CAPACITY BUILDING FOR RENEWABLE ENERGY IN INDIA

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ABSTRACT

The transition from a fossil fuel driven energy system to the renewable energy based systems of the future requires a concerted effort for capacity building. A review of select international experiences revealed innovations in School kits, international co-operation, web based modules and inter-disciplinary post-graduates degree programmes. This paper examines the manpower requirements for renewable energy in India. Recommendations include integration of renewables in the engineering curriculum, development of web based modules, renewable technology incubators and an emphasis on R & D for renewables.

Keyword: Capacity Building, Renewable Curriculum, Institutions, Manpower

1 INTRODUCTION

The present energy use pattern in the world is characterized by a dependence on fossil fuels. About 80% of the world's primary energy consumption is from fossil fuels [WEA, 2000]. Modern renewables account for only a small proportion (2-3%) of the total. Existing estimates of oil and natural gas reserves indicate that they can only support present levels of consumption for 40-50 years (or less). Even coal that is relatively more abundant will be depleted in the next 100 years. Apart from the fossil fuel depletion issue the global warming problem constrains the continued use of fossil fuels. The major contribution of anthropogenic carbon dioxide emissions is fossil fuel combustion. This indicates that the present energy use pattern cannot be sustained in the future. Future energy systems are likely to have significant shares of renewable energy. The transition from the existing fossil fuel driven energy systems to the sustainable energy systems of the future based on renewable energy needs concerted efforts in capacity building for renewable energy. This paper discusses the requirements for capacity building to accelerate the adoption of renewables in future energy systems in the Indian context. Initially a review of select international experiences is presented before focusing on the Indian scenario.

2 REVIEW OF SELECT INTERNATIONAL EXPERIENCES

School Kits - Broman [1994] shares his experiences with two decades of renewable energy education in Sweden. He differentiates the training required at different levels – university, vocational training, school, pre-school, educating, decision makers and educating the general public. An interesting idea implemented by Broman and his colleagues is a solar trailer that includes laboratory models of solar hot water systems, PV systems, a wind turbine, a wood stove, measurement instrument and can be loaned to schools around the country.

International Co-operation - Schools can also benefit by participation in ongoing research projects as demonstrated by a European community project between schools in London and Frankfurt and support by a consortium led by the Batelle Institute [Brekley and Kuetz (1994)] for manufacture and testing of Cds-CdTe thin film solar cells. A Canadian initiative [lawand and Ayoub (1998)] resulted in developing a training network for rural schools in Argentina. This involved preparation of a Solar Primer, Micro-Hydel Guide, development of educational videos and working models.

Web-based Modules - An interesting initiative is the Australian Co-operative Research Centre for Renewable Energy (ACRE) that provides a multidisciplinary approach and caters to graduates of any discipline [Jennings and Lund (2001)]. The ACRE education program focuses on energy for sustainable development and provides flexibility for part-time, distance education and continuing professional education (Details are available at http://acre.murdoch.edu.au/education) O'mara and Jennings (2001) review some of the websites available for renewable education and suggests the need for an integrated site that provides a classification methodology. Hui and Cheung (1999) provide details of a web based learning environment set up at the Hong Kong University focusing on Building Energy Efficiency and Solar Energy in Architecture.

Degree Programmes - Most universities prefer to offer inter-disciplinary courses at the post-graduate level with a specialization in Energy. These are usually available to graduates with a science / engineering background and result in a Master of Science. Several US and European universities have opted for this. A compilation of US universities offering energy courses revealed

more than 60 energy programmes among the top 200 US universities (Energy Foundation, 1992). Other International examples are University of Sheffield, UK (M.A./M.Sc. in Energy Studies, Post Graduate Diploma, Post Graduate Certification) Tsinghua University, China (M.Sc., M.Phil), University of Sao Paulo, Federal University of Rio de Janeiro, Brazil (Masters + Ph.D). Some programmes link Energy and Environmental (CEEP, Princeton) issues while others focus on Energy and development (EDRC, South Africa), on Energy Planning and Policy (University of Technology, Sydney, Australia).

3 NEED FOR CAPACITY BUILDING IN INDIA

India's fossil fuel reserves are limited. The major proportion of the domestic oil consumption is based on imports. Hence the importance of development of alternative energy sources has been recognised by the government. This has resulted in Government support for Nuclear Energy and Renewable Energy. India is one of the few countries that have a dedicated Ministry for the promotion of non-conventional energy (Ministry of Non-Conventional Energy Sources, MNES). The efforts of MNES have resulted in a steady growth of renewable energy in India. The present share of renewables in the Indian power sector is about 4.4% by installed capacity and 2.8% by gross generation. Table 1 shows the breakup of installed capacity of different renewables and their estimated capacity factors. India's energy sector has been growing at 6-7% per year. Despite this there are severe energy shortages and the energy services per capita are low. As India develops, the energy services would have to significantly increase. The Ministry of Power estimates an additional capacity of 100, 000 MW to be built in the next decade to meet India's power requirement. MNES has set a target of 10% of power generation from renewables in the next 10 years. The problem with renewables is their high initial cost, dependence on subsidies, incentives. Renewables are often suitable for distributed generation / decentralized energy systems and often need to be treated differently from the centralized fossil fuel based energy systems. In order to mainstream renewables in India's energy sector it is essential to focus on capacity building.

