Project title:	**Gasification of Agro-industrial residues for energy production**
Host country:	**China**
Partner country:	**Italy**
Contact person and address:	Dr.Pietro Marzetti ENEA - ERG/FORI CR.Casaccia Via Anguillarese, 301 00060-ROMA Tel: +39-06-30483281 Fax: +39-06-30486452 E-mail: pietro.marzetti @casaccia.enea.it
Project financing :	Financed by MAE, Italian Ministry of the Foreign Affairs and SSTC China, Chinese State Science and Technology Commission.
Executing agency:	ENEA, National Agency for New Technology, Energy and Environment, Rome, Italy. LIER, Liaoning Institute of Energy Resources, Yingkou, China.
Project period and costs:	Duration: 42 months, from January 97 to June 2000. Costs: 2,100 Million of Italian Liras + 5.6 million of Yuan by SSTC.

- *Brief description of the project*

The project is being carried out within the overall co-operation agreement between the Italian Ministry of Foreign Affairs and the Chinese State Science and Technology Commission on scientific and technological areas of common interest. Among these, one of the priorities were study and research activities for the development and use of alternative energies, particularly applied to the rural context. One of China's needs in the field of gasification technologies is to move from the research stage to practical utilisation. The project, therefore, has started in January 1997 focusing its activities on the "gasification of agro-industrial residues for energy production" and is articulated in two main goals:

- planning, designing, realisation and testing in Italy, in full co-operation with Chinese experts from LIER, of an experimental multifuel (wood residues and rice husk) fluid bed gasification plant of 160 kWe with motor and electro-generator, appropriately modified in order to use gas produced from waste. The plant will be set up at ENEA's Trisaia Research and will then be shipped to China and installed in a factory of Yingkou.

- supply of a 20-30 kWe fíxed bed gasifier fed by wood residues, realised with ENEA's know how, equipped with proper instrumentation necessary to perform experimental tests and laboratory analyses. The plant is now being built at ENEA's Trisaia Research Centre where Chinese experts are co-operating with ENEA's

experts in conducting experimental tests by means of data acquisition systems and other analytical facilities to verify the performance level of all auxiliary equipment connected with the gasification system. Following this stage it will be shipped and installed in the laboratories of LIER in China.

The project, therefore, constitutes a good example of bilateral co-operation on the identification, selection, building, testing and transfer of a technology chosen by the local counterpart on the basis of future replicability and diffusion in a wider context. To this effect, at the end of the project, a dedicated seminar is envisaged with the participation of local and neighbouring countries experts. An important part of the co-operation package has been the training and capacity building, both in Italy and China, of the Chinese scientific and technical personnel throughout the project cycle, from the scientific and technological stage to the Plant building and testing aspects with a strong emphasis on future technology use and dissemination.

- *Special aspects of the Technology*

The technology used in the gasifier of 160 kWe is "ICFBG", Internal Circulating Fluid Bed Gasification the traditional technology of "DFBG"(Down-draught Fixed Bed Gasification) is used.

- *Relevance of Project Type*

A substantial part of the Chinese population, 800 million people, live in the countries where the villages are mostly with short energy supply because of the elevated costs of the connection to the net even though, they could dispose great quantities of biomass available as renewable fuel and autochthonous for the local production of energy.

In China it is appraised in around 18 million tons the quantity of rice husk produced as residue of the corresponding crop and in around 60 million tons the woody residues that could be used in the same finality.

Such substantial quantity of biomass, corresponding to 24 TOE, if transformed in electric energy, would be able to produce over 40 billion of kWh per ear to satisfy the energy demand of a good part of the population that currently is deprived of it.

The Biomass gasification technology, that produces a combustible gas with which can be fed a motor-eletrogenerator, could effect this finality.

Project title :	**Fire extinguishing agents substitutes to Halons**
Host country :	**India**
Partner country:	**Italy**
Contact person and address:	Gianluca Indovino Safety Hi-Tech 14, Viale Gino Cervi 1-00139 Rome Italy Tel: +39 (6) 8713.4421 fax: +39 (6) 8713.2683 E- Mail: G.indovino@Mbox.it.net. The Trinity I Floor Kandigal Road Kattur Madras 600 076 India Tel: 0091 44 6256287 Fax: 0091 44 8522547
Project financing:	Safety Hi-Tech
Executing agency:	Safety Hi-Tech

- ***Brief description of the project***

NAF Extinguishing Agents have been developed as a replacement for Halon 1301 and 1211 in total flooding systems and portable extinguishers.

Although each potential hazard present a unique problem to the system designer, the installation of a NAF S III system would be advantageous in one or more of the following circumstances:

- When an inert, electrically non-conducting media is essential or desirable.
- When clean up of media would present a problem.
- When weight and/or space versus extinguishing potential is a factor.
- When there is difficulty in ensuring the safety of the personnel.

The extinguishing performance and low order of toxicity, together with low environmental impact, make the use of NAF agents particularly suitable for the following hazardous situations: computer and equipment rooms, electrical switch-gear, control rooms, chemical laboratories, military vehicles, aircraft engines, cargo and passengers compartments, microwave relay stations, flammable liquid storage or process areas, telephone exchange areas, transformers and conventional or nuclear plants, radioactive “caves” and hot cells archive storage.

- *Special aspects of the Technology:*

NAF SIII systems have already been installed in India in high value facilities including telephone companies and cement factories.

NAF SIII is the most cost-effective replacement for Halon 1301; NAF S III can be used in existing Halon 1301 without the necessity to undertake major changes to the system. The costs for replacement of Halon 1301 with NAF S III are minimal. The reduced quantity of NAF S III used, together with lower equipment costs, compared to other alternatives, results in a highly cost effective installation.

From an environmental standpoint, a key factor in evaluating the viability of Halon 1301 alternatives is the Global Warming Potential (GWP). The Kyoto Protocol to the United Nations Framework Convention on Climate Change binds signatory countries to reduce greenhouse effect gas emission including HFCs and PFCs. NAF S III has a GWP of 1444 (CO_2 - 100 years) which is the lowest of any HFC or PFCs being considered for use in normally " occupied areas" in addition, the Atmospheric Lifetime (ALT) of Naf S III is 12 years and the Ozone Depletion Potential (ODP) is only 0.036.

- *Relevance of Project Type:*

All personnel have been trained in order to design fire- fighting systems using the NAF SIII Computer Design Program. India is one of the most critical Article 5 countries in terms of population and ODS consumption , and therefore counts as an important testing branch to evaluate the implementation of the Montreal Protocol in these countries. Acquiring NAF environmental sound technology may signify an utmost turning over of Article 5 countries commitment to the Protocol and an anticipated accomplishment to the Halon phase out date of 2010. This changing attitude could also have a positive outcome in the light of the Climate Change debate considering the low GWP, ALT and TEWI values.

Project Title: **High temperature recycling plants for waste of any kind with a patented process called "thermoselect"**

Host country: **Korea**

Partner country: **Italy**

Contact person: **and address**

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Project financing: THERMOSELECT

Executing agency: THERMOSELECT

- *Brief description of the project*:

Refuse of all kinds is left untreated and compacted to around 10% of its original volume, and then press into a heated degasification channel. The high degree of compaction greatly reduces the residual air content, the air has not insulating effect, nitrogen does not need to be heated and subsequently cleaned, and heat conductivity is significantly improved. Liquids which escape during compaction flow into remaining cavities.

In an oxygen-free environment, the organic components in the refuse are degasified and converted into carbon as the temperature increases. The carbon-like product and the enclosed inorganic high components such as metals and minerals are continuously fed into a high-temperature reactor, where oxygen is added in measured quantities and the material is treated at temperatures up to 2,000°C and above. The carbon is gasified and the metallic and mineral components are melted. Chlorinated hydrocarbons such as dioxins and furans are

reliably destroyed along with other organic compounds, and all material conversion equilibria are assured.

Shock-cooling of the untreated synthesis gas prevents “de-novo” synthesis of dioxins, furans and other organic compounds. The synthesis gas then passes through a multi-stage cleaning process, during which the pollutants are absorbed or condensed. The clean synthesis gas can be used as a source of energy (e.g. electricity generation and heat recovery in generator blocks with gas motors). Pollutant emission is at or around the detection limits and is markedly lower than in conventional thermal systems.

