Birdsill Holly, the inventor of district heating.

Holly's home in Lockport, New York which was heated by the first underground steam lines in the United States. Story on Page 18.
General Report
Theme 1
by Professor Jacek Marecki

ROLE OF DISTRICT HEATING AND COMPETITION PROBLEMS
WITH THE OTHER MEANS OF HEAT SUPPLY AGAINST
A BACKGROUND OF THE WORLD FUEL AND ENERGY SITUATION

This General Report is a Summary of the papers presented during the first part of the
Third International District Heating Conference in Warsaw, Poland, April 6-9, 1976.
It is the first of four which are planned for subsequent issues of District Heating.
It should be pointed out to our readers, that these Summaries are verbatim transcripts
which were prepared by the host country, Poland.
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.
For a personal report by Mr. Ellwood Clymer, who attended the Warsaw Conference, please
refer to the "Address by the President" on another page in this issue.

District Heating Against a Background of the World­wide Fuel and Energy Development

The technical, economic and ecological problems connected with centralized heat energy supply have become
the subject of bigger concern in connexion with the so­called energy crisis and its effects in the form of
repeated growth of liquid fuel prices. These problems are of big significance not only in our country having
large resources of solid fuels but also in other countries of similar climate conditions, where seasonal
heat demand appears for habitable room heating, and where a full year's demand for hot water exists. The
significance of district heating has grown in recent years due to the changing of world energy situation.
The hitherto world energy development in the XXth century, and especially during the last 25 years was
characterized by annual vast growth of total energy consumption. In Table I, some of the most important
information on world primary fuel and energy consumption in the years 1900-1974 based on statistics of the
appears, among others, that relative growth of total energy consumption, which has been assumed as equal of
world energy production, amounted to about 2-3% per year till the middle of the century and in the years
1960-1970 it increased to about 5-6% annually. This growth set back rapidly in the years 1973-1974.
According to the unanomimous opinion of specialists in complex energetics, stated among others by K.
Kopecki (Problems of Complex Energy Development in Poland, Warsaw 1975, in Polish) at the last session
TABLE I

World Fuel and Primary Energy Production

<table>
<thead>
<tr>
<th>Year</th>
<th>Yearly Production $10^9$ CJ</th>
<th>Yearly Growth %</th>
<th>World Population $10^6$</th>
<th>Production Per Capita Per Year $t^2$</th>
<th>$t^6$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900</td>
<td>22</td>
<td>750</td>
<td>1571</td>
<td>14</td>
<td>0.48</td>
</tr>
<tr>
<td>1925</td>
<td>45</td>
<td>1535</td>
<td>1965</td>
<td>23</td>
<td>0.78</td>
</tr>
<tr>
<td>1950</td>
<td>80</td>
<td>2730</td>
<td>2486</td>
<td>32</td>
<td>1.10</td>
</tr>
<tr>
<td>1960</td>
<td>123</td>
<td>4200</td>
<td>2982</td>
<td>41</td>
<td>1.40</td>
</tr>
<tr>
<td>1965</td>
<td>158</td>
<td>5400</td>
<td>3289</td>
<td>48</td>
<td>1.64</td>
</tr>
<tr>
<td>1970</td>
<td>211</td>
<td>7200</td>
<td>3632</td>
<td>58</td>
<td>1.98</td>
</tr>
<tr>
<td>1973</td>
<td>230</td>
<td>7850</td>
<td>3860</td>
<td>59</td>
<td>2.03</td>
</tr>
<tr>
<td>1974</td>
<td>223</td>
<td>7620</td>
<td>3940</td>
<td>57</td>
<td>1.93</td>
</tr>
</tbody>
</table>

*Counted in tons of equivalent coal: 1 t = 7 Gcal = 29.3 CJ.

(Source: WEC - 1974 Statistics and K. Kopecki's works for the Polish Academy of Sciences.)

of the General Assembly of Polish Academy of Sciences, the reason of such a development has been the change in structure of covering the world demand for fuel and primary energy. The share of solid fuels in covering this demand, which before 1950 amounted to much higher values than 50%, decreased to 34% in 1970, while the share of crude oil and gas was increased to 61%. The most important reason of energy development in the years 1950-1970 was a low price of crude oil and gas, its general availability, lower costs of plants consuming oil and gas products, and the easiness of their regulation and automatization.

