Thurrock Energy Study

Assessment Of Renewable and Low-Carbon Energy Generation Opportunities for Thurrock Council

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on behalf of The Carbon Trust
for Thurrock Council

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EXECUTIVE SUMMARY

This report presents the results of an Energy Study of Thurrock Council's Planning Policies carried out by DWEcoCo. This survey and report are provided by the Carbon Trust, whose activities are grant funded by the Department for Environment, Food and Rural Affairs, the Department for Business, Enterprise and Regulatory Reform, the Scottish Government, the Welsh Assembly Government and Invest Northern Ireland.

The agreed scope of work was to produce evidence base to supports the proposed Planning Policies and evaluate feasibility of the renewable energy targets in new residential and non-residential buildings. The report reviews the following aspects of the policy implementation:

The renewable energy targets and their feasibility:
The renewable energy targets proposed in the Planning Policy are well in line with proposed changes to the Building Regulations and their impact on the performance of new buildings is only going to be substantial prior to the introduction of Zero Carbon national Building Regulations. The Zero Carbon Building Regulations will inherently require the developer to review and install most suitable renewable technology on-site or to opt for an 'allowable solution' (still to be defined, contribution to a carbon offset fund may be an option is no other solution is viable or feasible). The cost of meeting the renewable energy targets using individual renewable energy systems varies between £79 and £155 per m2 of floor area to meet the 20% target for non-domestic buildings (see chapter chapters 6.4 for more details).

The resource availability in the Borough:
The available resources for these technologies has been reviewed in and 10. There are resources to meet the required targets. The potential supply options are primarily the solar and biomass energy.

Opportunities for Priority Locations and Locations adjacent to Priority Locations:
The guidance on assessment of priority locations is provided in the Report. Thurrock Council's Policy PMD13 will require all opportunities for establishing district energy networks to be taken up within the Priority Locations, where they would provide higher proportions of renewable or low carbon energy to be delivered than the stipulated percentages of renewable energy generation in point (1) of the Policy. PMD13 also requires other developments considered suitable for connection to existing or feasible district energy networks to be designed to enable connection to such networks. The study supports this policy as it demonstrates that in developments of a certain size and density, it will be less capital intensive for the developer to connect to a district energy network instead of providing individual renewable energy systems to the developments. Higher density developments having fewer possibilities to include individual renewable technologies will be even more driven towards district energy networks

Designing and ESCO company:
The entity investing into and operating the district heating scheme will have to take a long term view on the investment. The Thurrock Council may therefore take a stake in such entity or form such entity themselves since public investments are typically less demanding on the internal rate of return of projects. The company can not only operate the district heating system but could also provide building retrofitting. Combining the billing system for the district energy network and the energy efficiency retrofitting service, the Council could create an efficient '*pay-as-you-save*' scheme.

The Carbon Offset Fund:
The Carbon Offset Fund is a very valuable tool for getting maximum leverage of capital for carbon emission abatement. The existing building retrofit and investment into district heating network may be the most suitable use of such contributions. As such, the contribution should be based on the actual cost of such measures. The payment into the carbon offset fund could be used for financing the connection of buildings to the district heating system. Considering the political implications of proposing a very high carbon offset price this report recommends using the carbon offset cost of £200 per tonne of CO_2 produced annually. This figure may be revisited once the full Zero Carbon policy comes into force.

THE ACTION PLAN

The following activities are to be undertaken to achieve the desired impact of the proposed policies:

Renewable Energy Targets	The currently proposed targets are in line with requirements of other Local Authorities. The increased targets after 2015 will have a minimum additional impact when compared to the Building Regulations. Continuous decarbonisation of the electricity grid and technology innovation will also decrease the overall requirement of the carbon to be offset and the cost of the offset. The targets are expressed as a proportion of the predicted energy. We recommend the methodology is based on carbon emission reductions rather then units of energy because each energy source has a different carbon intensity. The 10% of predicted energy of the development is therefore going to be expressed in kg/tonnes of carbon to be mitigated through the use of the renewable or low carbon energy. This approach will be more robust, transparent and in line with the Building Regulations. A sample methodology for such a calculation is included in the Report in Section 11.4 of this report.
Cost of meeting the renewable and zero carbon energy targets	The costs of meeting the targets have been evaluated together with a sample high level feasibility of a district energy network. The analysis has shown that a district energy network can be financially attractive to a private investor even if individual developers only make contributions equal to the avoided cost of providing individual renewable and low carbon technology installations. At the same time developers could acquire, by their contributions, a stake in the ESCO company and get a return on their investment. In contrast the investment in renewable and low carbon energy systems installed in individual buildings will not be a source of revenue since the system is sold with the building/dwelling. Thus there is an inherent advantage for individual developers to invest in, and connect to, district energy networks.
Priority locations	The Strategic Housing Land Availability Review and the Proposed Employment Areas document outline the likely scenarios for developments in the Borough. The following uncertainties have a substantial impact on the district energy networks feasibility: • the uncertainty of the phasing of non-domestic developments • the uncertainty of the connection rate to the district energy network by existing buildings • the final density of new residential units on individual sites. The feasibility of each site has to be assessed separately. A feasibility study for a central energy centre on site will be required for sites which consist of any of the following or combination of the following characteristics: • residential developments of 100 dwellings and more • residential developments on land larger than 2 ha • non-residential developments larger than 10,000 m2 The potential for smaller developments to connect to a network should be reviewed using the following distances as guidance: • <20 dwellings within 50 meters from an existing or proposed district energy network • 20-30 dwellings within 100 meters from an existing or proposed district energy network

	• 31-40 dwellings within 150 meters from an existing or proposed district energy network • > 40 dwellings within 200 meters from an existing or proposed district energy networks. Non-residential developments within 200 meters of a CHP or CCHP powered energy network should connect to the network unless it is demonstrated that there is not enough heating demand in the development for an efficient connection. Non-residential uses are important in helping to create a diversity of demand for heat so the system can be used efficiently at all times.
The resource availability in the Borough	There are sufficient renewable energy resources to meet the renewable and low carbon energy requirements of the new developments proposed in the Borough. The viability of specific renewable energy systems will likely be determined by restrictions on space, solar access and wind access on specific sites.
ESCO company	The establishment of district energy networks requires support from the Council. The Council should therefore start developing its own ESCO company by partnering with an experienced operator. The ESCO can be both an energy supply ESCO and a local retrofitting company. This combination might work best if the Council were setting up a 'pay-as-you-save' scheme. There are opportunities for much higher leverage of such invested capital. The start up funding for the ESCO could come from within the UK or through EU programmes such as ELENA or JESSICA which are administered by the European Investment Bank. The first steps to be undertaken for setting up an ESCO partnership are: 1. apply for funding to the EIB or UK Govt. to employ an experienced company to develop a business plan for the ESCO and a tender package for an experienced district energy network partner and retrofit contractor; 2. negotiate with the reputable companies on the tender list or go to tender to find suitable ESCO partners; 3. develop the first district energy network for publicly owned buildings in an area of high density and campaign/market the scheme to attract other connections and extend the network; 4. offer a 'pay as you save' retrofitting service to those buildings connected to the network using the network's billing system to make repayments for the costs of retrofitting simple to collect (on bill financing). This incentivises retrofitting thus helping to achieve the carbon reduction target and allows the network to expand while minimising the energy required to operate the network. 5. market the services of the ESCO to enable the development of a series of district energy networks with existing building owners and new building developers. 6. market the ESCO retrofitting service to all building owners and use Carbon Offset Funds and government programmes to incentivise retrofitting and provide innovative financing options for retrofitting.
Carbon Offset Fund	The Council can use the means of collecting the Carbon Offset Fund contributions as outlined in the proposed policy. This will have to be reviewed prior to 2014 when the new Community Infrastructure Levy regulations are implemented. We do not propose to use the EU Emissions Trading Scheme (ETS) for calculating the tariff. The fluctuations in the cost of emission allowances

	under the ETS could result in sudden step changes of the carbon offset tariff and result in unnecessary uncertainty for the developer. The cost of offsetting carbon locally does not follow the cost and pattern of the ETS. We recommend a fixed tariff is used, adjusted annually for inflation, which can be reviewed and become more stringent when the Zero Carbon Policy comes into use. The tariff of £200 per tonne of CO2 is proposed for the interim phase.

1 INTRODUCTION

This report presents the results of an Energy Study of Thurrock Council's Planning Policies carried out by DWEcoCo. This survey and report are provided by the Carbon Trust, whose activities are grant funded by the Department for Environment, Food and Rural Affairs, the Department for Business, Enterprise and Regulatory Reform, the Scottish Government, the Welsh Assembly Government and Invest Northern Ireland.

The agreed scope of work was to produce evidence base to supports the proposed Planning Policies and evaluate feasibility of the renewable energy targets in new residential and non-residential buildings.

2 POLICY BACKGROUND

2.1 Worldwide Strategy

Buildings worldwide account for 40% of global energy consumption and the resulting carbon footprint significantly exceeds that of all modes of transportation combined. Attractive opportunities exist to reduce buildings' energy use at lower costs and higher returns than most other energy using sectors of society. Building energy reductions are fundamental to support the International Energy Agency's (IEA) target of a 77% reduction in the planet's carbon footprint against the 2050 baseline to reach stabilized CO2 levels recommended by the Intergovernmental Panel on Climate Change (IPCC). Taking account of the energy savings resulting from efficiency investments, even including those not justified by conventional economics, the net cost additions to achieve the IEA target will only add 7% to building costs worldwide[1].

2.2 EU Strategy for the Built Environment

There are about 210 million existing buildings in the EU and most need a deep retrofit to achieve the EU's 2050 target of an 80-95% CO2 emissions reduction. This target can be met with a deep retrofit of 5 million buildings per year on average over the next 40 years. A deep retrofit is one that achieves an 84% energy reduction compared to current consumption[2]. The need for mandatory energy saving targets for retrofitted buildings is becoming more evident and the EU recommends that retrofits should achieve the energy performance standards of new buildings. The challenge to the construction industry is to achieve the energy savings while not compromising the indoor environmental quality.

1 WBCSD: Energy Efficiency in Buildings
2 E2APT: The Fundamental Importance of Buildings in Future EU Energy Saving Policies

2.3 EU policy

Energy accounts for 80% of all greenhouse gas emissions in the EU. Determined to fight against climate change, the EU is committed to reducing its own emissions by at least 20% by 2020. It also calls for the conclusion of an international agreement which will oblige developed countries to reduce their greenhouse gas emissions by 30% by 2020. In the framework of this agreement, the EU would set itself a new objective of reducing its own emissions by 30% compared with 1990 levels. These objectives are at the heart of the EU's strategy for limiting climate change. Reducing greenhouse gas emissions involves using less energy (reducing demand) and using more clean energy (renewable supply).

2.3.1 Energy efficiency

It is always more cost effective to reduce demand than it is to provide a renewable energy supply. Reducing energy demand by 20% by 2020 is the EU's objective in its Action Plan for Energy Efficiency (2007-2012). This can only be achieved with combined efforts in all sectors of society including: the transport sector, the development of minimum efficiency requirements for appliances, awareness raising amongst consumers about economic energy use, improving the efficiency of the production and distribution of heating and electricity, developing renewable energy technologies and improving the energy performance of buildings. The EU also hopes to achieve a common global approach for saving energy through the conclusion of an international agreement on energy efficiency.

2.3.2 Measure for energy efficiency in the building sector

Energy consumption in residential and commercial buildings represents around 40% of total energy use in the EU. The recast of the EPDB (Energy Performance of Buildings) Directive was approved on 19 May 2010. The main highlights of the recast version are:

- As of 31 December 2020 new buildings in the EU will have to consume 'nearly zero' energy and the energy will be 'to a very large extent' from renewable sources.
- Public authorities that own or occupy a new building should set an example by building, buying or renting such 'nearly zero energy building' as of 31 December 2018.
- The definition of very low energy building was agreed as: "nearly zero energy building means a building that has a very high energy performance, determined in accordance with Annex I. The nearly zero or very low amount of energy required should to a very significant level be covered by energy from renewable sources, including renewable energy produced on-site or nearby"
- There is no specific target set for the renovation of existing building, but Member States shall follow the leading example of the public sector by developing policies and take

measures such as targets in order to stimulate the transformation of buildings that are refurbished into very low energy buildings.

Member States will be required to introduce penalties for non-compliance. Member States shall lay down the rules on penalties applicable to infringements of the national provisions adopted pursuant to this Directive and shall take all measures necessary to ensure that they are implemented.

2.3.3 Renewable energy

The use of renewable energies (wind power, solar energy, biomass and biofuels, geothermal energy and heat-pump systems) undeniably contribute to limiting the anthropogenic causes of climate change. To increase the use of renewable energy sources, in its Renewable Energies Roadmap the EU has set itself the objective of increasing the proportion of renewable energies in its energy mix by 20% by 2020.

This objective requires progress to be made in the three main sectors where renewable energies are used: electricity (increasing the production of electricity from renewable sources and allowing the sustainable production of electricity from fossil fuels, principally through the implementation of CO2 capture and storage systems), biofuels, which should represent 10% of vehicle fuels by 2020, and finally heating and cooling systems. Each Member State has a target calculated according to the share of energy from renewable sources in its gross final consumption for 2020. This target is in line with the overall '20-20-20' goal for the EU Community.

2.4 National Policy Framework and Targets

The UK Climate Change Act (2008) sets a legally binding target for reducing UK CO2 emissions by at least 80% by 2050. The Climate Change Act is also supported by the Low Carbon Transition Plan which sets the binding carbon budgets. The first budgets were announced in 2009 with the aim to achieve 34% reduction in emissions by 2020.

The Low Carbon Transition Plan also refers to piloting "pay as you save" ways to help people make their whole house greener – the savings made on energy bills will be used to repay the upfront costs. This model will be further described in the section 12 as the business model for Carbon Offset Fund spending.

2.4.1 UK Renewable Energy Strategy

Under the Renewable Energy Directive, the UK has interim targets to achieve the following shares of renewables: 4.0% in 2011-12; 5.4% in 2013-14; 7.5% in 2015-16; 10.2% in 2017-18 and 15% in 2020. The lead scenario as published in the UK Renewable Energy Strategy 2009 suggests the following targets for sectors of energy consumption:

- More than 30% of our electricity generated from renewables, up from about 5.5% today. Much of this will be from wind power, on and offshore, but biomass, hydro and wave and tidal will also play an important role.
- 12% of our heat generated from renewables, up from very low levels today. We expect this to come from a range of sources including biomass, biogas, solar and heat pump sources in homes, businesses and communities across the UK.
- 10% of transport energy from renewables, up from the current level of 2.6% of road transport consumption. The Government will also act to support electric vehicles and pursue the case for further electrification of the rail network.

Such a scenario will only be possible with strong, co-ordinated efforts from a dynamic combination of central, regional and local Government and the Devolved Administrations, as well as other public groups, the private sector and dedicated community groups and individuals.

2.4.2 Support for Renewable Energy in UK

The Renewable Obligation (RO) is the main support scheme for renewable electricity projects in the UK. It places an obligation on UK suppliers of electricity to source an increasing proportion of their electricity from renewable sources. The UK's current target is that 15.4% of the UK's electricity supply will come from renewable resources by 2016 through measures in the RO. A Renewables Obligation Certificate (ROC) is a green certificate issued to an accredited generator for eligible renewable electricity generated within the United Kingdom and supplied to customers within the United Kingdom by a licensed electricity supplier. One ROC is issued for each megawatt hour (MWh) of eligible renewable output generated. The ROCs do not apply to installation < 50kW and are optional for installations greater than 50kW but smaller than 5 MW installed. Those installation which are not eligible or do not opt for the use of Renewable Obligation Certificates can be eligible for Feed-in Tariffs.

Feed-in Tariffs (FITs) became available in Great Britain on 1st April 2010. And isn't available in Northern Ireland - although this is under review. Under this scheme energy suppliers have to (compulsory for big six suppliers) make regular payments to householders and communities who generate their own electricity from renewable or low carbon sources. The scheme covers the following electricity-generating technologies, up to an installation size of 5 Megawatts (MW). The generator will receive payment in the form of generation tariff and export tariff. The generation tariff is a set rate paid by the energy supplier for each unit (or kWh) of electricity generated. This rate will change each year for new entrants to the scheme (except for the first 2 years), but once the installation joins the scheme, it will continue on the same tariff for the lifetime of the technology. The export tariff is a further payment from the energy supplier who will pay additional 3p/kWh for each unit exported back to the electricity grid. The export rate is the same for all technologies. The technologies covered under this scheme and current tariffs are included in the Annex 3: Feed-in tariffs.

2.5 Planning Policy – UK regulations

2.5.1 Planning Policy Statement 1

Planning Policy Statements (PPS) set out the Government's national policies on different aspects of land use planning in England. PPS1 sets out the overarching planning policies on the delivery of sustainable development through the planning system.

The PPS1 requires the Planning Authorities to set out a target percentage of the energy to be used in new development to be supplied from renewable or low-carbon energy sources. More stringent targets can be required from development area where higher renewable and low carbon energy contributions can be provided most cost-effectively. The Council has to provide clear justification for selecting the sites for more stringent targets. A spatial planning approach should be at the heart of planning for sustainable development.

2.5.1.1 PPS1 Supplement on Climate Change

This supplement summarises guidance on local requirements on sustainable buildings.

Planning authorities, developers and other partners in the provision of new development should engage constructively and imaginatively to encourage the delivery of sustainable buildings. Accordingly, planning policies should support innovation and investment in sustainable buildings and should not, unless there are exceptional reasons, deter novel or cutting-edge developments. Planning authorities should help to achieve the national timetable for reducing carbon emissions from domestic and non-domestic buildings.

There will be situations where it could be appropriate for planning authorities to anticipate levels of building sustainability in advance of those set out nationally. When proposing any local requirements for sustainable buildings planning authorities must be able to demonstrate clearly the local circumstances that warrant and allow this. These could include an evidence there are clear opportunities for significant use of decentralised and renewable or low-carbon energy; or

- without the requirement, for example on water efficiency, the envisaged development would be unacceptable for its proposed location

When proposing any local requirement for sustainable buildings planning authorities should:

- focus on development area or site-specific opportunities;
- specify the requirement in terms of achievement of nationally described sustainable buildings standards, for example in the case of housing by expecting identified housing proposals to be delivered at a specific level of the Code for Sustainable Homes;

- ensure the requirement is consistent with their policies on decentralised energy; and
- not require local approaches for a building's environmental performance on matters relating to construction techniques, building fabrics, products, fittings or finishes, or for measuring a building's performance unless for reasons of landscape or townscape.

Planning authorities should:

- ensure what is proposed is evidence-based and viable, having regard to the overall costs of bringing sites to the market (including the costs of any necessary supporting infrastructure) and the need to avoid any adverse impact on the development needs of communities;
- in the case of housing development and when setting development area or site-specific expectations, demonstrate that the proposed approach is consistent with securing the expected supply and pace of housing development shown in the housing trajectory required by PPS3, and does not inhibit the provision of affordable housing; and
- set out how they intend to advise potential developers on the implementation of the local requirements, and how these will be monitored and enforced.

2.5.2 Planning Policy Statement 22

Planning applications for renewable energy projects should be assessed against specific criteria set out in regional spatial strategies and local development documents. This includes a requirement for a percentage of the energy to be used in new residential, commercial or industrial development to come from onsite renewable energy developments.

Policies should set out the criteria that will be applied in assessing applications for planning permission for renewable energy projects. The wider environmental and economic benefits of all proposals for renewable energy projects, whatever their scale, are material considerations that should be given significant weight in determining whether proposals should be granted planning permission.

The Council must determine the degree to which it is reasonable to support a renewable energy scheme in the context of any adverse impact on the local environment or community which may outweigh the local and wider benefits they offer in producing energy or reducing pollution to land, air or water for example.

Planning authorities should only allocate specific sites for renewable energy in plans where a developer has already indicated an interest in the site, has confirmed that the site is viable, and that it will be brought forward during the plan period. This provision should not be interpreted too restrictively in the light of recent policy changes. However, specific sites that are allocated for RE or

Low Carbon generation should realistically be deliverable during the life of the development plan. The issue of viability should be determined on a case by case basis.

The Local Development documents should not include policies in relation to separation distances from power lines, roads, and railways. It is the responsibility of developers to address any potential impacts, and legislative requirements on separation distances, before planning applications are submitted.

2.5.3 Other PPS and PPG

Draft PPS: Planning for a Low Carbon Future in a Changing Climate is a draft replacement for PPS22 and PPS1. The proposed draft amends the wording with respect to targets in that it does not state that Local Authorities ‘should’ implement specific targets but describes how the targets should be expressed ‘if used’. This document is currently in consultation.

The following other national policies are relevant to the adoption of new policies and their implementation from an environmental point of view: PPS3: Housing; PPS5: Planning for the Historic Environment; PPS10: Planning for Sustainable Waste Management; PPS12 Local Spatial Planning 2008 – the approach to good infrastructure planning; PPG13 Transport; PPG24 Noise; and PPG25: Development and Flood Risk.

2.6 Building Regulations

2.6.1 Domestic Buildings

The government’s aim is that all new dwellings should be zero carbon by 2016 and sets out a delivery timetable with step changes to the Building Regulations in 2010, 2013 and 2016.

All new public housing has to achieve Code level 3 (Code for Sustainable Homes) as a minimum standard. This level is non-compulsory for private housing developments. The Code level 4 will be compulsory for all new residential developments from 2013 (equivalent to 44% reduction in target emission rate). All new dwellings will have to be zero carbon from 2016. This is equivalent to the Code level 6.

Code level 3 is an equivalent of 25% CO2 reduction compared to the 2002 Building Regulations.

2.6.2 Non-domestic Buildings

The new Part L for Buildings other than Dwellings is coming to force in October 2010. The specification delivers an overall 25% reduction in CO2 emissions across the new-build mix for the non-dwellings sector (compared to 2002 Building Regulations).[3]

[3] http://www.planningportal.gov.uk/uploads/br/BR_PDF_ADL2A_2010.pdf

The Government is aims to achieve zero carbon new public buildings by 2018 and zero carbon all new non domestic buildings by 2019.

The Building Research Establishment Environmental Assessment Method (BREEAM) is at the moment required for large new built primary and secondary schools and their retrofitting. The use of BREEAM for other project is strongly encouraged but not compulsory.

2.7 Thurrock Council Strategies

2.7.1 Residential Developments

According to the PMD 13, each residential development of 5 or more residential dwellings must secure as a minimum the following proportions of their predicted energy from decentralised and renewable or low-carbon sources, unless it can be demonstrated that this is not feasible or viable:

- 10% from 2010
- 15% from 2015
- 20% from 2020

These targets can be adjusted, subject to the location of the developments, as outlined in individual sections below.

Priority Locations: In addition to the targets set out in the section 2.7.1, the document also states that within the Priority Locations, the Council will require all opportunities for establishing district energy networks to be taken up, where they would provide higher proportions of renewable or low carbon energy to be delivered than the above percentages. The priority locations are those which meet any, or any combination, of the following conditions:

- residential developments of 100 dwellings or more;
- residential developments on sites larger than 2 ha;
- non-residential developments with a total floorspace exceeding 10,000 sq metres.

Proximity to priority Locations: In addition to the targets set out in the section 2.7.1, the document also requires other developments considered suitable for connection to existing or feasible district energy networks to be designed to enable connection to such networks. Smaller sites in close proximity to an existing or proposed district energy network are considered priority locations if they meet any of the following conditions:

- sites smaller than 20 dwellings within 50 metres of an existing or proposed district energy network,
- 20-30 dwellings within 100 metres of an existing or proposed district energy network,

- 31-40 dwellings within 150 metres of an existing or proposed district energy network,
- Sites larger than 40 dwellings within 200 metres of an existing or proposed district energy network
- All commercial and other non-domestic developments within 200 metres of an existing or proposed district energy network.

