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A comparative study on energy review among the developed and emerging nations

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ABSTRACT

The study explored the comparison of energy scenario and CO_2 emission among the developed and emerging nations such as USA, Canada, China, Brazil and India. It is recognized that the world is under serious threat of global warming, thus immediate actions are required to combat against it globally. The objective of this study was to examine the current situation of energy and emission in this high energy consumes countries. Total global coal production has been increased up to 35.36% in 2010 compare to 2001, and 5.5% increased compare to 2009. The production of natural gas has been increased in a similar manner. China alone contribute 26% of the world total CO_2, USA 18%, India 5%, Canada and Brazil 2% in 2009 due to the high consumption of coal, natural gas and petroleum. But the per capita emission of CO_2 was very high in developed countries such as USA's per capita emission was more than 3, 13 and 7 times than China, India and Brazil in 2009. So it is very important to adopt low e-technology and energy efficient initiatives in the energy and emission driving countries.

Keywords: Energy, Consumption, Production, CO_2 emission.

Introduction

Due to rapid increasing trends of development, urbanization, industrialization and improvement in human life worldwide, several critical factors need to be considered for maintaining eco-environmental balance, protecting climate and preserving natural resources. One of the critical factors is energy. Energy is the essential material base of human livelihood and development, and one of the key elements of the national economy[1]. With the rapid development of economy, human society's dependence on energy gradually increased, and the amount of energy consumption is increasing globally[2]. However, the production and use of energy will have some degree of negative impact on the environment, and also the deterioration of environment which prevent regional and national economic development. In addition, energy production is mostly comes from natural resources such as fossil fuels which are also related with global pollution as well as CO_2 emission and ultimately change of climate. Oil remained the largest energy source (33%) despite the fact that its share has been decreasing over time. Coal posted a growing role in the world's energy consumption, it accounted for 27% of the total in 2009[3].

The world energy demand in 2020 would be 50–80% higher than 1990 levels. Approximately, 80% is due to carbon emissions from the combustion of energy fuels[4]. The predominant Green House Gas (GHG) is CO_2, which represents more than half of the increase in radiative forcing from anthropogenic GHG sources. The majority of CO_2 arises from the use of fossil fuels, which in turn account for about 75% of total global energy use[5]. According to the International Energy Agency, energy demand has been increased at just over 2% per year for the past 25 years and will continue to climb at about this same rate over the next 15 years if current energy use patterns persist[6]. By 2030 total primary energy use in China is projected to be 6.4 billion tons of oil equivalents (btoe), about 30% of global energy use by that time and implying an increase of 6.7% per annum over 2002-30. With nearly 90% of energy use in 2030 still being provided from fossil fuel sources, in spite of a projected 10.5% per annum growth in energy from non-fossil fuel sources, emissions are projected to grow by 6.5% per annum and to total about 5.8 billion tons of carbon by 2030[7]. The world CO_2 emission from the consumption of fossil fuel is predicted to increase from about 25,000 billion metric tons in 2003, to more than 40,000 billion metric tons by 2030[8]. The construction industry is an

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important indicator of economic development, but it consumes a significant amount of energy and produces considerable pollution[9,10,11]. The study emphasized to review of energy scenario and CO_2 emission of high energy consume country by historical and multi-dimensional data analysis such energy production and consumption.

Materials and Method

The study has been designed mainly based on secondary information from different sources, especially Energy Information Administration (EIA), US Department of Energy[12]; World Resources Institute (WRI)[13,14]; Energy Home, Intergovernmental Panel on Climate Change (IPCC), various articles and internet sources[15,16], Energy India[17], etc were the principal one. The historical data from 1990 to 2010, to some extent 2009 and 2011 related to energy has been collected from these sources and then analyzed to obtain the objectives of the study.

Results and Discussion

Energy Section: Energy markets have combined crisis recovery and strong industry dynamism. Energy consumption in the G20 soared by more than 5% in 2010, after the slight decrease of 2009. This strong increase is the result of two converging trends. On the one-hand, industrialized countries, which experienced sharp decreases in energy demand in 2009, recovered firmly in 2010, almost coming back to historical trends. Oil, gas, coal, and electricity markets followed the same trend. On the other hand, China and India, which showed no signs of slowing down in 2009, continued their intense demand for all forms of energy.

