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General Report
Thema II

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DISTRICT HEATING AND ENVIRONMENT PROTECTION

This is the second summary of papers which were presented at the Third International District Heating Conference in Warsaw, Poland, April 1976. The first was printed in our July-August-September 1976 issue. The summaries are verbatim transcripts which were prepared by Poland, the host country.

IDHA Headquarters has copies of the referenced papers, which are written in the national languages of the authors; photocopy prices will be quoted, upon request.

Introduction

In the range of heating of the buildings there are not and could not be the uniform solutions in all countries. The main reason of differences in heating technique are undoubtedly the climatic differences, occuring not only between north and south and as well between east and west of Europe. For instance milder climate prevailing in Great Britain and resulting out of this the shorter heating season - influenced that remote district heating is developing there slower than in Poland or any other countries in the middle and east of Europe.

The technical progress in district heating in substance goes in two directions: (1) still greater centralization of heat production and distribution by the district heating network (2) utilizing of more noble mediums of energy such as fuel oils, natural gas, electric energy, permitting

for efficient utilization and not requiring labour consuming service.

The choice of energy medium in the large degree depends on economical and power situation of particular country, on the way the towns and settlements are erected, on requirements in the range of environment protection and even on tradition and habits of the population of particular country. In addition, the situations, possibilities and costs are also changing, what we felt distinctly in the past few years.

Our views on the roles and tasks of so called primary energy mediums are also changing now and again; raw materials which in particular country in certain epoch represented fuels, after certain period of time ceased to be considered as such; as an example one can quote the wood which 150 years ago has been the basic fuel for the whole Europe, today is considered either as the noble material

for joinery or as a raw material for cellulose production. Similar fate met the peat, which was found too precious for gardening – to be further considered as a fuel.

For other reasons in many countries in Europe the role of hard coal was changed. There are also changes in development of district heating systems. At first the production and consumption of electric energy was treated as the local trade. Gradually, in course of improvement of technology transmission of electric energy, bigger power systems comprising large areas took place, territories of particular countries and even systems on the continent, wide scale.

The first gas systems in Europe started up actually during the Second World War - today the local production of fuel gas has been practically liquidated and the gas systems in the majority of European countries are between themselves interconnected. In the next few years the gas from Iran will go through USSR, People's Democracies to Austria, Italy, GFR and up to France.

During the lifetime of our generation the heating of houses by individual hard coal fired stoves in many countries have been replaced by the central heating comprising one house and later few houses, whole districts, large towns and municipal agglomerations. Today it is considered to include by one district heating system the whole regions and even the territories of particular countries. It is the correctness of all network or line systems of the industrial infrastructure. It does not mean at the least that in all countries simultaneously are growing up the conditions for using the extensive district heating systems.

The problems of atmospheric air protection against pollution, particularly in the areas of large towns are difficult to solve and generally accelerating the centralization of heat production and development of district heating network; it seems, however, that not always and not in all conditions it is the most advantageous way to limit

pollution of environment. In the very large agglomerations one cannot freely increase the heat capacity particularly of coal fired thermal power stations, under the menace of exceeding permissible standards of atmospheric air pollution.

One of the basic contradictions of urbanization is quickly advancing in course of expansion of towns, the menace to environment, particularly of air pollution. Everywhere, where centralization of heat production favours to overcome this contradiction, undoubtedly the district heating network of still greater range will be developing.

The fundamental advantage of district heating based on big sources of heat was up to the present the possibility of locating them on the outskirts of towns and in any case beyond the limits of populous dwelling districts.

The present views on the role of suburban districts, aspiration for ensuring for them even better environment conditions than it is foreseen for the central districts - is crossing out the possibilities of locating there large heating plants or thermal power stations. It seems that the correct direction of action would be the employment of such technologies of heat production, which would enable to localize the big sources of heat in the populous districts. Insufficient quantities of "clean fuels" in the form of natural gas or low-sulphuric fuel oil, which could be assigned for district heating - are indicating for considerable future which will have in this range the nuclear reactors. Employment, however, of the nuclear thermal power stations, which can be only profitable when the large heat capacities are installed, requires great consumers of heat and so of large district heating systems. One can expect, therefore, that together with development of the nuclear energetics in the course of the next few decades, the systems of remote district heating will quickly expand until they will be replaced either by cheaper systems distributing other mediums of energy produced by employment of cheap nuclear fusion or by very cheap electric energy.

