Portland energy recovery facility

District heating paper

August 2021

Powerfuel Energy Recovery Facility (ERF)

District Heating Paper

Response to request for additional detail in respect of District Heating (Q12) received from Dorset Council on 30 April 2021

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Contents

1. Introduction

1.1. The purpose of this report is to provide responses to questions raised in the letter dated 30 April 2021 issued by Adrian Lynham on behalf of Dorset Council (the **Request**).

1.2. The points addressed in this paper are in relation to the District Heating section of the Request (point 12), included below for convenience:

1.2.1. **Request point 12:** Further detail in respect of how the prison and young offender institution could be connected to a district heating system supplied from the development. This should include the required infrastructure, technical supporting information, and description of the environmental (including climate change) and economic (for both for the supplier and purchaser) impacts.

1.3. Please note responses to point 13 of the Request (“Further consideration and information in respect of relevant district heating related issues raised through representations on the first consultation as appropriate”) are included in the Consultation Response Summary Document.

2. Executive Summary

2.1. The UK is substantially behind other European countries in maximising the benefit of using heat from ERFs in district heat networks.

2.2. Of the existing 54 UK ERF facilities, only 12 currently export heat due to the absence of viable heat offtakers that can commit to long term agreements to support the upfront capital investment required. The result is that UK ERFs are less efficient and have a higher carbon impact than their European counterparts.

2.3. Powerfuel's overall ambition as a developer is to maximise the environmental benefits of the proposed ERF. It has already committed that the proposed ERF will operate as a net-zero carbon infrastructure asset for its operational life – it is believed that this would be the first UK facility to make such a commitment.

2.4. There is a credible opportunity at Portland to provide a district heating network (**DHN**) that would allow local stakeholders to benefit from low carbon heat whilst maximising the overall energy efficiency of the proposed ERF and minimising the carbon impact.

2.5. The Portland site has significant locational advantages as the upfront investment can be supported by contracting to deliver heat to large demand users that have the appropriate financial standing to enter into long term contracts to support the upfront DHN capital investment, being HMP The Verne and HMP YOI Portland (the **Cornerstone Offtakers**).

2.6. The existence of the Cornerstone Offtakers clearly differentiates the proposed ERF from other sites (both in the Dorset Waste Plan and elsewhere the UK) where, whilst the potential to supply heat might exist, commercially the local demand users are too small and/or do not have appropriate financial standing to support the upfront investment such that a DHN will never be delivered.

2.7. The proposed ERF will be CHP enabled from the outset and there is a high probability that the DHN will be delivered, due to the environmental, policy and financial incentives to do so. Whilst provision of the DHN will require further detailed technical and planning analysis (including a separate planning approval from Dorset Council) we have not identified any gating items or risks to delivery.

2.8. The National Waste Strategy (2007) states that "particular attention should therefore be given to the siting of plant to maximise for opportunities for Combined Heat and Power". As such the opportunity to supply a DHN should be afforded substantial weight in the planning balance for the proposed ERF.

2.9. Powerfuel would be happy to agree an appropriate commitment with Dorset Council that would oblige Powerfuel to take reasonable steps to look to implement the DHN, subject to agreement of commercial terms with the Cornerstone Offtakers that mean the DHN project is commercially viable.

3. District Heating Overview

3.1. The Heat Networks (Metering and Billing) Regulations 2014 define a district heat network as “the distribution of thermal energy in the form of steam, hot water or chilled liquids from a central source of production through a network to multiple buildings or sites for the use of space or process heating, cooling or hot water”.

