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Introduction and welcome

Sustainable Development

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UP-RES Urban Planners with Renewable Energy Skills

Content

- Welcome and safety notes
- Course overall objective
- Course structure
- What we want you to bring home after the training?

Welcoming and safety notes

UP-RES Urban Planners with Renewable Energy Skills

- The sole responsibility for the content of this training course lies with the authors. It does not necessarily reflect the opinion of the European Communities. The European Commission is not responsible for any use that may be made of the information obtained therein.

Workshop – why are you on this course?

- What do you want to get out of the course
  - Personally
  - Professionally
- How did you hear about the course
  - Looking for these skills and found the details yourself (where, on-line, through networks)
  - Someone else in the LA suggested it (who, are they here too?)

Put the first things you think about when considering these questions onto the post-it notes provided

Course overall objective

- To provide Local Authority planners and the supporting network with the required skill and knowledge in order to:
  - develop and integrate sustainable energy policies (specifically focused upon renewable and district heating systems) into the planning process
  - be able to translate such policies into the day to day work of the Local Planning Authority

Course overall objective

- We will focus on those topics which we believe other existing courses do not cover
- Very little information exists that explains how to integrate renewable energy systems within district or community wide energy schemes
- Supporting implementation through planning

Course overall objective

- This course covers issues around planning for new developments and integrating renewable heat and cooling
- However, it is necessary to address the existing building stock when attempting a holistic approach to energy planning
- Highlight relationships and synergies that exist across all LA departments.
- How these relationships need to be understood for implementation of a sustainable energy strategy across a local authority

3 day course

Day 1:
Introduction, why we need to change, background and context to current policies and standards. Introduction to District Heating, application, benefits, barriers and identifying sites.

Day 2:
Sustainable urban energy planning, how this can be integrated into the planning system, examples of policies, evidences bases.

Day 3:
Making the right energy choices, lower temperature sources and a more detailed look into DH and how to integrate renewable sources. Workshop to look back at 3 days of learning

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At the end of the course you will:

- think and recognise the importance/benefits of thinking long term-energy wise
- understand what is the best energy system approach for the area (from small neighborhood to city wide) (individual vs. district energy solutions)
- understand the range of heat energy sources and technologies that are available and when they can be best used

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At the end of the course you will:

(continued)

- be able to understand the issues around developing an energy plan for a certain area (small community scale to city wide)
- understand the issues around detailed energy proposals/strategies
- understand how an energy plan can be implemented
- advise/understand planning applications on integrating energy supply and demand

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Why is a transition to an alternative energy system required?

- Sustainable Development

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Content

- What is energy?
- Current provision of energy
- Global Warming
- Why do we need a transition to an alternative energy system?
- Brief remarks about UK energy systems

What is energy?

- Energy is defined as capacity of a physical system to perform work
- Energy is found in every process in the earth: heat, wind, movement, life, etc…
- Energy can not be destroyed, only transformed from one form into another

Conventional provision of energy

- Most of the energy we use is from non-renewable fuels
  - Fuels can not be replaced at the same rate as they are consumed
- The carbon stored in fossil fuels is transformed into carbon dioxide during combustion

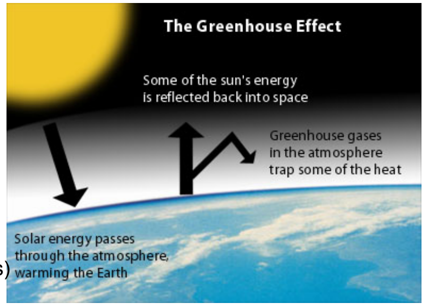
Global Warming and Climate Change

- Increased level of carbon dioxide in the atmosphere is widely recognised to be strongly related to the Global Warming

How does global warming occur and why does carbon dioxide contributes to it?

Greenhouse effect

- Some radiation received by the Earth's is reflected back to the space
- A proportion is trapped by greenhouse gases (GHG) that forms a layer that acts like a blanket in the atmosphere (natural process)
- Elevated GHG emissions increases the thickness of the blanket layer leading additional warming of the atmosphere



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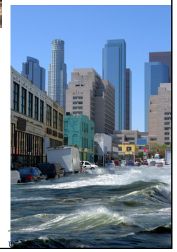
Consequences of Global Warming

- *'unique and threatened systems may be irreparably harmed by changes in climate'*
- *'some regions, countries, islands, and cultures may be adversely affected …'*
- Increased *'probability of extreme weather events such as, extreme floods, droughts, tropical cyclones, and storms'*.
- increased *'probability of large-scale singular events, such as collapse of the West Antarctic ice sheet'*.



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Why a transition to an alternative and sustainable energy system is required?

- To minimise the extent of global warming by reducing human induced GHG emissions
- To provide maximum fuel security
- To generate economic opportunities
- To provide affordable energy for all

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Why a transition to an alternative and sustainable energy system is required?

- Current system
  - Contribute to global warming
  - Relies on finite resources – fossil fuels
  - Price fluctuation and geopolitical situation
- Alternative system should
  - Reduce impact on global warming
  - Be sustainable with time
    - *rely on renewable energy and other low carbon sources*
  - Be affordable for all

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Environmental impact of buildings

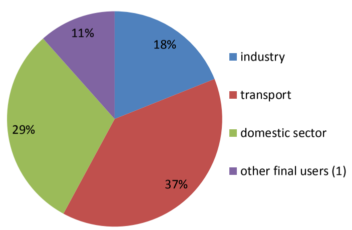
- Sustainable Development

Content

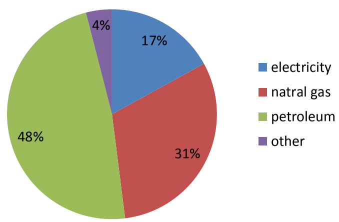
- Introduction to sustainable buildings
- Environmental impact of buildings within the UK
- Energy consumption of buildings within the UK

Brief remarks about UK energy system

Final energy consumption by sector (2009)



Final energy consumption by fuel type (2009)

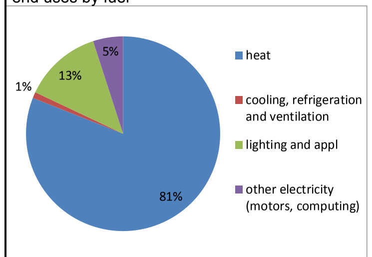


(1) includes services and agricultural sectors

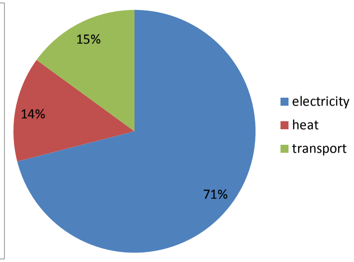
Source: Digest of United Kingdom energy statistics 2010 (DUKES) – 2009 figures

Brief remarks about UK energy system

Overall energy consumption for heat and other end uses by fuel



Renewable energy sources by end use

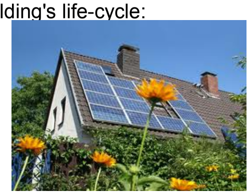


Source: Digest of United Kingdom energy statistics 2010 (DUKES) – 2008 figures

Sustainable buildings - Introduction

What is a sustainable building?

- The holistic nature of sustainability can be summarised as the 'triple bottom line' of social, economic and environmental considerations
- Broader than energy consumption and CO_2!
- Resource-efficient throughout the building's life-cycle:
  - Location
  - Design
  - Construction
  - Operation
  - Maintenance
  - Deconstruction



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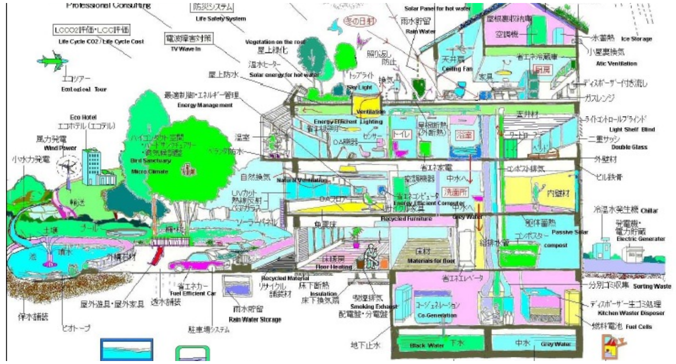
It doesn't need to be overly complicated!



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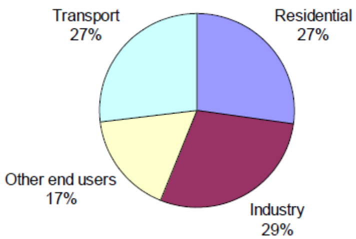
Context of housing and carbon emissions



'Domestic property contributes 27% of UK's CO_2 emissions. The government is seeking to reduce the emissions from new homes to zero carbon in all new housing by 2016'

(source UK Gov 2002)

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Existing and new build homes

- 85% of today's homes will be around in 2050
- Need to look at reducing emissions from existing dwellings as well as new build
- UK has the oldest housing stock in the developed world (one in five homes were built before 1918)
- Challenging and enormous refurbishment opportunity for businesses and homeowners
  - Rethinking Housing Refurbishment (RHR)
  - Retrofit for the future

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What can be achieved if you put your mind to it

From old….

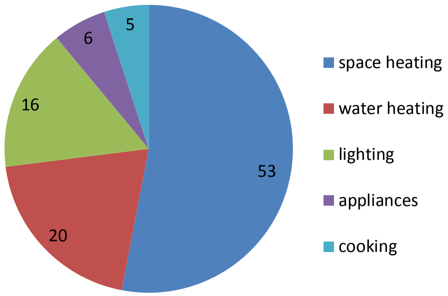
…. to new

Funding existing and new build homes

- CERT – Carbon Emissions Reduction Targets
- CESP – Community Energy Saving Programme
- ECO – Energy Companies Obligation
- The Green Deal

Environmental Impacts from Domestic Sector

Domestic carbon emissions by source, 2005
(average household emissions of 5.64 tonnes CO_2 per year)



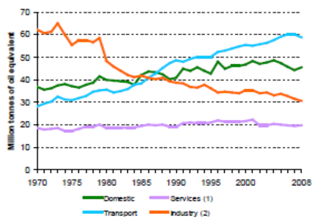
Renewable Heat Incentive

- Government scheme designed to encourage take-up of low-carbon heating systems
- Tariff system similar to that of FIT
- Launched from April 2012
- Premium payments to encourage early installations
- Measurement via a 'heat meter' or estimated
- 20 year life

Technology	Scale	Tariffs (pence/kWh)	Tariff lifetime (years)
Small installations			
Solid biomass	Up to 45kW	9	15
Biodiesel (restricted use)	Up to 45kW	6.5	15
Biogas on-site combustion	Up to 45kW	5.5	10
Ground source heat pumps	Up to 45kW	7	23
Air source heat pumps	Up to 45kW	7.5	18
Solar thermal	Up to 20kW	18	20
Medium installations			
Solid biomass	45kW-500kW	6.5	15
Biogas on-site combustion	45kW-200kW	5.5	10
Ground source heat pumps	45kW-350kW	5.5	20
Air source heat pumps	45kW-350kW	2	20
Solar thermal	20kW-100kW	17	20
Large installations			
Solid biomass	500kW and above	1.6-2.5	15
Ground source heat pumps	350kW and above	1.5	20
Biomethane injection	All scales	4	15

Energy consumption and carbon emissions

- Total UK energy consumption decreasing, domestic energy consumption increasing
- Energy is used directly within the building for heating and cooling
- New housing needs less heating due to increased insulation, but cooling demand may have increased
- Electrical use is increasing



Final energy consumption by sector, 1970 to 2008, Source DECC DUKES, 2009.

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European and UK energy policy drivers and incentives for renewables and GHG mitigation

- Sustainable Development

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- European directives and commitments
- UK energy and carbon emissions reduction targets
- UK financial incentives for RE
- UK planning policy

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EU Renewable Energy Directive

Renewable Electricity Directive 2001

12% renewable electricity by 2010

Anticipation that 2012 target would be missed

Renewable transport fuel obligation 2003

5.75%% by 2010

Anticipated to be missed and issues around sustainability of biofuels

New Renewable Energy Directive 2009

20% by 2020 of energy by renewable sources

10% of all transport fuels by renewable sources

Covers electricity, heat and transport

Binding targets

Environmental criteria for bioliquids and bio fuels

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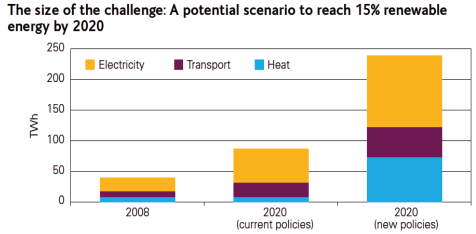
EU Renewable Energy Directive (RED)

Country “shares” of the proposed 20% renewable target for EU

- The UK’s share is 15% of final energy consumption across EU
- Currently the UK produces only 3% of its energy from renewables



Source: Energy trends, June 2009 and DECC internal analysis

EU Renewable Energy Directive

Percentage of gross final consumption of energy from renewable sources, 2008 and 2020

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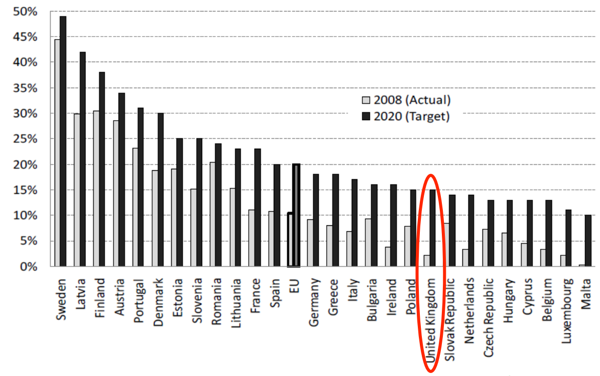
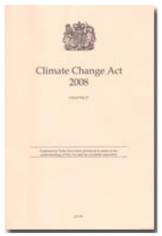


2008 UK Climate Change Act

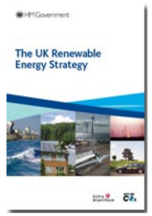
- Legally binding ‘carbon budgets’
  - cut UK emissions by 34% by 2020 AND
  - at least 80% by 2050 below 1990
- Through:
  - investment in energy efficiency
  - clean energy technologies such as renewables, nuclear and carbon capture & storage.
- To meet requirements the Government published in 2009
  - UK Low Carbon Transition Plan
  - The UK Renewable Energy Strategy



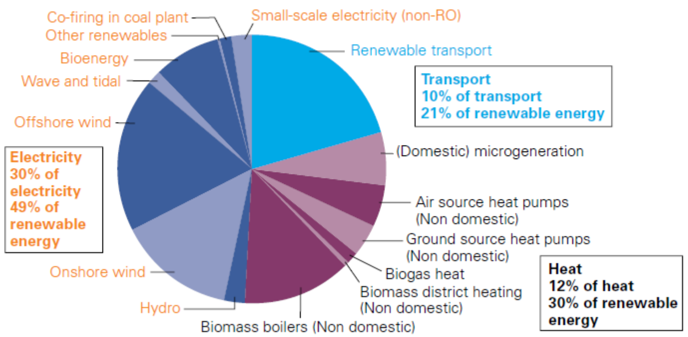
It implements the legislative aspects of the Energy white paper 2007: ‘Meeting the energy challenge’.

UK Renewable Energy Strategy

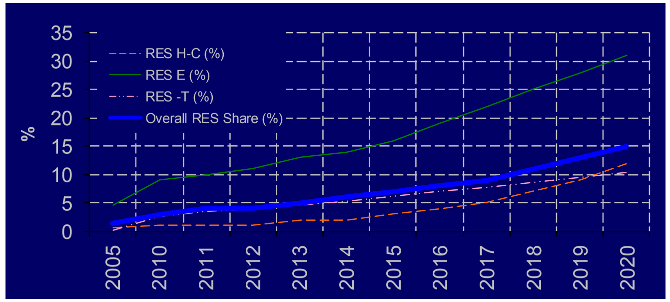
- Published July 2009
- Policy measures and scenario based analysis to meet the 15% target.
  - 30% electricity from renewable sources (currently 5.5%)
  - 12% heat from renewable sources
  - 10% transport energy from renewable (currently 2.6%)



UK Renewable Energy Strategy



Brief remarks about UK energy system



The figure above reflects a possible scenario of how the UK could reach the EU directive objectives of 20% renewable energy by 2020

Source: DECC analysis based on Redpoint/Trilemma (2009), Element/Pöyry (2009),Nera (2009) and DfT

UK Financial or incentive mechanisms for RE

- Market forces alone will not be sufficient
- A long term framework of financial support is required

[UK] Financial or incentive mechanisms for RE

- EU Trading scheme and other national carbon trading Schemes (Carbon Reduction Commitment)
  - set outs a price on carbon emissions
- Renewable obligation
  - incentive renewable electricity generation at large scale
  - requires electricity suppliers to source a specified and increasing proportion of their electricity from renewable sources
- Renewable transport fuel obligation
  - require an increasing level of sustainable biofuels for road transport
- Feed-in tariffs
  - Promote renewable electricity generation at small scale (since 2010)
- Renewable heat incentive
  - Promote renewable heat generation (March 2011)

National Planning Policy

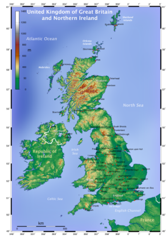
National Planning Policy

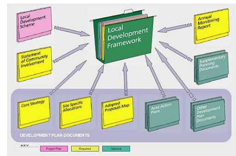
~~Regional Spatial Strategies.~~

Local (Authorities) Development Frameworks

National Planning Policy

- National Planning Policy
  - Government determines national policies on different aspects of planning
  - Planning Policy Statements (PPS), Planning Policy Guidance notes (PPG), etc
- Local level
  - Local Development Framework (LDF).
  - Folder of documents for delivering the spatial or planning strategy for the area

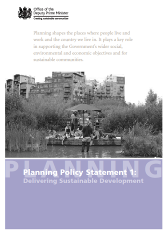




PPS22 and PPS1

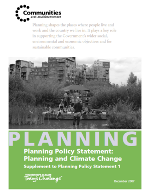
- Published Aug 2004
- Sets out the Government's policies for renewable energy
- Planning authorities should have regard to this when preparing local development documents and during planning decisions

- Published 2005
- Overarching planning policies on delivery of sustainable development through planning system.
- Local authorities can specify local requirements for sustainable building ahead of those set out nationally
- Supplement to Planning Policy Statement 1 was published…..



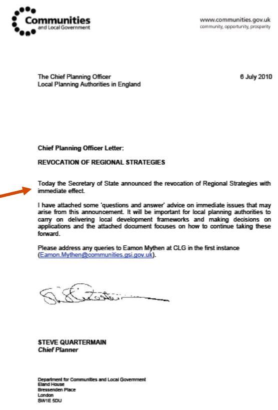
PPS1 Supplement and Consultation on new PPS

- Published Dec 07
  - promote and encourage renewable and low carbon energy generation
  - new development to be secured from decentralised and renewable energy sources
  - evidence-based understanding of local feasibility and potential for renewable technologies
  - opportunities for utilizing existing decentralised and renewable or systems
- Launched March 2010
  - Brings together PPS1 supplement with the PPS 22
  - Strong wording and Stand alone schemes
  - Planning process integrates all relevant legislation and policy initiatives rather than duplicating
  - Focus on evidence base, heat mapping
  - New Government??



The Coalition Government

- Plans to develop a new National Policy Framework -PPSs will continue to apply
- Regional Strategies revoked- References to RSS no longer valid
- LPAs should continue to develop LDF reflecting important issues such as climate change…
- Localism Bill


Communities and Local Government
www.communities.gov.uk

The Chief Planning Officer
Local Planning Authorities in England

6 July 2010

Chief Planning Officer Letter:

REVOCATION OF REGIONAL STRATEGIES

Today the Secretary of State announced the revocation of Regional Strategies with immediate effect.

I have attached some 'questions and answer' advice on immediate issues that may arise from this announcement. It will be important for local planning authorities to carry on delivering local development frameworks and making decisions on applications and the attached document focuses on how to continue taking these forward.

Please address any queries to Eamon Mythen at CLG in the first instance (Eamon.Mythen@communities.gsi.gov.uk).

STEVE QUARTERMAIN
Chief Planner

Source: Communities and Local Goverment. Chief Planning Officer Letter: REVOCATION OF REGIONAL STRATEGIES. July 2010

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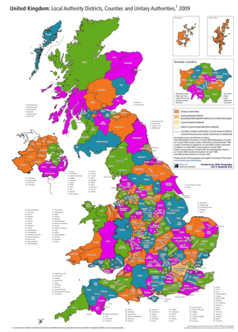
The Coalition government

- Summary – planning implications
  - Revocation of RSS will create local spatial plans, drawn up in conformity with national policy, the basis for local planning decisions.
  - The new system will hopefully be clear, efficient and will put 'greater power in the hands of local people', rather than regional bodies.



Draft National Planning Policy Framework will be less prescriptive as former government PPS guidelines and LA likely to be given more freedom to adoption of local energy planning policies.

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Draft National Planning Policy Framework

- Reduce Complexity, streamlining, more coherent
- Easier Interpretation for LA and communities
- Sets national priorities only where necessary
- Allows LPA to produce their own plans that local issues

However….
- Definition of Sustainable Development?
- Resources for Neighbourhood Planning?
- Brownfield Sites?
- Sustainable Design?
- Smart Growth?

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Environmental building standards and assessment methods

- Sustainable Development

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Content

- Building Standards
- Environmental Assessment Methods
- Code for Sustainable Homes
- BREEAM
- BREEAM communities
- Greenprint

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Building Standards

- Part L (conservation of fuel and power)
- Part F (ventilation)
- Part J (heat producing appliances)

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Environmental building standards and assessment methods

- Increasingly standards will help reduce environmental impact from future buildings
- Signal the direction of future regulations
- Bring about a step change in sustainable building practice
- There are several environmental assessment methods for new buildings
- Assessments should cover the whole building lifecycle

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Environmental assessment methods

Non Domestic (new build and refurbishment)
•BRE Environmental Assessment Method – BREEAM
•Leadership in Energy and Environmental Design – LEED

Domestic (new build)
•Code for Sustainable Homes
•EcoHomes

Domestic (refurbishment)
•BRE Environmental Assessment Method – EcoHomes
•LEED for Homes

BREEAM Communities for new-build domestic or mixed developments of over 50 units, anywhere in the world

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Environmental assessment methods

- Environmental assessment methods focus on measurable elements, i.e. energy and carbon, water and waste/resource efficiency
- The following areas are often assessed by the various assessment methods;

Management • Commissioning • Construction site impacts • Security	**Waste** • Construction waste • Recycled aggregates • Recycling facilities
Health and Wellbeing • Daylight • Occupant thermal comfort • Acoustics • Indoor air and water quality • Lighting	**Pollution** • Refrigerant use and leakage • Flood risk • NO_x emissions • Watercourse pollution • External light and noise pollution
Energy • CO_2 emissions • Low or zero carbon technologies • Energy sub metering • Energy efficient building systems	**Land Use and Ecology** • Site selection • Protection of ecological features • Mitigation/enhancement of ecological value
Transport • Public transport network connectivity • Pedestrian and Cyclist facilities • Access to amenities • Travel plans and information	**Materials** • Embodied life cycle impact of materials • Materials re-use • Responsible sourcing • Robustness
Water • Water consumption • Leak detection • Water re-use and recycling	**Innovation** • Exemplary performance levels • Use of BREEAM Accredited Professionals • New technologies and building processes

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Future sustainable building policy

Domestic
- Regulation requirements increase to meet Code for sustainable homes
- 2010 - 25% increase over 2006 requirements (Code 3)
- 2013 - 44% increase over 2006 requirements (Code 4)
- 2016 - Zero Carbon (Code 6)

Non Domestic
- Regulation requirements increase across all sectors
- 2010 - 25% increase over 2006 requirements
- 2016 - Schools and Colleges to become Zero Carbon
- 2018 - New public buildings to become Zero Carbon
- 2019 - New non domestic buildings to become Zero Carbon

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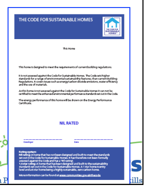
Code for the Sustainable Homes

THE CODE FOR SUSTAINABLE HOMES™

- 6 level rating system ★ ★ ★ ★ ★ ★ – a tool for marketing and a mark of quality
- Assesses individual dwellings not groups of dwellings
- Minimum mandatory standards for CO2 emission rates, indoor water use, materials, waste and surface water run-off
- Demands higher minimum mandatory standards for CO2 emission rates and indoor water use for higher levels.
- Mandatory pre and post construction review. Every new home MUST be assessed under the Code
- 1st May 2008 - mandatory for a Code sustainability certificate or a nil rated Certificate. This applies to all new homes that are marketed for sale



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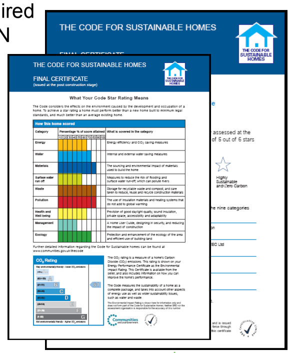
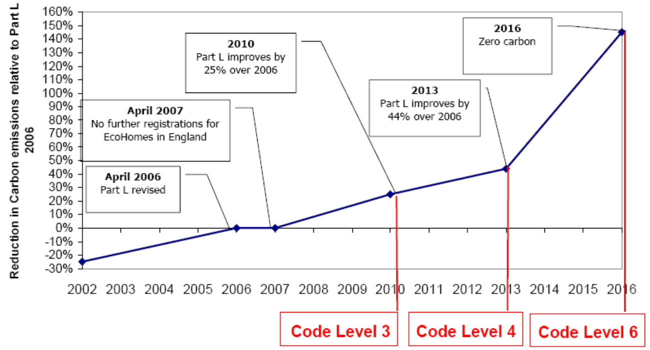
Assessment Process

•Pre- assessment – self assessment
•Design stage – Formal assessment - Required
•Post construction – FINAL CERTIFICATION
•BREEAM in USE - for Existing buildings

- Certificate presents:
  - Details of the development
  - Overall rating and score
  - Breakdown of score by category
  - EPC CO_2 rating



Key dates for Housing



Code homes are 'the new normal'

Illingworth Estate, Halifax

Mid Street, Nuffield, Surrey

BREEAM

- Voluntary assessment method for non-domestic buildings.
- BREEAM rating - set by many organisations including:
  - Private sector companies –developers have set voluntary minimum rating for all new buildings (i.e. British Land, Land Securities etc)
  - Public Sector – a minimum rating for all new buildings and refurbishments has been in place since 2006 (Department of Health, etc)
- Nine categories of environmental sustainability
- Mandatory standards for some issues
- Innovation credits
- Ratings awarded as....
  - Pass, Good, Very Good, Excellent and Outstanding
- Follows same assessment stages as CfSH

breeam Categories

- **Management**
- **Energy**
- **Water**
- **Land Use and Ecology**
- **Health and Wellbeing**
- **Transport**
- **Materials**
- **Waste**
- **Pollution**

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breeam case studies

Cardiff Central Library achieves BREEAM 'Excellent' rating with **no extra construction cost**

G.Park Blue Planet achieves first ever BREEAM Outstanding. North Staffordshire distribution centre

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BREEAM Communities

- Site wide methodology
- Incorporates sustainability into the heart of the development process

Incorporates:

Climate change and Energy	Community
Place shaping	Ecology
Transport	Resources
Business	Buildings

3 Stage Process:

1. Registration of Assessment Framework
2. Outline Planning Stage Certification (Interim)
3. Detailed Planning Stage Certification (Final)

Athletes Village: London 2012, receives first ever BREEAM communities certificate

(image courtesy of Andrew Kinsey, BLL)

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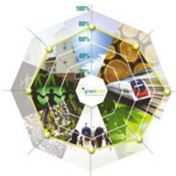
GreenPrint

- BRE service
- Site specific tool
- Looks at the sites sustainability potential and develops a way of assessing plans against this
- Compliments the CfSH, BREEAM and other recognised tools such as Secured by Design and Lifetime Homes
- Can be used to obtain BREEAM communities for large scale developments



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But…

- Other standards and methods and guidance should also be included

- Lifetime Homes
- Secured by Design
- ANGSt (Accessible Natural Green Space standard)
- LEAP (Local Equipped Area for Play)
- Building for Life
- Urban Design Compendium
- DCLG Developing Accessible Play Space

- Related services for Local Authorities …….

