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CANE COGEN INDIA

A QUARTERLY NEWSLETTER OF THE GEP PROJECT (ABC COMPONENT), INDIA, WITH SUPPORT FROM USAID

Greenhouse Gas Pollution Prevention Project's Alternative Bagasse Cogeneration Component: A Success Story

by Richard L Edwards, Director, Office of Environment, Energy and Enterprise, USAID/India

As I complete my assignment in India, I find during the past six years of my stay India has made significant inroads into sugar mill cogeneration using bagasse as the fuel. Against an estimated potential of nearly 5,000 MW with the deployment of high pressure/temperature configurations for these cogeneration projects, the achievements (as of 31 March this year) amount to 304 MW of exportable surplus fed to state grids, with an additional 312 MW of exportable surplus in advanced stages of implementation. The credit for this progress goes to the supportive policies and promotional efforts of the Ministry of Non-conventional Energy Sources (MNES), Government of India, and the US Agency for International Development (USAID) India's initiatives since the mid-1990s.

USAID launched the Alternative Bagasse Cogeneration (ABC) Component under its Greenhouse Gas Pollution Prevention Project (GEP) in 1995 to assist India's power sector development and to reduce greenhouse gas (GHG) emissions. Under this component, USAID and its partners have worked for the past seven years to demonstrate and to promote commercialization of high-efficiency cogeneration in sugar mills utilizing bagasse and other alternative biomass fuels, rather than fossil fuels, for year-round operation.

USAID partnered with the Industrial Development Bank of India (IDBI), US Department of Energy's National Energy Technology Laboratory (NETL), Winrock International India (WII) and the Industrial and Technical Consultancy Organization of Tamil Nadu (ITCOT) to provide technical assistance and training to sensitize the Indian sugar industry about high- efficiency cogeneration. Financial assistance of $ 7.3 million was provided in the form of grants to nine sugar mills in five different states to install and operate high-efficiency cogeneration units.

As a result of this combined effort, several milestones were achieved:

- All nine sugar mill cogeneration units were successfully commissioned with a combined installed capacity of 195 MW.
- GEP-ABC sugar mills demonstrated a 270-day cogeneration operation in a calendar year using bagasse/biomass fuels only, with a total energy generation of more than 675 million units per annum.
- Since the commissioning of the first cogeneration plant in 1997, the nine sugar mills have helped avoid more than two million tons of CO_2 emissions.
- Seven training programs/workshops were conducted with about 250 professionals participating.

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M KANNAPPAN

MINISTER OF STATE
(INDEPENDENT CHARGE)
NON-CONVENTIONAL
ENERGY SOURCES
GOVERNMENT OF INDIA
NEW DELHI
INDIA

I am very happy to know that *'Cane Cogen India'*, the newsletter published by Winrock International India, is bringing out a special issue highlighting achievements in reducing greenhouse gases through the Alternative Bagasse Cogeneration Project of USAID. Bagasse cogeneration has very high potential and is not only offsetting greenhouse gas emissions but is also generating additional sources of clean energy in the sugar industry. I appreciate the role played by *Cane Cogen India* in promoting and disseminating information on the various issues related to cogeneration.

I wish the publishers all success in their efforts.

(M Kannappan)

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- Two study tours were organized for personnel from Indian sugar mills to the US and Mauritius to exchange information on high-efficiency cogeneration.
- Fifteen issues of the *Cane Cogen India* newsletter were published for information dissemination.
- A reference guide, *Handbook on Sugar Mill Cogeneration in India,* was published.

Other Accomplishments

- The nine sugar mills have invested about Rs 500 crore (US$120 million) confirming the economic potential of high-efficiency cogeneration.
- Workable power purchase agreements with different State Electricity Boards were demonstrated.
- Local engineering firms, equipment and technology suppliers were spurred on to respond to the demands of the sugar industry.
- Superior technical performance was demonstrated over earlier cogeneration configurations.
- Sugar mills operated for more than 270 days in a calendar year on bagasse and biomass fuels only.
- Cogeneration in units helped to stabilize the grid and increase the availability of power especially in the rural areas.
- The GEP-ABC demonstration projects are in conformance with the Government of India's plans to increase renewable energy's share to 10% in the electricity mix.

As we come to the end of this ABC component, we hope that by 2012, bagasse cogeneration will substantially contribute to India's target of adding 10,000 MW from renewable energy. The ongoing power sector reforms, unbundling of utilities, and the Electricity Bill 2003, provide further opportunities to sugar mills to emerge as power producers. However, to increase the share of power from renewables in the grid and to achieve the full potential of bagasse cogeneration, the central and state governments must address the current policy and regulatory issues that hinder the growth of generation of power from renewable energy sources.

We at USAID, would like to thank all our partners who have contributed to this cause.

This issue of the *Cane Cogen India* newsletter is the last to be supported by USAID's GEP-ABC project. USAID wishes to thank all readers for their interest and support of this newsletter.

इरेडा
IREDA

भारतीय अक्षय ऊर्जा विकास संस्था सीमित
(भारत सरकार का प्रतिष्ठान)
Indian Renewable Energy Development Agency Limited
(A Government of India Enterprise)

DR V BAKTHAVATSALAM
MANAGING DIRECTOR

The use of biomass fuel as an alternative to conventional fossil fuels is a key aspect towards achieving energy efficiency and sustainability in India.

In India, the sugar mill cogeneration sector alone has a vast potential to produce nearly 5,000 MW of energy, out of which nearly 3,500,MW can be generated from bagasse-based cogeneration. Almost 300 MW of power (exportable surplus fed to the state grids) is produced through the cogeneration route using bagasse as fuel, with about another 400 MW of exportable surplus under implementation. With the continuation of these activities, we are certain that bagasse cogeneration will substantially contribute to India's target of adding 10,000 MW from renewables by the year 2012.

It is also heartening to know that high-efficiency cogeneration using biomass fuel for year-round operation (leading to surplus exportable power) is also dramatically helping the local people. Some immediate signs of improvement in villages (where these cogeneration plants are located) are evident from the reduction of agricultural pump set ignition due to voltage fluctuations and also improvements in commercial activities in villages after reliable and quality power is being supplied.

On the occasion of *World Environment Day* on behalf of IREDA, I would like to extend my congratulations to all the stakeholders working to make this target a reality. The Initiatives taken by USAID/India under their Greenhouse Gas Pollution Prevention project (GEP), as executed by Winrock International India (WII) have played a key role to reduce greenhouse gas (GHG) emissions and promote power sector development In India.