Planning of district heating equally as large power plants requires of many years' time horizon. The more so there are in time the problems discussed in seven reports submitted for debates of our Section, out of which almost each one is dedicated to distinct issue. It testifies on one hand the large range of problems connected with influence of district heating on environment and on the other allows to state a great differentiation of difficulties occurring in the various countries.

In the schemes of general report we will try to signal also the problems noticed by us and not included in the detailed reports. Among other things we will be trying to introduce to the participants of debates of the Section 2 - the problems of heat economy in Poland which in consideration of the fuel base being in our possession - are first of all the problems of coal burning influence on environment as well in small as in the large furnaces.

Essential Thesis Comprised in the Reports

1. A.Dychno, W. Sawin and E. Goufman (USSR) in their report are introducing the advantages of the centralized heat production in the large thermal power station. Owing to greater efficiency of centralized heat sources one can achieve globally the reduction of fuel consumption and thus less emission of noxious pollutions of the atmosphere. In USSR there are 43% of thermal power stations fired by gas, 26% by mazout and only 31% by coal.

For the power and thermal power stations situated in the compactly built towns it is forbidden to burn mazout of sulphur contents greater than 0.5%; for the heating plants with high chimneys, distant from the centres of towns - it is admissible to have the contents of sulphur in mazout up to 1.5%.

In order to diminish the pollution of atmosphere it is also foreseen the gasification of mazout.

The report is exposing the problem of atmosphere pollution by nitric oxides, which concentration, subject to fuel is reaching up to $1g/m^3$.

The problem of water pollution by sewages from power stations and dependence of these pollutions on the manner of boiler and district heating network's water preparation was also taken up.

The authors in conclusion of their report are stressing the great future of district heating based on heat production in the nuclear reactors - what would completely eliminate pollution of the atmosphere.

2. K. Hanlon (Great Britain) considers looking far in the future the problem of fuels and energy supply and is advancing extremely unconventional proposals of the new solutions in the range of erection or modernization of towns and their infrastructure. He calls attention to modern solutions of town's infrastructure, which makes possible to bring places of employment closer to dwelling settlements.

The author declares himself as an advocate of settlement's concentration seeing in this the great possibilities of energy savings. He also points out the profitability of buildings' thermal insulation increase.

3. H. H. Kindermann (GFR) at the beginning of his report does state the lack in literature of the works comprising totality of legal and commercial problems of district heating.

The author is an advocate of district heating system's management decentralization and not treating them identically as the electric and gas power systems. The report in a very limited range is referring to the influence of district heating on environment, though indirectly, the selection of standards, administrative and organizational instructions - undoubtedly would help.

4. H. Munser, R. Lehman (GDR) are giving series

of very interesting numerical data elucidating the positive for the environment effects replacing in German Democratic Republic individual furnaces - by the district heating network fed from thermal power stations; they are also indicating on concomitant of this process savings of fuel and thus indirectly reducing emission of SO_2. They are signalling the excess of permissible 24 hours mean value of SO_2/ 0.15 mg/m^3 concentration in the few regions of GDR.

The report in its last section refers to extremely important problem of municipal garbage incineration. Description of the garbage incineration plant in Berlin is given, which is working since 1974 and at present is dealing with 180,000 ton of garbage yearly of calorific mean value 1400 kcal/kg and producing heat power of 40 Gcal/h.

5. A. Triboulet (France) deals in his report with the location of heat sources in the area of Paris and their influence on environment. The Paris steam network of about 200 km in length is fed from eight heating plants fired by mazout delivered by waterway Seine.

In the protected regions it is required limitation of sulphur contents in mazout up to 0.5%.

A lot of attention is given to the aesthetics of heating plant, particularly of introducing the chimneys into the composition of the town's architecture. It is also aimed to reduce the noise by installation of quiet machinery (for instance electric motors and turbopumps) underground. The maximum outer noise of heating plant is limited to about 40 dB.

