Energy from Waste, Combined Heat and Power Facility

North Yard, Devonport

Environmental Permit Application (Application EPR/WP3833FT/A001)

Energy Management Report

June 2011

Prepared for

MVV Environment Devonport Ltd

Revision Schedule

Energy Management Report
June 2011

Rev	Date	Details	Prepared by	Reviewed by	Approved by
01	Feb 2011	Initial Draft	**Andrew Oliver** Consultant	**Angela Graham** Principal	**Mike Nutting** Associate
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Where field investigations are carried out, these have been restricted to a level of detail required to meet the stated objectives of the services. The results of any measurements taken may vary spatially or with time and further confirmatory measurements might need to be made after any significant delay in issuing this Report.

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1 Report Context

Scott Wilson Ltd has been commissioned by MVV Environment Devonport Ltd (MVV hereafter) to prepare an application for an environmental permit for an Energy from Waste, Combined Heat and Power Facility located at Devonport Dockyard, Plymouth (Devonport EfW/CHP hereafter).

Within the Site, as defined in planning terms, and the Installation, as defined in permitting terms, the proposed facility will comprise:

- Tipping Hall;
- Waste Bunker Hall with Waste Handling Cranes;
- Bale Store/Baling System;
- Turbine Hall with Steam Turbine Generator;
- Boiler House with Grate, Boiler and Ancillary Systems;
- Flue Gas Cleaning System and Chimney;
- Air Cooled Condensers;
- Water Treatment Plant;
- Bottom Ash Handling System.
- Administration Block; and
- Workshop and Stores

This report has been prepared to support an application for an environmental permit and details the energy management arrangements proposed for the site. The report should be read in conjunction with the other supporting application reports and risk assessments.

2 Plant Design Aspects

2.1 Introduction

The proposed facility is designed to deliver combined heat and power (CHP) in line with Government Policy which encourages the application of CHP wherever possible.

CHP will be implemented as outlined below.

2.2 Steam Supply To External Users

2.2.1 Steam Supply to Naval Base North Yard

The EfW CHP facility is already designed to deliver steam into the Naval Base North Yard steam system. This supply is economically viable and will be implemented from the outset of the project under the Good Quality CHP Scheme, using Renewable Obligation Certificates (ROCs hereafter) as an additional source of income to the project company. The steam will be purchased by Devonport Royal Dockyard Limited (DRDL) for use within buildings in the so called North Yard and the Fleet Accommodation Centre (FAC).

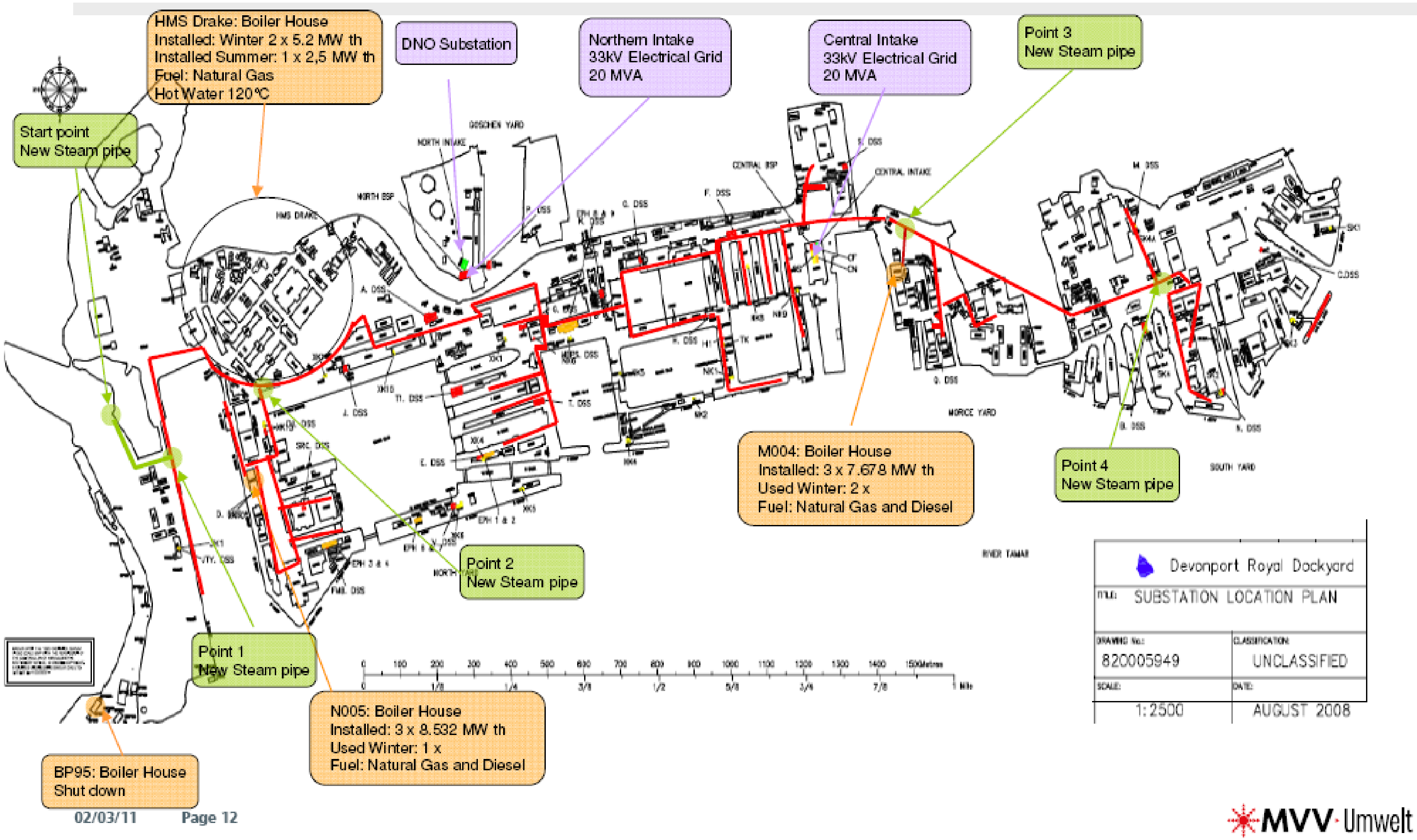
The system is designed to allow varying rates of steam extraction from the steam turbine casing at 9bar. The steam provided will be used to:

- Displace steam generated by the existing North Yard boilers which run on natural gas and occasionally on distillate oil during times of gas supply disruption. Steam supply will be during the winter months only when heat is required.
- Additionally steam will be used to also supply the Fleet Accommodation Centre (FAC) with heat which currently uses natural gas. The heat demand in the FAC is throughout the whole year with a peak in the winter months.

The existing North Yard boilers and infrastructure will be used during periods of EfW CHP unavailability, however, plant maintenance shutdowns at the EfW CHP facility will be arranged to coincide with the period of low demand thus reducing the need for using the existing North Yard boilers to a minimum.

The steam and electricity infrastructure in the dockyard is shown in figure 1 on the next page. The new steam pipeline arrangements are shown in green on this plan.

Figure 1


HMS Drake: Boiler House
Installed: Winter 2 x 5.2 MW th
Installed Summer: 1 x 2,5 MW th
Fuel: Natural Gas
Hot Water 120°C
DNO Substation
Northern Intake
33kV Electrical Grid
20 MVA
Central Intake
33kV Electrical Grid
20 MVA
Point 3
New Steam pipe
Start point
New Steam pipe
M004: Boiler House
Installed: 3 x 7.678 MW th
Used Winter: 2 x
Fuel: Natural Gas and Diesel
Point 4
New Steam pipe
Point 2
New Steam pipe
Point 1
New Steam pipe
N005: Boiler House
Installed: 3 x 8.532 MW th
Used Winter: 1 x
Fuel: Natural Gas and Diesel
BP95: Boiler House
Shut down
Devonport Royal Dockyard
SUBSTATION LOCATION PLAN
820005949
UNCLASSIFIED
1:2500
AUGUST 2008
02/03/11
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In assessing the potential for steam supply to DRDL, detailed data provided by them for the dockyard from April 2007 to March 2010 was analysed by MVV. This data is shown in table 2.1.1 below.

