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SUMMARY

1. The national report of Finland endeavours to describe not only our country's attitude towards the United Nations Conference on New and Renewable Sources of Energy, but also participation in international energy co-operation in general and the energy co-operation policy which we pursue. The report casts light on the position of new and renewable sources of energy in Finland now and in the next few decades, presenting factors which may impede their utilization. Taking the character and emphasis of the Conference into consideration, the report also devotes considerable attention to presenting our means of transferring technology in the field of energy and the efforts which we are making in this sector.

2. The most important new and renewable sources of energy in Finnish conditions are wood, hydro power and peat. As recently as 1960, wood and hydro power together accounted for 60% of total primary energy production. In 1980 this share (with peat added) was about 30 %. Compared with most other industrial countries, energy economy in Finland was based on the extensive use of renewable indigenous sources until exceptionally recently.

3. The era of cheap oil led to a decline in the share of indigenous energy in Finland as well. In spite of this, however, experience and expertise connected with the utilization of indigenous sources of energy are still available and currently being revitalized, as recent experiences have shown

4. Energy saving and promoting the production and use of indigenous energy have been set as the goals of Finnish energy policy. Many steps have already been taken in order to implement those goals. In Finnish conditions, the concept

of indigenous energy is virtually identical with that of new and renewable sources of energy. It is estimated that new and renewable sources of energy could satisfy 34-40 % of our primary energy consumption in 1990.

5. There are no significant factors which limit the use of new and renewable sources of energy in Finland, although the time needed to carry out structural changes in the energy economy, the limited nature of energy resources, financing and profitability questions and the level of technology may impede their use.

6. Finland actively participates in intergovernmental multilateral energy co-operation, especially under the auspices of the OECD and the ECE. Regional (i.e. Nordic) co-operation is growing and diversifying. However, concrete results can probably be anticipated primarily from Finland's bilateral co-operation, the framework for which has been created through agreements with several countries.

7. Finnish companies and research establishments in the field of energy as well as experts and researchers belonging to those bodies participate widely in the activities of non-governmental organizations engaged in this sector. The scope of those contacts includes a great deal more persons and covers a wider area than intergovernmental co-operation.

8. It is essential for Finland to participate in international co-operation if we are to have access to the results of energy research and development projects undertaken elsewhere. This co-operation also offers Finland the opportunity to participate in considerably larger and far-reaching projects in certain special areas than her resources would permit her to do alone.

9. Apart from the actual production of energy and trading in it, Finland has a particular need for co-operation in the following areas: energy research, energy management studies, information on international energy markets and energy policy measures taken by various countries.

10. The transfer of Finnish energy technology and know-how, both within development co-operation programmes and on a commercial basis, in connexion with new and renewable sources of energy is growing clearly. Due to her own natural conditions, Finland possesses a considerable fund of know-how and experience applicable to the transfer of technology, especially where forest energy, peat and to some extent, other biomass as well as hydro power (especially on a small scale) and energy transmission are concerned. Although preparedness to transfer technology is primarily centred around Finnish energy-sector companies, prominent research establishments also have good opportunities to participate, especially in connexion with Finland's development co-operation in the field of energy.

11. It has been forecast that the energy sector will constitute one of the areas of emphasis in Finland's development co-operation in the 1980s. Especially in development co-operation connected with the production of fuelwood, Finland's contribution during the decade which has now begun will rise to a level which will correspond better than is now the case to our substantial expertisein this sector. The inclusion of training aid and research know-how in Finland's development co-operation programme will also probably materialize in the near future. Co-operation with international financial institutions and, possibly, also with other donor countries should grow particularly much in the energy sector.

12. It is Finland's view that the United Nations Conference on New and Renewable Sources of Energy is a new and important part of the current North-South dialogue intended to promote the implementation of a new international economic order and the achievement of the objectives set for the international development strategy. The Conference will facilitate the creation of guidelines for planning the national energy policies of not only the developing countries, but of the industrial countries as well.

13. The primary goal of the Conference should be an endeavour to work towards the achievement of concrete results which, viewed from the perspectives of the whole world's and

individual countries' energy economy are beneficial and will, in particular, help to solve the developing countries' energy problems. In Finland's view, one of the principal objectives of the Conference is to outline the existing and future position of new and renewable sources of energy in the world energy economy and to find the requisite means, where both energy policy and co-operation in energy policy are concerned, to increase the share of those energy sources within a rational ecological framework. A task which will be of primary importance in this respect is to explore constraints on increasing the use of new and renewable sources of energy and searching for and creating means of abolishing or easing those constraints.

14. Finland believes that efforts to conserve energy should apply as much to new and renewable sources of energy as they do to conventional sources. Likewise, the environmental and social impacts of exploiting new and renewable sources of energy should also be studied and taken into consideration.

15. The need for increased international co-operation, forms and mechanisms of co-operation as well as, especially, the UN Organization's role in and resources for accomplishing progress in the exploitation of new and renewable sources of energy should be subjected to thorough study at the Conference. Finland considers it as being of primary importance that the position of the UN in international energy co-operation be strengthened.

16. However, the UN framework does not contain adequate institutional arrangements for practical co-operation in the field of energy, e.g. in exchanging research results and information. Therefore, consideration should be given to the question of whether, instead of setting up new UN agencies, one should create a system within which a lead institution would be set up for each area of energy technology; other institutions from various countries participating in the research programme would operate under the guidance of these lead institutions. Such a network of national and international research establishments could function within general guidelines issued by the UN General Assembly and ECOSOC.

17. Likewise, consideration should be given to the establishment of an international energy information system to promote the compilation and distribution of information on research, development and practical application, and to facilitate the systematic exchange of data between donor countries in development co-operation in the energy sector.

18. Energy information systems and questions of transferring and financing technology will be in a key position in easing the developing countries' energy problems. Only the allocation of adequate resources to research, development and demonstration projects can guarantee the accomplishment of viable solutions. Reinforcing the developing countries' own technological capacity will therefore be of primary importance.

19. Above all, the Conference should strive to strengthen the UN's ability to provide support, guidance and stimulus to other organizations, and especially to national entities engaged in utilizing new and renewable sources of energy. The opportunities provided by regional and bilateral co-operation should also be exploited to the full. The Conference will also be a propitious opportunity for both oil-producing and consuming nations to develop their co-operation, especially in easing the energy problems of the oil-importing developing countries.

20. Finland also considers the creation of a follow-up mechanism to monitor implementation of the Conference's results as being of primary importance.

21. Finland was entrusted with the preparation of a report dealing with the use of peat for energy production and is to present this report to the Conference. In addition to that, we shall arrange, in co-operation with the UN, a workshop and study tour on energy use of peat for representatives of developing countries. This seminar, which will take place in June 1981, will also contribute to the preparatory work for the Conference as far as the peat sector is concerned. In other respects as well, Finland has striven to make an active contribution to the preparations for the Conference both

globally and within the framework of Nordic co-operation.

22. Finland's national report to the United Nations Conference on New and Renewable Sources of Energy has been produced by the national preparatory committee. In addition to making preparations for Finland's participation in the Conference, the committee's frame of reference also includes making recommendations, on the basis of the Conference's results, for any measures deemed necessary for the formulation of national policies on energy and development co-operation.

23. A separate report on Finnish capabilities for transfer of energy technology is under preparation and will be available in May 1981. The Report covers: specialist organizations, consulting companies for project management and engineering design, manufacturing companies and products and research and development organizations.

I THE UNITED NATIONS CONFERENCE ON NEW AND RENEWABLE SOURCES OF ENERGY, and FINLAND.

1. Finland has greeted with satisfaction the decision taken by the UN General Assembly in December 1978 to convene a conference dealing with new and renewable sources of energy in 1981. Viewed from the perspectives of international politics and the international economy, the major significance of the event resides in the fact that, after several years of trying, a unanimous decision to deal with energy questions at the United Nations, in a universal forum, has been achieved. The Conference will provide an opportunity to pursue a dialogue on energy and to develop international co-operation in a sector which is limited but is becoming increasingly important: the utilization of new and renewable sources of energy.

