wood.

Technical note:
Venator Cost Benefit Analysis

1. Introduction

The Environmental Permit Variation application for the new proposed boilers requires an assessment for the potential reuse of waste heat from the boilers, as required by Schedule 24 of the Environmental Permitting Regulations 2016, as amended. Wood Environment & Infrastructure Solutions UK Limited (Wood) has been commissioned to undertake the assessment of the potential for heat recovery from the installation of four new gas-fired boilers at the Venator Greatham installation. Once commissioned, the new boilers will replace the existing steam raising boilers at the installation. The installation currently operates under an environmental permit (ref. EPR/TP3532PK).

1.1 Site description

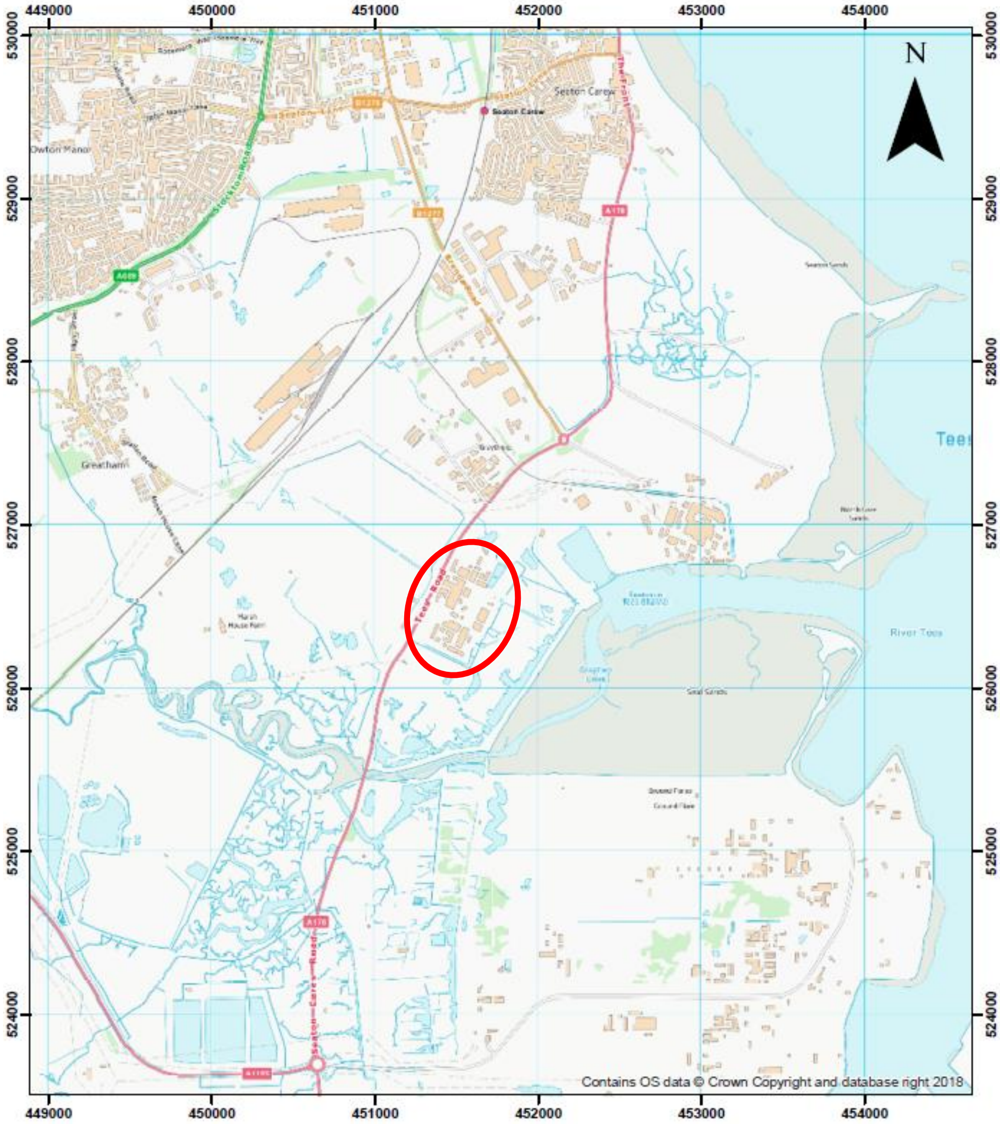
The Greatham installation is located on Tees Road, Hartlepool and centred on NZ515265. It occupies an area of ~23 ha.

The installation produces titanium dioxide (TiO_2) pigment at a rate of up to 150,000 tonnes per annum. In addition, up to 12,000 tonnes per annum of the intermediate titanium tetrachloride ($TiCl_4$) is produced for export. The process produces high purity TiO_2 and $TiCl_4$ from TiO_2 ores using a chlorination reaction (to convert TiO_2 in the ores to $TiCl_4$) followed by an oxidation reaction to produce high purity TiO_2. The chlorination and oxidation reactions take place within the ICON 1 and ICON 2 process plants, with TiO_2 product finishing taking place at the Wet Treatment and Packing plant.