This development was stopped in 1973-1974 due to the repeated growth of oil prices, which caused the far going rationalization of fuel and energy mainly in industry and room heating in developed countries. It is predicted that world demand of fuel and energy in the year 2000 will be about 20% less than it was estimated before 1973 and will amount to $770.10^9$ CJ (about $26.10^9$ t of equivalent coal) and its structure will change significantly.

According to K. Kopecki's paper mentioned above, the share of solid fuels in covering the world demand in the year 2000 will amount to 19%, oil and gas to 49%, water and geothermal energy to 2%, and nuclear energy to 30%.

In the structure of final energy utilization a big share is possessed by thermal energy used for room heating and air conditioning. In Poland in 1970 this share amounted to 40% of total direct energy utilization in all energy carriers, while the share of heat used for technological purposes in industry amounted to 43%. The rest, i.e., 17% were industrial drives, transportation, lighting and other small receivers. Similar structure of direct energy utilization in FRG in 1971 is given by H. P. Winkens in his paper presented at this Conference. In FRG, 40% of energy has been used for room heating and air conditioning, 36% for technological purposes, and 24% for electric drives, lighting and others.

In all industrial countries, urban housing is strongly developing. It causes continuous growth of energy demand for room heating. Also in rural housing the demand for this type of energy is still growing because its equipment is becoming more and more similar to the urban one. The increase of prices of liquid and gas fuels causes the growth of competition and the importance of district heating as of that branch of energetics which takes care of centralized heat supply by means of hot water from heating plants and conventional heat and power plants (on solid fuel mainly) and nuclear heat and power plants in the future.

To meet the fast growing heat demands in developing district heating systems in technological and economic respect, new exploitation methods of optimum investment programming and exploitation as well as other means of regulation and automatization of these systems are necessary. A new view on district heating develop-
ment is needed as one of the methods of environmental protection against pollution, since the emission from dispersed heat sources is several times higher than that from conventional heat and power plants. In future nuclear heating and power plants will be more profitable in this respect.

There exists a big similarity between a district heating system and other energy systems (electro-power and gas producing) despite of limited territorial range of a heating system. Similarity appears in parallel work of sources, in methods of peak heat load coverage, in economic load dispatching, in reliability of heat supply and reserve capacity planning, in automatic regulation of energy carrier parameters in distribution centers of the system, in capacity disposition in the system, etc. These problems have been almost completely recognized and controlled in electric power systems, and partially also in gas systems. Their importance in district heating systems is growing distinctly.

Review of Papers in the First Subject Group

General Characteristics and Classification of Papers

Eleven papers from nine countries submitted to the Conference have been numbered to the First Subject Group. The following countries submitted one paper each: Bulgaria, Czechoslovakia, Yugoslavia, German Democratic Republic, Federal Republic of Germany, Great Britain and Soviet Union. There were also submitted three papers from Poland.

The papers can be divided into three sub-groups of subjects. The first sub-group is composed of five papers, in which the authors are dealing mainly with methods of planning and optimization of district heating systems or comparison of variants of different kinds of energy carriers. The authors of these papers are: L. Borel, Switzerland; L. Khrilev, N. Zinger and I. Smirnow, U.S.S.R.; A. Siodelski, Poland; J. Swierniak and A. Pieszczyk, Poland; H. P. Winkens, FRG.

The second sub-group contains four papers in which the authors present the present stage of district heating development, the possibilities and prospects of its further development in author's countries are shown: A. E. Haseler, Great Britain; F. Hronek, Czechoslovakia; H. Surber, GDR; and D. Zywiecka-Pittner, Poland.

The third sub-group includes two papers dealing with different subjects connected with district heating development or such detailed solutions, which cannot be used directly in other conditions. The authors of these papers are: N. Djajic and D. Malic, Yugoslavia; C. Mumdjijan and A. Kirij, Bulgaria.

Papers on Planning and Optimization in District Heating

1. The Swiss paper of L. Borel is generally dealing with the application of energy to the evaluation of heat supply variants. A general dependence of energy on temperature at which heat is transferred is presented. The principles of making the energy balances are also given. On the base of energy efficiency conception, an evaluation of a number of energy processes has been performed: individual and central room heating, electric energy production and electric heating, heat pumps, combined energy production in a heat and power plant, heat distribution and transmission, and heat penetration through the walls of heated rooms to atmosphere.