Material conversion and homogenization of the mineral components is effected in a second high-temperature reactor directly connected to the first reactor. Oxygen and synthesis gas are added, and primary materials are created at temperatures of around 2,000°C which possess the quality of natural raw materials. The homogenized metals and minerals are separated out and discharged in a non-hazardous form following granulation in water jets. The minerals are suitable for the full range of standard applications.

• *Special aspects of the technology*:

The innovative THERMOSELECT technology proves many ecological advantages as compared to traditional waste treatment systems, no longer able to solve Korea’s waste problem and no longer accepted by the public.

Avoiding dangerous emissions threatening health, like dioxins and furans; avoiding landfilling and risking drinking water quality; fast realization period to solve waste problem in time; better acceptance of the public than conventional waste treatment.

Project title:	**INTERSUDMED**
Host region:	**Mediterranean Countries**
Partner country:	**Italy**
Contact person:	Mr Pietro Menna ENEA, Località Granatello, I-80055 PORTICI (Napoli) ITALY, and Paolo Paoli, ENEL, Italian partners within the larger Consortium (see below)
Project financing:	ENEA, ENEL for Italy within a larger project Consortium of electric utilities and research centres from the European Union and the Mediterranean Partner Countries with co-financing from the European Commission, DGXII- JOULE and INCO Programmes
Project purpose:	Prefeasibility study for the integration of renewable energies for electricity production in the southern Mediterranean Countries
Executing agency:	ENEA, Italian Agency for New Technologies Energy and Environment. ENEL, Italian Electric Utility Company, as partners for the PV component of the project.
Project period:	Duration: January 1996-January 1998

- *Brief description of the project:*

The project was designed to perform prefeasibility studies for large scale projects using Renewable Energies and to assess their related socio-economic and environmental benefits. The Italian partners, with their Southern Mediterranean counterparts have focused on Photovoltaics. As well known, life expectancy, infant mortality, food availability, literacy and all the other quality-of-life indicators are positively linked to energy consumption. Quality of life improves very rapidly as per-capita energy consumption increases from 0 to 75 GJ while the rate of improvement slows down significantly when consumption exceeds 100 GJ. In other words electricity investment in the rural areas of developing countries have a larger impact on quality of life than electricity investment in industrialized countries. Project experience shows that photovoltaic (PV) systems, in a variety of schemes, are an effective complement to grid-based power which is often too costly for sparsely distributed settlements in remote areas of less developed countries. The prospects for photovoltaic electricity generation in the countries from Morocco to Turkey have been analyzed. A potential for the installation of more than 350 MW of PV plants to electrify the almost 2.5 million off-grid households of the region has been reported. Due to their remote location and to the low average energy consumption, their electrification can be pursued best with photovoltaics. Furthermore, as a renewable energy source, PV systems are environmentally friendly, reducing the use of fossil fuels. The PV component of the project covered the analysis of PV potential, the selection of appropriate sites, the choice of PV systems as well as engineering studies. Moreover, specific issues like the institutional framework, socio-economic impacts and environmental impacts have also been investigated. Economic and financial evaluations

were performed to assess possible financing schemes to implement the specific projects selected in the pre-feasibility stage. On the industrial side, a specific task dealt with the possibilities for technology transfer of the components of the PV systems. The technologies studied were PV for decentralized or grid connected applications.

- *Special aspects of the Technology*

The schemes for the deployment of the photovoltaic installations as well as the economic and financing issues depend on the local socio-economic conditions and can be hardly generalized from one context to another. An enlarged customer base, while requiring relevant organizational skills, provides economies of scale in procurement, sales and servicing. Despite this, the cost of the electricity produced by photovoltaic single home systems remains high. The value of the electricity should be compared against its cost to assess the actual viability of a rural electrification project.

- *Relevance of Project Type:*

Small-scale, pilot projects using renewables are mainly focused on demonstrating the feasibility of the technologies. Sustainable, large-scale, rural electrification programs aim at maximizing the number of people that will get access to electricity by making the best use of the available resources. The transition from small to large scale implies a completely different organizational framework and a well founded methodological approach. This includes not only a comparison of investment costs but also technical, social, economic and environmental impacts. The implementation of large-scale PV projects requires the organization of highly scattered activities, because very extended areas are generally involved. The results of the project have demonstrated that several factors must be taken into account for the large scale deployment of PV systems. First, technological choices are strongly affected by local factors, like characteristics of the sites, distribution of dwellings, resources availability. At the same time, the modularity of PV systems and their standardization must be considered from the very beginning because they represent critical aspects for the affordability and reliability of the installations, and for the effectiveness of the operating and maintenance procedures, as well. Second, a strong coordination between the project management and the responsible for the electrification planning, to follow the medium-long run network evolution and identify the areas with lower probability of being provided with a centralized electric service. Third, the selection of the region for the PV installations need to be specified on a socio-economic basis, considering surveys of potential users. Fourth, the development of the technical framework must be accompanied by appropriate guidelines for the implementation of operational stage, identification of the concerned subjects, association forms, joint-ventures, partnerships, mixed public and private companies. The definition of financing forms and schemes, the evaluation of the business plan and the description of the relevant economic policies represent other essential factors to be taken into account.

Project title :	**Biomasses' cogeneration plants**
Host country:	**Ologbo – Nigeria**
Partner country:	**Italy**
Contact person and address:	Mr. F. Abbà Bono Energia S.p.a Via Resistenza, 12 20068 Peschiera Borromeo – Milano Italy Tel: 0039-2-55302848 Fax: 0039-2-5471955
Project financing:	Bono Energia S.p.a.
Executing agency:	UNDP

- *Brief description of the project:*

The utilization of renewable fuels in electric power cogeneration reduces the waste disposal, fuel oil utilization and pollution. Dedicated processes have been developed to utilize following residues wood waste, rice husks, olive husks, sunflowers etc. For Redco Inc. the cogeneration plant has been realized by burning wood wastes produced by wood processing.

- *Special aspects of the Technology:*

Cogeneration has been one of the most important technical issues for the past 10 years. The possibility to use alternative and renewable fuels, as well as availability of waste organic fuel free of cost, made the economic of this kind plants very attractive also for small/medium size industry.

- *Relevance of Project Type:*

Elimination of free disposal of wood wastes that are utilized in an industrial production of energy reducing VOC/CO emission.

Project title:	**Training Course on Energy planning for Small Island Developing States (SIDS)**
Host country:	**Several SIDS**
Partner country:	**Italy**
Contact person and address:	Anna L. De Carli Italian National Agency for New technology, Energy and the Environment (ENEA) Research Center, Casaccia Via Anguillarese 301, 00060 S. Maria di Galeria, Roma Italy Tel: 39 06 30483432
Project financing :	Italian Ministry of Industry, Handicraft and Commerce
Executing agency:	ENEA
Project period and costs:	Duration: 23/3/1998 – 17/7/1998 Costs: 125,000 ECUs

- *Brief description of the project:*

The training course was divided in two phases: the first was attended by 21 participants from SIDS and had a duration of six weeks. During this period, the training was focused on strong interaction and discussion among trainers and trainees in order to meet the demands of the latter. The subjects were: energy, environment and sustainable development; environmental effects of energy cycles; climate change; energy supply; renewable energy; electricity; efficient energy use and environmental protection in building and industrial sectors; energy and environment in the transport and agriculture sector; energy demand forecast. Several technical visits were organised to PV, wind, biomass, urban wastes and CHP plants and industries. The second phase was attended by 13 participants from SIDS who worked at ENEA laboratories on specific fields of their interest according to the technology needs identified in the first phase.

- *Special aspects of the Technology:*

All the technologies presented were appropriate to SIDS scale and included technology needs identification and technology assessment techniques. In addition, the importance of models for local energy use, taking into account the need of greenhouse gas emission reduction was stressed.

