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## "Global Trends in Renewable Energy Education"

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# GLOBAL TRENDS IN RENEWABLE ENERGY EDUCATION

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## ABSTRACT

A bibliographic review of the available published literature on renewable energy education and other relevant aspects is presented. Some important inferences and recommendations for future work are also included.

## INTRODUCTION

Research and development activities in the area of renewable energy technologies received a major boost immediately after the first oil crisis in early seventies. Efforts were made, on a global scale, towards the development and dissemination of a variety of renewable energy technologies to reduce the consumption of conventional fuels. While only a few technologies successfully penetrated into the consumer market, in view of the internationally falling oil prices the short-sighted policy makers made their development a low priority activity. Recently, once again, the interest in the development of renewable energy technologies has renewed primarily due to their environmental friendliness and also due to the realization of the fact that it is not at all possible to meet the global energy needs with conventional fossil fuels on a sustained basis.

Design, development and dissemination of appropriate renewable energy technologies to meet the growing energy requirement for improvement in the quality of life of their large population is a major challenge for most of the developing countries (Bourodinos, 1992). One of the serious handicaps in the implementation of any strategy in this direction is the unavailability of trained manpower at all levels. Moreover, the attitudes and preferences of the common public as well as of the decision makers have to be changed to effect wider acceptance of renewbale energy technologies. This necessitates that sincere efforts be made in the area of renewable energy education and training not only to provide the required technical manpower at all levels to design, develop, fabricate, install, operate and maintain the various renewable energy systems but also to motivate the common public towards a large scale utilization of these systems (Broman, 1988, 1991; Broman and Ott, 1992; Charters, 1990; Garg and Kandpal, 1991a, 1992a).

Efforts have been made in the past towards the establishment of education and training programmes in the field of renewable energy and other relevant disciplines (Broman and Ott, 1988, 1992; Broman, 1991; Chagwedera, 1990; Lahart 1986, 1991; Ott and Broman, 1988; Pinter 1991; Reinhardt, 1988; Shah, 1990; Trieb and Polo 1993; Wade and Lai 1988; Welch, 1986). In this paper a brief bibliographic review of the global efforts in this direction is presented. An attempt has been made to include all facets of renewable energy education and training on the basis of the available literature. Attempt has also been made to summarize the emerging recommendations for strengthening energy education efforts.

## LEVELS OF RENEWABLE ENERGY EDUCATION

It is now widely accepted that for successful and sustained implementation of renewable energy technology development and dissemination programmes, education and/or training at the following levels be provided (though the relative importance of each level for any specific country/region will depend upon local characteristics and priorities) :

(i) Primary, (ii) University level teaching/training programmes, (iii)Training of technicians/mechanics and (vi) Educating policy makers and common public.

A brief review of efforts undertaken, so far, in each of these categories is presented in the following sections :

## PRIMARY AND SECONDARY SCHOOL EDUCATION

The future well being of our younger generation primarily depends upon our individual and collective abilities to make the best possible use of presently existing nonrenewable resources of energy and to harness new and renewable sources of energy. Obviously, the problems involved are both immediate and long range. Many of the viable solutions inevitably will have to come from the scientists and engineers of tomorrow - the youth of today. Therefore, one of the most important responsibilities of the present generation of energy educators is to impart suitable education/training to our younger generation so that they appreciate all the energy related complex issues and are equipped to seek proper solutions. While the basic principles of energy conversion and utilization may be introduced in the primary school curriculum, it may be possible to explain the principles of operation of various energy devices at the secondary school level (Charters, 1992). Availability of appropriate teaching learning resource materials is an essential prerequisite for successfully introducing energy related new concepts in primary and secondary school curriculum.

As early as in 1978, Greenwald (1978) developed a lecture laboratory curriculum base for the teaching of alternate and renewable sources of energy within the secondary school industrial arts laboratory at the Montclair State college in New Jersey, USA. The course aimed at providing the students an insight into the identification of specific energy sources and their potential.

A detailed listing of solar energy experiments which may be offered to school level students has been presented by Kandpal and Mathur (1982). Full details of about twenty school level experiments on solar energy are given in Mathur and Kandpal (1988). The experiments developed are of varying difficulty and cover almost all important aspects of solar energy utilization. The experimental modules can be made from commonly available inexpensive materials.

Several groups around the globe have developed school curricula and packages (Britton et al, 1980; Broman, 1989a; Charters, 1990; Ott, 1990). For example, Charters (1990) has described the development of Victorian Renewable Energy Education Programme and the primary and secondary school teaching packages developed for this purpose. The packages were released to primary schools in Victoria (Australia) at nominal costs in 1987 and in-service training courses were organised for teachers involved with the use of the packages. The material included in the packages provides for games and activities for experimental work and for the construction of simple experimental apparatus for classroom and outdoor use. Similarly, concept of a new course for secondary schools and educational solar laboratories at the Moscow Institute of New Technologies in Education is discussed by Koltun and Gukhman (1993). It is being increasingly realized that the school students should develop an insight into the challenges of engineering designs of energy systems and should be able to follow such a design project through manufacture to testing and performance evaluation. With this objective, in 1990, secondary school students in Victoria (Australia) were invited to design, build, and enter model solar cars in a competition against each other (Wellington and Mellor, 1992). Considerable amount of work in the area of energy education at school level has also been undertaken at Florida Solar Energy Centre, USA (Allen and LaHart, 1978; LaHart, 1986, 1991).