The project activities as executed by WII related to information dissemination, technical assistance and professional development have been crucial towards uniting all stakeholders (be they sugar mills and their cogeneration units, equipment manufacturers and suppliers, state and central government agencies or the power sector).

As further efforts towards commercializing high-efficiency cogeneration in India as a common and successful practice are being made, I would once again like to extend my congratulations to all stakeholders working towards promoting cogeneration, especially USAID and WII for their contributions towards this sector. We hope that under the GEP project, they continue their efforts towards promoting bagasse cogeneration in India.

(Dr V Bakthavatsalam)

GEP-ABC Cogeneration Units: An Update

During the period from 1995-97, the US Agency for International Development (USAID), through the Industrial Development Bank of India (IDBI), under its Greenhouse Gas Pollution Prevention Project's Alternative Bagasse Cogeneration (GEP-ABC) component, extended financial assistance grants to nine sugar mills to demonstrate high-efficiency cogeneration and 270-day operation using only biomass fuels in their cogeneration projects. All of them have successfully commissioned high-efficiency cogeneration projects. The Cane Cogen India newsletter has been covering their progress since 1999. This issue provides updates on the three most recently completed projects, with technical schematics of all nine:

- EID Parry (I) Ltd, Nellikuppam, Tamil Nadu
- Dhampur Sugar Mills, Razagaon, Barabanki, Uttar Pradesh
- Rana Sugars Ltd, Buttar Seviyan, Punjab
- The Godavari Sugars Ltd, Sameervadi, Karnataka
- Ugar Sugar Works Ltd, Ugarkhurd, Karnataka
- Dharani Sugars & Chemicals Ltd, Karaipoondi, Tamil Nadu
- Thiru Arooran Sugars Ltd, Kollumangudi, Tamil Nadu
- Shamanur Sugars Ltd, Davangere, Karnataka
- Sagar Sugars & Allied Products Ltd, Chittoor, Andhra Pradesh

Rana Sugars

Rana Sugars Ltd (Rana) in Amritsar district, Punjab had a licensed cane crushing capacity of 2,500 TCD, which was expanded to 5,000 TCD in 1997-98 *(refer Cane Cogen India, Vol XIII, Oct 2001 issue)*. They implemented an advanced cogeneration project using a 1x10 MW extraction-cum-condensing turbine and a boiler of 62 kg/cm^2, 480^{o}C and 55 tph capacity. The 66-kV switchyard was commissioned in January 2001 in the first phase, and Rana was exporting power with the existing 6-MW double extraction-cum-back-pressure turbine. In the second phase, the 55 tph boiler and 10 MW turbine were commissioned in February 2002, and commercial operations began in March 2002.

Top: *High pressure boiler*
Bottom: *10 MW turbogenerator set*

Accomplishments

By 18 March 2003, the cogeneration plant had successfully operated for 272 days between March 2002 and March 2003 (198 days in the crushing season and 74 days in the off-season) using only bagasse (183,822 tons) and other biomass such as rice, mustard, and wheat husk (20,580 tons). About 83% of its fuel requirement was met from in-house bagasse and the remaining was met from purchased biomass. The average cost of rice husk was Rs 1,750/ton and that of wheat/mustard husk was Rs 1,150/ton (including transportation costs).

During the 272-day operation, Rana generated 65 million kWh of electricity, out of which 41 million kWh was sold to the Punjab State Electricity Board (PSEB). The gross generation has improved to 82 kWh/t from 53 kWh/ton of cane crushed. The revenue realized from surplus power export was Rs 1,340 lakh at the rate of Rs 3.16/kWh up to March 2002, and at the rate of Rs 3.32/kWh for the remaining period.

CO_2 offset from gross power generation was 71,404 tons, and from net power generation using biomass fuel was 44,684 tons.

(Courtesy: RK Millu, Vice President, Rana Sugars Ltd, SCO 49-50, Sector 8-C, Madhya Marg, Chandigarh 160018 Tel: 0172-540007: Fax: 0172-546809)

Sagar Sugars

Sagar Sugars and Allied Products Ltd, (SSAPL), promoted by the Mohan Breweries and Distilleries Ltd Group of Companies (MBDL), was granted a license to set up a 2,500 TCD sugar plant in Nelavoy village, Sri Rangarajapuram Mandal, Chittoor District, Andhra Pradesh, along with other downstream industries.

The management of SSAPL, realizing the potential available for cogeneration and surplus power export to the grid, decided to implement a cogeneration project with an 80 tph, 66 kg/cm^2, 485^{o}C boiler and a 20 MW extraction-cum - condensing turbine. Sagar commissioned the cogeneration plant on 8 January 2003, and plans to commission the sugar mill and a distillery of 70 klpd by January 2004.

Besides receiving financial assistance from USAID's GEP-ABC Project, SSAPL has taken a loan from IREDA for setting up their sugar mill cogeneration project. It has already received approvals from related government agencies (*details in Cane Cogen India, Vol XII, July 2001*).

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SSAPL entered into a Power Purchase Agreement with Andhra Pradesh Transmission Company (APTRANSCO) to export power. SSAPL erected the 132 kVA transmission line with 62 x 132 kV double circuit towers to the Kothapallimitta sub-station under APTRANSCO's supervision, which is about 19 km from the sugar mill.

Status

After undertaking boiler and turbogenerator trials and commissioning, the cogeneration plant was synchronized with the APTRANSCO grid on 7 January 2003 and full load was achieved the next day. The cogeneration plant was commissioned on 8 January 2003 and commercial operation began on 13 January 2003. As on 18 March 2003, the cogeneration unit had generated 275.86 lakh kWh and exported 251.69 lakh kWh to APTRANSCO, earning a revenue of Rs 833.54 lakh. The average loading was maintained at 18 MW, and export was maintained at 16 MW.

The open storage yard has a capacity of 20,000 tons of bagasse. The plant had tied up with Prudential Sugars and Sri Venkateswara Cooperative Sugars for the supply of 60,000 tons of bagasse during this season. Sagar plans to purchase 45,000 tons of bagasse from Gayatri Sugars and 100,000 tons of biomass fuel, such as wood chips, through biomass dealers. Sagar also plans to develop about 1000 acres of wasteland in nearby districts aiming at an average yield of 30 MT/acre (*Subabul* plantation).