Table 2.1.1 Electricity and Gas Consumption within the Dockyard (April 2007 - March 2010)

Month	Electricity Consumption (kWh)			Natural Gas Consumption (kWh)	
	North Yard	South Yard	FAC	DRDL Gas	FAC Gas
Apr 2007	11,266,099.8	552,935.7	798,145.0	9,782,870.0	1,176,754.0
May 2007	11,082,660.1	592,467.7	779,441.0	4,634,300.0	722,472.0
Jun 2007	10,757,671.7	560,858.1	746,191.0	2,574,613.0	452,670.0
Jul 2007	12,605,294.8	567,793.8	769,606.0	1,882,042.0	649,527.0
Aug 2007	14,833,985.3	540,676.5	689,877.0	1,479,807.0	518,425.0
Sep 2007	12,052,447.9	538,710.1	744,501.0	1,515,992.0	590,509.0
Oct 2007	12,556,763.2	608,071.8	853,943.0	4,888,666.0	1,648,519.0
Nov 2007	11,211,843.6	666,722.1	855,384.0	10,894,060.0	1,648,519.0
Dec 2007	14,221,755.8	671,494.4	828,759.0	13,480,983.0	1,648,519.0
Jan 2008	15,162,534.7	764,288.1	800,236.0	14,330,776.0	1,648,520.0
Feb 2008	11,501,067.0	723,644.1	829,230.0	13,005,766.0	1,758,487.0
Mar 2008	12,619,960.8	698,597.9	821,873.0	13,024,828.0	2,004,503.0
Apr 2008	11,390,056.0	631,669.0	801,571.0	11,103,175.0	1,404,520.0
May 2008	11,467,975.0	553,159.0	763,092.0	2,888,485.0	578,728.0
Jun 2008	10,067,163.0	527,775.0	741,234.0	735,290.0	517,512.0
Jul 2008	10,857,774.0	560,631.0	779,644.0	827,345.0	439,091.0
Aug 2008	14,613,082.0	538,327.0	690,897.0	911,039.0	321,917.0
Sep 2008	10,240,792.0	577,996.0	746,117.0	944,818.0	500,136.0
Oct 2008	11,402,797.0	656,351.0	824,461.0	4,079,697.6	1,178,894.8
Nov 2008	11,509,478.0	656,515.0	822,786.0	12,008,152.8	1,403,675.1
Dec 2008	13,410,935.0	652,233.0	815,368.0	14,443,398.6	1,801,113.9
Jan 2009	12,434,598.0	653,427.0	869,355.0	15,107,455.6	2,478,671.9
Feb 2009	11,069,868.2	605,991.4	805,555.0	13,039,413.3	1,927,654.8
Mar 2009	10,208,217.0	636,983.0	843,793.0	12,553,741.3	1,667,763.3
Apr 2009	10,803,744.0	558,295.0	771,498.0	9,524,355.0	1,303,317.9
May 2009	11,046,933.0	514,989.0	779,088.0	3,506,694.4	659,288.3
Jun 2009	9,386,584.0	490,780.0	744,690.0	1,612,731.6	392,864.2
Jul 2009	10,646,833.0	533,084.0	778,356.0	1,693,074.0	440,732.0
Aug 2009	14,382,825.0	475,199.0	695,645.0	2,355,925.0	397,211.9
Sep 2009	11,376,194.0	465,837.0	769,969.0	1,857,034.0	457,394.2
Oct 2009	12,650,245.0	565,964.0	831,455.0	2,784,518.0	907,235.9
Nov 2009	12,710,508.0	596,950.0	841,203.0	10,956,930.8	1,346,405.3
Dec 2009	15,410,485.0	621,816.0	817,360.0	14,030,644.0	1,310,769.4
Jan 2010	14,819,659.0	746,818.0	906,793.0	15,361,951.0	3,184,906.9
Feb 2010	11,381,850.0	677,257.0	800,862.0	12,186,506.9	2,066,121.4
Mar 2010	12,677,183.0	705,652.0	849,598.0	9,922,826.7	2,012,500.0

MVV has analysed this data and calculated that the annual gas demand of the combined North and South Yard boiler and FAC system is 103,000,000 kWh. Of this, approximately 14% (14,420,000 kWh) is due to the FAC. With the EfW CHP facility in operation the savings in the North Yard boilers and the FAC will amount to 82,200,000 kWh per annum of natural gas and 15,194.67[1] tonnes of Carbon Dioxide in carbon dioxide emissions, i.e. a reduction of some 90%. Overall the annual energy bill for the Dockyard and Naval Base will be reduced by approximately 20% per annum; commercial savings in terms of heat and power are estimated to be £1,900,000 per annum which will also lead to savings for the taxpayer. The entire commercial arrangements are covered by contracts between MVV, the Ministry of Defence (MOD) and Devonport Royal Dockyard Limited (DRDL) (a division of Babcock International), who own and manage large parts of the dockyard on behalf of the MOD. These arrangements are commercially confidential but the term of the contracts cover the life of the PFI contract with SWDWP (25 years). In these contracts MVV has reserved a heat delivery capacity of 23.3 MW for MoD and DRDL.

The steam system throughout the Naval Base has been built up over time as the Naval Base has expanded. It is owned and maintained by DRDL under their agreements with the MOD. The existing system requires certain areas to be upgraded, notably the most northern 60% of North Yard central spine (see Figure 2).

Figure 2

This upgrading will be completed by MVV at a total cost of approximately £1.5 million prior to handing over to DRDL thus meaning that the MoD and DRDL will benefit from reduced upkeep and maintenance costs associated with both the reduced requirement of steam boilers and the upgrade of existing steam pipe work. The system also includes a sub-system of pipes to return condensate back to the boilers. To minimise usage of raw water this condensate system will be fed into the EfW CHP facility where it will be cleaned up. DRDL will also carry out various boiler upgrade works to ensure that condensate return quality is maintained. All of the upgrading work will create additional job opportunities for the local mechanical engineering resource base, in addition to those created by the EfW CHP facility itself. Financial savings in the Dockyard and Naval Base will also help to create a sustainable business, which contributes to saving jobs and creating new employment opportunities.

[1] The conversion factor required to convert natural gas in kWh to CO_2 (kg CO_2 per unit) was sourced from the 2010 Guidelines to Defra/DECC's GHG Conversion Factors for Company Reporting (Defra 2010). The conversion factor required is shown in Table 1c as 0.18485. The result was converted from kg CO_2 per unit to tonnes CO_2 per unit by dividing by 1000.

2.2.2 Steam Supply to Naval Base South Yard

The South Yard (which term for these purposes includes also Morice Yard) also has a steam demand but this is quite small. The gas demand of the South Yard boiler is approximately 14,400,000 kWh per annum compared to the combined North Yard and FAC system demand of 88,600,000 kWh. In order to supply this steam from the EfW CHP facility location in the North Yard there will need to be some extensive enlargement of the central steam system that carries steam from north to south. Given the low demand in the South Yard this is not economically justified at this time so the South Yard will continue to be supplied with its steam from the existing boilers there. In the future the South yard could also be the location for a smaller CHP facility, possibly gas fired or if the local transport network allows, biomass fuelled, linked to the DH system.

2.2.3 Extension of Naval Base Steam System

Whilst activity in the North Yard may reduce over the longer term the South Yard is seen by the MOD as an area in which additional commercial activities will take place and may provide the opportunity to extend the heating system.

A recent example is the location of Princess Yachts who manufacture large recreation yachts. The manufacturing process requires heat throughout the year which might be supplied by the EfW CHP facility. Any additional demand will require the replacement of the central pipe work between North Yard and South Yard which under current South Yard demand is not considered viable. The estimated cost of this is between £1 million and £5 million, depending on the extent of upgrading required. In the future sufficient additional loads from within the South Yard, or from the nearby Devonport district of Plymouth (as identified by Plymouth City Council – see below) might mean that the connection upgrade to the South Yard becomes a viable project. The commercial supply of heat will be the subject of individual discussions with each off taker but the tariffs will clearly need to provide a commercial incentive to the off takers and as such are likely to be similar to those agreed with MoD and DRDL.

In the shorter term additional developments planned for the Naval Base will be able to be connected to the existing steam supply network. These include:

- Devonport Landing Craft Co- location Project;
- Help For Heroes' Accommodation Block; and
- Help for Heroes' Swimming Pool

The connections for these projects will be built from the outset of the EfW CHP project and thus will enable these projects to enjoy the same benefits of lower energy and maintenance costs, and more sustainable energy supply, from the outset of the EfW CHP facility coming on line.

2.2.4 Extension Beyond Naval Base

The EfW CHP facility has not been designed at this stage to deliver pressurised hot water, although this can be done in the future with changes to the steam turbine and the water-steam-cycle system. Depending on the additional demand such modifications may be quite minor in nature. These are not likely to require a change to the proposed building envelope, although if hot water storage is required this will require a new building or tank. Any District Heating (DH) system will require additional pipe connections to the EfW CHP facility to run through MOD and DRDL land.

