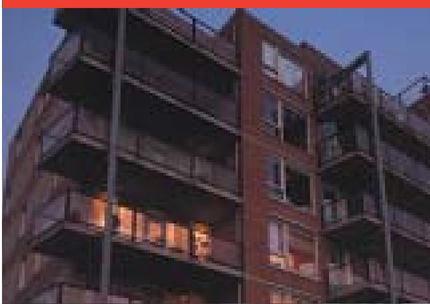
IEA DHC|CHP

IEA: International Energy Agency
IEA Implementing Agreement of District Heating and Cooling, including the integration of CHP

Annex VII

2002 -2005



District Heating & Cooling
the integrated solution

District Heating and Cooling (DHC) has proven to be a major contributor to Greenhouse Gas (GHG) reduction in many member countries and recognition of DHC's importance is growing. In fact, many countries where it is established are renewing their commitment to DHC as they find new ways to use the technology to reduce environmental impacts.
DHC facilitates linkages between supplies that are environmentally desirable and end users that could not otherwise make use of those energy sources.
District Heating not only offers excellent opportunities for reducing environmental pollution, but also for achieving the goal of saving energy. It is an extremely flexible technology which can make use of any fuel including the utilisation of waste energy, renewables and, most significantly, the application of combined heat and power (CHP).
It is by means of these integrated solutions that very substantial progress towards environmental targets, such as those emerging from Kyoto can be made.

Programme aims

The 'IEA Implementing Agreement on District Heating & Cooling including the integration of CHP' (DHC/CHP) is a programme that conducts highly effective Research and Development as well as policy analysis of District Heating and Cooling systems with low environmental impact through international collaboration.

We are furthering this mission by selecting, managing and publishing collaborative co-funded projects collating and exchanging information on R&D projects between countries.

Furthermore the Executive Committee strongly supports the co-operation with other IEA programmes. In particular the DHC/CHP programme is involved in the Building Co-ordination Group and contributes actively towards successful meetings and positive exposure of the results of these meetings, projects and other activities.

The activities of the DHC Programme started in 1983, each period of co-operation consists of a three-year period, which we call Annexes. This brochure gives information about the projects of Annex VII. The seventh three-year period.

More information about projects and our history can be found at: www.iea-dhc.org

DHC/CHP Annex VII Projects

Below you will find descriptions of the Annex VII projects, which cover a wide range of topics and have now been initiated. It is likely that a further one or two project will also be carried out under this Annex.

A comparison of distributed DH/CHP with large-scale DH/CHP

This project compares traditional centralised large-scale DH/CHP (as seen in Scandinavia, Eastern Europe and Korea) with the much smaller distributed DH/CHP systems, which are popular in Denmark and the Netherlands, and which may prove suitable for the UK's liberalised energy markets. Many countries, particularly where CHP and district heating is still in its infancy, have no clear view as to which type of CHP projects should be developed. Centralised systems extract heat from major power stations and distribute it over large-scale heating networks, while small-scale distributed systems consist of many smaller plants linked to localised heating networks.

The key benefits of this research include:

- a summary of the experience gained in three European countries with both centralised and distributed DH/CHP systems, and the practical advantages of using this technology;
- a survey of the latest technologies and their future development prospects;
- an economic comparison of centralised and distributed DH/CHP systems as opposed to non-CHP options and CHP in individual buildings;
- an assessment of the contribution that both centralised and distributed DH/CHP systems can make to environmental improvements as against CHP in individual buildings.

The results of this study will prove beneficial to energy planners in all IEA member countries and everyone concerned with the future development of DH/CHP systems.

Two-step decision and optimisation model for centralised or decentralised thermal storage in DHC systems

The main priority of this project is to develop a model for deciding whether or not centralised or decentralised thermal storage improves DHC systems and if so to determine the optimum size of this storage facility is. Analysing the need and effect of thermal storage can help to resolve capacity problems, production and distribution bottlenecks, as well as improving utilisation of waste heat. This results in a far more efficient heating and distribution system.

Step one: involves developing a simple method of looking at historical data (heating load and

production prices), which is then used to analyse the benefits of thermal storage.
Step two: optimises the size of the thermal storage, including product and efficiency optimisation of the entire system, where thermal storage may also be used as a capacity buffer.

This project highlights the various reasons for using thermal storage to improve the efficiency of DHC plants and their distribution networks, with several different methodology steps being taken to achieve an optimal solution.

Improvement of operational temperature differences in district heating systems

A new method of detecting malfunctioning consumer stations and other sources of high-return temperatures forms the main objective for this project. This method is based on five years' experience with consumer station improvements in Sweden. Using district heating systems efficiently means having a large energy transport capacity in relation to the size of the pipes. Large differences in supply and return temperatures are important prerequisites for transporting large amounts of energy, particularly during peak load times, because this can save pumping power and often reduce distribution heat losses. In practice this is often hampered by malfunctions in consumer stations and short-circuits in the distribution network. System designers also tend to build in extra 'reserve capacities', which lead to control instruments not functioning properly. These malfunctions result in higher pumping losses, high return and supply temperatures, and therefore higher heat losses from the network.
Expected results from this project involve:

- developing a method for improving temperature differences;
- analysing systems and producing reliable overflow capacity predictions;
- using simulation and evaluation tools to prioritise temperature difference improvements;
- verifying the method using adjustments already carried out in Sweden.

