INTERNATIONAL DISTRICT HEATING ASSOCIATION
IDHA

DISTRICT HEATING

JANUARY-FEBRUARY-MARCH 1978 VOLUME 63 - NUMBER 3

SIXTY-NINTH ANNUAL CONFERENCE

June 19-21, 1978
Hot Springs, Virginia

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AN OFFICIAL PUBLICATION OF THE INTERNATIONAL DISTRICT HEATING ASSOCIATION
PUBLISHED QUARTERLY SINCE 1915

Overseas Trip Report

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Introduction

Co-generation, the combined production of electric and heat energy, is being given increased attention in the United States as one way to improve the efficiency of using our fuel resources. This energy production method was specifically identified in President Carter's 1977 Energy Message to Congress. Part of the interest in co-generation stems from the often cited energy efficiency of the European and Scandinavian countries.

In August 1977, the author visited four cities in Finland and Sweden, and attended an international conference in Helsinki. The primary purpose of this trip was to gain a first-hand impression of the reality and potential of co-generation in these countries, as it is applied to district heating. The discussion which follows briefly describes highlights of this trip.

District Heating

An appreciation for the extent, methods, and trends in district heating systems was gained by visits to such systems in Helsinki, Turku, and Kuopio in Finland; and in Stockholm, Sweden. With the exception of Denmark, Finland and Sweden have the highest per capita use of district heating in Europe, and the trend in use of this technology is one of rapid growth.

In Helsinki, about 60 per cent of the heating demand was met in 1976 with district heat. This represents about 290,000 people, 218 miles of hot water pipelines, about 1560 Mw of heat generating capacity, and 35 per cent of the revenues of Helsinki Electricity Works. There is a large and growing list of customer applications for district heat. The delivered cost of heat to living space is in the range of $4 to $5 per/million Btu. Details of the Finnish experience are described in Mr. Kilpinen's article elsewhere in this issue of *District Heating.* He was the very fine host for a tour of the impressive Helsinki district heating system by conference attendants.

In Stockholm, about 25 per cent of the 1976 heat demand was met with district heat, serving 250,000 people with about 135 miles of pipelines. District heat revenue is about 25 per cent of total revenues of the Stockholm Energiverk. The waiting list of new customers is equivalent to about 110,000 people. (The spring issue of *District Heating* will include an article describing the Swedish experience with district heating.)

The living space of literally millions of people in Europe, Scandinavia, and the Socialist Republics, is reliably heated with district heating systems. About two-thirds of the space heating and domestic hot water needs of these people are met using co-generation facilities. These systems burn coal and heavy oil and are looking very hard at the nuclear heat source, the focal point of the Low-Temperature Nuclear Heat Conference attended by the author.

The primary reasons for the growth in district heating in Finland and Sweden, compared to firing light oils or gas in individual buildings, are the same. They are:

- —The need to reduce imports of coal, oil, natural gas and nuclear fuels, because of the lack of these resources and balance of payments impacts.
- —The doubling of fuel utilization efficiency, through the combined production of electric and heat energy.
- —The favorable economics and fuel flexibility of district heating systems in these countries.
- —The dramatic improvement in metropolitan air quality, due to the elimination of a multiplicity of low-level chimneys.

District heat in the cities visited, and elsewhere in Europe and the Socialist Republics, is supplied using hot water in a closed-cycle system, with steel supply and return piping. In winter the hot water supply temperature is in the range of 250 F, and the return about 130 F. The supply temperature varies with the season. Pipe design pressures are in the range of 250 psi. Some details of new district heating pipeline systems are shown in Figs. 1-6.

About two-thirds of the annual heat is supplied from co-generation facilities and the balance by heat-only

Fig. 1—District heating pipeline extension, Helsinki.

Fig. 2—District heating pipeline details, Helsinki.

Fig. 3—New district heating pipeline, Turku. Note customer tap at center.