- *Relevance of Project Type:*

The general aim of the project was to improve the capacity building of the participants in the field of energy, environment and sustainable development. In addition, follow up

actions are envisaged to build upon the training experience in order to identify specific bilateral or multilateral co-operation projects on renewable energy to promote renewable energy technologies, the rational use of energy as well as climate friendly techniques and practices.

Project title:	**SolarMed – Solar Water Heating in the Mediterranean Basin, with Guarantee of Results**
Host countríes:	**Algeria, Egypt, Lebanon, Morocco, Tunisia and Palestinian Authority**
Partner country:	**Portugal**
Contact person:	Luís Silva CCE Estrada de Alfragide, Praceta 1 P – 2720 Alfragide Portugal Tel: 351-1-4722800 Fax: 351-1-4722898 E-mail: dmre.cce@mail.telepac.pt
Project purpose:	Reduction of fossil fuel consumption for water heating and mitigation of related emissions. Development of local economies, through creation of SMEs and a network of solar equipment installer technicians
Executing agencies:	ADEME – Agence de l'Environnement et de la Maîtrise de l'Energie (France) IDAE – Instituto para la Diversificacion y Ahorro de la Energia (Spain) Isnova/ENEA – Instituto per la Promozione dell'Innovazione Tecnologica (Italy) CRES – Center for Renewable Energy Sources (Greece) CCE – Centro para a Conservação de Energia (Portugal) ALME – Association Libanaise pour la Maîtrise de l'Energie (Lebanon) AME – Agence pour la Maîtrise de l'Energie (Tunisia) APRUE – Agence Nationale par la Promotion et la Rationalisation de l'Utilisation de l'Energie (Algeria) CDER – Centre de Développement des Energies Renouvelables (Morocco) OEPC – Organisation for Energy Conservation and Planning (Egypt) PEC – Palestinian Energy and Environment Research Center (Palest. Terr.)
Project period: **and costs**	3 years 2 055 022 Euros

- *Which is the main problem targeted by the project?*

In the near future, the increasing energy demand will become one of the main problems for the Southern-Mediterranean countries. In fact, population is expected to grow

from the current 200 millions to 350 millions in 2020. Together with the forecasted economy growth and the rise of the standards of living, this fact will result in tripling the energy consumption, which in 2020 will reach more than 450 Mtoe.

The Mediterranean basin has a high potential for the development of thermal solar energy, namely for water heating purposes. Thermal solar installations reduce the fossil fuels consumption and the related emissions. Moreover, despite the initial investment, these kind of installations are usually cost effective.

The Cyprus example is quite eloquent: about 60 % of the island houses are equipped with solar water heating, resulting in a 10 % saving in the total CO_2 emissions.

• *Which instruments, methods and procedures are applied by the project in order to respond to the concrete needs of users and beneficiaries of the respective technology?*

In order to create a sustainable thermal solar market in the Southern-Mediterranean countries, it will be necessary surpass some barriers. Obviously, financial and information barriers, but also the low credibility of these technologies, which remains as a result of the commercialisation of low quality equipment in the past.

Within this project, the local markets will be studied and stimulated, through the organisation of seminaries and technical visits. Projectors and installers will also be trained.

Nevertheless, one of the most interesting topics is the implementation of a “GRS” system (Garantie de Résultats Solaires). GRS is a contract between the customer and the supplier, which certifies the quality of the installation and warrants its performance. Third-party Financing will also be encouraged.

• *Does the project support access to financing of technologies?*

The project does not comprise any financial instrument. However, interesting projects will be prepared and submitted for international funding.

The SolarMed project is supported by the European Commission with a 60 % contribution.

Project title:	**Precious Planet**
Host countries:	**Algeria, Egypt, Lebanon, Morocco, Tunisia and Palestinian Authority**
Partner country:	**Portugal**
Contact person:	Luís Silva CCE Estrada de Alfragide, Praceta 1 P – 2720 Alfragide Portugal Tel: 351-1-4722800 Fax: 351-1-4722898 E-mail: dmre.cce@mail.telepac.pt
Project purpose:	Awareness raising of youth in the Mediterranean countries for energy, environment and sustainable development
Executing agencies:	ADEME – Agence de l'Environnement et de la Maîtrise de l'Energie (France) CCE – Centro para a Conservação de Energia (Portugal) CRES – Center for Renewable Energy Sources (Greece) AME – Agence pour la Maîtrise de l'Energie (Tunisia) ALME – Association Libanaise pour la Maîtrise de l'Energie (Lebanon) PEC – Palestinian Energy and Environment Research Center (Palest. Terr.) APRUE – Agence Nationale par la Promotion et la Rationalisation de l'Utilisation de l'Energie (Algeria) CDER – Centre de Développement des Energies Renouvelables (Morocco) OEPC – Organisation for Energy Conservation and Planning (Egypt)
Project period: **and costs**	07/1998 – 07/2000 (2 years) 3850 000 Euros

- *Which is the main problem targeted by the project?*

The increasing use of fossil fuels is posing dramatic environmental, economic and social problems, namely climate change, acid rain and serious health problems, particularly in urban and industrial areas.

Reducing these impacts and achieving a sustainable development represents a considerable challenge. In this context, raising awareness for the youth is obviously a priority.

• *Which instruments, methods and procedures are applied by the project in order to respond to the concrete needs of users and beneficiaries of the respective technology?*

The *Precious Planet Project* will extend the French and Tunisian experiences to other Mediterranean countries.

Posters, brochures and other deliverables will be produced and distributed in schools and youth associations. In parallel with the information campaign, animators and monitors will be trained and prepared for future training actions.

Project title:	**Utilization of weather forecasts and climatic modelling to support the sustainable development in the PLOP and Macao Territory**
Host country:	**Angola, Cape Verde, Guinea Bissau, Mozambique, Macao, Portugal, S. Tomé e Príncipe**
Partner country:	**Portugal**
Project purpose:	Agência dos Países de Lingua Oficial Portuguesa Para a Área do Clima e das Respectivas Implicações Ambientais – Agência CRIA
Executing agency:	ECSC
Project period:	Oct. 1999 – 2002 Total cost 6.999.131 USD

1 - Brief description of the Project

Most of Portuguese speaking countries in Africa are still operating a number of Meteorological activities, such as weather and climatological services in the same manner as during the pre-independence days, when the main users of the services were the civil aviation and government itself. However, since then rapid social-economic development has taken place, new requirements from different sectors are needed, and Meteorological Services are unable to respond in a suitable manner.

The present project intends to promote a better utilisation of weather forecasts for the support of social and economical activities.

The major objective of the project is to create conditions for improving the weather prediction quality in long and medium term in all Portuguese Speaking African Countries (PALOPs) and in Macao using numerical models and implementing an operational scheme of regional climate simulation, without resorting of high-speed computers.

A Regional Atmospheric Modelling System (RAMS) will be used as a numerical limited area model, as well as global models of large scale.

The final result of this project will be the implementation of RAMS, in operational mode, to be used in the weather prediction and climate characterisation, at present and in future, in all Countries/Territories.

For the weather prediction, RAMS will be forced by initial and boundary conditions obtained from ECMWF, as well as by radiosonde and surface observations taking place in those Countries/Territories and/also in neighbouring countries.

In studying the climate, future scenarios of large scale produced by the Melbourne University General Circulation Model will be used to force RAMS.

The project will be implemented in two phases and will take three years and an half (42 months)

2 - Special aspects of the Technology

In the present Project a Limited Area Model will be calibrated and validated for each synoptic region of the PALOPs and Macao Territory.

An experimental phase will be installed in Lisbon, and two persons for each country will be trained. At the end of the first year the project will be implemented in all countries under the responsibility of the person trained in Lisbon during the experimental phase.

The transference of technology in the area of numerical weather models is the major objective to reach for promoting a better utilisation of weather forecasts in the support of social and economic activities.

3 - Relevance of Project Type

The technology of limited area models are been used all over the world with the objective of obtaining the improvement of regional weather forecasts for supporting different social and economical activities. The modelling technology is an important aspect to be developed and to be improved in order to obtain a better understanding of the climatic system and to have long-term forecasts in a seasonal perspective.

