SHEFFIELD HEAT MAPPING AND FEASIBILITY STUDY OF DECENTRALISED ENERGY

Identifying Potential Expansions to the Existing City-Wide District Energy Network Using GIS Heat Mapping

*Karen Finney[1] ● Vida Sharifi[1] ● Jim Swithenbank[1] ● Andy Nolan[2] ● Simon White[3]

[1]Sheffield University Waste Incineration Centre, Department of Chemical and Biological Engineering, The University of Sheffield, Sheffield, S1 3JD, UK ● [2]Sheffield City Council, Town Hall, Surrey Street, Sheffield, S1 2HH, UK ● [3]Creativesheffield, The Fountain Precinct, Balm Green, Sheffield, S1 2JA, UK

*Contact: tel: +44-114-222 7572 or e-mail: k.finney@sheffield.ac.uk

Introduction

District heating can provide cost-effective space and water heating to local populations. Although its use in the UK is currently low, many government policies are aimed at increasing this (e.g. Renewable Heat Incentive). Sheffield however already has an award-winning city-wide district energy network, which it is now looking to expand further.

Research Aims

The aim was to identify expansion possibilities of the existing energy network, using GIS (geographical information systems) to produce interactive heat maps. These would identify existing/emerging heat sources and sinks (potential suppliers and users).

District Heating in Sheffield

The Existing District Energy Network

The network, founded in 1988, is the largest and most successful in the UK. It incorporates a CHP energy recovery facility (see right, and Table 1), connected to a 44 km pipeline network.

Table 1: Plant Overview
Fuel Feedrate: 225,000 t/a local municipal waste
Electrical Capacity: 19 MW_e for National Grid
Thermal Capacity: 60 MW_{th} for district heating
System Back-Up: 3 stand-by boilers (84.6 MW capacity)
Heat Delivered: 120,000 MWh/a
CO_2 Mitigated: 21,000 t/a
Connected Sites: ~3000 residences and 140 other buildings (including shops, offices and both universities)

Reasons for Expanding the Network

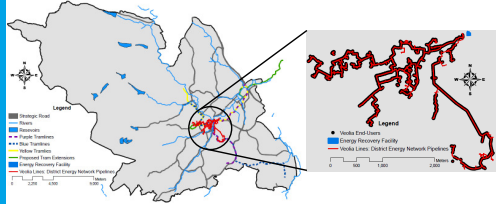
The rationale for this work includes:

- providing a sustainable and secure form of energy
- reducing carbon emissions
- generating heat in proximity to where it is used
- providing reasonably-priced heat, critical to the fuel poverty agenda
- aiding Sheffield in becoming a low-carbon city
- helping to meet legislation regarding renewable energy targets and CO_2 reductions (Renewable Energy Strategy, UK Low Carbon Transition Plan)

This will also set an example for other UK cities. Sheffield has an opportunity be a 'landmark' or 'beacon' city for decentralised, sustainable energy.

GIS Modelling – Part I Base-Mapping

ESRI ArcMap was used for the mapping exercise. Firstly, the existing district energy network and other infrastructure were mapped (Figure 1).



(a) (b)

Figure 1: The initial GIS maps identifying: (a) the city's energy and transport infrastructures; and (b) the energy recovery facility and network pipelines.

Secondly, the different buildings types – domestic, leisure, hospitals, education, industry, commercial and government – were mapped (Figure 2). These formed the base map, so waste heat and heat loads could later be attached to specific buildings.

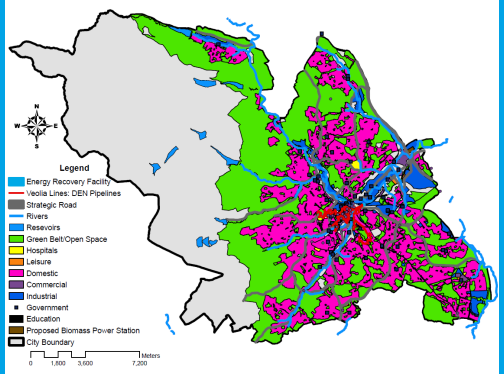


Figure 2: The final GIS base map, integrating the district energy network, infrastructure, watercourses and locations of different building types within the Sheffield City Council Boundary, including the "green" areas.