Eventually the method should be widely available for improving the temperature differences in district heating networks.

How cellular gases influence insulation properties of district heating pipes and the competitiveness of district energy

Heat loss (often 5-40%) is a significant economic factor in district heating systems, and this aspect has gained importance as energy prices rise. The heat loss depends primarily on the cellular gas and type of insulation used in the piping system. This project aims to clarify how cellular gases influence long-term insulation properties, calculates the financial consequences of using R11 or cyclopentane cellular gases in pre-insulated pipes, and considers whether cellular gases could be replaced with a vacuum (which could reduce heat losses by up to 75%). This would allow smaller pipes to be used and district heating systems to be developed in new areas. However, the mechanical properties and lifespan still need to be studied. The project team is therefore studying all cellular gas and insulation aspects and will estimate how heat losses in district heating pipes vary over time, depending on the type of cellular gas used and the insulation thickness. Model calculations are being carried out for various types of insulation, as standard insulation thickness differs between countries.

Biofouling and microbiologically influenced corrosion in district heating networks

District heating systems are invariably contaminated with bacteria, with 90% of this bacteria being found on surfaces that are in contact with water. The bacteria then form biofilms, a process also known as biofouling, which leads to corrosion (i.e. microbiologically influenced corrosion, or MIC) of metal surfaces. This corrosion is localised, develops very quickly and causes increased drag in pipes, which in turn results in increased pumping costs, reduced heat transfer and clogged filters and monitoring equipment. This project therefore considers the significance and consequences of biofouling and MIC in selected district heating networks in relevant IEA countries. The project team, consisting of microbiologists and corrosion specialists, is also developing a risk-assessment methodology. This research will lead to guidelines for determining the action necessary for monitoring, mitigating and controlling biofouling throughout the district heating industry.

Dynamic Heat Storage Optimisation and Demand Side Management

The pipeline system of a district heating system has a huge potential for the storage of energy. Especially for distributed systems like combined energy supply systems with renewable energies and CHP the optimal use of these storage capabilities increases the overall efficiency. Additionally, it enables the displacement of expensive peak power plants, to reduce electrical power peaks and to enable a better utilization of tariffs. With the application of sophisticated load management systems the complex dynamic interactions of combined energy systems can be considered and optimized with respect to improved heat storage processes and in the end with a higher efficiency of the system. While dynamic heat storage is a strategy regarding the energy supply and distribution, as a different approach demand side management (DSM) is a promising technique to increase the efficiency of energy supply systems focussing on energy peaks coming from the demand side.

This project will continue on the results of the project 'Simple Models for Operational Optimization' which was carried out in Annex VI. This project compiled data from real DH-systems in Denmark, Finland and Germany which has been used to study the effects of the different simplification strategies on the accuracy of DH network models for simulation and optimization purposes. The application of these algorithms was very promising. As a continuation this project will focus on the application of the developed and tested simplification strategies in order to evaluate advantages of dynamic heat storage optimization techniques for DH systems and to compare heat storage possibilities to DSM approaches.
On the basis of real data, models with special consideration towards heat storage and the co-generation plants have been elaborated in Denmark, Finland and Germany. By the exchange of the different systems data it will be ensured that the strategies will be applicable in each country. As a result of the analysis, information and recommendations can be given to energy suppliers, DH companies, decision-makers etc. on economic savings by dynamic supply temperature control and heat storage in the system. Furthermore economic savings and reductions in CO_2 and peak demands in the connected gas and electric systems will be evaluated from reducing peak loads in the connected buildings (DSM) and at the DH plants.

Strategies to manage heat losses – Technique and Economy

The main share of operational costs in heat distribution are the inevitable heat losses in networks. As total costs of heat losses depend on a broad spectrum of parameters it is a complex task in district heating engineering to optimise economy in relation to these influences.

Two extreme examples may illustrate the situation:

1. In DH areas with scattered small houses and with low heat demand a reliable supply of the DH system needs well insulated pipelines.
2. In big systems with main lines of big diameters and operated at moderate temperatures at least the return lines should be constructed without any insulation due to pure economic optimisation.

Engineering practice has to find an optimal balance between these extremes according to boundary conditions. - A technically independent demand is the protection of environment.

In today's practice conceptions on heat losses are influenced by a good portion of experience, custom and intuition. A better knowledge of the technical and economic interdependencies would help to make network design on a more reliable basis.

The main target of the project will be to make cost relations transparent and to number standard cost situations.

Costs of measures for lowering heat losses will be calculated for real situations. Results will be given in handy values [$/MWh and €/MWh]. Costs will be calculated for defined parameters and will be presented in form of tables and diagrams.

Results of the project will be gathered in a comprehensive report. This will have the character of a reference book on heat losses in DH networks. The results will be presented in form of helpful tools for network design (calculations, tables, and diagrams).