Coal and oil: The result of the study shows that both the production and consumption of coal in China and United States has increasing trends and maximum in 2010. About 5.1% and 15.9% consumption increased from 2009 to 2010 in USA and China, respectively. At the same way, 1%, 9%, 1.5% and 7.9% production increased from 2009 to 2010 in USA, China, India and Canada, respectively. Also, coal export has been increased 37.7% in USA, and import increased in China, Brazil and India at about 40.4%, 32.1% and 22.1%, respectively in 2010. In 2010, the reserve of oil is very high in Canada, and increased in China and Brazil, and constant in USA and India. The total coal production, consumption, exports and import; and their trends of the selected countries are shown in Fig. 1-4. Besides, the reservation of oil is shown in Fig. 5. Total global coal production has been increased up to 35.36% in 2010 compare to 2001, and also 5.5% increased compare to 2009. About 44.1% of the total global coal has been produced and 46.22% consumed by China alone in 2010.

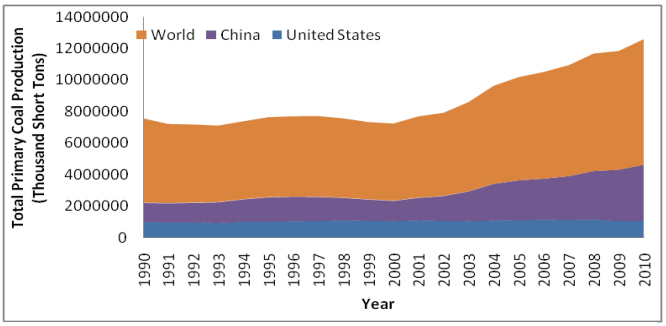

Figure 1. Total primary coal production in USA, China and the world.

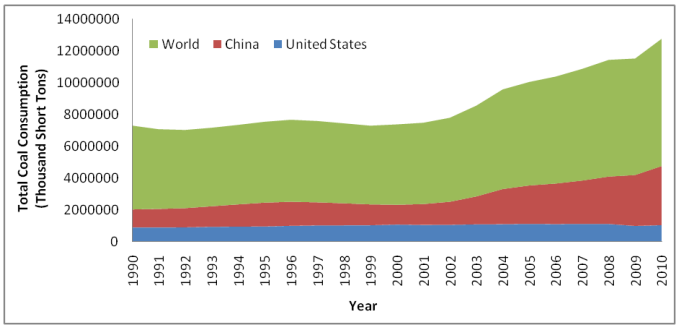

Figure 2. Total coal consumption in USA, China and the world.

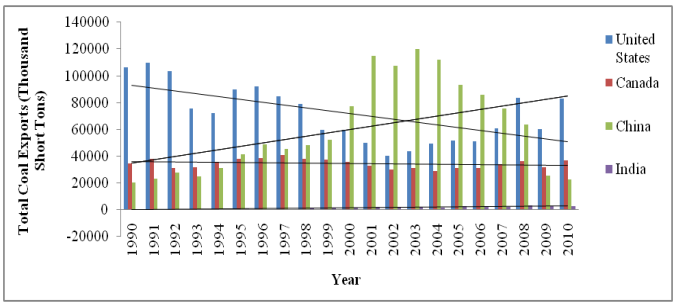

Figure 3. Total coal export in USA, China, Canada and India.

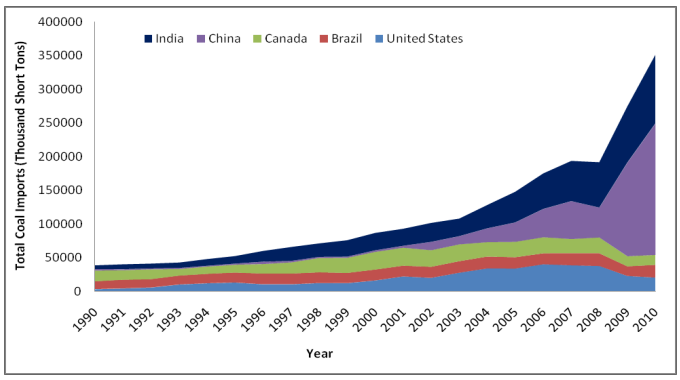

Figure 4. Total coal import in USA, China, Canada, Brazil and India

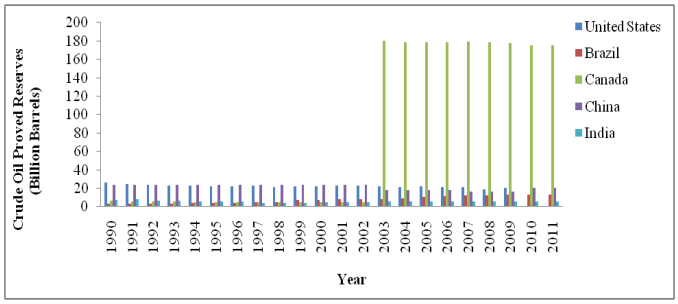

Figure 5. Crude oil reserved in USA, China, Canada, Brazil and India.

