Delivering a 'Waste to Resources' Plan for Somerset's Urban Extensions

Report B: Integrating Energy from Waste

Somerset County Council

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ABBREVIATIONS

AD	Anaerobic Digestion
CHP	Combined Heat and Power
CV	Calorific Value
EfW	Energy from Waste
FIT	Feed in Tariff
kW	kilowatt
kWh	Kilowatt-hour
LEC	Levy Exemption Certificate
MBT	Mechanical Biological Treatment
MRF	Materials Recovery Facility
MSW	Municipal Solid Waste
MW	Megawatt
RDF	Refuse Derived Fuel
REGO	Renewable Electricity Guarantee of Origin
RHI	Renewable Heat Incentive
RO	Renewables Obligation (Scheme)
ROC	Renewable Obligation Credit
RSE	Renewable Source Electricity

1 INTRODUCTION

1.1 Background

1.1.1 Somerset County Council (SCC) has commissioned Parsons Brinckerhoff (PB) to prepare advice on sustainable waste and resource planning for the urban extensions planned for Yeovil and Taunton in Somerset.

1.1.2 Initially conceived as Ecotowns as defined in the supplement to Planning Policy Statement (PPS) 1: *Delivering Sustainable Development* these areas will now be brought as eco developments that may not fulfil the precise Ecotown criteria but will continue to seek high standards of sustainable development.

1.1.3 As such it is proposed that these urban extensions can be exemplar developments, surpassing current best practice and being leaders in minimising residual waste arisings while optimising the extraction of value from waste.

1.1.4 Through 'placemaking' SCC wishes to be at the forefront of innovative waste management solutions.

1.2 Scope

1.2.1 This report reviews and updates evidence on opportunities for integration of waste-to-energy into the study areas, including (but not limited to):

- An assessment of global best practice and potential application locally at the appropriate scale.
- The potential demand for heat within the study area, drawing where appropriate from the regional heat mapping work by RegenSW.
- A review of potential technology options including Combined Heat and Power (CHP) and biogas generation through Anaerobic Digestion (AD).
- For AD, the potential uses of biogas (including use of the gas grid and use of gas as a service vehicle fuel)
- For local CHP the technology options including the potential use of refuse derived fuel in local scale facilities.
- An objective assessment of the environmental impacts and carbon merits of local versus larger scale.
- An assessment of technology risks at the present time and how the risk profile may change over time as "newer" technology options become more established
- An assessment of relative financial costs of schemes.

1.2.2 This includes consideration of the best location for any identified solution, integrating directly on-site into the urban extensions or via an appropriate mechanism within an agreed area of search.

2 GLOBAL BEST PRACTICE REVIEW

2.1.1 This section reviews the global best practice in deriving energy from waste. The review is split into three sections. The first section covers the main large-scale treatment technologies. The second section covers the pre-treatment technologies which assist in the energy recovery effort. The third section reviews an applicable small-scale technology.

2.2 Treatment Technologies for Residual Municipal Solid Waste

2.2.1 This section describes the main technologies that have been employed, or are being considered, for the treatment of residual waste across the UK, in particular those which recover energy from the waste stream. Some of the technologies are well proven at commercial scale whilst others are yet to be commercially employed to treat municipal residual waste.

2.2.2 Energy-from-waste technologies can be split broadly into the following three categories:

- Anaerobic Digestion
- Conventional Incineration
- Advanced Thermal Treatment

2.2.3 Within each category, there are numerous process variants and the efficiency of energy conversion varies significantly between systems. Overall energy efficiency is significantly improved when waste heat is also utilised in a combined heat and power (CHP) configuration, which is potentially feasible with each of these technologies. If considered "good quality" CHP, determined by the electrical efficiency and degree of heat that is consumed usefully by end users, Levy Exempt Certificates (LECs) can be obtained for some or all of the electricity generated. These schemes are also eligible for Renewable Source Energy (RSE) LECs which are awarded in proportion to the renewable nature of the fuel. The choice of LEC scheme thus depends on which is most advantageous for each particular energy from waste scheme. .

2.2.4 The financial incentives available for each of the technologies reviewed are reviewed in Section 7.

Anaerobic Digestion

2.2.5 Anaerobic Digestion (AD) involves the decomposition of biodegradable waste by micro-organisms in the absence of oxygen to produce a 'biogas' comprising 60% methane and 40% carbon dioxide as a gas at low pressure and temperature that is saturated with water and also contains some contaminants. It is a slow process, with digesters having a residence time of anywhere between 10 to 40 days, dictated by what pathogens and viruses are within the digestate, and the desired biogas level in the output.

2.2.6 If higher temperature digesters are selected, the activity within the unit increases, reducing the residence time and reducing the size of digester required for a given amount of waste.

2.2.7 The lower temperature (30-40C) processes use "mesophilic" micro-organisms, and are well proven at commercial scale and have primarily been used to treated source segregated biodegradable waste such as food and catering waste, garden waste, sewage sludge, agricultural waste and organic industrial waste. Higher temperature processes are less well proven, but both are increasingly being used for municipal solid waste (MSW) as part of an MBT solution (mechanical biological treatment) when preceded by mechanical treatment to separate out a mostly organic feed stock.

2.2.8 Within both temperature ranges there are numerous variations of the process ranging from simple single-stage units to complex multi-stage systems and variations in operational moisture content and temperature of the reactors. The biogas is generally used, after some pre-treatment, to fuel reciprocating diesel or gas engine combined heat and power generators to produce electricity. However, in the last 18 months pilot projects to clean and remove the CO_2 from the biogas and increase its CV to standard conditions so it can be injected into the TRANSCO natural gas network have been explored. Historically biogas has also been used as a vehicle fuel since the Second World War, but would require cleaning and drying before use in a modern petrol engine.

2.2.9 AD at lower temperatures is widely used in the UK for treating sewage sludge, and there is potentially an opportunity to include food waste treatment in these existing facilities. However there are significant regulatory hurdles to be overcome before this can occur concerning how water companies are funded as well as the need for some assets to be replaced if blood products need to be treated (see below).

2.2.10 The remaining solid residue, or digestate, can be aerobically stabilised for use as a soil conditioner. However, it should be noted that the solid digestate produced from mixed waste will contain some contamination and in England, it cannot be spread on agricultural land, but can only be used to restore brownfield and landfill sites. AD facilities treating mixed waste and food waste must also comply with the Animal By-products Regulations (2005 and amended in 2009) to sterilise the waste, which arose as a result of the foot-and-mouth crisis of 2001.

2.2.11 Unlike thermal recovery processes, AD can only recover energy from the easily biodegradable components of the waste stream, resulting in relatively low net conversion efficiencies and the generation of a product (the digestate) that is increasingly difficult to remove from site cost effectively.

2.2.12 The introduction of other concentrated liquid wastes that break down to form biogas easily can enhance the performance of the digester, and hence biogas output. For MSW, conversion efficiency may be as low as 6 to 10 per cent of the total energy contained in the mixed waste.

2.2.13 AD processes treating source segregated organic waste will generally be smaller scale in the range 10,000 to 60,000 tonnes per annum, while those treating MSW as part of an MBT facility may be between 50,000 and 200,000 tonnes per annum. The footprint requirement will vary significantly depending on the throughput, the process selected and the inclusion of pre-treatment equipment.

Case study: Biocycle AD facility, Shropshire

The development and operation of the AD plant situated in Ludlow was selected as a New Technology Demonstrator Project by Defra in 2004.

Biocycle South Shropshire Ltd (Biocycle) was set up as a partnership between Greenfinch Ltd and South Shropshire District Council (SSDC). The plant was designed to treat biodegradable municipal waste (BMW) from South Shropshire households, with the digestate to be spread on local agricultural land and the biogas burned in a combined heat and power unit (CHP), with surplus electricity exported to the National Grid and surplus heat to be used in a local district heating scheme.

The plant, which began operation in 2006, initially processed mixed garden and food waste, but the high levels of contamination caused processing difficulties and in 2007 the facility started treating predominantly source-separated food waste.

The design throughput was 5,000 tonnes per year, producing:

- 1,300 tonnes per year of solid digestate,
- 3,000 tonnes per year of liquid digestate,
- 1,300 MWh of electricity for export to the National Grid each year, and
- 1,700 MWh of surplus heat for use in a nearby district heating scheme.

Source: Biocycle South Shropshire, Defra Demonstration Project: Biocycle South Shropshire Ltd Biowaste Digester

http://www.defra.gov.uk/environment/waste/residual/newtech/demo/documents/Biocycle-final.pdf

Conventional Incineration

2.2.14 Conventional incineration plants burn waste in the presence of excess oxygen to ensure complete combustion, either as a mass-burn process treating raw MSW or using a pre-processed refuse-derived fuel (RDF). A number of different furnace technologies exist, including:

- Moving grate technology, which is the most prevalent in the UK and requires no pre-sorting of the waste. Of the UK’s 23 EfW facilities, 19 use moving grate technology.
- Fluidised bed technology, which requires pre-sorting and mechanical processing of waste in order to create a homogenous fuel (RDF). The waste enters the combustion chamber and mixes with a bed of inert material (usually sand) and air is blown up through the material to ‘fluidise’ it and so create good mixing conditions for rapid, complete combustion. This process is potentially more efficient than moving grate technology but is technically more complex so more prone to problems and hence lower annual availability. This process is used at two facilities including the Allington, Kent, EfW plant and in the Dundee EfW plant, as well as for around 19% of the UK’s sewage sludge by water companies.

- Oscillating kilns consist of a large horizontal drum inclined on a slight angle down, which move waste through the furnace by a gentle rocking action. The waste is thus shuffled through the combustion zone. Only one facility of this type has been built in the UK, at Grimsby, North Lincolnshire.

2.2.15 From the furnace, the hot flue gas is passed through a steam boiler to raise steam which then turns a steam turbine connected to a generator. Due to limitations of the steam turbine cycle, the overall net electrical conversion efficiency of the process is typically around 24 per cent and usually limited to a maximum of around 27 per cent for larger plants. Significant cooling capacity, generally in the form of wet cooling towers are required to allow the incinerator to operate when the steam turbine cannot take all the heat generated.

2.2.16 All of these processes require significant controls to ensure sufficient treatment of the flue gases and disposal of residues. Bottom ash may be further processed as a secondary aggregate including for the manufacture of bricks or landfilled as a non-hazardous material. Flue gas treatment residues are classified as hazardous (mainly due to the proportion of lime) and are usually disposed at a licensed hazardous landfill facility, of which there are only a limited number in the UK, resulting in high disposal costs.

2.2.17 The cost of constructing and operating a conventional mass-burn facility has risen considerably in recent years, partly due to escalating construction costs but also due to increasing costs of pollution control to meet tight new regulatory limits imposed by the Waste Incineration Directive (WID).

2.2.18 As such, conventional mass burn is generally only considered to be economically feasible at large scales (greater than 200,000 tonnes per annum) where economies of scale are gained and efficiency can be maximised.

2.2.19 Small scale incineration processes are available and commercially proven, but are less common. The net electrical conversion efficiencies tend to be significantly lower (16 to 18 per cent) whilst flue gas treatment requirements remain the same, resulting in higher unit costs. However small scale, decentralised systems can offer advantages of reduced point-impacts on the local environment, reduced transport miles for transfer of waste to the facility and potentially less public opposition.

2.2.20 There are 23 conventional incinerators currently operational and treating MSW in the UK, and a further three are under construction. These facilities range in size from 3,500 tonnes per annum on the Isle of Scilly to 850,000 tonnes per annum in the Ineos Chlor facility at Runcorn under construction in the North East.

2.2.21 The very small EfW facilities such as on the Isles of Scilly and on Shetland (see below) are viable only because of the specific characteristics of these island settings. Here, transport of waste to a larger facility elsewhere is simply not possible and so the cost of building and operating low capacity plants is sustainable.

Case study: Shetland Energy Recovery Plant

The Energy Recovery Plant in Lerwick was built in 1998 and treats approximately 22,000 tonnes of waste per year, including Shetland's domestic and commercial waste, municipal waste from Orkney, and waste from offshore oil rigs.

The process uses a moving grate incinerator with waste heat boiler. The hot water produced in the waste heat boiler supplies the Lerwick District Heating Scheme operated by Shetland Heat Energy and Power (SHEAP). An average of 6.5 MW is exported annually to some 700 homes and 90 businesses, including a hospital and leisure centre.

Source: Shetland Islands Council, Energy Recovery Plant

http://www.shetland.gov.uk/waste/documents/SICERPA4FlyerV4_000.pdf

Advanced Thermal Treatment

2.2.22 Advanced Thermal Treatment (ATT) primarily includes pyrolysis and gasification processes of which there are there are numerous different process variants and technologies at different stages of development.

2.2.23 Pyrolysis involves the break-down of carbon based waste materials through application of heat (400 to 700^{o}C) in the absence of oxygen. This process is generally optimised to produce a gas (syngas) which is a mixture of combustible gases such as carbon monoxide, hydrogen, methane and various volatile organic compounds. The syngas has a medium calorific value (CV) (up to around half that of natural gas) and can be burned to generate electricity in a gas engine generator set for power only or in CHP configuration. The process also produces liquid oil products which can be further refined to diesel and fuel oil products. The solid inorganic residue, or 'char', tends to contain a relatively high proportion of the original carbon and energy content of the waste. Therefore, to maximise overall energy recovery and efficiency, pyrolysis is often coupled with gasification or combustion of the char.

2.2.24 Gasification thermally degrades waste through partial combustion at a higher temperature than pyrolysis (800 to 1200^{o}C) with the controlled addition of air, oxygen and/or steam. The process produces a syngas with a lower CV than in pyrolysis, but generally still suitable to fuel a gas engine generator or CHP unit.

2.2.25 The syngas produced in these processes is generally one with a CV slightly lower than biogas and requires treatment to remove water, particulates, acid gases and tars prior to use in a specially modified natural gas engine. However, the scale of gas treatment and quantity of hazardous by-products is significantly less than in the flue gas treatment systems used for incineration.

2.2.26 In theory, these processes should be more efficient than mass burn incineration due to the reduced combustion air in the process and the use of reciprocating gas engines, which have higher electrical conversion efficiency than steam turbine generators. However, the gain in energy efficiency of the process can often be negated to some extent by the high energy demand of the front-end waste processing to produce a suitable homogenised fuel.

2.2.27 The main potential advantage of these processes is the smaller scale – typically 30,000 to 100,000 tonnes per annum throughput. This makes them more suited for decentralised applications of the sort that might be applied at Taunton and Yeovil.

