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Report

ESTABLISHMENT OF THE INTERNATIONAL CENTRE FOR HYDROGEN ENERGY TECHNOLOGIES

prepared for

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1. Description of sector

Today, fossil fuels meet about 88% of the world energy demand,mainly petroleum (approximately 38%), coal (30%) and natural gas (20%). Non-fossil energy in the form of electricity accounts for about 12%, of which hydropower contributes 7% and nuclear energy, approximately 5%. The world's known reserves of oil and natural gas will last for decades, and coal, perhaps for centuries. There would thus appear to be enough "energy" available to meet the world's energy needs in the foreseeable future, and at prices which at least the industrialized countries could afford.

In spite of this seemingly bright picture, the search for new alternative energy systems has intensified vigorously in the last several years. This may be attributed to the following reasons:

- It is conservatively estimated that the world energy consumption will double by the middle of the next century. This extra demand will necessitate additional energy production and additional energy discoveries;

- As mentioned above, about 88% of the world energy demand is currently met by fossil fuels. Even with increased discoveries of new deposits, these fossil fuels are by no means inexhaustible, and are not evenly spread among countries. Consequently, alternatives must be found;

- The combustion of fossil energy is directly connected to the production of pollutants (especially CO2 emissions) and resultant environmental problems (air pollution, acid rains, greenhouse effect, climate changes, oil spills, etc.). Even with the help of modern technology, the quantity of pollutants can only be minimized, but can never be removed completely. In fact, the world-wide environmental problems resulting from the use of fossil fuels are the most compelling reasons for the present vigorous search for future alternative energy options that are renewable and environmentally friendly.

Various non-conventional and/or renewable energy sources, such as nuclear (fission), thermonuclear (fusion), solar, wind, hydro, geothermal, etc. are being considered as possible primary energy sources to meet the growing demand. Renewable energy sources in their different forms also have disadvantages, however. They are either intermittent (solar radiation, wind) or fixed to certain locations (hydropower, geothermal, biomass). Also, they cannot be used as a transportation fuel directly. There is strong public opposition to nuclear (fission) energy because of potential danger of radioactivity, difficulties with the disposal of radioactive waste, and high cost of decommissioning and waste disposal. Regarding fusion energy, it is a hope that the break-even point may be achieved in the next 50 to 70 years; the general consensus, however, is that it may never become commercially feasible.

The shortcomings of the new energy sources point to the need for an intermediary energy system to form the link between them and the user. If, for example, heat and electricity from solar power plants are to be made available at all times to meet the demand profile for useful energy, then an energy carrier is

necessary which could be stored over long period of time for use when solar radiation is not available. The ideal intermediary energy carrier should be storable, transportable, pollution-free, independent of primary resources, renewable and applicable in many ways.

The above prerequisites could be well met by hydrogen, especially if hydrogen is produced electrolytically using renewable energy. Transformation to hydrogen is one of the most promising methods of storing and transporting solar, hydro and wind energy in large quantities and over long distances.

When renewable energy - in its direct and/or indirect form - is used to produce hydrogen, both the primary and secondary forms of energy become renewable and environmentally compatible, resulting in an ideal and permanent energy system - the Hydrogen Energy System.

Hydrogen can be used like natural gas for heat generation and like gasoline as fuel for transportation. In addition, hydrogen can be used for direct electricity production through electrochemical conversion processes. It is also used for the production or refinement of gaseous or liquid hydrocarbons, and is an important raw material for numerous chemical products, including fertilizers and food products (e.g. margarine).

An analysis of the energy demand patterns for a typical western country indicates that nearly two-thirds (63%) of the second energy is directly used as heat for cooking, space heating, water heating and industrial processes; 20% is required for transportation; and about 10% is needed as electricity for stationary power, light, communications, etc. Since hydrogen can be used in all of these applications, it means that at least 90% of the average energy demand could directly be met by hydrogen, when cost effective technologies are available.

In fact, of all the new and renewable energy resources currently under investigation, hydrogen is considered by energy scientists and researchers to possess the necessary properties of an ideal energy resource in the foreseeable future. For developing countries, where the energy infrastructure is less integrated, especially in rural areas, the need for self-sufficient energy supply is large. Hydrogen may offer a continuous energy supply based on renewable energy in remote areas where conventional fuel supply is unavailable.

