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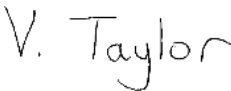

Consulting Engineers Limited



Medway Energy Recovery Limited

CHP Assessment

Document approval

	Name	Signature	Position	Date
Prepared by:	Vildan Taylor		Associate Senior Consultant	14/03/2024
Checked by:	James Sturman		Lead Consultant	14/03/2024

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Management Summary

Medway Energy Recovery Limited (the Applicant) is applying to the Environment Agency (EA) under the Environmental Permitting (England and Wales) Regulations 2016 (EPR) for an Environmental Permit (EP) to operate the MedwayOne Energy Hub (the Facility). The Facility will comprise a twin line waste incineration plant and associated infrastructure including battery storage, and will be located at MedwayOne, Kent. The purpose of this report is to undertake a CHP-ready assessment for the Facility.

The Facility will have a thermal capacity of 166 MW_{th} (83 MW_{th} per incineration line). The design fuel will have a net calorific value (NCV) of 10.5 MJ/kg, but the Facility will be designed to process waste with a range of NCVs between 8 – 14 MJ/kg without reducing load. At the design point, the Facility will have an hourly waste processing throughput of 28.5 tonnes per hour (tph) per line. Assuming an operational availability of 8,000 hours per annum, the Facility will process 456,000 tonnes per annum of waste. The Facility will generate up to 49.9 MWe of electricity with a parasitic load of approximately 5 MWe. Therefore, the Facility will be designed to export up to 44.9 MWe of electricity. The design case has been applied for the purposes of this CHP-r assessment.

The Environment Agency (EA) Combined Heat and Power (CHP) Ready Guidance requires Best Available Techniques (BAT) to be demonstrated by maximising energy efficiency.

The Facility is located within the wider MedwayOne development site, a large new development site in Medway. The MedwayOne development is the proposed regeneration and redevelopment of the former Kingsnorth power station site to create a modern new employment space on the Hoo Peninsula, Medway in Kent. The development includes a mixture of commercial, manufacturing and industrial uses along with storage and distribution, including data centre and energy uses with around 330,000sqm.

Uniper has submitted an outline planning application in March 2021 to enable the redevelopment of the site, which covers a total area of approximately 279 acres (113 hectares). Uniper's proposals for the MedwayOne development support Medway Council's ambitions for future economic development in the District, as part of its emerging Local Plan to 2037. The proposals could also enable the development of a lower carbon future for the peninsula, which is a high priority for Medway. For the purposes of this assessment the MedwayOne development is considered to be the potential heat consumer as a first network option. There is a possibility of a single user in the MedwayOne development which would be considered as a second heat network option. This report will consider these two options parallel. There are no fixed contracts in place with specific heat users; however, it is assumed that the heat demand for the annual average heat load of the MedwayOne development is approximately 10 MW_{th} and the single user in the MedwayOne development is 15 MW_{th}.

The Facility will be technically capable of meeting this heat demand for these two networks, subject to economic and commercial feasibility. The maximum heat capacity of the Facility will be confirmed during detailed design and will be set as a minimum to meet the requirements of the heat consumers identified. In the event that the heat demand more than 15 MW_{th}, the design of the Facility may need to be reconfigured to enable the additional heat export, and this would be subject to reaching appropriate commercial agreements with the relevant heat users.

While the quantity of heat demand identified is sufficient to achieve Primary Energy Savings (PES) in excess of the 10 % technical feasibility threshold, it is not sufficient for the Facility to be deemed 'Good Quality' in accordance with the CHP Quality Assurance (CHPQA) scheme. At the proposed heat network load, PES was calculated to be 19.72 % for the first heat network option and 21.15 % for the second heat network option. On this basis, the Facility will qualify as a high efficiency cogeneration operation when operating in CHP mode.

The CHPQA Quality Index (QI) score is 61.94 for first heat network option and 64.23 for the second heat network option. A QI score of 105 is required at the design stage to be deemed 'Good Quality'. The highly onerous new efficiency criteria set out in the latest CHPQA guidance means that it is unlikely that any energy recovery facility will now reach 'Good Quality' status.

In accordance with Article 14 of the Energy Efficiency Directive, a cost-benefit assessment (CBA) of opportunities for CHP is required when applying for an EP. An assessment of the costs and revenues associated with the construction and operation of the two parallel heat network options has been undertaken. This has been inputted into the Environment Agency's CBA template in accordance with the draft Article 14 guidance document issued by the EA. The results of the CBA indicate that both the nominal project internal rate of return and net present value (before financing and tax) over 30 years are:

1. For the first network option: 26.1 % and £0.46 million respectively; and
2. For the second network option: 30.6 % and £0.87 million respectively.

The NPV is positive indicating the project would be profitable. Therefore, it is considered that the proposed first and second heat network options yield an economically viable scheme in its current configuration. The full economic feasibility of the scheme will need to be reassessed when there is certainty regarding the heat loads. The assessment will also need to take into account any subsidies that might become available in the future to support the export of heat. Taking the above into consideration and given the current status of the MedwayOne development, the Facility will be constructed as CHP-Ready.

Therefore, it is considered that construction of the Facility as CHP-Ready demonstrates that the Facility represents BAT for the export of heat. A CHP Ready Assessment form has been completed and is provided in Appendix C of this report.

CHP-Ready means that the Facility will be able to export heat in the future with minimum modification. This will be achieved by virtue of having steam capacity designed into the turbine bleed and safeguarded space to house CHP equipment.

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1 Introduction

1.1 Background

Medway Energy Recovery Limited is applying to the Environment Agency (EA) under the Environmental Permitting Regulations (EPR's) for an Environmental Permit (EP) to operate the MedwayOne Energy Hub (the Facility). The Facility will comprise a twin line waste incineration plant and associated infrastructure including battery storage facility, and will be located at MedwayOne, Kent.

1.2 Objective

The principal objectives of this study are to:

1. Prepare a CHP Assessment in line with the Environment Agency (EA) guidance on cost-benefit assessment (CBA) for combustion installations, which will support an Environmental Permit (EP) application.
2. Provide a technical description of the proposed Facility and heat export infrastructure.
3. Calculate heat demands based on identified heat consumers and assess the feasibility of connecting identified heat consumers to the network.
4. Based on the heat loads anticipated for the outline solution identified, calculate relevant energy efficiency measures to demonstrate legislative compliance.
5. Produce provisional pipe routing drawing from the Facility to the likely heat consumers.
6. Conduct an economic assessment feeding into the CBA as required under Article 14 of the Energy Efficiency Directive.
7. Produce a CHP-Ready Assessment as required under the EA CHP-Ready guidance, including a clear statement on best available techniques (BAT), combined heat and power (CHP) envelope and the CHP-Ready Assessment form.

1.3 The Location

The site on which MedwayOne Energy Hub will be located has the following characteristics.

- The site is located on the Hoo Peninsula in Medway, Kent, immediately south of the Damhead Creek CCGT power station.
- The site is within the wider MedwayOne development.
- The site is accessed from Eschol Road to the west.
- Whilst the overall site is currently brownfield, following demolition of the coal fired power station, the Facility site is greenfield (the substation associated with the coal fired power station has been retained).

The red area in the north of Figure 1 has been identified for development of a building with a 45 m height and a stack of up to 100 m. The areas within Figure 1 are as follows.

1. Redline boundary – extent of the MedwayOne development.
2. Red shaded areas – areas suitable for developments up to 45 m in height above finished floor level with a 100 m stack.
3. Dark orange areas – areas suitable for development up to 25 m in height above finished floor level.

4. Light orange areas – areas suitable for developments up to 15 m in height above finished floor level.
5. Green areas – green infrastructure and sustainable urban drainage scheme (SuDs), landscaping and ecological enhancement.

Figure 1: The MedwayOne Energy Hub Site



A site location plan and Installation Boundary drawing are presented in Appendix A of the Pack.

2 Conclusions

2.1 Technical Solution

The Facility will have a gross electrical output of 49.9 MWe, (design when operating in fully condensing mode), with a parasitic load of approximately 5 MWe with the balance exported to the National Grid. Therefore, the Facility will export approximately 44.9 MWe in fully condensing mode. The Facility will export approximately 10 MW_{th} of heat to the first heat network option and 15 MW_{th} of heat to the second heat network option in MedwayOne development. The maximum heat capacity will be subject to the requirements of the heat consumers and confirmed during the detailed design stage. Based on the two heat networks identified within this Heat Plan, the average heat load of 10 MW_{th} results in an average gross electrical generation of approximately 48.44 MWe and the average heat load of 15 MW_{th} results in an average gross electrical generation of approximately 47.71 MWe.

A number of options for heat recovery and export from the Facility are available. Given the requirements of the heat consumers (refer to section 5), flexibility in terms of export temperatures and capacity, and the associated environmental benefits, steam extraction from the turbine is considered the most favourable solution. The steam from the Facility turbine will be delivered to a connection point which is controlled and owned by an ESCo, with the heat being distributed to the individual heat users by the ESCo. It is proposed that heat will be transferred to a closed hot water circuit via a series of condensing heat exchangers and supplied to consumers through a pre-insulated buried hot water pipeline, before being returned to the ESCo heat station for reheating. This technology is well proven and highly efficient.

2.2 Potential Heat Consumers

A review of the potential heat demand within a 15 km radius of the Facility has been undertaken in accordance with the requirements set out in Section 2 of the EA's draft Article 14 guidance. Physical constraints imposed by local infrastructure has a significant impact on which consumers can viably be connected. Both river and rail crossings exist in the area surrounding the Facility and may present obstructions to connect some consumers. Engineering a bridge crossing will likely require detailed structural assessments and the consent of the bridge owner. Trenching in road crossings will require traffic management and permission from the highway authority. Following screening of potential heat consumers, the identification of existing heat demands has centred on nearby industrial and commercial users, as the benefits of providing heat to large nearby premises is generally more financially viable than supply to multiple smaller consumers at further distances.

Four large heat consumers (point heat demands greater than 5 MW_{th} as defined by the UK CHP Development Map) have been identified within the specified 15 km search radius. The large consumers identified were located a significant distance away from the Facility and scattered at different locations and would require a prohibitively costly pipe network to connect to each consumer. Therefore, these large heat consumers have been discounted.

The Facility is located within the wider MedwayOne development site, a large new development site in Medway. MedwayOne development is the proposed regeneration and redevelopment of the former Kingsnorth power station site to create a modern new employment space on the Hoo Peninsula, Medway in Kent. The development includes a mixture of commercial, manufacturing and industrial uses along with storage and distribution, including data centre and energy uses with around 330,000sqm.

Uniper has submitted an outline planning application in March 2021 to enable the redevelopment of the site, which covers a total area of approximately 279 acres (113 hectares). Uniper's proposals for the MedwayOne development support Medway Council's ambitions for future economic development in the District, as part of its emerging Local Plan to 2037. The proposals could also enable the development of a lower carbon future for the peninsula, which is a high priority for Medway. For the purposes of this assessment the MedwayOne development is considered to be the potential heat consumer. There is a possibility of a single user in MedwayOne development which would be considered as a second heat network option. There are no fixed contracts in place with specific heat users; however, it is assumed that the heat demand for an annual average heat load of the MedwayOne development is approximately 10 MW_{th} and the single user in the MedwayOne development is 15 MW_{th}.

The Facility will be technically capable of meeting this heat demand for both heat network options in the MedwayOne development, subject to economic and commercial feasibility. The maximum heat capacity of the Facility will be confirmed during detailed design and will be set as a minimum to meet the requirements of the heat consumers identified. In the event that the heat demand of the MedwayOne development is more than 15 MW_{th}, the design of the Facility may need to be reconfigured to enable the additional heat export, and this would be subject to reaching appropriate commercial agreements with the relevant heat users.

