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3 I. Introduction

3 Energy questions have assumed an increasingly prominent role in the  
6 national and international economic debates of recent years. All  
6 countries had to recognize that provision of energy resources is  
8 essential to economic and social development. The instability which  
8 has prevailed in the energy sector since the steep rises in prices  
9 of oil in 1973-74 has had a decisive impact on economic and social  
9 conditions in industrialized and developing countries alike. The  
11 oil-producing countries have been faced with great adjustment problems  
11 and, as a result, particularly the oil-importing developing countries  
11 have seen serious setbacks in the development process. Developments  
11 in the oil sector have generated a need for national energy policy  
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12 At present, efforts are made to have energy questions dealt with  
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14 through, among other things, a rational energy policy. Such a  
16 policy presupposes that the role of oil in future energy consumption  
16 is substantially reduced. Because of soil erosion problems it would  
16 furthermore be necessary for many countries to curtail the con-  
16 sumption of wood for energy purposes. The principal contributions  
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16 and in further expansion of, notably, the hydro power reserves of  
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18 of energy supplies. Use of these sources of energy is also desirable  
18 because of possible detrimental effects on the climate by the burning  
18 of fossil fuels. Consequently, great interest attaches to the de-  
19 velopment and use of new and renewable energy sources. In the light  
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19 on Development of New and Renewable Sources of Energy.

20 II. Denmark's energy situation

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## I. Introduction

Energy questions have assumed an increasingly prominent role in the national and international economic debates of recent years. All countries had to recognize that provision of energy resources is essential to economic and social development. The instability which has prevailed in the energy sector since the steep rises in prices of oil in 1973-74 has had a decisive impact on economic and social conditions in industrialized and developing countries alike. The oil-producing countries have been faced with great adjustment problems and, as a result, particularly the oil-importing developing countries have seen serious setbacks in the development process. Developments in the oil sector have generated a need for national energy policy measures as well as for international cooperation in the solution of energy problems.

At present, efforts are made to have energy questions dealt with as a separate item on the agenda of a new round of global negotiations between industrialized and developing countries within the framework of the North-South dialogue which is taking place under the aegis of the United Nations. Other items on the agenda will be primary commodities, trade, development, and financial and monetary questions. Denmark supports the idea of holding a global negotiating round in which energy will be one of the subjects for deliberation. In the Danish view, it is essential that the United Nations system should help to bring about the best possible conditions for each country to achieve economic and social development through, among other things, a rational energy policy. Such a policy presupposes that the role of oil in future energy consumption is substantially reduced. Because of soil erosion problems it would furthermore be necessary for many countries to curtail the consumption of wood for energy purposes. The principal contributions to ensuring supplies on a global scale will in the next few decades have to be sought primarily in increased use of coal, nuclear power and in further expansion of, notably, the hydro power reserves of developing countries. But in the longer term, the contributions from new and renewable energy sources will be necessary in the balance of energy supplies. Use of these sources of energy is also desirable because of possible detrimental effects on the climate by the burning of fossil fuels. Consequently, great interest attaches to the development and use of new and renewable energy sources. In the light of these observations, Denmark welcomes the United Nations Conference on Development of New and Renewable Sources of Energy.

## II. Denmark's energy situation

Denmark is more dependent on imported oil than most other industrialized countries of the Western world. Oil imports account for around 70 per cent of the total consumption of primary energy. In the IEA cooperation, Denmark has accepted as a target to reduce

oil imports to 11 million tonnes oil equivalent (mtoe) in 1985 from the present quantity of around 14 mtoe. It is expected that fuel saving and fuel switching programmes will result in a decline in the share of oil in primary energy consumption to around 50 per cent in 1990.

Real price increases for oil have intensified the need to reduce the dependency on oil. Previous efforts in the energy area were primarily designed to ward off a supply crisis. But in present planning, balance of payments problems arising out of the soaring prices of energy, notably oil, are also and in increasing measure taken into account. The ultimate goal of the efforts which are made today over a wide front is generally, putting it briefly, on the one hand to minimize the cost of the society's energy supplies in the widest sense, including environmental impacts, and, on the other, to maximize the safety of supplies.

In pursuance of this policy, account is taken of the targets set for development in the economic, social and employment fields through efforts on the consumption as well as on the supply side.