BRE services for Local Authority planning departments

- Preparing evidence for LAs sustainability & energy policies
- Technical support to planning depts. assessing applications
- Low carbon energy assessments of LA building stock
- FITs/RHI opportunity studies
- Training for LA planners on energy efficiency, renewables & sustainability

Technical support in implementing energy policies

- Started working with the Greater London Authority (GLA) in 2006
- Assess strategic planning applications which have been referred to the Mayor of London
- Examine each developer's energy statements to ensure they comply with the energy policies in the London Plan
- Ensure effective and consistent implementation of policies
- Negotiate with applicants

Why do we need energy in buildings
Reducing the energy demand for heating

- Sustainable Development

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What if we lived outside?

Functions needing energy input in buildings

• Space heating	Heat
• Space cooling	Cooling
• Domestic hot water	Heat
• Light	Electricity
• Running appliances	Electricity
• Running machines	Electricity / fuels
• Manufacturing processes	Electricity / heat / cooling

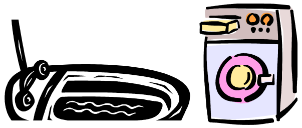
Functions needing energy input in buildings

• Space heating	Heat
• Space cooling	Cooling
• Domestic hot water	Heat
• Light	Electricity
• Running appliances	Electricity
• Running machines	Electricity / fuels
• Manufacturing processes	Electricity heat cooling

This course looks at low carbon/ renewable supply options for heat!

Heating demand for comfort

- Space heating is needed to provide comfort for occupants of buildings
- Space heating requirements are dependent on
  - Desired indoor conditions, e.g. room temperature
  - Outdoors conditions, e.g. external temperature
  - Building design
- Domestic hot water creates an all-year round heat demand
  - Bathroom, kitchen, cleaning, hot-filled appliances (e.g. washing machine, dishwasher)

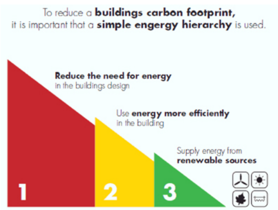


Heating for other functions

- Space heating may also be required in non-residential buildings - temperature and humidity controls to protect the building fabric and/or goods inside – frost protection
- May also be required for generation of hot water and for industrial processes such as drying processes, refineries, gas reduction pressure stations, etc…

Energy hierarchy - heating

1. Reduce energy demand
   - Design
   - Construction
   - Efficiency
   - User behaviour
   - …
2. Decarbonise energy supply
   - Replace fossil fuels
   - Low carbon electricity generation
   - Low carbon heating and cooling



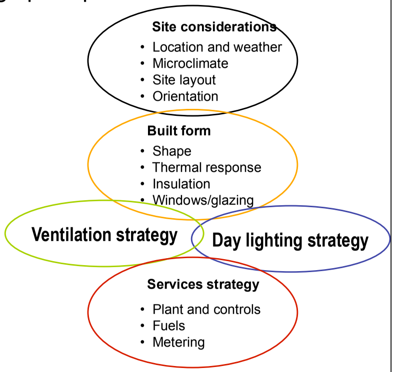
Reduce energy demand for heating

- Sustainable Development

Sustainable building - design principles

Integrating the design process :

“Normally all the really important mistakes are made on the first day of the design process!”
- Amory Lovins



Source: CIBSE Energy Efficiency in Buildings Guide

Passive Solar Design

Careful design optimises:

heat gain from sun in winter

shading in summer

glazed areas capture heat

high thermal mass (e.g. thick floor) delays daytime heat gains in summer, releases useful heat stored in winter

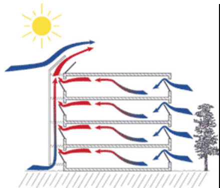
site layout needs consideration when planning development to ensure all buildings have sufficient access to sunlight light

adequate access to daylight

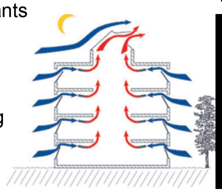
Natural ventilation

Key issues :

- building tightness
  (build tight - ventilate right)
- adequate ventilation for occupants
- When designed well natural ventilation can substitute need for air condition, whilst ensuring building users are comfortable

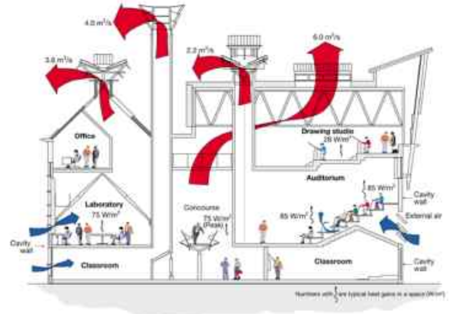


<u>Day time</u>
The natural buoyancy of hot air allows venting through high level vents. Replacement fresh air enters from the lower vents.



<u>Night time</u>
Floor slabs absorb heat during daytime usage. As External temperature drop at night, the building can be cooled by opening vents around the building.

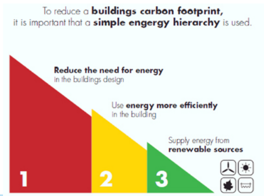
Natural ventilation



Design implementation for The Queens Building, De Montfort University

Summary

- Need to ensure building design principles are adhered to
- Buildings should fully exploit the natural systems available **for free** to provide;
  ventilation, cooling, heating, daylighting
- Passive solar systems are almost always cost effective
- Buildings with passive features are designed to have lower owning and operating costs



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Decarbonising energy supply for heating

- Sustainable Development

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Current heat supply systems in the UK

- Typical heating systems consist of individual boilers (gas, coal, oil) and electric heaters
- Almost half of the energy consumed is in the form of heat with the domestic sector accounting for more than 50%
- Generation of heat, including electrical heating, accounts for around 47% of UK CO_2 emissions (over 40% of this comes from the residential sector)

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Why is decarbonisation needed

- 15% of the UK's energy demand is expected from renewables by 2020
- Renewable heat will be a key contributor to the overall UK energy target
  - share in 2009 was 1.5%
- To meet the UKs future energy target decarbonise the heat supply needs to occur as a matter of urgency

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Options for decarbonising heat market

1. Electrical heating using decarbonised grid electricity
   e.g. use of electrically driven heat pumps

2. Renewable micro generation
   e.g. solar water heating, biomass boilers & air/ground source heat pumps.
   These technologies are mainly applicable in low density housing areas:
   - *GSHPs need land for piping,*
   - *biomass boilers need access and storage space for fuel, etc.)*

3. District heating
   e.g. Community heating schemes for compact city centres.

3. Decarbonised gas
   e.g. injection of bio-gas into the gas grid.

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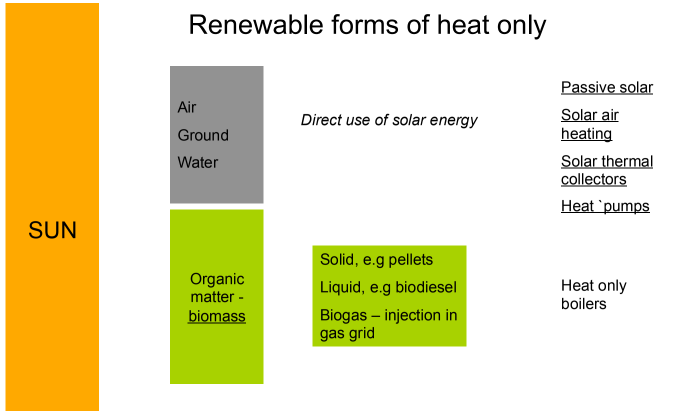
Renewable forms of heat only



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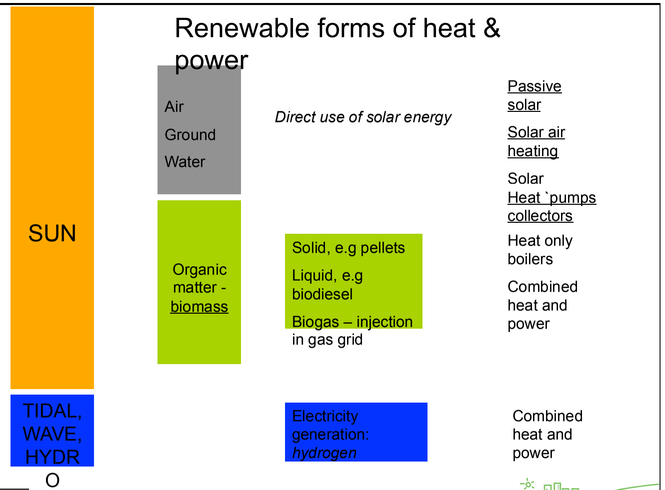
Renewable forms of heat & power



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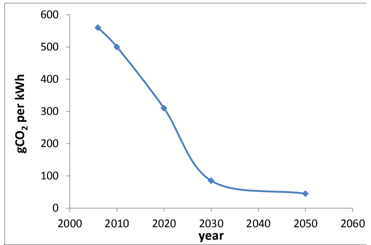
1. Use of low carbon grid electricity for heating

- The role of a decarbonised electricity supply is part of the UK government vision of how to decarbonise the UK heat supply
- Electricity for heating will continue for specific situations, e.g.
  - existing installations,
  - off gas grid areas,
  - new heat pumps installations
- Decarbonising the electricity grid is therefore necessary



UK CO_2 intensity per kWh of electricity generated, 2006-2050- scenairo presented in the Committee on Climate Change report, December 2008

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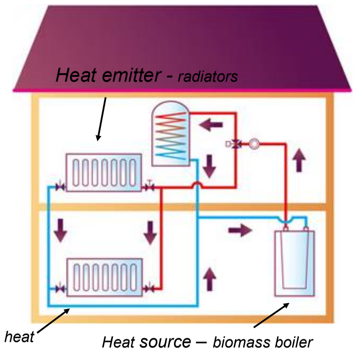
1. Use of low carbon grid electricity for heating

- Relying on heat supply using electricity cannot be the only solution
- Exploiting opportunities to use existing renewable heat systems should not be ignored
- New sources of heating are required to transfer to a cleaner heat supply system

2. Microgeneration of heat with renewables

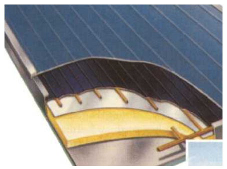
- Microgeneration refers to the use of systems at the building level, i.e the heat source, heat medium and distribution and heat emitter are all installed within the premises of the heat user
  - e.g. biomass boiler serving a dwelling
- It applies to both domestic and non-domestic buildings



Source: SHW heating limited. www.shwheating.co.uk/uhw_system.html

Solar water heating - basics

- Sun's energy heats water through solar thermal collectors
- south facing roof
- sound, practical and affordable
- Easily integrated in new houses or retrofitted
- Typical system size of around 2-4 m^2
- Can provide around 50% of the hot water requirements per annum



Flat plate collectors

Evacuated tube collectors

Solar water heating applications

Domestic

- Usually sized in the UK to provide only DHW
- Heat collected is used to elevate the temperature of water in a storage tank

Roof integrated flat plate

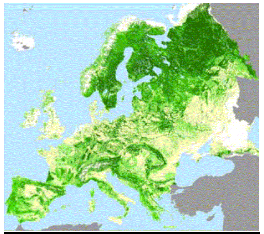
- Systems can be used in flats but not good practice to fit individual systems within each
  - Instead communal systems can be used

Collectors integrated with building roof supplying blocks of flats
Source:. Ritter Solar / ESTIF

Biomass: the resource

Biomass is (almost) carbon neutral

- CO_2 released during combustion is equivalent to CO_2 absorbed during growth
- There is some CO_2 released due to processing/ transportation of fossil fuels. The total amount depends on specific fuel
- BUT not necessarily a renewable energy source



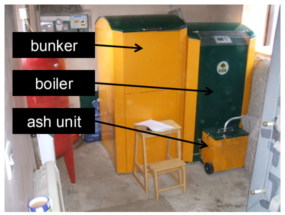
View of forest resources in Europe

Wood heating boilers– applicability for individual boilers

- The use of biomass at the building level includes anything as simple as an open fires to more sophisticated biomass boilers for space heating and hot water provision, e.g.
  - Woodstoves & log boilers,
  - Ceramic stoves,
  - Pellet stoves & boilers,
  - Woodchip boilers

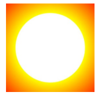
Wood heating boilers– applicability for individual buildings

- Biomass boilers are technically suitable to supply the space heating and hot water requirements of buildings
- But there are practical limitations to address
  - Handling
  - Delivery of Fuel/access
  - Air quality
- Hence individual biomass boilers in dwellings is likely to be limited to low density housing areas
- Flats where communal heating systems are in place that use a central boiler offer good opportunities



Heat pumps - basics

- A heat pump extracts low grade heat from a (usually free) source, and upgrades it to a higher (useful) temperature
- As a result heat pumps are able to deliver a greater amount of useful heat relative to the energy required to drive the HP
- HP can be driven using different sources of energy
  - Common ones-electrically driven
  - also gas fired heat pumps

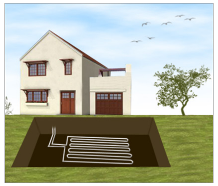


Heat pumps can achieve significant savings in CO_2 emissions – relative to conventional electric heating systems

However, they are not "carbon free" unless power 100% with renewable energy

Heat pumps - basics

- Heat pumps can be classified depending on the source from which thy take 'free heat', i.e. air source, ground source, water source
- For heating purposes, the higher the temperature of the 'free heat' source the better the heat pump performance
- The higher the temperature that heat pumps deliver, the lower the overall efficiency, i.e. limitations to deliver domestic hot water (over 60°C) at high efficiencies
- The use of ground source pumps offers good opportunity for operating heat pumps at high efficiencies (ground source temperature in quite constant)



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Heat pumps: when, where and how?

- The use of HP is attractive in areas without mains gas supply
- Heat pumps can in principle be used to deliver space heating and DHW but…
- The HP efficiency when delivering high temperatures (over 60° C required for DHW) is considerably reduced

An air source heat pump is simply attached to the outside of the building, which in principle, is suitable for flats – aesthetics?

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Heat pumps: when, where and how?

- Air source heat pumps could be used in individual flats
- However, individual GSHP are unlikely to be viable to supply block of flats as there maybe little opportunity to install a big enough ground loop to serve all of the apartments
- The use of heat pumps to provide energy to flats is more viable via the use of district heating schemes

Ground source heat pumps can in principle be used to supply block of flats if enough space exist for the installation of the boreholes

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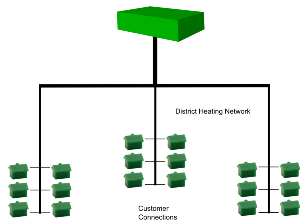
3. Use of district heating networks

District heating involves, heat…

- generation using a central source AND
- distribution via the use of heat networks



The role of DH in delivering low and renewable heat is dealt with in detail throughout this course

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4. Injection of biogas into the grid

- Rich methane gas can be obtained from the biological and thermal processing of organic material
  e.g. household/garden/food waste and biomass sources
- Adequately treated and clean (bio) gas can be injected into existing natural gas distribution networks as an alternative to using biogas on-site
- Biogas can be used in individual gas fired combustion heat appliances, e.g. gas boilers

The mass scale injection of biogas/synthetic gas into the national grid network is unlikely to be widespread in the short term, but could play an important role should biogas generation on a wide scale occur

What heating system should I use?

The answer is not straight forward

- The final solution needs to be evaluated on a case by case basis
  - for areas of low energy demand the use of systems at the building level may be more appropriate, e.g. heat pumps, biogas driven boilers, etc
  - for areas with a high concentration of energy demand, a district energy based solution is likely to be more appropriate

The rest of this course deals with the opportunities that the use of district heating offers in the delivery of low carbon and renewable heat to our buildings and cities

Introduction to district heating What is it?

- Sustainable Development

What is district heating?

- DH is a means for delivering heat to multiple buildings from a central energy centre
- It can deliver:
  - space heating and domestic water
  - cooling by the means of heat driven chillers

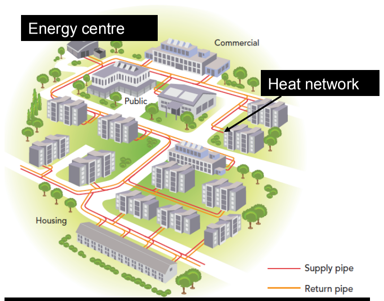
Energy centre supplying hot water to DH – Hillerod, Denmark © BRE

Basic parts of a DH scheme

energy centre containing the heat source/s

a **heat distribution network** used to deliver the heat to end users

hydraulic interface unit (HIU) e.g. heat exchangers, linking each customer to the wider heat distribution network



Schematic showing basic parts of DH scheme

© BRE

1. Energy centre

- Contains the heat sources
- Heat sources can include:
  - An external DH scheme
  - Locally available sources, e.g. waste heat from a nearby power station, industry
  - Dedicated heating plant
    - *Lead heating low carbon plant (CHP, biomass boiler)*
    - *Inexpensive top/back-up plant for breakdown and maintenance e.g. gas boilers*
    - *Heat stores*
    - *Pumps for circulating hot water throughout the heat network*
    - *Etc.*

Energy centre – Sweden

© BRE

1. Energy centre - examples

Gothenburg – Power station operating in CHP mode

- 260 MW elec
- 300 MW heat

Seaton, Aberdeen – Dedicated CHP plant

- 1MW elect
- Circa 1.5MW heat

1. Energy centre - examples

Hillerød, Denmark –

2MW wood biomass heating boiler

Lorry delivery and storage of pellets

Biomass boiler

Delivery of pellets into boiler

Source: BRE

2. Heat distribution network

- The majority of modern DH systems use hot water as a means to deliver heat
- Usually, the flow temperature will be enough to provide hot water requirements
- Steam networks have been used in the past although currently are not consider good practice

DH pipes © BRE

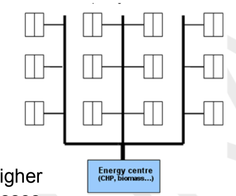
2. Heat distribution network

- Circulating hot water using pipes incurs heat losses to the ground or ambient air - heat distribution losses
- The greater the pipe length used to deliver the heat the greater the heat distribution losses
- The greater the heat distribution losses the higher the overall cost of heat delivered.

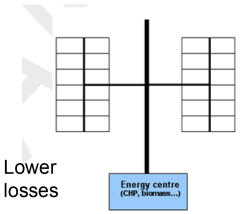
  Why?

  – more primary energy is required to deliver the same amount of heat

Higher losses



Lower losses



2. Heat distribution network

- Traditionally, and this is still the case in the UK, heat distribution networks consist of pre-insulated steel single pipe flow and return systems

© BRE

Source: Logstor

Source: Aberdeen Heat and Power

Pre-insulated single pipe flow and return DH systems

2. Heat distribution network

- Higher performance systems exist that reduce the heat distribution losses relative to the use of single pipe systems, *e.g. twin pipes*

Twin pipe DH pipe system

© Logstor

Work undertaken under the International Energy Agency and BRE suggested that heat distribution losses can be reduced by 20-37% in twin pipe systems relative to single pipe systems


INFORMATION PAPER IP X/11

THE PERFORMANCE OF DISTRICT HEATING IN NEW DEVELOPMENTS

Application guidance

3. Hydraulic interface unit (HIU)

- It acts as an interface between the heat distribution network and building heating system
- It acts as a boiler
- It is able to provide space heating and hot water on demand

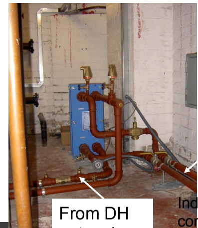
HIU - Heat exchanger - for hot water and space heating provision for a flat connected to DH network

© BRE

bre

3. Hydraulic interface unit (HIU)

- Examples
  - The space required for the HIU serving non-domestic building is considerably smaller compared to that needed by heating equipment at the building



From DH network

To building heating system

Indirect connection using heat exchanger supplying a commercial building

2 MW heat exchanger – capacity meets the needs of a typical 30,000 m² office building

BRE ©

bre

3. Hydraulic interface unit (HIU)

- Examples
  - The space required for the HIU serving non-domestic building is considerably smaller relative to the use of heating equipment at the building

DH flow

DH return

To building heating system

Direct connection supplying a small office building

bre

Scale of DH schemes

- In principle, any building can be connected to a DH scheme,
  - e.g. dwellings, commercial and institutional buildings, retail premises and industrial applications, etc

BRE ©

bre

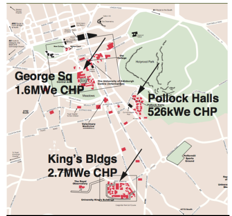
Scale of DH schemes

DH can be integrated within a single building, such as a block of flats - sometimes referred to as block heating

BRE ©

Scale of DH schemes

DH can serve a number of buildings;
- at a single site (e.g. university campus)
- close proximity (e.g. several blocks of flats)



CHP fired DH schemes supplying heat to the University of Edinburgh

CHP fired heating system for the University of East Anglia

DH schemes supplying nearby block of flats, Falkirk, Scotland BRE ©

Scale of DH schemes

- DH schemes can serve a whole community, town or city centre

Sheffield city wide DH scheme fired with heat from waste incineration

Copyright © Trevor Smith

Southampton city wide DH scheme

Your experience of DH WORKSHOP

- Sustainable Development

Introduction to district heating
Why to do DH? Summary of benefits

- Sustainable Development

Environmental benefits

- DH pipes simply transport hot water from an energy centre to consumers
- Therefore, DH offers the opportunity to
  - implement low or zero carbon technologies such as biomass, solar thermal …and make use of locally available waste heat
  - switch whole communities to new and emerging technologies with ease

Energy centre where heat generated is delivered via DH

A fossil fuel based heat source could be replaced by a low carbon or renewable energy source with no disruption to residents

Security of supply

- DH schemes that use more than one fuel source:
  - enhance security of supply due to the diversification of fuels - as well as
  - provide a buffer against price volatility in the market.

Biomass fired DH in Sweden

A small municipality in the periphery of Gothenburg uses biomass as the main fuel for the DH scheme. This minimises the need for expensive oil. Oil is still used a back-up.

Affordable warmth

- With modern DH schemes a lower heat prices can be offered than when using individual gas/ oil boilers or electrical heating.

  e.g.

  systems with CHP derive revenue from electricity to reduce the price of heat– as fuel is burnt more efficiently than conventional alternatives.

Social housing estates connected to DH

Electrically heated social housing at Aberdeen was retrofitted with district heating fired with CHP plant as a means to alleviating fuel poverty.

Heat offered on a flat rent basis (circa £7.75 per week – 2008), electricity sold to commercial buildings.

Affordable warmth

- Operators of DH schemes use considerably more heat energy then individual householders and therefore have much greater purchasing power
- This means they can better exploit the competitive, cheaper, commercial fuel markets
- Consequently, the heat price charged to customers can be pitched at a very competitive rate.

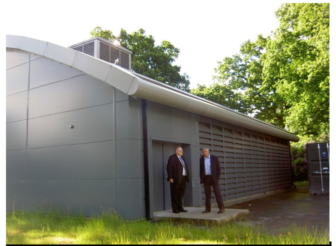
Callendar Park, Falkirk, Scotland

Council housing retrofitted with communal heating fired with CHP

Optimising the supply of heat

Less plant required

- Individual heating systems are sized for maximum demand on the coldest winter day.
- For DH, demand for heat is aggregated and the probability of peaks demand in all buildings occurring at the same time is reduced.
- Demand is consequently spread more evenly and total plant size required is reduced



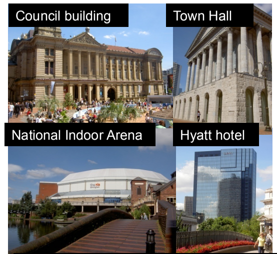
Energy centre hosting CHP plant and back-up boilers

The plant is enough to supply 1,000 existing council flats at Callendar Park, Falkirk, Scotland

Optimising the supply of heat

Energy efficiency of plant is increased due to the diversity of load

- Each building connected to a DH scheme has its own characteristic heat demand load profiles
  - *some buildings have increased demand during 'office hours': offices, schools*
  - *while homes tend to have increased demand out of office hours…*
  - *and hospitals have significant demand through whole 24 hours*

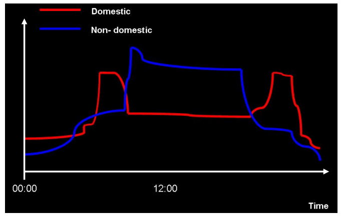


Pictures showing some of the heat loads connected to the Birmingham City Centre District Heating scheme

Supplying heat to domestic and non domestic buildings

Energy efficiency of plant is increased due to the diversity of load

- Together the profiles tend to be complimentary making a smoother aggregate profile
- It is easier and more efficient to integrate heat generating technologies e.g. CHP, biomass boilers when the aggregate profile is smooth



Simplifying the supply of heat

Space savings at the building level

- For domestic users, the HIU is smaller than wall-hung boilers and in most of the schemes there is no need for stored domestic hot water
- For non-domestic buildings the plant area required is less

(left) Heat exchanger for hot water and space heating provision for a flat connected to DH

There is no need for a boiler at the dwelling

(right) Heat exchanger

This is enough to provide the peak requirements of a circa 30,000 m² office building

Simplifying the supply of heat

Easier maintenance

- Boilers in rented houses require an annual safety inspection and servicing
- For DH, the plant is located in one energy centre making planned maintenance straightforward and hassle free for the building owners
- Plant area is also monitored automatically so its operation can be proactively maintained at a high level of performance.