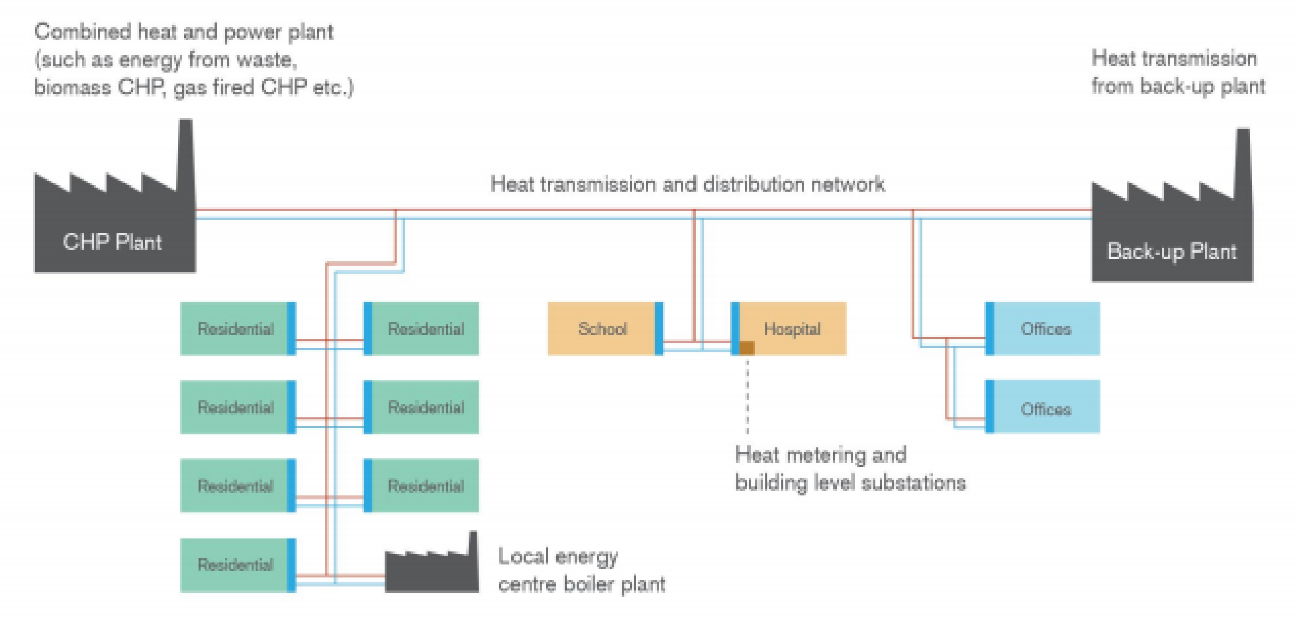
3.2. Whilst heat networks or district heating network (**DHN**) can vary in size, scope and heat source each has at its core one or more significant sources of heat that is then transported by pipes to end demand users, such that multiple buildings or premises can be heated from these centralised sources, as opposed to requiring independent boilers/heaters in each location.

3.3. The heat is typically generated by a related activity that produces heat where that heat is not required by the facility for its regular activities, for example power stations, ERF generators, and process industry.

3.4. Typically, the heat produced by such processes is lost unused as flue gas which is not efficient from an energy perspective.

3.5. A DHN allows the heat, in the form of hot water or steam, to be transported from the point of generation to an end-user. A DHN can serve different types of offtaker, from entire communities to a limited number of high demand users.

3.6. A typical DHN setup is shown below [1]:



[1] London Heat Map Manual 2014

3.7. There are a number of key benefits of district heating:

3.7.1. **Carbon Reduction:** The carbon emissions from a DHN are significantly lower than from traditional fossil fuel sources. This is because the facility that is generating the heat is able to do so at a much lower carbon intensity than even modern gas boilers. As a point of reference, Veolia confirms that their 225,000 tonnes per annum ERF supplied district heating network in Sheffield (developed as part of a 35-year PFI contract with Sheffield City Council) reduces carbon emissions for heating from 184g CO_2/kWh assuming a modern gas boiler (A or B rated) at 80% boiler efficiency (gas) to 8g CO_2/kWh [2].

3.7.2. **Cost:** A DHN allows large industrials and generators to identify a use for heat produced that is otherwise wasted and disposed of via the flue. This means that, absent the upfront capital cost to install the heat network, there are limited ongoing costs, in the case of generation mainly limited to lost electrical power generation to enable heat export. Once the network is installed to service the Cornerstone Offtakers, Powerfuel would anticipate extending to other users which would reduce heating costs for the local community generally.

3.7.3. **Air Quality:** A DHN allows existing heat generation to be largely retired therefore removing any associated emissions from this fossil fuel based generation that would previously have impacted the local population.

[2] https://www.veolia.co.uk/sheffield/dealing-waste/district-energy-sheffield-heat-network/benefits

4. UK Government Policy and Status

Background

4.1. Large heat networks are common in Europe, for example over 50% of the population in some European countries are served by District Heating and in Germany every town with a population of more than 80,000 residents has at least one heat network. This was in part due to historical acceptance and in part as a response to fossil fuel shocks in the 1970s.

4.2. The UK, by contrast, was until recently the world's largest market for gas boilers. In part this was driven by the availability of North Sea gas at the time when central heating was penetrating the UK market and in part due to poor experiences with badly designed and poorly operated early DHN schemes.

4.3. According to a BEIS Energy Trends report published in March 2018, at that time there were around 14,000 heat networks in the UK, of which only 2,000 were classified as district heating. The remaining c. 12,000 were classified as communal heating, meaning that the distribution of heat from a central source in a building that is occupied by more than one final customer, e.g. a hospital, prison or university.

4.4. The Committee for Climate Change Net Zero Technical Report published in May 2019 confirms that direct emissions from buildings resulting primarily from the use of fossil fuels for heat contributed 85mtCO_2e in 2017, accounting for 17% of UK GHG emissions.

4.5. Given the success achieved in decarbonising the electricity system over the past decade, the UK focus is now shifting to other sectors, including the provision of heat.