(Courtesy: A Nandagopal, Executive Director, Sagar Sugars & Allied Chemicals, 2nd floor, Rayala Towers, 781-85 Anna Salai, Chennai - 400 002; Tel: 28521238; Fax: 28521266)

Godavari Sugars

The Godavari Sugar Mills Ltd, Sameerwadi, Karnataka, has a present crushing capacity of 8,500 TCD. The management conceived the idea of setting up a 24 MW high-efficiency cogeneration plant in 1997.

BSES Noida was the EPC contractor for the cogeneration project, and Desein (P) Ltd was the project consultant and also the Operations & Maintenance (O&M) contractor for the project for five years. Such an EPC/O&M contract for a cogeneration project was undertaken for the first time in India.

The 24 MW cogeneration plant was synchronized with the Karnataka Power Transmission Corporation (KPTCL) grid through a sub-station at Mahalingpur on 16 March 2002.

Side view of TG building and transformers

View of control room - generator panels

Commercial operation commenced from April 9, 2002.

There is a captive consumption of 6 MW during the season and 3 MW in the off-season and the balance is exported to the KPTCL. Apart from power generation, the cogeneration plant also meets part of the steam requirements of the sugar factory and distillery.

The total project cost of Rs 108 crore was met with loans (Rs 74 crore) from IDBI, Andhra Bank and the State Bank of India (SBI), while the equity was met (Rs 34 crore) with the USAID GEP-ABC grant of Rs 4.2 crore.

The plant is fully automatic with state-of-the-art technology including triple modular redundancy in all controls. The plant also incorporates the latest version of distributed control systems (DCS).

Special Features of the Cogeneration Plant

- The highest capacity bagasse-fired boiler in India
- Turnkey EPC/O&M contract for the first time in India
- Fully automatic plant with logic redundancy for all criticial controls
- Mechanized bagasse stacking
- Modern fire-fighting system

Cogeneration Plant Data

Installed capacity	24 MW
Boiler	130 tph, 66 kg/cm^2 , 495°C ± 5°C, travelling grate, Mitsui Babcock make
Turbogenerators	24 MW double extraction-cum-condensing type, BHEL make
Condenser size	100 tph
Boiler efficiency at 100% MCR	70.5%
Total bagasse fired in season	51 tph at 50% moisture
Steam flow required	120 tph
Raw water reservoir	80,000 m^3
Transmission line	7 km double circuit, 110 kV
Bagasse storage & handling	Mechanized storage of 19,000 tons and a handling system of 150 tph with automatic feeding arrangements to the boiler

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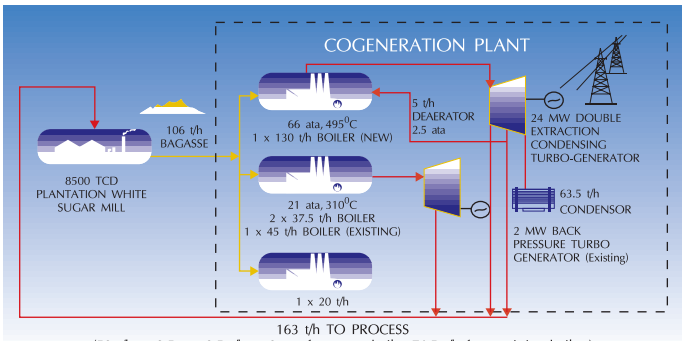
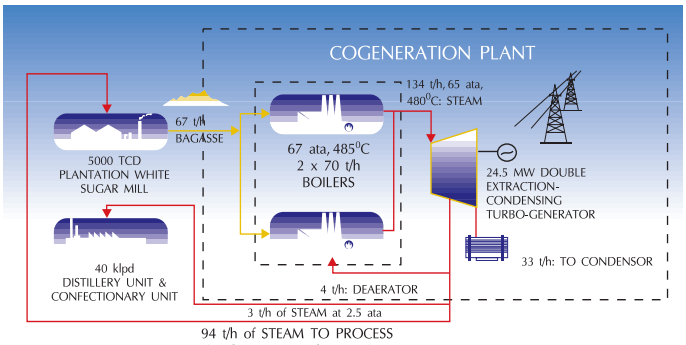
Block Diagrams of the Sugarmill Cogeneration Units supported under the USAID's GEP-ABC Component

Godavari Sugar Mills Ltd., Sameerwadi, Karnataka



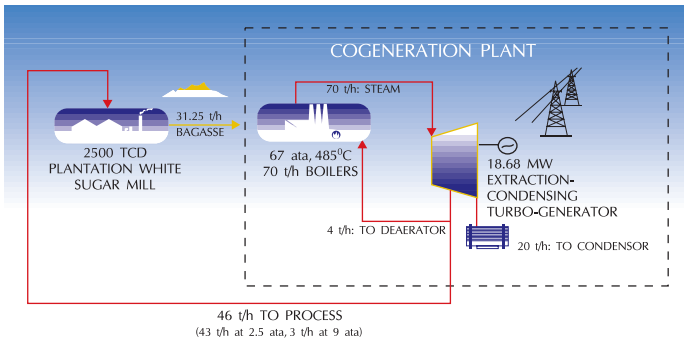
163 t/h TO PROCESS
(58 t/h at 2.5 ata, 8.5 t/h at 8 ata from new boiler, 76.5 t/h from existing boilers)

EID Parry India, Nellikuppam, Tamil Nadu



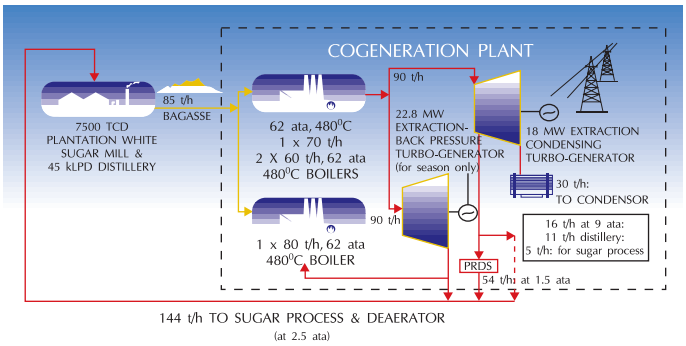
94 t/h of STEAM TO PROCESS
(90 t/h at 2.5 ata, 4 t/h at 8 ata)

