Appendix 3.2

Fichtner Heat Network Report

Appendix 3.2

FICHTNER
Consulting Engineers Limited



Heat Network Feasibility Study

Indaver

Review of the potential for a Heat Network in 6 areas of Co Cork

ENGINEERING CONSULTING

Document approval

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Management Summary

Indaver Ireland Limited (Indaver) is considering the development of a waste to energy facility in Co Cork that could process 240,000 tonnes per annum of waste. The plant would generate up to 21 MW_e of electricity (in fully condensing mode) and could export heat if a viable heat network opportunity exists. Similar projects of this scale that Fichtner have worked on typically export around 12 MW_{th} but the figure in Cork will be dependent on the final plant design. This heat could either be exported as hot water or steam, but it is typical for a heat network to use one (but not both) of these mediums.

As outlined in the planning report prepared by Coakley O'Neill in Appendix 3.1 of the Environmental Impact Assessment Report (EIAR) for the Indaver licence application to the Environmental Protection Agency (EPA), the latest Cork County Development Plan, published in 2014, lists 6 areas that could be suitable for siting a large scale industrial development such as a waste to energy plant; Bottlehill, Carrigtwohill, Kilbarry, Little Island, Ringaskiddy and Whitegate.

Indaver has engaged Fichtner Consulting Engineers Limited (Fichtner) to undertake a high level assessment of these 6 areas to consider which may be suitable for a heat network. There is no Irish guidance on how to assess the feasibility of a heat network adjacent to a waste to energy plant. In the absence of this, Fichtner has undertaken its assessment in line with the UK Environment Agency's document "CHP Ready Guidance for Combustion and Energy from Waste Power Plants". Fichtner also undertook a series of visits to each of the 6 areas to verify potential heat consumers in each and assess potential pipe routing options.

Fichtner used a heat map published by the Sustainable Energy Authority of Ireland (SEAI) to review heat demand (excluding industrial sites) within a 10 km radius of each area. The results of the heat mapping analysis show the area with the largest heat demand is Kilbarry which has an estimated demand of 729 GWh/annum, followed by Little Island (289 GWh/annum) and Ringaskiddy (156 GWh/annum). However, the heat density (GWh/km^2) is relatively low when compared to areas across the UK where heat networks have been realised. As a comparison the Dublin Waste to Energy plant has over 3 times as much heat within both a 10 km and 5 km radius as Kilbarry. In combination with the fact that no buildings within these areas were planned to connect to a heat network and much of the demand is existing residential dwellings, the development of a conventional hot water heat network (serving retail, commercial and residential consumers) is not considered feasible at this time.

As a separate study, Fichtner reviewed details of all EPA licensed facilities in Co Cork, which are likely to require higher grade heat (steam). Sites that were over 10 km from each area or had no steam load were screened out. The Annual Environmental Reports (AERs) for the remaining sites were reviewed and an estimate of the site heat load was calculated from this information.

Little Island has 4 facilities with a total estimated heat load of 100 GWh/annum and Ringaskiddy has 6 facilities that use an estimated 209 GWh/annum of heat, comprising large scale pharmaceutical plants. Both areas could support a steam based industrial heat network, although compatibility with the heat available from the Indaver plant would need to be confirmed. Middleton Distillers is a single large heat load (262 GWh/annum) located 9.6 km to the east of Carrigtwohill, however a connection is not considered viable due to the economic case and complexities of above ground pipe routing over this distance. A further 3 facilities exist in Carrigtwohill, all of which are located at least 2.7 km from the centre, with relatively modest demand totalling 57 GWh/annum. No licensed facilities exist within 10km of Bottlehill.

Whitegate has a single large heat load of approximately 145 GWh/annum. Fichtner understands that the site owner previously looked at obtaining steam from a neighbouring power station but

did not progress this project due to reliance concerns and a competitive existing cost base. It is therefore considered highly unlikely that steam from a waste to energy plant would be suitable.

This report concludes that implementation of a heat network could be considered in Little Island or Ringaskiddy, but that with a larger number of customers in Ringaskiddy and with a larger average heat load, Ringaskiddy would be the most suitable of the 6 areas considered. This conclusion was substantiated by site visits to each of the 6 areas, which highlighted Ringaskiddy as the most favourable due to the concentration of large heat loads, pipe routing feasibility and potential for development expansion in the locality. Little Island also accommodates pharmaceutical plants (and to a lesser degree office and retail space) which may offer connection prospects, although these are smaller in scale.

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1 Introduction

1.1 Background

Indaver is considering the development of a waste to energy facility in Co Cork for the treatment of up to 240,000 tonnes per annum of residual household, commercial, industrial, non-hazardous and suitable hazardous waste. The plant will be capable of generating 21 MW_e of electricity, of which approximately 18.5 MW_e will be exported to the grid. Indaver is considering the feasibility of exporting a proportion of heat to offsite consumers via a heat network, which would require the plant to be capable of combined heat and power (CHP) operation.

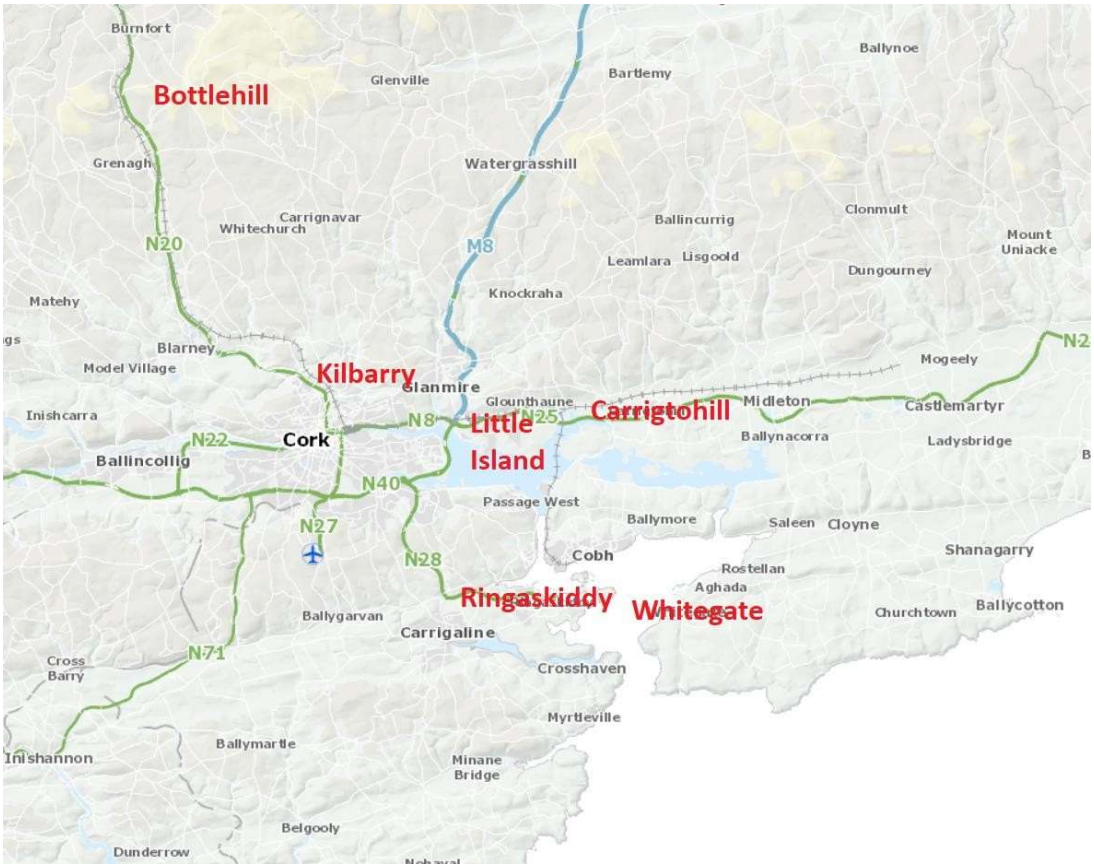
The Cork County Development Plan published in 2014 lists the following 6 areas in the County that could be suitable for a waste to energy plant: Bottlehill; Carrigtwohill; Kilbarry; Little Island; Ringaskiddy; and Whitegate. Indaver has engaged Fichtner to undertake a high-level assessment of heat loads for these 6 sites.

Figure 1: Map of Ireland showing Cork



Source: www.landdirect.ie

Figure 2: Map of 6 areas of Cork



Source: www.landdirect.ie

1.2 Objective

Fichtner was engaged to review the potential for establishing a heat network in 6 areas of County Cork, which were identified in the Cork County Development Plan as potential locations for a waste to energy facility. The principal objectives of this study are as follows.

1. Detail technical considerations for heat export and distribution from the Indaver waste to energy facility.
2. Review the heat demand within 10 km of the centre of each of the 6 areas, using the heat map published by SEAI.
3. Identify potential anchor loads from publicly available information.
4. Review which site locations could be connected to a heat network drawing on industry experience of the heat grade likely to be required.

This assessment has used publicly available information to compare the 6 areas. At no stage did the authors engage with site owners. As a result, heat demands will need to be verified in later studies, as well as the willingness of site owners to enter into commercial agreements for heat supply.

2 Description of the technology and heat network

2.1 The facility

Indaver is considering a plant with a design capacity of 240,000 tonnes per annum, through a single combustion line, of residual household, commercial, industrial, non-hazardous and suitable hazardous waste. The fuel will have an estimated net calorific value (NCV) of 10 MJ/kg. The design point of the plant is approximately 29 tonnes per hour, based on an annual operational availability of 8,000 hours per annum. The process is illustrated in Figure 3.

