

## Energy, Sustainability and Development

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### ABSTRACT

The role of energy supply and use in relation to sustainability and development are discussed. The criteria for sustainability and the conditions necessary to create a sustainable energy industry are reviewed. The barriers to sustainability and methods of overcoming them are discussed. A range of technical, regulatory, economic and social measures can form part of a strategy for the development of a sustainable energy industry. The crucial roles of education and community development in achieving sustainability are addressed. Some examples of sustainable energy solutions and references to sources of further information are provided.

## Introduction

Sustainability is a crucial issue for society today. It is clear that current lifestyles and practices are causing irreversible ecological damage, which could hamper development programs and ultimately affect the survival of human society. Various efforts have been made to develop models and approaches to sustainable development and some progress has been made in articulating and implementing them. To be effective they need to address all aspects of human activity, including energy production and use.

Energy is used for a wide variety of purposes in modern society. Most of it comes from fossil fuels and this is causing increasing concern because of rising costs, declining reserves, pollution and global warming. Sustainable development requires the world to move towards a new approach to energy production and use.

Energy use is generally grouped into four main categories - industrial, transport, commercial and domestic. Each of these categories contains many different applications. An understanding of these patterns of energy use in a society is essential for developing a strategy for sustainability. Patterns of energy use differ considerably between developed and developing countries and also between different geographical areas. The patterns of use also change considerably throughout the year, especially in temperate regions.

Comparisons between different nations and regions can be useful in highlighting areas of efficiency and waste. End use analysis is an essential basis for addressing inefficiencies through technical, social and policy initiatives. Many of these improvements are cost-effective in the short term and they also bring benefits in the campaign against pollution and global warming. In the longer term energy efficiency must play a central role if we are to achieve a sustainable energy industry.

Energy efficiency often involves a combination of social and technical factors. Social change is difficult to legislate but it can be facilitated by education and consultation. Women have a crucial role to play in this process because they are the major users of domestic appliances and public transport and have a major say in technology choice in homes and offices. Women's networks and organisations can raise awareness and help to ensure that development is sustainable and that lifestyle changes are made to achieve sustainability.

Energy is essential for all forms of life and most obtain it through natural processes associated with ecological cycles such as the hydrological and carbon cycles (Miller, 1980). Over the centuries humans recognised that they could improve their quality of life by exploiting natural resources such as plants, animals, minerals and fossil fuels. By utilising our scientific and technological knowledge, we have developed large industries devoted to agriculture, mining and power supply. However, because these industries are economically-driven they have tended to ignore ecological and social principles until quite recently, when serious problems have emerged (Ramage, 1997).

In our quest to increase power supply to meet the needs of development and a burgeoning human population we have begun to cause irreversible damage to the biosphere, which supports all forms of life. Serious air pollution problems have been caused by burning fossil fuels in motor vehicles, homes, factories and power stations. Climate change now appears to be under way as a result of the enhanced greenhouse effect, which is partly caused by our extensive use of hydrocarbon fuels (IGCC, 1995, 2001)

Concern about these problems has accelerated over the past decade and international action is now under way to address the causes. This is taking the form of international treaties with

mandatory restrictions proposed on the use of fossil fuels by industrialised nations. These may be achieved via fuel substitution, energy management, improved energy efficiency, the use of renewable energy systems and restrictions on land clearing.(DFAT, 1997, UNFCCC)

Some of the solutions are technical but there are also other important ways of tackling these problems. They involve policies, legislation, economic incentives and education. All of these initiatives have an important role to play in modifying human behaviour and moving society towards a sustainable future.

Sustainability involves modifying traditional economic thinking to include social and ecological factors to ensure that development does not have adverse effects on society or the environment (IUCN, 1991; Earth Charter, 2000). Such thinking is becoming increasingly important in many aspects of education and it is therefore important to ensure that students are exposed to a range of relevant disciplines to prepare them for future careers in a world where sustainability is imperative for survival.

