Renewable Energy Technologies and Their Role in Reducing Global Warming

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Abstract

During the last century, global warming has been raised as a worldwide issue in public, since that it has a serious impact on the climate change which firmly connects not only human life but also other creatures on the earth. In fact, global warming is basically the result of cumulative net warming by greenhouse gas (GHG) effect in the whole world. Carbon dioxide (CO_2) is one main category of GHG. Approved by a majority of scientists, the increasing anthropogenic CO_2 emission from energy industry takes the primary responsibility of global warming. Therefore, theoretically the control of releasing CO_2 during the energy generation and consumption would probably mitigate global warming.

Keywords

Renewable energy, CO_2 emission, Global warming.

1. Introduction

Considering the source of CO_2 emission, traditional fossil fuel, mainly coal, oil and gas, accounts for over three quarters in the world [1,2]. Hence, renewable energy sources and their advanced corresponding technologies could be an alternative to cope with this problem. A massive quantity of recent research and projects based on the green energy technologies indicate the high probability to reduce CO_2 emission. This short essay will simply describe several typical technologies in terms of different renewable energy sources and generally evaluate their contributions to alleviation of global warming.

2. Solutions

There are various types of renewable energy. The corresponding technologies are always modified and updated to ensure sound performance with low or even non CO_2 emission. The following content will concentrate on five sections, namely solar energy, wind power, hydropower, biomass and geothermal energy.

2.1 Solar energy

Solar energy in the form of radiant light and heat is transferred directly into different energy forms, which can provide electricity and space heating in domestic, commercial and industrial fields. It is widely believed that solar energy is a promising alternative since it is free, clean, extensive, and most importantly quite less carbon emission. Nowadays, there are two popular technologies based on solar energy, which are photovoltaic (PV) system and solar hot water system.

Firstly, PV system is utilized to convert sunlight into electricity directly. Figure 1 shows the typical PV system components [3]. When the incident sunlight hits the PV cells, the electrical field changes and simulates a certain number of electrons to move in the same direction. After inverting and control, a stable current flows in a load circuit or a distribution system. Some elelctricty energy might be stored in batteries. Therotically there is non GHG emission in the view of electricity generation section.

The other one is solar hot water system. The solar thermal collectors absorbs heat from solar radiance. Then the heated working fluid inside pipes flows to a vessel for the purpose of heat exchange with water. As a result, warm water is achieved and can be used for both hot water supply and space heating. To some degree, it can share the burden of electrical heating and water boiling. Although

actually pumping power require the additional electricity supply, the ratio of heat output to eletricity input would be less than that of pure electrcity supplmentary system.

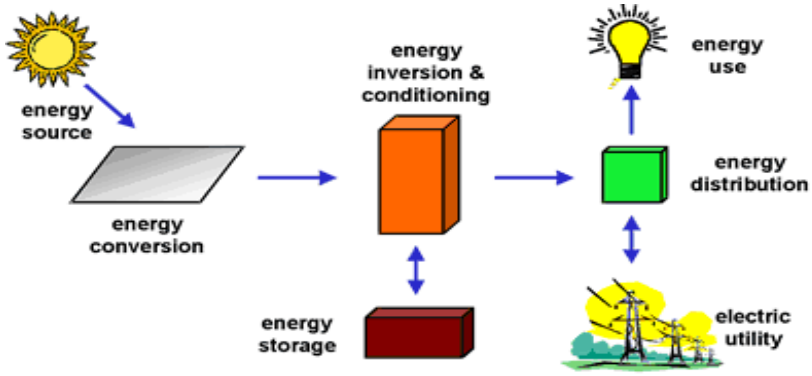

Figure 1: PV system components [3]

2.2 Wind power

In ancient times, people usually harness the kinetic energy of wind to spur device to run directly, such as water pumping, grinding wheat and ship propelling. Today, the most common method for wind energy utility is wind turbines which can efficiently convert the force of moving air into electricity using sophisticated design and high-tech materials. Wind turbines vary in many different sizes from small-scale systems for only one unit domestic usage to large-scale systems for maximum of 1000 homes electricity supply [4].

