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UNITED NATIONS CONFERENCE ON NEW AND RENEWABLE SOURCES OF ENERGY

NAIROBI - AUGUST 1981

A BELGIAN GOVERNMENT REPORT

THE SITUATION IN BELGIUM - THE PROSPECTS FOR INTERNATIONAL CO-OPERATION

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C O N T E N T S

UNITED NATIONS CONFERENCE ON NEW AND RENEWABLE SOURCES OF ENERGY (NRSE).

THE SITUATION IN BELGIUM - THE PROSPECTS FOR INTERNATIONAL CO-OPERATION

1. BELGIUM AND ITS ENERGY SITUATION TODAY

1.1. Geography and climate

- Belgium is a country with an area of 30,500 km^2 (i.e. 11,780 square miles) situated in the NW part of Europe at 51° N and 4-5° E, between France, the Federal Republic of Germany and the United Kingdom. It has a maritime climate.
Altitude ranges from 0 to 700 metres. Prevailing winds from West/South-West have an average velocity of 3.75 m/sec. As appears from observations made over a long period, air temperature has an average daily maximum of 22.7° C in July and an average minimum of -0.6° C in December. Extreme temperatures, slightly above 26° C at the maximum, and -10° C at the minimum are only of very rare occurence.
Using a temperature of 15° C as the basis of reckoning, heating requirements calculated in units of degree/days vary from 2,000 to 3,000 according to the type of accommodation.

- The average annual precipitation amounts to 780 mm. The average rate of sunshine is approximately 1,570 hours, with an average annual intensity (on a horizontal surface) of 115 W/m^2, which means a total insolation of 1,000 kWh/m^2 per annum, of which two thirds is diffuse radiation.

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1.2. Economic situation in 1979 - (1)

- Population : 9,855,000

- G.N.P. : 3.25 10^{12} BF (108.5 10^{9} US$)

- Net income per capita : 267,214 BF (8,907 US$)

- Trade balance :
  total energy deficit : 148.5 10^{9} BF
  (4.95 10^{9} US$)

1.3. Energy situation

- In 1979, Belgium's dependence on imported energy stood at 86 % of its total requirements; the remaining 14 % were met by domestic production of coal and nuclear energy.
Imports of oil products constitute 91.10^{9} BF (3.03 10^{9} US$) of the total deficit of the trade balance of the Belgo-Luxembourg Economic Union.

- Main energy indicators

	1976	1979
Total primary energy consumption (mtoe)	45.1	48.8
Primary energy consumption per capita (toe)	4.6	4.95
Oil consumption (as a percentage of total primary consumption) (2)	53.0	51.5
Production of energy (mtoe)	7.7	6.9
Net imports (mtoe)	37.0	43.3

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(1) 1 $ = 30 BF (Belgian francs)

(2) A reduction in the percentage of oil consumption was recorded as far back as 1973. Belgium is maintaining a constant effort to make sure this reduction continues.

The high level of consumption per capita as shown above may be explained by the country's ageing industrial structure : considerable coal reserves made it possible, before World War II, to create energy-intensive industries (iron and steel, non-ferrous metal industry, cement, brick, glass works, basic chemistry).

As coal mining grew more expensive, coal was to a large extent replaced by oil, while the petrochemical industry made considerable strides.

Today's industrial policy is tending towards diversification and the creation of industries with a lower energy consumption. However, the original industrial structure still gives rise to high energy demands.

- Primary energy consumption : breakdown by source of energy

	1976		1979	
	mtoe	%	mtoe	%
Oil	23.9	53.0	25.1	51.5
Coal	9.9	21.9	11.0	22.5
Natural gas	9.7	21.4	10.3	21.2
Nuclear power	2.3	5.2	2.5	5.1
Others (1)	-0.7	-1.5	-0.2	-0.3
Total	45.1	100	48.8	100

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(1) Hydro-electric power (exports minus imports)

- In balance sheets, primary energy consumption is generally broken down into 5 sectors, three of which are related to final consumption, another to the production, the conversion and the distribution of energy, and the last one to non-energy uses.

