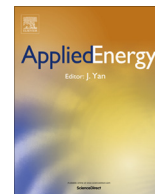




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## Energy consumption, associated questions and some answers

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### HIGHLIGHTS

- Characteristics, trends and consequences of global energy consumption is discussed.
- Connection between energy consumption, wealth and human development is shown.
- Future of energy demand is explored.

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### ABSTRACT

Characteristics, trends and consequences of global energy consumption along with the disparity amongst nations regarding energy consumption, wealth and human development are discussed. The connection between energy consumption, wealth and human development is shown and the impact of this connection on the future of energy demand and supply is explored taking into consideration the projected increase in population. It is posited that increased international awareness and effort is needed to put in place realistic plans to address the socio-economic problems that will be faced as the competition for the already strained energy resources increases over the coming decades.

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### 1. Introduction

Energy is one of the key commodities required to sustain human existence and advancement, and one of the largest components of the world economy. Global energy consumption<sup>1</sup> has been increasing due to the increasing population and gross domestic product (GDP) as shown in Fig. 1. However, the evolution of population, GDP and energy consumption has been substantially different in different parts of the world, resulting in large disparities amongst regions and nations in terms of wealth and the state of human development. As global population continues to increase, still a long way from its predicted peak, and as conventional energy sources become harder to reach and more expensive in terms of both economic and environmental costs, first it is necessary to analyze historical trends to be able to gauge the magnitude of the demand for energy in the future under different scenarios. A review of historical trends is done in the next section. An analysis of the relationship between energy, wealth and human development is presented next. A discussion on

the potential magnitude of future energy needs of the global society under different scenarios follows.

Since the discussion presented in the following sections makes use of various technical terms, first these terms are briefly explained using World Bank definitions [2].

When studying global trends, it is useful to classify countries according to their economic wealth because many parameters, including energy consumption and demand, show distinct differences when countries are classified according to their level of wealth. In this analysis, the World Bank classification of national economies according to the annual gross national income (GNI) per capita is used. The latest World Bank classification, as of July 1, 2012, by GNI per capita is as follows:

- Low-income countries \$1025 or less.
- Middle-income, \$1026–\$12,475.
  - Lower middle-income, \$1026–\$4035.
  - Upper middle-income, \$4036–\$12,475.
- High-income, \$12,476 or more.

The indicator widely used to measure wealth is per capita GDP. GDP is the sum of gross value added by all producers in a given economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making

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<sup>1</sup> The terms “energy consumption” and “energy use” are used interchangeably in this paper, both referring to the use of primary energy before transformation to other end-use fuels. The term “electricity consumption” refers to the use of electricity, which is an end-use fuel.

**Nomenclature**

GDP	gross national product
GNI	gross national income
LI	low-income countries
HDI	human development index
HI	high-income countries

IEA	International Energy Agency
MI	medium-income countries
PPP	purchasing power parity
UN	United Nations

deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.

Since one U.S. dollar has a different purchasing power in each country, per capita GDP converted to international dollars using purchasing power parity (PPP) rates is used to compare wealth amongst countries. Purchasing power parity GDP is GDP converted to international dollars using PPP conversion factor. PPP conversion factor is the number of units of a country's currency required to buy the same amounts of goods and services in the domestic market as one U.S. dollar would buy in the United States. Thus, an international dollar has the same purchasing power over GDP as the U.S. dollar has in the USA.

While per capita PPP GDP is a good measure for wealth, it provides an incomplete measure of the overall socio-economic development of a country. A more complete measure of socio-economic development is the Human Development Index (HDI). HDI was introduced in the first Human Development Report of the United Nations (UN) in 1990 as a new way of measuring development by combining three basic dimensions: life expectancy, educational attainment (through literacy index and registration combined index) and economic performance (through per capita PPP GNI in international dollars) [3]. HDI spans a range of 0–1 with the interpretation:

- High human development:  $1 \geq \text{HDI} \geq 0.8$ .
- Moderate human development:  $0.799 \geq \text{HDI} \geq 0.5$ .
- Low human development:  $0.499 \geq \text{HDI} \geq 0.0$ .