Project title:	**Demonstration of M&T and Development of Sustainable M&T Infrastructure**
Host country:	**Brazil**
Partner country:	**Portugal**
Contact person:	Jorge Mendonça e Costa CCE - Centro para a Conservação de Energia Estrada de Alfragide, Praçeta 1 2720 Alfragide Portugal
Project purpose:	Encourage the widespread use of M&T to deliver sustainable energy savings to industrial companies in Latin American countries.
Executing agency:	March Consulting Group and CCE - Centro para a Conservação de Energia
Project period:	11/1997 -

Requested specific information:

- *Which is the main problem targeted by the project?*
- *How can the applied technologies assist in solving this problem?*

Reducing energy consumption in industrial companies is crucial at a global level, both economically, with reduced energetic costs increasing the competitiveness, and environmentally, contributing to the overall reduction of gaseous emissions.

M&T techniques can provide a sustainable way to achieve such savings. Being easy to implement, the widespread replication of these techniques can be relatively straightforward.

- *Which instruments, methods and procedures are applied by the project in order to respond to the concrete needs of users and beneficiaries of the respective technology?*

- *Which instruments are used to improve the respective groups' access to information and their knowledge of climate relevant technologies?*

In order to achieve the proposed objectives, a best practice approach was selected. Working close to the federal government and local industrial associations, 5 representative sites were chosen, to be used as role models in the implementation of M&T systems. All M&T material, including energy audit, software and European consultancy were provided for free thus ensuring project success. The only economical effort required from the host sites consisted in metering acquisition and installation, but even this could be eased up by applying to a special low interest loan provided by the Federal Government.

Furthermore the project also comprises the development of other financial instruments, training local consultants to facilitate the replication, developing M&T material

in Portuguese and disseminate the main results throughout workshops and seminars.

• *Which positive experience has been gained up to now (lessons learned / best practices)?*

Although the project is not concluded, the first results from the sites with the M&T system already running are excellent, with the expected 5% energy saving being overtaken in most of them.

Another positive aspect is the increasing involvement of the employees as soon as the results start to show up, building up this way an effective and sustainable M&T system.

• *How does your project support access to financing technologies?*

The project also comprises a financial instruments development in order to enable other industrial companies to fund the installation of M&T systems. The Federal Government is the most adequate to co-ordinate at National level the World Bank funding. Being a very large country, regional co-ordination is also needed, and this can be either accomplished by government branches or local industrial associations.

• *With respect to technology transfer, which factors and conditions are crucial to the success of your project?*

The crucial factors to the success of this project are maintaining constant funding flow, in order to keep up the momentum in the selected sites, and to assure an efficient financial support since, from our experience, the lack of capital and high interest rates are the greatest concerns of the industrialists.

In order to achieve a fair replication rate, the effective training of local consultants is also a main issue. In a first phase this can only be reached by continuing to have joint demonstration projects or close support to their initiatives.

The dissemination of the results is also crucial. It is necessary to take those examples and turn them into best practices, enable people to share their experiences, presenting the local consultants and the existing financial instruments, as part of a series of workshops and seminars.

Project title:	**Wave Models for the PLOPS**
Host countries:	**Portugal, Portuguese speaking countries in Africa and Macao**
Partner country:	**Portugal**
Contact persons:	Sergio Ferreira Instituto de Meteorologia, Rua C ao Aeroporto 1700 LISBOA PORTUGAL
Project purpose:	Research
Executing agency:	CRIA - Clima e Respectivas Implicações Ambientais Financial and technical cooperation
Project period:	The expected period of duration for the Project is 4 years. The expected total costs are 80 000 000$00. The Project can also be implemented by phases with the execution in different countries differed in time.

Project Main Targets

The Project will develop and improve the capabilities of the Portuguese speaking countries in Africa and of Macao (PLOP) to provide meteorological support to the activities related with the sea, trough the use of numerical models for wave forecast, wave hindcast and wave climatology.

Waves have a large influence in the safety and efficiency of most activities at sea. In many cases there are large budgets involved in these activities and their relative weight in the country economy is considerable. So, this is one of the fields where the economic impact of meteorology can be much significant.

Instruments Methods and Procedures

The project will have two main components:

- Implementation of regional versions of a third generation sea wave numerical model;
- Courses on sea waves, training on the use of the wave models and on the interpretation of their results.

The project will have two phases.

The first phase will be held in Portugal and will involve the training of the national teams that will became, the national responsible for the wave models operation and maintenance. This phase will include:

- Development of the adequate regional version of the wave model;
- Courses in sea waves and sea wave models
- Training in the use of wave models

The second phase will take place in the different PLOP and will include the training of other meteorological personal that will use the results of the wave model. This phase will include:

- Operational implementation of the regional wave model;

- Courses in sea waves, their influence in the human activities at sea and in the use of wave models to provide the relevant information for the users.

Previous Experience, Success Factors and Other Information

The Portuguese experience in the development and use of sea wave models began in 1986 with the development and implementation of a first generation wave model named MAR211. The present third generation wave model MAR3G, was developed in 1992 and was implemented as an operational model for wave forecast in 1994. The present version of this third generation model can be run in microcomputers, and so, it can be easily implemented in developing countries.

The Portuguese experience has shown that wave models can improve dramatically the capability of providing reliable wave forecasts and that these forecasts can be used by shipping, fisheries, coastal and harbour operations, offshore activities, etc. The experience at the Portuguese Meteorological Institute has shown that the model wave forecast can be easily sold and became profitable to the Meteorological Institute.

The model results have also proven useful in wave hindcast cases and in wave climatology. This is even more important in the cases where wave data obtained form wave meters is lacking.

The success of the project depends mainly of eventual problems related to the political conditions in some of the PLOPS.

Wave models have been in use for several decades in many countries. In most cases these models were obtained by projects of transfer of technology. One of the components of the present project that can contribute to a successful achievement is the component of education and training.

Project title:	**Euro-Mediterranean Fair for Energy Efficiency and Renewable Energies**
Host countries:	**Tunisia and other Mediterranean countries**
Partner country:	**Portugal**
Contact persons:	Luís Silva CCE Estrada de Alfragide, Praceta 1 P – 2720 Alfragide Portugal Tel. 351-1-4722800 Fax 351-1-4722898 E-mail: dmre.cce@mail.telepac.pt
Project purpose:	Promote energy efficient technologies and renewable energies in the Mediterranean countries
Executing agencies:	CRES – Center for Renewable Energy Sources (Greece) CCE – Centro para a Conservação de Energia (Portugal) ANER – Agence National des Energies Renouvelables (Tunisia)
Project period:	09/98 – 06/99 (10 months)

- *Which is the main problem targeted by the project?*

It's now an evidence that greenhouse gases are inducing climate change at an alarming rate and thus posing serious environmental, economic and social risks. Given the need for environmental protection and also the increasing scarcity of fossil fuel resources, energy efficiency and renewable energies became central topics in energy policy. Therefore, the promotion of new energy technologies and renewable energy sources should be further encouraged.

- *Which instruments, methods and procedures are applied by the project in order to respond to the concrete needs of users and beneficiaries of the respective technology?*

Two events will be organised in Tunisia, under the auspices of MEDENER, the Mediterranean Association of the National Energy Agencies:

- an exhibition of energy efficient technologies and renewable energies equipment;
- a conference presenting innovative technologies, in order to assist Mediterranean energy actors in defining technology priorities.

- *Which positive experience has been gained up to now?*

The project is still at an early stage and therefore no results are yet available.

Nevertheless, it is expected to create opportunities for technology transfer, commercial relationships and a dynamic partnership between the two shores of the Mediterranean.

- *Does the project support access to financing of technologies?*

The project does not comprise any financial instrument, since its main aim is to disseminate information about energy technologies.

The project is supported by the European Commission, under the THERMIE Programme (150 000 Euros).