Frankly speaking, wind could be regarded as an abundant renewable energy with no emissions and would be not depleted over time. For example, one single wind turbine which produces one megawatt (MW) electricity running for one per can displace over 1,500 tons of CO_2 [5]. Due to the concern of CO_2 emission from burning fossil fuel, the use of wind for electricity generation grows dramatically recently. To be specific, the worldwide installed capacity in 2008 achieved 121,188 MW, over 12 times as ten years ago [6]. Nevertheless, it was only equivalent to 1.5% in total electricity generation [6].

2.3 Hydropower

So far, hydropower seems to have been already advanced because of the relative higher percentage in electricity generation field comparing with other forms of renewable energy [7], but still has impressively exploitative potential owing to its ample reserves and the immediate requirement on sustainable development. It is claimed by Ocampo that “Once built, hydropower facilities have low operation costs and a long service life” [8]. Additionally, taking the adverse effects on environment and heavy external costs on credits of carbon dioxide emission of coal or oil into account, hydropower appears to be much cleaner and more economical in the long-term.

The world’s largest hydropower plant is the Three Gorges Dam in China currently, of which the output is estimated to be more than 18.2 million kilowatt, nearly one-ninth of China’s electricity supply [9]. In the meanwhile, 100 million tonnes of GHG gas will be cut off [9]. However, for the dams of enormous size in the large-scale hydro field, the sudden ecological system changes thus destroying the stable habitation for both aquatic organisms and human beings. Environmental and social impacts should be assessed and evaluated carefully before the design and installation of large-scale hydropower dam.

In spite of these, small-scale hydropower plant (SHP), refereed as damless plant, is given good opportunity. Recognizing SHP is more environmental benign, less expensive, lower technology level and also no GHG gas emission, hydropower is still a sustainable renewable energy source and can be developed splendidly in streams and rivers.

2.4 Biomass

Combustion process of both a fossil fuel and a biomass would discharge carbon dioxide. The crucial difference is that the time frame of the carbon cycle [10]. As finite energy, fossil fuel release CO_2

which has been stored under the ground for millions of years and need an extremely long time to go back to the ground. By contrast, the net CO_2 emission in biomass burning is zero, since that CO_2 emitted into the atmosphere is identical as the amount of CO_2 absorbed from atmosphere during biological materials' growth period (much shorter than millions of years). Fig. 2 presents the simple idea of carbon cycle with biomass combustion [11].