Natural gas: About 19%, 4.7% and 2.4 % of the world gross natural gas produced by USA, Canada and China in 2010, and the trends of production is increasing. In China, the production has been increased by 67.9% compare to 2001. Besides, the trends of reserve of natural gas in most of these countries are increasing, but USA has very high reserve and rapid increasing trend has been found in China in 2011. The production of natural gas and proved reserves, and their trends of the selected countries are shown in Fig. 6 and Fig. 7.

Globally, total natural gas production has been increased up to 21.9% in 2010 compare to 2001, and also 4.7% increased compare to 2009.

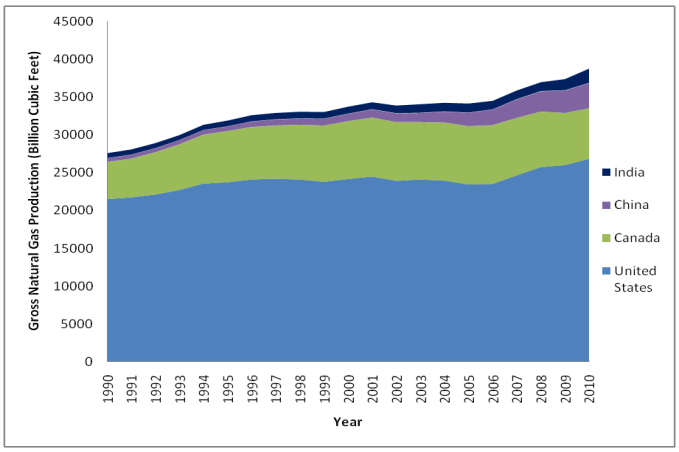

Figure 6. Gross natural gas production in USA, China, Canada and India

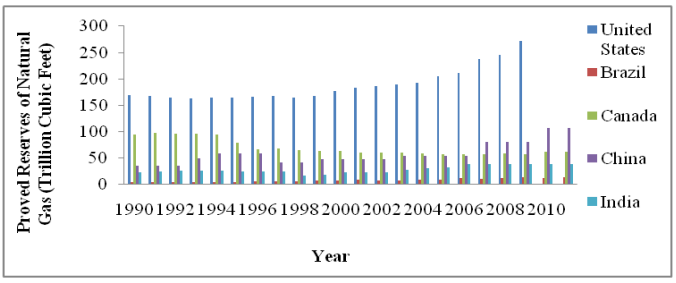

Figure 7. Proved natural gas reserve in USA, China, Canada, Brazil and India

Electricity: Although most the countries total electricity consumption and generation is increasing, but China has rapid increasing trends (6.5% more generation in 2009 than 2008) due to rapid industrial and economic development. A nearly constant trend in renewable electricity generation has been found in USA and Canada, and India has increasing trends, but in China (6.8%) and Brazil (6%) renewable electricity generation has been found rapid increasing trend in 2009. The total non-renewable and renewable sources of electricity generation and their trends of the selected countries are shown in Fig. 8 and Fig. 9.

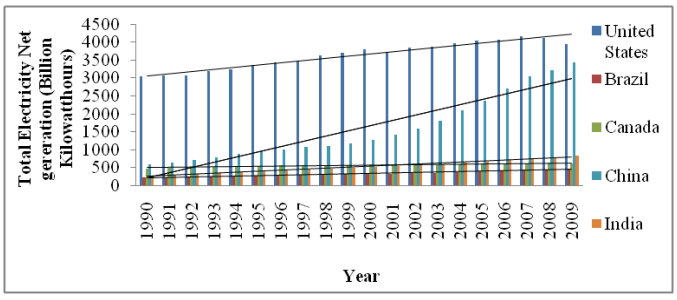

Figure 8. Total electricity generation in USA, China, Canada, Brazil and India.

Although the energy production and consumption is increasing in developing countries, like China, Brazil and India, but the per capita energy consumption is extremely high in developed countries, such as in USA and Canada. The per capita consumption of dry natural gas in USA was 78018.95 cf which was 95.4% more than in China 2812.86 cf, and in Canada, 96.7% more than China in 2010.

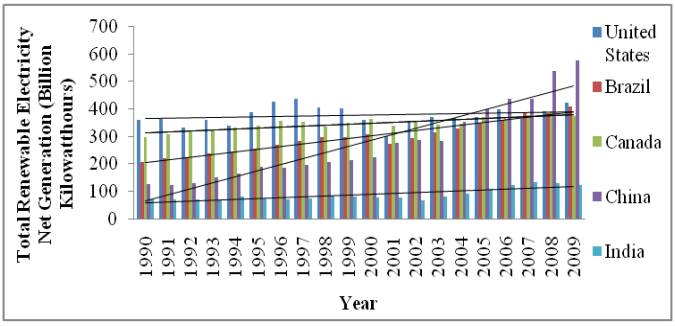

Figure 9. Total renewable electricity generation in USA, China, Canada, Brazil and India.