Although the application of energy conception and energy efficiency to the evaluation of heat supply variants might be discussed, nevertheless L. Borel's proposals based on thermodynamical conceptions are interesting. He suggests the following schemes of supplying heat to the consumers:
- In large urban agglomerations: hot water from heat and power plants
- In small towns and villages: by heat pumps
- In rural areas: electric heating of houses.
He also suggests to include the degree of heat energy dispersion in environment, as a result of the ratio of heat loss to the atmosphere (air or water) to the effectively consumed energy in receivers. Furthermore he suggests to fix the price of heat energy on the base of its energy. From the general conclusions of the author, three following statements are worth mentioning:

- For the evaluation of heat consumption, temperature level at which heat is consumed and the environment temperature are important.
- The electric and heat energy are equal and none of them is a side product of the other energy mentioned here.
- The optimization of heat supply should be performed from the energetic, economic and ecological points of view.

2. The Soviet paper of L. Khrilev, N. Zinger and I. Smirnov deals with the different aspects and methods of heat systems optimization. Different factors result in different way on perspective planning of district heating systems in dependence on time horizon, which can be five, ten or 15 years. For average planning period, i.e. 10 years, the subject of optimization can be:

- Kind, number and limit output of heat sources.
- Installed heat output capacity in heat and power plants, units composition, time of introducing them into the system, and utilization methods.
- Parameters of heat carriers, configuration and dimensions of pipelines in district heating system with regard to reliability factor.

An outline of optimization methods for the solution of following problems is given in this paper:

- Choice of installed capacity of heat and power plant, units composition and time of introducing them into the system.
- Determination of optimum concentration of heat sources capacity.
- Optimization of boiler houses (local heating plants) development.
- Optimization of the main pipelines development.
- Optimization of district heating systems with not synonymous input data.

The authors have divided all information, necessary for system development planning into three categories: determined (complete) information, incomplete information and information determined in probabilistic way, i.e., having a determined distribution of probability. One of the most interesting statements in the paper concerns the shares of the above kinds of information which depend on the time horizon. The authors say that by passing from five years to 15 years planning period the share of determined information decreases from 60 to 25% and the participation of incomplete information increases from 35 to 70%.

In both cases the share of information determined in probabilistic way remains the same and amounts to about 5%.

Further on, the authors composed the most important limitations resulting on the choice of the optimum variant of district heating system development, and particularly:

- Total investment expenditures on district heating development.
- Volume of fuel (divided into many kinds) for possible consumption for heating purposes in given regions.
- Existing production capacity in electromechanical industry and possible level of their development.
- Volume of pipelines possible to be achieved for district heating system construction.
- Capacity of labour forces.

Some of these limitations are identical with those examined in A. Siodelski's paper, also belonging to this group of papers.
In final part of their paper L. Khrilev, H. Zinger, and L. Smirnov give the optimization principles of heat and power plant temperature diagram, which shows the dependence of network water temperature on the external air temperature. The suggestion to pass from temperature 150°C to 170°C during winter time seems to be controversial because of still growing fuel prices in comparison with the price of steel. The authors are also considering the methods of regulating heat supplied by a heat and power plant taking into account the domestic hot water consumption.

3. The Polish paper by A. Siodelski deals with programming the combined production of heat and electric energy development with limited investment means. By "investment means" the author understands the total necessary means for investment realization. And so these are not only finances but also materials, devices, equipment necessary for work performance, labour forces, etc. The quantitative limitations of investment means usually possess balance character. They are a result of domestic balance of finances, material balance, labour forces balance, potentials of assembly companies, etc.

In the paper the two-value linear programming methods have been used, which enable the choice of such a variant from many possible variants of developing the reconsidered district heating systems set, that the limitation of investment means in domestic scale will be fulfilled, and the assumed target function will reach the minimum value within this limitation. In particular the two-value programming enables to determine whether the combined heat and electric energy production, or separate production of heat in a heating plant should be applied. In this case, the total yearly costs discounted on a chosen time moment, are the target function, and the limitations can be as follows:

- Total investment costs in a given time interval.
- Materials volume (for example, pipes for distance heating system construction).
- Quantity or capacity of disponible energy equipment (for example, steam boilers, hearing turbo-sets, water boilers, etc.).

It is also possible to determine such a subset of development programme, close to optimum, which differ from the optimum one by a value of target function which is smaller than the assumed in advance value $E$. The other particular programme, which extremize other linear target functions can also be determined in this subset. These may be programmes minimizing the number of places in which the given equipment is assembled simultaneously, or the number of places, in which investment starts simultaneously.

