VATIS UPDATE

Non-conventional Energy

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Highlights

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- Hybrid wind/photovoltaic system
- Futuristic solar light unit
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APCTT
ASIAN AND PACIFIC CENTRE FOR TRANSFER OF TECHNOLOGY

curtin
CRESTA

A P C T T

The Asian and Pacific Centre for Transfer of Technology (*APCTT*), established in 1977, is a UN regional institution under the aegis of the Economic and Social Commission for Asia and the Pacific (ESCAP). The Centre receives overall policy directions from the annual ESCAP sessions, and specific guidelines from the yearly meetings of its Governing Board and Technical Advisory Committee.

OBJECTIVES

- *The statute of the Asian and Pacific Centre for Transfer of Technology defines the organization's objectives as: to assist member and associate member countries of ESCAP, through strengthening their capabilities to develop, transfer, adapt and apply technology; improve the terms of transfer of technology; identify and promote the transfer of environmentally sound technologies relevant to the region.*

METHODS

APCTT plays a catalytic role in technology transfer among the nations of Asia and the Pacific. At the national level, the Centre's approach is to evolve new methodologies, and pilot tests to demonstrate their usefulness for eventual adoption by member countries. At the enterprise level, the main emphasis is to assist small and medium enterprises in technology acquisition, adoption and upgrading through its technology information and promotion services.

SERVICES

- *Information on technology, business and investment opportunities.*
- *Matching of business partners, and search for technology worldwide.*
- *Training, consultancy and technology evaluation.*
- *Assistance in project financing and contract negotiation.*
- *Market studies and marketing assistance.*

C R E S T A

The Centre for Renewable Energy Systems Technology Australia (CRESTA) is a University Research Centre within the School of Electrical and Computer Engineering at Curtin University of Technology, in Perth, Western Australia.

The Centre is active in pure and applied research and development in the general area of renewable energy systems technology. Innovative developments are rapidly turned into technologies that are used in a wide range of national and international industry-based projects. The Centre has long and strong collaboration with a number of key industry partners in Australia and overseas.

CRESTA is a founder and a major node of the Australian Co-operative Research Centre (CRC) on Renewable Energy, and responsible for the power conditioning programme, which is aimed at developing improved power electronics converters for interconnection of renewable energy sources with conventional power generators, rural distribution lines, battery storage and power in commercial buildings.

CRESTA has an on-going industry-sponsored renewable energy training programme.

OBJECTIVES

- *To assist the industry with R&D projects in renewable system technologies.*
- *To provide advice to governments and industry on matters related to renewable energy technology.*
- *To provide opportunities for education and training through courses for technicians, engineers and managers.*
- *To participate in major demonstration projects in Australia and overseas.*
- *To involve in technology transfer and commercialization.*

SERVICES

- *Research, Development and Commercialization*
- *Technology Transfer*
- *Consulting*
- *Education and Training*
- *Information Services*

Cover Photo

Windside Windturbines

(Courtesy: Windside OY, Finland)

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* Value Added Technology Information Service

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IN THE NEWS

Energy database keeps growing

The GREENTIE directory is increasingly gaining international recognition as the most comprehensive database on suppliers and other experts of energy technologies. Compared to most directories and catalogues, which have one or two classification systems, GREENTIE directory has up to seven different classification systems. These are:

- Technology;
- Products or services;
- Target groups by industry;
- Target groups by geographic area;
- Commercial status of technology;
- Greenhouse gas; and
- Organization type.

Some highlights of the directory are:

- Technology categories covering the entire energy chain, from energy supply to energy transfer and end-use, including both conventional and renewable technologies;
- Suppliers and other experts involved in the entire life cycle of technology development, from basic research to commercial application;
- Expertise embodied in products or services ranging from power plants, machinery, equipment and components to engineering, consultancy, training, literature, databases, software and finance;
- Approximately 9,000 organizations around the world, including over 40 IEA programmes for international collaboration in energy technology, R&D and information dissemination;
- Entries include both contact details and a brief organizational profile;
- Available free of charge, both on-line through the Internet, and on CD-ROM or diskettes for Windows;
- Contains hundreds of leading technology experts that do not yet have their own web site and whose profile can therefore only be found on the Internet via the GREENTIE web site;
- Funded by governments, GREENTIE is independent from industry and strives for maximum neutrality; and
- The 36 countries participating in GREENTIE jointly account for 75 per cent of the energy technology patents granted worldwide every year.

Contact: GREENTIE Centre, Swentiboldstraat 21, P.O. Box 17, 6130AA Sittard, the Netherlands; Tel: +31 (46) 4202203; Fax: +31 (46) 4510389; E-mail: greentie@greentie.org; Internet: http://www.greentie.org. (Greentime News, Vol. 4(1-2), July 1997)

A database with a focus on energy conservation

GreenBuss®, a database for environment, trade and technology, is designed to look out for environmental developments which could impede export of developing country products to the European Union. Information in Green-Buss® regarding reduction of energy and use of renewable energy sources was recently expanded and now covers cogeneration, heat recovery, motors and drives, boilers and burners, and renewable energy. The information in the GreenBuss® documents are comprehensive, and contains examples of successful energy saving methods, addresses and phone numbers of relevant organizations. *Contact: GreenBuss®, P.O. Box 600, NI-2900 AE Capelle a/d IJssel, the Netherlands. Fax: +31 (10) 4510549; E-mail: greenbus@worldaccess.nl; Web: http://www.Kom manet.nl or http://194.178.177.33.* (CBI News Bulletin, September 1997)

Record sales for Danish windmills

Sixty per cent of the world's windmills are from Danish manufacturers and their sales have increased unexpectedly during the first quarter of 1997 – more than double the sales during the same period in 1996. Danish manufacturers are preparing to take on the fierce competition in the international markets through mergers and alliances. Two large companies, Nordtank and Micon, have agreed to a merger which will eventually create Denmark's (and the world's) largest windmill manufacturer. The two companies are particularly strong in Europe, the

United States, South America and Japan. Vestas, also from Denmark, remains the world leader. (Denmark Review, July 1997)

Chinese wind power project

The Chinese government has launched a 'Ride the Wind' project to achieve 1,000 MW of installed wind power capacity by the end of the year 2000. The State Planning Commission has appointed Luoyang First Tractor Factory and Xian Aero Engine Co. Aviation Industries as local partners in this project, to avoid large-scale import of equipment and to bring the local industry into business. Xian Aero Engine Co. Aviation Industries and Nordex Balcke-Dürr, Germany, approved and appointed as advanced wind turbine manufacturers, are expected to set up a joint venture company in China by the end of 1997 to realize projects, with an accumulated size of at least 200 MW, allocated by the State Planning Commission. (European Power News, September 1997)

