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UN Conference on new and renewable sources of energy

National contribution of the Netherlands

Contents

List of abbreviations

BEOP : Bureau Energie Onderzoek Projecten bij het ECN (Energy Research Projects Office at the ECN)

ECN : Energie-onderzoek Centrum Nederland te Petten (Netherlands Energy Research Centre, Petten)

LSEO : Landelijke Stuurgroep Energie Onderzoek (National Energy Research Steering Group)

OTEC : Ocean Thermal Energy Conversion

NOZ : Nationaal Onderzoekprogramma Zonne-energie (National Solar Energy Research Programme)

NOW : Nationaal Onderzoekprogramma Windenergie (National Wind Energy Research Programme)

NOA : Nationaal Onderzoekprogramma Aardwarmte (National Geothermal Energy Research Programme)

IEA : International Energy Agency

EEC : European Economic Community

PBE : Projecten Bureau Energie-onderzoek (Energy Research Projects Office)

TNO : Stichting voor Toegepast Natuurwetenschappelijk Onderzoek (Organisation for Applied Scientific Research)

ZWO : Stichting voor Zuiver Wetenschappelijk Onderzoek (Organisation for the Advancement of Pure Research)

REO : Raad voor het Energie Onderzoek (Energy Research Council)

NEOM : Nederlandse Energie Ontwikkelings Maatschappij (Netherlands Energy Development Cooperation)

PJ : Peta Joules ($=10^{15}$ Joules)

Mt o.e.: Million tons oil equivalent

1. Introduction

The 1973 oil crisis forced the world to realize that abundant supplies of energy could no longer be taken for granted. Subsequent developments have underlined this. The anticipated growth in world demand for increasingly scarce energy sources, the dependence of many consumer countries on imported energy supplies and the possibilities open to producer countries to manipulate supplies and prices are potential causes of scarcity and tension in the future.

Given these facts, the solution to the energy problem must be sought through national and international policies aimed at affecting a transition to more diverse sources of energy and reducing the importance of oil, and at a more efficient and economical use of energy. Guaranteeing sufficient supplies of energy and an equitable world distribution constitute one of the major problems facing the international community today.

The need for policies of this kind is emphasized by the gloomy predictions for world supply and demand. The uncertain energy prospects and the wide disparities between developing countries, where the implications of the energy problem are in many cases different from those in the industrial countries, do not facilitate the formulation of a world policy which will be fair to all countries.

In order to ensure that national and international aims are consistent and in the interest of all countries, efforts must be made to reduce the consumption of energy, particularly in the industrial countries. At the same time research into energy saving methods and alternative sources of energy should be intensified. Special attention will have to be paid in this context to the developing countries whose energy position could

be improved considerably by the development of alternative energy sources.

The following gives a brief account of Dutch national energy policy and a more detailed description of the potential of and policy on new and renewable energies. Finally Dutch aid efforts in this field are discussed.

2. The energy situation in the Netherlands

Although the Netherlands has its own supply of gas, it is still very much concerned about the world energy situation for the following reasons.

a. The gas supplies will rapidly diminish in the next 20 years. New discoveries to compensate for the high rate of production have not been made, as was originally expected. The declining production of natural gas, which is evident from exports, domestic consumption and - a factor which is partly linked to both of these - the increase in energy imports, has very serious economic consequences.

b. The Netherlands have fewer options than many other countries as far as improving the energy situation is concerned: the density of the population means there is a limit to the extent to which high-grade sources of energy like oil and gas can be replaced by coal and nuclear energy, for example. Moreover it is extremely difficult to plan the balanced development of the Dutch energy situation in the mid-term, partly because the prospects of new and renewable energy sources contributing to energy supplies in the Netherlands are very limited.

Working on a number of assumptions, the CPB (the Central Planning Office) calculated the development in energy consumption in various sectors up to the year 2000 on the basis of certain policies.

Table 1 shows how consumption could be spread amongst various sources of energy.

Table 1: total consumption[1] spread amongst various sources of energy in PJ.

	coal	oil	gas	nuclear[2]	other	total
1977	134,0	1067,7	1394,2	46,1	8,4	2650,4
1985	297,3	1524,1	1406,8	41,9	8,4	3278,5
1990	376,8	1620,4	1415,2	41,9	8,4	3462,7
2000	858,3-389,4	1787,8	1277,0	41,9-510,8	75,4	4040,4

[1] including oil consumed in non-energy applications excluding bunkers.
[2] including imported electricity.

Efforts to improve the energy situation in the Netherlands in the next few years will concentrate on:
1. restraining the demand for energy;
2. using more sources of energy (diversification).
The development of new and renewable sources of energy is part of the policy of diversification.