Around 35 per cent of the oil imported by Denmark is used for heating of dwellings and institutions. This area of consumption is therefore, quite naturally, in the focus of attention. Various initiatives have been taken to achieve conservation of energy in this field. In 1979, the requirements as to insulation set out in the building regulations for new-built houses were tightened. Obligatory annual inspection of oil burners has been introduced. A system of tax deductions and direct support has been adopted to encourage energy-saving measures (insulation, replacement of oil burners by new ones, etc.) in dwellings. Furthermore, it is being considered to prescribe by law that by 1995 all buildings shall be in a proper state to ensure maximum energy-saving.

Financial aid is granted to encourage industrial investments in equipment which reduces the consumption of process energy. In the field of transport, speed limits have been reduced for purposes of energy saving, and use of collective transport is being encouraged by a higher service level and a flexible fares policy. Fairly heavy taxes are levied on oil products and electricity to encourage energy-saving.

On the supply side, a nationwide plan for heat supply has been adopted. Under the plan, which is now in the process of execution, the country will be divided into various geographical areas for which the use of specific methods of heating will be prescribed, and a framework will be established for economic planning of

future investment in energy supply systems. According to the plan, well over two thirds of the housing stock shall, by 1995, be heated by district heating, waste heat from power plants, Combined Heat and Power supply, (CHP), or natural gas. Today, district heating and waste heat account already for about one fourth of urban heat supplies, and the existing systems, which are included in the plan, are being expanded and reconditioned. In areas where no technical systems exist today for supply of district heating or from conventional boiler plants or CHP, and where there are no investment plans for such systems, natural gas from the Danish fields in the North Sea will be a possible source of supply. The pipeline systems for the three afore-mentioned forms of heat supply call for substantial investments and presuppose hook-up, foreseeably mandatory, of a reasonably large number of consumers. In thinly populated areas it will be uneconomical to use piped energy such as district heating and natural gas. In these areas the heat supply will therefore continue to be based on other types of energy, e.g. oil, electricity and renewable energy. It is envisaged that delivery of natural gas from the Danish fields in the North Sea will start at the end of 1984. As from 1987, supplies under the adopted production plans will amount to some 2.5 billion m<sup>3</sup> per year. But if the natural gas project were expanded to comprise a second phase, an annual output of at least 4 billion m<sup>3</sup> could be attained in 1995. Natural gas will be used primarily for heating and industrial purposes, and in both cases in substitution of oil.

The oil resources in the Danish sector of the North Sea are inadequate to make Denmark self-sufficient in oil, but they will help to enhance the Danish degree of self-sufficiency. The degree of self-sufficiency in oil and natural gas from the North Sea may amount to around 40 per cent in 1990, but will have dropped to around 35 per cent in the year 2000 unless new finds are made. In the next 20 years, taken as a whole, almost 50 per cent of Denmark's energy consumption will, according to present estimates, have to be covered by imported oil; 33 per cent is expected to be covered by natural gas and oil produced in the North Sea, and the remaining demand by coal, to a minor degree by renewable energy and, possibly, by nuclear power. To encourage use of renewable energy, Denmark has introduced schemes for 1979, 1980 and 1981 for financial support of establishment of plants for utilization of renewable energy.

Recent years have seen a marked increase in Danish imports of coal, from 4.2 million tonnes and 7.6 million tonnes in 1976 and 1979, respectively, to nearly 10 million tonnes in 1980. This increase in coal consumption is accounted for by the fact that the power companies have carried through an effective shift from oil to coal firing. In 1972, coal accounted for 20 per cent and, in 1980, for 82 per cent of the fuel consumed in electricity production. This corresponds to 25 per cent of the Danish consumption of primary

energy. The power stations will continue their substitution efforts, and a coal-based share of about 85 per cent of electricity production in 1985 would seem realistic.

The current efforts have already borne fruit. In 1980, oil consumption was about 25 per cent below the 1973 level, and further savings are expected. The dependency on imported oil will, however, continue to be considerable. Nuclear power is considered as a possibility in Danish energy planning, but its introduction awaits clarification of various environmental and safety problems. With the dwindling oil resources and increasing oil prices much interest attaches, quite naturally, to the question of what role new and renewable sources of energy could play, particularly in the long run, in future energy supply.