Non-priority Locations: The targets set out in the section 2.7.1 are valid for residential developments of 5 or more dwellings outside of the priority locations.

Sites which are not identified as Priority Locations at adoption of the Core Strategy, but which are demonstrated subsequently to meet the conditions to provide district energy networks, will be considered to be Priority Locations and will be subject to the requirements of this policy.

Developments smaller than 5 dwellings: There are currently no local requirements in terms of renewable energy supply for projects of less than 5 individual dwellings.

2.7.2 Non-residential Developments

According to the PMD13, each non-residential development of 1000 sqm and more must secure as a minimum the following proportions of their predicted energy from decentralised and renewable or low-carbon sources, unless it can be demonstrated that this is not feasible or viable:

- 10% from 2010
- 15% from 2015
- 20% from 2020

Priority Locations: In addition to the targets set out in the section 2.7.1, the document also states that within the Priority Locations, the Council will require all opportunities for establishing district energy networks to be taken up, where they would provide higher proportions of renewable or low carbon energy to be delivered than the above percentages. The priority locations are those which meet any, or any combination, of the following conditions:

- residential developments of 100 dwellings or more;
- residential developments on sites larger than 2 ha;
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Proximity to priority Locations: In addition to the targets set out in the section 2.7.1, the document also requires other developments considered suitable for connection to existing or feasible district energy networks to be designed to enable connection to such networks. Smaller sites in close proximity to an existing or proposed district energy network are considered priority locations if they meet any of the following conditions:

- sites smaller than 20 dwellings within 50 metres of an existing or proposed district energy network,
- 20-30 dwellings within 100 metres of an existing or proposed district energy network,
- 31-40 dwellings within 150 metres of an existing or proposed district energy network,
- Sites larger than 40 dwellings within 200 metres of an existing or proposed district energy network
- All commercial and other non-domestic developments within 200 metres of an existing or proposed district energy network.

Non-priority Locations: The targets set out in the section 2.7.1 are valid for non-residential developments of less than 1000 sqm outside of priority locations.

Sites which are not identified as Priority Locations at adoption of the Core Strategy, but which are demonstrated subsequently to meet the conditions to provide district energy networks, will be considered to be Priority Locations and will be subject to the requirements of this policy.

Developments smaller than 1000 sqm: There are currently no local requirements in terms of renewable energy supply for non-residential projects of less than 1000 sqm.

2.8 Carbon Offset Fund and National Policy

Carbon reduction obligations on new developments can be set by both national regulations, i.e. the Building Regulations, or local planning policy. The Building Regulations set a minimum requirement for the level of carbon reduction that must be achieved, without flexibility for this requirement to be offset by a payment (this is most likely going to change with the introduction of zero carbon policy). Local planning authorities, however, have a remit to set targets for sites in their areas in terms of carbon reduction or renewable energy generation, provided these targets are justified by a sound evidence base. The local policy could provide for a payment into an offset fund, rather than meeting the target on-site, if the developer can demonstrate that achieving the target on-site is not technically feasible or jeopardises the commercial viability of the site.

The zero carbon policy (currently under review) will require that all emissions from a development are eliminated, by reducing energy demand or providing a low carbon supply, or using so called ‘allowable solutions’. The range of measures that will be included as ‘allowable solutions’ is currently being considered by Government.

2.8.1 Section 106

Section 106 (S106) of the Town and Country Planning Act 1990 allows a local planning authority (LPA) to enter into a legally-binding agreement or planning obligation with a landowner in association with the granting of planning permission. These agreements are a way of delivering or addressing matters that are necessary to make a development acceptable in planning terms. Matters agreed as part of a S106 Agreement must be:

- relevant to planning
- necessary to make the proposed development acceptable in planning terms
- directly related to the proposed development
- fairly and reasonably related in scale and kind to the proposed development
- reasonable in all other respects

A council's approach to securing benefits through the S106 process should be grounded in evidence-based policy. The new Community Infrastructure Levy Regulation 122 (which came into effect on 6 April 2010) has reduced the five tests described in Circular 05/2005 to three tests.

2.8.2 Community Infrastructure Levy

The Community Infrastructure Levy (CIL) is a voluntary mechanism that allows local authorities in England and Wales to levy a standard charge on most types of new development, to fund the infrastructure needed to support development in their area. The CIL has been designed to replace the current system of planning obligations. After 2014 it will be necessary for each of the local authorities to progress CIL if they are to progress strategic infrastructure projects that contribute towards carbon emissions reductions or wish to pool contributions from a larger number of developments. The CIL regime should offer a number of advantages over the current system of planning obligations:

- Simplicity: CIL will take the form of fixed standard charges, levied as pounds per square meter of floor space.
- Predictability: CIL charging schedules will be published, and developers will be able to readily predict the size of their potential liability, perhaps months or years in advance of development speeding up the planning process.
- Transparency: draft CIL charging schedules will be subject to consultation with local stakeholders and developers; CIL charging authorities will also be required to monitor the use of CIL and provide regular reports to ensure that people can understand how contributions from developers are helping to make their local communities more sustainable

and that developers can see how their contributions through CIL are being used to support the development of the area.

- Fairness: CIL will be levied on most types of new development in a local authority area, thus broadening the range of developments being asked to contribute something towards local infrastructure.
- Efficiency: infrastructure typically has the characteristics of a public good, so that if Infrastructure is available for consumption by one person, it is very difficult to exclude another person from consuming the same infrastructure. CIL will make it easier for charging authorities to address the cumulative impact of developments, ensuring developers cannot free-ride on others in the community, but rather make a fair contribution towards larger items of infrastructure.

Local authorities can set differential rates of CIL so that it is more responsive to local economic circumstances. Authorities will need to subject their proposed charging schedules to a public examination by an independent examiner.

2.8.3 Carbon Offset Policy Thurrock

The Policy PMD14 Carbon Neutral Development proposes the set up of the Thurrock Carbon Offset Fund by means of an obligation under Section 106. Options for setting such a contribution are outlined in the chapter Carbon Offset Funds. The regulatory compliance of the policy will have to be reviewed prior to 2014. The Community Infrastructure Levy may be more suitable mechanism for collection of contribution after 2014.

3 RENEWABLE ENERGY REQUIREMENTS IN PROPOSED PLANNING POLICY

3.1 Size limitation

Existing PMD13 requires developments of 5 or more residential dwellings and developments above 1000m2 of non-domestic floor area to meet prescribed targets for renewable energy or low carbon energy supply. There is a sufficient body of evidence to consider these limits as reasonable. The same size limits have previously been implemented e.g. by Sheffield City Council in their CS65 Policy and by Chelmsford Borough Council in their DC24 Policy.

By proposing a size limit of 5 dwellings as opposed to the limit of 10 dwellings (as used e.g. in the London Plan), an additional 334 new dwellings will be included under this policy.

3.2 Renewable Energy Targets

According to the PMD 13, each residential development of 5 or more residential dwellings and non-residential developments larger than 1000 m2 must secure as a minimum the following proportions of their predicted energy from decentralised and renewable or low-carbon sources, unless it can be demonstrated that this is not feasible or viable:

- 10% from 2010
- 15% from 2015
- 20% from 2020

The target of 10% set for the time period between 2010 and 2015 has been used by other Local Authorities. Both Sheffield Council and Chelmsford Borough Council included 10% minimum target for the provision of energy from renewable or low carbon energy in their policies.

Taking into consideration that the residential buildings will have to be Zero Carbon Buildings from 2016 there is a minimum additional burden for the developers resulting from the 15% target after 2015.

The 20% renewable energy target proposed for 2020 is already in place in the London Plan and is well in line with the 20/20/20 EU Strategy. In conclusion the targets contained in PMD13 are reasonable, achievable and supportable.

3.3 Energy Statement Methodology

The Planning applicants will have to provide a statement outlining how their development proposals meet the requirements of the PMD 13 together with their planning application. The proposed methodology for preparation of an Energy Statement is as follows:

a) **Establish the Base Case:** The base case energy consumption is the energy that would be consumed by the proposed development when occupied over the course of a year. For the purpose of establishing the base case it should be assumed that the development was built to current Building Regulations minimum requirements. The energy demand of the buildings should be estimated to provide the carbon emissions for all proposed uses: space heating, hot water and electricity. This can be done using the SAP and SBEM methodologies and software which are a part of the building regulations.

b) **Calculate the 'actual' predicted energy consumption:** This is the predicted energy consumption of the entire development, taking into account additional energy efficiency measures (measured in KWh/yr for the entire development). Energy consumption is converted to carbon to take into account the difference in the carbon dioxide intensity of different fuels.

There are a number of methodologies that can be used to calculate the baseline and actual predicted energy consumption such as SAP or SBEM. The use of benchmarks is possible as well, however it will inevitably lead to a higher absolute renewable energy requirement. (The benchmarks are often out of date and therefore higher than performance calculated using SBEM or SAP, resulting in higher renewable contribution required.)

c) **Calculate required renewable energy requirement:** The renewable energy requirement in kg of carbon per year (i.e. kgC) is derived by calculating 10% of the predicted carbon emissions evaluated in point b). The proposed technology should reduce the overall carbon emissions by 10%, 15% or 20%. Expressing the renewable energy contribution in the form or carbon reduction is more suitable due to the fact that it is going to be in line with calculations required by the Building Regulations.

d) **Decide what measures will be used to generate the renewable energy:** The overall suitability and feasibility of appropriate technology will have to be reviewed and technologies carefully considered. The site size, location, orientation, density or management structure will all have significant impact on the selection of suitable technology.

The assessment for non-residential buildings in this report is based on benchmarks and as such therefore indicates the worse scenario. This is due to the fact that the benchmark energy consumption typically includes all energy consumption in the building including office equipment or white goods at home. The absolute value of renewable energy to be supplied to the new developments is therefore higher than when based on SAP or SBEM using standardized occupancy.

3.4 Priority Locations and sites Adjacent to Priority Locations

The current version of the PMD 13 states, that the proposed LZC targets can be adjusted, subject to the location of the developments. The priority locations are those which meet any, or any combination, of the following conditions:

- residential developments of 100 dwellings or more;
- residential developments on sites larger than 2 ha;
- non-residential developments with a total floorspace exceeding 10,000 sq metres.

Smaller sites in close proximity to an existing or proposed district energy network are considered priority locations if they meet any of the following conditions:

- sites smaller than 20 dwellings within 50 metres of an existing or proposed district energy network,
- 20-30 dwellings within 100 metres of an existing or proposed district energy network,
- 31-40 dwellings within 150 metres of an existing or proposed district energy network,
- Sites larger than 40 dwellings within 200 metres of an existing or proposed district energy network
- All commercial and other non-domestic developments within 200 metres of an existing or proposed district energy network.

The priority locations are locations where there is a potential for development of larger district energy networks. The District Energy Networks for the purpose of this document stand for networks supplying locally generated energy. This can be distributed in the form of heat, cold, electricity and/or biogas. The types of district energy networks are described in more detail in Chapter 7.

The Community Heating Guide published by the Energy Saving Trust concluded, that for a district heating network to be cost-effective and attractive to all stakeholders, it has to provide energy at 15% less cost than the current supplier and it has to generate return for the investor. Other guides refer to a minimum difference between 5 – 15%. This cost difference can be generalized to all types of district energy networks. The capital discount rate will be critical for any financial feasibility study.

3.4.1 Priority Locations for District Heating

For new built, the heat demand density is most critical for evaluating the feasibility of a district heating network. It has been evaluated that new developments of 55 dwellings per hectare with at least 100 dwellings are most likely viable[4] for district heating network.

[4] Energy Saving Trust: The Community Heating Guide

For smaller developments of 100 homes or less, (typical of infill projects) densities may need to be around 75 dwellings per hectare to be cost effective. These limitations do not apply for sites close to existing district energy network.

Therefore all sites larger than 2ha and/or with a minimum of 100 dwellings at 55 d/ha and more could sustain an independent district heating network. The minimum size limitations and economies of scale for technologies will play a significant role in the feasibility of such systems.

a) The district heating feasibility study should be required from the following developments: Developments larger than 2ha and/or developments larger than 100 dwellings.

b) Non-domestic developments larger than 10,000 m2 should be reviewed in order to evaluate the potential for becoming an energy source for surrounding buildings and developments.

Such developments should also investigate a potential for connection to other existing or proposed district energy networks. If there is no spare capacity in the system, the feasibility of contributing to, expanding the capacity or upgrading the system should be investigated.

The following developments in the Thurrock Council area meet the size (>100 dwellings and density condition (>55 dwellings per hectare) and would therefore, be suitable for development of a district energy network as represented in Table 1.

Table 1a: Future residential development >100 dwellings, >55 dwellings per hectare within Thurrock

Type	Development Density (dwellings per hectare)	Development Size	Number of sites	Notes
1	>55 dwellings	>100 dwellings	25	Self sustaining DEN* possible
2	>55 dwellings	25 - 100 dwellings	16	DEN feasible if anchor load in close proximity
3	<55 dwellings	>100 dwellings	15	DEN feasible but less cost effective
4	<55 dwellings	25 - 100 dwellings	12	DEN feasible but most likely not cost effective
5	Any density	< 25 dwellings	225	DEN not cost effective, only if next to a large development being developed at the same time

* District Energy Network

The report identified the following aspects as the ones significantly affecting the financial feasibility of district heating system:

- Low temperature and low pressure systems with direct connection (connection without heat exchanger) can reduce cost. The direct system is only feasible in areas where none of the customers requires higher flow temperature. The network has to be operated at a temperature suitable for all the end users otherwise there would be need for an additional top-up boiler at the customer site.
- Substituting heat exchangers with hot water accumulators can help to reduce pipe dimensions and thus reduce capital cost.
- The connection cost will significantly decrease with the district heating up-take.
- The cost of district heating systems in UK is still approximately 50% higher than in continental Europe. There is a scope for reducing the cost.

A study from the International Energy Agency[5] evaluated that district energy network can be technically and economically feasible for areas with heat densities of 10 kWh/m2 pa or with a line density demand of 0.3 MWh/m pa. However useful these 'rules of thumb' a more sophisticated and innovative analytical approach is required for low heat demand density areas. Making the district heating network feasible in low density areas may also require introduction of new loads. Substituting electricity with heat from the district heating system to supply heat for white goods such as washing machines or dishwashers and cooling through absorption chillers can help to increase the overall heat densities.

Case Study: New loads for low density developments

The city of Gothenburg achieved an overall 35% reduction in primary energy through introduction of the new loads outlined above. 5,500 kWh of electricity were substituted with 7500 kWh of heat supplied through their district heating network.

3.4.1.1 Adjacent to Priority Locations

Smaller developments do not typically have a sufficient base load to sustain their own energy centre. However, their connection to existing/proposed district energy network in their vicinity should be investigated. The calculations in the Chapter 7 show that it will be more attractive for the developers to provide the new buildings with district heating connections as opposed to installing individual renewable energy systems on-site since this option is going to be less capital intensive. This will only hold true for premises built in or adjacent to priority locations.

[5] International Energy Agency, 2008: District Heating Distribution in Areas with Low Heat Demand Density

The feasibility studies of connection to district heating system should be required from developments of the following size[6]:

a) <20 dwellings within 50 meters from existing/proposed district heating system

b) 20-30 dwellings within 100 meters from existing/proposed district heating system

c) 31-40 dwellings within 150 meters from existing/proposed district heating system

d) >40 dwellings within 200 meters from existing/proposed district heating system

e) Commercial and other non-residential development within 200 meters of an area-wide CHP or CCHP system should connect unless it is demonstrated that there is not enough heating demand for an efficient connection. Non-residential uses are important in helping to create a constant demand for heat and power throughout the day.

If there is no spare capacity in the system, the feasibility of contributing to expanding the capacity or upgrading the system should be investigated.

3.4.2 Priority Locations for other District Energy Networks

Potential district cooling, electricity and biogas networks can be investigated as an alternative or a parallel network to a district heating system. The same thresholds for such networks apply as outlined in 3.4.1.

[6] The Southwark Sustainable Design and Construction SPD: adopted in February 2009

4 BASELINE ENERGY CONSUMPTION AND ENERGY MAPPING

4.1 Existing Energy Demand

The existing energy demand was reviewed using data from the Department of Energy and Climate Change[7]. The 2008 consumption of electricity and natural gas was published in March 2010 for both domestic and non-domestic users. The spatial distribution of the data is based on the Middle Layer Super Output Areas which were first introduced in the Census 2001 and are becoming a standard for National Statistics. (The MLSOAs represent areas of minimum population of 5000 equating to approximately 2000 households.)

4.1.1 Electricity Consumption

The electricity consumption of the domestic users is broken down to users with standard and Economy7 meters. For the purpose of our analysis we have included both of these as one figure.

The electricity consumption of the customers with half hourly metering (large industrial users) could not be split into MLSOAs due to the information protection laws. Only one figure representing the half-hourly metered consumption is available for the entire Borough. 7% of the non-domestic electricity meters installed in the Borough are metered half-hourly, and these cover 85% of total electricity consumption.

Table 1: Electricity Consumption Breakdown 2008

2008	Number of meters	Consumption
Domestic Meters	64,927	295 GWh pa.
Non-domestic Meters	4,304	793 GWh pa.

The map represents electricity consumption density based on the information from the sources above, for both domestic and non-domestic buildings.

7 http://www.decc.gov.uk

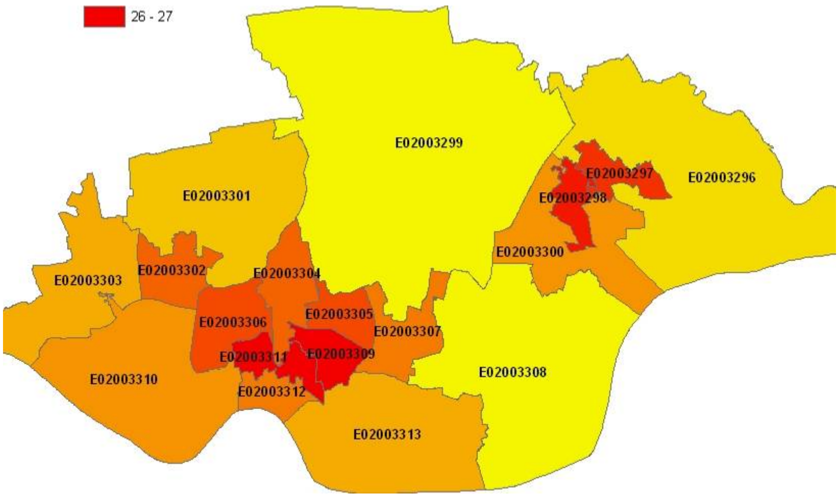


Figure 1: Electricity Consumption Intensity

4.1.2 Gas Consumption

The gas consumption data are all split based on the MLSOAs and the map of the gas consumption represents visually the heat demand in the Borough.

Table 2: Natural Gas Consumption 2008

2008	Number of meters	Consumption
Domestic Meters	54,870	845 GWh
Non-domestic Meters	527	2,528 GWh

The map represents natural gas consumption density based on the information from the sources above, for both domestic and non-domestic buildings.

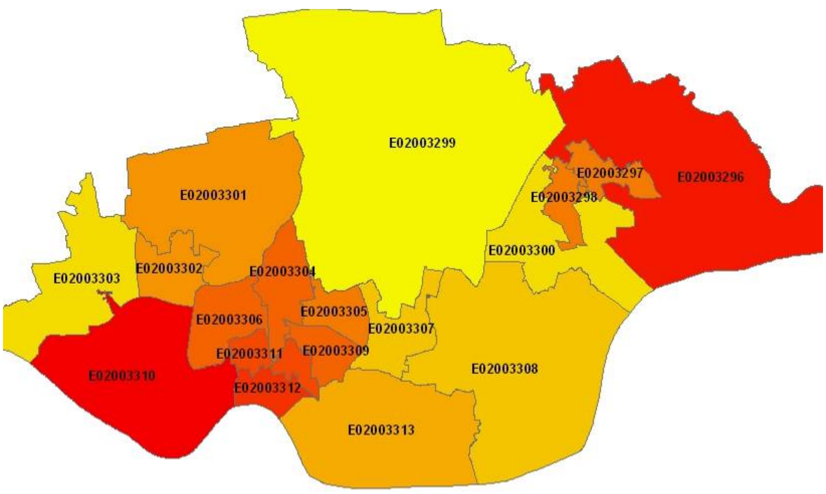


Figure 2: Gas Consumption Intensity

4.1.3 Other Fuels Consumption

The map represented in this chapter only shows gas and electricity consumption distribution. This is due to the fact that the breakdown of the solid fuel consumption for the Borough is not known and there are only figures of total CO2 emissions from solid fuel available for the Borough.

4.1.4 Existing CO2 Emissions

The charts in the Figure 3 represent the CO2 emissions from the fuel used in domestic buildings and fuel used by the Industrial and Commercial sector for the year 2007.

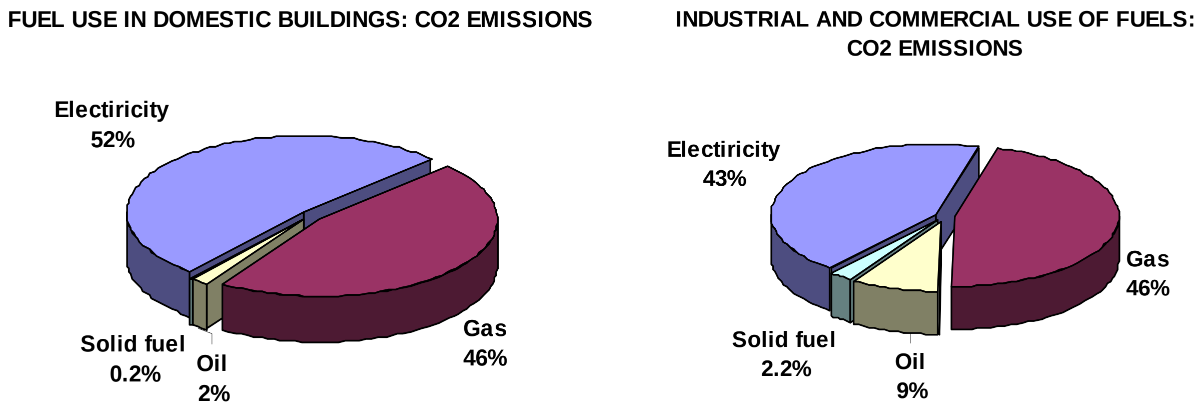


Figure 3: CO2 emissions breakdown by fuel and use

The current CO2 emissions are presented in the Table 3 (excluding agriculture and transport).

Table 3: CO2e emission of existing buildings

2007	Fuel type	k t CO2
Industry and commercial	Electricity	418.7
	Gas	450.8
	Oil	83.7
	Solid fuel	21.8
Domestic	Electricity	166.7
	Gas	149.6
	Oil	5.4
	Solid fuel	0.6

Emission factors for fuels were used in accordance with the Carbon Trust Guidelines published in December 2009. The factors are as follows:

Table 4: CO2e emission factors by fuel

	Tonnes CO2e per MWh
Electricity	0.544
Natural Gas	0.184
Biomethane	0.201

5 FUTURE ENERGY CONSUMPTION AND CO2 EMISSIONS SCENARIOS

The information on domestic and non-domestic developments was sourced from the GIS information provided by Thurrock Council. The energy consumption for the new developments was evaluated based on proposed scenarios for the residential and non-residential developments in the Borough and currently available energy consumption benchmarks.

5.1 New Residential Developments

The Strategic Housing Land Availability Assessment analyses 3 scenarios for the residential land development with regards to the number of dwellings to be developed on-site. This report uses the midpoint scenario for further analysis. The Table 5 compares the proposed renewable energy targets with the CO2 reduction in the Building Regulations.