2.3 Heat Network Profile

The Facility will provide a constant rate of 10.0 MW_{th} heat and 15.0 MW_{th} heat, which is equivalent to an annual heat of 77,964 MWh/annum and 116,946 MWh/annum respectively, when the Facility is operating. During non-operational hours of the Facility, the ESCo backup boilers will supply the heat demand. Detailed techno-economic modelling will be undertaken when there is a better understanding of the final consumer heat demands within the MedwayOne development.

2.4 Economic Assessment

The costs and revenues associated with the construction and operation of the proposed heat supply infrastructure to the ESCo connection point has been undertaken. This has been inputted into the EA's CBA template. The CBA takes account of heat supply system capital and operating costs, heat sales revenue and lost electricity revenue as a result of diverting energy to the heat network.

The results of the CBA indicate that the estimated £0.89 million for the first network option and £1.1 million capital investment for the second network option will be offset by heat sales revenue. The nominal project internal rate of return (before financing and tax) over 30 years is projected as 26.1 %, with a net present value of £0.46 million for the first network option and 30.6 %, with a net present value of £0.87 million for the second network option. The NPVs for both network options are positive indicating the project would be profitable. Therefore, it is considered that the both heat network options yield an economically viable scheme in its current configuration.

The detailed economic feasibility of the scheme will be reassessed in the future when the heat demands are confirmed, at which time a final decision will be made on connecting the development.

As construction of a district heating network is currently economically feasible, the Facility will initially be built to be CHP-Ready. A decision on progressing with the district heating network will be taken once the economic feasibility has been confirmed. As such, the Facility will meet the requirements of BAT tests outlined in the EA CHP Ready Guidance.

2.5 Energy Efficiency Measures

In order to qualify as technically feasible under the draft Article 14 guidance, the heat demand must be sufficient to achieve high efficiency cogeneration, equivalent to at least 10 % savings in primary energy usage compared to the separate generation of heat and power. When operating in fully condensing mode (i.e. without heat export) the Facility will achieve a primary energy saving (PES) of 14.91 %, which is in excess of the technical feasibility threshold defined in the draft Article 14 guidance. Adding the proposed heat network option 1 and 2 will result in PES of 19.729 % and 21.15 % respectively. The PES is in excess of the technical feasibility threshold and would therefore be technically feasible to supply.

To be considered 'Good Quality' CHP under the CHPQA scheme, the quantity of heat exported to a heat network must be sufficient to achieve a Quality Index (QI) of at least 105 at the design stage (reducing to 100 at the operational stage). Changes to CHPQA guidance in December 2018 mean that the maximum QI score which could be achieved by the proposed heat network 1 and 2 would be 61.94 and 64.23 respectively. On this basis, any heat network would not qualify as Good Quality CHP. The efficiency criteria set out in the latest CHPQA guidance means that it is unlikely that any energy recovery facility will now achieve 'Good Quality' status.

2.6 CHP-Ready Assessment

A CHP-Ready Assessment has been carried out as part of this Heat Plan and the completed CHP Ready Assessment form is provided in Appendix C. The economic assessment for the proposed both heat network options confirm it is economically viable at this stage, and constructing the Facility as CHP Ready is considered to represent BAT. This would enable the Facility to export heat when the heat loads have been confirmed and there are formal agreements in place with the potential heat users.

As CHP-Ready, the Facility will be designed to be ready, with minimum modification, to supply heat in the future. The EA CHP Ready Guidance in February 2013 states that given the uncertainty of future heat loads, the initial electrical efficiency of a CHP-Ready facility (before any opportunities for the supply of heat are realised) should be no less than that of the equivalent non-CHP-Ready facility. The Facility will include steam capacity designed into the turbine bleeds to facilitate heat export in the future, and safeguarded space to house CHP equipment.

To satisfy the third BAT test on an ongoing basis, the Medway Energy Recovery Limited is committed to carrying out periodic reviews of opportunities for the supply of heat to realise CHP.

3 Legislative Requirements

3.1 CHP-Ready Guidance

In February 2013, the EA produced a guidance note titled 'CHP Ready Guidance for Combustion and Energy from Waste Power Plants'¹. This guidance applies to the following facilities, which will be regulated under the Environmental Permitting (England and Wales) Regulations 2016:

- new combustion power plants (referred to as power plants) with a gross rated thermal input of 50 MW or more; and
- new EfW plants with a throughput of more than 3 tonnes per hour of non-hazardous waste or 10 tonnes per day of hazardous waste.

The Facility will be regulated as a waste incineration facility with a throughput of more than 3 tonnes per hour. Therefore, the requirements of the CHP-Ready guidance will apply.

The EA requires developers to demonstrate BAT for a number of criteria, including energy efficiency. One of the principal ways of improving energy efficiency is through the use of CHP, for which three BAT tests exist. The first involves considering and identifying opportunities for the immediate use of heat off-site. Where this is not technically or economically possible, the second test involves ensuring that the plant is built to be CHP-Ready. The third test involves carrying out periodic reviews to determine whether the situation has changed and if there are opportunities for heat use off site.

3.2 Energy Efficiency Directive

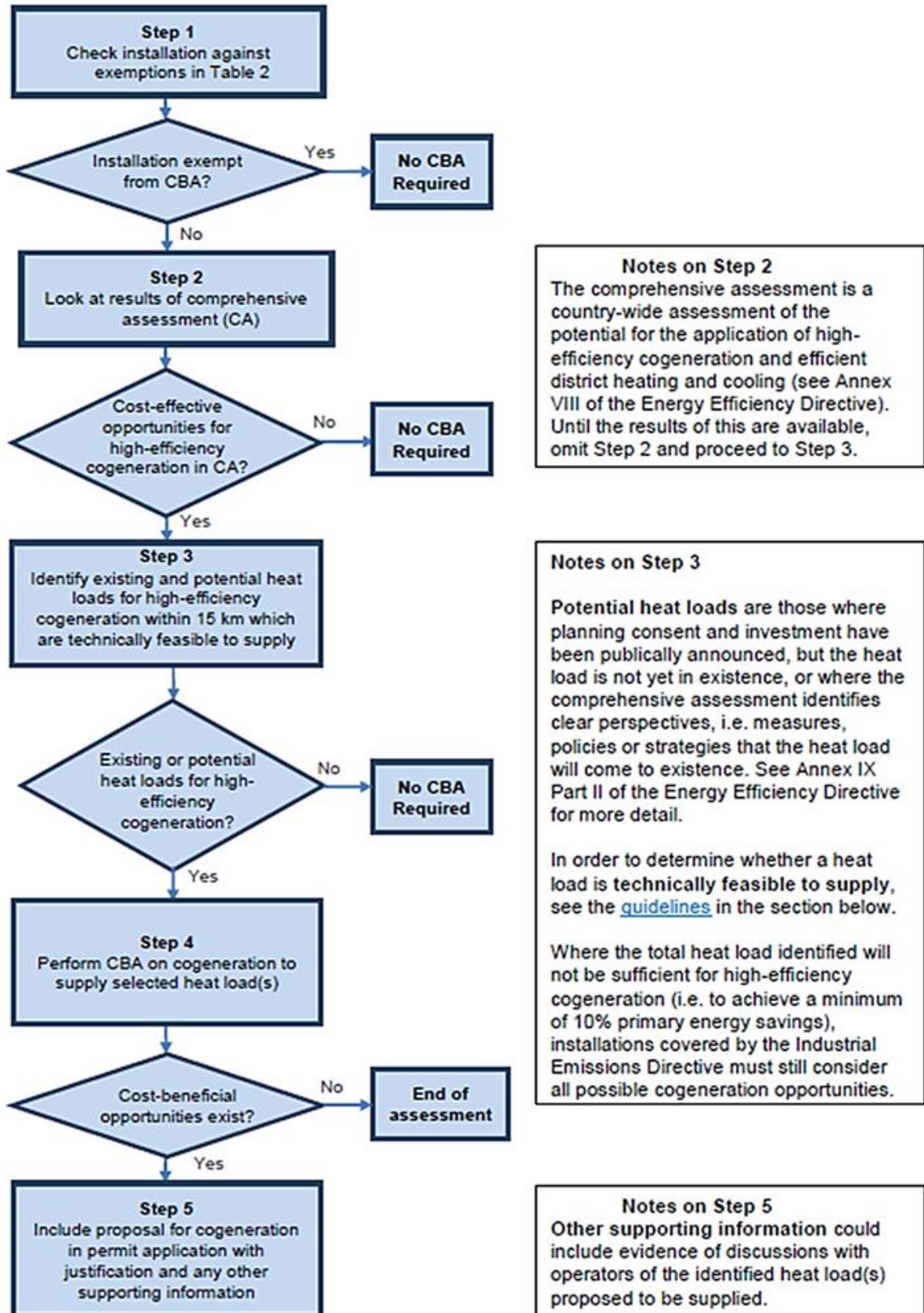
From 21 March 2015, operators of certain types of combustion installations are required to carry out a CBA of opportunities for CHP when applying for an EP. This is a requirement under Article 14 of the Energy Efficiency Directive and applies to a number of combustion installation types. As a new electricity generation installation with a total aggregated net thermal input of more than 20 MW, the Facility will be classified as an installation type 14.5(a).

In April 2015, the EA issued draft guidance on completing the CBA, entitled '*Draft guidance on completing cost-benefit assessments for installations under Article 14 of the Energy Efficiency Directive*'². Figure 2 describes the process that must be followed for type 14.5(a) and 14.5(b) installations.

¹ CHP Ready Guidance for Combustion and Energy from Waste Power Plants v1.0, February 2013

² Draft guidance on completing cost-benefit assessments for installations under Article 14 of the Energy Efficiency Directive, V9.0 April 2015

Figure 2: CBA methodology for type 14.5(a) and 14.5(b) installations



4 Description of the Waste Incineration Technology

4.1 The Facility

The main activities associated with the Facility will be the combustion of incoming non-hazardous waste to raise steam and the generation of electricity in a steam turbine/generator, with the potential to export heat subject to commercial and economic viability.

The Facility will include the following key components/infrastructure:

- waste reception and storage areas;
- reagent and raw material tanks and silos;
- residue silos and storage areas (including wastewater storage facilities);
- water, fuel oil and air supply systems;
- two incineration lines;
- boilers;
- steam turbine/generator set;
- facilities for the treatment of exhaust or flue gases;
- flues with associated stack; and
- devices and systems for controlling combustion operations and recording and monitoring conditions.

In addition to the following ancillary equipment/infrastructure:

- offices, control room and staff welfare facilities;
- site fencing, security barriers, gates and landscaping;
- drainage infrastructure;
- lighting and CCTV;
- external hard standing areas for vehicle manoeuvring/parking;
- internal access roads and car parking;
- transformer and sub-station enclosure; and
- fire water tank and water treatment plant.

The Facility will have a thermal capacity of 166 MWth (83 MWth per incineration line). The design fuel will have a net calorific value (NCV) of 10.5 MJ/kg, but the Facility will be designed to process waste with a range of NCVs between 8 – 14 MJ/kg without reducing load. At the design point, the Facility will have an hourly waste processing throughput of 28.5 tonnes per hour (tph) per line. Assuming an operational availability of 8,000 hours per annum, the Facility will process 456,000 tonnes per annum of waste. The Facility will generate up to 49.9 MWe of electricity with a parasitic load of approximately 5 MWe. Therefore, the Facility will be designed to export up to 44.9 MWe of electricity. The design case has been applied for the purposes of this CHP-r assessment.

However, as explained within the Supporting Information the Facility will be capable of processing waste with an NCV of 8 MJ/kg without reducing load. Assuming an availability of 8,000 hours, the Facility can process approximately 606,000 tpa of waste.

As the waste quality will fluctuate, and if heat is exported from the Facility to local heat users in the future, the power exported will fluctuate. The power exported will fluctuate also depending on the ambient temperature.