3. The potential contribution to be made by new and renewable sources of energy.

At present new and renewable energy sources make practically no contribution to energy supplies in the Netherlands, and there are no firm figures available yet for the role they will play in the future, since their various applications are still being researched and developed. All the reports

published to date estimate that the maximum contributions to be made by these sources of energy in the Netherlands will be relatively small. The estimates for the year 2000 vary from 100 to 200 PJ (about 2.5 - 5.0 Mt.o.e.), but they are based on estimates for levels of production costs which may not be socially acceptable. The use of new and renewable sources of energy and thus their contribution to the energy supply in the Netherlands is dependent on the increase in the energyprice. If the rise in energyprices is steeper than expected both the absolute and the relative contribution of new and renewable sources of energy will increase.
Once there is more certainty about the applicability of alternative energy sources, target figures will be drawn up. However, some initial estimates are given below.

3.1. Solar energy

This section concentrates in particular on the application of solar energy for space and water heating. For the time being the large-scale use of solar cells to generate electricity does not seem feasible because of:

a. the expected coststst of the system;
b. the low yields per surface unit in the Dutch climate;
c. the problem of integrating a varying supply into the electricity grid.

In the meantime, therefore, the main application of solar energy in het Netherlands will be to provide low calorific heating.

In its report entitled, "Zonneenergie voor Verwarming" (Solar Energy for Heating) an LSEO working group has estimated the possible importance of solar energy in the Netherlands, assuming that in the long term it could meet some of the

heating requirements in a half to two thirds of homes and other buildings. This means that the ultimate contribution made by solar energy could amount to about 5% of domestic energy consumption. As the investment costs of the installations required will be large, solar energy will clearly have to be introduced over a period of many decades. Spaceheating with solar energy will be incorporated in new buildings first of all, but as the average life of houses and other buildings lies between 50 and 100 years, this is not expected to bring about the rapid introduction of solar energy either. The LSEO working group has calculated that in the year 200 the maximum contribution that could be made by solar energy would be 40 PJ (1 Mt.o.e.).

3.2. Wind energy

It is difficult to estimate the potential importance of wind energy because of its numerous possible applications, such as centralised and decentralised electricity generation, polder drainage and heating. However, it could make a contribution to the Netherlands' energy supplies, particularly if used for heating and generating electricity.

The estimates made in a number of studies vary from a capacity when installed to generate between 1500 and 2500 MW of electricity in the year 2000. Taking into account that installations can influence each other, that they do not all produce simultaneously, that there is an average period of time when machines are not working because of faults and maintenance work and that they are not productive all year round, they could make a contribution of roughly 2 to 4 TWh in the year 2000, thus making a saving in primary energy of 20 to 40 PJ (about 0.5 - 1 Mt.o.e.) possible. If, in addition, wind energy installations with a capacity of say 500 MW were erected for heating purposes, this would yield a further contribution of about 1 TWh (0.1 Mt.o.e.).

3.3. Geothermal energy

There is little detailed information available on the potent of geothermal energy in the Netherlands. However, it is known that at a depth of 1500 to 3000 metres under the surface there are water-bearing rock strata with a temperature of 60 - 120°C which could in principle be used for in industry as well as, for example, district, domestic and glasshouse heating.

In het future geothermal energy will have to compete with other new forms of energy saving such as the use of industrial waste and solar energy. At present it is being investigated whether a geothermal experimental project could be implemented in the Netherlands. Assuming that about 50 projects could be created by the year 2000, geothermal energy could contribute from 5 to 10 PJ (about 0.1 - 0.3 Mt.o.e.).

3.4. Energy from water

There is little potential for conventional hydro-electric power in the Netherlands because the country is so flat. Moreover, it is not possible to produce energy from the River Waal, the major Dutch waterway, because international conventions lay down that shipping shall have free passage. Research into the possibilities of producing energy from the other rivers has shown the technical potential to be slight. The cost of generating electricity in this way would be unacceptable. It would only be economic if sluices and dams had to be built anyway by the Public Works Department in connection with water management and their cost did not exclusively derive from generating electricity. The potential that could be profitably exploited is therefore much lower.

Other forms of water power which have been studied are:

1. tidal energy;
2. wave energy;
3. ocean thermal energy conversion.

In general, enormous installations and hydraulic engineering works are required for wave and tidal energy and their size can present serious problems. The costs are so high and the potential contribution so low - owing to the lack of favourable circumstances - that it would not be justifiable to apply these methods yet.

As far as OTEC is concerned, the temperature gradient in the waters along the Dutch coast is too slight for economic production to any extent. In fact the application of OTEC will for the time being be restricted to tropical regions.