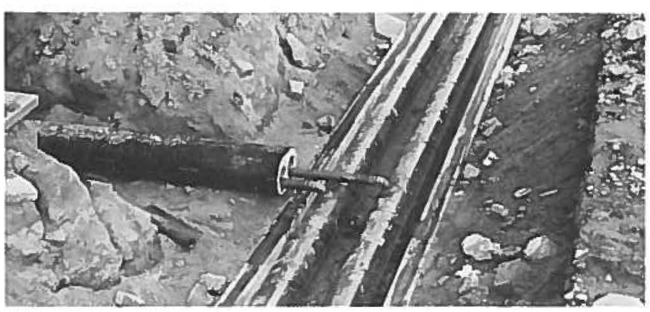

Fig. 4—Customer service tap of pipelines, Turku.

peaking units, usually fired with heavy oil. Transportable, oil-fired heating units are used to start up new building complexes, until the district heating pipelines can be extended. Forty such transportable units are in use, e.g., by the Helsinki Electricity Works.

The majority of new residential construction is apartment buildings. It should be noted that while the areas visited have heating seasons similar to the North Central area of the U.S., they do not have a summer cooling load because of their relatively cool summers.

Low-Temperature Nuclear Heat Conference

This three-day Conference was held in Otaniemi, Finland in August 1977. It was organized by the Finnish, European, and American Nuclear Societies. The purpose of the Conference was to focus attention on a variety of possible low-temperature heat uses from different sizes and types of nuclear reactors. Obviously, the principles apply to fossil fuel heat sources as well.

That the Conference was of wide and timely interest is illustrated by the fact that there were 52 high quality papers from 12 different countries, and about 300 registrants from 25 difference countries. The author was the only U.S. electric utility and IDHA representative.

The low-temperature heat uses described were primarily in the areas of district heating, aqua/agricultural complexes, and desalination. Although the latter two are of interest in many areas of the world, including the U.S., the primary topic of the Conference was district heating using nuclear heat sources. Three basic types of reactors for district heating application were described in papers from several different countries:

—Large light water reactors (LWR), now in use and available commercially in the 800-1200 Mw electric range in various parts of the world.

—Small, electric power producing LWR's with thermal ratings of several hundred Mw's. These designs are based on submarine and surface ship reactor designs.

—Single purpose, heat-only nuclear reactors designed for about 200 Mw of heat output.

Design features, adaptation to combined electric power-district heating schemes, and application case studies were described. The Table, prepared by Peter Margen, AB Atomenergi (Sweden), summarized for conferees some of the major nuclear district heating studies underway in the fall of 1977.

Several papers described existing district heating systems, including those in Stockholm and Helsinki. Of particular interest was an invited paper which surveyed existing district heating systems. [Paper No. 6, "Survey About the Existing District Heating Systems," V. Scholten, Kraftwerk Union AG and M. Timm, Hamburgische Electricitats-Werke, FR Germany.] Figs. 7 and 8 from that paper show the connected district heating loads in Western and Eastern Europe. Fig. 9 shows these loads on a per-inhabitant basis. Essentially, all of these existing district heating systems, and those discussed at the Conference, were hot water systems operating in a closed cycle.

Today there are no district heating systems in the world using nuclear heat sources, although a small unit (Agësta) operated with district heat output for about ten years in Sweden. It remains to be seen whether the studies described in the Table will result in a nuclear district heating decision(s) in the years ahead. It seems

Fig. 5—Portable heating unit, Turku.

clear that the heat source technology exists, and that the economic promise is real. The question is whether the political and institutional problems will be overcome.

Major Nuclear District Heating Projects

Country		Project Name	Approx. Heat Transport Rate MW	Status of Study
Canada		New Pickering (and other cities)	Several 100	Feasibility Study
Chekoslo-	O	Brno	~1 000	Outline
vakia	O	Prag		Outline
Denmark		Gylling/Naes Storårhus	700	Outline
Finland	O	Greater Helsinki	800 (initial)	Detailed
France		Saclay and surroundings*	100	Detailed
Germany	O	Grids for Berlin, Hamburg and Ruhr district	Several 1 000s	More or Less Detailed
Sweden		Barsebäck/Malmö-Lund	950	Detailed
	O	Greater Stockholm	2 100	Detailed
		Greater Gothenburg	~1 000	Outline
Switzer-	O	Bern	"100 s"	Outline
land	O	Basel		Detailed
USA	O	Minneapolis/ St. Paul**	Large	Started

* Heat only; all other projects refer to combined Heat/Electric Stations
** Coal or nuclear
O Project mentioned by conference paper

Personal Impressions About Energy Use

Recently, the energy efficiency of various European and Scandinavian countries has been compared to U.S. energy use, without considering the total picture. While such a picture cannot be developed in a few days in another country, there are some points which can be made about energy consumption based on the following:

—General observations during facility visits.
—Visits to three private residences in Finland; two single-family homes, and one apartment.
—A visit to a summer home near Stockholm.
—Stays in two hotel rooms in Finland.
—A tour of a Finnish elementary school.
—Brief discussions on this subject with friends and acquaintances in both Finland and Sweden.