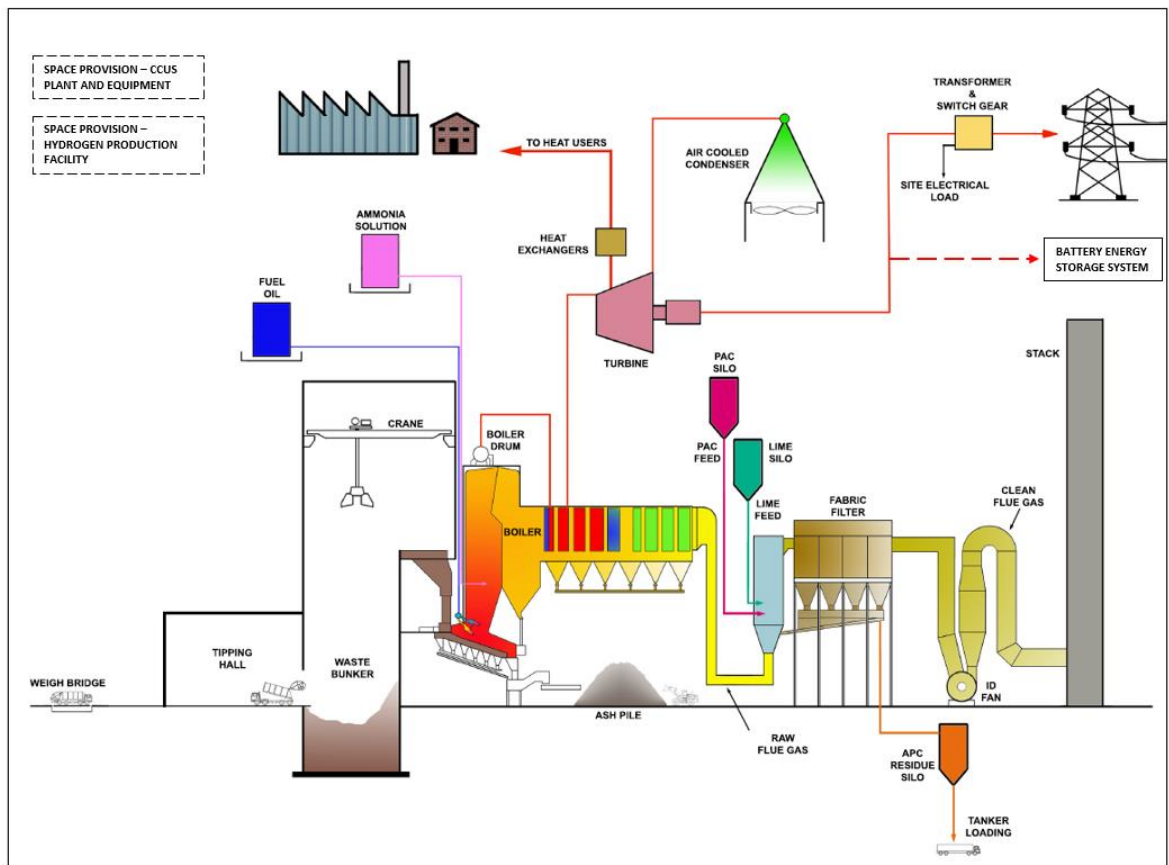
The Facility will be constructed as ‘CHP Ready’ and will have the capacity to export approximately 10 MW_{th} of heat to the wider the MedwayOne development and 15 MW_{th} of heat to the single user in the MedwayOne development. The maximum heat capacity will be confirmed during the detailed design stage and will be set as a minimum to meet the requirements of the heat consumers identified.

Based on two heat network options identified within this Heat Plan, the heat export from the Facility is expected to be constant at 10 MW_{th}, resulting in an electrical export of approximately 43.44 MW_e for the first network option and at 15 MW_{th} results in an average electrical export of approximately 42.71 MW_e for the second network option.

However, at the time of writing this report, there are no formal agreements in place for the export of heat from the Facility.

Figure 3 is an indicative schematic of the combustion process that will be used in the Facility.

Figure 3: Process schematic



4.1.1 Energy Recovery

The heat released by the combustion of the incoming waste will be recovered by means of a water tube boiler, which is integral to the furnace and will produce (in combination with superheaters) at approximately 430 °C and approximately 63 bar(a). The steam from the boiler will then feed a high-

efficiency steam turbine which will generate electricity. The turbine will have a series of extractions at different pressures that will be used for preheating air and water in the steam cycle.

The remainder of the steam left after the turbine will be condensed back to water to generate the pressure drop to drive the turbine. A fraction of the steam will condense at the exhaust of the turbine in the form of wet steam, however the majority will be condensed and cooled using an air-cooled condenser. The condensed steam will be returned as feed water in a closed-circuit pipework system to the boiler.

Depending on the requirements of the heat users, either high pressure steam or hot water could be supplied. High pressure steam could be extracted from the turbine and piped directly to the heat users. Alternatively, low pressure steam exiting the turbine could pass through an onsite heat exchanger to heat up water for use in a heat network. The volume of steam extracted would vary depending on the heat load requirements of the heat users. It should be noted that at the time of writing this report, there are no formal agreements in place for the export of heat from the Facility.

4.1.2 Details of Input Waste

Table 1: Expected input waste characteristics

Parameter	Unit	Value
Nominal waste throughput	tpa	456,000
Proposed NCV	MJ/kg	10.50
Proposed GCV	MJ/kg	12.09

4.2 Details of Heat Supply System

Heat is typically supplied from the energy recovery process in the form of steam and / or hot water, depending on the grade of heat required by the end consumers.

The most commonly considered options for recovering heat are discussed below.

1. Heat recovery from the condenser

Wet steam emerges from the steam turbine typically at around 40 °C. This energy can be recovered in the form of low-grade hot water from the condenser depending on the type of cooling implemented.

An ACC will be installed at the Facility. Steam is condensed in a large air-cooled system which rejects the heat in the steam into the air flow, which is rejected to atmosphere. An ACC generates a similar temperature condensate to mechanical draught or hybrid cooling towers. The condensate then returns back to the boiler. Cooling this condensate further by extracting heat for use in a heat network requires additional steam to be extracted from the turbine to heat the condensate prior to being returned to the boiler. This additional steam extraction reduces the power generation from the plant and therefore reduces the plant power efficiency and power revenues.

2. Heat extraction from the steam turbine

Steam extracted from the steam turbine can be used to generate hot water for district heating schemes. District heating schemes typically operate with a flow temperature of 90 to 120 °C and return water temperature of 50 to 80 °C. Steam is preferably extracted from the turbine at low pressure to maximise the power generated from the steam. Extraction steam is passed through a condensing heat exchanger(s), with condensate recovered back into the feedwater system. Hot water is pumped to heat consumers for consumption before being returned to the primary heat exchangers where it is reheated.

Where steam is used for heating hot water, it is normally extracted from a lowest pressure bleeds on the turbine, depending on the heating requirements of the heat consumers.

This source of heat offers the most flexible design for a heat network. The steam bleeds can be sized to provide additional steam above the Facility's parasitic steam loads. However, the size of the heat load needs to be clearly defined to allow the steam bleeds and associated pipework to be adequately sized. The capacity of the bleeds cannot be increased once the turbine has been installed.

3. Heat extraction from the flue gas

The temperature of flue gas exiting the flue gas treatment plant is typically around 140 °C and contains water in vapour form. This can be cooled further using a flue gas condenser to recover the latent heat from the moisture. This heat can be used to produce hot water for district heating in the range 90 to 120 °C. This method of heat extraction does not significantly impact the power generation from the plant.

Condensing the flue gas can be achieved in a flue gas condenser. However, the recovered temperature is typically no more than 80 °C, which restricts the hot water temperature available for the consumer. Additionally, condensing water vapour from the flue gas reduces the flue gas volume and hence increases the concentration of non-condensable pollutants within it. The lower volume of cooler gas containing higher concentration of some pollutants would likely require a different stack height to effect adequate dispersion. The additional cooling of the flue gas results in the frequent production of a visible plume from the chimney and although this is only water vapour it can be misinterpreted as pollution. The water condensed from the flue gas needs to be treated and then discharged under a controlled consent.

The best solution to supply heat for the network under consideration is by extracting steam from the turbine. This method for the supply of heat is considered to be favourable for the following reasons.

1. The heat requirements of the identified consumers (as described in section 5.1.5) are too high for the temperatures attainable from the turbine exhaust steam.
2. The use of a flue gas condenser would generate a visible plume which would be present for significant periods of the year. This is not desirable as it will significantly add to the visual impact of the Facility and as such has not been included.
3. Extraction of steam from the turbine offers the most flexibility for varying heat quality and capacity to supply variable demands or new future demands.
4. Extraction of steam from the turbine, heat transfer to a hot water circuit and delivery of heat to consumers can be facilitated by well proven and highly efficient technology.

5 Heat Demand Investigation

5.1 Wider Heat Export Opportunities

5.1.1 The National Comprehensive Assessment

Opportunity areas for district heating networks in the UK: National Comprehensive Assessment of the potential for efficient heating and cooling³ (the NCA), dated September 2021, was published by Arup on behalf of the Department for Business, Energy and Industrial Strategy (BEIS). The report was produced to fulfil the requirement (under Directive 2012/27/EU on energy efficiency) on all EU Member States to undertake a National Comprehensive Assessment (NCA) to establish the technical and socially cost-effective potential for high-efficiency cogeneration. The report also sets out information pertaining to heat policy development in the UK. Due to the low resolution of the data, the results of the NCA can be considered as an overview only.

Table 2 details the heat consumption in 2020 and estimated consumption in 2050 by non-domestic and domestic for Southeast of the UK as extracted from the NCA. Heat consumption is greatest in the domestic sector. Heat demand from the non-domestic and domestic sectors is below the national average. The estimated heat consumption in 2020 is lower than in 2050. The energy projections take account of climate change policies where funding has been agreed and where decisions on policy design are sufficiently advanced to allow robust estimates of policy impacts to be made, including measures such as Building Regulations.

Table 2: Heat consumption in the Southeast of the UK

Sector	2020 consumption (TWh/annum)	2050 consumption (TWh/annum)
Non-domestic	9.1	-
Domestic	53.1	-
Total	62.2	68.3

Source: National Comprehensive Assessment of the Potential for Combined Heat and Power and District Heating and Cooling in the UK, Arup, September 2021

Current and projected space cooling consumption data is detailed in Table 3. Forecasts of cooling demand to 2050 have not been possible to compile for the NCA. BEIS is currently developing the evidence base for cooling in the UK, as part of a separate study. Given the paucity of available data on energy consumption for cooling, these figures are estimates based on consumption indicators, building types and floor areas; consequently, they should be considered as indicative.

Table 3: Cooling consumption in the Southeast of the UK

Sector	2020 consumption (TWh/annum)
Non-domestic	5.0

³Opportunity areas for district heating networks in the UK, Sep 2021

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1015585/opps_for_dhnnca_hc.pdf

Sector	2020 consumption (TWh/annum)
Domestic	No assumed domestic cooling
Total	5.0

Source: *National Comprehensive Assessment of the Potential for Combined Heat and Power and District Heating and Cooling in the UK*, Arup, September 2021

Heating and cooling consumption data presented in the 2021 report should be considered an overview only due to the low resolution of the data. For example, the data does not specify the locations of heat and cooling demands within each region.

5.1.2 UK CHP Development Map

The Department for Business, Energy and Industrial Strategy (BEIS) UK CHP Development Map⁴ geographically represents heat demand across various sectors in England, Scotland, Wales and Northern Ireland. A search of heat consumers within 15 km of the Facility was carried out, as shown in Table 4. This is represented as coloured contour areas in Figure 4, with each colour band representing a range of heat demand density values.

The data returned considers the entire regional area into which the search area extends. If a search radius extends marginally into a particular region, the data for the entire region will be included in the results table so there is a possibility that the heat demand can be overestimated.

With the exception of public buildings, the heat map is produced entirely without access to the meter readings or energy bills of individual premises. Therefore, results should be taken as estimates only.

