ABSTRACT

Development and dissemination of efficient and economic techniques of harnessing new and renewable sources of energy to bridge the ever increasing gap between the energy demand and supply in developing countries is a formidable challenge for their governments. Availability of educated and trained manpower at all levels is very crucial for successful implementation of any programmes towards sustainable use of new and renewable sources of energy. Renewable energy education is, therefore, of prime importance. An attempt to analyse several issues involved in this regard is made in this paper.

INTRODUCTION

The growing scarcity of conventional fuels and the adverse ecological and environmental impacts associated with their excessive use have raised global interest in the harnessing of various renewable energy sources. Development of appropriate renewable energy technologies, proper energy-end use matching, and suitable energy conservation measures offer new options towards meeting the increasing energy requirements of developing countries for an improvement in the quality of life of their population. Renewable energy resources, which may be practically inexhaustible, could play a very important role in the future energy supply strategies of the entire world in general, and of the oil importing developing countries in particular, provided the techno-socio-economic barriers in their dissemination are minimized.

The objective of large scale dissemination of appropriate renewable energy technologies in a developing country to substantially modify the existing fuel mix, however, calls for dedicated efforts in this direction. Availability of adequate manpower and appropriate resources is crucial for success in these endeavours. Providing renewable energy education at all the required levels in an efficient and effective manner is a challenging task before the Governments of most of the developing countries. While there is broad appreciation of the need to impart renewable energy education only a few developing countries are actively pursuing teaching/training activities in this area. It is expected that with increasing pressures of fossil-fuel scarcity and adverse environmental effects of their use more number of developing countries would make efforts towards providing renewable energy education. It is in this scenario that an attempt to analyse some of the challenges and problems in imparting renewable energy education in developing countries is made in this paper.
PRESENT STATUS

In the last two decades some efforts have been made to provide renewable energy education and training in the developing countries (Garg and Kandpal, 1992a, 1992b, 1993a, 1993b, 1995, 1996; Kandpal and Garg, 1994a, 1994b; Mathur and Kandpal, 1994). However, most of these efforts have been made in the area of postgraduate level courses in universities, engineering colleges and institutes of technologies. Introducing relevant inputs into the school curricula has not yet been seriously considered. Similarly, the programmes for technicians and mechanics are also not available. Sometimes refresher courses are organised. Professionals from the majority of the developing countries usually go abroad for education and training in this area.

EMPLOYMENT POTENTIAL AND CURRICULUM DEVELOPMENT

Large scale unemployment and underemployment is a rather common characteristic of many developing countries. In a country like India it is highly probable that, unless carefully planned, the manpower with certificates/diplomas/degrees awarded in the field of renewable energy also do not get suitable employment. Therefore, prior to the development of any course-curriculum it is necessary to identify and analyse the potential job opportunities in the field of renewable energy. Depending on the job requirements of each type of skilled manpower the necessary inputs to satisfy the cognitive, psychomotor and affective domains of education must be provided. This necessitates an indepth analysis of the job requirements for each job opportunity (self or wage employment) envisaged with a specific teaching/training programme in the field of renewable energy. Only then the syllabus for the respective courses should be formulated (Fig. 1).

![Diagram of steps involved in the development of a course-curriculum](image-url)

Fig. 1. Steps Involved in the Development of a Course-Curriculum.
Realizing the importance of imparting renewable energy education at all levels (Table 1) it is quite likely (desirable as well) that such an attempt is made simultaneously at several levels. It is necessary to ensure consistency and continuity in the inputs provided at different levels to maximize the overall efficiency and effectiveness of the renewable energy education strategy. While the inputs given at a certain level must match with the expected job responsibilities it is also necessary to maintain a clear distinction between the learning objectives of two different level courses.

The course-structures of the renewable energy education programmes often have the subjective bias of the educators/professionals developing and implementing the curriculum. Rather than the inputs ought to be given at a particular level the inputs which can be given with the available expertise of educators often dominate the course curricula. Such a strategy, though unavoidable at times, may lead to a mismatch between the knowledge and skills required for the jobs to be undertaken by the student (when employed) and those acquired by him in the course.