Whereas the industrialized countries have already established their energy systems based on fossil fuels, most developing countries are just now in the process of establishing their energy system in order to improve their socio-economic standards. They must now decide whether to base their energy infrastructure on the fossil fuel system, on a new and renewable energy system of the future, or look for combinations which emphasize the latter. Because of the exhaustible nature of fossil fuels, any energy system based on them will have to be changed sooner or later. It would be more economical to invest in a durable system.

It is considered technically feasible to introduce the hydrogen energy system in developing countries, it would involve the conversion of a primary energy source to electricity using solar cells, wind machines or water turbines, depending on the primary energy source available, followed by the production of hydrogen by electrolysis. The technologies for the production and utilization of hydrogen already exist, requiring only moderate levels of technical skills.

Hydrogen is also an efficient fuel. It can be converted to other forms of energy at the consumer end with higher efficiencies - on the average 26% more efficiently than fossil fuels, resulting in the conservation of primary energy sources, as well as in the conservation of other resources and materials.

The most important property of hydrogen is that it is the cleanest fuel. Hydrogen itself is not toxic, thus production, storage and transportation will not create environmental hazards. Combustion of hydrogen with oxygen and electrochemical conversion of hydrogen produce absolutely no pollution whatsoever. Only the combustion of hydrogen in air produces small amounts of nitrogen oxides. Hydrogen, as a universal fuel of the future, will therefore produce little or no pollution, no acid rains, no greenhouse effect, no ozone layer depleting chemicals, and no oil spills or leaks. Table I presents the pollutants produced by the present fossil fuel system and two possible energy systems for the future - the coal/synthetic fossil fuel system and the solar hydrogen system.

Table I: Pollutants produced by three energy systems (kg/GJ)

Pollutants	Fossil fuel system	Coal/synthetic fuel system	Solar hydrogen system
CO2	72.4	100	0
CO	0.80	0.65	0
COx	0.38	0.50	0
NOx	0.34	0.32	0.10
HC	0.20	0.12	0
Particulates	0.09	0.14	0

2. Strategy

Most industrialized countries have already recognized the future importance of hydrogen as an environmentally clean energy alternative, and are already conducting research into all aspects of the hydrogen energy system. They possess the technological know-how for its implementation. As energy and environmental problems are global problems, no one country can solve them by itself. No border barriers can stop pollution, acid rains and the greenhouse effect from spreading.

Therefore it is to the advantage of both the industrialized and the developing countries to cooperate in the following:

- R&D for the development and application of hydrogen energy technologies.
- The transfer of such technologies.
- The establishment of the appropriate industries.
- The initiation of a durable and environmentally compatible energy system based on hydrogen.

Although several companies are working on technologies for hydrogen application in various fields, company based initiatives by themselves will not be sufficient. The energy infrastructure development and design of energy systems requires efforts and advice in the public domain of a larger nature that what companies could do. An orderly and world-wide transition to greater hydrogen use will require an international mechanism.

Many developing countries have established national centres for research on renewable energy sources, including solar energy. Some of these conduct research on hydrogen production; however, no single developing country presently performs R&D work covering all aspects of the hydrogen energy system, i.e., production, storage, transmission, distribution, utilization by the energy consuming sectors, environmental impact studies, and economics of the system. It would be economical and effective to have an international centre to disseminate knowledge and information in this respect.

The Centre would help to bridge the gap by undertaking some of the missing R&D, and by coordinating the ongoing research and development efforts. The Centre would cooperate with the existing national centres in order to make use of the knowledge already generated, and in order to eliminate overlap and duplication. The activities of the Centre will focus on practical applications of hydrogen energy technologies, especially equipment development and training of personnel. The Centre will not be involved in long term basic research, but focus on transfer and development of application oriented hydrogen energy technologies.

There is also the recognition in many countries that national efforts, whether scientific and technological, industrial and commercial, would be considerably facilitated by international interaction. The scientific and technological community feels that it is imperative to have the opportunities for interaction and exchanges on an international scale. In several developing countries visited, the need for advisory services on matters ranging from policy and institutional aspects to specific projects and disciplines is evident. In those countries, another identified need pertains to the formulation and execution of R&D programmes and projects of common concern to several countries which those countries have neither the resources nor the capacity to take up individually.

The creation of the Centre will be the most practical and effective means of assisting, in an integrated fashion, the strengthening of national technological capabilities in this important field. The spin-off effects of the Centre could in fact be

considerable, not only in the developing parts of the world, but also in many small developed countries. For the former, given the general lack of infrastructure and financial resources to support an adequate R&D effort in this field, the Centre may well be the only means by which they can get a start in this field and ensure that optimal technology choices are made, local problems addressed and major natural resources utilized.