Table 5: CO2 reduction scenarios

	From	Min CO2 Reduction required by the Building Regulations	Phasing in Thurrock	Predicted energy to be supplied from RE sources as per PMD
Code 3	Now	25%	0-5	10%
Code 4	2013	44%	0-5	10%
Code 6	2016	100%	6+	15%

The analysis in this report assume that the overall carbon reduction achievable by designing dwellings for energy efficiency without implementation of renewable and low and zero carbon technologies is 60%. Any reduction beyond this level is most likely to be met with renewable energy sources and advanced energy supply technologies.

Table 6: Energy consumption scenarios for new residential developments

		Electricity kWh/m2/yr	Electricity kg CO2 per m2/yr	Thermal kWh/m2/yr	Thermal kg CO2 per m2/yr
Now	Code level 3	65	35	80	15
2010 - 2015	Code level 4	49	26	60	11
2016 - 2020	Code level 6	35	19	43	8
2021 - 2025	Code level 6	35	19	43	8
2025 - ?	Code level 6	35	19	43	8

5.2 Existing Residential Buildings

The CO2 emission reduction of 30% from the residential sector (against 2006 baseline) will be achieved by 2020 as outlined in the Heat and Energy Saving Strategy Consultation[8].

The analysis considers a 40% demand reduction in existing dwellings by retrofitting and a 60% reduction in new dwellings through energy efficiency.

8 http://hes.decc.gov.uk/consultation/download/index-46613.pdf

5.3 Non-residential Developments

The non residential development floor areas are listed in the Employment Sites Review[9] and this information was used for further analysis. The benchmark energy consumption of non-residential buildings is estimated based on CIBSE Guide F: Energy Efficiency in Buildings. Since the mix of the building types in each of the groups is not known and the energy consumption varies significantly among various buildings within the group, we used the following benchmarks for our calculations:

Table 7: Energy consumption benchmarks for non domestic buildings

	Electricity kWh/m2/yr	Thermal kWh/m2/yr	Benchmark
A1	194	237	Department Stores
B1	97	128	Offices
B2	324	82	Light manufacturing
B8	114	53	Distribution warehouses
D1	97	128	Offices
D2	113	22	Secondary schools

The codes in the table above are based on the breakdown by type in the report by Tribal: Employment Sites Review. It should be noted, that the consumption benchmarks above are empirical and as such include all electricity consumption within buildings.

The Building Regulations will in 2019 require all new buildings to be carbon neutral. Until then, the following requirements apply for the non-domestic buildings (based on the Council's PMD documents).

Table 8: Other requirements for non-domestic buildings

	From	Min CO2 Reduction required
BREEAM Very Good	Now	-
BREEAM Excellent	2016	CO2 index < 0.4
BREEAM Outstanding	2019	Zero Carbon

The energy demand in new non-domestic buildings is assumed to follow the same scale of emissions reductions as domestic buildings.

5.4 Existing Nondomestic Buildings

For the existing non-domestic buildings we assume the CO2 reduction of 20% by 2020 (this is in line with the EU 20/20/20 Vision). For the purpose of the analysis we have assumed that the energy demand of existing buildings which will form part of a district energy network is going to be cut by 40% by 2020.

9 Tribal, 2010: Employment Sites Review

5.5 Scenario Summary

New domestic and non-domestic buildings are assumed to have their energy consumption reduced in line with the Building Regulations requirements. The analysis assumes that 60% reduction in both new domestic and new non-domestic buildings is achievable through energy efficiency design.

The analysis considers a 40% demand reduction in existing dwellings and non-domestic buildings by retrofitting prior to their connection to a district energy network.

6 TECHNOLOGIES FOR INDIVIDUAL PREMISES (NON PRIORITY LOCATIONS)

The non-priority locations are those which are: away from existing or proposed sources of waste heat, from proposed large residential developments and away from proposed large non-domestic developments as outlined in the section. The non-priority locations are small scale developments with base loads insufficient to sustain large energy systems.

6.1 Assessment Methodology

The renewable energy targets for these developments will have to be met using micro generation technologies (in absence of adjacent district heating network). The applicability of these technologies is less dependent on the overall size of the development and can be scaled down to the size suitable for an individual dwelling or individual building. Basic principles for cost effectiveness have to be considered, e.g. orientation for solar systems must be obeyed or an optimum sizing to avoid inefficiencies in operation. The cost of individual technologies varies. The Table 9: Cost of individual technologies summarises unit cost by technology type.

Table 9: Cost of individual technologies

Technology	Cost average	Small Scale	Large Scale
	£/kW	£/kW	£/kW
Solar PV	4,500	5,500	3,500
Solar Thermal	1,400	1,800	1,200
Wind	2,000	3,000	1,000
Biomass Boiler	600	800	400
Ground Source Heat Pump	1,000	1,200	800
Combined Heat and Power	1,500	1,800	1,200
Biomass CHP	5,500	7,000	4,000

6.2 Combination of technologies

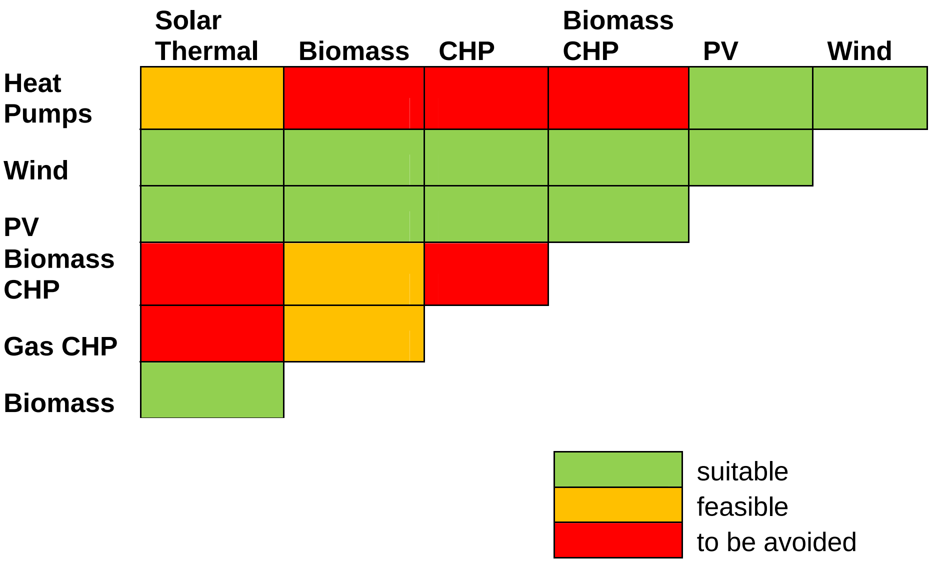
Individual technologies can be combined to match better the energy demand of the site. Microgeneration and small scale renewable and low and zero carbon technologies can be combined but their synergy effects must be considered. Combinations of technologies can lead to a system which is capital intensive, difficult to manage and where technologies might compete against each other reducing their overall efficiency. The combined technologies must complement each other.

Systems that generate electricity only can be combined with any other technology because they act as an independent energy source and any excess can be sold to the grid.

For example the combination of a biomass boiler and a solar thermal system is particularly efficient because the biomass boiler can be switched off during the summer when the solar collectors have the maximum output. The combination of a geothermal heat source with any other renewable heat technology is not suitable due to the negative synergy effects on the efficiency of the system.

The matrix below summarises the compatibility of individual renewable systems.

Figure 4: Combining technologies



6.3 Innovative Technologies

There are other technologies in addition to the ones outlined above, which can help individual premises to overcome site constrains or to meet the requirements more cost effectively. Such technologies are included in Chapter 10.

Some innovative technologies that can be installed on individual buildings include:

- Solar Thermal Air Collector
- PV twin collector acting as both solar thermal and photovoltaic technology
- Asphalt solar collector system with interseasonal heat storage
- Vertical axis wind turbines
- Two stage heat pump cooling system
- Three stage chemical heat pump combined heating and cooling systems

6.3.1 Evaluating the Policy Impact

There are many variables in the review of the required LZC contribution. The following should be considered when evaluating the impact of the Council's targets on the developers:

- Increased energy efficiency in buildings will also decrease the absolute quantum of renewable energy required from the renewable energy sources thus decreasing the economic impact of the targets. The scale and degree of retrofitting existing buildings over time will need to be considered.
- There is continuous technological development which both increases the efficiency of low and zero carbon technologies as well as decreasing their cost and embodied energy. (The markets have seen for example a step change downwards in the cost of photovoltaic panels in the second quarter of 2010 driven primarily by producers scaling up to meet increased demand.)
- The required increase in the renewable energy contribution is going to overlap with the updated UK Building Regulations. All new buildings will have to be 'zero carbon' from 2018 (residential from 2016 already). This will inherently mean that new buildings will have to use renewable energy sources for meeting the requirements of the building regulations. The required contribution will therefore not impact on the overall cost competitiveness of the developments in the Borough beyond 2016.
- The required targets will only have an impact prior to the national 'Zero Carbon' policy.

The financial analysis of the requirements is included in the Chapter 6.

6.4 Results for Individual Technologies

The individual technologies were reviewed in order to evaluate potential costs and benefits of achieving the LZC targets outlined in the PMD13. Tables 10 and 11 **Error! Reference source not found.**list the main economic indicators for meeting the targets for an individual house and for an individual non-domestic building (floor area of 2,500m2). The tables state the capital investment required to meet the target. The developer/investor will not benefit directly from the installation of the individual technologies as all the benefits will accrue to the building occupier/owner.

The Table 10 summarises the cost of renewable energy systems for individual domestic applications (cost of the systems sized to provide the optimum performance). The table clearly shows that the solar thermal collectors are possibly the most cost effective option for the developer to meet the 10% renewable energy target.

Table 10: Domestic buildings

Technology		Solar PV	Solar Thermal	Wind	Biomass Boiler	Ground Source Heat Pump	Micro CHP
Typical Size of domestic installation	kW, m2	2kWp	5m2	1.5kW	15kW	4kW	1kWel
Cost to the developer (minus avoided cost)	£	8,000	4,000	5,000	3,200	4,500	3,700
Fuel used	-	-	-	-	wood pellets	electricity	natural gas
Fuel consumption	kWh pa	-	-	-	5,579	809	5,840
Electricity Generated per year	kWh pa	1,700	-	1,500	-	-	730
Heat generated per year	kWh pa	-	2,500	-	4,853	3,640	4,380
CO2 saving in absolute figures	kg CO2 pa	925	511	816	853	288	218
CO2 saved	**%**	**22%**	**12%**	**20%**	**21%**	**7%**	**5%**
Cost per tonne of CO2 saved (20 years)	£/t CO2	433	391	306	188	781	849
Cost per floor area	£/m2	80	40	50	32	45	37
Annual revenue (to the occupant)	£/pa	625	175	553	152	119	117
IRR* (5% energy cost inflation, 20 yrs)	%	8%	Positive IRR beyond 20 years	12%	Positive IRR beyond 20 years	Positive IRR beyond 20 years	Positive IRR beyond 20 years

*Internal Rate of Return (IRR): The internal rate of return on an investment or project is the discount rate that makes the net present value of all cash flows (both positive and negative) from a particular investment equal to zero. It's the break-even discount rate, the rate at which the value of cash outflows equals the value of cash inflows over the lifetime of the project.

Table 11: Cost of meeting the low and zero carbon energy targets with individual installations

Investment required to meet the targets		Solar PV	Solar Thermal	Wind	Biomass Boiler	Ground Source Heat Pump	Micro CHP
Meeting 10% LZC target	per 5 dwellings	£11,552	£10,451	£8,183	£5,011	£20,869	£22,663
Meeting 15% LZC target	per 5 dwellings	£17,329	£15,677	£12,275	£7,517	£31,304	£33,995
Meeting 20% LZC target	per 5 dwellings	£23,105	£20,903	£16,366	£10,023	£41,738	£45,327
Meeting 10% LZC target	per 10 dwellings	£23,105	£20,903	£16,366	£10,023	£41,738	£45,327
Meeting 15% LZC target	per 10 dwellings	£34,657	£31,354	£24,549	£15,034	£62,608	£67,990
Meeting 20% LZC target	per 10 dwellings	£46,210	£41,806	£32,732	£20,045	£83,477	£90,654
Meeting 10% LZC target	per 25 dwellings	£57,762	£52,257	£40,915	£25,056	£104,346	£113,317
Meeting 15% LZC target	per 25 dwellings	£86,644	£78,386	£61,373	£37,585	£156,519	£169,976
Meeting 20% LZC target	per 25 dwellings	£115,525	£104,515	£81,830	£50,113	£208,692	£226,634
Meeting 10% LZC target	per 50 dwellings	£115,525	£104,515	£81,830	£50,113	£208,692	£226,634
Meeting 15% LZC target	per 50 dwellings	£173,287	£156,772	£122,745	£75,169	£313,039	£339,951
Meeting 20% LZC target	per 50 dwellings	£231,050	£209,030	£163,660	£100,226	£417,385	£453,268
Meeting 10% LZC target	per 100 dwellings	£231,050	£209,030	£163,660	£100,226	£417,385	£453,268
Meeting 15% LZC target	per 100 dwellings	£346,574	£313,544	£245,490	£150,339	£626,077	£679,902
Meeting 20% LZC target	per 100 dwellings	£462,099	£418,059	£327,320	£200,452	£834,770	£906,536

The non-domestic buildings require higher contribution of renewable energy per meter square of floor area due to higher benchmark consumption. The Table 12 summarises the cost of renewable energy installation for a non-domestic building.

Table 12: Non-domestic buildings

Investment required to meet the RE targets		Solar PV	Solar Thermal	Wind	Biomass Boiler	Ground Source Heat Pump	Small Scale gas CHP
Meeting 10%	per 2500m2	£98,591	£89,195	£69,835	£42,767	£178,102	£193,414
Meeting 15%	per 2500m2	£147,887	£133,792	£104,753	£64,151	£267,153	£290,121
Meeting 20%	per 2500m2	£197,182	£178,390	£139,671	£85,535	£356,204	£386,827
Meeting 10%	per m2	£39	£36	£28	£17	£71	£77
Meeting 15%	per m2	£59	£54	£42	£26	£107	£116
Meeting 20%	per m2	£79	£71	£56	£34	£142	£155

6.4.1 Impact on New Residential Developments

The policy targets prior to 2016 for residential and prior to 2018 for non-domestic buildings will have a different economic impact on individual building developments. The sites which are not suitable for a district energy network will require higher capital investment to meet the targets, with small developments on constrained sites experiencing the highest costs. This is primarily caused by technical constrains on microgeneration feasibility. As can be seen in the Table 10 and Table 12, the biomass and wind technologies are the most cost effective means of meeting the target contributions. Both of these technologies are not suitable for constrained sites.

It may often not be possible to size the technologies to meet exactly the target energy reduction. The final investment will therefore be most likely optimized for performance of the system and may result in renewable energy contributions that are higher than those required in the building regulations or in the local authority policies.

The most suitable technology for meeting the 10% renewable energy target is the solar thermal technology due to its ability to be scaled down to meet just the 10% reduction. Other technologies may be more cost effective per tonne of CO_2 saved, but cannot be scaled down to meet only 10% target. The most cost effective technologies for meeting the 15% reduction and beyond are then biomass technologies, solar PV and wind technology.

6.4.2 Impact on New Non Residential Developments

New non-residential developments will be constrained in the technology selection by the heat demand of the premises. This will vary significantly with the type of the premises.

The cost uplift for individual technologies (based on 2500 m2 office space) is in the **Error! Reference source not found.**.

6.4.3 Higher Targets for Priority Locations

The Priority Locations are those locations where delivery of higher renewable energy proportions should be achievable. The feasibility of district energy network is very sensitive to number of variables is very site specific. Any higher targets for new developments should therefore be assessed on site-by-site basis. Potential Priority Locations are analysed in the Chapter 7.

6.5 Conclusions on Individual Technology Impact

The proposed renewable energy targets will only have a short term impact on the required performance of the new developments and will be superseded by the Building Regulations. The targets only exceed the Building Regulations for the time prior to 2016 for domestic buildings and prior to 2018 for non-domestic developments.

The 10% renewable energy target requires additional capital of £2200 - £ 4700 per dwelling prior to 2016 Building Regulations and between £ 25/m2 and £45/m2 for non-domestic buildings prior to 2018 Building Regulations.

Developments in the priority locations suitable for district heating network are capable of achieving much higher renewable energy targets with lower capital uplift (see chapter 7 for more details).

It should be noted that there is typically no revenue for the developer or an ESCO for operating of these systems for individual dwellings. The building occupant is benefiting from the installed technology directly.

The analysis in this Report is not an analysis of the economic viability of developments as a result of the implementation of the renewable energy targets in the Borough. A full viability assessment would have to be undertaken for each individual project.

7 DISTRICT ENERGY NETWORKS

The PPS1 Supplement supports the development of community scale networks from local sources. The draft of the PPS on Planning for a Low Carbon Future also confirms that new developments can be mandated to connect to district energy networks.

7.1 District Heating

District heating is a system of heat supply consisting of a central heat source and pipework distributing the heat to multiple buildings. District heating allows the centralised generation of heat which can be more efficient and can utilize more advanced technologies than small installations in individual buildings. District heating (DH) schemes are often supplied with waste heat from electricity generators or with waste heat from industrial users.

DH systems are typically operated by Energy Service Companies (ESCO) who can be involved in any stage and aspect of the DH design, development and operation. ESCO contracts can cover just the operation and maintenance of the energy centre. They can also be very complex and require the ESCO company to design the system, invest in the system and operate and maintain the entire system for its lifetime and supply energy to premises which have contracts with the ESCO company.

There are numerous criteria that have to be reviewed in detail for each of the sites which will have a significant impact on the district energy network feasibility. The following are the main aspects to be considered:

- Size of the development and its density has an impact on the cost effectiveness of the network installation.
- The operation pattern of the building will have a critical impact on the technology selection for the site. Buildings with 24/7 operation and high base load consumption will be suitable for more innovative technologies.
- Phasing of the development
- Presence of anchor loads and proximity to potential energy centre (schools are usually not suitable as anchor loads because they are not used in the summer)
- Ownership and technical feasibility of energy network construction
- Planning restrictions will also play an important role.

Heat distribution network costs can be broken down as follows:

- Capital costs of the distribution system
- Distribution losses due to the heat losses in the distribution network

- Distribution cost due to pumping losses
- System maintenance costs

The cost related to the pumping of the water in a DH network will depend on the pipe diameter and the length of the pipe work.

The priority locations for the development of the district heating systems were identified using the information available from the Council's GIS files.

The district heating is not widely extended and adopted in UK yet. Only 2% of the total housing stock in England, Wales and Northern Ireland was connected to district heating system. Only 11% of the dwellings connected were houses10.

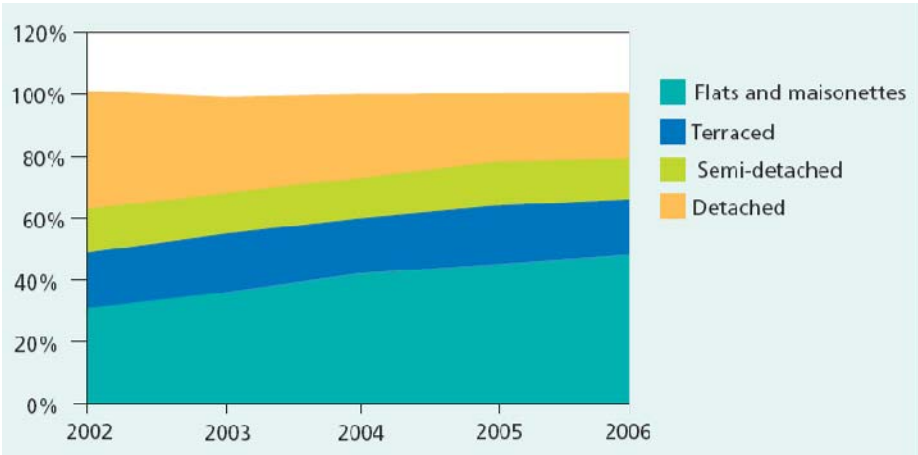


Figure 5: UK new housing built by type of dwelling[11]

The trend in indicates that more dwellings nowadays are flats and maisonettes as opposed to other types of dwelling. These are more suitable for implementation of district heating system. The flats/apartments/maisonettes have typically lower energy consumption for heating than houses and their heat demand is primarily driven to larger extent by the domestic hot water demand. The difference in the overall heat demand between houses and apartment however decreases with increased energy efficiency as demonstrated in the Figure 6 and Figure 7.

[10] BRE report Desk Study on Heat Metering, 2007 and adapted by Energy Saving Trust in CE299
[11] Energy Saving Trust: CE299

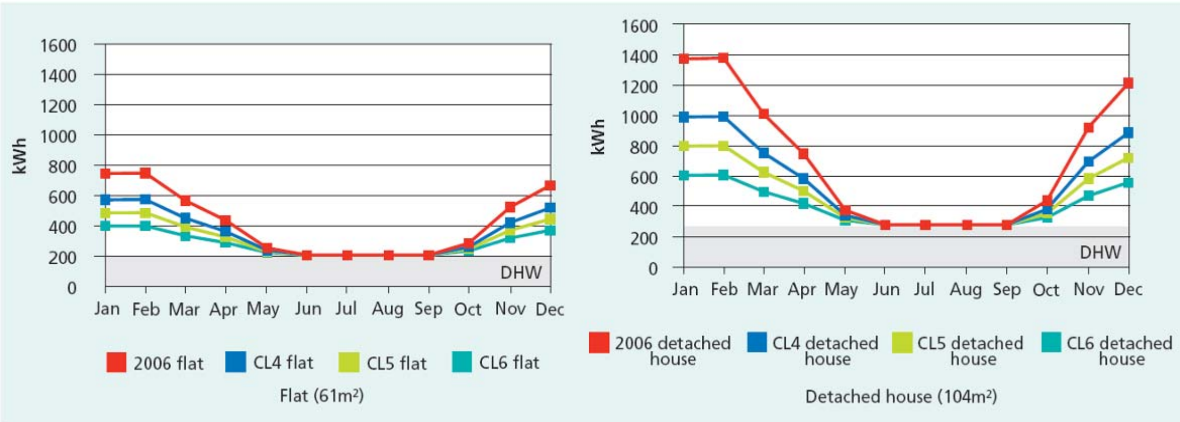


Figure 6: Monthly variation of a dwelling's heating requirements for different heat loss standards12

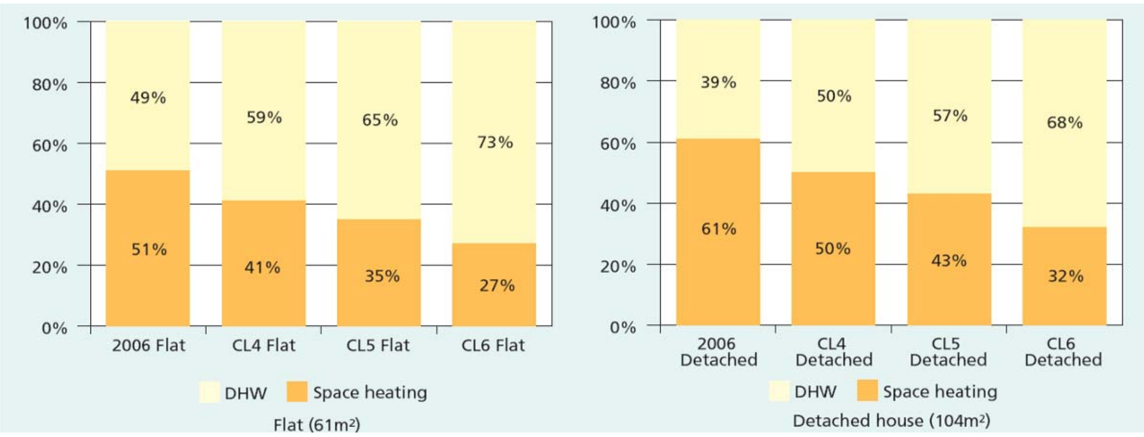


Figure 7: Proportion of space heating and domestic hot water requirements for different dwelling heat loss standards[13]

7.2 Electricity Distribution

The electricity generated within the Energy Centre can either be supplied to the existing electricity grid, or be supplied via 'private wire' to a local customer. A 'private wire' arrangement is only possible for energy sources that are smaller than 5 MWel and supply to non-domestic customers without Supply Licenses. Energy Centres generating more than 5MWel will have to either be operated by a company that has a Supply License or have a partner with a Supply License as an intermediary.