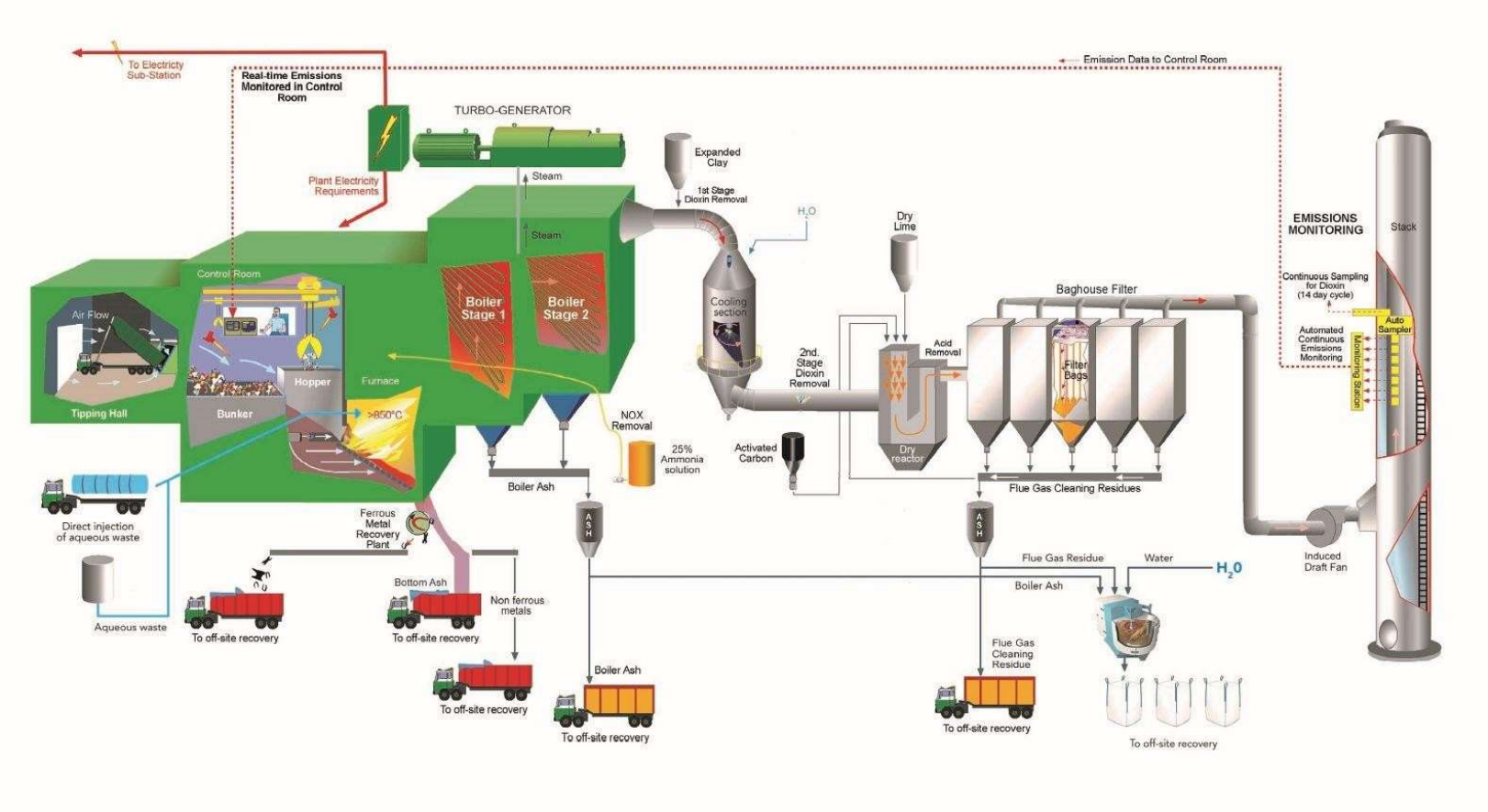
Waste will be combusted on a moving grate to ensure continuous mixing of the fuel and hence promote good combustion. The heat released by combustion will be recovered in a water tube boiler, which is integral to the furnace and will produce (in combination with superheaters) high pressure superheated steam. The steam from the boiler will feed a steam turbine-generator used to generate electricity. Exhaust steam will then be cooled using an air-cooled condenser, with condensate being retained for reheating, to minimise make-up water volumes.

In fully condensing mode, the steam turbine will generate up to 21 MW_e. The house load is projected to consume approximately 2.5 MW_e, leaving the balance of 18.5 MW_e available for export to the grid.

Based on Fichtner's experience of similar facilities, it should be possible to export approximately 12 MW_{th} of heat. This figure will be subject to the method of heat recovery selected and the design of the turbine and primary water/steam cycle. This figure could therefore vary considerably from 12 MW_{th} when the detailed design is completed.

Subject to technical and economic feasibility, a heat supply system may be installed to export heat to offsite consumers, as discussed in the following sections.

Figure 3: Indicative process schematic



Source: Indaver

2.2 Heat available

Assuming detailed design of the Indaver plant is progressed based on exporting up to 12 MW_{th} of heat (subject to the method of heat recovery selected), a maximum of 96 GWh/annum would be available for export. Due to seasonal and diurnal variations in heat demand which are universally present in heat networks, it is not possible to utilise the maximum heat export capacity consistently. The heat supply system must be capable of supplying peak heat loads, or alternatively peak lopping plant or accumulators (thermal stores) could be incorporated within the network, as discussed in the following section.

2.3 Back-up heat source

During periods of routine maintenance or unplanned outages of the Indaver plant, the heat consumers will still require heat. There is therefore a need, somewhere within the heat distribution system, to provide a back-up source of heat to meet the needs of the heat consumers.

At the scale of the heat network under consideration, the standby plant will likely comprise oil- or gas- fired hot water heaters or steam boilers, with separate dedicated chimney stack(s). 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.

In the case that a majority of heat consumers were retrofit connections to industrial consumers, it is possible that existing heating infrastructure could be retained as back-up. The back-up strategy would need to be developed as part of the detailed design phase. Subject to detailed heat demand modelling, once heat consumer requirements are known with more certainty, opportunities for installing thermal stores may also be considered to lessen reliance on the back-up plant/peak lopping boilers by storing excess heat generated during off-peak periods for use during times of peak heat demand.

2.4 Heat recovery

Heat is typically supplied from waste to energy plants in the form of steam and/or hot water, depending on the grade of heat required by end consumers. The most commonly considered options for recovering heat from waste to energy facilities are discussed below.

2.4.1 Heat recovery from the air-cooled condenser

Wet steam emerges from the steam turbine typically at around 40°C. Steam is condensed in a large air-cooled system which rejects the heat in the steam into an air flow, which is rejected to atmosphere. An air-cooled condenser generates a similar temperature condensate to mechanical draught or hybrid cooling towers but 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 feedwater prior to being returned to the boiler. The additional steam extraction reduces the power generation from the facility.

2.4.2 Heat extraction from the steam turbine

Steam extracted from the steam turbine can be used to generate hot water or steam for a heat network. Conventional hot water networks typically operate with a flow temperature of 90 to 120°C and return water temperature of 50 to 80°C. If heat is exported as steam, temperatures and

pressures will be subject to end user requirements and the turbine extractions will be designed accordingly.

Steam is preferably extracted from the turbine at low pressure to maximise the power generated from the steam. Extraction steam is passed through condensing heat exchangers, with condensate recovered back into the feedwater system. Hot water is pumped to heat consumers for consumption before being returned to the condensing heat exchangers where it is reheated.

In this case, the steam is normally extracted from the two 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 plant'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. Increasing the capacity of the bleeds once the turbine has been installed can be difficult.

2.4.3 Heat extraction from the flue gas

The temperature of flue gas existing 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 in the range 90 to 120°C and this method of heat extraction does not significantly impact the power generation from the plant.

Condensing the flue gas can also be achieved in a wet scrubber, but this has several disadvantages over the option described above. The scrubber temperature is typically no more than 80°C, which restricts the hot water temperature available for consumers. 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 could require a higher stack height to effect adequate dispersion. The additional cooling of the flue gas results in the 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 as an effluent.

2.4.4 Summary

The solution most commonly selected to extract heat to a heat network is extraction of low or medium pressure steam from the turbine. This is typically chosen for the following reasons.

1. Extraction of steam from the turbine offers the most flexibility for varying heat quality and capacity to supply variable demands or new future demands, which is particularly relevant where there is uncertainty over heat loads.
2. Extraction of steam from the turbine, heat transfer to a distribution circuit and delivery of heat to consumers can be facilitated by well proven and highly efficient technology.
3. The use of a flue gas condenser often generates a visible plume which would be present for significant periods of the year. This is often not desirable as it significantly adds to the visual impact of the plant.

2.5 Heat export medium

The choice to export heat as hot water or steam is substantially driven by the requirements of consumers in the locality of the plant. The main considerations for each option are discussed in the following sections.

2.5.1 Heat export via hot water

In the case of a conventional heat network served by hot water, heat is typically distributed using buried pipework. Pre-insulated steel pipes are used to supply pressurised hot water and to return cooler water. Less expensive polymer pipes can be incorporated where the temperature and pressure are within design limitations. Where pipes are small, two pipes may be integrated within a single insulated sleeve. For larger heat demands, large bore pipes are installed as a single insulated run. Pipe technology is well proven and can provide a heat distribution system with a design life of 30 years or more. Additional pipe work can be added retrospectively, and it is reasonably straightforward to add branches to serve new developments.