2. In Finland's view, the decision to convene the UN Conference on New and Renewable Sources of Energy reflects the increased attention and interest which the international community is now devoting to energy matters. A growing degree of unanimity is beginning to prevail in the world to the effect that the next few decades will be a transitional period, during which the world economy will gradually shift more and more clearly away from oil and other depletable sources of energy towards new and renewable alternatives. This endeavour also manifests itself in the Energy Policy Programme approved by the Government of Finland in 1979.

3. Finland takes the view that the Conference will be of primary importance in efforts to promote the utilization of new and renewable sources of energy and associated international co-operation both globally and, particularly, in the

developing countries in the remaining two decades of this century, which will be a period of transition away from an economy dominated by fossil fuels.

4. The arrangement of the Conference will emphasize the central role of energy in international and national economic planning. This central role has been accentuated by steep increases in energy prices in recent years and the disturbances and uncertainty factors which have troubled the supply situation, especially where oil is concerned. Taken generally, the Conference can be considered to mean the most extensive global effort to date to promote the achievement of a structural change in the energy economy - a substantial shift towards new and renewable forms of energy.

5. It is Finland's view that the United Nations Conference on New and Renewable Sources of Energy is a new and important part of the current North-South dialogue intended to promote the implementation of a new international economic order and the achievement of the objectives set for the international development strategy. However, in spite of its linkage with the NIEO, the Conference will assist the planning of national energy policies in both industrial and developing countries; in other words, its results will affect all countries.

6. Finland's policy on international co-operation in the energy sector has been to strengthen the role of the UN. Thus she has supported proposals made within the world organization with the aim of achieving this objective. An example of this is provided by her unreserved support for the Conference and her subsequent active contribution to the preparatory work. At the UN, Finland has likewise supported a proposal to initiate the Global Negotiations Relating to International Economic Co-Operation for Development, in which energy would be one of the five themes for discussion.

7. Finland has endeavoured to make an active contribution to preparations for the Conference both at the global level and regionally within the framework of Nordic co-operation. Our country was entrusted with the preparation of a report, to be presented to the Conference, on means of producing and utilizing peat as a fuel. This study has also been financed by Finland. In addition to that, Finland, in co-operation with the UN Secretariat's Department of Technical

Co-operation, is arranging a seminar in June 1981, at which representatives of developing countries will study means of producing and using fuel peat. Most of the costs of this seminar will be borne by Finland, and it will also contribute to the preparations for the Conference as far as the peat sector is concerned. A Finnish expert has also participated in preparations for the Conference on the Fuelwood Panel and in the Ad Hoc Expert Group dealing with industrial issues.

8. In the absence of a global forum for co-operation in the field of energy, the Conference will provide an excellent framework for achieving progress in the development of international energy co-operation where the increasingly important sector of new and renewable sources is concerned. Finland takes the view that the primary goal of the Conference should be an endeavour to work towards the achievement of concrete results which would bring progress towards easing the energy problems of all countries, and particularly the developing countries.

9. Finland considers it important that the Conference concentrate on exploring constraints on increasing the utilization of new and renewable sources of energy and endeavour to seek and create means of abolishing or reducing those constraints. This presupposes, however, that the technical and economic aspects of exploiting such sources of energy be given adequate study during preparations for the Conference. In Finland's view, this work of creating a foundation should also study the social and environmental impacts of exploiting new sources of energy. In this respect, the task of the Conference will be to outline the existing and future status of new and renewable sources of energy in the world energy economy and to find the necessary policy measures to bring about a substantial increase in the role played by these sources, within a sensible ecological framework.

10. Finland emphasizes that efforts aimed at the efficient use of energy should apply just as well to new and renewable sources as to conventional sources. This principle should also be enshrined in every country's national energy programme. Energy conservation is a particularly suitable area for international co-operation, in which it is possible to achieve important results within a relatively brief time span. Finland considers it important that

the resources devoted to this activity be substantially increased.

11. The Conference should also contribute to bringing about better co-ordination of functions and creating a division of labour in international efforts to increase the use of new and renewable sources of energy. The Conference should strive to map out the need for increased international co-operation, forms and mechanisms of co-operation as well as, in particular, the role of and resources available to the UN system in bringing about progress towards using more of those sources of energy. Strengthening the role of the UN in international energy co-operation is a matter of primary importance.

12. Energy information systems and questions of transferring and financing technology will be in a key position in easing the developing countries' energy problems. With this in mind, the Conference should explore and study the functionability of existing research, development and demonstration programmes and of compilation and transfer mechanisms for energy as well as the need for financing and technical assistance. Only the allocation of adequate resources to research, development and demonstration projects will guarantee the achievement of durable solutions. Therefore it will be of primary importance to strengthen the developing countries' own technological capacity.

13. Although a multilateral approach should be dominant in seeking means of solving the problems, attention should also be devoted to the opportunities presented by regional and bilateral co-operation. Above all, the Conference should strive to reinforce the UN's ability to give support, guidance and stimulus to other organisations, and especially to national efforts to exploit new and renewable sources of energy.

14. Finland believes that the Conference will also provide both oil-producing and consuming nations with a favourable opportunity to develop fruitful co-operation aimed at solving global energy problems, and especially the energy problems of the oil-importing developing countries, over the longer term. It would be important for the Conference to be able to

accomplish progress in this respect as well.

15. To put it in a nutshell, the Conference should succeed not only in arousing awareness of the growing scarcity and ultimate exhaustion of conventional sources of energy, but also in its even more important goal: preparing mechanisms and forms of co-operation as well as joint measures in order to promote the development and exploitation of new and renewable sources of energy all over the world, and especially in the developing countries. Finland believes that in order to achieve this objective the Conference should lead to a strengthening of the UN's role in international energy co-operation in general. This also presupposes the creation of a follow-up mechanism to monitor implementation of the Conference's results, e.g. a programme of action.

16. Finland's participation in the United Nations Conference on New and Renewable Sources of Energy has been prepared by a national preparatory committee, appointed in December 1979, which has produced this report. The committee's frame of reference also includes producing, on the basis of the results from the Conference, recommendations for national policies on energy and development co-operation.

A. The Finnish Energy Economy

17. Wood and hydro power have historically been the most important indigenous sources of energy (Diagram 1). In addition to the use of fuelwood, wood has also played a significant role in transport, e.g. as fuel for steam locomotives and steam-powered craft as well as (during the Second World War) in charcoal-burning road vehicles. As recently as 1960, wood and hydro power between them accounted for about 60% of total energy production. Thus, compared with most other industrial countries, energy economy in Finland was based on the use of renewable indigenous sources for an exceptionally long period.

