# Energy Education in Ethiopia: The Status Quo and Future Prospects

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**Abstract:** Energy has often been described as the 'heart beat' of the economic world. Without energy, economic development would not occur. The movement of goods, services, people and information, and the development of commercial agriculture and large-scale industry depend upon the availability of energy. Availability of energy resources is, however, not enough to bring about economic development. For energy resource to contribute to a social and economic development of a given nation, there must be high level of know-how as to how to use and manage the resource. Energy resources of countries of the developing world in general and of Ethiopia in particular remain unused/underutilized until such a time when people learn how to tap and use the resource. Hence a desperate need for energy education. This study was aimed at assessing the state of energy education in Ethiopia. Policies related to energy education and students' textbooks prepared for use in selected grades have been analysed to see the potential for, the extent to and ways in which energy issues have been addressed. The assessment indicated that there is adequate policy backing for undertaking energy education in the country. However, energy issues have been only partly integrated at present. For example, a proposal has been put forth to prepare a 'Module' for energy education in Ethiopian schools. A framework for preparation of such a module has been worked out based on the assessment of the strengths and weaknesses of the existing educational materials; the policies pertaining to energy and environmental education; and assessment of the practices and problems of energy education in other countries. It has also been strongly recommended that schools in Ethiopia be used as 'mission centres' not only for awareness creation about the causes, consequences and solutions of the prevailing energy crisis in the country but also as centres for dissemination of alternative energy technologies like improved cooking stoves, biogas plants and solar home systems.

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## Introduction

### *Energy: Meaning and Classification*

Energy is an integral part of our daily life (WRI and CEE, 2000). But energy as a concept is not always understood in the same way. The common or 'layman's' understanding of energy clearly differs from the way 'hard sciences' define it. Physicists, for instance, define energy as the capacity to do work (work being understood as what happens when something is moved over a distance by using force). For living organisms including human beings, work means all biological functions including breathing. Energy is therefore essential for life to exist and function (WRI and CEE, 2000, Jadhav, 1997).

The energy from food sustains biological functions of organisms. Muscle energy of humans and animals is obtained from food through conversion as heat energy by releasing the chemical energy stored in the mechanical bonds of food materials. What is more, all natural processes are driven by energy. The water cycle, the wind system, storms, the growth and decay of plants, the formation of mountains, the weathering of rocks, etc., all use energy in one form or the other. In general, the relationship between human civilization and use of energy appears to be one of the issues that dominate contemporary discussions on energy. Varadarajan (1993:vii) has, for instance, made an interesting remark: "The wheels of civilization are kept turning by energy and all this energy, whether we draw it from a gallon of gasoline, a tone of coal or a pound of butter, has come to us from the sun".

Energy as a resource is often divided into renewable and non-renewable sources. Renewable energy sources are mostly biomass-based and are available in unlimited amount in nature. Under this category come such energy sources as fuel wood, petro-plants, agricultural waste like bagas, animal dung, wind energy, water energy, tidal energy, geothermal energy, solar energy, etc. The non-renewable or exhaustible energy sources are available in limited

amount and develop over a longer period of time. This category of energy resources includes coal, mineral oil, natural gas and nuclear power. As a result of unlimited use, such resources are likely to be exhausted any day.

### *Energy and Development*

Energy use is inextricably bound with the development of modern economy. In fact, energy is one of the most important natural resources used as input for development at large. Sokona (2002:39) rightly underscores when he/she says: "… Energy is a critical and irreplaceable element of life and development, in the sense that it plays a key role in the establishment of economic, social and environmental conditions". It is also true that energy stood at the heart of the industrial revolution of the nineteenth century, which resulted in an incredible gap (socio-economic and cultural) between the different communities on Earth. This led to the conclusion that "Societies are characterised by their level of ability for, access to, and use of energy" (Shakya, 2000:145).

Over the last two centuries, science and technology have helped to intensify the invention and refinement of devices for converting energy from naturally available forms to those that perform various tasks (Jadhav, 1997). Energy still maintains its pivotal position in the era of information technology that marks the 21st century. Those who command the energy are in a position to compete in the world development race if not in a position to command it. Commanding energy means not only commanding the resources but also commanding energy related **know-how**. This, in turn, implies that ***Energy Literacy***[1] is one of the most critical factors that make a difference in the social and economic development of a nation.

[1] Energy Literacy refers to the awareness about energy both as a physical phenomenon and natural resource; and ability to covert, use and manage energy resources.