Any additional heat load in the vicinity of the EfW CHP facility not close to the Naval Base and capable of being connected to the existing steam distribution system can only be supplied within a DH system. The surrounding terrain makes it almost impossible to deliver steam because it is very hilly and will therefore cause high transportation losses. Also the distances involved make it difficult to deliver steam.

2.3 Energy Export Potential

Electrical Power will be exported and sold under three separate arrangements which are outlined below.

2.3.1 Export via Distribution Network Operator (DNO)

This will be achieved by exporting to the DNO 33 kV grid under a PPA with 24/7 Energie Trading GmbH.

MVV has studied the electrical distribution system in the Devonport area, and has determined that the full generating capacity of the EfW/CHP Facility could be exported into the DNO system by connection to the DRDL system via a private wire connection, such that the dockyard appears on the DNO system as a generator.

It is envisaged that power supplied into the DNO grid will be sold as standardised market bilateral OTC trades under a long term power purchase agreement.

2.3.2 Power Exchange via Distribution Network

Power exchanged (import and export) through the Distribution Network will be undertaken using the ELEXON settlement mechanism set out in the Balancing and Settlement Code. This allows all power not in compliance with standardised market products, which would otherwise cause a trade imbalance at the DNO connection, to be managed via the regulated system.

2.3.3 Power to Devonport Royal Dockyard Limited (DRDL)

DRDL itself has a significant power demand, which has been confirmed could be supplied in full for most of the time by the EfW/CHP facility. It is envisaged that the Devonport EfW/CHP facility will provide power to DRDL and the MOD using a private-wire connection under the terms of a 25 year Energy Services Agreement (ESA hereafter) between MVV, DRDL and the MOD.

2.3.4 Heat to Devonport Royal Dockyard Limited (DRDL)

Heat will also be sold to DRDL under the same ESA for power sales. The heat will be sold as steam at the same pressure and temperature supply conditions as is presently used by DRDL in the dockyard steam distribution system.

Steam will be supplied directly to the DRDL steam system within the naval base, close to 14 Wharf. In order to meet the connection requirements, a study has identified that a substantial part of the present steam system main spine will need to be replaced with larger capacity piping. This work will be carried out by MVV and handed over to DRDL, who will then assume responsibility for ongoing maintenance. The solution will also enable DRDL to decommission one of their main boiler-houses, thus saving maintenance and fuel costs, and put the other into standby mode.

The dockyard heat demand will include the Fleet Accommodation Centre (FAC), which is presently heated by hot water. A new heat-exchanger will be provided (by MVV) which will use steam energy to heat water (a commonly used process), and replace the current FAC gas fired boilers. The demand in the South Yard of the dockyard is considered insufficient to justify an upgrade of the spine in this area, and so the South yard steam system will be isolated from the rest of the system by a dedicated valve, and supplied solely from the existing boilers in that area.

2.4 District Heating Opportunities

2.4.1 District Heating In Plymouth

There are presently no DH systems in Plymouth. Such systems are expensive to build and normally need a significant heat demand to be viable. Only two significant waste fired systems exist in cities in the UK; in Nottingham and in Sheffield. Both systems were originated as council led schemes in the 1970s and were expanded over the following decades. These days both systems are owned by limited liability companies; in the case of Nottingham the company is owned by the city council, and in Sheffield the company is owned under the terms of a PFI agreement by a French firm which is part of the Veolia group. Other gas fired systems exist, e.g. in Southampton.

Energy Service Companies (ESCos) can be set up as joint ventures between local authorities and the private sector. In 2009 Plymouth City Council (PCC), South West Devon Waste Partnership (SWDWP), Devonport Regeneration Community Partnership (DRCP) and RegenSW commissioned ICE (UK) Ltd to undertake a commercial feasibility study into the development of several low carbon district energy schemes in Plymouth utilising Good Quality Combined Heat and Power ("CHP") as an initial low carbon foundation technology. See: http://www.plymouth.gov.uk/feasibilitystudyforesco.htm

The study was published in January 2010 and examined the setting up of an ESCo in Plymouth, as a vehicle for developing up to three DH systems in south Devonport (that area of the city, rather than the Naval Base), the city centre and around Derriford Hospital. Since then the Plymouth District Energy Procurement Partnership, which consists of Plymouth City Council, the University of Plymouth and the Plymouth Hospitals NHS Trust has initiated a joint procurement for the services of an Energy Service Company to finance, design, build and manage a District Energy Network. The first step has been a Market Testing exercise for which submissions were due at the start of April 2011.

MVV's ultimate parent company is Germany's third largest operator of DH systems and is well placed to assess the viability of any DH systems in Plymouth. MVV has reviewed the above study report and believes that subject to further detailed analysis such DH systems as envisaged in the report can be established and maintained independently of each other, or could, eventually, be interconnected. Whilst according to the study the heat source is envisaged to be a mixture of fossil (e.g. natural gas) or biomass fuels, the latter can also include heat from the EfW CHP facility, especially for the Devonport and the city centre schemes.

There are significant benefits of being part of a wider network including greater resilience, maximising efficiency, greater flexibility, and backup facilities for maintenance, and MVV believes further DH systems in Plymouth will add significantly to the City's targets of reducing its carbon footprint. There are three separate areas in which MVV intends to be involved in DH systems:

- The Devonport/city centre DH systems being considered by PCC and referred to above. MVV has already submitted a response to the market testing exercise carried out by the Plymouth District Energy Procurement Partnership mentioned above and will continue to pursue this opportunity and participate in any formal procurement activity instigated by the Partnership.
- A smaller residential system for the housing association and privately owned properties immediately close to the EfW CHP facility site in Barne Barton.
- Similar residential systems as for Barne Barton but in the Keyham, St Budeaux, Devonport and Weston Mill areas.

For reasons stated below it is not possible to state specific numbers but there will be savings in the above areas in terms of the kWh per annum of natural gas consumed and the saving in CO_2 emissions.

2.4.2 ESCo-based District Heating Systems

The ESCo-based District Heating Systems will be taken forward by the Plymouth District Energy Procurement Partnership through a market testing exercise to test the private sector's appetite for involvement and then, perhaps, a competitive tendering procedure to select a private sector partner.

The market testing exercise started in February 2011. MVV has taken part in the market testing exercise independently of its involvement in the SWDWP project. At this stage it is not possible to predict the outcome of this exercise nor to make any commitments to the implementation of any DH system. Any DH system will, regardless of promoter or heat source, require separate planning permission before it can be constructed.

From a commercial point of view the supply of heat to all customers will be somewhat cheaper than gas or electricity fed systems, with the latter being particularly expensive. It will also be possible for the tariffs to be adjusted only to normal inflation, eg the Retail Prices Index, rather than be subject to the volatility inherent in the gas and electricity markets which gain much public attention, especially when prices rise steeply. However, the quid pro quo for such attractive heat pricing is that customers are required to enter into long term contracts. For residents of housing associations or sheltered accommodation this may not present a problem as the supply contract is likely to be with the landlord, but for private property owner-occupiers there may be some reluctance to give up their current ability to switch between suppliers of energy. This therefore represents a real commercial issue which needs to be overcome, for if the cost of the DH system is not covered by a reliable and long term income stream then investors in the scheme may not be forthcoming, especially from the private sector.

2.4.3 Potential for District Heating in Barne Barton

The Barne Barton area is the closest residential area to the EfW CHP facility. It comprises mainly residential flats and houses, with a few shops and schools. There are no significant commercial or industrial premises. Many of the flats are owned by housing associations.

As such the heat demand of the area has typical characteristics of UK residential heat demand, i.e. strong seasonal variations and also diurnal (i.e. twice daily) variations in heat demand. This means that the DH system has to be designed to cater for peak flows, plus a margin of error, which in turn means that for a large part of the time the system is not operating at its full capacity.

The implementation of a DH system also depends on the nature of heating in individual residences. Based on preliminary investigations MVV understands that whilst many residences are heated by traditional gas fired hot water systems several, including the blocks of flats closest to the EfW CHP facility, are heated by electricity, with storage heaters. In order to benefit from any DH system such residences will need to be fitted with new hot water systems which will add to the financial burden of any project and reduce its viability as well as causing significant disruption to the occupiers of property during the installation.

MVV will continue to investigate an appropriate size DH system for Barne Barton, and will present its findings as soon as possible. MVV has already contacted the relevant housing associations and requested technical information with which to begin a more detailed assessment. Further discussions with the relevant associations will be held in the Summer of 2011. The close proximity of residences to the EfW CHP facility will make it cheaper to build the necessary pressurised hot water system but the small heat demand presented by those residences may not make the scheme viable. MVV will therefore examine how far away from the EfW CHP facility additional residences will need to be connected in order to achieve the best balance between increasing heat load and increasing cost of a DH system.

