Programme Area: Smart Systems and Heat

Project: WP2 Bridgend Area Energy Strategy

Title: Bridgend Local Area Energy Strategy – District Energy & District Heating Deployment

Abstract:

This assessment of the EnergyPath Networks district heating deployment in Bridgend takes outputs from the EPN tool and determines the viability of the proposed heat networks by considering constraints and opportunities to distribution and transmission network development alongside Energy Centre placement. The report considers the suitability of the prime mover specified and the implications this may have on the network and local area. The report also discusses the opportunities and impacts associated with large scale heat pumps as a long term heat supply option.

Context:

Bridgend County Borough Council has been working with a group of stakeholders consisting of Welsh Government, Western Power Distribution, Wales and West Utilities and the Energy Systems Catapult, to pilot an advanced whole system approach to local area energy planning. Bridgend is one of three areas including Newcastle and Bury in Greater Manchester participating in the pilot project as part of the Energy Technologies Institute (ETI) Smart Systems and Heat (SSH) Programme.

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Energy systems Catapult

EPN District Energy & District Heating Deployment, Bridgend

Task 012 Report

ESC001262

FINAL | 23 June 2017

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 254996-12

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Contents

1 Executive Summary

This assessment of the EnergyPath Networks district heating deployment in Bridgend takes outputs from the EPN tool and determines the viability of the proposed heat networks by considering constraints and opportunities to distribution and transmission network development alongside Energy Centre placement. The report considers the suitability of the prime mover specified and the implications this may have on the network and local area. The report discusses the opportunities and impacts associated with large scale heat pumps as a long term heat supply option.

The report highlights that a large proportion of specified plant across all pathways has a low utilisation factor and in some cases the technology selection should be reassessed to ensure that the optimum solution can be, and is, reached. It is suggested that this be a holistic assessment which also considers plant complexity, practical capacity changes and plant lifetimes.

The report finds that all the proposed pathways are considered valid (at this initial stage) and technically feasible for implementation by a local authority. Some pathways encounter more local constraints, particularly focused around road and rail infrastructure. These may mean than sub-optimal distribution and transmission routes and/or bespoke crossing points are required. Flooding is also an issue in some pathways which may add complexity to the design requirements.

2 Introduction

This report provides a desktop review of the EnergyPath Networks (EPN) Decentralised Energy and District Heating deployment in Bridgend. The EPN model develops a heat network within a cluster area. This report assesses the heat networks developed in terms of:

- Implementation barriers of developing Energy Centres and heat network in each cluster using a High/Medium/Low risk traffic light system;
- Key constraints including: highways, air quality, noise, visual impact;
- Indicative Energy Centre size and flue height, and appropriateness of Energy Centre location and plant specified;
- Values and risks of significant heat transmission between Energy Centres;
- The suitability and constraints of the use of large scale heat pumps to supply networks.

The risk attributed to each barrier has been assessed based on the feasibility compared with an average/typical network. A low risk criteria is comparable to a typical heat network requirement and will not need any additional activity. A medium risk is one in which there are additional aspects which will need considering which may hinder network development. A high risk indicated the network is not feasible and should not be progressed.

There are two types of Energy Centre placement specified by the model: Actual location and Centre of Gravity (CoG). The Centre of Gravity option assumes that the Energy Centre will be placed in the centre of the heat demand.

The capacity of plant installed in each cluster has been inferred from the models output of the active capacity of each plant item over its lifetime. This report has relied on information supplied by others, and Arup accept no liability for any errors or omissions in this information. Databases of information for the constraints have been sourced and energy consultants have taken perceived major constraints into analysis. Our initial views from this high-level study are reported in each section. The study carried out was high-level and further detailed assessments may be required.

The scope excludes assessment of the financial viability of the proposed schemes.

3 Received information

Name	Data Type	Included	Arup Notes
Bridgend Analysis Clusters NB: Re-issued as BCBC_1.shp (updated areas)	GIS	Outline of cluster areas	10 clusters shown No cluster 1 or 11 provided
Data Centre for Arup	GIS	Centre of heat clusters or ‘actual location’	1 or 2 centres per cluster
BCBC_R1.3_partsyn_UPRNdata_for ArupNEWER	Excel	Domestic buildings Property type/ age Heating system archetype/ combination and change over years Cost to change heating system and retrofit insulation Insulation type and improvements over years Current and future gas/elec annual and peak use Floor area bands	DHN22: connected to heat network UPRN not starting 45100 are new builds (unable to view this) Attempted to re-allocate the EPN results back down to a UPRN level 3 phases described: current (2015) heating system, first transition (2022), second transition (2037)
Cluster & Ward Boundaries	Image	Picture of cluster and ward boundaries	
Copy of Heat_Network_Data_for_Bridgend	Excel	Network Costs Network Lengths Network Demand Heat Transmission EC technologies Peak and annual demand (developing every 10 years) for domestic and non-domestic connections	One heat network per cluster Heat networks are linked via transmission links Clusters 1,2,3,4,11,12 do not have non-domestic connections Clusters 1,3,4,11 do not have domestic connections No clusters 1 or 11 No network in clusters 3 or 4 Non-domestic connections have no given location

4 Constraints considered

Item	Description
Utilities	Major utilities in the area including gas distribution mains and electricity transmission infrastructure (national and local 132kV and 66kV). Local utilities have not been assessed as this is too fine a resolution for the scope of this report.
Roads	Major roads and the impact on them of local heat network/energy centre development. Minor roads have been highlighted where their capacity may not support the required traffic increase.
Railways	Railway lines in the local area.
Rivers	Any water body within the local area.
Listed Buildings	Listed buildings.
Air quality	Air Quality Management Areas, and the possibility the scheme development may lead to their creation.
Noise Action Plan	Noise in the local area, and Noise Action Plan priority areas highlighted by the Welsh government.
Conservation Areas	Areas of outstanding natural beauty, Ramsar sites, Sites of Specific Scientific Interest, Special Areas of Conservation, Special Protection Areas, Local Nature Reserves, National Parks, Country Parks, Ancient Woodland (2011 inventory) and National Forest (2014 inventory).
Flooding	Flood areas including, historic flood areas, high risk areas (both 100:1 or greater and 1000:1 or greater), flood risk zones, water storage areas and risk of flooding from rivers and seas (rofras).
Historic Landfill Sites	Historic landfill sites in the local area.
Common Land	Common land.

Constraints mapping source: http://lle.gov.wales/home

5 Supporting maps

The following maps have been included to provide the reader a quick reference point.

