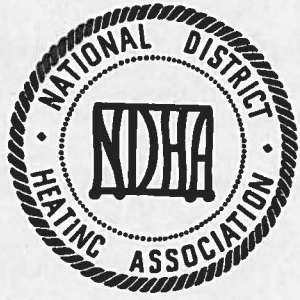
DISTRICT HEATING HANDBOOK

THIRD EDITION

A Manual of District Heating Practice

A Description of the District Heating Industry

A Guide to Modern Commercial Equipment



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requirements of the City as well as supplying a portion of the steam used for heating. The greater portion of the heating steam, however, owing to the size of the heating system, is supplied directly from the boilers.

The total investment in outside distribution mains is about $810,000. The investment in boiler-plant and steam-generating equipment chargeable to the Steam Heat Department is $400,000. Because extensions are financed by assessments to the houses benefited, the municipality has no direct financial interest in the outside mains. The system covers practically the entire city with the exception of some outlying section where, at present, it is not practical to extend the lines because of transmission losses.

Main extension cost is assessed against benefited property on the basis of a ten-year special assessment, payable to the City to be credited to the sinking fund for bond retirement.

Steam is supplied to several large office buildings, public buildings and schools, the city hospital, and residences.

The revenue from the sale of steam is intended to defray the cost of operating and maintaining the plants, plus a reasonable amount for depreciation. It is not the desire of the officials to make profits to build up a large reserve.

The success of this system can be attributed to the fact that in the early days, low-cost steam was obtained from the saw mill, and that the City has so developed that for the most part it is possible to distribute the steam in a more or less densely built-up area with the generating plant centrally located.

ALASKA

District heating probably has received its most severe test in Fairbanks, Alaska, where temperatures of minus 60 F are experienced. The system serves the dual purpose of heating the City and keeping underground water and fire mains from freezing. It is 8,000 ft long and in 1945 served 225 customers a total of 200,000,000 lb of steam. The steam, water, and fire mains are installed in the same duct thus preventing the latter two from freezing.

DISTRICT HEATING OUTSIDE THE UNITED STATES

CANADA

There is considerable institutional district heating in Canada, such as at the University of Toronto; the Government buildings in Ottawa; and the Toronto Terminal Railway Company development, which serves the Union Station, the Royal York Hotel, and Government and other buildings.

Commercial developments are limited to ten, the principal ones being in Winnipeg, Manitoba; London, Ontario; North Battleford, Saskatchewan; Brandon, Manitoba; and Quebec, Quebec. Winnipeg has three systems, each under different management.

The Winnipeg Hydro-Electric System, steam division, supplies the commercial district from a steam plant which serves the dual purpose of stand-by for the hydroelectric system and as a district heating generating station. The steam distribution system is approximately six miles long and supplies 284 customers with a total of 400,000,000 lb of steam annually.

The Winnipeg Heating Company supplies approximately 250,000,000 lb of steam annually to 1,600 residential customers through approximately twenty miles of main.

The Northern Public Service Corporation, Limited, in Winnipeg supplies approximately 320,000,000 lb of steam annually to 1,740 residential customers through 30 miles of main.

The system in London, Ontario, has eleven miles of mains serving 275 customers with approximately 330,000,000 lb of steam annually.

North Battleford, Saskatchewan, supplies 130 customers and Brandon, Manitoba 190 customers.

Saint Malo Heating Limited in the City of Quebec supplies 13 industrial organizations with steam for heating and processes.

ICELAND

Reykjavik, Iceland, is soon to be completely heated with district heat. The hot-water system is supplied from hot springs with water averaging 170 F. In April 1943, 2,700 buildings were heated and others are now being added.