Boiler inspection

Simplifying the supply of heat

Increased safety

- In buildings connected to DH scheme there is no need for boiler plant in the building.
- Hence, there is no need for combustion appliances and associated flues.
- This avoids for instance the need for gas-fired appliances removing any risk of carbon monoxide poisoning or gas explosion.

Risers carrying hot water form the DH network into the dwelling

Risers and heat exchanger

In an apartment connected to a DH scheme only hot water pipes enter the premises to the HUI. There is no need for gas connection

Summary of benefits

- Environmental – carbon reduction
- Enhanced security of supply
- Affordable warmth
- Efficient use of heat sources (fossil fuel, biomass)
- More straightforward maintenance of heating plant
- Space savings at the building level
- Increased safety of the building occupiers

Introduction to district heating
Where to apply it?

- Sustainable Development

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Where is it implemented?

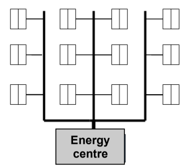
Generally speaking, DH is best applied in the following:

- Areas of high heat demand density
- Areas with a mix of building types
- Built up areas around sources of heat

It is also suited to other situations too.

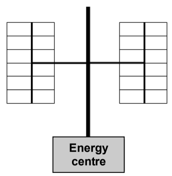
Building density

- Installing a *district heating* network is a *major capital investment* due to the high costs of the heat distribution infrastructure
- The installed cost associated with the heat distribution network is heavily influenced by
  - the distance between the connected buildings
  - the distance to the energy centre



Low density - Detached houses

High capital costs per dwelling



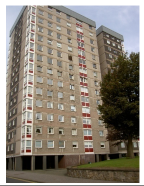
High density – Block of flats

Lower capital costs per dwelling

Building density

- The shorter the distances between connected buildings and the energy centre, the shorter the pipe-work involved, hence
  - capital cost are minimized.
  - heat distribution losses are reduced
- Hence DH is best applied in high heat density areas

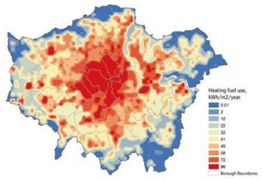
Low density detached houses, high heat distribution losses



High density block of flats, Low heat distribution losses

Heat demand density

- The heat demand density identifies the levels of heat required for a certain area or DH scheme
- Heat maps showing levels of heat demand per area of land can be used to highlight areas with high heat demand density
- In areas of high heat demand density, the income from heat sales is most likely to be large enough to offset the upfront capital investment required for a DH scheme



London heat map showing the heat density

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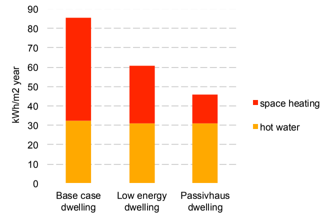
Heat demand density

- High heat demand densities are typically found at the heart of town and cities, where the building density is highest
- High heat density can also occur in areas of regeneration, although the heat demand of new buildings is usually lower than similar existing buildings of equivalent type and size



New buildings are generally more energy efficient than existing buildings. This trend will continue into the future due to the increasingly stringent energy efficiency requirements for new buildings.

Where new buildings are serviced by DH, the heat demand density will tend to be less as the demand for heat for new buildings will be lower

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Heat demand density

Summary

- DH applications in areas with higher heat demand densities will have a better return as
  - they incur in lower investments costs per unit of heat sold and
  - have better heat distribution efficiencies, i.e. lower heat distribution losses

…**but**

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Heat demand density

Summary

- The lower heat requirements of future buildings could mean that higher building densities than traditionally has been the case are required to make DH a viable solution for new build developments
- Therefore, where possible, DH schemes should link existing and new buildings in order to take advantage of the greater heat densities of existing buildings

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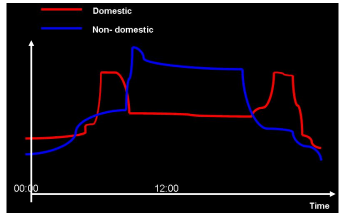
Areas with a mix of building types

- Each building connected to a DH scheme has its own characteristic heat demand load profiles
  - *some buildings have increased demand during 'office hours': offices, schools*
  - *while homes tend to have increased demand out of office hours…*
  - *and hospitals have significant demand through whole 24 hours*

Pictures showing some of the heat loads connected to the Birmingham City Centre DH scheme. This city centre scheme provides heat to a different range of building types

Areas with a mix of building types

- Together the profiles tend to be complimentary making a smoother aggregate profile
- It is easier and more efficient to integrate efficient heat generating technologies e.g. CHP, biomass boilers when the aggregate profile is smooth
- Hence areas DH is best applied in areas with a mix of building types



Built up areas around sources of heat

- The existence of a source of low cost heat can also be the catalyst to the development of a district heating network serving an area.
- A variety of heat sources exist that include
  - bi-product heat from power stations
  - heat from the incineration of waste, either in heat only mode or as the bi-product heat produced from electricity generation.
  - geothermal surface aquifers
  - etc


The existence of a waste incineration plant was the catalyst for the Sheffield DH scheme, one of the largest in the UK.

Heat is recovered form the waste incineration process ant and distributed throughout the city

Other situations

- The use of DH to supply off-gas rural communities may be justified when comparing this option relative to adopting high cost individual heating systems such as electric or oil



12 semi-detached bungalows in West Wales – example of an off gas grid location

•a communal network fed by a biomass boiler is the heat source.

•the alternative heating would have been individual oil boilers

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Introduction to district heating
Who has done it?

- Sustainable Development

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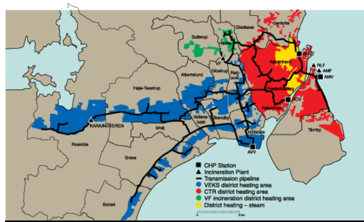
Brief history of DH

- District heating is widely used worldwide and in some European countries schemes exist that supply entire cities with heat
  - Most of the towns and cities of Denmark and Sweden are heated in this way and
  - German cities like Berlin and Hamburg have some of the biggest networks in the world.



DH supplying the city of Copenhagen.

160km of primary pipes and 1,500km of distribution pipes

About 30 % supplied with surplus heat from waste incineration and the remaining is based on geothermal energy and fuels such as wood pellets, straw, straw pellets, natural gas, oil and coal.

Brief history of DH in the UK

- The UK saw significant growth of District Heating (DH) during the Council house building boom of the 1950s to 1970s
- Initial systems were poorly installed and maintained and problems regularly arose with water penetration and corroded pipes
- As they failed to provide an adequate service, many of these systems were decommissioned
- Lessons have been learned and modern systems do not suffer in this way due to better design of both systems and components

Recognition of DH

- In high density areas it is more difficult to reach challenging carbon reduction targets adopting energy solutions at the building level
- Often it will be more effective to consider the whole site
  - Including any existing buildings

Who has done district heating?

Local Authorities

- Main district heating networks that are operational in the UK have been instigated by local authorities connecting, or agreeing to connect buildings they are responsible for.
- LA buildings, e.g. leisure centres, town halls and residential tower blocks, have acted as the anchor loads underpinning the substantial capital investment required to initiate schemes.

LA energy champions

Who has done district heating?

Local Authorities

- Examples of this approach are in Birmingham, Southampton, Sheffield and Woking
- Other local authorities, such as Aberdeen, have also led the way in retrofitting communal heating to tower blocks, as a way of alleviating fuel poverty.

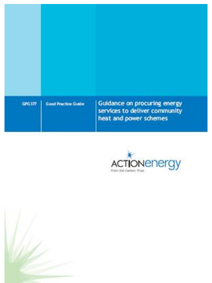
Sheffield city wide DH scheme fired with heat from waste incineration

© Trevor Smith

Who has done district heating?

Local Authorities

- The procuring authority will not usually want to own or operate the scheme, as this would mean taking on board the risk on the capital cost and operation.
- That being the case, the authority often looks to a specialist service provider to provide finance, expertise and risk management services to deliver successfully deliver the scheme.

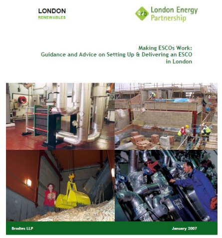


GPG 377. Guidance on procuring energy services to deliver community heat and power solutions

Who has done district heating?

Local Authorities

- The majority of schemes have been developed in this way, through partnerships between the public sector and an Energy Services Company (ESCO).



Making ESCOs work: Guidance and advice on setting-up and delivering an ESCO in London

Who has done district heating?

Housing developers

- The arrival of the Code for Sustainable Homes (CSH) and the plans for zero carbon new build developments mean that low carbon solutions, such as district heating, are a key consideration for new developments.

THE CODE FOR SUSTAINABLE HOMES™

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Who has done district heating?

Housing developers

- A number of developers have already committed to and implemented heat networks to help meet planning requirements and comply with carbon reduction targets
- This is particularly the case in London, where new build developments with enough heat density are either required to connect to existing heat networks or to implement new DH schemes

Community heating and combined heat and power.

Written by the BRE on behalf of the NHBC foundation

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Case study: Local Authority driven DH scheme

- Sustainable Development

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Aberdeen DH schemes

Project Driver

- Alleviation of fuel poverty
- Indirectly carbon savings have been achieved
- Future proofing of the city

Implementation

- A special non-for profit company was formed, Aberdeen heat and power
  - Local council members, energy and DH experts
- Business case allowed for circa 90% funding
  - Council (conversion of electrically heated flats to affordable warmth provision)
  - CEP
- Ongoing selling of heat and electricity to self finance scheme operation, increase in capacity and network extension

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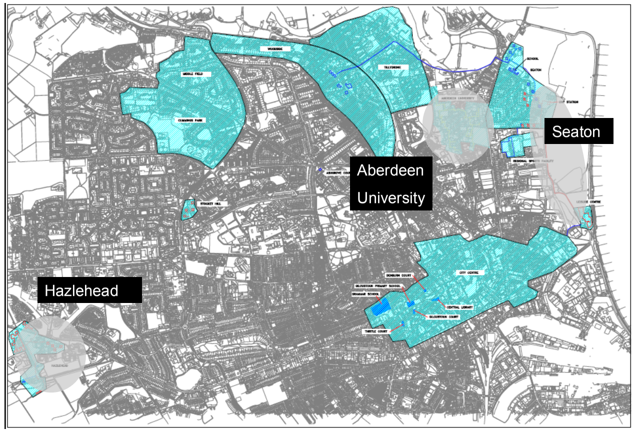
Aberdeen DH schemes



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Seaton DH scheme

- 1 MWe gas fired CHP with supplementary gas boilers
- Linking group of tower blocks and 3 non-domestic buildings
- Over 300 dwellings connected
- Potential for 1,000 dwellings to be connected
- Heat sold at £7.75 per week (2008 figures)
- The current energy centre at Seaton has the ability to accommodate extra CHP capacity

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Seaton DH scheme

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Seaton DH scheme

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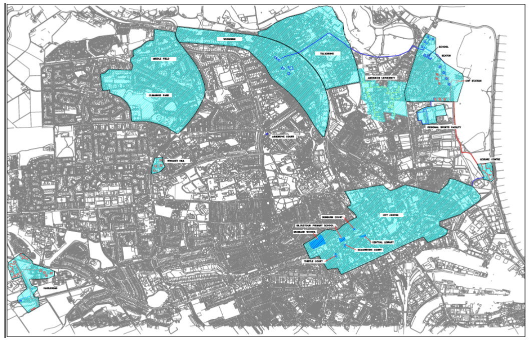
Future development

- It is the intention to growth the DH scheme to reach city centre



Case study: Property developer driven DH scheme

- Sustainable Development

The Tachbrook Triangle, London

- Newly built private and affordable apartments with some commercial office space for the Westminster Primary Care Trust
- Apartments are connected to an existing district heating scheme via an internal pipework connection from the Pimlico District Heating Undertaking (PDHU)

The Tachbrook Triangle, South London

The Tachbrook Triangle, London

- An internal distribution pipework along with HIUs providing heating and hot water to each individual apartment.
- The scheme incorporates a meter reading solution that measures heat consumption inside the dwellings.
- Data is collected from each meter by ‘touring’ the premises with a wireless Bluetooth receiver and handheld computer to receive real-time on-demand data.
- This is more cost effective than other data collection methods because there is no need to knock on doors to read meters.

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Planning for DH for new build developments
What is needed?

- Sustainable Development

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Background

- The viability of using DH to supply an area with heat depends on the heat demand
- High dwelling/heat density city centers are likely to be areas suitable for DH
- Less densely populated suburban areas are more likely to use heating solutions at the building level.


DH scheme supplying Birmingham city centre with heat


Solar thermal installation at a house

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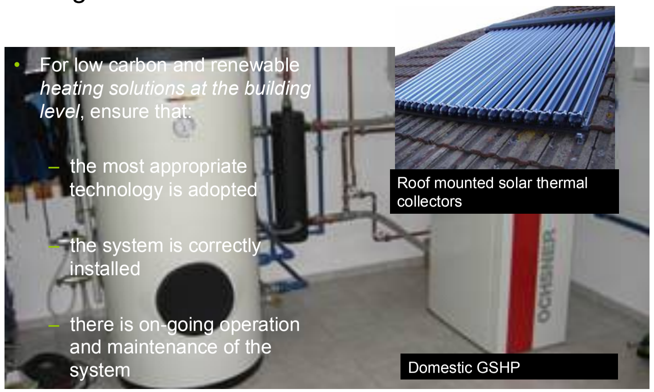
Background



- For low carbon and renewable *heating solutions at the building level*, ensure that:
  - the most appropriate technology is adopted
  - the system is correctly installed
  - there is on-going operation and maintenance of the system

Roof mounted solar thermal collectors

Domestic GSHP

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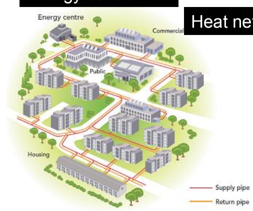
Background

- The complexity of the infrastructure required for DH schemes requires careful planning

Energy centre

Heat network



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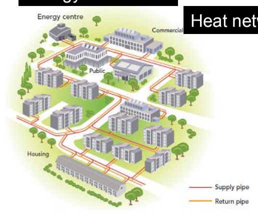
Planning DH for new developments

- In assessing the heating supply options , the following needs to be considered by order of priority
  1. Connection to existing DH scheme
  2. Future proofing schemes in areas with potential for DH
  3. Use of new build DH schemes

Energy centre

Heat network



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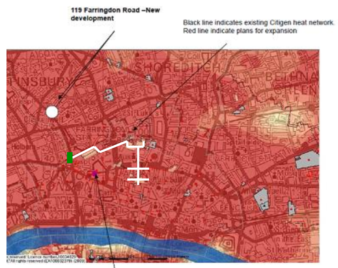
1. Connection to existing DH scheme

- Likely to be the most cost effective option
- Would achieve the greatest carbon savings
- Is it practical to connect to it



London heat map showing existing Citigen district heating scheme.

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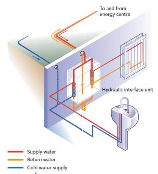
2. Future proofing schemes in areas with potential for DH

- Few DH schemes exist in the UK and most of developments are not close to them
- If no existing DH scheme, investigate if a new heat network is planned
- In areas suitable for DH, the heating systems of new developments should be designed for connection to a future district energy network

City centre with high heat density

HIU in the form of heat exchanger for a dwelling connected to a DH scheme



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3. Use of new build DH schemes with low carbon heat supply

- New developments of adequate scale and heat density, offer an opportunity for the use of DH
  - e.g. residential mixed-use developments of over several hundred units
- Schemes of this type may justify their own DH network as a means to deliver low carbon heat, e.g. CHP

Planning decentralised energy system in large new developments. Williams, J.W. BRE Trust. 2010

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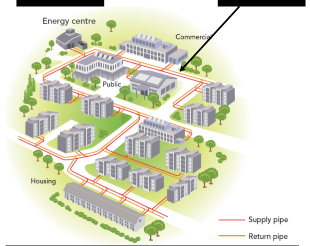
Planning for new DH schemes

- The following needs to be considered as early on in the planning process as possible:
  1. space allocation for the energy centre
  2. planning for the installation of the DH network
  3. the heat source and supply technology
  4. building heating systems that are compatible with the DH unit
  5. opportunities to expand the DH scheme beyond the development boundaries

Energy centre

Heat network



Basic elements of a DH scheme

1. Allocating space for an energy centre

- A key issue is to identify the location of the energy centre

Energy centre containing a combined heat and power of 1 MWe

1. Allocating space for energy centre

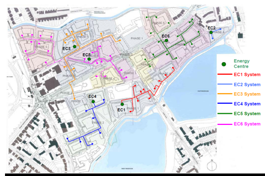
- A single energy centre supplying one heat distribution network is preferable to multiple smaller ones:
  - bigger plant with better conversion efficiencies, e.g. larger CHP engines
  - easier future integration of low and renewable energy sources
  - lower operation and maintenance costs

Energy centre hosting combined heat and power plant with enough capacity to supply circa1,000 apartments

Example 1

- The phasing of developments and other practical issues means that it is not always possible to install a site wide heat network with a single energy centre.
- Early planning can minimise the number of energy centres and heat networks used
- At the planning stage this is one of the most important things planners can influence

Multiple heat networks and energy centres **= No!**

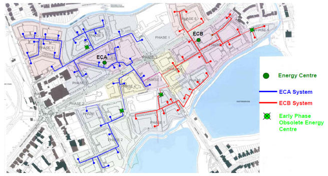


Multi phased development consisting of over 4,000 residential units with non commercial spaces including school, community facilities, etc.

Example 1 (cont)

- Temporary energy centres to supply earlier phases replaced by one large energy centre
- Separate island networks for earlier phases linked at later stages
- Fewer energy centres simplifies changing to renewable energy in the future.
- Sort of commitment that planners should get as a result of the planning process

Single heat networks and reduced number of energy centres **= Yes!**



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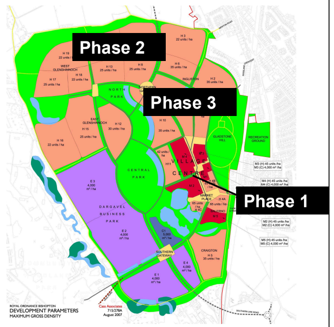
Example 2

- Phased large new developments
  - The phasing can complicate the use of a single energy centre e.g.
    - *The initial phase is very small relative to the rest of the development*
    - *Two consecutive phases of the development are built at opposite sides and can not be linked initially*



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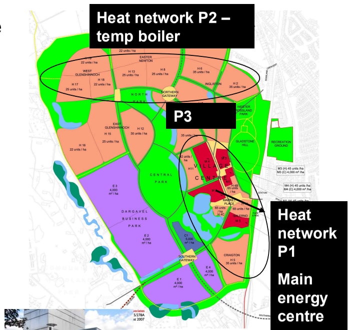
Example 2 (cont)

- the solution could be to allocate space in the initial phase for a singe energy centre
- if this is not possible use a temporary energy centre until the main one is in a position
- The temporary energy centre could be re-used elsewhere or be retained as a back-up



Temporary packaged boiler
Source: Watkins hire. www.watkinshire.co.uk

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1. Allocating space for the energy centre

- During the planning process
  - ensure early dialogue between master planners, developers and LA’s
  - an energy centre of circa 200m^2 would be necessary to supply 500 dwellings with gas fired CHP backed-up with gas boilers

Energy centre hosting combined heat and power plant with enough capacity to supply circa1,000 apartments

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2. Planning for the heat network infrastructure

- A heat network linking all buildings and apartments should be adopted
- This will enable large numbers of customers in the future to benefit from new and renewable energy sources

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2. Planning for the heat network infrastructure

- A single energy centre has only a single heat network
- With more than one energy centre the risk is that separate heat networks are installed:
  - difficult to shift towards new and renewable sources
  - increased efforts in the operation and maintenance of the scheme

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2. Planning for the heat network infrastructure

- Minimise the number of heat networks and energy centres :
  - consider when and how the different heat networks can be linked
  - ensure that separate networks have compatible operating characteristics, e.g. temperatures
  - size pipes to allow the supply of all heat loads once all the phases are complete and, ideally, for future buildings
  - understand the route the network will follow through the different phases
  - If this is not understood then potential routes for the heat network may become unavailable

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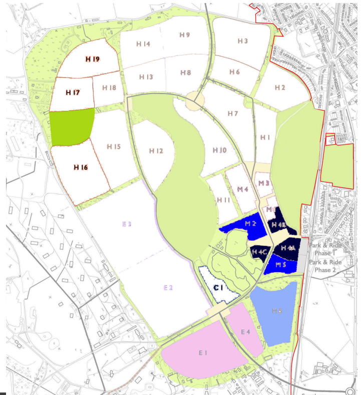
2. Planning for the heat network infrastructure



Phase 1

Density dwellings/ha
20-30
30-40

dwellings/ha
40-50
>50

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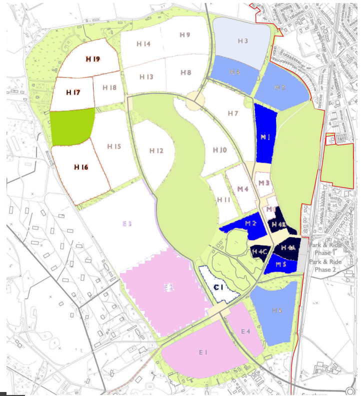
2. Planning for the heat network infrastructure



Phase 2

Density dwellings/ha		dwellings/ha	
	20-30		40-50
	30-40		>50

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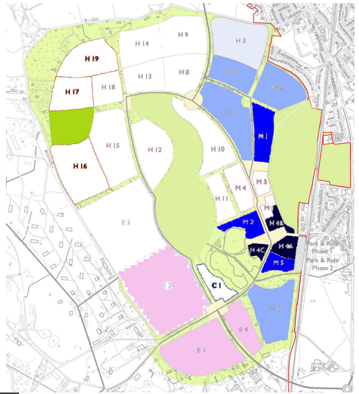
2. Planning for the heat network infrastructure



Phase 3

Density dwellings/ha		dwellings/ha	
	20-30		40-50
	30-40		>50

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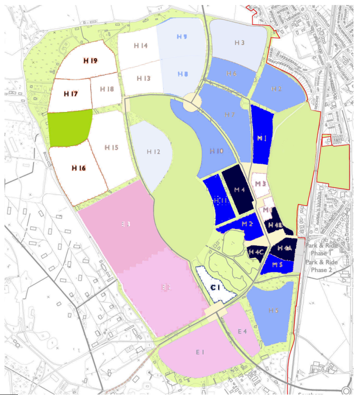
2. Planning for the heat network infrastructure



Phase 4

Density dwellings/ha		dwellings/ha	
	20-30		40-50
	30-40		>50

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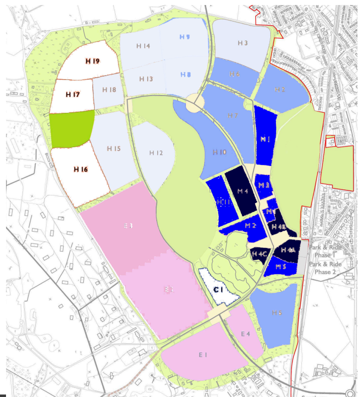
2. Planning for the heat network infrastructure



Phase 5

Density dwellings/ha		dwellings/ha	
	20-30		40-50
	30-40		>50

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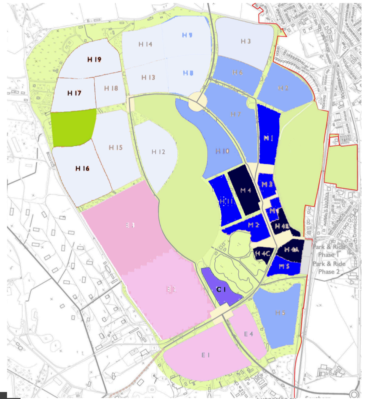
2. Planning for the heat network infrastructure



Phase 6

Density dwellings/ha		dwellings/ha	
	20-30		40-50
	30-40		>50

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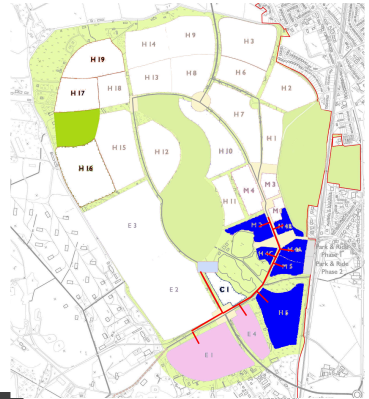
2. Planning for the heat network infrastructure



Phase 1

Bdg Int

Distric Htg

bre

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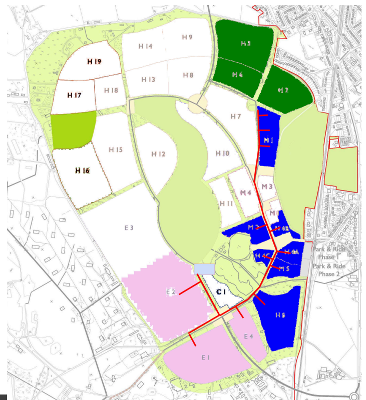
2. Planning for the heat network infrastructure



Phase 2

Bdg Int

Distric Htg

bre

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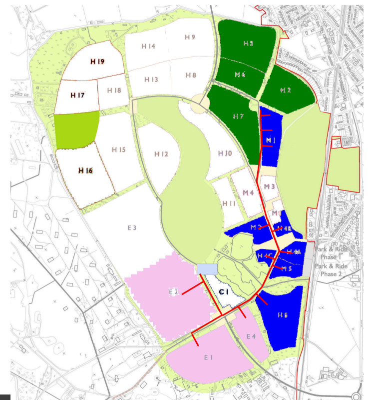
2. Planning for the heat network infrastructure



Phase 3

Bdg Int

Distric Htg

bre

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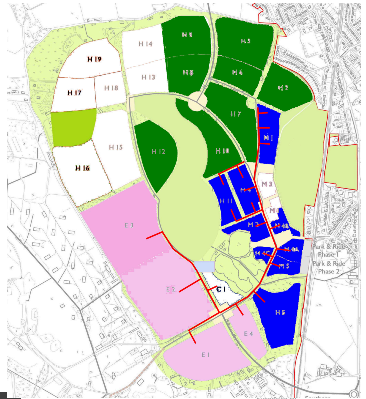
2. Planning for the heat network infrastructure

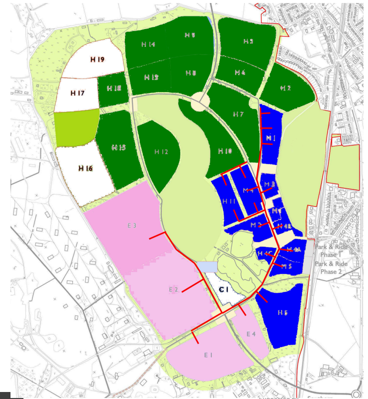


Phase 4

Bdg Int

Distric Htg

2. Planning for the heat network infrastructure

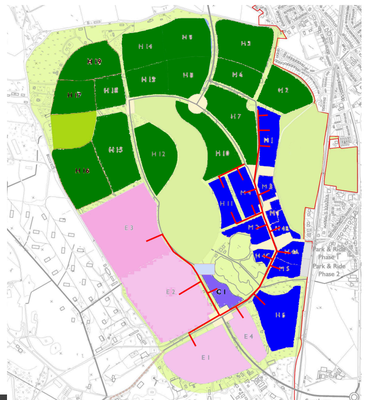


Phase 5

Bdg Int

Distric Htg

2. Planning for the heat network infrastructure



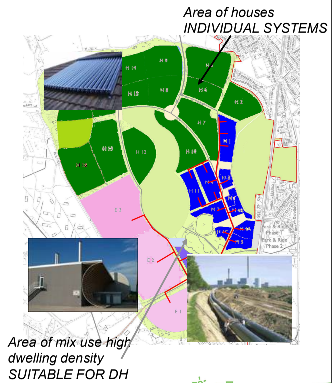
Phase 6

Bdg Int

Distric Htg

2. Planning for the heat network infrastructure

- The longer the distance between buildings the longer the pipe lengths that will be required
- Longer pipes will result in greater relative heat distribution losses and higher capital costs
- Connecting DH networks to low density housing areas needs to be considered carefully



3. Deciding on heat source and supply technology

- The heat source used will depend on the type of load to be supplied and on the particulars of the scheme, e.g. local supply sources
- For instance:
  - CHP
  - biomass heating
  - solar thermal DH

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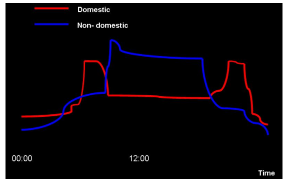
3. Deciding on heat source and supply technology

- A feasibility analysis undertaken by an experienced consultant would be required



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4. Use heating systems compatible with DH

- Where DH is viable, communal heating systems should be adopted to ensure the development:
  - can connect to an existing or planned network in the area
  - install a DH system to serve its premises
- The term communal heating systems is used to refer to heating systems that are able to use an external source of heat to supply all the heat requirements to the premises it serves.