3.5. Biomass, Wood and Charcoal

The cultivation of biomass (fast-growing crops and algae) is in principle another way of using solar radiation, this time by means of solar energy stored in plants through photosynthesis. A number of countries, including Brazil, the United States, France, Ireland and Sweden are considering using this method to contribute to their energy supplies.

The method has a very low overall efficiency ($< 1\%$) and is therefore hardly suitable for the Netherlands in view of the area of land required which would otherwise be used to produce food. By way of illustration, a simple calculation shows that the total surface area of the North-East polder (35,000 ha.) would be required to fuel an electricity power station of about 150 MWe.

3.6. Energy from Waste

An analysis of the possibility of using household and industrial waste as sources of energy has shown that, in principle, the energy savings already achieved by using them can be increased. At present the savings in primary energy

by burning waste substances amount to about 0.2% of total national consumption. In view of the fact that at the moment about half of all urban waste is dumped, it would be possible to double this figure resulting in a contribution of 5 to 10 PJ. It has to be borne in mind that environmental conditions have to be taken in consideration.

It follows from a potential estimate by the LSEO that the amount of organic waste (cattle and pig manure, sewage, etc.) can be put at about 45.10^6 tons per year. In theory this could produce about $10^9 m^3$ (30 PJ) of methane gas. However, as the waste has to be treated and the methane gas has to be used close to the source of the waste it cannot be expected that this theoretical potential will be completely achieved in the near future. The contribution by the year 2000 can be estimated at 15 - 30 PJ.

Other waste substances such as waste wood, and horticultural waste could also be used. At present an inventory of agricultural waste is being made in order to estimate its energy potential. The problem with using such waste is that it must be done on the spot, as transport usually entails an unavoidable increase in costs.

3.7. Oil shales and tar sands

As far as is known there are no oil shales or tar sands in the Netherlands so a contribution to the Dutch energy supplies cannot be expected from these sources.

3.8. Conclusion

In assessing the total contribution to be made by the above alternative sources of energy it must be remembered that some of them have the same applications. This, together with the

fact that there are other energy-saving techniques, means that the ultimate contribution could be lower than the sum total of all the alternative sources.

		In percentage of total demand.
Solar energy	20 - 40 PJ	0.5 - 1.0
Wind energy	20 - 40 PJ	0.5 - 1.0
Energy from waste	20 - 40 PJ	0.5 - 1.0
Geothermal energy	5 - 10 PJ	0.1 - 0.2
Others	-	

The potential contribution from these sources of energy, particularly the direct application of solar energy in particular is higher. The LSEO working group put it at 10% of energy consumption provided summer heat can be stored for use in the winter. However, it will be well into the 21st century before this figure is achieved.

4. Policy on alternative energies

At present alternative sources of energy play practically no role in the energy supplies of the Netherlands. There are no precise figures for the role they might play in the future since the various applications are still being researched and developed. Most of the applications will only become competitive when the energy price levels have increased considerably and the costs of the required installations have dropped further.

Policy therefore not only encourages research and development but aims to find the most economic application as soon as possible by means of experimental projects. The criteria used for current and new research projects are:

1. the expected contribution to the energy supply;
2. when this contribution can be achieved;
3. the opportunities for industrial innovation;

4. the expected effects on the environment and health;
5. the opportunities for international cooperation (in this context the EEC and the IEA are of importance).

The following sections will deal first with the organisation of the research on energy and the various bodies involved and then discuss the projects at present being conducted on alternative energies.

4.1. Solar energy

A considerable amount of research and development work will need to be carried out if solar energy is to be used in the Netherlands. A large number of projects have been started since 1974 with government support. In 1978 a National Solar Energy Research Programme (NOZ) was launched, the principal aim of which is to introduce and develop the use of solar energy in a responsible fashion. To this end, as a follow-up to existing experiments, installations are being developed which are specially adapted to the Dutch climate and which can be produced by Dutch industry. The research will be conducted by the various research institutes and universities in cooperation with Dutch industry and the future users of the solar installations. The Energy Research Projects Office (BEOP) at the ECN has been given responsibility for management and coordination of the project.

The aim of the first stage of NOZ, which runs from the beginning of 1978 to the end of 1981, is linked to the recommendations made by the LSEO working group. The main object of concern is to make the solar boiler ready for the market. The technical development is now so advanced that the emphasis will be placed on a number of large-scale experimental projects. In addition studies will be conducted on the

possibilities of space heating (particularly active systems), solar cooling and seasonal storage of heat.

Table 2 below shows the allocation of the NOZ budget.