Thiru Arooran Sugars Limited, Kollumangudi, Tamil Nadu



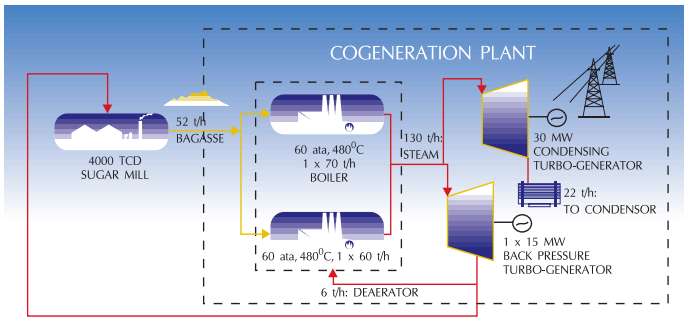
46 t/h TO PROCESS
(43 t/h at 2.5 ata, 3 t/h at 9 ata)

Ugar Sugar Works Ltd., Ugar Khurd, Karnataka



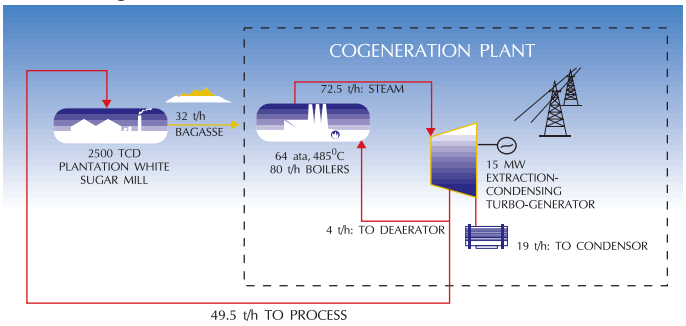
144 t/h TO SUGAR PROCESS & DEAERATOR
(at 2.5 ata)

Dhampur Sugar Mills Ltd., Rauzagaon, Uttar Pradesh



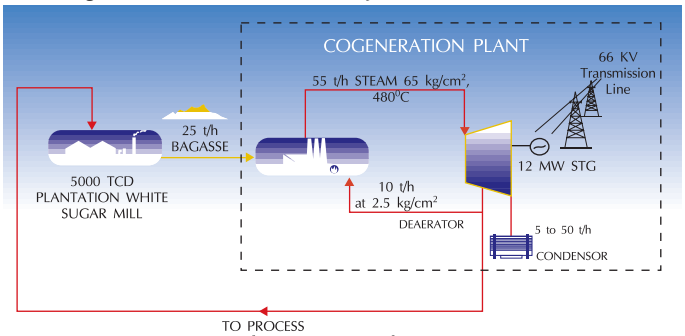
102 t/h TO PROCESS

Dharani Sugars & Chemicals Ltd., Polur, Tamil Nadu



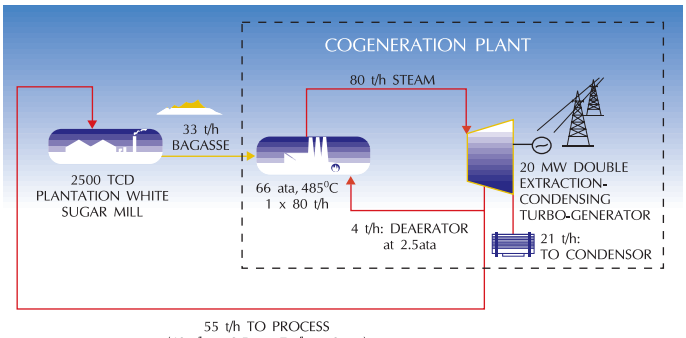
49.5 t/h TO PROCESS

Rana Sugars Ltd., Buttar Sevian, Punjab



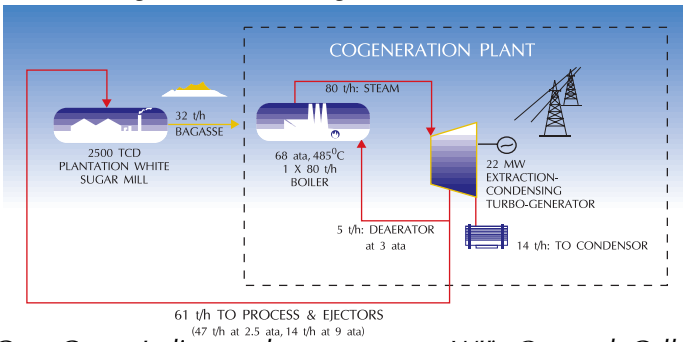
TO PROCESS
(36 t/h at 2.2 kg/cm², 14 t/h at 8.25 kg/cm²)

Sagar Sugars & Allied Products Ltd, Chittoor, Andhra Pradesh



55 t/h TO PROCESS
(48 t/h at 2.5 ata, 7 t/h at 8 ata)

Shamanur Sugars Limited, Davangere, Karnataka



61 t/h TO PROCESS & EJECTORS
(47 t/h at 2.5 ata, 14 t/h at 9 ata)

For further information, please refer to past issues of the Cane Cogen India newsletter or contact WII's Outreach Cell.

Sharing Experiences

3rd International CHP and Decentralized Energy Symposium and the USAID International Conference and Exhibition on Bagasse Cogeneration, New Delhi, October 24-26, 2002

Combined Heat and Power (CHP) or cogeneration and other forms of decentralized energy have been emerging as more efficient and eco-friendly alternatives to centralized coal-fired power generation systems. With this backdrop, the above conference was organized:

- To highlight the significance of cogeneration and decentralized energy in South Asia and share international experiences to accelerate development in India and to foster international partnerships and linkages
- To share experiences on sugar mill cogeneration, particularly under USAID's Greenhouse Gas Pollution Prevention (GEP) project's Alternative Bagasse Cogeneration (ABC) component, with the Indian and international community to accelerate growth of high efficiency, and year-round operational sugar mill cogeneration in India

This highly successful event was sponsored by USAID, the World Alliance for Decentralized Energy (WADE), the Ministry of Non-Conventional Energy Sources (MNES), and Rabo India, and co-sponsored by the US Department of Energy, Tata Power, Infrastructure Leasing & Financial Services Ltd (IL&FS), Thermax Babcock, Triveni Engineering, ThyssenKrupp, Alstom Power and MITCON Consultancy Services.