The points noted are provided as observed, or later calculated. No attempt has been made to compare these observations with the situation in the U.S. or Southeast Michigan.

Finland and Sweden do not have the extent of industrialization we have in such areas as Detroit. Also, for all practical purposes there is no air-conditioning load because of their relatively cool summers. The heating season is similar to that in Michigan or other Northern states.

The majority of existing and new residential construction is apartment buildings, requiring perhaps one-third less energy for heating than single-family homes. Also, the central or district heating systems are more energy efficient than single-family furnaces. The extensive use of combined electric power/district heating systems is a significant factor in fuel utilization efficiency.

Essentially, all windows in residential and commercial buildings are double glazed. This is not a new practice. Some special types of triple-glazed windows are in limited use, and more are planned. Heavy wall and ceiling insulation is standard for all buildings. For example, about four inches of batt-type insulation was being used on the outside of a concrete block wall of a commercial building, prior to installing external, concrete decorative panels.

The floor space in residences is somewhat smaller than we are accustomed to building. Apartments in new suburbs of Helsinki are in the 800 to 850 sq ft range for small families. The floor space in the single-family home of an engineering manager was about 1135 sq ft. This home, oil-heated, had an annual oil consumption of about 1100 gallons.

Fig. 6—Typical parallel plate room heater.

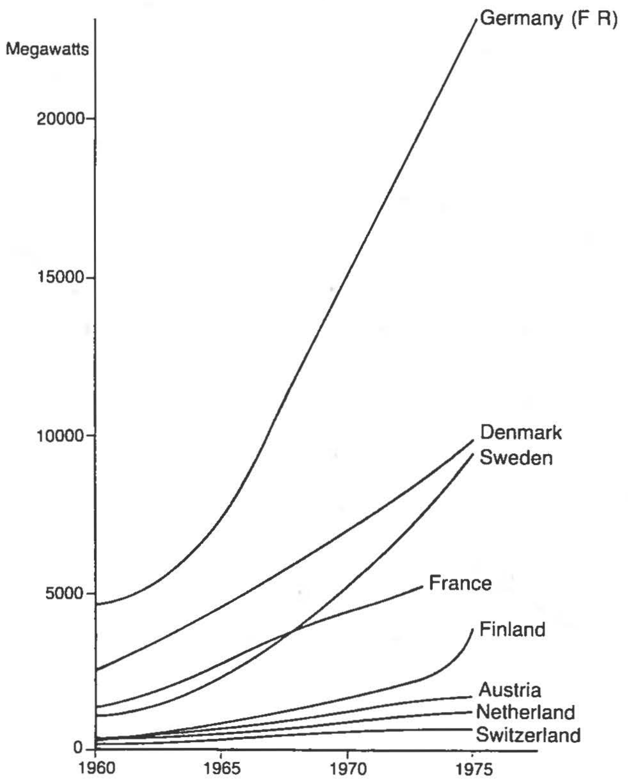

Fig. 7—Connected thermal capacity, Western Europe.