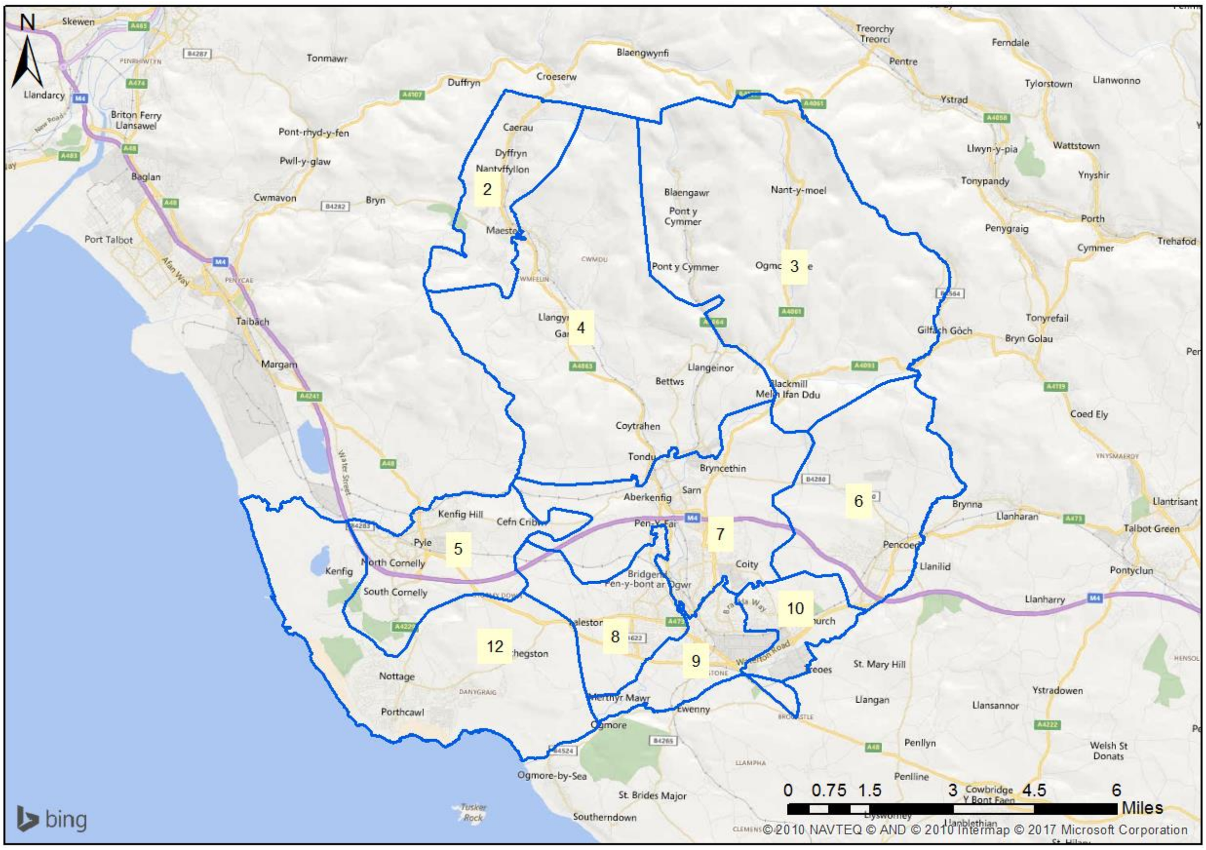

Figure 1 Cluster areas

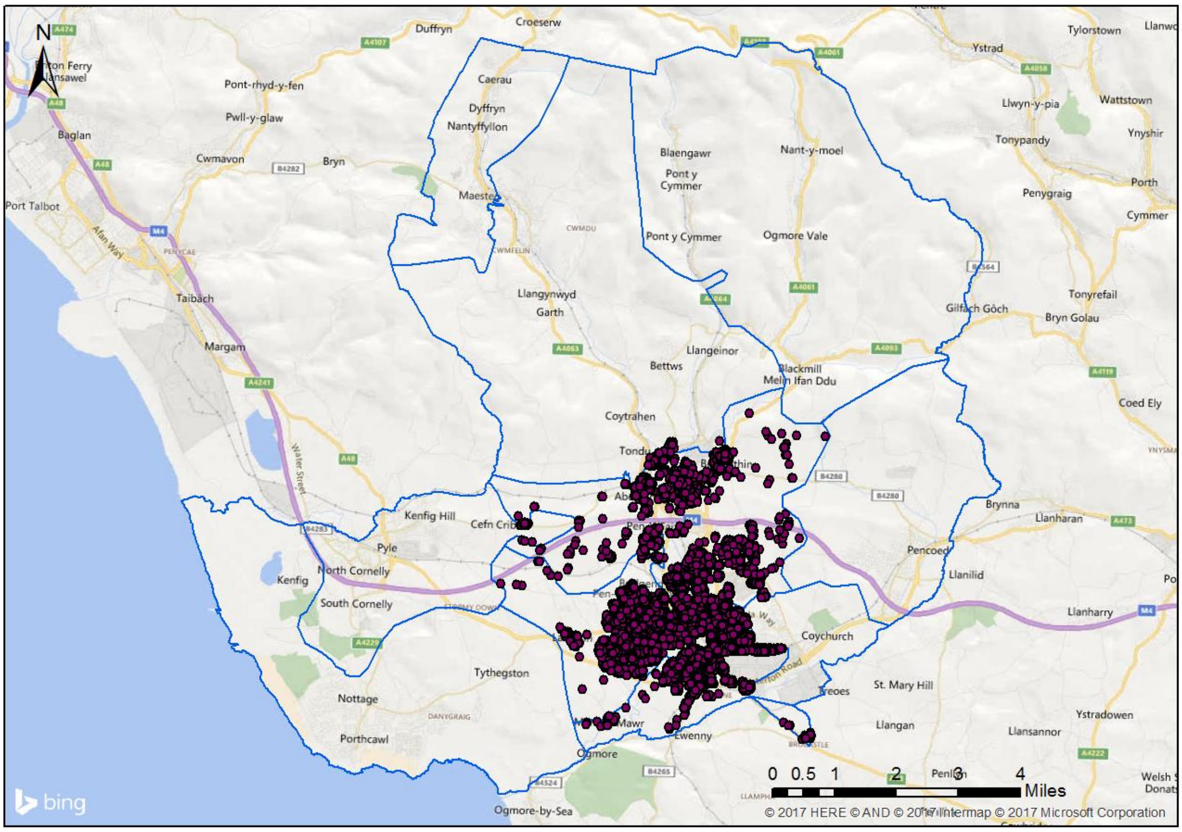

Figure 2 District heating, domestic connections, 2022

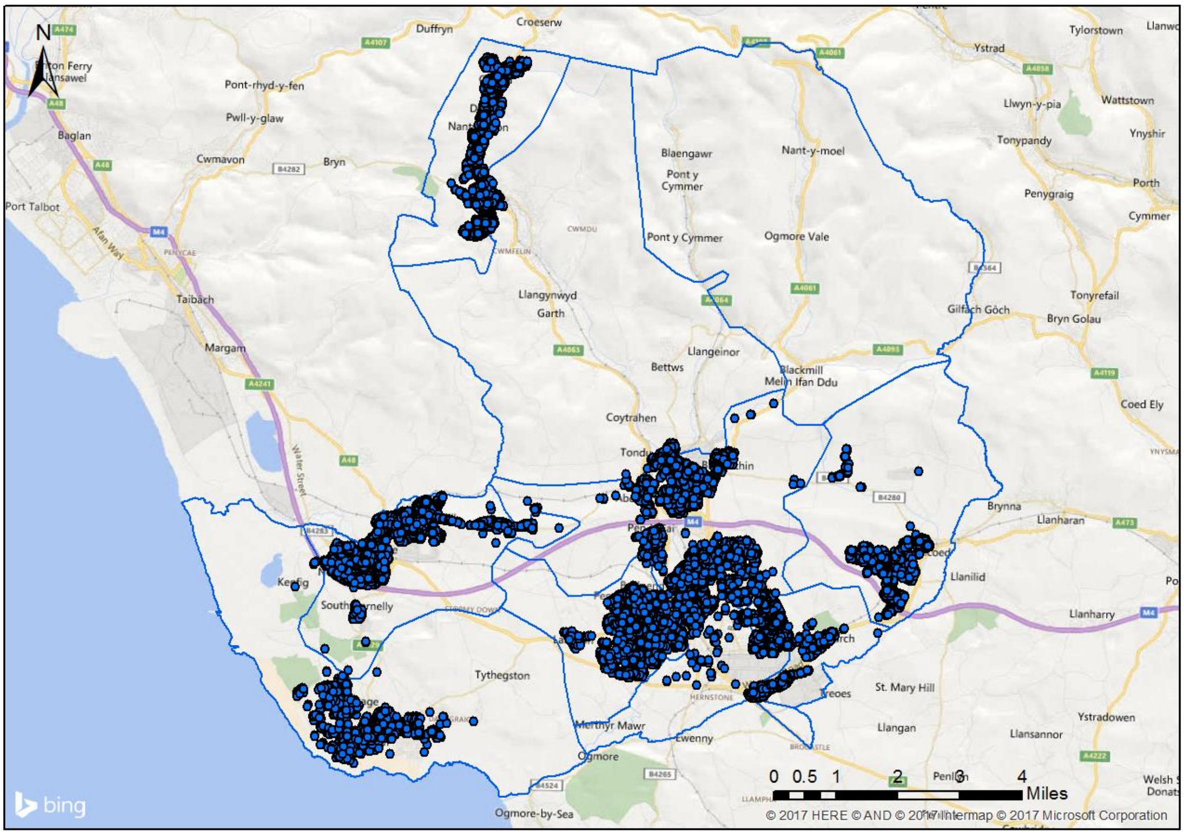

Figure 3 District heating, domestic connections, 2037

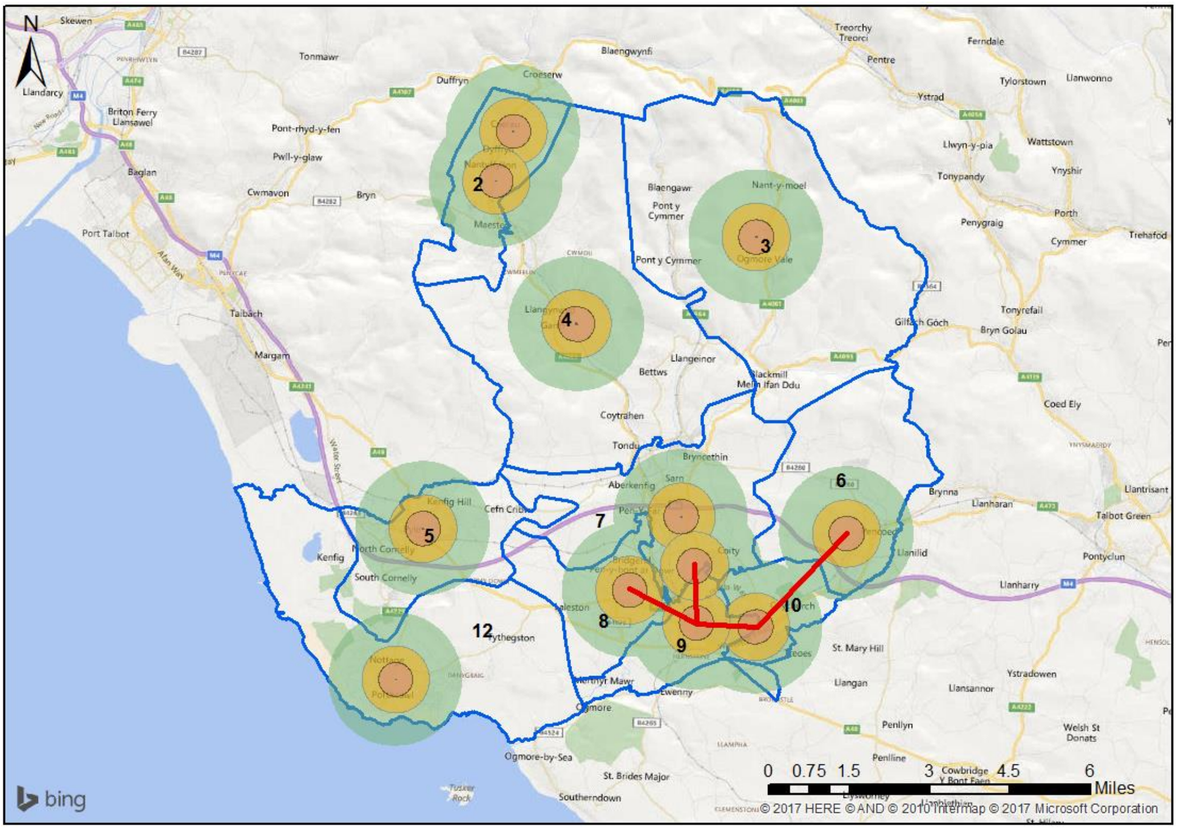

Figure 4 Map of transmission lines and heat centre of gravity/ Energy Centre locations (shown with 500m, 1km and 2km bands)

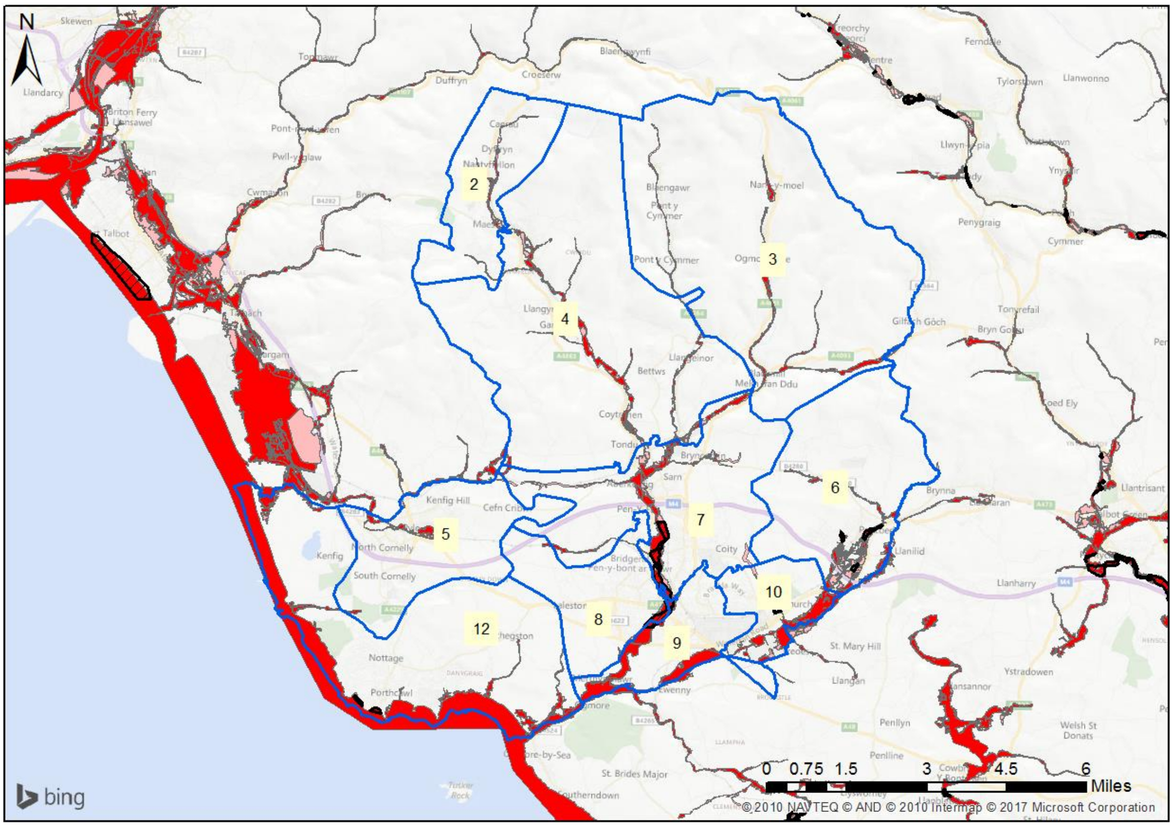

Figure 5 Flood risk map.

