Sheffield City Polytechnic

SHEFFIELD Partnership in Action

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"AFFORDABLE HEAT"

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1.0 Introduction

1.1 Sheffield was one of the original cities included in the Department of Energy short list to participate in a study programme to examine the potential for the introduction of Combined Heat and Power / District Heating (CHP/DH) in the UK.

1.2 A Combined Heat and Power plant works by taking the heat energy produced as a by-product of making electricity and using it to heat up water for use in central heating systems in buildings. In a conventional power station this valuable heat is cooled for discharge into rivers or the sea or is dissipated into the atmosphere through cooling towers. Even in the most efficient station two thirds of the energy value is wasted. At the cost of a slight reduction in the output of electricity, however, heat can be recovered at a temperature high enough for use for heating buildings. CHP therefore has an advantage over the technology currently in use in the UK - it can increase the amount of energy obtained from fuel, thereby producing cheaper heat.

1.3 The waste heat in the form of hot water, is piped through well-insulated pipes to individual buildings by means of group heating schemes. Many such groups, or district heating schemes are already in existence; these schemes, improved to higher standards where necessary, present the greatest opportunity to introduce CHP/DH. Heating schemes can be designed to serve a single block, several blocks or whole areas of a city.

1.4 Any other source of waste heat can be easily connected to a CHP pipe distribution network, such as waste heat from factories like steel making plants, and refuse incinerators.

1.5 Many European countries have had CHP/DH systems in operation for many years. There are over 3,000 working CHP/DH schemes in Europe alone and include cities like Berlin, Copenhagen, Paris, Vienna and Helsinki. CHP/DH is not

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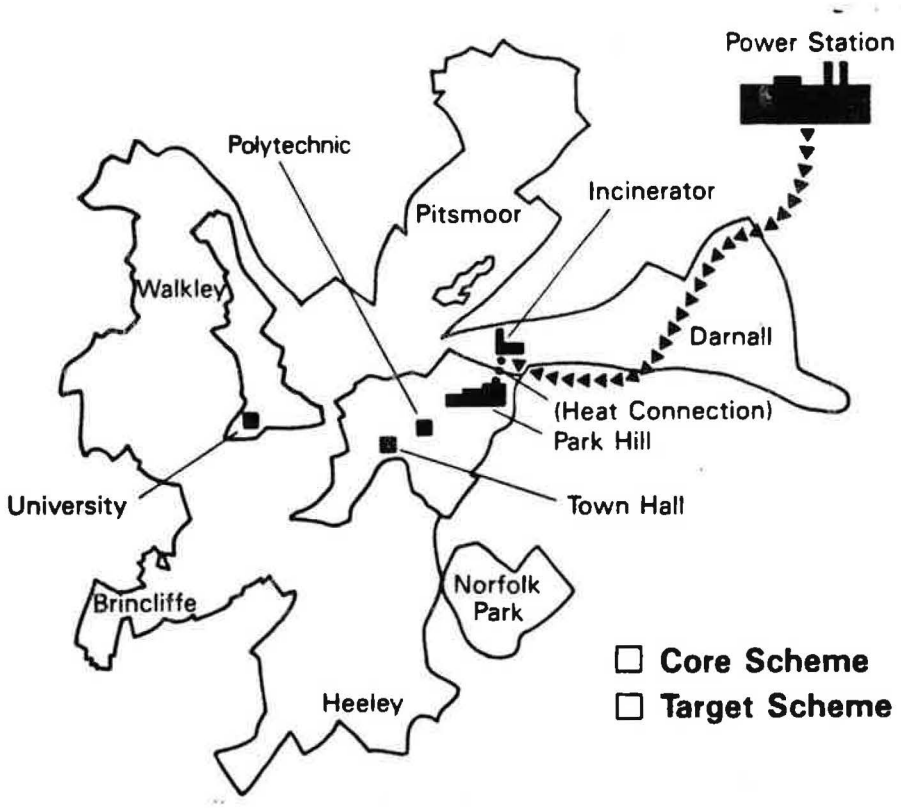
restricted to cities in Denmark small towns are connected and in Denmark today over 40% of all space heating comes from CHP.