## RENEWABLE ENERGY EDUCATION AT UNIVERSITY LEVEL

Efforts to offer university level courses in the area of new and renewable energy sources have already been initiated in several countries. Postgraduate level teaching/training programmes have, so for, been given priority as compared to the full fledged undergraduate level programmes in this area

(Charters, 1992). The international postgraduate level teaching/training programmes being offered presently include those at AIT Bangkok (Bhattacharya, 1993), University of Reading, University of Oldenburg (Blum et al 1988a, 1988b, 1989) and IIT Delhi (Mathur and Kandpal, 1993). Some other postgraduate level programmes are (i) one year renewable energy course at University college of Falun/Borlange (Broman and Hadell, 1992) (ii) one year full time M.Sc. Course in the area of Energy Systems and Environmental Management (Burek and McVeigh, 1991), (iii) M.Sc. Programme at Guru Nanak Dev University in Amritsar, India (Singh and Bhatti, 1991) (iv) M. Tech in Energy Studies at IIT Delhi and several other postgraduate programme in India (Garg and Kandpal, 1992c). Details of many more such programmes presently operational as well as of those offered in the past can be obtained in Blum (1992), Chuah et al, 1979; Garg and Kandpal (1992a, 1992b), Smith and Lowry (1983) and UNESCO (1980,1984). It is widely appreciated that development of structured curricula for university level courses in the area of new and renewable sources of energy is crucial for their successful and effective implementation (Garg and Kandpal 1991a, Greenwald, 1978, McVeigh 1982, 1987).

Preliminary efforts towards the development of a postgraduate level teaching programme in the area of energy engineering have been made at the Centre for Energy Studies of the Indian Institute of Technology, Delhi (Garg and Kandpal 1993a, 1993b; Kandpal and Garg, 1993a, 1993b). For efficient and effective communication between the teacher and the learner, development of appropriate teaching learning aids, laboratory experiments etc. is quite important. Some such attempts for university level programmes have also been reported in the literature (Blum, 1992; Borer Jr. 1991; Boyle et al 1992; Everett et al 1993; Gonzalo 1993; Gordon and Weintraub, 1991; Klima, 1991; Lechner 1991; Naumann 1991). Several other attempts towards development and implementation of curricula in this area (on one or more subjects) are also reported in literature (Broman et al, 1991; Broman, 1993; Marx, 1993; Slater, 1985).

## TRAINING OF TECHNICIANS AND MECHANICS

Training of technicians to supervise fabrication, manufacture, installation etc of technologies and of mechanics to actually work on the shop floor and to provide repair and maintenance back up is very necessary for sustained development and dissemination of new energy technologies (Mathur, 1988). A very interesting exercise for assessing the need for developing and implementing technical and skilled worker training for the solar energy industry has been carried out by Orsak et al (1978). By forecasting the future manpower requirements for the solar industry and identifying the tasks that should be performed by technical and skilled workers, the authors have provided

guidelines for developing a curriculum to train these workers. The detailed contents of a vocational training programme for designers and installers of photovoltaic (PV) systems developed by Colorado Mountain College in Glenwood Springs (USA) are described by Olson et al (1985).

## EDUCATING POLICY MAKERS AND COMMON PUBLIC

It is necessary to educate and convince policy makers about the merits of the new innovations in the area of energy. Similarly educating the common public about the energy related issues and exposing them to the state of the art energy technologies is also of immense importance as the utilization and maintenance of the energy technologies is the responsibility of the end user (Charters, 1992). Bara and Muntasser (1993) have emphasized the need for educating and training women in the use and management of renewable technologies.

## RECOMMENDATIONS

On the basis of the present study the following recommendations may be made for strengthening energy education programmes in general and renewable energy education in particular at all levels :

(a) Energy related concepts and courses must be introduced from primary classes through all formal and informal stages of education. All sections of the society should be made aware of the existing energy related problems and should be motivated to seek appropriate solutions.

(b) There is an urgent need of developing and implementing structured course-curricula for all types of teaching/ training programmes on energy. The curricula may be standardised at the national, regional or even global level to facilitate technology transfer and exchange of know how.

(c) Energy education programmes must offer a mix of academic as well as hands-on skills training to the student. The later can be accomplished by conducting laboratory experiments, practical demonstration of operational systems, field visits and field installation of an actual working system. Wherever applicable, the students may be encouraged to undertake hardware oriented projects during the course of the teaching/training programmes.

(d) Preparation of text books, laboratory manuals, teacher's guides and other teaching-learning aids for all levels and modes of education in the field of energy is very important for successful implementation of the teaching/training

programmes. If appropriate, modern techniques of communication and information processing as well as computer aided instruction techniques may also be used for this purpose.

(e) Sincere efforts must be made to educate all the members of the society at large about the basic concepts of efficient energy utilization and also about the various energy options available to them. Use of mass communication media, organisation of exhibitions and trade fairs etc and offering community college courses and adult education programmes are some suggested mechanisms for this purpose.

(f) It is necessary to organize short term courses/workshops etc for providing basic input about energy and relevant topics to the policy makers and other associated administrative personnel.

(g) For providing an efficient and effective energy education at the school level it is necessary to establish facilities and device mechanisms for inservice training of existing teachers.

(h) The objectives of the teaching/training programmes on energy should be consistent with the development strategy followed by the country/region.

(i) The university level teaching/training programmes should be designed to provide ample job opportunities and/or should be capable of providing self employment.

(j) A close interaction among the organisations imparting energy education at national, regional as well as international level is quite necessary for increased efficiency, economy and effectiveness of the teaching/training programmes. An active global network should be established for this purpose (Broman 1989b, 1990, 1992).

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