4.6. Currently, heat networks of all types provide around 2% of the UK's heat.

4.7. Full decarbonisation of heat is one of the biggest challenges in reducing emissions from the energy system to net zero by 2050. The Committee on Climate Change's central scenario for the fifth carbon budget assumes heat networks will need to provide at least 18% of the UK's heat by 2050 if the net-zero ambition is to be achieved.

4.8. As a result Government policy has focussed on this area, both in requiring the public sector to find routes to decarbonise where possible and putting in place subsidy and incentive programmes to bring forward private investment capital in heat networks, in the same way that the Government initially provided subsidy/incentives to enable the power generation transition.

ERF - Existing Contribution

4.9. Due to the existence of developed DHNs it is common for European ERFs to generate both power and heat. Around 15 million citizens in Europe receive heat generated by ERF plants via DHNs [3].

4.10. In contrast, as a result of historic under-investment in DHNs and the location of historical ERF facilities very few UK ERFs provide heat. This is very inefficient from an energy perspective and also results in a greater overall carbon impact.

4.11. Figures provided by Tolvik Consulting below show that of the 54 ERFs operating in the UK in 2020 only 12 currently provide any form of heat offtake.

EfW	First Operational Year, EfW	First Operational Year, Heat	2020 Export GWh_{th}	Heat/Steam Offtake
Runcorn	2015		**480**	Steam supply to Ineos
Eastcroft	1970's		**405**	Enviroenergy for electricity generation and hot water
Wilton 11	2016	2018	**373**	Adjacent Wilton International site
Kemsley	2020		**123**	DS Smith papermill
Sheffield	2006	Pre 2006	**95**	District heating operated by Veolia
Devonport	2015		**54**	Adjacent naval dock yard
Gremista	1990's		**50**	District heating on the Shetland Islands *(estimated)*
SELCHP	1994	~2000's	**40**	District heating operated by Veolia
Leeds	2015	2018	**14**	District heating operated by Vital Energi
Coventry	1975	~2010-15	**8**	District heating operated by Engie
NewLincs	2004		**7**	To local industry
Edmonton	1975	recently	**2**	Very modest export reported
Total			**1,651**	

Source: Tolvik Consulting

4.12. In 2020 the UK ERF sector exported 7,762 GWh_e and 1,651 GWh_{th}. This means that 82% of energy produced was power export with only 18% heat export.

[3] Joint-statement of the role of waste-to-energy in the EU taxonomy, 19 October 2020

4.13. Contrasting this with the European position, where on average almost 50% of the energy produced is heat leads to the conclusion that existing UK ERFs are losing significant potential value by only being able to run their facilities in power-only due to the lack of DHN infrastructure and local, high demand, bankable offtakers.

4.14. In addition to lower revenues, operating in power-only mode also results in higher overall emissions and higher carbon impact, in both cases because the offset that a DHN provides on reducing high-emitting gas boilers is not realised.

4.15. For those limited number of facilities that do currently provide a DHN offtake, in the majority of cases the heat offtake was developed in a phased approach post the construction of the ERF facility.

4.16. This is because it is necessary to identify and contract with heat offtakers prior to making the significant capital investment required to install the DHN and it is only possible to progress formal contractual discussions with offtakers once they are confident that the source of the heat (i.e. the ERF facility) will be delivered.

ERF - Existing Requirements

4.17. UK ERF facilities are not currently required to be able to provide heat in order to be developed and operated, although this is encouraged in planning policy.

4.18. However, in order to achieve an Environmental Permit, a UK ERF that has a throughput of more than 3 tonnes per hour of non-hazardous waste (as the proposed ERF will have) is required to comply with CHP-ready Guidance published by the Environment Agency in February 2013 and also, since March 2015, carry out a cost-benefit analysis (CBA) of opportunities for CHP under Article 14 of the Energy Efficiency Directive when applying for an Environmental Permit.

4.19. The Environment Agency requires developers to demonstrate best available techniques (BAT) for a number of criteria, including energy efficiency.

4.20. 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.

4.21. Fichtner Consulting Engineers (**Fichtner**) has submitted a report for the proposed ERF for the purposes of the Environmental Permit application. This report includes a CHP-Ready Assessment and a CBA analysis, both produced in line with current Environment Agency guidance.

4.22. If there are existing agreements in place with heat offtakers then a facility can be classified as a CHP plant and therefore will meet the first of the BAT tests. This is not a typical position in the UK, given the lack of infrastructure to enable the offtake of heat and the reluctance of offtakers to engage until a potential ERF is fully permitted.

4.23. If there are not agreements in place with heat users (as is the case for the proposed ERF) then a project that is capable of achieving an Environmental Permit is likely to meet the criteria to be classified as a "CHP-ready facility", which means that it will be designed to be ready, with minimum modification, to supply heat in the future. This is the case for the proposed ERF.