(L to R) R Bakshi, Member, WII Governing Board; A Thibault, Dy Chief of Mission, USAID/India; M Alan Ganoo, Minister from Mauritius; M Kannappan, MOS, MNES; S Pawar, MP, GoI; T Casten, Chairman, WADE; R Kapoor, MD, Rabo India; and L Menezes, Chairman, WII Governing Board during the inauguration.

The Exhibition

The exhibition had representation from equipment manufacturers, suppliers to the cogeneration industry, engineering support and service companies, environment and pollution control experts in the energy, environment and infrastructure sectors. They showcased the progress made in these fields and interacted with cogeneration experts from across the world to build alliances and to market their services. Participants included Woodward Governor, Sitson India, New Delhi Power, Desein Indure, Doshi Ion Exchange, Rajasthan Agro-waste, Electrotek Inter-national, and Lipi Boilers.

Shri Kannappan inaugurating the exhibition (top) and (right) later visiting the exhibits.

The Conference

Inaugurated by Shri M Kannappan, Minister of State, MNES, the event was well attended by over 200 participants from across India, the European Union, North America, Southern Africa, and Southeast Asia. The conference attracted a number of policy makers, government officials, financial institutions, multilateral/bilateral agencies, academicians, and technology and service providers. Shri Kannappan also released the *'Handbook on Sugar Mill Cogeneration in India'* prepared by Winrock International India under USAID's GEP-ABC project.

The conference opened with the USAID International Conference on Bagasse Cogeneration. The presentations centered around USAID's clean energy initiatives, in particular on the achievements of the GEP-ABC. Both, the MNES and the Indian Renewable Energy Development Agency (IREDA) highlighted the Indian Government's initiatives and accomplishments.

Mr Surya Sethi, Adviser (Energy), Planning Commission, presided over several sessions, and addressed issues relating to government perspectives and planning for decentralized energy, including cogeneration.

Mr Richard L Edwards, Director, E3, USAID/ India speaking at the conference

The second session, which was chaired by Mr RV Shahi, Secretary, Ministry of Power, and co-chaired by Mr BJ Krouwel, Managing Director, Sustainability and Social Innovation Division, Rabobank International, The Netherlands, provided a global overview of CHP and decentralized renewable energy with a focus on developments in North America, Europe and Asia, along with the benefits and challenges that the decentralized energy sector in India faces today.

The third session highlighted the relationship between decentralized energy and climate change, another important theme of the conference, and reviewed the impact of climate change policy mechanisms on decentralized energy development in India and other developing countries. Dr James Ekmann, Associate Director, National Energy Technical Laboratory/US Department of Energy, chaired this session. The barriers in the way of decentralized energy policies were highlighted through case studies of Asian countries in the following session chaired by Mr AK Basu, Chairman, Central Electricity Regulatory Commission.

In the next session, issues relating to the potential of centralized versus decentralized power were discussed. The UK CHP Association, IL&FS-India, and WADE presented their findings.

A special session in the conference focused on the Rabo India Global Review of Technology, Commercialization and Financing with presentations by the Prototype Carbon Fund, IFC-Netherlands Carbon Facility and Rabo India, on the finance front.

During the last session, the UN Industrial Development Organization and the World Bank discussed the role of global institutions in the area of capacity building and the importance of fostering partnerships to achieve international goals.

The event concluded with optimism about the prospects for financing CHP and decentralized energy projects in India. The role and potential for capacity building and fostering partnerships among institutions in decentralized energy areas was envisioned. The efficiency and environmental benefits of decentralized energy over centralized coal-fired power generation systems will provide new opportunities in the energy sector. The significantly lower electricity transmission and distribution (T&D) losses under the decentralized energy scenario held promise for the Indian market.

The initiatives of MNES, IREDA, and USAID have proven very successful in demonstrating the benefits of high efficiency sugar mill cogeneration, a form of decentralized energy. In view of the poor financial status of the electricity sector, where the costs exceed revenues by a large margin, it will be difficult to expect large capital inflows into centralized coal-fired power generation systems. In this context, there is great commercial potential for renewable distributed generation systems in India because of their high thermal efficiency, low T&D losses, high potential for local community development, and good future prospects for technology development and cost reductions.

(Courtesy: Anita Khuller, Program Officer, WII)

सत्यमेव जयते

राष्ट्रपति के प्रेस सचिव
Press Secretary to the President

राष्ट्रपति सचिवालय
राष्ट्रपति भवन
नई दिल्ली - 110 004
President's Secretariat
Rashtrapati Bhavan
New Delhi - 110 004

Message

The President of India, Mr APJ Abdul Kalam, is happy to know that Winrock International India and Cogeneration Association of India are jointly organizing the 3rd International CHP and Decentralized Energy Symposium and USAID International Conference and Exhibition on Bagasse Cogeneration from 24 to 26 October 2002 at New Delhi.

The President extends his warm greeting and felicitations to the organizers and the participants, and sends his best wishes for the success of the deliberations.

Press Secretary to the President

Emerging Technology Options for Distributed Generation

At the 3rd International CHP and Decentralized Energy Symposium and the USAID International Conference and Exhibition on Bagasse Cogeneration, held in New Delhi between October 24 and 26, 2002, the status and benefits of distributed generation (DG) were highlighted by organizations such as the World Alliance for Decentralized Energy, the Tata Energy Research Institute, and Infrastructure Leasing and Financial Services Limited. This event not only highlighted renewable energy efforts in India but also recognized decentralized energy as an essential mechanism for promoting climate change mitigation and addressing concerns on transmission and distribution (T&D) losses and rural development in India. The workshop entitled "Green Energy for Green Productivity," organized by the US Environmental Protection Agency (USEPA), Asian Productivity Organization, and India's National Productivity Council (NPC) in New Delhi in November 2002, also emphasized the merits of decentralized energy systems, such as fuel cells, microturbines, and combined heat and power, for improving energy efficiency and for reducing greenhouse gas (GHG) emissions. In view of increased interest in DG, highlights of emerging DG technology options, their benefits and costs are presented here.

Distributed generation is production of electricity near the point of use, and this approach is moving into the mainstream of energy planning in the US. The DG units can be as small as 1 kWe and as large as 50 MW. DG technologies have very low emissions of sulfur dioxide, nitrogen oxides, and particulate matter. Although these technologies typically use natural gas at present, renewables/biofuels are being commercialized for effective utilization in these technologies.