Primary energy consumption : breakdown by sector

	1976	1979
- Domestic and equivalents (buildings, services, agriculture)	27.7 %	29.4 %
- Industry	32.8 %	30.5 %
- Transport	11.2 %	11.8 %
- Energy (production, conversion, distribution)	21.8 %	21.8 %
- Non-energy (raw materials, chemical industry, etc...)	6.5 %	6.5 %

- Energy consumption in 1979 by sector and by source in percentages

Source / Sector	Coal	Oil	Natural gas	Electricity(1)	Nuclear	
Domestic and equivalents	2.7	15.6	8.0	3.1	-	29.4
Industry	9.9	8.0	8.3	4.3	-	30.5
Transport	-	11.5	-	0.3	-	11.8
Energy	2.5	3.3	0.2	15.9	-	21.8
Power stations	7.4	8.0	3.3	-	5.1	6.5
Non-energy	-	5.1	1.4	-	-	-
	22.5	51.5	21.2	-0.3	5.1	100

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(1) Balance of electricity exports.

The energy situation shown in the tables above calls for certain intensive actions :

- In the short term, the emphasis should be given to a programme for the rational use of energy and for energy saving :

. research into the possibilities of using alternative fuels to oil in industries which have a high energy requirement ;

. a programme for converting oil-burning power stations to coal ;

. the financing of a research and development programme in the field of energy saving for home and industry ;

. a cutback on deliveries of oil-based fuels ;

. temperature controls in government buildings ;

. speed limits on motorways ;

. promotion campaigns to make everyone aware of the possibilities of energy saving .

- In the medium term i.e. from 1985 to 1990, official programmes will aim at increasing the contribution of coal and nuclear power to the total supply. This option is dictated by technical and economic necessity.

The bulk of the said coal will have to be imported. New technologies such as liquefaction and gasification at ground level will play an important part in its utilization (1).

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(1) The impact of new technologies in general was the subject of a recent study issued in October 1980 as part of the national survey of Phase 2 of the International Energy Agency (IEA) project on the analysis of energy systems ("MARKAL" survey).

Belgian underground coal resources will be made available through on-site gasification. Recovery of coal from spoil heaps is also being considered (fluidized bed technology).

- It is only in the long term, after the year 2000, that alternative sources of energy can be expected to play a significant role.

2. THE PRESENT AND FUTURE ROLE OF NRSE IN MEETING BELGIUM'S ENERGY NEEDS

2.1 In general

- The political willingness to make use of the NRSE is shown in various research and development efforts :

a) a national R-D programme for energy ;

b) financing or loans for research projects in various centres or in industry.

Demonstration projects are taking place at local level.

- Some industries are interested in this field as it may afford them an opportunity for a redeployment of their activities and new outlets in home and foreign markets.
Our industry is capable of mastering the NRSE-related technologies, which are the subject of comparatively advanced studies.
However, the problems of production costs and profitability should be examined in greater depth by such studies.

- The public is inclined to look with favour on "clean" energy sources, a factor which could also facilitate the penetration of NRSE.

2.2. According to sectors of use.

- It is extremely difficult to provide an estimate of the future share of NRSE in the different sectors.

- The sector "domestic and equivalents" seems the most appropriate for introducing NRSE, especially for the heating of premises and hot water.

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The demand is predominantly for heat at low temperature, a need which can be met most adequately by the technologies already developed (flat-plate collectors, heat pump, geothermal energy), taking the Belgian climate into consideration.

- Industry will aim primarily at enhancing the efficiency of some processes by using new technologies and by heat recuperation (especially for use as district heating).

- NRSE seem to offer rather limited prospects for transport (methanol, electric cars, hydrogen) : experiments are proceeding.

- No significant contribution of NRSE to the sector of power production (electricity) is expected in the short and medium term, but tests are being conducted in this field too.

2.3. According to the source.

* SOLAR ENERGY

- Although it has a comparatively low rate of sunshine, Belgium receives far more energy from the sun than would be needed to meet the country's primary energy demand.

- The production of heat at low temperatures (under 100°C) through thermal solar conversion (flat plate collectors, integral solar roof panels) is adequate for our climate (high rate of diffuse radiation) and offers some possibilities, especially in conjunction with the heat pump.