If there is electricity generated within the Energy Centre and this electricity is to be supplied to a local customer, the Energy Centre should be located close to the customer to reduce the length and cost of the cable.

[12] Energy Saving Trust: CE299
[13] Energy Saving Trust: CE299

7.3 Cooling Distribution

A district cooling system distributes thermal energy (typically chilled water) from a central source to the end user allowing the end user to reject heat into the system or use the water for direct cooling, without the need for individual cooling systems in the buildings. District cooling systems have been used more for individual institutions such as college campuses or business parks. It is the most likely option that individual premises will use the district heating supply as means of meeting their cooling demand through absorption cooling. Such cooling has however technical limitations on scale and low efficiencies. Such cooling system will only be feasible if low cost heat supply is available.

Case Study 1: Helsinki Energia

The Helsinki Energia supplies district cooling and heating with approximately five times better efficiency than building specific cooling systems and manages a district cooling system in the Helsinki city centre. The current share of renewable cooling in the system is 60%. The system uses three primary technologies: ‘free cooling’ using sea water between November and May; absorption cooling to utilize any waste heat generated in the locality; heat pumps recover heat from the district cooling system which is injected into the district heating system.

7.4 Biogas Distribution

Where an anaerobic digestion (AD) system is feasible it is common to use the biogas immediately in a CHP system (Combined Heat and Power) to generate electricity and heat centrally. A possible alternative utilization would be the direct marketing of the biogas to consumers by a local “biogas micro grid”. In the biogas micro grid the cleaned and conditioned biogas is fed directly to the consumers in low pressure pipes. These pipes are smaller and cheaper because they are not insulated like district heating pipework. Thus this approach can be more cost effective than a centralised CHP use of the biogas. The study showed that the technical implementation of biogas micro grids on basis of the (current) state of the art is feasible. However, certain basic conditions have to be considered.

- It is advantageous to maintain the micro grid at a constant gas quality, with approx. 90 % methane content, as the end consumer equipment (gas burners) and the measurement technique (consumption measurement) are not suitable for fluctuating gas qualities. However, methane enrichment of the biogas up to the natural gas is not necessary, but gives a considerable advantage regarding the seasonal gas storage, the feed into the natural gas grid or the use as fuel.
- The load management is a challenge, especially in completely self-sufficient biogas micro grids with no access to a natural gas grid. In order to obtain a day-time and seasonal balance between production and consumption, storage of relatively large quantities of biogas is often

necessary. There still exists a substantial R&D need for economically effective storage technologies.

The calculations of biogas costs in different prototypical micro grid structures and a pilot location, demonstrate the competitiveness of biogas micro grids compared to fossil fuels. The calculations showed that the costs are considerably affected by investment and operating costs for biogas storage and the backup-system of the biogas micro grid. In an industrial area or a rural local area the methane-enriched biogas (bio-methane) with a lower heating value of approximately 10.7 kWh/m3 (corresponds to the lower heating value of natural gas) can be supplied to the end consumers for respectively 0.61 and 0.65 €/m3 which is an equivalent of 4.9 p/kWh supplied. Considering the end-user conversion to heat, the final cost of heat supplied in this way is approximately 5.3 p/kWh. This is still high compared to other fuel options and further research needs to be done in this area to make such system cost effective under standard conditions.

7.5 Energy Centre

The technology for energy generation is typically housed in an Energy Centre. This is a plant room or a boiler house with a sufficient space to place any ancillary equipment, stand-by technology and any additional monitoring and controls equipment.

One of the main benefits of a district energy network is its flexibility. The distribution infrastructure has a very long life but most plant equipment needs major overhaul or replacement about every 20 years. The district energy centre can in future be easily fitted with new, more efficient technology when this becomes available. There is also a substantial reduction in the maintenance requirement compared to the installation of individual plant rooms in buildings.

7.6 Connecting the End User

The interface between the district heating network and building's heating system is typically through a heat exchanger. The network has to take into consideration both the internal distribution temperatures in individual buildings but also the pressure to which are the building systems designed. The network has to be designed and operated at a flow temperature compatible with the highest internal distribution temperature in the system. If this condition cannot be met, then the building with the highest internal distribution temperature has to have a top-up boiler installed. This can still be cost effective.

The connection of the end user to the district energy network should be kept to minimal length if possible. Long distribution networks can make the district energy network financially unfeasible due to the high cost of installing the infrastructure pipework and high losses in the network.

An important aspect of the end user connection is the energy base load of the customer and the consistency of the energy demand. All potential customers considering a connection into an energy network should first evaluate their potential for energy efficiency improvements prior to signing up for the district energy supply.

7.6.1 Connection Charges

Connection charges are agreed between the network operator (ESCO) and the end-user. There are essentially two ways of calculating the connection charges. The connection charges of existing buildings can be compared to the capital cost of replacing the existing plant.

The connection charges for new buildings where there is a minimum carbon emission reduction requirement can be equal to the value of the emissions reduction due to the connection to the district energy system.

The connection charges can also be incorporated into the Life Cycle Costing of the district energy system and therefore paid in the form of an increased standing charge over the agreed contract period. This approach will result in smaller price difference between the district heating and another energy supply. This can be a more attractive cash flow for businesses and public organizations.

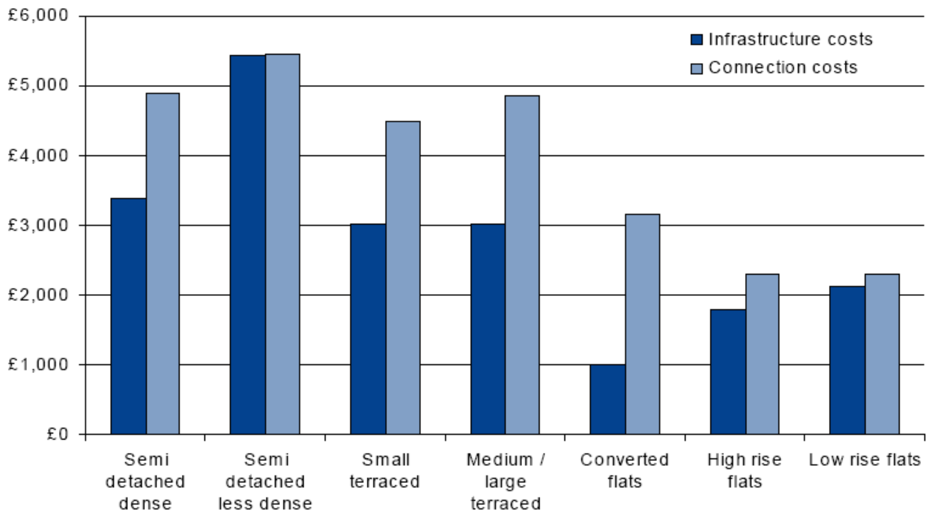


Figure 8: District heating infrastructure and connection costs by built form14

The Figure 8 shows the benchmark connection and infrastructure costs for dwellings of different types. It can be seen that high rise apartment buildings can be connected most cost effectively to a district heating system.

[14] Poyry: The potential and costs of district heating networks

7.7 Anchor Loads

7.7.1 Potential Existing Anchor Loads

The list of suitable existing anchor loads draws from the full list of potential anchor loads gathered from the Thurrock Council's website and GIS information. The analysis can not estimate whether existing buildings would be interested in participating in the wider energy network scheme. These buildings may already employ advanced technology which could make the potential connection to district heating network economically unattractive. The table below lists the anchor loads which were used in the analysis and also the source of information:

Table 13: Number of schools and hospitals included in the analysis

Activity	Number of Sites
Retail Centre	10
Primary School	43
Secondary School	10
Colleges	5
Civic Offices	8
Hospital	2
Health Centre	10
Library	10
Leisure Centre	7

There is limited energy consumption information for existing buildings. The energy consumption of some of the buildings[15] in the Borough was provided by the Council and included in the analysis. There is at the moment no information with regards to the individual process heat users in the Borough and therefore this information could not be part of the analysis.

Table 14: Suitability of buildings by building type

Proposed Development	General Suitability
Swimming Pools / Leisure Centres	Swimming pools require significant energy input not only to maintain the pool water temperature, but for ventilation and dehumidification to prevent condensation. As the energy requirement is relatively consistent, this is ideal for CHP. Even without swimming pools, leisure centres require significant energy for ventilation, shower facilities and good lighting.
Retail buildings	The use of display lighting and the levels of activity mean that retail space typically requires cooling for much of the year. The heat demand is often limited to winter 'heat-up' periods only. As retail will require year round heating or cooling, combined heat, power and cooling (tri-generation) may be appropriate. The summer heat load will be used primarily for absorption cooling. Diversity between retail units can give advantage to heat recovery systems, such as condenser water loop systems.
Offices	Typical office space requires significant power for cooling, IT equipment and lighting. Heat demand is frequently limited to winter 'heat-up' periods.
Hotels	While hotels usually require both heating and cooling, the demands of bedrooms and function rooms are to some extent intermittent.

15 Thurrock Council: NI 106 CO2 emissions evidence

Proposed Development	General Suitability
	However public areas, being continuously used, provide a base load suitable for ground source heat pumps or small scale CHP.
Hospitals	Hospitals present a good opportunity for the use as anchor loads due to their continuous operation, and the extent of ventilation required. Diverse ancillary activities (e.g. catering, sterile services, laundry, etc) provide additional energy demands.
Elderly Homes and Homes for Adults with permanent Care	The demands of comfort, often at higher temperatures, require more energy than other homes, but there is little demand for cooling. The requirement is typically 24/7, but is weather-dependent. Likely to be smaller in scale than Leisure or Retail demand.
Healthcare centres for outpatients	While energy is required dependent on occupancy, the demand is not as continuous as Care Homes, see above. Likely to be smaller in scale than Leisure or Retail demand.
Schools (primary, secondary, special)	Demand for heat and power is typically only for 8-10 hours/day, and there is very little requirement for cooling. If the school is used in the evenings, typically only a portion will require heating.
Libraries	Similar demand to schools, do not usually require cooling. Likely to be smaller in scale than Leisure or Retail demand.
Existing residential developments	Residential energy demand is often intermittent. The cost of distribution and metering can be prohibitive, in comparison to, say, a shopping centre. However, as demand runs into evenings, it can extend the demand profile for a school or office site.
Industrial sites	Process energy, in addition to heating, ventilation and lighting, can provide a good baseload. The demand profile should be analysed, not just peak demand, and account taken of opportunities to recycle waste energy.

The existing buildings to be connected to any district energy network should undergo an energy efficiency retrofit to minimize the risk to the ESCO in reduced energy up-take in future. Providing the energy efficiency retrofit can form part of the ESCO business. See section 0 for more details.

7.7.2 Potential New Anchor Loads

The areas allocated for residential and C&I development were reviewed based on the available GIS information. The suitability of individual types of developments to become an anchor load for a larger district heating system is reviewed in the following sections 7.7.1 and 7.7.2.

7.7.2.1 New Residential Developments

For the purpose of this study we will assume all the developments of sites larger than 2 hectares to be considered for a development of a district energy network. We will also include developments which are smaller than 2 hectares but with at least 100 dwellings. The scenarios currently outlined in the SHLAA are not binding and therefore no final conclusions can be drawn with regards to the suitability of individual sites for district energy networks.

7.7.2.2 New Non-residential Large developments

The energy consumption assumptions were based on the information contained in CIBSE Guide F. The non residential developments are less predictable with regards to their base load and as such are more difficult to be evaluated for their alternative technology potential. These are developments larger than 10,000 m2 which could sustain their own energy centre and could form an anchor load for the development of a local energy network.

Table 15: Proposed non-residential developments larger than 10,000 m2 of floor area

Code	Non-residential Floor area (m2)	Estimated Electricity Consumption Total (kWh pa)	Estimated Thermal Energy Consumption Total (kWh pa)
E2 Raa	38,686	6,899,003	3,391,473
E2d	10,157	2,153,298	675,781
E2e	24,509	4,588,192	1,789,769
E2f	50,764	9,503,290	3,707,059
E2ma	74,206	13,891,726	5,418,970
E2mb	44,454	9,315,990	3,208,644
E2q	28,946	5,418,867	2,113,802
E2q(b)	14,700	2,385,075	1,161,300
E2r	58,500	10,951,500	4,272,000
E2s	55,756	6,356,184	2,955,068
E4d	14,080	2,786,326	1,514,372
E4e	18,729	3,706,261	2,014,408
ED17	30,000	660,000	3,390,000
L12	46,875	9,937,500	3,118,750
L17	23,826	2,716,164	1,262,778
L6	12,000	1,164,000	1,536,000
LR3	36,500	7,081,000	8,650,500
LRZ1	35,000	6,790,000	8,295,000
M7	10,400	1,008,800	1,331,200
MRA1	55,000	1,210,000	6,215,000

7.7.2.3 Other Developments

Other developments can become a valuable part of a Local Energy Network but may not have sufficient energy consumption to be the anchor load to support a large Local Energy Network. There is also not very clear evidence on the energy consumption in industry in the study area. The waste and waste heat from any industrial operations can form a very useful base supply for setting up a district energy network either utilizing waste heat directly or using their waste as a fuel for an Energy Centre. The guidance in 3.4 applies for sites in and adjacent to priority locations.

8 OPPORTUNITIES FOR PRIORITY LOCATIONS

This chapter outlines the potential size and growth of the district energy networks in selected areas. Due to the absence of information on phasing of non-domestic developments it was assumed that all the non-domestic developments will be built within the next 10 years. The Strategic Housing Land Availability Assessment outlines the proposed number of dwellings in 3 scenarios however these scenarios are not binding. The results presented in this chapter only relate to one scenario and the feasibility of the system will depend on final choices on development density, level of energy efficiency and the willingness of existing buildings to participate in the scheme.

8.1 Load Assessment

Four potential cores for a district energy network were analysed from the point of view of base load. The analysis included existing non-domestic sites. We have assumed a 40% energy consumption reduction in these buildings to allow for likely retrofits. The assessment takes into account the proposed changes to the Building Regulations and improvements in the performance of new buildings. The loads for the four selected areas are assessed in the Sections 8.4, 8.5, 8.6 and 8.7 . Considering the uncertainty with the size and phasing of the developments, the feasibility of district energy networks should be assessed on site-by-site basis.

8.2 Technology Assessment

Four scenarios were investigated from considering their suitability, life cycle performance and capital cost requirements. These technologies were compared to a performance of a standard case where heat is supplied by individual gas boilers.

Individual technologies can be combined to match better the energy demand of the premises. Systems that generate electricity only can be typically combined with any other technology because they act as an independent electricity source. (See Figure 4: Combining technologies for more details)

The investigated scenarios were:

- District heating system supplied with heat from biomass boilers
- District heating system with biomass CHP and biomass boilers
- Biomass CHP combined with biomass boilers and PV panels
- Biomass Boilers with solar thermal collectors

The system can also be supplied with waste heat from any of the proposed and existing power stations. The existing landfill gas power stations are not located in the vicinity of any proposed development. Supplying the heat from these power stations would require installation of transmission network to bring the heat to the district heating energy centre and then redistribution to the end-users. Considering the uncertainty with the future gas extraction from these landfill sites there would be a high risk in the long term operation of such transmission network. The distribution of energy from the landfills may be more viable through the biogas network. This option could provide attractive options for landfills where there is untapped potential for landfill gas extractions. Sites with already operating electricity generators are not suitable due to the cost associated with relocation of the generator.

8.3 Cost Benefit Analysis

The heat supplied by the system has to be competitive with the cost of heat from individual conventional systems such as individual gas boilers. For the district heating system to be attractive there has to be typically a 5% to 15% discount compared to the unit cost of heat from a standard system (a larger cost difference is needed for domestic buildings, smaller for non-domestic).

The design and layout of the distribution network is crucial for the cost effective operation of a district heating system. Low temperature systems with variable flow and modulating pumps will have substantially better performance than other system designs.

The cost benefit analysis for a district energy network should take this into account and subtract the energy consumption of the individual systems from the total cost of the district energy network. The cost benefit analysis of additional investment should then be conducted for the life cycle cost assessment of the project.

8.4 Lakeside Local Energy Network

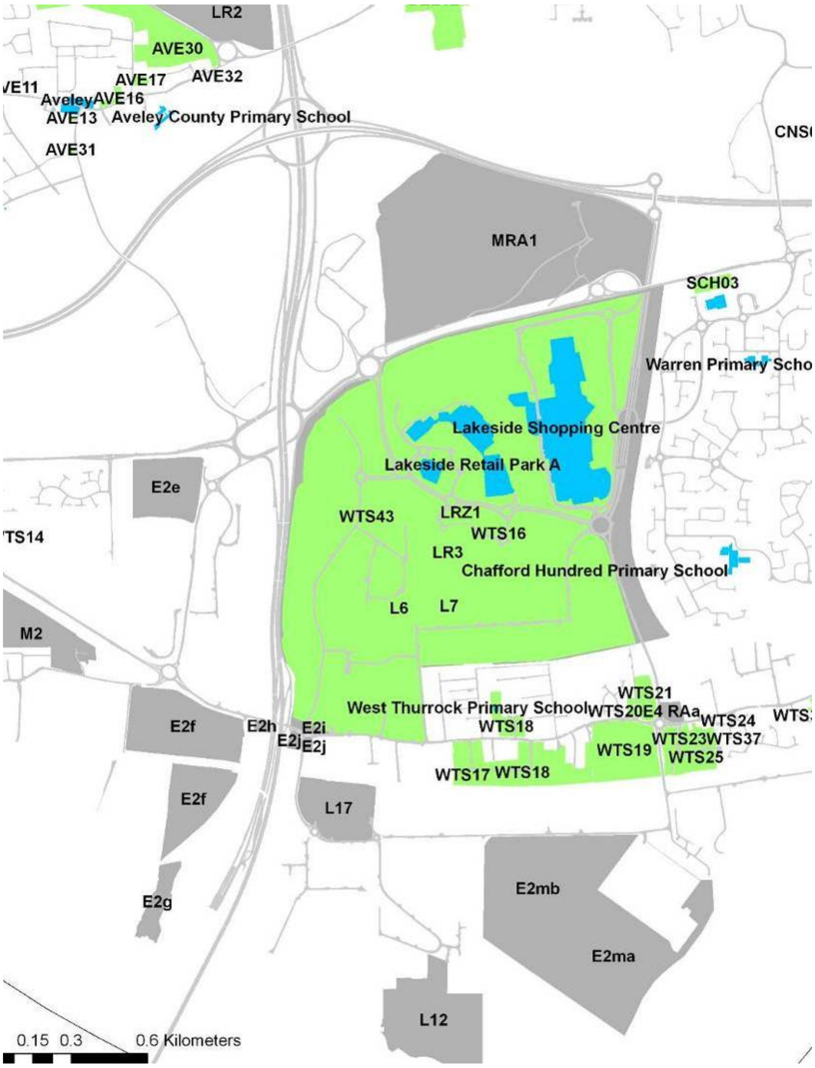


Table 16: Lakeside heat load assessment

Network Growth	Floor area total	Electricity Consumption	Heat Consumption	Heat base load
	m2	kWh pa.	kWh pa.	kW
2010 - 2015	268,945	25,203,231	30,843,078	1,542
2015 - 2020	791,735	65,725,781	73,220,582	3,661
2020 - 2025	812,492	66,500,721	74,050,875	3,703
2025 - 2030	812,492	66,500,721	74,050,875	3,703

8.5 Grays Centre Local Energy Network

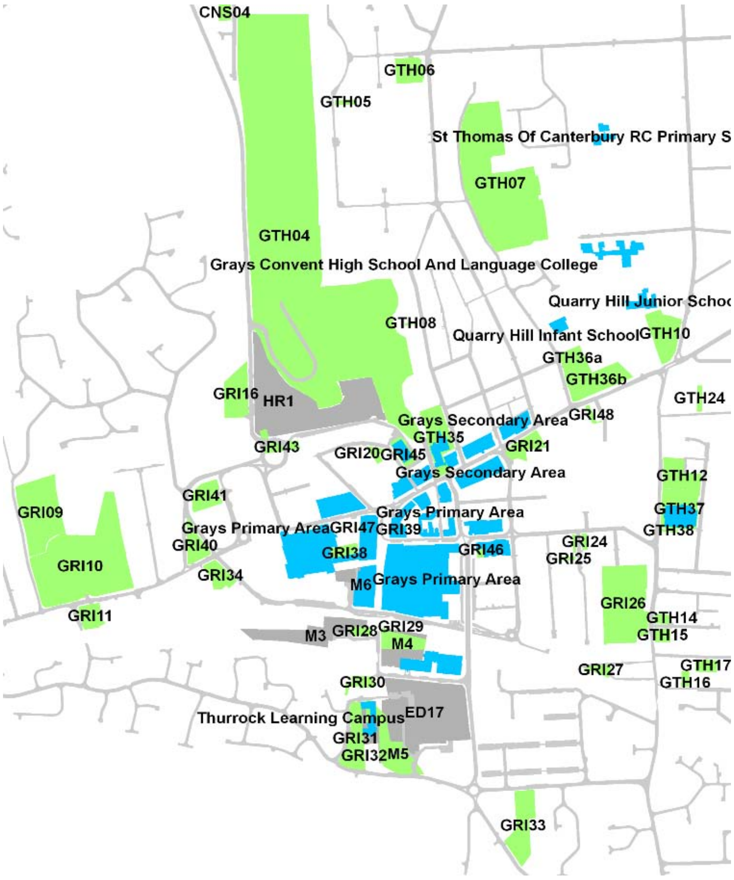


Table 17: Grays Centre heat demand estimate

Network Growth	Floor area total	Electricity Consumption	Heat Consumption	Heat base load
	m2	kWh pa.	kWh pa.	kW
2010 - 2015	57,436	5,159,263	7,046,202	352
2015 - 2020	239,385	12,018,603	15,022,597	751
2020 - 2025	276,185	13,392,470	16,494,597	825
2025 - 2030	276,185	13,392,470	16,494,597	825

This network demand would suit a biomass boiler based district heating system. The estimated demand prior to 2015 is too small for a biomass CHP system but this could change by sometime before 2020 and the project could be re-assessed then.

8.6 West Thurrock Local Energy Network

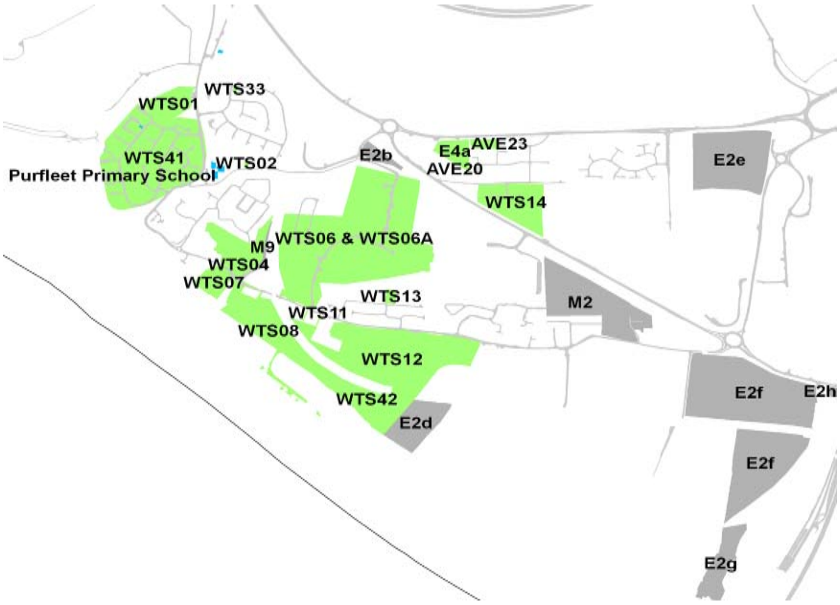


Table 18: West Thurrock heat demand estimate

Network Growth	Floor area total	Electricity Consumption	Heat Consumption	Heat base load
	m2	kWh pa.	kWh pa.	kW
2010 - 2015	115,500	6,036,800	6,468,000	323
2015 - 2020	290,080	13,359,294	14,108,651	705
2020 - 2025	328,580	14,796,628	15,648,651	782
2025 - 2030	328,580	14,796,628	15,648,651	782

This network base load would suit a biomass boiler based district heating system. At the moment the demand is too small for a biomass CHP system but this could change by sometime before 2020 and the project could be re-assessed then.

