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Review on Sustainable Energy Potential

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Abstract: *Energy plays a major role in a country's social-economic development, and fossil fuels, which are the leading source of world energy, are being depleted due to the high rate of consumption globally, which has led to the call for the need for alternative energy sources. Presently, the world population has increased with concomitant economic growth, which has led to an increase in the demand for energy. This review presents an overview of the renewable energy resources and current potential use scenario, most especially renewable energy, such as biomass, solar, wind, and geothermal as alternative sources of energy. It is found that, since many countries have many windy areas and considerable hours of sunshine every year, they have high potential for utilizing wind, solar and different types of renewable energy. Therefore, it has become necessary that countries should optimize energy consumption and also enhance the contribution of renewable energy to the energy supply to make the energy mix secure and environmentally sustainable.*

Keywords: *Fossil fuels; renewable energy; CO_2 emission; Clean Development Mechanism; Electrical Power Resources.*

I. Introduction

Presently energy is the major determinant of the social-economic development of countries, and as the world population grows together with the changes in economic development, the energy consumption behaviour will be affected. Energy consumption has taken a new trend, as, between 1980 and 2008, it was noticed that the energy consumption rate increased from 6630 to 11,295 million tons of oil equivalent (Mtoe) globally (BP, 2008), thereby indicating that the rate of consumption has rapidly changed over the years. The IEA (2010) estimated that crude oil and natural gas reserves will be depleted within 41.8 to 60.3 years due to the high rate of exploitation and consumption. In addition, the energy from fossil fuels is responsible for the climate change due to the emission of greenhouse gas.

The last half of the century showed a rapid increase in the rate of global energy consumption, which is expected to continue over the next 50 years, as this is recorded in the change in the total primary energy demand, such as fossil fuels. Furthermore, the consumption rate of fossil fuels is certainly having a negative impact on the increase in the amount of carbon dioxide (CO_2) emissions globally and thereby increasing global warming (Kreith & Goswami, 2007). Global warming has drastically affected the melting of the polar ice caps, which is noticeable in the increase in sea level, limited land use for an increasing world population, along with changes in climate. The rapid usage and depletion of fossil fuel reserves and the need to meet the increasing demand in global energy have accelerated the need to seek alternative sources of fuel, such as water power, wind power and solar production. Such energy sources help decrease the imports for sustainable development in many countries (Mostafaeipour, 2010).

Many challenges have resulted from the consumption of fossil fuel, and, as a result, many scientists and researchers have suggested various methods, such as optimizing energy consumption and using renewable energy sources (Fadai, 2007; Mohammadnejad et al. 2011; Ong et al. 2011; Saidur et al. 2011; Abdelaziz et al. 2010; Saidur & Leong, 2011; Husnawan et al. 2009; Ong et al. 2011; Jayed et al. 2009). Various developed countries are currently using these methods and it seems that renewable energy will be the main source of energy for the world in the future. Carbon dioxide emissions, which are the major source of greenhouse gas have increased significantly as changes were significantly observed from 1960 to 2008 (Fig 1). The high rate of fossil fuel consumption and depletion of reserves with the adverse effects of greenhouse gas emissions on the climate are two factors that indicate the necessity of increasing the contribution of renewable and sustainable energy in energy consumption globally.