3. Past and on-going UNIDO activities

The relevance of the hydrogen energy technologies for developing countries was examined by UNIDO during the late 80s-early 90s.

Based on the Memorandum of Understanding with Arabian Gulf University, UNIDO prepared in 1988 a project proposal for a workshop in Bahrain for Arabic countries on "Hydrogen as a Fuel of the Future" and consequently carried out a study "Hydrogen Energy Technology for Developing Countries".

In this study it was concluded that the necessary technologies for the near term application of the Hydrogen Energy exist and the these technologies are especially attractive to the developing countries for two reasons:

i) almost all of them have abundant potential of renewable energy available to them (solar radiation, wind energy, hydro power) which could be use for hydrogen/electricity production, while this can not be said for the fossil fuels;

ii) since the developing countries are just starting to build their energy infrastructures they could avoid the mistakes of the industrial countries, by giving more emphasis to renewable rather than a nonrenewable and environmentally incompatible system.

In 1991 the report "Hydrogen Energy Initiation in Developing Countries" was issued by UNIDO in which special consideration was given to the technologies suitable for developing countries and in conclusion the following actions were suggested:

i) to establish pilot and/or demonstration projects for hydrogen production, storage and utilization in developing countries;

ii) to arrange collaborative research and training programmes between selected institutions in the developing countries; and

iii) to establish an International Centre for Hydrogen Energy Technologies (ICHET) to conduct R&D and training programmes needed for the personnel to run the hydrogen energy system, to evaluate and coordinate the initiation and founding of the hydrogen energy system in the world in general, and in developing countries in particular.

Following these recommendations UNIDO in cooperation with the Asian and Pacific Centre for Transfer of Technology (APCTT) and the United Nations Economic and Social Commission for Asia and Pacific (ESCAP) arranged in 1992 in Nepal an Expert Group Meeting on "Hydrogen as an Energy Alternative for Developing Countries". The objective of the meeting was to create awareness, exchange views and to explore the opportunities for developing countries to acquire capability to participate in research and development of technology and adapt it to their specific needs. The meeting was attended by the experts from China, India, Indonesia, Malaysia, Pakistan, Philippines, Sri Lanka, Thailand, Viet Nam.

Another Expert Group Meeting with the same objective for the experts from Guatemala, Honduras, Jamaica, Mexico was organized in Cuba.

Both meetings confirmed the growing interest from developing countries to the hydrogen energy technologies as a viable option for the future energy system. The participants of EGMs noted that:

i) hydrogen technologies in several fields have reached the stage of maturity, allowing hydrogen to be used for practical applications as the cleanest and most sustainable fuel;

ii) based on the total energy cost calculations, hydrogen produced from hydro, solar or wind power is the most economical fuel of all alternatives;

iii) most research and development on hydrogen energy is taking place in the industrialized countries, although more and more developing countries are joining the R&D. However, the R&D being carried out by the industrialized countries is often far too sophisticated for the developing countries and an appropriate mechanism must be found to enable the developing countries to benefit from the world-wide R&D effort;

iv) therefore the meetings strongly endorsed the UNIDO initiative on the establishment of an International Centre for Hydrogen Energy Technologies (ICHET) which, inter alia, will monitor and develop a data base on hydrogen energy technology R&D, and also identify suitable areas for research of special relevance to the needs and priorities of developing countries.

In 1992 the Government of Turkey took up the issue and supported a UNIDO project to carry out preparatory promotional activities towards the establishment of an International Centre for Hydrogen Energy Technologies in Turkey through:

i) undertaking international contacts with interested countries, institutions and organizations in order to verify and ascertain their interest and participation in the project;

ii) defining the structure and functions of the proposed Centre and identifying an appropriate work programme; and

iii) promoting international cooperation for its establishment and operation.

4. Institutional framework

As part of the feasibility study for the establishment of an International Centre for Hydrogen Energy Technology, visits to numerous governments, government agencies, international organizations and research institutes were made, including Turkey - the proposed host country - United States, Japan, China, India, Kuwait, Egypt, France, Germany, Italy, European Community and the World Bank.

Early in 1993, the World Bank, the U.S. Department of Energy and the U.S. State Department in Washington, D.C. were visited. Short presentations about the proposed centre, its aims and functions were made to interested parties in the three organizations. The responses were encouraging. The World Bank officials mentioned that the activities of the Centre fell in the province of the newly established Global Environment Facility (GEF). GEF would not fund the establishment of centres or institutes; however, GEF could fund individual projects to be undertaken by the Centre. Department of Energy officials were also supportive, indicating that they would cooperate with the proposed Centre. The State Department officials were also encouraging.

