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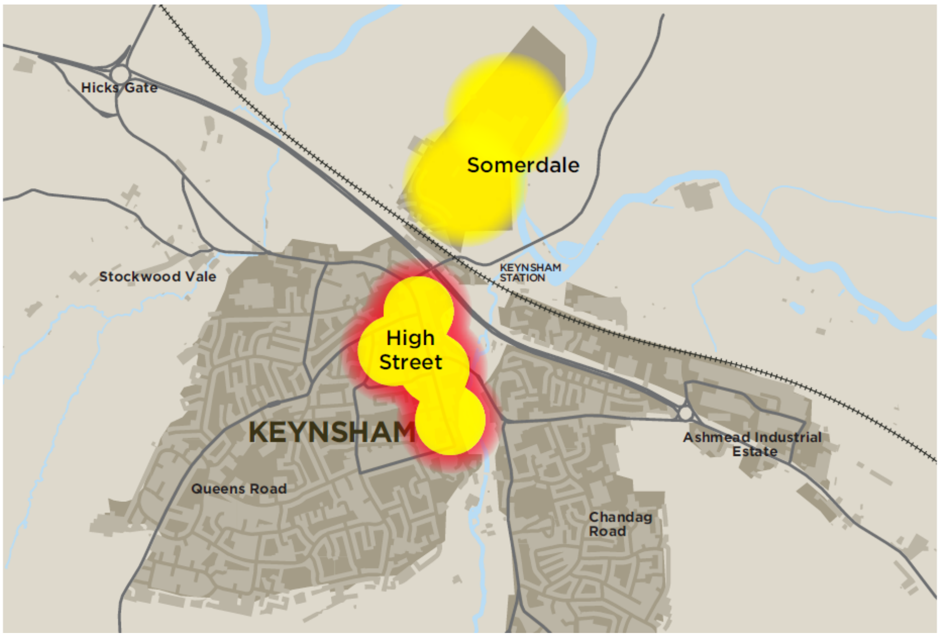

District Heating in Keynsham

Phase 1 Feasibility Study

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Glossary

Term	Definition
DH	District Heating
GHG	Green House Gas
O&M	Operations and Maintenance

1 Executive Summary

1.1 Scope

This report updates the previous district heating study carried out by AECOM in 2010 to reflect new development proposals in Keynsham town centre: construction of the Civic Centre, the redevelopment of the Riverside Office site and the relocation of the existing leisure centre. The study focuses on the previously identified "district heating priority area", but also considers two additional clusters which could be catalysed by the relocation of the leisure centre: Somerdale (mixed use new development) and Wellsway (consolidation of existing school buildings).

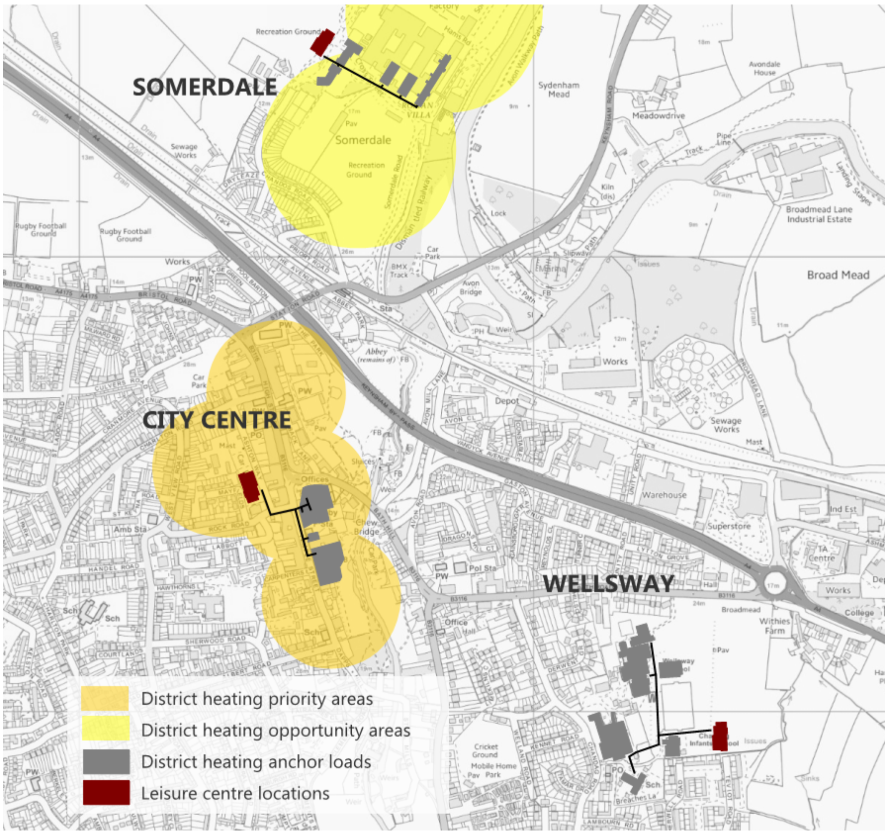

Figure 1—1 Keynsham district heating clusters considered

1.2 Analysis

A technical and financial appraisal of all clusters has been carried out considering two possible sources for district heating supply: gas CHP engines or biomass boilers. The clusters are similar in order of magnitude, and the majority of baseload heating supply could be provided by primary plant coupled with thermal storage. . It is assumed that peak heating demands would also be met by the district network, provided by central gas boiler plant.

All the options considered offer good CO_2 emissions savings, but none of them generate revenue sufficient to pay back the initial capital costs of the schemes unless there is a significant need to replace heating plant in existing buildings that the avoided cost of this can be used to offset the capital cost of the district heating scheme. The heat and electricity sales required to give an indicative 8% IRR are too high to be considered viable. Assumptions for the financial modelling are given in Appendix A.

Table 1—1 Technical and financial modelling results

Assumption	Town centre	Somerdale	Wellsway
Annual heat sales	1,400MWh/year	2,350MWh/year	2,600MWh/year
Peak heat load	1.1MW	2.0MW	2.3MW
Gas CHP district heating supply			
Heat supplied by primary plant	1,150MWh/year	1,800MWh/year	1,900MWh/year
Primary plant size	152kWe, 236kWth	185kWe, 309kWth	185kWe, 309kWth
CO_2 emission savings (tCO_2/year)	148	211	232
% reduction in heating CO_2 emissions	41%	35%	35%
Capital cost (less connection charges)	£0.92 million (£0.73 million)	£1.16 million (£0.76 million)	£1.56 million (£1.44 million)
Year 1 net revenue	-£9,000	£300	£5,300
25 years NPV @ 3.5% discount factor	-£0.8 million	-£0.69 million	-£1.26 million
IRR	N/A	N/A	N/A
Heat sales price to achieve 8% IRR	£90/MWh	£68/MWh	£87/MWh
Electricity sales price to achieve 8% IRR	£130/MWh	£102/MWh	£136/MWh
Biomass boiler district heating supply			
Heat supplied by primary plant	1,300MWh/year	1,900MWh/year	2,350MWh/year
Primary plant size	300kWth	350kWth	400kWth
CO_2 emission savings (tCO_2/year)	254	361	456
% reduction in heating CO_2 emissions	70%	61%	70%
Capital cost (less connection charges)	£0.86 million (£0.66 million)	£1.04 million (£0.64 million)	£1.49 million (£1.37 million)
Year 1 net revenue	£12,200	£54,700	£35,700
25 years NPV @ 3.5% discount factor	-£0.57	-£0.36 million	-£0.98 million
IRR	N/A	N/A	N/A
Heat sales price to achieve 8% IRR	£77/MWh	£56/MWh	£78/MWh
Electricity sales price to achieve 8% IRR	N/A	N/A	N/A

1.3 Conclusions

None of the district heating options considered provide a viable business case for investment without some level of capital grant. In each case the equivalent CO_2 savings from solar PV installations are considered more cost effective (though it is noted that low carbon heat *and* power solutions will be required in transitioning to a low to zero carbon future).

It is however recommended that new major developments in the district heating priority area continue to be considered for suitability for future connection (see Section 1.4). As the electricity grid decarbonises towards 2050 targets the low carbon credentials of gas CHP lessen as the CO_2 offset through electricity production reduce. This assessment does not consider in detail other sources, but recognises that to remain CO_2 competitive, the future transition to an alternative fuel must be possible if gas CHP is specified; for the Town Centre cluster river source heat pumps could provide one possible alternative. However the flow rate may be too low to support a heat pump of sufficient size. For the other clusters there is a less clear alternative and so biomass boiler supply may be considered a more suitable long term approach.

1.4 Recommendations

Leisure centre

The new leisure centre is the largest heating and hot water load considered in this study. The characteristics of swimming pool heating and high baseload power demands is well suited to the optimised performance of either gas CHP or biomass boilers as a low carbon heat supply. As a standalone scheme, gas CHP should still be considered for the leisure centre only (biomass at a small scale is less likely to be viable). In doing so, the ability for future connection to a heat network should be provided. From the conclusions of this study there is insufficient density of heat demand to justify a requirement for the leisure centre to provide plant or plant space for a wider DH network. Therefore, the Council's decision on the location of the new leisure centre should not be influenced by consideration of district heating opportunities.

Town Centre Cluster

The current connection opportunities in the town centre do not provide sufficient demand to offset the initial capital costs of a district heating network. The absolute heat demand of the town centre remains high, but the density of heat demands suitable for DH connection is insufficient for a district heating network to be considered viable. By continuing to promote the ability for future connection, the opportunity is retained for a DH network in the future if more high density town centre developments are forthcoming.

Somerdale and Wellsway clusters

If the leisure centre is located in proximity to either the Sommerdale or Wellsway clusters then discussions should be initiated with key stakeholders (Taylor Wimpey or the schools respectively) to gauge appetite for connection to a district heating network. This opportunity is not considered a priority and should not be viewed as a key driver when considering the location of the leisure centre. If a leisure centre is in adjacent to either of these sites and there is significant interest for a private wire connection and avoided heating plant, a revision of the financial assessment should be carried out. It is however considered unlikely that the commercial viability of connection will change beyond the point sensitivity tested as part of this study.