The per capita consumption of non-renewable sources of fuel in 2010 of the selected countries is shown in Table 1.

Table 1: Per capita fossil fuel consumption in 2010.

Country	Coal (Short ton)	Petroleum (Barrels)	Dry Natural gas (Cubic feet)
China	2.76	---	2812.86
United States	3.40	21.9	78018.95
Canada	1.53	25.6	85467.78
India	0.60	---	1881.90
Brazil	0.13	---	4665.90

CO_2 Section: The overall trend of CO_2 emission has been increasing globally. In Canada and Brazil, the emission trends has been found at nearly constant, and in USA, it is slightly increasing (but at decreasing rate), but in India, the emission trend has high, and extremely increasing trend has been found in China in 2009. China alone has responsible for 26% global CO_2 emission, while 18% by USA and 5% by India in 2009. The emission of CO_2 in China was 12% in 2001 which has increased up to 26% by 2009, but in USA was 24% in 2001 which has down to 18% in 2009. But the per capita consumption of CO_2 in USA and Canada is still very high, and achieved first and second position in the world, and it is 17.57 and 15.75 $_{Ton}$, whereas in China, Brazil and India is only 5.75, 2.23 and 1.32 $_{Ton}$, respectively. The trends of CO_2 emission of the selected countries is shown in Fig. 10, and individual contribution and comparison between 2009 and 2001 is shown in Fig. 11. The per capita consumption of CO_2 emission of the selected countries in 2009 is given in Table 2. Globally, total 19.9%, 44.2% and 35.9% CO_2 emission comes from the

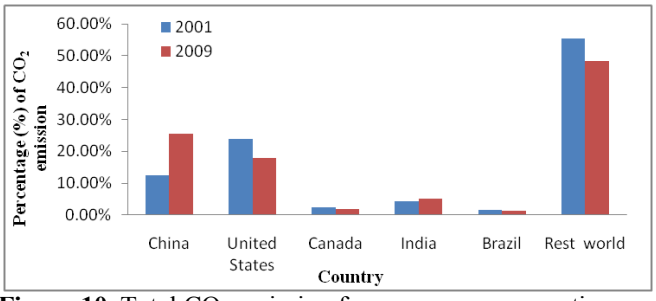

Figure 10. Total CO_2 emission from energy consumption.

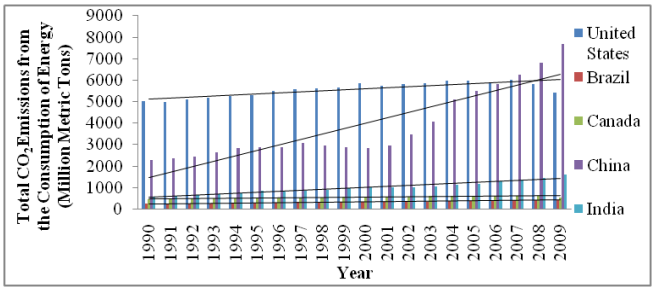

Figure 11. Comparison of CO_2 emission from energy consumption**.**

consumption of natural gas, coal and petroleum, respectively in 2009, and total CO_2 emission has been increased by 21% and 28. 7% in 2009 compare to 2001 and 1990 respectively.

Table 2: Per capita emission of CO_2 in 2009.

Country	Ton(s) of CO_2 emission
China	5.75
United States	17.57
Canada	15.75
India	1.32
Brazil	2.23

Conclusions

Historically, global energy consumption has grown at an average annual rate of about 2% for almost two centuries, although growth rates vary considerably over time and among regions. In the developed world, energy use per capita is already extremely high and continues to increase slowly. By contrast, the most rapid growth is now occurring in developing countries, where energy use is still low compared with that in more affluent nations. Developing nations account for more than 80% of world population, but consume only about one third of the world's energy. It can be concluded from the study that energy production and consumption is increasing with subsequent emission of CO_2 worldwide. The developed country such as USA and Canada's energy production and consumption is very high, although increasing trends is low, especially in Canada but in USA the trends of increasing is still high. In case of emerging country such as China, Brazil and India's energy production and consumption is very high and growing because of their rapid economic, industrial, infrastructural and social development. Besides, the generation of renewable energy in China and Brazil has been increased up to 7% and 6%, respectively because of their technology development and various initiatives. China's total yearly renewable energy generation is more even than USA and Canada. So it is very important to adopt low e-technology, sustainable and green building design and green economy, etc. for reducing consumption of fossil fuel, saving energy, controlling CO_2 emission, sustainable economic development and protecting environment as a whole.

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