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Structure and environmental impact of global energy consumption



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ABSTRACT

This paper presents information on global energy consumption by fuel type (liquid fuels, coal, natural gas, renewables and nuclear) and sectors (buildings, industrial, transportation and electricity), and environmental impact of global energy consumption (SO_x , NO_x and CO_2 emissions). There is a strong relationship between energy consumption and economic growth. The Global Financial Crisis has affected the global economic growth violently. The governments have recently adopted some effective measures to fight against the Global Financial Crisis. The structure of energy consumption and the conditions of SO_x , NO_x , and CO_2 emissions affect the global changes (acid rain and greenhouse effect). Today, considerable effort is being devoted to reduce CO_2 emissions because of the Kyoto Protocol on climate change. This publication presents multidisciplinary perspectives on the interrelated topics of energy consumption, energy security and energy policy. Additionally, the present study examines the relationship between energy consumption and greenhouse gas emission.

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1. Introduction

Energy is essential for economic and social development and improved quality of life in all countries [1]. Energy is defined as the ability to do work and it can be found in different forms such as

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chemical, thermal, electricity, mechanical, gravitational, nuclear, radiant, sound, and motion. Energy can be stored, converted and/or amplified depending on the application. Energy sources can be fossil (petroleum, coal, bitumes, natural gas, shale oil, etc.), renewable (alternative) (biomass, hydro, wind, solar, geothermal, marine, hydrogen, etc.) and fissile (uranium, thorium, etc.) [2].

Energy is a special topic because it is a key input to almost all other consumptions and production processes. Energy is therefore a crucial parameter controlling growth and determining many aspects of human activity in general [3].

The increases in economical growth of the developing countries in the last decades have caused rapid increase in energy consumption. According to Kaygusuz and Bilgen, this trend is expected to increase in the near future [4]. Energy use is very important for people's survival and development. The increases in energy consumption have usually affected to improve life styles [5]. Consumption is a key lever to achieve more sustainable development. Unsustainable consumption is a major cause of global environmental deterioration, including overexploitation of renewable resources and pollution caused by fossil fuels [6].

Li et al. have recognized a strong relationship between energy consumption and economic growth. Energy demands of most countries declined during the economic depression which caused a worldwide economic crisis between 2008 and 2009 [7]. The Global Financial Crisis has been called the most serious financial crisis since the Great Depression. This crisis has caused a significant decline in economic activity [8].

The by-products of energy production, distribution, and consumption define the single largest environmental loading of society when taken together. Awareness of this loading has recently evolved from a focus on point sources of pollution with point effects to distributed sources with distributed effects [9].

Major problems in global economy are energy and environmental security. Fossil fuels are confined to a few regions of the world. The continuity of supply is governed by dynamics of political, economical and ecological factors. Increased growth and demand for the welfare of developed and developing countries is creating a higher pressure on energy resources. A large part of new consumers in developing countries have already started purchasing high power so as to be able to access commodity and energy markets worldwide, thus boosting the energy consumption and competition for all kinds of resources [10].

A projection of the future energy consumption is a vital input to analyze economic, energy, and environmental policies. An outlook on the future energy consumption helps us in deciding on future energy investment. It is very important that the prediction of future energy consumption be as accurate as possible. Since there is no information about the future of industrial structure and level of energy efficiency in each industry for a country, we may start with the assumption that it will follow the usual trend observed in the past. This is exactly how we have made our projections on the future energy intensity and consumption: the projections are based on their historical trend identified by the experience model [11].

Energy source is the basic element of socio-economic development. Energy supply and security has become the major issues of the development of human society and global political and economic pattern. Countries in the world have natural resource endowment conditions and different economic development level. Thus, energy supply and consumption of different countries also have some geographical differences [12].

2. Structure of global energy consumption

In view of the new millennium challenges for the modern faster socio-economic upgradation and adoption of new lifestyle,

the industrial development seems to be at a very high demand as revealed from the on-going energy consumption and its anticipated energy requirements as a whole in developed countries in general and in developing countries of the world in particular. It appears that energy demand will keep increasing but the conventional sources for generating electricity will deplete with time or may become environmentally hazardous enhancing global warming. Due to deplete of coal, petroleum and natural gas reserves and/or associated world politics, the nuclear energy source is also being considered as one of the alternate by the developing countries but because of its hazardous issues, relatively higher expenses and technological monopolies, it is not approachable for most of the countries of the world. Anticipating this decline, renewables are being given preferences as alternate and long-lasting sources of energy generation. This rational approach is environmental friendly and free from the danger of producing pollution and health hazards of the people [13].

Though global energy demand and resource consumption are at a slower rate than in recent years, it is projected to increase over the next several decades [14]. The need for energy and fuels is one of the common threads throughout history and related to development criteria for developing countries. It is vital for consumption of energy to be used in a productive manner for sustainable development due to the increase of petroleum prices recently and the limited lifetime of fossil fuels [15]. Most of the global increase comes from developing countries for energy and population. As Lawrence et al., the issues of total energy consumption and carbon emissions are inextricably related to the problem of energy inequality among the countries of the world [16].

The world consumption of energy in 1990 was about 1 billion gigawatts, and now is approaching 10 billion gigawatts. This tenfold increase in one century is the product of a threefold increase in world population and a roughly threefold increase in average per capita use. The increase in per capita energy use is linked to the growth of the world economy [9].

As discussed by Zhang and Conan, the United States maintains a significant volume of demand for energy but its relative consumption share is decreasing over time, from 24.1% in 2010 to 19.8% by 2050. Japan sustains very high demand in oil with a share of 31.5% in the global market in 2010, 27.7% in 2030, and 24.8% in 2050. Global energy consumption is projected to increase significantly, growing from 13.6 billion tons of oil equivalent (t.o.e.) in 2010 to 44.6 billion t.o.e. by 2050. Owing to China's significant and growing role within global energy markets, global coal demand increases from 3.6 billion t.o.e. in 2010 to 12.9 billion t.o.e. in 2050. Global coal energy demand also expands from 26.5% in 2010 to 28.9% in 2050, with gas and electricity representing a contracting share of total demand [17].

10% of the population of the world exploits 90% of fossil fuel resources. Today's energy systems rely heavily on fossil fuel resources diminishing ever faster. The world must prepare for a future without fossil fuels. Sustainable energy consumption has become urgent matter for all countries [18].

World energy consumption increases from 524 quadrillion Btu in 2010 to 630 quadrillion Btu in 2020 and 820 quadrillion Btu in 2040 (Table 1) [19].

2.1. Global energy consumption by fuel type

If all of the carbon present in the fuel is burned to carbon dioxide, all of the hydrogen is burned to water, and all of the sulfur is burned to sulfur dioxide combustion is complete [20,21]. Saving fuel is the most important measure for the protection of the environment and climate. Development will be shaped by saving resources, decelerating fuel consumption, and supporting technical developments [22].

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