Impact on Core Policy

B&NES Core Policy CP4 – District Heating states that developments within the identified "district heat priority areas" (see Figure 3—2) will be expected to incorporate infrastructure for district heating, and will be expected to connect to existing systems where and when this is available.

Although this study suggests a heat network is not viable for the current building mix in the district heating priority area, future high density developments with the ability to connect will impact the viability of a scheme. Therefore CP4 should be retained as a material consideration for Keynsham town centre unless it can be demonstrated that such a design would result in uneconomic costs to end users.

For major new planning applications not proposing to connect to a DH network, it is suggested that the applicant should be asked to provide a whole life cost analysis over a 30 year period comparing equivalent CO_2 emissions savings through other approaches to low carbon building design.

Details of this exemption test are not considered in this study but should include a consideration of initial capital cost, replacement costs, annual fuel costs annual O&M costs and annual meter reading and billing administration costs.

2 Introduction

2.1 Scope

This report updates the previous district heating study[1] carried out by AECOM in 2010 to reflect new development proposals in Keynsham town centre. The 2010 AECOM study identified Keynsham town centre as a district heating priority area centred on the development of the new town hall and leisure centre.

The following key developments since this study merit the reconsideration of this cluster:

- Construction of the Civic Centre: now completed, district heating 'ready' but with a lower energy demand than previously predicted
- Relocation of the leisure centre: alternative locations being considered, site on the existing Ashton Way car park is not guaranteed.

An appraisal of the 2010 town centre cluster area has been carried out as well as the consideration of two alternative locations, Sommerdale and Wellsway, considered to test the viability for district heating if an alternative leisure centre location is chosen.

2.2 Methodology

Table 2—1 Heat mapping study approach

Task	Approach
Stakeholder engagement	To understanding the potential viability of a district energy scheme and buy-in of stakeholders. Identification of potential energy users and motivations, commercial drivers and potential alternative solutions they could adopt. Development of stakeholder mapping table.
Update heating mapping	Update previous heat mapping GIS layers for the Keynsham clusters in the 2010 AECOM report based upon latest development proposals.
Technical analysis	Update of energy demands, options for energy supply, network layout and CO_2 emissions savings. Discussion of phasing based upon development programme.
Delivery barriers and opportunities	Identification of key barriers and opportunities including planned infrastructure development, planning requirements, licensing, consents and planning.
Financial analysis	Understanding and comparison of the financial viability of each option. Analysis of potential network options including capital costs, income, IRR and CO_2 emission reductions.
Report and stakeholder workshop production	Identification of a preferred option to take forward and key decision making tool to guide discussions. Workshop with key local stakeholders to present options and gain feedback.

[1] AECOM. District Heating Opportunity Assessment Study. District Heating Opportunity Assessment Study

3 Heat Mapping Overview

3.1 Town centre heat demand

An update of the 2010 heat mapping exercise has been carried out mapping all building with a predicted heating demand. The data for this study is built up from predictions from the National Heat Map[2] data, updated with predictions for new building demands, updated estimates for the leisure centre demand and the removal of buildings demolished as part of the town centre redevelopment. Figure 3—1 shows the *total* head demand density for the town centre. This is dominated by the new leisure centre and retail units along Keynsham High Street.

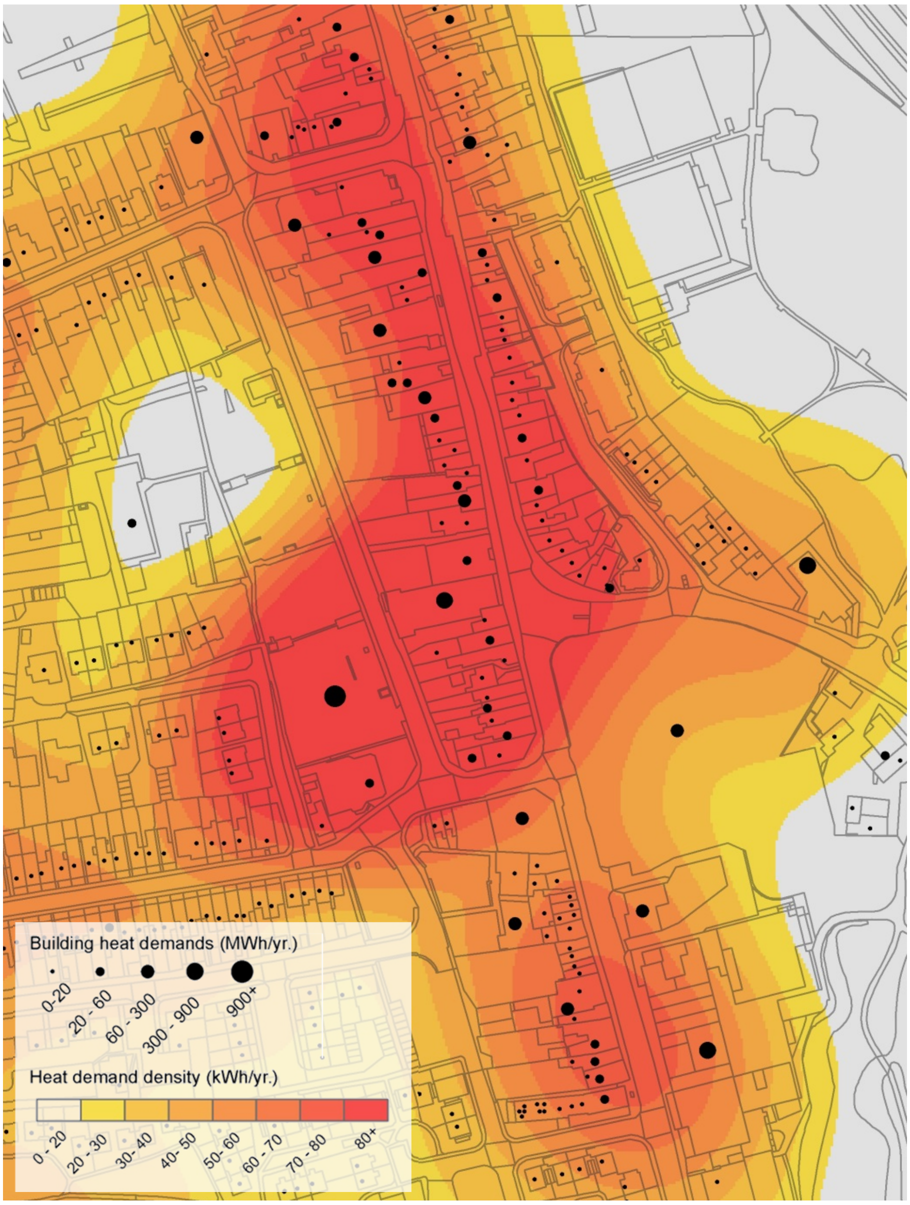

Figure 3—1 Keynsham town centre total heat demand density

2 DECC (2012). National heat map. Available at: http://tools.decc.gov.uk/nationalheatmap/

3.2 Identifying anchor loads

Total heat demand density is only an indication for district heating viability - for a scheme to be viable there must be an incentive for buildings to connect. This incentive is usually one of four drivers,

1. Capital cost savings of new heating plant
2. Revenue cost savings of heating bills
3. Avoided plant space and maintenance
4. CO_2 heating emissions savings

For the retail units, small offices and individual houses making up the majority of the heat demand of Keynsham, the above incentives are not sufficient to merit a switch to a district heating network. Furthermore it is likely that these building are for the most part electrically heated and would require significant conversion works to convert to a district heating compatible wet heating system.

The focus of this study is therefore on key 'anchor' loads; buildings with significant heating demands where the above drivers apply and incentivise connection over the counterfactual case of building by building heating system.

Where the connection viability is marginal, B&NES council can influence planning applications to encourage DH connections where the CO_2 emissions savings are significant.

3.3 Key stakeholders

Table 3—1 below identifies the key stakeholders consulted with on developments since the 2010 Keynsham DH study.

Table 3—1 Stakeholder engagement list

Stakeholder	Item requested	Key contact
B&NES Council (Sustainability)	Heat/gas consumption data for public building in central Keynsham (as part of CRC register)	Cathy Hough
B&NES Council (Leisure)	Details of the proposed new leisure centre in Keynsham (floor area, facilities, design proposals etc.)	Marc Higgins
B&NES Council (Planning)	Details of the private flats development at the Keynsham Riverside site (floor area, facilities, design proposals etc.)	Neil Best,
	Planning application details for Milland House	
	Planning application details for Somerdale	
	Energy consumption targets for new Council offices in Keynsham	Derek Quilter (Divisional Director responsible for project)
Avon Fire and Rescue	Details of Keynsham fire station relocation	Simon Richards

3.4 District heating clusters

Following stakeholder consultation and a review of key relevant applications in the planning portal, two additional cluster areas have been selected for consideration of a district heating scheme. These locations have been selected because of significant loads in the local area and the possible availability of land for the leisure centre relocation. These fall outside of the CP4 district heating priority area but are potentially of interest as standalone schemes. The leisure centre has been included in each case as a key anchor load:

Town Centre: Planning precedent as district heating priority area. New civic centre and riverside developments.

Somerdale: Phase 2 of the Cadbury Factory site regeneration: mixed use high density site

Wellsway: Consolidation of five existing school buildings. Land available for a leisure centre on recreation ground to the east of the site.

