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REPORT OF THE GERMAN DEMOCRATIC REPUBLIC ON THE USE OF NEW AND RENEWABLE SOURCES OF ENERGY

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During the last few years, the problems of raw material and energy supplies have exacerbated. It has become a global problem to ensure a safe and reliable supply with fuels and energy which confronts all countries, although in different ways, with new and complex problems.

The fuel and energy problems are characterized by their complex nature. Their successfull solution depends on a political, economic and scientific-technological cooperation of the states on a world-wide scale.

The preparation and implementation of the UN conference on new and renewable energy sources shows the necessity and possibility of tackling the solution of the present problems. The further development of an international, mutually advantageous cooperation in the field of new and renewable energy sources can substantially contribute to the economic and social progress, in particular of the developing countries. The UN conference should aim at helping to implement the Charter of Economic Rights and Duties of States, especially the principle of the full and permanent sovereignty of every State over its natural resources and thus contributing to develop stable and just international economic relations.

No state has the right to obtain access to foreign energy resources by force and jeopardize preservation of peace. The solution of these questions, build on reason and sense of realism, is in the interest of all states.

The relation between energy consumption on the one hand, and economic growth, industrialization, labour productivity etc. on the other hand, requires that the further economic growth

can only be achieved by an equivalent extension of each country's energy basis.

For years, the energy policy of the GDR has been based on the maximum use of the national energy resources, the most efficient energy use and the development of the socialist economic integration within the framework of the Council of Mutual Economic Assistance (CMEA), and the GDR will reinforce these efforts.

Contrary to other countries the GDR has practically no resources of crude oil and only restricted resources of natural gas. There are, however, important resources of lignite, whereby mining meets with worsening geological and hydrological conditions. The world-wide change of primary energy carriers structure is realized in the GDR under these specific conditions. Raw lignite will be the most important energy carrier still for a long time.

In search of alternative energy sources for substituting fossil energy carriers also non-conventional and non-nuclear energy carriers are investigated for their potential use and productiveness.

On the territory of the GDR, there is no potential for using some of the new and renewable energy sources - for some only a restricted potential. Despite this fact, a systematic research and development is implemented as well as the participation in international activities. In this connection, the GDR can rely on scientific-technological experience and operation experience made during the utilization of other energy resources with low

heating value, and their optimum integration into the energy economy.

1. Role of raw lignite

Raw lignite and products of its processing (briquets, coke, gas, benzine) can for a long time become important for the development of national economy of many developing countries which have this energy source but not yet use it. Under this aspect the following chapter gives a short characteristic of the role of raw lignite in power industry of the German Democratic Republic.

The domestic raw lignite as primary energy carrier (heating value: about 8,8 MJ/kg; water content: about 50 - 60 %) plays the dominant role, it meets more than two thirds of the total primary energy revenue. The GDR disposes only of a limited deposit of natural gas and during the last few years, the extraction of hard coal was stopped due to exhaustion of deposits. Thus, the demand for priority utilization of the domestic energy resources leads to the maximum utilization of the national lignite deposits which are not unlimited but admit an industrial utilization.

According to the importance of lignite as most essential basis of the GDR, government stipulations ensure that all deposits being extract-worthy due to the prior art will be largely protected from erecting industrial plants and housing areas.

At present, about 260 . 10^6 t of raw lignite are extracted in the GDR. Thus the extraction quantity doubled compared with the foundation year of our republic - more than 30 years ago. A further increase of up to 280 to 300 . 10^6 t is envisaged for

the eighties and nineties. It must be noted that this extraction development takes place under mining conditions which become increasingly unfavourable. At present, approximately 4 m^3 of earth have to be removed in order to extract one ton of lignite whereas it will be approximately 5 m^3 of earth in 1990. Therefore, the most important task of the GDR's lignite industry consists in compensating these increased expenditures by a further reduction of the extraction losses, an efficient application of the available open-cast mining high-capacity equipment and new technologies as well as most up-to-date equipment.