Source: BRE

bre

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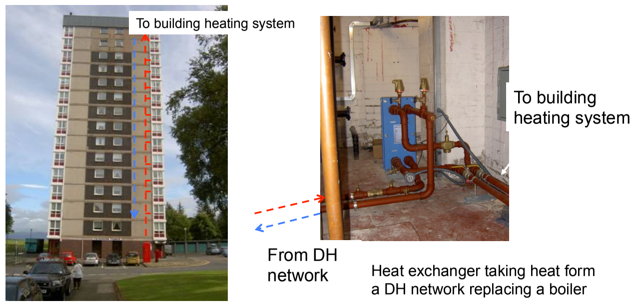
4. Use heating systems compatible with DH



Heat exchanger taking heat form a DH network replacing a boiler

A block of flats using a central boiler to feed a distribution system is compatible for connection to a DH heating scheme provided that operating temperatures are suitable

Source: BRE

bre

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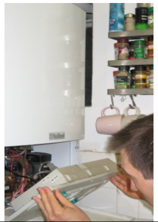
4. Use heating systems compatible with DH



Gas boiler serving a flat
Source: Heating and pumbling central.
www.heatingcentral.com

If the same block of flats is fitted with individual heating systems in each flat, it will not be compatible for connection to a DH scheme in the future

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4. Use heating systems compatible with DH

- LA planners are important players that can influence how developers connect to an area wide heat network when the time comes
- It is here where planners will play a key role and will have a strong position to have an impact

Source: BRE

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5. Expanding heat networks

- DH schemes have greater benefits when connecting a large number of customers e.g.
  - economies of scale and better operational efficiencies.
  - greater diversity of heat demand and reduced heat demand peaks
  - allows heating plant to operate at high load factors.
  - a greater number of customers would be able to shift to a renewable source of heat supply at once.

Council building

Natioanl Indoor Arena

Hyatt hotel

Pictures showing some of the heat loads connected to the Birmingham City Centre District Heating scheme

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5. Expanding heat networks

- Where possible it make sense to develop networks that supply the maximum amount of customers
- For instance the situation where two adjacent developments are planned within similar timescales
- A joint energy approach might incur a series of benefits e.g.
  - more flexible and cost effective better carbon savings
  - space and cost savings
  - better efficiencies

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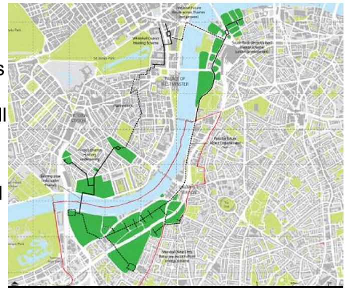
5. Expanding heat networks

- The role of LA planners in engaging with different developers to secure new DH joint schemes for different new developments will be fundamental
- This approach would be facilitated if one of the developments is LA owned
- It might prove difficult to engage two different developers to develop a joint energy strategy; this is only likely to be the case for the bigger schemes



Map showing strategic concept in relation to adjacent DH networks (existing and planned)

Source: Vauxhall Nine Elms Battersea Opportunity Area Planning Framework. Consultation Draft. November 2009. Published by the GLA.

Planning for DH across a LA

- Sustainable Development

The importance of addressing the existing building stock

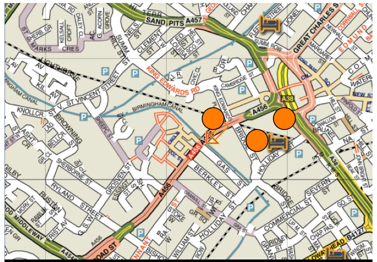
- Around 60% of the building stock that will exist in 2050 has already been built…
- …and nearly half of these buildings were built before 1985 when the energy efficiency requirements of Part L were introduced
- This means that the largest carbon savings achievable reside in the existing building stock

The importance of addressing the existing building stock

- When it comes to tackling carbon emissions in the existing building stock the use of basic energy efficiency measures should be prioritised
- Alternative ways to deliver low carbon and renewable heat should then be sought
- The use of DH has a vast potential to deliver low carbon and renewable heat to the existing building stock.

Initiating a DH across a LA

- LA owned buildings can play a key role in the delivery of the scheme
- Such buildings are under the control of the LA
- They are usually significant consumers of heat that can be used as anchor loads for the DH scheme



LA authority buildings as anchor loads

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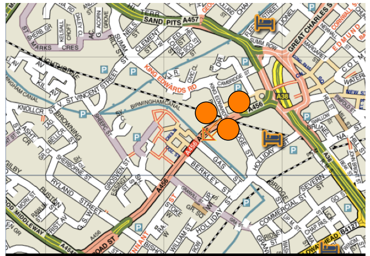
Initiating a DH across a LA

- Anchor loads could also be found in the form of large non-domestic new build developments
- Such new build developments would offer a high amount of heat load that could be used to attract the interest of a dedicated DH company



New non-domestic new build as anchor loads

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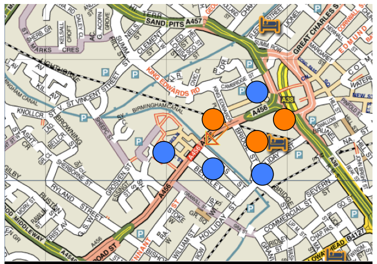
Initiating a DH across a LA

- Heat contract agreements can also be sought with other public and private single users of heat
- All of them will add to the business case for the delivery of the DH scheme,



LA owned buildings plus other private single heat user

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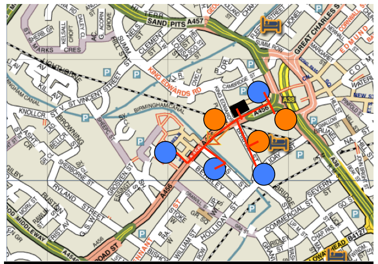
Initiating a DH across a LA

- In facilitating the deployment of DH, land is required to accommodate the energy centre
- Ideally, the LA would assist in finding land for the energy centre
- If the case for DH is favourable, adequate routes will have to be found to finance, detail design, install and operate the scheme



LA owned buildings plus other private single heat user and energy centre

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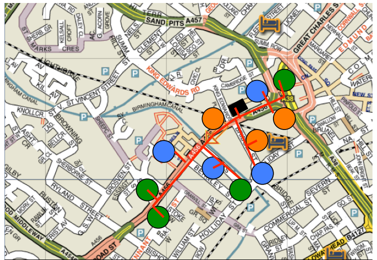
Initiating a DH across a LA

- Once the DH system is in place and in operation, the objective will be to expand the number of customers it serves
- This could be done by connecting other existing buildings and also new build developments



LA owned buildings plus other private single heat user, energy centre and expansion of DH network

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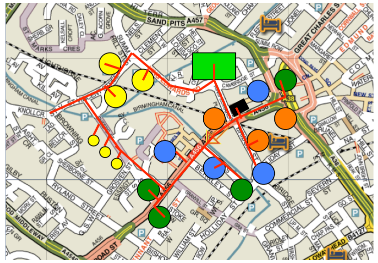
Initiating a DH across a LA

- in the medium/long term city wide schemes can be developed
- a small size DH scheme supplying a small number of customers can then become a city wide scheme
- opportunities for using larger sources of heat could arise that would allow entire communities to switch to new sources of heat supply



During the next two days examples of LAs that have actually developed city wide schemes will be presented

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How to identify potential sites for DH WORKSHOP

- Sustainable Development

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Recap on Heat and Cooling Demands

- Sustainable Development

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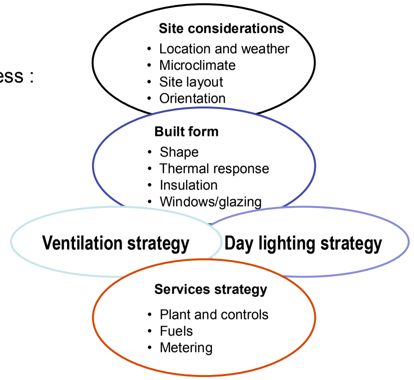
Design principles

Integrating the design process :

"Normally all the really Important mistakes are made on the first day of the design process!"
- Amory Lovins



Source: CIBSE Energy Efficiency in Buildings Guide

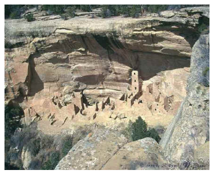
Passive Solar Design

heat gain from sun in winter

shading in summer

glazed areas capture heat

high thermal mass



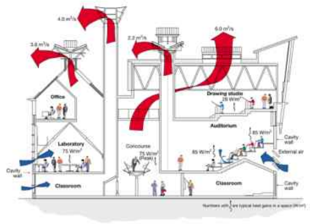
site layout needs consideration when planning development to ensure all buildings have sufficient access to sunlight

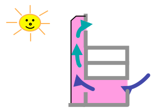
Daylighting

Natural ventilation

key issues :

- Low energy approach
- Air tightness
  (build tight - ventilate right)
- Night time ventilation for summer operation
- Avoidance of building sickness syndrome associated with air conditioned buildings





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Renewable forms of heat

SUN

TIDAL, WAVE, HYDRO

Air
Ground
Water

Organic matter - biomass

Direct use of solar energy

Passive solar
Solar air heating
Solar thermal collectors
Heat `pumps

Solid, e.g pellets
Liquid, e.g biodiesel
Biogas – injection in gas grid

Heat only boilers
Combined heat and power

Electricity generation: *hydrogen*

Combined heat and power

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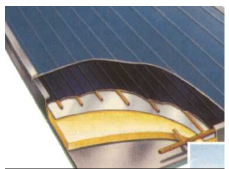
Solar water heating - basics

- Sun's energy is captured to heat water through the use of solar thermal collectors
- south facing roof
- sound, practical and affordable
- easily integrated in to new houses or retrofitted to existing properties
- Typical system consists of around 2-4 m^2
- Over a year a typical system can provide around 50% of the hot water requirements of a house in the UK


Flat plate collectors


Evacuated tube collectors

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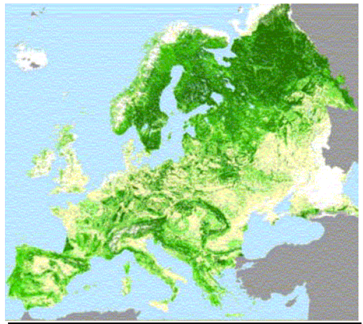
Biomass: the resource


View of forest resources in Europe

Biomass is (almost) carbon neutral

- the CO_2 released during combustion is equivalent to the CO_2 absorbed during growth
- there is in fact some CO_2 released due to processing and transportation of the biomass fuels used. The total amount will depend on the specific fuel

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Heat pumps - basics

- A heat pump extracts low grade heat from a (usually free) source, and upgrades it to a higher (useful).

Although the name may imply the opposite heat pumps can be used for space heating and cooling

Combined heat and power

- A Combined Heat and Power (CHP) plant is a power station that uses the heat produced during the generation of electricity.
- CHP equipment is available in pre-packaged units suitable for a range of applications from large single buildings to district heating networks

A mini-CHP 5.5 kWe/12.5 kWth unit is used to supply heat and power to a sports club, community and health facility.

EXERCISE: Why is your LA interested in developing policy

- Sustainable Development

Sustainable Urban Energy Planning (SUEP) - an introduction

- Sustainable Development

Definition of (spatial) planning

"Planning is the system by which the use and development of land is managed for the benefit of all the community"

"The overall aim of the system is to ensure a balance between enabling development to take place and con-serving and protecting the environment and local amenities"

Source: Royal Town Planning Institute

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A possible definition of a sustainable system

- Consistent
  - Short term actions should be compatible with long term objectives
- Renewable
  - It should be driven by renewable sources
- Diverse
  - The more diverse a system is the more flexible it is to respond to changes
- Comprehensive
  - The value of the elements of the system is evaluated according to benefits of the individual parts and of the system as a whole
- Interconnected
  - Each of the elements of the system relies on and sustains several other elements

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What is Sustainable Energy Planning about?

- SUEP encompass a series of strategies, planning policies and enabling mechanisms with the following objectives:
  - Minimize the need/demand for energy
  - Maximize the use of low carbon, surplus (residual) energy and renewable energy sources
  - Ensure good quality, secure supply and affordable energy for all

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What is Sustainable Energy Planning about?

- An integrated approach to SUEP should consider *economical, environmental* and *social* factors
- SUEP will work at a number of different scales:
  - Town and cities, districts, boroughs and neighborhoods,etc

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Characteristics of SUEP

- Considers all energy sources, users and energy related activates as a whole
- Environmental and social cost analysis
- Uses carbon mitigation as a key factor in the decision making process
- Focus on need for energy services rather than on what energy can be supplied, *e.g. need to keep buildings warm, need for lighting, need for drying, etc.*
- Prioritize demand side before considering the supply options, *i.e demand reduction and energy efficient measures before renewables*
- Flexible enough to anticipate and respond to changes

SUEP – the context and conditions

- Crucial to create the context and conditions for integrating and optimising efficient low carbon energy use within the urban built environment.
- SUEP increases the efficiency, reliability and sustainability of energy use through innovative infrastructure solutions and new governance approaches.
- Cities can become drivers for a low carbon energy future due to population densities and industrial and commercial activity. SUEP is required to achieve this.

Benefits of SUEP

- Setting the framework for long term strategic plan and vision
  - Where are we now?
  - Where do we want to get to?
  - How can we get there?
- Achieving environmental targets – e.g. on carbon reduction
- Enhancing security and quality of supply
- Providing affordable energy
- Obtaining economical savings
- Identifying synergies that individual project by project approaches may miss e.g. waste to energy, use of waste/surplus heat, etc.

The role of Local Authority Planners in setting up SUEP

- Local Authority planners can play a central role in shaping the energy aspects of cities through adoption of SUEP
  - Incorporate SUEP into local planning policy
  - Development Control influenced by SUEP policies
- Role of Local Authorities to develop and implement SUEP and integrate it with other elements of the planning system such as:
  - Site allocations for development
  - Transport system planning and management
  - Waste management

Integrating SUEP into local policies

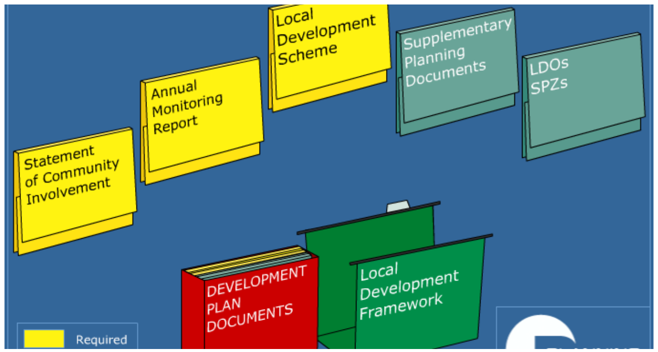
- Sustainable Development

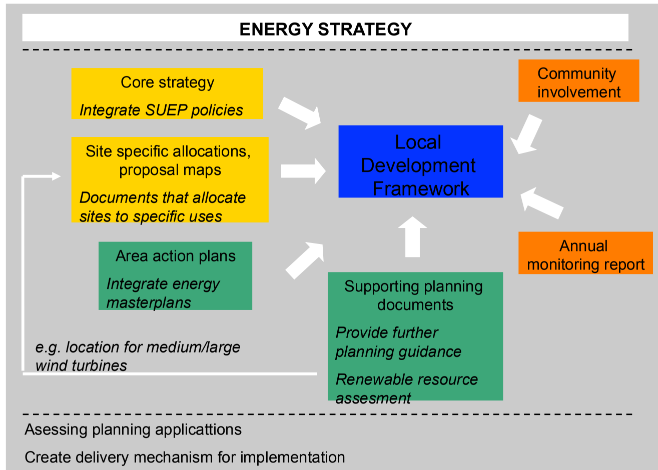
Integrating SUEP in the planning process

Role of the Local Authority planners:

1. to develop planning policies (LDFs) in line with SUEP principles and objectives
2. to produce technical studies to support policy documents
   - Renewable resource assessment
   - Energy masterplans for key areas
3. to assess planning applications against SUEP policies
   - Evaluate energy strategies for site specific planning applications
4. to create delivery mechanisms for implementation

Think of a Local Development Framework as a folder of documents

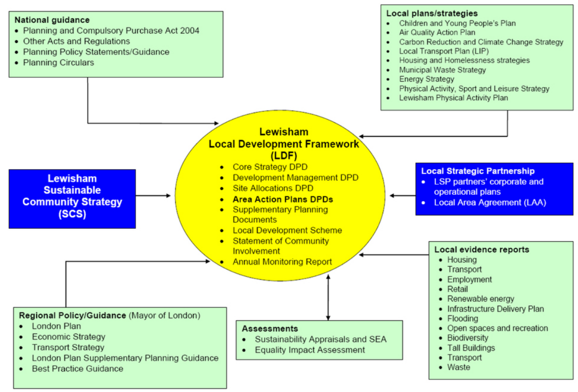




Establish long term vision

- Set medium and long terms objectives In line with national carbon reduction targets
- The Climate Change Act 2008 set legally binding emission reduction targets:
  - 34% reduction in greenhouse gas emissions by 2020
  - 80% reduction in greenhouse gas emissions by 2050

Establish long term vision



1. Developing SUEP planning policies

- Specific energy planning requirements within Local Development Framework
- Include specific targets
  - Energy efficiency, renewable energy, etc.
  - Code for sustainable homes, BREEAM

Ashford LDF 2007 - 2014

			(CS3) Town Centre & (CS4) Brownfield Urban Sites	(CS5) Urban Extensions & (CS4) Greenfield Urban Sites	(CS6) Tenterden, the Villages	Existing and refurbishment
(A)		Residential	Code Level 3	Code Level 4	Code Level 2	EcoHomes 'Very Good'
	BREEAM	Overall level	Very Good	Excellent	Good	Very Good
		Energy Credits	Excellent	Excellent	Excellent	Excellent
		Water Credits	Maximum	Maximum	Excellent	Excellent
		Material Credits	Excellent	Excellent	Very Good	Very Good
(B)		Minimum Carbon Dioxide Reduction				
			20%	30%	10%	10%

1. Developing SUEP planning policies

Address existing building stock

- Local authority building stock
  - Housing estates, public buildings
- Undertake energy surveys and identify improvements
  - Insulation, replacing windows, low energy lighting retrofitting, district heating, renewable energy systems, etc.
- Identify sources of funding
- Establish programmes to include other buildings
  - Private dwellings, commercial buildings, etc.
- Where possible add specific policies for existing buildings

2. Supporting policy documents

Renewable resource assessments

- Develop studies identifying the potential for renewable energy sources in your area
- Use as supporting evidence to back-up long term carbon reduction objectives
- This could include:
  - *wind resource assessment and potential for wind energy locations, biomass resource assessment,*
  - *availability of waste heat sources,*
  - *potential for waste to energy,*
  - *etc*

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2. Supporting policy documents

Energy masterplans

- Provide the energy guidelines that developments in a wider area should follow
  - set carbon reduction targets for buildings in the area
  - set energy efficiency standards
  - identify areas with potential for district heating
  - identify locally available heat sources
  - identify site locations for heat generating plant, etc.
- It should occur at the masterplanning stage – prior to outline planning application
  - all opportunities and constraints should be identified early
- Ensures future proofing of early development in the area

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3. Assessing planning applications

- Energy strategies should be produced for developments in agreement with LDFs policy and with area specific energy masterplans
- SUEP policies used as basis for the assessment of energy proposals of planning applications
  - new/refurbished, domestic/commercial/industrial, large/small
- Planning conditions or ideally section 106 agreements should be used to retain key energy aspects, e.g. energy infrastructure
- Monitoring at post-construction stage is crucial

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3. Assessing planning applications

- Planning conditions / section 106 agreements – example
  - A heating network supplying all domestic and non-domestic spaces within the [name] development shall be installed and sized to the heating requirements of the [name development], and shall have the following characteristics:
    - *It shall be operational prior to the occupation of the [yyy]th apartment and shall thereafter serve all spaces within the [name development]*
    - *It shall be supplied with heat from either an external district heating system or by heat generating plant installed in a single energy centre located within the [name development] and that includes Combined heat and Power technology*

Reason: to ensure compliance with Policies 4A.5 and 4A.6 of the London Plan Spatial Development Strategy for Greater London (Consolidated with Alterations since 2004) dated February 2008

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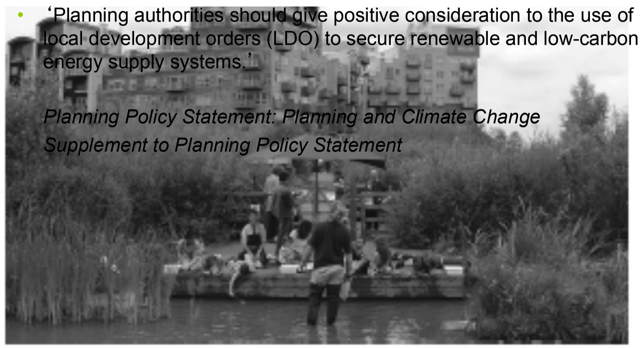
3. Assessing site specific energy strategies

- Assess application against SUEP policies
- The principles in the energy strategy should be compatible with long term vision
  - *In a potential DH area, buildings should be designed to connect to the DH scheme*
- A minimum technical understanding of the issues involved is required
- Compare carbon reduction savings achieved against policy targets
- Provide feedback to the applicant where necessary and be firm

3. Liaison with developers

- Developers may often:
  - face financial concerns
  - try to only comply with minimum national requirements
  - oppose non-conventional approaches – they are not used to *e.g. district heating and renewable technologies*
- LPA should engage with developers early in the process to facilitate the interchange of information
  - For key-strategic applications pre-application meetings should occur
- Proactive engagement versus reactive attitude

Using Local Development Orders (LDO)



- 'Planning authorities should give positive consideration to the use of local development orders (LDO) to secure renewable and low-carbon energy supply systems.'

Planning Policy Statement: Planning and Climate Change Supplement to Planning Policy Statement

Set out in Development Plan Documents (DPD)

- *'Any policy relating to local requirements for decentralised energy supply to new development or for sustainable buildings should be set out in a DPD, not a supplementary planning document, so as to ensure examination by an independent Inspector.'*

Planning Policy Statement: Planning and Climate Change Supplement to Planning Policy Statement

Steps to SUEP and Evidence Bases

Sustainable Development

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Steps in developing a SUEP

- Urban planners on their own are not only responsible for developing a sustainable energy plan for a LA
- Other LA departments are involved in the process
  - Environmental officers
  - Housing, waste, transport departments
  - Accounting and legal representatives
- The role of LA urban planners is critical and therefore it is important that the process to creating a SUEP is understood

Steps in developing a SUEP

1. Characterising the region (city, town)
   - including existing and planned development
2. Identifying the potential for low and zero carbon energy sources across the region
3. Establishing gross energy demand
   - e.g. heat maps
4. Designing a city wide energy masterplanning strategy
   - Identifying opportunities
5. Detailed studies for specific projects
   - From technical options appraisal, feasibility, financial and business modeling to project procurement, implementation and delivery

1. Characterising the region

- A character area is an area that has a unique and recognizable character. It is different form other adjacent areas, e.g. housing age and style, land use, etc.
- Character areas across a city/town should be a starting point upon which energy planning policies can be developed
- Character areas should be identified by considering
  - Type, mix and use of buildings, building and heating densities
  - Include both existing and future planned development

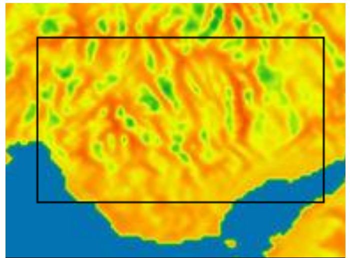
1. Characterising the region

- Typical character areas will include city centres, edge of centre, inner city districts, industrial areas, suburban districts, urban extensions, rural areas, etc.