GIS Modelling – Part II Heat Mapping

Location of Existing and Emerging Heat Sources: Potential Suppliers

There are a number of heat sources that could provide additional thermal capacity to an expanded network (Figure 3). These currently have a capacity of up to **11 MW_{th}**, which could be increased further.

- proposed E.ON biomass plant – total of 30 MW capacity (20-25 MW_e plus **5-10 MW_{th}**), although the thermal capacity could be increased
- waste heat from the various steelworks located in the eastern part of the city – at least **1 MW_{th}**
- renewable energy – current output of 8 MW_{th}
- potential CHP plant – Northern General Hospital

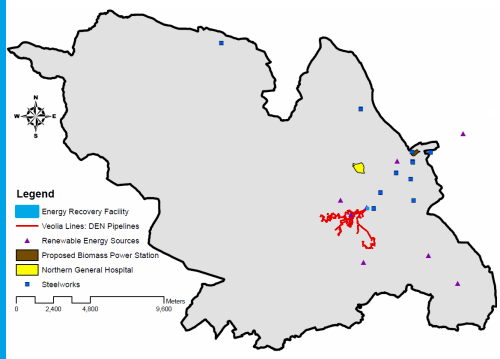


Figure 3: Heat map of existing/emerging heat sources – potential suppliers that could be incorporated into an expansion of the current network.

Location of Existing and Emerging Heat Sinks: Potential End-Users

A range of heat sinks have been identified. The first of these are the residential areas. There are 26 housing developments in the planning stage (Figure 4), which will have around 1500 new homes – a total heat load of **10 MW**. Existing residential areas also have high heat loads, however retro-fitting can be difficult.

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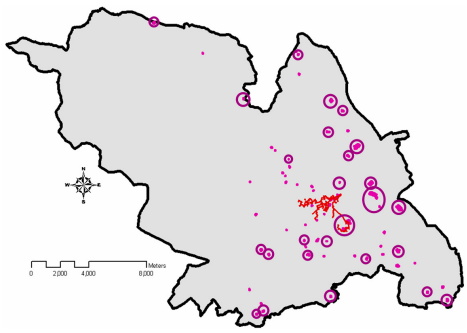

Figure 4: The locations of all the new housing developments in Sheffield – the circled areas are the 26 that are yet to be built (planning stage).

A range of other building types with significant heat loads have been mapped (Figure 5) – total of **~35 MW**; data is being collected for another 500+ identified buildings. At present, data is mapped for:

- 120 educational buildings – **14.5 MW_{th}**
- 3 large industrial sites – **9.5 MW_{th}**
- 10 council/governmental buildings – **1.8 MW_{th}**
- 15 leisure areas – **6.1 MW_{th}**
- 11 health care facilities (care homes) – **1.8 MW_{th}**
- one commercial site – **0.4 MW_{th}**

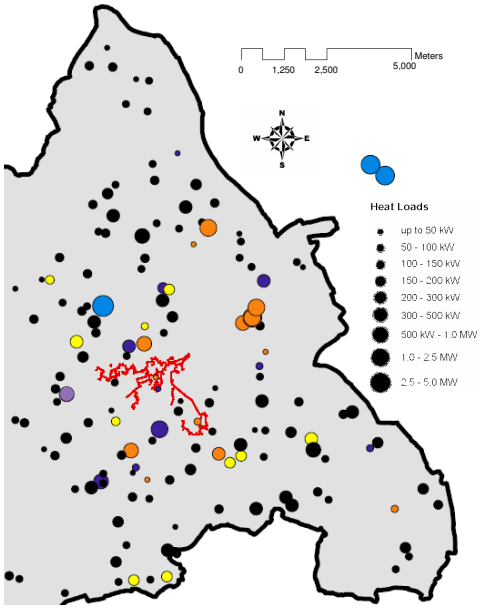

Figure 5: Estimated heat loads for buildings in the eastern part of the city.

Conclusions So Far and Future Work

This work located existing/emerging heat sources and sinks, which could be the suppliers or end-users of heat in an expanded network. The heat maps can be used to identify the areas where an expansion is feasible. The future direction of this project is to:

- locate discrete areas where a link to the existing network would be both possible and beneficial
- priority rate the most promising developments
- consider the economic (financial support and cost savings) and environmental (CO_2 savings) impacts
- examine barriers to decentralised energy