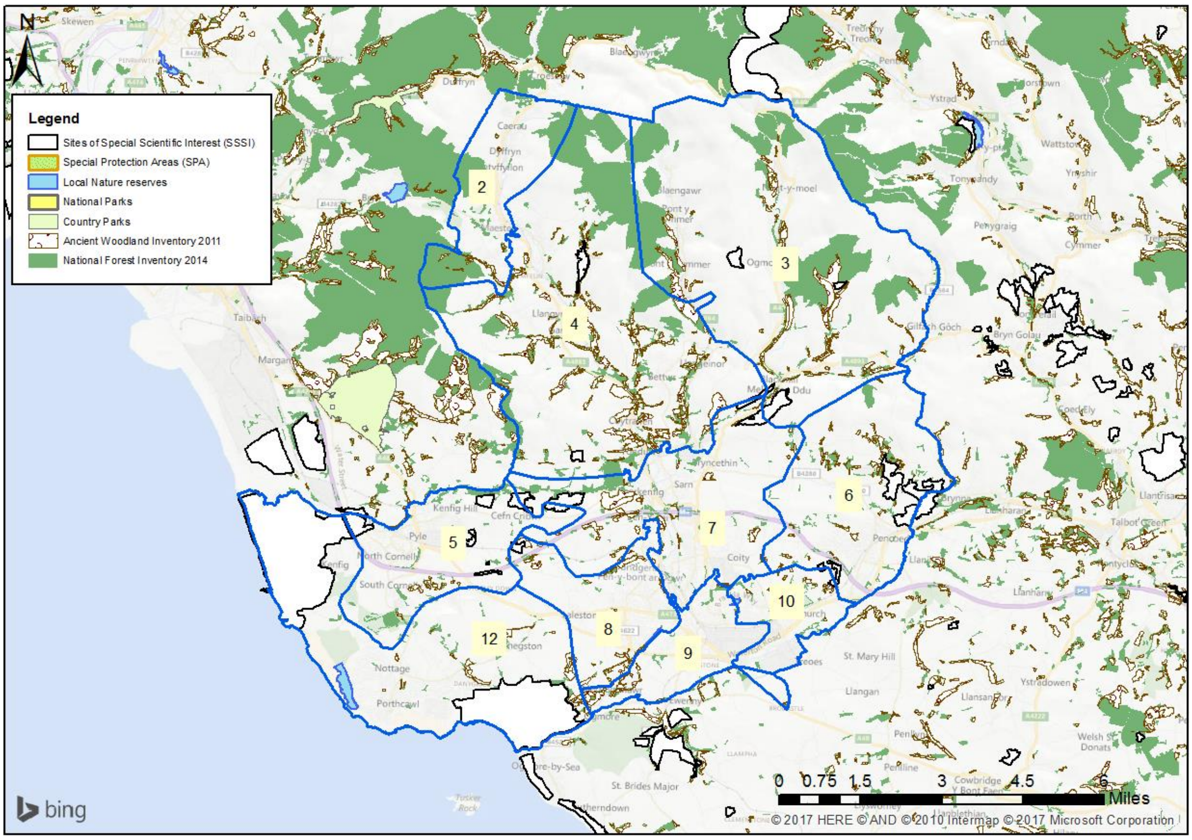

Figure 6 Conservation Areas

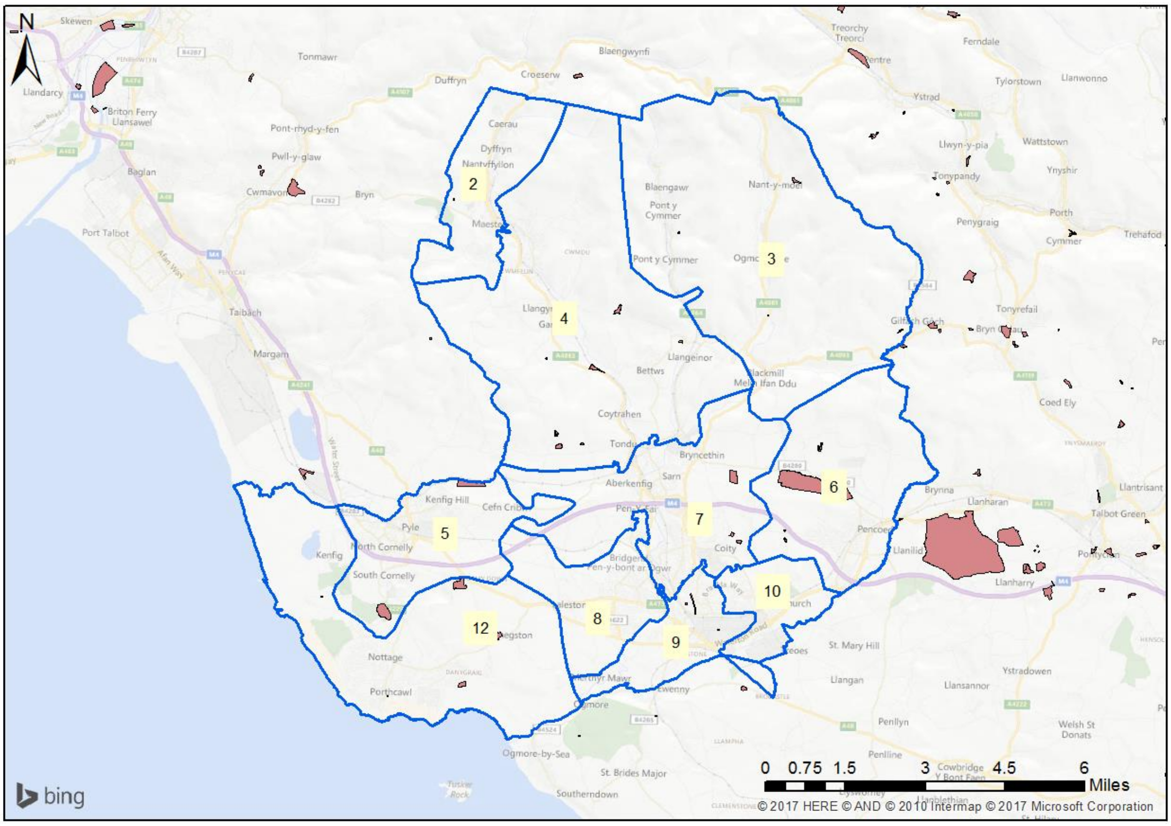

Figure 7 Historic Landfill Sites

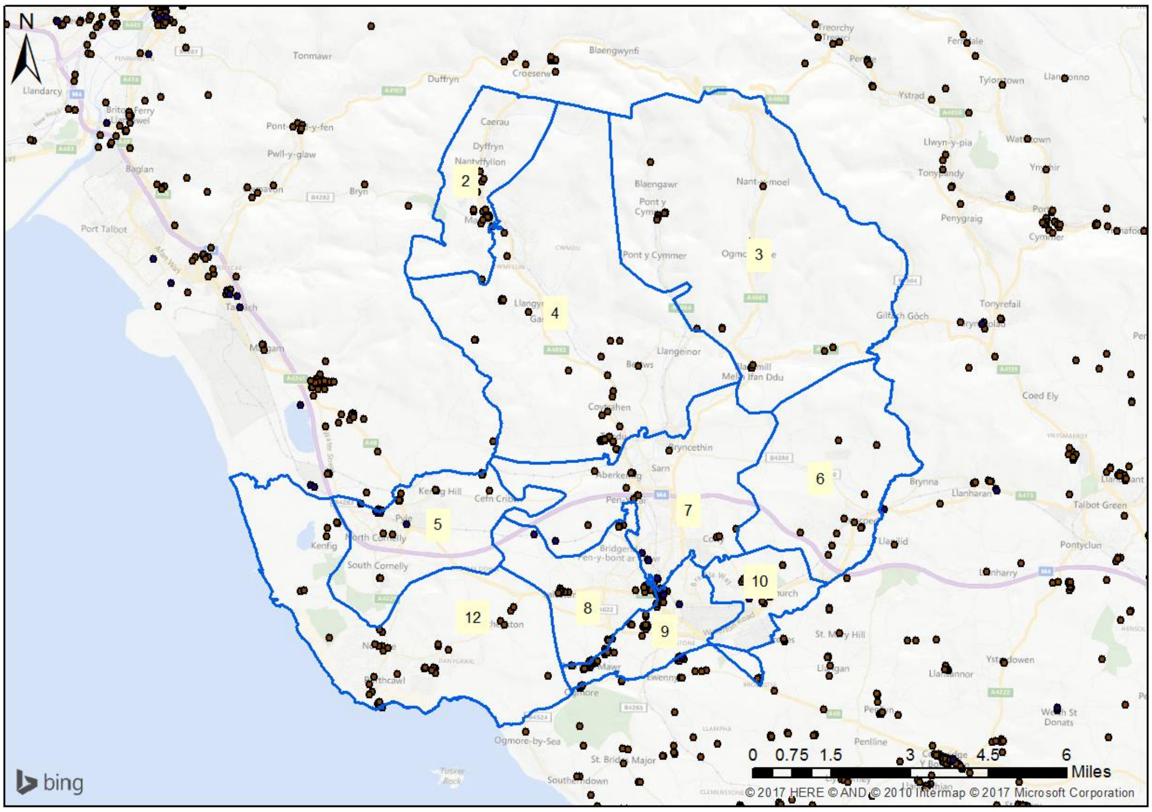

Figure 8 Listed Buildings

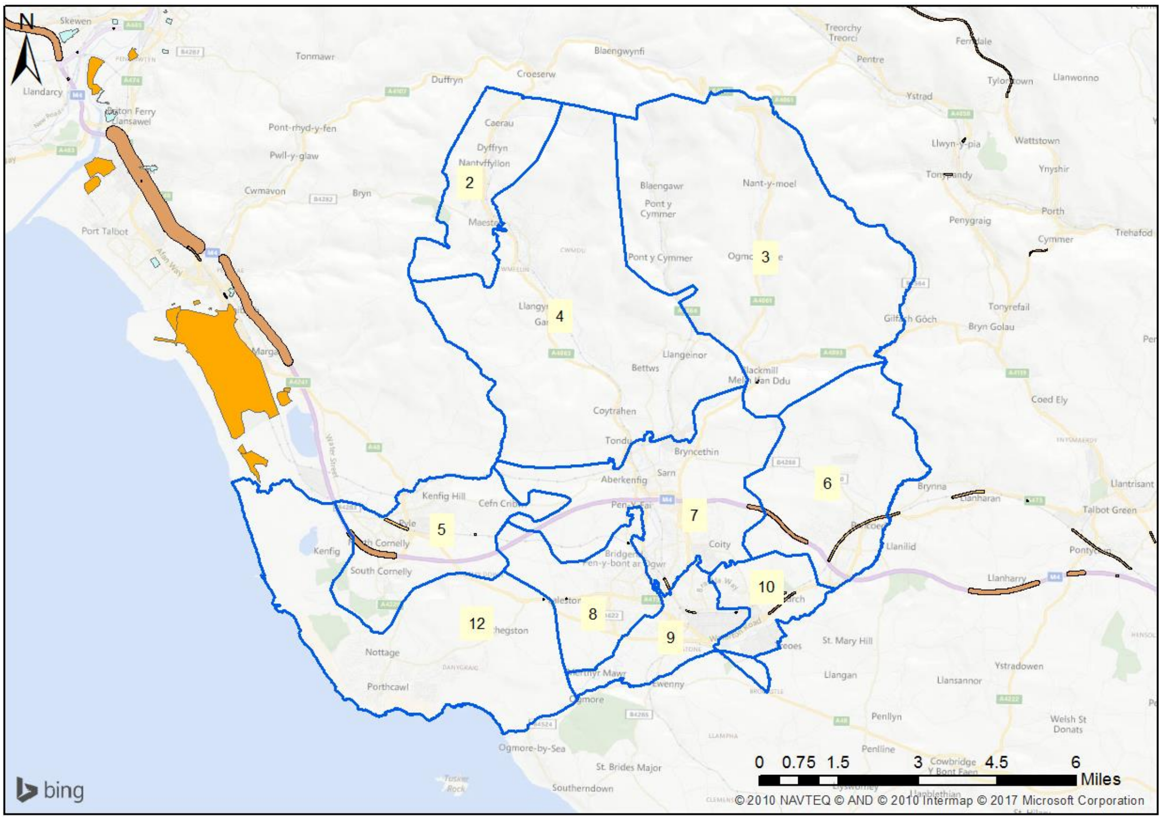

Figure 9 Noise Action Plan areas

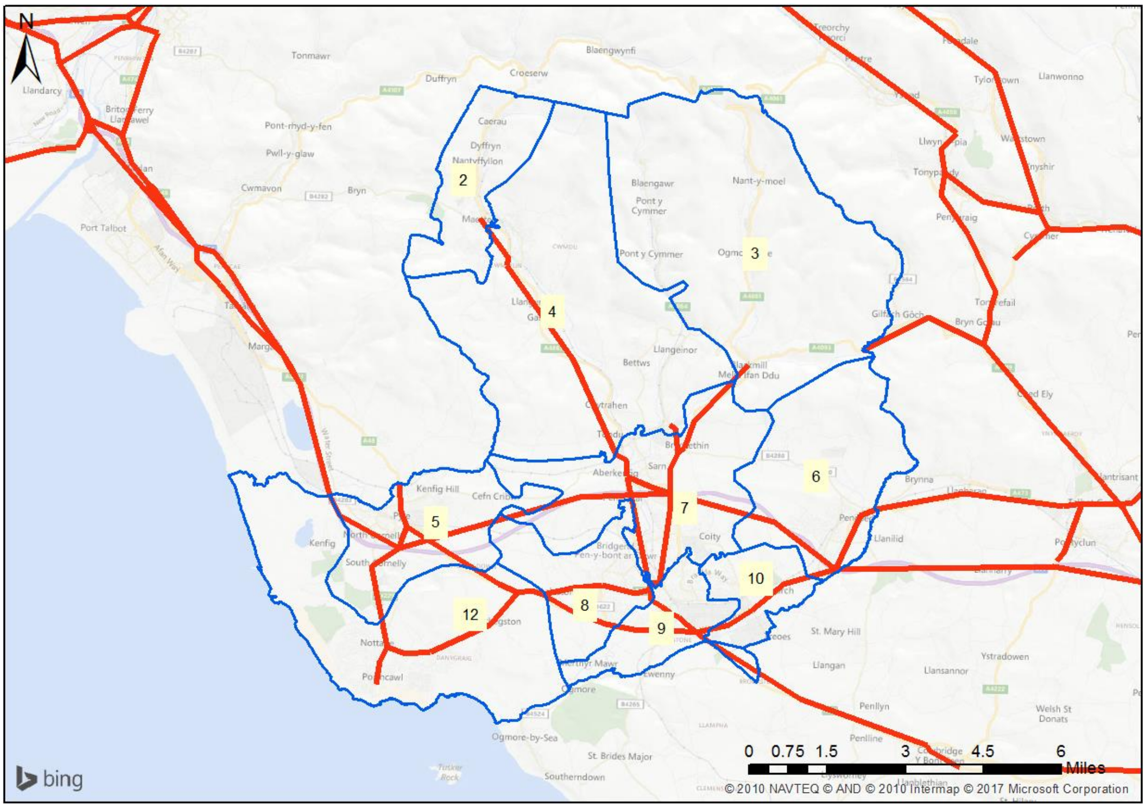

Figure 10 Major Roads

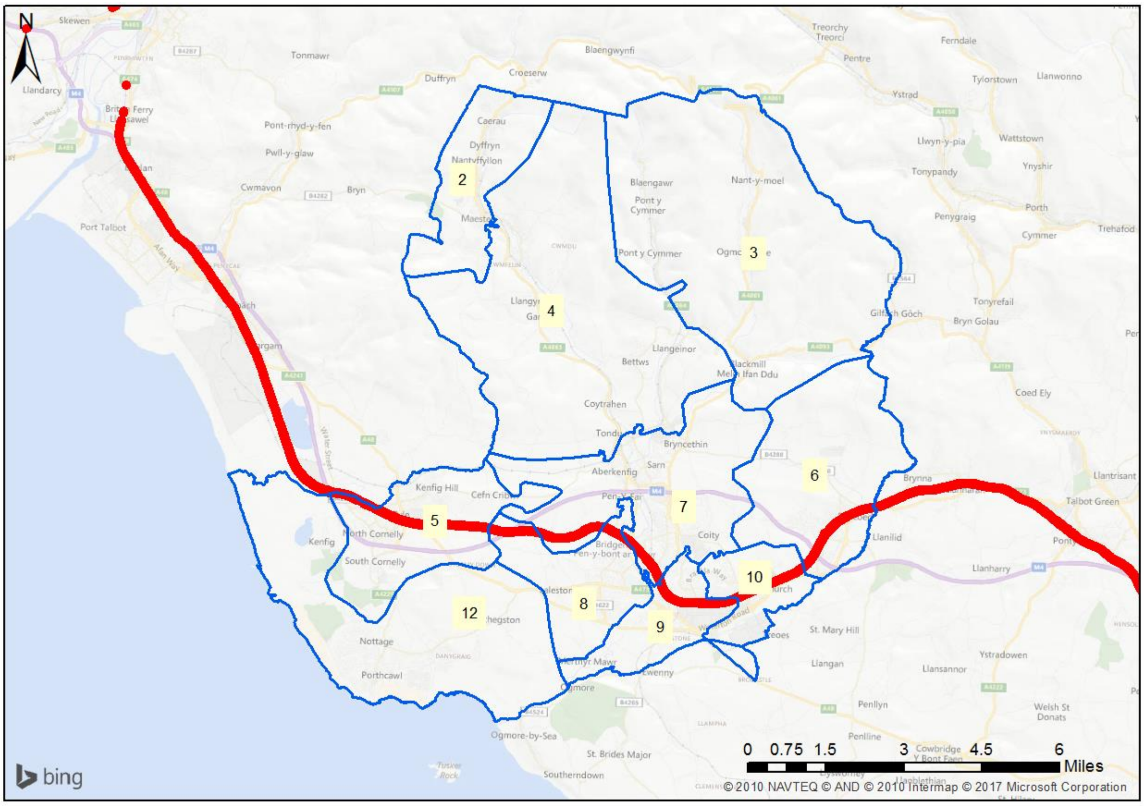

Figure 11 Major Railways

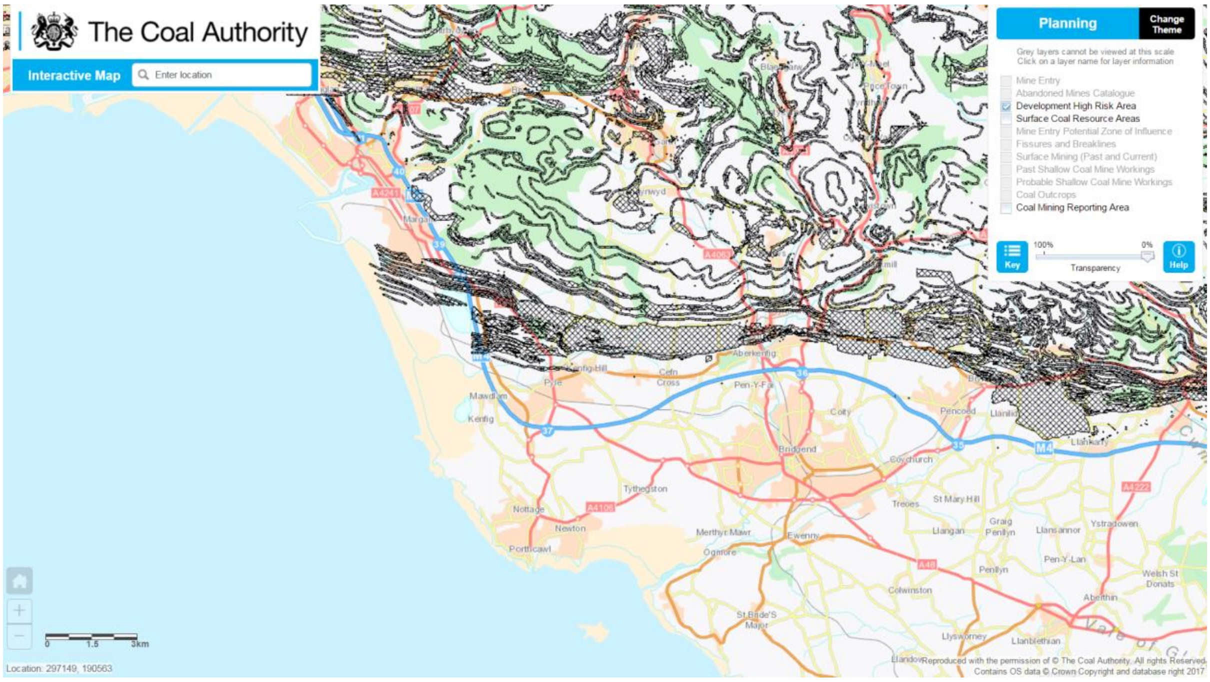

Figure 12 Coal Board Map, showing development high risk areas (grey). © The Coal Authority

6 Cluster overview

Cluster	**Area covered [km2]**	**Network length [m]**	**Total heat demand (2050)**		**Non-domestic heat demand (2050)**		**Domestic heat demand (2050)**		**Energy Centre prime mover**	Utilities	Roads	Railways	Rivers	Listed building	AQMAs	Noise action plan	Conservation areas	Flooding	Historic landfill sites	Common land	**Non-domestic key potential connections**
			Annual [MWh]	Peak [MW]	Annual [MWh]	Peak [MW]	Annual [MWh]	Peak [MW]		H/M/L	H/M/L	H/M/L	H/M/L	H/M/L	H/M/L	H/M/L	H/M/L	H/M/L	H/M/L	H/M/L	
1	0	0	0	0	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	13.01	73,311	22,854	9.05	0	0	22,854	9.05	Heat pump Biomass CHP Gas Boilers Gas Engine CHP	L	L	L	L	L	L	L	L	M	L	L	Primary School
3	56	107,194	0	0	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	55.18	157,166	0	0	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	16.92	95,860	35,526	12.86	5,705	1.23	29,822	11.62	Gas Boilers Biomass Boilers Gas Engine CHP Large Scale Heat Pump	L	M	M	L	L	L	L	L	M	L	L	Maesteg Comprehensive School
6	23.25	92,577	12,032	4.05	2,719	0.59	9,314	3.47	Gas Boilers Gas Engine CHP	M	M	M	L	L	L	L	L	M	M	L	Technology Park Comprehensive School Swimming pool Bridgend College
7	25.82	174,577	89,408	28.74	39,083	8.46	50,325	20.28	Gas Boilers Biomass Boiler Gas Engine CHP Gas Turbine CHP Large Scale Heat Pump	L	M	L	L	L	L	L	L	L	L	L	HMP Parc
8	12.04	90,362	41,996	15.39	6,655	1.44	35,341	13.95	Gas Boilers Gas Engine CHP	M	L	L	M	L	L	L	L	L	L	L	

Cluster	**Area covered [km2]**	**Network length [m]**	**Total heat demand (2050)**		**Non-domestic heat demand (2050)**		**Domestic heat demand (2050)**		**Energy Centre prime mover**	Utilities	Roads	Railways	Rivers	Listed building	AQMAs	Noise action plan	Conservation areas	Flooding	Historic landfill sites	Common land	**Non-domestic key potential connections**
9	9.28	93,089	64,959	20.99	32,114	7	32,846	14.04	Gas Boilers Biomass CHP Gas Turbine CHP Large Scale Heat Pump	L	M	L	L	L	L	L	L	L	L	L	
10	7.16	0	26,474	9.30	7,316	1.58	19,159	7.71	Gas Boilers Gas Turbine CHP	L	L	L	L	L	L	L	L	L	L	L	Bridgend Industrial Estate Waterton Industrial Park
11	0	60,795	11,269	4.19	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
12	36.62	119,915	11,269	4.19	0	0	11,269	4.19	Gas Boilers Biomass CHP Gas Turbine CHP Large Scale Heat Pump EW Anaerobic Digestion	L	L	L	L	L	L	L	M	M	M	L	

7 Cluster Reviews

7.1 Cluster 1

No cluster 1 specified on map or in datasets.

7.2 Cluster 2

Cluster information

Item	Number	Comments
Domestic heat network connections: DHN22 transition 1 (2022)	0	No domestic connections within the first transition phase.
Domestic heat network connections: DHN22 transition 2 (2037)	4056	Large number of domestic connections within the second transition phase. Annual heat demand in this cluster (Heat Transition 2 Annual) = 22,854 MWh. The connections are distributed along the valley in a linear orientation.
Non-domestic heat network connections	0	No non-domestic connections specified. Several public and private non-domestic buildings are located within the town, including the multiple schools.
Topography	N/A	The domestic connections run along the Llynfi River, which is at the bottom of a valley orientated north-south across the cluster. Large open fields in the surrounding area. There is green space throughout the cluster which could lead to lower installation costs.
Social impact	N/A	The northern area covered by the cluster is categorised in as being in the 10% most deprived areas of Wales. It is assumed from this that there may be high levels of fuel poverty in this area. This would increase the social value of a heat network within this cluster.