During the summer of 1993, two trips were made, covering Asian countries, Egypt and Europe.

In Tokyo, Japan, the Ministry of International Trade and Industry (MITI) and the Ministry of Foreign Affairs were visited. After the presentations in MITI, they gave an outline of the proposed WeNet Programme under their New Sunshine Project. This programme envisaged international cooperation in the hydrogen energy field, and had a budget of 300 billion Yens for the next 28 years. They mentioned that the proposed Centre would fit well with their WeNet Programme. The officials at the Ministry of Foreign Affairs mentioned that there could be in kind assistance for the Centre on a bilateral basis, and they could provide scientists on loan, of whose the expenses would be covered by Japan. They also mentioned that Yen loans to the Centre might be possible, but no grants.

In Beijing, China, a presentation was made to the interested government officials under the auspices of the energy Association of China, and the meetings were held with the officials of China State Science and Technology Commission, Department of Industrial Technology. They said that the UNIDO initiative was a good one, and made the following suggestions:

1. Their Hydrogen Energy Panel is involved in planning from the start.
2. They assist with the necessary international cooperation.
3. They carry out R&D on Hydrogen Energy Technologies for the Centre.
4. Affiliated centres should be established to work with the ICHET.

5. Developments which take place should be regarded as intellectual property.

In Delhi, India, a meeting was held with the Minister for Non-conventional Energy Sources and the Secretary for Environment and Forests. Also, there was a round-table discussion with Indian scientists involved with Hydrogen Energy. It was stated that public awareness was important; politicians were not aware of the future potential of Hydrogen Energy Technologies, and they had to be informed; there was a need to be open-minded; and all forms of hydrogen methods had to be explored, including biological methods. All in all, they were very supportive of the proposed Centre. They also mentioned that the Indian government would provide funds for the Centre in a manner similar to other participants.

In Kuwait, a meeting was arranged with the officials of Kuwait Institute for Scientific Research (KISR), Kuwait Foundation for the Advancement of Science (KFAS), Kuwait University, the Ministry of Health, the Ministry of Foreign Affairs, Environmental Protection Council, and the Regional Organization for Protection of Marine Environment (which covered the entire Gulf region, as well as Kuwait). They recognized that their main export commodity - petroleum - would sooner or later be depleted, and therefore they looked at solar produced hydrogen as a future energy carrier, which they could produce and export. They promised support for the proposed Centre.

In Cairo, Egypt, a UNIDO representative and a UNIDO consultant met the officials of the Ministry of Electricity and Energy, the New and Renewable Energy Authority, and the National Research Centre, who suggested that at least one of the demonstration projects should be located in Egypt, and promised support for the proposed Centre.

In Paris, France, a presentation was given to the French officials interested in Hydrogen Energy Technologies. These included representatives of the government, universities, and the industry. France is already a large user of hydrogen as an energy carrier through their space programme. They indicated support of the proposed Centre. The, the International Energy Agency, Hydrogen Energy Section, was visited. They suggested that Turkey should join the Hydrogen Energy Committee of the International Energy Agency, and they would have one of their future meetings in Istanbul, Turkey.

In Brussels, Belgium, the officials from the Ministry of Public Health, Environment and Social Integration of the European Community, and the Programme for Regional Use of Energy were visited. In general, they were supportive of the idea of the Centre. They thought that the European Community may be able to provide in kind and/or financial assistance for such an initiative, and recommended that the Turkish government should approach the European Community about the requirements and needs of the Centre. They also mentioned that the European Parliament might be approached to support the Centre, given the existing Parliamentary support for the German/Saudi Arabia HySolar Project.

In Bonn, Germany, the issue was discussed with the officials from the Ministry of Science and Technology, Ministry of Economic Cooperation and Development, Directorate for Cooperation with the Developing Countries, and the Ministry for the Environment, Nature, Conservation and Nuclear Safety. They agreed that hydrogen would be an important component of the future energy system, and were positive about hydrogen, and as such, were supportive of the project.