2.0 Target Scheme

2.1 The studies carried out by W.S.Atkins identified a target CHP/DH scheme which would provide heat to a population of 100,000 in the inner city area. The scheme also provides heat to 70 of the largest commercial and institutional buildings in the city centre.

Scheme boundaries



2.2 The development strategy adopted is based on the classic approach of a 'core scheme' utilising the cheapest available energy which in this case is municipal refuse. Refuse is burned in the existing municipal incinerator based at Bernard Road, close by the City Centre.

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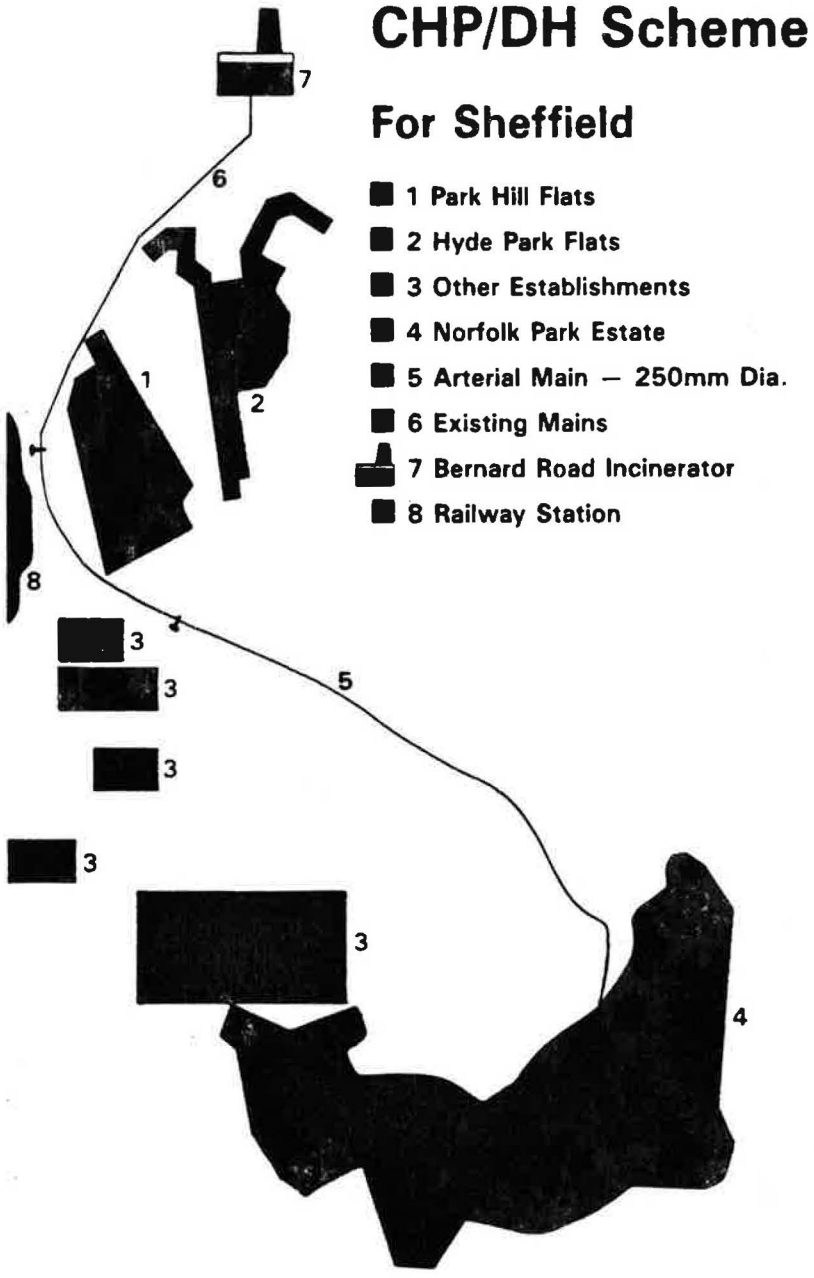
The incinerator already supplies heat to 2,400 flats at Hyde Park and Park Hill but over 50% of it's recovered energy is wasted.

2.3 The construction of the 'core scheme' was started with an initial scheme taking heat to Norfolk Park housing estate which comprises 1890 flats in 15 tower blocks. The next stages of development will extend the district heating network into the City Centre and throughout the core scheme area.