4.24. However, post receipt of the Environmental Permit, historically ERFs have been built and operated on a power-only mode basis with the result that the efficiency and carbon benefits are significantly lower than could otherwise be achieved.

Typical Barriers to ERF Heat Offtake

4.25. The majority of ERFs do not export heat. The key reason for this is because there are no available offtakers that have sufficient heat demand and financial standing, locally to support the upfront capital investment in the DHN.

4.26. Historically ERF facilities have been located in rural areas, away from large housing or industrial communities. This means that a heat connection is not viable as the distance to the end users is too great. Again, this contrasts with Europe where government and municipal authorities influence waste and energy planning, resulting in the development of ERF facilities close to end heat users (in many cases within large cities).

4.27. Where location is not a challenge there is still the investment risk to be considered. A DHN is a high capital expenditure project with uncertain returns where the supply is to a disparate group of offtakers – from an investment perspective whilst the capital expenditure is understood the revenues can be very uncertain – both volume or heat and the price paid per unit of heat can be variable. This contrasts with the economics of an ERF where a number of the key revenue streams can be addressed via contracts.

4.28. The DHN schemes that have been successfully implemented in the UK to date have been possible due to local and national government support/subsidy. The below table provides some context on the existing schemes and public support provided.

Existing UK DHN Schemes

EfW	Offtake	Government Support
Eastcroft	Enviroenergy for electricity generation and hot water	Owned by Nottingham City Council
Sheffield	District heating operated by Veolia	Originally a joint venture with Sheffield Council. Currently wholly owned by Veolia
Gremista	District heating on the Shetland Islands	Developed by Shetland Charitable Trust
SELCHP	District heating operated by Veolia	Public/private sector partnership, originally developed by London Boroughs of Lewisham and Greenwich
Leeds	District heating operated by Vital Energi	Public/private sector partnership with Leeds City Council – funding support from West Yorkshire Combined Authority and Leeds City Region Enterprise Partnership
Coventry	District heating operated by Engie	Development of DHN by Engie under a 25 year concession agreement with Coventry City Council
Edmonton	Very modest export reported	Funding provided by The Mayor of London's Energy Efficiency Fund, the UK Government Heat Network Investment Programmes and from Enfield Council

Source: Powerfuel Analysis

Portland ERF Advantages

4.29. The proposed ERF has a significant advantage due to its location close to HMP The Verne and HMP YOI Portland (**Cornerstone Offtakers**).

4.30. Both the Cornerstone Offtakers have significant demand for heat and that could facilitate investment in a DHN that could benefit the wider community.

4.31. The specific advantages for Portland are:

4.31.1. **Location** – both potential offtakers are close to the proposed ERF location. This means that the capital expenditure is much lower than would be the case for the majority of UK ERFs.

4.31.2. **Demand** – both the Cornerstone Offtakers are large heat demand users and, importantly, this demand can be accurately projected to remain over the long term.

4.31.3. **Financial Standing** - a key concern when considering investment in a DHN is the certainty of future cash flows. A long term contract for heat (and potentially power) with HMP The Verne and HMP YOI Portland would generate the long term, contracted and therefore bankable cashflows that would allow external finance to be raised to fund the upfront capital investment.

4.32. The existence of the Cornerstone Offtakers is a key differentiator of the proposed ERF from other facilities in the UK and other allocated sites in the Dorset Waste Plan in the Dorset context, which do not have such an advantage. Once the Cornerstone Offtakers are in place then there is clear potential for the expansion to supply other customers on the island including community infrastructure and social and private housing both existing and proposed/planned.

4.33. As such the proposed ERF provides an opportunity to use a merchant ERF facility to provide heat offtake to a local community. Whilst this is common in Europe this would be a key step-forward for Dorset, and the UK as a whole, in demonstrating its commitment to net zero and the circular economy.

4.34. Siting the proposed ERF at Portland is also consistent with national policy. The National Waste Strategy 2007 states in paragraph 28 of Chapter 5 that:

"Any given technology is (where applicable) more beneficial if both heat and electricity can be recovered. Particular attention should therefore be given to the siting of plant to maximise the opportunities for Combined Heat and Power".

4.35. The proposed ERF at Portland provides an opportunity to deliver CHP to local high demand users and, in due course, the local Portland community. None of the other proposed sites identified in the Dorset Waste Plan would be capable of delivering a similar opportunity and this therefore represents a significant advantage in the context of DWP Policy 4.

5. Planning and Implementation

Planning Approach

5.1. Neither the Powerfuel ERF planning application nor environmental permit (“EP”) application currently includes details of the physical infrastructure required for a DHN. The majority of the infrastructure required for a DHN will be located outside of the planning application “red line”.

5.2. This is standard for ERF applications of this type in the UK, where the primary purpose is not heat supply and where contractual agreements with heat offtakers are not in place upfront.