### III. New and renewable energy sources in Denmark

The future aggregate contribution to Denmark's energy supply from new and renewable energy sources is difficult to assess. Danish energy planners expect a share of 4 per cent in 1995. In the longer term, however, the potential will be substantially larger. In recent years, intensive development and research, supported financially by the Danish Government, has taken place in the below-mentioned new and renewable energy sources. In several areas the development has reached an advanced stage. Industrial production of renewable energy systems has been established for sale on the domestic market and for export. After the increases in oil prices in 1973, growing attention has been devoted to research and development in new and renewable energy sources. In a few areas, Denmark, due mainly to her general lack of primary energy, has a historical tradition for utilizing renewable energy sources. This applies especially to wind power for which the climate offers favourable conditions. Danish research and development in new and renewable energy sources is to a large extent a result of technological advances in private - often small or medium-sized - Danish enterprises. Broad public interest has helped to promote this development.

Energy has for many years been a natural area for research at Danish universities and institutes of higher education. Energy research is also conducted by institutions such as the Risø National Laboratory, the Geological Survey of Greenland and the National Building Research Institute. Several energy research projects are supported by the research councils set up by the Government, the Danish Council of Technology and the Danish Development Fund.

Based on the energy policy targets formulated in 1976, the Government has launched a number of comprehensive programmes in energy-oriented research and development - the first one in 1977.



It is estimated that these programmes have covered half the total input in energy research at the national level. With the latest energy research programme (ERP) of the Ministry of Energy, the funds allocated to these programmes total D.kr. 550 million. Of this sum, approximately D.kr. 200 million will be devoted to research and development in renewable energy sources.

A number of research projects have been implemented in the framework of international cooperation, especially within the IEA. Denmark participates in agreements for cooperation with regard to solar energy, heat pumps, energy consumption in buildings and dwellings, energy storage, biomass, wind energy, coal research, and reactor safety. In addition, Denmark participates in the work of the IEA in developing models of energy systems.

There is reason to underline the intensive cooperation on energy research which takes place within the European Communities, EC. EC funds in the amount of around D.kr. 40 million have been allocated to Danish research and development in the energy sector. Within the EC cooperation Denmark also participates in the development of models of energy systems.

The Nordic countries are engaged in an intensive cooperation in new and renewable energy sources.

Part of this cooperation is exchange of information on Nordic research, development and projects. The aim is to avoid duplication of effort and to analyse in which areas two or more projects on new and renewable energy sources may be coordinated.

Exchange among the Nordic countries of information on development assistance involving energy is nothing new. It is one of the aspects of the regular close cooperation of the Nordic assistance agencies. Cooperation in specific projects would be a welcome addition.

The United Nations Conference will be dealing with the following new and renewable sources of energy:

- biomass
- fuelwood and charcoal
- geothermal energy
- hydro power
- ocean energy
- oil shale and tar sands
- solar energy
- wind energy
- peat
- draught animal power

Some of these sources of energy cannot or can only to a negligible extent be used in Denmark. Consequently, Danish experience in their use is limited. The review presented below covers only those new and renewable energy sources which Denmark, through exports, transfer of technology and/or technical assistance can make other countries share in Danish knowledge and experience.

a. Wind power

In 1957, the Danish power companies started experiments with wind energy for electricity production. In southern Denmark, a 200 kW wind generator - the Gedser Mill - was erected. It produced alternating current direct to the electricity supply network. Later, other research and development projects have been started, comprising large wind turbines as well as smaller local wind-mills. The Tvind wind turbine in particular has attracted international attention.

In recent years, several hundred small wind turbines with generators have been built, and the number keeps growing. The turbines, many of which are connected to the public electricity supply network, are typically capable of supplying a single or a few households with electricity. Like hitherto, they will probably be used primarily in sparsely populated areas. Because of the great variations in wind conditions throughout the year, very large storages of energy would be required if a windmill were to cover the regular energy consumption of a household. In periods with little wind, supplementary energy has to be provided from other sources, for instance from the public supply network. (Conversely, surplus production in periods with strong wind will be supplied to the network). In addition to these minor wind turbines, a few large electricity-producing wind power plants with a capacity corresponding to the consumption of a small urban community have been built. The experience gained in the use of these plants will be taken into consideration in the final deliberations as to the potential role of wind power in Danish energy supply.

The Ministry of Energy and the power companies have built two 45 m tall wind turbines with a vane span of 40 m. Both turbines have a maximum capacity of 630 kW.

On the basis of experience gained in the operation of these two plants and the findings of a comprehensive measurement programme it is intended to examine which types and sizes of large wind machines are best suited for Danish conditions. At the same time an assessment is being made of the possibilities of placing 1,000-2,000 large wind-power plants in Denmark, taking account of wind conditions, environment, preservation of natural amenities, etc. Noise nuisance from wind turbines may be considerable in the vicinity, but the noise depends on the type and design of turbine. The principal sources of noise are the gear, the generator and the vanes. In determining where to locate windmills account must be taken also of the risk of castoff of ice in the winter and of vane fragments in case of breakdown.