## Energy and Sustainability

Ecologically sustainable development has been defined in various ways including:

*“Development which meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED 1987) ;and*

*“Improving the quality of life while living within the carrying capacity of supporting ecosystems” (IUCN 1991)*

According to the IUCN (1991), sustainability is based on the following principles:

- respect and care for the community of life
- improving the quality of human life
- conserving the earth’s vitality and diversity
- minimizing the depletion of non-renewable resources
- keeping within the earth’s carrying capacity
- changing personal attitudes and perspectives
- enabling communities to care for their own environments
- providing a national framework for integrating development and conservation
- creating a global balance

This ambitious agenda was discussed and analysed in detail by many nations and by the international community at the original Earth Summit in Rio de Janeiro in June 1992 and at the Earth Summit +5 in New York in 1997. A program of action called Agenda 21 was developed at Rio and this is gradually being implemented by the signatories. The Earth Charter secretariat has taken these principles and developed them into a statement on sustainability and this is now being promoted internationally prior to the UN World Summit for Sustainable Development (Rio+10) to be held in 2002.(Earth Charter, 2000)

For the energy industry the IUCN (1991) has developed a general strategy for sustainability, which contains the following seven elements :

- develop explicit national energy strategies
- reduce the use of fossil fuels
- reduce the wastage in energy production and distribution
- reduce pollution from power generation

- develop renewable energy sources
- use energy more efficiently in the home, industry, commerce and transport.
- Conduct publicity campaigns to promote energy conservation and energy efficient products.

While all of these aspects are important, the greatest scope for immediate substantial steps towards sustainability in the energy industry are through energy efficiency and fuel substitution. However for developing nations renewable energy technology is available now to provide a sustainable path to improved quality of life.

## Renewable Energy Options

Renewable energy sources are abundant and potentially form the basis for sustainable energy systems. Currently only a few renewable energy technologies are cost effective when compared to fossil fuels, ignoring the external costs of resource depletion, pollution, global warming, etc which are associated with burning fossil fuels.

Hydroelectric power is cost effective in many situations but it is not always sustainable as there are adverse environmental and social effects associated with some large-scale hydroelectric projects. For developing countries microhydro power systems provide distributed supply options with fewer adverse environmental effects.

Geothermal power is available in some countries and in suitable situations it can be used as a cost effective and sustainable energy supply option.

Biomass utilisation is also cost effective in any situations, especially where a subsidy is available for waste disposal. This has led to the use of landfill gas, sewage gas and bagasse plants in many countries. These systems have the advantage of reclaiming energy from a waste product and sometimes reducing the amount of pollution it would otherwise produce. While these processes are not truly sustainable they are an important improvement on existing waste disposal methods. In the longer term better options will emerge including waste to energy plants combined with resource recovery (UNEP, 2002).

Wind power is cost effective for electricity generation on a large scale in suitable locations. There are some concerns about its environmental impacts, especially on landscape protection but these are being addressed through siting new wind farms in less sensitive locations and the development of new variable speed turbines and advanced energy storage and power conditioning systems. In remote locations wind systems are cost effective for both small-scale power generation and water pumping.

Solar thermal domestic and industrial hot water systems have been used for many years in industrialised countries and they are now cost effective and reliable. When external costs are considered they are preferable to fossil fuelled hot water systems but economic reforms are needed to ensure that the market prices are fair.

Photovoltaic solar energy conversion offers many advantages over fossil fuels but it is not yet cost effective in urban situations. However, PV hybrid systems are ideal for remote locations and for village power systems and for water pumping in many situations. Further technical improvements and incentives are needed to make this technology widely available. The industry is growing strongly and it is likely that economies of scale will lead to a dramatic reduction in prices over the next decade. Once prices fall to a point where distributed rooftop generation in cities becomes cost effective the PV industry will begin to replace fossil fuels. Many people see this step as essential for achieving sustainability. (UNEP, 2001)

Renewable energy supply options are now available but the public is not generally aware of this. There is also a major economic problem because renewable energy systems use a free fuel but they usually require a major up-front investment in a new system. The transition to renewable energy use is a crucial step in achieving sustainability and it may be easier in developing countries where the fossil fuel alternatives are not so strongly entrenched. However, it will still require education, good technologies and innovative policy frameworks for this to occur.