From a commercial point of view the supply of heat to residences will be somewhat cheaper than gas or electricity fed systems, with the latter being particularly expensive. This will help with fuel poverty and affordable warmth issues. It will also be possible for the tariffs to be adjusted only to normal inflation, e.g. the Retail Prices Index, rather than be subject to the volatility inherent in the gas and electricity markets which gain much public attention, especially when prices rise steeply. However, the quid pro quo for such attractive heat pricing is that customers are required to enter into long term contracts. For residents of housing associations or sheltered accommodation this may not present a problem as the supply contract is likely to be with the landlord. In the Barne Barton area, a large proportion of the housing stock is affordable housing and is therefore potentially easier in terms of the commercial issues. For private property owner-occupiers there may be some reluctance to give up the current ability to switch between suppliers of energy. This therefore represents a real commercial issue which needs to be overcome, for if the cost of the DH system is not covered by a reliable and long term income stream then investors in the scheme may not be forthcoming, especially from the private sector.

2.4.4 Potential for District Heating in Keyham, St Budeaux and Weston Mill

The same statements made above for Barne Barton apply to the areas of Keyham, St Budeaux and Weston Mill, except that the cost of the infrastructure will be higher, and there are some small commercial and industrial demands. However, the heat demand and cost balance may be more difficult to achieve and so make such schemes less viable. Additional future heat demand from developments such as the proposed Weston Mill District Centre will make such a DH scheme more likely to be viable. MVV will investigate a DH system in these areas. The areas of scoping work need to be agreed as it will be important to understand the feasibility of opportunities (in both technical and commercial terms) for supplying heat to existing or proposed developments in the vicinity, so that these can be facilitated or future proofed.

2.4.5 Advantages and Disadvantages of District Heating Compared To Thermal Insulation

The main advantages and disadvantages of implementing a DH scheme compared to thermal insulation of properties are listed in Table 2.4.5 below.

Table 4.5.5: Advantages and disadvantages of DH compared to thermal insulation of properties

	District Heating	Insulation only
Advantages	1) From a commercial point of view, linking up with the local residences provides an additional revenue stream to MVV. 2) For customers, a DH system has the potential to provide a cheaper source of heat in comparison with gas or electricity fed systems. 3) DH provides a degree of energy security and will not be subject to the volatility inherent in the gas and electricity markets 4) The close proximity of residences to the EfW CHP facility will make it cheaper to build a DH system. 5) Much greater efficiencies can be achieved in the system compared with conventional means of space heating. 6) Eligibility for RHI funding and ROCs (see section 7.1 for details regarding the interaction between two schemes).	1) In terms of the cost of carbon abatement, insulating buildings is recognised as one of the cheapest and most cost effective solutions. 2) Payback times are relatively short.
Disadvantages	1) The fact that several flats are heated by electricity, with storage heaters, means that those residences will require new hot water systems, so that they are compatible with the system, which will add to the financial burden of any project. 2) The heat demand of the residences needs to be quantified, as there is a risk that the demand will be too low to make the scheme viable. 3) Private property owner-occupiers may be reluctant to give up the current ability to switch between suppliers of energy. This represents a real commercial issue which needs to be assessed and overcome. 4) Providing heat from EfW CHP is one of the more expensive options for renewable heat generation under current market conditions. However, given the current surplus of heat already generated by the plant, this may not be the case in this instance (DECC, 2009)	1) It is possible that reaching similar carbon abatement levels as that offered by a DH scheme will be very expensive in aging properties particularly. 2) Some of the houses in the area have solid walls. Solid wall properties are more difficult and expensive to insulate efficiently. For these properties there will be an increased cost associated with ensuring they are adequately insulated. 3.) With increased insulation the venting (circulation of air) is very important otherwise the building can mould

The main explanation for the low penetration of district heating systems in the UK to date is the comparatively higher cost of installing such systems. Nevertheless, there are some combinations of fuel sources and building types that can reduce the relative cost. For example (DECC, 2009):

1) Where the DH uses waste heat from a conveniently located power station, since the heat is produced at a low marginal cost (i.e. in the case of the MVV EfW CHP facility).

2) Where DH replaces electric heating systems.

3) Where DH is supplied to high rise flats, commercial areas, or high heat density areas.

"Even without financial subsidies and regulation DH could replace electric heating systems purely on economic grounds" (DECC, 2009).

Ensuring properties are adequately insulated prior to implementing a DH network guarantees that the network can be correctly sized and constructed. If the DH network is installed without insulation and this is subsequently upgraded then there is a risk that the DH network will provide heat surplus to requirements by the residences. District heating networks have the potential to reduce utility bills and shield customers from the volatility of the electricity and gas markets. Replacing the heating systems of those residences that heat their houses using electricity increases the attractiveness of the DH network.

In summary there is certainly merit in considering the implementation of a DH network as opposed to a strategy that upgrades the insulation of the existing building stock. The viability of the scheme requires a further and more detailed feasibility assessment, which draws on data relating to the abatement cost of the two options.

MVV has examined the condition assessments of the nearby properties in Barne Barton undertaken by Plymouth City Council and will take these into account when making its final assessment of the viability of a DH system supplying Barne Barton.

2.5 Renewable Obligations Qualification

The Government has provided the opportunity for EfW/CHP facilities such as Devonport to qualify for certain benefits under the Good Quality CHP Scheme, notably ROCs, which effectively provide a premium price on the sale of all net electricity generated.

Under the Good Quality CHP Scheme (CHPQA scheme) the methodology for assessing the quality of schemes is based on energy efficiency and environmental impact, and defines threshold criteria for 'Good Quality CHP', notably the Power Efficiency (PE) and the Quality Index (QI). Most schemes are expected to meet the threshold criteria, but where either or both the PE or QI Threshold Criterion is not met, then only a portion of scheme fuel input or power output qualifies as Good Quality CHP.

The proposed Devonport EfW/CHP system will be designed to meet the CHPQA criteria, and as such should qualify for ROCs. For each level of steam demand, the gross electrical power output has been calculated by means of a thermodynamic model using Thermoflow software. Using specified equivalent availability levels, the electrical output of the EfW/CHP facility is compared to the demand of the Dockyard on an hourly basis, and the parasitic load of the facility is then deducted from the output figure.

In respect of the electrical output of the facility and the determination of the Quality Index (QI), the proposed thermal input of the facility is 82.1 MW_{th} although this can be affected by waste composition and the calorific value (CV). The basic data pertaining to the steam supply arrangements at Devonport EfW/CHP, and the corresponding QI, are summarised in Table 2.5 below:

Table 2.5: Summary of Data Relevant to ROCs and QI Calculation

Parameter	Unit	Full Supply
EfW/CHP Gross Production	MWh/a	181,668
Parasitic Load	MWh/a	20,419
Electrical Power Demand, Dockyard	MWh/a	163,000
Electrical Power Supplied from EfW	MWh/a	141,486
Electrical Power External for Dockyard	MWh/a	22,232
Electrical Power Surplus EfW for Market	MWh/a	20,502
Heat Demand, Dockyard	MWh/a	75,429
Heat Supply, EfW/CHP	MWh/a	75,429
Gas Demand 2008	MWh/a	88,180
Gas Demand with EfW	MWh/a	0
ROC Calculations		
Power Efficiency	%	24.42
Heat Efficiency	%	10.14
Quality Index	-	104.55
ROCs Granted	-	80,994

In the case of the EfW CHP facility, being fuelled by waste, the QI has to be at least 100 in each operational year. At the design stage the QI has to be between 100 and 105. Under the current design the proposed EfW CHP facility has a QI of 102 and therefore has been accepted and registered as a project under the Good Quality CHP Scheme (see registration certificate enclosed at Appendices A and B).

3 Plant Energy Requirements

3.1 Basic Energy Consumption Requirements

3.1.1 Energy Supply

The EfW Facility energy requirements include:

- Electrical power primarily generated on-site;
- Parasitic load met from the public supply at times when the EfW/CHP facility is non-operational;
- Heat generated on-site; and
- Gas oil which will be used as an auxiliary fuel to facilitate start-up or maintenance of combustion temperature above the WID requirement of 850^{O}C.

3.1.2 Energy Export

The EfW/CHP facility will be a net producer of:

- Electricity, which will be sold directly to the local DNO supply network or to support DRDL and MOD operations; and
- Heat, which will be supplied to support DRDL and MOD operations.