If by reducing the cost of construction and/or because of rising prices of fuel it proves profitable to build the aforementioned number of large windmills, this might be accomplished by serial production of 150-200 windmills per year. It is anticipated that Danish-built large wind power plants will be competitive in the international market.

Among the projects in the research programme of the Ministry of Energy is a test station for minor windmills at the Risø National Laboratory. At the test station, manufacturers erect their windmills on own account, and the mills are subjected to testing and appraisal of performance. Test station approval of a mill is required for obtaining financial support under the aforementioned support scheme for development of renewable energy. Furthermore, the test station performs measurements on mills which are already in operation at various places in Denmark.

The comprehensive Danish know-how in the wind power area has resulted in a machinery for production of wind power plants of various sizes and of such quality that the wind power industry has been able to hold its own in export markets. This competitiveness is ascribable to the individual producer's practical experience and the flexibility which the wind power industry has shown in adapting wind power plants to the different technical norms and standards of export markets. An estimated 70 wind turbine units will be exported in 1981.

Today, about 20 Danish enterprises are producing windmills on a commercial basis and their know-how could profitably be transferred to developing countries. They are organized in the Association of Manufacturers of Wind Power Plants.

#### b. Solar energy

In recent years, solar heating has gained some ground in Denmark. Solar heating supplies energy for hot water household consumption and, to a lesser degree, for room heating. The present number of installed plants is estimated to be 2,000-3,000. The systems usually consist of a planar solar collector with a layer of glass on top and a water tank for shortterm storage of heat. Systems with a solar collector of typically 6-10 m<sup>2</sup> and a storage tank of 0.2-0.6 m<sup>3</sup> are used exclusively for supply of hot water. In Denmark, 80 per cent of the solar energy is collected during the months from April through September. With the technology used today heating of rooms throughout the year by solar energy alone is not profitable because of the problems involved in storing solar energy for use in the winter months (October-March).

The research programme of the Ministry of Energy comprises development of more effective solar heating systems. A number of pilot plants of various types has been installed and a facility has been established for testing of solar heating systems and individual components.

Because of the marginal conditions for utilization of solar energy in Denmark, the Danish research and development programme aims at the development of more efficient systems, including solar collectors with selective surfaces.

The results up till now of the research and development programme show that the technical design of the systems can be improved to enhance capacity and lifetime and to reduce the cost of construction.

Although solar heating technologies have proved not to be profitable in Denmark, they may already now be profitable in terms of current energy prices under better climatic conditions with larger annual solar irradiation.

In addition, the manufacture and installation of solar heating plants are quite labour-intensive. An estimated 2,000 units will be exported in 1981.

A major technical problem in solar heating is the surface material of the individual components. It will usually be necessary in the winter to add anti-freeze substance to the liquid in solar collectors. In the event of bursting of a water pipe or leakage in the heat exchanger these additives could cause pollution of the hot tap water. Manufacturers are therefore aware of the need of using durable materials for pipes and of care in the construction of solar collectors. Numerous Danish manufacturers have been successful in devising their own development methods.

Today, the systems of some 30 Danish manufacturers have been approved as eligible for financial support. As mentioned, most of the systems sold in the domestic market are designed for supply of hot water to households. Solar collectors producing energy for heating of individual dwellings are also on the market. Danish industry has furthermore achieved remarkable results in the production of large units for use in factories and public buildings. A case in point is Scandinavia's largest solar heating system which is installed as the heating system for a public indoor swimming pool in Denmark. This system is designed with approximately  $3 \text{ m}^2$  of solar collectors for each  $\text{m}^3$  of pool water.

It is contemplated, with financial support from EC and other sources to install a solar cell power plant to serve as a test facility in Denmark. This would be a full-scale research project to examine, among other things, the output of energy from diffuse light which is a predominant solar component in Denmark because of the frequent cloud cover. The total cost of construction of the proposed power plant with appurtenant batteries and of the research activities to be performed will amount to Dkr. 17 million. It would be the first major solar cell power plant to be built in these northern latitudes and the results are awaited with interest. There are, however, no immediate expectations that solar cell power plants could become a profitable alternative to the present power production in Denmark.