They can be housed within standard industrial buildings and located in light to moderate industrial zones. Both pyrolysis and gasification processes are eligible for double Renewable Obligation Certificates (ROC) allocations on the biomass component of the waste feed, provided a minimum syngas CV of 4 MJ/m^3 is achieved.

2.2.28 There are very few pyrolysis systems treating residual waste that have been commercially proven at full scale outside of Japan. A number of demonstration plants have been recently constructed or are under development in the UK. Gasification technologies are somewhat more advanced. For example, Energos has seven operating reference plants in Europe using gasification of MSW with throughputs from 10,000 to 75,000 tonnes per annum.

2.2.29 There are a number of other proven gasification technologies for biomass feedstocks such as timber waste. For example, a recently commissioned timber gasification facility in the North West of England is currently treating 30,000 tonnes per annum of C&D timber waste to generate approximately 3MW electric power. That facility is housed in a standard industrial building covering $1,700m^2$.

2.2.30 There are only two operational ATT facilities treating MSW in the UK: the 30,000 tonnes per annum Energos gasification facility on the Isle of Wight and the 18,000 tonnes per annum pyrolysis demonstration facility in Scarborough. A further seven facilities have planning permission, with eight more in planning. As such, ATT has some way to go to prove itself at commercial scale in operation in the UK.

Case study: Scarborough Power Pyrolysis Plant

Scarborough Power Ltd took part in Defra's New Technology Demonstrator Programme. It is owned by Yorwaste Ltd, a local waste management company, GEM, the technology provider, and BB Newco, an asset management and finance company.

The pyrolysis plant was designed to divert 18,000 tonnes of residual waste per annum, which has been processed into a refuse-derived fuel, and generate approximately 1.8 MW of electricity. GEM's pyrolysis technology produces a syngas, which is fed into a reciprocating engine / generator pack and produces electricity that is exported to the national grid. The syngas is cooled and cleaned before it is fed into the engine. The fuel preparation system is central to the successful operation of the facility.

The performance of the plant provided provisional data on throughput processing capacity conversion efficiency and electricity sales which gives confidence that a commercial plant could be taken to market at a competitive gate fee.

Source: Scarborough Power, Defra New technologies demonstrator Programme: Scarborough Power Ltd, September 2009

http://www.defra.gov.uk/environment/waste/residual/newtech/demo/documents/Scarborough-final.pdf

2.3 Pre-Treatment Technologies

2.3.1 There are a number of potential pre-treatment technologies in the market. These can further enhance recovery of recyclables, homogenise the fuel feedstock and improve the energy efficiency of an EfW process.

MBT

2.3.2 A number of these technologies produce what is generally referred to as refuse derived fuel (RDF). RDF refers to a wide range of waste materials that have been processed to achieve guideline, regulatory or industry specifications. These mainly relate to the need to achieve a high calorific value. RDF can include residues from MSW recycling, industrial/trade waste, sewage sludge, industrial hazardous waste and biomass waste among others. The most common and least expensive of these technologies is MBT.

2.3.3 MBT is applied to residual MSW and refers to various configurations of mechanical pre-treatment processes to separate recyclables and biodegradable waste. The biodegradable component is then processed through an AD or composting process. Mechanical separation utilises techniques similar to Materials Recovery Facilities (MRFs) to separate recyclable materials such as paper, card, metals and plastics. Some or all of these will be removed dependant on the biological process to be used and the requirements of the final product. The biological phase may use conventional composting techniques to produce a bio-stabilised material that can be used for land restoration, or as a partially inert material to landfill, or anaerobic digestion with the potential to generate electricity from the biogas.

2.3.4 Mechanical heat treatment involves sterilisation of waste using heat or steam (autoclaving) prior to mechanical separation of recyclates. When followed by screening, these processes usually produce a fine, homogenous, fibrous product derived from the organic content of the waste, which can be used as a renewable fuel. Autoclaving has been used historically for sterilising small batches of medical waste, however it has more recently been developed at sufficient scale for MSW treatment.

Case study: Sterecycle Autoclave Facility in Rotherham

Sterecycle operates a full scale autoclave plant in Yorkshire. The plant has operated since June 2008 and processes 100,000 tonnes per annum of waste. Sterecycle states that the facility is ‘the world’s first full scale commercial autoclave plant to treat residual household waste’. The plant processes residual MSW under a 10-year contract with Rotherham, Barnsley and Doncaster Councils.

The Sterecycle process is a two-stage process, with the autoclaves followed by mechanical separation. Currently the facility is diverting over 60 per cent of the waste from landfill. The treatment produces clean recyclables (aluminium cans, steel cans, plastics, wood, aggregates, and glass) as well as an organic biomass fibre. The fibre can be treated (such as through AD or combustion) to produce energy.

Source: Sterecycle: http://www.sterecycle.com/index.htm

Hydrolysis for AD

2.3.5 A recent development that promises to expand the viability of anaerobic digestion is the addition of a Hydrolysis “front end”. This technology incorporates a batch pre-digestion step into the digestion process, which should increase biogas yield whilst allowing flexibility in feedstock.

2.3.6 The development separates out the hydrolysis and acidification stages of the methane production process from the acetogenesis and methanogenesis stages.

The bacteria undertaking these initial stages are more robust than the traditional AD bacteria and can operate over a wider range of conditions and materials. The role of the first stage is to provide a consistent, high quality feedstock to the methane producing bacteria regardless of the input materials. The pre-treatment can breakdown lignocelllulosic biomass more effectively than a standard AD process. This allows garden waste and energy crops to be processed alongside more traditional food or sewage wastes.

2.3.7 The hydrolysis system has the added advantage that it produces a solid material suitable for direct combustion, when converted to pellets, or as a soil improver. The pumpable product of the hydrolysis system is fed into the normal anaerobic digestion process where gas yields are reported to be up to 30% higher.

2.3.8 A number of plants are in operation and under construction in the UK presently and many existing AD systems in Germany have now been upgraded by the addition of this hydrolysis system.

Case study: Nebauer, Germany

This plant, started in 2006, and feedstock utilised for the biogas production is pre-hydrolysed for 2-3 days before being pumped to an acidification tank. The liquid from this tank is then pumped into the biogas digester on a half hourly cycle.

The substrate used for biogas production consists of a mixture of duck manure (25%), maize silage (40%), wheat whole plant silage (10%), rye whole plant silage (10%) and grass silage (15%). The biogas is high quality, 56% methane. The plant has a stable production of 3,080 m3/day of bio gas with a fuel feed on average of just under 30Te/day (11,000 Te/yr).

Source: AGROBIOGAS Report: An integrated approach for biogas production with agricultural waste http://www.agrobiogas.eu/fileadmin/files/agrobiogas/deliverables2/D19_final_version.pdf

2.4 Specialist Small-Scale Applications

2.4.1 Due to economies of scale, waste streams are usually aggregated (for example by a group of local authorities working together). Small-scale applications are more common where aggregation is not a viable, such as for island communities. In the UK, the Isles of Scilly operates a 3,500 tonnes per annum incinerator (with no energy recovery) and the Shetland Energy Recovery Plant feeds a district heating scheme by treating 22,000 tonnes of waste per annum. Other small-scale applications have been developed for specialist markets, such as the military. It should be noted that these specialist markets typically have very high cost base operations and the techniques adopted are not generally applicable to standard commercial applications.

Case study: QinetiQ Pyrolysis for the US Army

In 2009 QinetiQ won a contract to develop and deliver its PyTEC ISO-containerised Pyrolysis Waste Disposal System to the US Army.

The system is designed to process up to 100 kg of waste per hour (876 tonnes per annum), including all the general domestic waste that might be produced in an army base. The PyTEC system also generates up to 500 kW of thermal energy per hour, which is used to sustain the process and also for electricity generation. The system produces 25 litres of inert ‘char’ per 100 kg of waste processed (depending on the waste composition).

The benefits for the Army of the on-site system include reduced reliance on outside waste contractors needing to access the secure base camp, management of the base's environmental impact, and reduced fuel demand through the energy recovery aspect.

Source: QinetiQ, QinetiQ to deliver its Pyrolysis Waste Disposal System to US Army, 6 October 2009

http://www.qinetiq.com/home/newsroom/news_releases_homepage/2009/4th_quarter/pytec_us_army_contract.html

3 ENERGY DEMAND

3.1.1 This section presents the estimated heat and electricity demand of the Taunton and Yeovil Urban Extensions based on analysis by PB, information from Urban Initiatives, and data from RegenSW.

3.2 Monkton Heathfield Urban Extension

3.2.1 This proposed urban extension is based around the village of Monkton Heathfield on the north east boundary of Taunton. The majority of the land to be developed lies to east of the village.

3.2.2 The development is scheduled to be built in three phases from 2011 to 2027 and will comprise a mix of residential, retail, business and public development. Table 3-1 summarises the heat demand in the urban extension by phase[1]. A breakdown by land type is presented is Appendix A.

Table 3-1 Monkton Heathfield Urban Extension Heat and Electricity Demand Summary

	Heat		Electricity	
Block	Annual Demand (MWh_{th})	Peak – Non Co-incidental (MW_{th})	Annual Demand (MWh_e)	Peak – Non Co-incidental (MW_e)
Phase One 2011 – 2016	7,080	7.7	4,167	3.7
Phase Two 2016 – 2021	14,107	13.7	8,486	6.4
Phase Three 2021 - 2027	14,242	14.3	8,335	6.9
Total	**35,429**	**35.7**	**20,988**	**17**

3.3 Yeovil Urban Extension

3.3.1 The location of the Yeovil Urban Extension is not defined at present but will be located within one of three potential areas to the south of Yeovil known as Brympton & Coker, East Coker, Keyford & Barwick, East Yeovil & Over Compton (see Section 8.4).

3.3.2 The Urban Extension was originally scheduled to comprise approximately 4,700 houses. When the Government abandoned formal housing targets, however, South Somerset District Council opted to keep the Urban Extension proposal and reduce the number of homes to be built to 3,725.[2] In addition, the development is anticipated to accommodate 23 ha of land for employment, primary and secondary school provision and appropriate supporting transport infrastructure.

3.3.3 At the time of writing master planning has not been undertaken and so detailed development plans are not available. The heat demand assessment is based on the housing requirement projection for the urban extension although it should be noted that market delivery constraints might limit the number of houses delivered by 2026 to

[1] Heat assessment based on PB analysis of Urban Extension Land Budget Rev J
[2] 8.20, Housing Requirement for South Somerset and Yeovil, Baker Associates for South Somerset District Council, January 2011

2,640.[3] Table 3-1 summarises heat demand for houses and anticipated employment and school provision. A breakdown by land type is presented is Appendix A.

Table 3-2 Yeovil Urban Extension Heat and Electricity Demand Summary

	Heat		**Electricity**	
Block	Annual Demand (MWh_{th})	Peak – Non Co-incidental (MW_{th})	Annual Demand (MWh_e)	Peak – Non Co-incidental (MW_e)
Total	**21,815**	**23.8**	**13,128**	**11.7**

[3] 8.2.3, Housing Requirement for South Somerset and Yeovil, Baker Associates for South Somerset District Council, January 2011

4 REVIEW OF TECHNOLOGY OPTIONS

4.1.1 This section reviews the anaerobic digestion, conventional incineration and advanced thermal treatment; the main energy from waste technologies identified in the global best practice review. The review narrows the range of energy from waste options available to the appropriate technology that could be applicable to the proposed urban extensions at Taunton and Yeovil. The review considers each technology's capacity, efficiency, viability, deliverability, sustainability and acceptability.

4.2 Anaerobic Digestion

4.2.1 Anaerobic digestion is considered in two parts, the first concentrates on the process itself and the second the uses for the biogas generated.

Gas Generation

Capacity

4.2.2 The capacity of anaerobic digestion systems can range from 1,000 to 50,000 t/yr. Small scale facilities usually have unique circumstances which ensure their viability. In practice, facilities from 10,000 t/yr sourcing waste from the local area are viable in their own right, while facilities of around 40,000 t/yr capacity, sourcing waste from the sub-region achieve significant economies of scale.

Efficiency

4.2.3 Efficiency depends on the volume of gas produced, and the amount of parasitic energy consumed by the process plant.

4.2.4 The volume of biogas produced per tonne of feedstock varies with the type of feed stock as the dry matter content, wetness, and process technology varies. Source segregated food waste has typically been found to produce 100 to 150 cubic meters per tonne (m^3/t) and green waste approximately 65 to 75 m^3/t. If as previously described aggressive pre-treatment technologies are used and process improvements to the main process are incorporated then this yield can rise by up to 30%.

4.2.5 Anaerobic digestion processes typically require 105 kWh of electricity and 100 kWh of heat per tonne of waste processed to operate plant and associated equipment.

Viability

4.2.6 As noted above, stand alone anaerobic digestion plants are generally commercially viable when processing 10,000 t/yr or more. Importantly in the context of the urban extensions, lower throughputs are feasible when linked to heating and/or development energy strategy, although the heat energy produced will only supply a fraction of the local area's requirements and so at the smaller scale could only form part of a District Heating solution.

4.2.7 Capital and operating costs will improve in the near future as more anaerobic digestion facilities are built in response to government incentives (e.g. landfill tax, RO, FiTs) and as manufacturers, suppliers, and installers benefit from economies of scale.

4.2.8 As previously mentioned, pre-treatment technologies have the potential to improve gas yield for a given tonne of feedstock and / or widen the range of feedstocks which can be processed, and improved yields will increase the income generated. Moreover, accepting additional waste from agricultural sources and / or commercially segregated food waste will enhance the viability of a plant and will help meet the waste management/disposal needs of the catchment.

4.2.9 AD facilities can also charge a gate fee depending on the type and quality of the waste accepted.

Deliverability

4.2.10 AD facilities and can be delivered by a range of established companies, although the expanding market size may cause slight delays as companies gear up to meet demand. Obtaining funding is relatively straightforward especially if AD is matched with CHP. The scale required for an independently viable facility may bring competition for fuel supply in a local, sub-regional or regional context.

Sustainability

4.2.11 Source separated food waste can be regarded as a sustainable resource because it is being diverted from landfill and does not compete with or disrupt other markets significantly.

Acceptability

4.2.12 Anaerobic digestion is a biological process producing biogas from organic matter, compared to the public perception of incineration this process is more acceptable. However, facilities will need to manage traffic movements (estimated at one HGV per week per 1,000 tonne/year of plant capacity).