Modern pre-insulated pipes enable hot water to be transferred large distances without significant heat losses. Where the topography creates challenges, for example to provide heat to buildings on a hill significantly higher than the plant, heat exchangers and additional pumping systems can be installed to create pressure breaks, enabling the network to be extended.

Heat delivery arriving at a 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 the customers' existing 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 heat network. Pumps are operated with 100% standby capacity to maintain heat supply in the event of a pump fault. Pumps are likely to utilise variable speed drives to minimise energy usage.

2.5.2 Heat export via steam

Steam is considerably less dense than water so the space requirements and capital cost of the pipework is typically higher than a comparative hot water system. In addition, expansion loops may be required, which increase the total pipe length. Heat losses from steam pipework, resulting from higher working fluid temperatures, can be offset though improved insulation.

Depending on the processes undertaken at the consumer sites, it may or may not be possible to recover and return condensate to the source. Any condensate lost, for example due to direct use within an industrial process, would need to be made up to ensure that water supply to the Indaver boiler is not compromised. This configuration could necessitate an increased water usage and larger water treatment plant but can be managed with appropriate heat pricing structure.

Where condensate is returned from consumers monitoring of condensate conductivity is advisable to ensure that water quality remains within acceptable limits stipulated by the boiler and turbine suppliers. This risk could be mitigated by incorporating a hydraulic break in the system, in this case by means of steam generators, so that heat supply to consumers is provided via a secondary circuit.

To protect against condensate formation in the steam supply pipeline, pipe gradients, steam traps and associated valving need to be incorporated into the design. These additional components require ongoing maintenance and as a result steam pipelines are typically routed above ground. Health and safety, planning and asset protection considerations of running steam mains above ground would need to be considered. However, this approach has already been adopted on

industrial sites within Co Cork, for example at the GlaxoSmithKline and Pfizer Ireland Pharmaceuticals sites, amongst others. Indaver has also commissioned a large-scale industrial steam network, ECLUSE, at the Port of Antwerp which commenced operations in March 2019. The network provides steam from three waste to energy plants to six chemical companies at the port, reducing CO2 emissions by an estimated 100,000 tonnes per year. The majority of the steam and condensate piping is routed above ground.

2.6 Heat station

Within the Indaver site, space will be required for the heat export infrastructure. Subject to the heat export medium selected, the heat station could house heat exchangers, circulation pumps, metering, pressurisation and water treatment systems and ancillary equipment. The quantity of equipment required to export steam from the site would be reduced, however the steam supply pipework would be larger, relative to a comparative hot water system.

In consultation with Indaver, sufficient space will be allowed for in close proximity to relevant steam and condensate interface points in the boiler hall area of the plant.

In the case of a buried pipe system, it would be prudent to install any onsite pipe sections alongside other buried services, and prior to surfacing and road laying. Otherwise a pipe bridge may be required for hot water (or steam) supply and hot water (or condensate) return.

3 Heat load assessment for a hot water-based network

3.1 SEAI heat map

There is no Irish guidance on how to assess the feasibility of a heat network adjacent to a waste to energy plant. In the absence of this, Fichtner have based this assessment on the Environment Agency's document "CHP Ready Guidance for Combustion and Energy from Waste Power Plants", which was published in February 2013. Section 4 of this document explains that a review of potential heat loads in the area should be conducted and advises that an indicative search radius of 10 km should be used for plants less than 300 MW and 15 km for plants greater than 300 MW.

In 2015, AECOM completed a study commissioned by SEAI to fulfil Ireland's obligation under Article 14 of the Energy Efficiency Directive (2012/27/EU) and SEAI's obligation under 23(1) of Statutory Instrument 426. As part of this study a spatial representation of Ireland's heat demand was developed and is available online at http://maps.seai.ie/heatdemand/.

This SEAI heat map presents the following data:

1. heat demands for domestic and non-domestic (public sector, commercial, and industrial) buildings. Annual demand is shown per m^2 of building footprint (MWh/m^2) and as the linear heat density (MWh/km);
2. industrial demands and waste heat availability for EU Emissions Trading Scheme (ETS) sites;
3. the location of industrial sites within the Large Industry Energy Network (LIEN);
4. water network lengths, gas network lengths and road lengths used for the calculation of linear heat density; and
5. key energy supply technologies including power stations.

Data is provided as annual heat demands for 2015 and 2025 in MWh. A heat demand calculator tool is included in the heat map and has been used in this study to analyse the heat demand within a 10 km search radius, as suggested in the Environment Agency's guide for plants under 300 MW, of each of the 6 areas.

To choose the centre point of the search radius, the point provided by Google Maps for Carrigtwohill, Kilbarry, Little Island and Whitegate was used. For Ringaskiddy, the site owned by Indaver was used. The Bottlehill landfill site was used as the centre point for the radius around Bottlehill.

Table 1: Co-ordinate used for centre of search areas

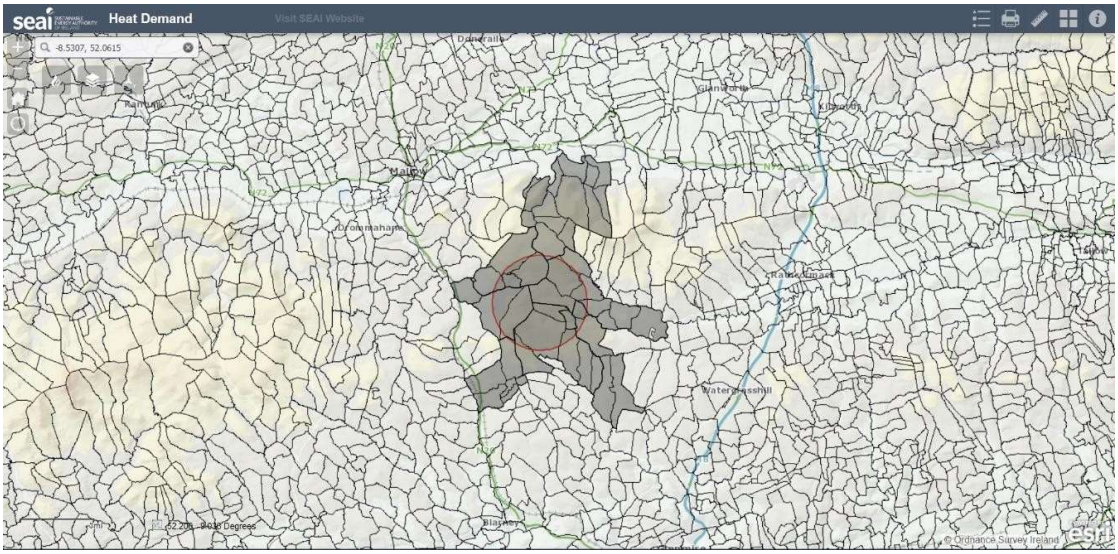
Area	Co-ordinates
Bottlehill	52.0615, -8.5307
Carrigtwohill	51.9100, -8.2589
Kilbarry	51.9284, -8.4741
Little Island	51.9027, -8.3512
Ringaskiddy	51.8303, -8.3065
Whitegate	51.8272, -8.2320

Source: Fichtner

Spatial representations of the areas included are presented in Sections 3.2 to 3.7. This shows two scenarios, one with a 5 km radius and another with a 10 km radius of each area. It should be noted that the tool on the SEAI map includes any townland that has a section within the relevant search radius. In rural areas these townlands are larger, and the shape of the areas assessed is more irregular. As an example, the 5 km search around Bottlehill includes some land that is over 10km from the centre point of the circle (as can be seen in Figure 5). However, as this study is a comparative assessment of the 6 areas, and the methodology is consistent for assessing each area, any errors as a result are not considered material.