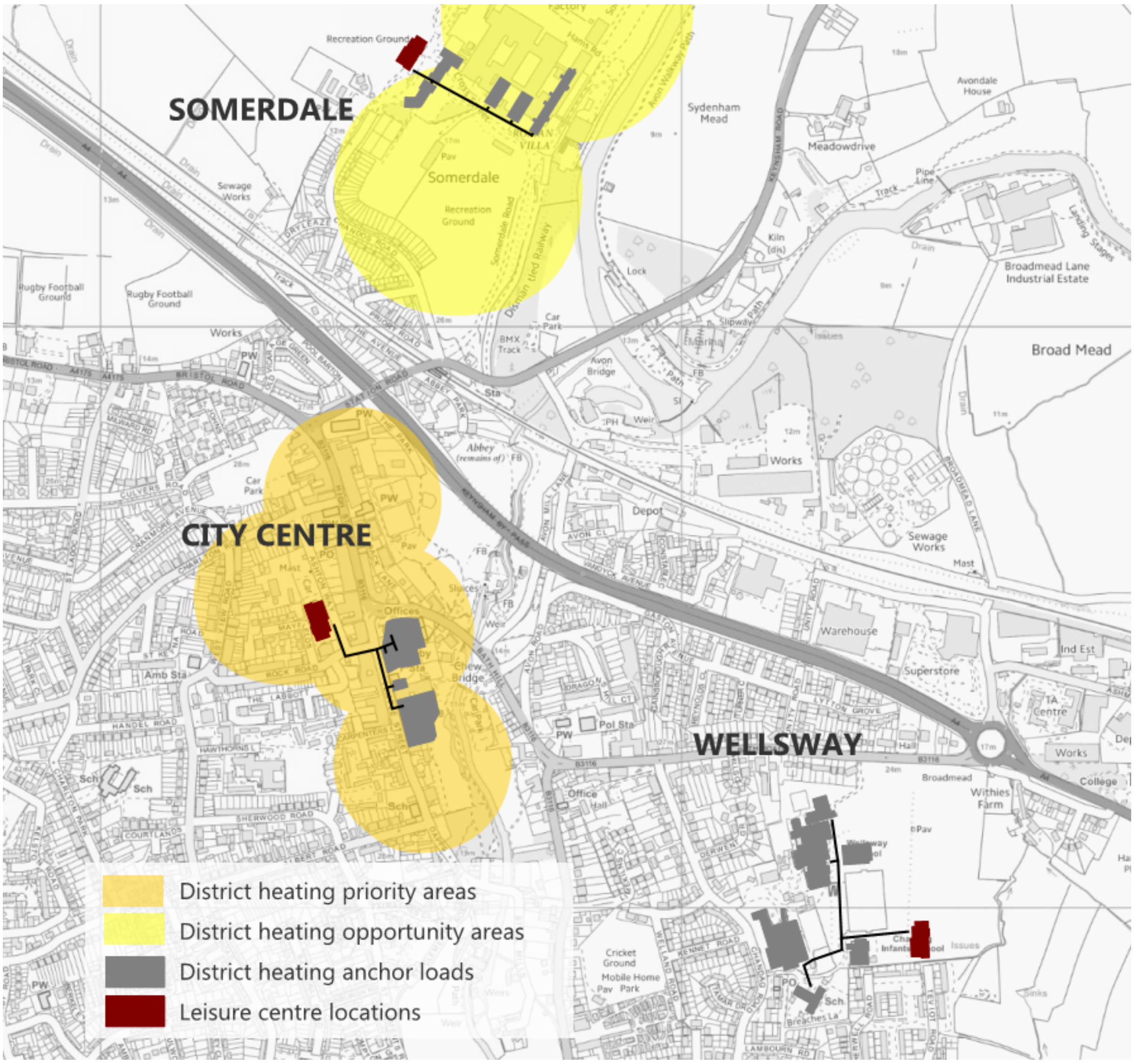

Figure 3—2 Keynsham DH cluster areas

3.5 Leisure centre

The proposed leisure centre is a common load consideration in all three clusters. Details of the design of the centre are not yet developed as a preferred developer has not yet been finalised. A heat demand estimate has been calculated based on a 25m 6 lane swimming pool, a learner pool and 1,500m^2 of changing rooms, fitness suite, front of house and offices. The predicted heating and how water demand of the leisure centre is 923 MWh/yr., of which 795MWh/yr. is associated with swimming pool heating.

This demand is approximately one-third of the demand estimated in the 2010 study, but is in line with projected energy savings at the existing Bath leisure centre and reasonable for a well-designed new leisure centre. It remains the largest load considered for connection to a Keynsham DH scheme and as a new building, a key catalyst to development with the option of housing the heating plant for a wider network.

4 Town Centre Cluster

4.1 Anchor load head demands

The proposed town centre network is show in Figure 4—1 . This connects the following key anchor loads:

Civic Centre: New site including with two office buildings. Site was developed so that it is compatible for future DH connection. The main office building recovers waste heat from server rooms, supplying the site's baseload, and approximately 50% of the annual heat demand. This directly competes with CHP supply from district heating and so the demand met by a DH network is far less than was assumed in the 2010 study. Server waste heat is a low carbon heat source: it is assumed that a DH connection would only replace the gas boiler fraction of the sites heating demand.

Avon Fire and Rescue: relocation of headquarter offices to Keynsham. Centrally located between Civic Centre and Riverside development. 2800m^2 proposed new office with influence remaining on the heating system design.

Riverside Regeneration: The Riverside site redevelopment has progressed since the 2010 study. Proposals remain in flux, however the preferred design at the time of writing consists of a mix of private accommodation and retirement homes. Benchmarks have been applied per m^2 based on a typical new build Part L compliant building design.

Leisure centre: as detailed in section 3.5.

Table 4—1 Town centre anchor load heat demands

Site	Heat demand estimate (kWh/yr.)	Source
Civic Centre - main office	83,900*	Max Fordham Energy calculations for tender design
Civic Centre – One stop shop building	40,300	
Avon Fire and Rescue Office	70,000	Email correspondence with Simon Richards. Office benchmarks applied for 2800m^2 new building
Riverside Regeneration	316,800	Area estimates from Aedas report
Leisure centre	922,500	Demand benchmarks based on 25m 6 lane swimming pool and 1500m^2 associated leisure space
Total	**1,433,500**	

*total heat use is 190,700kWh/yr. of which 106,800kWh/yr. is assumed to be provided by server heat rejection

Figure 4—1 includes a number of buildings highlighted in grey which were considered in the 2010 study but have been removed from consideration for an initial network in the current study. It is possible that some of these buildings may connect to a network in the future but each present significant risks, highlighted in section 4.2.

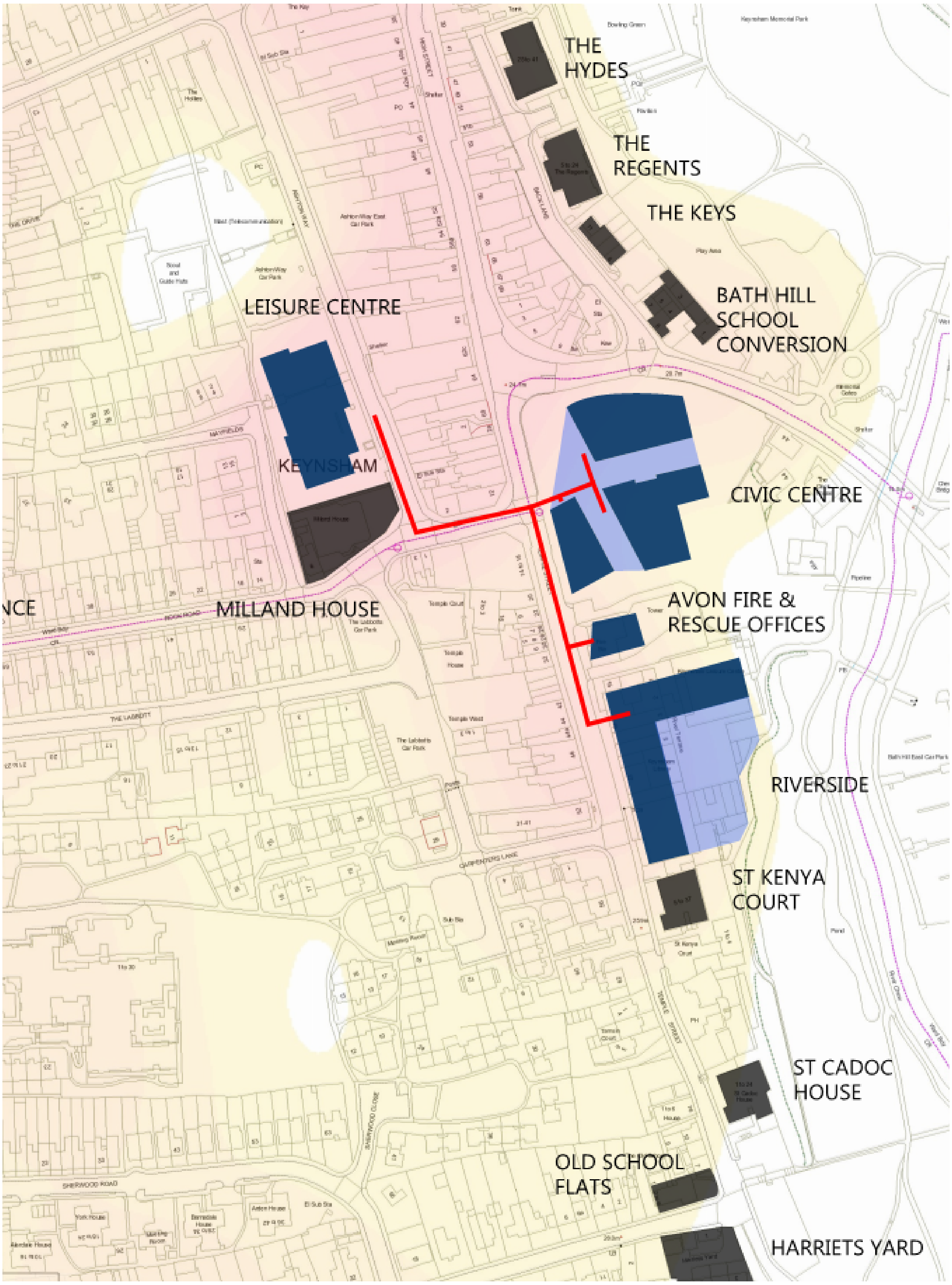

Figure 4—1 Town centre district heat network

4.2 Discounted building demands

The following buildings have been included in the demand assessment by virtue of their significance in the 2010 study or for their size in the local area. They have been removed from the loads considered for a heat network because of constraints considering heating system conversion requirements, occupancy and ownership, future development uncertainty or distance from the core scheme. Details of these buildings are given in Table 4—2 below. Unless noted otherwise heat demands have been derived from project team benchmark assumptions and the known number of flats.