8.7 Grays Riverside Local Energy Network

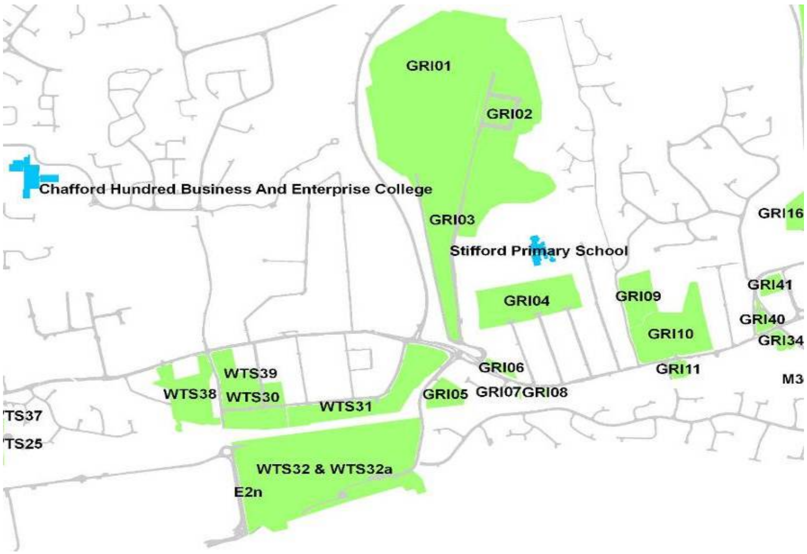


Table 19: Grays Riverside heat demand estimate

Network Growth	Floor area total	Electricity Consumption	Heat Consumption	Heat base load
	m2	kWh pa.	kWh pa.	kW
2010 - 2015	63,302	3,169,348	3,497,131	175
2015 - 2020	127,010	5,558,984	6,057,259	303
2020 - 2025	230,010	9,404,317	10,177,259	509
2025 - 2030	378,210	14,937,117	16,105,259	805

The base load prior to 2020-2025 for this potential district energy scheme is not sufficient to support a reasonably sized biomass CHP due to the technological limitations and economies of scale. However, would be suitable for installation of biomass boilers and/or for installation of other heat generating technologies.

8.8 Conclusion

There is a substantial potential for district energy networks in the Borough. 83% of the proposed dwellings are in the developments of more than 100 dwellings and as such suitable for district heating system. 89% of floor area of new non-domestic buildings is going to be in a development larger than 10,000m2. As such, the opportunities for district energy networks are substantial. The individual developments should produce their own review of district heating feasibility based on the final design, size and density of such development.

9 COMPARISON OF DISTRICT NETWORKS AND INDIVIDUAL INSTALLATIONS

Previous research into the economics of district energy networks[16] analysed the potential internal rate of return against the heat demand density in the locality analysed. The research concluded that heat density of 3,000 kW/km2 will have financial returns of 6% which is considered to be an acceptable rate of return for public sector funding (but not attractive enough for private sector investment).

This chapter analyzes the potential scenarios for a connection charge. The first scenario assesses the connection charge based on the actual connection cost. The second scenario assesses the connection charge based on avoided installation of renewable or low and zero carbon technologies in individual units.

This chapter analyzes one of the priority locations in order to evaluate the potential required connection charge and internal rate of return of such project for four selected technologies.

9.1 Charge based on the real cost of connection

The cost of a district heating system varies with size and density of a development. The cost difference is illustrated in the Table 20 for domestic buildings and in the Table 21 for non-domestic buildings. The figures are going to be subject to the final design of the network and local constraints.[17]

Table 20: Unit cost of connection to district heating system (domestic buildings)

Dwelling Type	District Heating mechanical and civil costs of distribution pipework	District heating Branch mechanical and civil costs of distribution pipework	Heat Interface Unit and Heat Meter	Total Cost
Small terrace	£2,135	£1,912	£2,300	£6,347
Medium/large terrace	£2,135	£2,255	£2,300	£6,690
Semi-detached	£2,719	£2,598	£2,300	£7,617
Semi detached	£2,719	£3,198	£2,300	£8,217
Converted flat	£712	£752	£2,300	£3,764
Low rise flat	£1,500	£1,500	£2,300	£5,300
High rise flat	£1,000	£1,500	£2,300	£4,800

16 Poyry: The potential and cost of district energy networks

17 Poyry: The potential and costs of district heating networks, April 2009

Table 21: Unit cost of connection to district heating system (non-domestic building)

Type of area (non-residential buildings)	Total district heating network mechanical and civil cost of distribution pipe work	Heat interface unit and heat meter
	Cost £/m2	**Cost £/m2**
City Centre	£8.40	£20.00
Other Urban Area	£16.50	£20.00

There may in addition to the charges above the transmission charge. Such charge has to be included in the feasibility calculation if the district heating network is supplied with heat/energy from an energy centre located outside of the site (e.g. taking waste heat from power plant). Such charge is project specific.

9.2 Charge Based on Avoided Cost of Individual Technologies

The charges can be set in line with the cost of individual systems to be installed to meet the required renewable energy contribution. Due to the fact that the district heating delivers higher renewable contribution than 20% it will cover the renewable energy requirements for all the scenarios (10%, 15% and 20% required contribution). The charges for individual systems are included in the section 6.4

9.3 Conclusion

The analysis has shown the sensitivities of district energy network feasibility for number of factors such as energy inflation and the internal rate of return. The following scenarios can be used for setting up the cost of connection to the network in order to maximize the take-up of the district heating systems.

The analysed scenarios translate into the following options (considering 5% energy inflation and 12% Internal Rate of Return scenario for district energy network):

Table 22: capital cost for carbon abatement domestic buildings

		Real Cost of connecting	Equivalent cost of individual LZC	Charge for economic viability of DH system
High contribution	£/ dwelling	£8,217	£8,000	£2,700
Low contribution	£/ dwelling	£4,800	£4,000 (£3,200*)	£2,500
High contribution	per m2	£82	£80	£27
Low contribution	per m2	£48	£40 (£32*)	£25

*The low contribution level may only be limited to sites with either suitable location of small scale wind or for sites with access for biomass supply.

Table 23: capital cost for carbon abatement non-domestic buildings

		Real Cost of connecting	Equivalent cost of individual LZC	Charge for economic viability of DH system**
High contribution	per m2	£37	£130	£27
Low contribution	per m2	£28	£36 (£34*)	£25

* The low contribution level may only be limited to sites with either suitable location of small scale wind or for sites with access for biomass supply.

**This charge is based on

10 LOW AND ZERO CARBON RESOURCES AND TECHNOLOGIES

10.1 Solar Energy

10.1.1 Resource

Solar energy is inexhaustible resource; however it is relatively diffuse and is intermittent. Yearly total of global horizontal irradiation in the study area is approximately 1000 kWh/m2 which presents a good opportunity for employing solar technologies, particularly on sites where the connection to district heating may not be possible and individual renewable energy system will have to be installed.

The main factors affecting the technical potential of solar energy are:

- The compatibility of the energy demand and supply respective profiles;
- The availability of hosting surfaces (roofs, ground, etc.) with sufficient area for large arrays and no or minimal overshading;
- Orientation and inclination (a deviation of up to 30 degree from due South is acceptable.

The technologies that could be employed to utilize solar energy available are listed below with high level feasibility.

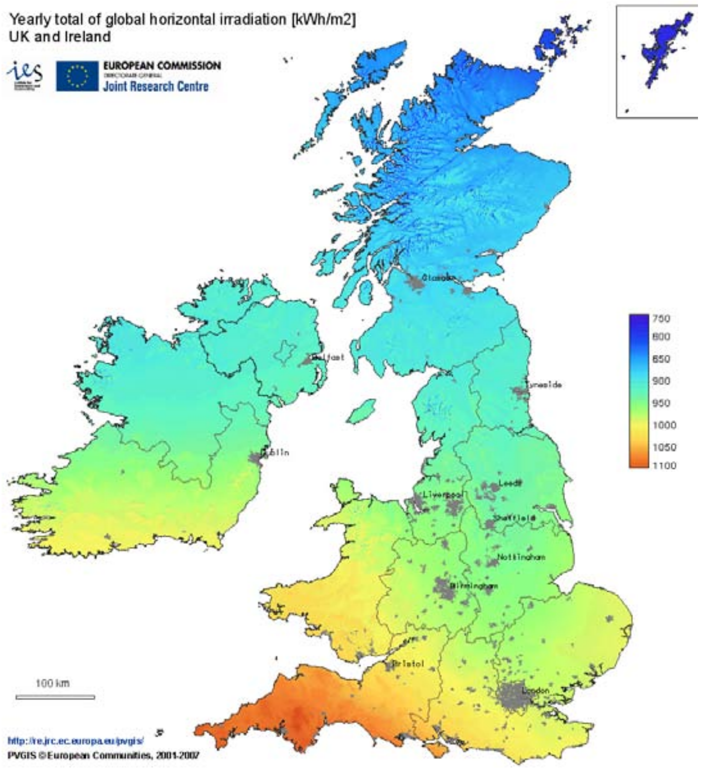


Figure 9: Annual Total Global Horizontal Irradiation in kWh/m2

10.1.2 Technologies

10.1.2.1 Solar Thermal

Solar thermal systems are feasible on both large and small scale. Demand-led approach to sizing of the technology has to be taken to ensure cost-effectiveness of the installation. The summer hot water load therefore guides the decision on the size of the installation. The yield achievable through the system is approximately 450 kWh per yr per m2 of solar collector (aperture area). The actual amount of energy collected by the system very much depends on its design, the solar fraction (the proportion of the heat demand profile) throughout the year and the management of such installation by the owner.

10.1.2.2 Photovoltaic

Solar photovoltaic energy is limited by the space available to host solar arrays and associated orientations and inclinations for the panels. Demand is not a factor as all solar power produced can in theory be exported to the grid. We assume a specific yield of 850 to 1000 kWh per kW of PV capacity per year at an optimum angle and orientation, free of overshadowing.

10.1.2.3 Innovative Solar Technologies

Solar air collectors

Solar wall hot air collectors are one of the most cost effective systems of utilizing solar energy in buildings. The air collector system uses metal cladding to collect hot air for use in buildings. It is simply profiled metal cladding with perforations through which air heated by the sun is gently pulled up through a void at the back of the metal panels by the building's air handling units (AHUs). The air collector can be installed to any external wall with a suitable orientation (south is best but east and west also work) and the installation results in minimal disruption even in retrofitting scenario.

Road solar collectors

The black surface of the roads can be used as a solar collector. An array of pipes can be placed into the surface of the road to collect the heat absorbed by the surface of the road and transfer this heat using fluid either to the building for immediate use or storage.

Solar Thermal/Photovoltaic Collector

The PV/ST collector is used for generating both heat and electricity. The collector is a combination of photovoltaic cells and a solar thermal absorber. Excess heat generated in the PV cells is removed and converted into useful thermal energy. This solution is particularly useful on installations where there is not sufficient space on the roof to meet the renewable energy contribution using standard photovoltaic or solar thermal collectors.

10.2 Hydro Energy

10.2.1 Resource

10.2.1.1 Small Scale Hydro Power

The Environment Agency has conducted an analysis of hydropower potential throughout England and Wales in 2009[18]. This analysis has shown that there is negligent potential for hydropower projects in the Borough. The Figure 10: Hydropower Potential in East England presents a snapshot of the maps produced. Only one potential site for small scale hydropower project was identified in the Thurrock Council area. The size of the installation would be less than 10 kW. The hydropower potential is therefore not investigated further in this report.

18 Environment Agency, 2009, Opportunity and Sensitivity Mapping for Hydropower in England and Wales

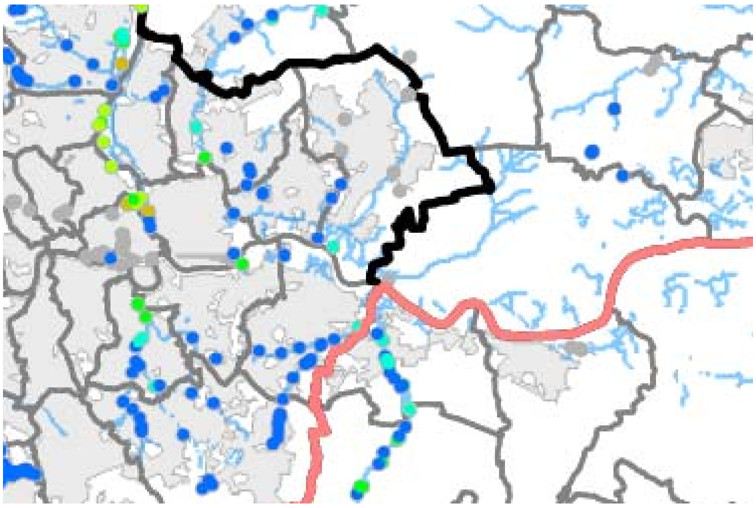


Figure 10: Hydropower Potential in East England

10.3 Wind Energy

10.3.1 Resource

Wind speed for individual location can be evaluated using the online tool available on the website of the Department of Energy19. The use of the wind resource will be primarily guided by the local planning restrictions, topography and existing structures.

19 http://www.decc.gov.uk/en/windspeed/default.aspx

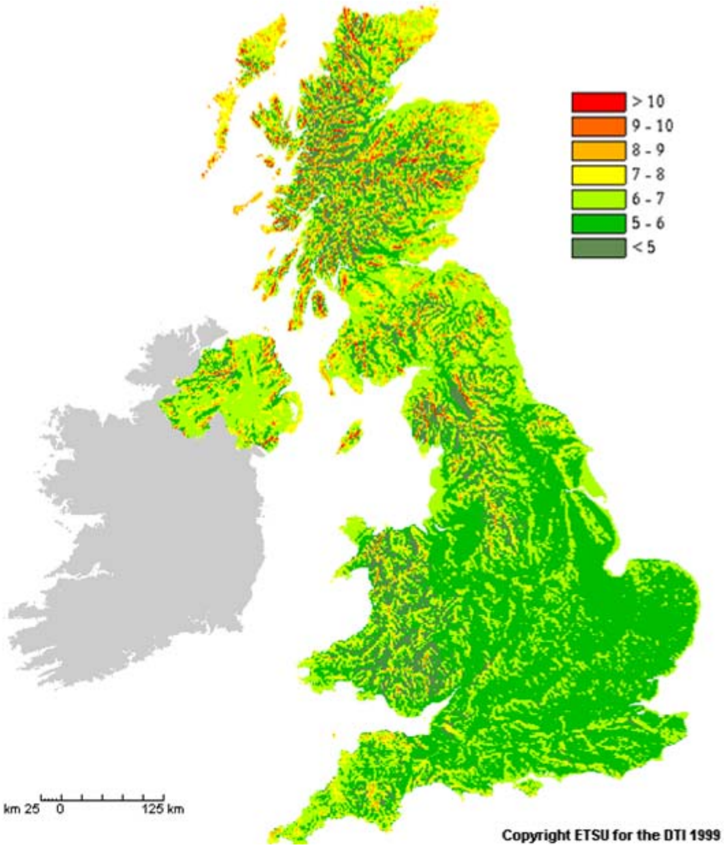


Figure 11: Mean Annual Wind Speed (at 25m height)

The availability of wind is relatively consistent across the Borough due to the type of terrain (see Figure 11). The feasibility of wind technology installation is going to be primarily guided by other restrictions such as proximity to residential developments, acceptability by the local community and / or proximity to nature reserves or special protection areas.

The installation of wind in the urban area depends on the height of neighbouring buildings and their proximity and therefore has to be assessed on site-by-site basis. The map in Figure 12 highlights the areas where installation of medium scale wind turbine could be possible (in green). The low grade land proposed as suitable for energy crops (as described in 10.5.1.2) could be used also for the installation of wind systems.

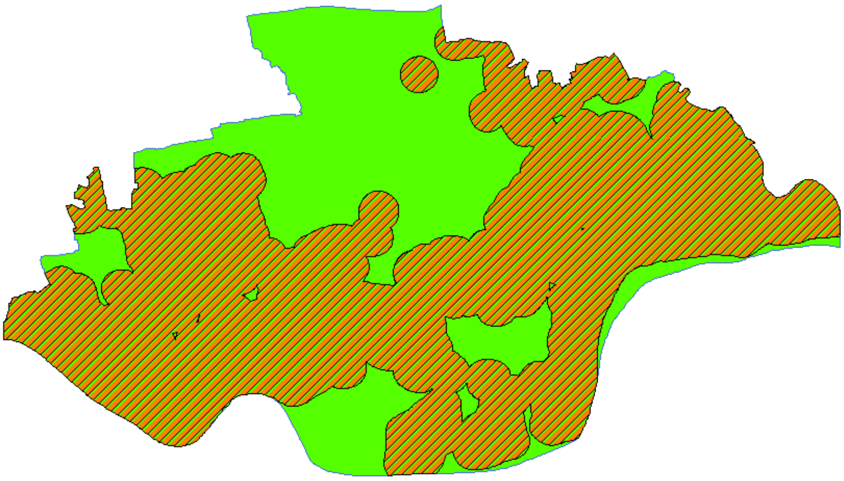


Figure 12: Wind Energy Installation Potential

10.3.2 Technologies

10.3.2.1 Large Scale Wind

Wind turbines start operating at approximately 4 - 5 metres per second (approximately 16-18 kmph) reach a maximum output at 12 - 14 m/s and automatically shut down for safety at wind speeds greater than 25 m/s (approximately 80 km.p.h.). A modern wind turbine produces electricity 70-85% of the time, but it generates different outputs dependent on wind speed. Over the course of a year, it will generate about 25-30% of the theoretical maximum output.

Considering the capacity factor of 25%, the total yield of a 1 MW turbine over one year is going to be approximately 2,190MW.

The wind profile and wind speeds at each specific site need to be evaluated to identify which turbine is suitable for the particular site conditions. As the wind turbine itself may be as much as 70% of the total project cost it is vital that it produces optimal electricity for the given site.

Current total capital costs range between 1.4 to 1.7 million £/MW, The cost of the turbine being between 700,000 and 900,000 £/MW.

10.3.2.2 Small Scale Wind

Substantial care has to be given to selecting suitable location of small scale wind. Due to the air turbulences around buildings, there may be only very limited utilization for small scale wind.

10.4 Geothermal Energy

10.4.1 Resource

Energy can be collected from the earth for use in buildings, using either water or air as the heat transfer medium. The lower heat capacity of air renders it more appropriate to small scale use, while water or water/glycol mixture can be used both in horizontal and vertical geothermal collection systems.

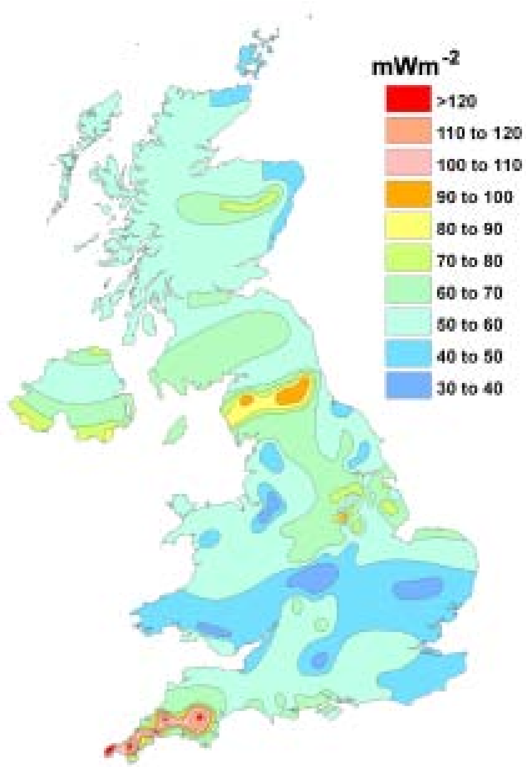


Figure 13: Potential for geothermal energy in UK

10.4.2 Technologies

10.4.2.1 Shallow Ground Source

The temperature of the earth in UK below 1.5 metres depth is relatively constant year round at about 12oC. Horizontal pipe collectors at this depth circulating at around 0oC pick up energy, which ultimately is replenished by solar radiation. This low grade heat can be elevated through heat pumps to temperatures (~40oC) appropriate for underfloor heating or low-temperature radiator systems.

The heat capacity available from the ground is impacted by the soils type, geology, moisture content and the presence of ground water. Typically ground source heat pumps can achieve a coefficient of performance of around 4, which means that for 1 kW of heat output, the heat pump requires 0.25 kW of electrical energy input. Note, the CoP decreases as the output temperatures increases, and for this reason ground source heat pumps are not ideally suited to heating hot water for sanitary use, due to the temperatures required to avoid the risk associated with legionnaire's disease.

10.4.2.2 Deep Borehole

Frequently buildings do not have sufficient external area for shallow ground collectors, and in these cases the collector pipework can be installed in deep boreholes, typically 50 to 150 metres deep. Water/glycol mixture is circulated through the pipes at around 0oC, as for shallow boreholes, and the temperature elevated for use in underfloor heating or other low temperature heating systems.

The heat extracted from the earth in this way is replenished by ground water, so the system works particularly well where moving water is encountered by the boreholes.

Deeper boreholes, in excess of 1 km, may be capable of delivering hot water or steam without the need for heat pumps, but this is highly site dependent, and the cost of drilling to this depth is very significant.

10.4.2.3 Ground Heat Storage

Heat derived from solar collectors or processes which do not match the cyclical heat demand (e.g. waste-derived heat) can be stored in the earth. Some systems create both a ‘hot well’ and a ‘cool well’ so that heat from a summer air-conditioning heatpump can be recovered in winter.

Storage can take the form of a large water tank or a receptacle of other energy store media, or storage in the ground itself. To improve storage, the temperature is often low, so that a heat pump is used to recover the heat at useable temperature. Investigation of the geology / hydrology is essential to ensure the stored heat is not dissipated by moving water.

While storage systems do not of themselves generate heat, they can improve the effectiveness of other renewable systems, e.g. solar collectors, waste-derived energy and heat from air conditioning systems.

There is not sufficient number of energy storage system that has been built to give generic figures on energy storage technology and this has to be reviewed on case-by-case basis.

10.5 Energy from Biomass and Biomass Waste

10.5.1 Resource

10.5.1.1 Current Wood Biomass Production

Thurrock Council has indicated there is a limited biomass resource in the area. There are no figures available with regards to the biomass availability or production in the Borough.

10.5.1.2 Potential for Energy Crops

DEFRA has conducted a detailed review and soil classification across Thurrock. This data provides some insight into the quality of existing agricultural land and its corresponding value. High quality agricultural land was identified as sites within Grades 1 and 2 and within these categories change of use was not considered20. Areas of a lower agricultural grade can be considered for the production of biomass crops such as:

Mischantus: Miscanthus is a perennial high yielding grass with lignified stems resembling bamboo. Once established miscanthus can remain in situ for at least fifteen years. Miscanthus is planted in spring and harvested over the winter and early spring months. The crop can grow on a wide range of soils, from sands to high organic matter soils. Harvestable yields vary on average between about 12 t/ha to around 16 t/ha.