5.3. Potential customers to a DHN will need to do significant work to understand technically how they could participate in the DHN. Until the heat source has been consented and is certain to be delivered, that work could be premature and without completing this they cannot contract their participation.

5.4. Powerfuel cannot “force” a customer to take the heat offered but can make this available to the customer such that it would be rational to contract with the proposed ERF (both on a carbon and cost grounds). Note this contrasts with the typical European approach where “mandatory connection” is a feature such that a proposed energy generator has a high degree of certainty that the heat will be demanded.

5.5. Powerfuel has engaged with the Cornerstone Offtakers over the past 12 months and feedback suggests that a heat offtake would be an attractive option, specifically given the UK Government focus on reducing the carbon impact of its estate.

5.6. Powerfuel has also completed an initial technical and planning review of the potential DHN to confirm there are no gating items or risks to delivery of the DHN on the assumption that an appropriate contract can be agreed with the Cornerstone Offtakers.

Planning – Potential Route Appraisal

5.7. There is an identified route for heat pipes that can convey the heat from the plant to identified potential customers along the existing road network.

5.8. The ES addendum confirms that the provision of district heating, including constructing the required DHN infrastructure and hosting pipes in the road, would not lead to any significant adverse environmental effects. Arup has confirmed that the local terrain would not create a barrier to the installation of a DHN.

Implementation

5.9. Powerfuel would expect to implement the DHN in phases, beginning with the Cornerstone Offtakers. This will enable the infrastructure and benefits of heat supply to be realised quickly but allow for expansion of the DHN to other users over time. Appropriate technology specification would facilitate future modular extensions and can therefore be seen as "future proof".

5.10. The initial installation will be along the DHN "southern route" to provide heat to the Cornerstone Offtakers with further expansions of the "southern route" and delivery of the "northern route" to follow.

5.11. Prior to implementation a separate planning application will need to be submitted and approved by Dorset Council and appropriate investment funding will need to be identified, supported either by contracted cashflows from the Cornerstone Offtakers or by Government grant funding.

5.12. In relation to the Cornerstone Offtakers, Powerfuel has engaged with the Ministry of Justice (**MoJ**), AECOM (their external engineering consultants), the Cabinet Office and BEIS over the past 12 months.

5.13. It should be noted that it is unusual for an ERF developer and potential offtakers to engage in this way at this (pre-planning) stage but in this case all parties recognise the unique opportunity at Portland to develop and implement a merchant CHP ERF facility that will also be able to deliver low carbon heat over the long term to the MoJ that will reduce the carbon impact of the estate.

5.14. The MoJ sustainability team and AECOM have participated in a number of calls with Powerfuel and Arup to ensure that the key technical requirements were understood on both sides.

5.15. BEIS has recommended that Powerfuel engage with wider stakeholders and potentially seek to collaborate with Dorset Council and other public bodies (e.g. Portland Town Council) with a view to submitting an application for grant funding to support a wider DHN.

5.16. Once planning approval for the proposed ERF is confirmed, Powerfuel expects to further develop the technical solution with the MoJ/AECOM and progress with local bodies as recommended by BEIS.

5.17. It should be noted that the availability of a DHN solution is often uncertain at the planning stage. Reference should be made to Paragraph 237 of the Government's Review of Waste Policy which states

"*Experience to date with CHP infrastructure has highlighted a potential difficulty in securing long term customers for heat ahead of construction of the plant".*

5.18. Whilst Powerfuel has not secured the Cornerstone Offtakers it has committed significant time and cost to develop a proposal with the MoJ and review the potential for a DHN such that it is confident that this could be delivered.

5.19. Powerfuel would be happy to agree an appropriate commitment with Dorset Council that would oblige Powerfuel to take reasonable steps to look to implement the DHN, subject to agreement of commercial terms with the Cornerstone Offtakers that mean the DHN project is commercially viable.

6. Technical Infrastructure and Design [4]

Overview

6.1. The proposed ERF is expected to process an average throughput of c. 22.8 tonnes per hour Refuse Derived Fuel (**RDF**), resulting in a total throughput of 183,000-202,000 tonnes RDF per year, depending on delivered plant efficiency and availability.

6.2. The RDF typically has a net calorific value of 11MJ/kg which allows the proposed ERF to potentially export both power and heat.

6.3. To export power the proposed ERF requires a connection to a local electricity distribution network. The connection in this case is to SSE Portland Sub-Station, located on Lerret Rd approximately 1.5 km to the west of the site. The route of the grid connection would follow existing highways. This connection allows the proposed ERF to export a maximum level of around 15.2MWe, on the assumption that it is operated in power-only mode, and no heat is exported.