Table 2: allocation of NOZ funds, stage 1

Topic	Government contribution*
solar boiler	5,235
space heating	10,368
seasonal storage	1,649
general	1,288
unforeseen	1,610
	20,050

*thousands of Dutch guilders

It is expected that third parties (participants, the EEC, the municipal authorities, etc.) will contribute approximately 10 million guilders so that the total budget will amount to about 30 million guilders.

The solar boiler is expected to be the first solar energy system to be economic under Dutch climatic conditions. It has proved difficult to set up a number of large scale experimental projects because of the poor economic viability of the systems and various non-technical problems. At the end of 1980 financial scope was created within the NOZ to fund experimental solar boiler projects. While they are being set up and implemented, an analysis will be made of the non-technical difficulties involved in introducing solar energy.

Space heating systems will only be economic in the long term (after the year 2000). The NOZ is therefore mainly concerned with study and research and a number of pilot projects at the moment.

Cooling and air-conditioning are considered to be of minor importance in the Netherlands and no work in this area is being done under the NOZ at this stage. However, the Ministry of Development Cooperation has commissioned the development of an absorption cooling machine based on solar energy outside the NOZ and a prototype will be put into operation in the Sudan some time in 1981.

Solar energy will become a considerably more important source of energy in the Netherlands if a method can be developed of storing heat generated in the summer for use in the winter. The Netherlands is participating in the IEA research programme on this which is entitled, "Energy Conservation through Energy Storage".

At the end of 1980 an extensive research project was started to complement the NOZ. If the results are favourable, an energy storage system will be linked to a hundred homes. The storage of low-grade energy is not only important in the application of solar energy, it can contribute to the use of superfluous industrial heat, waste heat from electric power stations, etc.

4.2. Wind energy

The National Wind Energy Research Programme (NOW), financed entirely by the government, was launched in 1976. The aim of the programme, which was prepared by an LSEO committee, is to discover how wind energy can contribute to the supply of energy in the Netherlands. Initially the NOW was concerned

with the large-scale generation of electricity for the national grid. Data were collected, a study was made of the problems of integrating highly fluctuating wind power into the grid and it was investigated how wind turbines influence each other when they are operated in groups.

In the course of the NOW, which officially ends at the end of 1980, interest in the decentralised application of wind energy has increased considerably. The programme was therefore extended in 1980 to cover this topic and to study the application of small wind turbines (10 - 100 kW) which have been set up close to the users of the electricity, heat and/or mechanical energy which they generate. The NOW's evaluation will has recently been completed. Whatever the results, it has been decided to start a follow-up programme in which industry will be more directly involved and which will place more emphasis on experimental projects and the construction of prototypes. Important research topics at the NOW are:

1. The Tip-vane study at Delft University of Technology, which is concerned with increasing the capacity of a wind turbine ofacertain size by fitting the rotary blades with what are known as tip-vanes. Laboratory experiments have shown an power increase with a factor of 2.5 to be possible. At present a demonstration project is being prepared.
2. The wake-effect study by TNO which has built a model to determine the extent to which wind turbines effect each other when they are placed close together. The experiment and calculations show that the optimal distance between the turbines is 6 to 7 rotary diameters and not 10 as has been assumed until now. The model is now being perfected on the basis of measurements from experimental wind turbines.
3. The design and construction of a wind turbine in Petten with a horizontal axis 25 metres in diameter. This is in

fact a construction to provide readings which will enable designers to create reliable wind turbines. The first measurements will be made in early 1981.

There are many other institutes besides those working under the NOW which are concerned with wind energy. Their results will therefore also be taken into account when evaluating the potential contribution to be made by wind energy to energy supplies in the Netherlands.

The total budet of the NOW is 20 billion guilders approximately.

4.3. Geothermal energy

The basic problem with geothermal energy is that, before it can be decided to exploit it, relatively expensive and highly risky exploration work has to be carried out in order to establish with some measure of certainty the production potential. At present insufficient data are available to make a serious assessment of the potential and the contribution in the year 2000.

In order to get some idea of the potential of geothermal heat, a National Geothermal Research Programme (NOA) was started in 1979. Its aim in the first place is to gain as much information as possible on the presence and properties of geothermal strata and reservoirs and the heat flow 2 to 4 km under the surface of the Netherlands.

Research is also being conducted into the possibility of storing heat in aquifers. An inventory is now being made

of suitable aquifers at a depth of 300 to 800 metres under the ground.

The NOA budget is Fls. 4.2 million, excluding experimental projects. The programme continues officially until the end of 1982.

4.4. Energy from Waste

Research into the possibility of saving energy by recycling waste has so far mainly been carried out as part of the research into methods of treating waste. The disposal of urban waste is in the first instance an environmental problem. Research into the possibility of reducing the amount of waste and of reclaiming certain of its components shows that a considerable saving in energy can be achieved by means of most of the alternative disposal methods. The saving can be direct by burning the waste or some of its components or indirect as a result of industry using recycled products instead of conventional raw materials.