Table 1: Installed capacity and estimated generation from different renewables in India

	Installed[a] Capacity	Estimated Capacity* factor	Estimated Generation
Wind	2483 MW	14%	3045 GWh
Biomass Power	234 MW	70%	1435 GWh
Biomass Gasifier	69 MW	70%	423 GWh
Bagasse Cogeneration	379 MW	60%	1992 GWh
Small Hydro	1603 MW	50%	7021 GWh
Waste to Energy	41 MW	70%	251 GWh
Solar PV	2.5 MW	20%	4GWh
	4813 MW		14,171 GWh

a Source MNES (2004) + 2001-2002 value was 13.3% - average * Authors estimate

What are the dimensions of capacity building required?

The three main aspects required are

a) Manpower
b) Institutions
c) Infrastructure / Facilities

The skills required for development and deployment of cost – effective renewables need inter-disciplinary approaches, innovative financing and marketing.

4 RECOMMENDATIONS

Manpower Requirements - The manpower requirements for renewable energy sector can be classified based on the nature of jobs that they would perform. Figure 1 shows a listing of the typical functional areas required directly for renewable energy systems. Each of the functional areas would require different skills and may be performed by manpower employed by different institutions. For example the installation of solar PV systems may need technicians who have undergone a few weeks of training on solar PV. Siemens carried out a few training modules for technicians in India during 1995-96. In addition to these functional areas manpower would be required for financing renewables and for policy analysis and regulation. The different institutions that are involved with renewable energy can be classified as given in Figure 2.

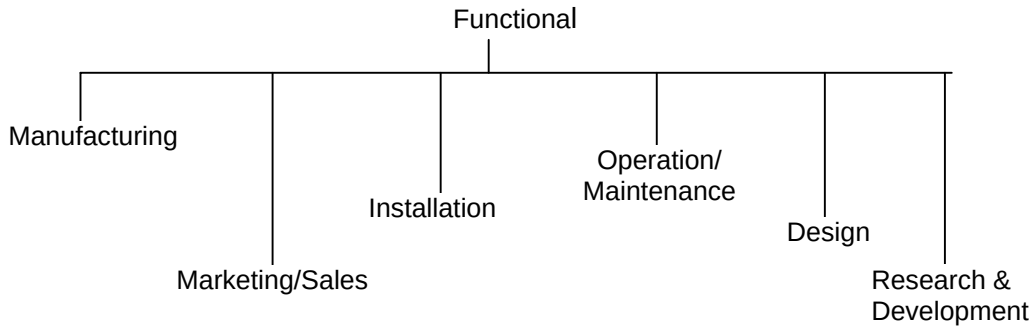

Figure 1: Functional areas for Renewable Energy Systems

Some of the existing institutions in the energy sector may need to impart training to existing employees to enable them to deal with renewable energy systems e.g. a State Electricity Board may need to train its engineers to deal with Wind generators, Grid connected Solar PV. Non-energy companies (e.g. traditional manufacturing industry) may need exposure to renewable energy systems in order for them to exploit the potential for solar heating, energy from waste, renewable electricity. Banks and financial institutions need an appreciation of renewable systems and an idea of the different benefits, risks and cash flows associated with renewable systems. For many existing institutions the demand for training modules in renewable energy may not be recognised. However these need to be pro-actively initiated by the government and the renewable energy industry. This is also likely to open up new job opportunities e.g. Renewable Energy Supply Companies.

Curriculum - Since the nature of the energy system itself is likely to change in the future it is essential that renewable energy be integrated into the traditional engineering curriculum.

A draft model curriculum in renewable energy was prepared for MNES (Banerjee, 2003) that provides two alternative modules to be integrated as lectures in existing courses.

Module 1- Compulsory/core of 20 hours followed by an elective (full course) related to renewables (Wind/Solar/Waste to Energy etc…)

Module 2- Compulsory course on Renewable Energy (40 hours of lectures + experiments)
A course in Environmental studies has been mandated for all Engineering students based on a Supreme Court judgment. MNES should initiate discussions with UGC / AICTE / IITs / MHRD to facilitate the integration of renewable energy in the engineering/science curriculum. At the postgraduate level there are several programmes offered for M.Tech in Energy (IIT Bombay, IIT Delhi, Ahilya Devi University Indore...). MNES initiated a National Renewable Energy Fellowship scheme to support post-graduate students (M.Tech/PhD) working on renewable energy projects. Unfortunately the demand for post-graduate engineers in the renewable energy sector is yet to materialize. Energy engineers prefer to opt for software/conventional energy sector companies.