The addition of the apartments along Back Lane was considered as an extension to the proposed scheme but at present it is assumed that the additional pipe routing and conversion works of building heating systems do not merit this extension. Should a core scheme be forthcoming this option could be investigated in more detail but is not considered as an anchor load to catalyse a DH networks.

Table 4—2 Discounted town centre demands

Site	Heat demand estimate	Reason for exclusion
Albert Rd Old School flats	76 kWh/yr.	Previously temple infants school, now converted to 11 private flats. Heating system conversion likely prohibitive for DH connection priority and remote from main scheme.
Rock Road St Johns Ambulance Station	3 kWh/yr.	Single storey temporary accommodation block, minimal load, likely electric heating. 200m^2 floor area assumed.
Harriet's Yard	167* kWh/yr.	Private semi-detached residences. Heating system conversion likely prohibitive for DH connection priority and remote from main scheme.
The Hydes	66 kWh/yr.	16 retirement flats. Electrically heated, unsuitable for DH connection.
The Regents	79 kWh/yr.	19 retirement flats. Electrically heated, unsuitable for DH connection.
The Keys	28 kWh/yr.	4 flats. Recently constructed, heating system unknown, small anticipated demand.
Bath Hill School Conversion	42 kWh/yr.	6 flats. Current refurbishment of existing school, small anticipated demand.
St Cadoc House	270* kWh/yr.	Individually heated flats, conversion to connect to DH likely to be cost prohibitive.
St Kenya Court	319* kWh/yr.	Individually heated flats, conversion to connect to DH likely to be cost prohibitive.
Milland House	82 kWh/yr.	2,200m^2 proposed mixed use development – refused planning approval but adjacent to potential leisure centre site – noted should a revised application be submitted

* Demands based on 2010 AECOM Study

4.3 Barriers and opportunities

A summary of key barriers and opportunities is given in Table 4—3 below. The main barrier for this cluster is the limited heat demand suitable to connect to a heat network. Conversely the main opportunity is the development potential of the town centre: despite current limitations it is the most likely area for future development of buildings suitable for DH connection.

Table 4—3 Town centre barriers and opportunities

Barriers	Opportunities
- Current and projected heat demand estimates are low, high fabric efficiency and heat recovery competes with need for district heating - Multiple stakeholder buy in required - Hard dig pipe routes - Plans for Riverside regeneration unconfirmed	- Civic centre heating systems compatible for connection to a DH scheme - Milland House application may be resubmitted, giving additional town centre load. - Diversity across mixed use development suits CHP operation - DH connection can be enforced through CP4 - Favoured site for leisure centre location - Town centre is most dense heat demand, chance of future DH compatible sites is highest

4.4 Technical Assessment

The viability of as a town centre district heating network has been tested for two cases – with the proposed new leisure centre and without the leisure centre. Two primary heat supply sources have been considered, gas CHP and biomass boilers. The demands have been modelled in the thermal modelling software EnergyPro to determine the optimum CHP or biomass and thermal store size to provide the baseload heat supply to the district network. Peak demands are assumed to be met by central gas boiler plant. All heating plant and district heating pumps and controls are assumed to be located in the new leisure centre as a new build development with scope for plant space allocation.

Table 4—4 Town centre district heating technical results

Assumption	CHP	Biomass
Annual heat sales	1,400MWh/year	1,400MWh/year
Peak heat load	1.1MW	1.1MW
Heat supplied by primary plant	1,150MWh/year	1,300MWh/year
Primary plant size	152kWe, 236kWth	300kWth
Length of trunk network	290m	290m
Trunk network pipe diameter	125mm	125mm
CO_2 emission savings (tCO_2/year)	148	254
% reduction in heating CO_2 emissions	41%	70%

4.5 Financial assessment

Table 4—5 below summarises the financial modelling for the Town Centre cluster. A breakdown of costs and financial modelling assumptions are given in Appendix A. The Town Centre cluster has the highest network cost compared to energy centre cost because of the costs associated with a hard dig along Temple Street and the road crossing to the leisure centre. Over a 25 year life, the scheme does not pay back the capital investment required, therefore it is not suggested for investment. Cash flow graphs for the model results below are given in Appendix B.

Table 4—5 Town centre financial modelling

Assumption	CHP	Biomass
Capital cost (less connection charges)	£0.92 million (£0.73 million)	£0.86 million (£0.66 million)
Year 1 net revenue	-£9,000	£12,200
25 years NPV @ 3.5% discount factor	-£0.8 million	-£0.57
IRR	N/A	N/A
CO_2 saved	148 tonnes/year	254 tonnes/year
Capital cost of PV to achieve equivalent CO_2 saving	£0.57 million	£0.98 million
Heat sales price to achieve 8% IRR	£90/MWh	£77/MWh
Electricity sales price to achieve 8% IRR	£130/MWh	N/A

Sensitivity testing of modelling assumptions shows that even a high power export price (10p/kWh) is insufficient to provide a return on investment. This would have to be increased to 13p/kWh to give and IRR of 8% - higher than is likely to be guaranteed for 100% of CHP electricity sales.

4.6 Conclusions

The Town Centre cluster is not a viable cluster under current assumptions. There is no investment potential unless a private wire connection and high heat sales price can be secured for all CHP power sales. This is not likely to be competitive against the 'business as usual' case for the anchor loads considered and so there is not incentive to catalyse a heat network. Total heat demand density in the city centre is high but this is dominated by small retail and office units, likely electrically heated, and unsuitable for district heating connection.

However, future proofing new major developments for heat network connection will ensure that these buildings can be captured if this cluster is reconsidered in future years as and when more developments in the town centre come forward.

5 Somerdale cluster

5.1 Proposal

The site, formerly home to the Cadbury factory, was granted outline planning permission for a mixed-use development in September 2013. The first phase of the development has recently been completed and consists of low density townhouses deemed not suitable for connection to a DH network.

The future phases of development have not yet been developed and so remain as a potential opportunity for district heating. The planning statement for the outline application did not consider district heating as a viable solution at the time, however the higher density aspects of the site (school, fry club, office blocks and apartments) have been reappraised in light of the possible location of the leisure centre occupying the corner of the adjacent recreation ground.

As the scheme has been granted planning permission without connection to a heat network, there is no planning influence that can be used to connect the Somerdale buildings to a heat network - a scheme is likely to only come to fruition where there is an inherent financial or space saving benefit to the developer in connecting to a leisure centre led network.

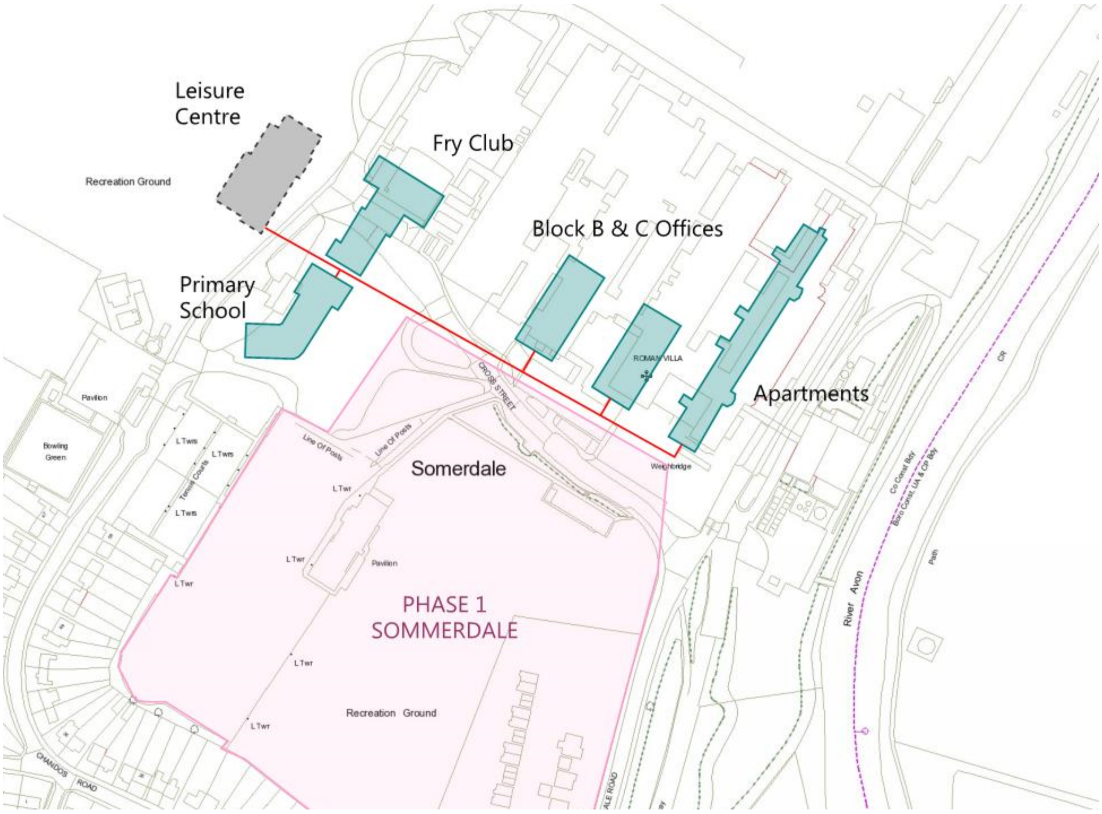

Figure 5—1 Somerdale site indicative layout and heat network

5.2 Barriers and opportunities

The main barrier for development of this site is a suitable location for the Leisure centre. The current location shown is indicative only. The Keynsham Hams site is a Scheduled Ancient Monument and therefore likely to be restricted for development. Locating the leisure centre on the Taylor Wimpey site is possible but would require reconfiguration of the masterplan for no clear benefit to the developer. Other locations are further away and would require longer lengths of DH pipe network, increasing the capital costs of a scheme.