## Energy Efficiency and Energy Use

The IUCN (1991) advocates the following priorities for energy efficiency in the power generation industry:

- Increase efficiency in the power generation industry by imposing standards of fuel use efficiency, based on the best available technology. These should in turn promote the use of new technologies which are well suited to distributed generation and have higher efficiencies.
- Promote co-generation and demand management
- Use taxes and charges to promote energy efficiency.
- Set standards for the acceptable loss of energy or fuel in distribution and require that losses above that standard be charged against the profits of the industry rather than against the customer
- Where possible substitute natural gas for coal. This is because coal burning emits between 70 and 95% more carbon dioxide than gas per kWh of final energy produced. Oil is intermediate, producing 35 -45% more carbon dioxide per kWh than gas.
- The waste of natural gas by flaring during oil extraction should be eliminated wherever possible.

These are issues for all nations to address via their responses to Agenda 21 and the UN Framework Convention on Climate Change. They are areas where considerable savings can be made by retrofitting or by fuel substitution. Some nations have already legislated to enforce such strategies.

There is also considerable scope to save energy and money through energy efficiency. This is particularly true in the domestic, transport and commercial sectors where women have considerable influence. In many countries the systems used for cooking and heating are very inefficient and huge savings of money and carbon dioxide can be made through efficiency measures. This is a very promising way to approach sustainability in energy use .

The IUCN (1991) advocates the following approach to sustainability in energy use.

- Establish, publish and enforce standards for energy efficiency in industry, space heating, building construction and transport.
- Use charging and pricing systems to achieve improved standards of efficiency.
- Encourage the development and rapid introduction in developing countries of more efficient cooking stoves. These have many benefits including the reduction in pollution and deafforestation and improvements in indoor air quality.
- Set performance standards for transport, covering energy use and pollution. Use fuel taxes to encourage the use of public transport and energy efficient vehicles.
- Ensure that transport modes are charged their full cost to the community, including their impact on roads, the environment and society. If heavy trucks were charged in this way there could be a major shift to the use of rail and a corresponding increase in efficiency.
- Require all government and public sector agencies to carry out regular energy audits to identify where significant savings could be made and implement these recommendations. Incentives should be offered to encourage the private sector to carry out similar programs.
- Ensure that the efficiency of all electrical appliances and vehicles is clearly stated on the product or in the user manual under standard test conditions.

All of these measures should be incorporated into a national energy efficiency strategy and many national and regional governments have already done so. Australia has a National Greenhouse Strategy (AGO, 1998) but there have been some difficulties in implementing it. This illustrates the point that policy alone will not solve the problem of changing social practices and technologies to achieve sustainability. Social change occurs slowly and it requires knowledge and awareness which often come through education, communication and consultation. Social change cannot be legislated, rather social change provides the foundation for effective legislation.

The IUCN (1991) has drawn attention to the need for community education and promotion in order to gain public support for this strategy and to train people to implement it. It recommends that Governments, industry and community groups collaborate to:

- Draw attention to and explain the energy efficiency labelling of consumer products such as appliances and vehicles.
- Explain the savings that householders, office managers and industrial firms can make through energy efficiency and energy management.
- Explain the value of energy audits and how to obtain one
- Ensure that energy efficiency information is readily available to the public.
- Introduce award schemes to reward people and companies whose performance in energy efficiency or energy innovation has been outstanding.

In addition to this the formal education sector needs to directly address the needs of the sustainable energy industry. Conventional energy education has generally failed to do this. Most energy professionals have been trained in either the technical or economic aspects of conventional energy conversion and until recently the technical aspects of energy management and renewable energy technology have been largely neglected. Very few energy professionals have had any formal training in energy policy, energy economics or the social and ecological aspects of energy production or use.

The Australian Cooperative Research Centre for Renewable Energy is dedicated to energy efficiency and the development of renewable energy solutions to power supply problems. Its education program was designed to provide a sound technical base in renewable energy technology (Jennings, 1996). However it also addresses the need for ecologically sustainable development by covering the social and environmental aspects of energy use as well as the economic and policy issues. The entire program is taught in the context of ecologically sustainable development (ESD) - that is, solutions should be economically, environmentally and socially acceptable in terms of the principles for ESD. In this way students receive an education that equips them to work on new energy systems which can be used to build a sustainable energy industry for the future.