The immediate land use around the site is primarily industrial to the north, with open land to the south and west. The Seaton on Tees Channel is located to the east/south-east of the site. The nearest residential usage is to the north west, in Greatham, which is located approximately 2 km from the new boiler stack location at its closest point. The closest ecological receptor to the site is the Teesmouth and Cleveland Coast SPA/Ramsar/SSSI, which is adjacent to the east of the site.

The site location is shown in Figure 1.1.

Figure 1.1 Site location



2. Process emissions and operating scenarios

Current steam demands of the existing installation are met by four natural gas boilers:

- Boiler 2 rated at 21.4 MW net thermal input; and
- Boilers 4, 5 and 6, each rated at 19.5 MW net thermal input.

The boilers have a combined thermal input of ~ 80 MW and discharge via a common stack (permit emission point reference A250). Venator is proposing to replace the existing boiler plant with four new gas-fired boilers, each rated at 20.4 MW net thermal input (22.5 MW gross thermal input).

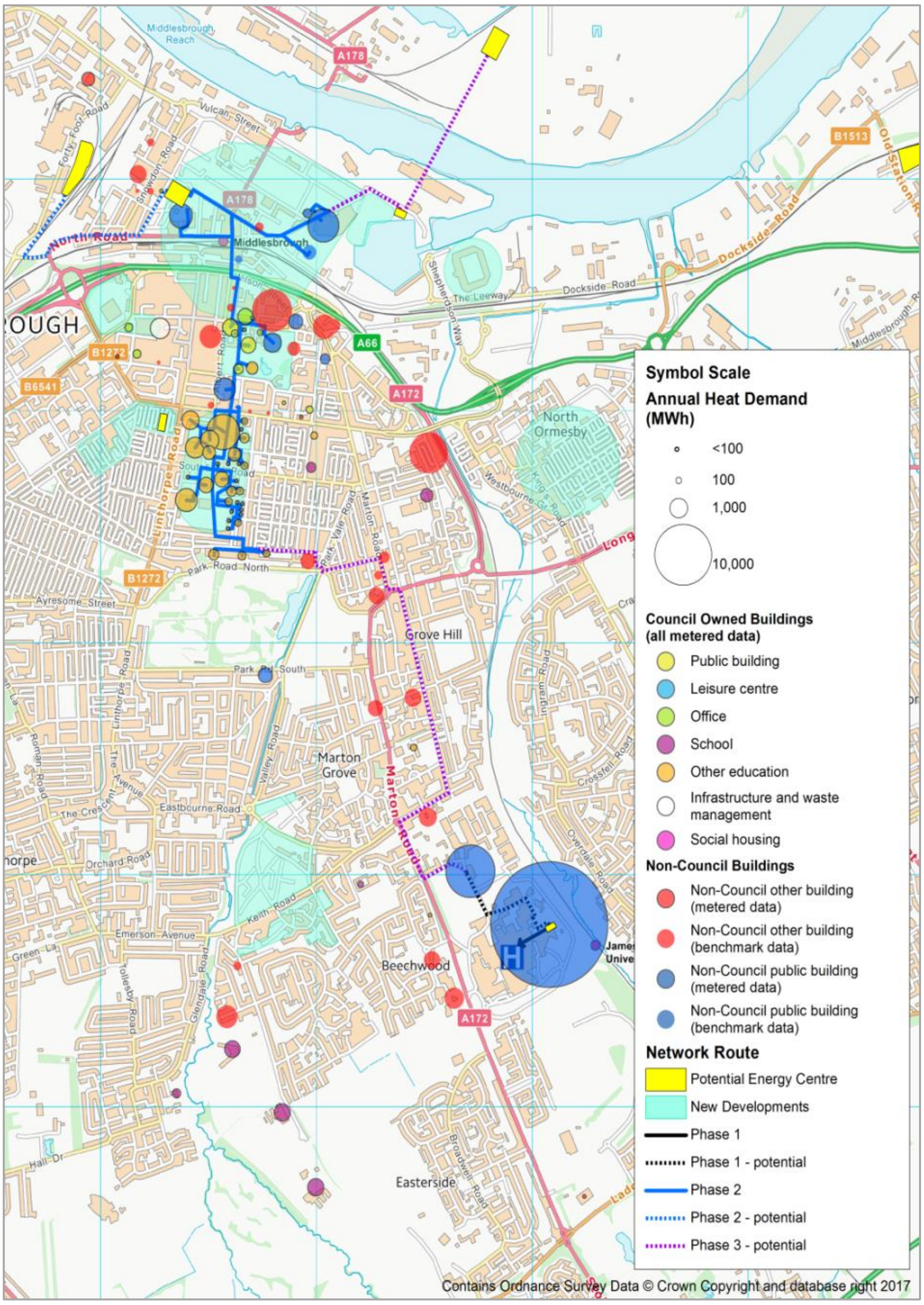
The exhaust from the boilers will discharge at a calculated temperature of 152°C and a volumetric flow rate of 10.4 m^3/s per boiler.