The main opportunity is the density of the heat demands. All buildings are in close proximity requiring short lengths of DH pipework without the need to dig up public highways. The mixed use of buildings brings demand diversity which maximises CHP or biomass operation regimes.

Table 5—1 Somerdale barriers and opportunities

Barriers	Opportunities
- DH cannot be enforced - Planning permission granted without requirement to be DH compatible - Leisure centre site only speculative	- Scheme not yet constructed, opportunity for influence - Connection to leisure centre could provide business case for reassessment - Need for public realm works reduces cost for DH pipe installation - Single stakeholder buy in required - All new build – connection charges available to offset capital cost

5.3 Anchor load heat demands and plant sizing

Table 5—2 and Table 5—3 below summarises the anchor load heat demands for the Somerdale cluster and technical results for CHP and biomass options for low carbon heat supply.

Table 5—2 Somerdale anchor load heat demands

Site	Heat demand estimate (kWh/yr.)	Data source
Fry Club	243,700	Outline planning design and access statement, cross checked against sensible new building heat demand benchmarks.
Block B & C Offices	594,600	
Primary School	124,600	
Apartments	455,900	
Leisure centre	922,500	Demand benchmarks based on 25m 6 lane swimming pool and 1500m^2 associated leisure space
Total	**2,341,300**	

Table 5—3 Somerdale district heating technical results

Assumption	CHP	Biomass
Annual heat sales	2,350MWh/year	2,350MWh/year
Peak heat load	2.0MW	2.0MW
Heat supplied by primary plant	1,800MWh/year	1,900MWh/year
Primary plant size	185kWe, 309kWth	350kWth
Length of trunk network	300m	300m
Trunk network pipe diameter	150mm	150mm
CO_2 emission savings (tCO_2/year)	211	361
% reduction in heating CO_2 emissions	35%	61%

The Somerdale heating demands have been taken from the 2013 outline planning application; the addition of the leisure centre adds an additional 40% to the total heat demand.

5.4 Financial assessment

Table 5—4 below summarises the financial modelling for the Somerdale cluster. A breakdown of costs and financial modelling assumptions are given in Appendix A. The Somerdale cluster has the lowest network cost compared to energy centre cost because of the density of the site and soft dig of the network. Over a 25 year life, the scheme does not pay back the capital investment required therefore it is not suggested for investment. Cash flow graphs for the model results below are given in Appendix B.

Table 5—4 Somerdale financial modelling

Assumption	CHP	Biomass
Capital cost (less connection charges)	£1.16 million (£0.76 million)	£1.04 million (£0.64 million)
Year 1 net revenue	£300	£54,700
25 years NPV @ 3.5% discount factor	-£0.69 million	-£0.36 million
IRR	N/A	N/A
CO_2 saved	211 tonnes/year	361 tonnes/year
Capital cost of PV to achieve equivalent CO_2 saving	£0.81 million	£1.39 million
Heat sales price to achieve 8% IRR	£68/MWh	£56/MWh
Electricity sales price to achieve 8% IRR	£102/MWh	N/A

If the power export price was increased to 10.2 p/kWh the scheme could be profitable, but this would be reliant on all power being purchased from a private wire connection; this price would not be offered for spill to the local grid.

5.5 Conclusions

The Somerdale cluster is not a viable cluster under current assumptions. There is no investment potential unless a private wire connection can be secured for all CHP power sales which, when considered alongside a lack of suitable location for the leisure centre and no prior interest from the masterplan developer, is too high a risk assumption to assume in the modelling undergone. As an alternative strategy, a solar PV installation to deliver the same CO_2 savings as a CHP heat network would have a lower capital cost, indicatively £810,000, a saving of £350,000.

6 Wellsway

6.1 Proposal

The Wellsway site centres on the existing Wellsway School and adjacent Chandang Junior School and Chandang Infant School. There is land to the west of the site for the possible location for the leisure centre, with the school buildings acting as potential loads for a heat network. The viability of this scheme will be largely affected by the schools appetite for connection. As singular public sector entities, they can be commercially more practical to connect to than multiple individual private demands, but may only merit connection where either the existing boiler heating plant is in need of replacement of the school has aspirations towards lower carbon heat supply.

The school heating demands have been back calculated from metered gas consumption data with an allowance for the split between DHW and space heating. There are seven gas meters across the school site; it is assumed for the techno-economic assessment that each would require a separate heat connection. Should this cluster be progressed it will be important to investigate this in more detail, considering consolidating building heat networks and whether smaller blocks merit exclusion from the network.

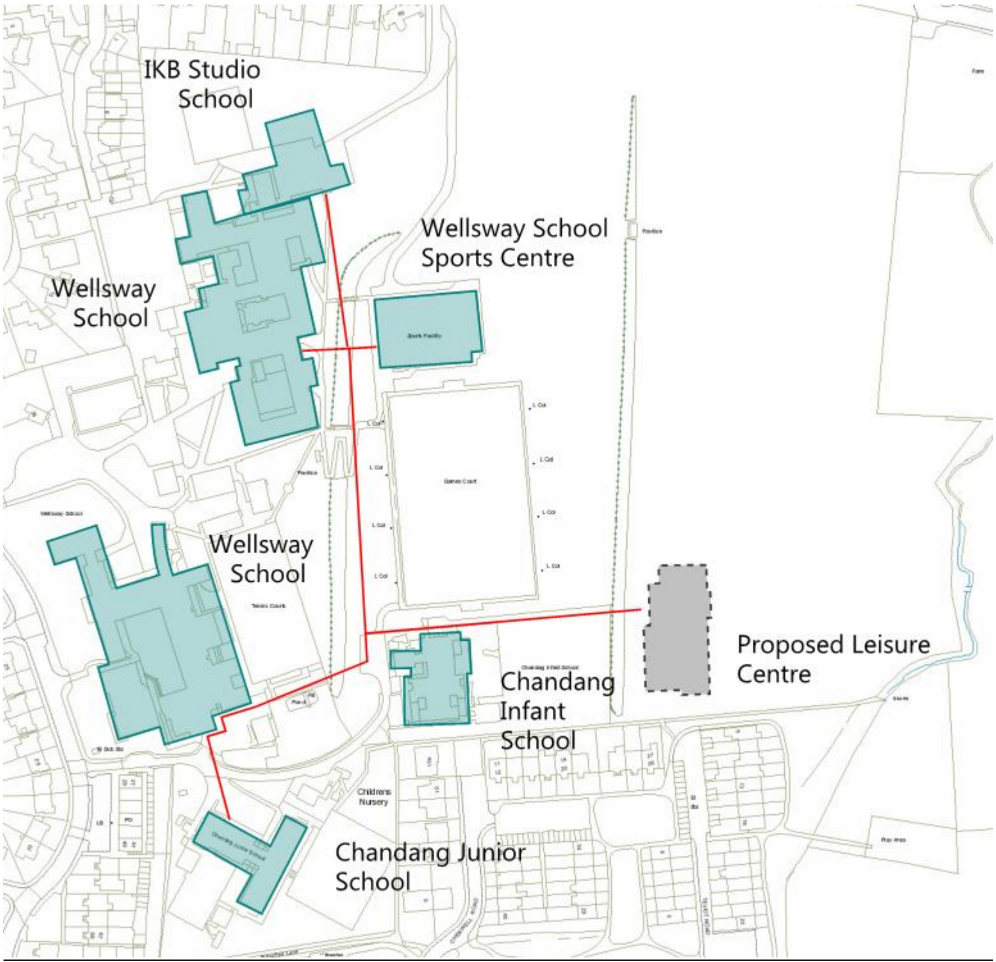

Figure 6—1 Wellsway site indicative layout and heat network

6.2 Barriers and opportunities

Table 6—1 below summarises the key barriers and opportunities for the Wellsway cluster. A key consideration for this cluster in the buy in from the school(s). If actively engaged, a heat network for this area could be feasible, however it is unlikely to be so unless it coincides with a need for the school to replace existing heating plant. The avoided cost of new heating plant could catalyse a new network, but it is unlikely that the renewal of heating plant coincides across enough of the school assets to form a critical mass to catalyse a heat network.

Table 6—1 Wellsway cluster barriers and opportunities

Barriers	Opportunities
- Minimal load during school holiday as cluster dominated by school buildings - Buy in required from schools - Leisure centre site only speculated - Wellsway School is an academy and so outside of direct B&NES influence - Age of boilers and current heating strategy is unknown i.e. may have new plant	- CO_2 emissions typically high on school agenda - Third party network could provide joined up thinking between separate schools - Network within school site boundary – avoids disturbance of road network - East Keynsham earmarked for possible future housing and employment allocations

6.3 Anchor load heat demands and plant sizing

Table 6—2 and Table 6—3 below summarise the anchor load heat demands for the Wellsway cluster and technical results for CHP and biomass options for low carbon heat supply.

Table 6—2 Wellsway anchor load heat demands

Site	Heat demand estimate (kWh/yr.)	Source
IKB studio school	87,800	Area measured from planning drawings, education benchmark applied
Wellsway School (New Sports Centre)	165,400	Metered gas readings from Council GHG reporting. 0.8 gas to heat factor applied.
Wellsway School (Lansdown)	656,700	
Wellsway School (Mendip 6th Form)	464,100	
Wellsway School (Student Centre)	16,400	
Wellsway School (Science Block)	5,700	
Wellsway School (Room33-34 Terra)	45,100	
Wellsway School (Admin Block)	42,800	
Chandag Infant School	22,000	
Chandag Junior School	142,700	
Leisure centre	922,500	Demand benchmarks based on 25m 6 lane swimming pool and 1500m^2 associated leisure space
Total	**2,571,200**	

Table 6—3 Wellsway district heating technical results

Assumption	CHP	Biomass
Annual heat sales	2,600MWh/year	2,600MWh/year
Peak heat load	2.3MW	2.3MW
Heat supplied by primary plant	1,900MWh/year	2,350MWh/year
Primary plant size	185kWe, 309kWth	400kWth
Length of trunk network	510m	510m
Trunk network pipe diameter	200mm	200mm
CO_2 emission savings (tCO_2/year)	232	456
% reduction in heating CO_2 emissions	35%	70%

6.4 Financial assessment

Table 6—4 below summarises the financial modelling for the Wellsway cluster. A breakdown of costs and financial modelling assumptions are given in Appendix A. The Wellsway cluster has the least investment potential of the three clusters, in part as there is no benefit of connection charges from avoided new heating plant. The financial modelling assumes that the energy centre will meet all heat demands of the site however it is noted that Wellsway sports centre and the IKB studio school have recently been completed and as such, dependant on phasing, may continue to use its existing boiler to meet peak demands of the network, reducing the need for peak boilers at the energy centre, but also the demand that would be of interest to connect.