3.1.3 H1 Assessment of Energy Consumption

An assessment of the energy consumption for the site using the EA's H1 software was completed, based on 7884 operating hours per year, the thermal design throughput of 82.1 MW and accordingly the design Waste Calorific Value of 9.5 MJ/kg and respectively 245,000 t/a waste throughput. The plant operating characteristics in this assessment reflect the expected annual steam demand profil for the CHP mode. This assessment is summarised in Table 3.1 below:

Table 3.1: Annual Energy Consumption (based on design figures)

Energy Source	Delivered MWh	Primary MWh		% Total Utilised Energy	Specific Energy Consumption (MWh/Te waste)	Emissions CO_2 Te/yr
		Generated	Used			
Electricity (public supply)	350	-	840	0.59	0.0034	139
Electricity (site generated)	-	181,688	19,701	13.73	0.0804	0
Heat (site generated)	-	178,901	103,472	72.14	0.4223	0
Gas Oil (Auxiliary Fuel)	19,418		19,418	13.54	0.0793	4,855
TOTAL	**19,761**	**360,589**	**143,431**	**-**	**0.5854**	**4,994**
Heat (site generated)	**-**	Exported	75,429	N/A	N/A	N/A
Electricity (site generated)	**-**	Exported	161,987	N/A	N/A	N/A

3.1.4 Specific Energy Consumption (SEC)

There is no specific industry benchmark set within SGN S5.01 regarding the SEC for waste incineration processes. The BREF Guidance Document for Waste Incineration does provide some reference data, and this is summarised in Table 3.2 below:

Table 3.2: BREF Specific Energy Consumption for Waste Incineration

Energy	Minimum MWh/Te Waste	Average MWh/Te Waste	Maximum MWh/Te Waste
Electricity	0.062	0.142	0.257
Heat	0.021	0.433	0.935

The specific energy consumption for the Devonport EfW/CHP facility has been calculated to be around:

- 0.080 MWh/Te for electricity;
- 0.422 MWh/Te for heat; and
- 0.502 MWh/Te for total demand.

The specific electrical Energy Consumption for the Devonport EfW/CHP facility is much below the BREF average and very close to the BREF minimum value. This reflects the High Efficiency Concept of the facility with a reduced Parasitic Load. The specific Heat Consumption is below the BREF average and related to the heat demand of the multistage air preheating system of the boiler that is also part of the High Efficiency Concept.

The overall specific Energy Consumption compared to the BREF data does not reflect fully the High Efficiency Concept of this facility as multistage air preheating is evaluated with a high Heat Consumption. But a multistage air preheating system is an essential part of the High Efficiency Concept and necessary for a robust NOx control.

The outstanding Energy Efficiency is more reflected in the R1 Evaluation. The Devonport EfW/CHP facility archives a R1-factor of 0.95 in Full Power Mode and 1.01 in CHP Mode. These results are much above the necessary R1-factor of 0.65 that is required for new developments. Most of the newer average UK EfW facilities are around 0.65 to 0.70.

3.1.5 Energy Balance

The predicted energy balance for the facility is summarised below in Table 3.3a for CHP Operation and Table 3.3b for Electrical Production only. These tables show the significant energy recovery, utilisation and loss from each stage of the process. The energy balance information has been taken from the plant design data based on the total capacity of the plant.

Table 3.3a: Energy Balance for EfW in CHP Mode

Main Process			
Energy In		**Energy Out**	
Waste Input	82.1	Flue Gases	7.1
		Radiation Losses	0.7
		Ash Losses	1.2
		Waste Heat ACC	30.5
		Electrical Output	19.3
		CHP Heat Output	23.3
TOTAL	**82,1**	**TOTAL**	**82.1**
Energy Generation			
Electricity Generation		**Electricity Use**	
Electricity Generated	19.3	Electricity Exported	16.8
		Parasitic Power To Site	2.5
Heat Generated	22.69	Heat Own Use	9.57
		Heat Exported	13.12
TOTAL	**41.99**	**TOTAL**	**41.99**

Table 3.3b: Energy Balance for EfW in Electricity Only Mode

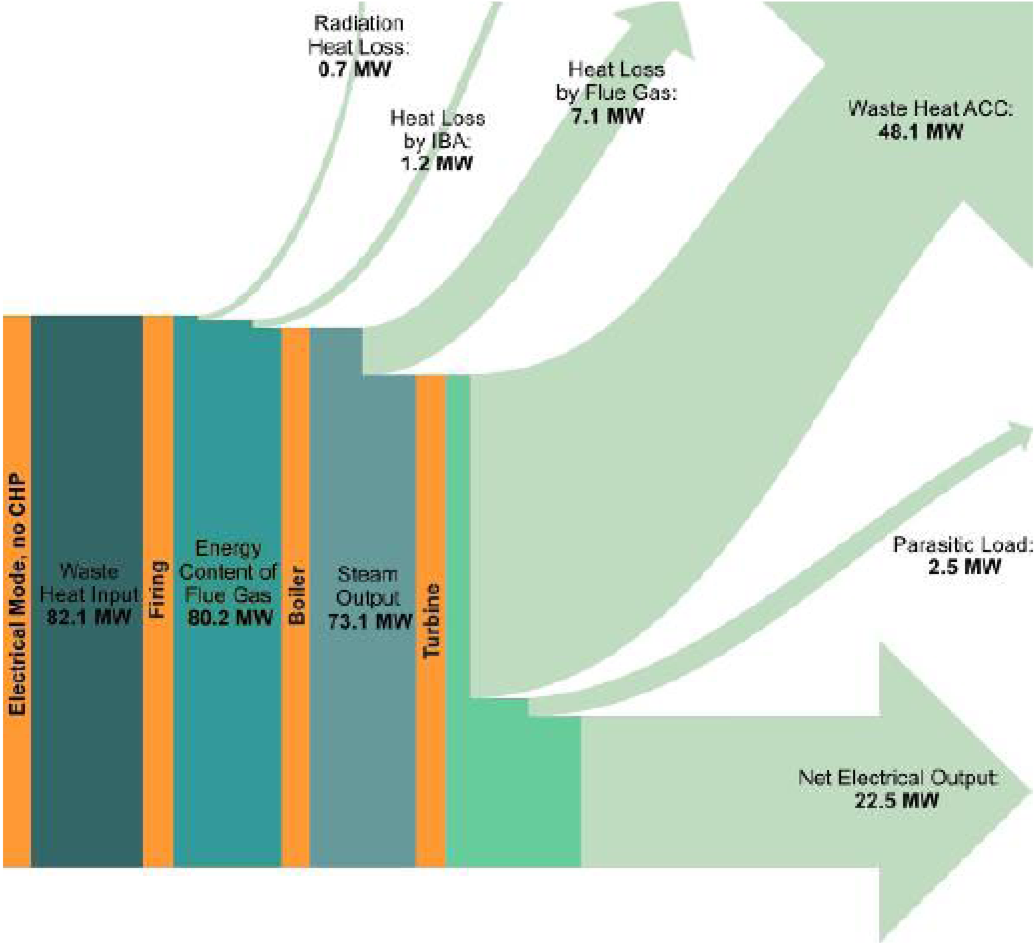
Main Process			
Energy In		***Energy Out***	
Waste Input	82.1	Flue Gases	7.1
		Radiation Losses	0.7
		Ash Losses	1.2
		Waste Heat ACC	48.1
		Electrical Output	25.0
		CHP Heat Output	0
TOTAL	**82,1**	**TOTAL**	**82.1**
Energy Generation			
Electricity Generation		***Electricity Use***	
Electricity Generated	25.0	Electricity Exported	22.5
		Parasitic Power To Site	2.5
Heat Generated	0	Heat Own Use	0
		Heat Exported	0
TOTAL	**25.0**	**TOTAL**	**25.0**

3.1.6 Sankey Diagrams

The energy balance for the facility is presented in Figures 5 and 6 below in the form of two Sankey Diagrams. The diagrams are presented for the total capacity of the plant. The thermal capacity of the plant as designed is 82.1 MW or 646,528 MWh (based on 90% annual availability, equal to 7884 operating hours per year). The design thermal capacity of 82.1 MW relates in this assessment to the design Calorific Value of 9.5 MJ/kg and accordingly the design waste throughput of 245,000 t/a. In the case that the estimated Calorific Value of the waste is lower the waste throughput could increase to up to 265,000 t/a without changing the thermal throughput of 82.1 MW. E.g. a Calorific Value of 9 MJ/kg relates also to 82.1 MW thermal throughput and a comparable Energy Generation, but to waste throughput of 258,600 t/a.