2. Identifying the potential for low and renewable energy sources

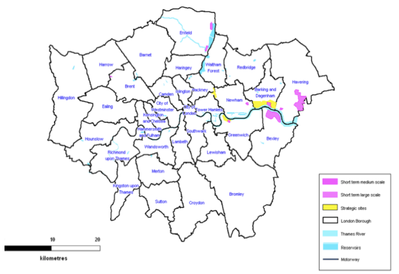
- Investigation of the energy sources that are available
- Including resources available beyond the LA boundary
  - Establishing a supply chain of biomass sources outside form the LA boundaries
- All sources of energy need to be investigated



Wind resource around the Head of Valleys region in Wales

2. Identifying the potential for low and renewable energy sources

- Low and renewable energy sources include:
  - Areas with biomass resource
  - Potential location for medium/large scale turbines
  - Available roof space for urban integrated solar technologies

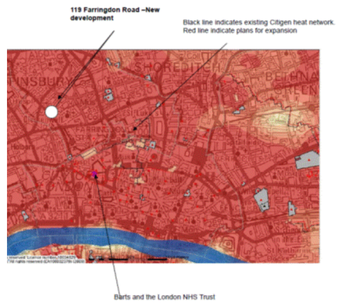


Potential wind development locations across London.

Source: London Wind & Biomass Study Summary Report: Feasibility of the Potential for Stand Alone Wind and Biomass Plants in London .London Energy Partnership. Nov 2006

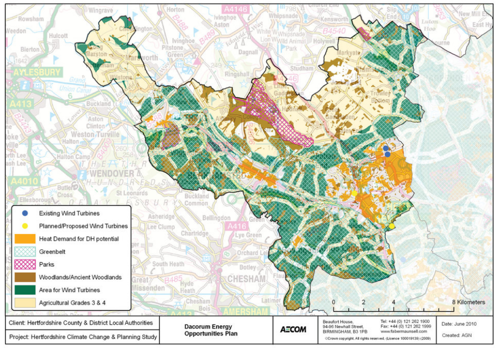
2. Identifying the potential for low and renewable energy sources

- Low and renewable energy sources include:
  - Sources of waste heat, i.e. industry processes
  - Waste treatment facilities – to evaluate waste to energy potential
  - Existing sources of heat including large DH networks



London heat map showing existing Citigen district heating scheme.

2. Identifying the potential for low and renewable energy sources



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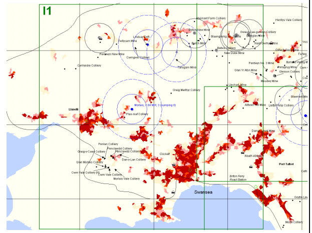
3. Establishing gross energy demand

An energy demand assessment of the region should:

- account for all building sectors
- consider existing and planned development
- identify large customers of energy, e.g. universities, hospitals, council owned buildings
- group customers by the need of services they require, e.g. space heat , hot water, space cooling, etc.



By addressing all of the issues above matching overall demand with the available supply can be made

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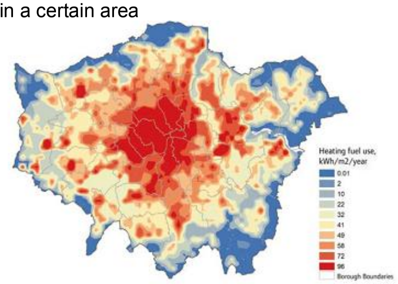
3. Establishing gross energy demand

- Heat maps are contour plots showing the levels of area heat demand density in a certain area



London heat map showing the heat density

Source:Centre for Sustainable Energy. © Cown copright. All rights resrved. Greater London Authority 100032379. 2009

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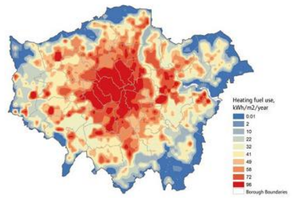
3. Establishing gross energy demand

Heat maps should include:

- All types of end heat demand
- All building sectors
- Anchor loads
- Future planned developments in order to asses the potential heat loads in the area.



London heat map showing the heat density

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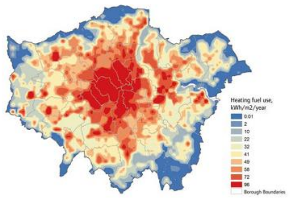
3. Establishing gross energy demand – heat maps

Heat maps are a useful tool

- Identify potential areas for DH schemes where the heat demand density is sufficient
- Evaluate retrofitting of DH to areas of existing buildings
- Link heat demands with efficient sources of heat including waste heat.
  - Heat maps can be used to plan the location of new heat sources such as energy from waste facilities

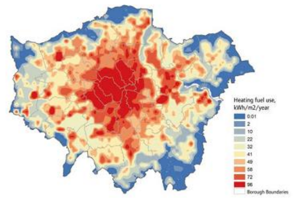


London heat map showing the heat density

Source:Centre for Sutianable Energy. © Cown copright. All rights resrved. Greater London Authority 100032379. 2009

3. Establishing gross energy demand – heat maps

- Heat maps can be developed at regional and sub regional level, splitting areas into coarse blocks does not provide the required resolution for considering DH.
- It is necessary to go to finer resolutions, e.g. census output areas
  - for site specific projects a more fine analysis is therefore required

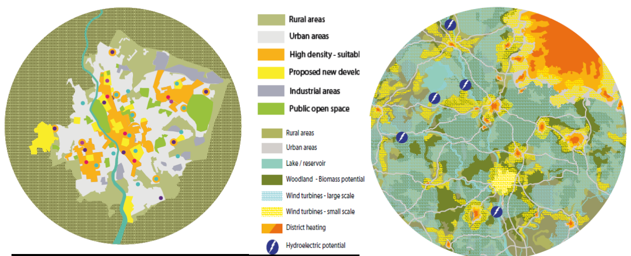


London heat map showing the heat density

Source:Centre for Sutianable Energy. © Cown copright. All rights resrved. Greater London Authority 100032379. 2009

4. Designing an energy strategy

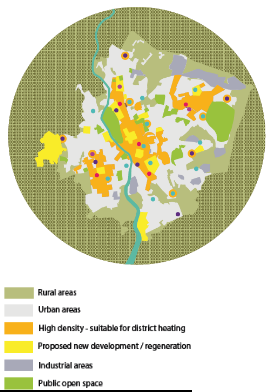
- We have an understanding of:
  - Character areas
  - Available and potential energy sources
  - Energy demand requirements – heat maps
- All this information can be combined to develop energy maps



Source: Community energy – planning, development and delivery. CHPA and TCPA. 2010.

4. Designing an energy strategy

- Energy maps are useful for:
  - Informing the masterplanning stage of new developments
  - Aiding developers in making good decisions
  - Identifying potential areas for implementing DH in regeneration areas
  - Identifying the location for new DH developments
  - Matching demand and supply for heat



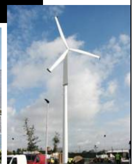
Source: Community energy – planning, development and delivery. CHPA and TCPA. 2010.

4. Energy maps

- Energy maps are also useful to define energy character areas.
  - High dwelling /heat city centres are suitable for district heating
  - Industrial areas offer opportunity for installing medium and large wind turbines
  - Less densely populated suburban areas are likely to use heating solutions at building level such as heat pumps and solar thermal


DH scheme a Birmingham city centre

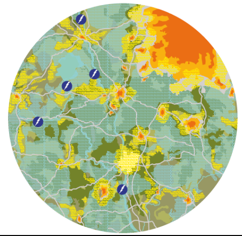

Solar thermal installation at a house


Wind turbine at Ford Dagenham-East London

Source: middle (www.autoevolution.com). bottom (www.radiantkc.com)

4. Energy maps

- Energy maps can be seen as the result of city wide energy master planning
- Energy maps can be used as the starting point for :
  - development of energy planning policies to the city level and for the different energy character areas
  - development of more detailed energy strategies at smaller scales


Source: Community energy – planning, development and delivery. CHPA and TCPA. 2010.

5. Detailed studies for specific projects

What are the steps that follow city wide energy master planning?

- Energy opportunities across the region of study can be indentified
- A series of detailed studies are required to develop more specific energy projects
- Each of the detailed projects will be developed to follow the findings of the area wide energy mapping exercises
  - Identified synergies that arise form a holistic approach to energy are taking advantage of
  - Individual project by project approach is therefore a non-go option anymore

5. Detailed studies for specific projects

- In line with the objective of SUEP each of the detailed projects will need to give to consideration to:
  - In line with long term objectives
  - Achieving environmental – carbon reduction targets
  - Enhancing security and quality of supply
  - Providing affordable energy
  - Cost effectiveness
- For each of the projects it is likely the following steps will be followed

5. Detailed studies for specific projects

1. Detailed data gathering and definition of the project
   - E.g. Detailed energy demand data, determine barriers, etc
   - Setting objectives for each project:
     - *Carbon reduction, affordable energy, security of supply, etc*
2. Option appraisal
   - Creation of different technical options that can be used, these need to be investigated in more detailed and to conclude one or a range that are appropriate
3. Feasibility study
   - More detailed technical and feasibility study
   - Considers phasing of development, planning of heat network installation, space for energy centre, fuel availability, while life costing, etc

5. Detailed studies for specific projects

4. Financial and business modeling

5. Procurement and delivery

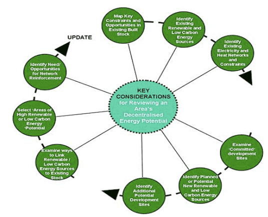
5. Detailed studies for specific projects

- The LA will need to ensure that they align and seek technical support from a suitable team and for each for the different stages:
  – Master planning team, engineering consultants, cost consultants, legal advisers, procurement officers, etc

- It the scope of this course to provide detailed guidance about each of the steps above, although further assistance can be provided

Summary

- Build up existing heat/cooling and density map
- Any existing public sector housing refurbishment?
- Existing anchor loads?
- Location/capacity of existing DH schemes?
- Location/capacity of sources of waste heat?
- Additional heat load to existing CHP schemes?



Summary *cont...*

- Heat map of proposed developments
- Complementary heat demands?
- Can development of adjacent sites share an energy centre
- New developments near waste heat?
- Public-private sector partnerships?
- New developments on mains gas?
- Designations?
- Capacity of existing road network

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- Sustainable Development

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Examples of Policies

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Woking Borough Council

Energy Efficiency Accreditation

The Queen's Award for Enterprise

Beacon Council 2005-2006 Sustainable Energy

Beacon Authority 2007-2008 Promoting Sustainable Communities Through the Planning Process

Beacon Authority 2008-2009 Tackling Climate Change

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Woking town centre energy station

- Operational 2000
- 1.2 MW_e natural gas-fired
- CCHP ('Trigeneration')
- Private wire network

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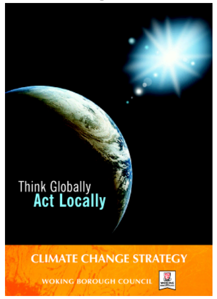
Woking's Climate Change Strategy



Adopted December 2002

Three Overarching Aims:
- Reduction of CO2 equivalent emissions
- Adaptation to climate change
- Promotion of sustainable development

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Woking's Climate Change Strategy

- 8 key themes
- Aims to deliver 60% CO_2 reductions by 2050
- Long term strategy, with short and medium term targets
- Regular progress reports to cross-party group

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Climate Neutral Development guidance

(Woking Borough Council 2004)

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‘Climate Neutral’ development

Development that has *no avoidable impact on the climate*, by not contributing to greenhouse gas emissions;

<u>and</u>

there will be *no avoidable impact of climate on the development*, by designing in resilience to predicted dramatic changes in climate

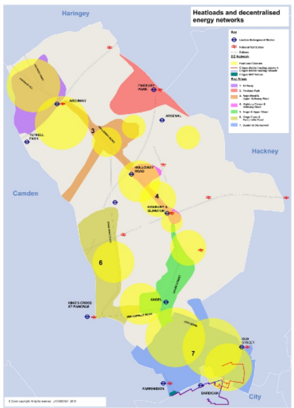
London Borough of Islington

Issues
- Lack of open space and access to nature
- Water stress, urban heat island and surface water flood risk
- Challenging CO2 reduction targets
- Quantity of growth –small infill developments
- Limited opportunities for large scale renewables

Opportunities
- London Plan and other supportive regional initiatives
- Political and officer commitment to sustainability
- High sales (although also land) values
- High built environment and therefore heat densities

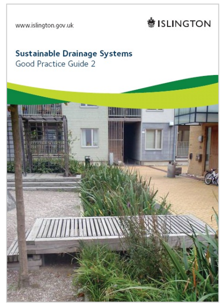
Policy development – carbon reduction

1. Analysing role of planning in supporting carbon reduction targets
2. Scoping opportunities for low and zero carbon technologies
3. Reviewing current implementation of climate change policies
4. Evidence gathering to set carbon reduction targets for new development
5. Wider policy development, including offsetting remaining emissions, decentralised energy networks and sustainable transport policies



Role of Development Management

- Strengthened development management process – pre-application advice to committee decision
- Improved enforcement through robust, standardised conditions
- Regular sustainability seminars for planners
- Guidance for householders and developers
- Updated green planning website pages
- Process for monitoring improvements – with 6 monthly reporting



Progress so far (March 2009)

- 51% of schemes achieved BREEAM Excellent or Code Level 4, increasing over time to 85% in 2007-8
- 1/5 schemes incorporated CHP
- Average reduction in CO_2 from renewables rose from 3% to 17% over period (towards 20% target)
- 63% of major schemes have a green roof (totals over 14,000m2) – now have most in London
- 60% of major developments were car-free
- Several exemplar schemes now built or underway

Ashford Borough Council

- One of four growth areas in the South East. Expected to double in size and population by 2031.
- Core Strategy adopted 10th July 2008 - sets out overall vision and objectives for the delivery of Ashford's Local Development Framework between 2006 and 2021
- Includes condition for Code/BREEAM (policy CS10 - Sustainable Design and Construction). This was amended to update from EcoHomes to Code.
- http://www.ashford.gov.uk/pdf/Planning_Adopted_Core_Strategy_July08.pdf

Inspectorate comment

- *"…in a growth area, where decisions taken now will affect a large number of dwellings to be built in the near future and where exemplary standards might be expected, I consider that an aspiration to such a level is appropriate. However, other parts of Ashford seem to have less potential and I consider it reasonable for the standards to take this into account".*
- *"…there has been relatively little opposition to those proposed for non-residential schemes, the main concern appearing to be with the requirements for water credits. In the town centre there may be some difficulties in achieving the desired levels. However, water consumption is an issue of particular importance in Ashford. On balance, subject again to the inclusion of a specific caveat regarding viability and practicability, I conclude that it is reasonable to aim for the proposed standard."*

http://www.ashford.gov.uk/pdf/Planning_FINAL_REPORT.pdf

Ashford LDF 2007 - 2014

			(CS3) Town Centre & (CS4) Brownfield Urban Sites	(CS5) Urban Extensions & (CS4) Greenfield Urban Sites	(CS6) Tenterden, the Villages	Existing and refurbishment
(A)	BREEAM	Residential	Code Level 3	Code Level 4	Code Level 2	EcoHomes 'Very Good'
		Overall level	Very Good	Excellent	Good	Very Good
		Energy Credits	Excellent	Excellent	Excellent	Excellent
		Water Credits	Maximum	Maximum	Excellent	Excellent
		Material Credits	Excellent	Excellent	Very Good	Very Good
(B)		Minimum Carbon Dioxide Reduction				
			20%	30%	10%	10%

Brighton and Hove City Council

- Since 2006: standard condition for new development to meet BREEAM/EcoHomes 'Very Good' (CSH level 3)
- major apps 2006-2007: 34 new developments
  - 2 'zero carbon'
  - 7 BREEAM Excellent
  - 13 BREEAM Very Good/Excellent
  - 5 Combined Heat and Power (CHP)

RECOMMENDED STANDARDS FOR MEDIUM-SCALE RESIDENTIAL DEVELOPMENTS INCLUDE:

Development type	What is recommended
All	▪ Minimise 'heat island effect' via contribution towards off-site tree planting (see annexed document)**; and ▪ achieve a level of performance equivalent to that required under the Considerate Constructors Scheme[16].
New build residential (including mixed-use developments)	▪ Emit zero net annual CO_2 from energy use; ▪ submit a completed Sustainability Checklist*; ▪ achieve a minimum rating of Level 3 of the Code for Sustainable Homes (CSH)[17]; and ▪ be designed to Lifetime Home Standards[18].
New build non-residential developments	▪ Score at least 50% in the energy and water sections of the relevant BREEAM[19] assessment within a minimum overall rating of 'Very Good'.

http://www.brighton-hove.gov.uk/downloads/bhcc/ldf/adopted_Sustainable_Building_Design_SPD_8.pdf

The London Plan

London Plan Decentralised Energy Policies

'Boroughs should ensure that all DPDs identify and safeguard existing heat and cooling networks and maximise the opportunities for providing new networks that are supplied by decentralised energy.'

'The Mayor will and boroughs should work in partnership to identify and establish network opportunities, to ensure the delivery of these networks and to maximise the potential for existing developments to connect to them.'

(Policy 4A.5 Provision of heating and cooling networks)

The London Plan

Individual Developments

- *'Developments should evaluate combined cooling, heat, and power(CCHP)and combined heat and power (CHP) systems and where a new CCHP/CHP system is installed as part of a new development, examine opportunities to extend the scheme beyond the site boundary to adjacent areas.*
- *The proposed heating and cooling systems should be selected in accordance with the following order of preference:*
- *connection to existing CCHP/CHP distribution networks*
- *site-wide CCHP/CHP powered by renewable energy*
- *gas-fired CCHP/CHP or hydrogen fuel cells, both accompanied by renewables, communal heating and cooling fuelled by renewable sources of energy, gas fired communal heating and cooling.'*

(Policy 4A.6 Decentralised Energy: Heating, Cooling and Power)

- Sustainable Development

Implementing and developing sustainable energy planning policies.
Guidance for planners

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Introduction

- The preparation of local development plans is a complex process and very dependent of the specific circumstances and characteristics of each LA
- This course will not provide a standard formula to how energy polices should be written
- We intend to provide guidelines about how energy policy writing should be addressed and thought through so that you can start drafting policies for your LA.

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What are the aim of the policies?

- SUEP policies should be written with the aim of underpinning the objectives of the overarching Climate Change and Energy Strategy as defined by the LA, i.e. reduction of carbon emissions
- This course focuses on the impact that the energy supply to our towns and cites has in the overall LA carbon emissions
- Emissions from other sectors such as transportation and waste have been left out, although the need for cross sector policies will be mentioned

bre

What are the aims of the policies?

- Local development plan policies should be specific enough to guide the design of development proposals
- Policies should be clear enough to serve the purpose with which they have been written in the first instance

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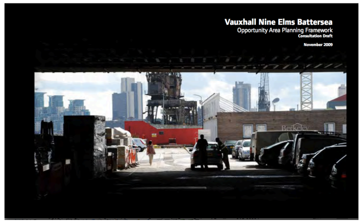
Evidence base studies

- The writing of SUEP policies should be informed with evidence base studies
  - Conclusions from LA wide energy master planning and more specific energy studies for key areas such as large regeneration areas or urban extensions



Energy masterplan for the Vauxhall Nine Elms Battersea Oportunity Area. GLA.

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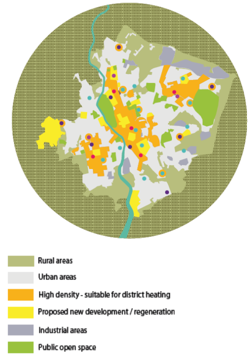
Evidence base studies

- Evidence base studies should be the starting point of policy writing and the basis of the development of SUEP in order to ensure that:
  1. Policy targets reflect realistic and achievable objectives
  2. Policies reflect the particularities and needs of the LA, e.g. creation of specific policies for character areas to which development proposals should adhere to



Source: Community energy – planning, development and delivery. CHPA and TCPA. 2010.

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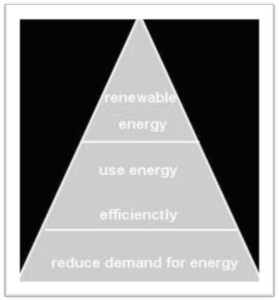
The importance of the hierarchy of enforcement in policy writing

- It is the structure and hierarchy with which policies are written and subsequently enforced
- Priority of enforcement should be given to policies that are more important to achieve the long term vision objectives



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The importance of the hierarchy of enforcement in policy writing

- Guidelines are not prescriptive, in most of the occasions the following overall hierarchy should be used:
  1. Reducing the demand for energy
     - Prioritisation should be given to reducing the demand for energy
  2. Infrastructure for the delivery of energy
     - New build should facilitate and contribute to the development of an energy infrastructure that allows mass scale deployment of residual/renewable energy across the LA
  3. Renewable and residual energy
     - As a key element to reduce carbon emissions, all new developments should provide a significant proportion of its energy residual/renewable energy sources.

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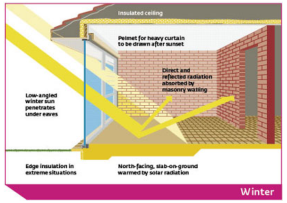
1. Reducing the demand for energy

- Prioritisation given to reducing the demand for energy using building design measures
  - e.g. solar passive design, super insulated material, use of natural ventilation, access to day lighting, etc.
- Building design measures are addressed as part of the *design and access statement* but consideration to it should also be also given in the energy proposals



Passive solar design for building

Source: Solar Energy Technologies Power from the Sun. http://is.njit.edu/competition/2009/Cat2_2_Winner_Group142/index.html

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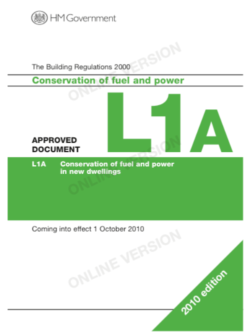
1. Reducing the demand for energy

- High standards of energy efficiency are already required by national building codes
- Standards will be tightened as a part of future Building Reg revisions
- In the future there may be little benefit in spending resources in enforcing a policy for reducing the demand for energy.
- However, policies requesting to demonstrate and provide evidence on measures to reduce the demand for energy should remain in policy documents
- Measures should be used as guidelines for the detailed design of the development proposals



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2. Infrastructure for the delivery of energy

- SUEP policies need to ensure new build developments facilitate and contribute to the development of adequate energy infrastructure across the LA
- This should allow for the use of residual and renewable energy in a wide scale

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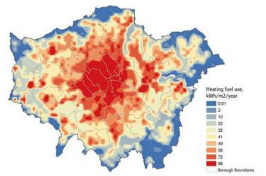
2. Infrastructure for the delivery of energy

- In areas where the heat density is sufficient, all new developments should be requested to adopt heating systems that are compatible for connection to DH systems

DH pipes Source:Logstor



London heat map showing the heat density

Source:Centre for Sutianable Energy. © Cown copright. All rights resrved. Greater London Authority 100032379. 2009

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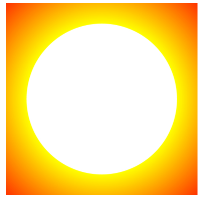
2. Infrastructure for the delivery of energy

- In the long term, the use of a DH system to supply large areas within a LA would allow whole communities to shift to a renewable source of heat at once

3. Renewable and residual energy

- Renewable energy - source of energy that can be replenish at the same rate that is used
- Residual energy - useful energy that would exist independently of it being used, e.g. residual biomass from tree surgery or waste heat from industrial processes.
- Key element to reduce carbon emissions - all new developments should provide a significant proportion of its energy residual/ renewable energy sources.



3. Renewable and residual energy

- In reality for certain type of developments, e.g. few hundred apartments block in a city centre location, the use of renewable energy is largely limited by technical constraints
- Therefore, any renewable policy, although necessary, will have to be enforced with an awareness of existing technical constraints.

Policy writing guidelines

- Use of specific targets in policy writing can be useful in certain situations.
  - e.g.in setting a cap in the maximum level off carbon emission allowed for development proposals.
- The establishment of targets on its own is not enough to indicate how cities should grow energy wise
- Policy should be written to establish the manner in which the LA wishes its towns and cities to grow, expand and regenerate

Policy writing guidelines

- Polices were limited to requesting new development to contribute a certain percentage of its energy from renewable energy
- Policies may be useful in the immediate terms but may undermine the medium and long term objectives
  - E.g. use of individual heat pumps to supply 1,000 new apartments in an area where waste heat is available would reduce the viability of re-using the already existing residual waste heat to provide not only the 1,000 apartment in particular but to any other future development in the area.

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Policy writing guidelines

- This is the purpose of the evidence base studies:

  "to help identifying the special particularities of the different LA areas to ensure the residual/renewable energy potential is fully exploited"

- For areas where residual heat available exist , policies should enforce, if feasible, the recovery and subsequent use of such heat for development in the area

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Policy writing guidelines

- Leaving it to the individuals to decide how to achieve a certain level of carbon reduction is counter productive for the long-term aspirations and plans of the LA.
- It is necessary to have local development plans that include policies that can guide the energy proposals of new build developments according to the conclusions of the evidence base studies.

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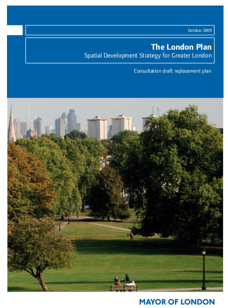
Policy making examples

- Different LA will have specific circumstance and it is evidence base studies that should ultimately shape the policy writing process for a specific LA.
- The bullet points below illustrate a possible hierarchy and a set of policies that are likely to be applicable for the majority of LA.



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Policy 1: Minimising carbon emission of new build development

- This overarching policy should be to minimise the carbon emissions of new build developments
- Carbon emissions for new build developments should be capped below a certain threshold
- Whilst this threshold will have to be agreed at each time, it refers to national building standards, e.g. code for sustainable homes
- LA should try to enforce carbon savings levels that go beyond national requirements (this might prove difficult with the strengthening of future building codes)

Policy 1: Minimising carbon emission of new build development

- Example of policy for the domestic building stock:

  "All development proposals should achieve as a minimum the following carbon savings"

  "Code level 4 for the period 2010-2012"
  "Code level 5 for the period 2013-2016"
  "Zero carbon homes beyond 2016"

Policy 2: Energy assessments

- Require the submission of an energy assessment for all development proposals referable to the LA
- Energy assessment will be the basis upon which the energy proposals will be evaluated against the SUEP
- Energy assessments should contain enough information to demonstrate how policy requirements are fulfilled
- More about energy assessment later on

Policy 2: Energy assessments

- Example of policy to request the submission of an energy assessment:

  "All development proposals should include and energy assessment to demonstrate the minimum carbon reduction targets outlines in the policies above are to be met within the context of the policy hierarchy established"

Policy 2: Energy assessments

- A policy should exist that indicates what energy assessment should include

    "Such a policy will depend on each LA but it should at least state that energy assessment should address each of elements of the policy hierarchy, i.e. reducing the demand for energy, deployment of adequate energy infrastructure and use of residual/renewable energy"

Policy 3: Planning for energy infrastructure

- The objective of this policy should be to develop an energy infrastructure across the city that allow for the maximisation of the uptake of renewable and residual energy across the LA.
- Such infrastructure could consist of heat networks to take advantage of waste heat from industrial processes, smart grids for large new development to optimise renewable electricity generation, etc

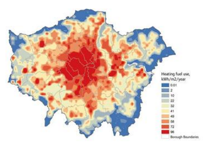
Policy 3: Planning for energy infrastructure

In areas where the heat density is sufficient for using DH:

1. Where existing DH networks exist the best solution is almost certainly to negotiate a connection to the existing network e.g. new 500 flats in the vicinity of existing DH network

    LAs should be aware of where the DH is in their areas and to request developments in the area to connect to DH networks where feasible.