Project title: **Environment Protection Training and Research Institute (EPTRI), Hyderabad, Andhra Pradesh**
Host country: **India**
Partner country: **Sweden**

- *What are the project´s main targets ? What technologies are applied and how do they contribute to the targets ?*

- *Which instruments, methods and procedures are applied by the project in order to respond to the concrete needs of users and beneficiaries of the respective technology?*

- *Which instruments are used to improve the respective groups access to information and their knowledge of climate relevant technologies ?*

Following an Agreement between the Government of Sweden and the Government of India in 1991, EPTRI was established at Hyderabad as an Autonomous Society in 1992.

Sida funded the setting up costs with equipment and Swedish consultancy support during a 4 years period.

The Government of Andhra Pradesh alienated land to set up the Institute´s permanent facilities and extended a grant for constructing the building and an initial start-up running expenses support. The MoEF-GOI provided financial support for institutional development

The Society´s aim was to extend technical training and consultancy services to polluting categories of industries.

The project completed its first phase by mid year 1996. With training support by the Swedish consultancy organisation ÅF-IPK, EPTRI´s core staff developed training and consultancy expertise in the following areas:

- Safety and Risk Assessment
- Micro-biological applications in wastewater treatment
- Waste audit and waste minimisation
- Air quality monitoring
- Wastewater monitoring and treatment

The project was evaluated by Sida in September-October 1996. The evaluation report was very positive with constructive criticism in the areas of management and the need for business orientation. It recommended a further period of assistance for the EPTRI.

The EPTRI-II project was initiated by April 1997 with the overall objective to strengthen investments already made and make the organisation self sufficient by the year 2000. The Project plan for the second phase defined the following purposes:

1. To conduct training programmes for industry and State Pollution Control Boards.

2. To make available environmental quality information to policy makers, students, researchers, industry, EPTRI faculty and NGOs.

3. To establish a mechanism of Joint Indo-Swedish business collaboration to extend environmental management services in India and abroad.

4. To assist industry in obtaining Environmental Management certification.

5. To plan, locate and design Hazardous solid wastes T.S.D.Fs.

6. To map environmental quality to assess carrying capacities, zone industrial locations and analyse impact scenarios.

7. To upgrade the laboratory.

8. To establish in EPTRI a professional management system.

- *Which positive experience has been gained up to now ?*

  - Competence development in consultancy services, for staff with basic technical knowledge, is best performed by experienced consultancy organisations in joint projects with the trainees working in hands-on situations.

  - The experienced trainee consultancy firms should, where available, primarily be selected from local sources. They will have a clear understanding of prevailing conditions and will normally offer more services for available money.

  - Whenever the competence development services are offered by two or more consultancy firms, the demands on monitoring the project are high.

  - Efficient and professional communication practises are one of the keys to success.

- *Does the project support access to financing of technologies (and how) ?*

Yes. According to the above the project is concentrating on a business orientation of EPTRI - in its widest sense. One of the main purposes is to establish collaboration with internationally well established consultancy organisations, resulting in ”financing of technologies”.

Another result of the project is the availability of up-to-date database information on projects sponsored by international funding organisations in EPTRI´s fields of activities.

- *With respect to technology transfer, which factors and conditions are crucial to the success of the project ?*

That the project period is long enough. For the project here described a period of 4+4 years might prove to be long enough. A 4 year project period was too short under the conditions.

That the trainees are senior professionals of highest caliber.

That yearly control stations are applied.
That the project is well documented.
That the monitoring of the project functions timely and with precision.
That the funding organisation is following the project closely.

Examples of energy efficiency projects

Project:	**Guizhou and Shanxi Energy Efficiency Demonstartion**
Partner Country:	**United Kingdom**
Country:	**China**
Commitment:	**£1,900,000**
Duration:	**1996 - 1999**

The Guizhou and Shanxi energy efficiency project aims to identify and implement a programme of activities which will encourage industry to introduce practical, cost- effective, affordable and immediately applicable energy efficiency measures. Phase 1, now complete, was primarily an assessment study examining the scope for industrial energy savings while determining the barriers to making such savings. Phase 2, scheduled for completion by the end of April 1999, set up a series of technical improvement demonstration activities supported by a major capacity building initiative. The ten demonstration projects being undertaken illustrate that energy efficiency measures can be of low capital cost (in absolute terms), can offer rapid and significant payback and have significant replication potential.

Project:	**Commercialisation of Innovative Woodstoves**
Partner Country:	**United Kingdom**
Country:	**Research (East Africa)**
Commitment:	**£132,899**
Duration:	**1996 - 1998**

DFID has funded research into the development of fuel efficient cooking stoves in East Africa, where woody biomass consumption for cooking by the public and private sector accounts for up to 15% of all biomass use. Production of the improved stoves was supported by a training programme to develop better business skills and practises. The design has increased the commercial viability of both public institutions and commercial establishments, while also contributing positively to the environment through reduced deforestation and reduced demand for fuel oil.

Project:	**Orissa Power Sector Reform**
Partner Country:	**United Kingdom**
Host Country:	**India**
Commitment:	**£12,050,000**
Duration:	**1996 - 1999**

Orissa was the first state in India to undertake radical energy sector reform and is regarded as a test case for similar reforms nation-wide. These reforms will ensure the long-term viability of the power sector by enabling the state to attract private sector investment; improving the quality of service for customers; and helping improve the state government's finances by eliminating the need for massive subsides. The reform paid by the Government of Orissa to the State Electricity Board and is now reaching a crucial stage with electricity

distribution companies scheduled to be sold into private ownership. A number of other states have followed suit, including Andhra Pradesh and Haryana where DFID has agreed to support their own reform programmes.

In-situ Remediation of Oil Contamination

Partner Country:	**United Kingdom**	
Industry:	**Property/Land Developers**	
Operating Company:	**Retail Developer**	
Supplier:	**Celtic Technologies Ltd**	
Address:	**CBT Centre**	
	Senghenydd Road	
	Cardiff CF2 4AY	
Contact:	**Ian Viney**	
	Tel:	**+44 1222 372311**
	Fax:	**+44 1222 645565**

Background

Land for development is often at a premium in heavily populated areas, particularly those which have a restriction on building in 'green belt' - land that is protected from development, usually in order to halt the spread of urbanisation into the surrounding countryside. Therefore, when land becomes available through the closure of an industrial operation, property companies are keen to investigate the opportunities for redevelopment. They are not alone in this; local authorities want to encourage reuse of industrial land because of the potential for employment, both during the construction stage, and afterwards, particularly if the site is re-used for another industrial purpose or for a commercial undertaking. They are also keen to see unsightly industrial wasteland redeveloped, thus improving the local environment.

However, land that has been used for industrial purposes, is often contaminated with the bi-products of whatever industrial process has been undertaken at that site. This is particularly true of older industrial sites, where environmental controls have not been as tight as they are today. Therefore, it is necessary to clean up or remediate the contamination, ideally before redevelopment begins.

The Problem

Construction of a new superstore was underway on the site of a former engineering works when it was discovered that the ground and groundwater was contaminated with diesel and kerosene. Measurements showed that 12000 litres of diesel and kerosene had leaked into the ground and groundwater to a maximum concentration of 70,000 mg/kg and 1000mg/l respectively.

Construction was in progress but the contamination was causing problems and needed to be removed. Celtic Technologies Ltd, based in Cardiff, South Wales, were appointed to undertake remediation as construction proceeded in order to prevent hold-ups to the construction contract.

The Technical Approach

Building work had commenced and so removal of soil was not practical. Therefore in-situ remediation using biological treatment and vapour extraction was integrated with the construction programme.

The treatment strategy involved the use of a combined system of in-situ enhanced bioremediation, vacuum extraction, vapour control and oil/water separation to treat oil contamination to safe levels and to remove volatile compounds. Documented certification of these were a key part of the contract in order to satisfy the requirements of the Regulatory Authorities.

Benefits

The contract lasted five months, cost £58,000 and saved the developers £300,000. The source of the groundwater contamination was treated and groundwater contamination concentrations were reduced to the satisfaction of the UK National Rivers Authority (now the UK Environmental Protection Agency).