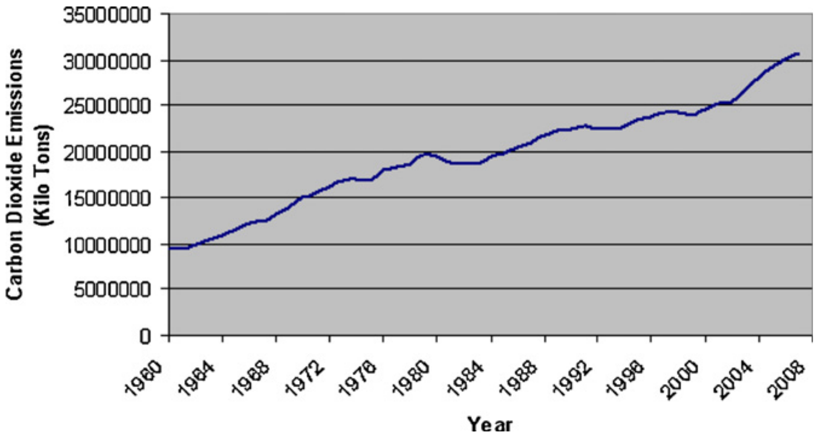

Fig. 1. Global total carbon dioxide emissions

Source: The world Bank Group 2011.

The rapid increase in global energy consumption in the last half century is expected to continue to grow over the next 50 years. Of the total primary energy demand, the fossil fuels that provide the energy are natural gas, oil and coal. However, carbon dioxide (CO_2) emissions will certainly increase worldwide due to the continuous use of fossil fuels, and further exacerbate the increase in global warming (Kreith & Goswami, 2007). Global warming is already causing considerable environmental degradation with a negative effect on the world population and respective ecosystems. As a result, there is an urgent need for alternative sources of energy, which will help in decreasing imports for sustainable development in many countries (Tiang & Ishak, 2012).

The Rationale for Renewable Energy Sources

Most services in developing and developed countries depend on the availability of electrical energy and the scarcity of electricity therefore deprives environmental, economic and social growth. The poor or limited supply of electricity would result in the less than optimal operation of hospitals, schools, industrial companies, and other state institutions/agencies (Tamo et al. 2010). This is because electricity enhances the spread of information and communication technology, which plays a vital role in the economy of any country. According to the 2011 CIA figures, 42% of Cameroon's population lives in rural areas while 58% live in urban areas.

Furthermore, of this high percentage of rural population, only 4%–6% have access to electricity (Nfah et al. 2007; Tchouate, 2003). The main challenges of the low accessibility to electricity in most areas are twofold: firstly, in most cases, grid extension is practically impossible because of the rugged terrain, increased and sparse population, and poor road infrastructural network (Nfah et al. 2010). This translates into opportunities for off-grid standalone renewable energy systems to fill this vacuum and provide energy to certain areas. Secondly, grid-connected electricity is expensive and not easily affordable for most developing countries. It has been reported by Ketlogetswe et al. (2007) that sparsely populated areas with highly dispersed households have high grid-connection costs, and it has been further estimated that, in certain areas, the grid-connection cost of an electricity line for a distance of 100 m with two poles of 8 or 9 m amounts to electricity bills of about 7 years and 14 years for high and low energy households, respectively (Nfahet et al. 2010).

II. Various Renewable Energy

Renewable energy is defined as an energy that can be produced from natural processes and does not include exhaustible energy resources like fossil fuels and uranium. It has been estimated that, globally, renewable energy in power generation and transport fuels will contribute 29% and 7%, respectively, by 2030 (IEA 2007). Achieving a solution to the environmental challenges that we face in the present century requires long-term potential action for sustainable development. In this regard, renewable energy resources (RERs) appear to be one of the most efficient and effective solutions (Kaya, 2006). RERs (i.e. biomass, solar, hydroelectric, ocean, wind and geothermal energy are the kinds of renewable energy that can be utilized) are inexhaustible and offer many environmental benefits compared to conventional energy sources. Each type of renewable energy (RE) also has its own special advantages that make it uniquely suited to certain applications, as almost none of them release gaseous or liquid pollutants during operation. In their technological development, the renewable sources range from technologies that are well established and mature to those that need further research and development (Kaya, 2006; Boyle 1990). Even though conventional sources, such as oil, natural gas and coal meet most of the energy demand at the moment, the role of RERs and their current advances have to take more relevance in order to contribute to energy supply and support the energy conservation (or efficiency) strategy by establishing energy management systems (Beccali et al. 2007). The use of RE offers a range of exceptional benefits, including a decrease in external energy dependence, a boost to local and regional component manufacturing industries, the promotion of regional engineering and consultancy services specializing in the utilization of RE, increased R&D, a decrease in the impact of electricity production and transformation; an increase in the level of services for the rural population, and the creation of employment (Mi' gueza et al. 2010) .