Over a 25 year life, the scheme does not pay back the capital investment required therefore it is not suggested for investment. Sensitivity testing shows that to achieve an 8% IRR, the heat or electricity price would have to be higher than is competitive with a traditional gas boiler approach. Cash flow graphs for the model results below are given in Appendix B.

Table 6—4 Wellsway financial modelling

Assumption	CHP	Biomass
Capital cost (less connection charges)	£1.56 million (£1.44 million)	£1.49 million (£1.37 million)
Year 1 net revenue	£5,300	£35,700
25 years NPV @ 3.5% discount factor	-£1.26 million	-£0.98 million
IRR	N/A	N/A
CO_2 saved	232 tonnes/year	456 tonnes/year
Capital cost of PV to achieve equivalent CO_2 saving	£0.89 million	£1.76 million
Heat sales price to achieve 8% IRR	£87/MWh	£78/MWh
Electricity sales price to achieve 8% IRR	£136/MWh	N/A

6.5 Conclusions

The Wellsway cluster is not a viable cluster under current assumptions. There is no investment potential unless a private wire connection can be secured for all CHP power sales and a high heat price secured. This is unlikely, and would require the schools to discontinue use of heating plant which may be near new. Providing baseload heat only from the DH network would allow the buildings to retain local boiler plant to meet peak heat demands which still improving CO2 emissions savings while reducing capital costs for the energy centre and pipe network. However, revenues would also be reduced and the scheme would not pay back the initial capital costs of the scheme without much increased connection charges or energy sales prices.

7 Alternative ways forward

Although district heating has limited viability in Keynsham, there is still an aim for the Council to reduce CO_2 emissions in the town. It is worth noting that a significant proportion of new development over the next decade or more in Keynsham is predicted to be low density residential sites. From the 2016 update to Part L of the Building Regulations the Government's Zero Carbon Home legislation will apply. The current status of national planning policy means that it is unlikely that B&NES will be able to set CO_2 reduction targets beyond this.

The Zero Carbon Hub have defined qualification for Zero Carbon as:

- All homes must achieve the Fabric Energy Efficiency Standard (FEES), which relates to a maximum space heating and cooling requirement.
- Any CO_2 emissions that remain after consideration of heating, cooling, fixed lighting and ventilation, must be less than or equal to the Carbon Compliance limit established for zero carbon homes.
- Any remaining CO_2 emissions, from regulated energy sources, must be reduced to zero by either deliberately 'over performing' on requirements 1 and 2 so that there are no remaining emissions, or by investing in Allowable Solutions.

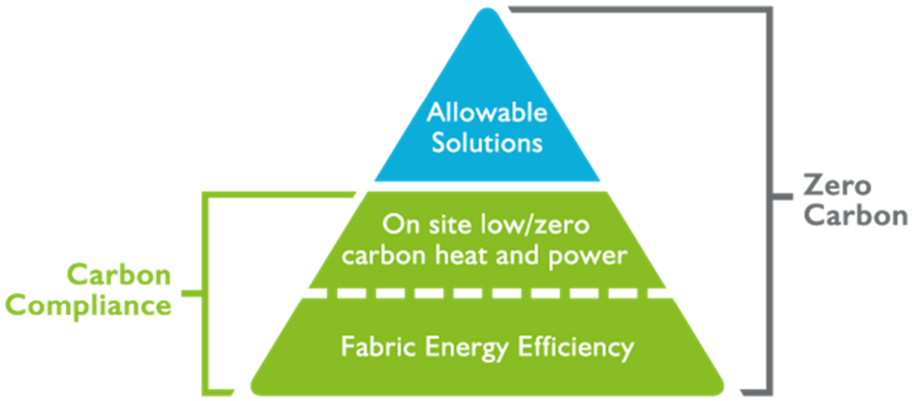

Figure 7-1 Zero Carbon policy framework

The requirement for onsite 'Carbon Compliance ' means that the CO_2 emission savings that could be delivered by district heating will have to be met by developers by other means.

Any residual emissions would have to be offset by 'Allowable Solutions'. The structure for 'Allowable Solutions' is yet to be fully defined but one of the options consulted on was payment to a Local Authority operated CO_2 abatement fund.

There is potential for this fund to be used to contribute towards alternative methods of CO2 reduction, such as:

- Renewable electricity generation such as retrofit or ground mounted solar PV, potentially in conjunction with Bath and West Community Energy
- Energy efficiency retrofit through Energy at Home scheme, potentially expanded to cover non-residential buildings

Appendix A Financial modelling assumptions

Table 7—1 Financial model inputs

Input	Unit	Value	Reference
Operating assumptions			
Gas boiler efficiency	%	85%	Project team assumption
Biomass boiler efficiency	%	80%	Project team assumption
DH heating network losses	%	8%	Project team assumption
Energy centre parasitic load	%	1%	Assumption of % of heat production
% heat demand met with CHP	Set by cluster		From EnergyPro results
CHP gross heat efficiency	Set by cluster		Set in model inputs tab based on CHP size
CHP gross electrical efficiency	Set by cluster		Set in model inputs tab based on CHP size
Heat sale revenues (unit charge and service charge combined)			
Variable - resi	£/MWh	40	B&NES estate cost of heat based upon 80% efficient boilers would be 32. Small consumer based on DECC energy prices would be 46.
Variable - non-resi	£/MWh	40	
Fixed - resi	£/kW	13.6	Assumption based on avoided cost of boiler maintenance & avoided gas standing charge. Small consumer based on DECC energy prices would be 46.
Fixed - non resi	£/kW	13.6	
Electricity sale revenues			
Grid spill average	£/MWh	50	All electricity sales assumed as grid spill (conservative assumption of no private wire)
Connection charges			
New build boiler avoided cost	Set by building		
Operational & maintenance costs			
Fuel cost - gas at energy centre	£/MWh	25	B&NES current gas cost lower bound
Fuel cost - electricity (for pumping energy)	£/MWh	99.8	B&NES Email 25/03/15 Average Estate Electricity Price
Biomass fuel cost	£/MWh	31	Woodchip: http://www.biomassenergycentre.org.uk/
Plant replacement fund	%	80%	% of energy centre capex that will need replacing within below period
Plant lifetime	years	20	Replacement period for energy centre capex
Funding assumptions			
Model lifetime	Years	25	
Discount rate	%	3.5%	HM Treasury Green Book - test at 6% and 12% to reflect public and private
Gas price indexing	DECC ref.		DECC BAU scenario
Heat sales	DECC ref.		DECC residential heat retail price
Electricity sales	DECC ref.		Matched to DECC retail price for services electricity
Electricity purchase	DECC ref.		Industrial retail price
Funding streams and charges			
ECO/ STOR / TRIAD / CPS		n/a	Excluded from simplified modelling, assumed included in bulk prices
RHI Tier 1	£/MWh	51.8	
RHI Tier 2	£/MWh	22.4	
RHI Lifetime	years	20	
Council grant		n/a	Assume 100% financed from a combination of existing funds, grant support including Energy Company Obligation (ECO), and either soft loan or borrowing

Table 7—2 Building connection charges

Connection name	Cluster	Building details	Heat load	Heat load	Plant space avoided	Boiler avoided cost	Avoided CHP capacity	CHP avoided cost	Plant space rate	Connection charge	HIU Cost
			MWh/yr.	*kWp*	*m²*	*£*	*kWp*	*£*	*£*	**£**	*£*
Leisure centre	Town Centre	New build	923	646	55	39,671	100	78,968	-	118,638	11,127
Riverside Development	Town Centre	New build	317	269	23	16,543	34	27,119	18,883	62,545	9,660
AFR new offices	Town Centre	New build	70	69	6	4,214	8	5,992	4,811	15,017	8,877
Civic Centre - OSS building	Town Centre	Existing	40	40	0	-	-	-	-	-	8,764
Civic Centre - B&NES Office	Town Centre	Existing	84	82	0	-	-	-	-	-	8,930
Leisure centre	Wellsway	New build	923	646	55	39,671	100	78,968	-	118,638	11,127
IKB studio school	Wellsway	Existing	88	90	0	-	-	-	-	-	8,959
Wellsway School (New Sports Centre)	Wellsway	Existing	165	169	0	-	-	-	-	-	9,267
Wellsway School (Boiler Lansdown)	Wellsway	Existing	657	670	0	-	-	-	-	-	11,222
Wellsway School Mendip 6th Form)	Wellsway	Existing	464	473	0	-	-	-	-	-	10,455
Wellsway School (Student Centre)	Wellsway	Existing	16	17	0	-	-	-	-	-	8,675
Wellsway School (Science Block)	Wellsway	Existing	6	6	0	-	-	-	-	-	8,633
Wellsway School (Room33-34 Terra)	Wellsway	Existing	45	46	0	-	-	-	-	-	8,789
Wellsway School (Admin Block)	Wellsway	Existing	43	44	0	-	-	-	-	-	8,780
Chandag Infant School	Wellsway	Existing	22	22	0	-	-	-	-	-	8,697
Chandag Junior School	Wellsway	Existing	143	146	0	-	-	-	-	-	9,177
Leisure centre	Sommerdale	New build	923	646	55	39,671	100	78,968	-	118,638	11,127
Fry Club	Sommerdale	New build	244	290	25	17,816	26	20,861	-	38,676	9,741
Block B & C Offices	Sommerdale	New build	595	583	50	35,800	64	50,903	40,865	127,568	10,882
Primary School	Sommerdale	New build	125	127	11	7,807	13	10,665	-	18,471	9,105
Apartments	Sommerdale	New build	456	388	33	23,809	49	39,029	27,177	90,015	10,121

