Power generation through renewable sources of energy

As a part of the Nehru Centenary celebrations the Karnataka State Council for Science and Technology conducted a two-day seminar on the above topic on the 27 and 28 of November 1989, at the Indian Institute of Science. The seminar began with an inaugural address by C. L. Gupta of Aurobindo Ashram, Pondicherry. He reviewed the status of research in renewable energy in India and highlighted the successes in the area of biogas, wind energy and passive solar heating. He argued that if a renewable energy technology is used in a rural area, without assessing the needs of the people, the project was doomed to fail. He concluded his address by comparing the cost of various renewable energy technologies.

The first technical session began with a talk by Sudhir Mohan of the Department of Non-conventional Energy Sources on Techno-economic consideration of solar thermal power generation using line-focusing collectors. He discussed various techniques of converting solar energy into electricity. He argued that the use of line-focusing collectors for generation of steam was the most appropriate for large-scale power generation. He highlighted that his technique had been used by a private company in California and they had an installed capacity of 200 MW. This is the largest solar–thermal power plant in the world and has demonstrated the technical viability of large-scale power generation using solar energy. Sudhir Mohan argued that these systems would produce electricity at the same cost as diesel generator sets. J. Srinivasan of the Indian Institute of Science discussed the potential of solar ponds for power generation. He showed that if 0.5% of India's area is covered with solar pond power plants, it would generate sufficient electrical energy to meet the electricity demand of India in 1988. He argued that solar-pond-power-plants can produce electricity at a cost comparable to diesel-generator sets at very favourable sites that could be found in Tamil Nadu and Gujarat. He demonstrated, however, that the utilization of solar ponds to meet process heat needs would be more appropriate than power generation because of the thermodynamics penalty paid in the generation of power from low-grade heat. Vaidehi of Bharat Heavy Electricals Limited discussed the techno-economic feasibility of power generation using photovoltaic systems. She showed that for villages situated more than 10 km from the electrical grid, the photovoltaic system is cost-effective when compared to centralized thermal power generation. She presented other examples such as microwave repeater stations, signalling systems in railways, rural telephones, off-shore platforms, etc.

The second technical session began with a talk by S. Krishnamurthy of Tamil Energy Development Agency who discussed the performance of wind generators installed in Tuticorin. He indicated that the installed capacity of this system was 1.1 MW and the system had delivered 46.5 lakh units to the grid. He discussed the wind climatology of Tamil Nadu obtained from intensive wind monitoring project. He highlighted the future plans for harnessing wind energy in Tamil Nadu.

H. S. Mukunda of IISc discussed the development of a 100 kW wood gasifier-based power generation for Port Blair. He discussed the performance of the gasifier system and highlighted the ability of this system to work at an average diesel replacement rate of 70%. The consumption of wood was around 1 kg/kWh. Baliga of IISc discussed the economics of the wood gasifier-based power generation. The payback period was shown to be dependent on the cost of wood chips and plant load factor. The payback period for wood chips cost below Rs 0.50/kg and 8000 h of operation was below 2 years.

Soundranayagam of IISc discussed the potential of microhydel power generation in the country. He highlighted the tremendous achievements of China in this area. He indicated that the cost of small hydroelectric system is highly site-dependent. He discussed the typical layout of a micro hydel power station using the example of a proposed plant near Mussorie. In this case the cost was shown to be around Rs 25,000/kW. He argued that the cost may decrease if a large number of micro-hydel power stations are installed on a regular basis.

The third technical session began with a talk by Amulya Reddy on power generation using biogas. Based on a detailed analysis of the experience with the biogas plant at Pura in Karnataka, Reddy estimated the cost of electricity from biogas to be around Rs 1.50/k Wh. He argued that rural electricity should be provided through decentralized electricity systems with grid-electricity as a standby.

B. R. Pai of National Aeronautical Laboratory discussed the use of gas turbine engines to generate power using a variety of fuels. He considered fuels such as high speed diesel, natural gas and sludge gas. He provided detailed study of the economics of power generation using different types of fuel. His analysis indicated the power generation using sludge gas was the most economical. He demonstrated that a co-generation system will be cost-effective if it is operated on a continuous basis and not on peaking mode.

M. Ravindran of IIT, Madras discussed the uses of wave energy. He estimated the potential of wave energy along the 6000 km coast of India to be around 40,000 MW. He indicated that the use of oscillating water column as the most suitable method for converting wave energy to mechanical energy. He presented the details of the wave energy system to be installed near Trivandrum. This system is expected to generate a peak power output of 150 kW during the monsoon season. He estimated the cost of wave energy generation system to be around Rs 1/kWh if this system serves also as a breakwater.