During the last few years, scientific-technological results being guiding for the further development have been put into practice by the use of highly productive conveying bridges for open casts being controlled by process computers and having a stripping thickness of 60 m, new equipment combinations, automatically controlled drainage works and highly efficient belt equipment.

On the basis of the large lignite deposits, the GDR can look back on a historically grown development of the lignite industry. Lignite is used in almost all energetical fields of application. Due to its high water content and low heating value, lignite is very seldom used directly as utility energy carrier but converted into utility energy carriers with essentially extended use spectra.

In the GDR, the share of appoximately 60 % of lignite is used directly as fuel in power and heating stations in order to generate electric energy and process steam as well as heat for the housing heating. The amount of about 85 % of the generation of electric energy is based on power stations supplied

with lignite. It is also envisaged for the future to build new coal power stations.

The share of about 40 % of lignite is used for the briquet production, the briquets are either combusted directly or supplied to the further processing. At present, a total of appoximately 50 . 10^6 t/a of briquets with a heating value of 19,4 MJ/kg is produced, the share of about 27 % is converted for the production of by-products such as coke, tar, gas and others which themselves serve as highly efficient fuel or are processed into organic-chemical products.

Essentially, the following refining processes are applied:

- Low-temperature coking (carbonization involving gas recirculation) at about 700 °C
- High-temperature coking (heating surface coking) at about 1 000 °C, and
- oxygen high-pressure gasification at 2,5 MPa.

High-temperature coking of lignite developed in the GDR is unique in the world and the basis of town gas generation together with oxygen high-pressure gasification.

2. Economical energy use

The economical use of energy carriers is an indirect means to enlarge energy resources in any country.

The economical energy use has been an integrated part of the socialist energy policy since the foundation of our state and not just since the increases of energy prices after 1973/74 on the world market, although this recent development has further increased the politico-economic importance of the rationalization in the processes of energy transformation, transmission and application. In the GDR, a system has been developed and legally embodied for implementing this economy principle with the help of which good results were achieved during the last years. It is based on the central governmental energy planning and comprises for instance approval procedures for the energy carrier use, energy consumption principles for the production and operation of plants, measures for managing, controlling and stimulating economical energy use as well as the education and further education related to energy economy.

The GDR succeeded in increasing the national income by an essentially lower rise of the primary energy yield. In 1980, for instance, the use of primary energy per unit of the national income amounted to 70 % compared with the basis year 1970, or the use of utility energy per unit of the commodity production amounted to 60 %, respectively. The intentional reduction of the specific energy consumption will continue to be considered as a way of covering the increasing

demand of effective energy more economically than it is possible by providing more primary energy and utility energy, whereby, however, high expenditures for the further necessary extension of the energetic basis are required and will be systematically made.

Economic calculations showed that the reflux duration of energetic rationalization investments was approximately one and a half year, after 1975. Thus, it is several times lower than the reflux duration of energetic extension investments. Analyses prove that the future main tasks of an economical energy use consist in:

- Increasing the efficiency of energy conversion, e. g. by intensified co-generation when generating electric energy, and by closing older plants
- Reducing the specific energy consumption in energy-intensive processes, e. g. in metallurgy and the chemical industry
- Decreasing the use of utility energy by using energy which is produced elsewhere, e.g. waste heat from high-temperature processes to be used for district heat supply or low-temperature waste heat to be used for water heating, greenhouse heating etc.
- Reducing the specific heat demand for space heating, in particular by improved thermal insulation in buildings, and by suitable temperature regulation
- Improving the energetic quality of processes by applying further developed and new effective principles, such as in illuminating engineering and industrial furnace construction
- Implementing more efficient solutions of energy application in case of non-industrial consumers, e. g. by railway electrification and improvement of electrical devices

Including renewable energy resources into conventional supply technologies in order to save highly efficient energy carriers (fuel oil, natural gas, electric energy), e. g. by using solar radiation and natural ambient energies with the help of heat pumps for producing utility and process heat waters.

