Mission energy planning—the Tata Energy Research Institute

Set up in 1974 with generous funding from some Tata companies—chiefly Tata Chemicals—and other industries, the Tata Energy Research Institute (TERI) is a non-profit autonomous organization that conducts projects supported by the central and state governments and several international organizations, including the World Bank, the Commission of the European Communities, the UN University, ESCAP, UNESCO, FAO and others.

The institute took a major step in 1989 in setting up an information and research centre on global warming and climate change to initiate work on global environmental issues. The aim of the centre is to provide a focal point for policy analysis on economic and social issues of particular reference to the countries in the South Asian region, and relating to potential global warming issues. The institute has been identified as a working partner of the Centre for 'Our Common Future', in Geneva to provide the latter with information on research initiatives on environment and sustainable development.

TERI has the privilege of being the nodal agency to promote development of the Asian Energy Institute (AEI), essentially a network involving 11 countries that links several energy research institutions in Asia. TERI, having been chosen as the secretariat of AEI, acts as the coordinating centre

The mission of TERI is to find solutions to a range of problems relating to (i) the gradual depletion of the earth's finite energy resources, which are non-renewable, and (ii) the existing methods of the use of these resources, which lead to increasing pollution. Often in this country, there is failure or ineffectiveness in the translation of successful laboratory work into industrial activity or output, and TERI aims to bridge this gap. The activities and programmes at TERI attack problems at several levels and scales The institute is at present active on the following broad fronts.

Energy policy and planning

Since the early eighties, TERI has laid special emphasis on policy analysis relating to various aspects of energy. The energy policy group's role is in the development of scientific knowledge and the application of this knowledge in finding solutions to the complex, short- and long-term energy and environmental problems of national and regional importance These problems are addressed by interdisciplinary teams of engineers, scientists and economists working in small groups. The major areas being covered are.

- Energy modelling
- Energy–environment interface
- Energy data systems
- Fossil fuels
- Power systems.

(See Box A)

Box A. Energy policy and planning

Energy modelling

The energy modelling and intersectoral analysis group develops energy-economy models and uses them to provide inputs for planning and policy issues It also carries out sectoral and intersectoral energy analysis of demand–supply patterns, pricing issues, etc One interesting project is the development of the TEESE (TERI energy economy simulation and evaluation) model, set up at the national level This model is a powerful instrument for the depiction of energy and economic developments in the country or in a region The model allows several options being assessed in quantitative terms for a variety of rational objectives

Energy–environment interface

The energy–environment interface group conducts studies on the environmental aspects of existing and emerging energy systems and applies this information to ensure that technology development and energy use are consistent with national environmental goals The group maintains a comprehensive data base which forms a part of the Environmental Information System (ENVIS) of the Government of India

Energy data systems

An on-going study in the data systems area attempts to establish a data base on energy-related technologies in collaboration with the Technology Information, Forecasting and Assessment Council (TIFAC) The technologies include energy conservation, rural energy and pollution control The reserves of fossil fuels, namely oil, coal and natural gas, are finite and supply is a constraint, whereas consumption is growing at an alarming rate The limited supplies are to be used judiciously and efficiently Towards this objective, studies are conducted to examine the policy issues stemming from the interaction between fossil-fuel demand and supply and other factors such as recovery, conversion and utilization technologies, transportation options, and substitution by non-conventional fuels

Fossil fuels

The fossil fuel group deals with oil, coal and natural gas

Power systems

The power policy group deals with studies relating to the power sector Electric power is the prime mover of our economy The quantum of electric power available determines the dynamics of growth of both industry and agriculture Power shortages have to be eliminated to accelerate the growth of industry and to improve the standard of living of the people Policy-oriented research to make planning and operations in the power sector more efficient is the major concern of the power policy and planning group Accordingly, a number of studies are being conducted in the area of load management, energy conservation, optimal investment planning for power capacity expansion, etc

Rural energy, including forestry

In the rural area, the focus is on implementing different energy options and disseminating them for their development and impact. The group has actively worked in collaboration with government and international organizations on energy-planning methodologies for rural areas at different levels. Dependence on firewood for energy is on the increase in spite of increase in the use of other forms of energy. In the forestry area, TERI has a significant programme on afforestation of degraded land, as well as agro-forestry.

Renewable energy technologies

In renewable and energy-efficient technology hardware, TERI has undertaken several projects such as biomass gasification, development of family-size biogas plants, solar ponds, energy-efficient cash crop driers, improved *bukharis* (space heaters) and stand-alone wind electric generators, all of which are field-oriented and end-use-oriented projects. The activities in this area consist of modelling, design, fabrication, laboratory testing and field demonstration. Studies have also been undertaken to assess solar photovoltaic technologies and to estimate the potential of renewable-energy utilization in the state of Rajasthan and in the Andaman and Nicobar and Lakshadweep Islands.

Energy conservation

An increase in energy efficiency through energy conservation in the industrial sector will lead to substantial savings in energy. The industrial energy group of TERI (i) evaluates the technical and economical viability of technologies to increase energy efficiency in the industrial sector, (ii) conducts preliminary and detailed energy audits in industrial units and identifies areas and opportunities for energy conservation, (iii) analyses energy-use patterns in different manufacturing industries, and (iv) assesses the impact of technical and economic factors and policy measures on energy consumption in the industrial sector.

Biotechnology

TERI's research in biotechnology has reached a stage where the results attained promise some early breakthroughs. TERI also has the distinction of being selected as one of the two institutions in India to be awarded a project by the Department of Biotechnology, Government of India, to establish a tissue culture pilot plant for propagation of selected tree species. Three major ongoing projects in biotechnology are:

- Tissue culture for cloning of elite tree species, and selection of microbes for increasing biomass production
- Breeding for higher yield and yield stability in oilseed mustard by conventional and molecular methods
- Improvement of efficiency of biogas production by using agricultural waste in biogas digesters.