    Heat maps could be used that include existing and planned DH networks

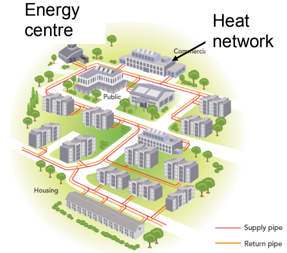


Policy 3: Planning for energy infrastructure

In areas where the heat density is sufficient for DH:

2. Where no existing DH networks exist, but DH is viable, the entire development should use a communal heat network to supply its heating requirements and that priorities the use of residual and renewable energy

    e.g biomass heating, CHP and renewable, CHP, solar thermal, heat pumps, waste to energy facilities, etc



Basic elements of a DH scheme

Policy 3: Planning for energy infrastructure

In areas where the heat density is not sufficient for DH:

- e.g. areas of detached housing, local authorities may want to explore the opportunities for:
  - use of smart grids
  - large scale programmes fro the installation of individual roof mounted solar technologies such as solar thermal or photovoltaics

Roof mounted solar at Drake Landing Solar Community

Source: http://urbancsa.wordpress.com/2008/11/

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Policy 3: Planning for energy infrastructure

- Example of policy to promote the adequate use of DH systems across the LA

Where technically viable, all development proposals should proposed heating systems according to the following hierarchy:

1. *Connection to existing heat networks*
2. *Use of site wide communal heating systems supplied with heat with the lowest carbon content*

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Policy 3: Planning for energy infrastructure

- Example of policy to promote the adequate use of DH systems across the LA

In areas identified and specified by the LA as potential for DH all development proposals should install heating systems that are compatible for connection to DH networks

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Policy 4: Renewable and residual energy

- It has been common practice to establish policies requesting new build developments to provide a certain amount of their energy requirements with renewable/residual energy.
- This approach is unlikely to be as relevant as it was before, because as building regulations strengthen the use of renewable energy becomes more and more necessary to achieve the requested carbon reduction targets.
- An increase share in renewable could be robustly achieved by simply tightening the overall carbon savings that new development should comply with at different points in time (refer to policy 1)

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Policy 4: Renewable and residual energy

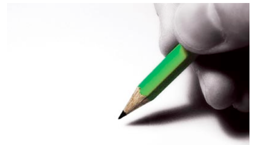
- A policy requesting to maximise the use of renewable to supply new development can be included in specific occasions.
- This might be key for certain type of planning applications
  - New build industrial developments might offer a good opportunity for use of medium wind turbines.
  - A specific policy on the maximisation of renewable energy for development proposals would allow the LA to be in a stronger position to request the installation of wind turbines

Policy 4: Renewable and residual energy

- Example of policy to maximise the use of renewables

All development proposals should contribute to the achievement of the policy minimum carbon reduction targets through the use of residual/renewable energy where technically feasible

In specific circumstances and where viable the use of renewable to exceed minimum carbon savings should be evaluated and adopted



Policy 5: Allowable solutions

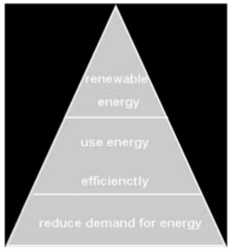
- It is likely that for some particular developments, carbon reduction targets are not achieved.
- In such situations, the use of the so-called allowable solutions should be permitted.
- Such solutions should be designed to contribute to the objectives of the policies elsewhere.
  - for instance, a carbon price could be set-up with the aim of financing a *green fund* for energy infrastructure rejects elsewhere

Policy making

- The policy examples given do not represent an exhaustive list that a LDF should include.
- They provide an indication of the key issues that need to be addressed to reduce carbon emissions in new build developments but also to encourage the development of a LA wide energy infrastructure which will benefit the wider area.

Policy interpretation

- There will be occasions when it will not be possible to fulfil all of policies at the same time.
- When this is the case, the hierarchy, should be strictly followed and enforced where applicable.



Policy interpretation: example 1

- Example 1:
  - phased development consisting, on completion, of 1,000 apartments.
  - phase 1 only sees 150 apartments built in a single block

Policy interpretation: example 1

- Following the hierarchy, and leaving aside demand reduction, the first consideration should be to install energy infrastructure that will maximise the uptake of renewable/ residual energy
- Using this example, a total of 1,000 new apartments, a DH system sourced with low/renewable heat is likely to be the most adequate option

Policy interpretation: example

- The first phase of the development in isolation?
- Biomass boiler could initially be thought of, but the size of the boiler required to supply 150 dwellings is unlikely to comply with the air emissions requirements

Policy interpretation: example

- Instead, the use of individual air source heat pumps for each flat, would be a better option for this scheme and the one with the highest initial carbon savings – only in Phase 1
- The use of heat pumps in the first phase would not be an adequate solution as it will reduce the number of heat customers and reduce the viability of a site wide DH area supplying the complete development

Policy interpretation: example 1

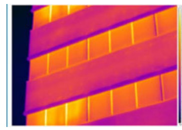
- Use of a site wide heat network powered by a renewable source of heat should be the solution adopted as this will allow for the maximisation of the uptake of renewable energy not only for this scheme but also across the LA if we extrapolate this example to other schemes in the LA
- Policies should therefore be written and enforced to ensure that short terms objectives do not conflict with long time aspirations

Policy interpretation: example 2

- Instead of apartments, the development consists of 1,000 houses, the use of DH is unlike to be viable due to the low heat density.
- In such an development, the use of GSHP with some component of solar energy would result in an acceptable approach.

Addressing the existing building stock

- Relative to new build, the retrofitting of buildings can contribute to a greater carbon mitigation
- Fundamental that efforts are also put to address the existing building stock
- The refurbishment of large estates means LA could request high level of energy standards and to even request the same SUEP as for new build

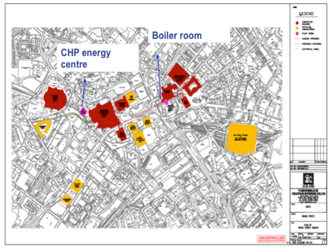


100mm thick insulating panels are applied directly to the flat's exterior wall

Addressing the existing building stock

- In areas with sufficient heat density, policies could be developed to create synergies between existing and new build that encourage the development of heat network
- May be difficult to achieve in practice (with the planning power alone) could be easier when considering the LA owned building stock

Broad Street DH scheme



Birmingham city centre DH scheme

Cross section policies

- SUEP policies should be created with other LA strategies and policies in mind, e.g. the use of waste as an energy fuel is of a great potential
  - Cross policies should be included as part of both energy and waste strategies to maximise the potential of using waste as a source of energy
  - A policy requesting new waste treatment facilities, where viable, to generate heat and power could result useful
  - Such policies may require that waste facilities are located closer to heat customers and hence populated areas
  - In developing such policies, be careful to engage with other departments in the LA as there may arise other issues such as health and safety, etc.

Summary of do and don'ts

- Policies should be written supported with evidence base studies
- Policies should be written without being in conflict with national regulations requirements
- Policies should not be written thinking in short term results
- They should be drafted to shape the manner in which energy infrastructure will evolve and will allow the medium and long-term transition towards zero carbon energy supply

- Sustainable Development

Enforcing SUEP policies for new build development
Assessing planning applications

Basis for assessing the energy aspects of planning applications

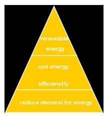
- Energy should be an integral element to all planning applications
- An energy strategy should be required as part of a planning application
  - new/refurbished, domestic/commercial/industrial, large small…
- The principles in the energy strategy should be compatible with the LA energy long term vision
  - e.g. in an potential DH area, buildings should be designed to be able to connect to a DH scheme
- SUEP policies should be used as the basis for the assessment of energy proposals of planning applications

Basis for assessing the energy aspects of planning applications

- The energy strategy should set-out commitments that will be used to guide the design of the proposed development during the detailed design stages
- The LA should secure the accepted strategies using section 106 agreement or adequate planning conditions, e.g. energy infrastructure
- Monitoring at post-construction stage is fundamental

Content of energy strategies

- Energy strategies should include:
  - a description of the development,
    - *number and type of residential units, e.g. 250 flats and 50 houses*
    - *Floor area and type of non-domestic spaces*
  - executive summary that sets-out and commits to the key measures and carbon reduction targets as part of the planning applications
  - Main body of the report following a strategy based on the following hierarchy
    - *Reducing the demand for energy*
    - *Supplying energy efficiently with DH where viable*
    - *Use of renewable energy sources*



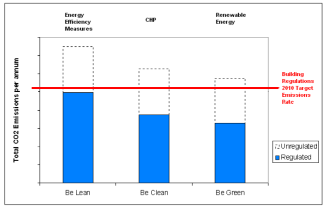
Content of energy strategies

- Bear in mind that as national building regulations strengthen, the role of LA in assessing certain elements of energy strategies will be less relevant, e.g.
  - High standards of energy efficiency are already required within national building codes so there would be little benefit putting too much effort into it

The planning process for new planning applications should focus on achieving those aspects that are not already covered by national regulations and that are important for the LA vision, *e.g. developing adequate local energy infrastructure*

Structure of energy strategies

- The following hierarchy should be adopted:
  1. Set-up a baseline scenario that complies with minimum nationals requirements for carbon emissions
  2. Investigate, where viable, the potential for demand reduction and energy efficiency measures to reduce the demand for energy below the baseline scenario
  3. Investigate the potential for using DH including and assessment of the heat density of the proposed development
  4. Investigate the use of renewable energy sources to supply the development



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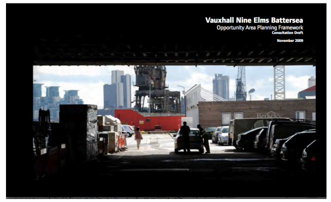
Structure of energy strategies

- For new development coming forward in strategic areas e.g. new urban extensions or AAP, for which energy master plans have been developed, the energy strategy should in agreement with the master plan principles



An energy master plan has been developed in support for the OAPF for the Vauxhall Nine Elms Battersea Opportunity Area

All new development in the area needs to adhere to the principles of the energy master plan

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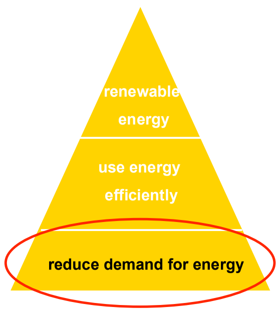
Demand reduction and energy efficiency

- Reducing heating demand
  - Use of solar passive energy, super insulated buildings, air tight facades, etc...
- Reducing electricity demand
  - Access to natural daylighting, energy efficient lighting systems and lighting controls, energy efficient appliances, etc



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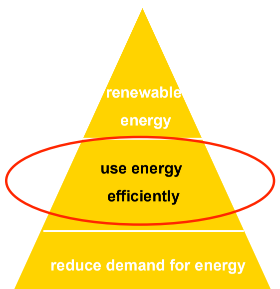
Use energy efficiently – Investigation of DH

- Where a DH network exist in the area the strategy should investigate the viability of connecting to it
- If there is no a DH network in the area, but this is planned, the proposed development should be designed to be able to connect in the future
  - future proofing



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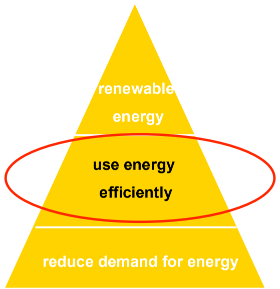
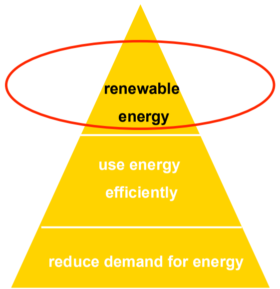
Use energy efficiently – Investigation of DH

- Where multiple buildings are proposed and the heat density is sufficient, a DH network should be adopted to serve the proposed development that where viable:
  - Uses a single energy centre
  - It is supplied with low and renewable energy sources, e.g. combined heat and power, solar thermal, etc



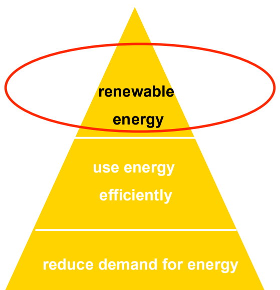
Renewable energy

- Investigate the potential for using renewable energy sources
- The renewable options examined should be technically compatible with the former elements of the energy hierarchy e.g.
  - *The proposed renewable energy technologies should be compatible with the proposed district heating networks*



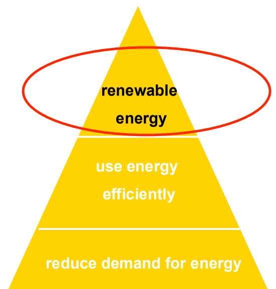
Renewable energy

- Practicalities arising from using the different renewable technologies need to be dealt with in the energy strategy
  - Biomass
    - *Air quality implications, origin of biomass, etc*
  - Solar energy
    - *Roof available, etc*
  - Wind energy
    - *estimation of wind resource, location of wind turbines*
  - Ground source heat pump
    - *Land area available for boreholes, ground conditions, etc*



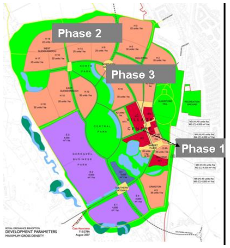
Renewable energy

- Use of allowable solutions could be permitted to compensate for smaller carbon savings achieved in new build developments where real constraints exist
- This would include for instance:
  - Achieving carbon savings by investment in renewable energy offsite
  - Contributing to carbon funds for energy infrastructure, e.g. heat networks elsewhere



Securing energy strategies

- The level of detail that an energy strategy should contain will be different depending the type of application
  - outline planning applications
  - detailed planning applications



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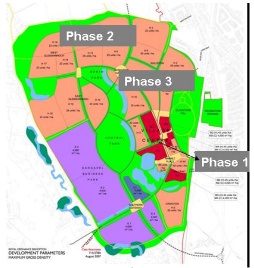
Securing energy strategies

Outline planning applications

- At the outline planning stage not much is always known about the details of the development
- What should be known is the type of buildings to be built and in some situations the phasing of works, e.g.
  - Phase 1: 250 apartments and hotel
  - Phase 2: 350 apartment, 100 houses and office space
  - Phase 3: 400 apartments and community center



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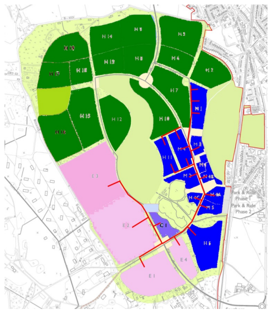
Securing energy strategies

Outline planning applications

- The energy strategy for large phased developments should include the fundamental commitments as accepted by the LA in relation to the energy infrastructure

- E.g. if DH is suitable, 106 agreements or planning conditions will be essential to retain the key energy infrastructre, e.g
  - Site wide heat network
  - space for future energy centre to supply the heat network



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Securing energy strategies

Example of planning condition for an outline planning application:
Mix used development with 1000 apartments, office block and hotel

- A heating network supplying all apartments and non-domestic spaces within the [name] development shall be installed and sized to the heating requirements of the [name development], and shall have the following characteristics:
  - It shall be operational prior to the occupation of the [yyy]th apartment and shall thereafter serve all spaces within the [name] development
  - It shall be supplied with heat from either an external district heating system or by heat generating plant installed in a single energy centre located within the [name] development

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Securing energy strategies

Detailed planning application

- Detailed planning applications contain a much greater level of detail
- Usually include detailed drawings
- Drawings accompanying energy strategies should include details for the different systems of the energy strategy:
  - Locations and space for the energy centre if applicable
  - Amount of roof available for solar
  - Storage and delivery strategies for the biomass if applicable
  - Etc
- When enough details are provided, the use of planning conditions or 106 agreements will be less relevant than it is the case for outline applications

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Day to day implementation of SUEP – pitfalls and difficulties

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<u>Pitfalls</u> in the day to day implementation of SUEP

- Developers using ambiguous text in the energy strategy
  - Can allow the developer to step back from perceived commitments
- Developers relating savings to old Building Regulations
- Developers adopting a building by building approach rather than an integrated site wide strategy
- Conditioning further feasibility work at a later date
  - Can let the developer off the hook

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<u>Difficulties</u> in the day to day implementation of SUEP

- Demonstrating savings over and above those that occur anyway
  - High levels of carbon reductions are required under 2010 Building Regulations
- Is there a realistic chance that the development will be able to connect into a wider network?
  - If not, will it be large enough to justify its own low carbon energy source?
    - *CHP can be too complex for many smaller schemes*
- Air quality considerations can limit the potential for some low carbon sources, e.g. biomass boilers, on all but the largest schemes

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Difficulties in the day to day implementation of SUEP

- Monitoring the general implementation of commitments

- Ensuring commitments to high levels of performance through energy efficiency alone are implemented
  - *CHP and renewables are highly visible*
    - Its obvious if the technology has not been implemented

What is Sustainable Urban Energy Planning - SUEP? A reminder

- Sustainable Development

By sustainable we mean…

- <u>Consistent</u>
  - Short term actions should be compatible with long term objectives
- <u>Renewable</u>
  - It should be driven by renewable sources
- <u>Diverse</u>
  - The more diverse a system is the more flexible it is to respond to changes
- <u>Comprehensive</u>
  - The value of the elements of the system is evaluated according to benefits of the individual parts and of the system as a whole
- <u>Interconnected</u>
  - Each of the elements of the system relies on and sustains several other elements

The definition we gave for SUEP

- A SUEP encompass a series of strategies, planning policies and enabling mechanisms with the following objectives:
  - Minimize the need/demand for energy
  - Maximize the use of low carbon, surplus (residual) energy and renewable energy sources
  - Ensure good quality, secure supply and affordable energy for all
- An integrated approach to SUEP should consider *economical, environmental* and *social* factors
- SUEP will work at a number of different scales:
  - Town and cities, districts, boroughs and neighborhoods, etc

The characteristics of SUEP

- Considers all energy sources, energy users and other energy related activates as a whole
- Includes environmental and social costs in the analysis
- Uses carbon mitigation as a key factor in the decision making process
- Is focused on the need for energy services rather than on what energy can be supplied, *e.g. need to keep buildings warm, need for lighting, need for drying, etc.*
- Gives priority to the demand side before considering the supply options, *i.e demand reduction and energy efficient measures are first*
- Is flexible enough to anticipate and respond to changes

The benefits of SUEP

- Setting the framework for a long term strategic plan and vision
  - Where are we now?
  - Where do we want to get?
  - How can we get there?
- Achieving environmental – carbon reduction - targets
- Enhancing security and quality of energy supply
- Providing affordable energy
- Obtaining economical savings
- Identifying synergies that the individual project by project approach would have missed e.g. waste to energy, use of waste/surplus heat, etc

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Liaising with developers for new build developments

- Sustainable Development

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The issues

- LA will face different type of developers
  - Private property developers, public sector developers and local authorities themselves
- Developers will often:
  - face financial concerns
  - try to only comply with minimum national requirements
  - Be reactive to non-conventional approaches – they are not used to
    - *district heating and renewable technologies*
    - *communal management of energy facilities*

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How strong can policies be enforced?

- The extent to which a LA can/is willing to push for energy aspects of new build developments is dependent on different factors
- The attitude of the political leaders at the time may or not may not justify to advise rejection of a planning application based on energy grounds
- Also, the economical situation at the time, will influence when deciding how strong to push for certain elements of planning implications with a significant cost burden

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How strong can policies be enforced?

- Also, the willingness of developers to comply with demanding aspects of planning policy will vary depending on where the development is located:
  - when the development is located in an attractive area, e.g. city centre of London, there will be many developers keen to bring forward the development despite of the local planning requirements
  - when there is little interest to develop a certain area, e.g. little commercial value, it might be required to loose out certain elements of the planning process, e.g. energy issues, to attract the interest of developers

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Role of case officer planners

- Planning case officers within the LA should engage with developers as early in the process as possible to facilitate the interchange of information early on in the process
- For strategic and large applications pre-application meetings should occur to set the basis of what the LA wish to take out of the planning process

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Role of case officer planners

- The LA should adopt a proactive engagement versus reactive attitude
- In liaising with developers the planning case officers should demonstrate the benefits that following an integral approach to energy has relative to a building a building approach
  - *Easier compliance with carbon savings*
  - *Affordable energy*
  - *Security of supply*
  - *Cost effectiveness*
  - *etc*

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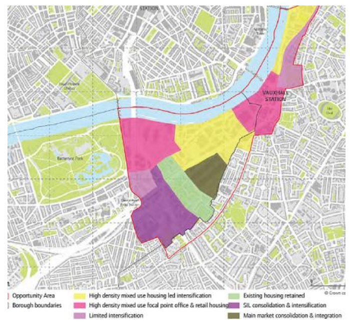
Engaging with developers for key schemes

- For planned large urban extensions and regeneration areas it is likely that more than one developer will be involved
- For such developments a masterplan coordinated by the LA, inclusive of energy issues, should ideally be developed, that provides energy recommendations
- Such documents and studies can be commissioned to experienced consultants and are will be useful to understand and communicate the vision for the area



Land use strategy for Vauxhall Nine Elms Battersea Opportunity Area

Source: Vauxhall Nine Elms Battersea Opportunity Area Planning Framework. Consultation Draft.

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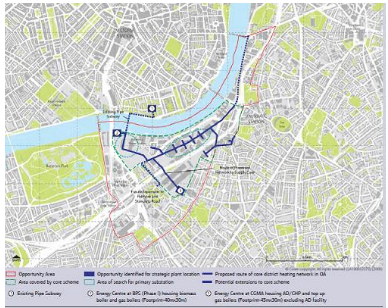
Engaging with developers for key schemes

- An energy focused steering group involving all key stakeholders (LAs and developers) should be set-up as early in the process as possible
- The objective is to engage all stakeholders with the energy objectives emerging for the area energy master plan and with the LA SUEP policies



Conceptual map showing proposed DH network and energy centre for core scheme.

Source: Vauxhall Nine Elms Battersea Opportunity Area Planning Framework. Consultation Draft.

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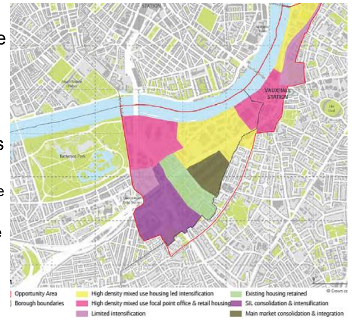
Engaging with developers for key schemes

- However, in reality, achieving that all private developers in the area adhere to such vision will be a much more complicated objective
- Developers will often raise objections such as:
  - Why should I allow the energy centre to be on my site?
  - How and who would cover the costs of the initial infrastructure?
  - Who will take the lead in organizing the meeting?
  - etc



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Source: Vauxhall Nine Elms Battersea Opportunity Area Planning Framework. Consultation Draft.

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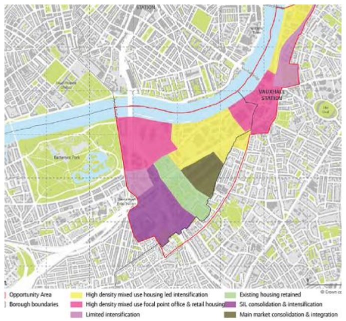
Engaging with developers for key schemes

- Normally it will be easier to start delivering area wide DH scheme using LA owned buildings as anchor loads to first attract the interest of an ESCO
- Also, if the LA owns the land it will be easier to find adequate land for the energy centre and to create the case for a commercial ESCO to develop the scheme forward
- Once a DH scheme is on place it will be easier to let the ESCO to attract new customers



Land use strategy for Vauxhall Nine Elms Battersea Opportunity Area

Source: Vauxhall Nine Elms Battersea Opportunity Area Planning Framework. Consultation Draft.

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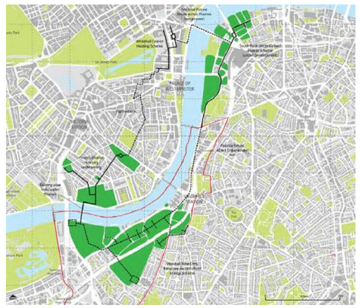
Engaging with developers for key schemes

- The energy masterplan recommendations should include:
  - Allocation of space for the energy centre/s
  - Safeguarding route for heat networks
  - Site allocation for relevant infrastructure, e.g.
    - *Delivery of biomass, locations for wind turbines, waste to energy facilities, etc*



Map showing strategic concept in relation to adjacent DH networks (existing and planned)

Source: Vauxhall Nine Elms Battersea Opportunity Area Planning Framework. Consultation Draft.

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Liaison with developers - Summary

- Engage with developers as early in the process as possible
  - Start with meetings at the pre-application stage
  - For large regeneration areas set-up energy focused steering groups at the earlier stages
- Be sympathetic with developer concerns and the circumstances at each time but be firm on what the LA want to achieve
  - Robust energy policies should be developed first

Liaison with developers - Summary

- Proactive engagement is more effective reactive attitude
- Demonstrate the benefits to be gained from using an integral approach to energy as opposite to a building by building approach:
  - *Easier and more cost effective compliance with carbon reduction targets*
  - *Providing affordable energy*
  - *Ensuring security of supply*
- Support discussions with technical base evidences
  - Energy masterplans, renewable source assessments, etc

Liaising with developers WORKSHOP

- Sustainable Development

Heat sources for DH

Sustainable Development

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Some preliminary notes

- Distinguish between resource and the technology
- Decide how best the resource can be used
- DH can use heat sources that are not suited to supply individual buildings
  - Including low carbon, residual and renewable heat
  - e.g. waste to energy technologies, biomass CHP, waste heat from industrial process, etc.

Biomass resource

Biomass boiler and CHP engine

Some preliminary notes

- This presentation sets out the potential of using a range of heat sources for DH and implications for planning that arise form their use
- For a more detail technical review please refer to the information package

Biomass resource

Biomass boiler and CHP engine

Some definitions

- Low carbon heat : heat that is being delivered with a lower carbon content than conventional sources, e.g. gas boiler.
- Residual heat : e.g. by-product heat of industrial processes, biomass from the maintenance of woodlands, etc.
- Renewable heat : sources that can be replenished at the same rate at which they are being used, e.g. solar, wind, biomass when sustainably sourced, etc…

Tate & Lyle Thames Sugar Refinery at Silverton London

The process undertaken has a surplus of circa 20 MW heat

Large solar thermal collector field supplying a DH scheme, Marstal, Denmark

Heat sources available

- Where existing DH networks exist the best solution is almost certainly to negotiate a connection to the existing network
  - e.g. 500 new flats in the vicinity of existing DH network
  - LAs should be aware of DH in their areas and request developments connect to DH networks where feasible
  - Heat maps could be used that include existing and planned DH network
- In areas where an existing source of low cost heat exist, use of this should be investigated
  - e.g. sources of residual heat
- Where neither existing DH networks nor local low cost heat is available/feasible new heating plant needs to be planned
  - e.g. biomass, solar thermal, waste to energy, etc.