Because many of the people who require this education are already in the workforce and often are working at remote locations the entire program has been placed on the world wide web so that students from any part of Australia or overseas can access this course. (see the ACRE web site and Lund and Jennings, 1998)

Education and training have a vital role to play in achieving sustainability. They create awareness of the issues and equip people with the technical, ecological and economic knowledge required to implement ESD. Education can provide examples of ESD in practise and through presentation of these examples create consumer confidence in renewable energy and energy management. Education is an essential foundation for market development of the renewable energy industry (Jennings, 1997)

## Women and Energy Use

Women have a major role to play in developing and implementing this strategy for sustainability. In the area of energy use women are:

- the principal consumers and managers of household energy
- the primary purchasers of household appliances that consume energy
- the primary purchasers or collectors of cooking fuels in many developing countries
- the principal users of public transport
- the main victims of pollution from low grade fuels
- frequently involved in industries that are energy intensive

Women therefore have a central role in developing energy options in three of the four major sectors of energy use - domestic, transport and commercial. As a result of this women can:

- influence the choice of cooking fuels
- influence the choice of appliances
- influence transport options through consumer power
- influence energy management practices in the workplace
- through their purchases help to support the development of sustainable energy industries
- participate in energy policy development through their role as stakeholders

Many of the changes necessary for sustainable development involve changing attitudes to energy use in the home and the workplace. It is here that education, consultation and community groups can have a significant impact. Governments can provide incentives and assistance but these changes in lifestyles will only come about when people decide to make them. All community groups have a vital role to play in achieving sustainable development. This is something that Government agencies have often been slow to realise but there are now many examples of effective community action in this area and some of these will be discussed later in this seminar.

Because women often work in situations where they are able to influence people's attitudes to energy efficiency and energy use they can play a major role in achieving the social changes needed. In working with children the groundwork can also be laid for a sustainable future.

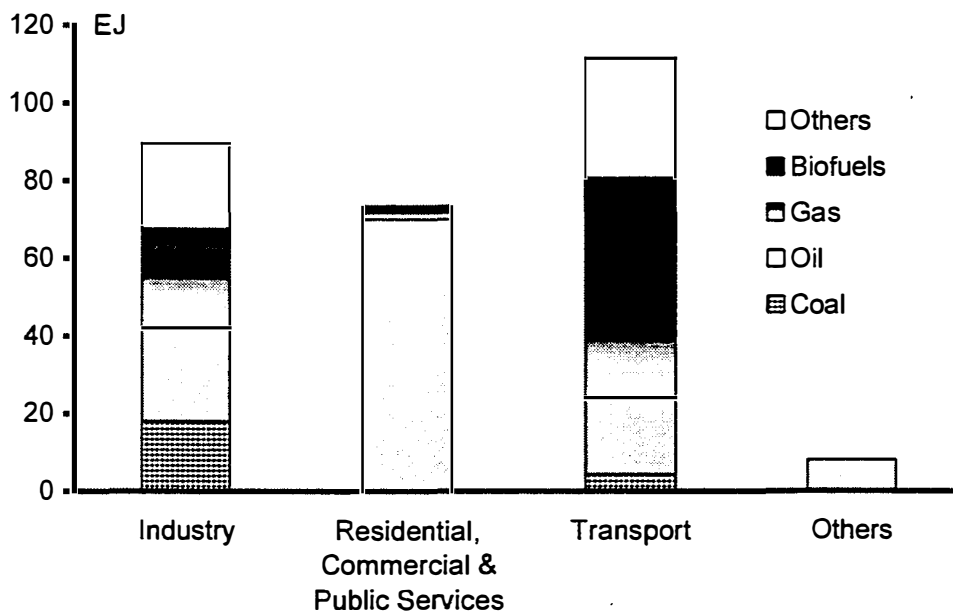
This topic is covered in more detail in a recent publication by UNEP (2001).