"Built-to-inspire" solar centre

The "Solarch Centre", Sydney, Australia, is a research centre built to showcase Australian solar technology and to promote environmentally sound practices in the building industry. The Centre overlooking the Pacific Ocean at Little Bay, was built by 200 senior-year architecture students at the University of NSW and 20 students from three New Zealand Universities. The Centre's electricity needs are met largely from the sun using photovoltaic cells designed and manufactured by BP Solar and Solarex. Any excess electricity generated is injected into the NSW electricity grid, from which it can be used by other consumers. Apart from using the principles of passive heat control by minimizing summer heat and maximizing winter heat, the Centre minimizes other environmental damage. Rainwater is collected for use, while sewage is treated biologically and reused.

Last year the Centre received a major award from the NSW Chapter of the Royal Australian Institute of Architects. The award entry stating that the building was an intellectually stimulating research environment, providing flexible testing facilities and postgraduate research rooms. Educationally it spans the gulf between theory and practice in undergraduate architectural education. *Contact: Mr. Alan Ogg. Tel: +61(2) 96642622.* (Ascent Technology Magazine, March 1997)

Technical information centres on energy in Thailand

In Thailand, the Energy Conservation Promotion Act was promulgated to encourage efficient use of energy in the country and the Department of Energy Development and Promotion (DEDP) was assigned to implement the Act. To ensure timely access of information to professional consultants, owners, the scientific community, management and technical staff of industrial enterprises and commercial buildings, the Regional Energy Resources Information Centre (RERIC) undertook a project for DEDP to study the execution and operation of Technical Information Centres (TIC) for energy efficient technologies. The Thai-German Energy Efficiency Promotion Project (TG-ENEP) supported DEDP on this activity.

The study, which was completed in January 1997, surveyed 61 of the 115 major libraries and information centres in Thailand and analysed their responses. The study focused on three main points:

- to gather data of existing TICs in various sectors in Thailand – to analyse scope, form procedures and services of appropriate TIC;
- to assess the requirements of clients/target groups; and
- to set up a conceptual design of TIC in the area of energy efficiency and energy conservation.

A user needs assessment study was undertaken to identify the needs and services they require. The users were classified into six groups: decision makers, academicians/researchers, engineers, consultants, manufacturers and owners. Based on the results, the study recommended various aspects of establishment, operation and evaluation of a TIC. It also recommended establishing a sound networking of all stakeholders on energy in Thailand to share resources and not to duplicate/repeat what others are doing. (RERIC News, March 1997)

Wind power in India

According to the Ministry of Non-conventional Energy Sources (MNES), India, up to 20,000 MW of wind turbine capacity could be installed, making wind a significant contributor to the national grid. As a result of an increase of 150-200 MW annually from 1992, India had an installed capacity of 820 MW by the end of 1996, producing 1.5 billion kWh/year.

The starting point of this development was the establishment of a wind-monitoring and mapping network in all 23 states, with about 530 mapping sites and 213 monitoring stations. The centrally controlled electricity network has been opened up to private investors in each state and private investors in wind energy are being offered a series of legal and financial incentives. The main incentives offered are:

- depreciation of 100 per cent on investment during the first year allowing the buyers to buy the turbine out of profit;
- five year tax-free period for income from sale of electricity;
- subsidies on capital investment;
- facility of banking;
- premium price paid for electricity;
- opportunity for sale of power to a third party.

More than 25 local companies have set up manufacturing facilities along with Danish, German, Dutch, American, Austrian, Belgian, and Swedish manufacturers. (Sustainable Energy News, No. 18, September 1997)

Energy efficiency drive launched in India

The Government of India and the Government of Netherlands, through the Asian Development Bank, have launched the "Energy Efficiency Support Project" (EESP) to accelerate the pace of energy efficiency in Indian industrial sector. The project is being executed by the Industrial Credit Investment Corporation (ICICI) along with the Tata Energy Research Institute (TERI), Confederation of Indian Industries (CII) and the Energy Management Centre (EMC). (The Times of India, 15 August 1997)

INVENTIONS/ NEW PRODUCTS

Photovoltaic refrigerators

Photovoltaic (PV) refrigerators may offer good prospects for many important cold storage uses. As part of recent research efforts, government bodies, international organizations and manufacturers participated in market assessment and testing programmes for applications ranging from ice-making plants to vaccine storage. The World Health Organization (WHO) has approved solar photovoltaic refrigerators, opening the way for wider implementation of the technology.

Solar refrigerators have the potential for better performance, lower running costs, greater reliability and longer working life than kerosene or liquefied petroleum gas refrigerators, or diesel generator-powered electric refrigerators. WHO, the Centre for Disease Control, the United States Agency for International Development, the European community and other agencies have installed and evaluated many PV refrigerators throughout the developing world. (TERI Information Digest on Energy, June 1997)

Hybrid wind/photovoltaic generating system

Researchers at Montana State University, Montana, the United States, have studied the application of a hybrid wind/photovoltaic (PV) power generating system for utilization as a stand-alone or a network connected system.

The optimum combination of wind and PV generation coupled with battery storage for a stand-alone system has been obtained for a hypothetical site in Montana. Generation and storage units for system are properly sized in order to meet the annual load and minimize the total annual cost to the customer. Optimal solutions were found by a numerical study using hourly load demand for a typical residential home in the Northwest. Hourly wind speed and approximate solar radiation data have been used.

Contact: Department of Electrical Engineering, Montana State University, Bozeman, Montana 59717, the United States. (ASSET, Vol. 19(2), June 1997)

Gas-powered truck

Electrobel, a major gas and electricity utility company in Belgium, has put into service Europe's first natural gas-fuelled truck. The six-wheel truck is powered by a 12.2 litre Eagle 340 TxSi natural gas engine, and is designed to operate at 44 tonnes gross combination weight. The engine is air-to-air charge cooled, fitted with a wastegated turbocharger and two-way oxidation catalyst. It has a drive-by-wire system, electronically controlling the ignition, air and gas management systems, resulting in quiet, smoke-free, low-particulate operation and clean refuelling. (Power News, Vol. 7, No. 2, 1997)

Futuristic solar light unit

Sunset Lighting Ltd., the United Kingdom, has developed a low-cost solar-powered lighting system. Nimbus, can operate independent of cable-supplied electricity and requires little maintenance. The unit is housed in moulded glass reinforced plastic (GRP) incorporating monocrystalline silicon cells in a tough laminated acrylic fibre available in many colours.