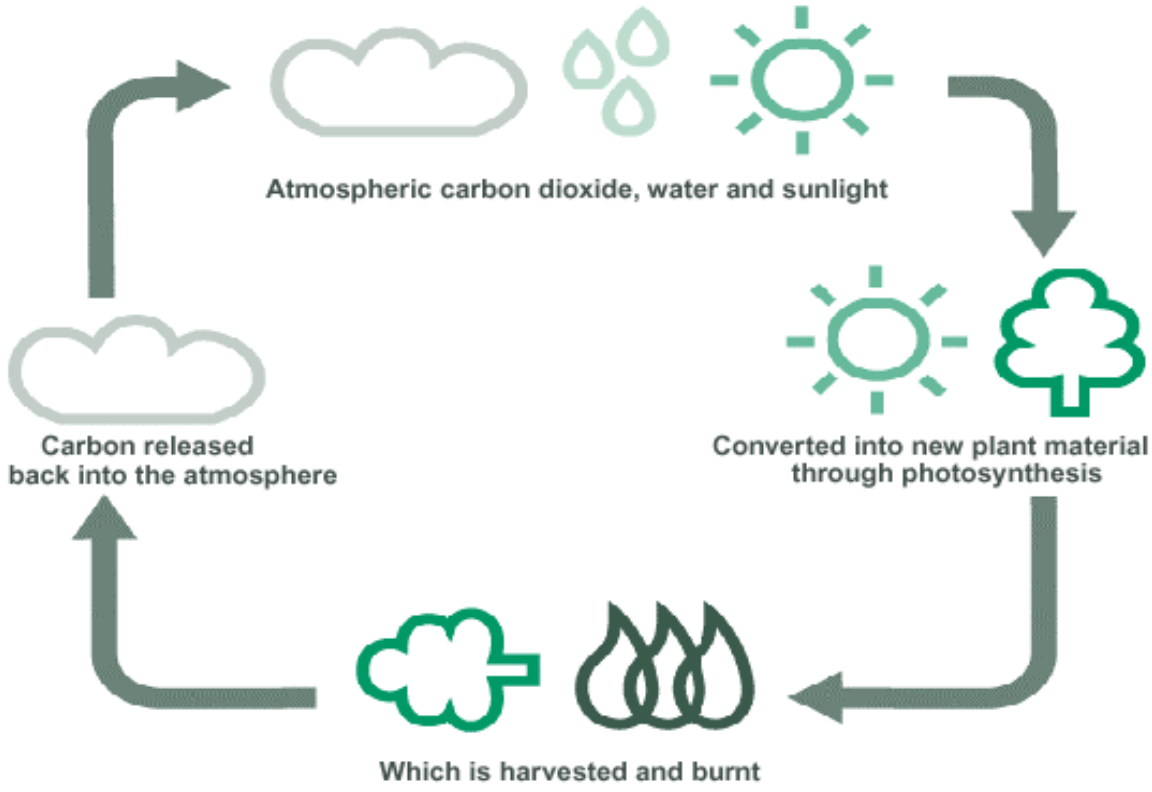

Fig. 2. Carbon cycle with biomass combustion [11]

The primary source of biomass can be easily achieved and is relatively cheap, covering woody biomass, non-woody biomass and other organic waste. Biomass can burn directly to obtain heat energy or generate electricity, and sometimes is processed to make biofuel product, such as bio-gas, bio-oil and bio-ethanol. The system efficiency and waste treatment are two vital factors to be considered carefully when using biomass. Otherwise, the final waste could contains harmful gases, such as nitrogen oxide, which is also a threat to environment. As mentioned previously, although there should be no net carbon emission, it is based on the necessary condition that when the cycle of growth and harvest is balanced. In other words, after using biomass, efforts should be taken to create new source of biomass, like planting trees.

2.5 Geothermal energy

All the renewable energy described above has a common point, the same energy source – the sun, while geothermal energy is the heat generated and kept beneath the Earth's surface. As estimated, the soil temperature maintains comparably constant below 15m depth. If it goes deeper, the temperature climbs up with a roughly gradient of 30°C/km as the consequence of geothermal energy [12]. Accordingly, the stable energy source is favored by scientists and researchers to investigate for hot water supply and space heating.

The feasible corresponding technology is the Ground Source Heat Pump (GSHP) system. But the current capital investment of installation seems expensive since it calls for land drilling and trenching. The low running and maintenance cost can greatly offset the total cost over the long lifetime of normally 20-25 years and up to 50 years [13]. Furthermore, the system efficiency, also known as the

Coefficient of Performance (COP), reaches 3-4, which means only one kilowatt input energy can produce 3-4 kilowatt energy output [14]. The one kilowatt input involves electricity consumption for operating compressor and pumps. Therefore, comparing to the system entirely using electricity, GSHP reduce the CO_2 emission. Table 1 displays the effective CO_2 emission from various systems by different fuels [15]. When considering the high COP factor, the low overall effective CO_2 emission of GSHP system proofs its outstanding competitive strength to traditional approaches.

Table 1: CO_2 emission from various types of heating technologies [15]

Technology	Fuel type	CO_2 emission kg/GJ (kg/kWh) delivered	Efficiency %	Effective CO_2 emission kg/GJ
GSHPs	Electricity	139 (0.50)	300	46
Condensing boiler	Fuel oil	78 (0.28)	93	84
Condensing boiler	LPG	61 (0.23)	93	66
Condensing boiler	Natural gas	53 (0.19)	93	57

2.6 Overall view of renewable energy technologies

The main types of renewable energy above seem have great potential in reduction of GHG emission. Thereafter, the global warming theoretically can be mitigated to a certain extent. According to the statistics from Figure 3, over three quarters of total world primary energy was supplied by traditional fuels (i.e. coal, oil and natural gas) [16]. Among renewable energies, biomass accounts for 10% showing its great contribution to energy supply, but still cannot rival fossil fuel for quantity. Similar phenomenon appears in the total world electricity generation. Conventional fuel remains dominant though hydro reaches 16%.

The condition in the developed countries seems no great difference comparing to the world energy supply. For instance, Figure 4 illustrates the primary energy consumption by source and sector in the United States of America in 2007 [17]. Renewable energies supply only occupied 6.8%.