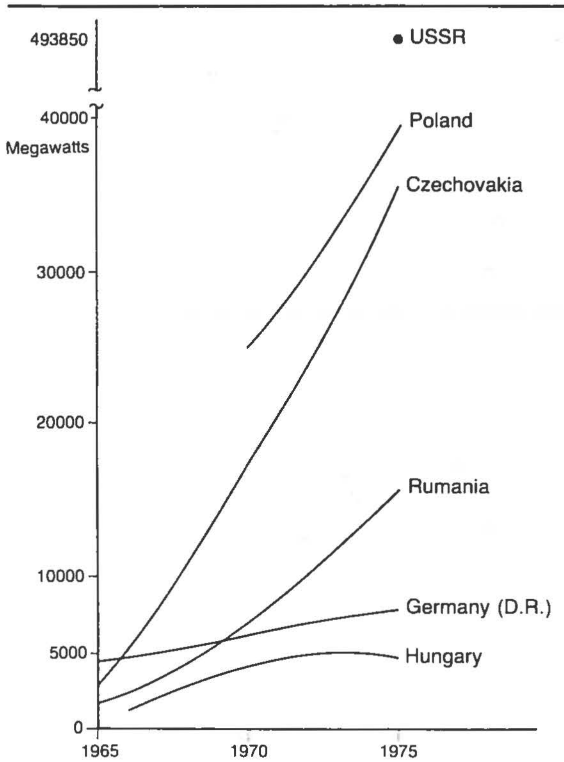

Fig. 8—Connected thermal capacity, Eastern Europe.

The heating level in homes, apartments, and commercial space is typically 20 C (68 F). Lighting levels are lower than we are accustomed to, but entirely adequate. Home electrical outlets are for 220-volt service.

Appliances in the home are generally the same, but tend to be somewhat smaller in size. Smaller refrigerator/freezers suggest somewhat more frequent shopping. In many new apartment complexes, outdoor clothes drying lines were built into the complex.

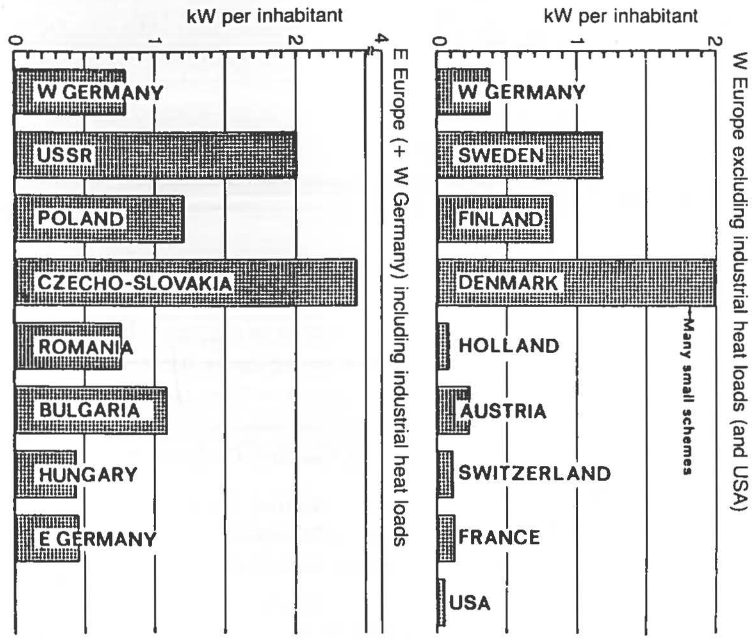

Fig. 9—Connected district heating loads.

Both the public and private personal transportation systems reflect the high (to us) cost of gasoline or diesel fuel. Bus transportation systems are extensive and service is frequent, clean, and widely utilized. Among other things, this minimizes the need for second cars. Automobiles are of a size and efficiency that we are now evolving to in the U.S. The cost of a Swedish-made car, which sells in the U.S. for $7000, can be twice that in Sweden when all taxes are considered. Rail, highway, and airline systems are first class by any standard.

The extent to which people walk and ride bicycles, and the extent to which new community planning provides for walking and cycling, is immediately apparent to any observer.

U.S. adoption of the energy use practices described would result in more efficient use of energy supplies. However, the extent of our industrialization and climate factors; e.g., suggest it is unlikely we could achieve the same energy use efficiency without severe impacts on our economy.

Closing

The Conference and facility visits provided a first-hand and fascinating view of a hot water technology which reliably meets the heating needs of many millions of people across the Atlantic. This technology may have major application in the U.S., not only in new towns, but in older urban areas where renewal/rebuilding is planned. The extent to which it is competitive with steam, heat pumps and other heating and cooling options, can only be determined by specific case studies.

Finally, the author would like to thank the many individuals in Finland and Sweden, who graciously helped make the trip so worthwhile for a representative of Detroit Edison and IDHA. ✹