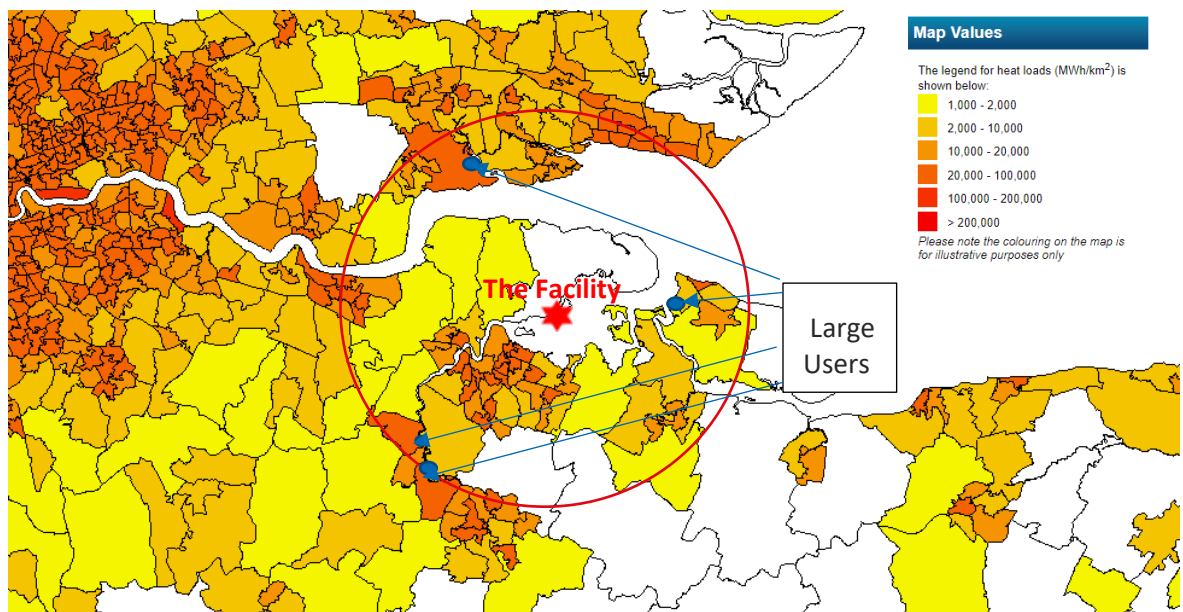
⁴ <http://chptools.decc.gov.uk/developmentmap/>

Table 4: Heat demand within 15 km of the Facility

Sector	Heat demand	
	MWh/a	% share
Communications and Transport	4,855	0.08%
Commercial Offices	15,372	0.26%
Domestic	2,744,410	46.51%
Education	79,934	1.35%
Government Buildings	10,722	0.18%
Hotels	14,546	0.25%
Large Industrial	2,818,086	47.76%
Health	32,432	0.55%
Other	7,110	0.12%
Small Industrial	134,535	2.28%
Prisons	-	0.00%
Retail	23,083	0.39%
Sport and Leisure	4,855	0.08%
Warehouses	10,946	0.19%
District Heating	-	0.00%
Total heat load in area	5,900,884	100%

Source: UK CHP Development Map

Figure 4: Local heat demand density



Source: UK CHP Development Map

The heat demand in the area surrounding the Facility is predominantly from the commercial/industrial sectors, and to a lesser extent, the domestic sector. In most cases, existing

domestic buildings are unsuitable for inclusion in a heat network as a result of the prohibitive costs of replacing existing heating infrastructure and connecting multiple smaller heat consumers to a network. To secure the most economically viable heat network, Fichtner has attempted to identify consumers that will provide maximum return and carbon saving for the minimum cost. Therefore, the approach to this study has focused on industrial and commercial consumers within the search radius.

Sections 5.1.3 and 5.1.4 identify potential heat users that would provide maximum return and carbon saving.

5.1.3 Large Heat Consumers

Four large heat consumers (point heat demands greater than 5 MW_{th}) were identified within 15km of the Facility using the BEIS UK CHP Development Map⁵ tool, as shown as shown in detailed in Table 5 and Figure 4.

Table 5: Large Heat Consumers

Site	Heat demand (MWh/annum)
Large heat consumer 1	1,784,018
Large heat consumer 2	409,331
Large heat consumer 3	27,213
Large heat consumer 4	23,722

The locations of the large heat consumers identified are at distances that would require a prohibitively costly pipe network to connect. Physical constraints imposed by the local infrastructure and topology have a significant impact on which loads can viably be connected. River and rail crossings are technically challenging and may obstruct the most direct route to the consumer. Connecting most of these large heat users to a heat network from the Facility would require river and rail crossings. The above distances assume river crossings and rail crossings will use existing road bridges. Crossings and associated new infrastructure will increase the cost of the network. Due to the estimated distances and complexity of the connections to these heat consumers, they have been discounted.

5.1.4 First heat network option - MedwayOne

The Facility is located within the wider MedwayOne development site, a large new development site in Medway. Access to the site is via Eschol Road to the west. The MedwayOne development is the proposed regeneration and redevelopment of the former Kingsnorth power station site to create a modern new employment space on the Hoo Peninsula, Medway in Kent.

The development includes a mixture of commercial, manufacturing and industrial uses along with storage and distribution, including data centre and energy uses with around 330,000sqm.

Uniper has submitted an outline planning application in March 2021 to enable the redevelopment of the site, which covers a total area of approximately 279 acres (113 hectares). Just over half of the site, 152 acres (62 hectares) is readily developable land. Uniper’s proposals for MedwayOne support Medway Council’s ambitions for future economic development in the District, as part of its emerging Local Plan to 2037. The proposals could also enable the development of a lower carbon future for the peninsula, which is a high priority for Medway.

⁵ <http://chptools.decc.gov.uk/developmentmap/>

For the purposes of this assessment the MedwayOne development is considered to be the potential heat consumer. There are no fixed contracts in place with specific heat users; however, it is assumed that the heat demand for an annual average heat load of the MedwayOne development is approximately 10 MW_{th}. The Facility will be technically capable of meeting this heat demand for the MedwayOne development, subject to economic and commercial feasibility. The maximum heat capacity of the Facility will be confirmed during detailed design and will be set as a minimum to meet the requirements of the heat consumers identified. In the event that the heat demand of the MedwayOne development is more than 10 MW_{th}, the design of the Facility may need to be reconfigured to enable the additional heat export, and this would be subject to reaching appropriate commercial agreements with the relevant heat users.

The Masterplan for the MedwayOne development is presented in Figure 5.

Figure 5: MedwayOne masterplan



Source: <https://medwayone.co.uk/the-scheme/>

5.1.5 Second heat network option – a single heat user in MedwayOne

There have been meetings with a potential single heat user in the MedwayOne development which has a heat demand of 15 MW_{th} from the Facility, subject to commercial agreement.

5.2 Estimated Overall Heat Load

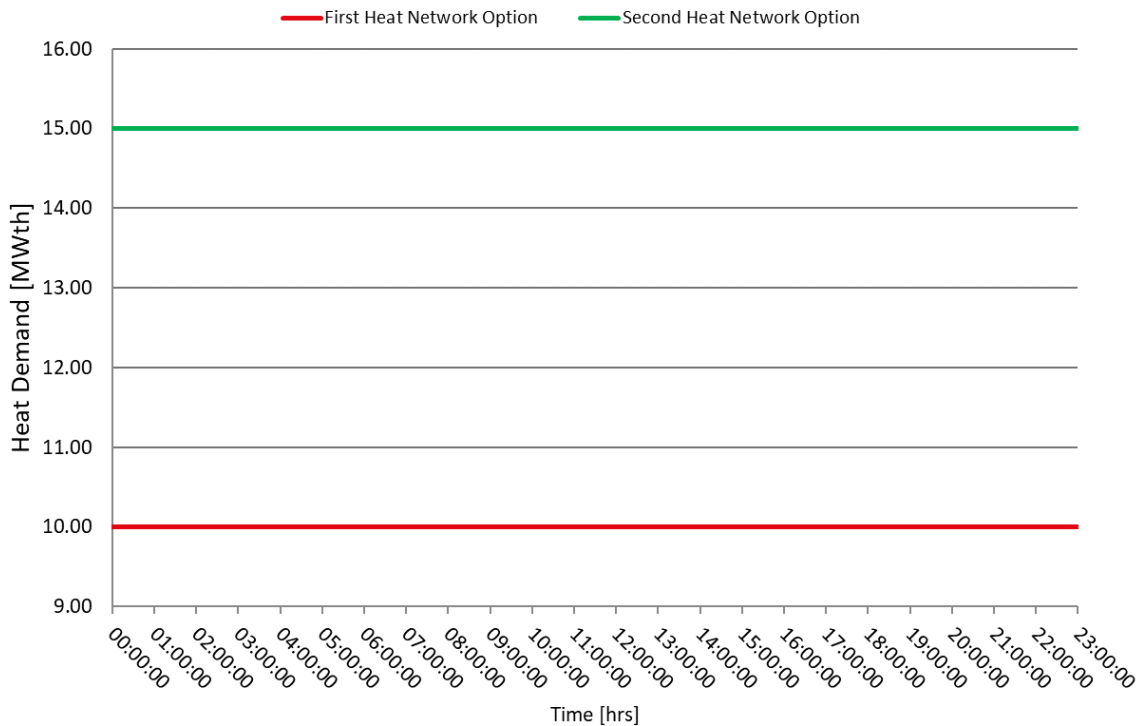
For the purposes of this report, the MedwayOne development has been identified as the potential first option heat user for the Facility and a potential single heat user in the MedwayOne development as a second heat user option. The Facility will export up to 77,964 MWh of heat per annum to the first heat network option and 116,946 MWh to the second heat network option.

6 Heat Network Technical Solution

6.1 Heat Network Profile

The heat network profile for the first and second heat network options is shown in Figure 6 and illustrates the constant heat demand that is anticipated. The profile represents heat demand at the Facility boundary.

Figure 6: Heat network profile



The total annual heat export and average instantaneous network values are projected in Table 6.

Table 6: Proposed heat network demand - Supply from Facility

Annual Heat Load		
First heat network option	MWh/a	77,964
Second heat network option	MWh/a	116,946
Average heat demand		
First heat network option	MW _{th}	10.00
Second heat network option	MW _{th}	15.00

6.2 ESCo Arrangements

The MedwayOne development will utilise an Energy Services Company (ESCo) to manage the interface between the Facility and the energy consumers for the MedwayOne development district heating system (DHS). This allows for separate accountability and risk management. The ESCo would buy energy from the Facility at a rate that provided an acceptable rate of return to the producer and with the ability for the ESCo to make sufficient margin to cover their costs and risks and then to make a profit.

The ESCo would normally be responsible for:

- Ensuring that there is sufficient heat available at all times to meet the demand of the DHS;
- Maintaining the DHS;
- DHS operational costs such as peak lopping fuel, pumping and water treatment;
- Billing, revenue collection and debt risk;
- Sales and marketing activities; and
- Customer care.

The assets required to deliver heat normally have a long service life. If designed and installed correctly the district heating pipeline should have a life in excess of 30 years. Standby/peak lopping boilers also have a long life as their utilisation is relatively low. Other key items such as burners, heat exchangers, pumps and pressurisation equipment should have an operational life of over 15 years. Control equipment may have a more limited life, possibly due to changes in technology or the ability to obtain service support.

Heat is normally delivered via one or more heat exchanger substations. This equipment could be owned by the ESCo or, similar to a back-up boiler installation.

6.3 Heat Network Design

The steam from the Facility turbine will be delivered to a connection point which is controlled and owned by an ESCo, with the heat being distributed to the individual heat users by the ESCo. As a conventional heat network, heat distribution between the heat exchanger in the ESCo connection point and the MedwayOne development is assumed to be via a buried pipework. Pre-insulated steel pipes would be used to supply pressurised hot water to the customer, and to return cooler water. Where pipes are small, two pipes may be integrated within a single insulated sleeve. For larger heat demands, large bore pipes would be installed as a single insulated run. Pipe technology is well proven and can provide a heat distribution system with a 30 year plus design life. Additional pipe work will be able to be added retrospectively, and it would be reasonably straightforward to add branches to serve any new/additional developments.