Figure 5 identifies the energy balance in power generation only mode, i.e. with electricity generation maximised and no useable heat output and shows power in Megawatts (MW) produced over one year.

Figure 5: Energy Balance for electrical mode without CHP in MW



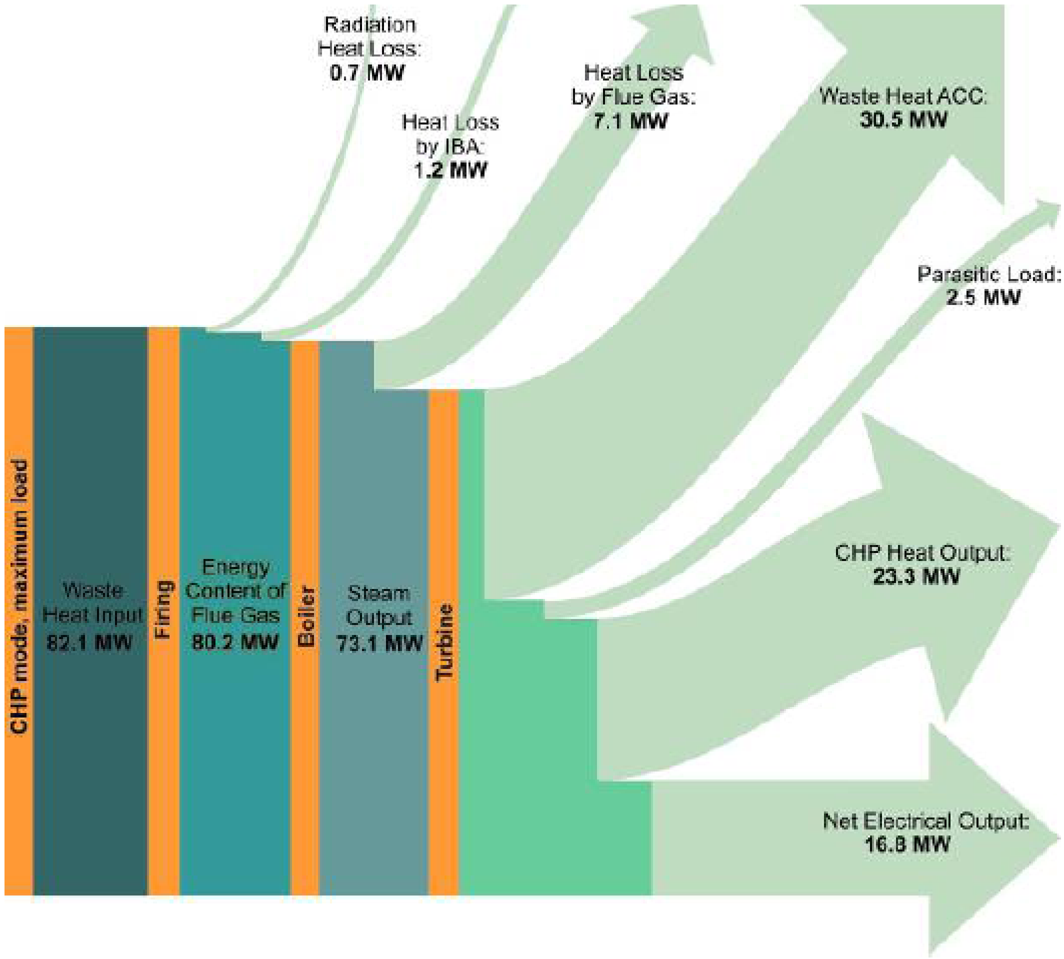
The thermal energy from the waste input to the facility is 82.1 MW that reflects the thermal design throughput. This relates e.g. to the design Calorific Value of 9.5 MJ/kg and the design waste throughput of 245.000 t/a. The energy outputs are associated with:

- 0.7 MW is lost by radiant heat from the surfaces of the boiler;
- 1.2 MW is lost as a result from the heat retained in the Incinerator Bottom Ash (IBA), which is quenched with water;
- 7.1 MW is lost from the gases which are emitted from the stack;
- 25 MW of electricity is generated by the steam turbine, of which 2.5 MW is consumed by the facility as the parasitic load, leaving 22.5 MW as the net electrical output for export; and
- The remaining 48.1 MW of heat is in the form of low grade residual heat and is dissipated to air by means of the air cooled condenser.

These figures result in a gross efficiency of 30.45%, and a net efficiency of 27.41% for electrical mode only.

Figure 6 identifies the energy balance in the Combined Heat and Power (CHP) mode and is presented as power in Megawatts (MW) with the maximum extraction of 30 t/h of steam based on the annual average steam extraction taking into account the anticipated annual heat demand of the dockyard.

Figure 6: Energy Balance for CHP mode in MW



As with the electrical generation only mode, the energy from the waste input to the facility is 82.1 MW, with outputs accounted by:

- 0.7 MW is lost by radiant heat;
- 1.2 MW is lost as a result of the retained heat in the Incinerator bottom ash;
- 7.1 MW is lost from the gases which are emitted from the stack;
- A lower value of 19.3 MW of electricity is generated, of which the same figure of 2.5 MW is consumed by the facility as the parasitic load, leaving 16.8 MW as the net electrical output for export; and
- 23.3 MW of heat is recovered into the Dockyard steam network; the remaining 30.5 MW of heat, 17.6 MW lower than in the electrical generation only mode, is dissipated to air by means of the air cooled condensers.

The CHP mode thus has substantially increased total energy recovery of 40.1 MW in comparison to 22.5 MW for the electrical mode. Operating with maximum CHP output, the gross efficiency of the plant will be 51.89 %, and the net efficiency 48.84 %.

3.2 Energy Efficiency

3.2.1 R1 Calculation

Background

The R1 efficiency criteria, as defined under the Waste Framework Directive 2008 (WFD 2008) (Annex II), is used to determine whether incineration facilities dedicated to the processing of municipal solid waste qualify as recovery operations.

The WFD 2008 came into force in December 2008. Member States of the European Union are required to bring into force by 12 December 2010 the laws, regulations and administrative provisions necessary to comply with the WFD 2008. In July 2009, Defra issued a Stage 1 consultation document, and invited views on the transposition and implementation of the Directive, including the R1 efficiency criteria. This was followed by Stage 2 consultation that was issued between July 2010 and 16th September 2010. At the time of writing no guidance has been issued by Defra on the process of accrediting EfW plants as being compliant with the R1 efficiency criteria or on the regulating authority.

The application of the R1 formula is currently undergoing discussions at European level, and the European Commission is currently developing guidelines for the application of the R1 efficiency criteria and its calculation. Defra has therefore stated that any discussions regarding (the) efficiency criteria "… is subject to reappraisal in the light of any guidelines developed by the Commission" (Defra/ WAG 2009). Draft guidance on the 'R1-formula', in Annex II of the Waste Framework Directive, was submitted to interested parties in May 2010 (see Appendix C R1 Draft Guidance'). The final guidance will have the status of a technical document.

R1 Calculation for the proposed Facility at Devonport

The R1 formula is shown in the footnote to point R1 of the WFD 2008:

Energy efficiency = (Ep - (Ef + Ei))/(0,97 × (Ew + Ef))

In which:

- 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 (GJ/year)
- Ef means annual energy input to the system from fuels contributing to the production of steam (GJ/year)
- Ew means annual energy contained in the treated waste calculated using the net calorific value of the waste (GJ/year)
- Ei means annual energy imported excluding Ew and Ef (GJ/year)
- 0.97 is a factor accounting for energy losses due to bottom ash and radiation.

WFD 2008 states that this formula *"….. includes incineration facilities dedicated to the processing of municipal solid waste only where their energy efficiency is equal to or above:*

- *0.60 for installations in operation and permitted in accordance with applicable Community legislation before 1 January 2009; or*
- *0.65 for installations permitted after 31 December 2008.*

This formula shall be applied in accordance with the reference document on Best Available Techniques (BAT) for waste incineration."

In relation to the Devonport EfW/CHP facility, all calculations were made following the principles stated in the current draft document “Proposal for a European Guidance for the use of the R1 energy efficiency formula for incineration facilities dedicated to the processing of Municipal Solid Waste according to (Waste Framework Directive 2000/98/EC, Annex II, R1 formula)” (Appendix B ’R1 Draft Guidance’).

