

**Review Article**

## **RENEWABLE ENERGY AND SUSTAINABLE RURAL DEVELOPMENT**

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### **ABSTRACT**

Energy is an essential input to all aspects of modern life. It is indeed the life wire of industrial production, the fuel for transportation as well as for the generation of electricity in conventional thermal power plants. However, oil producing countries caused a world-wide reaction by deciding to increase the prices of crude oil in the early seventies and it led to energy crisis. Currently a high proportion of the world's total energy output is generated from fossil fuels such as oil and coal. In general, the quest for an option to conventional power schemes particularly for application in remote and rural locations of developing countries. The paper will review the current level of the use of renewable energy systems and thereafter put forward necessary policy measures that are essential in order to promote the use of the technologies.

### **INTRODUCTION**

The twentieth century is accurately described as the golden era of fossil fuels. Fossil fuels supplemented biomass as the dominant primary energy source globally in the 1890s and their use increased 16 times between 1900 and 2000. Even more impressive has been the spectacular rise in electricity generation and consumption. In 1900, electricity generation accounted for less than 2% of fossil fuel use compared to over 30% by 2000 (Venema & Rehman, 2007). However current fossil fuel- and nuclear power-based energy systems have been worldwide recognized as unsustainable (Byrne & Rich, 1992; World Commission of Environment Development, 1987). The environmental risks and uncertainties associated with its operation include climate change, air pollution, and acid rain from fossil fuel combustion; the risks of nuclear reactor accidents; the problem of waste disposal and dismantling of reactors (after their service life is completed); and the danger of weapons proliferation associated with the use of nuclear energy. The common denominator of most policy proposals to pursue a sustainable energy path is a shift from the current regime to one relying increasingly on renewable energy.

The shift to renewable energy must address not only urban but also rural energy needs. Presently, the majority of the world's citizens (53%) live in rural settings (United Nations, 2001). Greater use of renewable energy resources could provide electricity to more than 2 billion rural people in developing countries who currently lack reliable electricity service (Lenssen, 1993). Decentralized, renewable-based energy service can bring tangible social and economic benefits to rural populations that have been largely neglected by current development patterns. These benefits include the ability to refrigerate food and medicine, the provision of lighting for household needs, evening adult and children's education classes, and power for small electric motors (such as water pumps) to assist rural economic development (Byrne, Shen, & Wallace, 1998; Cabraal, Cosgrove-Davies, & Schaeffer, 1996). The consumption of energy is very unevenly distributed in the world, and so is its growth. Recently in many industrialized countries energy policies are now being seen in the perspective of global environmental sustainability. The drive to promote the rational use of energy gained new momentum. Efforts are now made to rationalize the consumption of electricity and to reduce the environmental effects of power production; public transport, the insulation of buildings and houses; retrofitting of boilers and improving the efficiency of industrial production processes are being promoted. Research and development on environmentally sound energy technologies have become a priority. At the same time, the discussion on sustainable development has stimulated renewed interest in alternative sources such as wind and solar energy. Some of the policies still require a change in the attitudes and habits of the public. In general, the energy needs in the rural and semi-urban areas of India can be categorized as follows:

**A. Domestic Needs :** 1-Cooking, 2 - House lighting, 3 - Domestic water pumping and distribution, 3- Television and radio powering, 4- Water heating, 5 - Refrigeration

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**B. Agricultural Production :** 1- Water pumping and distribution for irrigation, 2- Operation of various agricultural equipment or implements, 3- Processing and storage of agricultural products, 4- Drying

**C. Community Needs:** 1- Hospitals, Clinics, 2- Schools, 3- Barracks, prison houses etc.

**D. Industrial/Commercial Needs:** 1- Small to medium industries, 2- Business establishments (shops, banks, restaurants, bakeries etc).

In developing countries the situation is completely different. Biomass plays a major role as a non-commercial fuel in the residential sector and is widely used as a commercial fuel in other sectors, whereas the use of modern forms of energy is still limited. It is estimated that, by 1980, 14% of global energy and 35% of energy used in developing countries was derived from biomass (Surlock and Holl, 1990). National energy policies are often confined to fuel policies, and many developing countries have a stated objective of substituting imported fossil fuels by indigenous resources. Since 1980 the total amount of biofuel has increased, but biofuels have not been widely substituted for oil (Gowen, 1989). At the same time, the expansion of the power sector and the economy at large is a common goal. Rational use of energy receives relatively little attention, and sustainability is not a major issue.