The proposed method is illustrated by a simple example of investment programme optimization in three district heating systems, in which seven investment variants with two inequality limitations and three equality limitations can be realized. The well known algorithms of two-value linear programming permit to regard dozens of variables at several limitations. According to the author there are sufficient possibilities for combined heat and electric energy production at limitation of investment means in domestic conditions.

4. The second Polish paper of J. Swierniak and A. Pieszczyk is dealing with the choice of heat supply method for new compact housing estate. In the economic evaluation of different variants of heat supply for housekeeping, the authors accepted the following principles:

- On the base of discount method actualization of the costs, investment and effect streams at the same time moment.
- On the base of energy costs drawing from primary energy production till energy utilization inclusive.
- On the complexity base, considering all 3 ways of heat utilization, i.e., for room heating, for preparing the domestic hot water and preparing meals.
The proposed method is especially useful in model research. However, no numerical results have been given in the paper. They are available in the source work of J. Swierniak and his team of 1975 (Optimization of the Heat Supply Structure in New Housing Estates. The work of the Central Institute of Mining, Communique No. 87, Katowice 1975, in Polish). It is to be desired that the authors would give, during discussion, some information on the profitability limit of room heating from a district heating system in comparison with the methods of heat supply. They could be compared with the calculation results of other authors. For example, C. Mejro in his work of 1974 (Principles of Energy Economics, Second Edition, WNT Warsaw 1975, p. 316, in Polish), based on fuel price before 1973, stated that the construction of 15-20 m²/ha was unprofitable, with no regard on whether it considers systems supplied by heat and power plants, or local heating plants.

5. The paper of H. P. Winkens (FRG) contains a very interesting dependence of heat demand on external temperature. This is a non-linear dependence which says that the rated value of peak demand for heat at external nominal temperature amounts only to about 60% of the value determined according to the standards assuming linear dependence. This is one of the basic problems of district heating and it is to be desired that it would be confirmed during the discussion. The existence of such a non-linear dependence has also been noticed in Poland, among others at the symposium (J. Marecki - Communique... on "Heat and Power Balances in District Heating Systems," Archiwum Energetyki No. 4, 1974, in Polish) of the Energy Committee of the Polish Academy of Sciences on heat and power balances in district heating systems (Jablonna, April 1974).

Furthermore H. P. Winkens compares the costs of supplying heat to a compact housing estate from the district heating system supplied by the heat and power plant and from the gas system distributing natural gas. In new economic conditions which have been caused by significant growth of liquid and gas fuel prices in the years 1973-74, the following conclusions can be drawn:
- By district heating, about 15-20% of the primary energy for room heating and hot water preparing, can be saved.
- In new building systems, if the distance of heat transmission is not too large, it is profitable to connect buildings to a district heating system even when the consumer's heating capacity is very small.
- In already existing building systems on the areas supplied with natural gas the profitability of conversion to heat supply from a district heating system depends on the density of heat consumption and connected heat capacity.

From the analogical comparison of district heating and electric room heating, it comes out that in the nearest future the growth of the share of electric heating in different forms is possible, however, not in the compact housing estates, but rather in dispersed buildings.

Papers Dealing with District Heating Development in Different Countries

1. The British paper of A. E. Haseler is dealing with different aspects of replacing the direct consumption of primary fuels as well as electric energy and gas for room heating by a centralized heat supply from district heating systems. The author mentions the profits connected not only with fuel savings but also with smaller polluting emission. The density of population in England and Wales is one of the biggest in the world proofs (according to the author) the sense of large district heating development. The author estimates that the fuel savings resulting from the centralization of heat supply amount to 20-30%. In the case of combined heat and electric energy production the fuel savings reach 25-40%. There are 31 towns and agglomerations in Great Britain with more than 200,000 inhabitants. The density of population in these agglomerations, where district heating development is proposed, amounted in 1971 from 1370 to 5580 persons per 1 km².
2. The Czechoslovak paper of F. Hronek is dealing with main directions of research and studies connected with district heating development. He underlines the necessity of a system approach to the problems involved as it is the case in other energy systems. A part of the paper concerns the problems of future development of nuclear heat and power stations. According to the author, the combined production factor in such a heat and power plant should be much higher than in conventional solutions and may amount to 0.7-0.8. The development of nuclear heat and power plants in Czechoslovakia will be based on pressurized water reactors of VVER type, which will also be installed in condensing nuclear power plants.