Gas Utilisation

Combined Heat and Power

4.2.13 CHP is an established and mature technology. Manufacturers produce specialist versions of their engines for biogas, which are, are typically 40% electrically efficient, the uptime for which is generally dependant on the availability of biogas from the AD facility rather than the engine itself.

4.2.14 The utilisation of the biogas in a CHP engine brings in income from the following sources; heat and electricity sales; renewable incentive income from either the Feed in Tariff or Renewable Obligation schemes; and levy exemption certificates. In addition, the CHP engine provides on-site heat and power to the AD facility, which would otherwise be an additional and highly variable expense.

4.2.15 In March 2011 the Department of Energy and Climate conducted a fast-track review of the Feed-in Tariff scheme in response to the potential for large solar PV installations to consume more of the planned Feed-in Tariff funding than anticipated, due to decreasing production costs. The consultation also expressed a disappointment on the uptake of AD and proposed two higher tariffs, subject to confirmation, for units below 500 kWe.

Table 4-1: Incentive Income from Renewable Schemes

<table>
<tr><th></th><th>Feed in Tariff</th><th>Renewables Obligation</th></tr>
<tr><td>≤50kW</td><td rowspan="2">14 p/kWh$_e$</td><td>Not Eligible</td></tr>
<tr><td>≤250kW</td><td rowspan="4">2 ROCs per MWh$_e$</td></tr>
<tr><td>250 to ≤500kW</td><td>13 p/kWh$_e$</td></tr>
<tr><td>500 to ≤5,000kW</td><td>9 p/kWh$_e$</td></tr>
<tr><td>≥5,000</td><td>Not Eligible</td></tr>
</table>

Biogas Combustion

4.2.16 In the proposed Renewable Heat Incentive, installations of up to 200 kW$_{th}$ can combust biogas directly and receive support of 6.5 p/kWh$_{th}$ inflation linked for 20 years. For small scale facilities biogas combustion may be more appropriate rather than utilisation in a CHP engine. This requires a balancing of the costs of running a CHP engine against the cost of importing electricity from the grid to run the anaerobic digestion plant.

Biogas Upgrading

4.2.17 The UK experience of biogas upgrading is limited, with only two projects of sufficient scale for comparison. Whilst EU and US experience is more extensive the technology, its integration, support and service infrastructure are still at the developmental stage in the UK. This is reflected in the capital costs. As this is a developing industry without standardised designs, each installation will be custom built and this will be reflected in the price paid and may impact anticipated plant availability.

4.2.18 In the proposed Renewable Heat Incentive, bio-methane injected into the gas grid is eligible for 6.5 p/kWh of gas inflation linked for 20 years. This rate is designed to cover for the anticipated capital expenditure required for bio-methane processing plant of 1 MW$_{th}$ capacity. However, CHP is more valuable because the technology is mature and ROC income can be received on electricity parasitic electricity requirements of the AD plant as well as supplying free heat as by product.

4.2.19 With bio-methane injection none of these benefits are realised and the site's parasitic heat demand is met by the combustion of biogas and electricity from the grid. This reduces the profitability of this option by utilising premium energy sources to meet the process site's requirements.

Vehicle Fuelling

4.2.20 An alternative use of upgraded biogas is as a replacement fuel for specially adapted vehicles. This use of biogas has been in use for many years – during periods of petrol rationing such as the 2nd World War biogas vehicles were a common site on British roads. More recently local authorities and other organisations with large vehicle fleets have been re-examining the potential for cost and carbon savings through replacement of diesel and petrol with gaseous fuels.

4.2.21 There is a range of potential technologies for use of gaseous fuels in vehicles from simple injection of low pressure gas into the air feed to diesel engines to specially designed high pressure storage and combustion in spark ignition engines.

4.2.22 The attractive element of this potential use is that it offsets very high cost and carbon oil fuels. Road fuel duties make petrol and diesel very expensive by comparison with oil used for heating, which is in turn more expensive than natural gas used for heating. Road fuel duties for LPG have been kept comparatively low as have duties on biodiesel. Duties on biogas are also relatively low but reports to date have indicated that the high additional capital costs and maintenance costs for gas engines limit economic use. It is understood that only HGVs using gas are competitive with a diesel vehicle over an operating life of four years.[4]

4.3 Conventional Incineration

Capacity

4.3.1 The capacity of conventional incineration systems can range from 3,500 to 1,000,000 tonnes per year. At the higher capacities there is obviously a need to source feedstock from an increasingly wide catchment with attendant increase in road transport impacts unless rail transfer is possible.

Efficiency

4.3.2 Conventional incineration systems have a low overall electrical efficiency (depends on scale and may be as low as 12-15% for small schemes and only 25-28% for large schemes) even when excluding parasitic consumption, which is typically 12% of generation for mid-scale schemes. The nature of the fuel limits the temperatures that can be achieved due to its moisture and inerts content.

Viability

4.3.3 For a conventional incineration plant to be economically viable, the plant capacity should be at least 200,000 tonnes per annum. Smaller scale installations may work due to unique circumstances such as an island or other isolated setting. This in part due to the significant pollution control technology required to meet Environmental Permit requirements, which is a significant capital and ongoing cost.

4.3.4 The renewable incentive income for this technology is also the least generous, with 1 ROC per MWh of qualifying power generated received, net of the plant's own parasitic requirements when operating as CHP. If the scheme achieves the CHPQA Quality Index threshold then ROCs are awarded in proportion to the renewable content of the waste. If the CHPQA threshold is not reached then ROCs are awarded on the amount of qualifying power as a proportion of the eligible renewable power.

Deliverability

4.3.5 This technology is established and mature and funding will be relatively straight forward to obtain. However, significant local opposition is common, which can significantly delay the implementation of projects and increase development costs. In addition, the scale for a viable project will potentially create competition for fuel supply.

[4] - National Society for Clean Air and Environmental Protection June 2006

Sustainability

4.3.6 The biomass fraction of the fuel supply can be regarded as a sustainable resource because it is being diverted from landfill and does not compete with or disrupt other markets significantly. However, as waste minimisation initiatives and recycling rates improve waste will need to be drawn from an ever expanding area, unless source separation of combustible waste is discouraged. As a result a common argument against conventional incineration is that it can stifle continued improvement in waste minimisation and recycling – which are higher up the waste hierarchy.

Acceptability

4.3.7 Conventional incineration presents an attractive solution. Minimal segregation of waste can be carried out, designs are standardised and the technology mature. Public perception however presents a barrier to adoption. This combined with the traffic movements required to make a facility economically viable make this option the least acceptable of the three options considered.

RDF

4.3.8 A refuse derived fuel (RDF) plant combusts dry pellets made from collected waste. Typically, the pellets are manufactured at a pre-processing facility before being distributed to combustion plants. This potentially allows for slightly smaller combustion plants than with conventional incineration although significant scale is required on behalf of the pre-processing facility for schemes to be economic. In addition, the same pollution control requirements apply and the environmental permit required for plants over 400kWth input are a heavy regulatory burden for a small plant.

4.4 Advanced Thermal Treatment

4.4.1 The two technologies classified under advanced thermal treatment are gasification and pyrolysis.

Capacity

4.4.2 This technology's capacity can range from 10,000 to 75,000 tonnes per year, although UK experience currently is between 18,000 to 30,000 tonnes. This also appears to be the minimum capacity which should be considered for a plant to be viable. Small-scale facilities usually have unique circumstances which ensure their viability. At this scale a relatively wide catchment is required, significantly beyond, for example, the hinterlands of Taunton and Yeovil.

Efficiency

4.4.3 Scale is very important to overall efficiencies achieved – the reported efficiencies of conversion from fuel to syngas vary widely depending on the specific process adopted.

Viability

4.4.4 Advanced Thermal Treatment is eligible is for two ROC's per MWh of qualifying power generated, net of the plant's own parasitic requirements. This level of support is intended to support a technology in the early stages of commercial development.

The capital cost of the technology is high and continues to have significant levels of uncertainty. In the UK, the technology is not regarded as being economic at present.

Deliverability

4.4.5 This technology remains essentially at the development stage in the UK, where experience is limited. It is not yet commercially proven and retains a high technology risk. NB, the risk lies in the technology to generate and process the syngas and not in the plant in which it is combusted.

Sustainability

4.4.6 The biomass fraction of the fuel supply can be regarded as a sustainable resource because it is being diverted from landfill and does not compete with or disrupt other markets significantly. However, as waste minimisation initiatives and recycling rates improve waste will need to be drawn from an ever expanding area, unless source separation of combustible waste is discouraged and hence similar arguments in respect of waste minimisation and recycling incentive may be applied as for conventional incineration.

Acceptability

4.4.7 This technology presents an attractive solution as technologically advanced solution, which does not yet carry the reputation of conventional incineration. Public perception however may present a barrier to adoption depending how this technology is presented to the public. Traffic movements necessary for a viable facility may also present a barrier to adoption.

4.5 Summary

	Anaerobic Digestion	Conventional Incineration	Advanced Thermal Treatment
Economic Capacity	10,000 to 50,000	200,000 to 1 m	18,000 to 20,000
Efficiency	High	Medium	Medium
Viability	High	High	Low
Deliverability	High	High	Low
Sustainability	High	Low	Medium
Acceptability	High	Low	Medium

4.6 Selected Technology – AD with CHP

4.6.1 Of the currently available technologies, anaerobic digestion with CHP is the only one that appears to offer a balance between scale, deliverability and viability, which would suit incorporation into a new development area. Even this technology would require a scale of 5,000-10,000 Te/yr in order to provide a sensible level of energy output. It is likely that this will require waste to be supplied from a wider area and/or alternative feedstock such as agricultural and garden wastes to be used.

4.6.2 On a positive note, the use of AD allows for the waste treatment and the energy elements of the scheme to be undertaken somewhat remote from each other – the biogas can be piped quite economically from the point of production to the point of heat demand. This may allow a more sensitive allocation of space for the waste treatment aspects of the operation thus minimising the impacts on land values within a development area.

4.6.3 Incorporation of biogas into a CHP scheme is relatively straightforward and the key issues with successful development of CHP with district heating are density of heat load rather than fuel type. There may be opportunities for use of dual fuel engine technology – subject to agreement with regulators on use of mixed fuels related to revenue support such as Feed in Tariffs and Renewable Heat Incentive

5 ENERGY AVAILABILITY

5.1.1 This section reviews the volume of waste potentially available which is appropriate to the energy from waste technology selected. This review also considers the potential shortfall between the renewable energy available and the estimated demand from the urban extensions, including advice on how this shortfall can be met.

5.2 Waste Volume and Gas Yields

5.2.1 Anaerobic digestion processes organic waste. Organic waste collected from local properties comprises food and green waste.

5.2.2 The predicted volume of organic waste available per household is derived from the Waste Data Flow resource for South Somerset and Taunton Deane both of which are part of the Somerset Waste Partnership. Table 5-1 shows the waste volumes for these areas on a household basis and also presents an increased estimate of the potential volume of organic waste collected if 70% of all waste is recycled. Table 5-2 presents the breakdown of the organic waste between green waste and food for each area.

Table 5-1: Organic Waste per Household

	Units	Taunton Deane	South Somerset	Somerset Waste Partnership
Total Waste per Household	t/y	0.68	0.65	0.81
Organic Waste Collected – Current	t/y	0.15	0.11	0.18
Organic Waste Collected – Improved	t/y	0.19	0.18	0.27

Table 5-2: Organic Waste Composition

	Taunton Deane	South Somerset	Somerset Waste Partnership
Green Waste	48%	25%	69%
Food Waste	52%	75%	31%

5.3 Aggressive Anaerobic Digestion Biogas Production

5.3.1 Section 2.3 discussed a new pre-treatment technology for anaerobic digestion, which allows for an increase of up to 30% in gas output. As anaerobic digestion plant becomes increasingly common, pre-treatment technologies and process improvements will improve gas yields. In this analysis, consistent and improved gas yields are assumed and shown in the table below. Current best practice food-only anaerobic digestion plant achieve 125 m^3/hr of biogas, however the yield depends on the make-up of the waste which can be influenced by the time of year.

Table 5-3: Additional Waste required meeting Heat Demand, which CHP can Supply.

	Units	Standard Yield	Improved Yield
Green Waste	m^3/t	70 – 75	90
Food Waste	m^3/t	100 – 150	150

5.4 Urban Extension – Energy Contribution

5.4.1 This section determines the quantity of energy, which could be made available if organic waste is collected from each urban extension.

5.4.2 The Urban Extensions for Monkton Heathfield and Yeovil are expected to contain 5,044 and 3,725 houses respectively plus business units. If recycling rates are improved, Table 5.4 shows the anticipated volume of waste collected and the organic fraction.

Table 5-4: Quantity and Energy Content of Waste Collected within the Urban Extension

	Units	Monkton Heathfield	Yeovil
Number of Households		5,044	3725
Volume of Waste Collected	t/yr	3,419	2,439
Organic Waste Collected – Improved	t/yr	957	683

5.4.3 At approximately 1,000 and 700 tonnes per year respectively the Urban Extensions of Monkton Heathfield and Yeovil the volume of organic waste collected from is at least an order or magnitude too small to make an AD facility viable.

5.4.4 Notwithstanding this, Table 5-5 outlines the potential energy which could be realised from this quantity of waste. The table also shows the electrical and thermal energy which would be practically realised from the anaerobic digestion and combined heat and power process.

Table 5-5: Annual Heat and Electricity Potential based on Waste Collected within each Urban Extension

	Units	Monkton Heathfield	Yeovil
Organic Waste Collected – Improved (from Table 5-4)	t/yr	957	683
Biogas Yielded	m^3/yr	110,179	87,431
Methane Content	m^3/yr	60,598	48,087
Energy Potential	kWh/yr	543,749	431,486
Annual Electricity Potential – Based on 90% Availability	kWh/yr	174,000	138,075
Annual Heat Potential – Based on 90% Availability	kWh/yr	244,687	194,169
CHP Engine Size	kWe	17	14
	kWth	31	25

5.4.5 After meeting the AD facility's requirements Table 5-6 shows the quantity of electricity available and how much of each Urban Extensions demand would be satisfied, which is less than 1% at both locations.

Table 5-6: Electricity Demand Summary

	Units	Monkton Heathfield	Yeovil
Electricity Available after AD Plant Requirements	kWhth	101,953	80,904
Annual Demand	kWhth	20,988,084	13,127,886
Fraction of Electricity Demand Supplied		**0.5%**	**0.6%**
Remaining Electricity Demand	kWhth	20,886,131	13,046,982

5.4.6 The quantity of electricity available is sufficient to supply the equivalent of 30 energy efficient households in Monkton Heathfield Urban Extension and 24 at Yeovil's Urban Extension.