MVV Environment Devonport Ltd has made the following assumptions to calculate the R1 criteria for the proposed Devonport EfW/CHP facility:

- MVV will need to reach an efficiency which equals or is above 0.65 because the facility will be permitted after 31st of December 2008;
- The calculations are based on gross electricity output only, while the plant is designed to produce combined heat and power as well (CHP enabled mode); typical yearly heat consumption was used to calculate the heat and electricity supplied;
- The energy produced (Ep) refers to heat and power produced in the plant. Heat is divided into heat for commercial use, as sold to third parties, and heat used within the process or related functions like air preheating, heating of administration buildings of the plant etc. In the proposed guidance all produced heat is evaluated with a factor of 1.1 since ,self-consumed heat replaces that which would otherwise result from third party production elsewhere;
- Another assumption has to be made for auxiliary power imported from the grid during outages of the plant; this is calculated with an availability of 7884 hrs/annum;
- The last input taken into account is auxiliary fuel, e.g. for shut down and start-up of the facility, and is estimated at being equivalent to 3% of the waste energy input; under normal operation conditions, values in MVV plants in Germany are typically less than 1%; and
- This auxiliary fuel has to be divided to fit with energy types mentioned in the R1 formula, and it is therefore assumed that 50% of the fuel is associated with steam production (category Ef) and 50% without steam production (category Ei), following the rules in the BREF/BAT document.

Using the above assumptions, the figures derived from the calculation of 1.01 (with heat) and 0.95 (without heat) are above the efficiency figure for installations permitted after 31 December 2008, meaning that the plant will be compliant with the R1 definition, and thus be qualified as a Recovery operation under the definition of the WFD 2008.

Detailed calculations, and a graph showing the inputs and outputs for the formula, are shown in Appendix D, presented for two scenarios: Scenario 1 takes into consideration heat output; Scenario 2 ignores this.

3.2.2 BREF Plant Efficiency Assessment

In addition to the R1 calculation, plant efficiency was assessed using the plant efficiency potential calculation quoted in the Incineration BREF:

Plant efficiency potential = (Oexp - (Ef + Eimp))/(Ecirc + Eimp + Ef))

In which:

Oexp means annual energy exported as the combined total of heat plus electricity as equivalents (GJ/year)

Ef means annual energy input to the system from non-waste fuels contributing to the production of steam (GJ/year)

Ecirc means annual energy used in the process that is generated on site (GJ/year)

Eimp means annual energy imported excluding energy from waste

The BREF calculation is based on the ratio of exported and consumed energy and the result for Devonport EfW/CHP facility is presented in Table 3.4a below for the facility operating in CHP mode:

Table 3.4a: Facility Operating in CHP Mode

Electricity Generated	181,688 MWh	**Heat Generated**	178,901 MWh
Auxiliary Fuel Input	19,418 MWh	**Electricity Exported**	161,988 MWh
Power Imported	350 MWh	**Own Power Used**	19,701 MWh
Own Heat Used	103,472 MWh	**Heat Exported**	75,429 MWh
Oexp	1,833,023 GJ	**Eimp**	3,316 GJ
Ecirc	290,113 GJ	**Ef**	76,818 GJ
Ratio		4.73	

The result for Devonport EfW/CHP facility is presented in Table 3.4b below for the facility operating in electricity only mode:

Table 3.4b: Facility Operating in Electricity Mode Only

Electricity Generated	197,005 MWh	**Heat Generated**	103,472 MWh
Auxiliary Fuel Input	19,418 MWh	**Electricity Exported**	177,305 MWh
Power Imported	350 MWh	**Own Power Used**	19,700 MWh
Own Heat Used	103,472 MWh	**Heat Exported**	0 MWh
Oexp	1,679,734 GJ	**Eimp**	3,316 GJ
Ecirc	290,113 GJ	**Ef**	76,818 GJ
Ratio		4.32	

The ratio for Devonport EfW/CHP facility is significantly higher than the average quoted in BREF both for CHP plants and for plants producing electricity only.

4 Energy Management Techniques

4.1 Energy Policy

An energy policy that demonstrates the operator's commitment to continuous improvement in energy efficiency will be developed as part of the facility's Integrated Management System (IMS).

4.2 Monitoring, Control, Reporting and Review

Effective monitoring of energy consumption is essential in order to achieve improvements across the facility, and as such energy consumption will form one of the Key Performance Indicators (KPIs) set within the IMS. Performance against the KPIs will be reviewed on a monthly basis, to identify trends.

4.3 Control Measures for Energy Efficiency

All plant and equipment will be operated by trained personnel in accordance with management procedures defined within the site's IMS and related management systems. Where necessary, operational control procedures will be developed to ensure efficient operation of equipment particularly during start up and shut down when energy useage is at its optimum.

4.4 Reporting

As part of the site's IMS management system, reports on energy use and progress against specific KPI targets will be produced in line with the operator's benchmark reporting system.

4.5 Reviewing Performance

As part of the annual management review, to be completed under the IMS, the energy plan and performance against the previous years KPI targets will be reviewed by site management. The review will include:

- Consideration of company policy;
- Comparison of quantitative performance against targets;
- Comparison with benchmark data where available; and
- Review of the implementation of energy efficiency improvements.

The energy plan will be subsequently revised to take account the results of this review.

4.6 Staff Responsibility and Structure

Responsibility for effective energy management will lie across various levels of the organisation. The main areas of responsibility are:

- Operations Engineer – will be responsible for the overall efficiency of the Devonport EfW/CHP facility operation with to regards energy consumption;

- Shift Team Leaders – will be responsible for ensuring that processes within the facility are operated in line with operational control procedures, optimising throughput and minimising the number of plant starts and stops; and
- Maintenance Engineer– will be responsible for maintaining all plant and equipment within the facility in efficient operating order, and for ensuring that energy efficiency considerations are undertaken when plant or equipment needs to be replaced.

It is also acknowledged that all staff will have a part to play in the successful implementation of the energy management system at the site**.**

4.7 Training and Awareness

To ensure the effective communication of policies and procedures, the facility will utilise team meetings and formal training sessions to ensure that individuals fully understand the energy management requirements for the site. Focus will include general energy management awareness as well as specific operational requirements in respect of operating the facility to achieve energy efficiency targets.

5 Energy Efficiency Measures

5.1 Introduction

This section provides evidence of the existence of relevant controls for the management of energy to the standard indicated by the Environment Agency in:

- *"Guidance for the Incineration of Waste and Fuel Manufactured From or Including Waste*" (SGN S5.01, Section 2.7); and
- Horizontal Guidance H2 *"Energy Efficiency."*

5.2 Basic Energy Requirements

5.2.1 Operating and Maintenance Procedures

Optimised Plant Start-Up

The facility's operational control system will include appropriate start-up sequences, heating rates and instructions for starting up individual items of plant in the most efficient, and as safe a manner, as possible.

Process Optimisation

This will be implemented in order to achieve benefits of improved operational throughput and improve the efficiency of the treatment processes. This will be achieved by:

- Optimising throughput - this seeks to ensure that the optimum amount of energy is recovered from the waste treated. Improvements to maximise energy recovered will be delivered through process monitoring to determine plant performance, followed by subsequent work to optimise the process, which may include changes to, plant operational control settings or improving the awareness of operators; and
- Stabilising the process – by reducing, as far as practical, the variability of waste inputs to the facility, this will help to maintain steady plant operation and optimised energy recovery.

Process optimisation activities will commence during plant commissioning.

Maintaining Plant Reliability

This applies to all areas of the processes used across the facility, and is aimed at reducing the number of stops on each item of plant. As energy drawn by items of plant is generally higher during start up/shut-down than when running continuously, reducing the number of stops experienced by any item of plant will assist with reducing overall energy consumption. This will be achieved by:

- Effective planned maintenance which will ensure that equipment is kept in good operational order, thus minimising energy consumption during operation, and also reducing the number of breakdowns– the facility will utilise a computerised system to assist tracking and monitoring of equipment condition and effectively plan maintenance; and
- All maintenance will be undertaken by trained/ experienced personnel and particular areas which will benefit from regular maintenance with respect to energy management are:

- Compressed air systems are energy intensive and leaks are generally the single biggest area of wastage – regular maintenance and checks ensures that wastage from these systems is minimised;
- Maintenance of steam and water systems is undertaken to ensure effective heat transfer and reduction of energy losses through leakage, poor insulation etc to reduce the associated energy consumption;
- Lubrication of plant drives and motors on defined lubrication strategies supplemented by planned maintenance checks ensures the load on motors and drives is minimised as much as possible – this reduction of load, in turn assists in improving energy efficiency; and
- Regular cleaning and maintenance of filtration systems on the gaseous and liquid lines for plant instrumentation, ensures that the operating pressure drop and load on fans and pumps is minimised – this in turn assists in improving energy efficiency.