At present an inventory is being made of the results of waste disposal studies and of the methods of saving energy which have emerged in the course of the research. The inventory will be used to determine whether further research into "Energy saving by recycling" will be worthwhile.

4.5. Other alternatives

For reasons mentioned in the foregoing chapter relatively little attention is being paid to the other alternative sources of energy at the moment. However, developments in this field are being followed by means of international discussions (IEA, EEC) and conferences. These concern primarily the use of water power, wave and tidal energy and biomass.

4.6. How research on energy is organised

Research which is wholly or partly financed by the government is conducted by the Netherlands Energy Research Centre (ECN), the TNO, the various universities and industry. In order to coordinate the research as far as possible and ensure optimal use of the available manpower, materials and funds, the research on the various priority areas is planned as far as possible before hand and carried out in the form of national research programmes. The ECN, the TNO and the ZWO are responsible for coordinating the research programmes and both the ECN and TNO have set up special energy research projects offices for this purpose, the BEOP and the PBE respectively. These offices receive work direct from the Ministry of Economic Affairs which consults other ministries beforehand.

At present the BEOP is coordinating the research programmes on wind energy, solar energy and energy storage in fly-wheels. Whether the BEOP should be called in to manage the research on coal is a matter now under discussion.

The PBE is at present coordinating the research programme on geothermal energy. It will also be given the task of managing the research on energy saving.

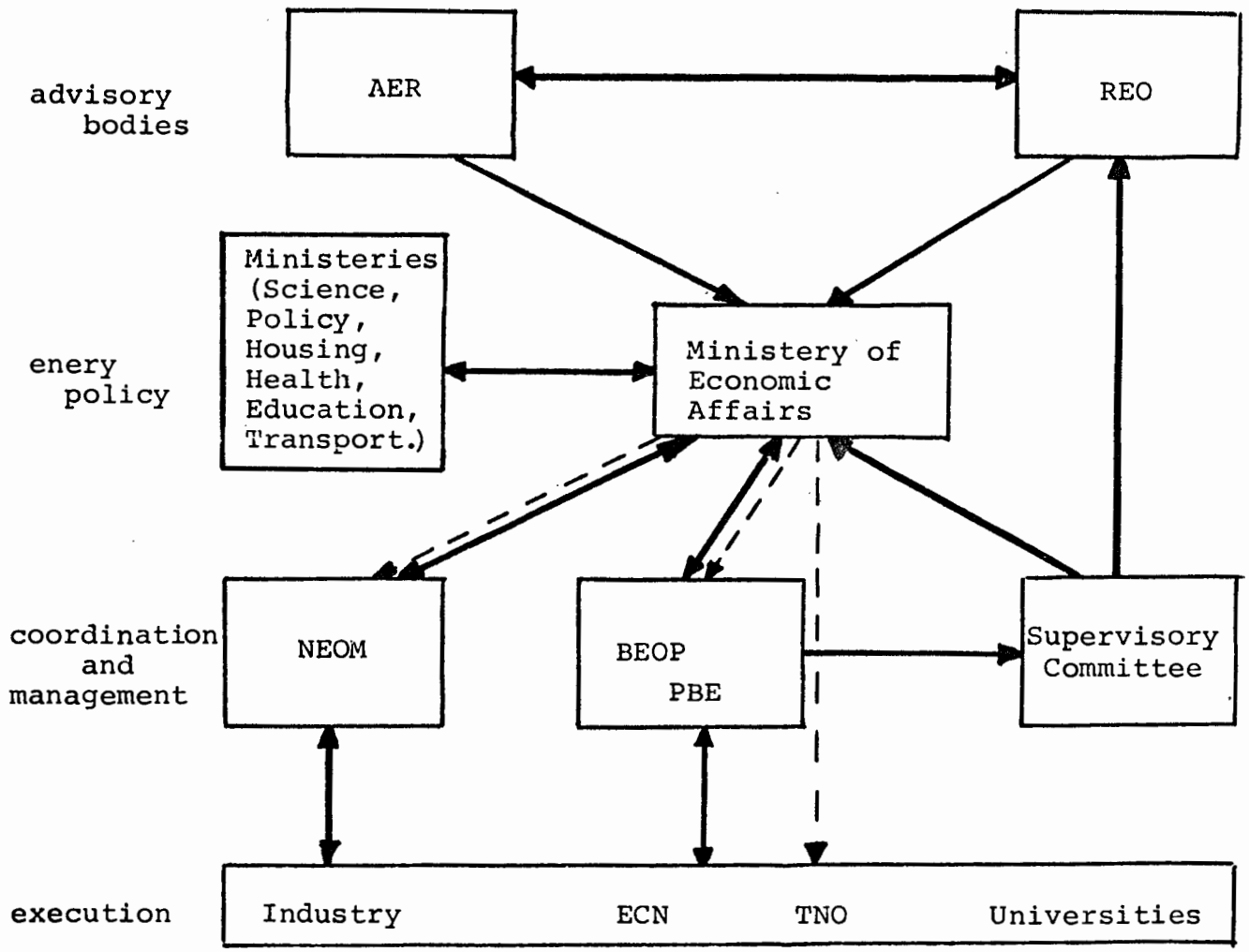
Supervisory committees consisting of independent experts are appointed to assess the progress, the effectiveness and the quality of the research. The committees advise the Minister for Economic Affairs. The Energy Research Council (REO), which is composed of the three parties involved - researchers, users and industry - has been set up to outline and coordinate the various research programmes. It also evaluates progress made in general and fosters and promotes consultations between all the parties concerned.