Energy is collected from a solar panel at the top of the unit and stored in a sealed maintenance-free battery featuring a recombination system, essential in some harsh environments in which they may be installed. Gas generated by the battery pack is converted into water to maintain electrolyte level, eliminating periodic topping-up maintenance. Special features of the unit include a solid state inverter that converts the battery output into 240 volts alternating current to light up a sodium-xenon lamp, a battery management control module that can prevent overcharging or severe discharging, an automatic dusk-switching module and a programmable timer allowing a time range of one to nine hours. *Contact: Sunset Lighting Ltd., Unit D-6, Capel Hendre Industrial Estate, Ammanford, Carmarthenshire, the United Kingdom, SA18 3SJ; Tel/Fax: +44 (1269) 844670; E-mail: sunset@connect-wales.co.uk.* (BCN, Sept-Oct 1997)

High-temperature stable glass substrate

GEC Alsthom Engineering Research Centre (ERC), the United Kingdom, has developed a glass – with a coefficient of thermal expansion equivalent to that of silicon and is stable at high temperature – on behalf of Max Planck Institut für Festkörperforschung (MPI) under a programme funded by the German government. 'Silcomat', was designed for use in substrates for low-cost, silicon-based photovoltaic devices. It has demonstrated its suitability in photovoltaic arrays and its resistance to the conditions used for their growth by deposition techniques at temperatures up to 1,100ºC. It can be used to produce high-efficiency, thin-film transistor displays as used in flat computer screens and 'silicon-on-insulator' (SOI) devices, apart from applications in the conversion of light to electricity. *Contact: GEC Alsthom Engineering Research Centre, Great Baddow, Chelmsford, Essex, CM2 8 HN, the United Kingdom; Tel: +44 (1245) 473331; Fax: +44 (1245) 475244.* (The GEC Journal of Technology, Vol. 14, No. 1, 1997)

Secondary storage battery

Hitachi Ltd. and Shin-Kobe Electric Machinery Co. Ltd., Japan, have jointly developed a large lithium secondary storage battery for use in distributed battery-type energy storage systems. The work is being carried out under contract to the New Energy and Industrial Technology Development Organization (NEDO) as part of a project of the Agency of Industrial Science and Technology, Ministry of International Trade and Industry.

The battery has a positive electrode made from lithium oxide material and a negative electrode of carbon compound material. Lithium ions travel back and forth between these electrodes during charge and discharge enabling repeated cycles of recharge and use. Compared with other batteries such as lead acid, nickel cadmium and nickel hydride, these batteries are smaller and lighter. Also the voltage of a single cell is higher, making them optimum for large batteries. Hitachi has succeeded in developing a prototype of 210 Wh batteries. (Hitachi Technology '97)

R&D IDEAS

Hydrogen from microbes

German scientists are experimenting with *Thiorhodaceae,* a strain of bacteria, to produce hydrogen in the Sahara. They are developing a heliomite, a cone shaped wooden construction with a transparent plastic pipe for the movement of *Thiorhodaceae.* Results show that the rate of hydrogen production almost doubles when the reactor is irradiated from a side as the bacteria favour long-wave radiation reflected by the Sahara sand.

Scientists combined bacteria and plant photosynthesis to provide nutrients for the bacteria. Two reaction chambers were constructed in which green algae and *Thiorhodaceae* were positioned adjacent to each other. The green algae reacted with bacterial carbon dioxide and water to form oxygen and carbohydrates. While oxygen escaped, carbohydrates fed the *Thiorhodaceae* solution. The bacteria then produced carbon dioxide and hydrogen. One photobioreactor unit can produce 285 litres of hydrogen per hour. The scientists plan to construct a photobioreactor either at a landfill site or at a sewage plant. (Down to Earth, 15 September 1997)

Novel high-temperature solar chemical reactor

Researchers at the Paul Scherrer Institute, Switzerland, have employed computational fluid dynamics (CFD) in the design and optimization of a novel high-temperature solar chemical reactor. The reaction considered is the thermal reduction of metal oxides, as part of a two-step water-splitting cycle for hydrogen production. The solar reactor uses a flow of metal oxide particles under concentrated solar radiation, that serve simultaneously as energy absorbers and chemical reactants.

CFD simulation offers the possibility to calculate velocity, temperature and pressure fields, and particle trajectories, which cannot be measured under severe flux radiation (above 3,000 kW/m^2) and high temperature (above 1,500 K) environment of solar furnace experiments. CFD validation is accomplished by comparing with experimental results in cold operating conditions. *Contact: Paul Scherrer Institute, CH-5232 Villigen PSI, Switzerland.* (ASSET, Vol. 19(2), June 1997)

Flash-binary combined cycle for geothermal plants

Researchers at the University of Tehran, Iran, have developed a new technology for increasing the efficiency of geothermal plants. Geothermal energy is a widely used renewable source of energy. Although most resources are of the hot, dry rock type, the technology used currently was developed for hydrothermal resources. These are either vapour-dominated or liquid-dominated resources. Both flash and binary cycles are suitable for liquid-dominated resources. Flash cycles used for reservoirs with higher temperature are more economical and widely used than binary cycles, but these plants have low efficiencies compared with fossil-fuel power plants. Flash-binary combined cycle promises to be the solution for more efficient and economical geothermal plants.