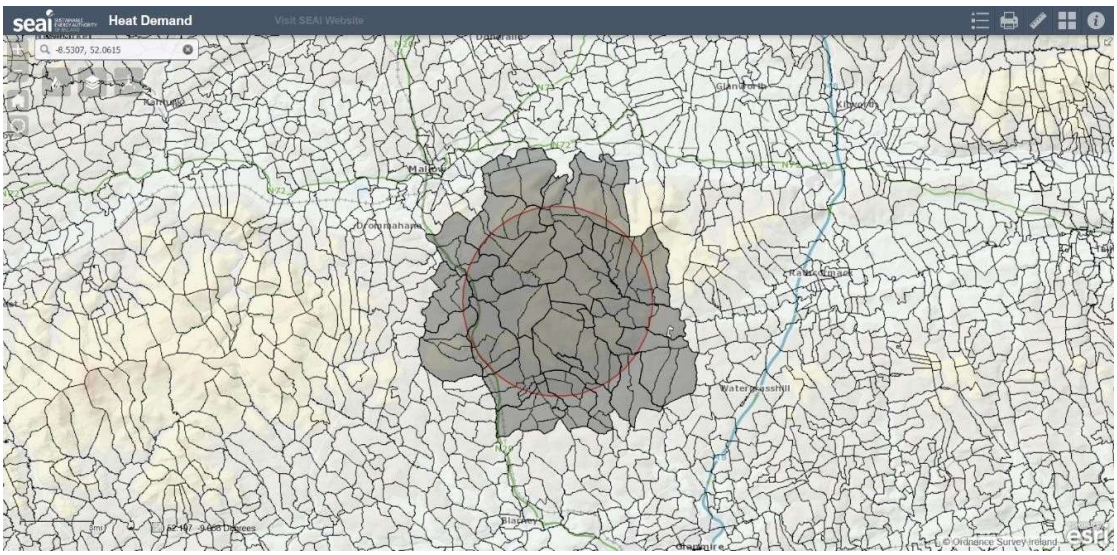
3.2 Bottlehill screenshots

Figure 4: 5 km search radius around Bottlehill



Source: Screenshot from SEAI heat map

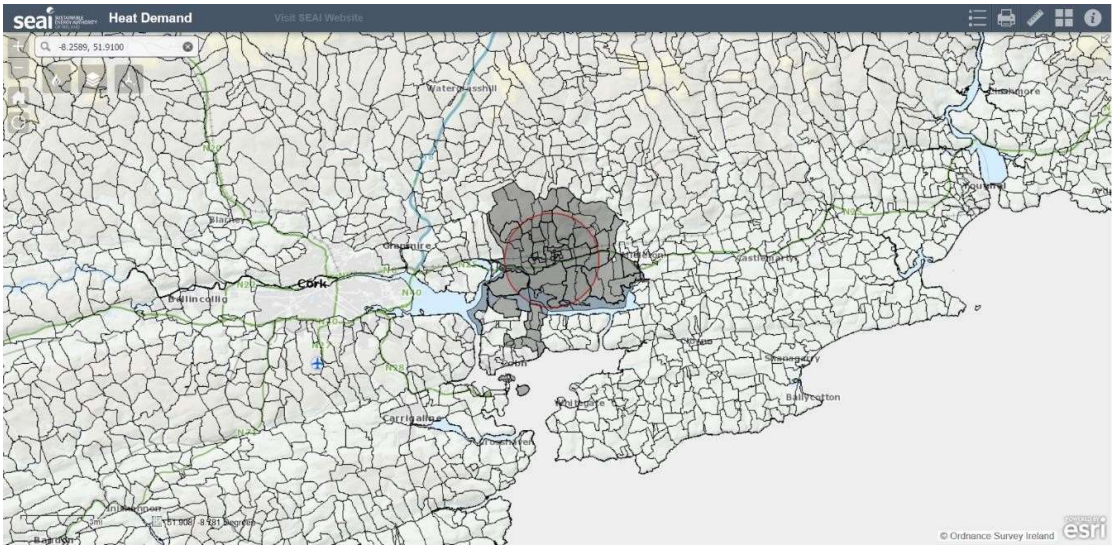
Figure 5: 10 km search radius around Bottlehill



Source: Screenshot from SEAI heat map

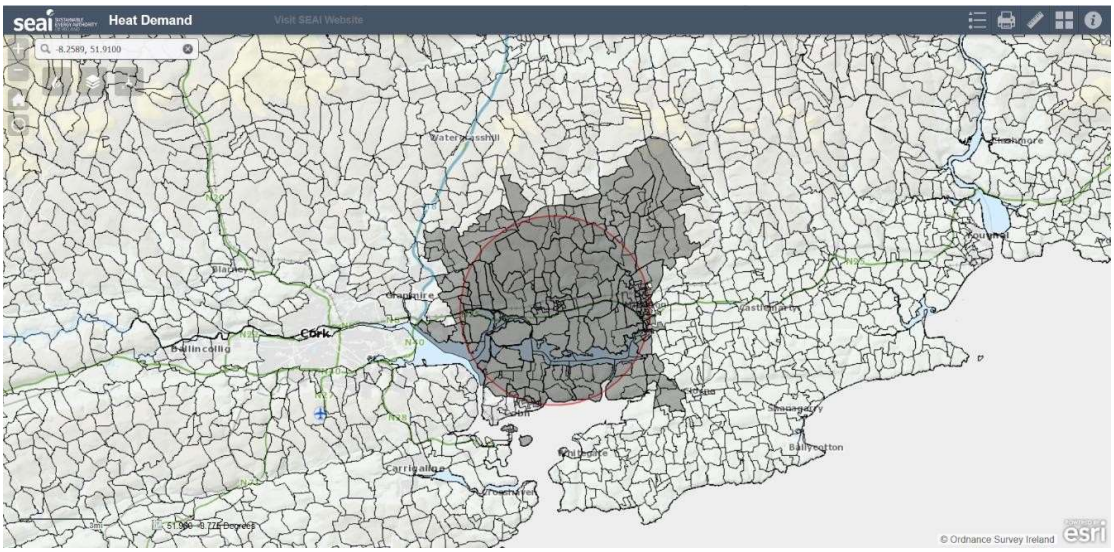
3.3 Carrigtwohill screenshots

Figure 6: 5 km search radius around Carrigtwohill



Source: Screenshot from SEAI heat map

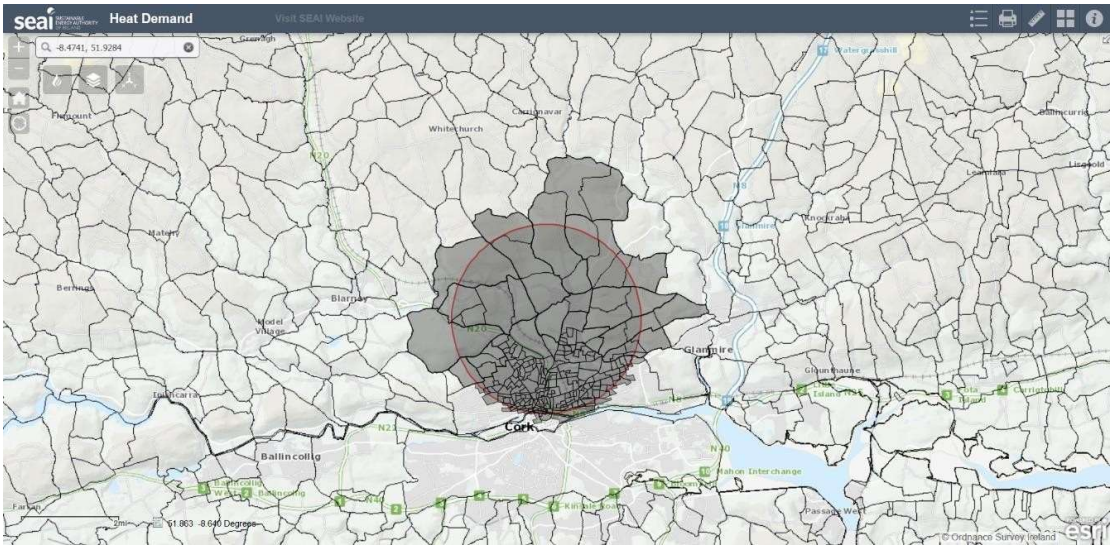
Figure 7: 10 km search radius around Carrigtwohill



Source: Screenshot from SEAI heat map

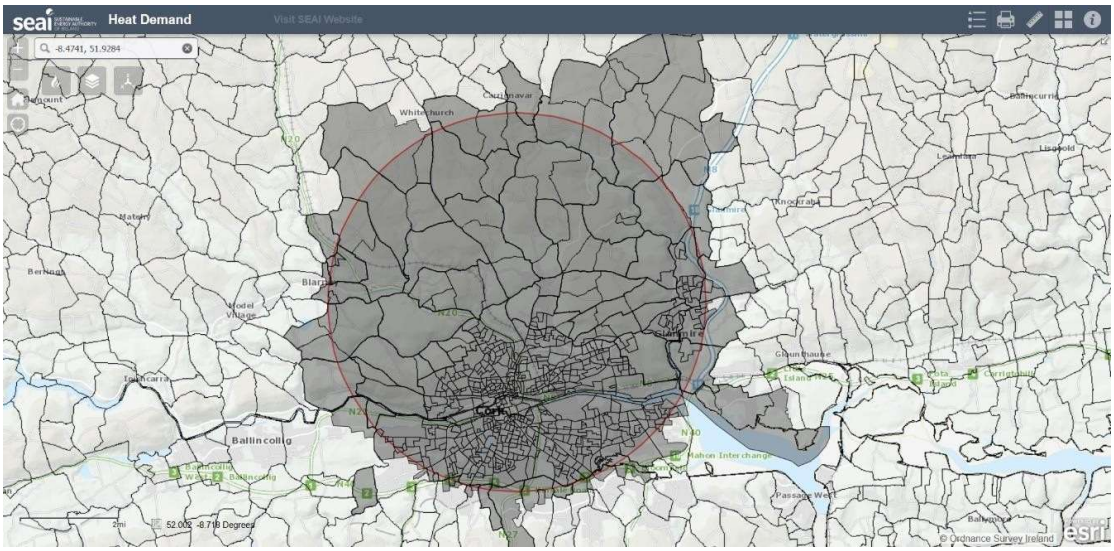
3.4 Kilbarry screenshots

Figure 8: 5 km search radius around Kilbarry



Source: Screenshot from SEAI heat map

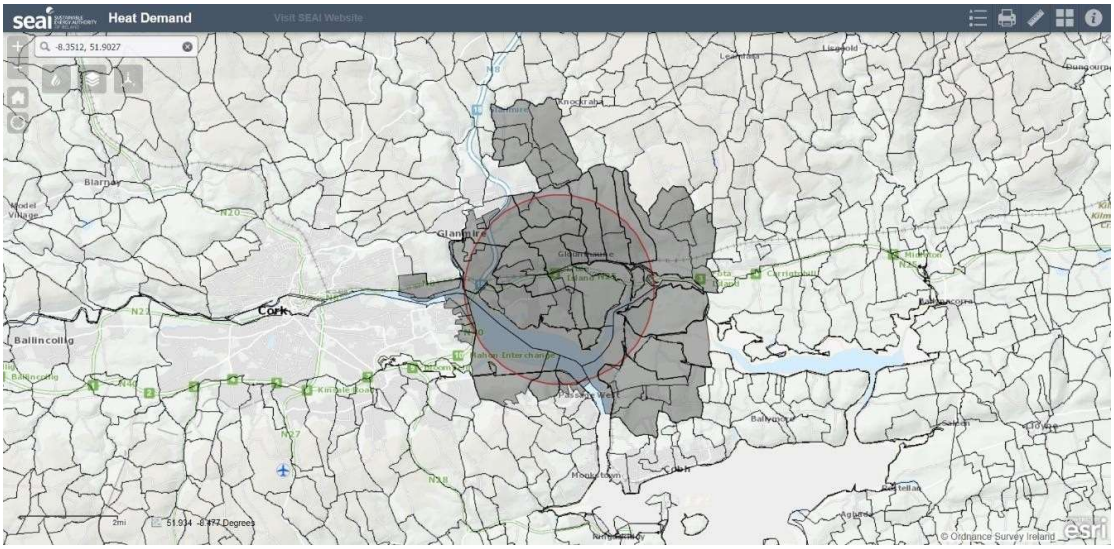
Figure 9: 10 km search radius around Kilbarry