The wind turbine technology has a unique technical identity and unique demands in terms of the methods used for design. Remarkable advances in the wind power design have been achieved due to modern technological developments. Since 1980, advances in aerodynamics, structural dynamics, and ''micrometeorology'' have contributed to a 5% annual increase in the energy yield of the turbines. Current research techniques are producing stronger, lighter and more efficient blades for the turbines. The annual energy output for turbines has increased enormously, and the weights of the turbine and the noise they emit have been halved over the last few years. We can generate more power from wind energy by the establishment of a larger number of wind monitoring stations, selection of wind farm sites with suitable wind electric generators, improved maintenance procedure of wind turbines to increase the machine availability, use of high capacity machines, low wind regime turbines, higher tower height, wider swept area of the rotor blades, better aerodynamic and structural design, faster computer-based machining technique, increasing power factor and better policies from Government (Joselin et al. 2007). Wind energy is expected to play an increasingly important role in the future national energy scene (Fung, et al. 1981; Ezio &Claudio, 1998). Wind turbines convert the kinetic energy of the wind to electrical energy by rotating the blades. Greenpeace states that about 10% of electricity can be supplied by the wind by 2020. In good windy sites, it is already competitive with that of traditional fossil fuel generation technologies.

Potential sources of sustainable energy options, such as solar and wind energy, are non-depleting, non-polluting and site-dependent. Many countries that have an average wind speed in the range of 3–8 m/s are going for wind energy conversion systems (WECSs), in an effort to reduce their dependence on non-renewable fuels (Bellarmine & Joe, 1996; Carta, 2001; Fortunato et al. 1997). Wind is the world's fastest-growing energy source, with installed generating capacity increasing by an average of 20–25% annually for the last five years.

Cumulative global wind energy capacity reached 93.849MW in December 2007. The price of generating energy using wind machines has dropped considerably and is about 4–5 cents per kWh (Shaahid, 2011). Also, presently, thousands of PV deployments (with monthly average daily solar radiation in the range of 3–6 kWh/m2) exist worldwide, providing power to remote applications (Post & Thomass, 1988). By the end of 2006 the cumulative installed capacity of solar PV systems around the world reached more than 6500MWp (Muhammad-Sukki, Ret al. 2011). The United States, Japan, and Germany are leading the race in photovoltaic power development (Penick & Louk et al. 1998).

Stand-alone WECSs do not produce energy for a considerable portion of the year because of their intermittent nature (associated with high cut-in speeds) Infield (Shaahid, 2011). Although solar energy is available in abundance, a PV-alone system needs a large storage system, and is an expensive option. Stand-alone diesel generator sets are expensive to operate and maintain, especially at low load levels and they contribute to atmospheric degradation. The diesel generator efficiency drops when it operates at less than 40% of full load (Nayar et al. 1993). The use of a PV-wind system alone (i.e. during night and when there is no wind) cannot satisfy loads on a 24-h basis. In order to overcome this downtime, the use of hybrid (wind-PV-diesel) systems has been recommended in the literature. Furthermore, wind and solar systems are expandable, as additional capacity may be added as the need arises (Shah et al. 2013). Seasonal variations of wind and solar resources are complementary to each other. The hybrid wind-solar-diesel based power generation is becoming a viable, cost-effective approach for electricity supply, especially for remotely located communities The prospects of hybrid systems is booming steadily and a number of hybrid installations are deployed around the world (Bergey, 1993; Chadjivassiliadis 1987; Dubois et al. 1987; Beyer & Langer, 1996).