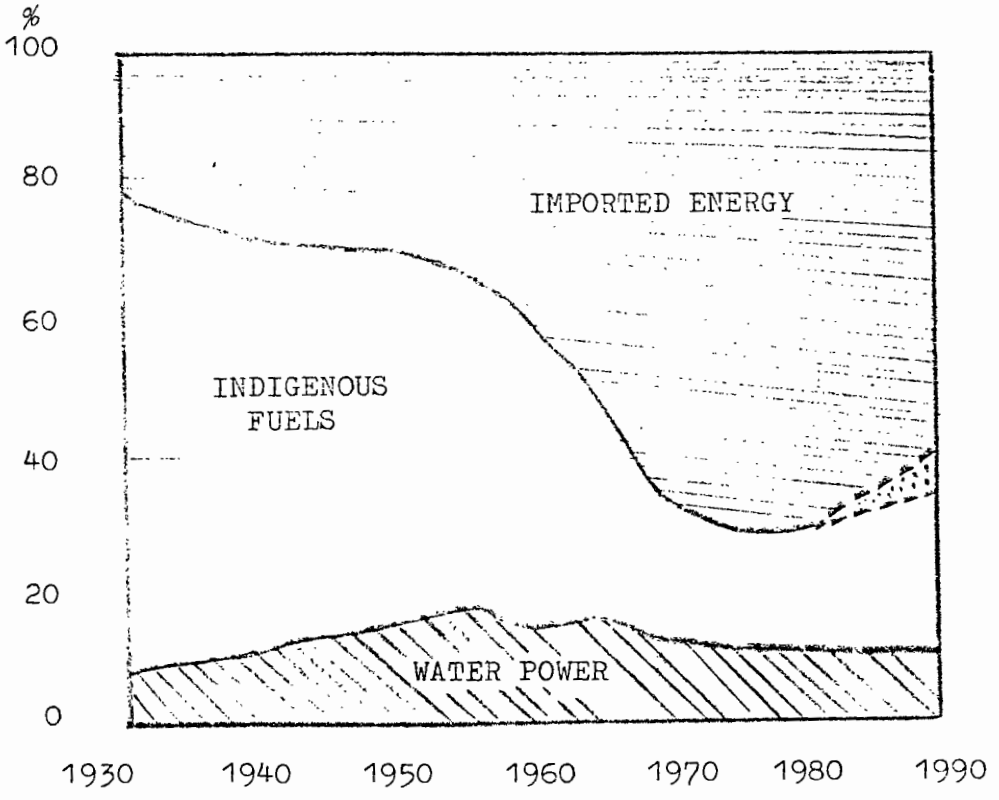

Diagram 1 Development of energy self-sufficiency rate in Finland 1930-1980 and projected development up to 1990 as envisaged in the national energy programme

18. During a period of cheap oil and changes in the structure of society in the 1960s and early 1970s, energy imports and

their relative share of total energy consumption increased very strongly in Finland, as in many other industrial countries. On the other hand, hydro-electric power capacity was developed during the same period to the extent that its share of total energy consumption remained approximately the same throughout the past two decades. The use of wood for energy production has declined both absolutely and relatively, but has remained at quite a high level compared with other industrial countries. In absolute terms, the use of wood for energy production has been rising again since 1978. Prior to and during the 1970s, the quantities of peat used were small, but they are expected to increase substantially by the end of the century.

19. Although the era of cheap oil temporarily altered the course of development, experience and know-how connected with the exploitation of indigenous sources of energy are still possessed by experts in the energy sector, and can thus be revived. Recent experiences support this view.

20. Typical features of the Finnish energy economy as now constituted are a high rate of consumption relative to GDP and the absence of indigenous fossil fuels. The structure of our industry as well as climatic and geographical factors influence our energy consumption rate. For geological reasons, Finland has no deposits whatsoever of oil, coal and natural gas, which between them account for nearly 90% of world energy consumption. By contrast, Finland has relatively large peat deposits and, calculated per capita, quite a high production potential with regard to renewable sources of energy.

21. As in the other Western industrial countries, Finland's energy management has been mainly founded on fossil sources. Different types' shares of total energy consumption in 1979 are shown in Table 1.

Table 1 Energy consumption in Finland in 1979

	Quantity, Mtoe	Share, %
Oil	11.8	48
Natural gas	0.8	3
Coal	3.2	13
Nuclear	1.6	6
Electricity imports	0.2	1
Hydro-electric power	2.7	11
Peat	0.4	2
Wood-based fuels	4.1	16

22. Of the various types of energy which will be discussed at the conference, the most important from Finland's point of view are wood, hydro-electric power and peat. Other biomass forms, such as straw and bio-gas, as well as solar and wind energy can be important in Finland. By contrast, the large-scale exploitation of tidal, wave or geothermal energy is hardly likely to enter the picture in Finland during the next few decades.

23. Economy and promoting the use of domestic sources have been stipulated as the principal goals of Finnish energy policy. Many measures have already been implemented in order to achieve those goals. In Finnish conditions, the concept of indigenous energy is virtually identical with that of new and renewable sources of energy. In this respect, and in the light of international comparisons, our energy policy can be considered quite progressive, because it is largely based on the use of new and renewable sources of energy.

24. It is difficult to forecast the share of Finland's total energy supply which new and renewable sources of energy will represent in the future, because many still unresolved factors are involved. These include the availability of various forms of energy and the relationship between their prices, as well as the way in which the energy policy pursued develops. In Table 2, an effort is made to assess the production and use potential of each energy form in question. It should be noted that these figures cannot be combined, because the various forms of energy are substitutes for each other in the way they are used, and mutually competitive.

Table 2 New and renewable sources of energy in Finland, Mtoe/year

Source	Use in 1979	Estimated potential at end of century
Wood	4.1	10 - 11
Peat	0.4	3 - 5
Water power	2.7	4
Other biomass	0	0.5
Community wastes	0	0.5
Direct solar energy	0	0.5
Wind power	0	0.5

B. The Use of Wood for Energy Production

25. In 1979, 4.1 Mtoe of energy, i.e. about 16% of total consumption, was generated from wood fuel. This share was broken down as shown in Table 3.

Table 3 The use of wood for energy production in 1979

	Quantity, Mtoe	Share, %
Fuelwood for space heating	1.5	37
Industrial waste wood and bark	0.5	12
Industrial waste slurries	2.1	51
Total	4.1	100

26. Since 1978, the quantity of wood used as fuel has been increasing in absolute terms after a long period of decline. The main reason for this is a rise in the wood-processing industry's capacity utilization rate. The effects of measures implemented in line with national energy policy have also begun to show.

27. In order to increase the use of wood for energy production, one can intensify the use of fuelwood reserves (i.e. burn trees below the dimensions normally used by the forest industry as well as logging residue) and begin producing biomass from natural coppicing deciduous trees and in specially established plantations. As the eighties begin, the fuel wood reserves in our forests and in the form of industrial waste wood total over 15 million cubic metres per year, with an energy content equivalent to about 3 million tonnes of oil per year. It is estimated that the existing fuel wood reserves and their development make it possible to double the amount of energy derived from wood.

28. It can be assumed that the use of industrial waste slurries will further increase as the capacity of the pulp industry expands. However, processes are being developed to save wood, which will in turn increase energy consumption. If the price of energy continues to increase, it will be difficult to

predict whether expanding production by the pulp industry in the 1980s and 1990s will lead to an increase in the use of industrial waste slurries as fuel or not.

29. In addition to the fuel resources produced and to be produced in conjunction with natural forest growth, biomass suitable for combustion can also be grown in natural low forests or in specially cultivated stands.

30. Natural deciduous trees, which mostly reproduce by suckering, will be cultivated within a short-cycle system. Growth can be enhanced by regulating the water supply to the subsoil and by fertilizing with artificial fertilizers or wastes.

31. In energy tree plantations , biomass will be produced by using field cultivation methods and a short growth cycle of 1 - 15 years. Suitable varieties for cultivation include deciduous coppicing bushes and trees, such as certain willows, aspens and poplars.

32. According to one estimate, Finland could be producing the equivalent of 2.5 - 3 million tonnes of oil a year in natural low forest growths and energy tree plantations totalling 1 million hectares by the end of this century. This is a maximum figure, the achievement of which will presuppose large-scale research and experimentation (already begun) and the active participation of the State in the programme's implementation.

33. However, in using and producing wood-based energy it would be advisable to proceed in such a way that one makes more judicious use than at present of existing wood fuel reserves and those produced in conjunction with industrial wood supplies, after which production from coppicing forest growths and short rotation plantations could be increased. That being the case, our forest energy production potential would be 6 - 7 Mtoe per year in 1990 and about 10 Mtoe per year by the end of the century.