Web-based Module - There is significant potential in exploiting web-enabled education (e.g. Centre for Distance Education Programme at IIT Bombay) and Distance education through relay of a live classroom (e.g. IIT Bombay's KRESITs Distance education programme through VSAT linked to remote centers in Pune, Nagpur, Hyderabad, Indore, Goa…). Video recordings of different modules can be prepared and made available via the web. This can be supplemented by classroom teaching and can provide flexibility of learning for working professionals. A team of industry-academic-government should identify the requirements for certificate / diploma modules and use the existing institutions IITs, TERI, NITs as content providers.

School Education - In the case of school education a number of solar toys, renewable kits and solar trailers should be designed and disseminated in schools. Workshops for training teachers should be carried out in each region. The different boards ICSE/KV/SSC should be approached to effectively implement this.

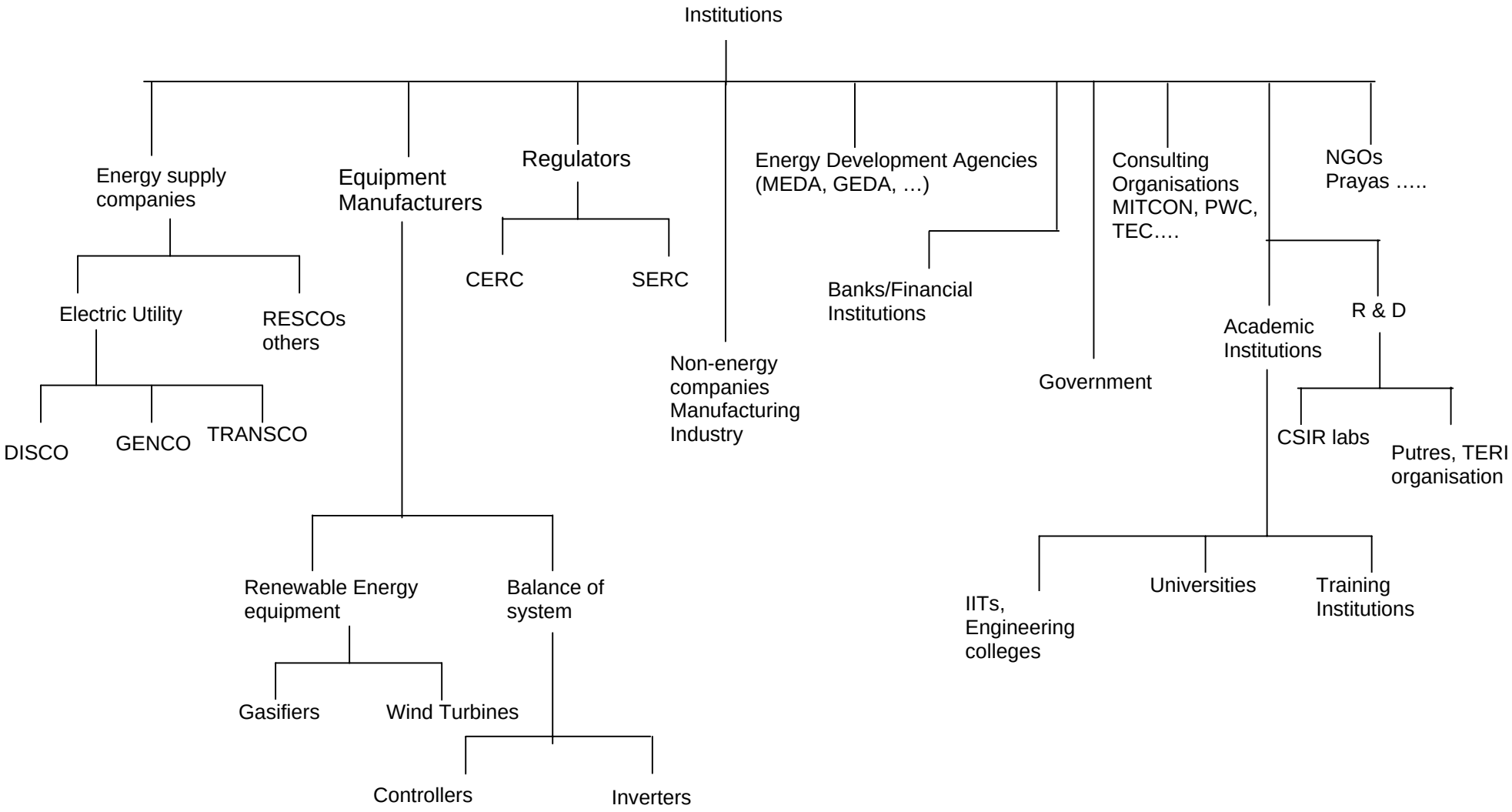

Figure 2: Institutions involved with renewable energy

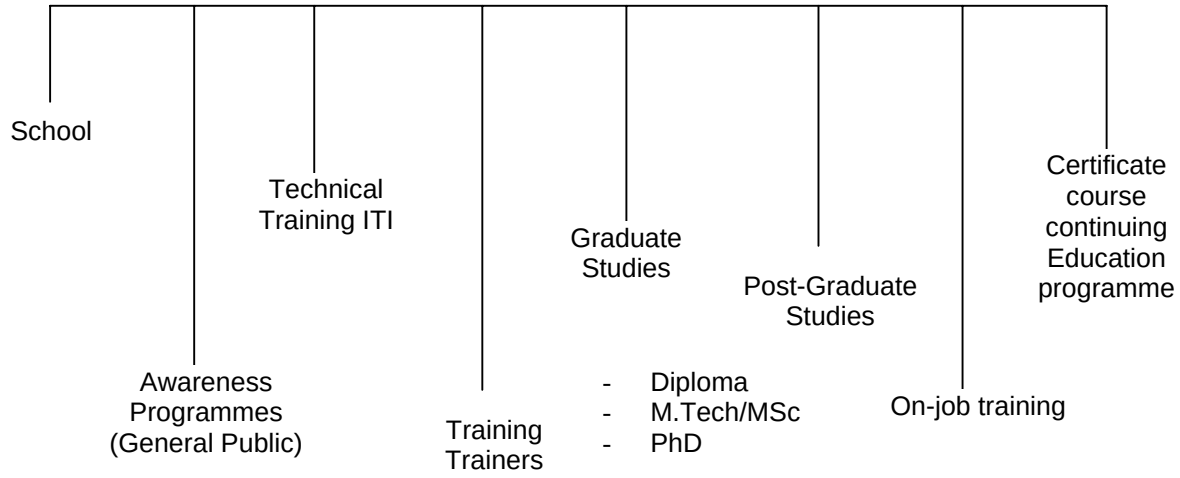

Figure 3: Classification of Training Levels

Renewable Technology Incubators - There is a need to encourage Incubators for Renewable Energy enterprises. The Department of Science and Technology and the National Entrepreneurship Network is encouraging the establishment of Technology Business Incubators in the company. These provide seed funding, infrastructure support and guidance to help convert ideas into marketable products. A virtual national renewable energy Incubator can be established with linkages to them existing Technology Business Incubators. A venture capital fund can be provided specifically for this purpose.

Infrastructure - There is a need for strengthening of existing institutions and creation of a few centers of excellence that have state of the art research / testing facilities for renewables. Setting up of a public sector / joint sector Bio-energy corporation on the lines of National Thermal Power Corporation/ Nuclear Power Corporation would help in promoting biomass energy in the country.