Belgium had approximately 9000 m^2 of collectors in 1980. An increasing number of Belgian companies are

becoming involved in this field.

For the housing sector alone, the total surface of collectors produced and operating could rise from about 11,000 m^2 during the period 1981-1985 to approximately 770,000 m^2 for the period 1996-2000. These estimates could almost double if the government intervened to reduce the cost price of such installations.

A number of major experimental facilities are being implemented, for example by the Free University of Brussels (VUB), the Catholic University of Louvain (UCL), the Luxembourg University Foundation (FUL), the Polytechnic Faculty of Mons (FPMs) or the Antwerp State University Centre (RUCA) : passive utilization of solar energy in residential or office buildings, indoor swimming pools and sports centres, single family integral solar house.

These experimental buildings will be optimized with a view to larger-scale production in the medium term.

This technology will spread more widely as it becomes competitive. It might in particular cater for a considerable share of water heating.

- Thermodynamic conversion offers some advantages, but is less feasible in Belgium where direct radiation is scarce. The industry however produces for export concentrating collector systems and components for solar power stations (heliostats).

Belgian industry participates in the establishment of solar power stations within the framework of IEA and EEC programmes in Spain and Sicily.

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- Photovoltaic conversion : the leading factor in the production of solar electricity generators is the cost of the cells, although the latter are becoming less expensive. Belgium will start manufacturing single crystal silicon photovoltaic cells in 1981 and further investigate the field of $CdS-Cu_2S$ cells and thin-film cells. Belgian industry can supply photovoltaic systems for various purposes (pumping, lighting, telecommunications, etc...)
Some projects are being implemented, for instance in Ghent, where the University (RUG) has launched a demonstration, within EEC programmes, of a photovoltaic power station connected to the grid and at the Catholic University of Louvain (KUL), where an electric car is being tested.
Pilot projects initiated by Belgian companies within the said EEC framework are being developed on the following themes : producing electric power through photovoltaic conversion, producing hydrogen as a way of storing energy released through photovoltaic conversion, supplying electricity for the ancillary equipment of the heating system in swimming pools and sports centres.

Solar radiation is scattered and irregular in Belgium, and will therefore remain a marginal source in the country's energy output, but a considerable technological potential is available in this field for producing export-oriented systems.

* BIOMASS

- Substantial efforts are being made to develop new technologies or improve existing technologies with a view to producing alternative fuels : digesters,

gasifiers, ethanol production, etc...

Projects are being implemented, for example :

- A number of methane digesters have been erected in agricultural areas, on the initiative of the Louvain Catholic University and the State University in Ghent. The development of economical methods in this field might make many a farm self-sufficient in energy.

- Tanks for digesting refuse from slaughterhouses have been developed by the International Rural Development Association (AIDR) with the scientific support of a team from the Louvain Catholic University.

- Short rotation forestry can be developed for producing energy-oriented biomass. Considerable amounts of wood wastes are still unutilized in Belgium.

- Research in the field of biological production of hydrogen through algae culture is still in an early phase (Liège University - ULg).

- Charcoal-fired gasifiers for vehicles, generating sets, etc... have been developed by a Belgian company with the support of a team from the Louvain Catholic University.

- Studies are proceeding for catalytic liquefaction of wood at the Louvain Catholic University (UCL).

- Combining the results of methanisation of refuse (liquid manure, waste water, sewage sludge, etc...), of gasification of agricultural (straw, wood) or urban residues, and of energy forestry and farming - for which no estimate is available now -, biomass

may be expected to make a significant contribution to energy production within the next five years.

* GEOTHERMAL ENERGY

- The present sources, which are only found in certain areas, have low temperatures (70°-80° C), and are therefore suitable for space heating (district heating, greenhouses) and domestic water heating, in limited areas. Projects are being executed, for instance : drillings in the Mons area will eventually enable a district heating network to be completed by 1982.
In Hoogstrate, geothermal energy is used for heating greenhouses.
Belgium has gained a wide expertise in drilling techniques applicable in this field.