The further part of the paper is dealing with problems of reliability in district heating systems. In the final part of the paper problems included in government plan of technical development, and rationalization of fuel and energy economy in the years 1976-80 are discussed.

3. The paper of H. Surber (GDR) is dealing with district heating development resulting from houses building programme in GDR till 1990. In the provisions ten years from 1964-74, the growth of heating capacity installed in district heating systems of GDR amounted to 132%. It is supposed that in the years 1976-80 about 415 000 new houses will be centrally supplied with heat which should amount to 90% of new houses. Furthermore about 90 000 flats will be supplied with heat from the industrial plants. About 2.1-2.3 million flats are supposed to be built in GDR till 1990. The share of flats centrally supplied with heat is supposed to grow from 12.5% in 1975 to 32% in 1990.

The author gives following values as an economic limit of combined heat and electric energy production in heat and power plants:

For brown coal: 120 Gcal/h at 2500 h/a
or: 100 Gcal/h at 4000 h/a

For hard coal: 200 Gcal/h at 2500 h/a
or: 130 Gcal/h at 4000 h/a

As a distance limit of heat transmission the author suggests 1200 Gcal/h at the distance of 25 km. He also considers the possibility of utilizing heat contained in return water of about 80 C, e.g., for production purposes in greenhouses in suburban areas.

4. The Polish paper of D. Zywiecka-Pittner contains a synthetic look at the problems of district heating development in Poland and its prospects till 1990. The heat and power plants and communal heating plants produce heat in 30 towns today, and ten more towns are supplied with heat from heating units in condensing power plants. The local heating plants work in almost all towns. Over 100 industrial power plants supply with heat the adjacent housing estates. The share of communal and industrial power plants in heat production for heating and hot water has grown from 12.8% in 1970 to 21% in 1975. The further growth is planned up to 40.8% in 1980 and 58.4% in 1990 (Table II).

The yearly fuel savings resulting from centralized heating supply have been estimated by D. Zywiecka-Pittner for two million tons (at the present stage of district heating development in Poland) and the employment reduction of 11 000 persons. The total yearly profits have been estimated for one billion zloty at the prices of 1975. An incommensurable profit as, for example, diminishing of air pollution by dust and SO₂ emission has also been underlined.

Remaining Papers Included in the First Subject Group

1. The Yugoslav paper of N. Djajic and D. Malic concerns the application of a heat pump utilizing geothermal waters for district heating system purposes. In the paper two variants of a heat pump have been presented. In winter they serve for heating purposes, whereas in summer for air conditioning of rooms, and during the whole year, for preparing hot domestic water. It is provided, however, that the electric energy supplied to the pump is produced in conventional electric
TABLE II
Structure of Heat Production
for Heating and Hot Water
in the Years 1970-1990 (in %)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Communal power plants</td>
<td>11.2</td>
<td>18.7</td>
<td>37.2</td>
<td>52.2</td>
</tr>
<tr>
<td>Industrial power plants</td>
<td>1.6</td>
<td>2.3</td>
<td>3.6</td>
<td>6.2</td>
</tr>
<tr>
<td>Local heating plants</td>
<td>13.8</td>
<td>19.4</td>
<td>12.1</td>
<td>9.7</td>
</tr>
<tr>
<td>Local and individual boiler houses</td>
<td>3.9</td>
<td>5.9</td>
<td>7.9</td>
<td>5.7</td>
</tr>
<tr>
<td>Stoves</td>
<td>69.5</td>
<td>53.4</td>
<td>38.0</td>
<td>19.4</td>
</tr>
<tr>
<td>Accumulation heating</td>
<td>-</td>
<td>0.3</td>
<td>1.2</td>
<td>6.8</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

power stations. Electric energy produced in hydroelectric plants seems to be more profitable for the pump's drive. The solution adopted in the Yugoslav town Kikinda could be applied not only in other countries with sources of geothermal waters, but also with large resources of water energy in rivers, having cheap electric energy and lack of cheap fuel.

2. The Bulgarian paper of G. Mundijian and A. Kirij contains a method of central heating regulation in the district heating system of Sofia. It permits to take into consideration not only the influence of the external temperature, but also the speed of wind, the solar irradiation and other factors, which are taken as aleatory variables. The district heating system is considered in this case as a regulation system, having several inputs and outputs, whereas the output values are the internal temperatures of the heated rooms.