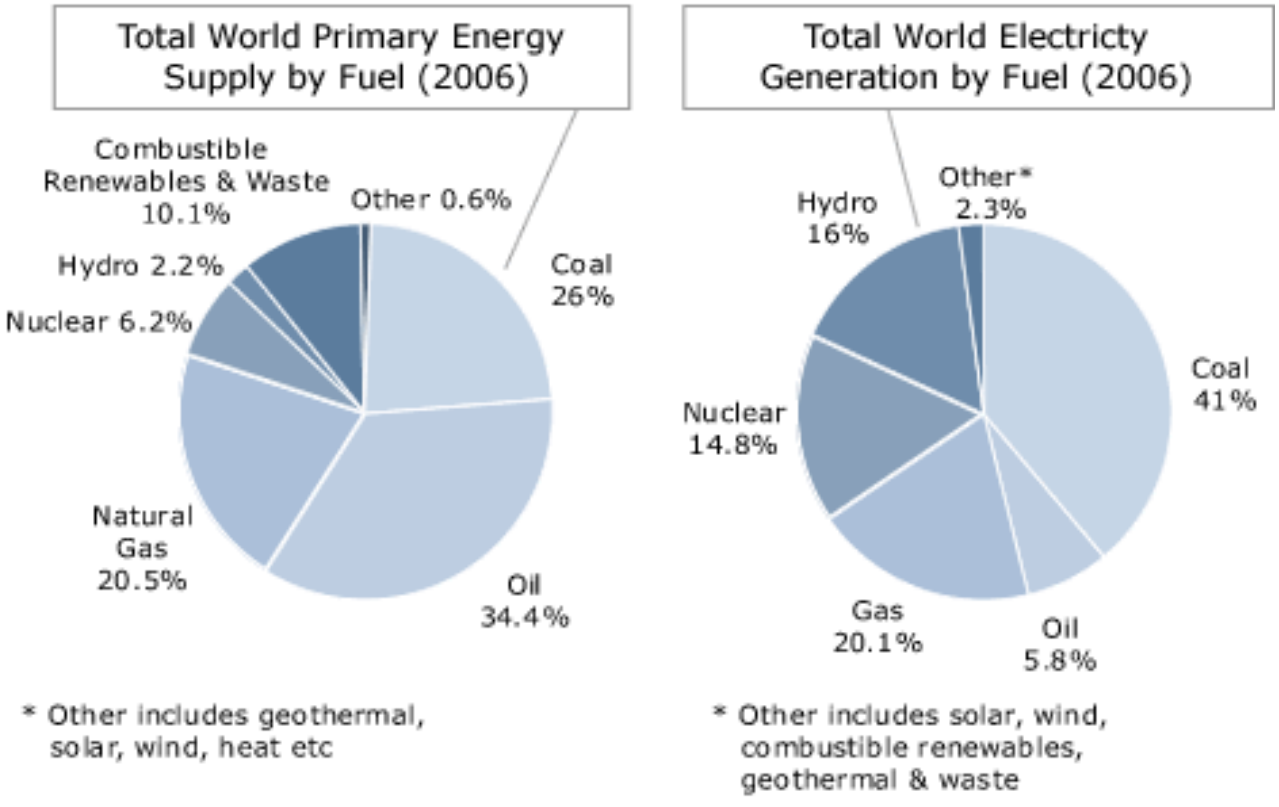

Fig. 3: World total primary energy supply and total electricity generation by fuel in 2006 [16]