Modern heat-insulated piping technology enables hot water to be transferred large distances without significant losses. Where the topography creates challenges, heat exchangers and additional pumping systems can be installed to create pressure breaks, enabling the network to be extended.

Heat delivery arriving at a heat consumer's premises usually terminates using a secondary heat exchanger. The heat exchanger is typically arranged to supply heat to a tertiary heating circuit upstream of any boiler plant. The water in the tertiary circuit is boosted to the temperature required to satisfy the heating needs of the building.

Water is pumped continuously around the system. Pumps are operated with 100% standby capacity to maintain heat in the event of a pump fault. Pumps are likely to utilise variable speed drives to minimise energy usage.

The following conservative design criteria relate to a typical hot water network utilising conventional heat extraction (as detailed in section 4.2) and have been used to size the heat transmission pipe diameters. Where possible, the flow temperature will be reduced to minimise heat losses and this will be subject to the requirements of the heat consumers. Flow and return temperatures presented in Table 7 have been selected on the basis of the likely requirements of identified consumers.

Table 7: District heating network design criteria

Parameter	Value
Water supply temperature to consumer	100°C
Water return temperature from consumer	80°C
Distance between flow and return pipes	250 mm
Soil temperature	10°C
Depth of soil covering	600 mm

Using the above design criteria and allowing for the estimated heat demand for the preferred network, the primary hot water transmission pipe size has been calculated as DN250 for the first heat network option and DN350 for the second heat network option. This is an indicative figure and will be subject to heat demand verification and subsequent network design. Assuming the difference between the flow and return temperatures (deltaT) remains constant, it will be possible to reduce the flow temperature in the future in line with the CIBSE Code of Practice without impacting the pipe size and thereby reduce system energy losses.

6.4 Back-up Heat Sources

The Facility has been designed to achieve an availability of 91.3 % (i.e. 8,000 operational hours per year). During periods of routine maintenance or unplanned outages the Facility will not be operating, however the heat consumers will still require heat. There is therefore a need, somewhere within the heat distribution system run ESCo, to provide a back-up source of heat to meet the needs of the heat consumers.

At the heat network scale under consideration, the standby plant will likely comprise oil- or gas-fired hot water heaters (boilers) with a separate dedicated chimney stack. Back-up boilers are typically designed to ensure that the peak heat export capacity can be met but also provide sufficient turndown to supply smaller summer loads with reasonable efficiency. Electric boiler may become an option in the future.

Cost of back-up plant have not been included in the economic assessment in Section 8.3 as it will be installed and operated by ESCo.

6.5 Considerations for Pipe Route

At the present time, no definitive fixed route has been established for the connections from the Facility to the MedwayOne development connection point, since no specific agreements have been made. However, an indicative pipe route is presented in Appendix A.

Planning permission, easements and Highways Licenses would need to be obtained for access, construction, and maintenance of the pipeline infrastructure. There is a significant financial implication for obtaining easements, and these would only be progressed once planning permission and an EP have been granted for the Facility and heat supply agreements put in place. Traffic management requirements would need to be agreed prior to being able to obtain the necessary Highways Licenses granting permission to install the pipework. The projected timetable for the development of the heat mains is detailed in Section 6.6.

Discussions with the developers of the MedwayOne development will need to be entered into which, if successful, would lead into the production of a heat supply agreement and designs for the pipework. A full economic analysis will need to be undertaken, considering the costs associated with pipe installation and lost electricity revenue in order to determine a suitable heat price per unit. However, without an EP being granted for the Facility, any firm commitment to a supply of heat is difficult to achieve.

6.6 Implementation Timescale

The table below gives an indicative timetable for the programme for the construction of the Facility and heat network. The start of the construction of the heat system is dependent on the viability of the system and the location of the connection point to the MedwayOne development. For example, planning and gaining consent for installation of the pipework off the site would take a significant amount of time due to the potential impact on local traffic management. Until a core of heat consumers in the MedwayOne development have been identified and contracted to take heat, pipeline installation will not commence. The indicative timetable allows for obtaining Planning consent, discharging Planning conditions, negotiating heat supply agreements and some nominal float to cover possible Facility construction delays.

Table 8: Implementation programme

Description	Schedule (from Day 1)
Obtain Permitting for the Facility	Day 1
Completion of Negotiation for Heat Supply Contracts	+6 months
Start of Construction of plant	+9 months
Submit planning application for heat mains	+18 months
Start of commissioning of the Facility	+30 months
Take Over of the Facility	+36 months
Completion of Construction on Heat System	+46 months
Testing & Commissioning of Heat Network	+47 months
Start-up of the Heat Supply	+48 months

7 Energy Efficiency Calculations

7.1 Heat and Power Export

The Z ratio, which is the ratio of reduction in power export for a given increase in heat export, can be used to calculate the effect of variations in heat export on the electrical output of the Facility. A value of 6.85 was obtained following the approach set out in CHPQA Guidance Note 28⁶, assuming steam extraction at a pressure of 1.9 bar(a), which is considered sufficient to meet the requirements of the potential heat consumers identified for the Facility. The heat and power export has been modelled across a range of load cases and the results are presented in Table 9.

Table 9: Heat and power export

Load case	Heat export at turbine (MW _{th})	Gross power generated (MWe)	Net power exported (MWe)	Z ratio
1. No heat export	0.0	49.90	44.90	N/A
2. First option network heat load	10.00	48.44	43.44	6.85
3. Second option network heat load	15.00	47.71	42.71	6.85

The results indicate that for the heat consumers identified in Section 5.1, first network option corresponding to a heat export of 10 MW_{th} will result in a net power export of 43.44 MW_e and second network option corresponding to a heat export of 15 MW_{th} will result in a net power export of 42.71 MW

7.2 CHPQA Quality Index

CHPQA is an energy efficiency best practice programme initiative by the UK Government. CHPQA aims to monitor, assess and improve the quality of CHP in the UK. In order to prove that a plant is a ‘Good Quality’ CHP plant, a QI of at least 105 must be achieved at the design, specification, tendering and approval stages. Under normal operating conditions (i.e. when the scheme is operational) the QI threshold drops to 100. The QI for CHP schemes is a function of their heat efficiency and power efficiency according to the following formula:

$$QI = X\eta_{power} + Y\eta_{heat}$$

where: η_{power} = power efficiency; and

η_{heat} = heat efficiency.

The power efficiency within the formula is calculated using the gross electrical output and is based on the gross calorific value of the input fuel. The heat efficiency is also based on the gross calorific value of the input fuel. The coefficients X and Y are defined by CHPQA based on the total gross electrical capacity of the scheme and the fuel / technology type used.

⁶ CHPQA Guidance Note 28, 2007

In December 2018, the Government released a revised CHPQA Standard Issue 7. The document sets out revisions to the design and implementation of the CHPQA scheme. These revisions are intended to ensure schemes which receive Government support are supplying significant quantities of heat and delivering intended energy savings. The following X and Y coefficients apply to the Facility:

- X value = 220; and
- Y value = 120.

The QI and efficiency values (based on a gross calorific value of 12.09 MJ/kg) have been calculated in accordance with CHPQA methodology for various load cases and the results are presented in Table 10.

Table 10: QI and efficiency calculations

Load case	Gross power efficiency (%)	Heat efficiency (%)	Overall efficiency (%)	CHPQA QI
1. No heat export	26.07	0.00	26.07	57.35
2. First option network heat load	25.30	5.22	30.53	61.94
3. Second option network heat load	24.92	7.84	32.76	64.23

The results indicate that the Facility will not achieve a QI score in excess of the ‘Good Quality’ CHP threshold (QI of 105 at the design stage) for the first and second options. The highly onerous efficiency criteria set out in the latest CHPQA guidance, most notably the underpinning requirement to achieve an overall efficiency (NCV basis) of at least 70%, means that none of the load cases considered will enable heat export from the Facility to be considered Good Quality.

For reference, assuming the same Z ratio as set out in the preceding section, an average heat export of 104 MW_{th} would be required for a heat network to achieve Good Quality status. It is clear that the design proposed for heat recovery is not capable of supplying this quantity of heat at the assumed conditions required by the local network.

8 Heat Network Economic Assessment

8.1 Fiscal Support

The following fiscal incentives are available to energy generation projects and impact the feasibility of delivering a district heating network.

8.1.1 Capacity Market for electricity supplied by the Facility

Under the Capacity Market, subsidies are paid to electricity generators (and large electricity consumers who can offer demand-side response) to ensure long-term energy security for the UK. Capacity Agreements are awarded in a competitive auction and new plants (such as the Facility) are eligible for contracts lasting up to 15 years. Based on the eligibility criteria of the mechanism, the Facility will be eligible for Capacity Market support. Since support is based on electrical generation capacity (which would reduce when operating in CHP mode), these payments will act to disincentivise heat export and have therefore not been included in the economic assessment.

8.1.2 Renewable Heat Incentive

The Renewable Heat Incentive (RHI) was created by the Government to promote the deployment of heat generated from renewable sources. However, no funding announcements have been published for the RHI post March 2022. Therefore, it is unlikely the Facility will receive incentives under the RHI.

8.1.3 Contracts for Difference

Contracts for Difference (CfD) replaced the Renewables Obligation (RO) as the mechanism by which the Government has supported low carbon power generation. Launched in 2014, there have been four rounds aimed at incentivising investment in renewable energy. CfD incentivises investment by providing project developers with protection from volatile wholesale prices while protecting consumers from paying increased support costs when electricity prices are high. CfD de-risks investments by guaranteeing a fixed price (the Strike Price) for electricity over a 15-year period.

The fourth CfD allocation round (AR4) was executed on 13th December 2021, with deadline for bids on 14th January 2022, and is now closed. The Government has moved to annual CfD allocation rounds (instead of every two years) with allocation round 5 (AR5) scheduled for March 2023. As of June 2023, the Government has not announced the AR5 results but should be available by late summer / early Autumn.

Based on AR4's budget allocation, we would not expect that energy from waste with CHP will be considered high priority for AR5. On this basis, for the purpose of this assessment, we have assumed that the Facility will not receive support under the CfD mechanism.

8.1.4 Green Heat Networks Fund

The GHNF is a three-year £288 million capital grant fund to support the commercialisation and construction of new low and zero carbon heat networks and the retrofitting and expansion of existing heat networks. The GHNF is open to organisations in the public or private sectors in England.

1. The GHNF opened to applicants in March 2022, Round 4 was open to applications until 24 February 2023. There will be a series of quarterly application rounds until the scheme closes in 2025.

2. Minimum project eligibility metrics include:
 - a. 100 g CO₂e/kWh thermal energy delivered to consumers; and
 - b. minimum demand of 2 GWh/year for urban networks.
3. The GHNH will fund up to 50% of a project's total combined commercialisation and construction costs (with an upper limit of £1 million for commercialisation).
4. The GHNH will provide support for accessing heat sources such as capturing waste heat from an industrial process, energy from waste, wastewater, low carbon generation such as energy centres and low-carbon generation and support for primary heat network distribution including distribution pipework for transmission and distribution of low-carbon heating and cooling.

Whether the Facility would be eligible for GHNH would be investigated in more detail at a later stage. To be conservative, GHNH is not included in the economic assessment at this stage.

8.2 Technical feasibility

Step 3 of the CBA methodology requires identification of existing and proposed heat loads which are technically feasible to supply. The draft Article 14 guidance states that the following factors should be accounted for when determining the technical feasibility of a scheme, pertaining to a type 14.5(a) installation.

1. The compatibility of the heat source(s) and load(s) in terms of temperature and load profiles

The CHP scheme has been developed on the basis of delivering heat at typical district heating conditions (refer to Section 6.2). It is reasonable to assume that identified potential heat consumers would be able to utilise hot water at the design conditions. Consumer requirements (in terms of hot water temperature and load profiles) will need to be verified in any subsequent design process prior to the implementation of a heat network. Therefore, the heat source and heat load are considered to be compatible.