Under the GEP project, USAID was very successful in demonstrating the benefits of one form of decentralized energy in India—sugar mill cogeneration—by introducing high-efficiency electricity generation technologies and using alternative fuels in place of carbon-intensive coal. In contrast to coal-fired power generation, biomass-based generation is environmentally benign. Additionally, the GHG avoidance can be readily verified based on the electricity generated using biomass fuels, because both can be continuously quantified and monitored and have a direct relationship with GHG avoidance.

The success of the nine sugar mill cogeneration projects, which received USAID grants, demonstrated the technical merit of the USAID initiative and equally, the spirit of private enterprise in India. Unlike most business investments which focus on large cities, cogeneration investments were made in rural areas where most farmers need reliable customers to buy sugar cane and a reliable electricity supply that can meet the needs of local agriculture. Against this backdrop, introducing advanced distributed generation technologies in India will not only reduce carbon-intensive coal use to some degree, but also assist the Indian government in moving closer to its goal of capacity addition. Such distributed generation will also help in stabilizing the grid by reducing transmission and distribution (T&D) losses.

The Government of India (GoI) set a goal of using renewables for 10% of the new generation capacity by 2012. The GoI's Integrated Rural Energy Programme's Energy Plan envisions 10,000 MW of new, carbon dioxide neutral, installed capacity by 2012. Several financial institutions, such as the Indian Renewable Energy Development Agency (IREDA), are looking forward to supporting the introduction of energy efficient technologies. Global financial institutions, such as the Global Environmental Facility, also encourage such projects for climate change mitigation.

The advantages of distributed generation systems are significant compared to centralized coal-fired power plants. The thermal efficiency of coal-based power generation using the conventional Rankine cycle to generate steam, even using state-of-the-art technologies in the US, is typically about 38%. Because of the poor quality of Indian coals, the thermal efficiencies of even the best power plants are only about 35%. Several coal-fired power plants in India operate at less than 30% thermal efficiency and more than 70% of the carbon emissions from burning coal at these plants do not result in a usable product.

By contrast, emerging advanced DG technologies — fuel cells — can generate electricity at efficiencies of up to 50%. When fuel cells are used to generate both electricity and heat (cogeneration), they can achieve 85% efficiency. Current combined heat and power systems already have up to 85% thermal efficiency depending on the type of fuel and technology utilized. A high T&D efficiency is another significant advantage of distributed energy systems, because electricity is consumed in the vicinity of generation.

The natural gas based reciprocating engines and small turbines are some mature technology options for distributed generation. The reciprocating engines, which use mature

two-stroke or four-stroke internal combustion technology, are becoming popular because of high efficiency, low maintenance costs, and low emissions. Their size ranges from 30 kW to 5 MW, and they have electric-efficiencies of up to 42% and cogeneration efficiency at 85%. The US installed cost ranges from $600/kW to $1,000/kW depending on the size of the unit.[1] The gas turbines or combustion turbines also use natural gas and have a size range of 2 to 30 MW with efficiencies of up to 40% (electric) and 85% (cogeneration). The US installed cost for small turbine units ranges from $400/kW to $900/kW. If the carbon dioxide emissions from a coal-fired power plant are about 1.1 kg/kWh, the same estimated for CHP systems using natural gas based reciprocating engines and small turbines are 0.35 and 0.3 kg/kWh, respectively.

A fuel cell is an electrochemical device. It consists of an anode (negative electrode), a cathode (positive electrode), and an electrolyte for the movement of charged ions. Fuel cells directly convert the chemical energy of the reactants into electrical energy. For example, hydrogen gas fed continuously to the anode and oxygen fed to the cathode react at the electrodes produces an electric current. Hydrogen-based fuel cells are environmentally benign because they use clean fuels and emit only water vapor.

Microturbines (up to 30% electric efficiency and 85% CHP efficiency, 25 kW to 300 kW size range) and fuel cells (40% to 50% efficiency, 1 kW to 200 kW commercial size range) are the new technology additions to distributed generation. The US installed cost for microturbine units ranges from $700/kW to $1,100/kW. Of the different types of fuel cells, phosphoric acid fuel cells are the most commercially viable. They have demonstrated greater than 40% efficiency, 95% to 98% availability, and nearly 100% reliability. In 2002, more than 200 units of 200 kW size were in use at medical, industrial, and commercial facilities in the US. The US cost for these fuel cells ranges from $3,000/kW to $4,000/kW. The US Department of Energy and several private companies in the US are making continued efforts to bring DG technologies to the marketplace at significantly lower costs for mass production by technology development.

The World Alliance for Decentralized Energy is promoting the increase of the global share of distributed generation from the current 7% to 14% by 2012. Promoting distributed energy systems offers excellent market opportunities for small businesses in India. The major advantages of adopting decentralized energy systems, which are commercially available now, are low capital investment, fuel flexibility (both fossil and renewables), and ready suitability to Indian conditions.

Courtesy: Dr Sai V Gollakota, SAIC, USA
For additional information on distributed generation, contact: sai.gollakota@sa.netl.doe.gov

[1] $1 US = 47 Indian Rupees

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Some of the major technical problems faced by the unit after commissioning were improper feeding of bagasse to the boiler, gearbox vibrations in the turbine at higher loads, automatic voltage regulator settings and islanding problems due to grid variations, which were resolved.

Performance Data

Parameter	1999-2000	2000-2001	2001-2002	2002-2003
Cane crushed (lakh tons)	13.8	11.3	11.8	15.6
Average cane crushed TCD	5,416	5,810	5,905	7,000
Recovery %	11.4	11.5	11.1	11.2
Fibre % cane	14	14.5	14.3	14.7
Power generation (lakh kWh)	299	271	438*	303
Heat Rate Processing (kcal/kWh)	31,791	28,575	33,094	5,020
Gross Generation: Cane (kWh/ton of cane)	22	25	21	24
Operation time efficiency %)	85	83	77	82

**Power generation includes old turbines and the new high efficiency cogeneration plants*

Future Plans

Godavari Sugars conducted a detailed energy audit in April 2003 and plans to implement measures that would optimize power export. The plant has increased the crushing capacity this season to 8,500 TCD and targets to maintain the average crushing level at 8,000 TCD. The unit has adequate fuel storage capacities and stocks of bagasse for off-season operation. The tentative completion of the 270-day operation compliance of using only biomass fuels has been planned for August 2003.