5.4.7 After meeting the AD facility's requirements Table 5-7 shows the quantity of heat available and how much of each Urban Extensions demand would be satisfied. Again, this would be less than 1% at each location.

Table 5-7: Heat Demand Summary

	Units	Monkton Heathfield	Yeovil
Heat Available after AD Plant Requirements	kWhth	183,515	145,626
Annual Demand	kWhth	35,427,961	21,815,325
Fraction of Heat Demand Supplied	**-**	**0.5%**	**0.7%**
Remaining Heat Demand	kWhth	35,244,446	21,669,699

5.4.8 The quantity of heat available is sufficient to supply the equivalent of 33 energy efficient households in Monkton Heathfield Urban Extension and 27 at Yeovil's Urban Extension.

5.5 Borough/District Area – Energy Contribution

5.5.1 This section determines the quantity of energy, which could be made available if organic waste is collected from the wider Borough/District in which each urban extension lies.

5.5.2 Taunton Dean Borough and South Somerset District in 2010 had 48,738 and 72,186 households respectively. Table 5-4 shows the quantity of waste collected from these households currently and assuming recycling rates approach those expected of the urban extension.

Table 5-8: Quantity and Energy Content of Waste Collected within the Borough/District

	Units	Taunton Deane	South Somerset
Number of Households inc. Urban extensions		48,738	72,186
Volume of Waste Collected - Current	t/yr	33,033	47,269
Organic Waste Collected – Current	t/yr	7,422	8,153
Organic Waste Collected – Improved	t/yr	9,249	13,235

5.5.3 At approximately 9,250 and 13,250 tonnes per year, the organic waste collected from the two districts would start to make an anaerobic digestion facility viable.

5.5.4 Table 5-9 outlines the potential energy which could be realised from the waste collected from these catchments. The table also shows the electrical and thermal energy which would be practically realised from the anaerobic digestion and combined heat and power process.

Table 5-9: Annual Heat and Electricity Potential based on Waste Collected within the Borough/District

	Units	Taunton Deane	South Somerset
Organic Waste Collected – Improved (from Table 5-8)	t/yr	9,249	13,235
Biogas Yielded	m^3/yr	1,064,611	1,694,310
Methane Content	m^3/yr	585,536	931,871
Energy Potential	kWh/yr	5,254,015	8,361,675
Annual Electricity Potential – Based on 90% Availability	kWh/yr	1,576,204	2,508,503
Annual Heat Potential – Based on 90% Availability	kWh/yr	2,521,927	4,013,604
CHP Engine Size	kWe	200	318
	kWth	320	509

5.5.5 After meeting the AD facility's requirements Table 5-10 shows the quantity of electricity available and how much of each Urban Extension's demand would be satisfied – at each urban extension, using waste collected from the district within which the extension was located.

Table 5-10: Electricity Demand Summary

	Units	Monkton Heathfield	Yeovil
Electricity Available after AD Plant Requirements	kWhth	1,182,153	1,881,377
Annual Demand	kWhth	20,988,084	13,127,886
Fraction of Electricity Demand Supplied		**5.6%**	**14.3%**
Remaining Electricity Demand	kWhth	19,805,930	11,246,509

5.5.6 The quantity of electricity available is sufficient to supply the equivalent of 352 energy efficient households in Monkton Heathfield Urban Extension and 561 at Yeovil's Urban Extension.

5.5.7 After meeting the AD facility's requirements Table 5-11 shows the quantity of heat available and how much of each Urban Extensions demand would be satisfied.

Table 5-11: Heat Demand Summary

	Units	Monkton Heathfield	Yeovil
Heat Available after AD Plant Requirements	kWhth	1,891,445	3,010,203
Annual Demand	kWhth	35,427,961	21,815,325
Fraction of Heat Demand Supplied	**-**	**5.3%**	**13.8%**
Remaining Heat Demand	kWhth	33,536,516	18,805,122

5.5.8 The quantity of heat available is sufficient to supply the equivalent of 347 energy efficient households in Monkton Heathfield Urban Extension and 898 at Yeovil's Urban Extension.

5.6 County Area – Energy Contribution

5.6.1 In order to understand the scales of waste arisings needed to sustain viable AD facilities this section considers the quantity of energy which could be made available if organic waste is collected from all of the Somerset County area. For the purposes of analysis it has been assumed that the collected waste would only be utilised in one urban extension, which would leave the other scheme to meet it energy requirements from alternative solutions.

5.6.2 Somerset County in 2010 had 237,381 households. Table 5-12 shows the quantity of waste collected from these households currently and if recycling rates approach those expected of the urban extension.

Table 5-12: Quantity and Energy Content of Waste Collected within Somerset

	Units	Somerset Waste Partnership
Number of Households		237,281
Volume of Waste Collected	t/yr	227,102
Organic Waste Collected – Currently	t/yr	43,781
Organic Waste Collected – Improved	t/yr	63,589

5.6.3 Based on the average household collection rate predicted for SWP as a whole (Table 5-1) which includes improved organic waste collection, theoretically up to 64,000 tonnes per year, of organic waste could be collected in Somerset. As noted above, the current figure is about 44,000 tonnes per year. This volume of organic waste collected from a Somerset-wide catchment would make an anaerobic digestion facility commercially viable and indeed a county-wide catchment forms the basis of the proposed new AD facility near Bridgwater which will be delivered by SWP's contractor Viridor. NB, this arisings figure excludes commercial food waste which would also be available to a new AD plant but for which accurate arisings data are not available.

5.6.4 Table 5-13 outlines the potential energy which could be realised from the organic household waste collected. The table also shows the electrical and thermal energy which would be practically realised from the anaerobic digestion and combined heat and power process.

Table 5-13: Annual Heat and Electricity Potential based on Waste Collected within Somerset

	Units	Somerset Waste Partnership
Organic Waste Collected – Improved (Table 5-12)	t/yr	63,589
Biogas Yielded	m^3/yr	6,556,005
Methane Content	m^3/yr	3,605,803
Energy Potential	kWh/yr	32,354,867
Annual Electricity Potential – Based on 90% Availability	kWh/yr	11,647,752
Annual Heat Potential – Based on 90% Availability	kWh/yr	13,589,044
CHP Engine Size	kWe	1,477
	kWth	1,724

5.6.5 After meeting the AD facility's requirements Table 5-14 shows the quantity of electricity available and how much one or other of the Urban Extensions demand would be satisfied.

Table 5-14: Electricity Demand Summary

	Units	Monkton Heathfield	Yeovil
Electricity Available after AD Plant Requirements	kWhth	8,735,814	8,735,814
Annual Demand	kWhth	20,988,084	13,127,886
Fraction of Electricity Demand Supplied (one location or the other)		**41.6%**	**66.5%**
Remaining Electricity Demand	kWhth	12,252,269	4,392,072

5.6.6 The quantity of electricity available is sufficient to supply the equivalent of 2,607 energy efficient households in either Urban Extension.

5.6.7 After meeting the AD facility's requirements Table 5-15 shows the quantity of heat available and how much of each Urban Extensions demand would be satisfied.

Table 5-15: Heat Demand Summary

	Units	Monkton Heathfield	Yeovil
Heat Available after AD Plant Requirements	kWhth	10,191,783	10,191,783
Annual Demand	kWhth	35,427,961	21,815,325
Fraction of Heat Demand Supplied (one location or the other)		28.8%	46.7%
Remaining Heat Demand	kWhth	25,236,178	11,623,542

5.6.8 The quantity of heat available is sufficient to supply the equivalent of 1,870 energy efficient households at either the Taunton or Yeovil Urban Extension.

6 ENVIRONMENTAL IMPACT

6.1.1 This section highlights the key considerations in respect of potential environmental impacts of an AD CHP facility from a site planning perspective and briefly reviews key permitting issues.

6.2 Visual Impact

6.2.1 The visual impact of an AD facility can be minimised through a range of measures including siting, screening, and cladding.

6.2.2 Locating the facility away from residential zones and nearer light industry or rural area with good road access reduces the visual impact by placing the facility in a more appropriate context and minimising direct views and simple proximity. In employment zones transport infrastructure is more geared towards handling the number of vehicle movements and the HGVs required (see below). Here too a range of other mitigation measures can be more easily be introduced.

6.2.3 In this context the facility can be screened by the topography of the land, screened from the roadside, and/or housed in aesthetically designed and clad buildings.

6.2.4 Unless the immediate area where the AD facility is located has users with a demand for heat, energy will need to be delivered to the users; this can be delivered to the core district heating network by low temperature hot water pipeline, or the biogas could be piped directly to an energy centre located closer to heat users. In this case an aesthetically designed urban energy centre can be designed and may be easier to integrate within a residential area.

6.3 Transport

6.3.1 An AD facility will increase the number of road traffic movements associated with the site. Delivery of organic waste will be an issue along with outward transfer of digestate and rejected material.

6.3.2 Table 6-1 presents the typical scale of vehicle movements for each potential waste collection scenario. Even at the highest capacity it is not considered that the level of traffic impacts would be such to impact significantly on either the local road networks or the amenity of local communities.

6.3.3 In addition to traffic impacts during operation, there will also be a number of large haulage vehicles transporting equipment and supplies to the site during construction. This may on occasion cause temporary disruption on the road network, particularly at the local level, but in the context of implementation of the wide urban extensions would not be likely to be significant. Depending on the size of the facility, the duration of the construction period is likely to be over a year.

Table 6-1: Number of Vehicle Movements

	Monkton Heathfield		Yeovil		Somerset Waste Partnership
	Urban Extension	Taunton Deane	Urban Extension	South Somerset	
Volume of Waste	957	9,249	683	13,235	63,589
Annual Vehicle Movements	48	462	34	662	3,179
Weekly Vehicle Movements	1	9	1	13	64
Daily Vehicle Movements (5 Day Week)	-	2	-	3	13

6.4 Acoustics

6.4.1 CHP engine noise emissions are very high, typically 110-120 dBA at 1m from the engine. These noise emissions can however be effectively mitigated through enclosure in an acoustic cell and use of suitable silencers. Measures will also need to be taken to protect against transmission of vibration, especially for larger units, which may need substantial foundations.

6.4.2 There are numerous examples of CHP engines installed within sensitive locations close to residential accommodation and even theatres and TV studios. Noise should not be an issue for this type of plant provided sufficient space is allocation to allow proper controls as described.

6.5 Air quality

6.5.1 Odour is a potential risk for any waste development. The odour risk will be determined and assessed as part of the planning process. Odour can be mitigated by enclosing all activities in buildings, by operating buildings under negative pressure and through the use of filters on exhaust air. Appropriate location is also significant in helping mitigate the risk of odour on nearby receptors.

6.5.2 The biogas will be combusted in a CHP engine, the emissions from which will be mainly carbon dioxide and water. The main polluting flue gas emissions from gas engines are oxides of nitrogen (NOx) and carbon monoxide. Most modern engines are designed to be “lean-burn” technologies to reduce NOx, however on a large energy centre, it may be expected that additional emissions abatement plant will be required. The usual technology for this is Selective Catalytic Reduction (SCR) that works by injecting aqueous urea into the exhaust stream. This is likely to be a requirement for any plant operated under Environmental Permitting legislation.

6.6 Carbon Dioxide

6.6.1 This section presents the Carbon Dioxide emissions for each Urban Extension for the three organic waste collection scenarios, modelled against a base case supply of heat and power from natural gas boilers and grid electricity.

Table 6-2: Monkton Heathfield Carbon Dioxide Emissions and Saving for each Waste Collection Scenario

	Units	Base Case	Urban Extension	Taunton Deane	Somerset Waste Partnership
Electricity	tCO_2/y	10,851	10,797	10,225	6,230
Heat	tCO_2/y	8,768	8,726	8,334	6,429
Total	tCO_2/y	19,619	19,523	18,560	12,659
Saving relative to Base Case			96	1,059	6,960
			0.5%	5.4%	35.5%

Table 6-3: Yeovil Carbon Dioxide Emissions and Saving for each Waste Collection Scenario

	Units	Base Case	Urban Extension	Taunton Deane	Somerset Waste Partnership
Electricity	tCO_2/y	6,787	6,744	5,792	2,166
Heat	tCO_2/y	5,399	5,366	4,708	3,060
Total	tCO_2/y	12,186	12,110	10,500	5,226
Saving relative to Base Case			76	1,686	6,960
			0.6%	13.8%	57.1%

6.7 Permitting

6.7.1 An Environmental Permit (EP) will be required for operation of any AD facility that treats waste. EPs may also be required for the storage and use of any digestate.

6.7.2 The Environment Agency operates a two-tiered system of Environmental Permitting. Standard Permits have been developed for common, often generic processes such as waste transfer, storage and low risk treatment methods. Standard Permits set out minimum operating parameter and are often limited by a certain waste throughput in tonnes per annum. The timescales and costs of applying for Standard Permits vary widely but the intention is that Standard Permits will be determined more quickly and require less administration, resulting in shorter determination times and application costs.

6.7.3 There are a number of Standard Permits which may be applicable to an AD facility. The most relevant is SR2010No15 - Anaerobic digestion facility including use of the resultant biogas. This permit is available for AD facilities with an aggregated thermal input of up to 3MW and covers use of compression and spark ignition engines, commercial gas turbines, production of fuel cells and injection of biomethane into the Grid. The location of the facility is crucial for this Standard Permit and all activities should not be within:

- 500 metres of a European Site, Ramsar site or a Site of Special Scientific Interest (SSSI);
- A specified Air Quality Management Area (AQMA);

- **<u>250 metres of any dwelling or workplace;</u>**

- 10 metres of a watercourse;

- 50 metres of any spring or well, or of any borehole not used to supply water for domestic or food production purposes;

- 250 metres of any borehole used to supply water for domestic or food production; and

- A groundwater source protection zone 1.

6.7.4 If a proposed facility does not fall within the limits of this Standard Permit a Bespoke Permit can be applied for. This process takes longer and requires detailed consultation with the Environment Agency to ensure that all potential environmental impacts have been mitigated and suitable conditions on operation have been put in place through the EP.

6.7.5 Depending on the proposed configuration and management of any AD development other EPs which may also be applicable are, Storage of digestate from anaerobic digestion plants; Composting in open windrows; and Composting in closed vessels.