2. Whether thermal stores or other techniques can be used to match heat source(s) and load(s) which will otherwise have incompatible load profiles

Conventional thermal stores or back-up boilers (as detailed in Section 6.4) will likely be included in the CHP scheme to ensure continuity of supply. The specific arrangement will be selected when there is greater certainty with regards heat loads.

3. Whether there is enough demand for heat to allow high-efficiency cogeneration

High-efficiency cogeneration is cogeneration which achieves at least 10% savings in primary energy usage compared to the separate generation of heat and power. Primary energy saving (PES) is calculated in the following section.

8.2.1 Primary energy savings

To be considered high-efficiency cogeneration, the scheme must achieve at least 10% savings in primary energy usage compared to the separate generation of heat and power. PES have been calculated in accordance with European Commission Delegated Regulation (EU) 2015/2402 of 12 October 2015 Annex II part (b), using the following assumptions.

1. Annual nominal throughput capacity of 456,000 tonnes per annum based on an NCV of 10.5 MJ/kg.
2. Nominal gross electrical output (expected capacity in fully condensing mode) of 49.90 MW_e.
3. Parasitic load is 5.00 MW_e.
4. Z ratio of 6.85.

5. Efficiency reference values for the separate production of heat and electricity have been taken as 75 % and 25 % respectively as defined in Commission Delegated Regulation (EU) 2015/2402 of 12 October 2015⁷.

When operating in fully condensing mode (i.e. without heat export) the Facility will achieve a PES of 16.71 %. This is in excess of the technical feasibility threshold defined in the draft Article 14 guidance. The inclusion of heat export at the design case level anticipated for the first heat network option increases PES to 19.72 % and for the second heat network option increases PES to 21.15 %. On this basis, the Facility will qualify as a high-efficiency cogeneration operation when operating in CHP mode.

8.3 Results of CBA

A CBA has been carried out on the selected heat load, in accordance with section 3 of the draft Article 14 guidance. The CBA uses an Excel template, '*Environment Agency Article 14 CBA Template.xlsx*' provided by the EA, with inputs updated to correspond with the specifics of this Heat Plan.

The CBA model considers:

1. the revenue streams (heat sales to EScO for the first and second options);
2. the costs streams for the heat supply infrastructure (construction and operational); and
3. the lost electricity sales revenue, over the lifetime of the scheme.

The following assumptions have been made:

1. The DH scheme will commence operation in 2027.
2. The heat export infrastructure required to export heat from the Facility to the EScO connection point is estimated to have a capital cost of approximately:
 - a. £0.89 million for the first network option; and
 - b. £1.1 million for the second network option.
3. The heat export infrastructure required to export heat from the Facility to the EScO connection point is split over an up to two-year construction programme.
4. Operational costs have been estimated based on similar sized projects.
5. Heat sales revenue will be £13.0 / MWh, current price and index linked for inflation in CBA.
6. Electricity sales revenue will be £59.7/ MWh, current price and index linked for inflation in CBA.

The results of the CBA indicate that both the nominal project internal rate of return and net present value (before financing and tax) over 30 years are:

7. For the first network option: 26.1 % and £0.46 million respectively; and
8. For the second network option: 30.6 % and £0.87 million respectively.

Therefore, it is considered that the proposed first and second heat network options yield an economically viable scheme in its current configuration. Model inputs and key outputs are presented in Appendix B.

⁷ <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32015R2402>

9 CHP-Ready BAT Assessment

9.1 CHP-Ready BAT Assessment

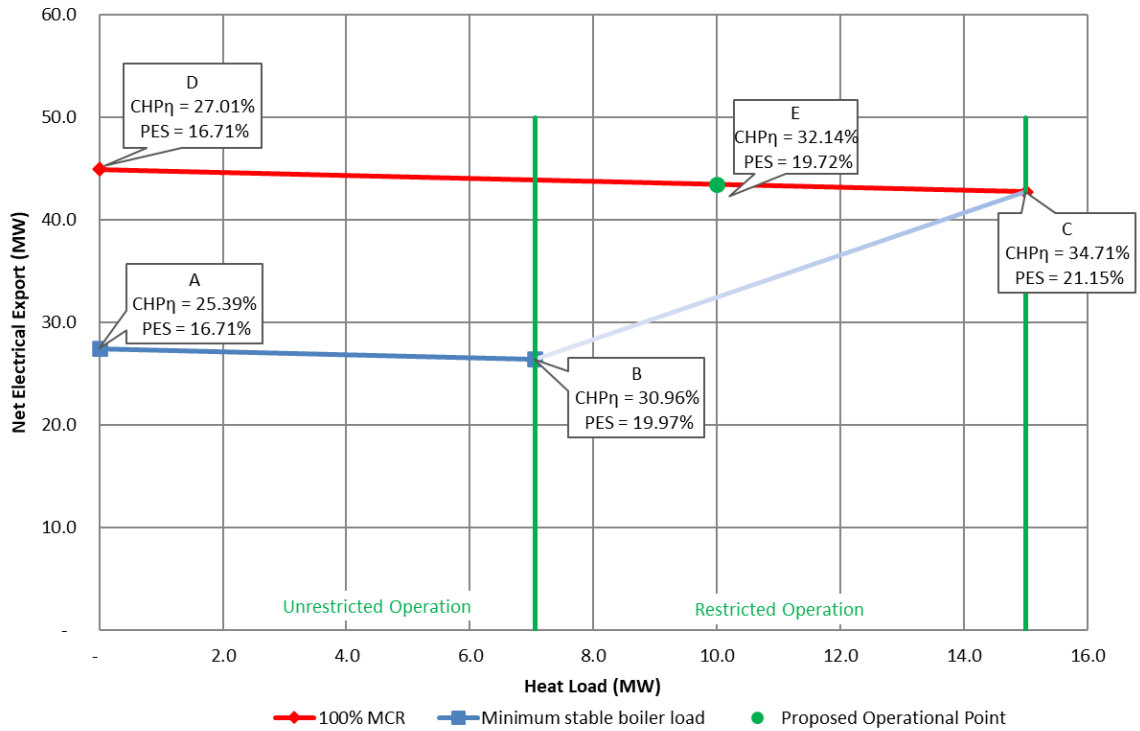
This report includes a CHP-Ready Assessment which considers the requirements of the EA's CHP-Ready Guidance. The completed CHP-Ready Assessment form is provided in Appendix C.

The 'CHP envelope' as outlined under requirement 2 of the CHP-Ready guidance, which identifies the potential operational range of a new plant where it could be technically feasible to operate electrical power generation with heat generation, is provided in Figure 7.

The points defining the CHP envelope are as follows.

- A: minimum stable load (with no heat extraction).
- B: minimum stable load (with maximum heat extraction).
- Line A to B: minimum electrical power output for any given heat load (corresponds to the minimum stable plant load).
- **C: 100% load (with maximum heat extraction), second heat network option.**
- D: 100% load (with no heat extraction).
- Line D to C: maximum electrical power output for any given heat load (corresponds to 100% plant load).
- **E: proposed operational point of the Facility, first heat network option.**
- Unrestricted operation: if a selected heat load is located in this region, the Facility will have the ability to operate at any load between minimum stable plant load and 100% plant load whilst maintaining the selected heat load.
- Restricted operation: if a selected heat load is located in this region, the Facility will not have the ability to operate over its full operational range without a reduction in heat load.

Figure 7: Graphical representation of CHP envelope



The proposed operational point (point E) represents the first option network heat demand. The proposed operational point (point C) represents the second option network heat demand.

It considers the heat losses and pressure drop in the pipe network and therefore corresponds to the heat demand predicted at the Facility site boundary. The operational range for the Facility will ultimately be subject to the required hot water flow temperature and final steam turbine selection, which are subject to detailed design.

Appendices

A Pipe route and heat users

B CBA Inputs and Key Outputs

B.1 The first network option (10MW_{th})

INPUTS

Version Jan 2015

Scenario Choice (dropdown box)

Technical solution features

Heat carrying medium (hot water, steam or other) (dropdown box)
 Total length of supply pipework (kms)
 Peak heat demand from Heat User(s) (MWth)

Annual quantity of heat supplied from the Heat Source(s) to Heat User(s) (MWh)

DCF Model Parameters

Discount rate (pre-tax pre-financing) (%) - 17% suggested rate
 Project lifespan (yrs)
Exceptional shorter lifespan (yrs)

Cost and revenue streams

Construction costs and build up of operating costs and revenues during construction phase

Project asset lifespan (yrs)
Exceptional reason for shorter lifespan of Heat Supply Infrastructure, Standby Boiler and/ or Heat Station (yrs)
 Construction length before system operational and at steady state (yrs)
 Number of years to build

Year 1 costs (£m) and build up of operating costs and revenues (%)
 Year 2 costs (£m) and build up of operating costs and revenues (%)
 Year 3 costs (£m) and build up of operating costs and revenues (%)
 Year 4 costs (£m) and build up of operating costs and revenues (%)
 Year 5 costs (£m) and build up of operating costs and revenues (%)

Non-power related operations

1 Power generator (Heat Source) same fuel amount

Hot water
 0.4
 10

Lines 49 & 79

17%

30
 0

Key

- 2** Participant to define
- 2** Regulatory prescribed
- 2** Calculated
- 2** Prescribed - but possibility to change if make a case

% operating costs and revenues during construction phase	Heat Supply Infrastructure - used in Scenarios 1, 2, 3 and 5	Heat Station - used in Scenarios 1, 2 and 3	Standby boilers (only if needed for Scenarios 1, 2 and 3)	Industrial CHP - used in Scenario 4 *
	30	30	30	

2

0 2 0 0

% (ONLY IF APPLICABLE)	£m	£m	£m	£m
0%		0.44343018		
0%		0.44343018		

OPEX for full steady state Heat Supply Infrastructure on price basis of first year of operations (partial or steady state) (£m)	0.0
OPEX for full steady state Heat Station on price basis of first year of operations (partial or steady state) (£m)	0.0
OPEX for full steady state Standby Boilers on price basis of first year of operations (partial or steady state) (£m)	0.0
OPEX for full steady state Industrial CHP on price basis of first year of operations (partial or steady state) (£m) *	
Additional equivalent OPEX to pay for a major Industrial CHP overall spread over the life of the asset (£m) on price basis of first year of operations (partial or steady state) (£m) *	
Other 1 - Participant to define (£m)	
Other 2 - Participant to define (£m)	
Total non-power related operations	0.1
Annual inflation for all non-power related OPEX from first year of operations (full or partial) (%)	2.0%

Unit Energy Prices, Energy Balance, Fuel Related Operational costs and Revenue Stream

Scenario used					
	1	2	3	4	5
	Power generator (Heat Source) same fuel amount	Power generator (Heat Source) same electrical output	Industrial installation (Heat Source) - use waste heat	Industrial installation (Heat Source) - CHP set to thermal input	District heating (Heat User)
Heat sale price (£/ MWh) at first year of operations (partial or full)	13.00	13.00			
Annual quantity of heat supplied from the Heat Source(s) to Heat User(s) at steady state (MWh)	77,964	77,964			
Equivalent heat sales if first year of operations is steady state (£ m)	1.0				
Heat sale price inflation from first year of operations (full or partial) (% per year)	2.0%				
Percentage of heat supplied by Standby Boiler (if relevant)	0%				
'Lost' electricity sale price (£/ MWh) at first year of operations	59.70	59.70			
Z-ratio (commonly in the range 3.5 - 8.5)	6.85	6.85			
Power generation lost at steady state (MWh)	11,382	11,382			
Equivalent 'lost' revenue from power generation if first year of operations is steady state (£ m)	0.68				
Electricity sale price inflation from first year of operations (full or partial) (% per year)	2.0%				
Industrial CHP electricity sale price (£/ MWh) at first year of operations (full or partial)	0.00				
Industrial CHP electrical generation in steady state (MWh)	0				
Equivalent revenue from power generation if first year of operations is steady state (£ m)	0.00				