Results will give the answers to:

1. What is the optimal strategy to manage heat losses under specified conditions?
2. Cost assessment of strategies
3. What is an alternative solution and what are the costs?
4. Experiences on optimisation from past decades, consequences
5. How does aging of today's PUR foams influence economy?

Project Title	Lead Country	Project Management
A Comparison of distributed CHP/DH with large-scale CHP/DH	United Kingdom	PB Power Ltd. - Energy Services Division Mr. Paul Woods 4 Roger Street London WC1N 2JX United Kingdom Woodsp@pbworld.com
Two-step decision and optimisation model for centralised or decentralised thermal storage in DH&C systems	Sweden	SP Swedish National Testing and Research Institute Dr. John Rune Nielsen P.O. Box 857 SE-501 15 Borås Sweden john.r.nielsen@sp.se
Improvement of operational temperature differences in district heating systems	Sweden	ZW Energiteknik AB Mr. Heimo Zinko Box 137S-611 23 Nyköping Sweden Zinko@algonet.se
How cellular gases influence insulation properties of district heating pipes and the competitiveness of district energy	Denmark	Danish Technological Institute Mr. Henning D. Smidt Teknologiparken, Kongsvang Allé 29 DK-8000 Århus C Denmark Henning.D.Smidt@teknologisk.dk
Biofouling and Microbiologically Influenced Corrosion in District Heating Networks	Denmark	Danish Technological Institute Environmental and Water Technology Mr. Bo Højris Olesen Teknologiparken, Kongsvang Allé 29 DK-8000 Århus C Denmark Bo.Hojris@teknologisk.dk
Strategies to Manage Heat Losses – Technique and Economy	Germany	MVV Energie AG Dr.-Ing. Frieder Schmitt Technologies and Innovations Dept. Luisenring 49 D-68159 Mannheim (Germany) F.Schmitt@mvv.de
Dynamic Heat Storage Optimisation and Demand Side Management	Germany	Fraunhofer-Institut für Umwelt, Sicherheits- und Energietechnik UMSICHT Dipl.-ing. M. Wigbels Osterfelder Straße 3, 46047 Oberhausen, Germany wim@umsicht.fhg.de

EXECUTIVE COMMITTEE

The control of the Co-operative Programme is vested in the Executive Commitee. Each participating country has appointed one formal representative of its country. Each country also has the opportunity to assign an alternate member. The Executive Committee meets twice a year, normally in May and November. Representatives of Euroheat and Power and the International District Energy Association often attend these meetings.

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International Energy Agency (IEA)

The IEA brings together policy-makers and experts from Member countries to discuss common energy technology issues, to undertake studies and to organise workshops which assist Members with technology policy development. They provide a framework for more than 40 international collaborative energy research, development and demonstration projects known as Implementing Agreements

The International Energy Agency, based in Paris, is an autonomous agency linked with the Organisation for Economic Co-operation and Development (OECD).
The IEA is the energy forum for 26 Member countries. IEA Member governments are committed to taking joint measures to meet oil supply emergencies. They have also agreed to share energy information, to co-ordinate their energy policies and to co-operate in the development of rational energy programmes.

Objectives

- To maintain and improve systems for coping with oil supply disruptions;
- To promote rational energy policies in a global context through co-operative relations with non-Member countries, industry and international organisations;
- To operate a permanent information system on the international oil market;
- To improve the world's energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use;
- To assist in the integration of environmental and energy policies.

Twenty-five Years On

The Agency celebrated its first quarter century in 1999. Its core missions remain unchanged, but it has extended its activities in many directions.
Today the IEA Secretariat has become the authoritative source for energy statistics worldwide

- it publishes the indispensable monthly Oil Market Report and the influential biannual World Energy Outlook
- reports regularly on the energy policies of its Member states and those of selected non-Members
- provides Member countries and the public with a steady stream of information and analysis on the rapidly changing world of energy
- actively reaches out to non-Member countries whose role in the world economy and world energy markets is rapidly growing
- plays a leading role in the international effort to combat climate destabilisation
- stimulates the development and deployment of new energy technologies through a vast network of Implementing Agreements

This Implementing Agreement (IA) on DHC and CHP is one of seven buildings-related IAs operating under the auspices of the IEA, but also maintains in active contact with the renewables family of IAs.

DHC and CHP provide a variety of opportunities to reduce emissions of greenhouse gases (GHG) and air pollution and increase energy security. The fundamental idea of DHC is to use local fuel or energy resources that would otherwise be wasted in order to satisfy local customer thermal energy requirements. Examples of local energy resources include thermal energy from combined heat and power (CHP) plants, refuse incineration plants, waste heat from industrial processes, natural geothermal heat sources, wood waste, and cold sea or lake water.

Membership proves invaluable in enhancing the quality of support given under national programmes. The final materials from the research are tangible examples, but other benefits include the cross-fertilisation of ideas and experiences, which has resulted not only in shared knowledge but also opportunities for further collaboration.

Please contact the Operating Agent for further information on joining our Implementing Agreement at iea-dhc@novem.nl

Design Bobbert van Wezel

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