34. Most of the existing use of wood as fuel occurs in the forest industry and in space heating (principally in sparsely

populated areas. It is possible to raise wood's share of the energy used in these applications, but not by a particularly substantial margin. If the aim is to bring about a substantial increase from the present level in the share of Finland's energy supply which wood accounts for, new utilization methods and application areas will have to be found. The principle use which can be considered in this respect is in large boilers, such as those used for district heating systems, as well as wood chips or briquettes in individual buildings. One precondition for more widespread use of wood as fuel is that processed, easily transported and used fuel products of consistent quality be developed.

35. Taking the longer-term view, liquefaction and gasification of wood, as well as of peat and other biomass, can be of fairly major importance. The primary aim in gasification will be to produce gas of low calorific value in the immediate vicinity of the place where it is used. Liquefaction can be used to produce either alcohols (methanol or ethanol) suitable for use as fuel or synthetic oil.

C. Hydro Power

36. Right up to the latter part of the 1950s, water power produced as much as 80 - 90% of the electricity generated in Finland. Strongly growing consumption has, however, sharply reduced this share in the course of the past couple of decades. Measured according to mean flow conditions it now totals about 12 TWh/a (= 3 Mtoe, 1 Mtoe being counted as corresponding to 11.28 TWh) or 30% of the total electricity generated. Although the relative share of hydro power has deereased, its technical properties have increased its importance in the regulation of the thermal-power-dominated system and as a back-up reserve.

37. It has been estimated that the technically harnessable water power resources in Finland total some 18 - 19 TWh/a. The existing hydro power capacity and that under construction are set forth in Table 4.

Table 4 Finland's hydro-power potential in 1979

Harnessed		Harnessable		Total	
Capacity MW	Energy TWh/a	Capacity MW	Energy TWh/a	Capacity MW	Energy TWh/a
2400	11.6	1700	7.2	4100	18.8

38. As far as the amount of energy is concerned, the greatest hydro power potential is in Northern Finland. Excluding frontier rivers and rapids which are now absolutely recommended for preservation in their natural state, the hydro-electric power potential actually harnessable in Finland is in the region of 5 TWh/a, which corresponds to 1.25 million tonnes of oil per year. Since, in addition to those, some of the objects are of such a nature that for economic or environmental reasons their harnessing is difficult to countenance, the additional hydro power power potential available is about 1 Mtoe/a. When Finland's share of frontier rivers is included, the figure rises by about 50%, i.e. to 1.5 Mtoe/a.

39. Planned additional capacity on rivers already harnessed will total about 600 MW and about 2.2 TWh/a of energy, corresponding to over 0.5 Mtoe/a. This construction will also presuppose a certain amount of additional river regulation, which will make it possible to make more effective and economic use of the capacity mentioned above.

D. The Use of Peat for Energy Production

40. The greatest part of the world's peat resources inventoried to date are located in the cooler parts of the temperate zone in the Northern Hemisphere. Finland's peat reserves are the equivalent of about 5,000 million tonnes of oil in energy content. However, existing technology does not permit anything like all of this to be exploited economically

for energy production. Fuel peat should be well decomposed. Bogs should be large in area, deep enough and favourably located in relation to the places where the fuel is used. The total quantity of economically exploitable peat is estimated to total 1000 - 2000 Mtoe, depending on what depth of bog is defined as workable.

41. The quality of peat as fuel varies from that of wood to lignite. The surface layers of Finnish bogs generally contain peat which has not decomposed very much, and the calorific content is low. Further down, however, the degree of decomposition is higher and the calorific value is also better. Peat from surface layers is generally used for horticultural purposes.

42. Peat production and consumption has grown particularly rapidly in recent years (Table 5). Milled peat accounts for the greatest part of total production. Most of the peat produced is used by industry and district-heating utilities. In 1978, industry used about one third of the total produced. District heating and other consumers used the remaining two-thirds.

Table 5 Production and consumption of fuel peat in Finland 1977-79
Millions of cubic metres per year (1 Mtoe = 11 million m^3 of peat)

	1977	1978	1979
Production	3.2	5.6	4.7
Consumption	1.8	4.0	5.7

43. Finland's national energy programme envisages peat production of 25 - 30 Mm^3 by 1990. Most of this will be used by traditional consumers. Opportunities to increase the use of peat will also depend on whether or not new applications are found. New potential uses for peat include:

- combustion in small boilers, e.g. for household heating, mainly in sod, pellet or briquette form;
- use as feedstock for the chemical industry, e.g. for

ammonia synthesis, or liquefaction or gasification;

- use as a fuel in separate condensing power generation.

If these possible uses are combined, it can be estimated that a potential total of at least 30 - 40 million m^3/a of peat can be used for energy production by the end of the century. Indeed, some estimates put the total as high as 50 million m^3/a.

E. Other New and Renewable Sources of Energy

44. Other future sources of energy which can be considered in Finnish conditions include such biomass types as straw, agricultural wastes, water vegetation, etc., community wastes, wind power and solar energy.

45. Straw could potentially provide about 0.9 Mtoe of energy in Finland. However, means of utilizing it are limited by collection difficulties and the fact that cereal cultivation is concentrated in Southern Finland. It has been estimated that the realistic potential at the end of the century would be about 0.3 Mtoe/a. It has also been estimated that 0.3 Mtoe/a of biogas could be developed from agricultural and community slurry-type organic wastes. Water vegetation can be used as a source of energy, but there are no reliable estimates of its potential. It is also believed that certain other cultivated plants can be used as sources of energy. These sources of biomass are mainly suitable for local energy production, e.g. on farms, where they could compete with each other and with firewood. The combined production and consumption potential is estimated at about 0.5 Mtoe/a.

46. Community wastes are already being used as a source of energy. The maximum potential is about 0.5 Mtoe/a. Burning these wastes serves a dual purpose in that it solves a waste management problem in addition to providing energy.

47. The use of direct solar energy can be considered in Finland mainly in relation to space and water heating. Although the amount of solar radiation is not great in Finland, the considerable need for space heating means that a greater

proportion of what is available can be used than is the case in countries further south. Thus the possibilities of solar heating are not substantially worse in Finland than in lower latitudes. However, the slow rate of renewal of the housing stock is a limiting factor on the speed with which solar energy can be harnessed. Theoretically, solar energy could be providing about 1 Mtoe/a by the end of the century, but the practical potential is more like 0.5 Mtoe/a.

48. Technology for harnessing wind power is not so advanced as that in the field of solar energy. There are two main types of technology worthy of consideration: the use of small rotors for electricity and/or heat generation in individual houses and the use of large wind aggregates for supplying electricity to a national grid. The potential depends on wind conditions and how back-up power systems can be arranged. Taking those into the calculation, it can be estimated that wind power has a potential in the region of 1 Mtoe/a by the end of the century. However, the practical potential is probably around 0.5 Mtoe.

F. Energy Transmission

49. Energy transmitted within energy transmission systems is usually in the form of electricity. The Finnish electricity supply was initially based entirely on hydro power, but thermal power achieved dominance during the 1970s, i.e. coal, nuclear fuel, oil, gas as well as new and renewable sources of energy are used to generate this country's electricity. This presupposes carefully planned electricity transmission grids. Indeed, this is considered one of the key questions involved in exploiting new and renewable sources of energy in the developing countries, as well as elsewhere.

50. The Finnish national grid has been developed for the most part in the course of the past few decades. Special problems have been caused by the long distances involved in this sparsely populated country, the geographically dispersed character of consumption and severe, fluctuating climatic

conditions. The extensiveness of the grid system has also required the development of computer-based design methods. Where the grid is concerned, detailed design and construction has mostly been carried out by the power generation companies and the distribution utilities. The aim in developing equipment and structures has been to stimulate domestic manufacture, which has presupposed a broad degree of co-operation with Finnish industry.

51. In recent times it has become necessary to examine the whole structure of our energy supply system in increasingly fine detail in order to make it possible for us to exploit our energy resources with optimal efficiency. There is an old tradition of cogenerating electricity and heat in Finland. Some towns and cities have had district-heat mains for the past 20 years. At the moment, nearly a third of the total building volume in the country is served by district-heating systems.