Heat supply sources for DH


Existing DH scheme


Residual (waste heat)
Industrial waste heat recovery


New heating plant
Aberdeen -CHP
- 1MW elect
- Circa 1.5MW heat


Renewable source
Biomass (boiler, CHP)


Heat recovery from power generation
Gothenburg –CHP
- 260 MW elec
- 300 MW heat


Renewable source
Solar plant, 20,000 m2
Marstal, Denmark.
Source: ARCON / ESTIF


Renewable source
Sheffield waste incineration plant
19 MWelec, 60 MW heat


Renewable source
Southampton geothermal

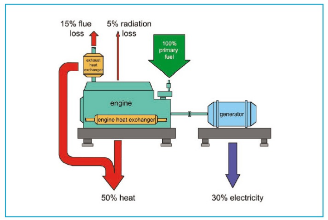
What is combined heat and power?

- In the UK the vast majority of electricity is generated remotely in very large power stations
- Only 30-50% of the energy content of the fuel is converted into useful electricity
- A similar amount of heat is normally rejected to the atmosphere


Condensing towers reject the by product heat of electricity generation to the atmosphere

What is combined heat and power?

- Combined heat and power refers to the simultaneous generation of heat and electricity
- For heat recovery, power plants should be located close to where a demand for heat exists
- CHP varies in scale, from a few kilowatts (micro CHP) to thousands of megawatts in power plants



CHP has higher efficiencies relative to conventional heat and electricity supply, i.e. less fuel is required to deliver a certain amount of energy

Source: GPG 388. Combined heat and power for buildings for buildings.

What is combined heat and power?

- Can be both:
  - Power plants that are originally constructed for electrical generation and from which waste heat is recovered, e.g. large power stations

Heat recovery from power generation
Gothenburg –CHP, 260 MW elec, 300 MW heat

  - Power plants that are specifically designed for simultaneous generation of heat and power
    - *Smaller range of plants, e.g. CHP engines supplying either individual buildings (hospitals) or DH networks serving mix-use developments*
    - *Such plants are used to supply a year round base heat load, e.g. domestic hot water*

New CHP engine plant Aberdeen -CHP
1MW elect, 1.5MW heat

What is combined heat and power?

- Different fuels and different scales:

1-1.5 MWe intenal combustion engine

Sheffield city wide DH scheme fired with heat from waste incineration

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Biomass

Biomass: the resource

Type of biomass

- Forestry materials
  - by-product of forestry activities
  - logs, thinning and tree maintenance, etc
- Energy crops
  - crop is grown for energy generation purposes
  - short rotation coppice willow or miscanthus
- Agricultural residues
  - crop residues such as straw
  - animal residue such as chicken litter
- Others
  - Industrial waste: recycled untreated timber from pallets and construction industry
  - Plant cuttings form parks, gardens, side roads, etc.

Biomass: the resource

Biomass fuel can be used as:

- Solid fuel
  - Woody biomass
    - *Logs, woodchips and pellets*
  - Animal residues
- Liquid fuel
  - Vegetable oil crops – bio fuel
- Gas fuel
  - A rich methane gas referred to as biogas can be obtained via the gasification of biomass (woodchips, animal residues, etc)

Pictures – example of solid biomass fuel - from top to bottom and right to left: woodchips, pellets, wood briquettes, biomass briquette made of compressed hay (Manufacturer: Ruf -Germany-. Picture source: Wikipedia)

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Biomass heat only boilers

- Boilers can burn biomass:
  - As raw material, e.g. straw
  - As processed fuel, e.g. chips, briquettes, pellets, biogas, liquid biofuel
- Proven technology
- Boilers can be operated in (almost) fully automatic mode
- Choice of boiler depends on site specific factors:
  - space available for biomass storage,
  - availability of local fuel supply
  - local air quality regulations

150 kW pellet boiler

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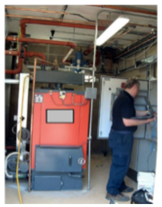
Biomass boilers vs. gas boilers

- Biomass boilers
  - generally have higher capital and maintenance costs
  - Require more space for boiler and for biomass storage
  - Fuel handling and delivery is more complicated though the process is highly automatic



150 kW pellet boiler

Three 70kW wall mounted gas boiler

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Biomass combined heat and power

Biomass can also be used to generate heat and power

- Large scale
  - Solid biomass fuel can be used to raise steam for steam turbines for the generation of heat and electricity similar to conventional power stations
  - Proven application
- Smaller scale,
  - internal combustion engines can be used that are driven by either solid, gaseous and liquid biomass fuels
  - Some examples in the UK, but operation over the long term not yet seen

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District Energy St. Paul, USA – biomass CHP

- Supplies heating to more than 187 buildings and 300 townhomes in the downtown Saint Paul area
- Hot water district heating delivered to customers year-round for space heating, domestic hot water and industrial process use
- Also provides cooling to 86 commercial buildings
- 32 km of heating pipes and 11km of cooling pipes
- Large biomass CHP plant is used to supply a large proportion of the heat requirement

Main energy centre -
Biomass (woodchips) 28.5 Mwe/65 MWth

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Planning for the use of biomass

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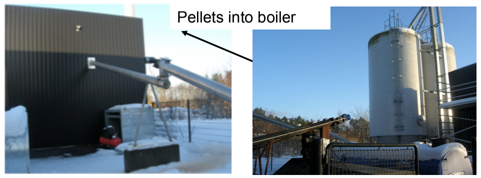
Delivery and handling of the biomass

- For the end user, the handling and delivery of the fuel for biomass applications is more complicated than conventional fuel , e.g gas, though nowadays the process is highly automatic
- As an example, below a biomass fired DH scheme of circa 2 MW boiler
- The fuel is automatically fed into the biomass boiler from the silo

Biomass boiler



Pellets into boiler

From silo into boiler

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Delivery and handling of the biomass

- The exhaust gases are filtered using cyclones to reduce the particulate matters emitted to the atmosphere
- Ashes are automatically deposited to an external bunker

To external ash collection bunker

Ash collection bunker

Ashes are automatically conveyed to an external bunker

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Availability of biomass supply

- When sustainably sourced, biomass can be considered a renewable fuel
- Sourcing of biomass feedstock should avoid damage to the environment and food supplies
- Biomass is a carbon neutral fuel
- There is however net CO_2 released due to use of fossil fuel in the processing and transportation of the fuel to the point of use.
- Hence where possible, locally sourced biomass should be used

Transportation of biomass using lorries

Availability of biomass supply

Croydon Tree Station

- One of the first sites in the UK where arboriculture arisings are being processed into fuel suitable for use in smaller wood chip boiler (since 2006)
- Circa 10,000 tonnes per year

Loading logs onto the chipper in-feed

Screened wood chip being discharged

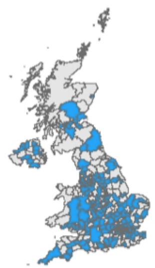
Source: Wood chip production from tree surgery s in Croydon. A case study by bioregional

Planning implications of biomass fuel

- New biomass installations require regulatory approval e.g. air quality and in many cases planning consent
- Implications include:
  - Visual impact
    - *Particularly for installations in greenbelt and areas of outstanding beauty, e.g. energy centre, chimney height, etc*
  - Transport
    - *Large biomass installations will require frequent lorry deliveries that may have local transport impacts*
  - Environmental issues – air quality
  - Noise
    - *Arising from plant operation and transportation of the biomass*

Biomass: Air quality implications

- The combustion of biomass has greater air quality implications than the use of natural gas
- In particular in relation to the emissions of NOx and particulate matter (PM)
- In response to National Air Quality regulations a number , local authorities have a duty to declare Air Quality Management Areas (AQM) in particular "contaminated areas"



Blue areas show LA declared AQM areas

Source: DEFRA website http://aqma.defra.gov.uk/maps.php Accessed Dec 2010

Biomass: Air quality implications

- In practice this means that biomass installations in AQM areas are unlikely to be permitted unless they are equipped with emissions abatement technologies

London Mayor's Air quality strategy:

- *"Strategic applications with small biomass boilers below 500kWth in AQMs are considered unsuitable unless they can demonstrate that they have no adverse effects on local air quality when compared with conventional gas fired boilers"*

The whole of London has been declared an AQM

Source: DEFRA website http://aqma.defra.gov.uk/maps.php Accessed Dec 2010

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Biomass: Air quality implications

- Such abatement technologies, for the smaller range of biomass boilers such as those supplying several hundred flats, can be prohibitively expensive
- Therefore, in AQM areas, biomass only heating schemes are likely to be limited to large installations - over the megawatt scale

Multi cyclone dedusters provide the removal of ash from the flue gas to prevent PM emissions.

Source: Thermo Energy Systems Inc. http://thermoenergy.ca/index.html

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Biomass: Air quality implications

- In summary:
  - Air quality implications of biomass applications should be dealt with by an qualified air quality officer
  - Assessment of biomass applications should follow a risk based approach:
    - *Where is the boiler?, i.e. if it affects areas of poor air quality a more detailed assessment of emissions is required including dispersion modeling*
    - *What is the fuel the biomass would replace? i.e. if it is coal or oil emissions can actually decrease*
    - *Estimation of boiler emissions, e.g. is it an exempt appliance?*
    - *Type of fuel used*

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Waste to energy

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Waste: the resource

- Waste is produced from everyday processes and activities
- General classification:
  - Industrial and agricultural waste
  - Construction and demolition waste
  - Municipal solid waste (MSW)
    - *waste generated in a community including residential, commercial and institutional waste.*
    - *solid or semi-solid in form and excludes industrial hazardous wastes*
    - *residual waste: waste left from household sources containing materials that have not been separated out or sent for reprocessing.*

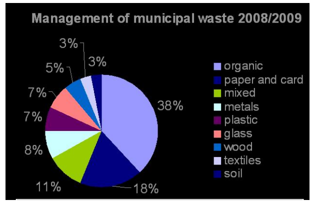
Demolition waste

Source: www.tophazardouswaste.com/demolitionwaste.php

Waste: the resource

Composition of MSW:

- Organic materials
  - biomass raw materials such as paper, card, green and food waste, wood, etc.
  - organic synthetic products based on fossil fuels such as plastics
- Inorganic – inert materials
  - construction and demolition waste, dirt, rocks and debris



MSW waste composition on London.

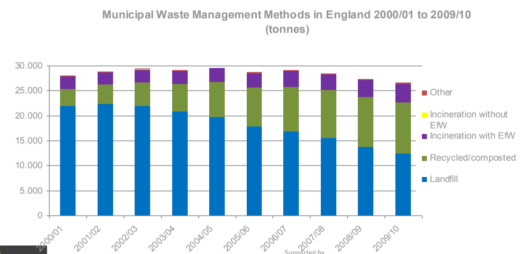
Adapted from The Mayors draft MSW management strategy. January 2010. GLA

Organics include food and green garden waste

Source: Defra statistics 2009. accessed Dec 2009

MSW – Background context

- Traditionally all MSW left after recycling and composting was diverted as untreated waste to landfill, but…
  - significant green house emissions due to methane release
  - high land costs
  - not a sustainable approach to the disposal of waste

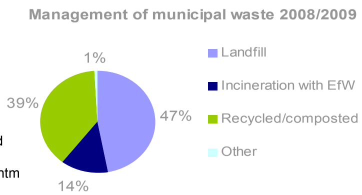


Source: Defra statistics for municipal solid waste. http://www.defra.gov.uk/evidence/statistics/environment/wastats/bulletin10.htm

Accessed Dec 2010.

MSW – Background context

- As a result of the European Landfill directive:
  - the UK amount of biodegradable material sent to landfill compared to 1995 levels shall be reduced by:
    - *75% by 2010,*
    - *50% by 2013*
    - *35% by 2020*



Source: Defra statistics for municipal solid waste. http://www.defra.gov.uk/evidence/statistics/environment/wastats/bulletin10.htm Accessed Dec 2010.

MSW – Background context

- Alternative ways to treat and dispose of MSW are required
- The role of LAs in developing adequate waste strategies and policies to achieve national objectives is fundamental
- This presentation describes some of the alternatives for the treatment and use of MSW

Sheffield city wide DH scheme fired with heat from waste incineration

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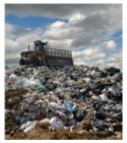
Waste to energy - MSW

- For the purpose of this presentation WtE or EfW refers to the conversion of MSW into energy by the means of:
  - thermal processes
    1. combustion (incineration) – established technology
    2. gasification and pyrolisis – advanced treatment technology (ATT) – no UK long term track record
  - biochemical process
    3. anaerobic digestion (AD) - established technology but not for all compositions/types of MSW



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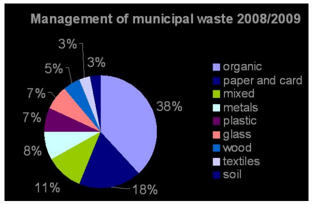
Waste to energy - MSW

- The biomass fraction in the MSW that is being burnt can be considered as a renewable energy source – non contributing to net carbon emissions
- Emissions arising from the thermal treatment of waste are regulated by the European Waste Incineration Directive (WID)



MSW waste composition on London.

Adapted from The Mayors draft MSW management strategy. January 2010. GLA

Organics include food and green garden waste

Source: Defra statistics 2009. accessed Dec 2009

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Waste Incineration

- Incineration of MSW
  - Combustion of waste in excess of air – temperatures can exceed 1000degC
  - Established technology
  - It can deal with unprepared and unsorted waste
  - Any non-combustible material (metal, glass) remains as solid after the combustion process –*solid ash*

Sheffield city wide DH scheme fired with heat from waste incineration

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Waste incineration – not in my back yard

- Incineration of MSW
  - Waste incineration is widely used throughout Europe and worldwide
  - Denmark burns its 54% of its waste in heat and power stations
    - *Circa 30% of the heat supplying the Copenhagen city wide DH network uses waste incineration as the primary energy*
  - In England, in 2008, 14% of MSW was incinerated with some form of energy recovery (electricity only or heat and electricity)

The H. C. Ørsted and Avedøre power stations in Copenhagen

Photo: askeholst on Flickr

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Waste incineration – not in my back yard

Heat produced during the incineration of MSW is used to generate steam to drive a steam turbine producing 19 MW of electricity.

60 MW of residual waste is recovered and distributed to over 150 buildings across Sheffield

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"While it is not possible to rule out adverse health effects from modern, well regulated municipal waste incinerators with complete certainty, any potential damage to the health of those living close-by is likely to be very small, if detectable. This view is based on detailed assessments of the effects of air pollutants on health and on the fact that modern and well managed municipal waste incinerators make only a very small contribution to local concentrations of air pollutants"

Source: The Impact on Health of Emissions to Air from Municipal Waste Incinerators. Health Protection Agency. Sep 2009

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State of ATT in the UK

- ATT refers to Advance treatment Technologies.
- They include the use of gasification/pyroliss technologies to obtain of a syngas for its posterior use for the generation of heat and power
- A track record of ATT in the UK does not exist but some installations exist elsewhere
- It is out of the scope of this course to go into more detail but further information can be found in the IP

Location of ENERGOS gasification plants.

Source: Energos, part of the ENER-G Group

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Planning for the use of waste as an energy source

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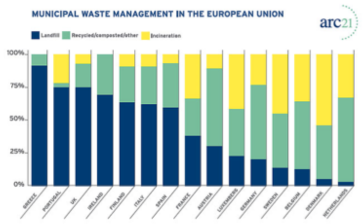
Recycling and composting vs WtE?

- European experiences show that the waste to energy technologies can be implemented alongside high levels of recycling and composting
- WtE should be introduced downstream of the recycling chain



MSW management in the EU

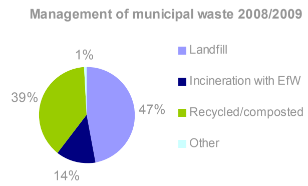
Switzerland:50% recycle and 50% to EfW

Sweden: 48% recycle and 47% to EfW

Source: Arc 21. www.arc21.org.uk

Drivers for waste to energy in the UK

- Landfill Directive
  - the amount of biodegradable material to be landfilled compared to 1995 levels shall be reduced to 35% by 2020,
- Higher cost of land for landfill
- Contributing to renewable energy target – biomass fraction of waste
- WtE is starting to be perceived as a common sense / economical approach to the disposal of waste

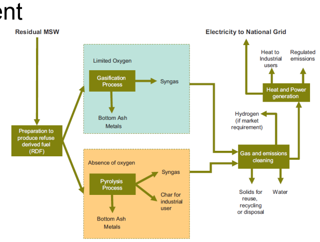


Source: Defra statistics for municipal solid waste. http://www.defra.gov.uk/evidence/statistics/environment/wastats/bulletin10.htm Accessed Dec 2010.

Integrated waste management

A holistic approach to waste should consider integrated waste management technologies:

1. Waste reception, handling and pre-treatment
2. Thermal/biological treatment
3. Energy recovery
4. Clean-up of emissions



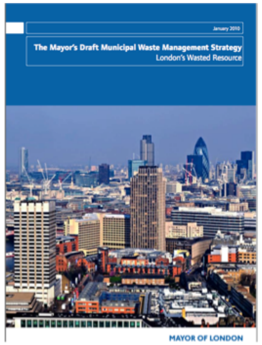
Need to plan for waste to energy

- Waste to energy technologies are only part of the solution
- An integral waste management strategy should aim to:
  - minimise generation of waste
  - maximise the reutilisation / recycling of the fraction of the waste that can not be transformed to energy
  - maximize the generation of heat and power from waste
- As a result, the amount of waste diverted to landfill is minimised

reduce | **reuse** | **recycle, compost** | **energy recovery** | landfill

Planning for a waste management strategy

- Can be seen as a burden, but offers LAs an opportunity to develop waste management strategies that contribute to the fulfillment of renewable energy and carbon mitigation objectives
- Coordinated waste and energy policies are required
- When planning for new waste to energy installations both regulatory approval i.e. emissions, and planning consent will be required



Planning for a waste management strategy

Locating WtE facilities (1)

- Seems reasonable to locate ATT in areas previously used for industrial purposes
- Good transport infrastructure – frequent traffic of heavy vehicles required for waste delivery
- But other factors should be considered to maximise waste to energy synergies

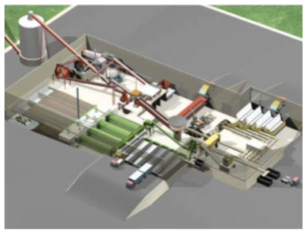

Industrial Estate in North London

Photogrpaher: Sandy Stockwell © Skyscan/Corbis

Planning for a waste management strategy

Locating WtE facilities (2)

- Areas adjacent to existing waste treatment plants – *to create fully integrated waste management facilities* including delivery and treatment of waste and energy generation and distribution


Artist impression of waste management facility

- An MBT plant processes the residual waste to break up and separate into 3 streams: 1. metal, glass and plastic, 2. organic material and 3. stabilised landfill
- The organic fraction is treated in an anaerobic digestor to produce biogas which can produce electricity to run the plant and supply the national grid as well as to produce the required heat for the process and distribution to heat customers
- Source: www.eclipse.co.uk/exeter/burner/alternative.htm

Planning for a waste management strategy

Locating WtE facilities (3)

- To facilitate the export of power and use of residual heat WtE facilities might need to be brought closer to urban/populated areas
- An impact assessment will be required that includes air quality, dust and odour, noise, visual intrusion, public concern, etc


Planning permission has been secured for a 120,000 tonnes a year energy recovery facility in the London Sustainable Industries Park in Dagenham, East London

The facility will process non-recyclable, commercial and industrial residual waste streams using gasification technology generating 15 MWe/64 MWth, equivalent of powering 31,500 homes.

Heat will also be available to future occupiers of the Park

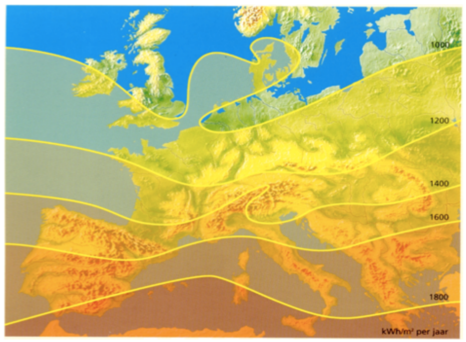
Planning for a waste management strategy

Benefits of a municipal waste management strategy

- Reducing amount of waste
- Reusing and recycling of existing waste materials
- Increasing flexibility and security of energy supply
- Reducing greenhouse emissions
  - when using the organic fraction of waste as fuel
  - avoiding emissions from landfill
- Achieving economical savings

Solar thermal

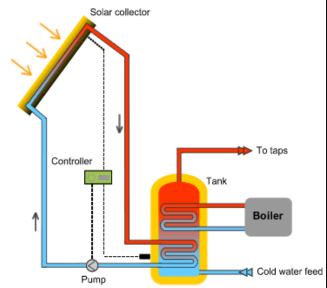
Solar - Resource



Annual solar energy on horizontal plane kWh/m2
Source: Ubbink Nederland

Solar thermal

- The majority of UK installations consist on solar thermal systems installed at individual buildings to provide DHW
- The collected heat is used to increase the temperature of water in a storage tank



Solar Trade Association Ltd

Solar thermal

- During the summer months, solar thermal can often heat the water to the required temperature without the need of top up boilers – no fuel costs
- Over a year a typical system can provide around 50% of the hot water requirements of a house

Roof integrated flat plate solar thermal collector for DHW generation

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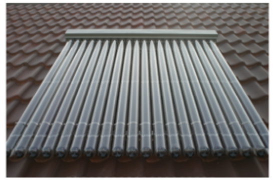
Solar thermal

- Solar thermal district heating in the UK is negligible
- Large examples exist in Scandinavia
- Potential applications
  - small schemes serving a block or group of dwellings
  - large district heating schemes serving large developments



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Small (communal) solar thermal DH schemes

- Collectors integrated with the building roof supplying a block/s of flats
  - Hot water or
  - Space heating plus hot water

Solar thermal district heating for PassivHouses

Source:. Ritter Solar / ESTIF

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Larger solar DH schemes

- Ground mounted collector fields supplying a large DH scheme
- They require significant areas of land but…
- …can be roof mounted installations feeding an urban DH scheme

District heating solar plant, 20,000 m2. Marstal, Denmark

Source:ARCON / ESTIF

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Larger solar DH schemes

- Solar thermal collectors can also be integrated in roofs and supply an area wide DH network

Evacuated tube collectors mounted at a building but supplying heat to the area wide heat network

Source: BRE

Planning implications

- Building mounted installations
  - For the vast majority, a planning application is not required although it is good practice to consult the planning authorities
    - *E.g. panels should not protrude more than 200 mm*
  - For special designs, conservation areas and for listed buildings, planning permission might be required
  - Accredited installer should ensure reliability of installation, e.g. roof loads
- Ground mounted collector fields
  - Such applications do not exist in the UK but the potential exists
  - There are constraint that include
    - *land requirements*
    - *cost of land*
  - Planning application required as they are major installations

Marstal solar thermal DH plant, Denmark

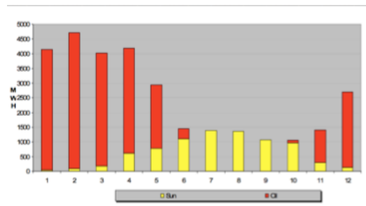
- Constructed between 1996 and 2003
- 1994 circa 9,000 m2 connected to DH network
- 2003 expanded to over 18,000 m2, circa 13 MW thermal
- 18 MW back/top-up waste oil boilers
- Provides hot water and space heating to over 1,400 customers

Source:SUNSTORE 4. Project no. 249800. Rev 26.02.2010 WWW.solarmarstal.dk

Marstal solar thermal DH plant, Denmark

Measured data:

- Solar plant nearly 100% of demand in 3 summer months
- 28% of total DH network heat demand (2007-2008)
- 2 to 3 kWh electricity to produce 1 MWh solar heat

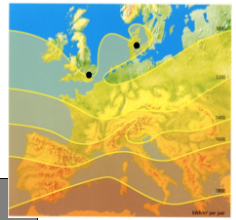


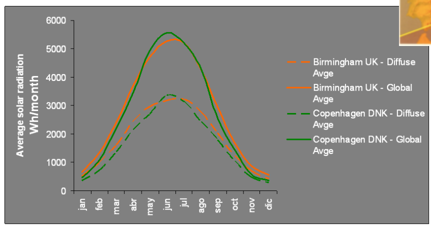
Marstal solar thermal DH performance for 2006

Source:SUNSTORE 4. Project no. 249800. Rev 26.02.2010 WWW.solarmarstal.dk

Is solar thermal DH possible in UK?

- Solar radiation levels in Denmark and UK are similar
- Denmark has a number of examples of solar thermal DH
- From a resource point of view the UK could do the same





Source weather data:
energyplus weather data.

Is solar thermal DH possible in UK?

- There will be situations where the use of renewable DH technologies is limited, e.g.
  - Biomass use is restricted due to air quality issues
  - New developments consisting of scattered block of flats among houses for which a site wide heat network is not viable
    - *This means site wide CHP is not viable neither*
- For these situations the use of solar thermal DH can offer an alternative, e.g.
  - new build low rise block of flats
  - retrofitting existing block heating schemes where sufficient roof area/land exist for solar collectors field

Solar thermal district heating for PassivHouses

Source:. Ritter Solar / ESTIF

Is solar thermal DH possible in UK?

But:
- Little UK experience with technology
- Use of solar thermal increases capital costs of investment
- Significant cost issues for land for ground mounted fields

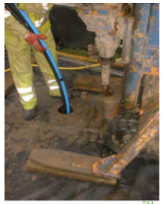
Solar thermal district heating for PassivHouses

Source:. Ritter Solar / ESTIF

Other heating sources for DH

Heat pumps in DH

- Using heat pumps to provide district heating serving blocks of flats or even larger DH systems is technically viable
- However, there are practical difficulties for the integration of heat pumps in DH networks, i.e. poor performance for generating the temperatures required for hot water



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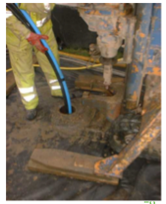
Heat pumps in DH

- Advances in heat pump technology have produced pumps that use carbon dioxide as a refrigerant
- It is claimed that they are able to operate more efficiently when producing higher temperature outputs, i.e. DHW
- However, within the UK, applications are limited to a few installations and they supply individual buildings
- More research is required to further understand the role of using heat pumps for DH in the UK context



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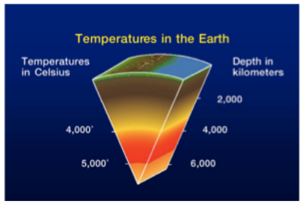
Geothermal energy

- Geothermal energy available in the form of heat stored in the Earths core
- This energy is not the same as that upgraded by ground source heat pumps
  - *GSHPs take advantage of the heat close to earth's surface that has been heated by the sun*
- The temperature of the earth increases closer to its centre
- To exploit geothermal energy deep boreholes (1km or more) are required
- Geothermal energy is not always available at viable depths to justify exploitation of the resource



Temperatures in the earth.