This approach is suggested owing to the fact that hot brine with high enthalpy is injected back into the reservoir, thus wasting a great deal of energy. In flash-binary combined cycle, hot brine runs a binary cycle to generate electricity so that it is possible to obtain more energy from a unit mass of geofluid. *Contact: Department of Mechanical Engineering, University of Tehran, P.O. Box 11365-4563, Tehran, Iran.* (TERI Information Digest on Energy, June 1997)

Molten carbonate fuel cells

In an R&D programme, started in 1992, on molten carbonate fuel cells (MCFC) at the Central Electrochemical Research Institute, Karaikudi, India, researchers have found that MCFCs are capable of delivering DC electricity owing to electrochemical reaction between any hydrogen-rich carbonaceous fuel and oxygen at 650ºC. The first phase of the programme aims at the development of 500 W cell stack with 1,000 cm^2 geometric area electrodes and

a capacity of 100 watts per cell. Porous nickel electrodes were prepared by loose powder sintering or slurry casting technique. Nickel – 10 per cent *in situ* conditions – served as the cathode. Electrolyte structure was fabricated by tape casting technique. *Contact: Central Electrochemical Research Institute, Karaikudi 623006, India.* (ASSET, Vol. 19(2), June 1997)

SOE/SOFC reversible cell

Kansai Electric Power Co. Ltd., Japan, has manufactured a bench-scale SOE/SOFC reversible cell, measuring 75 mm x 75 mm square in size and 22 cm^2 in effective area. It generates eclectic power with SOFC and stores electric power in the form of hydrogen and oxygen with SOE. Stabilized zirconia is used for SOE, while the cell is made of ceramic. The cell generates 200 mA of current at 1.01 V and 200 ml of hydrogen. This has proved the possibility of this cell being used as a low-cost power storage device. (Techno Japan, Vol. 30, No. 4, April 1997)

Universities boost performance of geothermal

Geothermal heat pump technology is a rapidly growing business. The heat pump acts as an intermediate driving mechanism to either push heat into the building by taking it out of the ground in winter (thereby increasing the room temperature) or push heat into the ground by taking it out of the building in summer (cooling the room by removing excess heat). In the United States the present rate of installation of such systems, 40,000 a year, is expected to rise to 400,000 a year by 2003. In Australia, the market is expanding by 50 per cent a year.

Professor Bill Charters and his associates at the University of Melbourne, Australia, with more than 20 years experience in heat pump systems, have worked in conjunction with the Advanced Engineering Centre for Manufacturing (AECM) and an Australian company, Water Furnace Pty. Ltd., to optimize the "ground loop" (plastic pipes) to get maximum capability from the exchange with the ground. Recently they collaborated with researchers at the Australian National University, to include thermal storage in the circuit using paraffin wax as a "phase change material" on either side of the heat pump. It is believed that by adding this to the circuit, the coefficient of performance will be raised from 4:1 to 6:1, i.e., getting the equivalent of six times the energy put in. The phase change materials will be tested in a geothermal system to be installed in new buildings at ANU this year, and if successful could go into commercial production immediately. *Contact: Professor Bill Charters. Tel: +61 (3) 9344 6751. Dr. Don Gibson, AECM. Tel: +61 (3) 9287 9218. Dr. Keith Garzoli. Tel: +61 (6) 249 0481. Water Furnace Australia Pty. Ltd. Tel: +61 (8) 8373 5587.* (Ascent Technology Magazine, June 1997)

Biogas from antibiotic mycelial waste

Researchers at the Division of Microbial Sciences, Agharkar Research Institute, Pune, India, have conducted some experiments on producing biogas from mycelial waste. All antibiotic industries generate mycelial waste, which comprises microbial cells, their metabolic products, residual medium, etc. The waste being rich in organic matter can serve as a good substrate for biogas production, provided antibiotic residues do not interfere in the anaerobic process.

Solid waste of *Penicillium mycelia* collected during the recovery of antibiotics was stored at 4ºC. Chemical analysis with regard to its pH, total solids, total volatile solids, colouring matter and total Kjeldahl's nitrogen, were carried out. Three 25 litre capacity laboratory-scale anaerobic digestors of floating dome design were initially charged and stabilized with cattle dung slurry containing 10 per cent total solids at 30 days hydraulic retention time (HRT). Actual addition of mycelial waste was then commenced by mixing solid waste with water in 1:2 proportion (w/v) so as to obtain a slurry with eight per cent total solids. The plants were then charged daily with specific quantity of the slurry, viz., 0.83, 0.62 and 0.50 litre per day so as to have three different HRT of 30, 40 and 50 days respectively. Biogas produced in each plant was measured daily with a wet gas flow meter and analyzed on gas

chromatograph for its methane content. It was observed that though biogas production at three different HRT was more or less similar in the first 15 days, there was a continuous decline in the gas production at 30 and 40 days HRT.

However, in the case of 50 days HRT, the rate of biogas production was almost constant (on an average, 16 litres per day with 62 per cent methane) throughout the experiment. It was concluded that mycelial waste from antibiotic producing companies is amenable to anaerobic digestion. A medium size penicillin factory producing 60 MMU antibiotic per month generates about 3,000 kg of mycelial waste per day which, if digested anerobically, can produce 300 m^3 biogas with about 62 per cent methane. *Contact: Division of Microbial Sciences, Agharkar Research Institute, G.G. Agharkar Road, Pune 411004, India.* (Bio Energy News, Vol. 1, No. 4, June 1997)

Plug-in solar cells

Pacific Solar of Australia plans to develop a novel concept in solar technology, that should allow solar panels to be plugged directly into the 240 V wiring system of a house – and directly into the grid – by integrating an electronic power conditioner into the company's glass-based multi-layer thin film, laser grooved, embedded contact, polycrystalline silicon solar cells. The 'Integral Power Conditioner' is intended to be built into the back of every solar module effectively making it a "plug-and-play" technology. The Integral Power Conditioner will convert DC output from the solar panels to AC mains quality power of 240 V at 50 Hz, thus totally eliminating the need for battery storage.

A pilot production plant is under construction which will manufacture 30 cm square modules, trialing a variety of production techniques. Over a life span of 20 years, each megawatt of solar electricity capacity will save more than 40,000 tonnes of carbon dioxide emissions at Australian emissions per kW rate. The Federal Government has supported Pacific Solar's plans by recently offering them financial assistance in support of further R&D work on the Integral Power Conditioner. (Australian Energy News, September 1997)

SOLAR ENERGY

Solar future in polar town

Scan Wafer, Glomfjord, Norway, after just a few months in production, has carved a niche for its silicon wafers in the international market. The company started production in January and has now made its first deliveries to Japan and France. Having access to cheap hydropower and qualified labour, the company's order books are full till the end of next year. Compared to weight, value of the product is high enough to imbibe transportation costs. The raw material super silicon is not even Norwegian – it is a by-product of the electronics industry in Europe and Japan. The factory purifies and melts it down before it is made to crystallize in a directionally controlled molecular pattern. (Norway Now, July 1997)

Cheaper solar cells

Three companies – Canon Japan, and Solarex Corporation, Pennsylvania and United Solar System Corporation, Michigan, the United States – will soon start marketing solar panels made from amorphous silicon, a more disordered form of silicon that is cheaper and easier to process into solar cells. Compared to the efficiency of conventional crystalline silicon cells (having an efficiency of around 12 per cent), amorphous silicon cells have been less efficient with light degrading the panel over a period of time causing it to lose up to 30 per cent of its efficiency owing to the phenomenon known as Staebler-Wronski Effect.