G. Research and Development

52. The Finnish organizations which produce and consume electric energy have long experience of using wood, peat and hydro power. They have long been devoting resources of their own to research and development in this sector, and have thus created a good foundation for further development. In recent years, the State has begun allocating large sums towards research aimed at promoting energy saving and the use of indigenous sources of energy. In 1980, a total of about 65 million Finnmarks (approx. US $ 17m.) of public money was allocated to research in the field of energy. About 30% of this total went towards research into the use of new and renewable sources of energy, principally wood and peat.

III FACTORS WHICH IMPEDE THE UTILIZATION OF NEW AND RENEWABLE SOURCES OF ENERGY IN FINLAND

A. General

53. Nearly 30 per cent of Finland's energy is now derived from new and renewable sources, and this proportion is clearly increasing. Finland is one of the few industrial countries which use biomass-based fuels on a large scale, and thus there are no major obstacles to her introducing the use of new and renewable sources of energy. However, there are certain factors which will limit the speed at which the use of these new sources will be able to grow. Important factors are the time needed to change the structure of the energy economy, the limited nature of new and renewable sources of energy, environmental questions, financing and profitability aspects and the level of the available technology. However, the most important factor is the prices of alternative forms of energy.

B. The Speed of Change in the Energy Economy

54. Quite a large amount of capital is tied up in energy acquisition and consumption facilities, and in many cases their technical and economic life span is quite long. Replacing old, but still serviceable facilities is economically burdensome and permits a lesser degree of freedom of action than when new capacity is being built up. In some sectors of energy production and consumption in Finland, the existing capacity is qualitatively adequate to meet requirements for a good few years to come. This is a braking factor on the need to build up new capacity and may thus also impede the adoption of new forms of energy.

55. Viewed on the whole, however, a structural change in the Finnish energy economy away from oil and more towards indigenous sources appears to be progressing faster than in the developed world in general.

C. Environmental Impacts

56. Viewed in general, new and renewable sources of energy are relatively favourable from the environmental protection viewpoint when compared with fossil fuels. In certain cases, however, the need to minimize environmental impacts can slow down the adoption of these forms of energy.

57. The environmental aspect comes most prominently to the fore in the case of hydro-electric power. Some of the rivers still unharnessed are considered important from the viewpoints of environmental protection and fisheries and there is a powerful lobby in favour of their preservation.

58. Where the production of wood for energy production is concerned (short rotation culture), the environmental aspect can be examined from the angle of the forestry sector's environmental impact in general. In principle, other uses for peat bogs, especially their conservation in a natural state, can be a competing alternative to peat harvesting. In practice, however, it has been possible to reconcile different objectives to a great extent, enabling both the preconditions for peat production and conservation to be moderately satisfied.

59. As regards the worst air-polluting emissions, mainly sulphur, peat and wood are relatively clean fuels. Solid particles emitted when peat and wood are burned are easier to filter out in large institutional units and in district-heating plants.

D. Financing

60. A characteristic feature of the costs structure of new and renewable sources of energy is that the initial investments are relatively large, after which operating costs are low. Compared with the sums flowing outwards to pay for energy imports, these investment requirements are not large at all. Without special arrangements for financing, however, the investment aspect can be a threshold which slows down the adoptation of these new and renewable sources of energy.

Within the Finnish energy economy, there is already a tradition of providing public financial support for the harnessing of water power resources. This is also the case where peat production is concerned. Establishments which use indigenous fuels have also been paid investment grants out of public funds. When one takes account of these measures, financial arrangements can probably not be considered a central obstacle to the use of new and renewable sources of energy in Finland.

E. Research and Development

61. There is good and comprehensive mastery of the technology involved in the conventional utilization of water power, peat and wood, and in this respect there is no noteworthy obstacle to the use of these sources of energy. Research and development efforts are being focused primarily on further improving the effeciency, dependability and economy of this technology.

62. Factors limiting growth in the use of indigenous fuels are their low calorific value and inconsistent quality. By developing peat- and wood-based compressed fuels as well as liquid and gaseous fuels it will be possible to enhance their use potential. Research and development programmes intended to achieve this are actively in the pipeline in Finland.

IV FINLAND'S PARTICIPATION IN INTERNATIONAL CO-OPERATION IN THIS SECTOR

63. This chapter of the report covers participation by Finnish organizations in international co-operation in the field of energy, the need for co-operation and means of developing it. Finland participates in international energy co-operation in many different ways. However, new and renewable sources of energy have not been emphatically to the fore in actual organized co-operation forms of a permanent character.

A. Intergovernmental Multilateral Co-operation.

64. The most important international organizations engaged in the energy sector of which Finland is a member are the OECD and the UN's Economic Commission for Europe. Finland has stressed the importance of strengthening the UN's role in international energy co-operation. This policy has been a natural and consistent one since 1974, when a decision was taken not to become a member of the IEA, a body which functions under the auspices of the OECD.

65. Within the OECD, Finland is represented on Energy Political Committee and in the past couple of years has participated in the work of three ad hoc working parties set up to study new and renewable sources of energy. The first of these explored the OECD countries' development co-operation with respect to renewable sources of energy and issued recommendations to member countries in this connexion. The other two working parties have studied the promotion of the use of promising new energy technologies (also with a bearing on fossil sources) and their commercialization in OECD countries. In work which is still going on, four Finnish peat and biomass projects will become the object of investigation and may be recommended for further action.

66. Work within the ECE in relation to new and renewable sources of energy has up to now been limited in practice to the ex-

change of statistical material and to deliberation of water-power-related questions by the Power Committee, in the work of which Finland has been participating. Finland considers it particularly important that the ECE's work in relation to new and renewable sources of energy - as in energy co-operation in general - be powerfully intensified. In fact, there are already signs that this is happening, because new sources of energy are being given an increasing amount of attention in the work of the Science And Technology Committee Similarly, the establishment of the Senior Advisers on Energy to ECE Governments is making the energy sector as a whole one of the areas of emphasis in East-West economic co-operation. Finland is also actively involved in the FAO's work in relation to forest-derived energy.

B. Intergovernmental Nordic and Bilateral Co-operation

67. Our neighbouring countries are natural co-operation partners both in energy matters generally and in relation to new and renewable sources of energy in particular. Potential new co-operation partners are the developing countries, which can use energy-related technology and know-how developed in Finland. In most cases, Finland's bilateral co-operation in energy matters with various countries has been connected with trade in energy, mostly derived from conventional sources. The energy sector is mentioned as one area of co-operation in most of the economic, technological and scientific co-operation agreements and/or protocols signed by Finland.

68. Energy co-operation between the Nordic countries (Finland, Sweden, Norway, Denmark and Iceland) has primarily taken place under the auspices of the Nordic Council. It includes meetings of Nordic energy ministers two or three times a year and even more frequent meetings of the civil service committee responsible for industrial and energy policies and an ad hoc working party of civil servants concerned with energy questions. No actual permanent forum for dealing with energy matters has so far been formed to deal with either general questions of energy policy or research matters. For dealing with questions of co-operation in the field of nuclear technology there is a separate body called Nordisk Kontaktorgan för atomenergifrågor, NKA, (The Nordic Contact Body for

Nuclear Energy Questions). The Nordic Industrial Fund (Nordisk Industrifond) finances joint-Nordic research and development projects. Co-operation in the field of research is mainly confined to contacts between state research establishments.

69. A programme for co-operation in the field of energy has been worked out by the Nordic countries. In addition to co-operation in relation to energy saving, coal, oil and natural gas, it covers research, new and renewable sources of energy and energy systems analyses. Nordic energy co-operation will increase particularly rapidly in the research field in the coming years. Where renewable sources of energy are concerned, the main focus of Finnish attention in Nordic co-operation will be on wood and peat. There will also be a strong effort to promote co-operation in transfers of energy-related technology, especially to the developing countries.