Recent Overseas Projects

During 1996, Celtic Technologies was appointed by the Czech Republic's National Property Fund to study bioremediation of oil sludges. The contract involved the development of a destructive treatment strategy for oily tar wastes at an oil refinery containing some 28,000 m^3 of oil hydrocarbons high in PAHs. Laboratory studies and feasibility trials have been undertaken to improve handleability and optimise biological treatment processes. Celtic Technologies provides contracting services for the remediation of contaminated land and groundwater. The company has an extensive track record in the application of a range of low-cost in-situ treatment techniques, including biological treatment, vapour extraction, pollution containment, non-aqueous phase liquid (NAPL) recovery, groundwater "pump and treat" and contaminant source control.

Effluent Treatment Plant Brings Life to Arid Desert

Partner Country:	**United Kingdom**
Industry:	**Milk Processing**
Operating Company:	**Almarai Trading Company, Riyadh, Saudi Arabia**
Consultant:	**McDonald Stevens Associates**
Address:	**Kestrel House**
	Mill Street
	Trowbridge BA14 8BE
Contact:	**Nigel Stevens**
	Tel: +44 (0) 1225 774775
	Fax: +44 (0) 1225 751972
Supplier:	**ACWa Services Ltd**
Address:	**ACWa House**
	Keighley Road
	Skipton BD23 2UE
Contact:	**Mark Little**
	Tel: +44 (0) 1756 794794
	Fax: +44 (0) 1756 790898

Background

Milk processing, like every operation in the food & drink industry, requires a high level of hygiene and cleanliness. Every element in the production process - the pipelines, tanks and heat exchangers - has to be cleaned thoroughly after each cycle, sometimes two or three times a day. This ongoing cleaning process results in high-strength effluent from the plant, and a vast requirement for water - a scarce resource in many arid countries.

The Almarai Trading Company's central processing plant near Riyadh is the largest milk processing facility in the Middle East with the capacity to convert 1.4 million litres a day of milk into drinking yoghurts, set yoghurts, cream, pasteurised milk and a number of other milk-based products. The company has recently commissioned an innovative treatment plant which is turning the wastewater produced by the processing facility into a source of agricultural irrigation.

Technology

The treatment plant, designed by McDonald Stevens Associates of Trowbridge in Wiltshire, and built and installed by ACWa Services Ltd of Skipton, in North Yorkshire, has to handle 1,500 m^3/day volume of effluent which consists of dilute milk and dairy washings, with acid and caustic cleaning solutions, and small quantities of domestic effluent. The raw effluent has a chemical oxygen demand (COD) load of 4,100kg/day, a biological oxygen demand (BOD) load of 2,560 kg/day and a pH range of 5-11.

The key to the treatment process is the Effluent Monitoring System (EMS).
A network of floor drains and pipelines draws the waste water from all the different sections

of the factory to a central Floor Drain Measuring Box. Turbidity probes are inserted into the box to determine effluent strength and to highlight areas of product wastage throughout the dairy operation. Integral screens in the EMS remove anything greater than 5mm, such as bottle caps and other objects.

The EMS then directs the screened and monitored effluent to continuously agitating balance tanks. The waste water is then pumped through a pH correction tank, in which the effluent is dosed with an acid or alkali solution, before being treated in an activated sludge treatment process. Final effluent from the plant has an average COD concentration of 300mg/l and an average BOD concentration of 100 mg/l with a pH of approximately 7.4.

Advantages

The Manufacturing Manager at Almarai, Steve Perkins, commented, “Milk processing uses a very large amount of water, and in Saudi Arabia water is a scarce resource. The water used in the cleaning process can, once treated, be introduced into our irrigation system around the plant, thus reducing the overall amount of water Almarai consumes.”

The animal feed crops given sustenance by the treated effluent can, in turn, be fed to the dairy cows on Almarai’s super-farms to help them come full circle and produce the milk being produced by Almarai’s facility.

Pakistan sewerage system pumped into action

Partner Country:	**United Kingdom**
Industry:	**Municipal Waste Water Treatment**
Operating Company:	**Lahore Water & Sanitation Agency**

Supplier:	**Brain Associates**
Address:	**Redstone Plant**
	Redstone Road
	Narberth
	Pembrokeshire
	SA67 7ES
Contact:	**Mr Anthony Powell**
	Tel: +44 1834 860000
	Fax: +44 1834 860567

Background

The city of Lahore in Pakistan has been experiencing considerable problems with its trunk sewer network. The network, serving between five and seven million people, discharges directly into the local river and has had little maintenance since it was installed sixty years ago. Consequently sewers are heavily silted up with many of the 48” diameter runs blocked to half their depth.

In the past the problem was tackled by pumping the flows into surface drains originally designed to cope with monsoon flows. However these sewers were then left alone and the city has experienced extreme flooding in the monsoon period because of the blocked drains. The problem has been exacerbated by the city’s population using the sewers as rubbish disposal sites.

A pilot project supported by the UK’s Department for International Development (DFID) and run by Carl Bro International was initiated to clean the city’s trunk sewer network and avoid future blockage and flooding. Brain Associates was the main equipment supplier for this project and the company worked in close conjunction with Carl Bro International to provide the most efficient solution to the cleaning problem.

Technology

The section of the sewer network to be cleaned was 4.5km in length and is located in the densely populated walled area of Lahore, below the fort. This particular section currently accounts for only 5% of the network but serves 20% of the population.

The deposits of compacted silt and debris were manually broken down and then conveyed out of the sewer using the high vacuum and air flow of the Brain Power Pack 2000 system. The debris was pneumatically conveyed into the awaiting Self Filling skips and then taken to site by tractor for tipping whilst the next Self Filling skip was loaded, allowing a continuous cleaning operation. Following the removal of debris, the sewer was then cleaned

using the Brain 4@ 12 Trailer Jetter producing 4000 psi at 12gpm prior to any remedial work. Brain Associates have manufactured a modular cleaning system which incorporates a very powerful, low maintenance liquid ring vacuum system in conjunction with a number of rugged trailer mounted Self Filling skips. This system provides high production rates and gives horizontal runs of 150m and vertical lifts in excess of 10m. The system has been deliberately designed to allow the operator to continuously clean the sewer which in turn generates higher production rates.

Benefits

Carl Bro Group's Field Project Manager, Peter Rowley, utilised Brain Associates equipment to its full potential through integration with local manual labour. This on site management coupled with UK Divisional Director David Whiles persistence has proved that managed sewer cleaning using local contractors will provide the answer to the ever growing problem of blocked sewers across Asia.

Managed sewer cleaning has resulted in the following improvements:

- flooding incidents reduced
- complaints minimised
- reaction to emergencies minimised
- resources diverted to productive tasks
- community awareness of sewer cleaning and solid waste activities
- less environmental pollution and disease

The efficient cleaning of the trunk sewer system and the overall success of the project is leading the city's Water & Sanitation Agency (WASA) to call for the work to be extended and it may prove to be a model for similar work in cities across the region.

Environmental Impact Study for the Port of Karachi

Partner Country: **United Kingdom**
Industry: **Property Development**
Operating Company: **Karachi Port Trust**
Supplier: **AEA Technology**
Address: **NETCEN**
Culham
Abingdon
Oxfordshire OX14 3DB
Contact: **Ms Madeleine McDonagh**
Tel: **+44 1235 464040**
Fax: **+44 1235 463030**

Background

The port of Karachi is a major industrial centre for national and international trade, as well as a primary fishing port. When the port was earmarked for development there was a need to investigate sources of pollution in the port and harbour area, with a view to developing long term strategies to control pollutant discharges. The Karachi Port Trust commissioned an international collaboration to develop a strategic environmental plan for the port. NETCEN was one of the companies involved in the consortium which undertook the environmental impact study and developed an appropriate strategy. Other participating consultants were:

- National Engineering Services Pakistan (NESPAK)
- Frank Ayles & Associates (UK)
- Port of Liverpool (UK)
- HR Wallingford Ltd (UK)

The project was funded by the World Bank and took place during 1994-1995.

Problem

Pollution in the Port of Karachi comes from a variety of sources including:

- industrial and municipal wastes from Karachi city
- garbage and sewage from the port area itself
- oil spills from ships using the port
- organic waste from the fish harbour
- atmospheric emissions from local industry and vehicles

Increased trade and activity in the port would only add to these existing problems. It was therefore vital that the planned development of the harbour was completed with due consideration given to the potential impact on the environment.