Source: Screenshot from SEAI heat map

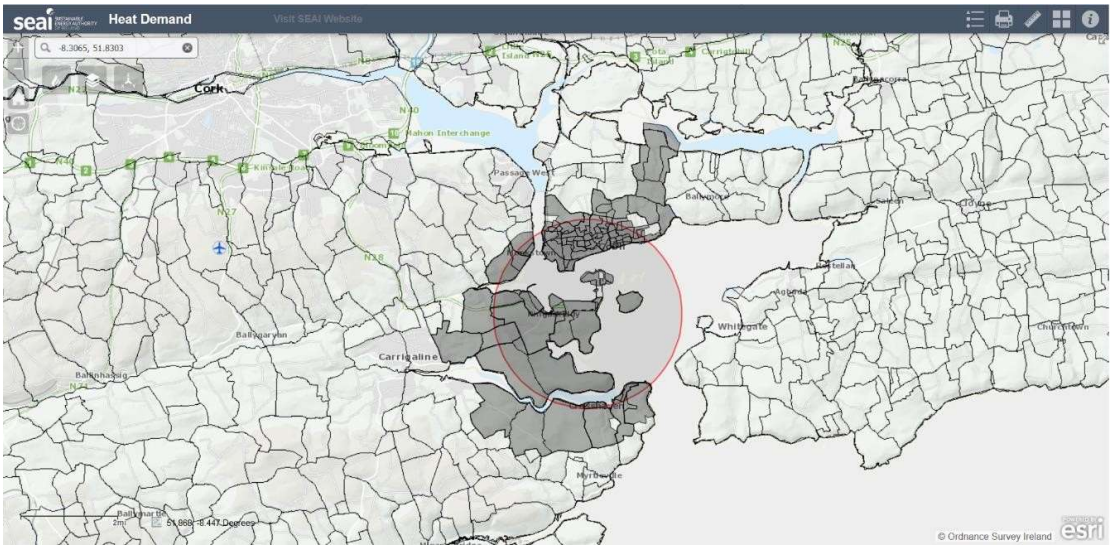
3.5 Little Island screenshots

Figure 10: 5 km search radius around Little Island


Heat Demand
Visit SEAI Website
-8.3512, 51.9027
Cork
Ballincollig
Blarney
Glanmire
Carrigtwohill
Midleton
Whitegate
Cobh
Passage West
Monkstown
Ballycotton
Tower
Tullagh
Kinsale
Model Village
N20
N25
N27
N28
N8
N40
Lissarda
Lisgold
Dungourney
Ballinacorra
Ballyvolane
Knocknahaha
Ballyhooly
Kilmurry
Rathcoursey
Ballinrostig
Kilbrittain
Ballinadee
Ballinspittle
Ballymacoda
Youghal
Ballycrenane
Ballyfinboy
Ballyhea
Ballyvourney
Macroom
Inchigeelagh
Coachford
Dunmanway
Bandon
Clonakilty
Rosscarbery
Courtmacsherry
Timoleague
Kinsale
Old Head of Kinsale
Harbour
Kinsale Harbour
Cork Harbour
Roche's Point
Whitegate
Aghada
Ballycotton
Ballycotton Bay
Youghal Bay
Youghal
Ballymacoda
Clonakilty Bay
Courtmacsherry Bay
Timoleague
Rosscarbery
Glandore Harbour
Glandore
Castletownshend
Skibbereen
Baltimore
Roaring Water Bay
Schull
Goleen
Crookhaven
Mizen Head
Dunmanway
Bandon

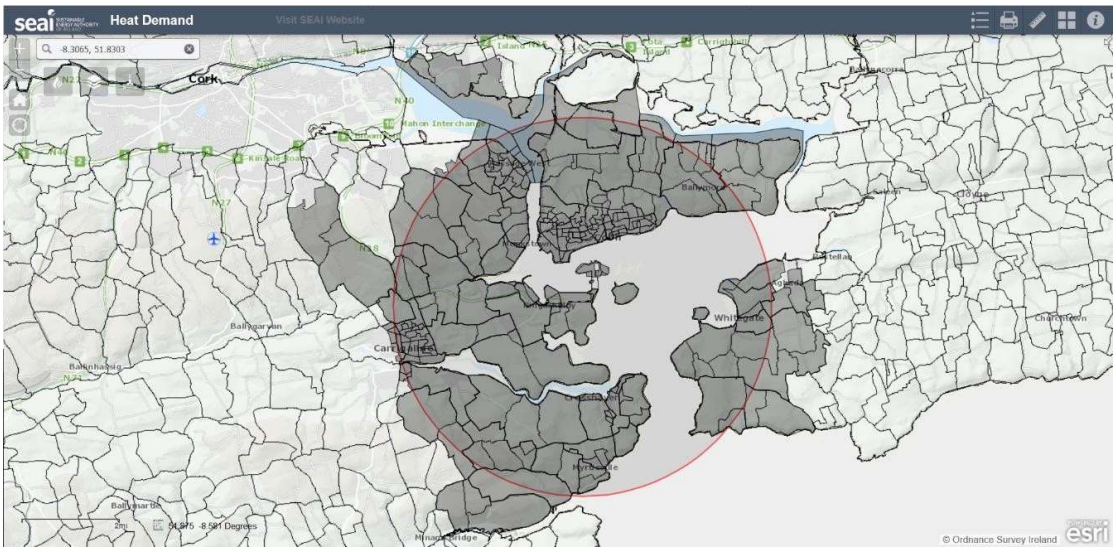
3.6 Ringaskiddy screenshots

Figure 12: 5 km search radius around Ringaskiddy



Source: Screenshot from SEAI heat map

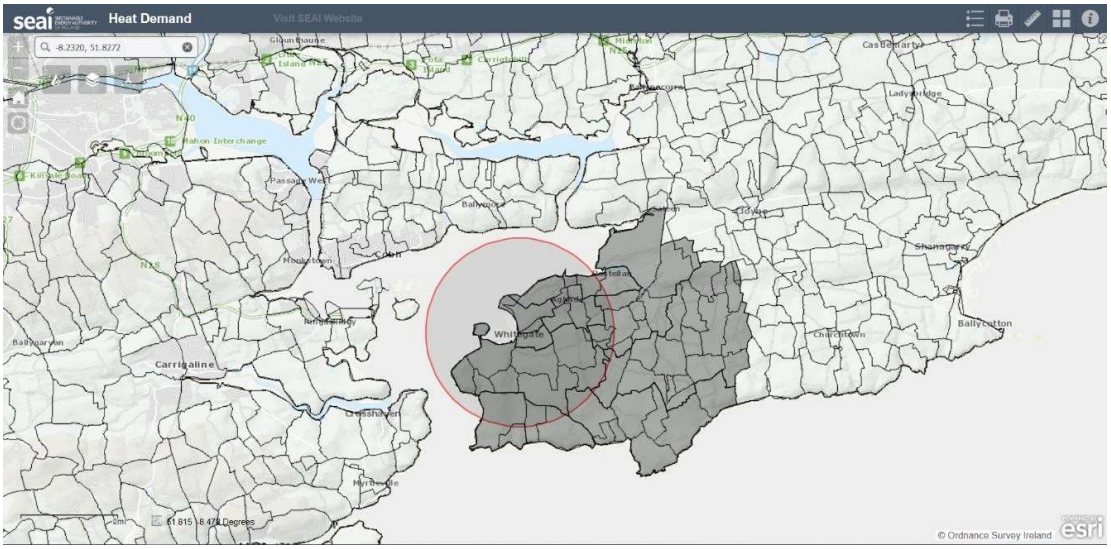
Figure 13: 10 km search radius around Ringaskiddy



Source: Screenshot from SEAI heat map

3.7 Whitegate screenshots

Figure 14: 5 km search radius around Whitegate


Heat Demand
Visit SEAI Website
-8.2320, 51.8272
Whitegate
Carrigaline
Ballycotton
Shanagarry
Ladysbridge
Passage West
Ballyvolane
Ballygarvan
Cobh
Glounthaune
Castlemartyr
Midleton
Youghal
Carrigtwohill
Kinsale
N40
N25
N8
Ballincurrig
Ballinhassig
Crosshaven
Myrtleville
Inishannon
Knocktown
Tower
Ballinacorra
Island Field
Belvelly
Ballinrostig
Ballinvarrig
Ballinacurra
Ballinrostig
Ballinvarrig
Ballinacurra
Ballinrostig
Ballinvarrig
Ballinacurra

3.8 Discussion

The projected heat demands for 2025, based on this initial assessment of the SEAI heat map are summarised in Table 2. It should be noted that these figures are unscreened, and it would be impractical to connect many of the heat loads included within these figures to a heat network in that area. The most obvious examples of this are where areas included in the 10 km search radii for Little Island, Ringaskiddy and Whitegate include areas on the opposite side of Cork Harbour.