6.7.6 If the facility is to process municipal, commercial and industrial waste which could contain food and catering wastes, the plant must also be approved under the Animal By-Products Regulations (ABPR). The ABPR sets out the requirements for waste treatment in terms of the temperature and treatment time for different wastes and processes. In addition, the treatment of the waste must be carried out in enclosed or covered conditions to prevent the spread of pathogens by birds and other wildlife.

7 FINANCIAL OVERVIEW

7.1.1 This section presents a high level review of the costs of anaerobic digestion with CHP technology and the potential income which could be generated.

7.2 Support Schemes

7.2.1 A range of grant supporting bodies have had their funding cut in the recent spending review, including the Carbon Trust and the Energy Savings Trust who have had their budget cut by 40%. As such upfront grants and interest free loans are not typically available unless part of an early stage development programme. The Government's main support mechanism for renewable power is the Feed in Tariff scheme for projects below 5 MW_e and the Renewables Obligation scheme for projects above 50 kW_e, but primarily greater than 5 MW_e.

7.3 Capital Costs

7.3.1 There will be a range of costs associated with development of any AD facility. Likely capital expenditure for a range of facility throughputs are presented in Table 7-1. Capital costs vary by throughput depending on the type of facility adopted. These capital costs do not include the costs of preparatory works or Grid connections, which will vary greatly depending on the location and ground conditions of any facility. Additional costs may also be incurred as a result of planning conditions such as full enclosure in a building to reduce odour or visual impact, or construction to a specific design standard.

Table 7-1: Indicative Capital Cost for AD

Capacity (annual tonnage throughput)	Indicative Capital Cost
1,000	£500,000 – £1m
10,000	£2m – £4m
25,000	£5m – £8m
50,000	£8m – £11m

Table 7-2: Indicative Capital Cost for Biogas CHP Engine, Grid Electrical Connection and Plant Side District Heating Equipment

CHP Electrical Capacity	Indicative Capital Cost
25	£150,000 - £200,000
250	£300,000 - £400,000
500	£600,000 - £900,000
1,000	£900,000 - £1.2m
1,500	£1m - £1.5m

Operational Costs

7.3.2 Operational costs will vary considerably depending on the AD technology adopted and the feedstock used. For example, a 25,000 tonne per annum capacity plant treating farm slurry will require minimal or no pre-screening, reducing upfront operating costs. This could result in operating costs as low as £6 per tonne. In contrast, a similar system treating municipal food wastes is likely to have operating costs in the region of £20 per tonne. This significantly higher cost is attributed to greater upfront screening and shredding to remove contaminants and homogenise the waste along with additional processing to meet the requirements of the Animal By-Products Regulations.

7.3.3 An onsite CHP engine generally meets the heat and power requirements of the AD facility as the least cost option. If the AD facility is not co-located with the CHP engine then consideration should be given as to how the facility will be supplied with heat and power to meet its process requirements. This will likely come from a siphoning of biogas before gas export for onsite heat generation and imported electricity. A feasibility study would be required to assess if this is economically viable.

7.4 Income

7.4.1 In each section below, the income potential for a scheme fuelled by waste collected from the designated area is shown. The reasoning and value of each line item is explained and is intended to be indicative only. Appendix C details the assumptions behind this income analysis.

Heat and Power Sales

7.4.2 The parasitic heat and power requirements of the anaerobic digestion plant are satisfied first and the balance is available to be sold. The power can be sold directly to another customer and / or exported to the grid. Heat is sold to local connected customers and if not utilised in short term, is dumped to the environment. Table 7-3 shows the income potential for heat and electricity sales and assumes that all heat and power not used by the AD plant is sold.

7.4.3 Under the Feed in Tariff scheme an installation can choose between receiving a guaranteed export credit of 3 p/kWh or opting out to sell the electricity directly. With the exception of small schemes it is more valuable to sell the power directly than to receive the export credit. In the table below only the schemes drawing waste from the Urban Extension are assumed to receive the FiT export credit.

7.4.4 Exported electricity can also receive additional income from Levy Exemption Certificates (LECs) from either Renewable Source Energy (RSE) LECs in proportion to the renewable nature of the fuel or alternatively if the scheme utilises the heat as well it is eligible to receive CHP LECs through the CHP Quality Assurance Programme (CHPQA).

7.4.5 CHP LECs are not an additional form of income, but a secondary route to receiving the LECs on the electricity generated. CHPQA is a programme where the efficiencies of a scheme are quantified and converted to a Quality Index score. A scheme which achieves a score of 100 or higher is considered Good Quality CHP and receives the full LEC value, if below the proportion of the LEC value received reduces accordingly.

7.4.6 The choice of LEC scheme thus depends on which is most advantageous each particular energy from waste scheme.

Table 7-3: Annual Income Potential from Heat and Power Sales

	Monkton Heathfield	Taunton Dean	Yeovil	South Somerset	Somerset Waste Partnership
Heat Sales	£5,872	£60,526	£4,660	£96,327	£326,137
Electricity Export Value	£3,059	£62,654	£2,427	£99,713	£462,998
LEC Value Received	£383	£4,445	£304	£7,074	£32,847

Renewable Incentive Income

7.4.7 Schemes below 50 kWe can only receive support under the Feed in Tariff Scheme, between 50 kWe and 5 MWe schemes have the option to choose between the FiTs and the Renewables Obligation, and above 5 MWe the schemes can only receive support from the RO.

7.4.8 The schemes which only collected waste from the Urban Extension would only be able to collect incentive income under the Feed in Tariff Scheme whereas those collecting a greater volume of waste and thus requiring an engine greater than 50 kWe can chose the RO scheme as well. For schemes below 500 kWe the FiT scheme is more valuable with the proposed revision to the anaerobic digestion rates proposed in the March 2011 fast track review of the scheme (see section 0). For schemes between 500 kWe and 5 MWe the RO is more valuable.

Table 7-4: Annual Income Potential from Renewable Incentive Schemes

	Monkton Heathfield	Taunton Deans	Yeovil	South Somerset	Somerset Waste Partnership
Feed in Tariff Income	£19,031	£220,669	£15,102	£326,105	£1,048,298
OR					
Renewables Obligation	n/a	£153,838	n/a	£244,830	£1,136,827

Waste Gate Fee

7.4.9 The income potential from accepting waste is uncertain and depends on the local market. In some cases high value waste may be taken for free or even paid for depending on local competition for the waste and / or the biogas production potential of the waste. For segregated food waste, the gate fee can range from £45 to £60/tonne. In this analysis, a value of £50 is assumed.

Table 7-5: Annual Income Potential from Waste Gate Fees

	Monkton Heathfield	Taunton Deans	Yeovil	South Somerset	Somerset Waste Partnership
Waste Gate Fee	£47,861	£462,460	£34,149	£661,767	£3,179,426

Total Income Potential

7.4.10 The total income potential for an anaerobic digestion and CHP scheme scales linearly with the volume of waste processed. The table below shows the potential under the FiT and RO schemes.

Table 7-6: Total Annual Income Potential

	Monkton Heathfield	Taunton Deans	Yeovil	South Somerset	Somerset County
Feed in Tariff Scheme[5]	£76,207	£810,753	£56,642	£1,190,986	£4,263,483
			OR		
Renewables Obligation		£743,922		£1,109,710	£5,138,229

[5] Based on revised rates published in March 2011 in the Fast Track Review of the Feed in Tariff Scheme.

8 ADVICE ON INTEGRATION WITH NEW AND EXISTING DEVELOPMENTS

8.1.1 This section advises on the approaches to integrating energy from waste technology into the proposed urban extension developments. This section starts with advice, which is applicable to both Monkton Heathfield and Yeovil followed by each site individually.

8.2 General Advice

8.2.1 This section looks at the aspects that will make an AD scheme located at or near each of the urban extensions viable, in the context of the earlier comments about the in-principle viability of different waste input scenarios. It considers how and where it is appropriate to site such a facility and then considering how to fill the energy gap between what can be generated by AD-CHP and demand.

Viable Anaerobic Digestion Scheme

8.2.2 Section 4 advised the minimum throughput required for an AD facility to be considered economically viable and section 5 determined the waste volumes that would be collected depending on the area it was collected from.

8.2.3 The volume of waste that would be collected from just the Urban Extensions is an order of magnitude too small to make an AD facility economically viable and should not be considered on this basis alone. AD facilities start to be economic when processing capacity exceeds 10,000 tonnes per annum. This quantity of waste is potentially available in both Taunton Deane at 9,250 t/yr and South Somerset 13,250 t/yr. At the Somerset Waste Partnership level the volume of waste available would make a facility quite profitable, however at this scale other issues will arise. Also there are already initiatives underway by the SWP for AD within the County that would draw on the same catchment.

8.2.4 An AD facility will make money on its entire electrical output net of its own parasitic requirements. The renewable incentive income from the FiT and RO schemes are intended to subsidise the costs involved in the AD process.

8.2.5 Heat generated by the engine can be regarded as a by-product and ‘free issue’. It is typically used to supply the AD facilities process requirements first and then any heat users second. If heat cannot be utilised then it is dumped to the environment.

8.2.6 If this heat is sold to a third party, it is a valuable form of addition income. However, this can only contribute to the profitability of the AD facility if the income from the district-heating scheme is sufficient to pay back the cost of a distribution network in a reasonable timeframe; this depends on the price which can be charged for heat.

Viable District Heating Scheme

8.2.7 A viable district heating scheme must be able to pay back the cost of the network and cover the capital and operational costs of any heat generation or heat recovery plant.

8.2.8 Ideally, a scheme is built around a core area with baseload demand provided by a diversity of users from residential units to businesses whose demand patterns complement each other. Based on a core scheme that gives an energy centre a viable and economic load, the district heating pipe network can be extended to supply as many additional units as is economically practicable.

8.2.9 If district heating is integrated at the master planning stage, then the network can be installed at lower cost compared to a retrofitted scheme. In addition if it can be specified as the heating system of choice it has the advantage of developers not unnecessarily ruling out district heating and removing valuable loads which may make a scheme viable.

8.2.10 A core scheme should focus on areas with density of development where high density residential and commercial centres are served with less dense developments can be treated by building specific techniques.

Potential Anaerobic Digestion, CHP, and Energy Centre Site Locations

8.2.11 The environmental impacts section identified some key issues and mitigation measures that can be used to minimise the impact of an AD facility. Key amongst these is the location/siting of the AD facility, the associated CHP unit, and the energy centre. The energy centre is a facility that provides pumping, top-up and standby heating for the district heating network. Each of these units does not necessarily have to be in the same location. The following options are potential configurations:

- AD and Energy Centre site co-located and heat piped to district heating scheme.
- AD and CHP co-located with Energy Centre located nearer to the district heating core scheme.
- AD and CHP site in different locations with biogas piped to CHP / Energy Centre.

8.2.12 The AD facility location will be affected by the following considerations:

- Ensuring access for type of vehicles expected and number of daily movements expected.
- Avoiding residential zones on delivery routes.
- Location near light industrial or rural area, but with relatively short distance to delivery of gas or heat to the district heating network.
- Potential to use landscape and topography to minimise visual impact and other screening measures.

8.2.13 The AD biogas CHP unit will be only one of a number heat sources necessary to supply a district heating scheme. Along with the networking pumping facilities, these will be located in an energy centre. The location of the energy centre will be affected by the following considerations.

- The practicality, both financial and regulatory, of piping biogas to the CHP unit located some distance from the AD facility rather than transport heat through district heating pipe.
- The choice of fuel for additional heat sources required. If biomass is selected additional deliveries will be required.

- Availability of space. An energy centre located nearer the core scheme heat users will be likely to occupy land of higher development value than land close to the AD facility.

- Whether there are significant heat users away from the core network close to the AD facility.

Meeting the Energy Shortfall

8.2.14 The potential quantity of heat and electricity produced in each of the organic waste scenarios considered in this report is not sufficient to satisfy the energy demands of either urban extension. However, in the district and county waste collection scenarios (or other catchment scenarios delivering a minimum of c.10,000 t/y of organic waste per location) the available energy can provide valuable baseload heat for a scaled down district heating scheme serving a core area of viable heat users.

8.2.15 In this scenario the AD CHP would act as lead heat source supplemented by additional CHP technology, either gas or biomass if additional CHP capacity is required and by gas or biomass boilers to provide top-up and standby heat.

8.2.16 The fundamental requirement, which is more significant than planning for an energy from waste technology per se, is that a core district heating scheme should be identified for each urban extension. Once this core scheme is identified the practicality of extending the network to meet the needs of additional users in the surround area can be assessed and added to the scheme if viable.

8.2.17 From this, a baseload demand can be identified and thus the volume of organic waste required. Alternatively if the volume of waste is constrained this process can be conducted the other way round. The size of the baseload AD CHP is not relevant to the initial scheme loads as it can dump heat to the environment without affecting its economic viability. The additional CHP and boiler capacity required to ensure security of supply can be added as appropriate as the district heating scheme expands.

8.2.18 With the area and properties to be served by the district heating scheme identified attention can then focus on residential and business units not economically served by AD. For these properties an array of renewable technologies briefly summarised below can be used to meet heat requirements:

- Solar Thermal panels can contribute to meeting hot water demand.

- Air, water, or ground source heat pumps can meet both space heating and hot water demand, but are more efficient when meeting space heating demand. This is especially true in new buildings when matched with low temperature radiators. Ground source heat pumps are easier to integrate in new build and benefit from a constant ground temperature, which improves seasonal efficiency.

- Biomass boilers may economically serve large single dwellings, a cluster of low density properties, or an apartment block which may be uneconomic to connect to district heating.