Considerable research work is being carried out worldwide on the feasibility and sizing of autonomous wind farms and solar parks. In their studies, Borowy & Salameh (1994) and Borowy & Salameh (1996) developed a methodology for the calculation of the optimum size of a battery bank and the PV array for a stand-alone hybrid wind/PV system. The variability in the available energy from the wind/PV system makes it necessary to choose the right size of battery bank so that the system will satisfy the load demand at any time. Hourly wind speed and irradiance data have been used to calculate the average power generated by a wind turbine and a PV module for every hour of a typical day in a month. A load of a typical house has been used as the load demand of the hybrid system (Bergey 1.5kW wind turbine, 53W PV, 100 Ah battery capacity). The system operation is simulated for various combinations of PV array and battery sizes and the loss of power supply probability (LPSP) is calculated for each combination. The choice of the optimum number of PV modules and batteries is based on the minimum cost of the system (for a given load and loss of power supply probability). It has been concluded that the optimum mix of PV modules and batteries depends on the particular site, load profile, and the desired reliability of the hybrid system.

Hashem et al. (2000) developed a computer approach for evaluating (to gain more insight of the system component sizes before they are built) the general performance of stand-alone wind/photovoltaic generating systems. Simple models for different system components were developed, integrated and used to predict the behaviour of generating systems based on the available wind/solar data. These include the simulation (using MATLAB) results for the performance evaluation of a stand-alone generating system designed to supply the average power demand of a typical rural residential house located in south-central Montana. An electric water heater model is used as a dump load (excess energy is used to heat the water).

Diaf et al. (2006) developed a methodology to perform the optimal sizing of an autonomous hybrid PV/wind system using an optimization model. The aim was to find the configuration that meets the desired system reliability requirements with the lowest value of levelised cost of energy (LCE). The methodology includes proposing mathematical models (for characterizing PV module, wind generator and battery), optimizing the sizing of a system according to the loss of power supply probability (LPSP) and the LCE concepts. Several system configurations (by considering various types and size of the devices) that can meet the desired system reliability were obtained. The configuration with the lowest LCE gives the optimal choice. The methodology was applied to a PV/wind hybrid system to be installed at a remote island. The study concludes that a hybrid system comprising of wind (600 W), PV (125W) and battery storage (253 Ah) has been found to be optimal from both the economic and technical point of view (LPSP = 0, and LCE is lowest). The study also indicates that in order to reduce the excess energy, corresponding to the lowest LCE, the use of a third energy source (diesel) can be beneficial to the system. Diaf et al. (2008) later applied the above methodology to determine the optimum size of system to fulfil the energy requirements (3 kWh/day) of a given load distribution for three sites located on the Isle of Corsica and analysed the impact of different parameters on the system size.

They concluded that the optimal configuration system size depends on the available wind and solar potential at a site, a 2 days storage capacity is best for the optimal configuration with the lowest LCE (for 3 kW/day load), the LCE decreases sharply with an increase in load. Diaf et al. (2008) also used the above methodology to define the optimum dimensions of PV/wind/battery system for five sites on Corsica and to study the impact of the renewable energy potential quality on the system size. They showed that LCE depends largely on the renewable energy potential quality. At high wind potential sites, more than 40% of the total production energy is provided by the wind generator, while at low wind potential sites, less than 20% of the total production energy is generated by the wind generator (Yang et al. 2009).

Although the various renewable energy systems are considered as promising power generating sources, a drawback of the mentioned energy options is their unpredictable nature and dependence on weather and climatic conditions. This issue means that renewable power production may not totally satisfy the power demand of the load at each instant (Shaahid, 2011; Alawi et al. 2007). This problem is related to the variable nature of these resources, which can be resolved by integrating the mentioned resources in a suitable hybrid combination that provides the potential to improve the system efficiency and the energy supply reliability (Shaahid & Elhadidy, 2007; Ekren & Ekren, 2010). Thus, the renewable energy penetration in future sustainable communities can be enhanced (Chen et al. 2007).