70. Energy-related co-operation between Finland and the Soviet Union has been dealt with by the energy co-operation sub-committee of the economic co-operation commission set up jointly by the two countries. In addition to nuclear power, co-operation in relation to energy saving, water power and peat production has been discussed. In association with the Finnish-Soviet committee for scientific and technological co-operation, there is also a working party charged with studying peat-related questions. At the moment, it is studying technology for producing peat briquettes and the development of new peat-harvesting equipment.

71. Frame agreement was recently signed by Finland and the United States covering co-operation in energy technology and related research. The areas covered by this co-operation will be peat-, biomass- mini- hydro district-heating- and electricity/heat-cogeneration-related technology as well as the efficient use and saving of energy in construction and industry. During the initial stage, co-operation will concentrate on peat technology. The outline agreement will in due course be supplemented by protocols covering the separate areas mentioned above. These protocols will cover co-operation in greater detail.

C. Non-governmental Co-operation

72. Finnish associations and research establishments active in the energy sector maintain constant international contacts. These links consist largely of personal contacts formed by experts and researchers in the field and their participation in the work of international energy-sector associations and organizations. Examples include the World Energy Conference (WEC), the International Institute for Applied System Analysis (IIASA), Union Internationale des Producteurs et Distributeurs d'Energie Electrique (UNIPEDE), Conférence International des Grands Réseaux Electriques à Haute Tension (CIGRE) and the International Peat Society. Finland will also participate in the work of an energy sub-committee set up by the International Chamber of Commerce. In this committee, trade and industry will be linked closer together in international energy-sector co-operation.

73. There is also established company-level co-operation in the Nordic countries. An example is NORDEL, under the auspices of which co-operation between electricity producers has been practised for many years. By means of short-term exchanges of electricity between Nordic countries, the use of production capacity has been optimized and the amount of reserve capacity needed reduced. Company-level co-operation with the Soviet Union has also been lively.

74. Civil servants engaged with energy questions and representatives of universities and comparable institutes working in the sphere have taken part in fixed-term international energy studies such as the Workshop on Alternative Energy Strategies (WAES) and the World Coal Study (WOCOL).

D. The Need for International Co-operation

75. Finland has a considerable need for international co-operation in the field of energy. In addition to the actual trade in and production of energy, there is a need for co-operation in the following sectors:

- energy research
- research into the economic aspects of energy

- information about international energy markets
- information about energy policies in various countries

The above aspects apply both to the energy economy in general and to new and renewable sources of energy in particular.

76. Where Finland is concerned, the most important new and renewable sources of energy are wood, hydro power and peat. In co-operation relating to these sources, Finland is usually the know-how-donating party. Where other sources such as wind power and solar energy are concerned, Finland is generally the recipient in international co-operation.

77. From Finland's point of view, participation in international co-operation is essential if we are to be able to avail of research and development results obtained elsewhere in the field. Within an international co-operation programme and division of labour, Finland could, in certain sub-sectors, participate in considerably larger and farther-reaching projects than her resources would permit her to do alone.

78. Having decided not to become a member of the IEA, Finland considers it particularly important that the role of the UN in international energy-related co-operation be strengthened. The importance of the world organization as an energy forum will obviously grow vigorously in the next few years. However, the UN framework does not contain adequate institutional arrangements for the promotion of practical co-operation in the field of energy, e.g. in energy research and the exchange of information. Therefore, a question that should be investigated is whether it would be possible to create a system within which a lead institution would be set up for each area of energy technology; other institutions from various countries participating in the research programme would operate under the guidance of those lead institutions. Such a network of national and international research establishments could function within general guidelines issued by the UN General Assembly and ECOSOC, whilst the relevant UN secretariate bodies could be entrusted with co-ordinating the functions of the various components making up the network.

79. Consideration should also be given to the establishment of an international energy information system, which would compile and disseminate information on research and development results, applications with a bearing on new and renewable sources of energy, etc., as well as facilitate the exchange of systematic data between donor countries with regard to such things as plans, areas of emphasis and experience of development co-operation in the energy sector.

V. FINLAND'S POSSIBILITIES OF TRANSFERRING TECHNOLOGY BASED ON NEW AND RENEWABLE SOURCES OF ENERGY

A. Transfers of Energy-related Technology in Recent Years

(i) Transfers of Technology on a Commercial Basis

80. Transfers of energy-based technology on a purely commercial basis by Finnish companies have grown clearly in the past two or three years, although their share of total technology exports is probably still under five per cent. Exports of technology and consultancy services associated with new and renewable sources of energy are also growing clearly. A considerable proportion of these exports are already going to developing countries, although industrial countries remain the most important market area.

81. In relation to the exploitation of new and renewable sources of energy, exports of know-how and technology connected with the utilization of hydro power are backed up by a powerful tradition. New spheres of activity have primarily been concerned with the use of wood as fuel, including the combustion of waste wood and sludges from the wood-processing industry and peat burning. A large number of these tasks have been tackled in collaboration with the forest industry. Some of the studies have been carried out for UN agencies.

82. Energy saving by building owners, communities and industry, especially waste heat recovery, have been areas of emphasis in our exports of energy-related technology and know-how, mainly to industrial countries. Another important area of operation in our exports has been heat production and distribution. Projects executed in this sector have had to do with district- and regional-heating systems, central heating plants and mains systems as well as diesel-powered heating plants. Exports in this sector have also been focused mainly on the more developed countries.

83. Electrification, the associated small-scale power production and mini-hydro power plants have been a third area in which Finnish companies have executed a considerable number of export projects, especially in developing countries. It is

forecast that developing countries will form an important customer category in the future. A fourth important area of operation has consisted of power plant projects, in which Finnish companies have participated by conducting research, studies and planning tasks and by supplying machinery and equipment.

84. A fifth area of operation has been the production, processing and use of peat, in connexion with which machinery and equipment have been supplied to industrial countries, mainly. The production, recovery and harvesting of bio-fuels (especially waste wood and short-cycle energy forests) as well as their processing and use have formed a sixth important area of operation in transfers of energy-related technology and know-how by Finnish companies. Here, too, the principal marketing area has been the developed countries.

(ii) Development Co-operation in the Energy Sector

85. The degree of interest felt in Finland in relation to development co-operation in the energy sector has been growing at a rapid pace. Last May, a working party appointed by the Ministry for Foreign Affairs to study renewable natural resources submitted its report, which contained detailed recommendations for Finland's development co-operation, also in respect of expertise related to renewable sources of energy. Among the views expressed by the working party were that areas suitable for co-operation projects were afforestation for fuelwood production, mini- hydro power plants, the use of peat for energy production and the manufacture of gasohol from various raw materials. The report also emphasizes the importance of increased energy-related research co-operation between institutes in Finland and developing countries. It also recommends that state funds for energy research and product development support grants also be channelled into creating technological designs and products suitable for use in development co-operation. The report's recommendations regarding renewable energy resources are intended to be taken into consideration in Finland's energy-related development co-operation in the next few years.

86. It is expected that the energy sector will constitute one of the principal areas of emphasis in Finland's development co-operation programme in the 1980s. The number of development co-operation projects has been increasing rapidly, especially in the course of the past year, and the total sums involved have also risen steeply. The following tabulation shows how grant aid has been growing in recent years:

	number of commitments	value (millions Fmk)
1978	7	5.6
1979	5	3.5
1980	15	16.1

Credits granted for development in the energy sector totalled 5.2 million marks in 1980.

87. Most of our development co-operation projects in the energy sector to date have concerned electrification and power distribution systems. In 1980, however, commitments concerning ten projects based on new and renewable sources of energy were entered into; they involve the utilization of mini-hydro power and peat as well as a wood-chips-fired power station. In addition to this, some multipurpose projects concerning the forest industry contain energy-production elements. Two projects have been donated to the UN as Finland's contribution towards the work of preparing the Conference on New and Renewable Sources of Energy.