The nuclear thermal power station 15 km distant from Paris with far reaching transportation of heat is planned to be in operation about 1982.

The author indicates on increasing possibilities of industrial establishments' location in the neighborhood of dwelling settlements.

6. J. Vlach, T. Fiala (Czechoslovakia) are giving the number of formulas permitting to estimate the influence on dustiness of environment - by various

methods of building's heating by means of solid fuel.

It is indicated on the local effect of electric heating - at the same time worsening of the nationwide environmental conditions, due to low efficiency of coal fired electric power stations.

The authors are anticipating more intensive development of electric heating after increase of the nuclear electric power station's participation in production of electric energy.

7. Housing Development Directorate (Great Britain). The collective report describes the development of district heating in Great Britain and explains the reasons for relatively slow introduction of centralized heating sources.

To these reasons one can include:

- Mild winters (the analytical open air temperature 1 C).
- Considerable participation of low buildings.
- Unfavourable conditions for construction of underground network in towns.
- Cheap coal until quite lately, in many cases in the open furnaces (the traditional fireplaces).

The mild climate in Great Britain did not affect as well increase of the buildings' thermal insulation.

It is foreseen the development of municipal garbage incineration with utilization of their calorific value which is estimated for 1/3 of the coal one.

The authors of the report are stating lack of State organization for controlling the district heating matters both in technical and in legal respect.

Problems of Environment Protection in Polish District Heating

1. Poland is the country rich in coal, does own practically no crude oil and resources of natural gas are permitting for limited extraction only.

Further development of production and utilization of coal demands mastering of three basic difficulties:

- Increasing of work productivity in mines due to decreasing supply of manpower and aversion for hard work underground.
- Increasing load carrying capacity of railways (water transport in Poland has minimal chances of development).
- Decreasing of noxious pollution of environment due to coal burning.

The last mentioned difficulty we are trying to overcome first of all by centralization of coal burning in the large boiler houses which relatively easier could be provided with electrofilters and other devices for cleaning the combustion gases from dust and probably in the future as well from sulphur oxides.

2. The quantity of burned coal yearly for every one ha of the country's area is in Poland the biggest in the world scale. Considerable part of power coal is sulphated; the mean contents of sulphur amounts to 1.4%, in some mines even exceeding 3%.

In Poland so far were not introduced restrictions limiting to burn of sulphated coal. Permissible 24 hours mean concentration of sulphur dioxide (SO_2) in the atmospheric air amounts to 0.35 mg/m^3 and on the areas specially protected (health resorts, national parks, etc.) 0.075 mg/m^3. These standards are milder than in many countries, none the less in many regions of the country are overran.

The total emission of SO_2 in Poland in 1974 was evaluated for about 6.5 mln tons; assuming that participation of strongly sulphated coal remains much the same as before - one could expect the emission of SO_2 in 1990 about 10 mln tons and in 2000 about 12 mln tons per year.

Assuming the zero balance of yearly exchange of SO_2 with abroad and accepting the total time of SO_2 decay in the atmosphere 72 hours, one could expect about 2000 the mean concentration of sulphated air in the country about 0.32 mg/m^3 and therefore, at the level noxious to the human health and vegetation of plants, diminishing growth of timber mass in the

forests and causing serious economic losses due to accelerated corrosion.

For reduction of mentioned above country-wide background of sulphating, the higher chimneys will not help, their number will increase and zones of noxious influence will overlap. Of course, in the neighbourhood of large power and thermal power station on the nation-wide "background" will overlap local pollutions, considerably exceeding the levels of SO_2 concentration permissible by the standards. The total capacity of power stations in Poland amounting at present to about 20 GW will increase up to the end of the current century to 110-120 GW out of which 60-80 GW will represent the hard and brown coal fired stations.

The battle against sulphation of atmospheric air will be carried out through:

- Elimination of strongly sulphated coal from the boiler's furnaces situated on the grounds of municipal and industrial agglomerations. It is planned to gasify in the first rotations the most sulphated coal.
- Enriching of the coal in mines and in particular removing pyrits out of coal.
- Using in all large power and thermal power stations the law sulphated interventional fuels, burned in the periods of disadvantageous atmospheric conditions.
- Searching for economical methods of desulphurising of coal combustion gases.