Researchers have over the years discovered ways to limit this effect. Adding hydrogen gas to silicon, as cells are manufactured, caps off many of the dangling bonds, and using thinner layers of silicon gives the electrons a better chance of escaping. The cell's efficiency can also be increased by using multiple layers of silicon to capture a broader spectrum of light, and adding traces of germanium to absorb longer wavelengths. An amorphous silicon cell with an initial efficiency of 14-16 per cent which declines to 13 per cent has been developed

by researchers at the United Solar Systems. To compete head-on with fossil fuels, the cells will need a stable efficiency of about 15 per cent. (TERI Information Digest on Energy, June 1997)

Solar power in India

At a social work research centre in Tilonia, Rajasthan, India, solar power is being used to run fax machines, computers and telephones. Ten panels mounted on the roof of the centre, traps the sun's rays and charges a series of 40-watt batteries which supply the power. The power thus generated meets the requirements at the Centre and also villages within a 5 km radius. The 10 kW solar power unit provides light to the Centre through 350 fluorescent lights, powers 17 computers, fax machines, telephone sets, all equipment in an audio-visual studio, and a pump that lifts water from a 150 feet deep well. The maintenance cost of the unit – capable of providing three hours of electricity to a village for 10 years at a stretch – works out to about US$0.60 per month. (Down to Earth, 31 August 1997)

New process to simplify PV module manufacturing

Researchers at the National Renewable Energy Laboratory (NREL), Colorado, the United States, are working together with university and industry experts in photovoltaics, on the scientific and technical development of advanced polycrystalline thin films. Among several thin-film PV technologies, those based on devices made from copper-indium-gallium diselenide ($CuInGaSe_2$ or CIGS) are strong candidates for solar energy systems of the future because of their demonstrated potential for both high performance and low-cost.

By breaking the absorber-layer deposition process into independent stages, researchers have found a number of opportunities to make good use of a variety of deposition techniques, reduce the time needed for high-temperature process segments, and introduce intelligent process control measures. Researchers at NREL have set a world record for a CIGS device by achieving a total-area device efficiency of 17.7 per cent last year. By producing a module nearly 4,000 cm^2 in size that is approximately 10 per cent efficient, an industry member has set a milestone in thin-film module development. (TERI Information Digest on Energy, June 1997)

Residential solar system

Mitsubishi Electric, Japan, has developed a 3.1 kW photovoltaic (PV) power system which provides high conversion efficiency and is designed to operate either in stand-alone mode or utility-connected mode. In the latter mode, power is automatically sold to the power utility when generation exceeds demand and purchased when demand exceeds generation. A power conditioner controls the entire system automatically with manual control required only in the stand-alone mode.

Each PV module – with a life exceeding 20 years of normal use – comprises an array of solar cells. The cells – high-efficiency single-crystal 125 x 125 mm cells with an efficiency of 16 per cent – are mounted on a surface, connected together and covered with a sheet of glass and clear plastic. Each panel houses 54 cells and has a rated output of 129 W with an efficiency of 13.4 per cent. The whole system employs 24 modules organized as three parallel strings of eight series-connected modules for a total rated capacity of 3.1 kW.

High-performance, trench-type, insulated-gate bipolar transistors (IGBTs) serve as switching elements for the converter and inverter functions, trimming power losses by 30 per cent compared to previous technology. A connection box makes electrical connections between the PV modules, while the power conditioner absorbs surges from the modules and isolates individual strings of modules for testing purposes. A local fault detection function shuts down the system immediately on detecting over-voltage, over-current or overheating. The system generates about 3,100 kWh in a year, which corresponds to the consumption of 730 litres of crude oil in a thermal power plant. *Contact: Mitsubishi Electric Corporation, 2-2-3 Marunouchi, Chiyoda-ku, Tokyo 100, Japan. Fax: + 81 (3) 3218 3455.* (Mitsubishi Electric Advance, September 1997)

Hybrid PV-diesel system

Mitsubishi Electric, Japan, has developed a hybrid photovoltaic (PV)-diesel power generation system under the Ministry of International Trade and Industry's New Sunshine Project. The primary power source is a 750 kW PV array supplemented by a 300 kW diesel generator. The PV modules have an average maximum output of 62 W and operating voltage of 20.3 V with an efficiency of 12 per cent under standard test conditions of 1 kW/m^2, 25ºC and air mass of 1.5. The storage batteries are 1,950 Ah (10 h), tubular-type, lead-acid batteries designed for repeated charge/discharge cycles. The inverter employs insulated-gate bipolar transistor (IGBT) power modules. The diesel generator cost is reduced by eliminating a synchronized closing/load-sharing controller and implementing synchronous load-sharing operation entirely through inverter control.

In this system, utilization rate of PV generation is high, provides a reliable power supply despite variations in solar irradiation and minimizes the capacity requirements for PV arrays and storage batteries. It offers a clean alternative to diesel power generation for islands and mountainous regions isolated from the commercial power grid. *Contact: Mitsubishi Electric Corporation, 2-2-3 Marunouchi, Chiyoda-ku, Tokyo 100, Japan. Fax: +81 (3) 3218 3455.* (Mitsubishi Electric Advance, September 1997)

Solar cooker on Mount Abu

A solar energy cooker installed at Mount Abu, Rajasthan, India, caters for 1,200 people at a time, making it one of the largest solar cooking systems in the world. Financed by German aid and administered by GTZ (Organization for Technical Cooperation), it has a capacity of 75 kW and generates 600 kg of steam per day.

Consisting of 24 parabolic concentrators covering a total area of 180 m^2, heat captured by the solar dishes is directed to 12 receivers, where water is heated up to 200°C at 16 bar pressure. Steam generated by this pressurized water is fed by a pipeline into the main kitchen using a heat exchanger and a solar steam generator. (German News, June-July 1997)

BIOMASS ENERGY

Fuel briquettes from organic wastes

The Society for Integrated Development of Rural Areas (SIDORA), a non-profit organization based in Uttar Pradesh, India, recently organized a demonstration-cum-training camp in Gurgaon for making beehive shaped briquettes from vegetable market waste and bagasse. The camp was held under the guidance of Prof. P.D. Grover, a retired professor of Indian Institute of Technology, New Delhi.