Industrial CHP electricity price inflation from first year of operations (full or partial) (% per year)	0.0%	
Fuel price for larger power generator/ CHP at first year of operations (full or partial) (£ / MWh)	0.00	
Z-ratio (commonly in the range 3.5 - 8.5)	0	
Power efficiency in cogeneration mode (%)	0	
Additional fuel required per year for larger power generator / CHP in steady state (MWh)	0	#DIV/0!
Equivalent additional fuel costs if first year of operations is steady state (£ m)	0.00	
Fuel price inflation from first year of operations (full or partial) (% per year)	0.0%	
Fuel price for Standby Boiler at first year of operations (£ / MWh)	25.00	25.00
Boiler efficiency of Standby Boiler (%)	80%	80% 80% 80%
Additional fuel required per year for Standby Boiler in steady state (MWh)	-	- - -
Equivalent additional fuel costs if first year of operations is steady state (£m)	-	
Fuel price inflation for Standby Boiler from first year of operations (full or partial) (% per year)	2.00%	2.0%
Heat purchase price (£/ MWh) at first year of operations (partial or full)	0.00	
Annual quantity of heat supplied from the Heat Source(s) to Heat User(s) at steady state (MWh)	0	
Equivalent cost of heat purchased if first year of operations is steady state (£ m)	0.0	
Heat purchase price inflation from first year of operations (full or partial) (% per year)	0.0%	
Fuel price (£ / MWh) at first year of operations (partial or full)	0.00	
Boiler efficiency of district heating plant	0%	80%
Fuel avoided per year in steady state (MWh)	0	-
Equivalent fuel savings if first year of operations is steady state (£m)	0.0	
Fuel price inflation from first year of operations (full or partial) (% per year)	0.0%	4.0%
Fiscal benefits (£m) in first year of operations assuming it is at steady state **	0.00	0.00
Fiscal benefits inflation rate from first year of operations (full or partial) (%) **	0.0%	

* In the case of Industrial CHP a separate model template is available for typical indicative CAPEX, non-power related OPEX, additional equivalent OPEX to pay for a major overall, MWh of electricity generated in the steady state and the additional fuel required.

** Operator only needs to enter a value for fiscal benefits (£m) and the annual fiscal benefit inflation rate (%) if the NPV without fiscal benefits is negative at the specified discount rate

OUTPUTS

Nominal Project IRR (before financing and tax) over 32 years	26.1%
Nominal NPV (before financing and tax) (£m) over 32 years	0.46

B.2 The second network option (15 MW_{th})

INPUTS Version Jan 2015

Scenario Choice (dropdown box)

1

Power generator (Heat Source) same fuel amount

Technical solution features

Heat carrying medium (hot water, steam or other) (dropdown box)
 Total length of supply pipework (kms)
 Peak heat demand from Heat User(s) (MW_{th})

Hot water
 0.4
 15
 Lines 49 & 79

Key

- 2 Participant to define
- 2 Regulatory prescribed
- 2 Calculated
- 2 Prescribed - but possibility to change if make a case

Annual quantity of heat supplied from the Heat Source(s) to Heat User(s) (MWh)

DCF Model Parameters

Discount rate (pre-tax pre-financing) (%) - 17% suggested rate
 Project lifespan (yrs)
Exceptional shorter lifespan (yrs)

17%
 30
 0

Cost and revenue streams

Construction costs and build up of operating costs and revenues during construction phase

% operating costs and revenues during construction phase	Heat Supply Infrastructure - used in Scenarios 1, 2, 3 and 5	Heat Station - used in Scenarios 1, 2 and 3	Standby boilers (only if needed for Scenarios 1, 2 and 3)	Industrial CHP - used in Scenario 4
	30	30	30	

Project asset lifespan (yrs)
Exceptional reason for shorter lifespan of Heat Supply Infrastructure, Standby Boiler and/ or Heat Station (yrs)
 Construction length before system operational and at steady state (yrs)
 Number of years to build

2

	0	2	0	0
%(ONLY IF APPLICABLE)	£m	£m	£m	£m
0%		0.551086274		
0%		0.551086274		

Year 1 costs (£m) and build up of operating costs and revenues (%)
 Year 2 costs (£m) and build up of operating costs and revenues (%)
 Year 3 costs (£m) and build up of operating costs and revenues (%)
 Year 4 costs (£m) and build up of operating costs and revenues (%)
 Year 5 costs (£m) and build up of operating costs and revenues (%)

Non-power related operations

OPEX for full steady state Heat Supply Infrastructure on price basis of first year of operations (partial or steady state) (£m)

0.0

OPEX for full steady state Heat Station on price basis of first year of operations (partial or steady state) (£m)	0.0
OPEX for full steady state Standby Boilers on price basis of first year of operations (partial or steady state) (£m)	0.0
OPEX for full steady state Industrial CHP on price basis of first year of operations (partial or steady state) (£m) *	
Additional equivalent OPEX to pay for a major Industrial CHP overall spread over the life of the asset (£m) on price basis of first year of operations (partial or steady state) (£m) *	
Other 1 - Participant to define (£m)	
Other 2 - Participant to define (£m)	
Total non-power related operations	0.0
Annual inflation for all non-power related OPEX from first year of operations (full or partial) (%)	2.0%

Unit Energy Prices, Energy Balance, Fuel Related Operational costs and Revenue Stream

Scenario used		1	2	3	4	5
		Power generator (Heat Source) same fuel amount	Power generator (Heat Source) same electrical output	Industrial installation (Heat Source) - use waste heat	Industrial installation (Heat Source) - CHP set to thermal input	District heating (Heat User)
Heat sale price (£/ MWh) at first year of operations (partial or full)	12.00	12.00				
Annual quantity of heat supplied from the Heat Source(s) to Heat User(s) at steady state (MWh)	116,940	116,940				
Equivalent heat sales if first year of operations is steady state (£ m)	1.4					
Heat sale price inflation from first year of operations (full or partial) (% per year)	2.0%	2.0%				
Percentage of heat supplied by Standby Boiler (if relevant)	0%	0%				
'Lost' electricity sale price (£/ MWh) at first year of operations	59.70	59.70				
Z-ratio (commonly in the range 3.5 - 8.5)	6.85	6.85				
Power generation lost at steady state (MWh)	17,072	17,072				
Equivalent 'lost' revenue from power generation if first year of operations is steady state (£ m)	1.02					
Electricity sale price inflation from first year of operations (full or partial) (% per year)	2.0%	2.0%				
Industrial CHP electricity sale price (£/ MWh) at first year of operations (full or partial)	0.00					
Industrial CHP electrical generation in steady state (MWh)	0					
Equivalent revenue from power generation if first year of operations is steady state (£ m)	0.00					
Industrial CHP electricity price inflation from first year of operations (full or partial) (% per year)	0.0%					
Fuel price for larger power generator/ CHP at first year of operations (full or partial) (£ / MWh)	0.00					
Z-ratio (commonly in the range 3.5 - 8.5)	0					
Power efficiency in cogeneration mode (%)	0					
Additional fuel required per year for larger power generator / CHP in steady state (MWh)	0	#DIV/0!				
Equivalent additional fuel costs if first year of operations is steady state (£ m)	0.00					
Fuel price inflation from first year of operations (full or partial) (% per year)	0.0%					

Fuel price for Standby Boiler at first year of operations (£ / MWh)	25.00	25.00			
Boiler efficiency of Standby Boiler (%)	80%	80%	80%	80%	
Additional fuel required per year for Standby Boiler in steady state (MWh)	-	-	-	-	
Equivalent additional fuel costs if first year of operations is steady state (£m)	-				
Fuel price inflation for Standby Boiler from first year of operations (full or partial) (% per year)	2.00%	2.0%			
Heat purchase price (£/ MWh) at first year of operations (partial or full)	0.00				
Annual quantity of heat supplied from the Heat Source(s) to Heat User(s) at steady state (MWh)	0				
Equivalent cost of heat purchased if first year of operations is steady state (£ m)	0.0				
Heat purchase price inflation from first year of operations (full or partial) (% per year)	0.0%				
Fuel price (£ / MWh) at first year of operations (partial or full)	0.00				
Boiler efficiency of district heating plant	0%			80%	
Fuel avoided per year in steady state (MWh)	0				
Equivalent fuel savings if first year of operations is steady state (£m)	0.0				
Fuel price inflation from first year of operations (full or partial) (% per year)	0.0%			4.0%	
Fiscal benefits (£m) in first year of operations assuming it is at steady state **	0.00	0.00			
Fiscal benefits inflation rate from first year of operations (full or partial) (%) **	0.0%				

* In the case of Industrial CHP a separate model template is available for typical indicative CAPEX, non-power related OPEX, additional equivalent OPEX to pay for a major overall, MWh of electricity generated in the steady state and the additional fuel required.

* Operator only needs to enter a value for fiscal benefits (£m) and the annual fiscal benefit inflation rate (%) if the NPV without fiscal benefits is negative at the specified discount rate

OUTPUTS	
Nominal Project IRR (before financing and tax) over 32 years	30.6%
Nominal NPV (before financing and tax) (£m) over 32 years	0.87

C CHP-R Assessment Form

#	Description	Units	Notes / Instructions
Requirement 1: Plant, Plant location and Potential heat loads			
1.1	Plant name		Medway Energy Recovery Facility
1.2	Plant description		<p>The main activities associated with the Facility will be the combustion of incoming waste to raise steam and the generation of electricity in a steam turbine/generator.</p> <p>The Facility includes two waste incineration lines, waste reception hall, main thermal treatment process, turbine hall, on-site facilities for the treatment or storage of residues and wastewater, flue gas treatment, stack, boilers, devices and systems for controlling operation of the waste incineration plant and recording and monitoring conditions.</p> <p>In addition to the main elements described, the Facility will also include weighbridges, water, auxiliary fuel and air supply systems, site fencing and security barriers, external hardstanding areas for vehicle manoeuvring, internal access roads and car parking, transformers, grid connection compound, firewater storage tanks, offices, workshop, stores and staff welfare facilities.</p> <p>The Facility has been designed to export power to the National Grid. The Facility will generate approximately 49.9 MWe of electricity in full condensing mode. The Facility will have a parasitic load of 5.0 MWe. Therefore, the maximum export capacity of the Facility is 44.90 MWe.</p> <p>In addition to generating power, the Facility has been designed to be capable of exporting approximately 10 MW_{th} heat to the identified district heating network of the MedwayOne development as a first option and also the 15 MW_{th} heat to a second heat network option. The maximum heat capacity will be subject to the requirements of the heat consumers and confirmed during detailed design stage.</p> <p>At the time of writing this report, there are no formal agreements in place for the export of heat from the Facility. The power exported may fluctuate as fuel quality fluctuates, and if heat is exported from the Facility to local heat users in the future.</p> <p>The Facility has been designed to thermally treat waste with a range of net calorific values (NCV's) with a Net Calorific Value (NCV) of 8 MJ/kg to 12.5 MJ/kg. The nominal capacity of the Facility is 57.0 tonnes per</p>