Competitive Conditions of the District Heating System as Compared with the Other Methods of Heat Supply

Against the background of the papers submitted to the present Conference and counted to the First Group of Subjects and other study works, elaborated in different countries, one can formulate several conditions of competition of district heating systems as compared with the other methods of heat supply for heating rooms. First of all, the rentability of the centralized supply of heat should be considered, compared with the application of individual sources of heat, and later one should determine the usefulness of combined heat and electric energy production in district heating systems, compared with a separate one. An indispensable condition of such an economic evaluation is its complexity. All social costs and the effects obtained in compared variants should be taken into account. For example, when determining individual usage costs of coal fired stoves and floor boilers, the following should be taken into consideration:

- Consumer's own labour cost connected with the exploitation of stoves.
- Costs resulting from lowering the used surface of flats by application of stoves and connected with them combustion ducts.
- Costs of supplying and storing fuel at the consumer's, and the ash removal.
- Social losses connected with environmental pollution.

A lower utilization effect of coal stoves compared with a central heating and electric system should also be taken into account. This lowering is a result of unsatisfactory heating in part of buildings as well as worsening of hygienic conditions in the flats. The further condition of exact comparisons in the considered range is the application of marginal costs instead of average costs. For example, while comparing the costs of a central heating system with the utilization of natural gas for this purpose, it is necessary to calculate the marginal cost of imported gas, instead of an average cost of gas obtained in the country and imported. Very often in different elaborations the district heating system supplied by a heating plant is compared with a heating system based on accumulated electric heating. There is no
doubt that the development of accumulation heating equipment should not cause a rise in loading the electric power system over the load occurring in power plants during the evening peak. Instead, the way of optimum filling the daily trough of loading the electric power system is discussed.

In the elaborations of the Institute of Energy executed by a team under the leadership of J. Filipowicz (Possibilities of Increasing the Electric Energy Supply to Cover the Communal Demand in the Field of Electric Heating. Works of the Institute of Energy No. 11148, Warsaw 1975, in Polish), it has been proved that it is economical to load the trough first by energy drawn for pumping water in pumped storage power stations, and later by energy used for accumulation heating of warm water of common use. Only in further order is it economical to fill up the load by accumulation heating of rooms.

The above mentioned statement of J. Filipowicz expressed also during the Polish Conference on Achievements and Prospects of District Heating Development in Poland (Lodz, June 1975) should, however, be confronted during the present Conference with the opinions of experts from other countries. The problem of profitability limit of electric power system development for the use of accumulation heating of houses in comparison with the other heating means, wherein by hot water from a district heating system, should also be discussed.

In many elaborations and publications (J. Marecki - Combined Generation of Heat and Electric Energy, WNT Warsaw 1973, pp. 187-192, in Polish), for many years the question of the lower limit of profitability has been discussed, i.e., combined heat and electric energy production in heat and power plants in comparison with separate heat production in heating plants and electric energy in condensing power plants. For many reasons, this limit is permanently growing and will grow further because the decisive influence has the size of investment costs in power plants and in heating systems, which is higher than the increase of fuel costs (mainly of coal) utilized in combined systems.

In spite of it, the question of profitability of combined production is still actual and should be the subject of studies and discussions, even if the suitability of district heating system in the sense of a centralized heat supply is beyond any doubts. In concrete cases one can consider the advisability of constructing big regional heating plants instead of heat and power plants.

The above mentioned almost classical problem of comparing the combined production with the separated one and of the limits of profitability of heat and power plants demands further studies and discussions from the beginning in the case of nuclear heat and power plants. If there is an equivalent variant for a nuclear heat and power plant consisting of a nuclear heating plant or plants from one side and a condensing nuclear power plant of great capacity from other side, it may come out that the profitability limit of combined generation would be very high.

Proposals of Subjects for Discussion

In order to clear up the discussion in the First Subject Group, it is recommended to concentrate the discussion on the following main questions:

- The main circumstances of a broad development of district heating resulting from the present situation in world fuel and energy supply.
- Methods of planning and optimization of district heating systems development.
- Methods, criteria and comparison conditions of different means of heat supply for heating rooms.
- The factors affecting the profitability limits of combined heat and electric energy production in conventional and nuclear power plants.
- The programmes of district heating development in different countries in comparison with the other energy systems and the other means of room heating.