The Initial Scheme



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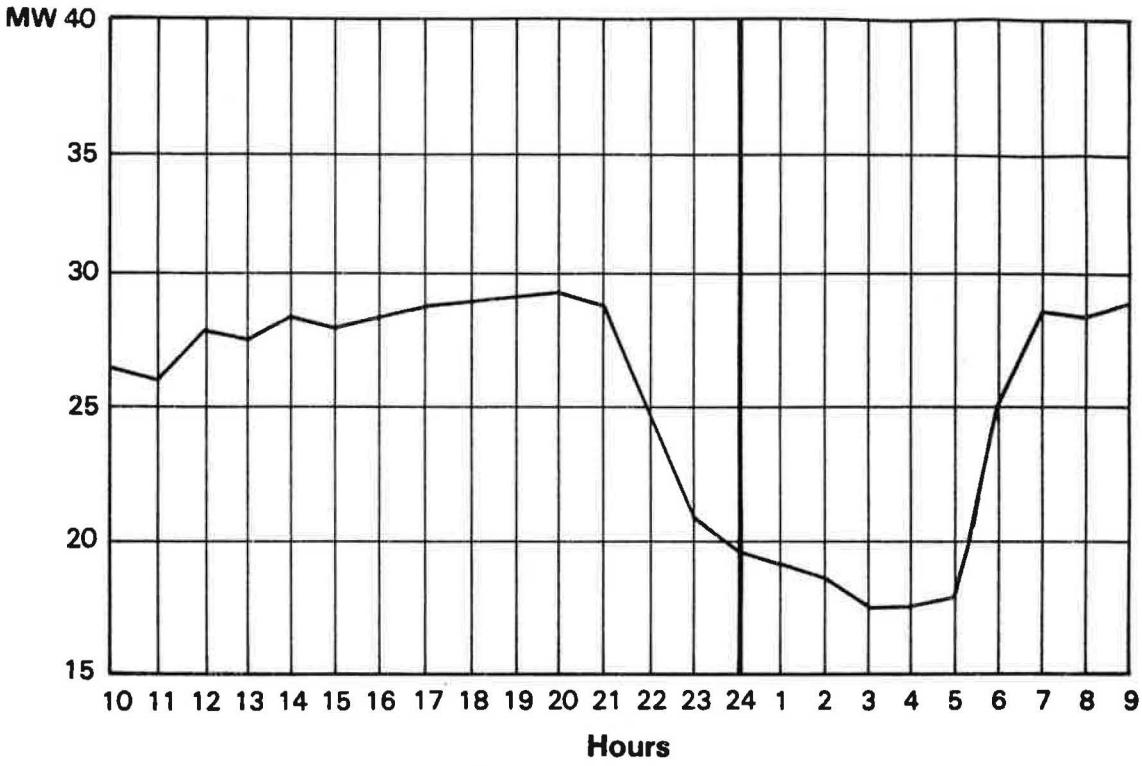
2.4 The Bernard Road Refuse Incinerator has one of the best operational records of any refuse incinerator in Europe. It currently treats 116,000 tonnes of refuse per year and has the capability - with careful and skilled management - to produce 30MW of heat. It is the key building block in the strategy to achieve the Target Scheme.

Bernard Road Steam Production



August 87 Daily Average

3.0 Corporate Structure

3.1 A second key factor in the introduction of CHP/DH in Sheffield was the Council's decision to enter into a joint venture partnership with the private sector. The City was anxious to link-up with a group with a proven track record in the field and this desire resulted in the formation of Sheffield Heat and Power Company (SHP) with EKONO of Finland, an engineering group with world-wide experience of CHP/DH.