The mentioned hybrid systems can be configured either in stand-alone or in grid-parallel application modes. The selection of the application mode is dependent on many parameters such as grid availability, cost of grid supplied electricity, and meteorological conditions in the application site. Grid-parallel renewable energy systems that are designed to meet their local power demands are mostly utilized in urban sites. It is to be noted that large wind and solar farms, etc., which are connected to the grid with a uni-directional power flow are outside the scope of this study. The necessary energy when grid-parallel renewable energy systems are not sufficient to meet the load demand can be supplied by the grid. In addition, the excess energy when the renewable energy sources generate more power than the requirements during lower demand conditions, as in night times, etc., are sold to the grid at a pre-defined price. However, the absence of an electrical network in remote regions and the significantly high connection cost-due to large distances and irregular topography often lead the various organizations to explore alternative solutions. Stand-alone hybrid systems are considered to be one of the most promising ways to handle the electrification requirements of these regions (Erdinc & Uzunoglu, 2012). Particularly, the employment of renewable energy in islands is a great opportunity to test these new technologies in the stand-alone application mode (Capizzi & Tina, 2007). Stand-alone applications require a back-up unit, such as batteries, electrolyzer-fuel cell combinations, and conventional diesel generators, for the reliability of the load demand supply in all operating conditions.

Even renewable energy systems provide various positive impacts for the different types of application mode, as defined above. The present costs of such systems prevent widespread deployment, and, therefore, research and development efforts are concentrated on the accelerated cost reductions and efficiency improvements of these systems (Straatman & van Sark, 2008). In order to obtain reliable electricity from a renewable energy based hybrid system and at an economical price, its design must also be optimal in terms of operation and component selection (Mellit et al. 2007; Anagnostopoulos & Papantonis, 2007). Thus, an optimum sizing method is quite necessary in order to efficiently and economically utilize the renewable energy resources (Erdinc & Uzunoglu, 2012). Particularly, the optimum sizing of such systems requires detailed analysis for a given location due to the influence of various site-dependent variables, such as solar radiation, wind speed, and temperature, and their relation to the system cost (Zhou et al. 2010; Phuanggpornpitak & Kumarr, 2007). The computation power of modern computers is increasing dramatically, and, hence, the computer-based simulation and optimization have received more and more attention, and becoming an important tool for the design of the power systems requiring a detailed analysis (Hwang et al. 2008).

Various optimization techniques for hybrid system sizing have been reported in the literature, such as genetic algorithm (GA), simulated annealing (SA), and particle swarm optimization (PSO). In addition, several sizing tools, such as the Hybrid Optimization Model for Electric Renewable (HOMER), have been developed and widely utilized in many applications. This paper provides a thorough review presenting the state-of-art of hybrid system sizing approaches. Thus, this paper may be useful for researchers to understand the recent trends about the optimum sizing of renewable energy based hybrid systems.

The organization of this paper is as follows. Section 2 presents the available software tools and optimization based sizing algorithms taking place in the current literature. Section 3 discusses the possible promising methodologies for future use in hybrid renewable energy system sizing. Finally, the conclusion is provided in Section 4.

III. Sizing Approaches in the Current Literature

The optimum design of hybrid renewable energy systems is a hot topic and there is rich literature dedicated to this topic. The mentioned design problem to be formulated is related to the determination of the optimal configuration of the power system and optimal location, and type and sizing of generation units installed in certain nodes, so that the system meets the load requirements at minimum cost (Ter-Gazarian & Kagan, 1992). The design of the hybrid renewable energy systems can be evaluated through their lifetime costs and emissions. Typically, the lifetime costs consist of two other components in addition to the operational cost.