6.4. It is also possible to operate the proposed ERF such that power and heat are produced. This increases the efficiency of a plant (greater energy, electrical and thermal, produced for each tonne of waste) and reduces its carbon impact. On the basis that the average heat load of 2.6MWth is exported, this reduces the power export by c. 400kWe.

Proposed ERF - Generation Loads

6.5. The proposed ERF comprises a single-line RDF combustion plant. The RDF is combusted in a moving grate furnace that produces high temperature combustion gases.

6.6. The gases from the furnace will then be passed through a heat recovery steam generator (boiler) to generate high pressure and temperature steam, which will then be passed through a steam turbine to generate electrical energy.

6.7. In the event that heat users are identified and can be connected, the turbine will be able to export medium pressure steam from an intermediate bleed point with the heat transferred to a hot water circuit to provide heat to users.

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[4] Technical details have been confirmed with Ove Arup & Partners Limited

Proposed ERF Operational Performance

Operational Performance	Minimum Stable Plant Load (70%)	Proposed Operational Plant Load (100%)	Maximum Plant Load (112%) [5]
Thermal Input (MW)	49 MW	70 MW	78 MW
Electricity only mode – net electrical output (MW)	12.7 MW	15.2 MW	17.4 MW
Electricity only mode – net electrical efficiency (%)	20.0%	21.8%	22.2%
CHP mode [6] – net electrical output (MW)	9.4 MW	14.8 MW	17.0 MW
CHP mode – net heat output (MW)	2.6 MW	2.6 MW	2.6 MW
CHP mode – net electrical efficiency (%)	19.3%	21.3%	21.8%
CHP mode – net heat efficiency (%)	5.2%	3.6%	3.2%
CHP mode – total efficiency, electricity and heat (%)	24.6%	25%	25.1%

Cornerstone Offtaker - Technical Requirements

6.8. Heat will be supplied to the Cornerstone Offtakers by a DHN. Indicative export and return requirements for each of the Cornerstone Offtakers is provided in the table below.

	HMP The Verne	HMP YOI Portland
Annual Energy Demand (MWh)	6,966	7,149
Peak Heat Load	4.1 MW	4.2 MW
Average Heat Load	874 kW	898 kW
Description of Heat Load Extraction	Hot Water	Hot Water
Description of Heat Load Profile	Variable	Variable
Flow Temperature	80°C	80°C
Return Temperature	55°C	55°C

[5] Note: it would only be possible to operate at this level for a limited duration
[6] Assuming average heat export

DHN Process Overview

6.9. The DHN is a closed network that circulates hot water via a pipe network at a temperature of c. 80°C from the proposed ERF to the Cornerstone Offtake facilities to provide heat. The water then returns to the proposed ERF along a second set of pipes are a lower temperature of c. 55°C.

6.10. The process starts at a heat exchanger (primary heat exchanger) where the cool water returning from the offtakers absorbs the heat from the identified steam extraction points in the proposed ERF.

6.11. The higher temperate water then leaves the proposed ERF and travels along the pipe network to the offtaker where it then transfers the heat to a second closed water network (the customer's network) via heat exchangers (secondary heat exchanger).

6.12. The water in the DHN will then return to the proposed ERF facility at the lower temperature and the process starts again.

DHN – Key Technical Infrastructure

6.13. The key equipment required as part of a DHN scheme include the following:

6.13.1. **Primary heat exchangers/substations** - steam extraction from the steam turbine is controlled based on the demand from the heat network, such that only the quantity of steam required would be extracted, and the remainder would be utilised for power generation. This enables the plant performance to be optimised regardless of district heating demand. The design of the proposed ERF incorporates an appropriately selected extraction condensing steam turbine, which allows for a continuous controlled bleed of medium pressure steam for heat use as well as for in-plant uses (deaeration of feed water). The amount of steam bled can be varied up to the maximums given above to enable the use of heat as and when this is required, without significantly affecting electrical efficiency for the plant running in "electricity only" mode. Pipes for this bleed have been sized appropriately to cater for the maximum flows given above, and blanked connections have been incorporated into the design to allow connection with minimal site works. Sufficient space has been allocated within the turbine hall for the steam-water heat exchangers required to convert the heat into usable hot water for the network.

6.13.2. **Pipework** - the hot water will be carried from the primary heat exchanger to the customers' network through pre-insulated carbon steel pipes. This type of pipe is typically used in district heating applications. The installation of district heating networks within roads is very common and governed by relevant British Standards, such as BS EN 13941:2019 *District heating pipes – Design and installation of thermal insulated bonded single and twin pipe systems for directly buried hot water* *networks.* Two pre-insulated pipes will be installed beneath the road network: one carrying the heated water from the ERF to the heat users and one bringing the water back to the ERF to be reheated and re-circulated. Full details of the installation will be confirmed at the detailed design and planning stage, but it is currently envisaged that the pipes will be buried approximately 500 mm below the ground surface in a trench approximately 1,500 mm wide at the top, reducing to approximately 1,000 mm wide at the bottom. The trench will be excavated in lengths of around 50 m to 60 m at a time to allow the pipes to be installed.