With a view to development and collection of operating data Danish research institutions and a Danish telephone company have conducted experiments in which solar cells were used for the power supply of telecommunications equipment.

Denmark participates within the framework of the EC and the IEA in international cooperation in solar energy research and development.

#### c. Geothermal energy

Geothermal energy is not utilized in Denmark today, but this source of energy could possibly make a minor contribution to Denmark's energy supply. Research activities are aimed at establishment of geothermal generating plants. The results of a single 3.5 km deep drilling are being studied.

A nationwide study has been conducted to determine the possibilities of utilizing geothermal energy in Denmark. Priority is given to localities providing the best conditions for extraction of geothermal energy and use of the hot water there.

On the basis of the results of these studies, a total sum of Dkr. 57 million has been set aside for 1980 and 1981 for planning and performance of 2-4 test drillings and geothermal investigations. It is estimated that about 1 per cent of Denmark's energy consumption, corresponding to 200,000 tonnes of oil equivalent, could be covered by geothermal energy if it proves possible to establish the necessary generating systems.

#### d. Heat pumps

Heat pump systems for room heating are already today a technologically and economically relevant supply alternative which is being used quite extensively in Denmark (about 3,000 systems have

been installed). Systems are being marketed for supply of hot tap water and room heating based on utilization of thermal energy in the ground, in groundwater or surfacewater, heat in outdoor air or heat from stables.

Developments in the heat pump area have been explosive. This applies both to systems for residential installation and systems for industrial use.

To ensure and enhance the development of heat pump systems and prevent groundwater pollution the Danish environmental authorities have drawn up guidelines for the establishment of heat pump systems, setting out the technical specifications and control measures required for approval of the systems.

Heat pumps with an output of typically 10 kW are being manufactured in Denmark. The systems marketed are often mass-produced standard systems - a factor which reduces the cost of production as well as of maintenance and operation.

In addition to systems for residential installation, Danish industry supplies "tailored" systems, for instance for heating of large residential areas. In these large systems as well standard units are used which cuts capital and maintenance costs. In 1981, about 16,000 heat pump systems valued at approx. Dkr. 180 million will be exported.

In several instances a combination of heat pumps and an already installed source of energy may be a sensible solution. Substantial know-how with respect to such combinations has accumulated in Denmark.

#### e. Biomass

Due to the high degree of land use for agricultural purposes, Denmark has little possibility of direct utilization of energy from biomass. The sources used are almost exclusively waste products such as animal liquid manure, straw, household refuse, and wood residues. In the following, a review is presented of the development and use of these supplementary sources of energy.

#### - Biogas

Around 20 biogas systems have been installed at Danish farms. Initially some operational difficulties were encountered, but it now looks as if it will be possible to establish functional and profitable systems.

Through the research programmes of the Ministry of Energy support is granted for research and development in this field. Furthermore, several pilot plants have been established, financed in whole or in part out of the research funds of the Ministry of Energy.

In the research programmes the main emphasis has so far been on technological development. Some extension is, however, envisaged in the years ahead of research in biological processes - among other things, the effects of adding of enzymes will be studied.

Aside from being an important source of energy, biogas systems present substantial environmental advantages.

Work in this area has resulted in the build-up of considerable expertise, and a few firms have started or are about to start commercial production of biogas systems.

It should be added that over the years, biogas systems have been installed in connection with treatment of sludge from water treatment plants. Danish firms conduct considerable activities in this special field.

#### - Straw

The Danish agricultural production of straw varies from year to year; in average it amounts to 6.5 million tonnes. Of this quantity, 2 million tonnes are surplus production for which the farmers themselves can find no use. This portion is therefore available for other purposes, for instance as an energy source. Previously this surplus was burned in the open field. Today, increasing quantities of straw are used in straw-fired plants for room heating of farmhouses, a development which is foreseen to continue in the years ahead. One major straw-fired plant has been built as a pilot project supplying heat to the district heating network of a provincial town.

#### - Refuse

Disposal of refuse in dumps without pretreatment is gradually being replaced by incineration in special refuse disposal plants. Out of Denmark's 60 refuse incineration plants, more than half (accounting for about 90 per cent of the incinerated refuse) are connected to district heating systems. All new refuse incineration plants are built for district heating. Through continued expansion of refuse disposal by incineration, these plants can make a sizeable contribution to Denmark's energy supply. The contribution is estimated to amount to half the total contribution from new and renewable energy sources in this century.