Table 7—3 Capital cost breakdown

Cost		Unit	Town Centre - CHP	Town Centre - Biomass	Wellsway - CHP	Wellsway - Biomass	Sommerdale - CHP	Sommerdale - Biomass
Infrastructure	Hard dig/Soft dig?	-	Hard	Hard	Soft	Soft	Soft	Soft
	Pipe diameter	mm	125	125	200	200	150	150
	Trunk pipe unit cost	£/m	918	918	1,137	1,137	962	962
	Additional pipe unit cost	£/m	728	728	618	618	618	618
	Pipe total cost	£	308,444	308,444	642,906	642,906	325,680	325,680
	HIU cost	£	47,359	47,359	103,783	103,783	50,976	50,976
	Total network cost	£	355,803	355,803	746,689	746,689	376,656	376,656
Energy centre	Boiler capacity	kW	1105	1105	2327	2327	2033	2033
	Boiler rate	£/kW	50	50	50	50	50	50
	Boiler plant cost	£	55,272	55,272	116,370	116,370	101,656	101,656
	CHP capacity	kWth	236		309		309	
	CHP cost	£	180,000		220,000		220,000	
	Biomass capacity	kWth		300		400		350
	Biomass cost rate	£/kW		484		450		465
	Biomass cost	£		145,286		179,858		162,892
	Additional plant costs	£	164,691	150,419	235,459	222,171	225,159	198,411
	Prelims - overheads & contingency	£	171,413	150,419	245,070	222,171	234,349	198,411
	Total energy centre cost	£	571,375	501,396	816,899	740,569	781,165	661,369
Connection charges		£	196,200	196,200	118,638	118,638	393,369	393,369
Nett capital cost balance		£	730,978	660,999	1,444,949	1,368,619	764,452	644,656