6.13.3. **Distribution pumps** - distribution pumps are the most important plant item for distributing the heat through the heat network carried by the hot water from the heat source to the customers. The pumps are controlled using variable speed drives which adjust the frequency of electricity supply to the pump to change the flow rate of the water as required. Without distribution pumps the DHN cannot function and therefore standby pumps are commonly installed to provide contingency. Various ancillary items including isolation valves, differential pressure gauges and strainers are installed around pumps to assist in monitoring, isolating for maintenance and protection of the impellers from particles that may be entrained in the flowing water.

6.13.4. **Pressurisation pumps -** pressure must be maintained at all points to ensure that sufficient water is maintained within the system to distribute heat and to prevent water vaporising within the pipe at the lowest pressure point. For this reason pressurisation pumps are essential and commonly linked to an expansion tank which allows for the removal of excess water and pressure from the system when the temperature increases and the water expands. As the temperature of the system falls, the same water held in the expansion tank may be re-introduced into the system to re-stabilise the pressure. Capture and re-use of this water is important since it is likely to be treated water and may retain some useful thermal energy, as such it is more valuable than the alternative of making up the system with fresh cold water. In some cases, directly connected pressurised thermal stores may act as expansion vessels.

6.13.5. **Valves -** isolation valves will be installed at regular intervals on the system and commonly at pipe work branches located in valve pits external to the consumer buildings to enable the supply to be controlled without having to enter the building. Isolation valves improve the resilience of the network by enabling parts to be shut off and sometimes bypassed. This allows damaged sections to be investigated and repaired without affecting the rest of the system, thereby minimising disruption to other consumers.

6.13.6. **Customer Side Technology –** the key equipment at the customer side is the secondary heat exchanger which transfers the heat from the DHN so that it can then be used within the customer building, without any direct contact between the DHN hot water and the customer network hot water.

The customer will also require control values, pressure/temperature instrumentation and a heat meter.

6.14. The expected design life for a DHN is typically assumed to be 30 years for the purposes of economic assessments but when correctly designed and installed it is reasonable to expect a lifespan of up to 50 years. The design life for the ancillary equipment, including the heat generating plant, distribution and pressurisation equipment and heat interface units is dependent on the type of technologies applied.

Private Electricity Supply

6.15. In addition to providing heat via a DHN, the proposed ERF would also be capable of supplying electricity direct to the Cornerstone Offtakers over a private network, thereby avoiding costs and losses arising in the public transmission and distribution system.

6.16. Electricity supply made in compliance with the Electricity Class Exemption Order does not have to be licensed and the regulatory burden of licensed supply does not apply.

6.17. Connecting the Cornerstone Offtakers to a private electrical network will require some alterations to the existing installations but this should not present any material difficulties.

6.18. The electrical cable should be able to follow the same route as the DHN. To cover the capital costs associated with a private wire solution, it will normally be necessary to enter into a long-term contract with the intended customers. The price at which electricity is to be supplied will also normally be benchmarked, to ensure customers obtain good value for money.

7. Environmental and Climate Change Impact

7.1. Fichtner Consulting Engineers Limited (**Fichtner**) have provided an update to the carbon assessment for the proposed ERF as a response to the request for further detail received from Dorset Council on 30 April 2020 (see Q22). This forms appendix 4.1 to the ES addendum.

7.2. The assessment compares the carbon impact of the proposed ERF to a number of comparators, including scenarios where the proposed ERF operates in power-only mode, CHP mode and where it provides shore power electricity supply.

7.3. The calculated carbon benefit of the proposed ERF increases by around a further 3,000 tCO_2e emissions per annum when the proposed ERF is operated in CHP mode, as opposed to power-only mode.

7.4. This reduction in CO_2e emissions is due to the avoided emissions produced by natural gas boilers at customers of the DHN, which will no longer be required.

8. Economic Impacts

Environmental Permit - Analysis & Assumptions

8.1. As part of the Environmental Permit application an assessment of the costs and revenues associated with the construction and operation of the proposed district heating network was undertaken by Fichtner using the Environment Agency's CBA temple. This is contained in the CHP-Ready Assessment document (**CHP-R Assessment**)

8.2. The CHP-R Assessment takes account of the assumed DHN capital and operating costs, heat sales revenue and lost electricity revenue as a result of diverting energy to the heat network.

8.3. The analysis assumes a capital investment cost for the DHN of £9.42m spread over a 3 year investment horizon which is based on Fichtner's experience from various reference projects that it has worked on previously.

8.4. The output of the economic analysis is that the nominal project internal rate of return (IRR) for the DHN at the proposed ERF is calculated to be 11.7%.