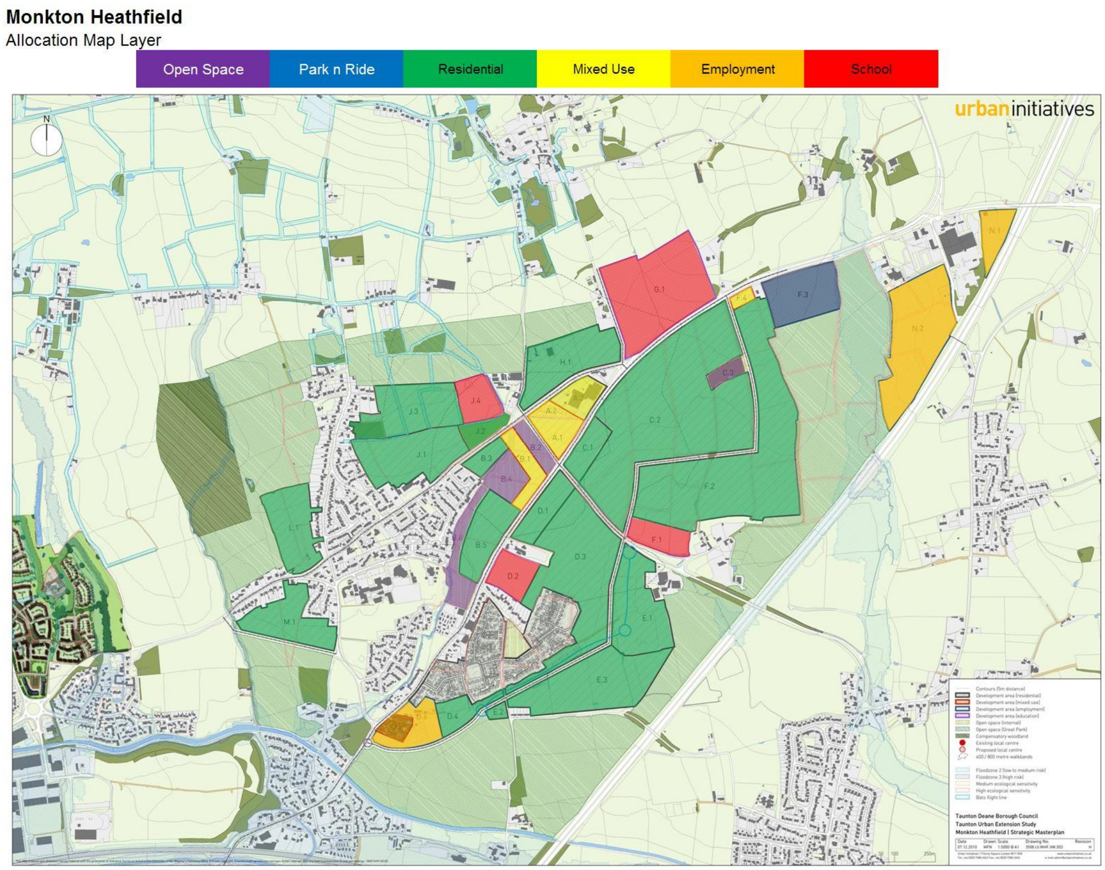
- Most if not all of these technologies will qualify for Renewable Heat Incentive payments when the domestic phase of the schemes begins in 2012.

8.3 Monkton Heathfield Urban Extension

8.3.1 The Monkton Heathfield Urban Extension is based around the village of Monkton Heathfield on the north east boundary of Taunton. The majority of the land to be developed is to east of the village. The urban extension is bounded by the M5 to the south and the roads A38 and A3259 pass though the development area.

8.3.2 The Urban Extension is planned to be built in three phases from 2012 through to 2026. Figure 8-1 presents the anticipated zoning. The scheme is centred on a mixed use areas which typically comprise a mix of retail units and flats east of the village surrounded by the residential areas on all sides. Schools are located close to residential areas whilst businesses are located on outskirts.

Figure 8-1 Monkton Heathfield Urban Extension Allocation Layer Map



8.3.3 In each phase, 80% of the developed area is residential, with primary school and employment provision appropriate for each phase. The mixed use developments which are scheduled to be built in phases two and three and the secondary school will built in phase three. Table 8-1 provides an indicative breakdown of the developed land use for each phase.

Table 8-1 Monkton Heathfield Developed Land Use Summary

Block	Residential	Primary School	Secondary School	Employment B2	Employment B8	Mixed Use
Phase One	87%	5%		8%		
Phase Two	80%	3%			13%	5%
Phase Three	78%	3%	13%		2%	3%
Total	80%	3%	6%	2%	6%	3%

Specific Energy Advice

8.3.4 The mixed use zones have a high energy density, which is an ideal area on which to base the core of a district heating scheme. The scheme can extend as far as economically practicable to serve the surrounding residential zones, practically only including the immediate zones. The scheme can then be extended to incorporate the planned schools and, if the heat demand is sufficient, also to the business areas. This recommendation is based on the current heat load assessment based on the potential loads in phase three.

8.3.5 The planned schools will have a significant energy requirement; however, they appear to have a low energy density because they have significant outdoor space allocated, whilst the residential zones have low energy density because they made up of low rise individual housing units.

8.3.6 The main employment areas located to the periphery of the development are designated for general industry and warehousing. These areas have a low energy density unless a business with a significant energy requirement locates to the area; this has not been assumed for purposes of the study.

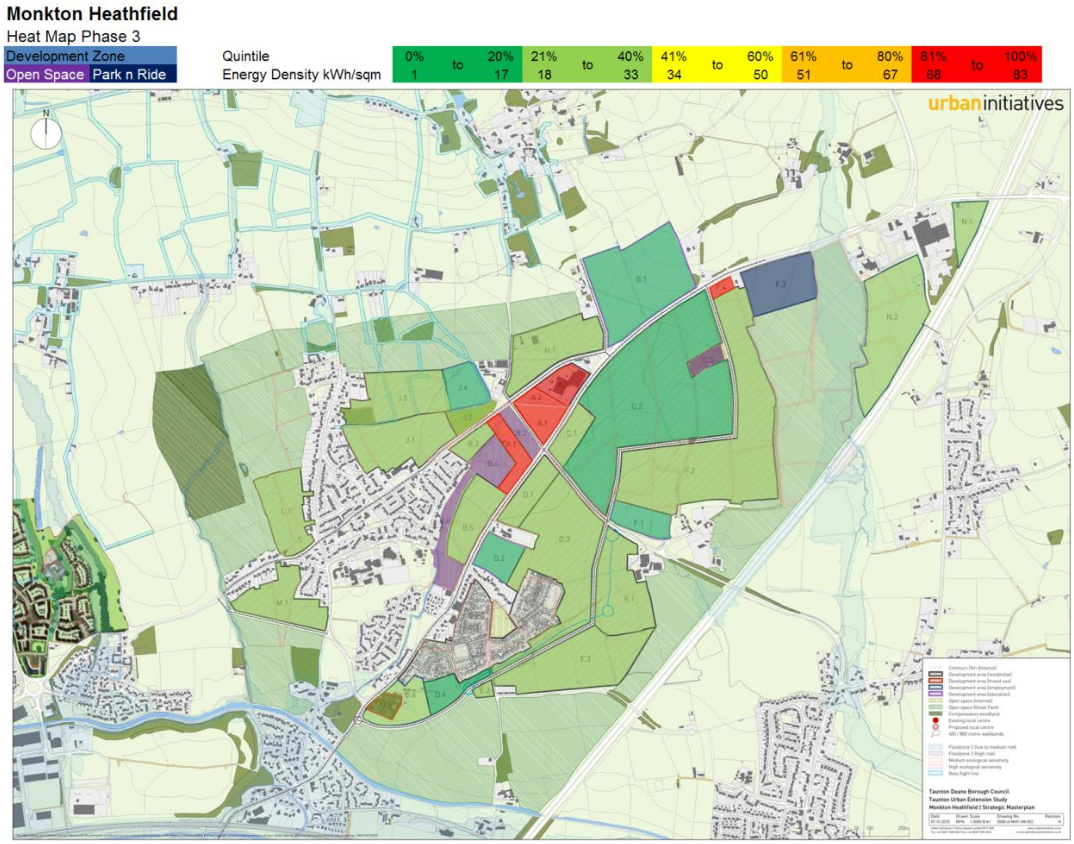
8.3.7 Appendix B shows the heat maps for each phase showing which zone is developed in each phase and the anticipated energy density.

8.3.8 In phase one from 2011 to 2016 the master plan development states residential & business zones and one primary school will be developed. These zones are to the west and south east of the village and are unlikely to provide the density of development required to make district heating viable.

8.3.9 The construction of the mixed use zones west of the village are spread over phase two (2016 – 2021) and three (2021 – 2026) as are the remaining residential & business zones, and schools.

8.3.10 Based on a core scheme around the mixed use development a district heating scheme may not be viable until the majority of phase two is complete.

Figure 8-2 Monkton Heathfield Urban Extension Heat Map



Integration

Monkton Heathfield Village

8.3.11 The existing village is composed of low density housing in the form of terraced, semi-detached, and detached houses. Integration of the existing housing stock in the village into a district heating scheme would not be economically cost effective due to the cost of laying the heat pipe network in an existing road network and installation of heat supply equipment. In addition, potential customers would need to sign up and would retain the ability to opt out of receiving district heat. Improving these buildings heat efficiency would be best talked through alternative scheme such as the 'Green Deal' [http://www.decc.gov.uk/en/content/cms/what_we_do/consumers/green_deal/green_deal.aspx] proposed by the Coalition Government and expected to start in 2012.

Firepool

8.3.12 Firepool is an urban regeneration project located in the centre of Taunton. The primary development area is based on the old livestock market. The area will be developed through to 2024 and will comprise up to 500 homes, 80,000 sqm of office space, hotel, leisure and retail facilities.

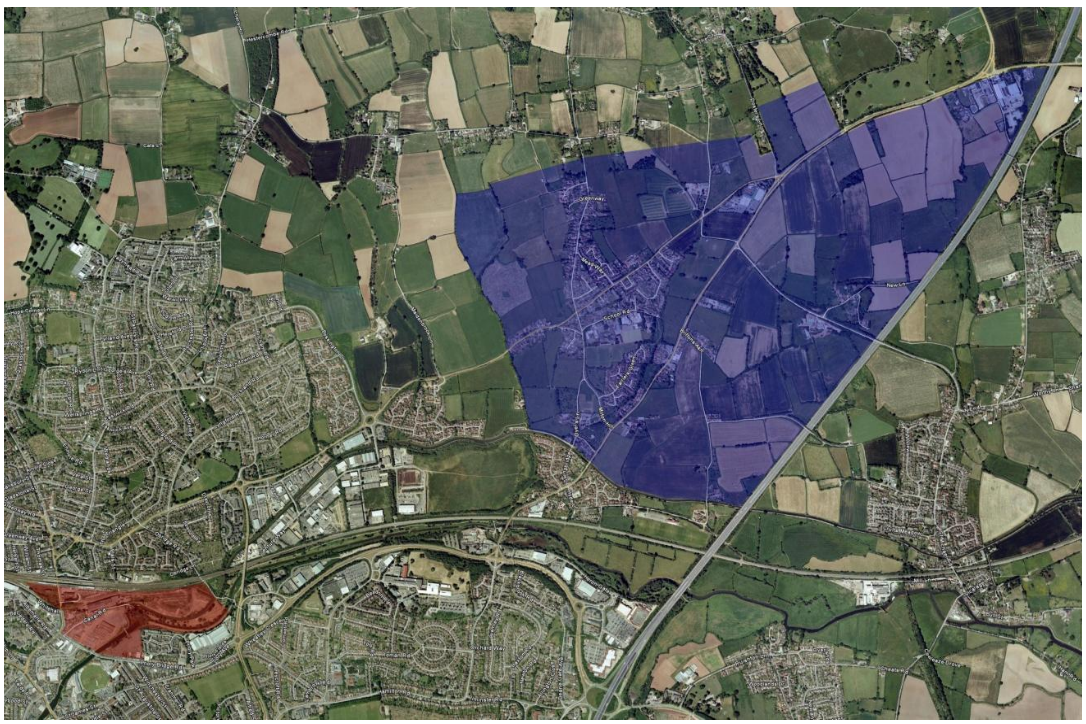
8.3.13 There is potential possible space, and demand at Firepool for a gas CHP energy centre but anything else would require a remote energy centre. This could possibly be located between Taunton and the Urban Extension.

8.3.14 The current proposals for energy supply to the development are not finalised but it is understood that CHP may already be planned. The development is planned as a dense urban centre and space at Firepool would be at premium.

8.3.15 It should be noted that Firepool is 4 km from the centre of the Monkton Heathfield Urban Extension and any potential pipeline connection would need to cross the main Great Western rail line. This would make pipe connections expensive. On the other hand this development has a more even balance of business and residential development and the planned density may better suit CHP.

8.3.16 In summary, integration of these two developments would be technically feasible and may have some commercial attractions. The commercial viability of such a connection would however not be obvious and would require a significant level of investment in time to develop.

Figure 8-3 Firepool (Red) and Monkton Heathfield Urban Extension (Blue)



Commercial Users

8.3.17 Whilst there are other potential commercial users around Monkton Heathfield the majority of these are retail parks. This type of user has relatively low density of energy demands and heat mapping information does not indicate any major loads within a reasonable distance of the development.

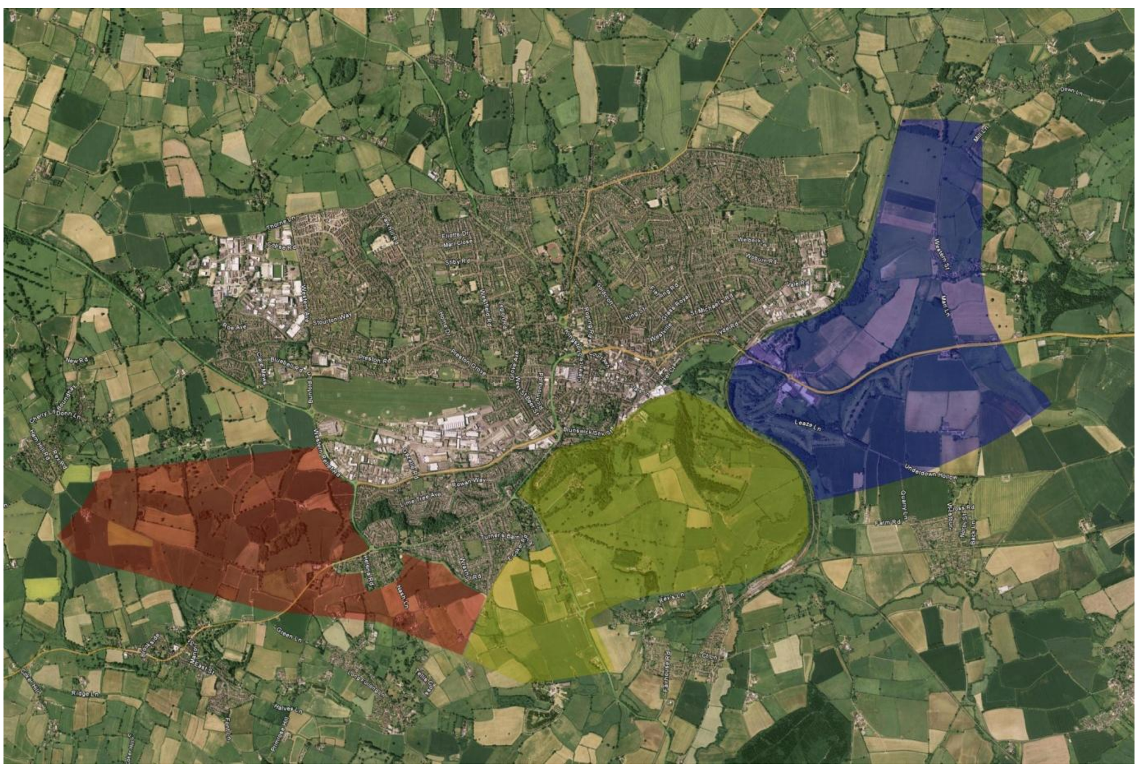
8.4 Yeovil Urban Extension

8.4.1 The location of the Yeovil Urban Extension is not defined at present but will be located within one of three potential areas shown in Figure 8-4. When selected the master planning process will begin. The three potential areas for the Yeovil Urban Extension are:

- Brympton & Coker
- East Coker, Keyford & Barwick
- East Yeovil & Over Compton

8.4.2 The area favoured in the South Somerset's Draft Core Strategy Consultation in October 2010 was East Coker, Keyford & Barwick. The area is constrained by topography and flood zones to the south and east. A railway line also bounds the area to the east as well as outlying settlements to the south and west. At the north of the proposed area is Somerset Country Park and Summer Hill House Park and Garden. The A37 passes through the area just west of Barwick village.