Short Rotation Coppice (willow and/or poplar): Short Rotation Coppice (willow) is a fast growing species that can be grown to produce woodchip for heat and power generation over a 3 to 4year cycle for up to 20 to25 years. The first harvest is usually undertaken three to four years after planting. Subsequent harvests are undertaken thereafter normally on a two to three year cycle. The crop is capable of yielding 7 to 11 oven dry (OD) tonnes of biomass per hectare per annum and research suggests that up to 18 OD tonnes / ha are achievable. Application of sewage sludge in the root zone can increase the yield by up to 30%, depending on the amount of precipitation (the higher precipitation, the lower the increase in the harvest) without affecting ground water or soil quality.

Grass silage: Silage is forage biomass harvested and fermented. Grass silage is harvested in the summer and stored anaerobically in a silage clamp under plastic sheeting, or in a silo. Although silage is primarily produced as a feed, excess production can also be suitable as a biomass fuel. Moisture content is high, typically 60-75%, and so it is not efficient to burn it, however it may be used as feedstock for anaerobic digestion. Corn silage can yield between 200 to 300 m3 of biogas per tonne. Fresh grass silage can yield between 250 to 350 m3 of biogas per tonne of silage.

The EU project 'Bioregen' has been investigating the use of energy crops for phytoregeneration of brownfield and unused landfill sites[21]. Short-rotation coppice willow, miscanthus, reed canary grass and switchgrass have each been planted at demonstration sites. Cost-benefit analysis indicates that the greater cost of biomass production compared to agricultural land can be offset if the added value of land restoration (bioremediation) and increased biodiversity can be realized. Removal of zinc and cadmium pollutants in soil has been demonstrated for willow, whereas other crops give clean fuel from the same site.

According to the Council's Greengrid Strategy there are in total 3,800 hectares which are suitable for energy crops. The proposed area covers some of the land which is classified as Grade 1&2. The land of this grade is in general assumed to be too valuable for energy crops. After excluding this zone, the total land area available for energy crops planting is 3,397 ha.

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20 http://www.thurrock.gov.uk/countryside/pdf/gg_strategy_greeninfrastructure_map_407.pdf

21 http://www.bioregen.eu/project/

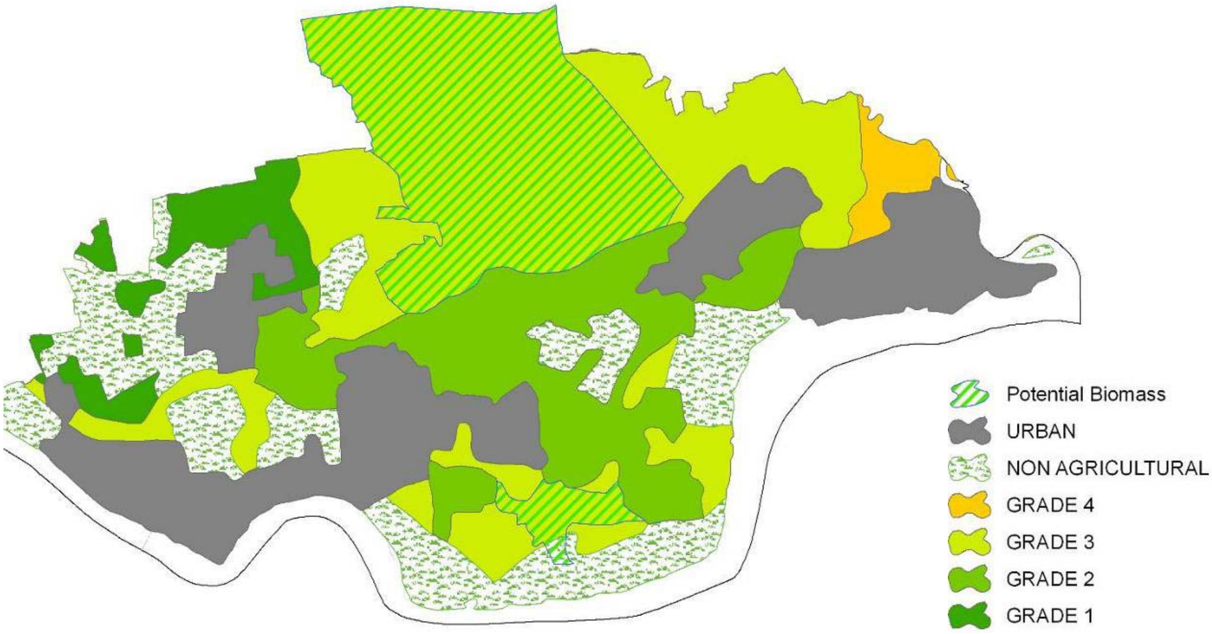

Figure: Land Classification and land suitable for energy crops production

In total there could be 51,000 ODt of biomass produced per year in the Borough. Assuming a calorific value of 18 GJ/tonne biomass the total potential primary energy would be 255 GWh per annum.

10.5.1.3 Mixed Municipal Waste

There was a total of 74,240 tonnes of mixed municipal waste (MSW) generated in the Thurrock Council area in 2008. A total of 51,445 tonnes of waste was diverted to landfill, 69 tonnes sent to Energy from Waste facility and 22,725 tonnes were send for recycling/composting[22].

The currently proposed 60 MWee facility in Tilbury will be most likely be capable of processing refuse derived fuel (RDF) as well.

Assuming that in total 50% of waste could be used for energy generation then the energy available from waste is approximately 353,000 GJ per annum (equivalent to 98 GWh per year). The gross calorific value of the waste is assumed to be 9.5 GJ/tonne which is the national average. [23].

10.5.1.4 Agricultural Waste

Agricultural waste forms only a small proportion of the overall waste mix generated in the Borough. The only estimate we can find is that around 450 tonnes of agricultural waste is generated in the Borough per annum. This amount of waste is not going to have a significant impact on the overall

22 WasteDataFlow, Department for Environment, Food and Rural Affairs (Defra), 2008 / 2009

23 http://webarchive.nationalarchives.gov.uk/tna/+/http://www.dti.gov.uk/energy/inform/table_a1_a2.xls/

carbon footprint of the Borough and could provide only a very limited amount of energy. There is no information on the distribution of waste generation in the Borough or its quality.

Assuming the gross calorific value of the waste at 9.5 GJ/tonne, the energy available in this agricultural waste is approximately 4,250 GJ per annum, equivalent to 1.2 GWh per year. It is therefore a negligible resource.

10.5.1.5 Industrial Organic Waste

No accurate data on industrial waste is available at the moment. The report ‘Thurrock Waste Capacity Needs Assessment 2007 and 2009’ only makes an estimate based on the total figures from 2003. DEFRA is currently in the process of updating the 2003 data and the survey is currently being undertaken[24]. Once the information on the industrial waste breakdown is available, further analysis can be conducted. The technologies below are applicable to the industrial organic waste streams, however their use will be subject to local regulations.

10.5.2 Technologies

10.5.2.1 Biomass Boilers

Wood heating systems burn a wood fuel (wood chips or wood pellets) to produce heat. Modern wood heating systems have been developed as an alternative to either oil or gas fired systems and can generally be plumbed directly into existing systems. They can be operated as independent stand alone boilers or they can be installed in conjunction with conventional boilers to operate as the base load boiler. They are fully controllable using programmable timers and room or zone thermostats and can be incorporated into building energy management systems. The biomass heating systems work particularly well in conjunction with solar thermal systems. There are a number of packaged systems on the market where the wood boiler, the wood fuel store and feeding system are pre-assembled in factory in a containerised system ready for connection to a building's central heating system with minimum on-site installation work.

10.5.2.2 Gasification

Gasification is a method for extracting energy at temperatures >700°C from many different types of organic materials with controlled amounts of oxygen and air. Gasification can be used as a process to extract energy from feedstocks such as mixed municipal waste, woody biomass, compost, house waste and agricultural waste. The resulting gas mixture is called synthesis gas or syngas and is itself a fuel. Using the syngas is potentially more efficient than direct combustion of the original fuel and it has lower emissions levels. The syngas may be used directly in internal combustion engines, or to produce methanol and hydrogen, or converted into a synthetic fuel.

[24] Defra.WasteSurvey@jacobs.com or +44 118 946 7800 to find out details

Biomass combined heat and power (CHP) is increasingly available commercially at a smaller scale (down to 300 kW electrical with wood gasification). However, its applicability is limited to projects where they can be guaranteed a minimum of 6500 operating hours, e.g. in the context of district heating or trigeneration with absorption cooling. The space requirement for fuel storage and handling for such a system should be carefully considered as it is considerable.

10.5.2.3 Anaerobic Digestion

Anaerobic digestion is the process of biodegradation in the absence of oxygen. During the process biogas is produced which can then be used for energy generation. The resultant digestate can be used as a fertilizer depending on the feedstock. Anaerobic digestion is feasible from a very small scale and can be used with a variety of biomass feedstocks.

Agricultural waste and industrial organic waste are suitable feedstocks for anaerobic digestion. There are anaerobic digestion technologies that can deal with mixed municipal waste through so called dry anaerobic digestion, but these technologies are only commercially viable on a very large scale.

10.5.2.4 Pyrolysis

Pyrolysis is the chemical decomposition of organic materials by heating in the absence of oxygen or any other reagents, except sometimes steam. During pyrolysis biomass is converted to produce bio-gas (~15%), bio-char (~30%) and sometimes the biogas is condensed to produce bio-oil (~55%). The percentages of products will vary with the system design. Pyrolysis involves trade offs between the production of biochar, bio-oil and gas, and the process can be calibrated to maximise the output of different products, depending on economic factors. The energy used in the above processes is provided by the biomass itself in the form of gas and other byproducts. Pyrolysis systems can utilize all biomass including agricultural waste, wood waste or industrial organic waste, provided these are reasonably uncontaminated waste streams with low moisture content.

10.6 Landfill Gas and Waste Heat from Existing Generators

10.6.1 Existing Landfill Gas Power Stations

There are 10 existing landfill sites which capture the landfill gas and use it for electricity generation but have no method of using the waste heat from the generator.

The following are the existing landfills are their heat availability at the moment:

Table 24: Existing landfills and potential waste heat

Name	MW electric	MW thermal estimate*
Aveley	3.95	6.59
Aveley - NFFO 5	2.01	3.34
Aveley Landfill	3.84	6.40
Aveley Phase 2 Generation	2.13	3.55
Mucking 3	4.07	6.79
Mucking Gas 2-NFFO	4.07	6.79
Mucking Landfill	3.20	5.33
Mucking Landfill 2	7.79	12.98
Ockendon "A" Power Plant	4.02	6.69
Ockendon "B" Power Plant	4.76	7.93
Total landfills	**39.84**	**66.39**

There is also Tilbury Power Station which is biomass co-fired, but the plant is going to be phased out by 2013 and substituted with a new 60MWel plant. Therefore we have not considered the existing Tilbury Power Station further in our analysis.

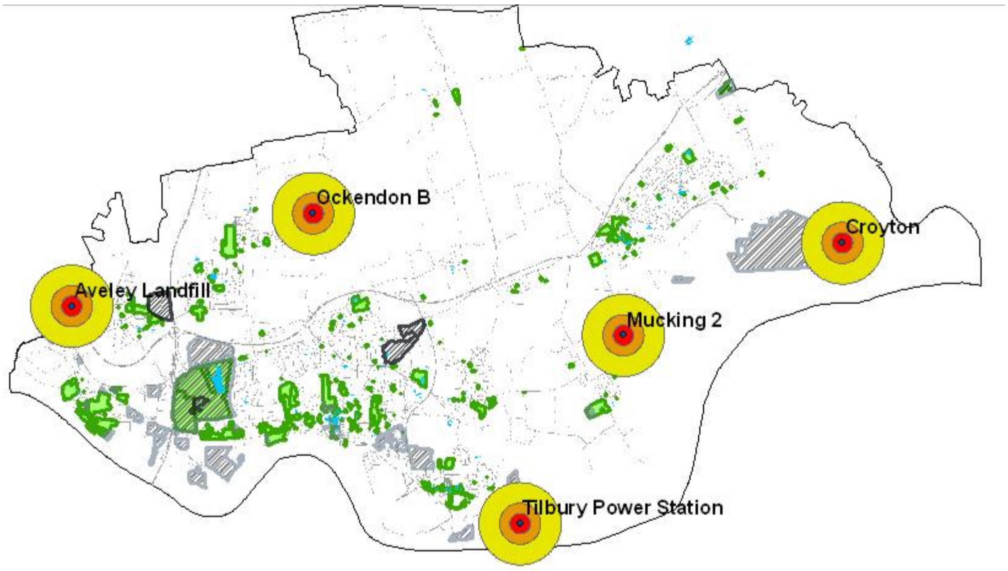

Figure 15: Existing (and potential) power plants with waste heat

The gross calorific value of the landfill gas is approximately 38.6 MJ / m3. The yield of the landfill gas depends substantially on the type of material in the landfill, the age of the waste and extent of landfill gas extraction up to date.

The technology used by individual sites is not known. The following electrical efficiencies are typically achievable for specific technologies:

Table 25: Typical electrical efficiencies of landfill gas cogeneration technologies

Name	Electrical Efficiency %	Notes
Internal Combustion Engine	33%	Can be used as part of CHP.
Gas Turbine	28%	Typically used for CHP applications.
Organic Rankine Cycle	18%	Poor performance and high pollution.
Sterling Cycle Engine	39%	Rare installations. Low in pollutants.

Considering the electric efficiency of the landfill power generation efficiency to be around 30% and thermal around 50% with 6,000 hours of operation in a year, then the total heat generated by the sites is approximately 398 GWh per year. This waste heat could be used in a district heating system.

10.6.1.1 Aveley plants (info from EPA)

The 3 landfills at Aveley are served by one Gas Utilisation Plant (permit number EP3730BL) that has a rated thermal input greater than 3 megawatts (MW) but less than 50MW. The site was permitted under the PPC Regulations on 9 November 2005. The volume of gas treated on site for 2009 was 4.657MW. The plant is running at 57.33% of its 8.154MW capacity.

(Contact with the EPA for the Aveley site is Clare Richards at the Thames North East office on 01707 632564.)

10.6.1.2 Mucking plants

Information from EPA)

The plants at Mucking have permits for 59 MW thermal input. There is a temporary agreement to install an additional 3 engines, increasing the net rated thermal input to 70 MW. This is the maximum permitted net rated thermal input. The plant does not work at full capacity all of the time (2 engines have yet to be installed, and a gas turbine on the site is only used as standby / replacement equipment). The heat is at the moment not used.

The longevity of the site is not known. Gas production is currently thought to be near its peak and will tail off considerably by 2050. Once at the end of life, the landfill will become a nature reserve.

Information from Energy Developments (UK) Ltd

Landfill gas generation using reciprocating engines with a standby gas turbine, capacity accredited by the regulator of 24.6MW. The heat output is not measured and a heat or electricity generation profile can not be provided by the company.

No definite increase in capacity expected, but over time the gas production will decease and so will output. The site is expected to operate until 2030 as a minimum. When EDL consider the site uneconomic to operate a generation plant they will leave the site and the landfill operator will be required to control any residue gas.

The use of heat from the generator would be feasible and EDL would not in principle object to such arrangement but they consider it doubtful that it would be economically feasible.

10.6.1.3 Ockendon plants (info from EPA)

The total electricity output of the 7 installed gas engines is 9.95MWe at the Ockendon plants. Additional engine(s) are likely to be added in the near future. Landfilling is currently permitted under a planning permission valid until 2040, however gas generation is variable and is dependent on types and amounts of inputs.

10.6.1.4 Tilbury power (info from the Tilbury Power Station directly)

The power station project is for a renewable energy facility, to be fuelled by a combination of biomass fuels. These include clean chipped wood, recycled wood, and biomass recovered from the municipal and commercial waste streams. The carbon emissions of the project are therefore projected to be extremely low. A comparative carbon emissions statement was prepared for the planning application in 2008. It concluded that the TGP facility would avoid 80% of the carbon emissions associated with the operation of a traditional fossil fuel power station.

The Tilbury Power Station is in principle interested in the potential supply of heat to a district heating network, subject to appropriate commercial arrangements. One of the objectives of the project is to provide waste heat to local customers and the Section 36 consent is specific in this regard. TGP is required to provide appropriate infrastructure to facilitate provision of waste heat, and to undertake periodic reviews of the opportunities for the use of waste heat. The relevant conditions are as follows:

Use of waste heat:

- Condition (66): The commissioning of the development shall not take place until sufficient plant and pipework has been installed to facilitate the future supply of heat to the boundary of the site under Condition (67) at a later date if opportunities to do so are identified pursuant to Condition (67).
- Condition (67): Prior to the commissioning of the development, an updated CHP feasibility review assessing potential opportunities for the use of heat from the development shall be submitted to, approved in writing by, and deposited with the relevant planning authority. This shall provide for ongoing monitoring and full exploration of potential opportunities to use heat from the development as part of a Good Quality CHP scheme (as defined in the CHPQA Standard issue 3), and for the provision subsequent reviews of such opportunities as necessary. Where viable opportunities for the use of heat in such a scheme are

identified, a scheme for the provision of the necessary plant and pipework to the boundary of the site shall be submitted to, approved in writing by, and deposited with the relevant Planning Authority. Any plant and pipework installed to the boundary of the site to enable the use of heat shall be installed in accordance with the agreed details.

The CHP feasibility review concluded that whilst there were no potentially suitable process heat loads available at the time of writing, future developments in the Grays and Thurrock areas may prove to be suitable heat customers in the future. TGP remains committed to reviewing the potential opportunities to provide waste heat.

10.7 Other Resources and Technologies

10.7.1 Gas CHP

Typically power stations generate electricity at 30 - 35% efficiency. It is possible to improve the overall operating efficiency by installing a prime mover and generator, provided the electrical power and heat generated can be utilized effectively, hence the name 'Combined Heat and Power'. Typically the ratio of heat to power is 2:1 for a reciprocating engine or 5:1 for a gas turbine.

Due to the significant capital cost, it is imperative that the system be accurately matched to both the power and heat demands of the site, and this can result in operating efficiencies of 70 - 80%.

Gas-fired CHP benefits from the relatively clean combustion of natural gas and is a well-proven technology. The CHP system should not be the sole heat or power source as downtime will be required for maintenance. CHP does not reduce the energy demand of the site, but can provide the required energy in a more efficient manner.

10.7.2 Trigeneration

In addition to the simultaneous generation of heat and power described above, a further development is to utilize the heat to provide cooling when required. Cooling can be derived from heat by an absorption chiller and this can benefit the economics of a CHP system by extending the demand and therefore the running hours. The addition of cooling often extends the CHP during summer months when the heat demand is lower.

10.7.3 Micro CHP

A micro CHP machine which generates heat and power more efficiently than conventional plant has been developed at a small scale suitable for dwellings and small buildings. These domestic boiler sized systems use natural gas to generate about 1 Kw of electricity and sufficient heat for a house and are easily installed. Several manufacturers have different systems on the market and their performance is improving quickly as the market for them grows. This might be a useful system for a dwelling on a natural gas or biogas grid.

10.7.4 Industrial Waste Heat Distribution

There is currently no information available with regards to the waste heat available from any industrial processes in the Borough. This study can therefore not evaluate the magnitude of potential process waste heat that could be utilized in local energy networks.

We recommend conducting a local study on the use of resources and waste heat generation and based on this study to evaluate the potential synergies in energy supply/demand.

10.7.5 Heat Supply Sources in Planning

Details for power station developments as follows:

Table 26: Proposed power plant developments

<table>
<tr><th>Name</th><th>Fuel</th><th>MW electric</th><th>Description</th></tr>
<tr><td>Tilbury Green Power</td><td>Biomass</td><td>60</td><td>A feasibility study was provided by Mott MacDonald. This study has shown what impact would the connection to district heating have on the overall output of the system. The study concluded that providing each 1 MWth to a district energy network would result in the drop in electricity output of 162kW electric.

The Secretary of States decision letter states that there were no CHP options at the time the development was consented but this is to be kept under review and the company is to design the proposed facility for CHP should the opportunity rise. (Note there are a range of development proposals in the LDF at varying stages of development around Grays Town Centre including an FE/HE campus, Community Hospital and housing.)

Tilbury Green Power (TGP) has proposed the development of a 60 MWe renewable energy generating station fuelled by biomass and solid recovered fuel (SRF) at a site on the north side of Tilbury Docks. The proposed technology is steam cycle.</td></tr>
<tr><td>Tilbury Power Station - OCGT</td><td>Natural gas</td><td>400</td><td rowspan="2">Potential for CHP has been raised with the applicants. Main focus is probably residential and town centre developments identified as an ‘eco quarter’ around Tilbury town centre in the LDF and other commercial development particularly the expansion of Tilbury Port.</td></tr>
<tr><td>Tilbury Power Station - CCGT</td><td>Natural gas</td><td>2000</td></tr>
<tr><td>Coryton and London Gateway - CCGT</td><td>Natural gas</td><td>900</td><td>Intergen operates a gas fired power station at Coryton in the east of the Borough. They have a Section 36 application with DECC for a new (additional) 900Mw CCGT Power station on adjacent land within the area of the proposed London Gateway port and associated commercial park development. They have been asked to address CHP issues and we expect further information from them in Q3/2010.
The London Gateway Port has outline planning permission/Harbour Empowerment Order consent and includes a deep water port and IRO 9million square feet of commercial floor space the detail of which will be subject to future reserved matters applications.</td></tr>
</table>

10.7.6 Potential for Additional Landfill Gas Collection

There are currently the following two landfill sites which could have landfill gas generation potential (considering their age, type of waste deposited and size): the Civic Amenity Site and the Thurrock Services Site. A study on the landfill gas potential at the Civic Amenity Site is currently undertaken. The potential for landfill gas extraction at the Thurrock Services Site has not been quantified by any study and can not be estimated at this stage.

10.8 Conclusion

The review of renewable energy potential in the Borough has confirmed that there are opportunities for renewable energy installations. The solar energy is available for any site with solar access, not overshadowed by neighbouring buildings.

There is also a good resource for wind installations but these will be limited by neighbouring structures and public acceptability.

There is currently only limited amount of green waste and energy crops generated in the Borough. The total amount of agricultural waste is only 1,200 MWh per annum. There is a potential for growing energy crops, primarily on low quality land. The overall potential for such biomass is 255,000 MWh per annum. Additional 98,000 MWh contained in mixed municipal waste could be available for energy generation per annum. The currently operating landfill gas generators without heat recovery could provide further 66 MW thermal capacity for heat supply (willingness to participate in district heating scheme would have to be confirmed by the landfill gas generators).

The overall renewable energy available in waste, biomass and energy crops (expressed in CO_2 to be substituted) is 143,000 tCO_2 per annum. This is an equivalent of 11 % of the current total carbon footprint of the Borough, equivalent to 44% of the existing residential sector carbon footprint. Comparing the energy consumption of the proposed residential and non-residential developments, this energy can cover more than 100% of the energy requirement of these developments.

11 ENERGY SERVICE COMPANIES AND BEYOND

The term ESCO is used to refer to an entity which has been set up for the purpose of delivering energy efficiency, energy savings and/or sustainable energy, whether through a variety of different initiatives or through a particular initiative, such as a CHP scheme. ESCOs can be both public and private entities. The main obstacles for setting up the ESCO company by the Council is primarily the time requirement for setting up such an organization and managing the organization in the long run.