## The Problem

As indicated earlier, energy is a driving force for economic development. One should also underline the complex relationship between use of energy and environmental degradation. In developing countries like those in Africa, there is a unique problem with regard to use of energy resources. On the one hand, there is only limited capacity to make use of energy resources thereby leading to underdevelopment. On the other, some types of energy resources have been overused causing massive environmental degradation. Davidson and Karekezi (2002:8) express their concern that in Africa, "Energy production and use have been linked to some of these environmental problems. Unsustainable land use, combined with urban demand for fuelwood, contributes to soil erosion, land degradation, devegitation, deforestation and, ultimately, to desertification". Kazoora and Wandera (2003:107) also expressed a similar concern on the delicate balance between energy use and economic development in Africa: "The crucial dilemma for Africa is how to reconcile development goals and the elimination of poverty which will require increased use of energy and raw materials".

Ethiopia has a huge potential to develop and use energy resources for national development. This includes hydroelectric power generation, solar power and geothermal energy (to a lesser extent). The level of utilization of modern fuels in the rural areas of the country (where 85% of the total population live) is, however, among the lowest in the world. Electricity consumption, for instance, is limited to no more than one percent of the rural population and only 10-13 percent nationally (Wolde-Ghiorgis, 2004:229). Consumption of petroleum products in rural parts of the country is also mostly limited to the use of kerosene for lighting in wick and lantern lamps. One of the encouraging developments in the recent years is that the national energy issue in general and the rural energy problem in particular are beginning to be considered as the core hindrance to poverty reduction. Over the last two decades, a number of proclamations related to environmental protection and management have been

issued; and natural resource conservation strategies were designed. Whether or not the education sector is responding to the issues related to energy use and conservation is, nevertheless, not known. This study is therefore aimed generally at exploring the state of energy education in the country.

## Energy Education in Schools: A Theoretical Framework

Three interrelated approaches to energy education in schools have been identified (Schröder, 1998). These are the pedagogical approach, the less intensive approach and the incentive-oriented approach. Success in attaining the goals of energy education in schools largely depends on the ability to combine the approaches in such a way that they produce maximum and long lasting effects. The three approaches are briefly described below.

### *The Pedagogical approach*

The pedagogical approach focuses on integration of energy issues into the school curricula, working out appropriate methods to teach the content in the curricula, and establishment of school energy clubs. Project-oriented education is another way highly emphasised by the proponents of the pedagogical approach (Schröder, 1998). Inclusion of energy-related topics into the school curricula is, however, not enough to bring about a lasting change in pupils' behaviour about use and management of energy resources. It is, therefore, necessary to use other approaches like the two presented hereunder.

### *The Less Intensive Approach*

It is obvious that supplementing the pedagogical efforts to energy saving by practical actions like the proper use of light in a classroom leads to a better result. The second approach is based on this premise. In general, pupils are expected to take part in some visible and tangible activities that contribute to a decrease in energy

consumption. This approach does not propagate, however, a massive and cost-intensive programme on energy saving actions.

*The Incentive-Oriented Approach*

This approach is entirely different from the other approaches. It is based on the provision of material incentives (bonus) to the participants of the energy saving activities. For instance, part of the money saved through an intelligent use of energy could be given to the participating schools. Experience shows that the incentive-oriented approach is more effective than the others. At the same time, it requires a more rigorous planning and organisation.

**Rationale and Aims**

Availability and cost are often considered as the major factors that affect the pattern of use of resources in general and energy resources in particular. Conservation and wise use of energy resources is also affected by awareness and attitude. This is true as much for the use of wood to cook beans on a three-stone stove as it is for use of electric energy to dry machine-washed clothes. It has already been noted that ***Energy Literacy*** is one of the most critical factors that make a difference in the social and economic development of a nation.

There are several ways of creating 'Energy Literacy'. Formal education is one. In fact, the school curricula are believed to be "the best vehicle for generating public awareness of areas of energy concern" (Barrow and Morrisey, 1987:15). Furthermore, there is a general agreement, according to Barrow and Morrisey, "**...** that attitudes about and knowledge of energy must be a part of every public schools student's education". Karekezi and Ranja (2002:190) suggest that development of a comprehensive and sustainable human resource base in energy issues and technologies requires sensitization of this potential resource from an early stage. This, in turn, "calls for the inclusion of important energy issues into the

existing school curricula, preferably from primary level up to the tertiary stages".