Figure 8-4 Yeovil Urban Extension Potential Areas



Red – Brympton & Coker, Yellow – East Coker, Keyford & Barwick, Blue – East Yeovil & Over Compton

Specific Energy Advice

8.4.3 The master planning stage of the Yeovil Urban Extension will define the layout and zone type in the East Coker, Keyford & Barwick area. The majority of the developed area will be for residential units with business and school provision appropriate to serve the requirements of the extension and the wider area.

8.4.4 The urban extension should be built around the core area with a high density heat load enhancing the commercial viability of the scheme from the start. This typically will involve a retail, offices, leisure and flats in a mixed used centre providing a consistent heat load from early morning to late evening.

8.4.5 The district heating network can then be extended as far as practicable or economically viable to serve other users in the surrounding area. This will be limited for residential area where low rise units which are space out mean that the area as a whole has a low energy density. Alternative energy solutions should be considered for residential units not served by district heating. The scheme can then be extended to incorporate the planned non residential developments including schools and business areas.

8.4.6 The location of the AD – CHP facility can also impact on the users served by a district heating scheme. For example it may be deemed practical to locate a facility on the outskirts of the urban extension and users within a reasonable distance of the main trunk connection which would connect the CHP station to the core network are more likely to be connected than users on the far side of the urban extension from the CHP station.

8.4.7 The scale of school provision for the extension will be defined in the master planning process. A school, especially a secondary school, will provide a valuable heat load, but will cost more to connect as they are typically allocated large areas for outdoor use. Key to enhancing the viability of a school is minimising the district heating connection distance from the trunk pipeline to the school plant room and extending hours of operation through additional community use in evening and weekends.

8.4.8 Larger scale employment provision will generally be located towards the outskirts of the Urban Extension where road access is better and traffic movements have less impact on the residential areas. The type of employment provision and businesses attracted can have a significant impact on the heat demand. For example, a large scale office block will have a significant space heating and hot water demand whereas a warehouse (where the contents do not need heating) requires very little. If a business with a large heat requirement were to locate to the area and this was co-located or near the AD – CHP station this would enhance the viability of the scheme. Some consideration may be required for the type and quality of heat required by such a business.

Integration

Yeovil, Barwick and Stoford Village

8.4.9 The proposed Urban Extension surrounds the housing estates in south Yeovil bounded by the A30 & A37 and the village of Barwick. Integration with either of these areas is likely to be uneconomic or practical. In each of these areas, the housing stock is composed of low density dwellings in the form of terraced, semi-detached, and detached houses. Integration of the existing housing stock in the village into a district heating scheme would not be economically cost effective due to the cost of laying the heat pipe network in an existing road network and installation of heat supply equipment. In addition, potential customers would need to sign up and would retain the ability to opt out of receiving district heat. Improving these buildings heat efficiency would be best talked through alternative scheme such as the 'Green Deal' previously mentioned.

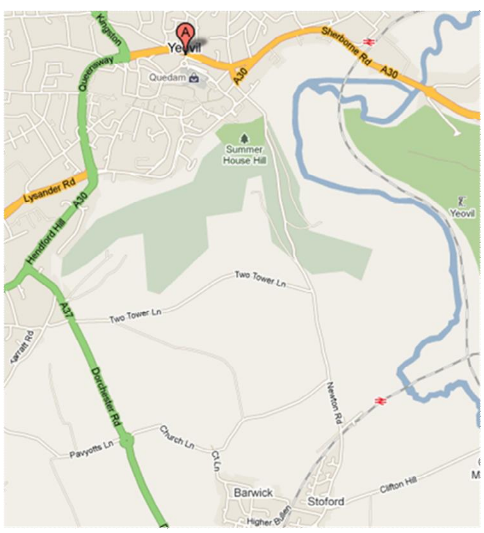
8.4.10 The village of Barwick as a whole, and part of Stoford, are considered areas with potential archaeological interest and this may impede any works if anything was found. In addition the south east part of Stoford is a conservation area and any development here (even if ultimately unseen) may have restrictions place upon it.

Commercial Loads

8.4.11 The only current potential commercial loads are to the north of the East Coker, Keyford & Barwick urban extension. This area contains retail and leisure facilities including a local leisure centre (containing a 350 sqm swimming pool), bowling & cinema complexes all of which may present a useful heat demand to enhance the viability of any district heating scheme if they can be connected at a reasonable cost. .

8.4.12 However at the top of this potential urban extension area is Somerset Country Park, Summer House Hill, and Yeovil Golf Club. These could impede the ability to connect these loads unless wayleaves can be obtained to direct the district heating main across the land or a alternative practicable route can be found; for example alongside A37 on the left hand side of the urban extension or Newton Road on the right hand side.

Figure 8-5: Barriers to Integration [mark up Somerset county park, golf club extension other side of railway line and other areas on map]



AgustaWestland

8.4.13 North West of the urban extension is the AgustaWestland industrial area. AgustaWestland is part of the Finmeccanica Company and the Yeovil factory produces transmission, blades, and is involved in the final assembly of helicopters.

8.4.14 PB have spoken to Roger Cornelius, Operations Manager at AgustaWestland. The company provided heat and electrical demand data for review. The site would be an ideal customer for power with a baseload demand of between 4 to 5 MW, twenty-four hours a day. However, as a large consumer of baseload power they are able to take advantage of this in the price they pay for power from the grid. This would limit the price, which could be achieved by a CHP plant. In addition, if power is sold to AgustaWestland the firm would cross a contractual boundary and would carry the grid factor for Carbon Electricity under the EU Emissions Trading Scheme or the Carbon Reduction Commitment Energy Efficiency Scheme, thus they would not be able to benefit from the green credentials of the electricity.

8.4.15 The site's gas demand is principally for space heating with small process loads from furnaces. The gas demand thus varies in relation to the ambient temperature with large seasonal swings in demand. The site heat distribution network which originally met the space heating demand is in the final stages of being decommissioned as buildings are converted from a 'wet' heating system to radiant heaters. Using radiant heater helps the company keep the workforce warm without unnecessarily heating the air and contents of the building. With this investment in new heating technology, the company is not looking to install a new district heating scheme.

Potential AD, CHP, and Energy Centre Locations

8.4.16 The Augusta site could provide a location for a co-located energy centre. The site only has one location suitable for an AD facility located towards the west of the facility, however AgustaWestland have advised this land may soon be earmarked for other uses. This location places the site at some significant distance from the Urban Extension heating loads. If energy centre co-location only was required then suitable sites could be found towards the east of the site, to which the biogas could be piped.

8.4.17 If as is likely an energy centre cannot be located at or close to AgustaWestland alternative locations should be considered. These locations could be more easily tailored to the requirements of an AD – CHP facility. A key consideration for this location will be access. The A303 and M5 are to the north of Yeovil and any traffic coming via these road will likely come the west along the A3088 as will traffic from west. Traffic from the east will come via the A30 and transit through the town centre.

8.4.18 The use of Newton Road as a key access route for an AD CHP facility is probably not viable and this leaves the A37 as the key access road.

9 CONCLUSIONS AND RECOMMENDATIONS

9.1.1 The total income potential for an anaerobic digestion and CHP scheme scales linearly with the volume of waste processed, whilst the cost per tonne processed decreases. This is counterbalanced slightly by the cost of drawing waste in from a greater area. Overall the larger an anaerobic digestion scheme can be made the more economic and viable it will be.

9.1.2 Both household derived and commercial organic waste can be processed in an AD facility and the use of both waste streams clearly makes it easier to reach a volume where a viable AD plant is possible. However, at the Urban Extension scale it has been shown that based on household organic waste arisings from within the new developments, neither Urban Extension can deliver sufficient organic waste arisings to even approach a viable self-supported AD facility. District-scale catchment arisings would be the lowest capacity at which AD could become commercially viable.

9.1.3 It would be possible in principle to locate an AD facility at either location as part of a district heating scheme for the new development and as part of a County-wide waste strategy. However, this potential is significantly reduced in practice at least for the time being because the SWP is already committed, with its waste contractor Viridor, to an AD plant at Walpole, Bridgwater, which should open in 2013. That plant will cater for a mix of household and commercial organic waste with up to about 21,000 of household food waste and 9,000 tonnes of commercial food and other organic wastes.

9.1.4 It is worth exploring the relationship of this plant to the Somerset-wide food waste arisings referred to in Chapter 5. The current household food waste arisings figure of about 44,000 tonnes per year and the theoretical figure of about 64,000 tonnes per year following improved collection are dependent on a range of variables, some of which are outside the control of SWP – such as the state of the economy and public attitudes to waste recycling. Therefore the plant has been sized so that there is a strong likelihood of sufficient food waste being available to run successfully. There are existing AD facilities that could accommodate short term peaks above plant capacity should they arise, and if a long term exceedance occurred then the Walpole plant could be increased in capacity.

9.1.5 It is considered unlikely that there will be sufficient household food waste arisings in Somerset in the future to make an AD plant at one or other of the urban extensions viable from that source alone. With the addition of commercial food and other suitable organic wastes this might change. It is likely that such an AD facility at one or other of the urban extensions would require developer investment as part of urban extension delivery process, perhaps secured by S106 as part of delivery of low carbon district heating. This is because the waste sector would be unlikely to invest in such a project in the context of the Walpole facility and its potential for expansion. The prospects for such an investment would also depend on the future waste collection strategy of SWP. If a combined commercial and household food waste collection was possible then SWP could control where that waste was taken for processing and additional capacity – particularly in the east of the County, covering a different catchment to Walpole, might be viable. It is not possible in this report to make recommendations on this potential beyond suggesting that Taunton Deane BC and in particular South Somerset DC, together with SWP, consider that as an option alongside future capacity needs at Walpole

9.1.6 What is considered the key requirement for the urban extensions is to ensure that district heating is provided for in the development briefing, masterplan assumptions and subsequent planning consents. This is becoming standard practice for larger scale residential and mixed use developments, and will be essential for achieving Code 5 of the Sustainable Homes grading system.

9.1.7 There will remain a substantial potential, for a variety of planning and commercial reasons, that AD does not get delivered at these locations and this highlights the need to focus on district heating and ensuring that is provided for and that it is capable of being energised by a variety of methods.

9.1.8 At the same time, of key importance in helping determine whether AD can in the future form the basis of a district heating scheme at one of the urban extensions or at another development location in Somerset, is the need to have a development management policy in the Waste LDF that requires AD (and other EfW-related process) to co-locate with a heat energy user – such as residential development, or to demonstrate why that is not possible. In that way the locational criteria for the development become more balanced between the need for a sustainable use of surplus heat and the optimum location to service a waste catchment.

9.1.9 District heating should form part of LDF Core Strategy objectives for medium to large scale new development in Taunton Deane BC and South Somerset DC and there should be a robust development management policy for each planning authority setting out how this should be delivered against different scales and scenarios of development.

9.1.10 Following consultation and review as part of this study, AgustaWestland appears not to provide a significant opportunity for integrating into a district heating strategy, other than possibly as a location for certain infrastructure. Recent investment and forward energy planning at the company means that integration with a wider energy network does not appear viable or attractive.