In Rome, Italy, discussion was held with the officials from the Directorate of Advanced Energy Technologies, the State Energy Ministry, the Ministry of Industry, the Ministry of Universities and Scientific & Industrial Research, the Ministry of Environment, the European Economic Community Joint Research Centre at Ispra, and the Italian State Oil Company (ENI). Even the Italian State Oil Company was supportive of the Centre idea. They suggested that the Centre should also look into hydrogen production from fossil resources. They thought that initially the fossil hydrogen would be the cheapest, and that the renewable hydrogen would come in later. Italian government officials were all supportive of the Centre, and promised cooperation.

Finally, in August 1993, Ankara, Istanbul, Turkey, was visited in order to meet with the appropriate government officials. In Ankara, the UNIDO representatives met with Deputy Prime Minister, as well as the with the Minister of Energy, the Minister of Environment, the Under Secretary of the Ministry of Foreign Affairs, the Deputy Director for Multilateral Economic Relations, and the European Economic Community Representative in Ankara. All the Turkish government officials were strongly supportive of the proposed Centre. The Deputy Prime Minister stated that Turkey would provide land, put up the necessary buildings, and provide the starting funds for the Centre. He also stated that, because this was a United Nations Centre, there must be financial, in kind and other support from member countries in general, and industrial countries in particular.

Most government and agency representatives in all the countries visited expressed a very positive attitude to the proposed Centre, some gave strong support, and all provided suggestions on the proposal. The scientific and technological community has expressed willingness to participate in various stages of the Centre's research and training activities. The importance of cooperation with ongoing regional, national and international research and development programmes in this field has been emphasized.

5. Problem to be addressed

Developing countries are in the process of the establishment of their energy system infrastructure with the aim to achieve a greater level of energy independence, therefore they should be given an opportunity to make decision and clearly define their attitude in regard to the usage of fossil fuels, renewable energy or blend of both.

Most research and development (R&D) on hydrogen energy is taking place in the industrialized countries, although more and more developing countries are joining the R&D. However, the R&D being carried out by the industrialized countries is often far too sophisticated for the developing countries and there is no appropriate mechanism to enable the developing countries to benefit from the world-wide R&D effort.

In dealing with these issues, ICHET will be acting as a bridge between industrial and developing countries in spanning the gap between R&D organizations, innovative enterprises and market place, so as to stimulate appropriate application of hydrogen energy technologies in industrial development throughout the world in general and in developing countries in particular.

ICHET will be addressing specific problems in several broad areas, such as:

- identifying opportunities in which hydrogen energy technologies may be cost-effectively deployed to improve living conditions within developing countries;

- identifying proven hydrogen energy technologies which are appropriate to the requirements of developing countries;

- identifying emerging hydrogen energy technologies which have the potential to be responsive to the needs of developing countries;

- promoting the application of hydrogen energy technologies in government, financial and commercial circles, and especially within the market-place;

- promoting technology transfer to, and industrial development of, the developing countries.

The Centre will promote and facilitate the introduction of hydrogen energy technologies in participating countries through studies, applied research, training/education programmes, and advisory services. The Centre will also provide expert assistance in establishing, running and evaluation of pilot projects.

6. Target beneficiaries

With the establishment of the International Centre for Hydrogen Energy Technologies a variety of benefits will be provided to its participants, both industrial and developing countries:

- a proper mechanism for technology transfer will be created, which will encourage international cooperation and eliminate duplication of effort;

- new opportunities for industries involved in hydrogen energy related areas will be defined;

- through the usage of an energy system reducing atmospheric, marine and soil pollution, an access to renewable energy sources and sustainable economic development will be provided.

Particularly for developing countries the ICHET will bring the following additional benefits:

- support the establishment of a clean and permanent energy system based on indigenous primary energy sources;

- assist the developing world to attain greater level of energy independence;

- provide access to the technologies involved in the implementation of hydrogen energy systems, technologies which currently are almost exclusively being developed and deployed by the industrial countries;

- provide access to information on hydrogen energy research and development world wide;

- encourage and promote cooperative research and development projects between developing and industrialized countries;

- help developing countries acquire the technical skills required for the changes due to take place in energy systems in the 21st century;

- assist developing countries in preparation for the coming period of energy source conversion;

- assist the current energy exporters in continuing to fill this role as the future exporters of hydrogen energy.

7. Project strategy and institutional arrangements

The project will be implemented using a step by step approach with a balanced mixture of institutional building and technical activities in several broad areas of hydrogen energy technologies.