(See Box B)

Box B. Biotechnology

In the area of tree tissue culture the institute has set up a pilot plant for producing over a million elite plants every year. This technique should help in providing elite material to foresters and farmers for enhancing biomass production in the country. It is planned to propagate some multipurpose species—*Acacia nilotica*, *Prosopis cineraria*, *Dendrocalamus strictus*, *Bambusa arundinacea*, *Bambusa vulgaris*—and some high-value timber species—*Tectona grandis*, *Santalum album* and *Populus deltoides*.

Back-up for this programme will be available from TERI staff who specialize in forestry. This group has already developed small-scale-level trials for mixed cropping of bamboo with *Casuarina* and bamboo with *Acacia nilotica*. As part of the biomass project, TERI is doing extensive field trials on the effect of mycorrhizae and nitrogen-fixing rhizobia for better growth of tree seedlings in degraded soils. Some work has also been done to establish pure cultures of mycorrhizae.

Keeping in view the tremendous shortage of edible oils in the country TERI has embarked on a programme to enhance the yield by heterosis breeding and to stabilize the yield by looking for hybrids that are resistant to biotic and abiotic stress factors. Four different sources of cytoplasmic male sterility (CMS) have been introduced into oilseed mustard and are at various stages of evaluation. High heterosis has been found in crosses between Indian and Russian types of oilseed mustard. These parent species will be suitable targets for the introduction of CMS and restorer genes in developing hybrid seed production.

Wide crosses have been made between *Eruca sativa*, a drought-tolerant relative of *Brassica* species, with *Brassica campestris* to make an allopolyploid hybrid. The yield of this hybrid is comparable to those of the available *B juncea* varieties. These hybrids are being tested for yields and resistance to pests and pathogens. Another hybrid between *B. napus* and *Raphanobrassica* has been made to transfer the non-shattering character of *Raphobrassica* to *B napus*. All these hybrids were produced by embryo rescue and characterized by species-specific DNA sequences. Repeated-sequence DNA from *Brassica* species has been analysed, including an AT-rich tandem repeat of *B nigra*, which has been characterized by cloning and sequencing of several units. Three more dispersed repeats of *B nigra* and two repeats from *E sativa* are being characterized as these are species-specific.

In an effort towards developing technology for genetic engineering of *Brassica* species various *Brassica* species have been transformed by plasmid *Agrobacterium*-based vectors. Plants with marker genes are being used for somatic cell hybridization.

In the microbiology area work has been initiated in biodegradation of lignocellulose and in increased degradation of cellulose and hemicellulose in biogas digesters. A facultative anaerobic bacterium *Cellulomonas fimia* and two more bacteria capable of degrading cellulose have been isolated and purified. The two enzymes involved in cellulose degradation, namely endoglucanase and xylanase, have been purified to homogeneity. A genomic library of *Cellulomonas* has been prepared in a multiple-copy plasmid pMK2004, a derivative of pBR322. The genes will be cloned and modulation of their expression attempted to increase the efficiency of cellulose degradation. The lignocellulose complex from rice straw has been isolated and purified. A bacterium and an actinomycete have been isolated which are capable of degrading the lignocellulose complex into lignin and cellulose. Further biochemical and genetic analysis of the lignocellulose-degrading microbes is in progress.

Encon bus—on-the-spot energy audits in industrial units

Focusing on energy

Computer applications

With a well-equipped computer centre, TERI has developed several software packages in different areas of energy research: a program to simulate solar radiation; one that calculates hourly indoor temperatures within buildings accounting for influences by weather etc.; a program for energy demand management; and others. There are also projects in mathematical modelling, computing methods in molecular biology, and other areas.

Training and information dissemination

TERI's training activities have now reached a point where several demands are made for training programmes in the field of energy and environment by government organizations and multilateral funding agencies. The institute conducts several annual training programmes and workshops for senior policy-makers and administrators. TERI has been involved in international activity as a member of the UNDP/UNESCO-sponsored Cooperative International Network for Training and Research in Energy Planning (CINTREP) as well as in other international networks sponsored by the UN University. It also runs training programmes for other Asian countries on behalf of UN-ESCAP, Bangkok, and the Commission of the European Communities.

In the initial years since its inception, the institute concentrated on establishing a large Documentation and Information Centre, and dissemination of information still receives special attention at TERI. The institute has a well-integrated information system whose objective is to acquire, compile, evaluate, document and disseminate energy-related data and information in support of TERI's R&D programmes.

TERI publishes several periodicals as well as proceedings of conferences, special reports, directories, case studies and books; TERI's abstracting services, namely *Indian Energy Abstracts*, *Energy Digest* [these two were merged in 1991 as *TIDE* (*TERI Information Digest on Energy*)] and *Asset* (*Abstracts of Selected Solar Energy Technology*, brought out on behalf of the United Nations University, Tokyo) are highly acclaimed and widely circulated. All these are edited, designed and typeset in-house. TERI has produced two films, one on biogas, which aims to educate the rural populace on construction of biogas plants and modes of acquiring financial assistance, and the second on global warming, which was the first film of its kind produced in India and focuses on long-term solutions to the greenhouse effect. TERI's library has a unique collection of energy, environment, plant biotechnology and forestry-related publications.

Poised for the nineties, TERI is confident of meeting the high expectations of its supporters and justifying the faith they have placed in the institute.