* HYDROPOWER

- Almost every available site for erecting hydro-electric dams and artificial reservoirs has already been used. Globally, this accounts for less than 1 % of the electricity output.

- Belgium also has know-how in the field of water-side mini-power stations (1 to 5 MW) suitable for providing electricity to the bordering villages and to small-scale processing units for agricultural products , and in the field of waterside micro-power stations (10 to 100 kW) for even more localised use.

* WIND POWER

- Belgium has a tradition in making generators suitable for use in this field and could produce wind

power systems.

- This energy source is not likely to play an important part in Belgium, although some local schemes might prove feasible.

2.4. Conclusion

- Taking into account the features of Belgium's geography, geology and climate, the aggregate production of heat and electricity from the aforesaid energy sources, subject to the constraints dealt with in following Chapter 3., could meet 0,5 % to 2.5 % of Belgium's primary energy consumption by year 2000, according to current forecasts.

- Even if the NRSE could only meet a small percentage of Belgium's primary energy needs, this could cut the energy bill by about 0.1 to 3 billion BF (i.e. 3,333,000 to 100,000,000 US $).

- The contribution of the NRSE will essentially depend on the fluctuations in the price of other energy sources, and on the efforts made by the government to facilitate their introduction.

A special effort is being made at developing and implementing other new technologies that are not directly related to NRSE but will contribute to saving energy, such as fuel cells, absorption heat pumps, etc.

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3. LIMITATIONS ON THE USE OF NRSE IN BELGIUM, AND REMEDIES

3.1. General limitations

- One general limitation appears from the aforegoing paragraphs : the limited resources in some NRSE available in Belgium, whether for biomass, wind power, hydropower or geothermal energy.
On the other hand, there is a definite will to develop new technologies in that an R & D effort is being made and the technological potential of Belgian industry rather adequately fits into the production of NRSE-based systems or system components.

- For the time being, the non-technological limitations are predominantly of an economic nature.
Macro- and microeconomic studies are under way and still have to work out the optimal conditions for implementing new technologies; in most cases, however, the capital expenditure (installation costs) compares very unfavourably with the price of conventional energy.

The soaring price of oil and the threatening shortage have so far failed to make potential users feel concerned to the extent that they would be pressing for new energy sources.

Converting and establishing industries for the production of new components or systems may require considerable investment, and would need government support.

- The markets accessible to NRSE are quite restricted in Belgium. However, the outcome of many years spent on research in this field (within the framework of

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the national energy R & D programme), and a growing interest from industry, will make it possible to develop in the short term an export-oriented policy. The resulting increase in the volume of production would help cut down prices.

- Other problems, of an institutional or legal nature arising in particular from the fact that these new energies are produced locally and are by their nature "free", are being considered : law in respect of sunlight, town planning legislation, technical approval of new systems, private production of electricity, etc...

3.2. Solar energy

- The irregular and comparatively low rate of sunshine in Belgium requires a considerable storage capacity (short and long term) in order to equalize the flow of energy; research is proceeding in this field, within the national energy R & D programme and within international (EEC, IEA) programmes.

- As large collecting areas are necessary to convert diffuse sunlight, they may be subject to building or site planning restrictions.

- Using solar collectors in conjunction with a heat pump opens up interesting prospects. As the latter technology is still very expensive, improvements, for instance through research on absorption heat pumps, are still expected.

- The high proportion of diffuse radiation in Belgium makes it difficult to use concentrating systems, although they do present some advantages.

- Furthermore, as regards photovoltaic solar energy, a legal problem is added to the storage problems above : electric power produced privately may not be fed into the grid.

- By conducting research in various centres and by starting its own production, Belgium shows its willingness to play a useful role in this market.

3.3. Biomass

- The production in Belgium of alternative fuels from biomass (methanol, ethanol) raises problems of raw materials rather than problems of technology. In this respect, Belgium has to make its way on the export market.

3.4. Geothermal energy

- The overall potential of this energy source is still undefinite : the map of Belgium's geothermal fields is still being worked on.

3.5. Hydropower

- The public is showing some hostility to new dam projects for reasons of landscape preservation.