APPENDICES

Appendix A – Urban Extensions Energy Demand Breakdown

Monkton Heathfield

Annual Heating Demand Breakdown (All Values kWh)

	Residential	Primary School	Secondary School	Employment B2	Employment B8	Mixed Use	Total
Phase 1	6,203,630	147,157		728,986			7,079,773
Phase 2	9,109,282	235,068		-	1,905,476	2,856,812	14,106,638
Phase 3	10,720,643	269,994	679,304	-	364,229	2,207,381	14,241,550
Total	26,033,555	652,218	679,304	728,986	2,269,705	5,064,193	**35,427,961**

Peak Heating Demand Breakdown (All Values kW)

	Residential	Primary School	Secondary School	Employment B2	Employment B8	Mixed Use	Total (Non-coincidental)
Phase 1	6,830	143		759			7,732
Phase 2	10,029	228			1,888	1,592	13,737
Phase 3	11,803	262	629		361	1,322	14,376
Total	28,661	632	629	759	2,249	2,915	35,845

Annual Electricity Demand Breakdown (All Values kWh)

	Residential	Primary School	Secondary School	Employment B2	Employment B8	Mixed Use	Total
Phase 1	3,813,241	30,961		322,728			4,166,930
Phase 2	5,599,283	49,457			1,116,564	1,720,662	8,485,967
Phase 3	6,589,753	56,806	160,880		213,429	1,314,319	8,335,187
Total	16,002,277	137,224	160,880	322,728	1,329,993	3,034,981	**20,988,084**

Peak Electricity Demand Breakdown (All Values kW)

	Residential	Primary School	Secondary School	Employment B2	Employment B8	Mixed Use	Total (Non-coincidental)
Phase 1	3,415	49		285			3,748
Phase 2	5,014	78			708	635	6,435
Phase 3	5,901	89	221		135	539	6,886
Total	14,330	216	221	285	844	1,173	17,069

Yeovil Urban Extension

Annual Heating Demand Breakdown (All Values kWh)

	Residential	Employment	Primary School	Secondary School	Total
Total Scheme	20,301,250	531,576	481,568	500,931	21,815,325

Peak Heating Demand Breakdown (All Values kW)

	Residential	Employment	Primary School	Secondary School	Total (Non-coincidental)
Total Scheme	22,350	531	467	467	23,815

Annual Electricity Demand Breakdown (All Values kWh)

	Residential	Employment	Primary School	Secondary School	Total
Total Scheme	12,478,750	429,180	101,320	118,636	13,127,886

Peak Electricity Demand Breakdown (All Values kW)

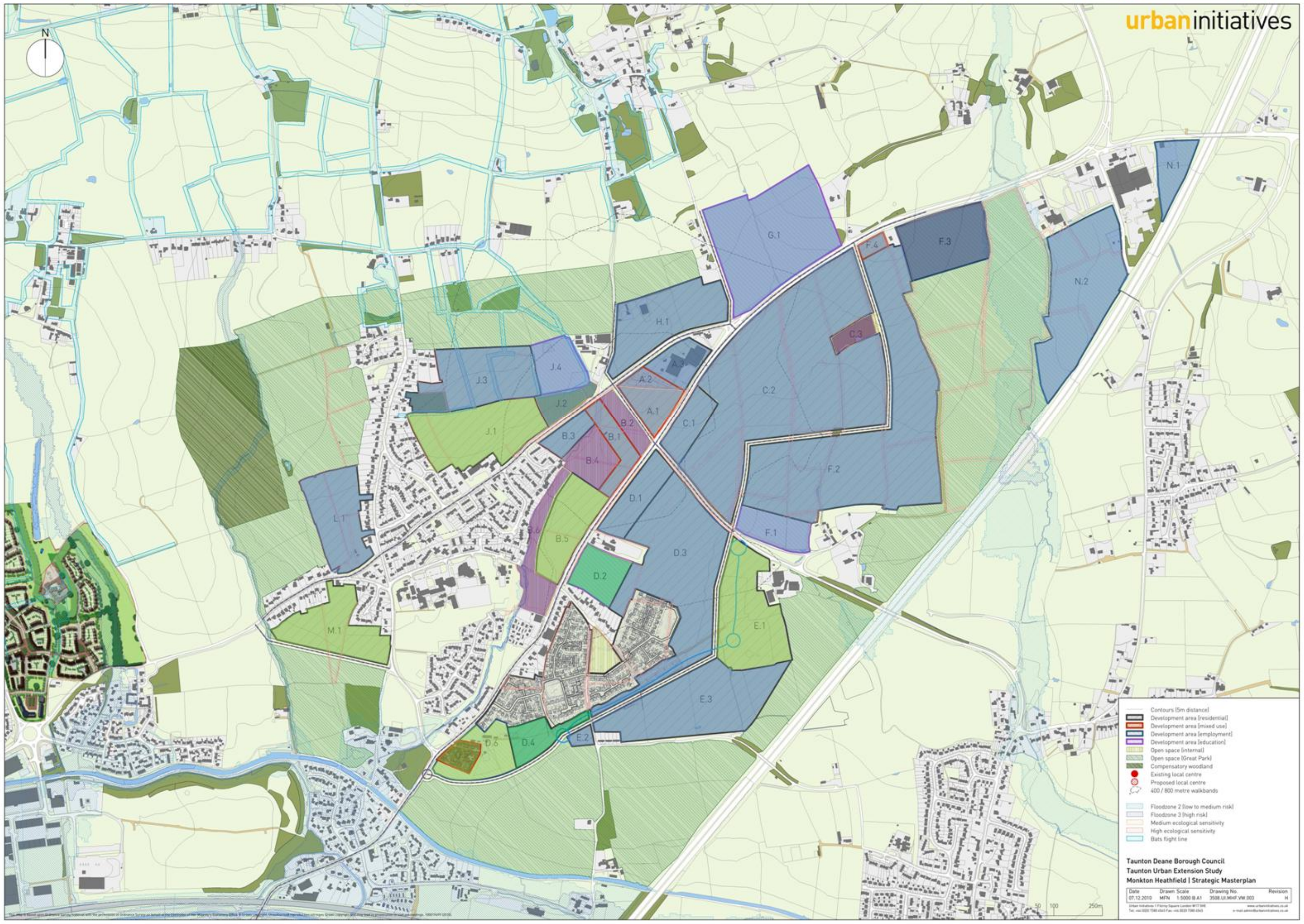
	Residential	Employment	Primary School	Secondary School	Total (Non-coincidental)
Total Scheme	11,175	207	159	163	11,704

APPENDIX B – MONKTON HEATHFIELD HEAT MAPS

Monkton Heathfield

Heat Map Phase 1

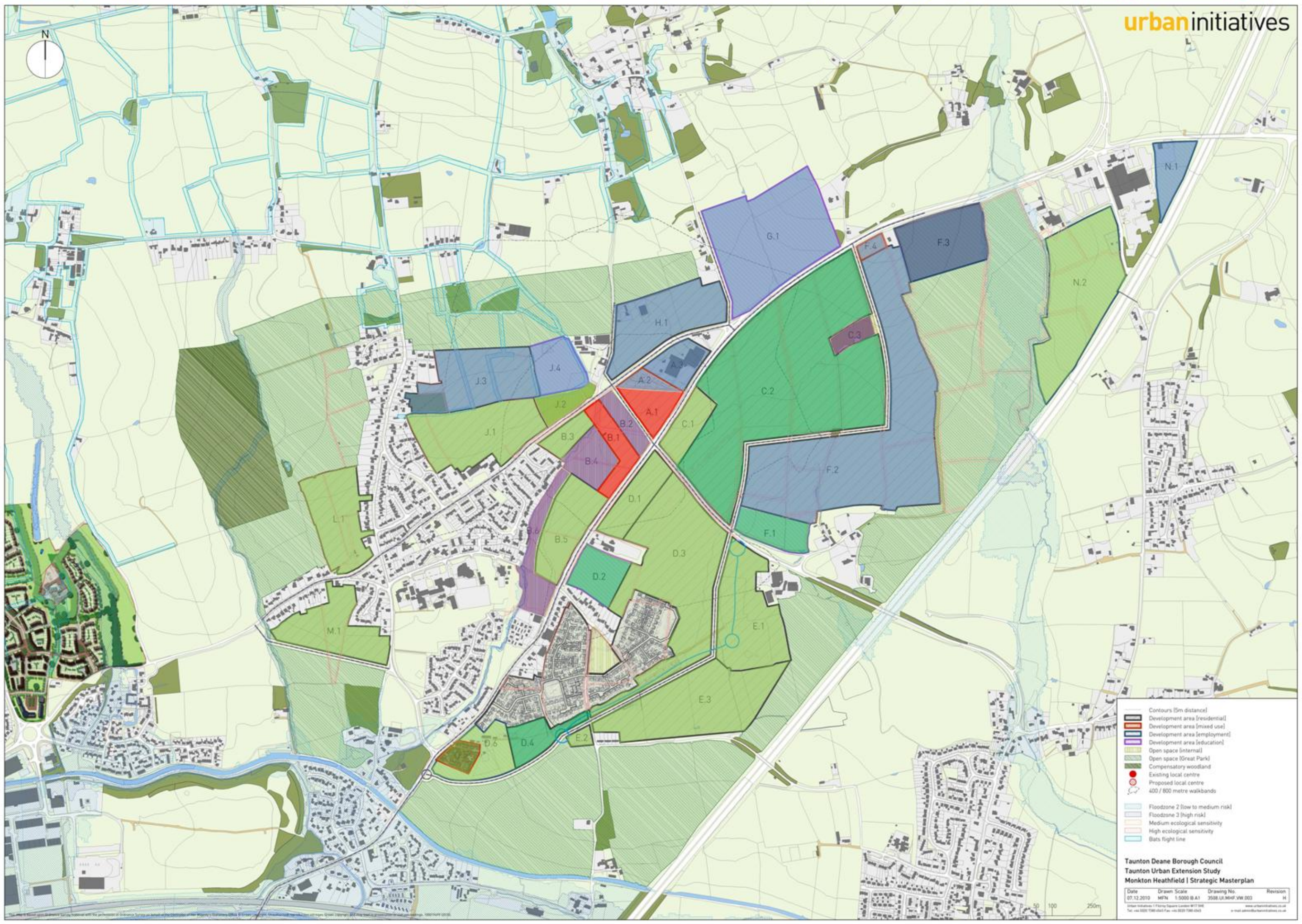
Development Zone		Quintile	0%	to	20%	21%	to	40%	41%	to	60%	61%	to	80%	81%	to	100%
Open Space	Park n Ride	Energy Density kWh/sqm	1		17	18		33	34		50	51		67	68		83



Monkton Heathfield

Heat Map Phase 2

Development Zone		Quintile	0%	to	20%	21%	to	40%	41%	to	60%	61%	to	80%	81%	to	100%
Open Space	Park n Ride	Energy Density kWh/sqm	1		17	18		33	34		50	51		67	68		83



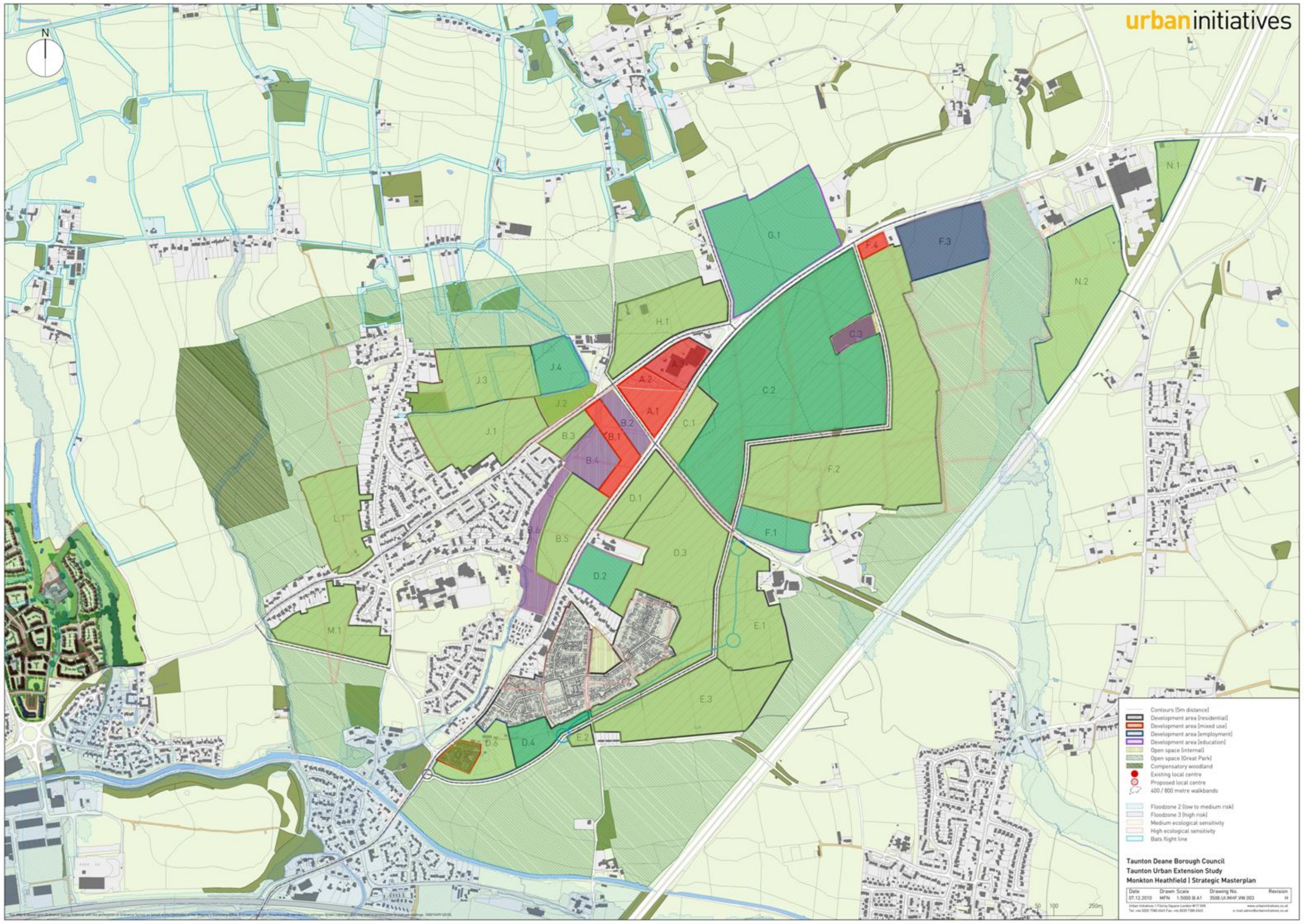
Monkton Heathfield

Heat Map Phase 3

Development Zone

Open Space | Park n Ride

Quintile	0%	to	20%	21%	to	40%	41%	to	60%	61%	to	80%	81%	to	100%
Energy Density kWh/sqm	1		17	18		33	34		50	51		67	68		83



APPENDIX C – FINANCIAL ASSUMPTIONS

Table A-0-1: Assumptions That Apply To both CHP and Gas Grid Injection Options

Parameter	Assumption / Reason	Value
Biogas value	Biogas is assumed to be free issue	0 p/kwh
Biogas composition	Methane Content	55%
CO2	CRC Value	£12 per tonne

Table A-0-2: CHP Option Assumptions

Item	Assumption	Value
Anaerobic Digestion and CHP Plant Availability	Best practice anaerobic digestion and CHP plants with biogas stores and combustion backup heat only plant.	90%
Heat and electricity priority order	The anaerobic digestion site has priority for heat and electricity before it is made available to the other consumers.	
CHP engine	Quotation for including installation from engine manufacturer.	
CHP engine servicing	Quotation for serving of engine from 0 to 120,000 hours including parts and labour from engine manufacturer	
Anaerobic digestion plant parasitic requirements	Heat and electricity supplied is free issue	
Electricity exported to Grid	UK base load power price for April 2011 from Utilyx Market Intelligence Report, 28th January 2011	5 p/kWh
Heat exported to domestic users	20% discount to the British Gas Standard Tariff for Gas excluding Standing Charge and VAT – March 2011	2.85 p/kWh
CHP LEC value	CHP engine meets CHPQA threshold	£4.70 per MWh
CHP LEC value received		80%
Renewable Obligation Credit Value	24th February 2011 ROC auction average value. Source http://www.e-roc.co.uk/trackrecord.htm	£48.80 per MWh