Biomass is first charred in a charring drum and the char obtained is mixed with binders like potter's clay. Cooked starch or molasses and the mixture are left for maturing for at least 24 hours. The matured mixture is then manually briquetted in moulds, sun-dried and used. (Bio Energy News, Vol. 1, No. 4, June 1997)

Wise use of wastes

Technology and Action for Rural Advancement (TARA), a part of Development Alternatives, an NGO in New Delhi, India, is manufacturing products using biomass and locally available raw materials like paper and building materials.

A power plant converts renewable biomass fuels (including mainly local agro-wastes and unusable weeds) into 80 kW of electricity using a highly efficient gasifier and diesel generating set. The power plant has a capacity of 100 kW. A pyrolysis unit generates excellent charcoal from local biomass. These fuel conversion technologies were developed by various research institutions in India and optimized for local conditions. The electricity generated meets the requirements of the manufacturing plants, training establishment, the artisan's village, and other facilities for community interaction, such as an open-air theatre.

Cotton rags from nearby urban markets and textile mills, used paper and waste biomass are used for the handmade paper unit, which occupies about 500 m^2 of covered and open area for pulping, lifting, drying and finishing of

paper. The layout and placement of work-stations have been carefully designed to simplify and reduce movement of materials, energy and people, leading to considerable savings in piping, wiring and human effort.

The structure uses a series of arches built with hand-moulded stonecrete blocks. The walls are made of compressed earth blocks where the building is not exposed to water. In dry places, the roof is made with micro-concrete roofing tiles, and are coloured green to blend with the foliage. Materials used for construction are largely of low to medium energy intensity and the use of industrial building products have been minimized. Wherever possible, waste and recycled material available locally are used. (Down to Earth, 15 August 1997)

Biomass plug flow fermentor: the future of biogas plants

Researchers at the Application of Science and Technology to Rural Areas (ASTRA) centre, Indian Institute of Science, India, have succeeded in developing biomass plug flow fermentors for non-homogenous feed. Indian biogas plants are designed to utilize bovine dung for biogas production. Although continuous operation is possible, flow problems occur when fed with biomass feedstocks other than dung.

The new biomass plug flow fermentors are shallow, horizontal and partially underground structures. They can also be made underground by creating differential ground levels for better aesthetics, cleanliness and performance. The digesters are connected to separate galvanized iron gas holders. Except for a little space consisting of gas holders, inlet and outlet chambers, most of the digester is underground, and offers advantages of both fixed dome and floating drum types of biogas plants. (Bio Energy News, Vol. 1, No. 4, June 1997)

Biogas from poultry waste

Western Hatcheries Limited, a group company of Venkateshwara Hatcheries – a leading name in the poultry industry, India – has installed a pilot-scale plant for the production of biogas from poultry wastes. The plant is based on modified Upward Anaerobic Sludge Blanket (UASB) technology indigenously developed by Mailhem Engineers Pvt. Ltd. It treats 600 kg of poultry waste and is fully automatic. It produces 60 m^3 of biogas per day, the equivalent of 24 kg of LPG. Also, COD and BOD in the treated water is reduced by 89 and 90 per cent, respectively, and the reduction in total solids is around 90 per cent.

Poultry waste is brought into the compact plant in half-cut drums and mixed with water in the right proportion in the mixing tank. The mixing tank is designed to ensure that only organic matter is fed from it into the acid digester. Hydrolysis takes place here and only the hydrolysed portion is pumped into the methane digester. The biogas produced is collected in gas balloons, pressurized and piped for use in the canteen kitchen. Treated water from the methane digester is partially recirculated and the rest flows out into the fields. Sludge collected at the bottom of the digester is collected periodically and used as manure. (Bio Energy News, Vol. 1, No. 4, June 1997)

Biogas plants for cheaper gas

In China, biogas plants are built in place of toilet pits in almost every house, thus providing gas for the house. The system is cheap to build and offers distinct advantages other than the gas obtained. Adjacent to the gas chamber, a cement pit, about four feet in diameter and five feet deep, collects a liquid that is given out after the reaction producing gas takes place. This liquid is completely odourless and rich in nitrogen, preventing mosquitoes or any insect from breeding in the liquid, and can be used as manure for plants. Normal toilet pit fills up in 3-4 years of continuous use, and has to be emptied. If a biogas plant is used, the waste matter is converted to fine particles. The toilet does not get blocked when using such a system as it is designed to automatically divert the matter into a stand-by pit if there is any problem in the biogas chamber. Even the nitrogen-rich liquid does not overflow as it will also be diverted to the stand-by pit. (News Digest, 16 June 1997)

WASTE TO ENERGY

Recycle generation system

Hitachi, Japan, is promoting the development of a waste-to-energy incineration system with high efficiency and clean operation for effective energy utilization and environmentally friendly waste disposal. The super-clean recycle generation (SCRG) system improves power generation efficiency by superheating steam from an incinerator boiler by utilizing high temperature exhaust gas from a fuel reformer/combustor. This system also converts dioxins in waste-incineration exhaust gas into harmless H_2O and CO_2 by high temperature decomposition. The fuel reformer/combustor re-burns the waste-incineration exhaust gas with hydrogen-containing fuel gas that is made from external fuel by the fuel reformer. Basic experiments have confirmed that the SCRG system can reduce dioxins as well as NO_x in the waste incineration exhaust gas. (Hitachi Technology, 1997)

Cogeneration power plant

The Moerdijk cogeneration power plant in the Netherlands was primarily built to provide large-scale waste incineration, as a means of waste disposal. The plant produces two million tonnes/year of high pressure steam at 400°C and a pressure of 100 bar. The Dutch electric utility N.V. Elektriciteits Productiemaatschappij Zuid-Nederland (EPZ) undertook the development of a combined heat and power plant which takes steam produced by the waste-to-energy plant, superheats it and generates power in a combined cycle power plant. The plant consists of three siemens V64.3 gas turbines each with an output of about 600 MW. A unique feature is that heat is exported from and imported to the process. Condensate is returned to the waste incineration plant. In future, such plants are likely to be based on natural gas-fired combined cycle gas turbine power plants owing to the benefits of low environmental emissions, smaller land requirements, smaller plant size and high efficiency. (Australian Energy News, September 1997)