**Current Energy Demand**

India has experienced dramatic economic growth over the past decade, with GDP growth of around 6% per year since the early 1990's, when market liberalizations began, and peak GDP growth of 8% in 2005-6. Some analysts have predicted 10-12% growth per year over the next decade, although many suggest more modest rates of 3-5%. Either way, given the vast economies of scale in India, even relatively modest GDP growth may result in large numbers of people being lifted out of poverty and joining the growing middle-class in India who is fuelling a consumer boom. The limited stock availability of fossil fuels has led to the energy demand of India has been met various sources as shown in table:

**Table 1: Coal demand and supply forecasts for India (million tonnes)**

	1997-98	2001-02	2006-07	2011-12
<b>Demand</b>	323	400	576	872
<b>Domestic Supply</b>	298	360	484	652
<b>Deficit</b>	25	40	92	220

**Table 2: Oil demand and supply in India (million barrels per day)**

Year	Crude production	Crude imports	Petroleum products demand	Self reliance (%)
1997/98	0.69	0.62	1.68	39
2001/02	0.74	1.57	2.1	33
2006/07	0.8	2.2	2.89	26
2011/12	0.9	3.31	4.06	21

**Table 3: Natural gas demand and supply in India (million cubic metres per day)**

	1996-97	2001-02	2006-07	2011-12
<b>Demand</b>	52.1	117.8	167.1	216.4
<b>Production</b>	49.3	71.2	57.5	43.8
<b>Gap</b>	2.8	46.6	109.6	172.6

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**Table 4:** Demand and supply forecasts for power in India (GW)

	<b>2001-02</b>	<b>2006-07</b>	<b>2011-12</b>
<b>Peak load</b>	95.76	130.94	176.65
<b>Installed capacity</b>	126.04	181.1	242
<b>Peaking capability</b>	88.92	129.82	146.67

**Energy Performance and Reliability**

Energy it is an essential ingredient for socio-economic development and economic growth. Renewable energy systems need to be evaluated for performance and reliability. But in rural contexts, these criteria have meanings beyond standard definitions. A broader perspective is required that takes into account social, economic, and environmental factors associated with rural life. The purely technical questions of reliability and bulk energy production cannot be primary concerns for communities whose livelihoods depend on raising animals and farming the land. Rather, performance and reliability refer to the ability of energy production to meet the needs of rural life in a manner that is consistent with local social organization and economic institutions and that does not harm key environmental resources (such as soil and fresh water supplies) that are essential to livelihoods. Thus, an energy system based on technology that cannot be serviced locally (such as large generators) and that requires fuels that either reduce nutrient regeneration of soils and/or that reduce air and water quality would be incompatible with rural community needs (Byrne et al., 1998; Kammen, 1999). For energy resources to be evaluated in terms of their contribution to sustainable rural development, performance must incorporate local technical capacity, natural resource availability, environmental effects, and full (life-cycle) cost and social impacts as well as energy supply characteristics. Renewable energy options that can meet basic energy needs and promote economic and social development without threatening human health or environmental sustainability will often receive positive evaluations from rural households, especially in comparison to conventional energy alternatives such as generators.

**Sustainability and Rural Development**

In the last few decades, rural development has been promoted through increased agricultural production, small-scale industry, education and health. Infrastructure such as roads, irrigation and rural electrification were among the policy instruments. From the point of view of sustainable development many negative effects have been identified: land degradation, deforestation, desertification, and pollution by pesticides and fertilizers. The price for agricultural development has often been high. In the rural economy agriculture and energy are closely intertwined. All agricultural systems not only consume, but also produce, energy. Perhaps two-thirds of all rural energy in China comes from agricultural wastes. The conceptual unclarities of from an environmental point of view, global and local interests do not always coincide, and can even conflict. Reduction of emissions from fossil fuels is a priority for the global environment. However, substitution by wood or hydro energy can have serious adverse effects on local ecology.° Moreover, developing countries cannot afford to substitute local coal by imported oil in order to protect the global atmosphere. The burning of agricultural waste in the fields is responsible for about 10% of all carbon released from biomass burning into the atmosphere (Hulscher and Hommes, 1992). On the energy consumption side, the options for environmental management are straightforward. Energy efficiency in the residential, transport and industrial sectors should be promoted. Unfortunately, many of the available options are not feasible for lack of finance and skills. As a result, energy planning for sustainable development is complicated. It is even more difficult to indicate which policy would meet the criteria for sustainable development.