Case Study: Examples of ESCOs set up by other Local Authorities

- **Woking Borough Council** wholly owns Thamesway Ltd which is an ESCo. The ESCo enters into public/private joint ventures to deliver its energy and environmental strategies and targets. This is a joint venture with a Danish company experienced in district heating systems.
- **Southwark Council** operates an in-house ESCo for delivering a number of CHP schemes supporting community housing schemes
- **The Southampton City District Energy Scheme -** energy for heating and cooling is provided to the city through an ESCo developed through a public-private partnership. The Energy Services company is called Southampton Geothermal Heating Company Ltd, and it is wholly owned by the private partner (Utilicom Group) with a small annual profit share to the public partner Southampton City Council)
- **Titanic Mill ESCo, Huddersfield -** is a company limited by shares, which is owned by the building's a management company which in turn is owned by the residents who are the end users of the energy.
- **Aberdeen Heat and Power Company Ltd.**, a council-led not-for-profit ESCo. The contractual relationship between the ESCo and Aberdeen City Council is regulated by a framework agreement, which sets out the general obligations of the ESCo to supply heat to the council, for onward supply by the council to tenants.

A step further than ESCOs are multi-utility service companies or MUSCOs. These companies provide a variety of utility services.

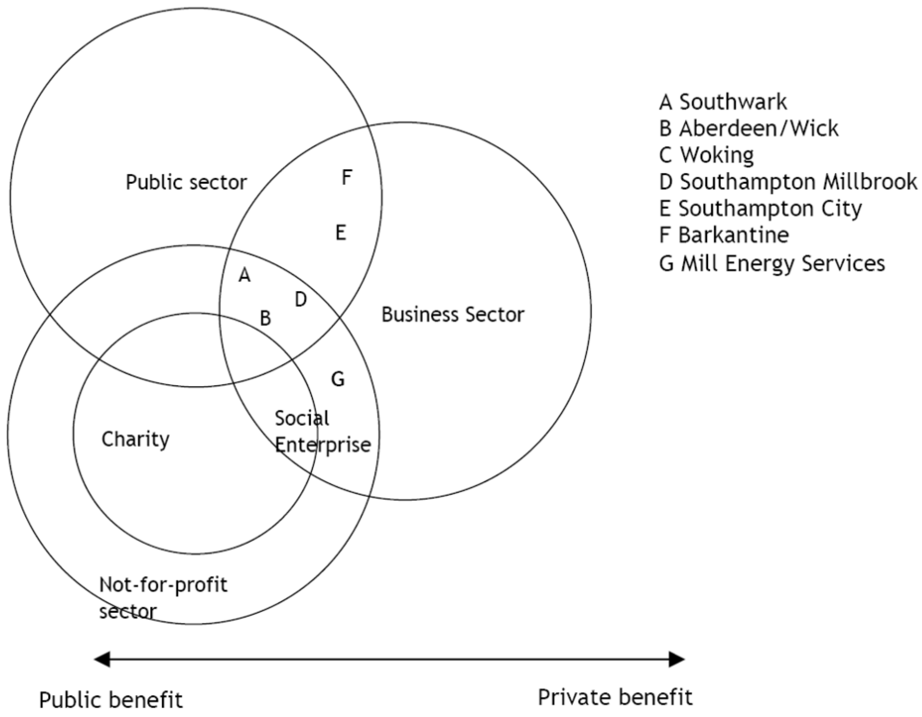

Figure 14: Business models of operating district heating systems[25]

Case Study: Elephant & Castle

Elephant & Castle MUSCO delivers the entire energy centre consisting of Combined heat and power (CHP) engines and ancillary equipment; peak - load boilers and ancillary equipment; biomass boilers and fuel storage and ancillary equipment; thermal storage devices and heating water treatment, pumps and controls.

In addition the ESCO also operates cooling plant, green (non potable) water treatment; data services management centre and an environmental resource centre.

MUSCO Thurrock

There is the potential for a 'MUSCO Thurrock' company to develop and manage any district heating systems, but also a retrofitting programme to reduce energy demand and meet government targets. The experience from the US has shown that the retrofitting market requires an independent party to review and accurately estimate the likely energy savings achieved with the retrofit. The proposed Company could take on such a role. A scheme such as 'pay-as-you-save' could form part of the business plan. Such a scheme would be easier to manage in combination with the district heating supply to the retrofitted premises. The building retrofit prior to district heating connection will reduce the risk of lower energy demands in the future.

[25] Source London Energy Partnership: Making ESCOs work: Guidance and Advice

12 CARBON OFFSET FUNDS

12.1 Introduction

The establishment of the Carbon Offset Fund is a powerful tool for achieving energy and carbon savings cost effectively. The Carbon Offset Fund provides a mechanism for collecting funds from developers within the Thurrock Council area. The funds can then be invested into the most cost-effective and efficient projects. Delivering zero or nearly zero carbon developments can be costly in some of the sites in particular while delivering minimum improvement. The developers are therefore allowed to purchase carbon offsets rather then meeting their entire carbon reduction obligation.

The carbon funds can be used on variety of projects, such as district energy networks for new and existing developments, but also investing into energy efficiency measures or renewable energy projects. The fund will initially be a vehicle for collecting the contributions from the developers but as more and more projects are developed, the scheme may also attract private funding. The operation of the Carbon Offset Fund is most likely going to develop into an organization very similar to an ESCO company.

12.2 Designing Carbon Offset Fund

Local Carbon Offset Funds (LCOF) have already been set up by other local authorities. Milton Keynes developed one of the first Carbon Neutral Development policy linked schemes. By setting up a LCOF the Council should be aiming to design a scheme that is capable of involving the whole community, not simply a means of paying for a way out a problem.

The main parameters of the proposed Carbon Offset Fund are listed below:

Table 27: Main parameters of Carbon Offset Fund design

Income into the fund	There is a variety of ways in which the funds can be raised ranging from compulsory contributions from developers to voluntary agreements with residents and businesses. Thurrock COF: The contribution to the COF is going to be evaluated based on the Energy and Water Statement as required by 'PMD12: Sustainable Buildings'. The Council will use this statement to calculate the required Thurrock Carbon Offset Fund contribution. A one-off contribution will be required for each tonne of CO2, by means of an obligation under section 106 of the Town and Country Planning Act 1990. The cost of each tonne of CO2 produced will be based on the methodology set out in the forthcoming Developer Contributions SPD and the Design and Sustainability SPD.
Management	The fund can be managed either in-house or by third party. The main activities of this body are financial and administrative governance of the scheme. The Thurrock Carbon Offset Fund will be managed and monitored by Thurrock Council, and the Council will identify and manage the carbon reduction measures the Fund will look to address, in accordance with the Thurrock Climate Change

	Strategy and the associated actions arising from the implementation of this strategy.
Delivery	An ongoing repertoire of deliverables would need to be developed. Although many projects be worked-up in-house, it is likely that another agency (-ies) would need to be engaged to help provide the quantity and detail relating to their actual deliverability. Again, it is likely that an energy agency such as those already described could fulfill this type of function.
Governance	The LCOF will need to have a formal governance process with terms of reference. The governance body will be tasked with steering the course of the project in terms of targeting input areas and agreeing priorities for output expenditure, based on officer recommendations. Early tasks would be the selection of appropriate management arrangements and agreement to branding and a marketing approach. The actual constitution of the governance arrangement needs more work but the membership is likely to consist of: - Members (Sustainable Energy Task Force) - Business representative - Housing Trust representative - CfLE Officers - Borough resident

12.3 Using the funds

The proposed strategy should be measured against a number of criteria. All the aspects of the potential funding impact have to be evaluated, from technical to economical and social impact.

12.3.1 Main considerations

Effectiveness and Efficiency: The measures selected for investment have to be effective in abatement of carbon dioxide and do this in a cost effective manner. A substantial amount of reports and research into CO2 abatement cost have been published to date[26]. The results show in general that the most cost effective investments are those into energy efficiency, such as efficient lighting, HVAC and improvements of building envelopes of existing buildings. These are followed with measures focusing on agricultural management and investment into renewable energy systems. For the system to be cost-effective and efficient the impact of so called ‘free riders’ has to be minimised (‘free riders’ are those who benefit from a system but don’t pay the full costs).

Equity and Fairness: Economic incentives can influence the distribution of wealth among members of society. The focus should therefore be on the community and the most vulnerable parts of society such as elderly or low income households. These are the groups of people who are the least likely to undertake any energy efficiency measures due to the fact that the discount rate they are facing is much higher than for most users.

26 McKinsey&Company,2009: Pathways to a Low Carbon Economy

Flexibility to achieve objectives: The Carbon Offset Funding mechanism should be flexible to reflect changes in the technology availability, performance and costs. This will ensure that maximum leverage is achieved through the investment.

Political Acceptability: The political acceptability of economic incentives has often a much stronger impact on the selection of the solution than the economic reasons. Even though the carbon dioxide abatement curve shows high returns on cost effective measures in non-domestic buildings, there may be political problem with funding individual commercial entities.

Other issues to consider: There has to be a sufficient information base and administrative capacity to manage the fund. Suitable legal structures will need to be put in place. The system will work the best if there is competitive market among individual participants.

12.4 Designing Carbon Offset Fund Contribution

There are essentially two approaches to setting up the carbon offset fund charges. In the time prior to the introduction of the Zero Carbon Policy, the tariffs have to be set on a much lower level than tariffs reflecting the true amount of emissions from the development in order to minimize the impact on economic viability of the development compared to developments in other Boroughs.

There are a number of risks which constrain the acceptable and suitable level of the carbon offset charge such as political acceptability and impact on economic viability of developments.

12.4.1 Government's view – capped cost once the Zero Carbon Policy comes to force

The Government is still in the process of finalizing their view on allowable solutions and the capped cost of the allowable solutions. This is essential to give some certainty to the developers in terms of the future costs. There are essentially 3 ways proposed in the Government's consultation paper on Zero Carbon Homes and Non-domestic Buildings. These are as follows:

- One approach would be to set the capped cost at the shadow price of carbon (SPC) used for Government's appraisal of policies. The SPC represents the social cost of carbon (ie the damage inflicted on the world by emitting a tonne of CO2. The figure used for the SPC is £25.5 / t CO2 for the year 2007 (in 2007 prices), rising over time at 2 per cent per annum in real terms to £59.6 / t CO2 by 2050. However, using the SPC alone would not provide industry with a sufficiently strong incentive for innovation.
- Using the price of CO2 implied by future prices of Renewable Obligation Certificates (ROCs). Based on analysis prepared for DECC's consultation on the Renewable Energy Strategy, we estimate this cost to be in the region of £100 / t CO2.
- Using the price of CO2 implied by the incentives for emerging renewable technologies, which are entitled to two ROCs per MWh generated. The rationale here is that the higher

incentive reflects the wider benefits of innovation referred to above. An implied price of CO_2 based on two ROCs would be in the region of £200 / t CO_2; or

- Using a price of avoided renewables, which recognises the consequences of the policy on the amount of renewable energy that needs to be generated in order to meet the RES and the costs thereby saved. Government has not yet finalised how the price of avoidable renewables will be calculated, and this is an area of ongoing policy development.

Government is interested in views on the level at which to set the capped cost.

12.4.2 Current experience – cost of carbon offset prior to the Zero Carbon Policy

The S106 can be used for collecting carbon offset contributions prior to the Zero Carbon policy implementation. There is a practical limitation on the carbon offset contribution. This is primarily due to the fact that the local authorities are not required to set the carbon offset policies and setting the carbon offset charge too high may have an impact on the commercial attractiveness of developments in the Borough. The cost of carbon offset has previously been set at £200 (Milton Keynes) per tonne of CO_2 emitted annually from the development. The original analysis for Milton Keynes' Carbon Offset Fund included measures such as the installation of CFL lights which brought the cost of the carbon offset down.

12.4.3 Deep Retrofit of Existing Dwellings

The existing building stock offers a significant potential for achieving cost effective carbon abatement. This analysis is considering the overall carbon abatement achievable through a deep retrofit of existing buildings. This approach is selected for the following reasons:

- Retrofitting of existing buildings is the most cost effective if conducted during one intervention, particularly when considering the upgrades of the external envelope.
- Considering the normal 30 year renovation cycle of a building, it is most likely that the buildings that are going to be renovated within next 10 to 20 years may not be retrofitted prior to 2050 again. Therefore the target should be for significant carbon reductions when undertaking retrofits now. The aim of a retrofit should therefore be the target performance required by the building stock in 2050 which will be zero carbon or even carbon 'positive.'
- Maintaining a healthy indoor environment is crucial. Deep retrofit is typically necessary due to the technological interdependencies of individual measures. For example, a designed ventilation system may need to be installed due to increased airtightness of dwellings to maintain healthy environment in the dwellings.
- The focus is on residential buildings due to the political acceptability of such measures. To minimize the increasing gap in wealth distribution the grants/funding/loans for

retrofitting are being designed in a way that their availability will not be restricted by requiring matching funding of large sums by low income households.

- High levels of efficiency in existing buildings are essential to maintaining the future viability of the housing stock through its protection from energy price volatility and increases.
- Investment into energy efficiency can also improve local employment. About 80% of expenditures on efficiency stay in the local economy, paying for local services. More than half of the retrofitting cost is the cost of labour which can be sourced locally.

There are at the moment a total of 65,000 dwellings in Thurrock. The total consumption of a typical dwelling is 4,500 kWh of electricity and 15,400 kWh of gas per annum. The total carbon footprint is 5.3 t CO2 pa. The comparison of investment costs per tonne of CO2 avoided is shown below.

There are varying costs for individual measures in the market at the moment. Table 28 is an example of such benchmarks.

Table 28: Domestic Efficiency Measures – estimated costs & savings[27]

Measures	*Average cost (£)*	*Cost saved (£/yr)*	*Carbon saved (kgC/yr)*	*Abatement efficiency (£ / t CO2)**
Cavity wall insulation	342	133	242	47
Loft insulation (full and top-up)	284	104	190	50
Improved heating controls	147	43	77	64
Draught proofing	100	23	43	78
Solid wall insulation	3150	380	694	151
A-rated boiler	1,500	168	177	282
Windows (Single to Double Glazing)	4,000	41	26	5128

*the abatement efficiency is calculated over 30 years

However, improving the existing building stock by adding each additional measure has a diminishing effect on both marginal returns and carbon savings. This report therefore does not analyze individual retrofitting measures due to the limitations of such an approach.

Retrofitting Example:

The benefits of retrofitting are going to be illustrated on an example of a typical 3 bed semi-detached house. A typical cost of achieving a deep retrofit is £17,000 per 3 bed semi-detached house. The cost of the deep retrofit includes upgrade to the ventilation systems of the dwellings which in itself does not improve energy efficiency but is essential for maintaining the healthy indoor

27 The First Draft Illustrative Mix of Measures for EEC 2008-11 (Defra), 2006 and †Buildings Research Establishment (BRE), 2005

environment in the retrofitted buildings. The estimated carbon reduction is based on average carbon emissions of existing dwellings in Thurrock.

Table 29: Estimated carbon reduction – costs and savings

Existing residential buildings	65,200	dwellings
Cost of deep retrofit	17,000	£ per dwelling
Energy saving	12,320	kWh pa per dwelling
Cost saving	505	£ pa per dwelling
CO2 saving through deep retrofit	2.27	t CO2 pa per dwelling
Total CO2 available per 30 years	68.01	t CO2 per dwelling
Cost per tCO2 saved over 30 years	7,499	£/ tCO2
Cost per tCO2 saved	250	£/ tCO2
Total CO2 available (30 years; all dwellings)	4,434,017	t CO2
Total cost to unlock the potential	1,108,400,000	£

The carbon offset funds could be used for full or partial funding of building retrofit. Previous energy efficiency schemes have proven that providing 50-75% funding increases substantially the up take of building retrofit. The funds can therefore double its impact in terms of saving and carbon abatement.

Table 30: Cost-effectiveness of carbon abatement with partial funding

Funding provided	**50%**	**Payment to the owner**
Funding efficiency for carbon abatement	125	£/tCO2 (per 30 years)
Rate of return for the occupant	4%	15 yrs, 5% energy cost inflation
Funding provided	**75%**	**Payment to the owner**
Funding efficiency for carbon abatement	187	£/tCO2 (per 30 years)
Rate of return for the occupant	14%	15 yrs, 5% energy cost inflation

The above calculation indicates that the abatement cost of one tonne of CO2 through a building retrofit is £250 per tonne of CO2 saved. If partial funding is implemented (50% to 75%) then the abatement cost decreases to £125 and £187 per tonne respectively.

12.4.3.1 District Heating

There are opportunities for installation of district energy networks in the Borough. The finances from the Carbon Offset Fund can be used as initial financing, for attracting further investors, for providing grants, low cost debt or by taking partial ownership of the system.

12.5 Potential Size of the Fund

The amount of emissions to be offset has to be calculated over a number of years to cover the emissions over the lifetime of the building. Considering the lifespan of buildings, the suitable time period to be covered should be around 60 years. Since the electricity grid is expected to be progressively decarbonized, then the overall emissions of the building will progressively decrease with time. The analysis below considers the life span of 30 years to reflect this fact.

The total impact of the carbon offset fund is evaluated based on the industry experience on similar projects. Achieving 60% carbon reductions has proven a reasonable target on projects. Achieving reductions higher than 60% are typically associated with large capital investments into renewable energy sources. We have therefore assumed that the proposed buildings will achieve 60% carbon emissions reduction through energy efficiency and further reduction will be achieved through installation of renewable energy sources or connection to district energy network.

The potential build up of the Carbon Offset Fund can only be estimated at this stage. The following table outlines the COF build-up based on the tariff of 200 £/t CO2 prior to the Zero Carbon Policy and £ 150/tCO2 (over 30 years) after the policy is implemented.

Table 31: Gradual Carbon Offset Fund Build-up

Carbon Offset Fund Build Up*	Carbon Emissions to be offset (over 30 years)	Carbon Offset Fund Build-up	Carbon Offset Tariff
	tCO2	£	
2011-2015	886,297	5,908,646	200 £/tCO2 pa
2016-2020	975,835	146,375,262	150£/tCO2 over 30 years
2021-2025	419,303	62,895,456	150£/tCO2 over 30 years
2026-2030	85,249	12,787,407	150£/tCO2 over 30 years

*See Annex 6 for details of this calculation.

12.6 Conclusion

We propose to set the initial carbon offset charge at a lower level (than calculated in the retrofitting example) to minimize the impact on currently planned developments in the Borough. The full tariff can then be introduced once the Zero Carbon policy comes into force. The amount of carbon to be offset (prior to Zero Carbon policy) is calculated only using the annual CO2 emissions (not emissions over 30 years) from the dwellings multiplied by the agreed rate, proposed at £200 per tCO2. This rate is in line with requirements of other Local Authorities.

Considering the scale of investment required for meeting the objectives we would recommend the payment of £150 per tonne of CO2 per total emissions over 30 years once the Zero Carbon policy comes to force. This is a reasonable assumption and is between the Government's proposed middle and high-contribution scenario. Such charge would be in line with required investments into energy efficiency measures for a 'deep retrofit'. The £150 per tonne of CO2 assumes that the funds will be used as grants for energy efficiency measures between 50% and 75% of the capital cost.

The funds should be used in a cost effective and politically acceptable manner while not allowing an easy 'way out' for developers to avoid investment in energy efficiency and renewable energy systems in new buildings.

The funds are typically spent on house retrofitting, domestic micro-generation, larger renewable energy or low carbon technology projects.

Case Study: Milton Keynes Carbon Offset Fund

A one off payment is required to the carbon offset fund, at a rate of £200 for each tonne of carbon dioxide which will be emitted by a new development beyond the level of emissions prior to the construction. The tariff is index linked to take account of inflation and changes within the property market. The increased carbon dioxide emissions from a new development are balanced by savings in carbon dioxide elsewhere, by making payments into a carbon offset fund. The fund is to be used elsewhere in Milton Keynes to reduce carbon emissions by cutting energy use or producing renewable energy. The fund is to be spent on carbon reduction measures with a lifespan of at least 20 yrs equivalent to the increased carbon output from new development. In line with MKC planning policy D4 developers pay contributions into the Carbon Offset Fund. The Fund is managed for Milton Keynes Council by third party.

Case Study: Cambridgeshire Offset Fund

The Cambridgeshire offset fund is going to be set at a rate of £100/tonne of carbon dioxide payable for emissions from the property over 30 years. The carbon offset fund in Cambridgeshire is not implemented yet and it is envisaged only to be implemented after the Zero Carbon policy comes to force. The analysis conducted so far considered the three cost scenarios proposed by the government and found the £100 charge as the most suitable.

Other Carbon Offset Funds have been established by these authorities:

- Greater Manchester Carbon Reduction Fund
- Manchester City Carbon Offset
- Birmingham Carbon Offset
- Eastleigh Borough Council “CarbonFree”
- Nottingham Carbon Trust
- Corsham Town Council Carbon offset initiative
- Hull City Council carbon offset initiative
- Newcastle Carbon Fund

13 WHERE NEXT

13.1 What Others Are Doing

13.1.1 Case Study: Gussing

Gussing is the district capital in the south of Austria. The district itself has a population of 27,000 and was the poorest region in Austria in the 90s. Even today 70% of the working population work outside of Gussing. The decision to become a carbon free district came in 1990. The main drive for this decision was to create an environmentally friendly community but also to provide businesses with 100% renewable energy generated from local sources, thus ensuring the stability of supply and price of the energy.

This energy technical independence of all energy suppliers of the town was reached in 2001; above this the annual balance shows that more energy is being generated from re-growing raw materials than is needed by the town.

13.1.2 Case Study: Clonakilty 2020

Clonakilty 2020 is an initiative of a small community in the South of Ireland to free the region from its dependence on fossil fuels and have 100% of energy supplied from renewable energy sources. The study was conducted by DW EcoCo and it identified renewable energy resources and potential for district energy networks. Due to the nature of the development in the area, there has been a limited opportunity for district energy networks. However, the dispersed settlements have a great opportunity to employ farm based renewable energy technologies. The study has also identified a great potential for a provision of retrofitting of houses with minimal contribution from the customer that can be paid over time. This project is currently searching funding to set up an independent organization to deliver this service.

13.1.3 Case Study: Clonburris Eco-District's Strategic Development Zone

South Dublin County Council developed a Sustainability Toolkit[28] for this special designated area to the west of Dublin. This area will form a new eco-district of Dublin with 11,000 proposed new dwellings.

The Sustainability Toolkit is an exemplary document describing in great detail a practical application of sustainability principles to development of large urban districts. The document is unique in its

[28] Available on (accessed on 26th of October 2010): http://www.southdublin.ie/clonburris_plan/Part%20G%20Sustainability%20Toolkit%20and%20Design%20Standards.pdf

nature because it not only gives targets, but also indicates why these targets are important and how the compliance with the targets will be assessed. The document is organized around the principles of *The Natural Step* and covers therefore the overall environmental, social and economic sustainability of the proposed development.

13.2 Available funding beyond UK

13.2.1 JESSICA

JESSICA stands for Joint European Support for Sustainable Investment in City Areas. This initiative is being developed by the European Commission and the European Investment Bank (EIB), in collaboration with the Council of Europe Development Bank (CEB). Under new procedures, Member States are being given the option of using some of their EU grant funding, their so-called Structural Funds, to make repayable investments in projects forming part of an integrated plan for sustainable urban development. These investments, which may take the form of equity, loans and/or guarantees, are delivered to projects via Urban Development Funds and, if required, Holding Funds.

Rules on the eligibility of project expenditure, using JESSICA, are the same as those on the use of Structural Funds as a whole, and also need to take account of any specific national constraints. Apart from specific non-eligible items listed in the Regulations, such as housing in some of the Member States, JESSICA may allow for more flexible management of projects, respecting at the same time eligibility rules, provided always that the projects being supported form part of "integrated and sustainable" urban development plans. Ineligible expenditure components might, for example, be included as part of a larger, multi-sector urban project, provided sufficient additional funding is attracted from other private or public sources to finance these ineligible components.

When considering which projects could make use of JESSICA funding, an integrated approach is necessary. JESSICA funds could be targeted specifically at projects such as

- Urban infrastructure, including transport, water, wastewater, energy or other public services.
- Redevelopment of brownfield sites, including site clearance and decontamination
- Energy efficiency improvements.