Table 2: Total estimated heat demand in 2025 (including all townlands within, or touching, a 5 km and 10 km of the areas centre point)

Area	5km	10km
Bottlehill	10 GWh	25 GWh
Carrigtwohill	27 GWh	104 GWh
Kilbarry	211 GWh	729 GWh
Little Island	49 GWh	289 GWh
Ringaskiddy	67 GWh	156 GWh
Whitegate	13 GWh	85 GWh

Source: SEAI heat map

The results of this initial data suggest that Kilbarry would be the most favourable site for a hot water-based heat network in Co Cork. It should be recognised that the volume of heat which could realistically be connected from a heat source located at Carrigtwohill and Kilbarry is overestimated due to constraints posed by the local rail network and River Lee respectively (see section 5).

For over a decade Dublin City Council has considered connecting a heat network to the Dublin Waste to Energy plant. As a comparison to the heat loads in Co Cork, Fichtner has reviewed the SEAI heat map and it shows a demand of 635 GWh of heat within 5 km of the waste to energy plant and 2,313 GWh within 10 km of the plant.

Table 3: Heat load around 6 areas compared to that around the Dublin waste to energy plant

Area	5 km	10 km
Bottlehill	2%	1%
Carrigtwohill	4%	4%
Kilbarry	33%	32%
Little Island	8%	13%
Ringaskiddy	10%	7%
Whitegate	2%	4%

Source: Fichtner

A more thorough investigation of the SEAI heat map shows that the areas around Kilbarry include a population of 47,959 in the 5 km scenario and 142,530 in the 10 km scenario. Assuming an average home size of 2.75 persons (2016 Irish Census) the scheme would connect to over 17,439 houses in the 5 km scenario and 51,829 dwellings in the 10 km scenario. In many 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. This market reality would considerably reduce the potential heat demand in Kilbarry. This effect would also impact the other areas to a lesser extent, since heat demand in other areas is comprised from a more diverse range of consumer types and heat volumes.

As a comparison we note that the Dublin District Heating scheme has been proposed for some time, with an initial feasibility study completed in 2008. In November 2018, Dublin District Council issued documents in relation to the Dublin District Heating scheme on eTenders. These documents explain that many buildings in an area called the Docklands Strategic Development Zone are District Heating Enabled. They estimate there is a total annual heat load of 66 GWh/annum that is ready to connect to a district heating scheme.

Based on these scenarios Fichtner does not consider it feasible for Indaver as a private company to develop a hot water-based district heating scheme in any of the areas reviewed in Co Cork. If local area plans were developed mandating new buildings to be enabled for district heating, it may be worth considering these areas in the medium term. Alternatively, if a scheme were to be developed by another entity, perhaps a public body offering relatively certain heat demand over the medium to long term, Indaver could potentially provide heat to such a scheme.

4 Heat load assessment for a heat network to serve industrial users

The SEAI heat map lists the locations of Emissions Trading Scheme (ETS) sites licensed by the EPA and members of SEAI's Large Industry Energy Network[1] (LIEN). Fichtner has reviewed the corresponding information on the heat map but some of the information appears to be out of date (the map was produced in 2015). As a result, a more detailed assessment of industrial heat demand in the 6 areas was conducted by assessing publicly available information on all EPA licensed sites in Co Cork.

4.1 Short listing sites

A search of the EPA's website on 27 February 2019 showed that the EPA has issued licences to 85 companies in Co Cork. This list was screened as follows.

- 25 companies are licensed for 'intensive agriculture'. Of these only 1 had an address in any of the 6 areas under assessment. The others were discounted.
- Power stations and waste collection/recycling sites do not have a heat demand and were removed from the list.
- Any sites with the following areas in their address were removed: Ballineen, Bandon, Ballyvourney, Bantry, Charleville, Enniskeane, Fermoy, Innishannon, Kinsale, Macroom, Mallow, Mogeely, Newmarket, Watergrasshill, Youghal.

After this screening 29 sites remained on the list. Of these 3 have an address in Carrigtwohill, 8 in Little Island, 7 in Ringaskiddy and one in Whitegate. As Bottlehill and Kilbarry did not have any sites on this list, they are not considered to have any significant industrial heat demand and were therefore not considered further in this assessment.

The addresses of the remaining sites were entered into Google Maps, and the shortest distance by road to any of the remaining 4 areas (Carrigtwohill, Little Island, Ringaskiddy or Whitegate) was recorded. Only 3 of these sites were within 10 km of one of the 3 areas, and the others were discarded.

The shortlisting process described above resulted in a list of 21 EPA licensed facilities within 10 km of Carrigtwohill, Little Island, Ringaskiddy or Whitegate. These facilities are listed in the table below.

Table 4: EPA licensed facilities within 10 km of Carrigtwohill, Little Island, Ringaskiddy or Whitegate

Name	Location	Area
Fournier Laboratories Ireland Limited T/A AbbVie	IDA Industrial Estate, Anngrove, Carrigtwohill	Carrigtwohill
Merck Millipore Limited	Tullagreen, Carrigtwohill	Carrigtwohill
Mr James O'Brien	Ballintubbrid East, Carrigtwohill	Carrigtwohill
Marinochem Limited	Marino Point, Cobh	Carrigtwohill
Irish Distillers Limited	Midleton Distilleries, Midleton	Carrigtwohill
BASF Ireland Limited	Inchera and Wallingstown, Little Island	Little Island
Cara Partners	Little Island Industrial Estate	Little Island

[1] Details at: https://www.seai.ie/energy-in-business/lien/

Name	Location	Area
Corden Pharma Limited	Little Island, Cork	Little Island
Janssen Pharmaceutical Sciences UC	Wallingstown, Little Island	Little Island
Pfizer Ireland Pharmaceuticals	Wallingstown, Little Island	Little Island
Punch Industries Limited	Wallingstown, Little Island	Little Island
Tapella Limited	Little Island	Little Island
Wexport Limited	Wallingstown, Little Island	Little Island
BioMarin International Ltd	Ballintaggart, Shanbally, Ringaskidddy	Ringaskiddy
Hovione Limited	Loughbeg, Ringaskiddy	Ringaskiddy
Janssen Sciences Ireland UC	Barnahely, Ringaskiddy	Ringaskiddy
Novartis Ringaskiddy Limited	Ringaskiddy	Ringaskiddy
Recordati Ireland Limited	Raheens East, Ringaskiddy	Ringaskiddy
The Hammond Lane Metal Company Limited	Ringaskiddy	Ringaskiddy
Smithkline Beecham (Cork) Limited	Currabinny, Carrigaline	Ringaskiddy
Pfizer Ireland Pharmaceuticals	PO Box 140, Ballintaggart, Ringaskiddy	Ringaskiddy
Irving Oil Whitegate Refinery Limited	Whitegate, Midleton, Cork	Whitegate

Source: EPA website and Google Maps

4.2 Estimating the heat load for each site

Licensed facilities are required to submit an Annual Environmental Return (AER) for each calendar year. The AER covers 11 different sections and most companies complete an excel spreadsheet provided by the EPA[2]. One of these sections is titled 'resource usage/energy efficiency' and a PDF of this page is attached in Appendix A. The sheet records energy use listed as electricity and fossil fuels (which are broken down into heavy fuel oil, light fuel oil, natural gas and coal/solid fuel).

AERs are submitted throughout the following years and 2017 AERs are accessible on the EPA's website. Fichtner has reviewed the published AERs of all sites listed in Table 4 but no AERs were published for the following sites:

- Fournier Laboratories Ireland Limited;
- Corden Pharma Limited;
- Punch Industries Limited;
- Tapella Limited; and
- Janssen Sciences Ireland UC.

It also became clear that the Hammond Lane Metal Company Limited site appears to have no steam or hot water load.

Most of the remaining sites use primarily natural gas, and while some will use natural gas for industrial processes, for this assessment we have used it for a proxy for the heat demand of the site. Where natural gas consumption was reported in m^3, this was converted to MWh of energy input by using a conversion of 11 kWh/m^3. The MWh of energy input for each site was then converted to MWh of heat, using an assumption that each site uses an 85% efficient boiler, in line with industry norms.

[2] As of 21 February 2019, this document is available to download at http://www.epa.ie/pubs/advice/aerprtr/aerguid/

Based on the nature of activities undertaken at these sites, it is reasonable to assume that most of the heat demand will be for high grade heat (steam). Discussion with potential heat consumers will be required to verify heat loads (in terms of volume of heat and grade of heat required) and to determine whether site owner/operators are willing to enter into a commercial agreement for the provision of heat.

The sections below show the annual heat load for all remaining sites. The distance to the relevant area (based on Google maps) is also shown.