#	Description	Units	Notes / Instructions
			hour of fuel with an NCV of 10.5 MJ/kg. The expected operational availability is 8,000 hours per annum. Therefore, the nominal capacity for the installation is 456,000 tonnes per annum.
1.3	Plant location (Postcode / Grid Ref)		<p>The site is located within the wider MedwayOne development site, a large new development site in Medway. Access to the site is via Eschol Road to the west.</p> <p>The site is located on the Hoo Peninsula in Medway, Kent, immediately south of the Damhead Creek CCGT power station. The site is located approximately 4 km east of Hoo St Werburgh, and approximately 15km northeast of Chatham. Damhead Creek Gas-fired Power Station is located to the north of the site, with the Kingsnorth industrial estate lying to the northeast of the site. Marshland lies to the west of the site, whilst the southern and eastern boundaries of the site are next to the Medway River estuary.</p> <p>The site is a mix of brownfield and greenfield land on which the former Kingsnorth coal-fired power station was located prior to demolition and has a varied topography.</p> <p>The Facility will be located at an approximate national grid reference TQ 80982 72531.</p>
1.4	Factors influencing selection of plant location		Refer to Chapter 3 of EIA, submitted with planning application.
1.5	Operation of plant		
a)	Proposed operational plant load	%	100
b)	Thermal input at proposed operational plant load	MW	166
c)	Net electrical output at proposed operational plant load	MW	44.90
d)	Net electrical efficiency at proposed operational plant load	%	27.01%
e)	Maximum plant load	%	100
f)	Thermal input at maximum plant load	MW	166.25
g)	Net electrical output at maximum plant load	MW	44.90
h)	Net electrical efficiency at maximum plant load	%	27.01%
i)	minimum stable plant load	%	65%

#	Description	Units	Notes / Instructions
j)	Thermal input at minimum stable plant load	MW	108.06
k)	Net electrical output at minimum stable plant load	MW	26.41
l)	Net electrical efficiency at minimum stable plant load	%	24.44%
1.6	Identified potential heat loads		
			<p>Details of the identified heat loads are in Sections 5 and 6.1.</p> <p>The MedwayOne development is a potential heat user with a constant heat load of 10 MW_{th} as a first option heat network.</p> <p>The estimated heat use of the identified network is 87,600 MWh/year.</p> <p>The second option heat load is 15 MW_{th}.</p> <p>The estimated heat use of the identified second option network is 131,400 MWh/year.</p>
1.7	Selected heat load(s)		
a)	Category (e.g. industrial / district heating)		District heating
b)	Maximum heat load extraction required	MW	<p>The heat demand of the first option heat network has been calculated to be 10 MW_{th}.</p> <p>The heat demand of the second option heat network has been calculated to be 15 MW_{th}, which is the maximum heat load extraction.</p>
1.8	Export and return requirements of heat load		
a)	Description of heat load extraction		Network to supply hot water at typical district heating temperatures (approximately 100°C) via turbine steam extractions at approximately 1.91 bar(a).
b)	Description of heat load profile		The heat load profile is constant. A detailed heat load profile can be found in section 6.1 of the Heat Plan. The consumer heat load and profile is subject to verification.
c)	Export pressure	bar a	4
d)	Export temperature	°C	100
e)	Export flow	t/h	428 (the first heat network option) 642 (the second heat network option)
f)	Return pressure	bar a	4
g)	Return temperature	°C	80

#	Description	Units	Notes / Instructions
h)	Return flow	t/h	428 t/h (the first heat network option) 642 t/h(the second heat network option)
Requirement 2: Identification of CHP Envelope			
2.0	Comparative efficiency of a standalone boiler for supplying the heat load	% LHV	80% - updated in accordance with CHPQA Stakeholder Engagement Document, April 2016, Table 1.
2.1	Heat extraction at 100% plant load		
a)	Maximum heat load extraction at 100% plant load	MW	The heat demand of the first option heat network has been calculated to be 10 MW _{th} . The heat demand of the second option heat network has been calculated to be 15 MW _{th} , which is the maximum heat load extraction.
b)	Maximum heat extraction export flow at 100% plant load	t/h	Assuming steam extraction at 1.91 bar(a), export flow rate would be: 16.32 t/h (the first heat network option) 24.48 t/h (the second heat network option)
c)	CHP mode net electrical output at 100% plant load	MW	42.71
d)	CHP mode net electrical efficiency at 100% plant load	%	25.69%
e)	CHP mode net CHP efficiency at 100% plant load	%	34.71%
f)	Reduction in primary energy usage for CHP mode at 100% plant load	%	21.15%
2.2	Heat extraction at minimum stable plant load		
a)	Maximum heat load extraction at minimum stable plant load	MW	7.05
b)	Maximum heat extraction export flow at minimum stable plant load	t/h	Assuming steam extraction at 1.91bar(a), export flow rate would be: 11.51 t/h
c)	CHP mode net electrical output at minimum stable plant load	MW	26.41
d)	CHP mode net electrical efficiency at minimum stable plant load	%	24.44%
e)	CHP mode net CHP efficiency at minimum stable plant load	%	30.96%
f)	Reduction in primary energy usage for CHP mode at minimum stable plant load	%	19.97%

#	Description	Units	Notes / Instructions
2.3	Can the plant supply the selected identified potential heat load (i.e. is the identified potential heat load within the 'CHP envelope')?		Yes, but not deemed 'Good Quality' CHP as detailed in section 7 of the Heat Plan.
Requirement 3: Operation of the Plant with the Selected Identified Heat Load			
3.1	Proposed operation of plant with CHP		
a)	CHP mode net electrical output at proposed operational plant load	MW	43.44 (the first heat network option) 42.71 (the second heat network option)
b)	CHP mode net electrical efficiency at proposed operational plant load	%	25.13% (the first heat network option) 25.69% (the second heat network option)
c)	CHP mode net CHP efficiency at proposed operational plant load	%	32.14% (the first heat network option) 34.71% (the second heat network option)
d)	Reduction in net electrical output for CHP mode at proposed operational plant load	MW	1.46 (the first heat network option) 2.19 (the second heat network option)
e)	Reduction in net electrical efficiency for CHP mode at proposed operational plant load	%	0.88% (the first heat network option) 1.32% (the second heat network option)
f)	Reduction in primary energy usage for CHP mode at proposed operational plant load	%	19.72% (the first heat network option) 21.15% (the second heat network option)
g)	Z ratio		6.85
Requirement 4: Technical provisions and space requirements			
4.1	Description of likely suitable extraction points		Steam for the district heating system could be supplied from low pressure turbine bleed at approximately 1.91 bar(a). Full details are provided in section 4.2 of the Heat Plan.
4.2	Description of potential options which could be incorporated in the plant, should a CHP opportunity be realised outside the 'CHP envelope'		The CHP opportunity lies within the CHP envelope.
4.3	Description of how the future costs and burdens associated with supplying the identified heat load / potential CHP opportunity have been minimised through the implementation of an appropriate CHP-R design		There will be a dedicated heat station for CHP Station. The turbine design will be selected to maximise electrical efficiency while allowing for the option of heat export to be implemented in the future. This is in line with the EA CHP-Ready Guidance which states that the initial electrical efficiency of a CHP-R plant (before any opportunities for the supply of heat are realised) should be no less than that of the equivalent non-CHP-R plant.

#	Description	Units	Notes / Instructions
4.4	Provision of site layout of the plant, indicating available space which could be made available for CHP-R		<p>Detailed design of the Facility has not been undertaken at this stage. However, there will be a dedicated heat station for CHP Station for heat export infrastructure. Refer to the installation boundary drawing provided in Appendix A of the Application Pack.</p> <p>The heat network will (likely) include steam extraction piping, control and shutoff valves. ESCo equipment will include heat exchangers, district heating supply and return lines, district heating circulation pumps, condensate return piping (to the condensate tank), control and instrumentation / electrical connections, an expansion tank for pressurisation of the district heating pipe network, heat metering and a back-up boiler.</p>

Requirement 5: Integration of CHP and carbon capture

5.1	Is the plant required to be CCR?		No
5.2	Export and return requirements identified for carbon capture		
	100% plant load		
a)	Heat load extraction for carbon capture at 100% plant load	MW	N/A
b)	Description of heat export (e.g. steam / hot water)		N/A
c)	Export pressure	bar a	N/A
d)	Export temperature	°C	N/A
e)	Export flow	t/h	N/A
f)	Return pressure	bar a	N/A
g)	Return temperature	°C	N/A
h)	Return flow	t/h	N/A
i)	Likely suitable extraction points		N/A
	Minimum stable plant load		
j)	Heat load extraction for carbon capture at minimum stable plant load	MW	N/A
k)	Description of heat export (e.g. steam / hot water)		N/A
l)	Export pressure	bar a	N/A
m)	Export temperature	°C	N/A
n)	Export flow	t/h	N/A

#	Description	Units	Notes / Instructions
o)	Return pressure	bar a	N/A
p)	Return temperature	°C	N/A
q)	Return flow	t/h	N/A
r)	Likely suitable extraction points		N/A
5.3	Operation of plant with carbon capture (without CHP)		
a)	Maximum plant load with carbon capture	%	N/A
b)	Carbon capture mode thermal input at maximum plant load	MW	N/A
c)	Carbon capture mode net electrical output at maximum plant load	MW	N/A
d)	Carbon capture mode net electrical efficiency at maximum plant load	%	N/A
e)	Minimum stable plant load with CCS	%	N/A
f)	Carbon capture mode CCS thermal input at minimum stable plant load	MW	N/A
g)	Carbon capture mode net electrical output at minimum stable plant load	MW	N/A
h)	Carbon capture mode net electrical efficiency at minimum stable plant load	%	N/A
5.4	Heat extraction for CHP at 100% plant load with carbon capture		
a)	Maximum heat load extraction at 100% plant load with carbon capture [H]	MW	N/A
b)	Maximum heat extraction export flow at 100% plant load with carbon capture	t/h	N/A
c)	Carbon capture and CHP mode net electrical output at 100% plant load	MW	N/A
d)	Carbon capture and CHP mode net electrical efficiency at 100% plant load	%	N/A
e)	Carbon capture and CHP mode net CHP efficiency at 100% plant load	%	N/A
f)	Reduction in primary energy usage for carbon capture and CHP mode at 100% plant load	%	N/A

#	Description	Units	Notes / Instructions
5.5	Heat extraction at minimum stable plant load with carbon capture		
a)	Maximum heat load extraction at minimum stable plant load with carbon capture	MW	N/A
b)	Maximum heat extraction export flow at minimum stable plant load with carbon capture	t/h	N/A
c)	Carbon capture and CHP mode net electrical output at minimum stable plant load	MW	N/A
d)	Carbon capture and CHP mode net electrical efficiency at minimum stable plant load	%	N/A
e)	Carbon capture and CHP mode net CHP efficiency at minimum stable plant load	%	N/A
f)	reduction in primary energy usage for carbon capture and CHP mode at minimum stable plant load	%	N/A
5.6	Can the plant with carbon capture supply the selected identified potential heat load (i.e. is the identified potential heat load within the 'CHP and carbon capture envelope')?		N/A
5.7	Description of potential options which could be incorporated in the plant for useful integration of any realised CHP system and carbon capture system		N/A
Requirement 6: Economics of CHP-R			
6.1	Economic assessment of CHP-R		<p>In order to assess the economic feasibility of the CHP scheme (as required under Article 14 of the Energy Efficiency Directive) a cost benefit assessment has been carried out in accordance with the draft Article 14 guidance.</p> <p>The results of the CBA indicate that both the nominal project internal rate of return and net present value (before financing and tax) over 30 years are:</p>

#	Description	Units	Notes / Instructions
			<p>1. For the first network option: 26.1 % and £0.46 million respectively; and</p> <p>2. For the second network option: 30.6 % and £0.87 million respectively.</p> <p>Therefore, it is considered that the proposed first and second options heat network yield an economically viable scheme in its current configuration.</p> <p>The economic feasibility of the scheme will be reassessed in the future when there is a better understanding of heat demands and considering any subsidies that support the export of heat.</p>
BAT assessment			
	Is the new plant a CHP plant at the outset (i.e. are there economically viable CHP opportunities at the outset)?		No
	If not, is the new plant a CHP-R plant at the outset?		Yes
	Once the new plant is CHP-R, is it BAT?		Yes

ENGINEERING  CONSULTING

FICHTNER

Consulting Engineers Limited

Kingsgate (Floor 3), Wellington Road North,
Stockport, Cheshire, SK4 1LW,
United Kingdom

t: +44 (0)161 476 0032

f: +44 (0)161 474 0618

www.fichtner.co.uk