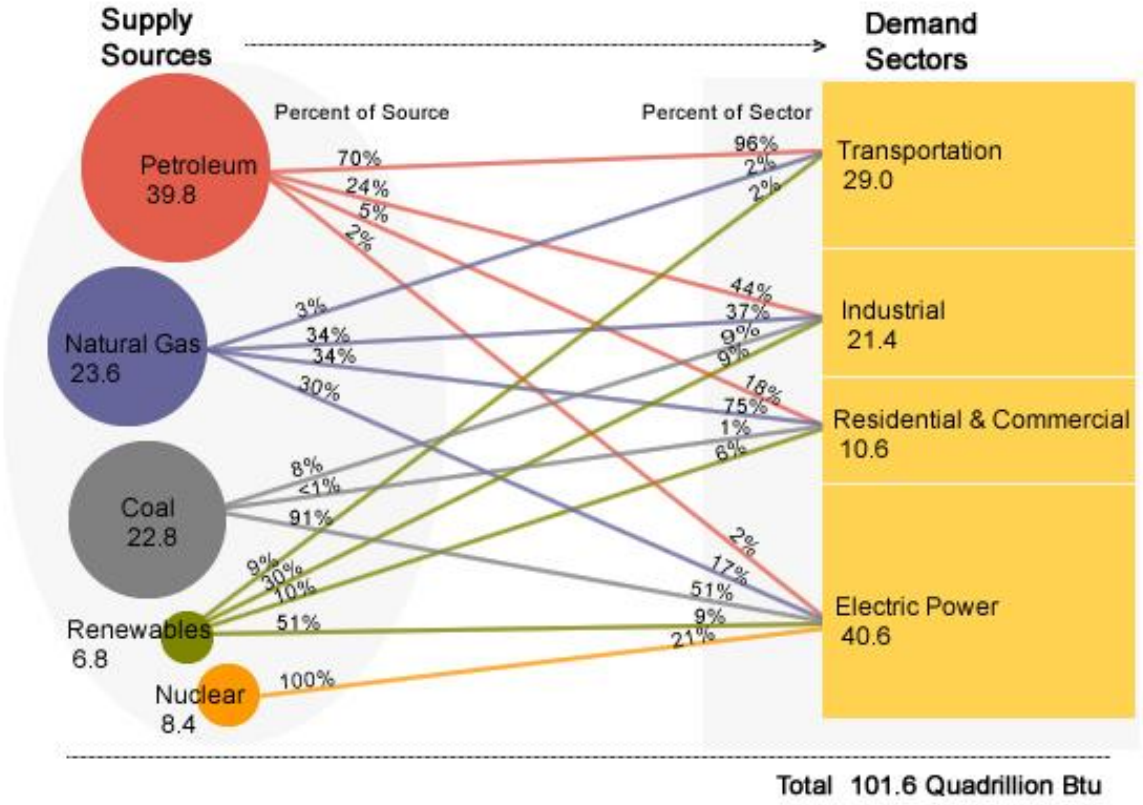

Fig. 4: Primary energy consumption by source and sector in the United States of America in 2007 [17]

Hence, there is still great potential for development of renewable energy to replace the conventional source gradually. The CO_2 emission from traditional power plants would decrease thereafter. However, some obstacles and barriers emerge to prevent the further development of renewable energy technologies. First is the intrinsic characteristic of renewable energy source. Either PV system or solar hot water system merely works during daytime. Wind power is heavily dependent on the availability of wind and always provides intermittent electricity. Environmental impacts should be reconsidered. Large-scale wind farms or hydropower plants often require quite vast land for installation, which would destroy the original environmental structure and might be a killer to animals by accident. Then in terms of technical problem, increasing the system efficiency can gain a better performance and on the other hand reducing the total expenditure. The byproduct from processing biomass should be precisely treated. Methods of drilling and trenching need to be modified to lower the initial huge installation cost.

Besides, mass media should take the responsibility to enhance the public awareness of renewable technologies and their potential in relieving effect of global warming. Moreover, government could take action to establish appropriate standards or codes and encourage the designers and manufacturers by offering sponsorship, which can share the burden of high investment.

3. Conclusion

So far, the renewable energy mainly refers to these five types, solar energy, wind power, hydropower, biomass and geothermal energy. Overall, renewable energy technologies play a significant role in reduction of global warming since they all release much lower level of GHG gas than traditional fuel. Until now, the benefit from green energy technologies application is obvious due to the direct decline of CO_2 emission. Notwithstanding, there is spacious room for development all over the world. The current situation shows that hydropower and biomass are promoted well and others account for extremely tiny percentage of world energy supply.

With the assistance and support from government, research organizations could accept sufficient funding to do further improvement and then eliminate the problems to ensure the spreading implementation. In order to discover potential customers, vigorously advocating the renewable energies technologies would make the public realize the advantages and feasibility as well as their major contribution to reducing carbon emission. It is possible that the renewable energy technologies can become the overwhelming part in energy industry someday in future.

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