4.3 Carrigtwohill

Table 5: Heat Loads within 10km of Carrigtwohill

Site name	Potential heat load (GWh/annum)	Distance for pipes from Centre of Carrigtwohill (km)	Potential to connect
Merck Millipore	57	2.7	Possible
Mr James O'Brien	0.1	3.3	No
Marinochem	2	8.4	Unlikely
Middleton Distillers	262	9.6	Possible

Source: EPA website and Google maps

In Carrigtwohill there are 3 potential heat loads. The largest of these, Middleton Distillers has a potential heat load of 262 GWh/annum and is located 9.6 km from the centre of Carrigtwohill. If the plant had a steady load for the entire year (which is unlikely) this would require an average heat input of 29.9 MW. With an exceptionally well insulated pipe that lost only 1% of energy/km, a waste to energy plant in Carrigtwohill would need to supply 32.7 MW of heat. This is considerably more than the Indaver plant is designed for. As the Middleton site is so far from a potential plant in Carrigtwohill and heat losses are likely to be prohibitively large, connecting to this consumer is not considered to be viable.

4.4 Little Island

Table 6: Heat Loads within 10 km of Little Island

Site name	Potential heat load (GWh/annum)	Distance for pipes from Centre of Little Island (km)	Potential to connect
Cara Partners	28	1.8	Possible
Janssen Pharmaceutical	51	1.3	Possible
Pfizer Ireland Pharmaceuticals	16	1.8	Possible
Wexport	5	1.3	Possible
BASF Ireland Limited[1]	53	2.0	Unlikely
[1]We understand that a contract to replace and upgrade heating infrastructure is out to tender.			

Source: EPA website and Google maps

Little Island has 4 plants with potential connection prospects, with a total estimated heat load of 100 GWh within 2.5 km of the centre of Little Island. This corresponds to an average instantaneous heat supply requirement of approximately 12.5 MW, assuming the facilities operate for 8,000 hours

per annum, which is within the range of the Indaver plant. All these sites are to the west of Little Island and if a suitable site were available it would be worth investigating Little Island as a potential site for an industrial heat network.

The average load per licensed facility of those with potential connection prospects in Little Island is 25 GWh/annum.

4.5 Ringaskiddy

Table 7: Heat Loads within 10 km of Ringaskiddy

Site name	Potential heat load (GWh/annum)	Distance for pipes from Centre of Ringaskiddy (km)	Potential to connect
BioMarin International	12	3.1	Possible
Hovione	26	1.9	Possible
Novartis	50	2.9	Possible
Recordati	3	2.8	Possible
Smithkline Beecham	44	5.2	Possible
Pfizer	74	2.7	Possible

Source: EPA website and Google maps

There are also sites that have applied for an EPA licence, but it is not yet granted. One of these is an application by Janssen Science Ireland UC in Ringaskiddy, which is 2.5 km from the Indaver site. This was not included in the current assessment but could be another heat user.

Ringaskiddy has 6 potential sites that use an estimated 209 GWh of heat per year. The furthest of these is 5.2 km by road from the Indaver site, but only approximately 1.7km 'as the crow flies'. It would be relatively easy to find a shorter route for a steam distribution pipe. This would give 209 GWh within 5 km of the site. This translates to an average instantaneous heat requirement of approximately 26 MW, assuming the facilities operate for 8,000 hours per annum, which is greater than the design capacity of the Indaver plant but it is likely that not all of the plants identified would take up this option in the future.

4.6 Whitegate

There is no AER available for Irving Oil Whitegate Refinery Limited, however Indaver has supplied a report by Tungsten Consulting Limited (attached as Appendix B) which shows that there is an average heat load of approximately 16.8 MW. Assuming the plant runs 24/7, this is equivalent to a heat load of 147 GWh/annum.

The report describes how Tungsten Consulting Limited consider it unlikely that Irving Oil Whitegate Refinery Limited would be a suitable site for connection to a heat network, primarily due to the preference of oil refineries to maintain self-reliance for energy supply services, in addition to the very cost effective baseline offered by the existing steam generation plant on site.

4.7 Discussion

Each of the areas of Carrigtwohill, Little Island, Ringaskiddy and Whitegate have sizeable industrial heat loads. The table below summarises the heat loads based on the distance to the centre of the area.

Table 8: Industrial heat loads in GWh/annum

Area	Less than 2.5km	2.6 to 5km	5.1 to 7.5km	7.6 to 10km	Total
Carrigtwohill	-	57	-	265	321
Little Island	100	-	-	-	100
Ringaskiddy	26	139	44	-	209
Whitegate	145	-	-	-	145

Source: EPA website and Google maps

Section 2.2 of this report describes how the Indaver plant may have up to 96 GWh/annum of heat available for export (subject to detailed design). This is insufficient to supply the entire heat demand of the large heat loads identified in Carrigtwohill and Ringaskiddy. This assessment considers sites which are licensed by the EPA. The feasibility of connecting these, and additional heat consumers, in each of the 6 areas is discussed in section 5.

From the information assessed for this study, Fichtner considers Ringaskiddy the most suitable area for a heat network that focuses on industrial users.

5 Site visits

In order to investigate the potential heat consumers within the 6 areas of Co Cork, Fichtner visited each of the areas on 25 and 26 February 2019. The visits comprised a visual inspection of each of the key heat consumers across all sectors, but did not include communication with any site owners or access onto the premises. Local infrastructure and topology were reviewed as part of the visits to better understand potential pipe routing options and constraints. A summary of each area is provided in the following sections.

5.1 Bottlehill

Bottlehill is a substantially rural area, located approximately 18 km north of Cork city centre, where the predominant land uses are agriculture and forestry, interspersed with residential dwellings. The centre of the area was taken as the disused landfill facility, located equidistantly between the settlements of Blarney and Mallow. Based on a visual assessment of the area, there does not appear to be any heat demands which would warrant a connection to a heat network. This is evidenced by the low heat demand density in the area, as detailed in section 3.8.

The Cork to Mallow line of the Cork Suburban Rail network runs substantially south-north approximately 4 km to the west of Bottlehill and would need to be considered in the event of development of a heat network in the wider area, which is considered unlikely.

5.2 Carrigtwohill

Carrigtwohill is located approximately 8 km to the east of Cork city centre. The majority of development in the area is situated between the N25 national road and the Cork to Midleton rail line. Land use includes a range of business, light industry, distribution and warehousing, offices, retail and commercial premises located at the Carrigtwohill Industrial Estate and Cobh Cross Industrial Estate.

Of relevance in establishing a heat network are the pharmaceutical plants Stryker, GE Healthcare, AbbVie, Gilead Sciences and Merck Millipore. While smaller than industrial units located at Ringaskiddy and Little Island, these developments could potentially act as anchor heat loads for the area. IDA Ireland owns lands to the west of the industrial estates, which is zoned for future industrial development but is currently vacant.

The Cork to Midleton line of the Cork Suburban Rail network runs east-west via a single-track section with a 1.7 km passing loop at Carrigtwohill. Engineering a crossing would require detailed structural assessments and the consent of the bridge and rail network owner. Service interruptions would have to be kept to an absolute minimum. As a result, connecting heat consumers located to the north of the line (the Gilead Sciences and Stryker Anngrove sites) would present a major challenge. Similarly, pipe routing to consumers located south of the N25 national road (Merck Millipore) would need to be carefully managed.

5.3 Kilbarry

Kilbarry is located approximately 4 km to the north of Cork city centre. The area to the south comprises well developed urban land uses, including a mix of residential, retail and light industrial development. This differs from the land to the north which is largely agricultural.

The majority of retail and light industrial development exists between the N20 and the Cork to Mallow rail line, at North Point Business Park and Blackpool Retail Park. Many of the business are

located within warehouse units which typically use radiant heaters (direct gas fired or infra-red electric) and are therefore not suitable for connection to heat network. Three residential tower blocks also exist (with commercial floorspace on the ground floor) at the junction of the N20 and Popham's Road which may be capable of accepting heat if a centralised boiler plant exists. As detailed in the preceding section, engineering a rail crossing to any of these potential heat consumers (from the potential plant site to the north) would present a major challenge.

Beyond this area to the north east is the Kilbarry Business Park, occupied by light manufacturing firms including Yves Rocher, Trulife and Flextronics. The demand of these consumers is likely to be very modest.

Although additional heat demand exists towards the centre of Cork City, much of this demand comprises existing domestic buildings which, as discussed previously, 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. In addition, the River Lee runs substantially eastwards through Cork city centre and would be technically challenging and expensive to route across. Non-traditional techniques such as horizontal directional drilling could potentially be used to install pipelines below ground, although this approach requires substantial capital outlay. To justify such a crossing, the economic returns associated with establishing the connection would need to be substantial, which does not appear to be the case in this location.

5.4 Little Island

Little Island is located approximately 9 km to the east of Cork city centre at the northern extent of Cork Harbour. It has developed rapidly as an employment location since the 1990s. Land use at Little Island comprises a diverse mix of business, technology, industry, offices, distribution and warehousing, and a handful of residential areas.

Chemical and pharmaceutical plants including Pfizer, BASF, Johnson & Johnson, FMC and Cara Partners exist towards the western side of the island. While these sites potentially offer anchor heat loads for a network, they are smaller in size than similar types of facilities in Ringaskiddy and connection to a greater number is therefore likely to be required. Based on a visual assessment, pipe routing in the area would be unconstrained in accessing the major heat consumers but could be complicated by a large quantity of buried services in the area.

A large quantity of retail, logistic and light industry units exist across a number of business parks to the north and at the centre of the island. As discussed previously, many of these types of developments will not be suitable for connection to a heat network. The Harbour Point Business Park located to the south-east of the island is of a similar nature. However, in the event that a heat network was established in the area, engagement with land owners would be worthwhile to ascertain whether upgrading of heating systems to be served by a heat network could be considered.