Constraints

Item	Number	Comments/ Mitigations: Distribution network	Comments/ Mitigations: Transmission network	Comments/ Mitigation: Energy Centre	H/M/L risk
Utilities	0	Gas distribution pipeline runs parallel (south of) Neath Road. This is not likely to conflict with heat network routes. Electricity infrastructure is not expected to impact on the distribution network.	No transmission line from cluster 2.	No impact.	L
Roads	1	The A4063 runs throughout along the length of the predicted heat network route. Crossing this may create additional cost and disruption during installation. Closure of this road during installation and maintenance is expected to cause significant disruption to the area as the road is the main carrier of local traffic. All other roads in the area are minor.	No transmission line from cluster 2.	The local road network may struggle to support the deliveries of biomass required for the capacity specified in the Energy Centre. The road leading to the Energy centre location (Library Road) may need to be reconfigured to allow the additional biomass delivery traffic.	L
Railways	0	The railway line ends at Maesteg station, and so would not impact network development in this cluster.	No transmission line from cluster 2.	No impact.	L
Rivers	1	The River Llynfi runs along the valley in the cluster. The river is small (less than a road-width) and is crossed in multiple places via road bridges. This should not provide a barrier to network installation.	No transmission line from cluster 2.	No impact.	L

Item	Number	Comments/ Mitigations: Distribution network	Comments/ Mitigations: Transmission network	Comments/ Mitigation: Energy Centre	H/M/L risk
Listed Buildings	20	All within the domestic connection area. Unclear if buildings are considered as connections to the network. If the buildings are connected to the network this may increase costs through connection complexity and requirements to be sympathetic to the visual impact.	No transmission line from cluster 2.	No impact.	L
Air quality	0	No impact.	No transmission line from cluster 2.	No AQMAs currently in the cluster. Energy Centre biomass deliveries will increase traffic and will increase the emissions along the A4063. Low emission delivery lorries can be used to minimise impact. The Energy Centre will increase emissions in the local area. An emissions impact assessment will need to be undertaken during design and any negative impacts addressed during the design. The biomass plant will require standard flue gas treatment and cleaning (such as bag filters) to reduce the local particulate emissions to acceptable levels. The flue will need to be designed following a dispersion modelling to emit at a height which will not impact the immediate area. This is not beyond the usual requirements of an energy centre design.	L
Noise Action Plan	1	No impact.	No transmission line from cluster 2.	Energy Centre biomass deliveries will increase traffic and will increase the noise along the A4063. This may lead to the development of a Noise Action priority area.	L
Conservation Areas	58	58 areas of Ancient woodland/National forest in the cluster. Some adjacent to connected domestic buildings but a large proportion are not. Root protection zones should be established and may impact pipe routes. Pipe protection may need to be installed to prevent long term damage to the pipes from expanding root systems.	No transmission line from cluster 2.	No impact.	L
Flooding		River (Llynfi River) running through the centre of the cluster and parallel to the network route/adjacent to the Energy Centre is at risk of flooding (100:1 or greater risk). The extent of the risk is greatest to the south (Commercial St/Bethania St region) of the cluster which would be the likely area transmission pipes cross to connect to other clusters. There is a minor risk from flooding during installation, however this is negligible. Any network infrastructure (pumping stations, access points, valves etc) should be water and weather proofed.	No transmission line from cluster 2.	The Energy Centre (CoG placement) is within a high flood risk zone. The energy centre should be designed to be flood resistant. This can involve mounting plant on plinths, increasing the height of the Energy Centre base etc. The Energy Centre (actual location) is not within a flood risk zone.	M
Historic Landfill Sites	1	One historic landfill site in the cluster, not close to the domestic connections or likely network routes.	No transmission line from cluster 2.	One historic landfill site in the cluster, not close to the either Energy Centre location.	L
Common Land	0	No common land in the cluster.	No transmission line from cluster 2.	No impact.	L

Energy Centre

The Energy Centre (actual location) has been placed at the rear of a primary school.

Plant installation date:	**2020**	**2030**	**2040**	**2050**
Heat pump			**1.93 MW**	**3.17 MW**
Biomass CHP			**0.77 MW**	**1.16 MW**
Gas Boilers		**18.00 MW**	**18.00 MW**	**4.99 MW**
Gas engine CHP		**4.19 MW**	**4.19 MW**	**1.05 MW**
Peak Demand (MW):		0	7.21	9.05

The approximate land take for this Energy Centre is 1,000 m^2. The flue height required is estimated to be 10 m. This is 3 m above the tallest building in the immediate area, which is the Energy Centre in this instance. Detailed dispersion modelling and more detailed information on the current and future buildings in the immediate area would be required to finalise this height. This flue height may cause planning permission issues in the area as it is heavily residential.

There is no demand specified in 2030, this suggests that the plant specified in 2030 has been installed ahead of load realisation, adding unnecessary risk to the project. The biomass CHP and gas engine CHP (installed 2050) are underutilised both with a load factor of 0.06%. This indicates that the plant is being used to meet peak demand only. These technologies are not well suited to perform this function. The biomass CHP in particular has a high thermal inertia, so is inefficient with a high number of turn ons/offs. In addition the ancillary requirements of the biomass CHP (fuel deliveries, fuel supply chain, fuel storage etc) are complex, and implementing them for an Energy Centre only producing 6.3 MWh (2050) through the biomass CHP is inefficient use of resources. It would be recommended to increase the size of the boilers or heat pumps to meet the peak demand, with thermal or electrical storage to smooth demand where possible.

Local assistance

There are a number of steps the local authority can put in place which can ease and assist the network development:

1. Take advantage of ongoing and future infrastructure projects in the local area by compiling survey data (desktop studies, GPR[1] scans etc) and detailed records of newly installed, replaced or maintenance on utilities, to develop a good understanding of the installed infrastructure along potential network routes.
2. Build relationships with large energy consumers in the local area and promote detailed record keeping of energy usage.
3. Closer to network build out, a local development order (LDO)[2] can help to progress the network at a more rapid pace, removing red-tape and unnecessary financial and time constraints.

Carrying out and maintaining these items will help de-risk network development by increasing the knowledge and available information on many of the high risk items during the feasibility and design stage.

[1] Ground penetrating radar
[2] Section 61, Town and Country Planning Act 1990

7.3 Cluster 3

Cluster information

Item	Number	Comments
Domestic heat network connections: DHN22 transition 1 (2022)	0	No domestic connections within the first transition phase.
Domestic heat network connections: DHN22 transition 2 (2037)	0	No domestic connections within the second transition phase.
Non-Domestic heat network connections	0	No non-domestic connections specified. Two primary schools in the Ogmore Vale area (centre of cluster 3), but not significant enough to warrant network development.
Topography		Some housing spread along two valleys running through cluster 3. Terrain profile indicates increased pumping costs may be required to circulate heat through distribution pipes across the cluster, or through transmission pipes to clusters 4 or 2.
Social Impact		The area covered by the cluster is predominately categorised in as being in the 10%-20% most deprived areas of Wales (Lewistown & Blackmill). It is assumed from this that there may be high levels of fuel poverty in this area. This would increase the social value of a heat network within this cluster.

7.4 Cluster 4

Cluster information

Item	Number	Comments
Domestic heat network connections: DHN22 transition 1 (2022)	0	No domestic connections within the first transition phase.
Domestic heat network connections: DHN22 transition 2 (2037)	0	No domestic connections within the second transition phase. This is a missed opportunity as the northern border of cluster 4 shares a boundary (and bisects Maesteg) with cluster 2. Given the domestic connections in cluster 2 (2037), this should be extended into cluster 4.
Non-Domestic heat network connections	0	No non-domestic connections specified. Some public sector connections available such as Maesteg Comprehensive School. More centrally in the cluster (not in close proximity to residential loads) there is a Northwood & WEPA Ltd Factory producing paper. This factory may have waste heat which could be made available to the network.
Topography		Two valleys, one along the Llynfi River and A4063, the other along the A4064. The valleys meet at the south in a densely residential area (Tondu, cluster 7). The A4603 leads to Maesteg, a larger town in cluster 2. The cluster is predominately made up of large open greenfield. The topology suggests that increased pumping costs may be required to distribute heat between the valleys.
Social Impact		The area covered by the cluster is categorised in as being in the 20% most deprived areas of Wales. However, with the exception of Maesteg, this area is very low density housing, and so is unlikely to provide a feasible heat network development area.

7.5 Cluster 5

Cluster information

Item	Number	Comments
Domestic heat network connections: DHN22 transition 1 (2022)	0	0 domestic connections within the first transition phase.
Domestic heat network connections: DHN22 transition 2 (2037)	5523	Large number of domestic connections within the second transition phase, with annual heat demand (Heat Transition 2 Annual) = 29,822 MWh. Most of the heat network connections are in central Pyle/North Cornelly, with a small cluster to the south of the M4 in South Cornelly, and come distributed to the east of Pyle along the B4281.
Non-Domestic heat network connections	9	47,660 m^2 of non-domestic area connected. Largest proportion of this is commercial offices (87% of connected floor area).
Topography		The north west side of the cluster is a residential area (Pyle), with an industrial area (Village Farm industrial estate) to the central to the cluster.
Social Impact		Some of central Pyle is classified as very deprived (lowest 10% of wales) but much of the cluster is the median (50% least deprived). Therefore there is likely to be low levels of fuel poverty in the area.

Constraints

Item	Number	Comments/ Mitigations: Distribution network	Comments/ Mitigations: Transmission network	Comments/ Mitigation: Energy Centre	H/M/L risk
Utilities	2	A gas distribution serving Port Talbot (northwest) line runs round the north and east side of Pyle. This is directly within the network development zone. This is a risk to the network route optimisation and installation. Extensive utilities mapping, trail pits, GPR surveys and engagement with WW Utilities will be needed during the design stage to mitigate this risk.	No transmission line from cluster 5.	No impact.	L
Roads	1	The M4 passes Pyle to the south and east. This could provide a significant barrier to network development if the network pipework was required to do west to the coast or south to cluster 12. There are however multiple minor road underpasses (with approximately max of 1 km distance between underpasses). These present an opportunity for mitigating disruption and cost to network development, although the network would need to be routed to one of these points, which may not be the optimum route. Other roads in the area are minor roads, with multiple diversion routes available should road closures be required.	No transmission line from cluster 5.	The Energy Centre (CoG) has been placed within Village Farm Industrial Estate. The roads in this area are able to support the required traffic including biomass deliveries, which do not deviate significantly from the normal operation of the site. Additionally, with the M4 in the local area, biomass deliveries are unlikely to impact the local road network.	M

Item	Number	Comments/ Mitigations: Distribution network	Comments/ Mitigations: Transmission network	Comments/ Mitigation: Energy Centre	H/M/L risk
Railways	1	A railway bisects Cluster 5 and the residential connections (Pyle), with the station centrally located. There are 3 current crossing points (one central, and one at either edge of the town). Crossing the railway presents a significant constraint as the road crossings are minor roads which may not support large heat network pipe. A network specific crossing may be required which would increase planning, stakeholder engagement, infrastructure and development requirements.	No transmission line from cluster 5.	No impact.	M
Rivers	1	There is a river running along the northern boundary, a minor tributary of this (Afon Fach) runs through central Pyle. Neither are expected to cause constraints to network development.	No transmission line from cluster 5.	No impact.	L
Listed Buildings	26	There are 26 listed buildings within Cluster 5. These are distributed throughout Pyle, but tend to be on the outer edges of connected residential areas. It is unknown if these buildings are to be connected to the network, if they are then this may add additional cost and complexity.	No transmission line from cluster 5.	No impact.	L
Air quality		No impact.	No transmission line from cluster 5.	No AQMAs currently in the cluster. Energy Centre biomass deliveries will increase local HGV traffic and will increase the emissions in the local area. Low emission delivery lorries can be used to minimise impact. The Energy Centre will increase emissions in the local area. An emissions impact assessment will need to be undertaken during design and any negative impacts addressed during the design. The biomass plant will require flue gas treatment and cleaning (such as bag filters) to reduce the local particulate emissions to acceptable levels. The flue will need to be designed following dispersion modelling to emit at a height which will not impact the immediate area. This is not beyond the usual requirements of an energy centre design.	L
Noise Action Plan		No impact.	No transmission line from cluster 5.	The M4 and the railway have Priority Area Noise Action Plans for the sections and through Pyle. These are not close to the proposed Energy Centre location, and will not impact it. The railway produces high levels of noise pollution, especially away from the station (where the train is travelling at higher speeds). The M4 also causes a high level of noise pollution to the immediate area. In addition, the surrounding area to the Energy Centre is low density industrial, bordered by the railway. It is unlikely that there are noise sensitive buildings in the surrounding area, however the Energy Centre should be designed to minimise adding to background noise pollution from the M4 and railway.	L

Item	Number	Comments/ Mitigations: Distribution network	Comments/ Mitigations: Transmission network	Comments/ Mitigation: Energy Centre	H/M/L risk
Conservation Areas	58 (areas)	Several Sites of Special Scientific Interest (SSSI) are within the cluster to the edge of Pyle (east side) and one nature reserve. Multiple wooded areas around the edges of Pyle. These areas may increase the planning requirements for the network development, or may require the network being routed around them. However their location at the edges of the connected area reduce the likelihood of this for the distribution pipes.	No transmission line from cluster 5.	No impact.	L
Flooding		The river and immediate surroundings are considered a flood risk area. This flood risk area extends into, and covers much of, the industrial estate.	No transmission line from cluster 5.	The Energy Centre (CoG placement) is very close to a high flood risk zone. The energy centre should be designed to be flood resistant. This can involve mounting plant on plinths, increasing the height of the Energy Centre base etc, which would have a direct effect on the capital cost of the building.	M
Historic Landfill Sites	1	There is a historic landfill site at the northern most point of the cluster. A row of domestic connections sit on the western edge of this landfill. Not expected to hinder network development.	No transmission line from cluster 5.	No impact.	L
Common Land	3	There is 9.35 ha area of common land adjacent to the B4281, next to domestic connections to the network. There is also a large area of common land around the M4 next to the A48. This could affect the network development, as additional planning permission may be required.	No transmission line from cluster 5.	No impact.	L

Energy Centre

The Energy Centre has been placed according to the heat Centre of Gravity (CoG) within Village Farm Industrial Estate.

Plant installation date:	**2020**	**2030**	**2040**	**2050**
Gas Boilers		**27.00 MW**	**27.00 MW**	**8.87 MW**
Biomass Boilers			**0.09 MW**	**0.14 MW**
Gas Engine CHP		**4.00 MW**	**4.00 MW**	**1.05 MW**
Large Scale Heat Pump			**3.51 MW**	**5.11 MW**
Peak Demand (MW):			10.52	11.86

The approximate land take for this Energy Centre is 650 m^2. The flue height required is estimated to be 10 m. This is 3 m above the tallest building in the immediate area, which is the Energy Centre in this instance. Detailed dispersion modelling and more detailed information on the current and future buildings in the immediate area would be required to finalise this height. This flue height may cause planning permission issues in the area as it is heavily residential.

There is no demand specified in 2030, this suggests that the plant specified in 2030 has been installed ahead of load realisation, adding unnecessary risk to the project. A 50 kW biomass boiler is added to the Energy Centre in 2050. This capacity biomass boiler is typical of a domestic property not an energy centre. Furthermore, this biomass boiler contributes to the installed biomass capacity which for the biomass boiler and gas engine CHP are underutilised in 2050 with a load factor of 0.09% and 0.03% respectively. This indicates that the plant is being used to meet peak demand only. These technologies are not well suited to perform this function, it is recommended instead to increase the size of the boilers or heat pumps to meet the peak demand, with thermal or electrical storage to smooth demand where possible. The added complexity (fuel requirements etc) of a biomass boiler is not recommended for such a small installed capacity (140 kW) compared with the total capacity of the Energy Centre (15 MW, 2050). Either the capacity of the biomass boiler should be significantly increased (as scaling the technology does not proportionally increase the complexity) to meet the baseload, or the technology should be removed and the additional capacity be installed within another existing technology. This could be absorbed within the gas engine CHP, which has a low load factor in 2050 and so may have spare capacity within the installed plant.

Local assistance

There are a number of steps the local authority can put in place which can ease and assist the network development:

1. Take advantage of ongoing and future infrastructure projects in the local area by compiling survey data (desktop studies, GPR scans etc) and detailed records of newly installed, replaced or maintenance on utilities, to develop a good understanding of the installed infrastructure along potential network routes.
2. Build relationships with large energy consumers in the local area and promote detailed record keeping of energy usage.
3. Closer to network build out, a local development order can help to progress the network at a more rapid pace, removing red-tape and unnecessary financial and time constraints.

Carrying out and maintaining these items will help de-risk network development by increasing the knowledge and available information on many of the high risk items during the feasibility and design stage.

7.6 Cluster 6

Cluster information

Item	Number	Comments
Domestic heat network connections: DHN22 transition 1 (2022)	0	0 domestic connections within the first transition phase.
Domestic heat network connections: DHN22 transition 2 (2037)	1787	Large number of domestic connections within the second transition phase, with annual heat demand (Heat Transition 2 Annual) = 9,314 MWh. The heat network connections are in Pencoed, with a small amount in Heol-Y-Cyw.
Non-Domestic heat network connections	4	31,670m^2 of non-domestic area connected. Largest proportion of this is commercial offices (88% of connected floor area). A large Rockwool factory is in the centre of the cluster, this has been omitted from the analysis due to a lack of available waste heat and engagement. Pencoed Technology Park, Bridgend College, Pencoed Swimming pool and Pencoed Comprehensive School are on the south east side of the cluster. It is not known if they are connected to the network.
Topography		The cluster is predominately fields with a town (Pencoed) in the south. The northern half is sparsely populated. The M4 runs across the south.
Social Impact		Cluster 6 is shown as being on average in the 50% least deprived areas. Therefore it is unlikely that fuel poverty will be significant in this area, and the social value from this would not be as high.