3.6. Wind power

- The number of suitable sites available (mainly along the coast) is quite restricted. Large-scale schemes might raise environmental problems.

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Conclusions

At national level

- Although the geographic and climatic features of Belgium will never allow NRSE to make a major contribution, production should be developed as much as possible, for two reasons at least :

  . the share of NRSE could stand at about 2.5 % of the primary energy consumption in year 2000 ; compared to the consumption for 1979, this could mean a saving of roughly 1.2 mtoe.

  . Belgian industry has considerable potential for developing NRSE-based systems or system components.

- Considerable means are being deployed to overcome the few remaining technical constraints, and most of all the economic restrictions. In the present phase, substantial efforts are being sustained (cf.paragraphs 2.3 and 4.2) in order to :

  . achieve a reduction in the production costs of the systems, in particular for solar energy, storage capacity, (methane) digesters, through the part of R & D already receiving government subsidies ;

  . launch demonstration projects and pilot plants for evaluating performance and cost ;

  . facilitate larger-scale production, making prices more reasonable ;

  . ensure that architects, builders and users receive ample information on reliable scientific grounds.

- Quick action should be taken in order to :

  . lay down standards for new buildings taking into account the possibility of applying NRSE ;

. institute economic incentives as is being done to reduce energy consumption (subsidies, tax concessions...)

. foster private production of electricity from NRSE by facilitating connection with the grid.

At regional and international level

- Research and studies conducted in the field of NRSE in Belgium have shown that the application of NRSE at national level will take a low percentage of the total primary energy consumption for reasons peculiar to the country.

- Research and studies, however, are sufficiently advanced to enable the development of an industrial potential that could prove useful in countries having more adequate resources, in particular in developing countries.

- It is Belgium's intention to :

. maintain its participation in demonstration and R & D projects within the framework of EEC and IEA ;

. promote bilateral agreements, in particular in the field of pilot projects and industrialization ;

. foster the exchange of information.

4. PROSPECTS FOR INTERNATIONAL CO-OPERATION

4.1. An overview of Belgian co-operation

* A long history in co-operation.

Belgium has always been oriented to the rest of the world.

Belgian scientists, anthropologists, explorers, traders and engineers have set their mark on every continent and every field of science, especially agriculture and medicine.

In the field of energy - the subject matter of this conference - Belgium has maintained a solid reputation for its achievements in mining engineering, hydroelectric and thermoelectric power, high voltage line installation, laying of pipelines for distributing solids, liquids and gases.

In the 19th century, long before co-operation took on its present meaning, Belgium was renowned in particular for its rolling stock and civil engineering works in Russia, China, Ethiopia, Egypt, Brazil ...

* Belgium's aid in 1979

In the new context of international co-operation, Belgium is resolutely pursuing a policy oriented towards the least developed countries, in varied fields.

a) The transfer of Belgian capital is effected through various channels. A distinction must be made between the private sector, essentially international trade which amounted to 71.2 % of

the transfer in 1979 and the public sector, which took up the other 28.2 % (quoted from Belgium's memorandum to the Development Assistance Committee).

b) The bulk of official assistance is handled by the "Administration générale de la Coopération au Développement" (AGCD), the agency within the Ministry of Foreign Affairs, External Trade and Co-operation in Development responsible for implementing Belgium's co-operation policy.

c) The Ministry of Finance too is responsible for a substantial share, i.e. mainly for Belgium's financial contributions to the World Bank and the regional development banks. These stood at 2.4 10^9 million Belgian francs (81.5 10^6 US $) in the 1979 budget.

d) Government-to-government loans will not be dealt with in this report.

* The various forms of co-operation applied by AGCD are shown in appendix 1 to this document.

4.2. Co-operation in the field of energy

In the 1979 budget, the funds allocated to aid in the sphere of energy were :

- 248.5 10^6 BF i.e. 2.6 % of bilateral aid
- 116.4 10^6 BF i.e. 3.1 % of multilateral aid
- 379.5 10^6 BF i.e. 15.5 % of contributions to development banks

744.4 10^6 BF (24.8 10^6 US $) i.e. 4.82 % of aggregate official aid.