These components include the capital cost and the maintenance cost; together these are referred to as the "fixed cost". In the calculation of the lifetime cost, changes in the monetary value due to time must also be taken into consideration. Thus, the optimal hybrid system configuration seeks a combination of generator type and size that results in the lowest lifetime cost and/or emission. Among all the possible hybrid system configurations that are optimally dispatched, the configuration with the lowest "Net Present Value (NPV)" is declared as the "optimal configuration" or the "optimal design" (Anglani & Muliere, 2010; Mizani & Yazdani, 2009).

There are many approaches for providing the aforementioned "optimal design" criteria. Many software tools are commercially available that can be helpful for real time system integration.
In addition, several optimization techniques have also been applied by many researchers for the sizing of hybrid renewable energy systems.

IV. Global Overview of Renewable Energies

The impacts of climate change are now too evident to be disputed. Although these impacts are being felt all over the world, some studies reveal that developing countries and sub-Sahara Africa will suffer the most (Stern, 2006; Dunster et al. 2009). Many governments and international organisations have designed policies and strategies aimed at the mitigation of climate change impacts, especially in developing countries. One of these strategies has been the recommendation of the use of renewable energy technologies in the generation of energy. For example, the Clean Development Mechanism is aimed at promoting clean energy development projects in developing countries that can lessen the emission of greenhouse gases.

With regards to the global environmental sustainability issues of developing countries, electricity shortage is not the only problem that needs tackling. Greenhouse gas emissions have become a top policy agenda item of most governments and developing countries, and most are now engaged in developing strategies to mitigate greenhouse gas emissions. For example, in Cameroon, many strategies are currently being implemented to minimise greenhouse gas emissions through the sustainable management of waste (Friedrich & Troism 2010; Couth & Trois, 2010). Another example in respect of the mitigation of greenhouse gas emissions and the provision of energy are strategies aimed at promoting the uptake of renewable energy technologies under the Clean Development Mechanism (CDM) (Gilau et al. 2007). However, the most common and generally agreed sources of renewable energy, especially with regards to Cameroon, are sunlight, wind, waterfalls, biomass, geothermal and tide. The different technologies associated with these sources are solar, wind, hydro, combined heat and power, geothermal and tidal energy systems. Solar energy systems harness energy from the sun (Roaf et al. 2007). Currently, this energy is used in three main ways, passive heat, solar thermal and photovoltaic systems. Wind energy systems or wind turbines are renewable energy technologies used in generating energy from wind in motion (Roaf et al. 2007). Hydro energy systems use energy from moving water, usually by channelling water at a high pressure from the top to the bottom of a dam or by making use of river flows to drive an electricity generator (Douglass, 2005). Combined heat and power is a community heating and electricity system that generates electricity from fuel derived from biomass, organic matter or natural gas (Szokolay, 2008). It is important to note that combined heat and power is only renewable when dedicated crops or the forests that are used are replanted. In this case, the carbon captured during growth will be equal to the carbon emitted during combustion. Turkey has significant wind energy potential because of its geographical characteristics, such as its shoreline and mountain-valley structures (Jowder, 2009). The wind sources in Turkey are concentrated in the western and southern regions of Turkey. The sea fronts of the Aegean, Marmara, Mediterranean, and Black Seas, and some places of the Southeast Anatolian belt have a high wind potential, with an average speed of 4.5–10 m/s (I˙kilic & Turkbay, 2010).

According to the wind atlas of Turkey prepared by the General Directorate of Electrical Power Resources of Turkey (EIE), the economic potential is 10 GW and the technical potential is 88 GW (EIE). The technical wind potential of Turkey carried out in 2006 by the EIE at 50 m above ground level in land regions was calculated as 131,756 MW, which is equivalent to a wind power density greater than 300 W/m^2 (Malkoc, 2007). Since the first wind-based power plant started operation in the Izmir-Cesme-Germiyan region in 1998 with an installed capacity of 1.5 MW, the total installed capacity reached 333.35 MW as of 2008 (Arslan, 2010), and 727.45 MW at the end of 2009 with a total of 28 operating wind power plants (Akdag & Guler, 2010). The installed capacities of the wind power plants vary from 0.85 to 90 MW (EPDK, 2009). With the rapid growth experienced, presently, wind power represents more than 1% of the total installed power capacity in Turkey. Energy investors have already applied for a further 751 wind projects, which would bring the installed wind capacity to 78 MW (EPDK, 2008), which is almost two times greater than Turkey's total installed capacity. Of these, 73% are for the Marmara and Aegean regions, while those for Izmir and Canakkale make up 15 and 12.5% of all the applications, respectively (Islam et al. 2009).