Appendix B Cash flow graphs

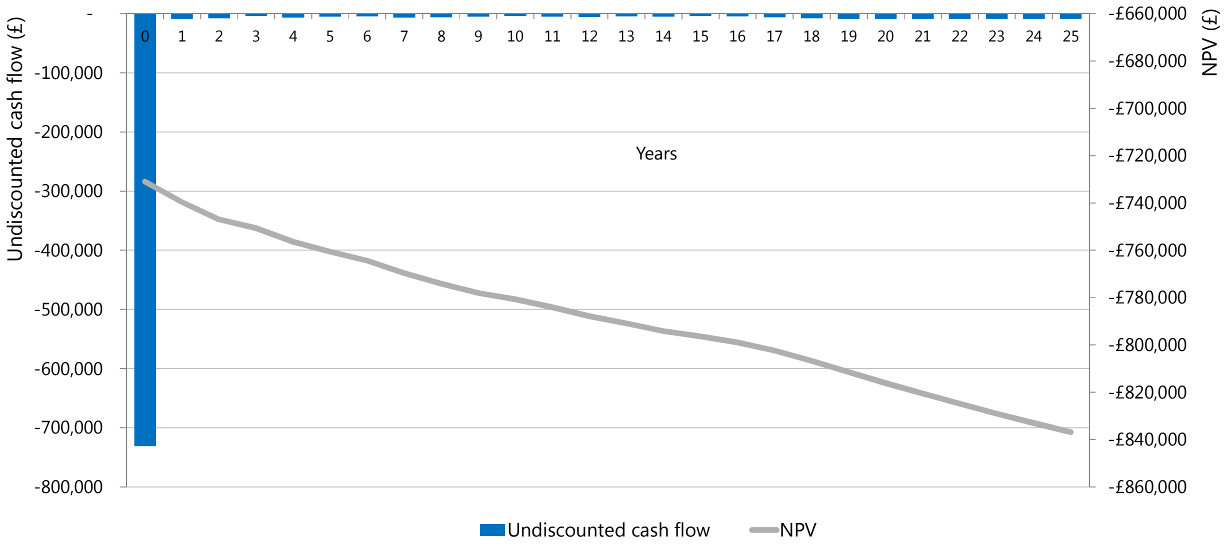

Figure 7—2 Gas CHP cash flow – Town Centre cluster

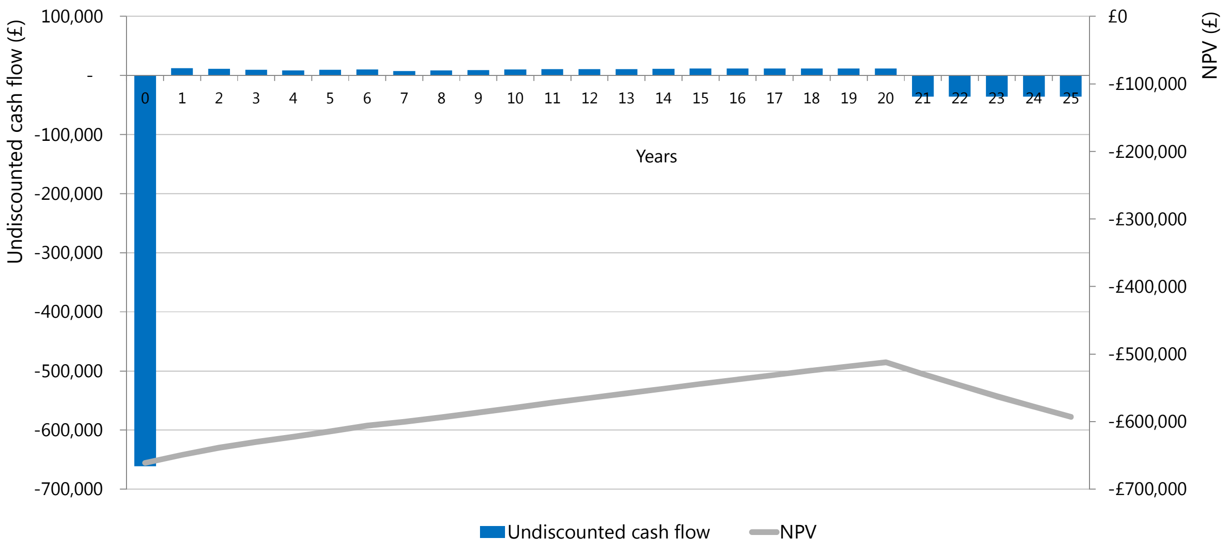

Figure 7—3 Biomass cash flow – Town Centre cluster

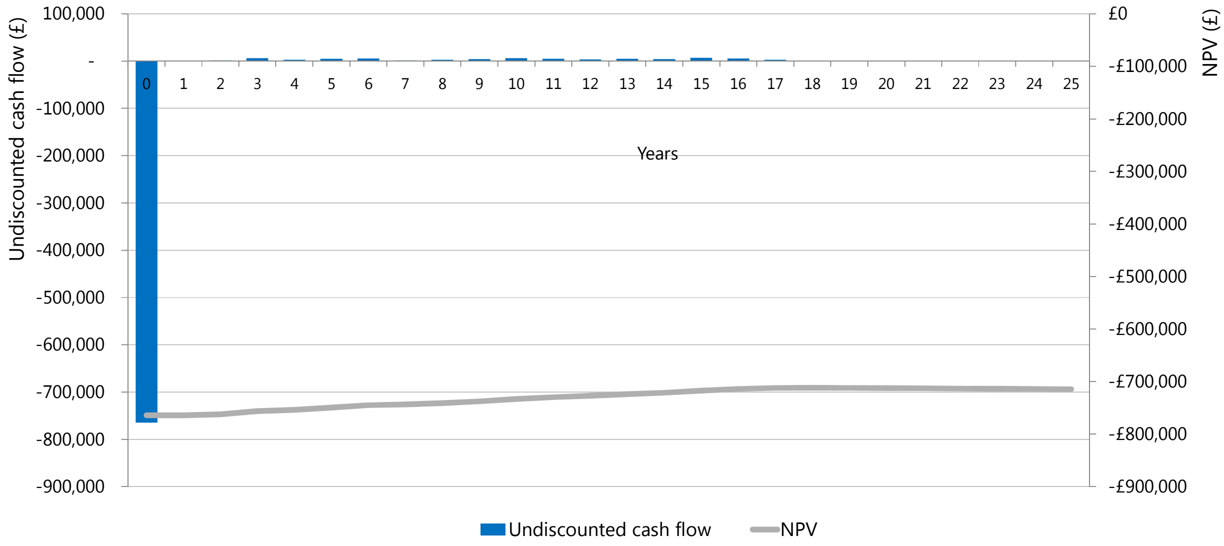

Figure 7—4 Gas CHP cash flow – Somerdale cluster

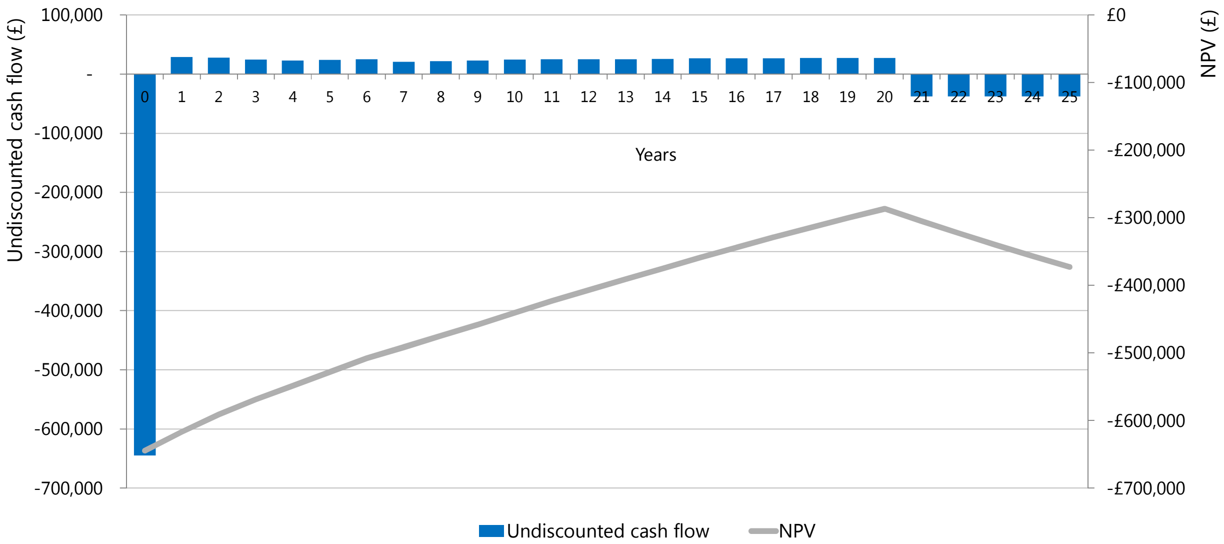

Figure 7—5 Biomass cash flow – Somerdale cluster

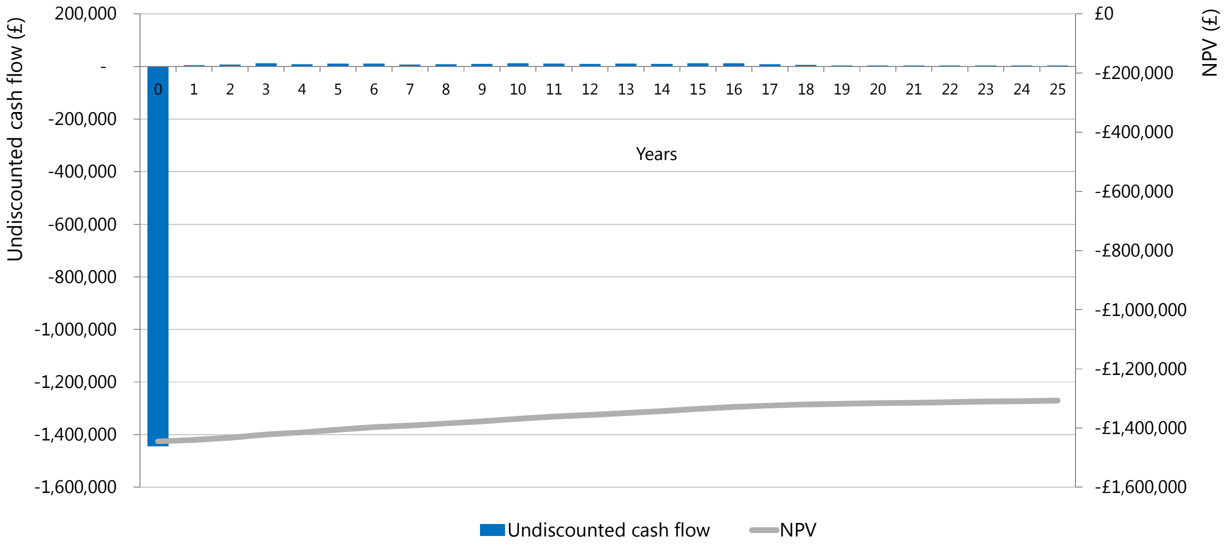

Figure 7—6 Gas CHP cash flow – Wellsway cluster

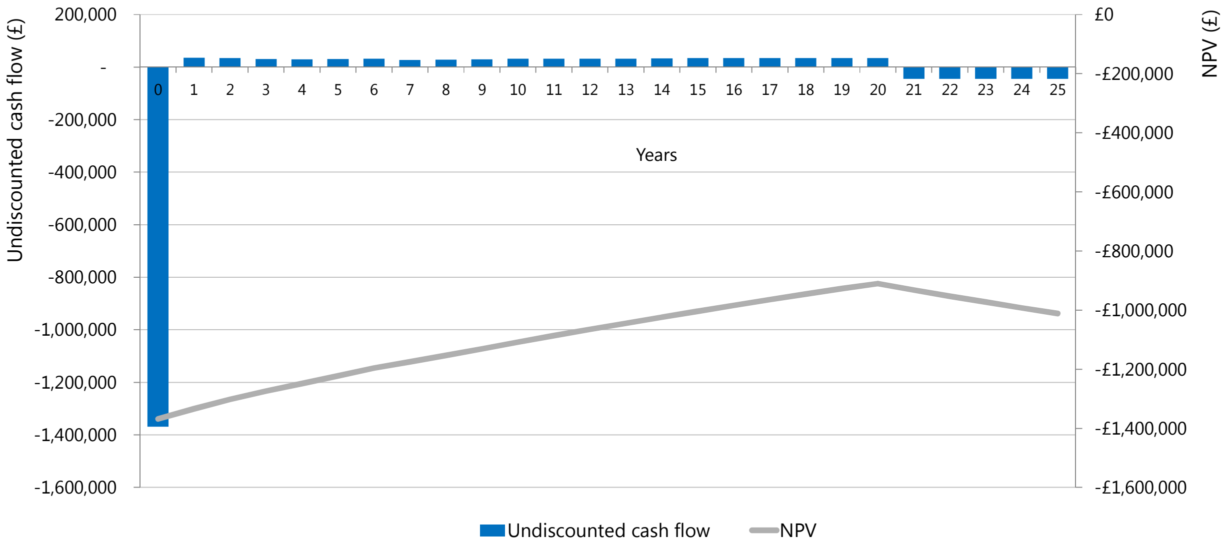

Figure 7—7 Biomass cash flow – Wellsway cluster

Appendix C Cluster heat demands

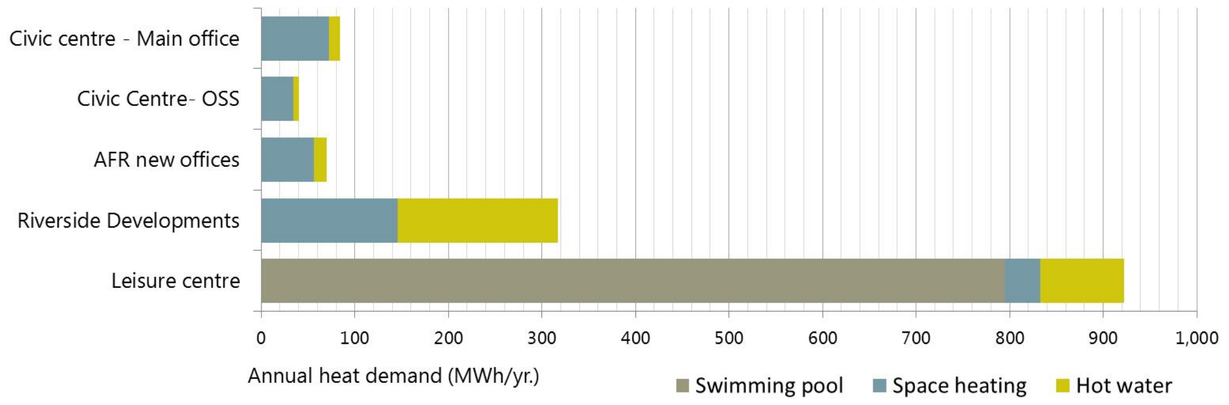

Figure 7—8 Town Centre cluster heat demands

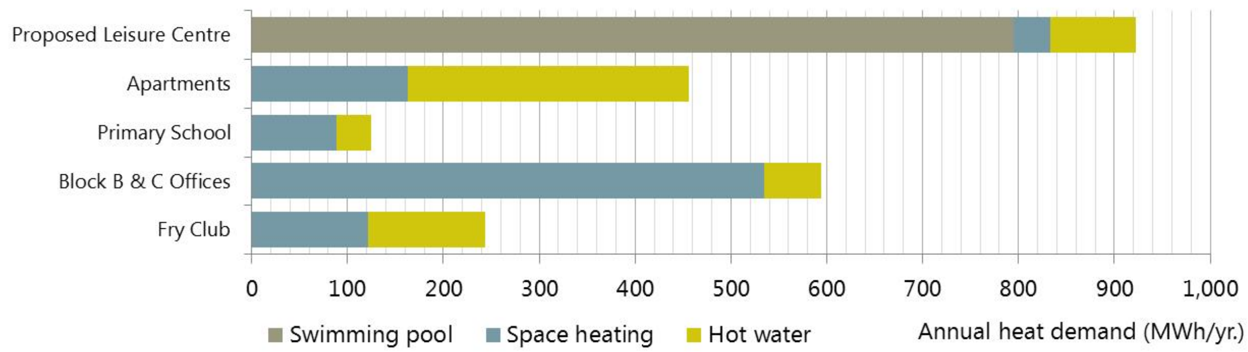

Figure 7—9 Somerdale cluster heat demands

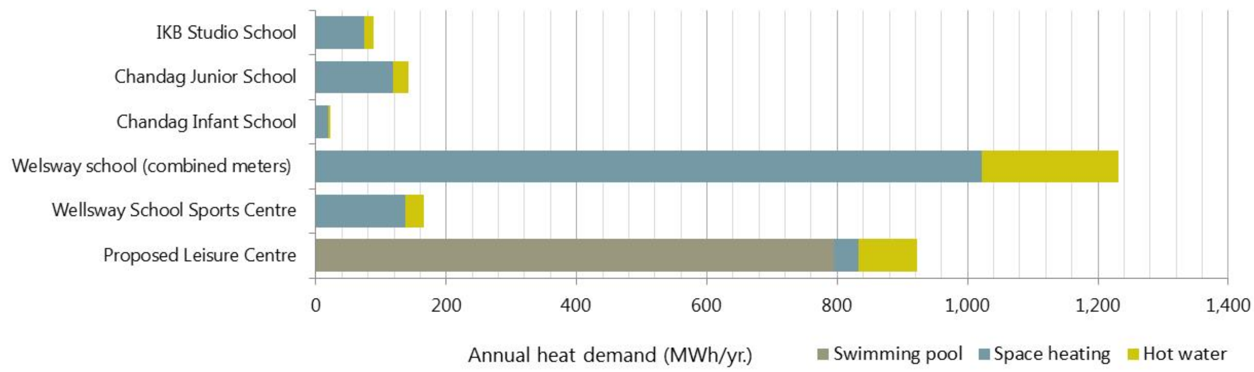

Figure 7—10 Wellsway cluster heat demands

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