when the ash quench does not act as a consumer, or times of increased demineralised water production, surplus process water is discharged into the foul sewer after a treatment to ensure it meets the requirements of the discharge consent.

3.8 Incinerator Bottom Ash (IBA)

The IBA remaining after combustion equates to approximately 23% by weight (dry) of the input waste, this equates to approximately 30,000 tpa (wet), assuming a total waste throughput of 110,000 tpa.

IBA including metals will be discharged from the end of the combustion grate directly into the ash quench bath. From there, the ash will be transferred by means of an ash extraction conveyor into the ash bunker, which has a storage capacity of 4 days The bunker will have a sloping floor so that surplus quench water runs back into a collection sump and can be returned to the quench bath from time to time. The ash retains approximately 20% by weight of the water from the quench bath.

The bottom ash will be loaded by means of a travelling overhead grab crane into a collection vehicle. The vehicle will be sheeted before leaving the ash loading station.

3.9 APC Residues

The residue from the bag filter, which contains fly ash, the reaction products from the acid gas neutralisation process and activated carbon with the absorbed metals and organic compounds, is considered hazardous waste. The main reason for these residues being classified as ‘hazardous’ is their alkalinity. The APC residues are not dissimilar to cement in this respect, which is routinely transported by road in the same type of vehicles as the APC residues would be transported.

The residue will be conveyed from the filter hoppers to an intermediate storage silo. Part of the residue will be returned to the dosing system to improve the utilisation of hydrated lime.

The balance is conveyed to the residue storage silo. The silo will have a capacity of 150m3 which provides a total of 4 days' storage. The residues have a very low moisture content. The silo is vented through a bag filter to ensure there are no fugitive emissions from the system.

The APC residues amount to approximately 3.5%of the total waste by weight, which equates to approximately 4,000 tonnes annually assuming a total waste throughput of 110,000 tpa.

4 Description of the waste to be treated and its energy value

The primary purpose of the EfW CHP facility is to treat the household waste collected by Dundee and Angus Councils that has not been recycled, reused or composted (residual waste). The remaining processing capacity will be used to process similar commercial and industrial (C&I) waste from local businesses in the surrounding area. This waste will be delivered by local waste collection companies and will be restricted to waste from which recyclable and biodegradable material has already been removed.

The EfW CHP facility is designed to treat 110,000 tonnes of waste per annum at the thermal design point of 39.9 Megawatts thermal (MWth) (hourly throughput of 13.725 tonnes per hour (tph)) with a Lower Calorific Value (LCV) of 10.5 Megajoules per kilogram (MJ/kg) and an availability of 91.3% (equal to 8,000 full load operational hours per year). Under low CV conditions the mechanical throughput could be as high as 18.750 tph.

4.1 Electricity

On average approximately 10MWe is generated by the steam turbine, of which 1.3MWe is consumed by the plant as the parasitic load, leaving 8.7MWe as the net electrical output for export to Michelin and the Scottish and Southern Energy distribution network. A drawing showing the route of the cable connections can be seen at Figure x of the ES.

4.2 Steam

On average approximately 10 MW of steam will be exported to Michelin for use within their factory for production and heating purposes. A new pipeline will be installed to connect to the existing heat distribution system and some existing pipework will need to be replaced. A separate planning application will be made for the steam connection once the arrangements have been agreed with Michelin.

Michelin has provided MVV with a steam demand forecast for 2020 of approximately 85,000 MWh per year. Based on an anticipated availability of the EfW CHP of 90% it is expected to export approximately 76,000 MWh medium pressure steam to Michelin.

According to the efficiency calculation examples of the Thermal Treatment of Waste Guidelines 2014 using the gross CV as energy input the proposed EfW CHP plant will have a power efficiency in power only mode of 20.1% and an overall efficiency of 36.2% in CHP mode when exporting 76,000 MWh steam to Michelin. Both operation modes will fulfil SEPA’s requirements of minimum 20% power efficiency in power only mode and the overall efficiency target of 35% in CHP mode.

By taking steam from MVV's EfW CHP facility, Michelin will be able to place their boilers, which are currently gas fired, on standby mode; and to be kept warm using steam, and only used when the Energy from Waste Combined Heat and Power facility is not producing energy.

5 Heat and Power Plan

The location of the EfW CHP facility on Forties Road was agreed with Dundee and Angus Councils in order to enable the facility to meet the requirement for new energy from waste facilities to operate at maximum efficiency as Combined Heat and Power plants. The location on Forties Road enables the proposed facility to provide steam and electricity directly to Michelin enabling them to receive energy at more economical prices and in a more sustainable form than if they were to generate it themselves or to buy it from the grid.

MVV have entered into discussions with Michelin and have agreed principles of a technical solution for the delivery of energy from the proposed EfW CHP facility to Michelin. The commercial terms for the supply of energy have still to be agreed. A separate planning application will be submitted for the energy connection. It is intended that the energy from the proposed EfW CHP facility would be supplied to Michelin as soon as the facility is commissioned.

Dundee City Council is investigating the possibility of developing a heat network around the city linking together the two universities; Ninewells hospital and the Energy from Waste facility at Baldovie so that they can distribute heat to industrial, commercial and residential premises in the city. The City Council held a conference at the Discovery Centre in Dundee on Friday June 2016 which MVV attended. Progress on the implementation of the citywide heat project is dependent on the development of a distribution network.

If a heat distribution network is available, and there is surplus power after supplying Michelin, MVV would be willing to work with the city council to use the surplus energy to heat the proposed housing in Whitfield which is being constructed with infrastructure for the use of hot water.

The applicant is therefore actively seeking to operate the proposed facility in CHP mode from the outset and explore further opportunities to maximize the energy saving opportunities the project presents. The CHP component of the facility will therefore make a major contribution to the strategic and local economic objectives of the City of Dundee, helping to safeguard existing jobs and to attract new jobs.