During the five years of the project, activities will be undertaken in a progressive manner leading to full establishment and operation of the Centre together with its focal points on an international basis, under the following broad headings.

a. Management structure of ICHET and staffing

b. Selection of site and construction of the building
c. Identification and purchase of necessary equipment
d. Development of a five year revolving work programme
e. Research, development and demonstration programmes, initial training programmes, information, etc.
f. Networking arrangements

The success of the ICHET will depend on its reputation in the international community. Only through the recruitment of a highly qualified international staff can the ICHET attain the leading position in the field of hydrogen energy technologies.

At the firs stage the management structure of ICHET will be formed which shall comprise the following organs: the Managing Director and ICHET Secretariat, the Steering Committee, and the International Scientific Advisory Committee.

A Managing Director of international repute will be nominated by UNIDO - someone capable of putting together the research and management team together. The director must have proven leadership and organisational capabilities, and technilcal expertise.

Futher, a Steering Committee will be composed of two representatives of the Government, a representative of UNIDO and a representative of developing countries selected on the proposal of the Director-General on a rotating basis. Subsequently, the Committee shall coopt other members representing major donors.

The International Scientific Advisory Committee will reflect the relevant scientific, technological and technology management disciplines and include an adequate number of qualified scientists, technologists and technology managers from both developing and industrial countries, and from the host country. The composition of the Committee will be decided by UNIDO, taking into consideration the proposals of the Steering Committee and the Managing Director.

The ICHET Secretariat will consist of the Managing Director, scientists, managers, technicians, administrative and other supporting staff and will service the Steering Committee and the International Scientific Advisory Committee. The staff will be appointed by UNIDO in accordance with the applicable Staff Regulations and Rules of UNIDO.

The ICHET should grow gradually, starting with a small group of researchers and managers, capable of desighing and implementing ICHET's programmes. It is envisioned that the ICHET will reach its full size and strength by the end of the fifth year of operation. At that time it would consist of approximately 30 managers, researches and other professional staff, 15 laboratory assistants and technicians, and 20 clerical and support staff.

The essential function of ICHET is to act as a bridge between the developing countries and the industrial countries in connection with the emerging hydrogen energy technologies. Because of the international nature of the ICHET's activities it must be located in a place, which will be able to provide this connection.

Istanbul, Turkey, meets these requirements and the Government of Turkey is going to provide land and build the premises of ICHET. Technical University of Istanbul and the University of Kocaeli offered land and facilities for ICHET.

UNIDO and the Government of Turkey will make the final decision regarding the place/seat for ICHET.

After approval of the work programme of ICHET and analysis of the resourses required for its implementation the construction drowings will be finalyzed.

It is expected that the construction work will be performed by the fifth year of the project.

8. Reasons for assistance from UNIDO

UNIDO has broad experience in the management of technology centres, both national and international. The organization's management of the International Centre for Biotechnology and Genetic Engineering (ICGEB) and the International Centre for Science and High Technology (ICS) will ensure that the implementation of the ICHET is carried out in an efficient and judicial manner, to the benefit of developing countries.

Framework for the Working Programme of ICHET Annex 1

A. *Physical establishment*

- staffing/composition of the management structure

  (i) ICHET secretariat
  (ii) visiting scientists, fellowships, etc.

- ICHET's premises

  (i) site selection
  (ii) architectural/engineering design
  (iii) construction and equipping

B. *Establishment of the contacts with countries and organizations having potential to contribute to ICHET*

- monetary contributions

- contributions "in kind"

- scientist/technologists for ICHET's programmes

C. *Networking arrangements*

- identification and establishment of the focal points in developing and industrialized countries
- identification and establishment of the focal points in international organizations

D. *R&D and demonstration/pilot projects leading to technology transfer*

- in-house R&D
- pilot projects
- evaluation

E. *Awareness/education/training activities, policy advice for developing countries, techno-economic studies*

- short courses/workshops/seminars
- forums/symposia/conferences
- feasibility studies
- publications
- video programmes

F. *Technology monitoring*

- establishment of 2 databases

Annex 2

UNIDO-ICHET BUDGET (1997-2001)
(IN 000'S OF US DOLLARS)

ITEM	1997	1998	1999	2000	2001
GENERAL (1995)	2,330	3,500	4,170	4,100	4,750
2 YEAR ESCALATION	233	350	417	410	475
CONSTRUCTION (1995)	3,000	5,000	5,000	2,000	0
2 YEAR ESCALATION	300	500	500	200	0
TOTALS	5,863	9,350	10,087	6,710	5,225

5 year total:	$38,235,000
UNIDO support costs (5%)	1,911,850
Grand Total:	$40,146,850
Rounded to:	$40,000,000