Constraints

Item	Number	Comments/ Mitigations: Distribution network	Comments/ Mitigations: Transmission network	Comments/ Mitigation: Energy Centre	H/M/L risk
Utilities	2	A gas distribution pipeline is located across the centre of the cluster. This is directly in the path of the network distribution route from Pencoed to Heol-y-Cyw. This is a risk to the network route optimisation and installation. Extensive utilities mapping, trail pits, GPR surveys and engagement with Wales & West Utilities will be needed during the design stage to mitigate this risk. There are overhead electricity lines in the same area which may impact the network route and increase construction complexity.	No transmission line from cluster 6.	No impact.	M
Roads	2	The M4 runs across the south of the cluster. This directly bisects the main domestic connection area in Cluster 6 with the cluster 7 and 10. There are five crossing points: a railway, a small road bridge and two which are part of the A473 junction with the M4. Therefore there may be only one viable crossing (Coychurch Road). The A473 runs along the south-east edge of the cluster. It may be a barrier to connection to Pencoed Technology Park which is on the other side of the road to the domestic connections.	No transmission line from cluster 6.	No impact.	M

Item	Number	Comments/ Mitigations: Distribution network	Comments/ Mitigations: Transmission network	Comments/ Mitigation: Energy Centre	H/M/L risk
Railways	1	The railway bisects Pencoed, with the station in the middle of the town. There are two bridges over the railway, both of which are minor roads and hence may constrain network development as the bridges may not be able to support the pipe diameter required. This would prevent heat being transferred to the southern side of Pencoed and to the Technology Park. An underpass (Ty Merchant) at the east edge of the town could be utilised, however this is likely to be a sub optimal network route.	No transmission line from cluster 6.	No impact.	M
Rivers	2	Ewenny River runs through the town, parallel to the A473. The river has a tributary from the west near Heol-y-Cyw and another from the east. The western tributary is likely to cause more problems with crossing as it splits domestic connections of Heol-y-Cyw with those in Pencoed. Ewenny River is a barrier to network extension from Pencoed to the Technology Park as there are only four road crossings in the immediate area (one of which is the M4, and another the A473), closure of any is likely to incur significant disruption to the local area.	No transmission line from cluster 6.	No impact.	L
Listed Buildings	13	13 listed buildings in the cluster. These are spread throughout the town, and may add complexity and cost to connection should they be connected to the network.	No transmission line from cluster 6.	No impact.	L
Air quality	0	No impact.	No transmission line from cluster 6.	There are no AQMAs currently in the area. The Energy Centre will increase emissions in the local area. An emissions impact assessment will need to be undertaken during design and any negative impacts addressed during the design. The CHP plant will require flue gas treatment and cleaning to reduce the local NOx emissions to acceptable levels. The flue will need to be designed following dispersion modelling to emit at a height which will not impact the immediate area. This is not beyond the usual requirements of an energy centre design. The surrounding area is low density residential, so the height of the flue is not expected to be significant, but may cause planning issues due to visual impact in the local area.	L
Noise Action Plan	2	No impact.	No transmission line from cluster 6.	There is a noise action plan priority area for the M4 in the eastern side of the cluster and for the railway throughout the town centre. Both the railway and the M4 (and A473 junction and road) produce high levels of noise pollution in the immediate area. The Energy Centre is within a residential area, the residents of which may be noise sensitive. This should be taken into account when locating and designing the Energy Centre.	L
Conservation Areas	121	Large areas of forest and ancient woodland to the north of the cluster (around Rockwool factory). Smaller areas near the heat network domestic connections, however this is unlikely to prevent network development.	No transmission line from cluster 6.	The Energy Centre is located adjacent to an area of ancient woodland. This may increase the planning requirements associated with the development.	L

Item	Number	Comments/ Mitigations: Distribution network	Comments/ Mitigations: Transmission network	Comments/ Mitigation: Energy Centre	H/M/L risk
Flooding		Three areas in the town have previously flooded. Much of Pencoed, in particular the southern end of the town, is a flood alert area with a high chance (100:1 or greater) of flooding. The network would need to be designed to be resilient to this. Any network infrastructure (pumping stations, access points, valves etc) should be water and weather proofed. There is a minor risk from flooding during installation, however this is negligible.	No transmission line from cluster 6.	The Energy Centre is located on the edge of a historic flood zone and in a high flood risk zone. This suggests the building will be at a high risk of flooding and will need to be designed to be resilient to this. This could involve raising the Energy Centre, or mounting plant on plinths.	M
Historic Landfill Sites	4	There are four historic landfill sites in the cluster. All are located a distance from the domestic connection points. However one, Hirwaun Common East OCCS, is a significant size (10 km^2), and is located in between the domestic connection points and the Rockwool factory. This may be a barrier to the optimum network route and could increase planning and installation costs, should the network be routed north to the factory. If the landfill has not been managed effectively there is the risk of explosion due to retained methane. This could significantly increase risk during installation of the network.	No transmission line from cluster 6.	No impact.	M
Common Land	10	Large areas of the north and east of the cluster are common land. This may affect the planning requirements should the network distribution pipes be required to extend in these directions. This is considered a low risk.	No transmission line from cluster 6.	No impact.	L

Energy Centre

The Energy Centre has been placed according to the heat Centre of Gravity (CoG) on the northern edge on Pencoed in a residential area.

Plant installation date:	2020	2030	2040	2050
Gas Boilers			**2.85 MW**	**2.85 MW**
Gas Engine CHP			**0.23 MW**	**0.23 MW**
Peak Demand (MW):			3.37	4.05

The table above shows that the Energy Centre has lower capacity (3.08 MW) than is required (4.05 MW). This suggests that the plant may be importing heat from cluster 10, or that the plant is undersized.

The approximate land take for this Energy Centre is 250 m^2. The flue height required is estimated to be 8 m. This is 3 m above the tallest building in the immediate area, which is the Energy Centre in this instance. Detailed dispersion modelling and more detailed information on the current and future buildings in the immediate area would be required to finalise this height. This flue height may cause planning permission issues in the area as it is heavily residential.

The gas engine has a high load factor (67.32%) in 2040, while the gas boiler has a low load factor (0.09%) in 2040. This indicates that the energy centre is operating efficiently with the gas engine meeting the baseload and the gas boilers being used only to meet peak demand. This is the recommended operational strategy for these technologies. In 2050, both technologies have a low load factor of 0.09%. This suggests, as the peak demand has increased, that the cluster is importing large amounts of heat via the transmission network, from cluster 10. This is not considered best practice as there are inefficiencies associated with high quantities of inter-cluster heat transfer such as heat loss and pumping requirements. It would be more efficient, and recommended, to utilise the installed assets more effectively within cluster 6 and reduce the need for heat transmission from another cluster.

Local assistance

There are a number of steps the local authority can put in place which can ease and assist the network development:

1. Take advantage of ongoing and future infrastructure projects in the local area by compiling survey data (desktop studies, GPR scans etc) and detailed records of newly installed, replaced or maintenance on utilities, to develop a good understanding of the installed infrastructure along potential network routes.
2. Build relationships with large energy consumers in the local area and promote detailed record keeping of energy usage.
3. Closer to network build out, a local development order can help to progress the network at a more rapid pace, removing red-tape and unnecessary financial and time constraints.

Carrying out and maintaining these items will help de-risk network development by increasing the knowledge and available information on many of the high risk items during the feasibility and design stage.

7.7 Cluster 7

Cluster information

Item	Number	Comments
Domestic heat network connections: DHN22 transition 1 (2022)	2732	2732 domestic connections within the first transition phase, with annual heat demand (Heat Transition 1) = 14,190 MWh. Heat network domestic connections are spread throughout northern Bridgend, both north and south of the M4. They are clustered into two areas with industrial estates separating them. A small proportion of connections are in outlying residential areas.
Domestic heat network connections: DHN22 transition 2 (2037)	6267	6267 domestic connections within the second transition phase, with annual heat demand (Heat Transition 2 Annual) = 33,700, MWh. Heat network domestic connections are spread throughout northern Bridgend, both north and south of the M4. They are clustered into two areas with industrial estates separating them. A small proportion of connections are in outlying residential areas.
Non-Domestic heat network connections		48 non-domestic properties connected, with total floor area of 270,000 m^2. Wide variety of load uses/profiles, including both private and public sector buildings. HMP Parc is located in the east of the cluster, this is not included in the list of connected non-domestic loads. The prison has its own energy centre on site which could connect to the network as an additional source of heat adding resilience to the network and the prison.
Topography		The centre of the cluster is heavily built up, with residential and industrial areas, making up the north of Bridgend. The east and west sides are green field with some scattered development. The M4 runs directly through the centre of the cluster (east to west). There are multiple green areas throughout the residential areas, which may be used to reduce installation costs. The area is expected to require extensive utilities investigation including both non-invasive and invasive surveys. This will increase the costs of network design.
Social Impact		A mix of more deprived residential areas and less deprived countryside areas. The heat network is expected to connect to the residential areas so may alleviate some fuel poverty.

Constraints

Item	Number	Comments/ Mitigations: Distribution network	Comments/ Mitigations: Transmission network	Comments/ Mitigation: Energy Centre	H/M/L risk
Utilities	0	A gas distribution serving Port Talbot (northwest) line runs to the north and east of Bridgend (north of the M4). This is not within the network development zone and so is not a direct risk to the network. Overhead electricity lines are present in the same area. These are low risk to the distribution network as the network is not expected to be developed in this area.	A gas distribution serving Port Talbot (northwest) line runs to the north and east of Bridgend (north of the M4). There is unlikely to be a risk to the design and installation of transmission lines, as the pipes do not cross the gas distribution pipe in this cluster. Overhead electricity lines are present in the same area. These are low risk to the transmission pipes as they are not expected to be developed in this area.	No impact.	L

Item	Number	Comments/ Mitigations: Distribution network	Comments/ Mitigations: Transmission network	Comments/ Mitigation: Energy Centre	H/M/L risk
Roads	3	Three key roads bisect this area of Bridgend, the M4, A4061 and A4063. The M4 will be the largest barrier to development as it splits the domestic connections in two. There are eight crossing points, the most direct being the A4061 and the A4063. A small footbridge crosses at the rear of the Bridgend shopping outlet. This would minimise disruption, however the bridge may need reinforcing to carry distribution pipes. The railway line crosses under the M4 in an optimum location. This could be considered as a pipe route, but would require engagement with National Rail and installation/maintenance of the network would be complex and expensive. Other roads in the area are minor, many of which are residential and are not likely to cause barriers to installation.	Three key roads bisect this area of Bridgend, the M4, A4061 and A4063. The M4 will be the largest barrier to development as it splits the domestic connections in two. There are eight crossing points, the most direct being the A4061 and the A4063. A small footbridge crosses at the rear of the Bridgend shopping outlet. This would minimise disruption, however the bridge may need reinforcing to carry transmission pipes. The railway line crosses under the M4 in an optimum location. This could be considered as a pipe route, but would require engagement with National Rail and installation/maintenance of the network would be complex and expensive. Other roads in the area are minor, many of which are residential and are not likely to cause barriers to installation.	The Energy Centre has been placed within Princess of Wales Hospital. There is easy access to the site via the Rotary International Way, so this is not considered to be a high risk. The roads may need to be reconfigured in the immediate area to allow biomass deliveries.	M
Railways	2	The main railway crosses the cluster in the south east. This section does not significantly affect the network or its route in the rest of the cluster. The railway branches north to Wildmill station in the centre of the domestic connections to the south of the M4. The railway will create a constraint to network connections from the east to the west of the cluster. However there are five minor road underpasses (north and south of the M4) which would allow the heat network to cross the railway. An underpass is preferred to a bridge, as installation is less complex and larger bore pipes can be laid more easily. The size of the roads mean closure of them is not likely to incur significant disruption, and utilities in the area is unlikely to be congested. The crossing points will constrain the network, and may mean a sub optimal path needs to be taken.	The main railway crosses the cluster in the south east. This may constrain the transmission route to cluster 9. The crossing points will constrain the network, and may mean a sub optimal path needs to be taken.	No impact.	L
Rivers	2	Ogmore River runs through the cluster from north to south. This will affect transmission from the domestic connections in the south of cluster 7 and the domestic connections in the north of cluster 12. The Ilynfi river joins the Ogmore river in the north of cluster 7 and this will add complexity to the route and installation of the network in this area. There are multiple crossings of both rivers throughout the cluster.	The Ogmore River runs through the cluster from north to south. Its location will not impact the transmission to cluster 9.	No impact.	L
Listed Buildings	24	24 listed buildings in the cluster. These are spread throughout the town, and may add complexity and cost to connection should they be connected to the network. There is an area in the south of the cluster (central Bridgend) where the density of listed buildings is higher. This suggests that the buildings in this area may be similarly historic, which may affect connection complexity to connections in this area. Additionally this may indicate that utilities will be historic and therefore may be congested, increasing costs and the risk of needing to divert them.	No impact.	No impact.	L

Item	Number	Comments/ Mitigations: Distribution network	Comments/ Mitigations: Transmission network	Comments/ Mitigation: Energy Centre	H/M/L risk
Air quality	0	No impact.	No impact.	No AQMAs currently in the cluster. Energy Centre biomass deliveries will increase local traffic and will increase the emissions in the local area. Low emission delivery lorries can be used to minimise impact. The Energy Centre will increase emissions in the local area. An emissions impact assessment will need to be undertaken during design and any negative impacts addressed during the design. The biomass plant will require flue gas treatment and cleaning (such as bag filters) to reduce the local particulate emissions to acceptable levels. The flue will need to be designed following dispersion modelling to emit at a height which will not impact the immediate area. This is not beyond the usual requirements of an energy centre design.	L
Noise Action Plan	4	No impact.	No impact.	There is a noise action plan for the railway in the south, just before the track splits. The M4, A4061, A4063 and railway all create significant local noise pollution. This is most significant in the centre of the cluster where the roads meet, not in the vicinity of the Energy Centre, but should be considered when planning the Energy Centre.	L
Conservation Areas	137	Areas of forest and ancient woodland are scattered around the cluster. These are unlikely to constrain network development, but should be considered when planning routes. Root protection zones should be identified at an early stage.	No impact.	No impact.	L
Flooding	708	Large area of the river surroundings has previously flooded. There is a large area of high flood risk. This would need to be taken into account when designing the network and building connections.	Large area of the river surroundings has previously flooded. There is a large area of high flood risk. This would need to be taken into account when designing the transmission network.	The Energy Centre is within 1 km of a historic flood area, and is close to a flood risk area. This is not considered a high risk to the Energy Centre.	L
Historic Landfill Sites	3	Three historic landfill sites. These are not close to any likely connections so is not expected to be a constraint to development.	Three historic landfill sites. These are not close to any likely connections so is not expected to be a constraint to development.	No impact.	L
Common Land	22	22 areas of common land. These are distributed in the east and centre of the cluster, and may increase planning requirements to the network connections between the north and south domestic areas.	22 areas of common land. These are distributed in the east and centre of the cluster, and unlikely to affect the transmission route.	No impact.	L

Energy Centre

The Energy Centre has been placed within Princess of Wales Hospital Car Park. Bordered by the hospital and the A4061. Consultation with the Hospital will be required to ascertain their resilience requirements, and local space available for the location of the Energy Centre. There is already a building with a high flue adjacent to the location provided which suggests that the Energy Centre would not struggle with planning permission in this regard.

Plant installation date:	2020	2030	2040	2050
Gas Boilers	**27 MW**	**27 MW**	**13.41 MW**	**13.41 MW**
Biomass Boiler			**0.55 MW**	**0.55 MW**
Gas Engine CHP	**3.91 MW**	**3.91 MW**	**3.91 MW**	
Gas Turbine CHP	**8.38 MW**	**8.38 MW**	**3.74 MW**	**3.74 MW**
Large Scale Heat Pump			**20.49 MW**	**20.49 MW**
Peak Demand (MW):	8.87	17	26.71	28.74

The table above shows that for years 2020, 2030 and 2040 the Energy Centre has significantly larger installed capacity than is required. This suggests that the plant may be exporting large amounts of heat to cluster 9, or that the plant is oversized. This is not considered good practice as this will lead to unnecessary transmission heat losses or high investment costs with only minimal asset utilisation.