The Netherlands Energy Development Corporation (NEOM)was set up in 1976 with a view to bringing new products and systems in the field of energy onto the market quickly. Although it is in principle not concerned with research and development, it is nevertheless very important that it cooperates with the research institutes, etc. The general aim of the NEOM is to contribute to improving the energy supply in the Netherlands. It is now doing so by investigating the possibilities of re-introducing coal and of saving energy in various areas.

The AER consists of 3 parties: industry, consumers and the universities. It advises the Minister for Economic Affairs on general matters concerning energy.

The diagram on the following page gives an overall impression of the structure of energy research in the Netherlands.

Bodies and institutions concerned with energy development



5. Non-technical obstacles why new and renewable sources of energy cannot be exploited.

There is a general feeling that the integration of new and renewable sources of energy into the energy supplies of the industrialised countries not only depends on the succes of research and development, but also on the timely identification of non-technical problems. Although most countries have an R & D policy with regard to alternative energies, there is still too little attention being paid to the effect non-technical problems could have on the introduction of these sources of energy. For these reasons the European Commission, in cooperation with the United States Department of Energy, has organised a seminar on this subject. Studies of the matter are also being carried out in various countries including the United States and Canada. Since fairly little work has been done in the Netherlands on this, this section is based mainly on the findings of the EEC-DOE seminar and the Canadian study.[1)]

The non-technical problems will be analysed within the framework of the national research programmes, making particular use of the experiences gained from the experimental projects. The non-technical problems can be roughly divided into the following aspects, though, they are so closely interwoven that a clear division is not possible in practice.

1. industrial and economic aspects
2. legal and financial aspects
3. involvement of energy companies
4. consumer aspects

1) "Accelerating the Acceptance of Solar Heating", W.R. Derrick Sewell, Report ER 79-7, University of Victoria.

The Canadian study showed that the following problems were considered to be the most serious:

a. high investment costs;
b. difficulties of incorporating into existing buildings and regulations;
c. lack of support from various groups;
    1. central government;
    2. Building contractors;
    3. financial institutions;
    4. scientists;
d. insufficient information.

More or less the same conclusions have been drawn in the Netherlands from the experience so far. However, the extent to which the non-technical problems apply in the Netherlands should be examined.

1. Industrial and economic aspects:
    a. high investment costs combined with a lack of financing methods;
    b. long pay-back time owing to the relatively slight energy saving;
    c. uncertain market as a result of which industry does not invest in mass production.
2. Legal and financial aspects:
    a. lack of subsidy facilities;
    b. increased building costs;
    c. subsidising of conventional sources of energy.
3. Involvement of energy industries:
    a. willingness to pay for electricity or gas supplied by alternative sources of energy;
    b. willingness to apply alternative sources of energy in the industry itself or to promote their application.
4. Consumer aspects:
    a. lack of objective information;
    b. uncertainty about life and reliability of equipment and consequently about for example maintenance costs.

These problems apply to a greater or lesser extent to the Netherlands. It is evident from the list, which is by no means complete, that they are not so much problems which apply specifically to solar energy or other new and renewable energies, they are rather problems which occur when any new techniques are being introduced.

The same problems are to some extent encountered when applying energy-saving techniques such as double glazing, highly efficient central-heating systems, etc. People will become all the more determined to overcome the problems if the economic advantage is clear. This is often more likely to be the case with energy-saving techniques than for new applications such as solar energy. Consequently the introduction of energy-saving measures is likely to be affected less by these non-technical problems.