3. Renewable sources of energy

Within the framework of intensified use of all domestic energy resources, more attention has been paid to the renewable energy sources since 1976 being expressed in the following activities:

- Exploration of the utilization potentials according to the meteorological and geophysical criteria of the country,
- technical-economic investigations in order to assess promising unconventional utilization technologies for suitable consumers,
- technological development of elements and systems for converting regenerative energy resources into conventional utility energy carriers,
- test of the utilization technology under experimental and practice conditions,
- step-by-step introduction of unconventional utilization technologies into the energy carrier and plant structures of the country's energy economy.

First results of these activities clearly prove that, in the long-term fuel and energy balances of the GDR, besides the dominating primary energy carriers raw lignite and nuclear energy, from the years 2000, regenerative energy resources can play a complementary role in covering the energy demand amounting to approximately 1 % of the primary energy.

Due to foreseeable further availability restrictions and price increases of fossil energy carriers, however, minor contributions become important which require a well-timed research and development in the field of regenerative energy resources. In the GDR, renewable energy resources will only be used indutrially if advantages for the national economy result therefrom. The economic expenditure for providing utility energy serves as an assessment criterion. Efficiency will be reached by means of technical perfection of the non-conventional utilization technologies, and in case of price increases for energy carriers and equipment. During the introduction period (1985 - 2000) most important will be the substitution of expensive imported high-quality energy carriers (crude oil and natural gas).

Under the geographical, climatic and geological conditions of the GDR, only the restricted use of solar, geothermal and wind energies for the energy economy can be considered on a long-term basis. Due to lack of natural conditions, glacial ice energy and ocean heat cannot be used. There are no practical prospects for using tidal energy and ocean wave energy in the area of the Baltic Sea coast.

The energy generation out of organic waste products is becoming more important and necessitates mainly conventional conversion technologies (combustion, gasification, liquefaction). The running-water potential of our country is almost completely used by water power stations. At present, the exploration of the remaining potential is investigated according to the new premises of the energy economy. In the following section, particular features of the utilization of some important regenerative energy resources will be examined.

Solar and wind energy

The climatic conditions of the GDR which are characterized by often changes of precipetation periods with strong wind and generally short sunshine periods with less wind provide only restricted possibilities for the utilization of solar and wind energy resources.

Therefore most important for any planning in this field is the detailed acquisition of the natural potential of these energy sources and its presentation in a form corresponding with the requirements of its technical utilization. That is why the meteorological service of the GDR does not only analyse and present measuring data for many years from the meteorological measuring stations grid in correspondence with the special requirements of energetics and building industry but also carries out for already ten years special measurements for the acquisition of the energy potential of direct and diffuse solar radiation on varions surfaces with different orientation and inclination. Solar and sky radiation measurements (total over one hour) are performed at about 20 measuring stations. Measurment series over many years exist at three of them. Wind direction and velocity is permanently measured at about 60 stations. The necessary data for planning, development and operation of energy converters are available for the whole territory. Energy prospecting in correspondence with the specific location conditions has been methodically prepared. The recommendations of the World Meteorological organisation have been taken into consideration.

Solar energy

The solar radiation conditions on the GDR territory can be characterized by

Low sunshine duration (on the average 1600/1700 h/a),
low global radiant intensity (on the average 1000 kWh/m^2/a)
and significant seasonal and daytime radiation variations
(e.g. monthly irradiation June/December 12 : 1).

Thus, processes of direct conversion into electric energy by means of solar cells, and the use of high-temperature collectors with focusing installations have to be eliminated.

The most promising possibility is the application of low-temperature flat collectors to provide hot water in the months of May until October. Besides the collectors, the solar collector system comprises a double accumulator (storage capacity for one and a half day and short-time accumulator with additional electric charge), the heat exchanger, recirculating pump, controller, pipes and valves.