Source: © 2000 Geothermal Office

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Geothermal energy

- Geothermal energy can be used to generate heat and power
- Reykjavik Municipal District Heating Service
  - It supplies heat to the majority of Reykjavik area (circa 170,000 people, 53% of Icelandic populations9)
  - 140 MWth peak requirements
  - Main source:
    - *Water heated with geothermal energy in a remote geothermal plant is distributed using a transmission network of circa 27 km*

Blue Lagoon in Iceland heated with geothermal heat with a geothermal power station behind

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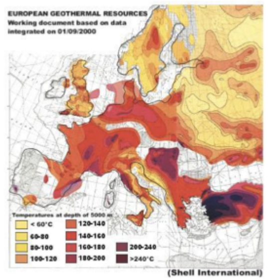
Geothermal energy – in the UK

- In the UK, studies have been undertaken looking at the geothermal resource
- The geothermal resource in the UK exists but installations are very limited with only once commercial plant in operation



Europe geothermal resource showing earth temperatures at 5000 m

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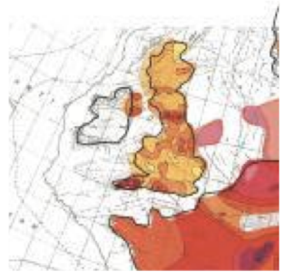
Geothermal energy – in the UK

- A government funded project has been given planning permission to develop the first deep geothermal power plant in Cornwall
- Plans include:
  - drilling 4.5 km to access 200 deg hot rocks
  - wate pumped into injection holes will recover the heat
  - Circa 55MW heat and 10MW elec
  - Works expected to commence early 2011



Europe geothermal resource showing earth temperatures at 5000 m

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Geothermal Southampton – case study

- Southampton is located just above a geothermal energy source in the form of hot water at 74degC at 1.7 km beneath the city – only heat production
- This source of geothermal energy was the catalyst for a city wide DH network and currently supplies 15% of the heat
- The rest of of the heat and cooling is supplied by CHP and absorption chillers

Geothermal scheme supplying part of the Southampton city centre DH scheme serving public, commercial and domestic buildings

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Summary

- There exist a wide range of available sources of residual and renewable heat sources
- The use of heat networks is fundamental to successfully exploit such sources
- Large carbon savings can be realised if opportunities are used to convert these sources into useful heat
- The role of LAs in delivering district heating networks needs to be part of the strategy to mitigate carbon emissions
- The next presentations look at in more detail at the issues around the integration of residual and renewable energy sources into DH networks

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Integration of residual and renewable energy sources into district heating networks

- Sustainable Development

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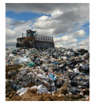
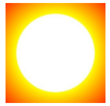
Opportunities for carbon free heat DH

- DH pipes simply transport hot water from an energy centre to consumers
- DH is therefore technology blind, i.e. it offers the opportunity to use residual and renewable heat and to deliver it in the form of heat to the end consumer
- The fuel flexibility that DH offers can be used to shift from initially fossil fuel fired DH to cleaner sources of heat when they become available




Reminder of some definitions

- By residual heat we refer to sources of heat that exist independently of them being used for heat generation purposes, e.g. by product heat of industrial processes, biomass from the maintenance of woodlands, etc.
- By renewable heat sources we refer to those sources that can be replenished at the same rate at which they are being used, e.g. solar, wind, biomass when sustainably sources, etc…

Tate & Lyle Thames Sugar Refinery at Silverton London

The process undertaken has a surplus of circa 20 MW heat

Large solar thermal collector field supplying a DH scheme, Marstal, Denmark

Extent of renewable DH in the UK

- The share of DH in the UK is very small, less than 2% of the overall heat demand
- Notable DH schemes exist that serve city centres but the number and the type of DH schemes in the UK is limited
- Although some of these schemes are fired with renewable energy, the majority are based on the use of fossil fuels





Extent of renewable DH in the UK

- The largest UK city-wide DH networks are fuelled with waste incineration plants
- Smaller schemes serving city centres exist that use gas fired CHP engines and biomass boilers
- There is one scheme in the UK uses geothermal energy (Southampton)

Locatio	Fuel	Technology	Descr	Sales MWh
Sheffield	MSW	Waste to CHP	City-centre wide	Over 100,000
Nottigham	MSW	Waste to CHP	City-centre wide	Over 100,000
Lerwick	MSW	Waste to heat		Over 35,000
Southampton	Gas, geothermal	Aquifer water, CHP		
Barnsley	Biomass	boiler	Island schemes	

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Opportunities for residual/renewable heat DH in the UK

- DH share in the UK is likely to expand in the following manner:
  - Consolidation of existing large city centre schemes by increasing the number of customers they serve
  - Connection of smaller fossil fuel powered city centre island schemes to develop larger DH city wide networks
  - New smaller DH schemes serving new residential led mixed-use developments of over several hundred dwellings
- The opportunities for using residual and renewable heat to fire DH schemes needs to be seen within this context

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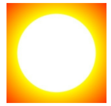

The applicability of a certain source/technology for DH depends, among other things, on the scale the scheme, e.g. biomass CHP is currently limited to very large DH

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Opportunities for WtE

- Existing DH schemes that use waste to energy for heat exist
- Where a waste plant exists or is planned, LA owned building stock and new large developments could be used as anchor loads to trigger the development of new DH schemes
- The availability of waste as a fuel was the catalyst for some of the largest UK DH schemes
  - e.g. Sheffield, Nottingham and Lerwick

The existence of a waste incineration plant was the catalyst for the Sheffield DH scheme, one of the largest in the UK.

Heat is recovered form the waste incineration process ant and distributed throughout the city

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Opportunities for residual waste

- In other situations where local sources of residual heat exist, the case for developing a new DH scheme would be favoured
- Again, LA owned building stock and large new build developments could be used as anchor loads for a new DH scheme

Tate & Lyle Thames Sugar Refinery at Silverton London

The process undertaken has a surplus of circa 20 MW heat

Plans exist to recover the residual heat to supply new development in the area

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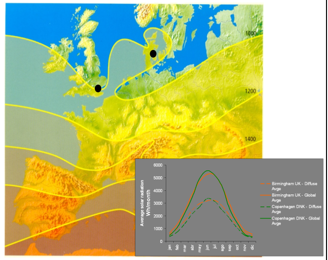
Opportunities for solar thermal

- The use of solar thermal DH to supply new build developments of several hundreds dwellings offers an opportunity yet to be exploited in the UK
- Experience of ST DH in the UK is limited but applications exist across Europe that could be replicated in the UK
- Solar radiation levels in the UK and Denmark are similar



Denmark has the largest share of ST DH. The solar resources of Denmark and England are similar.

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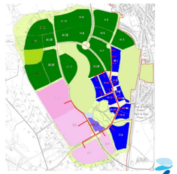
Opportunities for solar thermal

- Due to the cost of land, the use of solar thermal DH in urban locations is likely to be best suited to roof mounted installations
- Under this approach the solar collectors are mounted on the roof of the buildings providing heat to the site wide DH network



Solar thermal could be used to supply a proportion of the heat requirement of heat networks supplying new build developments

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Opportunities for solar thermal

- Where available land exists, larger ground mounted collectors could be used to supply large networks

Strandby District Heating, Denmark

Approx. 825 consumers

Pant consist of 8,000m2 of solar collectors plus gas fired CHP and top-up boilers.

Solar thermal supplies all hot water requirements in summer.

District heating solar plant, 20,000 m2. Marstal, Denmark

Source:ARCON / ESTIF

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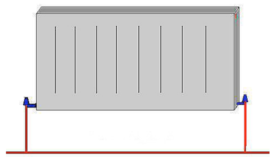
Increasing the availability of heat sources

- Traditional heating systems in the UK, e.g. radiators, have been designed to operate at high flow/return temperatures of 82º/71ºC
- This means that in order for such systems to perform adequately, water at high temperature is required
- This limits the availability of heat sources that could be used to supply useful heat to such buildings,
  - e.g. it will not be possible for hot water at 60ºC to adequately supply the heating requirements of such buildings



Conventional radiators are designed to deliver useful heat at temperatures of no less than 80degC

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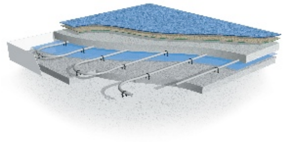
Increasing the availability of heat sources

- The use of heat sources for buildings with conventional heating systems are limited to those sources of heat that are able to deliver such high temperatures
- However, for new/retrofitted buildings, the use of heating systems that are designed to operate and deliver the required heat at lower temperatures is possible
  - e.g. use of low temperature under floor heating systems or larger radiators



Underfloor heating systems are able to deliver useful heat at about 40degC

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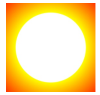
Increasing the availability of heat sources

- The use of lower temperature heating systems widens the range of heat sources that can be used to deliver useful heat to buildings, e.g.
  - use of low temperature residual heat from industrial processes
  - the utilisation of the solar resource can be maximised for those periods of the year in which the radiation is lower - as a greater amount of useful heat would be delivered if lower water temperatures can be used



LOW TEMPERATURE HEATING DISTRIBUTION SYSTEM

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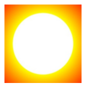
Issues around integrating renewable tehcnologies into DH

- DH offers the fuel and technology flexibility that is required to shift between different heat sources
- There are however technical issues involving the operation of different technologies at the same time
- This means that the use of renewable energy technologies in DH is not always straightforward



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Issues around integrating renewable tehcnologies into DH

- For large DH schemes, e.g. city wide schemes supplied with different heat sources, the use of renewable energy DH systems can work well as the wider heat network can act as a back-up in periods where this is required

Hillerod Forsyning uses a DH scheme to supply 15000 houses using 80% gas CCGT CHP, 4% gas boilers, 14% wood pellet boilers and 2% solar thermal fields.

Connected to the city wide heat network, a ground mounted solar thermal field of 3000 m2, is used as the lead heating source to serve 600 houses in Ullerødbyen.

When insufficient it uses heat from town-wide network.

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Issues around integrating renewable tehcnologies into DH

- For smaller schemes, in the order of several hundred homes, combining different technologies presents more challenges as:
  - Redundant plant is required to provide the heating requirements in periods when the renewable contribution is lower, e.g. solar resource is lower
  - The operation of simultaneous technologies at the same time is difficult, e.g. responsiveness of the plant is not always as quick as desired

The use of biomass boilers and solar thermal is in principle a sensible approach

In the heating seasons the biomass boiler provides the majority of the heating load with the solar thermal contributing when the solar resource is enough

In the summer seasons, when the solar resource is the highest, and the heating demand the lowest the solar can provide all or the majority of the hot water requirements

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Issues around integrating renewable technologies into DH

- The use of biomass boilers and solar thermal is in principle a sensible approach
- In the heating season the biomass boiler provides the majority of the heating load with the solar thermal contributing when the solar resource is enough
- In the summer season, when the solar resource is the highest, and the heating demand the lowest the solar can provide all or the majority of the hot water requirements

BUT

… the excessive solar thermal production in summer combined with the the slow responsiveness of large biomass boilers means that the biomass boiler can continue producing heat even when this is not required what would cause overheating of the system

In the summer season, the use of smaller biomass biomass boiler is required, to increase the responsiveness of the system

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Summary

- DH is technology blind, i.e. it offers the opportunity to use residual and renewable heat
- Although the share of DH in the UK is very small, notable large DH schemes exist that serve city centres
- Although the largest schemes use waste as a fuel the majority of other schemes use fossil fuel
- Opportunities exist for increasing the share of renewable DH by
  - shifting fossil fuel fired schemes to alternative energy sources, e.g. waste-to-energy and residual heat
  - develop new DH schemes using residual and renewable sources, e.g. solar thermal

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Summary

- The integration of renewable energy sources in large DH schemes supplied by several heat sources can work well as the wider heat network can act as a back-up in periods where this is required
- The use of renewable energy sources in smaller DH schemes, similar to the majority of UK DH schemes coming forward, presents technical challenges that require careful consideration:
  - The operating organisation needs to take responsibility of managing the system on the ground to ensure reliable and uninterrupted supply of heat for the customer, i.e. quality of service provided.
  - It needs to acknowledge that such systems need more engagement and day-to-day care than simpler systems such as individual gas and boilers.
  - It needs qualified staff to deal with the particularities of the technology. The system needs to be adapted to changes to ensure optimal operation.

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Experiences from integrating RES into DH Case studies

- Sustainable Development

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UK experience

- Sustainable Development

Extent of renewable DH in the UK

- Share of DH in the UK is very small, less than 2% of the heat demand
- Despite notable City DH schemes the number of DH schemes in the UK are limited
- Some schemes are fired with renewable energy, vast majority are based on the use of fossil fuels





Sheffield District Energy Scheme

- Source for the SDES is a waste Energy Recovery Facility (ERF).
- Heat produced during the incineration of Municipal Solid Waste - used to generate steam
- Steam drives steam turbine operating in combined heat and power (CHP) mode.
- The SDES is able to generate
  - 19 MW of electricity (equivalent of 22600 homes) and
  - 60 MW of heat that is distributed around Sheffield via a district heating network.

Sheffield District Energy Scheme

- In 2007 - supplying heat to over 140 buildings - over 100,000 MWh
- 79% of the heat was supplied by the “waste driven” steam turbine
- During periods where the ERF is down - gas and oil fired back-up boilers are used to supply heat to the district heating network

Sheffield waste to energy recovery facility

Various measures are taken to reduce various types of emissions. Cleaned gases are then released through the chimney. These gases are monitored to ensure they meet strict environmental regulations and legislation and do not represent a health risk.

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Other Waste to Energy schemes

- Nottingham DH scheme recovers heat and power from the combustion of waste
- Smaller scale – Lerwick - 8,500 people in the Shetland Island uses waste-to-Energy plant as its heat supply. No electricity is currently generated from it

The fact that a variety of business driven organisations take part in Waste To Energy (W2E) schemes shows that the investment in DH and W2E infrastructure pays off financially and has the potential to be implemented much more widely if people’s opposition to locating incinerators close to populated areas can be overcome

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Southampton District Energy Scheme

- Southampton is located above a geothermal energy source - hot water at 74°C at 1.7 km beneath the city
- Source of geothermal energy was catalyst for the SDES - now one of the largest district heating schemes in the UK
- Established in 1986 - instigated by Southampton City Council (SCC), with government collaboration and EU support.

Southampton District Energy

The geothermal heat provides circa 9% of the district energy heat requirements

Supplementing the geothermal source of heat, large gas fired CHP engine plants provide around 70% of the heat

Conventional top-up boilers provide the rest of the heat.

The District Energy scheme also includes absorption chillers that use heat from the CHP for a district cooling network.

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Southampton District Energy Scheme

- Primary example of the influence of the local Council
- SCC invested considerable effort to find an ESCO to form a long-term partnership for the development of the scheme
- The SDES serves commercial, public sector and residential customers with annual energy sales of 70GWh per annum.

Southampton District Energy

Without the efforts of the authorities to find a suitable private partner, there would not be a DH network in operation today.

Credit for the successful efforts in this case seems to fall upon individual DH Champions inside the LA who were personally pushing the project, not necessarily linked to their job descriptions.

In times when planning policies are loosening strict guidelines and passing more responsibilities on to local officers, their efforts become even more crucial for DH.

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Southampton District Energy Scheme

Use of lower temperature heat sources

- The available temperature for the SDES at 74ºC shows that temperature is a very important factor to consider.
- The network is designed as a low temperature network and operates at 70-82ºC (variable supply flow)/50ºC (return flow).
- In a network operated at a higher temperature, the geothermal source could thus not have been used directly, only to increase the temperature of the return flow.

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Chalveley, Slough

- Chalvey - pilot project of Scottish & Southern Energy (SSE) to increase experience and expertise in integrating RES into DH
- Greenwatt Way, Slough, comprises of 10 units of various sizes, inhabitated by a mix of people to gain experience on user behaviour, and how they interact with the different technologies.
- The houses are built to have a minimal energy demand

Use of renewable in DH in low temperature heat network

The DH network is operated at very low temperature, supplied with heat at only 55ºC, from the top of the thermal heat store in the energy centre.

The cooled water comes back at <30 ºC and goes back to the bottom of the heat store, the lowest temperature in the system.

The heating technologies increase the temperature of the water at the bottom of the tank and move it to the top again.

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Chalveley, Slough

- 4 different technologies feeding into the network:
  - Solar thermal, Air Source Heat Pump (ASHP), Ground Source Heat Pumps (GSHP) and biomass boiler
- The supply to the network can be switched between the sources to test all of them individually.
- It is also envisaged to test the performance of these technologies operating together

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Overseas experience

- Sustainable Development

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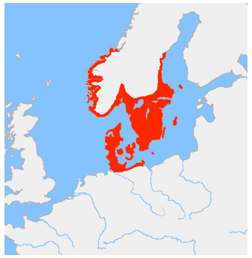
DH beyond the UK

- DH is widely used worldwide, in some European countries schemes exist that supply entire cities with heat.
- Most of the towns and cities of Denmark and Sweden are heated in this way – with DH having a market share of over 50% of the heat delivered
- German cities like Berlin and Hamburg have some of the biggest networks in the world
- Schemes that successfully integrate RES are in operation in these countries,



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DH beyond the UK

- DH in these countries is an established and accepted technology
- The end customer is mainly worried about the provision of heat than the how it is provided
- A recent study by Frederiksberg Forsyning, a heat distribution company in Copenhagen, revealed that only 50% of their customers knew they had DH.
- People only care about having heat, not where it comes from

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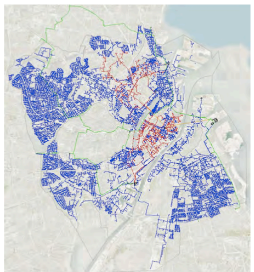
DH beyond the UK

- Due to their long tradition in DH, the existing networks in countries with an established DH market are sometimes of such large scales that direct comparisons with networks in the UK are somewhat difficult.
- The DH network in Copenhagen, for example, has a heat market a share of 98% DH in a city of 1 million inhabitants, an example that won't be reproduced in the UK in the immediate future.



The Copenhagen DH system

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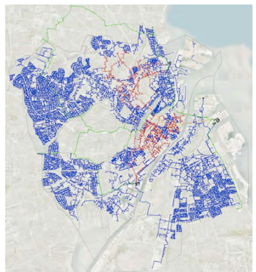
DH beyond the UK

- City-wide networks have different challenges and opportunities than small networks e.g. heat storage, back-up, economic feasibility, operation and maintenance.
- Smaller systems exist as well from which experiences can be transferred more readily
- DH is in these countries is an established technology but also has a highly developed professional workforce with long-standing experience



The Copenhagen DH system

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DH company in Hillerod, Denmark

- Hillerod Forsyning is a not-for-profit DH company owned by the municipality
- 95% of the municipality or 15000 houses are supplied with heat from the DH network, amounting to heat sales of 268 MWh/a – larger than any of the DH schemes in the UK
- Heat is supplied using 80% recovered heat from large power stations, 4% gas boilers, 14% wood pellet boilers and 2% solar thermal fields

Solar thermal collector DH field, 3000 m2. Hillerod, Denmark

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Bo01, Western Harbour in Malmo, Sweden

- The Bo01 area in the Western Harbour is a new development of approximately 1000 residential units
- Built in 2001 and served by 100% renewable energy supply averaged over the year but not at every moment.
- Electricity is generated by a 2 MW offshore wind turbine and 120 m2 of PV installed on one building.

Roof mounted solar thermal colelctors feeding the wider DH network in Western Harbour in Malmo, Sweden

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Bo01, Western Harbour in Malmo, Sweden

- Heat is produced by solar collectors placed on 10 different buildings of 1400 m2 in total and by a heat pump (HP) connected to an aquifer where heat is stored seasonally.
- Fluctuations between heat demand and supply are levelled out through the connection to the main DH network of the City of Malmo that serves as a convenient buffer
- The network in the Western Harbour is served by 65ºC

Roof mounted solar thermal collectors feeding the wider DH network in Western Harbour in Malmo, Sweden

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Bo01, Western Harbour in Malmo, Sweden

- The solar collectors are connected on a building level separated by a heat exchanger from the network
- While every plumber should be able to do repairs, not everyone would be able to do the initial design.
- To prevent 10 different systems (different operation, maintenance), the network planners insisted on standardised systems for each building

Roof mounted solar thermal collectors feeding the wider DH network in Western Harbour in Malmo, Sweden

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Bo01, Western Harbour in Malmo, Sweden

- The aquifer in the bedrock underneath the Harbour is used as a seasonal storage of both heat and cold.
- The heat from the summer is saved for the winter; it is pumped up with a large heat pump to the required temperature.
- Cold from the winter is saved for the summer and is distributed by a separate cooling network.

Roof mounted solar thermal collectors feeding the wider DH network in Western Harbour in Malmo, Sweden

Bo01, Western Harbour in Malmo, Sweden

- The Bo01 scheme supplies 100% from RES only over an entire year
- It would not work without being balanced by the network of the city of Malmo
- Bo01 is an example of ST installations in an urban context;
- Some of the installations are integrated into the architectural design

Roof mounted solar thermal collectors feeding the wider DH network in Western Harbour in Malmo, Sweden

Practical examples of how a DE network can evolve from fossil fuel to renewable energy sources

- Sustainable Development

Barnsley Metropolitan Borough Council

- Barnsley Metropolitan Borough Council located in a former mining area
- In 2004, introduced a Biomass Implementation Policy setting biomass as the standard solution for the future
- Planning requirements only ask for options appraisal for renewable sources
- Applicants need to make the case why biomass should not be implemented if they don' t want to use it

Biomass DH in Barnsley

Barnsley also benefits from the existence of a number of small district heating networks that have been maintained successfully until today, totalling 24 networks supplying from <20 units up to 166 units.

To this date, a number of these networks has been changed to biomass, and another ones are in the pipeline, totalling 12 MW heat.

Barnsley Metropolitan Borough Council

- Tradition with coal fired boilers, transition to biomass is from one solid fuel to another; changes to the system are minimal.
- Barnsley MBC trialled the use of biomass in existing coal fired boilers; the experience was positive.
- Implementing minimal changes, biomass could be burned in coal boilers without even changing the infrastructure.
- It was thus possible to transition from a carbon intensive fuel to a carbon neutral fuel without changing the infrastructure.

Biomass DH in Barnsley

Barnsley is surrounded by wooded areas. At the time of the implementation of the first biomass plant, there was however no supply chain in place.

In the meantime, companies have started that secure the constant supply of wood chips from local forestry management and coppices. ESCOs are in place for the supply of fuel but the assets are all owned by Barnsley MBC.

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Barnsley Metropolitan Borough Council

- Barnsley MBC shows that it is possible to heavily influence the transition policy in an area by adopting suitable policies
- The transition from coal to biomass reduces carbon emissions massively, especially because coal is so carbon intensive; it also created new businesses along the way
- From a financial point of view, it is advantageous that no gas network had been built in recent years that still needed to be paid off.
- The Council has plans to create new DH networks to connect several high profile buildings and supply heat by biomass; due to lacking funds, the plans have been shelved for the time being
- This could be the case for other municipalities over the coming years; it might also lead to a deepened engagement of commercial ESCOs

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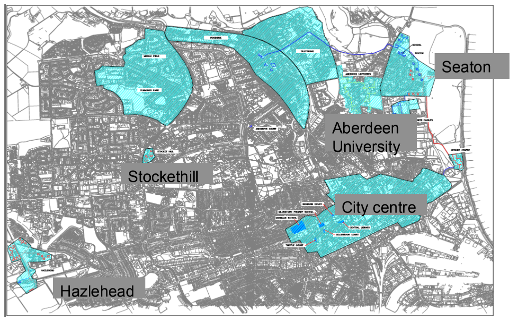
DH in Aberdeen

- A small number of island DH schemes powered mainly with gas-fired CHP engines have been installed throughout Aberdeen



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DH in Aberdeen

- CHP engines from several hundred kilowatt to a few megawatt (electrical) serve these schemes
- The catalyst for one of these schemes, was to alleviate fuel poverty
  - electrically heated council flats were retrofitted with gas CHP DH
  - this approach allowed lowering the heating bills

Seaton Social housing estates

Electrically heated social housing at Aberdeen was retrofitted with district heating fired with CHP plant as a means to alleviating fuel poverty.

Heat offered on a flat rent basis (circa £7.75 per week – 2008), electricity sold to commercial buildings.

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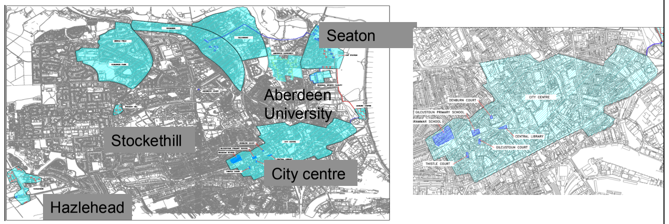
DH in Aberdeen

- Developing a city centre wide scheme from day one was not possible nor viable
- Instead a number of different island DH schemes across Aberdeen were developed with the intention of expanding then them into the city centre



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DH in Aberdeen

- The energy centre at the Seaton scheme currently used gas fired CHP
- However, enough space for further plant was conceived form the beginning with the idea of shifting to a biomass fired DH scheme

Seaton DH scheme energy centre and available adjacent space.
It is the intention to add biomass plant which in the future could supply the city centre

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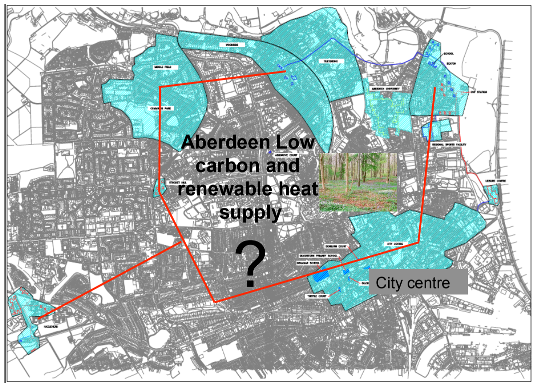
DH in Aberdeen



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