Action

The impact of each waste stream needed to be quantified and therefore the work undertaken by NETCEN included careful investigation, measurement and assessment of pollutant levels in:

- water
- sediment

The level of noise and soil contamination was also assessed and advice on oil spill prevention and response was directly provided by NETCEN.

From the impact assessment NETCEN was able to suggest possible remediation alternatives and develop short, medium and long term strategies to control increased discharges into the sea. A plan for a Marine Environmental Unit, equipped to measure and monitor pollution in the harbour area, was also devised.

Benefits

Through early involvement in the project NETCEN was able to plan the development of the harbour with due regard for the potential environmental impact. NETCEN's wide range of knowledge and experience ensured that suitable proposals could be developed rapidly and implemented successfully.

The Port of Karachi will benefit directly from this project as arrangements for the effective disposal of sediments from the harbour will remove one barrier to the ratification of international maritime agreements of Pakistan.

The implementation of the recommended strategies will ultimately provide Karachi with a better quality environment within the port area. It is also hoped that the work will improve the commercial fishery operations in the port.

Renewable Energy - Power for the next generation

Predictions for Growth

Renewable energy (RE) is increasingly seen as a key growth market for at least the next 50 years. One reasonably solid indicator for this is that Shell - the 2nd largest company in the world - has recently made Renewables its 5th core business. Shell claims that "renewable energy sources could provide between 5 and 10% of the world's energy by the year 2025, possibly rising to over 50% by mid-century".

Banks, too, are now recognising renewable energy as a primary growth industry. The World Bank, for instance, is financing large renewable energy projects in Argentina and Indonesia, and has been interested in solar thermal power generation for a while. For example, through its Global Environment Facility the World Bank has funded the Hilly Hydro Project in India, looking at sustainable development of small hydro for the sub-Himalayan region. It is also instigating a Photo Voltaic (PV) Market Transformation Initiative (PVMTI) which plans to provide private sector firms with a chance to obtain grant funding to diminish the perceived risks associated with developing the PV business in developing countries. The PVMTI will start with three selected countries: India, Morocco and Kenya.

The recent White Paper for a European Commission (EC) strategy and action plan has committed to a target of 12% for the contribution by RE to the EU's gross inland energy consumption by 2010. Not surprisingly, a target like that needs financial and political support and Europe is supporting renewable energy developments in a substantial and pioneering way. The present UK Government has also expressed interest and commitment to the development of renewable energy.

At the moment, the UK produces enough renewable energy for the needs of over 800,000 households (around 600MW). This will need to increase enormously over the next decade in order to achieve the new UK target for renewable energy contribution to electricity consumption (10% by 2010). Within the UK, Wales is particularly well endowed with renewable energy resources with an abudance of wind and rain. More surprisingly it has two of Europe's largest roof-mounted PV systems - one on the new Ford Factory in the South and another at the Centre for Alternative Technology in the North. The Welsh renewable energy industry is among the European leaders in terms of manufacture, expertise and on-the-ground implementation.

Continuing growth for UK renewable energy developments is inevitable however developing countries represent even greater potential. Around 2 billion people, roughly half of the world's population, do not yet have access to electricity. Many of these people will get access over the next 50 years and a significant proportion of these will be electrified off-the-grid (i.e. with stand alone generating systems). In this vast market, which extends to rural industries as well as households, renewables such as solar PV, wind, micro hydro and biomass, will compete with increasing success as costs drop in relation to rising economies of scale.

Review of Sustainable Energy Technologies

The major sustainable energy technologies are biomass, wind, solar and hydro power. It is impossible to deal with all of these in any detailed way here in this article, but an overview would help readers understand the overall renewable energy mix which is likely to be part of the global energy future for us all. One other technology - wave power - has vast future potential for electricity generation, particularly in island situations (which includes the UK, but more significantly countries like Indonesia which has a huge population spread over more than 17,000 islands). Wave power has not yet reached the market technically or commercially, therefore it is not covered in any detail in this article.

Biomass

Sustainable energy from biomass comes in a number of guises and is already well utilised in most parts of the world. In fact, in its simplest version for cooking and heating i.e. open fires, biomass has been in use since the discovery and manipulation of fire by humans over 100,000 years ago.

Today biomass comes from commercial forests (including the chippings after clearing for timber), crop residues, specially grown energy crops and even industrial wood waste. It can be used to provide heat for domestic or industrial processes and it can also be used to generate electricity.

Biogas also has a large potential mainly from agricultural manure, by-products of the food processing and other bio-degradable industrial wastes.

Wind

Wind power, too, has a long tradition. It has been used in sailing boats and, of course, old fashioned windmills which utilised cloth sails on a horizontal axis from which mechanical power was taken to mill flour or complete other heavy tasks. For a large part of this century, in places like the great plains of North America, multiblade wind machines were a common sight, normally utilised for water pumping. In the last 30 years wind turbines have been developed to produce electricity. Today these are among the most economic of all renewable energy sources which is why large scale wind farms are springing up in the UK, Europe, Argentina and India. Wind energy, however, is very dependent on having a good average wind speed at the location of a wind farm. Calculations for wind energy resources are a vital tool for wind energy developers and utilities considering wind power as an option. Wind resource monitoring is one of the services eminently exportable from specialist UK companies.

The scale of wind turbines has increased rapidly in the last 10 years or so. Most commonly, today, commercial wind turbines for linking to the grid are in the scale of 300kW to 1MW per machine and the wind farms more and more frequently combine between 50 and 100 turbines. The next generation of wind turbines will be in off-shore positions to minimise their visual impact and to optimise wind capture.

Solar

In some ways all renewable energies arise from solar power. Biomass needs the sun to grow plant matter, winds require the sun to give them energy and, without the sun's input to global evaporation there would be no water available in the form of rain for hydro power. Even ignoring all these renewable sources, there are still several main forms of solar power.

Solar thermal, or heat, power for instance, uses the direct sunlight to heat water. This can be for domestic or industrial hot water requirements, for swimming pools in the leisure trade, or even to generate electricity from steam powered turbines.

Passive solar technology is also an important aspect of renewable energy, though it relates most to architectural design and building integration. Again, this has a long history. In Northern countries glass houses are used for horticultural purposes, and glass glazing (now double or triple glazing) has been utilised to maximise light and incoming solar warmth for space heating.

One of the most exciting new developments in renewable energy, however, has to be solar photovoltaics. Many of the large oil companies - such as BP and Shell - now have solar divisions. In fact, there are few PV manufacturers which are not oil companies. The market for PV is vast and 1997 saw, for the first time, a shortfall in supply to match demand. Several European countries, Japan and the USA have government instigated PV-roof schemes encouraging and subsidising domestic and industrial implementation of building integrated and sometimes grid-linked PV arrays, however the real need is in developing countries.

PV is well suited to off-grid electrification requirements and is already cost-effective in many situations where the required electrical load is relatively low, such as lighting, refrigeration, water pumping and radio communications for small, remote communities. It also has the advantage of being easy to install, highly portable and modular. All of these factors can be seen as benefits in highly rural and relatively poor socio-economic environments.

Hydro

Hydro power is often thought of exclusively in terms of massive projects involving the construction of major dams. These are not always appropriate in social or environmental terms most of the best large scale hydro sites are already utilised. Where there is still significant room for development at a more appropriate level for the electrification of rural off-grid villages is in small or micro hydro power developments.

Mini and micro hydro schemes have enormous potential as cost effective solutions to the provision of environment-friendly energy. In many regions of the world, hydro power is abundantly available and will never run out. It can provide a reliable ,and efficient source of power for small, independent systems, schools, hospitals, hotels, entire communities, remote agricultural/industrial needs or for feeding into a national electricity grid. Such schemes can generate income as well as providing a long lasting and reliable source of power.

Mini hydro power - typically grid connected schemes of up to a few MW in capacity - are valuable, cost effective tools for providing environmental friendly electricity.