- Residual wood

The contribution to Denmark's energy supply from burning of residual wood and firewood is limited and serves only as a heating supplement. Danish forestry is extremely intensive; at the same time industrial use of residual and surplus wood is increasing. In the light of the rising oil prices many house-owners have, however, in recent years acquired woodburning stoves as a supplementary source of heating.

f. Hydro power

In Greenland, there is considerable potential for use of hydro power. Studies of the possibilities of utilization have not yet been completed. In the Faroe Islands, too, there is potential for use of hydro power. In the rest of Denmark, hydro power resources are negligible.

IV. Transfer of technology relating to new and renewable sources of energy

Denmark attaches great importance to the international cooperation in science and technology and takes an active part in this cooperation, bilaterally as well as multilaterally. The parties to the cooperation are individual researchers as well as private enterprises, organizations and governments. The development seen in recent years in the field of energy, and technological development in general, make a further expansion of this cooperation desirable.

Denmark takes an active part in the follow-up of the United Nations Conference on Science and Technology for Development (UNCSTD) which was held in Vienna in 1979, and in the ongoing negotiations under the auspices of UNCTAD for the establishment of an international codex for transfer of technology.

As a member of the EC, Denmark is a co-signatory to the Second Lomé Convention of 31 October 1979 under which programmes and projects taking special account of the experience of the ACP States are to be implemented, especially in wind energy, solar energy, geothermal energy and hydro power.

Together with the other Nordic countries Denmark is exploring the possibilities of identifying suitable energy projects in the developing countries. Projects with a bearing on the coal programme of Mozambique are, for instance, being contemplated.



International cooperation will not only promote exchange of and produce new knowledge, it will be an incentive to devising more efficient methods of utilizing existing knowledge and technology for development of, inter alia, new and renewable sources of energy.

Denmark supports the idea of establishing international research centres and new information systems as well as the efforts to build up scientific and technological infrastructure in the developing countries. Denmark considers it desirable, therefore, that the work which is already being done in this field within the United Nations framework - and to which the Vienna Programme of Action attaches great weight - should be expanded and intensified.

Concurrent with the national and international efforts that are being made to enable the developing countries to share in the results of research and development in the field of energy, the other channels, including the commercial ones, for international cooperation in this field should be strengthened. In that connection the efforts of private enterprises have a considerable role to play.

In Denmark, the sector producing equipment for utilization of renewable energy sources is dominated by highly specialized enterprises which through cooperation among themselves and/or membership of trade associations are afforded the opportunity to undertake and accomplish tasks on a broad basis.

Several Danish architecture and engineering firms have moreover accumulated specialist knowledge of and considerable experience in technical consultancy relative to transfer of technology.

The principal advantage of this structure is the flexibility in production which is characteristic of the specialized enterprise and enables it rapidly and at reasonable cost to adapt its products to for example the economic conditions prevailing in the individual areas.

Transfer of know-how from Danish enterprises is mostly based on licence agreements. Joint venture agreements are frequently used where transfer of know-how is coupled with transfer of technology.

The public sector and the private sector cooperate in the transfer of know-how and technology. Through cooperation with relevant public authorities, Danish enterprises may, on certain premises, gain access to public sector knowledge and expertise in scientific and administrative fields. Thereby, the Danish Government frequently takes an indirect part in joint venture projects or agreements on transfer of know-how.

One of the objectives of the Danish Industrialization Fund for Developing Countries (IFDC), on whose activities a detailed account is given in paragraph V below, is to encourage transfer of technological know-how from the private sector to developing countries, inter alia by assisting in the establishment of joint ventures.

Cooperation among individual enterprises, trade associations and the IFDC has provided opportunity for promoting efficient and flexible transfer to developing countries of technology relating to new and renewable energy sources. In this picture, the resources available under Denmark's official development assistance programme come into play.

V. Possibilities of development assistance with respect to new and renewable energy sources. Danish financial and technical assistance for development in developing countries of new and renewable sources of energy

1. Denmark's official development assistance programme and major aid policy orientations.

Denmark reached and surpassed in 1978 the 0.7% target for official development assistance (ODA) set by the United Nations. It is envisaged to maintain the aid appropriations at not less than 0.7% of GNP in the years up to 1985. In 1979 net disbursements under Denmark's official development assistance programme amounted to US Dollars 448.2 million, equal to 0.75 of GNP. a/