It is in any case clear that there are non-technical problems which can delay the introduction of alternative sources of energy.

Knowledge about these non-technical problems can be acquired above all by keeping a close eye on the problems which arise when setting up experimental projects. This has already been done to some extent when a number of solar boiler experimental projects have been set up.

6. Environmental aspects

The importance attached to environmental policies in the Netherlands means that the introduction and application of sources of energy is dependent on environmental factors. This also applies to the introduction of new and renewable sources of energy.

The introduction of new and renewable sources of energy is expected to cause fewer problems than the introduction of conventional sources, particularly as regards air and water pollution.

In the case of wind energy, attention must be paid to planning, security, noise nuisance and the dangers for birds. Geothermal energy may cause soil pollution.

The combustion of waste can lead to air pollution, so consideration should be given to reducing the flow of waste, for instance by recycling.

7. International cooperation

A considerable amount of the research subsidised by the government takes place in an international context, mainly as part of EEC and IEA research programmes. In addition a certain amount of bilateral cooperation takes place.

EEC

The European Community is conducting a large number of energy research and development programmes, most of which are spread over a number of years. There are two types of EEC research:

1. direct activities: research and development at the EEC research centre, the Community Research Centre;
2. indirect activities: research conducted in institutions or industries in the member states through contacts with the EEC.

These activities are complemented by experimental and promotional programmes which derive from the general energy policy of the Community.

IEA

Research programmes on various topics including alternative sources of energy are implemented or drawn up within the framework of the IEA, the aim being to exchange information and carry out joint studies. Recently considerable efforts have also been made to cooperate on the development and testing of installations. The Netherlands is participating in the programmes on solar, wind and geothermal energy and hydrogen production from water.

Participation in EEC and IEA activities has been found to be extremely useful. The exchange of information in the EEC and IEA expert groups is important in that it promotes progress in research and helps prevent work being unnecessarily duplicated. Participation in existing programmes and new projects will therefore be encouraged.

UNDP account.

The Netherlands contribute an amount of five million guilders annually to the energy account of UNDP. This account was established -on an interim basis- in 1980 in order to explore the energy potential of developing countries; this is done by stimulating high risk capital-intensive petroleum exploration and by developing alternative conventional and non-conventional energy resources.

Development cooperation

The Netherlands' Government attaches great importance to helping to solve the energy problems which are becoming increasingly serious in developing countries. These problems, notably the growing dependence on oil imports and the dwindling of traditional resources, are amongst the major problems which face many developing countries in the next twenty years.

Until recently only a limited amount of attention was given to energy in the Netherlands' development cooperation programmes. Any projects there were in this field, such as the provision of power stations and the and the accompanying infrastructure, concerned conventional sources of energy. Since then, however, an increasing amount of attention has been given to new and renewable energy sources.

Research and development on the possible applications of new and renewable energy sources is going on in various countries including the Netherlands. This work is separate from the Netherlands' national R&D effort in this area since it is aimed solely at determining the relevance of alternative energies in building up the economies of the developing countries. A survey of the various R&D activities is given below.

Forestry

In the year 1979-1980 the Netherlands allocated an initial sum of 10 million guilders from the development cooperation budget to energy projects. However, whatever its size, the Dutch contribution will remain insignificant if the governments of the countries where the availability of wood constitutes a problem do not take note of this fact and take suitable action. So far, however, some of the governments concerned have been postponing dealing with this problem and have concentrated mainly on balance-of-payments problems. One of the reasons for this is perhaps the fact that reforestation is difficult and by no means cheap (sometimes it costs up to 2,500 guilders per hectare).

Since there are generally no cheap alternatives for firewood and charcoal, reforestation must be given high priority; it has accordingly been made a separate item on the Netherlands budget. In 1980 a number of projects got underway in Sudan.

A joint programme is being prepared in cooperation with the FAO with a view to setting up a fairly extensive forestry programme. In addition, efforts will be made to develop other forestry activities in consultation with the World Bank and bilateral contractors. Since the international forestry activities still do not meet the need for wood, steps are also being taken which aim to reduce the demand. Research is now being conducted to establish a scientific basis for the design of coal stoves, while efforts to improve existing stoves and ovens are also being financed. Additional research is being conducted into the possibility of substituting coal for firewood and charcoal as a contribution to the firewood panel of the UN Conference on new and renewable sources of energy in which the Netherlands is represented. Eindhoven University of Technology and the International Technology

Development Group (ITDG) are also compiling a compendium of wood stove designs, while finally a study of the possibility of compressing vegetable waste and wood into briquettes is being financed.