Micro hydro power - typically stand alone systems in the range 1 to 50kW - have been proved useful by UK companies in powering remote domestic loads and as part of development projects in countries such as India, Peru and Ethiopia. A number of UK companies manufacture micro hydro turbines and supply technology for assembly in developing countries.

The utilisation of micro hydro electricity for small scale industry and productive processes can often reduce the payback period on capital investment from over 20 years (for simple domestic uses) to less than 5 years. Hydro powered agro-industrial projects frequently involve a wide range of practical end-uses, often in milling, crop drying, carpentry, lighting, refrigeration or light engineering.

Sustainable Energy for Developing Countries

The arrival of electricity and other forms of industrial power has had a significant impact on societies, similar to the arrival of other major harbingers of social, economic and environmental change, such as steel, gunpowder and an international money-based economy. One of the main benefits of renewable energy technologies compared to their competitors in power and heat supply, such as coal and nuclear, is the range of applications where they could be considered as 'appropriate'. Unlike conventional fuels, renewables offer both small and large-scale energy supply, they can be used in both grid and off-grid situations, they can be portable and modular and they can supply electricity, heat/cooling loads and fuels for transport purposes.

The consequence of this is that the nature of their use, especially in developing countries, is beneficial across a very diverse set of applications, including:

- rural electrification (domestic and agro/industrial processing)
- telecommunications
- transport fuels
- social provision (especially in health and educational)
- bulk power/heat supply (mainly for light industry and agro-processing)

With these uses, renewables are able to contribute to the 'development' of the economies and societies within the developing country. This is not only at the level of energy sector development, but also environmental protection and sustainable development, industrialisation of economies, alleviation of poverty, agricultural reform, health/education/welfare, plus, of course, the macro economic aspects associated with rural migration/depopulation and other policy areas.

CASE STUDY 1

In the field of small and micro hydro power, this case study takes a look at one major

international consultancy project which involves a wide ranging collection of specialists and consortiums. One of these consortiums is the Mini Hydro Power Group (which incorporates two UK companies - ITDG and Dulas).

Hilly Hydro - India

Small and micro hydro schemes are utilised by remote communities for community facilities, domestic lighting (ocassionally cooking) and small scale industrial or processing requirements. A case in point is the Hill Hydro Project which the Mini Hydro Power Group are engaged on as international consultants. This project is the very first UNDP-GEF funded project in the field of small hydro power.

Hilly Hydro aims to develop a national strategy and master plan for the utilisation of small hydro electric sources in the Himalayan and sub-Himalayan regions. This will involve the installation and commission of up to 20 working demonstration hydro schemes at a number of selected sites. A national strategy will be developed for the optimum utilisation of small hydel resources of the Himalayan and sub-Himalayan regions. The demonstration hydro will offer the necessary experience to local partners for the development of appropriate models of ownership, management and maintenance of the schemes, through a people-centred and participatory approach.

Devastating environmental damage is presently caused in the Himalayan regions of India by people collecting firewood. Forests are disappearing quickly; people cook in smoke-filled homes; irreplaceable flora and fauna disappear with the forests; and, of course, valuable topsoil is lost through deforestation. The introduction of small hydro turbines to generate electricity for heating and cooking in remote Himalayan villages will alleviate these environmental problems significantly.

As well as installing and commissioning up to 20 hydro schemes, this project also encompasses the establishment of the necessary expertise and capability at local and national levels in India for the sustainable development of the small-scale hydro electric industry in that country. This technology transfer has involved the training of Indian engineers in the UK as well as on the ground in the region itself. In many ways, the Hilly Hydro Project is a preferred option to larger hydro installation schemes which are viewed suspiciously in terms of their social and environmental costs. Small hydro schemes are more appropriate to remote mountain communities both in terms of the scale of the technology and as their effect on local issues of control and supply of power.

CASE STUDY 2

Another UK company - Energy for Sustainable Development (ESD) - has been working in Africa with local counterparts to develop energy efficient commercial cooking. Woody biomass energy consumption by schools, hospitals and other ‘institutions’, and by restaurants, hotels and other ‘commercial’ establishments, accounts for up to 15% of all biomass use in East African countries. Virtually all this consumption is for cooking, and almost all foods are cooked on highly inefficient three-stone fires or very inefficient fuel-

stoves.

With the help of the UK Department for International Development, ESD is carrying out a pilot activity to develop and commercially sell improved institutional and commercial woodstoves. This project is building on work previously undertaken in Kenya with a view to extending the developments into Tanzania, Uganda and Ethiopia. The project works on the principle that commercial stove producers in each country will learn from each other, exchange ideas and improve their own designs. In turn this will improve their products, boost sales and, of course, reduce the quantity of biomass consumption required for the present given energy outputs. This latter point should offer significant environmental benefits.

Consumer surveys showed that there is considerable demand for new improved stoves and a willingness to pay. Nine producers were brought together with four regional and international specialists in a four day workshop in Nairobi in January 1998. Training was held on improved commercialisation, sales, promotion and business practices. These commercial producers also received training on simple testing techniques, and agreed that the results from these tests should be an integral element in their marketing and promotion programmes.

The project has now entered its second phase where producers begin pilot-testing new designs, refining new commercial approaches, and developing better business practices.

Solar (PV) power is one of the major buzzwords in developing country rural electrification as we approach the 21st century. Solar photovoltaic (PV) power certainly is an increasingly preferred energy source utilised often for mainly environmental and policy reasons by international donor agencies like the World Bank and the EC. Many remote communities prefer, however, to use PV as a power source simply because it requires no constant supply of fuel and is simple to maintain (due to the absence of moving parts).

In 1997, the World Bank announced its intention to invest over $25 million in a PV Market Stimulation project focusing on Kenya, Morocco and India. The project aims to implement the first genuinely "successful" PV rural electrification programmes while at the same time stimulating economies of scale in PV production. Integral to their plan is to build the capacity of these countries indigenous solar energy industries.

Often the first services to be electrified by renewables are those basic facilities like health centres, schools and community buildings in remote, off-grid villages. Solar powered medical refrigerators, for instance, have helped extend the cold chain into areas beyond the reach of most facilities. These systems have a reputation for being reliable and, over the lifecycle of the equipment, less expensive than other refrigerators (such as kerosene or LP gas powered ones) which require a constant supply of fuel.

CASE STUDY 3

The DULAS VC150F solar medical refrigerator was developed over 10 years ago to fulfil the needs of the cold chain. These provide a well-tested, high reliability storage of vaccine or blood products with an integral ice pack freezing facility. It was amongst the first

solar compatible medical refrigerators to be produced and, once again, it is one of the leaders as a guaranteed CFC-free model. The design of the refrigerator provides excellent high performance at relatively low cost. Originally designed for the WHO Expanded Program of Immunisation, the refrigerator has proved remarkably versatile, also used for blood banking because of its ample internal volume.

After 11 years of manufacturing this product mainly for the African market, 1997 saw the first 100 DULAS solar refrigerators imported to India and 1998 saw the first arrive in South America. In both cases the training of local operatives is considered essential and has formed an integral part of the export package. Similarly, sophisticated equipment such as solar medical refrigerators requires in-country technical support which is generally provided by local agents.

There is an increasing demand for reliable and cost-effective electricity supply or generation for remote medical and health care applications throughout the world. Analysing costs over the design life of a health care project, solar powered medical equipment is one of the most economical options available. Diesel generators are often used but have the significant drawback of requiring fuel, oil and spare parts which make them expensive in the long run. Ensuring a continuous fuel supply is as unpredictable as the future cost for fossil fuels. Without diesel for generators, remote health clinics have no power for lights or refrigeration systems. Vaccines and blood products, in particular, only remain safe to use for a few hours without reliable cooling.

The use of state-of-the-art solar photovoltaic technology can overcome these problems and help extend power and appliances to communities otherwise seen as beyond the range of modern health care. The sun offers an abundant, inexhaustible, silent and non-polluting source of energy. Photovoltaic panels convert this directly into electricity which can be stored in deep cycle. Solar power incurs lower recurrent costs than diesel, avoids the danger of running out of fuel and requires very little maintenance.

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