Prabhakara Rao of KSCST presented the technoeconomics of co-generation in sugar industry. He demonstrated that the use of improved technology results in the generation of surplus power in sugar industries. In Karnataka the potential for additional power is estimated to be 245 MW. The price of electricity generated by this method is lower than conventional methods. He indicated, however, that to implement these ideas there is need to amend existing electricity laws. The present laws will not encourage sugar factories to generate excess electricity.

The last session began with a talk by

Amulya Reddy on the comparative costs of electricity generation and conservation. He provided a new and comprehensive approach for comparing different energy generation technologies and energy conservation. He demonstrated that the cost of nuclear power is higher than that of coal-based thermal power plant if reasonable interest rates are assumed. Hydro-electric power was shown to be always cheaper than nuclear power. Decentralized power generation such as biogas, producer gas, mini hydro and cogeneration into bagasse was shown to be cheaper than nuclear power. Energy conservation was demonstrated to be less expensive than all the above methods. He argued that in capital-starved developing countries there should be a greater emphasis on energy conservation. He highlighted the principle of least-cost planning in which the various options for bridging the demand–supply gap are taken up in the order of increasing cost. He cautioned, however, that the results presented by him were sensitive to the cost data that has been assumed. He observed that the ranking of the costs of different technological options is essential for a rational sequencing of various options in the least-cost electricity planning.

The seminar concluded with a discussion on the financial incentives offered by various agencies for renewable energy sources. This seminar was unique since it was for the first time that the field data collected on the performance of various renewable energy technologies in India were discussed in detail. This demonstrates that renewable energy technology has reached a take-off stage in India.

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RESEARCH NEWS

Recombinant gene therapy in the treatment of cardiovascular disease

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What distinguishes medical practice in the present century from that of earlier centuries is the impact of technology. Among the technological advances being made, recent excitement among medical men is caused by the rapid advances in somatic gene therapy research.

It has been demonstrated that genes can be inserted by retroviral-mediated gene transfer into a variety of mammalian cell types like the blood-forming cells, liver cells, neural cells, and endothelial cells. The objective of these gene transfer studies is to find cure for genetically-based deficiency diseases. It is also possible to enhance the function of otherwise normal cells by gene [illegible]. Application of this principle [illegible]ve the clinical efficiency of an [illegible]ble biomedical device forms the [illegible]f a recent article by Dichek

[illegible] a major cause [illegible]cular disease. [illegible]

plasty). Recurrent occlusions are reported after these procedures and to maintain the arteries patent, absorbable and nonabsorbable metallic stents have been in use. Many laboratories are involved in perfecting the use of these stents. An important clinical problem in these devices is thrombosis in the early period and re-occlusion due to cell proliferation in the late period. The risk of early thrombosis can be reduced if the stents are seeded with autologous endothelial cells before placing the stent *in vivo*. A distinct advantage would be gained if one could engineer the cells used for seeding, to express an increased anticoagulant or thrombolytic activity. This is precisely what has been accomplished by Dichek *et al.*

Dichek *et al.* have demonstrated that the gene encoding tissue type plasminogen activator (tPA is a naturally occurring anticoagulant in the body) could be introduced into endothelial cells by retroviral expression vectors. They have also successfully seeded these cells onto metallic stents *in vitro* and shown that the genetically modified endothelial cells continue to express tPA while still attached to the device. The amount of tPA produced by these cells is significantly greater than that normally produced by human endothelial cells *in vitro*.

One may ask whether these *in vitro* results guarantee clinical efficacy. To answer this question, *in vivo* studies are required. Nevertheless, two other recent reports favour an optimistic view. In animal experiments, Nabel *et al.*[2] demonstrated that endothelial cells genetically modified *in vitro* express an indicator gene for atleast four weeks after implantation on denuded arteries. In another experiment, when dacron grafts seeded with genetically modified endothelial cells were implanted in arteries of animals, Wilson *et al.*[3] observed that, even after five weeks, the genetically engineered endothelial cells continued to express the introduced gene.

These three reports together illustrate the potential for recombinant gene therapy in the treatment of cardiovascular diseases.

1. Dichek, D. A. *et al.*, *Circulation*, 1989, **80**, 1347.
2. Nabel, E. G., Plantz, G., Stanley, J. C., Nabel., G. J., *Clin. Res.*, 1989, **37**, 521A, (abstract).
3. Wilson, J. M., Birinyi, L. K., Salomon., R. N., *Clin. Res.*, 1989, **37**, 593A, (abstract).

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