WIND ENERGY

Indigenous wind pumps in the Philippines

The Affiliated Non-conventional Energy Centre of Silliman University, the Philippines, while monitoring existing non-conventional energy systems, have found locally made wind pumps in a rural village. Four rotor blades made of used corrugated galvanized iron sheet are attached to a wooden spar which form a cross, while the mounting frame and pump rod are made of bamboo. A pump cylinder, also serving as the pump riser, is made of PVC pipe. One end of the shaft is fastened to the rotor, while the other moves a crank mechanism driving the pump rod. The system does not have a tail vane and the rotor plane is permanently positioned perpendicular to the direction of the prevailing wind. *Contact: Silliman University, 6200 Dumaguete City, the Philippines. Fax: +63 (35) 225 2900.* (Small Scale Wind Energy Systems, March 1997)

Mini windmill turbines

Windside Oy, Finland, manufactures mini-sized wind turbines for use in lighting, water pumping, battery charging, electric systems in country cottages and boats, etc. The turbines are safe, soundless and can withstand any weather conditions, producing energy even in inland, where slow winds are common. They can also be used in sea areas where wind of 40 m/s are expected. Windside turbines can harness winds from any direction. Battery charging starts even at wind speeds of 2 m/s and has been tested at 60 m/s wind speed in wind tunnels. The turbine is being used in Arctic regions as it resists frost, ice, snow and humidity, producing energy in extreme weather conditions. The turbine components are made mainly from fibreglass and stainless steel and are designed for long life – over 50 years. They are easy to install, requiring minimum maintenance and can be used in offshore systems. The turbines are available in different sizes. *Contact: Oy Windside Production Ltd., Vaskikellontie 316, 86800 Pyhasalmi, Finland. Tel: +358 (208) 350700; Fax: +358 (207) 350700.*

TECHNOLOGY OFFERS

A few selected technology offers from APCTT's computerized database are given here. For further details on these technologies and others in the database, please contact APCTT.

GERMANY

Energy-saving Natural Daylighting and Sun Protection Systems Technology (Ref. No.: APCTT-002869-TOF)

A German company is offering an energy-saving technology. The efficient use of natural daylight in commercial, educational, industrial and public buildings is a rapidly increasing area in architecture and construction. Customers have recently started to realize that living and working in daylight increases one's sense of well-being and consequently one's productivity. At the same time, modern daylighting and sun protection systems reduce power requirement for lighting and air-conditioning through the controlled use of sunlight. This technology can be used in large buildings such as hospitals, homes for the elderly, commercial buildings, museums, libraries, public buildings, and also in large manufacturing areas, entrance halls, atriums, stairways of banks, shopping malls, hotels, parking lots and garages.

Transfer Forms: **Know-how; Licensing; Joint venture**

INDIA

Electrical Power, Steam and Process Heat from Gasification of Agricultural Residues (Ref. No.: APCTT-003087-TOF)

An Indian company is offering technology for generating electrical power, steam and process heat from agricultural residues by using a gasification plant. In the gasification system, solid biomass (wood, forestry waste, different agricultural waste/residue) and carbonaceous fuel are converted into a combustible gas generally known as producer gas. This gas, after proper cleaning and filtration, is injected into a modified diesel generating set as fuel (85-90 per cent gas and 10-15 per cent diesel oil) for the generation of electrical power. Producer gas can also be fired with a suitable burner for running a boiler. The technology is suitable for the generation of electrical power, steam and process heat for use in processing units for rice, ground nut (peanut) and maize, and for saw mills, decentralized mini power stations for rural electrification, etc. It can also be used for supplying to electrical power grid and co-generation for industrial application.

Transfer Forms: **Joint venture; Turnkey; Agency licence**

RUSSIA

Catalytic Heat Generators Based on Reverse Process with Low Calorific Value Off-gases as Fuel (Ref. No.: APCTT-003033-TOF)

A Russian organization is offering catalytic heat generators based on reverse process using low-calorific industry off-gases as fuel. The technology assumes the availability of methane-air off-gases from coal mines with a temperature of 10-30°C and a methane content of 0.5-1.5 per cent. This is fed into a catalytic reactor with a periodically reversing gas flow direction through a catalyst bed. The heat from the catalyst bed centre, where temperature attains 800-1,000°C, is removed to a standard power and heat equipment, e.g. recovery boiler, and used for power and heat generation and/or overheated steam and electricity production. The technology can produce up to 0.6 Kcal of heat per 10,000 m^3 of processed off-gases. The heat generators efficiently solve the problem of safe disposal of low-concentration methane from mines, and, at the same time, offer a dependable and economical source of power for productive uses.

Transfer Forms: **Licensing; Joint venture**

Hydropower Stations for Free-flowing Rivers (Ref. No.: APCTT-003075-TOF)

A Russian organization is offering technology for tapping hydropower from free-flowing rivers. The principal attraction of the technology is that

the micro hydropower stations employ a device called "oscillating wing" to drive electricity generator or other mechanisms. The device converts the kinetic energy of the natural river flow into electric or mechanical energy. The simple and reliable design of the device allows more efficient use the area of the wing even in sullen rivers with low flow speeds (1-3 m/s), unlike conventional turbines, screw propellers, and paddle-wheels which require substantial flow speeds. The micro hydropower station capacity can vary from 0.5 to 100 kWt. The technology offered provides substantially higher efficiency than other comparable mirco hydropower technologies that make use of free-flowing water.

Transfer Forms: **Joint venture**

THAILAND

Biogas Utilization for Electricity Generation (Ref. No.: APCTT-002732-TOF)

A Thai organization is offering a technology which utilizes biogas for generating electricity. A common problem often faced in animal farms – such as those that raise pigs or dairy cows – is the offensive odour from animal excreta. In large farms, handling and disposal of animal excreta tends to be a problem if a satisfactory level of hygienic standard is desired. Anaerobic digestion of the animal waste not only provides biogas for alternative energy supply, but also solves the problem of waste disposal.

The technology offered is for a 170 m^3 biogas generator known as the Plug Flow. The unit has been intensively studied and tested at a research station. The digester not only eliminates bad odour but also provides a large quantity of renewable energy. The system can be employed to boost on-farm economic performance.

This biogas generator can generate 0.71 kWh of electricity. The most common composition of gas generated from this biogas generator is:

- 47.32 per cent methane gas,
- 26.74 per cent nitrogen gas, and
- 18.58 per cent carbon dioxide gas.

Transfer Forms: **Know-how; Joint Venture.**

RECENT PUBLICATIONS

Enhancing the Market Deployment of Energy Technology

This publication contains a set of case studies that contribute to a better understanding of deployment processes, and the policies and programmes that influence them. It provides an overview within which the commercialization and diffusion of any energy technology can be better understood, plus timely detailed reports on eight areas of energy technology: clean-coal technologies, wind power, photovoltaics, active and passive solar design, refrigeration, lighting, biomass and small-scale hydro.