3. Apart from the battle against sulphur - oxides' pollution of atmospheric air - it still remains the current problem of fight against dustiness. This problem appears in the first place in small towns and settlements in which is not profitable to build the large centralized sources of heat and consequently clearing the combustion gases from dust will always be less effective. In the health resorts, recreation or historical places - it will be necessary to replace coal by the low-sulphuric furnace oil or even scarce in Poland, natural gas.

The problem of dustiness is still in existence in the large towns even at electro-filters' efficiency of 99%.

This problem is formed by particles of very fine dust (of diameter below 20 microns) which is not sinking on the ground but remaining suspended in the air and it can in unfavourable meteorological conditions increase noxiousness of sulphur compounds and create arising of so-called smog. Permissible mean 24 hours concentration of fine dust particles was defined for 0.2 mg/m^3.

In Lodz, the second largest town in Poland, after erecting of three thermal power stations and liquidating numerous industrial boiler houses and individual furnaces - the emission of dust of dimensions above 20 microns considerably decreased, but the total emission increased - because the quantity of dust of diameters below 20 microns increased nearly thrice. If before the thermal power erection the proportion of fine dust (below 20 microns) to coarse ones have been as 1:4, then after putting the thermal power stations (with pulverized fuel fired furnaces) into service - amounted to 1.8:1. So, there is now, quite a serious problem to be solved.

4. For dustiness of environment a considerable influence has also the management of "catched out" fly - ashes, slags and other furnaces waste. The quantities of waste are constantly increasing particularly due to tendency to burn of still worse quality of coals (fines, slimes, interlayers, etc.).

The waste from professional power and thermal power stations only (without the industrial ones) are considerably exceeding possibilities of country's utilization in production of building materials (cement, concretes, aggregates, etc.) or in construction of roads. At present in Poland already does occur the necessity to assign for the furnace waste storage yards about 100 ha yearly and in the face of planned five-six times increase of power station's capacity in the years of 1975-2000 the

area lost for waste storage yards will increase two-three times, despite that in the same time it is foreseen increasing of power station's waste utilization up to 40%.

The waste storage yards are growing to be the serious source of atmospheric air pollution. In order to decrease or just to liquidate the noxious influence of storage yards on the environment, it is planned to act in two stages. In the first stage recultivation of storage yards are carried out entirely in order to limit of the secondary dustiness. In the second stage it is planned to regain the full farming utility of the storage yard grounds.

The effects in this range one can attain by:

- To cart on the storage yard ground the layer of soil, what is effective but expensive.
- The biological recultivation.
- Chemical and biological recultivation (joining of the biological recultivation with covering of the storage yards by chemical film - creative or setting agents).

The biological recultivation is confronted with many difficulties, mainly due to toxic action of the ashes on plants. Also the climatic conditions and particularly big 24 hours temperature of ashes' amplitude - hinders biological recultivation. The works on biological recultivation are at present carried out in Poland on the storage yard grounds of about 130 ha; the number of affirmative results have been achieved and numerous plants were risen, which with proper doses of fertilizers (about 600 kg/ha) took roots on the storage yards.

In the scope of chemical-biological recultivation also good results have been achieved permitting for "immediate" liquidation of secondary dustiness and biological recultivation at the same time.

5. The problem of air pollution due to burning of coal in individual furnaces and in kitchen stoves in towns of over 20,000 of inhabitants is gradually cease to exist in Poland, because in the new building trade these installations are entirely eliminated and

in old buildings - as a rule, the central heating is introduced as the occasion occurs during major repair of buildings.

6. Considerations of environment protection against pollution of atmospheric air - will create serious restrictions for development of electric heating in Poland so far as the basic fuel in power and thermal power stations shall be hard and brown coal. The cause of this is low efficiency of the conventional power stations. In further future, in course of development of the nuclear power stations it will be possible to increase quantity of electric energy consumed (unfortunately in season only) for space heating. The electric heating shall be introduced in the first place in the villages and small towns, where however, the costs of heating will be highly debited on account of capital expenditures for development of power distribution lines of a low and medium voltage. In wider however range it is planned to use electric energy for water heating and for preparation of meals in housekeeping.