International Co-operation - India has the potential to emerge as a key global player in renewable energy. This can be achieved by positioning India's expertise / knowledge and making it available for the developing world. MNES initiated a series of international programmes on solar energy, biomass energy, and hydro energy. IIT Bombay's experience with running a two-week course on solar energy for energy professionals indicated an excellent response and potential to benefit from cross-country experiences. The course contents included a mix of classroom lectures, laboratory sessions, tutorials and assignments (country energy balances, sizing, selection of renewable systems) and site visits.

Consortium Approach - There is a need for establishment of a consortium of renewable industry – research and academic institutions and government to define the research and development needs of the sector and build targeted R & D programmes.

R & D Thrust - The renewable energy sector has to attract the brightest minds. In order to be cost-competitive several breakthroughs are required. This would require the pooling of intellectual (research) resources from the conventional science and engineering disciplines. In order to attract such researchers it is essential that the energy industry play a pro-active role in defining R & D directions. The R & D expenditure by Indian companies on renewable energy is marginal. The government spend on renewable energy is also low (MNES spent about Rs. 12.3 crores on R & D in 2000-2001) as compared to other countries ($2.47 billion by Japan (1997), $3.7 billion by USA (1999)). Indian technology development and R & D efforts are often sub-critical.

In order to effectively make the transition from a fossil fuel driven energy system to the future renewable based energy systems, it is essential for India to focus on building capacity for manpower training, strengthening institutions and building infrastructure. A road map for the next 20 years should be prepared detailing out the steps required for implementing the recommendations suggested in this

paper. This needs to be discussed and agreed upon by industry – academics and government and can form the basis for mainstreaming of renewables.

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