Keeping pace with the expansion of the sugar mill to 14,000 TCD, the cogeneration plant will also be augmented to 72 MW by installing two more identical 24 MW units.

(Courtesy: P Dutt, General Manager (Cogeneration Project)
The Godavari Sugar Mills Ltd, Fazalbhoy Building, 45/47
Mahatma Gandhi Road, Fort, Mumbai 400 001
Tel: 022-285 8430; Fax: 022-204 7297)

Handbook on Sugar Mill Cogeneration in India

This handbook, prepared by WII, is a one-stop guide providing the preliminaries of cogeneration to interested sugar mills. The preparation was funded by USAID-India through its agreement with the US Department of Energy's National Energy Technology Laboratory on the GEP-ABC component.

Mr A Thibault , Dy Chief of Mission, USAID/India hands over the Handbook to Shri Kannappan, Minister, MNES, on 24 October 2002 for its launch

The first chapter begins with an overview of the status of sugar mills, the agencies supporting cogeneration, the evolution of the technology, the suppliers of equipment, and the economic and environmental merits of high-efficiency cogeneration, followed by an assessment of state-wise bagasse and other biomass resources in the second chapter, to give the reader an idea of the potential for new MW cogeneration capacity. The third chapter points out significant design aspects of a cogeneration plant, which include selection of the site, steam cycles, process configuration, and equipment identification and selection.

Project development for a new cogeneration plant with respect to preparation of Detailed Project Reports (DPRs), plant capital costs, and Power Purchase Agreements (PPAs), and typical operating and maintenance (O&M) practices are also highlighted. The final chapter contains case studies of three grantees (Shamanur Sugars, EID Parry and Ugar Sugars) under USAID's GEP-ABC component, focusing on design aspects, plant flow sheets, and equipment specifications. The appendices include a list of organizations and service providers involved in cogeneration, the International Cane Energy Network's Sugar Energy Data Protocol summarizing the methodology for evaluating the performance of a cogeneration plant, and a typical PPA for bagasse-based cogeneration plants.

Contributors include MITCON Ltd, Zenith Corporate Services, Avant-Garde Engineers and Consultants, Shamanur Sugars Ltd, Dimension Engineering Consultants, EID Parry (India) Ltd, Ugar Sugar Works Ltd, and the University of Hawaii at Manoa.

If you are interested in a copy, please contact Mr PRK Sobhanbabu, Program Officer (E&E) at Winrock International India

Professional Development Update

Under USAID's GEP-ABC component, an important initiative was the Professional Development component managed by WII. Under this, WII was responsible for identifying areas of interest in the sector and organizing in-plant training programs, workshops, international study tours and conferences/exhibitions over the past five years. Resource persons from all over the world shared their experiences with over 700 professionals from the sugar and related sectors who benefited from these programs. A comprehensive list of these (1998-2002) is given below:

- Business Meet on 'Biomass/Bagasse-based Power Projects, Kolhapur, 1998
- Regional Workshop on 'Biomass Management & Energy Efficiency Improvement in Sugar Mills', Chennai, 1999
- International Workshop on 'Alternative Bagasse Cogeneration', New Delhi, 1999
- Regional Workshop on 'Investment Development & Commercialization of Bagasse-based Cogeneration in the Sugar Industry', Mumbai, 1999
- Training Program on 'Power Plant Management', Noida, 1999
- Sugar mill study tours to Mauritius, Reunion and USA, 1999
- Seminar on 'Business Opportunities in Bagasse-based Cogeneration', Chennai, 2000
- Training Program on 'Bagasse Cogeneration in Western India', Kolhapur, 2000
- Workshop on 'Sugar Factory & Cogeneration Plant Management', Hyderabad, 2000
- In-plant Training Program at Shamanur Sugars, 2001
- Workshop on 'Advancing Bagasse-based Cogeneration Projects', New Delhi, 2001
- Training Program on 'Heat Rate Improvement in Sugar Mill Cogeneration', Noida, 2001
- Training Program on 'Financing Bagasse-based Cogeneration Projects in India', Bangalore, 2002
- USAID International Conference & Exhibition on Bagasse Cogeneration, New Delhi, 2002

The past issues of the Cane Cogen India *newsletter cover each of these in brief, while detailed proceedings are available with WII's Outreach Cell. Organizations interested in holding similar programs may please contact Anita Khuller at WII's Outreach Cell.*

MNES' Financial Assistance for Biomass Power/Cogeneration

The Ministry of Non-Conventional Energy Sources (MNES), Government of India, has been promoting its biomass power program, which includes bagasse-based cogeneration, for over a decade now. Forty-three bagasse-based cogeneration plants with an aggregate capacity of 304 MW have so far been commissioned, while thirty-one projects with an aggregate capacity of 312 MW are under implementation.

Its program includes a variety of activities ranging from financial assistance/incentives for setting up projects and fiscal incentives for power generation (Tables I and II), to policies introduced by state governments for purchase of electricity from these projects (Table III).

The Ministry continues its efforts to persuade State Governments/Electricity Boards/Electricity Regulatory Commissions to announce remunerative policies for the purchase/wheeling/banking of power generated from these projects.

Table I: Pattern of Financial Assistance/Incentives for Setting up of Biomass Power/Cogeneration Projects

Schemes	Pressure Configuration	Interest Subsidy
Bagasse Cogeneration (Commercial Projects)		
Projects by Cooperative/Public/Joint Sector Sugar Mills	40 bar & above	3%
	60 bar & above	4%
	80 bar & above	5%
Projects in IPP Mode in Cooperative/ Public Sector Sugar Mills	60 bar & above	2%
	80 bar & above	3%
Projects by Private Sector Sugar Mills	60 bar & above	2%
	80 bar & above	3%

For bagasse cogeneration by cooperative/public sector sugar mills, the floor rates of interest shall not be lower than 8%, otherwise 10% for general category of projects.
Maximum subsidy for these projects is Rs 4 crore.