Thus, it is able to cover about 50 ... 60 % of the heating energy demand of selected consumers, or to save the same portion of primary energy, respectively. Additional bivalent or multivalent supply possibilities on the basis of fossil, nuclear or other regenerative energy resources must be available in order to cover the remaining demand.

From today's point of view the following fields of application are possible:

- Utility water heating in flats and social buildings and industrial consumers

- process hot water in agriculture, in particular for animal production, dairy farming and green-houses.

In the GDR, solar-thermal space heating has no prospects due to the unsatisfactory covering degree (about 25 %), and the storage problems which are in general not yet solved. The covering portion can be increased

by using additional heat pumps and combining them with utility water heating. To an increasing extent efforts are made to utilize solar radiation by solar absorbers combined with water-water heat pumps.

The scientific-technological level is essentially characterized by research and test works as well as first preparative measures for small batches of solar collectors and absorbers, or hot-water compact plants, respectively. The mass production will be increased until 1983 up to about 10 000 m^2 of collector surface per year. Solar thermal hot-water plants will be provided at decentralized places in order to partially substitute highly effective energy carriers (natural gas, fuel oil, electric energy). Only in this field of application, it will be possible within a measurable space of time that - compared with conventional plants - investment costs for solar plants will be amortized within the utility duration of 10 ... 15 years by saving primary energy. The development of the cost for raw lignite as well of the investment costs for solar plants will prove when and to what extent solar water heating plants will be able to partially substitute and complement conventional systems on the basis of solid fuels. Ambient air heat, ground heat, ground-water heat and surface-water heat are indirect phenomena of solar radiation which - due to the low temperature level (annual average: maximum of 10 ^{o}C) - can only be used with the help of heat pump plants to provide low-temperature heat.

At present for this purpose in the GDR there are available water-water heat pumps with performances of 50 - 680 kW which, however, are chiefly used for refrigerating and heating processes combinations but also in heating plants. Suitable

small heating pumps are available with performances of 12 kW (water-water type) and 1,2 and 14 kW (air-water system).

It is decisive for using natural ambient heat that it is optimized in connection with the location considering the demand criteria of the consumers (heat pump suitability) and the artificial energy produced (waste air, waste heat). From today's point of view, substitution of the electric heating, gas and oil heating is considered as favoured potential field of application.

Wind energy

The wind velocity usable on the GDR territory amounts to approximately 3 ... 8 m/s as annual average, the range of 4 ... 6 m/s being looked upon as optimum considering technical design, energy yield and output uniformity. The Baltic Sea region, ridge regions of the mountain areas and single locations in the inland plains are regions where a potential conversion of wind energy into mechanical propulsion energy and electric energy might be possible.

In the GDR, investigations for using wind energy are in the stage of fundamental research. The objective of these activities consists in providing conditions for the determination of extent and expenditure of further specific investigations in this field and for the provision of technologically effective prerequisites to the reconstruction of existing already for a long time devices using wind energy for irrigation and drainage purposes in agriculture.

Geothermal depth energy

In the GDR, there has been no success in finding tectonic zones with hot water and steam reservoirs permitting a con-

ventional generation of geothermal depth energy. The search for thermal water and its utilization will nevertheless be pursued further on.

From today's point of view geothermal energy is available by using low-temperature water and heat of hot dry rock.

The utilization of geothermal energy from low-temperature water in primary and secondary circuits by means of heat pumps for heating dwelling and social buildings as well as the provision of warm water are in the stage of preparation.

Furthermore hot dry rock technology at present is tested at a bi-boring system in a depth of 3000 ... 3500 m. Research in the fields of handling highly mineralized water and hydraulic fracturing with exactly determined location and geometry has still to be carried on. These conceptions still need experimental and operational confirmations.

As this low-temperature heat is continuously available consumers with a high quantity of utilization hours such as for utility water heating are especially suited because a comparatively continuous and thus efficient operation of geothermal plants can be obtained. Another objective consists in a small distance between consumer and bore hole in order to make use of geothermal heat without heat pumps, high-capacity reservoirs and bivalent heating. Utility and process water heatings for supply to the population, agriculture and industry up to a required temperature of 100 ^{o}C result as potential operational field.