88. The increasing importance of energy co-operation has also been reflected in our country programmes with the principle recipients under our bilateral programme. In the programmes for Egypt, Kenya and Sri Lanka, energy has been chosen as one of the main sectors. Aside from increased interest and preparedness in the private and public sectors - research establishments and companies - a factor which has clearly contributed to growth in our energy-related development co-operation is a marked rise in the number of requests by developing countries for

assistance with development projects.

89. To sum up: transfers of energy-related technology and know-how are clearly growing, both within development co-operation programmes and on a commercial basis. A considerable part of this growth has stemmed from an increase in the number of projects involving new and renewable sources of energy, although other energy-related projects still constitute the greater share.

B. Finnish Expertise and Possibilities of Transferring Technology

90. Due to the natural conditions in Finland, this country possesses considerable expertise and experience connected with certain new and renewable sources of energy. This know-how and technology can be applied particularly in the cases of forest-derived energy, peat and mini-hydraulic power.

(i) Expertise in Relation to Forest-derived Energy

91. Research into the use of wood as fuel began to expand rapidly during the late 1970s. Research and development is still continuing at a lively pace, being focused primarily on the utilization of existing forests, but also on tree cultivation for energy purposes (short rotation trees), which is being intensively investigated. Technical expertise in connexion with harvesting, transporting and processing short rotation energy trees and the Finnish machines, appliances and equipment developed are of top world class.

92. The further processing of wood (e.g. gasification and liquefaction) are also the subject of extensive research. On the whole, Finland has excellent opportunities to transfer technology and research results connected with the forest-derived energy sector.

(ii) Peat Know-how

93. The production and use of peat is increasing rapidly in Finland. Several large peat-fired power stations have been built or are planned and the use of peat in district heating plants in urban districts is also on the increase. Likewise,

there is a general aim of co-generating electricity and heat.

94. Peat upgrading has been begun and intensive research is being focused on peat gasification and liquefaction. One factory is already producing peat briquettes and peat coke. Two briquette factories are under construction and several pelletization factories are in the pipeline. International co-operation agreements already signed or which may be concluded in the future and project co-operation carried out on their basis should give a further boost to the development of know-how in all sub-areas of this sector in the next few years.

95. On the whole, more and more funds are being allocated to the development of technology for the production and use of peat in Finland. Very positive results have been gained from the application of this technology, which ensures that there are also good prospects for exchanges of technology in this sector. This applies in particular to the various stages of peat utilization, such as production, storage, transportation, handling, processing and combustion.

96. The fact that the UN has entrusted Finland with the task of drafting a report on the use of peat for energy production as part of the preparations for the Conference on New and Renewable Sources of Energy is a special token of confidence in the standard of Finnish peat-related know-how.

(iii) Expertise in Mini-hydro Power

97. In Finland, the development of technology in the field of hydro-electric power generation has followed the long development curve of the sector. In this respect, Finland differs from many countries which utilize hydro power and still depend on technology dating from pre-World-War-Two years. Finnish topographical features have meant that the power plants built have been based on the exploitation of low and medium heads. As a result of small basin volumes , the fact that rivers are susceptible to flooding and that they have traditionally been in multipurpose use, an

essential feature of water power utilization has been general schemes for whole watercourses, combined with research into and the implementation of regulation schemes for multipurpose use.

98. Because opportunities to harness medium-sized sources of water power are limited in Finland, research into and the construction of mini-hydro power plants have been given a special boost in recent years. A nationwide survey of mini-hydro power potential is among the measures carried out in this respect. This survey has covered harnessable potential both in new sites and in connexion with existing schemes, which can be improved or repaired.

99. Finland possesses state-of-the-art technology in connexion with hydro power generation machinery and equipment within the 200 ... 20,000 kW range in particular. Finnish manufacturers of these products have already penetrated international markets. Development in the sector should be further accelerated by international research co-operation under an intergovernmental agreement.

(iv) Expertise in Energy Transmission

100. Transferring energy to consumers will be an essential component in the exploitation of new and renewable sources. Designs will be influenced not only by the quality, quantity and location of the energy involved, but also by the type, development and geographical distribution of consumption and the standard and development of the rest of the country's infrastructure.

101. Virtually without exception, an important part of any comprehensive scheme consists of the transfer and distribution of energy in the form of electricity. In Finland in the course of the last few decades, appropriate know-how and technology connected with the manufacture of equipment has been developed to facilitate the transfer and distribution of electricity under Finland's severe conditions, which in several relevant respects resemble those posing the greatest problems in developing countries. This covers both transmission grids and local distribution networks and power system control

and remote control equipment. Finland also has an old-established tradition of international co-operation in research and development connected with the electricity sector.

(v) Other Expertise

102. As to expertise relating to biomass other than wood: technology for burning straw in small boilers has been developed in Finland. The use of straw for heating on farms is becoming more widespread, and the use of lake-shore vegetation (reeds, etc.) is also being looked into. Research is being conducted into the production of biogas from farmhouse wastes and a biogas reactor suitable for use on farmhouses is already being manufactured industrially. Biological decomposition units for sludges in sewage treatment plants are also planned for several towns and cities.

C. Opportunities for Technology Transfers within the Private and State Sectors

(i) Opportunities for Companies to Transfer Technology

103. Finnish companies working in the energy sector possess a wide and varied fund of expertise connected with the use of wood, peat and hydro power for energy production, because a considerable part of the energy used in Finland is derived from just those sources.

104. Finnish companies also have very good possibilities to transfer technology and know-how connected with new and renewable sources of energy. They have the preparedness to provide research, consultancy and planning services and to supply machinery and equipment. The carrying out even of large projects (supplying equipment, planning, execution, training, etc.) by Finnish organizations is getting under way.

105. Opportunities for technology transfers are mostly concentrated around short rotation trees, peat and mini-hydraulic

power as well as, to some extent, other biomass. Where other new and renewable sources of energy are concerned (e.g. geothermed , wind power and solar energy) the means available to Finnish companies to transfer technology and know-how are, with certain exceptions, quite limited. Research and development connected with those forms of energy are being conducted in Finland, but it is unlikely that a major capacity to transfer technology will be developed in the next few years.

106. Where forest-derived energy, peat and mini-hydraulic power are concerned, the opportunities available to Finnish companies to transfer technology connected with research services cover virtually the whole sector. Some large consultancy and planning companies have a wide and varied range of experience in the sector. There are also many smaller organizations which possess substantial know-how and experience of technology transfers within narrower fields of the forest-derived energy sector.

107. With a view to producing short rotation energy trees, a comprehensive project model has been developed in Finland. This covers the cultivation of short-cycle forests, tree harvesting and the construction of a wood-chip-fired power station. The first feasability study will be carried out as a development co-operation project in the Phillipines (tree variety: ipilipil) and a second project is currently the subject of negotiations with Kenya. Forest plantation is a relatively new area of operation, although already one of the most important, in which Finnish companies and organizations have a considerable ability to transfer technology. For the production and utilization of forest-derived energy, Finnish industrial undertakings have developed a considerable fund of technological expertise and export substantial quantities of machinery and equipment. The range of products manufactured by Finnish companies in this sphere includes boilers for wood waste, tree harvesters and chippers as well as complete power stations.

108. Technology developed by Finnish companies for producing peat and using it to generate energy include peat handling and combustion plant and equipment, peat harvesting machines, transport equipment as well as chip compressors and coking plants.