In the case of Africa, the issues of sustainable development (which includes energy) in relation to education or school curricula are just becoming a matter of concern to researchers (Raheem et al., 2006:15). The authors report that "**…** even though quite a remarkable amount of work has been done with the assessment of school curricula in Africa, this has not been carried out vis-à-vis sustainable development". There is thus an evident need to know whether the educational systems in Africa meets the goals of sustainable development. The same could be said about Ethiopia. The major aim of this study was therefore to investigate policies that encourage or hinder energy education; and the place of energy issues in students' textbooks prepared for Ethiopian schools.

## Methodology

There is a general consensus that energy issues should be addressed in all school types and at all grade levels (Karekezi and Ranja, 2002). It appears, however, that there is a paucity of information as to 'what' energy education should constitute at schools. Joshi et al., (1998:91) examined the state of energy education in different countries of Asia. They strongly suggested that, at the school level, "**…** efforts will have to be made to introduce firsthand exposure to basic energy related concepts and their application". It was further argued that education at this level should be aimed at making students "**…** aware of the various types of non-renewable and renewable sources of energy, their resource potential, existing technologies and socio-cultural and environmental issues related to their development and utilisation". It is also evident that energy has several dimensions: historical, social, economic, political, physical, etc. It is, therefore, only natural to expect energy education to reflect this extremely important feature that characterises energy issues and discussions thereon. No one subject is in a position to cover energy issues in any meaningful depth.

One of the major aims of this study was assessment of the extent to and ways in which energy issues have been addressed in student textbooks. To this end, students' textbooks or syllabi for selected school subjects, namely, biology, chemistry, geography and physics have been analysed. The four subjects have been selected because studies conducted elsewhere (Aklilu, 2001) indicate that energy issues have been addressed mainly thorough these subjects. The textbooks or syllabi analysed were prepared by the National Institute for Curriculum Development and Research (ICDR) and the Department of Curriculum Development and Research (DCDR) of the Addis Ababa City Administration.

For the sake of clarity and systematisation, energy education was divided into three categories:

- **Category I**: Energy as a physical phenomenon (definition, forms, generation, conversion, transmission, transportation, etc.);
- **Category II**: Energy as a resource (availability, geographical distribution, pattern of use, problem of depletion, need for conservation, use of alternative sources of energy, etc.); and
- **Category III**: Energy use and environmental degradation (environmental problems associated with use of energy, methods of pollution abatement, etc.).

It is to be noted here that all the syllabi and textbooks for the aforementioned school subjects are equally interesting to assess in view of the issue studied. For the sake of brevity, however, the author decided to focus only on four of the grades (grades seven and eight from the upper primary education and nine and ten from the lower secondary education). As regards energy and environmental policies considered in the paper, it is obvious that they transcend the grade levels and apply to the educational system across the board.

## Results

### Pro-environment Policies

Following the 1991 political changes, the Ethiopian educational system has undergone major modifications and changes. A new education and training policy has been issued and curricular materials have been modified or changed. The new policy is now in full operation throughout the country. The need for management and wise use of natural resources (energy being one of such resources) seems to have been adequately addressed. Two of the five general objectives of education and training, as stated in the new policy, are highly related to the use and management of natural resources:

- To bring up citizens who can take care of and utilise resources wisely, who are trained in various skills, by raising the private and social benefits of education.
- To cultivate the cognitive, creative, productive and appreciative potential of citizens by appropriately relating education to environment and societal needs (TGE, 1994:7-8).

The five general objectives are then divided into fifteen specific objectives, two of which are directly related to the role education plays in the use and protection of natural resources (TGE, 1994a:11):

- To provide education that can produce citizens who possess national and international outlook on the environment, protect natural resources and historical heritages of the country.

- To provide education that can produce citizens who have developed attitudes and skills to use private and public properties appropriately.

The recently issued policies on the environment also put emphasis on the need for proper environmental management (EPA, 1997a; EPA, 1997b). The need for the use of alternative energy sources (e.g. solar

power, wind, biogas, agricultural bio-fuel, liquid bio-fuel or small hydroelectric plants) for towns and villages remote from the national grid has also been well recognised. The following are some of the policy guidelines set for the development and management of the country's energy resources in general and use of alternative sources of energy in particular (EPA, 1997b:83-85).