Among the leading trends of our co-operation policy in a sector approach, the assistance effort should

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encourage rural development, appropriate technology and production of capital goods adequate for developing countries.

The aforesaid Belgian memorandum to DAC states :

"That the year 1979 served to some extent as a springboard for a policy that will only show tangible results in the next years, in that greater efforts would be dedicated to the energy sector in the developing countries which express a desire to do so."

In the first stage, the effort is limited to studying, exploring and planning energy in general, as these phases must be completed before operational work begins.

"That a growing proportion of means is allocated to alternative energies, within the framework of appropriate technologies."

Accordingly, projects have been launched on wind energy, solar power, methanization, inter alia in Bengladesh, Burundi, Cape Verde, Egypt, Rwanda, Zaire,...
But in the sector as a whole, conventional energy remains predominant.

"That special attention is being devoted to hydro-electric power, as the technology for this source of energy - no less renewable than the aforegoing ones - is the more proven."

A special effort is being made for mini and micro-power stations, when remoteness from power transmission lines make these essential for a rural community.

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In addition, co-operation between the official agencies and the private sector, - particularly active in the field of studies and specific schemes for conventional energy, - is also making some headway in research and pilot projects on alternative energies with the participation of universities and research centres and of the more dynamic members of the private sector.

4.3. Belgian know-how in a NRSE strategy

A major point must be emphasized : no one better than the developing countries themselves can identify their specific needs. However, an accurate determination of these needs often requires the assistance of experts.

In the field of alternative energies, decisions must be based on a thorough analysis of local conditions.

A number of comparatively sophisticated facilities, which operate satisfactorily in Belgium, could only work elsewhere subject to modifications.
Moreover, simple equipment may have no outlet in Belgium and, at the same time, be perfectly adequate for foreign markets with a different environment.
For instance, a domestic wood-burning oven with a heat-recuperation device, could substantially contribute to reducing wood consumption in the Sahel where wooded Savanna is scarce, though there would be little demand for it in Belgium.

With this in mind, let us now examine the fields in which Belgium can contribute to the development of new and renewable energies :

(a) Technical and economic analyses; consultancy
(b) Training; transfer of technology.
(c) Research
(d) Co-operation between developing countries.
(c) Export of technology and equipment.

(a) In the field of studies and consultancy, we can distinguish :

* The analysis of energy systems, i.e. :
  - an inventory of available energy sources and an assessment of practicable alternatives in view of the specific resources and characteristics (climate, economy and geographical conditions) of the country concerned on the one hand, and the political and social circumstances on the other hand ;
  - an assessment of feasible energy strategies within the framework of a comprehensive study of energy flows, inter alia with mathematical models of energy supply and demand;
  - assistance in the elaboration of national or regional energy programmes.

* Assistance in the conduct of studies, such as in particular : hydraulic, geological, climatic surveys...; in the identification of specific energy projects and the drawing up of (preliminary) feasability studies for such projects as : installation of solar or other power stations, power cables, biomethane digesters... .

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(b) In the field of training and transfer of technology

* Training courses and study grants in Belgium and/or in the applicant countries for the equivalent personnel to those engaged in research, decision-makers, economists and planners for the evaluation of alternatives, energy project managers, potential local users, with a view to making them more receptive to technologies suitable for their environment. Such training could be effected by Belgian universities, private organisations competent in this field or through co-operation workers.

* Transfer of technology
The Belgian government might consider some scientific and technological co-operation projects within the framework of its international co-operation policy and further to the requests from third countries.
As the Belgian economy is a market economy, each individual case of industrial property shall be settled according to commercial law, the parties being entirely liable.

(c) In the field of research

The idea is either to assist developing countries in their existing applied research, or to adapt research conducted in Belgium to different circumstances (social and economic, climatic). Such assistance may be effected locally or in Belgium.

Basic research on new energy sources could also be conducted with the assistance of Belgian laboratories.

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Research institutes and specialized organisations and agencies in the countries concerned may contact the local Belgian Embassy for useful information.

(d) Co-operation between developing countries

Belgium approves the idea of co-operation between developing countries and will readily support it.