The statutory basis for Denmark's official development aid is the International Development Cooperation Act No. 297 of 1971 (with subsequent amendments) stating that the objectives of the Danish assistance programme are to support, in collaboration with the governments and authorities of the developing countries, economic growth, social progress and political independence of these countries. Consequently, Danish development assistance is provided

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a/ The disbursements have been tabulated in accordance with the method of calculation prescribed by the OECD Development Assistance Committee (DAC). Accordingly, official commitments issued to multilateral assistance organizations are included in the overall assistance rather than in the amount which the organizations have actually drawn on the commitments during the period in question. According to the latter method which is used to tabulate Danish assistance grants, assistance in 1979 amounted to Dkr. 2,188.4 million or 0.7 per cent of GNP. The DAC calculation is used here as this report addresses itself to an international audience.

in compliance with the wishes and priorities of the recipient countries as established in their development planning and without imposing political strings on the recipient countries.

The assistance is almost equally distributed between multilateral and bilateral assistance, the latter being equally divided between grants and highly concessional loans. The assistance is concentrated on the poorest developing countries, and - as regards bilateral grant assistance - with special emphasis on rural development and the elementary needs of the poorer strata of the population. Danish development loans are mainly extended to the modern sector in recipient countries, principally for industrialization purposes.

## 2. The composition of the Danish aid programme

Bilateral grant assistance (29% of total assistance in 1979) is mainly disbursed for project aid, which to a large extent consists of: (1) financial assistance in the form of supplies of equipment (local as well as foreign), financing of assignment of experts direct to projects and - in certain cases - cash contributions for current expenses in connection with the execution of projects; (2) capital grants given to educational, health and financial institutions or bodies in developing countries for the purpose of financing construction and supply of various forms of equipment. The bilateral grant assistance is concentrated on a relatively small number of recipient countries, of which four (Kenya, Tanzania, India and Bangladesh) are main recipients (74% of total grant assistance in 1979).

Another major component of bilateral grant assistance is technical assistance, primarily in the form of assignment of experts and volunteers and study courses, seminars and scholarships - for persons from developing countries.

Bilateral development loans (26% of total assistance in 1979) are also reserved for the poorest developing countries. All developing countries with a per capita GNP of under US dollars 550 are, however, eligible. The loans are interest-free; the terms are of three categories, implying grant elements from 76% to 90%, graduated according to the economic circumstances of the recipient country. The loans are tied to procurement of Danish capital goods and services, although for the poorest recipient countries a number of modifications exist to this principle. Part of the loan may, e.g. be used to cover local costs.

Multilateral assistance (45% of total assistance in 1979) is an important part of the Danish aid programme. Almost one third of the multilateral share (Dkr. 328 million) is allocated to the UNDP. Another major recipient is the World Bank group with the main emphasis on IDA.

In accordance with the general principles of the Danish assistance programme Denmark has also in multilateral development institutions underlined the necessity of channeling an increasing share of resources to the poorest developing countries and advocated that the selection of projects should be in conformity with the priorities and plans of the recipients, taking into account the goals and objectives established in appropriate international fora.

The Danish assistance programme also stresses development research. Specific research projects receive direct financial support while development research is a major element of a large number of bilateral projects. Denmark moreover makes direct contributions to multilateral research institutions.

### 3. Encouragement of private flows

To encourage transfer of technology and know-how the Danish Government has established the Industrialization Fund for Developing Countries (IFDC) which assists in transfer of technology from the Danish private sector to developing countries. The IFDC was established in 1967 as a non-profit institution. Its objective is to promote development of trade and industry in developing countries by providing capital for investment in these countries in collaboration with the Danish business sector.

The contribution of the IFDC is mainly in the form of subscription of shares, extension of loans, and issue of guarantees in respect of joint ventures established in cooperation between Danish enterprises and local partners. Furthermore, loans are extended for financing of feasibility studies in connection with the establishment of such projects. The IFDC may also, if necessary, make experts available. It is presupposed that the Danish party to the project, in addition to contributing financially, will be able to supply know-how not only in the technological field, but also with respect to steering and management at the administrative/commercial level. On the other hand there are no ties with regard to procurement of for example machinery for the project. The emphasis is exclusively on developing a financially sound and profitable project. Another main criterion is that the project concerned should contribute to the economic development of the recipient country.

As a general rule, the IFDC does not hold more than 30 per cent of the share capital of a project. The Danish partner is usually required to contribute to the share capital by at least the same amount as the IFDC. There is nothing to prevent regional or international financing institutions from being parties to a project.