- To adopt an inter-sectoral process of planning and development which integrates energy development with energy conservation, environmental protection and sustainable utilisation of renewable resources;
- To promote the development of renewable energy sources and reduce the use of fossil energy sources both for ensuring sustainability and for protecting the environment, as well as their continuation into the future;
- To develop alternative energy sources for towns and villages remote from the national grid;
- To place an increasing reliance on energy efficient technologies, sustainable use of renewable resources, and the development of indigenous energy resources;
- To acquire, develop, test and disseminate appropriate and improved energy use technologies (e.g. improved stoves, solar powered cookers and heaters);
- To demonstrate and support the use of other energy sources (e.g. geothermal, solar, etc.) in the various economic sectors where it is currently little used such as in transportation, irrigation, crop-drying, food processing, fish drying, and thermal heating; and
- To promote and assist the private sector to assemble and manufacture energy development facilities and end-use appliances.

## Energy in Students' Textbooks

As indicated in the previous sections in this study energy education has been divided into three categories: energy as a physical phenomenon (Category I), energy as a resource (Category II) and

energy use and environmental degradation (Category III). Analysis of the students' textbooks indicates that the first category is well addressed in the educational materials. Category II is only partly treated. As far as the third Category of energy education is concerned, it is interesting to see that it received a substantial curricular space in almost all the subjects analysed in this study (Chart 1).

In relation to the results presented hereunder, readers are advised to remember the fact that energy is closely associated with most of the processes underlying both the bio-physical and socio-cultural environments. Categorization of chapters in specific textbooks as addressing energy issues or not addressing them is therefore only based on the more direct features of energy.

**Chart 1.** Energy in students' textbooks: What is treated where?

| | **Categories** | | |
|---|---|---|---|
| Subjects | **I** | **II** | **III** |
| Physics | | | |
| Chemistry | | | |
| Biology | | | |
| Geography | | | |

| **KEY:** | |
|---|---|
| | The respective category (as defined in the study) fully integrated |
| | The respective category (as defined in the study) partly integrated |
| | The respective category not integrated |

Results of detailed analysis of students' textbooks for each of the four subjects presented in the following sections.

***Physics***

Three of the ten chapters making up the grade seven physics textbook are directly related to energy (Table 1). An introductory information on mechanical energy, electrical energy and heat forms

are the main substance of energy education at this level. There is a noticeable emphasis on the formation and transformation of energy. Little effort has, nevertheless, been done to address issues related to use and management of energy resources.

**Table 1: Energy issues in Grade seven Students' Textbook**

| Chapters directly related to energy | Other chapters |
|---|---|
| - ***Chapter five – Mechanical work, energy and power*** Work and energy<br>♦ Transformation and conversion of mechanical energy Power<br>- ***Chapter seven – Electrical energy***<br>♦ Electrical current<br>♦ Effects of electric current<br>♦ Transmission of electric energy<br>♦ Electric safety rules<br>- ***Chapter eight – Heating things***<br>♦ Sources of heat<br>♦ Effects of heat | - Chapter one - Basic measurements<br>- Chapter two - Motion<br>- Chapter three - Laws of motion<br>- Chapter four - Pressure<br>- Chapter six - Magnets<br>- Chapter nine - Production and transmission of sound<br>- Chapter ten - Weather and climate |

**Source:** DCDR, 1999a

In chapter ten of the textbook, an attempt was made to present information on the greenhouse effect and some of its consequences. Nevertheless, the major forces behind the greenhouse effect and how developing countries are contributing to the problem are not addressed at all.

Almost the whole textbook for grade eight is devoted to energy education. Four of the six chapters deal directly with energy: heat energy, electric current, electromagnetism, and electronics (Table 2).

**Table 2: Energy issues in Grade Eight Students' Textbook**

| Chapters directly related to energy | Other chapters |
|---|---|
| - ***Chapter three – Heat energy*** <br> ♦ Quantity of heat <br> ♦ Specific heat capacity <br> ♦ Heat converter <br> ♦ Heat exchange <br> - ***Chapter three – Electric current and resistance*** <br> ♦ Electric current <br> ♦ Resistance <br> ♦ Combination of resistors <br> ♦ Colour coding of resistors <br> - ***Chapter five – Electromagnetism*** <br> ♦ Magnetic line forces <br> ♦ The magnetic effect of an electric current <br> ♦ Electric motor <br> ♦ Electromagnetic induction <br> ♦ Generators <br> ♦ Transformer <br> ♦ Hydro-electric power station (The Koka Dam in Ethiopia has been used as an example) <br> - ***Chapter six – Introduction to electronics*** <br> ♦ Capacitor <br> ♦ Semiconductor diodes <br> ♦ Transistors | - Chapter one – Force <br> - Chapter two - Seeing things |

Source: *DCDR, 1999b*

Only two of the ten chapters of students' textbook for grade nine address energy issues. Transformation of energy, expansion of solids, liquids and gases; measuring and converting heat energy are some of the topics included in the textbook. Moreover, the non-renewable and renewable sources of energy are presented and elaborated by taking examples from Ethiopia. The need for a wise use of energy resources has also been stressed.