Encourage the Use of Operational Best Practice

Operational best practice will be encouraged at the facility through the application of general common sense throughout the operations, in particular:

- Maintaining housekeeping standards across the facility will not only reduce the environmental impact of related emissions but if the root cause is identified and addressed then issues such as spillage will be minimised;
- Operators will be encouraged to switch off non-essential plant and equipment when not in use; this is particularly important on planned maintenance days and during breakdown responses;
- Operators will be encouraged to report faults promptly with respect to process control and general plant operation; this means that repairs to systems can be completed quickly and issues such as spillage and reduction of throughput are addressed; and
- Development and implementation of operational control procedures particularly covering individual plant and equipment start-up and shut-down' these procedures will be controlled within the process standardisation system and will be developed to ensure that energy is not wasted through over-extended start-up periods, while ensuring that other process conditions, such as minimum operating temperatures, are not compromised.

5.2.2 Basic Physical Measures

In line with SGN S5.01 and horizontal guidance note H2, basic physical measures have been considered during the initial engineering design of the facility, and the following will be implemented:

- A high standard of thermal; insulation will be used throughout..
- Office and plant buildings will be fitted with self-closing doors, which will reduce heat loss and minimises energy consumption; draught-proofing will be used where appropriate and double-glazing will be used on all external windows; and
- The design and layout of individual items of plant and equipment has been optimised to provide as small a footprint for the facility as can be achieved' this means that transport systems have been designed in such a manner as to reduce distances travelled, thus reducing power consumption required to facilitate such material movement.

5.2.3 Plant Design

For a waste treatment facility of this type, the basic process technology is essentially pre-determined by the selected technology provider, however the MVV design team has worked closely with their technology suppliers to optimise the process efficiency. The energy efficiency considerations that have been assessed at the design phase include:

- Maximisation of heat recovery from different parts of the process;
- Good insulation;
- Optimised plant layout;
- Optimised efficiency measures for the combustion plant; and
- Real-time monitoring of electricity demand.

Under the current design the EfW CHP facility will have a net overall efficiency of 39% on average, rising to 49% in the winter months when steam demand is highest. This compares to a normal "electricity only net efficiency" of about 27.4% which might occur in the summer months when there is no steam demand from North Yard. Other electricity only EfW facilities in the UK only achieve an efficiency of 23% typically.

When comparing the proposed EfW CHP facility to other energy from waste schemes recently built or planned in the UK the proposed scheme will be almost unique. Of the 10 or more schemes under active consideration or built in the last five years in the UK there are only two others that can claim to have CHP from the outset; the Sheffield facility, which was a replacement for an earlier, older facility from the 1970s, and the Runcorn facility which will supply process steam to the large chemical plant operated by Ineos Chlor. Existing schemes with CHP include the Eastcroft facility which supplies steam to a separate company owned by the City of Nottingham, which then generates electricity and sends hot water around a city centre district heating scheme. The Eastcroft facility does not achieve the Good Quality CHP benchmark.

Known potential facilities recently awarded planning permission include an energy from waste CHP facility at Kemsley, Kent, that would, if built, provide steam and electricity to a an adjacent paper mill. Almost all new energy from waste projects are built with the ability to supply steam, and almost all claim to have the intention of doing so, but most do not. A notable example is the South East London Combined Heat and Power (SELCHP) facility which despite having CHP in its title has not yet supplied steam or hot water to the local area of London in which it sits. No new energy from waste schemes that have the same real potential as this scheme to provide CHP or DH have been proposed. Indeed, the proposed EfW CHP scheme is more comparable to the higher levels of CHP commonly seen in continental Europe, in countries such as Denmark and Germany.

General Steam Cycle Design Considerations

Steam plant cycle efficiencies will be improved through engineering design being considered for

- Optimising the temperature and pressure of the steam to minimise corrosion of boiler tubes at high steam temperatures;
- Pre-heating of combustion air;
- Pre-heating of boiler feed-water;;

- Use of corrosion inhibitors to protect the boiler and flue gas treatment systems; and
- Maintenance of heat exchangers in order to maintain high heat transfer.

The steam cycle will be a closed loop, and there will be daily checks for leaks.

5.2.4 Building Services

The following key design parameters will be incorporated into the detailed design to maximise the opportunity for energy conservation:-

- Selection of low energy systems for providing heat, cooling and lighting;
- Compliance as a minimum with the Energy Conservation requirements as defined under the Building Regulations Part L;
- Sub-metering of each building and/or process areas;
- Use of high efficiency lighting systems;
- Use of high efficiency motors in accordance with GPG2 from the Energy Efficiency Best Practice Program; and

5.2.5 Energy Efficiency Plan

An energy efficiency plan will be developed and maintained as part of the facility's Integrated Management System. The plan development will be commenced at the time of facility commissioning, when base energy levels will be established, and can be used as an ongoing reference measure.

Issues that will be considered include:

- Monitoring and target setting for energy use;
- Use of natural lighting where possible;
- Maximise potential natural ventilation and adequate cross flow of air to reduce the need for air conditioning and active cooling, whilst avoiding over-cooling in winter, all having regard to zoning within the building;
- Incorporation of low energy lighting both internally and externally, with external lighting being directional to minimise losses to the sky;
- Regular maintenance of equipment to ensure operating efficiency;
- Introducing more energy and carbon efficient equipment as it becomes available, (in accordance with the planned equipment replacement program);
- Training of staff to ensure they are 'Energy Aware', such that they switch off equipment, machinery and lights etc, when not in use;
- Construction materials will be sourced as locally as possible;
- Passive measures will be included within the building design to minimise heating and cooling losses, and are likely to include ensuring that the building is robustly insulated and that air leakage through the building fabric is minimised; and
- Consideration will be given to zoning of lighting and incorporation of automated systems in order to reduce operating costs over the life of the installation, where relevant, having regard to Health and Safety.

5.3 Further Energy Efficiency Techniques

5.3.1 Energy Efficiency Techniques

The facility will utilise equipment and systems that have been designed on the basis of optimum energy efficiency. This will include:

- Electric Motors specified as EFF1 class, or if not classified under EFF1, to provide a minimum efficiency of 95%, which is significantly above the current industrial standard in EfW/CHP processes;
- Systems providing a variable control function during normal operation will use motors fitted with frequency control rather than a throttling device (valve or damper) to avoid energy losses;
- Natural convection is used as an integral feature of the aeration and de-aeration systems where applicable;
- The use of 'ring main' pipelines that are often used in normal EfW/CHP processes, produce pumping losses and are replaced in MVV's design by individually controlled direct feeds;
- Lighting inside and outside the facility is based on the use of high efficiency luminaries; and
- Piping and ducting is designed for the minimum feasible pressure loss by minimisation of pipe runs, avoidance of unnecessary changes of direction and selection of sensible pipe and duct velocities.

The operator will take energy efficiency into consideration during the procurement stage of any plant purchase to ensure that the most energy efficient equipment available is purchased when the marginal cost is justifiable.

The above mitigation points allow the operator to reduce parasitic load to 10% of the normal generator output during full load operation, in full condensing mode.

5.3.2 Energy Supply Techniques

Main Supply Requirements

The plant will operate continuously, 24 hours per day, for the treatment of the incoming municipal waste streams, and plant design considerations have assessed electricity supply arrangements in respect of:

- Maximising on-site power generation both in terms of meeting site supply demands and for export to the public grid; and
- Ensuring provision of public supply for periods when power import is required (e.g. during plant downtime).

Combined Heat and Power

The facility is designed to generate electricity for internal power requirements, and (principally) for export to the local network, as previously described.

The process will also provide low grade steam for the heating systems associated with the adjacent Dockyard.

Alternative Site-Based Power Supply (Essential Facilities)

On-site alternative power generation facilities will be provided to address the risk of Distribution Network Operator (DNO) outages for essential facilities (e.g. EfW/CHP safe shutdown, control room systems, emergency lighting, odour control & MSW aeration, fire protection systems). It is proposed that one 1,000Kva diesel powered generator will be provided for this purpose.

Emissions Trading/Climate Change

There are no emissions trading (ETS) or climate change agreements (CCA) in place for the facility at the time of writing. MVV has, however, identified that single ROCs will be available on the electricity exported that has been generated from the biomass material that is passed through the EfW/CHP process. This will be explored further once the facility is being commissioned.

Appendix A CHPQA Certificate

Appendix B CHPQA Certificate - ROCs

Appendix C R1 Draft Guidance

Appendix D R1 Calculation