The approximate land take for this Energy Centre is 1,000 m^2. The flue height required is estimated to be 12 m. This is 3 m above the tallest building in the immediate area, which is the Energy Centre in this instance. Detailed dispersion modelling and more detailed information on the current and future buildings in the immediate area would be required to finalise this height. This flue height may cause planning permission issues in the area as it is heavily residential.

The load factors suggest that the gas boilers are being used to meet peak demand, with load factors under 0.09% for all years. The gas engine CHP units have high load factors for all years. This suggests they are being used to meet the heat baseload. The biomass boiler has a high load factor in 2040 (65.19%) but is minimal in 2050 (0.09%). Therefore it may be more efficient to oversize another technology, and remove the biomass boilers completely, as the complexity of installing and running a 550 kW biomass boiler for only a 10 year period may not be practical. The gas turbine CHP installed in 2040 has a load factor of 0.07%. This shows that the asset is being underutilised and therefore is not a recommended investment.

The negligible usage of the gas turbine CHP and biomass boilers in 2050 indicates that their installation in 2040 may not be a good investment. Instead, if the other plant (or transmission) cannot meet the required capacity, containerised plant (biomass boilers or gas turbine) could be hired to meet this capacity. This may be a more efficient use of resources, reducing the future redundant capacity.

Local assistance

There are a number of steps the local authority can put in place which can ease and assist the network development:

1. Take advantage of ongoing and future infrastructure projects in the local area by compiling survey data (desktop studies, GPR scans etc) and detailed records of newly installed, replaced or maintenance on utilities, to develop a good understanding of the installed infrastructure along potential network routes.
2. Build relationships with large energy consumers in the local area and promote detailed record keeping of energy usage.
3. Closer to network build out, a local development order can help to progress the network at a more rapid pace, removing red-tape and unnecessary financial and time constraints.

Carrying out and maintaining these items will help de-risk network development by increasing the knowledge and available information on many of the high risk items during the feasibility and design stage.

7.8 Cluster 8

Cluster information

Item	Number	Comments
Domestic heat network connections: DHN22 transition 1 (2022)	1552	1552 domestic connections within the first transition phase, with annual heat demand (Heat Transition 1) = 7,580 MWh. Heat network domestic connections are concentrated in the east of the cluster, making up the west of Bridgend. A small proportion are outside this, and located in Lalestone (west of Bridgend) and Pen-y-fai (north of the railway).
Domestic heat network connections: DHN22 transition 2 (2037)	4858	4858 domestic connections within the second transition phase, with annual heat demand (Heat Transition 2 Annual) = 8,910 MWh. Heat network domestic connections are concentrated in the east of the cluster, making up the west of Bridgend (high density of connections in the north of this area). A small proportion are outside this and located in Lalestone (west of Bridgend) and Pen-y-fai (north of the railway).
Non-domestic heat network connections	28	28 non-domestic properties connected, with total floor area of 50,200 m^2. Wide variety of load uses/profiles, including both private and public sector buildings. Primary schools in the middle of the domestic connections which should be connected if possible. Several education loads are indicated in the non-domestic connections list, so it is expected that these have been highlighted by the model already.
Topography		The east of the cluster is made up of the western side of Bridgend. The area is expected to require extensive utilities investigation including both non-invasive and invasive surveys. This will increase the costs of network design. The rest of the cluster is green field areas and sparsely developed with the exception of Lalestone on the west side and Pen-y-fai at the north.
Social Impact		Most of the cluster is categorised as in the 50% least deprived areas of Wales. However some of the residential areas fall into the 30% most deprived areas. It is expected that a heat network in these areas would contribute to reducing fuel poverty.

Constraints

Item	Number	Comments/ Mitigations: Distribution network	Comments/ Mitigations: Transmission network	Comments/ Mitigation: Energy Centre	H/M/L risk
Utilities	1	There is a main gas distribution pipeline (high pressure) which runs through the centre of the cluster, from Laleston through the centre of the domestic connections. This is a risk to the network route optimisation and installation. Extensive utilities mapping, trail pits, GPR surveys and engagement with Wales & West Utilities will be needed during the design stage to mitigate this risk.	No impact.	No impact.	M

Item	Number	Comments/ Mitigations: Distribution network	Comments/ Mitigations: Transmission network	Comments/ Mitigation: Energy Centre	H/M/L risk
Roads	2	A473 and A48 are in the cluster. The A48 has little significance as there are no connection points to the other side of it from the main domestic connection area. The A473 cuts the domestic connection are in half and so would need to be crossed, this would cause local disruption during installation however is not considered to be a barrier to installation or to network routing, as the road could be feasibly crossed anywhere within the cluster. The M4 crosses the north west corner of the cluster but its placement is not expected to affect the network in anyway.	No impact.	No impact.	L
Railways	1	The main railway crosses the cluster in the north. This may increase the difficulty of connecting to Pen-y-fai, although there is a suitably placed underpass which could be used to route the network pipe.	No impact.	No impact.	L
Rivers	1	The Ogmore river runs along the eastern boundary of the cluster. Its placement is not likely to affect network development within Cluster 8.	The Ogmore river runs along the eastern boundary of the cluster. Its placement would constrain transmission and connection to central Bridgend (Clusters 9). There are several bridges in the area, but if connection was not physically feasible at one of these point then a custom-built crossing could be developed.	No impact.	M
Listed Buildings	34	34 listed buildings in the cluster. These are predominately in the town centre, and may add complexity and cost to connection should they be connected to the network. The density of listed buildings suggests that the buildings in this area may be similarly historic, which may affect connection complexity to connections in this area. Additionally this may indicate that utilities will be historic and therefore may be congested, increasing costs and the risk of needing to divert them.	No impact.	No impact.	L
Air quality	0	No impact.	No impact.	There are no AQMAs currently in the area. The Energy Centre will increase emissions in the local area. An emissions impact assessment will need to be undertaken during design and any negative impacts addressed during the design. The CHP plant will require flue gas treatment and cleaning to reduce the local NOx emissions to acceptable levels. The flue will need to be designed following dispersion modelling to emit at a height which will not impact the immediate area. This is not beyond the usual requirements of an energy centre design. The surrounding area is low density residential, so the height of the flue is not expected to be significant, but may cause planning issues due to visual impact in the local area.	L
Noise Action Plan	1	No impact.	No impact.	There is one localised noise action plan, where the railway crosses a local road. This is not a constraint to network development. In general the roads and railway create local noise pollution which will need to be considered when locating and designing the Energy Centre. It is not a significant risk in this cluster.	L

Item	**Number**	**Comments/ Mitigations: Distribution network**	**Comments/ Mitigations: Transmission network**	**Comments/ Mitigation: Energy Centre**	**H/M/L risk**
Conservation Areas	54	Areas of forest and ancient woodland are scattered around the edges of the cluster. These may constrain network development north to Pen-y-fai as they are denser in this area.	Areas of forest and ancient woodland are scattered around the edges of the cluster. These may constrain transmission development north as they are denser in this area. There is a nature reserve in the middle of the river in the south of the cluster (River splits around it). This would prevent crossing the river to cluster 9 in this area.	No impact.	L
Flooding		The town centre is a historic flood zone and the area immediately adjacent to the river Ogmore is a flood high risk area. This would need to be taken into account when designing the network and building connections.	The town centre is a historic flood zone and the area immediately adjacent to the river Ogmore is a flood high risk area. This would need to be taken into account when designing the network.	The energy centre is not near a flood risk zone.	L
Historic Landfill Sites	0	There are no historic landfill sites in the area.	No impact.	No impact.	L
Common Land	0	There are no areas of common land in the area.	No impact.	No impact.	L

Energy Centre

The Energy Centre has been placed according to the Centre of Gravity. This places it in the playing fields of Llangewydd Junior School. The school grounds are surrounded by semi-detached residential houses. It is expected that visual impact will be the largest risk to planning consent.

Plant installation date:	**2020**	**2030**	**2040**	**2050**
Gas Boilers	**18.00 MW**	**18.00 MW**		**1.91 MW**
Gas Engine CHP	**7.01 MW**	**7.01 MW**	**7.01 MW**	**0.54 MW**
Peak Demand (MW):	1.29	4.85	13.33	15.39

The Energy Centre does not have sufficient installed capacity to meet the peak demand (in 2040, and 2050). This suggests the network is relying on transmission of heat from cluster 9 to meet the peak demand or that the plant is undersized. In 2020 and 2030, the plant is oversized to meet capacity. It is recommended to use distributed the gas boilers to the clusters which require the heat. This would improve local resilience and should not add any additional issues as the local energy centres are expected to have gas boilers specified which could be scaled up.

The approximate land take for this Energy Centre is 300 m^2. The flue height required is estimated to be 8 m. This is 3 m above the tallest building in the immediate area, which is the Energy Centre in this instance. Detailed dispersion modelling and more detailed information on the current and future buildings in the immediate area would be required to finalise this height. This flue height may cause planning permission issues in the area as it is heavily residential.

Throughout 2020 and 2030, the gas engine has a high load factor, while the gas boiler has a low load factor. This indicates that the energy centre is operating efficiently with the gas engine meeting the baseload and the gas boilers being used only to meet peak demand. This is the recommended operational strategy for these technologies. In 2050, both technologies have a low load factor of 0.09%. This suggests, as the peak demand has increased, that the cluster is importing large amounts of heat via the transmission network, from cluster 9. This is not considered best practice as there are inefficiencies associated with high quantities of inter-cluster heat transfer such as heat loss and pumping requirements. This also increases the reliance on the transmission network, and so the resilience of the network in cluster 8 is reduce. It would be more resilient, and recommended, to utilise the installed assets more effectively within cluster 8 and reduce the need for heat transmission from another cluster. The capacity of the 550 kW gas engine could be increased if the demand profile allows it.

It is not clear why there are no installed gas boilers in 2040, but as the installed capacity is not sufficient to meet peak demand, it is recommended that this be reassessed. It is noted that the gas engine is sized at the maximum allowable size (7 MW) of the model. This suggests that the models allowable boundaries should be increased to confirm that a 7 MW engine is indeed the optimum size and that the modelling has not inadvertently constrained the optimisation process. The output heat to power ratio of the gas engine CHP should be reviewed as this is likely to change depending on the size of the plant selected. Hence the assumed heat to power output of the engine at the specified boundary point (7 MW) may be different to that chosen (550 kW) as there is such a gap in the output capacity. This is additional accuracy which may be useful to build into the model.

Local assistance

There are a number of steps the local authority can put in place which can ease and assist the network development:

1. Take advantage of ongoing and future infrastructure projects in the local area by compiling survey data (desktop studies, GPR scans etc) and detailed records of newly installed, replaced or maintenance on utilities, to develop a good understanding of the installed infrastructure along potential network routes.
2. Build relationships with large energy consumers in the local area and promote detailed record keeping of energy usage.
3. Closer to network build out, a local development order can help to progress the network at a more rapid pace, removing red-tape and unnecessary financial and time constraints.

Carrying out and maintaining these items will help de-risk network development by increasing the knowledge and available information on many of the high risk items during the feasibility and design stage.

7.9 Cluster 9

Cluster information

Item	Number	Comments
Domestic heat network connections: DHN22 transition 1 (2022)	5265	5265 domestic connections within the first transition phase, with annual heat demand (Heat Transition 1) = 26,040 MWh. Heat network domestic connections are concentrated in the north of the cluster, making up the west of Bridgend. Only a small proportion are outside this. The domestic connections are separated into two main groups, split by the railway and industrial areas. The central area is heavily built up and installation of network pipes is expected to be complicated with heavily congested utilities beneath the roads and pavements.
Domestic heat network connections: DHN22 transition 2 (2037)	159	159 domestic connections within the second transition phase, with annual heat demand (Heat Transition 2 Annual) = 833 MWh. These connections are spread throughout the rest of the transition 1 connections.
Non-Domestic heat network connections	43	43 non-domestic properties connected, with total floor area of 260,250 m^2. Wide variety of load uses/profiles, including both private and public sector buildings. The largest building included is a commercial office (68,400 m^2). It is not clear what proportion of the large industrial area in the cluster is connected, but this should be investigated both for heat demand and waste heat. There is a college and large school in the cluster which should be connected and may be included in the specified education loads.
Topography		The north half of the cluster is the south of Bridgend. This is heavily industrialised with dense residential areas. The area is expected to require extensive utilities investigation including both non-invasive and invasive surveys. This will increase the costs of network design. The south of the cluster is green field areas and sparsely developed. The network is not expected to extend into this area.
Social Impact		Most of the cluster is categorised as in the 50% least deprived areas of Wales. However some of the residential areas fall into the 10% most deprived areas. It is expected that a heat network in these areas would contribute to reducing fuel poverty.

Constraints

Item	Number	Comments/ Mitigations: Distribution network	Comments/ Mitigations: Transmission network	Comments/ Mitigation: Energy Centre	H/M/L risk
Utilities	1	A gas distribution is runs across the south of cluster 9. This is not directly within the network development zone and so is not a high risk to the network.	A gas distribution is runs across the south of cluster 9. It is not a risk to the design and installation of transmission pipes, as the pipes would not be required to head south and hence would not cross the gas distribution pipe.	No impact.	L

Item	Number	Comments/ Mitigations: Distribution network	Comments/ Mitigations: Transmission network	Comments/ Mitigation: Energy Centre	H/M/L risk
Roads	2	A473 and A48 cross the cluster. The A48 has little significance as there are no major connection points to the other side of it from the main domestic connection area. The A473 cuts the domestic connections are in half and so would need to be crossed, this would cause local disruption during installation however is not considered to be a barrier to installation or to network routing, as the road could be feasibly crossed anywhere within the cluster.	A473 and A48 cross the cluster. These are not considered to be a barrier to installation or to network routing, as the road could be feasibly crossed anywhere within the cluster.	The Energy Centre is located at the west end of the Bridgend Industrial Estate. The location is not clearly attached via road to the main estate road network and as it is in between two railway lines it is only accessible from the western most corner via the B4181 rail bridge. The bridge and local road infrastructure may need reinforcing to cope with the additional Energy Centre traffic, in particular the biomass deliveries. A preferable option would be to link the area with the rest of the Industrial Estate, so the traffic could make use of the infrastructure already in place.	M
Railways	2	Two railway lines enter the cluster from the east and south, joining in the centre of the cluster near Bridgend station. The railways are not expected to constrain the network development as there are multiple underpasses and bridges spread throughout the cluster. Crossing over the railway is likely to incur higher costs than utilising an existing underpass.	Two railway lines enter the cluster from the east and south, joining in the centre of the cluster near Bridgend station. The railways are not expected to constrain the network development as there are multiple underpasses and bridges spread throughout the cluster. Crossing over the railway is likely to incur higher costs than utilising an existing underpass.	No impact.	L
Rivers	2	The Ogmore river runs along the western boundary of the cluster. Its placement would not affect network development within Cluster 9. Ewenny Rover runs along the southern boundary. This is no considered a significant barrier as the network is not set to extend to the south of cluster 9 across the Ewenny.	The Ogmore river runs along the western boundary of the cluster. While its placement would not affect network development within Cluster 9, the river would constrain transmission and connection to Cluster 8. There are several bridges in the town centre, but less only the A48 outside the town centre. Ewenny Rover runs along the southern boundary. This is no considered a significant barrier as the network is not set to extend to the south of cluster 9 across the Ewenny.	No impact.	L
Listed Buildings	94	34 listed buildings in the cluster. These are predominately in the town centre and spread south along the Ogmore river. The town centre buildings may add complexity and cost to connection should they be connected to the network. The density of listed buildings suggests that the buildings in this area may be similarly historic, which may affect connection complexity to connections in this area. Additionally this may indicate that utilities will be historic and therefore may be congested, increasing costs and the risk of needing to divert them.	No impact.	No impact.	L

Item	Number	Comments/ Mitigations: Distribution network	Comments/ Mitigations: Transmission network	Comments/ Mitigation: Energy Centre	H/M/L risk
Air quality	0	No impact.	No impact.	No AQMAs currently in the cluster. Energy Centre biomass deliveries will increase local traffic and will increase the emissions in the local area. Low emission delivery lorries can be used to minimise impact. The Energy Centre will increase emissions in the local area. An emissions impact assessment will need to be undertaken during design and any negative impacts addressed during the design. The biomass plant will require flue gas treatment and cleaning (such as bag filters) to reduce the local particulate emissions to acceptable levels. The flue will need to be designed following dispersion modelling to emit at a height which will not impact the immediate area. This is not beyond the usual requirements of an energy centre design.	L
Noise Action Plan	2	No impact.	No impact.	There are two localised noise action plans on the main railway line. In general the roads and railway create local noise pollution which will need to be considered when locating and designing the Energy Centre. The surrounding area is not expected to contain noise sensitive buildings.	L
Conservation Areas		Areas of forest and ancient woodland are scattered around the edges of the cluster. They are not expected to constrain network development, however tree root protection zones may need to be assessed in the north of the cluster where forested areas are within residential areas.	Areas of forest and ancient woodland are scattered around the edges of the cluster. They are not expected to constrain network development, however tree root protection zones may need to be assessed in the north of the cluster where forested areas are within residential areas.	No impact.	L
Flooding		The edges of the cluster are historic flood zones and the area immediately adjacent to both rivers are a high risk flooding area. This would need to be taken into account when designing the network and building connections.	The edges of the cluster are historic flood zones and the area immediately adjacent to both rivers are a high risk flooding area. This would need to be taken into account when designing the network.	The Energy centre is not near a flood risk zone.	L
Historic Landfill Sites	3	There are three historic landfill sites. Two are small and likely to be inconsequential. One is larger and close to the town centre. This may affect network placement and development.	There are three historic landfill sites. Two are small and likely to be inconsequential. One is larger and close to the town centre. This may affect transmission line placement and development.	No impact.	L
Common Land	3	The areas of common land are far south and not a barrier to network development.	No impact.	No impact.	L

Energy Centre

The Energy Centre has been placed according to the heat Centre of Gravity. This places it at the eastern end of the Bridgend Industrial Estate. The site is bordered by the railway on two sides, and does not appear to have a direct road link with the rest of the industrial estate.