**Table 3: Energy Issues in Grade Nine Students' Textbook**

| Chapters directly related to energy | Other chapters |
|---|---|
| - ***Chapter four – Energy*** | - Chapter one – Physics and measurement |
| ♦ Work and energy | - Chapter two – Motion |
| ♦ Transformation of energy | - Chapter three – Force |
| - ***Chapter ten - Heat energy*** | - Chapter five – Mechanics |
| ♦ Expansion of solids, liquids, and gases | - Chapter six – Pressure |
| ♦ Measuring heat energy | - Chapter seven – Waves |
| ♦ Heat energy converters | - Chapter eight – Sound |
| | - Chapter nine – Matter |

Source: *DCDR, 1999c*

Electricity is the core of grade ten physics. Three of the five chapters in the textbook for this level deal with energy, particularly electrical energy. Topics covered include electric charges, electrical forces and fields, electricity and magnetism, application of electromagnetism, electromagnetic induction and electronics.

**Table 4: Energy Issues in Grade Ten Students' Textbook**

| Chapters directly related to energy | Other chapters |
|---|---|
| - ***Unit two – Electric charges*** | - Unit one - Motion in two dimensions and universal gravitation |
| ♦ Electric charges, forces and fields | - Unit five - Geometrical and wave optics |
| ♦ Electrical potential energy | |
| ♦ Capacitance | |
| - ***Unit three – Electricity and magnetism*** | |
| ♦ Electric current | |
| ♦ Resistors in series and parallel | |
| ♦ Ammeters and voltmeters | |
| ♦ Electromotive force and internal resistance | |
| ♦ Energy and power in DC current | |
| ♦ Magnetic field and magnetic force | |
| ♦ Some application of electromagnetism | |
| ♦ Electromagnetic induction | |
| - ***Unit four – Electronics*** | |
| ♦ Semiconductors | |
| ♦ Transistors | |
| ♦ The digital system | |

**Source:** *DCDR, 1999d*

### *Chemistry*

Some aspects of energy education have been integrated into the content of a series of chemistry textbooks with the exception of the

textbook for grade nine. See Table 5 for more details. The problem of environmental pollution is the outstanding topic in chemistry as far as energy related issues are concerned. The relationship between energy (particularly fossil fuels) use and environmental (particularly air) pollution has been adequately addressed.

Types of fuels have also been described in grades seven and eight. In grade ten, application of electrochemistry and the environmental impacts of such an application have been discussed in a greater depth. The problem of air, water and land pollution has been particularly emphasised with examples from the local context.

**Table 5: Energy Issues in Chemistry Textbooks for Grades 7-10**

| Grade 7 | Grade 8 |
|---|---|
| - ***Chapter five - Oxidation and Reduction***<br>♦ Composition of air<br>♦ The importance of air<br>♦ Air pollution (causes and consequences)<br>♦ Pollutants<br>♦ Oxidation and combustion<br>♦ Kinds of fuels<br>♦ Reduction | - ***Chapter four - Some Important Non-metals and their Compounds***<br>♦ Carbon and some of its compounds<br>• Properties, uses and oxides of carbon<br>• Coal, petroleum and natural gas (occurrence, types and importance) |
| **Grade 9** | **Grade 10** |
| ***Energy issues are not part of the content*** | - ***Chapter four – Electrochemistry***<br>♦ Electrical conduction<br>♦ Electrolysis<br>♦ Application of industrial chemistry<br>- ***Chapter five - Chemistry and Industry***<br>♦ Some important chemicals and related industries in Ethiopia<br>• Environmental pollution<br>• The major pollutants in the air<br>• The effect of air pollution on climate: the greenhouse effect<br>• Water pollution<br>• Pollution of the land<br>• The problem of waste disposal |

Source: DCDR (1999e); Gidey et al. (1999); Hanetse and Atersaw (1999); Gidey and Hagos (2000)

### *Biology*

Conversion of light energy into chemical energy lies at the core of the discussions related to energy in biology textbooks (Table 6). The mechanism of photosynthesis, energy flow in the ecosystem, and types of fuels are some of the topics included. Environmental problems like pollution and deforestation have also been addressed. In relation to the latter, fuel wood scarcity is just mentioned without elaboration. Conversion of plant material into methane and methanol are discussed. The steps underlying the construction of an experimental biogas plant are also outlined in the biology textbook series.