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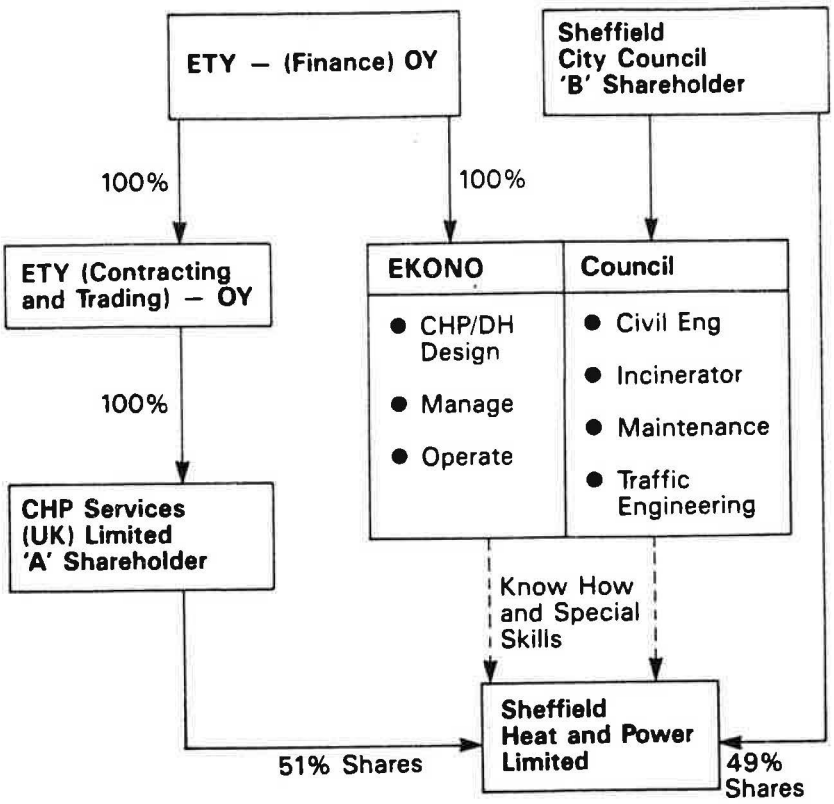
Sheffield Heat and Power Limited - SHP

Company Structure



3.2 The City could in theory have implemented the scheme without the need to set-up such a company but in practical terms it would never have been able to commit the large sums of capital, year on year, needed to expand the scheme. Furthermore the necessary design skills would have had to be 'bought in' to ensure a successful scheme so for these reasons SHP was formed.

The Purpose of Sheffield Heat and Power Limited

- Joint venture where both parties share in the risks and benefits.
- Finance the project using private sector capital and local authority powers.
- Provide a technical design capability.
- Establish a competent group to attract project finance.
- Supervise the implementation of the scheme.
- Take the operating responsibility.
- To provide cheaper energy.
- Compete in the market place.

Partnership
EKONO and Sheffield

3.3 The Company has raised the capital necessary to implement the initial scheme and is currently in discussions with Banks regarding further loans for expanding the system.

3.4 The Bank of Tokyo have provided funds for the initial scheme on a limited recourse financing basis, the security being provided through a take and pay contract with the Housing Department. The main features of the contract are shown below.

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Take and Pay Contract

- Minimum 'heat take' 47,000MWh per annum.
- Heat supplied will be metered.
- Buildings covered - Hyde Park, Park Hill, Hyde Park Walk and Terrace, Norfolk Park, Claywood and Bard St.
  Total Dwellings 4,640
- Unit price of heat is 1.9p/KWh.
- Payment only required if heat is available from the company.
- Compensation for prolonged interruption.
- Twenty year contract reviewed every three months on request.
- Comprehensive review after first twelve months.
- Payments monthly against agreed schedule.

4.0 Affordable Heat

4.1 The concept of affordable heat was developed by W.S.Atkins and Sheffield City Council following structured consumer surveys both during the Department of Energy sponsored study into CHP and the City's own studies carried out during 1984.

4.2 Affordable Heat is defined as the best level of heating comfort when required by the consumer at an acceptable cost. Tenants' estimates of weekly current spending showed that they were willing to pay between £6 and £8 per week (mid 1984) for the main energy bill (i.e. the bill including energy costs and standing charges) provided good comfort standards are achievable.

4.3 In households with low incomes, heating bills are frequently a source of anxiety. Some groups may perceive themselves as powerless to make energy savings and prefer to economise in other directions. There are cases in which some of the elderly in particular, deny themselves heat as they fear debt.

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One study of low income earners found that 29% could not or would not economise on fuel bills, a further 58% did not know if they could and only 13% thought it possible. This fatalistic attitude is not uncommon and is frequently accompanied by a feeling that debt is inescapable and that one might as well be warm whilst it is happening. Reductions in heat levels have significant health implications particularly for the very young and the very old.