Such co-operation may take various aspects :

- briefing and research seminars with specialists from various countries;
- energy surveys concerning several neighbouring countries;
- exchange of experience between one assisted country and another through publications and various contacts;
- implementation, within projects financed by Belgium, of processes worked out by a developing country.

(e) In the field of technical achievements (cf. §.2.3.)

The following remarks can be made for the different energy sources.

* Solar energy

Belgium already enjoys a reputation for its solar flat-plate and concentrating collectors. These could adequately be used in countries with more sunshine than ours.

However, local production of electricity has a promising future in view of the potential demand for photovoltaic cells in equatorial countries which have a low density of population and an infrastructure for the distribution

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of energy (electricity grid, roads...) which is relatively undeveloped.
Belgium is already in a position to supply combined photovoltaic systems (solar cells with appropriate electrical appliances) and will start producing silicon cells as from 1981.

Other configurations are possible, such as domestic parabolic solar cookers in conjunction with "hot boxes", various ovens for various purposes.

* Biomass

a) through carbonization :
Many developing countries face the crucial problem of having to economise on fuelwood. Belgium has for long been testing more appropriate technologies for carbonizing wood and has marketed different sizes of carbonization ovens : some are mobile and can operate on timber-cutting sites. Wood-burning cookers with a heat-recuperation device are also available.
Belgian industry produces all sizes of gasifiers for various purposes, sold all over the world.

b) through methanization :
In some African countries, Belgian technical assistance is active in some interesting schemes for production of gas through methanization.

* Hydropower

In the field of hydraulic energy, Belgium enjoys an unquestioned reputation as a result of

its achievements at home and abroad.

Belgium can also offer its know-how in the field of waterside mini-power stations (1 to 5 MW) adequate for supplying electricity to the bordering villages and to small-scale processing units for agricultural products, and of waterside micro-power stations (10 to 100 kW) for even more isolated applications.

* Wind power

Belgium has developed windmills to produce electric power in the low and medium range suitable for instance for supplying electricity to a small village and, obviously, for pumping water.

4.4. An overview of some Belgian applications

The following list only includes projects known to, and partially or totally sponsored by, AGCD. Projects relating to conventional energy or power lines and switching stations are not listed.

TITLE OF THE PROJECT	COUNTRY	PERIOD	COST IN B.F.	REMARKS
Projects related to energy supply as a whole				
1. Alternative energies for primary requirements (CETEDER)	Cape Verde	1978	completed	study completed; follow-up : see n° 2 below.
2. As above (Belgian Training Institute)	Cape Verde	1980-85	26 million	For appraisal.
3. Alternative energy study and implementation centre	Burundi	1980-82	25 million	For appraisal.
4. Directorate of water engineering and rural electrification	Burundi	1980-82	still undetermined	2 co-operation workers dispatched to draw up an inventory.
5. Assistance to the establishment and scientific management of the National Centre for Alternative Energies	Upper Volta	1981-86	still undetermined	For appraisal.
6. Study of the development of East Kalimantan Energy System (ETA 100)	Indonesia	1980-81	still undetermined	For appraisal.
7. Research and development for rural energies (ATA 251)	Indonesia	1980-81	still undetermined	For appraisal.

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Projects related to hydropower				
8. 5 micro-power stations (Courtois Consultants Bureau)	Burundi	1977-78	completed	Study completed : awaiting follow-up.
9. Mainstream hydraulic turbine for producing mechanical energy (ATOL - K.U.L.)	Zaire	1979-80	4.4 million	In the execution phase.
10. Study of the Rusumu Falls with a view to building a hydro-electric power station (3 countries concerned)	Tanzania Rwanda Burundi	1978-79		In progress.
11. Cavally Dam (1 and 2)	Ivory Coast	1979-83		In progress.
12. Selingue Dam	Mali	Partici-pation		In progress.
13. Study for two hydroelectric power stations	Comores Islands	1980	35 million	In progress.
14. Study for a hydroelectric power station in Pensangan	Indonesia	1980		For appraisal.
Projects related to solar energy				
a) Flat-plate solar collectors for hot water				
15. Solar collectors for hot water at the Kagera Hotel	Rwanda	1978-79	10 million	Operating.
16. Solar pump (Ile de paix)	Mali	1979		Operating.
b) Parabolic solar collectors for cooking				
17. Production of inexpensive solar cookers (V.U.B.)	Egypt	1978	3.3.million	Operating.