**Table 6: Energy Issues in Biology Textbooks for Grades 7-10**

| Grade 7 | Grade 8 |
|---|---|
| ***Energy issues are not part of the content*** | - ***Chapter four – Photosynthesis***<br>♦ Conversion of light energy into chemical energy<br>- ***Chapter five - Our Environment***<br>♦ Some environmental problems<br>♦ Deforestation<br>♦ Pollution |
| **Grade 9** | **Grade 10** |
| - ***Chapter two - Nutrition and Digestion***<br>Energy in food staff<br>- ***Chapter three – Breathing and Respiration***<br>Fuels and energy<br>Oxidation reduction reaction<br>♦ Anaerobic respiration in micro-organisms<br>- ***Chapter five – Organisms and their Environment***<br>♦ The flow of energy in an ecosystem | - ***Chapter two - Food Manufacturing in Green Plants***<br>♦ The mechanism of photosynthesis<br>- ***Chapter seven - Natural Resources and their Conservation***<br>♦ Air pollution<br>- ***Chapter eight – Biotechnology***<br>♦ Energy: Conversion of plant material into methane and methanol<br>♦ Construction of an experimental biogas<br>♦ Advantages of the biogas technology |

Source: *DCDR (1999f); Afework et al. (1999); Alemu and Yohannes (1999); Afework and Alemu (2000).*

### *Geography*

The new geography syllabi seem to have a provision for integrating issues related to the use of energy and related problems (Table 7). Most of the issues treated in Geography syllabi are, however, indirectly related to energy literacy. Natural vegetation and the problem of deforestation ore raised at all grade levels. Environmental degradation caused by industrialisation in general and air pollution in particular has also been included in the content for geography grades ten and nine respectively.

**Table 7: Topics Related to Energy Issues in the Revised Geography Syllabi**

| Grade 7 and 8 | Grade 9 | Grade 10 |
|---|---|---|
| - Man and his environment<br>- Vegetation and the human being | - Deforestation: Causes, consequences, protection, and mechanisms<br>- Air pollution: Sources, effects, and controlling methods | - Sustainable use of natural resources<br>- Forestry: Importance, problems, conservation, and management<br>- Environmental degradation caused by industrialisation |

Source: *ICDR, 1998*

### Major Shortcomings

*Energy Issues Partly Integrated*

The foregoing analysis of the syllabi and students' textbooks shows that energy issues have not been fully integrated. Energy as a physical phenomenon appears to have been well treated particularly in physics. Biology and chemistry have also addressed energy issues. The geography syllabi have a few provisions for energy education. The case of other countries (e.g. Germany) indicates that school

geography is in a best position to address the socio-economic and political issues related to the use and management of energy resources. In view of this, one can easily notice that the designers of the geography syllabi for Ethiopian schools have not utilised this opportunity.

*The Prevailing Energy Crisis Undermined*

In developing countries, the energy crisis is believed to be the second most serious problem, next only to the food crisis. The former is also contributing to the food crisis by exacerbating deforestation and thereby causing degradation of farmland. Moreover, dependence on imported fuel is known to have been weakening the capacity of the concerned countries to buy food whenever the need arises. All these situations apply to Ethiopia. Of the total energy consumption in the country, 89.7 per cent is accounted for by the rural population, of which 95.4 per cent is for household use. Traditional fuels contribute 99.9% to rural energy consumption, with fuel wood being by far the most important source (81.8%), followed by dung (9.4%), and crop residues (8.4%) (EPA, 1997a: 107). One can thus argue that this problem and the possible solutions should have been the integral parts of energy education in Ethiopia.

*The Energy Resources Potential Not Properly Addressed*

There is a huge energy resource potential in Ethiopia that, if utilised, could minimise the present energy crisis. It was, for instance, estimated that the country has a hydropower potential of 40,000 MW (installable potential) (Förch, 1989). Not more than 750 MW has been utilised so far. Geothermal energy resource suitable for power production is about 700 MW. The natural gas reserve is also estimated to be 10 to 30 billion $m^3$. Oil exploration is underway (EPA, 1997a: 110-111). What is more, large amount of coal reserves are said to be available in the western regions of the country. The study revealed that insufficient attempt had been made to create awareness

and mobilise the community to make use of the resource potential in the country.