Plant installation date:	**2020**	**2030**	**2040**	**2050**
Gas Boilers			**1.43 MW**	**13.1 MW**
Biomass CHP			**1.91 MW**	**2.70 MW**
Gas Turbine CHP			**0.72 MW**	**4.28 MW**
Large Scale Heat Pump			**11.18 MW**	**16.85 MW**
Peak Demand (MW):	8.18	21.12	21.29	20.99

The table above shows that the Energy Centre has does not have sufficient capacity to meet peak demand in 2020, 2030 and 2040. This suggests that the plant may be importing large amounts of heat from clusters 7, 8 and/or 10, or that the plant is undersized.

The approximate land take for this Energy Centre is 1,000 m^2. The flue height required is estimated to be 12 m. This is 3 m above the tallest building in the immediate area, which is the Energy Centre in this instance. Detailed dispersion modelling and more detailed information on the current and future buildings in the immediate area would be required to finalise this height. This flue height may cause planning permission issues in the area as it is heavily residential.

All technologies, apart from the heat pump, have load factors below 0.1% for all years. This suggests they are underutilised. If the heat pumps are able to supply most of the heat, it would be more efficient to scale them up and remove the additional technologies with the exception of the gas boilers which should be retained to help meet peak demand and add resilience. Alternatively, the heat pumps could be reduced in capacity, and allow the CHP plants to absorb more load. It is recommended that the optimisation of the plant sizing and utilisation be revisited.

Local assistance

There are a number of steps the local authority can put in place which can ease and assist the network development:

1. Take advantage of ongoing and future infrastructure projects in the local area by compiling survey data (desktop studies, GPR scans etc) and detailed records of newly installed, replaced or maintenance on utilities, to develop a good understanding of the installed infrastructure along potential network routes.
2. Build relationships with large energy consumers in the local area and promote detailed record keeping of energy usage.
3. Closer to network build out, a local development order can help to progress the network at a more rapid pace, removing red-tape and unnecessary financial and time constraints.

Carrying out and maintaining these items will help de-risk network development by increasing the knowledge and available information on many of the high risk items during the feasibility and design stage.

7.10 Cluster 10

Cluster information

Item	Number	Comments
Domestic heat network connections: DHN22 transition 1 (2022)	0	0 domestic connections within the first transition phase.
Domestic heat network connections: DHN22 transition 2 (2037)	3482	3482 domestic connections within the second transition phase, with annual heat demand (Heat Transition 2 Annual) = 19,160 MWh. These connections concentrated into three distinct areas. The largest in the northwest, bounded by Coychurch road and Simonston Road. South, bounded by Waterton Road and the Industrial Estate and central, bounded by Coychurch road and the railway line. The area in the northwest provides the simplest connection to other clusters as it directly borders residential areas in cluster 7. The other two areas are more constrained in terms of local domestic connections.
Non-Domestic heat network connections	10	10 non-domestic properties connected, with total floor area of 77,350 m^2. The largest building included is a commercial office (33,000 m^2). It is not clear what proportion of the Waterton industrial area is connected, but this should be investigated both for heat demand and waste heat. There is a crematorium adjacent to the northwest residential cluster which may be able to receive or supply heat from or to the network.
Topography		The west half of the cluster is the south east of Bridgend. This is heavily industrialised with dense residential areas. The east side is undeveloped green field with a golf course. The network is not expected to extend into this area, however transmission pipes would be expected to run though this area to cluster 6.
Social Impact		The cluster is categorised as in the 50% least deprived areas of Wales. This may be due to the high levels of both industrial activity and undeveloped greenfield in the cluster. The network is not expected to bring a high degree of social impact to the area.

Constraints

Item	Number	Comments/ Mitigations: Distribution network	Comments/ Mitigations: Transmission network	Comments/ Mitigation: Energy Centre	H/M/L risk
Utilities	1	A gas distribution pipe runs across the west of cluster 10 at the western edge of Waterton Industrial Estate. This is on the edge of the network development zone and so is not a high risk to the network, but should be considered when designing the network route.	A gas distribution pipe runs across the west of cluster 10 at the western edge of Waterton Industrial Estate. It is not a risk to the design and installation of transmission pipes, as the pipes would not be required to head south and hence would not cross the gas distribution pipe.	No impact.	L

Item	**Number**	**Comments/ Mitigations: Distribution network**	**Comments/ Mitigations: Transmission network**	**Comments/ Mitigation: Energy Centre**	**H/M/L risk**
Roads	1	The A473 bisects the cluster. The majority of the domestic connections are to the north and hence not affected by the road. The road may prevent connection to the southern domestic connections and the Waterton industrial estate.	The A473 bisects the cluster. This is unlikely to significantly affect the transmission network.	The road network appears sufficient to absorb any additional traffic generated by the Energy Centre.	L
Railways	1	The railway bisects the cluster. This is not a major constraint as there are two well-placed underpasses which the network could utilise to connect the two sides of the railway together.	The railway bisects the cluster. This is not a major constraint as there are two well-placed underpasses which the network could utilise to connect the two sides of the railway together.	No impact.	L
Rivers	1	Ewenny River runs along the southern boundary. The river may constrain network extension to some parts of Waterton industrial estates which are on the other side of the river. It is not a constraint to connection of any domestic connections. The river has a small tributary (Nant-Bryn-glas) from the north. This is minor and so not considered a major constraint to network development.	Ewenny River runs along the southern boundary. This is not a constraint to transmission line placement.	No impact.	L
Listed Buildings	11	The listed buildings in the cluster are in the central domestic connection area and the crematorium. They may incur additional complexity and cost if connected to the network.	No impact.	No impact.	L
Air quality	0	No impact.	No impact.	There are no AQMAs currently in the area. The Energy Centre will increase emissions in the local area. An emissions impact assessment will need to be undertaken during design and any negative impacts addressed during the design. The CHP plant will require flue gas treatment and cleaning to reduce the local NOx emissions to acceptable levels. The flue will need to be designed following dispersion modelling to emit at a height which will not impact the immediate area. This is not beyond the usual requirements of an energy centre design. The surrounding area is low density industrial, so the Energy Centre is unlikely to cause planning issues due to visual impact in the local area.	L
Noise Action Plan	2	No impact.	No impact.	There are two Noise Action Plan priority areas, both corresponding to road and rail in proximity to residential area. Neither are expected to constrain the network development or Energy Centre placement. The major road and rail in the cluster create local noise pollution which will need to be considered when locating and designing the Energy Centre.	L
Conservation Areas		Areas of forest and ancient woodland are predominately in the east of the cluster away from the local network areas. They are not expected to constrain network development. There are some wooded areas in the northwest residential area which would need to be assessed when designing a network in this area.	Areas of forest and ancient woodland are predominately in the east of the cluster away from the expected transmission line routes. They are not expected to constrain network development.	No impact.	L

Item	Number	Comments/ Mitigations: Distribution network	Comments/ Mitigations: Transmission network	Comments/ Mitigation: Energy Centre	H/M/L risk
Flooding		The areas surrounding the rivers are high flood risk areas. This significantly affects Waterton Industrial Estate, hence connections in this area would need to be designed to be resilient to this risk.	The areas surrounding the rivers are high flood risk areas. Transmission pipes should be designed to be resilient to local flooding if they are in this area.	The Energy Centre is not in a flood risk zone.	L
Historic Landfill Sites	0	There are no historic landfills in the area.	There are no historic landfills in the area.	No impact.	L
Common Land	2	There are two areas of common land in the cluster. Neither are in a position where they are likely to come into contact with the heat network.	There are two areas of common land in the cluster. Neither are in a position where they are likely to come into contact with the heat network.	No impact.	L

Energy Centre

The Energy Centre has been placed according to the heat Centre of Gravity. This places it in the middle of the Bridgend Industrial Estate. The site is an undeveloped area of land between Bennett St and Coity Crescent. The land is surrounded by low density industrial units and is expected to be suitable for development in terms of planning.

Plant installation date:	**2020**	**2030**	**2040**	**2050**
Gas Boilers		**27 MW**	**27 MW**	
Gas Turbine CHP		**22.78 MW**	**22.78 MW**	**22.78 MW**
Peak Demand (MW):			7.77	9.3

The approximate land take for this Energy Centre is 800 m^2. The flue height required is estimated to be 12 m. This is 3 m above the tallest building in the immediate area, which is the Energy Centre in this instance. Detailed dispersion modelling and more detailed information on the current and future buildings in the immediate area would be required to finalise this height.

The life expectancy of a gas turbine is ordinarily considered to be 15 years to 20 years. The data provided indicates that the turbine installed in 2030 runs for 27 years. This is above normal industry standards and this additional constraint should be reviewing for application to the modelling.

The table above shows that the Energy Centre has significantly larger installed capacity than is required. This suggests that the plant may be exporting large amounts of heat to other clusters, or that the plant is oversized. As the load factor of the turbine drops significantly, from 85.62% in 2030 to 0.04% in 2050. This suggests that the cluster is importing heat via the transmission network from clusters 6 or 8. Therefore the plant in this cluster is oversized in 2050. However as noted above, the turbine should be coming to its end of life in 2050, so although the model appears to have not produced optimum theoretical results, practically, they seem reasonable when the lifespan of the turbine is taken into account. Importing significant amounts of heat from another cluster will increase the heat losses and the reliance on the transmission network, reducing the resilience of the local network. This is not advised, as it would be preferable to locate the heat generation plant locally.

It is noted that the gas turbine is sized closely to the maximum allowable size (23 MW) in the model. This suggests that the models allowable boundaries should be increased to confirm that a 22.78 MW engine is indeed the optimum size and that the modelling has not inadvertently constrained the optimisation process.

Local assistance

There are a number of steps the local authority can put in place which can ease and assist the network development:

1. Take advantage of ongoing and future infrastructure projects in the local area by compiling survey data (desktop studies, GPR scans etc) and detailed records of newly installed, replaced or maintenance on utilities, to develop a good understanding of the installed infrastructure along potential network routes.
2. Build relationships with large energy consumers in the local area and promote detailed record keeping of energy usage.
3. Closer to network build out, a local development order can help to progress the network at a more rapid pace, removing red-tape and unnecessary financial and time constraints.

Carrying out and maintaining these items will help de-risk network development by increasing the knowledge and available information on many of the high risk items during the feasibility and design stage.

7.11 Cluster 11

No cluster 11 specified on map or in datasets.

7.12 Cluster 12

Cluster information

Item	Number	Comments
Domestic heat network connections: DHN22 transition 1 (2022)	0	0 domestic connections within the first transition phase.
Domestic heat network connections: DHN22 transition 2 (2037)	2218	2218 domestic connections within the second transition phase, with annual heat demand (Heat Transition 2 Annual) = 11,270 MWh. The heat network connections are in Porthcawl, a coastal town.
Non-Domestic heat network connections	0	0 non-domestic connections in cluster 12.
Topography		The cluster is bounded on the west by the coast. The north is forested around Kenfig Pool. The south are fields stretching out towards Bridgend. Porthcawl in the centre is a holiday town with static caravan parks. The town, and cluster is bordered on two sides by cliffs and sandy beaches.
Social Impact		Most of the cluster is categorised as in the 50% least deprived areas in Wales. Some of central Porthcawl is more deprived (30% most deprived). This indicates that the social value impact of a network in this area would be small.

Constraints

Item	Number	Comments/ Mitigations: Distribution network	Comments/ Mitigations: Transmission network	Comments/ Mitigation: Energy Centre	H/M/L risk
Utilities	0	No major utilities in the area.	No transmission line from cluster 12.	No impact.	L
Roads	1	The A4106 is the only major road to and from the town. The branch of this which meets the coast cuts the two sides of the town in half, and could prevent or complicate the two sides of the town network joining up. Closure, part or full, of this road would cause some local disruption, however there are multiple minor roads which could be utilised as diversion routes. All the other roads are minor local residential roads, and would not significantly impact network development.	No transmission line from cluster 12.	No impact.	L
Railways	0	There are no railways in the boundary.	No transmission line from cluster 12.	No impact.	L
Rivers	2	A river runs into the sea at either end of the cluster along the boundary. These would have no impact on the network within the town.	No transmission line from cluster 12.	No impact.	L

Item	**Number**	**Comments/ Mitigations: Distribution network**	**Comments/ Mitigations: Transmission network**	**Comments/ Mitigation: Energy Centre**	**H/M/L risk**
Listed Buildings	41	The listed buildings are scattered throughout the cluster, these are spread throughout the town, and may add complexity and cost to connection should they be connected to the network.	No transmission line from cluster 12.	No impact.	L
Air quality	0	No impact.	No transmission line from cluster 12.	No AQMAs currently in the cluster. Energy Centre biomass deliveries will increase local HGV traffic and will increase the emissions in the local area. Low emission delivery lorries can be used to minimise impact. The Energy Centre will increase emissions in the local area. An emissions impact assessment will need to be undertaken during design and any negative impacts addressed during the design. The biomass plant will require flue gas treatment and cleaning (such as bag filters) to reduce the local particulate emissions to acceptable levels. The flue will need to be designed following dispersion modelling to emit at a height which will not impact the immediate area. This is not beyond the usual requirements of an energy centre design.	L
Noise Action Plan	0	No impact.	No transmission line from cluster 12.	There are no noise action plans priority areas within the cluster. The A4106 generates come localised noise pollution, but this is not significant and should not impact network or Energy Centre development.	L
Conservation Areas	2	Some small areas of woodland across the cluster. There are two large Nature reserves, one across the whole of the northern end of the cluster around Kenfig pool, and a small one on the coast next to the town. Two large Sites of Special Scientific Interest: one across the nature reserve to the north and one in the south. These are also Special Areas of Conservation. It is expected that the heat network would not be given planning permission to develop through these areas. This is not a major risk to the heat network as the areas have no domestic or non-domestic connections within them and so they can be easily avoided by distribution pipes.	No transmission line from cluster 12.	The energy centre is placed in an area of national forest. This may increase the planning requirements for the developments. It is unknown where the onshore wind farms are due to be placed, but much of the cluster is a nature reserve and so this may reduce the number of options available for placement.	M
Flooding		The coastline is a high risk flood area to a distance of approximately 500 m inland, covering parts of the town, with historic flooding at the coast. This would need to be taken into account when designing the network and building connections.	No transmission line from cluster 12.	The coastline is a high risk flood area to a distance of approximately 500 m inland, covering parts of the town. This is not a direct risk by should be considered when designing the Energy Centre as the Energy Centre is located adjacent to a large pond (Ger-Y-Llyn Pond).	M
Historic Landfill Sites	4	No impact.	No transmission line from cluster 12.	No impact.	L
Common Land	1	There is a small area of common land in the cluster. This is not significant to heat network development.	No transmission line from cluster 12.	No impact.	L

Energy Centre

The Energy centre has been placed according to the heat centre of gravity. It is located in a residential area within a small area of woodland adjacent to a pond.