It is well known that Ethiopia has been suffering from cyclical droughts, which hamper the sustainability of the agro-ecological environment, The conventional electricity supply produced by the centralized energy production authority, which includes hydroelectric power plants and engine-driven generators, is not only inequitably distributed but also insufficient to meet the economic needs of the rural and urban population. Presently, the wind energy potential is established in four different sites in Ethiopia, as electricity is generated (Bekele & Palm, 2009).

India had a population of 1.1 billion and a Gross Domestic Product of 33 trillion Rupees1 (728 billion US$) in 2006 (Mulugetta & Drake, 1996). A breakup of India's primary commercial energy shows that more than 80% is supplied from fossil fuels. If we also consider traditional fuels and biomass, India's total primary energy consumption was about 20 EJ in 2004–2005 (an average of 18 GJ/capita/year). The installed capacity of wind increased from 41MW in 1992 to 6053MW in September 2006 (NREL, 2006; Manwell et al. 2002). The annual growth rate for this period was 40%. Almost all the installations have come from private sector investments.

The annual generation increased from 113.6 GWh in 1991 to 2929 GWh in 2003 (growth rate of 31% per year). The annual capacity factor ranges between 13 and 14%. In the initial period (1990–1993) the capacity factor was higher, due to the selection of sites with better wind speeds. Wind development has been accelerated by the provision of several incentives and enabling policies. In the initial period, 100% accelerated depreciation in the first year, capital subsidies and tax incentives created some market distortions where a number of installations came up at unviable sites. A survey of wind installations in 1996 MGMDAC, (2004) in Tamil Nadu and Gujarat revealed that the majority of installations (75% in Tamil Nadu and 60% in Gujarat) were motivated mainly by tax savings. The wind energy potential has been estimated by the CWET as 45,000MW assuming 1% of land availability for power generation in the potential areas. CWET also indicates a technical potential of 13,000MW based on 20% grid penetration (Bekele & Palm, 2009). However, grid penetration is not expected to be a serious limitation and it is expected that the total potential of 45,000MW can be achieved. The Indian Wind Energy Association estimates a potential of 100,000MW (more than double the CWET estimate)(Bekele & Palm, 2009).

The energy situation in Pakistan is seriously troubling today due to the lack of careful planning and implementation of its energy policies. To avoid the situation worsening in the years ahead, the country will have to exploit its huge natural renewable resources. Presently an average solar insolation of 5–7 kWh/m^2/day, wind speed 5–7.5 m/s, biogas 14 million m^3/day, microhydel more than 600 MW (for small units) with a persistency factor of more than 80% over a year exist in the country (Sheikh, 2009). Solar and wind maps are presented along with identification of hot spring sites as a resource of geothermal energy. Pakistan now processes more than 20,000MW of economically viable wind power potential (Sheikh, 2009).

Malaysia, which is located between 1° and 7° North of the Equator, has all these renewable energy resources in abundance, but most of these energy resources are yet to be exploited. Malaysia had a steady GDP growth of 4.6% in 2011, which is rare among the ASEAN countries (Shah Alam et al. 2013). In comparison with the fast economic development, its final energy consumption is also growing at a meteoric rate. It is observed that the growth rate of energy consumption between 2000 and 2005 was 5.6% and reached 38.9 M.toe in 2005 (Saidur et al. 2009). The final energy consumption is expected to reach 98.7 metric tons in 2030, which will be nearly three times higher than the 2002 level (Najib, 2009).