4.4 It is important therefore to avoid setting heating charges above the affordability level or installing systems which are incapable of providing an acceptable comfort level at an affordable cost.

4.5 The inadequacy of present heating systems and the poor thermal performance of much of our national housing stock are well known but little understood and are problems which will be with us for years to come.

4.6 Sheffield Housing Department have responded to this issue in a positive way through a capital investment programme to replace existing inadequate systems with new systems capable of providing the comfort levels demanded. All new heating systems currently being designed and installed in high rise and deck access accommodation are set to achieve a 21^{o}C external temperature. This is compared with previous standards of 15^{o} to 17^{o}C internal against a -1^{o}C external temperature.

4.7 Another important factor of design is the time taken by the system to reach an adequate comfort level. If the system takes too long to reach this level the tenants switch on supplementary heating, such as electric fires which affects system controls which exacerbates the problem and on a unit per unit basis can cost more than the cost of providing full heating and domestic hot water.

4.8 It is important therefore, regardless of the type of fuel used, to ensure that the heating systems themselves are capable of meeting users' needs at an affortable cost.

4.9 The most recent heating systems installed by the City in 15 Tower Blocks at Norfolk Park have been designed to meet the affortability criteria as stated above. The heat price has been fixed at 2.5p/kWh (73.3p) per useful therm. This cost is all inclusive of pumping power, standing charges etc. and based on an annual consumption of 12,000 kWh (410 therms) the weekly cost would be £5.77p.

4.10 Given that the heating systems are fitted with individual controls and meters so that each tenant can determine when and how much heat they wish to take, the maximum expected consumption necessary to provide adequate comfort throughout the whole day is 17,000 kWh (579 therms) which would cost £8.17p per week. This is inclusive of hot water, standing charges and management costs.

4.11 Fixing the tariff requires careful consideration but it must be competitive otherwise the scheme will not grow. Obviously production and distribution costs including a return on investment must be made.

4.12 Setting a cost based tariff is relatively easy and providing income from heat sales exceeds the production cost then all benefits can be passed on to the consumer. However, during the early years of CHP/DH schemes the tariff is usually based on market value.

4.13 The market level tariff is usually close to the cost of alternatives and provided the volume of sales can be maintained then a 'market level' tariff will produce surpluses for reinvestment in the expansion of the scheme. Market tariffs are mostly employed by CHP/DH utilities to ensure maximum expansion but when expansion is complete then the tariff can be reduced nearer to a cost based tariff.

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4.14 Heat costs for alternatives are shown in Tables 1 and 2 compared with 1.9p/kWh for heat supplied by SHP.

TABLE 1

Central Gas Fired Boiler at Norfolk Park

Gas Price (special contract)	31p/therm
Boiler Efficiency - 70%	44.286p/therm
Distribution losses - 3%	45.614p/therm
Convert to kWh ÷ 29.32	1.555p/kWh
Capital Charge @ 13%	0.39p/kWh
Pumping costs	0.24p/kWh
Maintenance costs	0.05p/kWh
Municipal Rates - 2.56%	0.07p/kWh
Base Heat Cost	2.31p/kWh
Management charge - internal pumping etc.	0.5p/kWh
Heat cost to consumer	2.81p/kWh

Notes

1. Gas is unlikely to remain at 31p for long
2. Boiler efficiency over the season is generally 65%
3. Distribution losses are usually 8%

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TABLE 2

Individual Gas Boiler in each Flat
Based on 410 therms of useful Energy

Gas Price		38.6p/therm
Boiler efficiency @ 65%		59.38p/therm
Standing Charge	£34.40	
Service Charge	£50.00	83.62p/therm
Pumping Cost	£15.00	
Convert to kWh ÷ 29.32		2.85p/kWh
Heat cost to consumer		2.85p/kWh

Notes

1. The figures ignore capital replacement costs

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Acknowledgments

1. Market and Consumer Acceptability Studies - W.S.Atkins & Partners (September 1985)

2. 'Looks Like We've Made It' - a CHP Scheme for Sheffield - a paper prepared by D.Lawrence for the 1987 International Conference hosted by the CHP Association.