Table II: Fiscal Incentives for Biomass Power Generation

Item	Description
Accelerated depreciation	80% depreciation in the first year can be claimed for the following equipment required for cogeneration systems: ■ Back pressure, pass-out, controlled extraction, extraction-cum-condensing turbine for cogeneration with pressure boilers ■ Vapour absorption refrigeration systems ■ Organic Rankine cycle power systems ■ Low inlet pressures small steam turbines
Income tax holiday	Five year tax holiday with 30% exemption in the next 5 years for power generation projects with PPAs
Customs duty	Duty leviable for NRSE power projects of less than 50 MW capacity (under Project Import Category) is 20% ad valorum.
General sales tax	Exemption is available in certain states

Source: MNES 2002-03 Annual Report

Table III: State Policies on Purchase of Electricity from Biomass Power Projects

State	Partici-pation	Wheeling	Banking	Buy Back	Third Party Sale	Other Incentives
Andhra Pradesh**	Pvt.	28.4% + Rs. 0.5 /kWh	Allowed at 2% for 8-12 months	@ Rs.2.25 per unit, escalated at 5% (94-95)	Not Allowed	—
Chattisgarh	Pvt.	—	—	@ Rs. 2.25 per unit	Allowed	As to other industry; Electricity Duty Exempted for first five years
Gujarat	Pvt.	4% of energy	Allowed 12 months	@ Rs.2.25 per unit, escalated at 5% (94-95)	Allowed	—
Karnataka**	Pvt.	20% of energy	Allowed 12 months	@ Rs.2.25 per unit, escalated at 5% (94-95)	Allowed linked to HT tariff	Subsidy @ Rs.25 lakh/ MW for cogen. only
Kerala	Pvt.	5% of energy	Allowed 4 months	@ Rs.2.80 per unit, escalated at 5% for 5 years (2000-01)	Not allowed	50% cost of power evacuation line to be borne by KSEB
Maharash-tra**	Pvt./ Coop.	7% of energy	Allowed	@ Rs.3.05 per unit, escalated at 2% from year of commissioning	Allowed	50% cost of power evacuation line to be borne by MSEB.
Punjab	Pvt.	2% of energy	Allowed 12 months	@ Rs.3.01 per unit, escalated at 3% for 5 Years (01-02)	Not Allowed	As to other industry
Rajasthan	Pvt.	2% of energy	Allowed 12 months	@ Rs.2.25 per unit, escalated at 5% (94-95)	Allowed	—
Tamil Nadu	Pvt.	2% for sister concerns, 10% for others	Allowed at 2% charge	@ Rs.2.73 per unit, escalated at 5% for 9 Years (2000-01)	Not Allowed	—
Uttar P.**	Pvt.	12.5%*	Allowed 24 months	@ Rs.2.25 per unit, escalated at 5% (99-00)	Allowed*	—

**Not allowed for cogeneration* ***SERC Policy announced*

Source: MNES 2002-03 Annual Report

For further information, contact MNES at Block 14, CGO Complex, Lodhi Road, New Delhi 110 003; Tel: 2436 0707 or visit their web site <mnes.nic.in>

International Conference on Biofuels

(L to R) MR Desai, V Machado, A Patil, A Singh, R Edwards, H Mori and J Uppal at the inauguration (for titles please refer text below)

An International Conference on Biofuels was organized by Winrock International India at Hotel Le Meridien on May 19 and 20, 2003. The objective of the Conference was to bring together major stakeholders in the areas of (bio) ethanol and biodiesel to gauge the potential, review progress and policies, identify barriers to growth, promote renewable energy friendly policies, and examine prospects for realizing the tremendous potential of biofuels in terms of rural employment creation and energy security.

The conference was sponsored by USAID, co-sponsored by Mitsui & Co and the Indian Sugar Exim Corporation, and supported by the Ministry of Rural Development, Indian Sugar Mills Association, the National Federation of Cooperative Sugar Factories (NFCSF), IREDA, the All India Distillery Association and Praj Industries.

> Production of biofuels, such as ethanol, by sugar mills opens new opportunities in the large transportation market, thereby increasing the financial viability of the sugar industry in India.

The first day was inaugurated by Shri Ajit Singh, the then Agriculture Minister, who spoke of the benefits of biofuels to the farmers and the environment. In his keynote address, Shri MK Annasahib Patel, Minister of State for Rural Development, highlighted the huge potential and advantages of biofuels. Madam Machado, Brazilian High Commissioner to India described the Brazilian experience in promoting ethanol and the emerging trends. Mr Edwards of USAID spoke of their role in promoting various renewable energy and environment-friendly programs in India, including cogeneration. Mr Mori, MD, Mitsui highlighted the availability of their technology for dehydration and the potential of Japan for importing ethanol. Mr MR Desai, Chairman, NFCSF talked about the role of sugar mills and the need to expand further into ethanol production as a diversification.

The first session dealt with policies and experiences of other countries, and was chaired by Dr Pradipto Ghosh, Addl. Secretary, PMO. The second session on the prospects for ethanol was chaired by Dr Desai. The last session was on Technology and R&D, chaired by Dr SJ Chopra, Chairman, Board of Studies, Indian School of Petroleum.

The second day focused on biodiesel and was inaugurated by Shri MKA Patil who highlighted the role of biodiesel and the Government's perspective.

Dr DN Tiwari, Member, Planning Commission, gave some details of the proposed National Biofuels Policy which would lead to widespread use of biofuels, and the benefits thereof. Shri RCA Jain, Secretary, Agriculture, and Shri AV Singh, Secretary, MNES, were both very supportive of the biofuels program for India.

The first session, 'Progress, Policies and Prospects of Biodiesel' was chaired by Dr SK Chopra, Senior Advisor, MNES. The Biodiesel Technology and R&D session was chaired by Dr Raje, Director, Indian Oil Corporation. This session included papers by Mr Holecek of Energia, Mr Teall of Biodiesel Industries, Mr Banerjee of Lurgi, and the Indian Institute of Petroleum, the Indian Institute of Technology and IOC.

The financing session was chaired by Mr Chakraborty, Director, Finance Engineers India. Various aspects of financing of Biofuels projects were covered by IREDA, ICICI Bank, NABARD, NCDC and IDFC.

Courtesy: Jai Uppal, Advisor, Renewable Energy, WII
For the complete proceedings, please contact WII's Outreach Cell

World Environment Day, commemorated each year on **5 June** is one of the principal vehicles through which the United Nations stimulates worldwide awareness of the environment and enhances political attention and action.

Editors: Anita Khuller and PRK Sobhanbabu, WII
Publisher:

Winrock International India (WII)
7 Poorvi Marg, Vasant Vihar
New Delhi 110 057 India
Tel : 91-11-2614-2965/66/67
Fax : 91-11-2614-6004
Email : winrock@vsnl.com
Web site : www.winrockindia.org
www.renewingindia.org

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