*Alternative Sources of Energy Insufficiently Addressed*

As indicated earlier, recent policies on energy and environment give alternative sources of energy their due place in the future of energy development in the country (EPA, 1997a; EPA 1997b). The designers of the syllabi and textbooks writers thus have a policy backing to fully integrate issues related to the use of alternative sources of energy which are not so well treated at present. Efficient and sustainable use of the biomass should receive due place in the future of energy development in the country.

## Conclusions and Recommendations

### Conclusions

In developing countries like Ethiopia energy education must focus on creating energy literacy: basic knowledge on energy as a physical phenomenon, skills to tap energy resources and use them in an efficient way possible, and skills to minimise harm on people and the environment that might follow use of energy. This study attempted to assess the present status of energy in Ethiopian school materials (syllabi and textbooks). The analysis revealed that energy issues has not been fully integrated. Energy as a physical phenomenon is well treated in the textbooks (physics in particular). Some of the most important issues related to use and management of energy resources were, however, insufficiently addressed or totally overlooked. One such issue was the prevailing energy crisis in the country. The energy resource potential of the country was not elaborated either. Worse still, the alternative sources of energy that could decrease the existing pressure on fuel wood has been underrepresented.

An assessment of the new developments in the country gives the impression that there is a strong backing for future integration of

energy issues into the educational system. The new policy of education emphasises the contribution of education for the proper use and management of natural resources. What is more, issues related to energy in general and renewable sources of energy in particular have been adequately addressed by the newly promulgated Federal Policies on energy and environment. One can thus observe that curriculum planners have the policy backing for including energy issues into the educational materials.

Examination of the experience of other countries shows that treating energy issues in schools requires an educational material that is not only comprehensive but also easy for use by all teachers teaching relevant subjects. Such a material is not available at present. As a short-term solution, a framework for preparing a 'Module' has been outlined (see APPENDIX I). The framework for the 'Module' was prepared on the basis of the assessment of the weaknesses of the existing syllabi and students' textbooks. The current energy and environmental situation and problems in the country; policies pertaining to energy and environmental education; and lessons from the instructional practices and problems in other countries are also planned to be considered in the module.

## Recommendations

Three actions are recommended which, in the opinion of the author, are hoped to help Ethiopian schools to create awareness about the value of energy resources; and form favourable behaviour towards use and management of such resources. These are a comprehensive integration of energy issues into the existing curricula, application of more dynamic approaches towards energy education, and use of schools as centres for testing and dissemination of alternative energy sources.

### *Integration of energy issues*

It has been found that some of the key energy issues (see the section on 'major limitations') are either underrepresented or totally

overlooked. It is, therefore, absolutely necessary to make sure that pupils have a complete and comprehensive picture of the energy problem in the country and beyond. This can, in the long run, be achieved by integrating relevant issues into the suitable subjects during future curriculum revisions. In the short run, however, it is possible to help teachers address the issues by supplying them with an energy education Module. It is therefore strongly recommended that the structure of Module outlined in this paper (APPENDIX I) be further developed and made available to teachers teaching in secondary schools. It would also be highly fruitful if teachers in training institutions use the Module as one of their reference materials.

### *Application of Dynamic Methods of Teaching*

It is difficult to change energy using behaviour simply by disseminating information. Pupils must be helped to appreciate the problem and actively and willingly participate in its solution. In general, the problem solving approach must be considered as the core of energy education. Pupils must be guided to make assessments and come up with not only the major problems facing the community and their country at large but they should also seek workable solutions. More importantly, pupils have to be encouraged to apply such solutions in their own environments.

Incentive-oriented approaches could also be considered. Such approaches should, however, not cost the school more than what it could afford. In Ethiopian situation, naming classes or individual students (during a flag ceremony) who have designed and carried out significant energy conservation projects can do a wonder. What is required is thus willingness on the part of the school administration and teachers. Such a willingness could at least partly be created by making energy and environmental education part of a training of prospective teachers and school administrators (Aklilu, 1998).