More details are available at: http://www.eib.org/projects/publications/jessica.htm

13.2.2 ELENA

To facilitate the mobilisation of funds for investments in sustainable energy at local level, the European Commission and the European Investment Bank have established the ELENA technical assistance facility (European Local Energy Assistance), financed through the Intelligent Energy

Europe programme. ELENA support covers a share of the cost for technical support that is necessary to prepare, implement and finance the investment programme, such as feasibility and market studies, structuring of programmes, business plans, energy audits, preparation for tendering procedures - in short, everything necessary to make cities' and regions' sustainable energy projects ready for EIB funding.

Investment programmes that can be supported by ELENA: Many EU cities and regions have recently started to prepare or are initiating large energy efficiency and renewable energy proposals to tackle energy and climate change challenges. However, most of them are still at the conceptual stage and their implementation is proving difficult because many regions and cities, particularly medium to small ones, often do not have the technical capacity to develop large programmes in this area.

ELENA helps public entities to solve such problems by offering specific support for the implementation of the investment programmes and projects such as retrofitting of public and private buildings, sustainable building, energy-efficient district heating and cooling networks, or environmentally-friendly transport etc.

More details are available at: http://www.eib.org/products/technical_assistance/elena/index.htm

14 AFTER THE REPORT

Providing Feedback

Following receipt of the final report we may ask for Feedback on your experiences of working with the Carbon Trust and our consultant. The Carbon Trust values all feedback obtained.

For Environmental Advice - Envirowise Can Help

Resource efficiency and waste minimisation are key drivers in sustainable development and this includes energy, water, raw materials and more. The Envirowise programme (funded by the Department of Trade & Industry and the Department for Environment, Food and Rural Affairs) provides a helpline service on environmental issues and publications on waste minimisation, clean technology, water and effluent savings, and more. Take a look at the Envirowise website (http://www.envirowise.gov.uk>) to see what is on offer, or call the Environment Helpline 0800 58 57 94.

APPENDICES

ANNEX 1: RESIDENTIAL DEVELOPMENT ANALYSIS

The following table is based on the information in the Strategic Housing Land Availability Assessment and quantifies the development by size and density.

	Number of sites	Total number of dwellings	Total size of sites
	-	-	ha
Accepted for development	296	21,182	640
Accepted for development, each ≥ 5 dwellings	204	21,012	635
Accepted for development, each ≥ 10 dwellings	157	20,678	628
Accepted for development, each ≥ 100 dwellings and density < 55 dw. pha	23	8,994	441
Accepted for development, each ≥ 100 dwellings and density > 55 dw. pha	27	8,769	102

By introducing the level of development at 5 dwellings per development we are able to address additional 47 sites, corresponding to additional 334 dwellings.

The following table summarises developments which were identified in the SHLAA as large high density developments (minimum of 100 dwellings, minimum of 55 dwellings per hectare).

Code of development	Number of dwellings	Area	Density	Phasing
	-	ha	Dwellings per hectare	
GRI33	140	0.46	304	0-5
SCH03	140	0.77	182	0-5
WTS08	502	5.32	94	0-5
WTS31	236	2.54	93	0-5
WTS32#	622	9.84	63	0-5
WTS38	180	1.76	102	0-5
BEL03	183	2	92	6-10
GRI26	127	1.3	98	6-10
GRI31	103	0.34	303	6-10
GRI32	141	0.46	307	6-10
GTH04	1100	13.78	80	6-10
WTS01	151	1.65	92	6-10
WTS19	551	6.02	92	6-10
WTS21	121	1.24	98	6-10
WTS32a	622	9.84	63	6-10
GRI03	521	5.69	92	11-15
GRI10	229	2.5	92	11-15
LTR08	140	1.53	92	11-15
LTR09	126	1.15	110	11-15
LTR10	583	7.95	73	11-15

Code of development	Number of dwellings	Area	Density	Phasing
	-	ha	Dwellings per hectare	
STW06	125	2.02	62	11-15
TRV19	143	2.39	60	11-15
WTS07	105	1.07	98	11-15
WTS25	163	1.78	92	11-15
WTS30	233	2.55	91	11-15
GRI01	886	9.69	91	15+
GRI02	596	6.52	91	15+
	8,769	**102.16**		

Phasing	Number of dwellings	Area	Density
	-	ha	Dwelling per hectare
2011 - 2016	1,820	20.69	88
2017 - 2021	3,099	36.63	85
2021 - 2026	2,368	28.63	83
2026 +	1,482	16.21	91
Total	**8,769**	**102.16**	**86**

Many development areas which do not have the density of 55 dwellings per hectare can still be suitable for the development of district energy networks. These developments are those above 100 dwellings. Their density may not achieve the threshold of 55 d/ha but this may only be due to the fact that the entire site may not be developed and the dwellings will only occupy a part of the site. The following table summarises developments which were identified in the SHLAA as large developments (minimum of 100 dwellings) however with lower density than 55 dwellings per ha.

Code of development	Number of dwellings	Area	Density	Phasing
	-	ha	Dwellings per hectare	
AVE30	340	12.3	28	0-5
EAT08	331	13.3	25	0-5
GRI04	114	2.6	44	0-5
TSC11	186	4.2	44	0-5
WTS06#	450	18.7	24	0-5
WTS14	119	3.3	36	0-5
WTS18	331	7.9	42	0-5
AVE05	110	2.5	44	6-10
EAT01	176	4.0	44	6-10
EAT03	100	2.3	44	6-10
EAT10	150	3.5	43	6-10
LTB08	281	9.4	30	6-10
OCK03	876	17.7	50	6-10
STW25	184	4.9	37	6-10

Code of development	Number of dwellings	Area	Density	Phasing
	-	ha	Dwellings per hectare	
WTS04	130	2.6	51	6-10
WTS06A	1000	18.7	54	6-10
WTS12	332	11.4	29	6-10
WTS16	400	120.3	3	6-10
WTS21	121	1.2	98	6-10
COF05	193	5.2	37	11-15
STC03vB	190	7.6	25	11-15
WTS41	280	11.2	25	11-15
WTS43	2600	156.4	17	11-15
	8994	**440.97**		

Phasing	Number of dwellings	Area	Density
	-	ha	Dwelling per hectare
2011 - 2016	1,871	62.24	30
2017 - 2021	3,860	198.31	19
2021 - 2026	3,263	180.42	18
2026 +	0	0	0
Total	**8,994**	**440.97**	**20**

ANNEX 2: NON-RESIDENTIAL DEVELOPMENT ANALYSIS

The following table summarises the total non-residential floor areas to be developed in the Borough (as outlined in the document on 'Other Employment Sites'). The total electricity and thermal consumption is based on available benchmarks assuming the same progressive energy performance improvement as for proposed residential buildings. Due to the absence of information on non-residential development phasing we assume that all the non-residential development will be performed within next 10 years.

Code	Total area	EE_total	TH_total	Total_total
	m2	kWh pa.	kWh pa.	kWh pa.
E2a	5,477	546,829	476,139	1,022,968
E2b	2,258	255,334	214,928	470,262
E2d	10,157	1,148,426	966,767	2,115,193
E2e	24,509	2,447,036	2,130,654	4,577,690
E2f	50,764	5,068,421	4,413,093	9,481,515
E2g	6,767	765,130	644,100	1,409,229
E2h	5,047	261,098	201,880	462,978
E2i	1,933	100,001	77,320	177,321
E2j	9,833	508,694	393,320	902,014
E2ma	74,206	7,408,921	6,450,956	13,859,876
E2mb	44,454	4,968,528	4,075,056	9,043,584
E2n	608	33,902	36,128	70,030
E2o	1,563	87,161	92,915	180,075
E2p	236	26,669	22,460	49,129
E2q	28,946	2,890,062	2,516,377	5,406,439
E2q(b)	14,700	1,272,040	1,160,320	2,432,360
E2r	58,500	5,840,800	5,085,600	10,926,400
E2s	55,756	3,389,965	4,668,636	8,058,601
E2t	-	-	-	-
E2 Raa	38,686	3,679,468	2,991,717	6,671,186
E4d	14,080	1,486,041	990,413	2,476,453
E4e	18,729	1,976,673	1,317,412	3,294,084
E4 Raa	2,889	304,907	203,214	508,122
M2	-	-	-	-

Code	Total area	EE_total	TH_total	Total_total
	m2	kWh pa.	kWh pa.	kWh pa.
M3	3,323	216,478	184,840	401,318
M4	2,658	129,852	173,514	303,366
M5	7,491	315,621	930,882	1,246,502
M6	1,467	32,239	192,962	225,200
M7	10,400	538,027	557,333	1,095,360
MRA1	55,000	645,333	5,954,667	6,600,000
E4a	5,180	230,683	534,576	765,259
M9	3,123	152,202	221,884	374,086
MRA5	11,063	519,200	908,600	1,427,800
L6	12,000	620,800	480,000	1,100,800
L7	2,800	144,853	112,000	256,853
L12	46,875	5,300,000	4,461,667	9,761,667
L17	23,826	1,448,621	1,995,030	3,443,651
LRZ1	35,000	3,621,333	3,509,333	7,130,667
HR1	9,000	465,600	360,000	825,600
LR2	5,000	58,667	541,333	600,000
LR1	8,000	93,867	866,133	960,000
LR3	36,500	3,776,533	3,659,733	7,436,267
ED17	30,000	352,000	3,248,000	3,600,000
	778,804	**63,128,012**	**68,021,892**	**131,149,905**

ANNEX 3: FEED-IN TARIFFS

Generation tariffs 1 April 2010 – 31 March 2013

Technology	Scale	Tariff level for new installations in period (p/kWh) [NB tariffs will be inflated annually]			Tariff lifetime (years)
		Year 1: 1/4/10 – 31/3/11	Year 2: 1/4/11 – 31/3/12	Year 3: 1/4/12 – 31/3/13	
Anaerobic digestion	≤500kW	11.5	11.5	11.5	20
Anaerobic digestion	>500kW	9.0	9.0	9.0	20
Hydro	≤15 kW	19.9	19.9	19.9	20
Hydro	>15-100 kW	17.8	17.8	17.8	20
Hydro	>100 kW-2 MW	11.0	11.0	11.0	20
Hydro	>2 MW – 5 MW	4.5	4.5	4.5	20
MicroCHP pilot*	≤2 kW*	10*	10*	10*	10
PV	≤4 kW (new build**)	36.1	36.1	33.0	25
PV	≤4 kW (retrofit**)	41.3	41.3	37.8	25
PV	>4-10 kW	36.1	36.1	33.0	25
PV	>10-100 kW	31.4	31.4	28.7	25
PV	>100kW-5MW	29.3	29.3	26.8	25
PV	Stand alone system**	29.3	29.3	26.8	25
Wind	≤1.5kW	34.5	34.5	32.6	20
Wind	>1.5-15kW	26.7	26.7	25.5	20
Wind	>15-100kW	24.1	24.1	23.0	20
Wind	>100-500kW	18.8	18.8	18.8	20
Wind	>500kW-1.5MW	9.4	9.4	9.4	20
Wind	>1.5MW-5MW	4.5	4.5	4.5	20
Existing microgenerators transferred from the RO		9.0	9.0	9.0	to 2027

* Note the microCHP pilot will support up to 30,000 installations with a review to start when the 12,000th installation has occurred

ANNEX 4: CARBON DIOXIDE ABATEMENT CURVE (UK)

A marginal abatement cost curve is a graphical presentation of the cost-effectiveness of carbon dioxide reduction options. It should be noted that large proportion of feasible abatement measures are net profit positive.

There are essentially three groups of carbon dioxide abatement measures that can be implemented:

- Energy efficiency measures
- Low carbon energy supply measures
- Terrestrial carbon (improvement on carbon sinks)

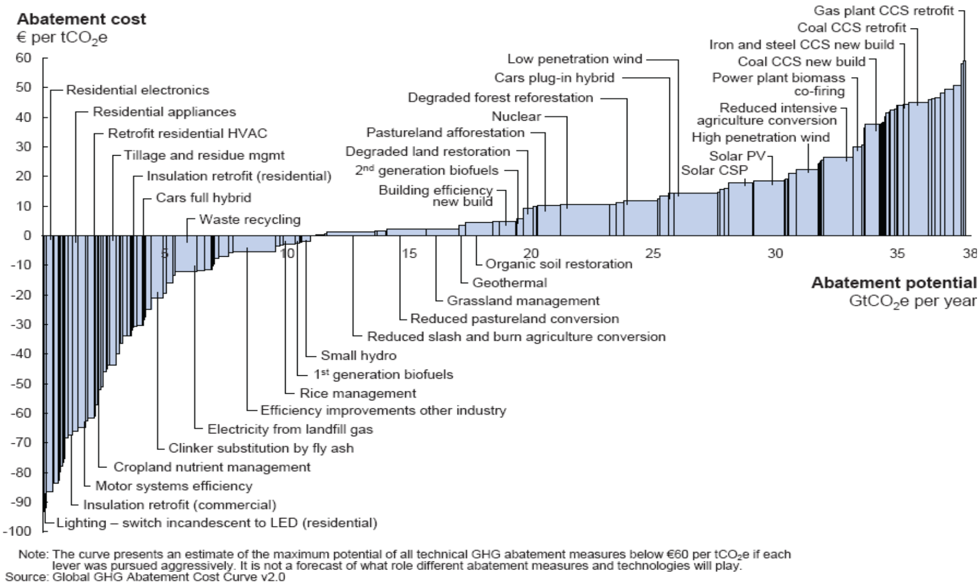

Figure 15: Global GHG abatement cost curve beyond business-as-usual - 2030[29]

The chart demonstrates the importance and cost-effectiveness of energy efficiency measures in existing building stock.

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[29] McKinsey, 2009: Pathways to Low Carbon Economy, Version 2 of the Global Greenhouse Gas Abatement Cost Curve

The carbon dioxide abatement curve for investment in building sector is below.

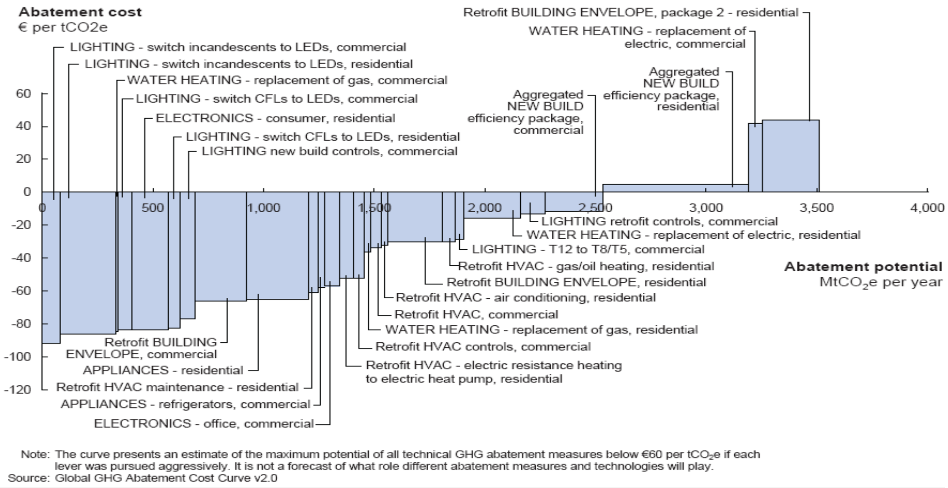

Figure 16: Global GHG abatement cost curve for the Buildings sector

ANNEX 5: TECHNOLOGY ASSESSMENT OF DISTRICT HEATING SCHEME IN LAKESIDE DEVELOPMENT

The following assessment outlines the potential for district energy network and energy centres which could feed into the proposed district heating scheme in the Lakeside area. The developments which were assumed to form part of this proposed district energy network were new domestic and non-domestic developments and large existing buildings such as schools and shopping centres.

Table 32: Developments in the vicinity of Lakeside considered in the analysis

	Dwellings	Phasing	Floor area	Electricity consump.	Heat consump.
LRZ1		6-10	35,000	3,621,333	3,602,667
LR3		6-10	36,500	3,776,533	3,757,067
L6		6-10	12,000	620,800	512,000
L7		6-10	2,800	144,853	119,467
MRA1		6-10	55,000	645,333	6,101,333
E4R4aa		6-10	2,889	304,907	210,918
E2e		6-10	24,509	2,447,036	2,196,012
E2f		6-10	50,764	5,068,421	4,548,464
E2g		6-10	6,767	765,130	662,145
L17		6-10	23,826	1,448,621	2,058,566
L12		6-10	46,875	5,300,000	4,586,667
E2mb		6-10	44,454	4,968,528	4,193,600
E2ma		6-10	74,206	7,408,921	6,648,838
WTS16	400	6-10	40,000	1,386,667	1,706,667
SCH03	140	0-5	14,000	679,467	836,267
WTS19	551	6-10	55,100	1,910,133	2,350,933
WTS21	121	6-10	12,100	419,467	516,267
WTS24	30	11-15	3,000	104,000	128,000
WTS23	86	11-15	8,600	298,133	366,933
WTS25	92	11-15	9,157	317,453	390,712
Existing Buildings in the area			254,945	24,471,498	30,059,078
			812,492	**66,107,234**	**75,552,601**

The energy consumption and base load evaluated on the basis of these developments were:

Table 33: Basic information about the total demand and floor area in the priority area

Total floor area	m2	812,492
Total head demand	MWh pa	75,553
Total base heat demand	MWh pa.	22,666
Total heat baseload for CHP	MWth	4
Total electricity consumption	MWh	66,107
Total carbon footprint with standard heat supply	tCO2 pa	51,073

Table 34: Analysis of options for heat supply into the district heating system

		Biomass Boilers	Biomass CHP + Biomass boilers	Biomass CHP + Biomass boilers + PV panels	Biomass Boilers + Solar thermal
Total electricity generated	MWh pa.	-	11,333	12,183	-
Total heat generated	MWh pa.	75,553	75,553	75,553	75,553
Total CO2 saving in the DH	tCO2 pa	12,831	18,058	18,488	12,844
Total CO2 saving in the DH	**%**	**25%**	**36%**	**36%**	**25%**
Energy Centre Cost	£	7,555,260	13,599,468	14,066,135	7,930,260
Grid Cost	£	25,586,780	26,058,984	26,058,984	25,586,780
Substituted cost*	£	2,981,204	2,981,204	2,981,204	2,981,204
Cost (minus savings)	**£**	**30,160,837**	**36,677,248**	**37,143,915**	**30,535,837**
Total Annual Running Cost	£ pa	2,035,144	2,622,109	2,623,276	2,024,185
Total revenue	£ pa	3,030,316	4,803,914	4,936,939	3,030,316
Annual profit	**£ pa**	**995,172**	**2,181,804**	**2,313,662**	**1,006,131**
Feasibility Review					
Total CO2 saving in the DH	%	25%	36%	36%	25%
Capital cost	£ / t CO2	78	68	67	79
Capital cost	£ / m2	37	45	46	38

*Avoided costs of installing gas boilers in the buildings. The cost of the heat exchangers/ interface units and heat meters are included in the grid cost.

Economic Assessment

The economic assessment investigates the economic performance of the project under a number of scenarios. Table 35 the performance if there were no funding or contribution from developers available.

Table 35: Economic performance of projects under varying energy inflation scenario

Scenario 1: No funding					
Economic parameters	**Energy Inflation**	**Biomass Boilers**	**Biomass CHP + Biomass boilers**	**Biomass CHP + Biomass boilers, PV**	**Biomass Boilers + Solar thermal**
Capital cost	£ / m2	37	45	46	38
IRR (15 yrs)	2.5%	-6%	1%	2%	-6%
IRR (15 yrs)	5.0%	-4%	3%	4%	-4%
IRR (15 yrs)	7.5%	-2%	5%	6%	-2%

Charge based on the amount of funding required for making the development economically attractive

The economic parameters of district energy projects are a crucial aspect for evaluating district heating feasibility. The economic parameters to attract private and public funding differ. Private companies typically require higher rates of return than what is required for publicly funded projects. The following analysis outlines the cost per meter square to achieve 12% and 7.5% Internal Rate of Return respectively. The cost represents the contribution required from the developer to the ESCO per meter square of floor area to make the scheme economically attractive and achieve the desired rate of return.

Table 36: Contributions to achieve 12% Internal Rate of Return

Contributions required to reach	Energy Inflatio n		Biomass Boilers	Biomass CHP + gas boilers	Biomass CHP + Biomass boilers	Biomass CHP + Biomass boilers + PV panels	Biomass Boilers + Solar thermal
Contribution per m2 required	2.5%	£/m2	28	24	24	24	28
Contribution per m2 required	5.0%	£/m2	26	22	21	21	27
Contribution per m2 required	7.5%	£/m2	25	19	18	17	25

Table 37: Contributions to achieve 7.5% Internal Rate of Return

Contributions required to reach	Energy Inflatio n		Biomass Boilers	Biomass CHP + gas boilers	Biomass CHP + Biomass boilers	Biomass CHP + Biomass boilers + PV panels	Biomass Boilers + Solar thermal
Contribution per m2 required	2.5%	£/m2	25	18	10	8	24
Contribution per m2 required	5.0%	£/m2	23	16	13	12	23
Contribution per m2 required	7.5%	£/m2	20	12	8	6	20

ANNEX 6: EVALUATION OF CARBON OFFSET FUND BUILD-UP

This annex summarises calculation of the carbon offset fund build-up over time. The following assumptions were made:

The non-domestic buildings larger than 10,000m2 are assumed to be part of district heating system or other district energy network achieving 30% carbon mission reduction through the use of such energy network.

The domestic developments larger than 100 dwellings are assumed to be part of district heating system or other district energy network achieving 30% carbon emission reduction through the use of such energy network.

Non-domestic buildings smaller than 10,000m2 and domestic developments smaller than 100 dwellings are assumed to meet the low and zero carbon energy targets through on-site renewables and achieving carbon reduction in line with the requirements of the Councils Policy PMD13.

Table 38: Carbon offset in non-domestic buildings with district heating potential

Non residential > 10,000m2						
floor area	Electricity	Heat	CO2	CO2 reduction through DH	CO2 reduced	CO2 to be offset
m2	kWh	kWh	tCO2 pa	%	tCO2 over 30 years	tCO2 over 30 years
694,151	58,388,394	63,392,433	43,427	30%	390,847	911,977

Table 39: Carbon offset in non-domestic buildings with lower district heating potential

Non residential < 10,000m2						
floor area	Electricity	Heat	CO2	CO2 reduction through LZC	CO2 reduced through LZC	CO2 to be offset
m2	kWh	kWh	tCO2 pa	%	tCO2 over 30 years	tCO2 over 30 years
84,653	4,704,843	6,706,270	3,793	15%	17,070	96,731

Table 40: Carbon offset in domestic buildings with district heating potential

> 100	Potential District Heating						
Dwellings	No of dwellings	Electricity	Thermal	Total emissions	Emission reduction through District Energy	Emission reduction through District Energy	Emission to be reduced through the COF
	No	kWh	kWh	tCO2 pa	%	tCO2 per 30 years	
0-5	3691	17913653	22047573	14155	30%	127391	297245
6-10	6738	23358400	28748800	18457	30%	166111	387591
11-15	5631	19520800	24025600	15424	30%	138820	323913
15+	1482	5137600	6323200	4059	30%	36535	85249
Total						**468857**	**1093999**

Table 41: Carbon offset in domestic buildings with low district heating potential

<100	Most likely individual						
Dwellings	No of dwellings	Electricity	Thermal	total	Emission reduction through District Energy	Emission reduction through LZC	Emission to be reduced through the COF
	No	kWh	kWh	tCO2 pa	%	tCO2 per 30 years	tCO2 per 30 years
0-5	818	3970027	4886187	3137	10%	9411	84697
6-10	1201	4163467	5124267	3290	15%	14804	83889
11-15	1451	5030133	6190933	3975	20%	23847	95390
15+	0	0	0	0	20%	0	0
						48062	**263976**

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- setting standards for carbon reduction.

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