Being a relatively new interdisciplinary area, renewable energy education largely suffers from the unavailability of appropriate resource materials for teaching-learning (text books are not available even for the postgraduate level teaching/training which has received maximum attention in developing countries). However, in view of the latest developments in the fields of computers and electronics effective audio-visual aids and appropriate materials for computer aided instruction can also be developed to impart renewable energy education besides a variety of other teaching-learning aids (Fig. 2).

One of the major constraints in promoting renewable energy education activities on a large scale is the unavailability of funds with most of the schools, colleges and universities in the developing countries. Being interdisciplinary and predominantly hardware intensive, renewable energy education and training efforts require a considerable amount of funds to provide the bare minimum inputs. In fact, to a large extent, the unavailability of appropriate teaching-learning materials can also be attributed to the lack of adequate funds.

The objective of providing renewable energy education in developing countries to face the challenge of meeting their rapidly increasing energy demand in a sustainable manner is an arduous task. A meticulously planned holistic approach is necessary taking cognizance of all the relevant facets of renewable energy education and training. Moreover, to enable implementation of any such strategy funds will have to be made available. The employment aspects of any renewable energy education programme offered beyond the secondary/high school level must be realistically analyzed before starting the course(s). International collaboration will go a long way in providing efficient, economic and effective education in the field of renewable energy.
Table 1. Different Levels of Renewable Energy Education.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Age Group</th>
<th>Institution</th>
<th>Type of Course(s)</th>
<th>Additional Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>5-10 years</td>
<td>Primary School</td>
<td>Introducing simple concepts in the course on environmental studies</td>
<td></td>
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<tr>
<td>2.</td>
<td>10-13 years</td>
<td>Junior High School</td>
<td>Introduction of relevant concepts and demonstration experiments in the science curriculum</td>
<td></td>
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<tr>
<td>3.</td>
<td>13-16 years</td>
<td>High School/Secondary School</td>
<td>(a) Introduction of relevant concepts, demonstration experiments in the science and Biology curricula. Separate chapters can also be introduced at appropriate places</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(b) Introduction of pre-vocational course(s) in the area of renewable energy technologies</td>
<td></td>
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<tr>
<td>4.</td>
<td>15-18 years</td>
<td>Senior Secondary School</td>
<td>(a) Introduction of relevant concepts, technologies, demonstration and laboratory experiments in the Physics, Chemistry and Biology curricula. A properly planned full fledged vocational course may be offered in this area.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>(b) Introduction of vocational course(s) in the area of renewable energy technologies</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Above 17 years</td>
<td>Technical Colleges</td>
<td>(a) Certificate and diploma courses for technicians and mechanics</td>
<td>Useful for policy makers and administrators as well besides teachers</td>
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<tr>
<td></td>
<td></td>
<td>Polytechnics</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Engineering Colleges</td>
<td>(b) Undergraduate and postgraduate degree courses</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Institutes of Technology</td>
<td>(c) Short term/on the job training courses for updating knowledge and skills</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Any age</td>
<td>Non-governmental and Voluntary organisations</td>
<td>Awareness programmes for common public</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Any other appropriate organisation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Mode(s) of Students-Teacher Interaction

Writing on a Board
Using Overhead and Slide Projection
Group Discussion
Competitive Activities
Demonstrations/Site Visits
Practical Design, Fabrication and Testing
Student Assignments and Presentations
Computer Aided Instruction

RESOURCE MATERIALS FOR RENEWABLE ENERGY EDUCATION

Resource Materials Used by Teachers/Instructors
Chalk/Pen and Board
Overhead Transparencies
Books
Handouts/Leaflets
Slides
Video-Films
Posters
Activity Sheets
Computer Software
Interactive Compact Discs
Teacher Guides/Manuals
Demonstration Equipment/Installations

Resource Materials Available to Students
Text Books
Reference Books
Research Journals
Popular Magazines
Activity Sheets
Lecture Notes/Handouts
Laboratory Manuals
Interactive Compact Discs
Do-it-Yourself Manuals
Computer Software Packages

Fig. 2. Resource Materials for Renewable Energy Education.

REFERENCES


1192