### *Using Schools as Mission Centres*

Schools in Ethiopia can and should be made centres for the development and dissemination of alternative energy technologies. It was argued, for instance, that schools, if strengthened with the required inputs, i.e., infrastructure, finance, educational materials, management and personnel, "are the best places to co-ordinate basic literacy and skill-training for adults in addition to the running of formal education programmes" (Haileselassie, 1997:72). Such technologies as improved cooking stoves, biogas plants, solar home systems, etc., could be demonstrated in schools. If installed, such plants also act not only as sources of knowledge and skills but also as sources of motivation. They generate a tangible material benefit to the school community (e.g. running a tea room using the biogas and night classes by the help of the solar home systems).

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APPENDIX I

**A Framework for Preparing Energy Education Module**

The following framework for preparation of energy education module for Ethiopian schools has been based on the assessment of:

- the weaknesses of the existing syllabi and students' textbooks;
- the current energy and environmental situation and problems in the country; and
- educational and environmental policies that guide preparation of instructional materials on energy and environmental education.

**I. Goals:**

1. To enable schools to disseminate a comprehensive information on issues related to the use and management of energy resources; and
2. To develop and disseminate alternative energy technologies to the local communities (and thereby contribute to the improvement of social and economic conditions of the population) using schools as mission centres.

II. Specific Objectives:

The specific objectives of energy education in Ethiopian schools include enabling students to:

1. have a basic understanding about energy as a physical phenomenon;
2. identify the social and economic significance of energy as a natural resource;
3. be aware of the availability and distribution of energy resources in the world and in Ethiopia;
4. develop the skills required for the use of alternative energy technologies; and
5. develop a favourable attitude towards use of alternative energy technologies.

III: Major Content Areas:

Table 8 outlines the main content of energy education in Ethiopian schools. A proposal is also made as to the school subjects where each of the contents areas can be treated. It should be noted that there is no hard and fast rule that hinders subject teachers from addressing aspects of energy other than the ones categorised under their subjects. Only four of the school subjects have been included here because, in Ethiopian context, these are subjects where environmental issues in general and energy in particular are often harboured. Teachers teaching the other subjects like mathematics and languages could also make use of the module to address energy issues in their classes.

**Table 8.** A proposed content of energy education for Ethiopian schools

| No. | Topic | Suitable subjects | | | |
|---|---|---|---|---|---|
| | | Phy | Ch | Bio | Geo |
| 1 | ***Energy as a physical phenomenon***<br>Energy: Definition, forms and types<br>Energy production (generation)<br>Energy transformation<br>Energy transport | | | | |
| 2 | ***Energy use and economic development***<br>Energy in the pre-industrial era<br>Energy and industrialisation<br>Socio-cultural significance of energy | | | | |
| 3 | ***Energy use and environmental degradation***<br>The fuelwood crisis<br>The greenhouse effect<br>Pollutants and their effect on human beings and other organisms<br>Methods of reducing environmental pollution | | | | |
| 4 | ***Resource base for energy production in Ethiopia***<br>Hydropower<br>Biomass/Biogas<br>Geothermal energy<br>Wind<br>Solar<br>Prospects of fossil fuel: coal, petroleum and natural gas | | | | |
| 5 | ***Current pattern of energy use in Ethiopia***<br>Use of non-commercial energy<br>Use of commercial energy | | | | |
| 6 | ***Prospects and problems of development and dissemination of alternative energy technologies in Ethiopia:***<br>Improved stoves<br>Biogas plants<br>Micro-hydropower plants<br>Solar home systems<br>Wind power plants<br>Bio-fuels | | | | |

**KEY:**

*In-depth and comprehensive integration recommended*
*Moderate integration recommended*
*No integration recommended*

IV. A Note on Teaching Approaches

As repeatedly noted in the paper, energy is a multi-dimensional issue the understanding of which requires not only a strong cross-disciplinary co-operation but also use of diverse methods suited to the nature of the topic under treatment. Understanding of energy as a physical phenomenon and the environmental damages that follow its use is, for instance, hardly achievable unless aided by experimentation. The socio-economic and political significance of energy requires, on the other hand, involving pupils in debates and discussions.

On the whole, activity-oriented instruction has a better chance to bring about an ultimate change in pupils' behaviour as to use and management of energy resources. It is also recommendable to attach energy education to some sort of tangible incentive so as to instil the fact that energy conservation is rewarding not only ecologically but also economically. It is, for instance, possible to organise a competition on 'improved stove' where each class attempts to make an energy saving stove. The class that comes up with the best could then be given a 'medal' and each of the participants get a small improved stove that could readily be used at home. Such a project is also feasible in Ethiopian situation where schools have very limited financial resources.