5.5 Ringaskiddy

Ringaskiddy is located circa 14 km southeast of Cork city centre on the western side of Cork Harbour. Significant industrial and port related development has been implemented since the 1970s and this was evident when visiting the area. The main pharmaceutical plants, specialising in pharmaceutical, bio-pharmaceutical and medical device manufacturing, include Hovione, Pfizer, De Puy, Novartis, Johnson & Johnson Biologics and GlaxoSmithKline. These facilities represent an extensive volume of heat demand, and while heat consumer requirements would need to be

confirmed (in particular whether the Indaver plant could supply heat at the required conditions), this appears to be an attractive location for establishing a heat network.

In addition to the large industrial facilities, other premises worth consideration include the National Maritime College of Ireland and the MaREI (Marine and Renewable Energy Ireland) Centre located on the north-eastern extent of the peninsula. Beyond these exists a crossing to Haulbowline Island, on which is located the Irish Defence Forces Naval Service Base and a crematorium on Rocky Island. Heat provision to these sites may be restricted due to the narrow crossing bridge, although this would need to be explored further.

Intensification and expansion at the Port of Cork is currently in the planning process, including significant additional lands available for development, which may result in additional heat demand in the short to medium term.

The large expanse of mudflats and estuary habitat constrains possible pipe routing options to the east of Ringaskiddy. However, large heat consumers are concentrated within 2.5 km of the site owned by Indaver and feasible routing options exist via established transport routes. A detailed engineering assessment including surveying of the route and potentially trial holes would be required to determine the extent of existing buried services and optimum pipe routes.

5.6 Whitegate

The Whitegate area is located on the eastern side of Cork Harbour some 18 km southeast of Cork city centre. The region comprises four relatively small settlements surrounded by agricultural land, with a handful of notable industrial zones.

The largest heat consumer by a considerable margin is the Irving Oil Whitegate Refinery but this is not considered to represent a viable connection opportunity for the reasons discussed in section 4.6. Three power stations are also located in the area but since these are net heat generators, they are not relevant for the purpose of understanding heat demand in the area. It is worth noting that if a heat network was developed to the east of Cork Harbour then the feasibility of utilising these assets to supply heat to the network should be considered. However, given the relatively large distance from population and industry centres, and the pipe routing constraints owing to the large expanse of estuary habitat in the locality, the location of these power stations is unfavourable.

5.7 Conclusion

Based on the concentration of large heat loads within a relatively short distance of the proposed plant, pipe routing feasibility and potential for development expansion in the locality, we consider Ringaskiddy as the most favourable area for establishing a heat network. Engagement with potential consumers would be required to verify requirements (in terms of heat medium and conditions, and load profiles) prior to the implementation of a heat network. Little Island also accommodates several pharmaceutical plants (and to a lesser degree office and retail space) which may offer connection prospects, although these are smaller in scale. Smaller still are the pharmaceutical and manufacturing plants located in Carrigtwohill.

Kilbarry comprises a wider mix of development types, many of which are unlikely to require heating or utilise heating systems which are not suitable for connection to a heat network. At Carrigtwohill and Kilbarry, local infrastructure presents a major barrier to connecting potential consumers, therefore reducing the amount of accessible heat demand.

There are poor synergies in terms of the development of a heat network in the areas of Bottlehill and Whitegate.

Appendices

A Resource Usage / Energy Efficiency tab of AER report

Resource Usage/Energy efficiency summary	Lic No:	P0xxx-01	Year	2013

				Additional information
1	When did the site carry out the most recent energy efficiency audit? Please list the recommendations in table 3 below		Enter date of audit	
2	Is the site a member of any accredited programmes for reducing energy usage/water conservation such as the SEAI programme linked to the right? If yes please list them in additional information	SEAI - Large Industry Energy Network (LIEN)	SELECT	
3	Where Fuel Oil is used in boilers on site is the sulphur content compliant with licence conditions? Please state percentage in additional information		SELECT	

Table R1 Energy usage on site

Energy Use	Previous year	Current year	Production +/- % compared to previous reporting year**	Energy Consumption +/- % vs overall site production*
Total Energy Used (MWHrs)				
Total Energy Generated (MWHrs)				
Total Renewable Energy Generated (MWHrs)				
Electricity Consumption (MWHrs)				
Fossil Fuels Consumption:				
Heavy Fuel Oil (m3)				
Light Fuel Oil (m3)				
Natural gas (m3)				
Coal/Solid fuel (metric tonnes)				
Peat (metric tonnes)				
Renewable Biomass				
Renewable energy generated on site				

* where consumption of energy can be compared to overall site production please enter this information as percentage increase or decrease compared to the previous reporting year.

** where site production information is available please enter percentage increase or decrease compared to previous year

Table R2 Water usage on site

					Water Emissions	Water Consumption	
Water use	Water extracted Previous year m3/yr.	Water extracted Current year m3/yr.	Production +/- % compared to previous reporting year**	Energy Consumption +/- % vs overall site production*	Volume Discharged back to environment(m^3yr):	Volume used i.e not discharged to environment e.g. released as steam m3/yr	Unaccounted for Water:
Groundwater							
Surface water							
Public supply							
Recycled water							
Total							

* where consumption of water can be compared to overall site production please enter this information as percentage increase or decrease compared to the previous reporting year.

** where site production information is available please enter percentage increase or decrease compared to previous year

Table R3 Waste Stream Summary

	Total	Landfill	Incineration	Recycled	Other
Hazardous (Tonnes)					
Non-Hazardous (Tonnes)					

Resource Usage/Energy efficiency summary Lic No: P0xxx-01 Year 2013

Table R4: Energy Audit finding recommendations

Date of audit	Recommendations	Description of Measures proposed	Origin of measures	Predicted energy savings %	Implementation date	Responsibility	Completion date	Status and comments
			SELECT					
			SELECT					
			SELECT					

Table R5: Power Generation: Where power is generated onsite (e.g. power generation facilities/food and drink industry)please complete the following information

	Unit ID	Unit ID	Unit ID	Unit ID	Station Total
Technology					
Primary Fuel					
Thermal Efficiency					
Unit Date of Commission					
Total Starts for year					
Total Running Time					
Total Electricity Generated (GWH)					
House Load (GWH)					
KWH per Litre of Process Water					
KWH per Litre of Total Water used on Site					

B Tungsten Consulting Limited report

Business Confidential - Preliminary Review of Potential Commercial Concerns on Locating at the Whitegate Refinery

1. Introduction

This preliminary report looks at some of the factors which might be relevant in considering if a waste to energy plant producing, electricity, steam and hot water could be located adjacent to the Whitegate Refinery.

2. Background and Security of Operation

Whitegate Refinery will celebrate 60 years in operation in 2019. It was widely recognised that the future operation of the refinery was in question until September 2016, when the business was acquired by the current owners Irving Oil.

Whitegate is Ireland's only crude oil processing refinery and is small and simple in configuration by international standards. The refinery provides about 35% of the transport fuels used in the country.

The refinery operates 24 hours a day, seven days a week and 365 days a year. The processing units shutdown for a turnaround every 5 years and even during that time products continue to be distributed from the site by sea or truck.

3. Land availability

It is my understanding that Whitegate Refinery has development plans to utilise any spare land within its boundary for its own use in the future.

An energy project of this nature would need to minimise pipe runs and so it would be desirable for any land for this project to be adjacent to the refinery boundary and as close to the processing units as possible. It is my understanding that the land is zoned industrial, which has given rise to high expectations of its value to the local landowners.

4. Electricity, Steam. and Hot Water

Whitegate refinery has no process requirement for hot water.

Electricity and steam are critical for continuous operation of the refinery. The plant is connected to the national grid for electricity supply with redundancy in supply points. Steam is even more critical as it is needed for safety reasons, including at a time of power loss for safe unit shutdown. The refinery has a number of steam generating boilers. The refinery also typically uses a CHP, which can provide about 50% of the electricity demand and about 40% of the steam demand. This steam generation is very cost effective as it is from a waste heat boiler.

The refinery's electrical demand is typically 10 MW. The boiler house produces approximately 20 tonnes per hour of steam plus or minus 10% at between 9 to 10 bar and at temperatures usually in the range of 280 to 285 degree C. These loads would be relatively stable given the 24/7/365 nature of the process operation.

There is no condensate recovery because of the slight risk of contamination with oil and this stream is processed in the refinery's waste water treatment plant.

In 2010, BGE commissioned the 440MW CCGT Whitegate Independent Power Plant, WIPP, on land leased to them by the refinery and close to the existing boiler house and processing units. It was envisaged at that time that this plant would be base loaded with an expected on stream time of typically 8000 hours per year. Although agreements were put in place between Whitegate Refinery and BGE for the provision of steam to the refinery, this has never been activated. Even at 8000 hours per year this leaves a sizeable gap in reliable steam supply. In my opinion, the factors which influenced this were the significant cost of installing the steam supply piping and the lack of incentive for the refinery as it still needed to keep all of its existing steam generating capability for when WIPP was unavailable. Another factor became the change in National electricity supply with the significant move to wind generation, which meant that WIPP is typically not a base load plant.

This would also be my experience of other refineries around the world, that the plants focus on self- reliance for these critical services of power and steam. External third party service providers are only part of the solution and are installed at a time that incentivized both parties.

5. Summary

Given Whitegate Refinery's previous experience with WIPP, I would think it would be difficult to justify sufficient synergies to locate a new waste to energy plant in the area for either party.



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