Hydroenergy

Pumped-storage hydropower plants play the decisive role in covering the variable part of the load line in the GDR's

electric energy system with a high share in thermal power station capacity on the basis of raw lignite and in nuclear power station capacity. Late in 1981, their share in installed capacity will amount to about 8 %.

Due to the existing hydrologic and topographic conditions (low rate of stream flow and few slopes) , high density of population and high degree of cultivation of its territory, in particular of the river valleys the GDR disposes of unfavourable conditions for using hydropower to generate electric energy.

However, the energy policy of the GDR government pays adequate attention to the use of the hydroenergetic potential of smaller streams striving for optimum utilization of all available sources of renewable energy.

Reconstruction measures to maintain the existing capacities of smaller hydroelectric power stations are envisaged ensuring the maximum utilization of the present hydroenergetic resources of the GDR being substantiated from the economic point of view. Economic effects resulting from extending and reconstructing small capacity hydroelectric power stations even in countries disposing of a developed electric energy grid are the following: electric power supply into medium-voltage and low-voltage grids to stabilize the voltage; rapid readiness of service; possibility to cooperate in covering peak loads by storing operating water; limited maintenance; long life of hydroelectric power stations.

Large-scale automation and remote control, simplified mechanical equipment, in particular by the use of pipe turbines result in a simplification and thus reduction of the structure and finally in lower investment costs, shorter construction periods and lower operation costs compared with

smaller hydroelectric power stations with turbines hitherto used and comparatively high operating expenditure.

4. Scientific-technological cooperation and staff education

In recent years, the German Democratic Republic developed and extended its relations with newly independent states also in the field of energy economies. The GDR supports these countries in the erection of their own fuel and power industry. In the field of new and renewable energy sources, the support will mainly focus on supplying and exchanging scientific-technological knowledge and educating and further educating staff for the energy economy.

The following fields are suited for the exchange of scientific research results and technological experience:

- Extraction, preparation and processing of fossil fuels, such as mining, briquetting, combusting, low-temperature carbonizing, coking and gasifying dirty lignite;
- Rationalization of energy conversion, transmission and application;
- Utilization of running-water energy of small streams in small hydroelectric power stations;
- Solar-thermal utility water heating and process water heating in countries with low solar radiation intensity.
- meteorological and geological investigation regarding various energy sources.

The GDR is ready and able to support newly independent states in education and further education of staff for energy technology and power industry. This offer includes professional education as well as technical and university education.

There exist numerous study directions and additional courses for training specialists.

The contents of education are permanently adapted to the last requirements resulting from scientific-technological progress. Thus the education of special staff for economical energy application including the field of climatic problems in building represents a new education profile. Up to now numerous newly independent states have sent people to the GDR to get education for future work in national power industry. Education takes into account the specific conditions and requirements of these states. Training specialists the GDR makes an effective contribution to the development of newly independent states national economy.

Summary

On the GDR territory, from today's point of view, there is a potential of regenerative energy resources of approximately 1 % of the primary energy requirements which can be used for the energy economy until the year 2 000 covering the unconventional utilization of solar radiation, ground heat, ground-water heat, surface-water heat, ambient-air heat, wind energy, geothermal depth energy as well as the conventional utilization of running water energy.

These resources at present can only be used by means of expenditure being higher compared with the conventional generation of the respective utility energy carriers. Generation of low-temperature heat out of ground heat, ground-water heat and surface-water heat being able to reach the threshold of efficieny until 1990, and the utilization of water power are exceptions.

The GDR takes the view that the important national, regional, and international tasks in the field of utilization of new and renewable energy sources can be fulfilled only to the same extent as peace will be maintained, danger of war will be banned, arms race will be stopped, and part of financial means set free by disarmament will be used for new progress in utilization of new and renewable energy sources and for the solution of other global problems.