Based on the expected operation of the boiler of around 8,000 hours per year as a rolling 5 year average, with three boilers operating at ~80% of the maximum continuous rating, a high level cost benefit analysis has been undertaken as required by the Regulations for the variation application. An assessment has been made of the potential for the use of heat from the boilers, by considering the quality, opportunities and potential benefits and impacts.

The maximum potential useable thermal output from the installation, based on manufacturer's information, would be approximately 2.5 MW_{th}. This would be in the form of low grade (less than 60°C) hot water with a water flow of 66 m^3/h. Utilising this heat would require an industrial site or other users that require this amount of low-grade hot water. There are no suitable facilities that could use this low-grade hot water within 1 km of the site. However, Middlesbrough Council does promote the use of district heating within the Council area. There are plans to develop a heat network[1] around the James Cook University Hospital, Teesside University and commercial properties to the south of the installation; currently this is in initial feasibility stage. One of the heat source points is north of the river adjacent to the A176. This heating network will be around 5 km from the Venator installation, as shown in Figure 2.1.

1 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/705122/HNDU_Pipeline_2018_Q1.pdf

Figure 2.1 Proposed Middlesbrough District Heating Map



Source: HNDU_Pipeline_2018[1]

Alternatively, there are the Graythorp and Tofts Farm Industrial Estates some 800 m to the north of the installation. Although there is no existing or proposed district heat scheme available here; appropriate industrial and commercial heat users may be identified.

The Middlesbrough heat network (if fully developed) and the industrial estate, are within sensitive ecological surroundings and direct pipe routes may not be possible. A review of the local maps gives indicative distances of 5 km and 0.8 km of pipe work required from the Venator Installation to these potential networks, respectively. The main Middlesbrough network may be able to accommodate the low-grade heat loads that could be recovered from the Venator installation due to the very large thermal inertia of the network, once fully developed. A suitable user(s) of the low-grade heat generated by Venator may be available on the Industrial estates, this would be subject to a suitable commercial arrangement being reached for the supply of low grade heat.

As district heating networks provide an opportunity to increase the overall energy efficiency of the installation, a simple, high-level cost benefit analysis is provided in Table 2.1 below. This assessment assumes that the operators of the heat networks will purchase the heat at a commercial rate of £2,504/TJ[2], 50% below the price of providing heat from mains gas (1.803p/kWh), due to the low temperature of the heat supplied.

The costs for the installation are based on simple straight lengths of flow and return pipework, trenched in soft ground, as a ±50% cost estimate. Excluded from the costs are any equipment or installation at the end user sites.

Table 2.1 District Heating Cost Benefit Review

Item	Units	Possible Heat Network 1	Possible Heat Network 2
		Main Middlesbrough network	Graythorp/Tofts Farm Industrial Estates
Approximate distance from installation	km	5.00	0.80
Estimated cost of installed flow and return district heating pipework	£/m	1,612	1,612
Estimated additional on-site heat exchangers, pumps and controls	£	150,000	150,000
Maximum heat export	MWth	2.47	2.47
Maximum heat export	TJ	0.0089	0.0089
Price Paid for heat by end user[2]	£/TJ	2,504	2,504
DH circulating Pump	kW	75	50
Typical Price of Electricity[2]	£/kWh	0.105	0.105
Hours run of power plant		8,000	8,000
Calculated Capital costs	£	8,210,000	1,439,000
Calculated Operation (opex) costs of the heat distribution pipes	£	62,820	41,880
Income from heat sales	£	178,280	178,280
Net income (Heat sales minus opex)	£	136,400	115,460
Simple payback	Years	71	11

The high-level cost benefit analysis shows a simple payback in excess of 70 years for the Middleborough District Heating Network. This is longer than the design life of the plant and can't therefore be considered

[2] https://www.gov.uk/government/statistical-data-sets/gas-and-electricity-prices-in-the-non-domestic-sector - Table 3.4.1 - 2018 annual figure for large gas consumer (excluding CCL)

commercially viable. For the local industrial estates, the payback is in excess of 10 years, again this is not considered to be commercially viable.

If this situation changes and a commercial agreement is reached that reduces the payback period significantly, the use of heat recovery will be reassessed.

Another important aspect to consider is that the use of this heat would reduce the exhaust gas temperature to approximately 80°C. Reducing exhaust temperature would reduce the buoyancy induced plume rise, thus increasing the environmental impact of the emissions on the local environment. To prevent the impact, increasing stack heights may be required and this cost has not been factored into the calculation in Table 2.1 above.

On consideration of the data available at this stage, the installation of heat recovery units to generate the low-grade heat for export to local users is not considered to be a commercially viable option and, therefore, this is not a justified best available technique.

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