7. It is foreseen to erect after 1985 in few municipal agglomerations the nuclear thermal power stations which in collaboration with the conventional peak thermal power stations will feed both the lines of the power system and as well the large district heating networks. The last ones until then shall be fed from thermal power stations and heating plants fired by coal. Introduction of nuclear thermal power stations will radically restrict the influence of district heating on environment.

Thesis for Discussion and Exchange of Experiences

1. Fuels.
   a. Development of the world fuel's situation indicates for necessity of careful planning of liquid fuels and natural gas consumption in district heating. The supply of these fuels will decrease, their prices will go up. These fuels should be reserved for the centres and settlements which require special protection of environmental conditions.
   b. In the countries which have coal at their disposal - to develop production of heat in large heating plants and thermal power stations - aiming to eliminate their noxious influence on environment. However, one should consider that both the new methods of clearing the combustion gases and as well in the further future, gasification of coal - will cause distinct increase of heat production costs.
   c. In the light of relatively distant time limits for wider offering of the new sources of energy, such as solar, geotermic energy, etc., one should for nearest few scores of years anticipate the dynamic increase of heat production in the large nuclear thermal power stations or even in the smaller nuclear heating plants. This method of heat production one should recognize as the least dangerous to environment.

2. Town Planning and Architecture.
   a. Compactness of towns' buildings undoubtedly may contribute to decrease of fuel consumption in the country's scale and thus to limit the noxious influence of district heating on environment. None the less on intensity of buildings could not decide power considerations entirely, that is considerably wider social problem relative to the directions of changes in the manner of population's existence.
   b. Bringing near the places of residence to the places of work is desirable both from the point of view of time saving of town's inhabitants and as well restriction of atmospheric air pollution due to excessive,

forced utilization of communication means and particularly of individual cars.

Distribution of energy consuming industrial establishments an the habitable grounds, harmless for environment, would profitably influence on decreasing of prime cost of heat and will give better yearly utilization of district heating installations.

c. Anticipated increase of energy costs in all of its forms indicates for necessity of paying greater attention to thermal insulation of the buildings as well in case of heat supply from the district heating network.

d. District heating installations erected on the town's area must be constructed in aesthetic manner (particularly it concerns the chimneys) and not to be noxious to the environment (noise, smell, litter on communication roads, etc.).

3. District Heating System.

a. Under the name of "district heating" one should understand the assembly of devices and organizing undertakings which have in view the production of heat energy mediums, their transmission and distribution among consumers by means of pipelines' network.

b. The district heating system demands to create similar planning and management organization as it is in power and gas systems. One should expect in future substantial increase of district heating range, not excluding of the country-wide network construction. One should recognize as indispensable, even at the decentralized management of the local district heating systems, the existence in the country of the organ controlling the development of district heating systems through issuance of legal acts, guiding instructions of

designing, standards and carrying out scientific researches in the range of district heating. These researches should also comprise relations of the district heating systems with the other power systems, fuel economy, water, transport and particularly with environment protection, which influence on the development of power economy will constantly be increasing.

c. For increasing district heating range great influence will have the erection of nuclear thermal power stations in which participation of fuel price in energy production is relatively smaller than in conventional thermal power stations. On the other hand the high participation of capital costs will force greater utilization of devices, which one can achieve better at the large range of district heating network, supplying the heat not only to the municipal consumers but also to the industry.

d. Increasing amount of municipal garbage and industrial waste justifies the erection of large incinerators with utilization of produced heat.

e. In the heating plants and thermal power stations one should employ the boilers of construction limiting to the minimum emission of nitric oxides.

f. One should carry out the research work on elimination of fine dust emission (0% 20 microns) remained in the air as suspended matter.

g. In the face of probable excessive "supply" of furnace waste in the countries basing their power economy on hard and brown coal - further studies and efforts are necessary on recultivation of waste storage yards and on restoring their agricultural and environmental values. ✹