8.5. IRR is a metric used by investors to determine the future profitability of an investment. The internal rate of return is the discount rate that makes the net present value (NPV) of all cash flows from a particular project equal to zero. More simply, it is the average rate of return an investor should expect to achieve on a certain investment amount over a given time period.

8.6. In the case of the proposed DHN, a £9.42m capital investment would realise total cashflow receipts over time of approximately £44m, i.e. an investor would recover their upfront capital investment and earn an average return on this investment of 11.7%, every year for 30 years.

8.7. The upfront capital expenditure will need external financing and the investor will have a specified return hurdle rate that it will need to exceed in order to conclude the investment is attractive.

8.8. The CHP-R Assessment uses an investment hurdle rate of 17%. This is the rate that is suggested by the Environment Agency and is used across the market by all consultants when completing this analysis for the purposes of applying for an Environmental Permit.

8.9. The result is that the CHP-R Assessment concludes that the project is economically unviable. This is because whilst it delivers an 11.7% return on investment for every year over a 30 year term, this is lower than the 17% that the CHP-R Assessment assumes is required by an investor.

Commercial Analysis

8.10. The DHN at the proposed ERF is significantly different from a “standard” ERF DHN in two key ways.

8.10.1. Firstly, it is located near to two major users of heat where it is reasonable to expect that this heat will continue to be required for the lifetime of the DHN; and

8.10.2. Secondly, the potential customers (the Cornerstone Offtakers) have the appropriate financial standing to enter into long term contracts to support the upfront capital investment.

8.11. A “standard” ERF DHN does not have these advantages. Typically, it would need to contract with a disparate group of offtakers, all of varying credit quality, with no guarantee that these offtakers will survive the full operational life of the DHN. This uncertainty results in the 17% return hurdle assumed to be required by a DHN investor under the Environmental Permit CHP-R analysis.

8.12. However, in this case the proposed ERF would benefit from certain volume and contracted long term cashflows backed by UK Government credit.

8.13. For reference BEIS currently applies a 7.6% investment hurdle rate for EfW CHP[7]. It is therefore commercially logical to assume that a DHN investment that relies on the underlying performance of the EfW CHP would attract a similar hurdle rate, potentially with a small increase given the increased functional risk of the DHN over and above the proposed ERF.

8.14. In any case, as a result the hurdle return that an investor would need to provide the DHN funding will be below the 11.7% IRR, and therefore will mean the project is investable and economically viable.

8.15. As a point of reference the “energetic” scheme, sponsored by Enfield Council was setup to serve 15,000 properties using low-carbon heat created as a by-product from the Edmonton Eco Park ERF. The Council expected to invest £58m of a total capex cost of £85m (the difference covered by generated revenue).

8.16. The upfront expected IRR of the scheme, based on pre-construction assumptions of development build-out rates, was 6.74% post-tax (approximately 8.3% pre-tax), significantly lower than the 11.7% IRR expected for the DHN scheme at the proposed ERF.

[7] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/911817/electricity-generation-cost-report-2020.pdf

8.17. Since inception the scheme has been successful in receiving over £50m in low cost loans and grant funding from Government bodies, including the HNIP, which is expected to allow expansion of supply to over 50k homes.

Cornerstone Offtaker - Analysis

8.18. From the perspective of the Cornerstone Offtakers, the potential to receive heat direct from the proposed ERF could provide a number of benefits.

8.19. In discussions with the Ministry of Justice to date it is clear that the key benefit identified is the potential to reduce the carbon impact of the Government estate.

8.20. If a DHN is installed, the low carbon heat provided by the ERF is expected to reduce the carbon impact by approximately 3,000 tonnes CO_2e per annum, relative to the existing high-emission gas boiler solution [8].

8.21. In addition, whilst we have not discussed detailed commercial terms at this stage (given neither the proposed ERF nor a potential DHN have local planning permission) it is anticipated that provision of direct heat would result in a cost benefit for the MoJ.

Portland Community - Analysis

8.22. On the assumption that a DHN is able to be installed this would provide a key first step to expanding this to the wider community at Portland, as has been seen in numerous other cases in the UK (see list of existing DHNs in section 4.28, most of which continue to expand).

8.23. The Committee for Climate Change has advised the UK Government it needs to consider phasing out all new gas boilers in the UK by 2035, and potentially earlier if it is to achieve its legally binding net zero 2050 target.

8.24. Given the prohibitive cost of alternative solutions and the limited space available on Portland it is likely to be difficult to replace existing gas or oil boilers with air or ground source heat pumps for the resident population.

8.25. In the event a DHN is installed this could provide part of the solution for the wider community.

[8] Note this figure assumes that the DHN supplies heat to the Cornerstone Offtakers and also the other identified potential customers (Osprey Leisure Centre and Comer Homes)