EUROPE

The rate of growth of district heating in Europe in recent years has been greater than in the United States. This is because the cost of plants, distribution systems and labor is lower and the cost of fuel higher in Europe, and because combined heat and power generation has been developed to a greater extent. This combined generation has the advantage of saving expensive fuel and reducing plant attendance and maintenance. A substantial part of the heat distribution is by hot water which permits a high-thermal efficiency of the steam electric generating stations. By the use of large-capacity, hot-water accumulators, heat is sometimes stored and a more economical balance between heat and power demands obtained. All hot-water installations being made at the present time are for high pressure with temperatures between 270 and 375 F. The use of low-pressure hot water (temperatures up to 200F) is being abandoned in Europe as a heating medium. Table II and the comments thereafter indicate the extent of the growth of district heating in Europe.

RUSSIA

Perhaps the most extensive European developments have been in Russia. It appears that district heating there is being developed as a part of the planned national economy, with particular reference to the utilization of local fuel, thus conserving fuel oil and in some cases avoiding long hauls of good coal from distant points. The development has been mainly in the form of combined steam-electric plants serving new towns which are not electrically interconnected. According to the Five-Year Plan of 1938-42, which was interrupted by World War II, about fifty per cent of the total steam-driven electric-generating capacity in Russia would have been in combined steam-electric plants.

In 1939 there were 156 district heating developments in Russia, which delivered the approximate equivalent of 33,000,000,000 lb of steam per year. The ten largest developments had 135 miles of mains and 1,063 consumers. One of the largest developments was in Leningrad, which in 1938 sent out the approximate equivalent of 3,300,000,000 lb of steam. The most modern installations using high-pressure hot water as the heating medium are in Stalin-