Direct solar energy

A number of projects which aim to make direct use of solar energy and develop solar energy technology are currently being financed from the Development Cooperation budget. The projects are being carried out in cooperation with research institutes in developing countries. In this way the Netherlands is at the same time helping to increase and strengthen the scientific and technological capacity of the countries concerned, thus enabling them to estimate the potential contribution to be made by solar energy themselves when planning energy policies.

Eindhoven University of Technology is transferring knowledge on photovoltaic cells to the University of Alexandria in Egypt. Dutch research institutes are also developing a cooling system fuelled by flat-plate collectors which will be put into operation in cooperation with the Sudan. Finally, funds have been made available for the development of a solar oven to dry nuts.

Wind energy

The wind energy programme launched in 1975 was the first long term alternative energy programme for developing countries started by the Netherlands. The Wind Energy Steering Group set up to supervise it now has representatives from Consultantsbureau Dwars, Hederijk and Verhey (DHV), Eindhoven University of Technology and Twente University of Technology.

The aim of the programme is to carry out research on wind energy and the knowledge so acquired is transferred to developing countries and used to support wind energy projects there. Staff are also trained in these countries and the research results are published. At present the Steering Group is working in Sri Lanka, Tunisia, Pakistan and Tanzania. New projects will probably be started in North Yemen, the Sudan and in Cape Verdie where the Steering Group will also help set up a centre for applied research on alternative energies. The Foundation for Technical Development in Developing Countries (TOOL) is carrying out a project on wind energy in India which is partly financed from the Development Cooperation budget. Although this is not connected to the work of the Steering Group, the TOOL and the Group do exchange information regularly. In addition, wind energy systems are being developed and used to pump water as part of the ITB (Institut Teknologi Bandung)/TOOL project in Indonesia.

Research

In addition to the research on wind energy and wood stoves described above, research is also being conducted on the possible applications of new and renewable sources of energy. The aim is to determine whether the new technologies could be economically viable, to put theories into practice and then to demonstrate the results by means of pilot projects. All this effort is essential, as there will be no transition from conventional to new and renewable energies in the developing countries until it is certain that the new technologies can indeed work and fit into the socio-economic and technical framework of the developing countries concerned apart from the cost aspect.

Besides the above projects on wood, solar energy and - the most extensive in the research programme - wind energy, the following projects are being financed.

First there are a number of projects which all involve research on water pumps. The Demetech organisation develops hydraulic ram pumps, steam ram pumps and animal traction pumps, and compiles test programmes and manuals for the use of these pumps. Delft University of Technology carries out a sort of programme of comparative testing of goods into both commercially and non-commercially obtainable hydraulic pumps. At the same time the potential for local production is investigated.

In addition to these two similar projects, a further project is being carried out by the ITDG with a view to developing a horizontal axis pump. The prototype is being tested in England and Sudan (in the Nile) and a manual for the construction, testing and use of this turbine will be compiled. Such an installation will enable farmers in developing countries to pump up water from slow-flowing rivers.

In order to reduce oil imports, a gas plant is being developed and tested in cooperation with Tanzania. If it is economically and technically sound it could result in considerable oil savings. The project is primarily aimed at providing power for the local maize factories, but it also trains technicians to repair and construct gas plants. The intention is also to help build a small gas plant industry there.

A similar project has been started in Indonesia by Twente University of Technology, DHV and the Institut Teknologi Bandung. Its aim is to introduce gas plants in small-scale

industry in Indonesia. The ITB is also carrying out a project which aims to improve the standard of living of economically weak groups by the transfer of various technologies. The project, which is being implemented in cooperation with the TOOL, covers a number of energy activities including the one on wind energy mentioned above. In addition, research is being conducted on bio-conversion and methane gas production, while improved wood stoves are being designed and introduced to reduce wood consumption.

The programme also covers research on agro forestry by the ICRAF (International Centre for Research on Agro Forestry). Their efforts aim particularly at providing poor communities in developing countries with a different way of life which does, however, have as much as possible in common with their traditional way of life. The aim of agro forestry is namely to create a "new" environment which is fairly well balanced, is not in danger of being destroyed and which will provide the inhabitants with a reasonable form of existence. The result will be that the inhabitants can continue to use firewood as their main fuel without doing irreparable damage to the environment as is now far too often the case.

BEOP

Besides coordinating the national research programmes, the BEOP is also responsible for maintaining bilateral contacts, particularly in wind and solar energy. The following recent activities are worth mentioning:

a. a study of the possible applications of alternative energies in the Netherlands Antilles. A number of projects are now being prepared as a practical follow-up to the study.

b. an arrangement with Indonesia to cooperate on wind energy. This has led to Indonesian experts working in the Netherlands and to the construction of a vertical axis wind turbine with a rotor diameter of 5.5 metres.