Renewable energy sources are indigenous, and can therefore contribute to reducing dependency on energy imports and increasing security of supply. Development of renewable energy sources can actively

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contribute to job creation, predominantly among the small and medium sized enterprises which are so central to the Community economic fabric, and indeed themselves form the majority in the various renewable energy sectors. Deployment of renewables can be a key feature in regional development with the aim of achieving greater social and economic cohesion within the Community. Renewable energy sources still make an unacceptably modest contribution to the Community's energy balance as compared with the available technical potential. There are signs, however, that this is changing, albeit slowly. The resource base is better understood, the technologies are improving steadily, attitudes towards their uses are changing, and the renewable energy manufacturing and service industries are maturing. But renewables still have difficulties in "taking off", in marketing terms. In fact many renewable technologies need little effort to become competitive. Moreover, biomass, including energy crops, wind and solar energy all offer a large unexploited technical potential. Current trends show that considerable technological progress related to renewable energy technologies has been achieved over recent years. Costs are rapidly dropping and many renewables, under the right conditions, have reached or are approaching economic viability.

The first signs of large-scale implementation are also appearing as regards wind energy and solar thermal collectors. Some technologies, in particular biomass, small hydro and wind, are currently competitive and economically viable in particular compared to other decentralised applications. Solar photo-voltaics, although characterised by rapidly declining costs, remain more dependent on favourable conditions. Solar water heaters are currently competitive in many regions. Under prevailing economic conditions, a serious obstacle to greater use of certain renewables has been higher initial investment costs. Although comparative costs for many renewables are becoming less disadvantageous, in certain cases quite markedly, their use is still hampered in many situations by higher initial investment costs as compared with conventional fuel cycles (although operational fuel costs are non-existent for renewables with the exception of biomass). This is particularly the case due to the fact that energy prices for conventional fuel cycles do not currently reflect the objective full cost, including the external cost to society of environmental damage caused by their use. A further obstacle is that renewable energy technologies, as is the case for many other innovative technologies, suffer from initial lack of confidence on the part of investors, governments and users, caused by lack of familiarity with their technical and economic potential and a general resistance to change and new ideas.

### **Community Strategy for Renewable Energy Sources**

A comprehensive strategy for renewables has become essential for a number of reasons. First and foremost, without a coherent and transparent strategy and an ambitious overall objective for renewables penetration, these sources of energy will not make major inroads into the Community energy balance. Technological progress by itself can not break down the several non-technical barriers which hamper the penetration of renewable energy technologies in the energy markets. At present, prices for most classical fuels are relatively stable at historically low levels and thus in themselves militate against recourse to renewables. This situation clearly calls for policy measures to redress the balance in support of the fundamental environmental and security responsibilities referred to above. Without a clear and comprehensive strategy accompanied by legislative measures, their development will be retarded. A long-term stable framework for the development of renewable sources of energy, covering political, legislative, administrative, economic and marketing aspects is in fact the top priority for the economic operators involved in their development. Furthermore, as the internal market develops, a Community-wide strategy for renewables is required to avoid imbalances between Member States or distortion of energy markets. The leading position of the renewable energy industry world-wide can only be maintained and strengthened on the basis of a significant and growing home market.

### **CONCLUSION**

If sustainable development is to occur in India and other developing countries, improvements are required in the rural areas that comprise the major part of the formal and informal national economy. Renewable

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energy technologies (RETs), used appropriately, may improve the quality of life of rural people and provide income-generating opportunities. Some of the issues required for successful dissemination of these technologies through an assisted market mechanism have been discussed. Sustainable development requires a model that specifically addresses social, economic and environmental issues. Several key suggestions have to be adapted in the field, notably social equity and gender equity aspects of introducing the RETs. Such practices will develop bio-energy packages with the involvement and governance by local community members and locally-elected village councils.

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