Plant installation date:	**2020**	**2030**	**2040**	**2050**
Gas Boilers			**2.00 MW**	**2.07 MW**
Biomass CHP			**0.25 MW**	**0.28 MW**
Gas Turbine CHP			**1.01 MW**	**1.03 MW**
Large Scale Heat Pump			**1.47 MW**	**1.66 MW**
Anaerobic Digestion			**2.80 MW**	**2.80 MW**
Peak Demand (MW):			3.34	4.19

The approximate land take for this Energy Centre is 1,200 m^2. The flue height required is estimated to be 12 m. This is 3 m above the tallest building in the immediate area, which is the Energy Centre in this instance. Detailed dispersion modelling and more detailed information on the current and future buildings in the immediate area would be required to finalise this height. This flue height may cause planning permission issues in the area as it is heavily residential.

The anaerobic digestion plant capacity has been allocated to 2040 and 2050. The base data has it allocated to 2020 and 2050 when there is no demand from the heat network.

The plant shows high load factors for the anaerobic digestion and heat pumps, and low load factors for the CHP plants and boilers. This indicates that the low carbon, sustainable technologies are meeting the baseload, which is the recommended operational strategy. However the low load factors for the CHP plants (both technologies are less the 1% for 2040 and 2050) shows that the plant is underutilised and therefore unlikely to be an efficient use of resources. All plant, apart from anaerobic digestion, increase capacity in 2050. These capacity increase are small both cardinally and relatively. This would be additions of small plant of dissimilar capacity to the existing plant. It is suggested individual plant of a type is kept at similar capacities to allow similar operation and maintenance. The 2040 capacity could be to the 2050 requirements to avoid this. Although, given the underutilisation of the turbines and biomass CHP, it is recommended one or both of these technologies be removed completely and absorb the capacity required into the other or another technology (if it cannot be added to the anaerobic digestion or heat pumps).

It is noted that the anaerobic digestion plant is sized closely to the maximum allowable size (2.8 MW) in the model. This suggests that the models allowable boundaries should be increased to confirm that a 2.8 MW capacity plant is indeed the optimum size and that the modelling has not inadvertently constrained the optimisation process.

Local assistance

There are a number of steps the local authority can put in place which can ease and assist the network development:

1. Take advantage of ongoing and future infrastructure projects in the local area by compiling survey data (desktop studies, GPR scans etc) and detailed records of newly installed, replaced or maintenance on utilities, to develop a good understanding of the installed infrastructure along potential network routes.
2. Build relationships with large energy consumers in the local area and promote detailed record keeping of energy usage.
3. Closer to network build out, a local development order can help to progress the network at a more rapid pace, removing red-tape and unnecessary financial and time constraints.

Carrying out and maintaining these items will help de-risk network development by increasing the knowledge and available information on many of the high risk items during the feasibility and design stage.

8 Heat Transmission

Opportunities

Connecting the clusters into an interlinked area wide network brings many benefits. The multiple generation assets connected to all the individual heat distribution networks within the clusters allows optimisation of generation. The assets can be controlled centrally to minimise operational cost or maximise carbon reduction, through the use of certain fuels and energy sources at times which are beneficial. Additionally the shared assets lead to increased resilience across the whole network as there is less dependence on any one energy centre/ fuel source. This can provide operational and financial resilience. The sharing of generation also allows a reduction in the overall capacity required, as plant in other Energy Centres can help provide the peak and backup capacity.

Through connecting the networks, all the clusters are able to access locational dependent low carbon energy. For example waste industrial heat in one cluster can be distributed to other clusters maximising the environmental benefits of the network as a whole.

Risks

The main risk to the transmission network is increased pumping costs. The increased pumping requirements of transmitting large qualities of heat across the area will need a large amount of power. This may impact the financial performance of the whole network and increase prices for the end user. Pumping stations will be required at strategic locations around the area increasing the land, initial investment and maintenance required.

In addition to this, the heat losses over the distances will be high. Not only will this mean that energy is lost during transit, but that there may need to be heat top-up stations before the transmitted heat enters the receiving network so as to not reduce the flow temperatures. These items all reduce the financial performance of the whole network.

The design, procurement and installation costs associated with such a large development may dissuade investors. It would be recommended that the individual heat distribution networks are developed separately and build their customer bases before connecting to a transmission network, as this would reduce the risk to the development.

There will be major disruption to local area during installation. Additionally access for maintenance purposes is a risk as heat networks currently do not have the same statutory rights as other utilities.

9 Heat Pump technology application

Technology Market Trends

Heat pumps operate using a reverse Carnot cycle. This uses a refrigerant to capture low grade heat, and through electrically driven compression, raise it to a higher, usable temperature.

Refrigerants currently used as the working fluid in heat pumps include R134a, R407c, R410a and R717 (ammonia). These have desirable thermodynamic properties but many come with environmental issues. The global market is continuing to phase out hydrofluorocarbons (HFCs) and other ozone depleting refrigerants, moving towards low GWP (global warming potential) refrigerants such as hydrofluoroolefins (HFO). Ammonia continues to be the most suitable refrigerant for large scale heat pumps as it has a high efficiency, while being a natural refrigerant which does not contribute to the greenhouse gas effect.

Fourth generation refrigerants (HFOs), such as R-1234ze, show the market progression towards working fluids which are both environmentally friendly and efficient.

The ideal reverse Carnot cycle has a limit to the coefficient of performance (CoP) available to the heat pump determined by the temperature of the source. In real world applications, this is further limited by the working efficiencies of the heat pump, such as the heat transfer through the heat exchangers etc. As a result, future improvements to heat pumps are limited theoretically by the source temperature, and practically, by improvements to the heat pumps themselves. A heat pumps are a mature technology, they are unlikely to improve much further technologically, as they have already reached a cost-effective efficiency peak.

Future improvements are likely to be found only in the ancillary plant items, or through the management of the heat pumps and optimisation of temperatures and electricity uses/sources. Further increases in efficiency can be found through the utilisation of the waste cooling. These actions are not directly related to the heat pump technology itself, and so not applicable as a general efficiency trend increase.

Energy Source

The energy source is the most crucial part of the heat pump system. The coefficient of performance (CoP) is limited by the temperature of the energy source, meaning that the lower the source temperature, the lower the coefficient of performance for any given flow temperature. This is the most important aspect when designing a heat pump and selecting its location.

1. **Air Source**

Air source heat pumps (ASHP) are not a viable technology over the scale and capacity forecast. There would be little benefit in centralising the ASHP and connecting them to a district heating network over having distributed ASHPs as an individual building solution. The main limitation for ASHPs is the low temperature of the source. This limits the available flow temperature, for a viable CoP heat pump.

2. **Ground source**

Ground source heat pumps (GSHP) using horizontal (surface) pipe loops are not viable for supplying a heat network as the area required would be too vast. Feasible heat sources for

GSHP are boreholes or aquifers (closed or open loop). At a depth of approximately 15 m below ground, the temperatures of the ground, and groundwater, are not highly influenced by seasonal air temperatures and therefore remain stable year round (approximately 9 °C – 13 °C). A borehole utilises this by passing a closed loop pipe system through a series of vertical boreholes absorbing this stable heat. An aquifer system uses a similar principle but takes in the groundwater via an open loop pipe system from an aquifer, captures the heat and re-injects the cooler water at another location. A heat pump is used to upgrade this low grade heat to a temperature suitable for the heat network. Deeper geothermal energy can be used where geological conditions provide high temperatures (150 °C to 200 °C) at greater depths. This heat can be extracted via injecting cold water into deep reservoirs and abstracting it once heated.

Ground source heat pumps operating at shallow depths can be implemented anywhere providing the local ground conditions permit. Deep geothermal energy can only be accessed where the conditions are suitable. Both require geological surveys and boreholes to be drilled. Due to the depth of the borehole, deep geothermal has significantly higher project development costs, and comes with higher risks regarding unrealised heat capacity.

3. Water source

Water source heat pumps are assumed here to be surface water (as deeper water is categorised as ground source heat). Therefore feasible sources are lakes, ponds, rivers, canals or the sea. A water source heat pump can also be open or closed loop, and again makes use of stable temperatures within bodies of water. For water source heat to be used, a body of water must be locally available. For the Energy Centres specified; Cluster 1 (Ilynfi River), Cluster 6 (Ewenny River), Cluster 7 (Ogmore River), Cluster 10 (Ewenny River) and Cluster 12 (Ger-Y-Llyn Pond, Kenfig Pool and the sea) have bodies of water close to them. The heat available from each water source would need to be investigated to determine the viability of using it to generate heat for the network.

4. Waste heat

Low grade waste heat from industrial process can be captured and upgraded using heat pumps. This heat is otherwise rejected to the environment and so might be considered low carbon. The availability of this heat is heavily dependent on the industrial activity in the area. Although, this is likely to be high in the Bridgend (and Port Talbot) area, and may increase in the future. Retrofitting heat capture onto industrial process can be expensive and will require significant engagement with the companies involved.

The future energy supply to the district heat network is anticipated to come from a wide variety of fuel sources, and so it is assumed that a combination of the heat pumps listed above are operated across the network. This will improve resilience and allow optimised local solutions. However waste heat may be the most viable source for heat pumps in the cluster areas if industrial activity in Bridgend increases.

Flow temperatures

A heat pump powered network may require conversion to lower flow temperatures (circa 75 °C) based on physical properties of refrigerants used. Additionally the lower the heat network flow temperature the better the coefficient of performance of the heat pump. Secondary side retrofitting may be necessary on buildings to meet these new standards. While this is considered a project risk, it should be noted that by 2050 many of the connections may be new builds that should be designed to higher standards and are able to connect to a lower temperature network without extensive works. In addition, much of the current housing stock many need retrofitting regardless to improve performance in line with national standards.

Lower flow temperatures will lower the heat losses across the distribution network, improving technical and financial performance.

Environment

The local environmental impact of the heat pumps should be assessed during design and during operation. Fluid used in closed loop pipes should be biodegradable and non-toxic to minimise the environmental impact should a leakage occur. Additionally any aquifers will need to be properly mass balanced to prevent depletion via reinjection of the spent water.

As discussed above, refrigerants should be environmentally friendly and with low GWP.

Electricity

To upgrade the heat to a usable temperature, heat pumps use electrical compressors. This will improve in the future as the technology develops which would reduce the electrical input cost for heat generated. Market prices will determine the financial implications of the additional electricity required over gas-fuelled plant (the price for gas is currently less than electricity, which makes it favourable at this time to use gas-fuelled electricity-generating assets). The electricity, if generated through centralised power stations also has resilience risks as a result of transmission and non-localised generation, especially if the electrical demand across the country continues to grow through the increasing prevalence of electric transport and conversion to electric heating. This can be mitigated through local renewable generation, e.g. wind or solar plants which would also minimise the carbon intensity of the heat pumps and could make the heat network zero carbon. Decarbonisation of the national grid is due to reduce the carbon intensity of grid electricity (see Figure 12), so this benefit may be applicable to the heat pumps regardless of the electricity source.

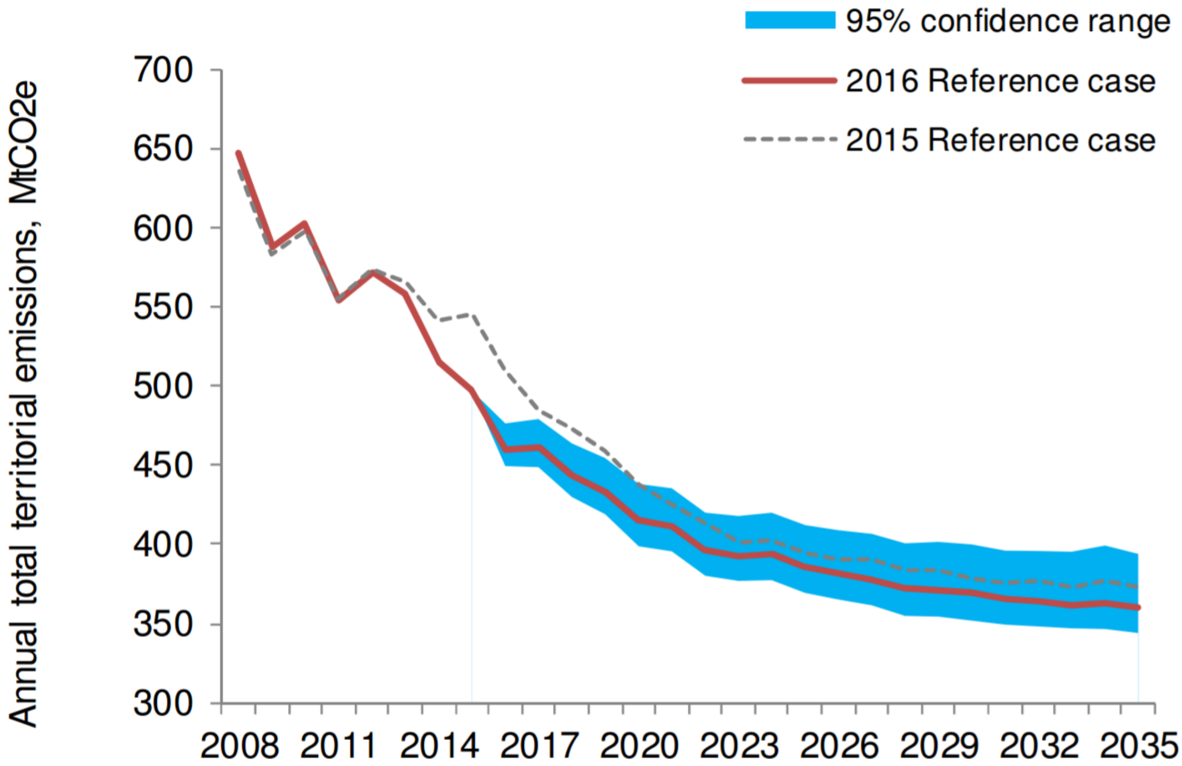

Figure12 BEIS grid emissions forecast (including uncertainty)

10 Conclusion

The results of the study show that there are multiple constraints the EnergyPath Networks tool should incorporate during analysis, to provide a more holistic understanding of the viability of networks in the area. These constraints have been found by using government-released GIS layers and investigating potential conflicts. The number and degree of conflicts are used indicate the level of risk and feasibility of network development.

Several key localised constraints in particular, such as high flood risk areas and highways showed that some areas may encounter more significant development risks than others. Without network routes specified, it is not possible to determine the proficiency of the tool at developing appropriate routes avoiding local transport infrastructure in particular. However there appear to be more risks to network development in areas of domestic connection. While the distribution networks have fewer constraints, crossing the cluster boundaries with transmission lines encounters potential issues.

Transmission between clusters will add to the resilience, however the technical aspects (heat loss) and financial requirements (infrastructure costs) need to be established to determine the viability of the connection. It is recommended that the individual networks be established independently to minimise the risk of such a large energy infrastructure project. Connection to an adjacent cluster for additional heat capacity will improve resilience as long as the cluster is not reliant on that additional capacity. As such, the capacity required to meet the majority of the annual demand should be installed locally.

Much of the plant installed across the clusters has a low utilisation factor suggesting that the assets are underutilised and therefore not an efficient use of resources. In some cases the technology selection should be reassessed to ensure that the operational strategy is aligned to the optimum technical operation of the selected technologies (e.g. clusters 2 and 5). The plant sizing should be investigated as (in clusters 5) unrealistically small capacity plant is installed instead of absorbing the capacity into other technologies, which would reduce the complexity of the Energy Centres and improve the efficiency of both the installed plant and its operation. Further to this, it has been identified that the specified plant is in some cases close to the nominal allowed capacity of the model. This may be restricting the solution from converging optimally and in these cases the upper allowable capacity should be increased to ensure the model can reach an optimum solution.

Following a thorough review of the information provided alongside additional data sources, all pathways are considered valid (at this initial stage) for heat network development, and could be implemented by a local authority. No pathways are considered no go options at this stage.