In addition to subscribing shares, the IFDC may extend loans for projects to which the IFDC itself is a partner, provided that loans cannot be raised elsewhere on acceptable terms.

Seeing that the primary objective of the IFDC is to establish new joint ventures the IFDC will, so as not to be permanently engaged in a project, and usually 6-10 years after the registration of a new enterprise, offer its shares to the other shareholders. Moreover, the loans extended shall, as a rule, be repaid within that period.

It is also possible to obtain loans for financing of feasibility studies to form the basis of a project.

Denmark also encourages private flows to developing countries through a general export credit scheme within a framework of Dkr. 10 billion, supplemented by a guarantee scheme for grant of highly concessional mediumterm credits in connection with Danish supplies of capital goods to developing countries. It is a condition for issue of such guarantees that the supplies concerned can be considered to be part of the development plans of the recipient country.

#### 4. Cooperation with developing countries in development of new and renewable sources of energy

The Danish Government fully recognizes the importance of intensified cooperation with the developing countries in the energy field, since this field is crucial to the development of developing countries and an important aspect of global interdependence. Consequently, Denmark keeps under active review in its bilateral development cooperation the possibilities of contributing to utilization of the energy sources of developing countries through the bilateral assistance programmes. In various multilateral agencies Denmark has also favoured that an increasing share of resources be allocated for energy development.

New and renewable energy sources, e.g. solar, wind, geothermal, biomass and minihydro energy projects, have become of increasing importance for developing countries in meeting their energy needs, especially in the agricultural sector.

It is a basic principle in Danish development assistance policy that development assistance should be provided in accordance with the expressed wishes and priorities of the recipient countries. So far, Denmark has received relatively few requests for financial assistance for projects aimed at promoting utilization in developing countries of new and renewable energy sources.

At the international level Denmark takes an active part in exchange of information and coordination among donors within the Development Assistance Committee (DAC) of the OECD and among the Nordic countries on assistance for energy development. The objects of this co-operation are to identify the most appropriate mechanisms for energy development and to improve the existing ones. In this context, special emphasis is placed on projects concerned with new and renewable sources of energy, because such projects could have considerable effects, notably in the long term.

#### 5. The composition of Danish assistance for development of new and renewable sources of energy

So far Denmark has only to a limited extent financed energy development projects in developing countries, but it is envisaged that assistance for such purposes will be extended on an increasing scale in the future. All components of the Danish aid programme can be applied to assistance in the energy sector.

In Denmark's bilateral grant assistance programme particular emphasis is placed on development of energy sources in rural areas. Three projects amounting to US dollars 33 million are being implemented in this field in Tanzania, and for the period 1980-84 an additional sum of US dollars 63 million has been appropriated for rural electrification in Tanzania.

Some Danish development loans have been granted for projects for electricity production and distribution in the modern sector of the recipient country. In 1979, US dollars 84 million and, in 1980, US dollars 158 million have been extended in this field. Also, a development loan in the amount of US dollars 18 million has been extended for a biomass project in Gambia, in which connection equipment has been delivered for briquetting of peanut shells. It is assessed that in this field there is basis for intensified cooperation with developing countries.

Furthermore, Danish expert assistance could be extended for energy planning and conservation. These are sectors of paramount importance for efficient utilization of energy sources in developing

countries. Due to the experimental stage of some forms of new and renewable energy sources, research projects are imperative and more funds are foreseen allocated for this purpose in the future under the Danish assistance programme. Until now, Denmark has granted assistance in the amount of US dollars 1.1 million for research projects in solar energy and hydropower which are being carried out in Sudan, Kenya and Tanzania.

Since energy projects often are risky and require large capital and expert resources, Denmark is in favour of intensified multilateral cooperation in energy development. As far as financing is concerned, Denmark is, in principle, opposed to the creation of new multilateral development funds, since such funds often result only in a reallocation of existing ODS flows and do not attract additional resources, and since new funds often involve a risk of duplication of the work in existing institutions. However, Denmark has taken a positive initial attitude both towards the creation of a new facility within the World Bank for the development of energy sources, and towards the UNDP proposal for the establishment of an Energy Fund for Exploration and Pre-Investment Surveys. These two proposals aim at creating facilities within existing institutions and would seem to stand a good chance of attracting additional resources. The definitive Danish position on the two proposals will be taken in the light of, i.a., the outcome of the Nairobi Conference on New and Renewable Energy Sources, and the possibilities of providing the required resources from the funds available under the Danish assistance programme.