In Malaysia, the application of the green technology is considered to be one of the important solutions that are being gradually followed by many countries around the world to identify the issues of energy and the environment (Islam et al. 2009). However, scientific technology and the suitability of RE resources will not help the government to implement successful use of RE sources throughout Malaysia, unless it can significantly garner public opinion towards the use of RE. Therefore, the application of RE technologies is more efficient to rely on local drivers, as, for example, increase in the employment, income and improved regional economies. The successful development and dissemination of RE technologies depends on their perfection of the isolated rural communities: providing energy, with the maintenance of a minimum level of income (Bush 2006).

Currently, Malaysia is adopting the 5th Fuel Diversification Policy (FDP), which was introduced in 1999 (Jafar et al. 2008). The introduction of FDP was to reduce Malaysia's over-reliance on a specific fuel type and to achieve a more balanced supply mix between natural gas, oil, coal and hydropower. The country is embarking on a gradual change for fuel consumption from depending solely on one specific source of energy to a mix of fuel sources derived from hydropower and coal (NMP, 2010). Malaysia has high solar energy potential with an average daily solar radiation of 4000–5000 Wh/m^2. The average sunshine duration was found to be in the range of 4–8 h/day. Therefore, Malaysia has favourable climatic conditions for the development of solar energy and SWHs for different economic sectors. Likewise, photovoltaic technology was introduced in Malaysia in the 1980s, with the aim of providing electricity to rural areas (electrification and telecommunication), communication towers and consumers (Mekhilef et al., 2012).

In Spain, the renewable energy sources have been promoted since the application of the Plan for the Promotion of Renewable Energies (IDEA, 2010) that set an initial target of generating 12% of the total energy consumption from renewable sources by 2010. Specifically, in the Valencian region, the Wind Energy Plan for the Valencian Community (DOGV 2001) identified 15 wind energy areas (3 of them located in the Alicante province) and programmed 67 wind farms – the first of these wind farms started in February 2006 – with a total installed power of 2300 MW. In recent years, much research has been done for constructing an adequate model for the wind speed frequency distribution (Dorvlo, 2002; Jaramillo & Borja, 2003; Aksoy et al. 2004). The most commonly used wind speed distribution is the Weibull probability distribution function; however, several authors have shown that Weibull does not fit well when the wind regimes present bimodality (Jaramillo & Borja, 2004) or when there are calms (Bivona et al. 2003; Aksoy 2004). The sea breeze in Alicante is the most important wind, and blows around 71% of the total days (Olcina & Azorı´n-Molina 2004), and the wind regimes normally present bimodality (Cabello & Orza, 2010).

V. Conclusion

The usage of renewable energy resources has a significant impact on the natural flows of energy in the environment. Efficient usage of resources makes the energy refillable. Most developing countries are agricultural based, which generates a significant amount of agro-industrial waste that is a potential energy resource. The sunny weather helps produce solar energy, which is another potential energy resource, as does the conversion system of wind energy.

The increase in the global energy demand and environmental problems relating to fossil energy utilization have promoted widespread research on renewable energy technologies to replace the traditional fossil fuels. Particularly, renewable energy systems, which can become an applicable solution to the challenges that the world faces today in respect of the sustainability issue of energy supply and environmental protection. The optimal sizing of these renewable energy systems can significantly improve the economic and technical performance of the power supply as well as promote the widespread use of such environmentally friendly sources. Different sizing methods can be applied to reach a techno-economically optimum of various renewable energy systems. Thus, the economic barriers for better penetration of renewable energy can be partly overcome. The selection of a suitable approach may change due to the type of application and user requirements, etc. In short, each developed sizing approach has the potential to significantly promote the applicability of renewable energy systems, and, thus, has great importance in the area of renewable energy.

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