109. Finnish companies' opportunities to contribute to technology transfers in relation to hydro power are presently concentrated around inventories of water power resources, general schemes for whole watercourse systems as well as, in particular, feasibility studies concerning mini-hydro power, planning, supplying machinery and equipment (turbines, generators, transformers, dam sluices, monitoring and switching equipment, etc.) and project supervision. They are also in a position to transfer technology applicable to large hydro-electric schemes involving moderate heads as well as to separate dam and canalization schemes, which could later be linked with hydro-electric schemes. In addition to projects carried out in Finland itself, reference can also be made to feasibility studies and planning tasks (also involving the supply of machinery and equipment) now in progress in developing countries.

110. Electrification schemes are nearly always associated with mini-hydro power projects. In recent years, Finland has been trying to link projects with something that has gradually been proving essential: the interconnection of separate electrification districts by means of medium-voltage transmission lines and the feeding of larger regional networks into national grids, the production and transmission systems of which must also often be developed at the same time.

111. In addition to technology connected with short rotation trees, peat-derived energy and mini-hydraulic power, Finnish companies have also recently been developing technology for other sources of energy. These include biogas power plants, straw-fired heating systems, solar cells and wind-powered generators, all of which are new products. Also in the field of solar energy, knowledge close to the applicability stage is being developed in Finland to facilitate the efficient design of buildings and their energy management. Technology for using alcohol as fuel (gasohol) has also been developed and the

capability to transfer this technology to other countries exists in Finland.

112. An indication of the organizations' increased interest and preparedness to transfer energy-related know-how and technology is the fact that various co-operation bodies have recently been set up jointly big industrial and consultancy companies, energy producers and research establishments.

(ii) Research Establishments' Means of Transferring Technology

113. Although Finnish preparedness to transfer technology and know-how is primarily concentrated in energy-sector companies, important research establishments which work in the energy sector also have good opportunities to participate, especially in connexion with development co-operation. Two of the most important establishments of this kind in Finland are the Forest Research Institute and the Technical Research Centre of Finland. The Forest Research Institute's expertise in relation to forest-derived energy is concentrated in the following areas:

- the establishment and fosterage of fuel-wood plantations
- inventorying existing firewood resources
- the utilization of existing, unmarketable firewood resources

The Institute's expertise also extends to the planning and preparation of simple harvesting chains and equipment as well as to the small-scale production of charcoal.

114. The Forest Research Institute has the capability to transfer technology in relation to the planning and execution of fuel-wood and village forest cultivation projects as well as carrying out inventories of fuel wood resources in conjunction with national timber resource surveys. The execution of research projects as a consultancy service is also a possibility.

115. Since 1978, the Forest Research Institute has been conducting a large-scale survey of wood resources suitable for energy production. Within this project, new methods are being developed to enable existing resources to be utilized and to grow wood specially for energy production by developing special cultivation methods. On the basis of the results obtained from the survey, a system model for studying forest-derived energy is currently being developed with the requirements of developing countries in mind.

116. The Technical Research Centre of Finland has important experience of transferring technology, because it has participated in several development co-operation projects and executed sub-contracts for export companies in the energy sector.

117. The Technical Research Centre of Finland's expertise in relation to new and renewable sources of energy is principally applicable to the production, utilization and processing of peat and wood, with the aid of models developed for examining both regional and national energy systems, in association with which technical and economic engineering tasks are carried out, in addition to research and development work with laboratory and pilot plant equipment involving feed capacities up to 1 - 2 T/h. Research dealing with wind power, solar heating and solar batteries has also been launched. The Centre has also carried out emission measurements and has developed emission-measuring equipment.

118. At the moment, a research programme of about 60 men years into peat and wood is being focused on the following areas, among others:

- optimization of peat production techniques on the basis of weather factors
- studying various supply systems for wood and processed wood products
- research into the production and use of gaseous fuel and fuel alcohol (methanol, ethanol)
- research into the manufacture and use of compressed wood fuels
- analytical services and developing the properties, quality and processability of fuels on the basis of the requirements posed by various applications.

119. The Geological Research Centre has considerable expertise in and experience of surveying peat resources and is in a position to offer expert assistance in international co-operation.

120. The Meteorological Service of Finland possesses advanced know-how in relation to preparing dispersion models, by means of which air pollution caused by emissions from energy

generation plants is forecast.

(iii) Training

121. Transfers of energy-related technology by Finnish organisations have been linked with training and services, primarily within the frameworks of projects executed by companies. Finnish companies and institutes have a considerable capacity to provide training in Finland, especially for personnel working with fuelwood, peat, water power and electricity systems. This training extends from basic courses to project-chief and managerial level. The capacity to arrange on-the-job training and to guide and offer operational and maintenance services also exists.

122. The arrangement of training can also be combined with Finnish development co-operation programmes. Our development co-operation programme has not yet included separate courses dealing with know-how in the field of energy, but the arrangement of such courses will probably materialize in the very near future. What will probably be done initially is the arrangement (in Finland) of courses lasting several weeks for personnel working in some narrower areas of the energy sector; these courses would be arranged annually to begin with. Finland has good experience of arranging courses of this kind in certain other areas.

D. Development Prospects

123. In principle, Finland has good opportunities to increase transfers of technology for energy derived from new and renewable sources, on both a commercial and a development co-operation basis. This stems primarily from Finnish companies'- and to a growing extent Finnish research establishments' - increasing interest and technical preparedness. In addition to that, there is a strong desire in most countries to increase the production and utilization of these sources of energy and to boost research and development activities connected with them, which will substantially increase the demand for know-how and technology. Where Finland is concerned, this applies in particular to the

use of forests for energy production and mini-hydro. Transfers of peat-related know-how and technology will be limited by the small number of countries which possess peat resources and by their lack of knowledge about their peat resources and how they can be used to produce energy. However, the thorough study of the peat sector to be conducted in conjunction with the Conference and the opportunities for action which it creates will probably contribute markedly to removing those obstacles.

124. In addition to energy-related technology transferred on a commercial basis, the powerful increase which can be anticipated in Finland's development co-operation appropriations - from the present 0.26% of GNP to 0.7% by 1989 - will offer excellent opportunities to expand both the volume of our development co-operation in the energy sector and the number of countries involved. Perhaps the major limiting factor will be a shortage of energy-sector experts, which is already in evidence in Finland in certain special fields.

125. When Finland is trying to increase her development co-operation in the energy sector, it will be natural for projects funded by multilateral development-financing institutions to enter the picture to a growing extent. For example, the expanded energy programme drafted by the World Bank for the period 1982-86 features a strong increase in the funds allocated for fuelwood, fuel alcohol, electrification and mini-hydraulic projects, all areas in which Finnish organizations and research establishments have the capability to transfer technology.

126. In transfers of technology in relation to the use of forests for energy-production purposes and mini-hydro power, co-operation opportunities of interest to Finnish companies (and research establishments) should be available, especially among the Nordic countries. Co-operation with other aid-donating countries may also enter the picture in relation to forest projects.

127. Finland's contribution to development co-operation in connexion with the production of fuel wood will increase during the 1980s and reach a level more commensurate with our expertise in this

sector. Especially with African countries, whose "fuelwood crisis" has strongly emphasized the importance of their forest management in recent years, many opportunities to get short rotation tree-growing projects started within our development co-operation programme present themselves.

128. At the same time as considerably more resources are devoted to short rotation tree projects, the use of wood for energy production will also be given substantially more attention in multi-purpose forestry projects. The considerable local costs often associated with forest-derived energy projects will make it essential for Finland to try to arrange joint financing facilities, e.g. with international development banks.

129. The question of including energy-related training and research services in Finland's development co-operation programme will soon materialize. It will be possible to establish co-operation between institutes in Finland and developing countries in relation to such things as research organisation, exchanges of research personnel, training for researchers and information exchange.

130. Good opportunities for Finnish bodies to transfer technology in relation to forest-derived energy, peat technology and mini-hydraulic power should present themselves in the developing countries first and foremost. Although it will probably be possible to focus a growing amount of development co-operation funds onto the energy sector, the main emphasis will, nevertheless, remain on the commercial exportation of energy-related technology and consultancy services.