TABLE II—PRINCIPLE DISTRICT HEATING SYSTEMS IN EUROPE

Location	Date of Installation	Heating Medium	Water Temperature, F	Connected Load, Million Btu/hr	Length of Distribution System, Miles	Maximum Diameter of Pipe, In.
Belgium						
Verviers	1938	Live Steam	.....	238.1	6.7	12
Czechoslovakia						
Bodenbach	1931	Hot Water	.....	8.7	1.1	6
Brno	1931	Steam	.....	722.2	6.8	20
Karlsbad	1931	Hot Water	356	63.5	4.0	8
Marienbad	1931	.....	.....	.....	.....	.....
Prague	1931	Steam	.....	369.0	7.4	12
Sendhubel	1931	Steam	.....	.....	0.1	12
Teplitz/Schonau	.....	Steam	.....	25.8	0.7	7
Usti	1931	Steam	.....	68.6	5.6	11
Denmark						
Aarhus	1931	Hot Water	248	48.8	2.6	12
Copenhagen	1931	Hot Water & Steam	194	324.2	12.4	10
Esbjerg	1931	Hot Water	194	10.7	0.8	8
Faaborg	1931	Hot Water	194	1.6	0.2	4
Frederiksberg	1931	Hot Water	194	37.3	2.7	5
Odense	1931	Hot Water	194	9.5	0.7	8
Randers	1931	Hot Water	194	12.3	1.1	10
Ronne	1931	Hot Water	194	1.5	0.3	6
Stige	1931	Live Steam	.....	67.5	7.4	5
France						
Chalon Sur Saone	1930	Hot Water	.....	7.9	3.7	.....
Grenoble	1937	Hot Water	.....	47.6	5.0	.....
Niort	.....	.....	.....	59.5	2.5	.....
Paris	1930	Live Steam	.....	952.4	19.9	28
Strasbourg	1920	Steam	.....	79.4	2.2	.....
Toulon	.....	.....	.....	3.2	.....	5
Toulouse	1942	Hot Water	.....	23.8	3.1	.....
Villeurbanne	1930	Hot Water	.....	158.7	4.0	10
Germany						
Aschaffenburg	1924	Steam	.....	23.7	0.9	.....
Berlin[1,2]						
Buch[2]	1929	Hot Water	248	91.3	5.9	14
Charlottenburg	1931	Steam	.....	103.6	2.9	20
Neukolln	1930	Hot Water	266	75.4	.....	9
Steglitz	1931	Hot Water	194	83.3	3.0	20
Bochum	.....	Steam	.....	39.7	1.5	8
Bremen	1931	Steam & Hot Water	176	47.6	1.8	14
Breslau	1929	Steam	.....	92.9	9.7	16
Brunswick	1929	Steam	.....	55.6	2.0	16
Chemnitz[3]	1929	Hot Water	374	59.5	2.4	6
Dresden [3]	1929	Steam & Hot Water	.....	182.5	6.6	8
Dusseldorf-Ehrenfeld	.....	Steam	.....	31.7	1.2	6
Forst[3]	1929	Steam	.....	31.7	1.5	24
Frankfurt-on-the-Main	.....	Steam	.....	89.3	1.2	16
Halle[3]	1930	Steam	.....	77.8	2.2	11
Hamburg[4]	1929	Steam & Hot Water	.....	634.9	16.8	32
Heidelberg	1934	Hot Water	365	84.4	6.8	.....
Karlsruhe	1929	Steam	.....	63.5	2.7	12
Kiel[5]	1929	Steam	.....	51.6	1.9	10
Leipzig[3]	1929	Steam & Hot Water	.....	198.4	6.5	20
Ludwigshafen[6]	1929	Steam	.....	24.2	1.2	.....
Mannheim	1937	Steam	259	40.0	0.3	.....
Meissen[3]	1929	Steam	.....	27.0	1.2	12
Munich[7]	1929	Steam & Hot Water	.....	95.2	.....	8
Munster	.....	Steam & Hot Water	.....	.....	.....	12
Nuernberg	1938	Steam	.....	11.8	0.6	.....
Pirmasens	1934	Steam & Hot Water	140	28.5	0.4	.....
Schwaebisch	1932-34	Steam	.....	33.2	0.8	.....
Schwerin[3]	1929	Hot Water	194	6.0	0.5	6
Stuttgart[8]	1935	Steam	.....	55.0	1.9	.....
Tubingen	.....	Steam	.....	81.3	1.9	11
Wolfsburg	1939	Hot Water	320	392.0	13.2	.....
Wuppertal						
Barmen	1929	Steam	.....	164.7	28.5	20
Elberfeld	1929	Steam	.....	158.7	4.9	18
Holland						
Eindhoven	1931	Steam & Hot Water	.....	5.9	.....	.....
Groningen	1931	.....	.....	.....	.....	.....
Leiden	1931	Steam & Hot Water	.....	32.5	.....	10
Utrecht	1931	Steam & Hot Water	248	95.2	7.1	11
Italy						
Vatican City	.....	Hot Water	.....	.....	.....	.....
Russia[9]						
Leningrad	1930	Steam & Hot Water	194-266	1,408.7	30.7	.....
Moscow	1931	Steam & Hot Water	194-266	1,587.3	37.3	.....
Switzerland						
Lausanne	.....	Hot Water	.....	23.8	0.7	.....
Zurich	.....	Steam	.....	27.7	1.2	8
Zurich	.....	Hot Water	.....	79.4	3.1	.....

See Footnotes on following page

grad and Moscow. There are approximately ten systems in Siberia and in the Far East.

GERMANY

In Germany the scarcity of fuel, the severity of winters, and the desire to use *brown* coal probably were important factors in the development of district heating. As in Russia, these developments were principally combination steam-electric and part of the planned economy. According to a report of the Association of Electricity Undertakings, there were in Germany in 1936, twenty-eight district heating plants. Sixteen of these were steam and twelve hot-water systems, principally of the low-pressure type. In 1936 the total send-out was the approximate equivalent of 5,000,000,000 lb of steam. The ten largest developments in 1939 had 90 miles of mains and 1,693 consumers.

GREAT BRITAIN

Prior to World War II there was little district heating in Great Britain. There were limited applications in Manchester, Dundee, Treforest, and in several other cities. In Treforest and Leicester substantial quantities of district steam were sold for process purposes.