Contact: OECD Publications Service, France; Fax: +33 (014) 9104276; E-mail: info@IEA.org.

Rural and Renewable Energy: Perspectives from Developing Countries

This publication focuses on some of the recent experiences in promoting renewable energy technologies (RETs) for rural energy applications at policy and field implementation levels. The case studies are mostly based on Indian experiences with some chapters covering programmes in China, Pakistan, Sahelian Africa, the Philippines, etc. The book is divided into four sections: Rural and Renewable Energy Policies; Rural Energy Supply and Demand; Rural and Renewable Energy Programmes; and Institutional Issues in Rural and Renewable Energy.

Some of the topics covered are: decentralized planning, rural energy vis-à-vis environmental policy, R & D in renewable energy development, availability and requirements of biomass and other energy resources including methods of estimation, various technology programmes disseminated in rural areas including biogas and improved cookstoves in China, biogas, small hydro and wind programmes in India,

solar photovoltaic programme in the Sahel region, important issues of technology transfer, financial aspects including those of commercialization, etc.

Contact: TERISCOPE, Tata Energy Research Institute, Darbari Seth Block, Habitat Place, Lodhi Road, New Delhi 110 003, India. Tel: +91 (11) 462 2246, 460 1550; Fax: +91 (11) 462 1770, 463 2609; E-mail: mailbox @teri.ernet.in; Internet: http://www.teriin.org.

Biomass Energy Systems

This book is based on the proceedings of an international conference held on 26 and 27 February 1996 at New Delhi, India, organized jointly by TERI and the British Council Division of the British High Commission. It presents the latest advancements in the field of biomass energy technologies and case studies, and discusses policy issues relevant to biomass energy processing and management. This volume contains 50 papers and is divided into seven sections: status of biomass resources and policies for their management; biomass processing and liquid fuels; biomass gasification; improved cookstoves; biogas technology; municipal solid wastes; and biomass-based power generation.

The publication includes papers from the United Kingdom, Sri Lanka, Switzerland, Myanmar, Pakistan, etc. Topics range from highly technical subjects like optimization of nozzle parameters for gasifiers to socio-economic issues such as how women cope with biomass scarcities in villages, and from discussion on multi-purpose tree species for energy production to joint forest management as an institutional initiative for biomass management. The book will be of use to all those associated with the biomass sector, namely, research scientists, academicians, policy-makers, programme implementors, entrepreneurs, multilateral funding agencies and voluntary agencies.

Contact: TERISCOPE, Tata Energy Research Institute, Darbari Seth Block, Habitat Place, Lodhi Road, New Delhi 110 003, India. Tel: +91 (11) 462 2246, 460 1550; Fax: +91 (11) 462 1770, 463 2609; E-mail: mailbox@teri.ernet.in; Internet: http://www.teriin.org.

CATCHING UP WITH EVENTS

1-3 Dec
Canberra, Australia
SOLAR '97
Contact: Australian and New Zealand Solar Energy Society Conference, P.O. Box 1402, Dee Why, NSW 2099, Australia.

4-5 Dec
Copenhagen, Denmark
3rd Annual International Conference on Waste-to-Energy
Contact: Euromanagement Holding Emmasingel 33, P.O. Box 2192, 5600 CD Eindhoven, The Netherlands.
Tel: +31 (40) 297 4944;
Fax: +31 (40) 297 4950.

1988

23-25 March
Hangzhou China
Global Small Hydro Conference
Contact: Global Small Hydro Conference, P.O. Box 607, Hangzhou 310006, China.
Tel: +86 (571) 705 5491;
Fax: +86 (571) 705 5492;
E-mail: hic2pub.zjpta.net.c.

8-11 June
Wurzburg Germany
Biomass for Energy and Industry 10th European Conference and Technology Exhibition
Contact: WIP, Sylvensteinstr. 2, 81369, Munchen, Germany.
Tel: +49 (89) 7201235;
Fax: +49 (89) 7201291;
Internet: http://www.wip.tnet.de.

14-17 June
Gold Coast Australia
2nd Asia Pacific Conference on Sustainable Energy and Environmental Technology
Contact: APCSEET '98 Secretariat.
Tel: +61 (07) 3369 0477;
Fax: +61 (07) 3369 1512;
E-mail: apc@cheque.uq.edu.au.

13-17 Sep
Houston (TE) United States
17th Congress of the World Energy Council
Contact: World Energy Council.
Fax: +1 (202) 331 0418.

20-25 Sep
Florence Italy
World Renewable Energy Conference
Contact: World Renewable Energy Network, 147 Hilmanton, Lower Earley, Reading RG6 4HN, The United Kingdom.
Tel: +44 (118) 961 1364;
Fax: +44 (118) 961 1365.

INDEX

The number appearing after the index term(s) directs the user to the page and the item in that page, e.g. 'pyrolysis 12.4' means the term 'pyrolysis' appears in page 12 under the fourth item. Items are not numbered in the main text, as each page normally carries three to five items.

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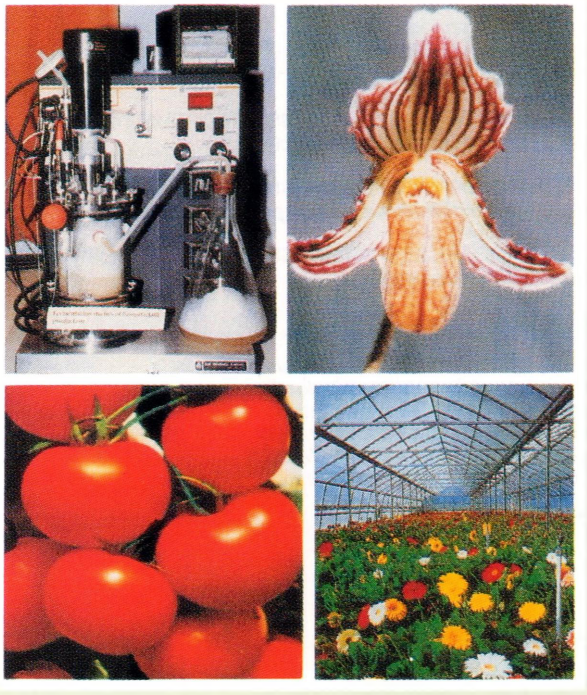

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