## Patterns of Energy Use

In order to prioritise energy efficiency measures we need to understand the patterns of energy use in society. Full details of the patterns of energy use throughout the world are available from the IEA and the US Department of Energy web sites. (IEA, DOE)

Figure 1 shows the worldwide pattern of energy use by sector.



**Figure 1: Worldwide Pattern of Primary Energy Use by Sector (Year 1999)**

Domestic energy use accounts for about 20% of all energy use worldwide. It includes four main components:

- electricity for lighting and appliances
- high temperature heat for cooking
- medium temperature heat for water heating
- low temperature heat for space heating.

Typically in cool climates 50% of all domestic energy is used for space heating, 30% for water heating and 10% each for cooking and appliances. In warmer climates the space heating component is much lower although the space cooling costs may be substantial in some countries.

This analysis of energy use indicates that it is very wasteful to use high grade sources of energy for low grade applications such as space heating and cooling and hot water. Substantial cost savings and environmental and social benefits can be made by providing incentives for insulation, passive solar design, efficient heating, cooling and hot water systems. However social factors such as the way in which energy is used in the home can have just as great an impact.

Women can influence these choices through their role as home managers and consumers and through their influence on their family's use of energy in the home.

The transport sector uses about 20% of all primary energy worldwide. The patterns of use differ considerably between developing and industrialised nations (Ramage, 1997). In the former, public transport is the principal mode and women are the principal users. In industrialised countries private vehicles dominate the transport sector but women are still the principal users of public transport. Many public transport systems are very inefficient and new environmentally sensitive options, such as fuel cell powered buses are now becoming available. This sector is one where considerable amounts of energy are wasted and consumers have considerable opportunity to conserve energy and save money. Measures that are available include:

- improved driving habits
- better vehicle maintenance
- improved vehicle design
- vehicle efficiency labelling
- incentives for use of public transport
- incentives for energy efficiency and clean technologies

The commercial sector also consumes about 20% of all primary energy produced worldwide. This energy is used primarily for:

- running appliances
- lighting
- heating and cooling

In commercial offices and institutions considerable savings can be made through end use efficiency campaigns. Mandatory audits, employee consultation, staff training can all assist, together with expenditure on hardware and education in achieving these goals. We will hear more about successful campaigns in this sector later in these proceedings.

Industry uses the remaining 40% of primary energy. Much of it is in the power generation industry where energy efficiency and renewable energy technology are essential in the longer term. Governments can legislate to compel industry to adopt more efficient practices but they are unlikely to do so without public support. Many State and national energy policies and strategies are never implemented because Governments lack the will to act if industry is opposed to the proposals. There is a vital role here for community groups, including women's organisations, to campaign for cleaner production and sustainable development. Only when overwhelming public pressure is applied will Governments and industry make the necessary changes to achieve a more sustainable production and use of energy. International networks of community organisations have a central role to play in laying the groundwork for social change.

## **Conclusions**

Sustainability and development are crucial issues for the modern world. Energy production and use are currently unsustainable and cannot form the basis for sustainable development. It is clear that massive changes in technology and social attitudes are necessary to achieve genuine sustainable development.

Renewable energy technologies are beginning to displace fossil fuels for power supply in remote areas and developing countries. As these technologies develop they will become cost effective for urban power supply. Incentives and training are essential to facilitate this transition,

Efficiency in power generation is essential for sustainability. Efficiency is also important for renewable energy systems in order to make them cost effective and sustainable.

End use efficiency is a very promising area for achieving substantial savings of energy. It is also a promising path to sustainability in the energy industry. It is difficult to implement without changing people's attitudes to energy use.

Education and consultation are powerful agents of social change. They can change attitudes and practices and provide skilled people to install and maintain new technologies.

Women are the primary managers of energy use in the home and they also have considerable influence over energy options in the transport and commercial sectors. They have a vital role to play in introducing sustainable energy technologies.

By establishing networks of community groups we can develop greater awareness of these issues and by sharing information about energy efficiency technology and policy people can play a major role in facilitating sustainable development in energy supply and use particularly in developing countries.

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