Since World War II the tremendous amount of reconstruction and the necessity to conserve fuel has stimulated consideration of district heating. New systems in Urmston, Bemerton Heath and Bonnyrigg serve over 2,000 consumers, principally residential. Projects have been approved for eight areas which ultimately may serve over 10,000 dwellings. The largest of these will be combination heating and electric projects. In such locations as Bristol, Coventry, sections of London, and where other cities will be largely rebuilt, district heating is now under serious consideration.

FRANCE

The principal installations in France are in Paris, Lyon-Villeurbanne, and Toulouse. The development in Paris was started in 1930 and was greatly expanded during World War II.

The Lyon-Villeurbanne system uses high pressure hot-water as a heating medium. It supplies apartment buildings, office buildings, and process requirements in factories. In Toulouse a system was installed during World War II using high-pressure hot water which obtains its supply from heat generated in the Municipal incinerator burning household refuse.

CZECHOSLOVAKIA

A number of cities in Czechoslovakia have fairly large systems. The development at Brno is of special interest, as it supplies steam for heating and processes to a majority of the large textile and chemical factories as well as to other buildings. Substantial enlargement of this system is planned.

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[1] Does not include 6 additional heating plants.
[2] Six combined heating and power plants, with boiler pressures between 510 and 1450 psi and live-steam temperature, between 845 and 935 F are planned or under erection in western Germany.
[3] These 7 plants and one at Soldin are in the Russian occupied zone of Germany.
[4] Includes the Neuhof and Tiefstack systems.
[5] Includes the Humboldt Street and Wik systems.
[6] System destroyed during World War II.
[7] Includes the Muffat and Schwabing systems.
[8] Includes Muenster system only. H.K.W. System should now also be in operation.
[9] Other Russian Systems for which no data are available: Kotelnich, Pskov, Smolensk installed, 1930; Arkhangelsh, Karkov, Omsk, Orel, Rostov, Samara, Tanbov installed in 1931.

ELSEWHERE IN EUROPE

District heating has also been adopted in other countries such as Austria, Denmark, Holland, Norway, Sweden and Finland. In the Scandinavian countries district heat is used rather extensively for industrial plants, hospitals and other institutions. They also have a type of block heating in which one or several blocks of houses are heated from one plant. Vatican City is the only City in Europe heated entirely by district steam. In Brussels, Belgium, the Compagnie Generale d'Enterprises Electriques et Industrielles is interested in district heating.

PRESENT STATUS AND FUTURE OF DISTRICT HEATING

The results of the combined experience of many district heating companies permit the forming of some fairly definite conclusions regarding the engineering and economic status of district heating in America and its probable future.

Distribution of the quantities of steam required for heating, even in the largest cities, can be successfully accomplished, and the distances which can be covered are fixed by economic and not by engineering limitations. The service, if it is to be profitable, must be limited to favorable areas, and there is little prospect of city-wide use unless there should be shortages of the types of fuels which can be conveniently burned automatically under individual heaters thus bringing about a demand for service extensions at favorable rates.

Use of low-pressure hot water for commercial district heating has been definitely abandoned in America in favor of steam, but high-pressure hot water is finding wide acceptance in Europe.

The distribution of exhaust steam from electric generating stations or from electric generators installed in district steam plants is desirable in some cases. The recent use of higher pressures and temperatures for electric generation makes this method of steam supply more practical and economical than it formerly was.

A district heating system is desirable to the electric utility as a means of eliminating electric generator plants in individual buildings.

District heating has its most profitable and most popular field in the business districts of large cities, and there is an increasing demand for the service. It is not always as profitable in residential districts made up of detached single family dwellings when in competition with other methods of heating. Except for certain types of community developments and in severely cold climates, it appears that other methods are at present satisfying the demand for automatic heating in residences.

The supplying of steam to industries for heating and for manufacturing processes is being developed in some cities and is a promising field for more general development.

District heating provides a means of fuel conservation and contributes to our national welfare. It provides a clean, orderly method of supplying the steam requirements of the congested districts of our modern large cities and contributes to their advancement and growth.

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