**2. Trends of population, wealth and energy consumption**

As shown in Fig. 2, the rates of increase of population over the past 35 years have been different depending on the wealth of the countries. While the rate of increase has been slow and slowing further in high-income countries, the rate of increase is steady in low- and middle-income countries. As a result, the proportion of population of low- and middle-income countries in the total population is increasing. On the other hand, as seen in Fig. 1, the rate of increase in both the global GDP and the energy consumption is

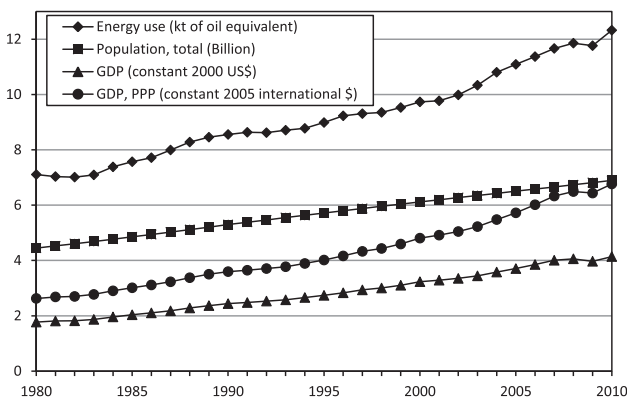


Fig. 1. Evolution of population, GDP and energy use (Source of data [1]).

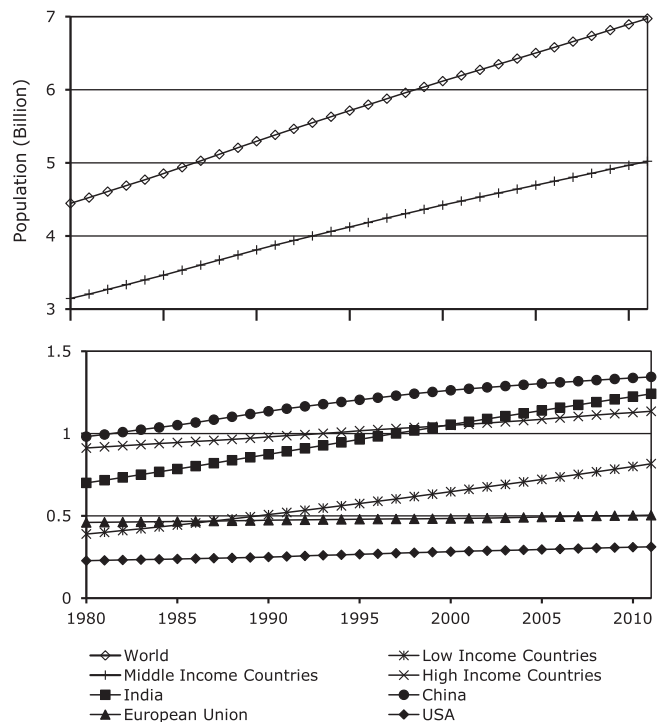


Fig. 2. Evolution of population (Source of data [1]).

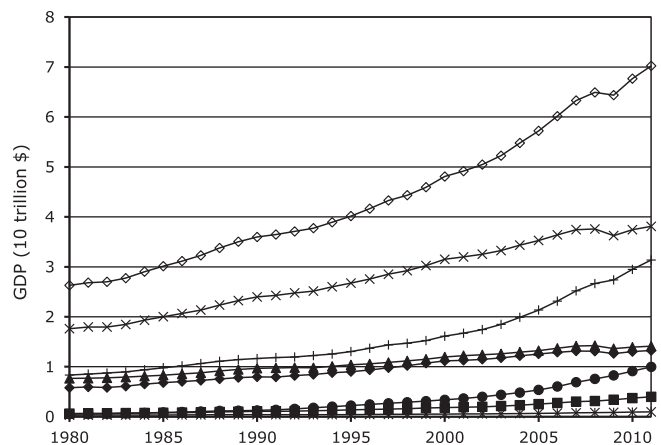


Fig. 3. Evolution of GDP, PPP (constant 2005 international \$) (Source of data [1]) (legend same as in Fig. 2).

higher than the rate of increase in global population. This is a sign that as a whole, the global society is advancing towards higher levels of wealth. As shown in Fig. 3, similar to the case of population growth, the increase in GDP is primarily due to middle-income countries. The low-income countries however do not benefit from a similar increase in the GDP growth, which is a global concern.

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