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c) Photovoltaic collectors

18. Power supply for bush mission stations (Caritas Catholica)	Zaire	1978	265,000 BF	Operating.
19. Photovoltaic conversion for the lepers' village in Dikungu (K.U.L.)	Zaire	1979-83	10 million now	Operating.
20. Electric power station in Mugogo for a radio link between Kigali and Ruengheri	Rwanda	1979	1.350 million	In the execution phase.
21. Combined windpower and photovoltaic conversion electric plant for Kigali-Bujumbura radio link and Bugamara air-to-surface station	Burundi	1980	1.5 million	For appraisal.
Projects related to biomass energy				
22. Biological methanisation of agricultural and agro-industrial refuse (UCL)	Burundi	1980-83 1979	? 3.4 million	Experiments Already in progress.
23. Methane recovery from Lake Kivu (AIDR)	Zaire	1981	3.5 million	Under study.
24. Fuel-efficient wood-burning cookers	Mali	1979-80		For appraisal.
25. Production of cement using peat	Rwanda	1977-80	29 million	In the execution phase.
Projects related to windpower				
26. Application of wind power (V.U.B.) (see also 19)	Bengladesh Burundi	1978-82 -	5.8 million	In the execution phase. -

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Various forms of co-operation applied by AGCD

APPENDIX.

Channel / Mode of assistance	Bilateral co-operation (1)		Multilateral co-operation (1)
	Direct	Indirect	Always indirect
Staff (2)	-Belgian technical co-operation assistants (CTB)	-Volunteers from Belgium NGOs (3) -University technical co-operation workers (CTU) (4)	-United Nations volunteers(5) -Associate and junior experts (6)
Training	-Scholarships -Training grants for nationals from assisted countries	-contribution to the running costs of Belgian universities in proportion to the number of students from assisted countries	-Scholarships
Projects	-Study and implementation of official projects with assisted countries	-Co-financing of projects submitted by Belgian NGOs	-The projects submitted by international organisations may be made chargeable to a reserve fund
Contribution by payment and/or otherwise	-Food aid -Emergency aid for assisted countries	-Co-financing of food and emergency aid through Belgian NGOs	-Food aid -Emergency aid through international organisations

(1) The budget of AGCD, the ratio between bilateral and multilateral aid, and its share of the gross national product (GNP) are shown below :

Year	Bilateral co-operation	Multilateral co-operation	Total in $ m	% of GNP
1975	66.7	33.3	377.7	0.59
1976	67.4	32.6	340.1	0.51
1977	70.6	29.4	371.0	0.46
1978	58.0	42.0	536.1	0.55
1979	68.6	31.4	630.8	0.56

(2) Staff : exclusively Belgian nationals. In 1979, Belgium had approximately 2,800 field workers on government payroll, as per table below (a substantial number of Belgian expatriates, some of whom are working for charity or religous relief organisations, are not considered here).

Status	Number	Paid by	Engaged by
C.T.B.	1,550	Belgium	AGCD
C.T.U.	150	Belgium	Belgian Universities
Volunteers	900	Belgium	Belgian NGOs
Assoc. experts	200	Belgium	Internat.organisations

(3) NGOs : Non-governmental organisations. Often charity or religious associations. They are autonomous, very flexible in management, and generally work closer to the population than official projects.
As for Belgium, AGCD has registered over 100 NGOs.
They exist in most countries; some have a supranational character, such as the Red Cross, Caritas Catholica, Oxfam,...

(4) University technical co-operation workers (CTU) : graduates from our universities can be found among CTBs, CTUs and volunteers ; CTUs have a special status whereby they depend on their "mother" university for projects in which the universities generally act as the government's subcontractor.

(5) United Nations volunteers : Belgium contributes to the financial support of about forty young people from aided countries who join the UN volunteer force.

(6) Associate and junior experts : another special status enabling young people - mostly university graduates - to begin a career with an international organization.