



# Future Trends on Global Energy Demand

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**Abstract**— The human race has carved a niche in the use of various energy sources to do work, such that it simplifies all types of operation, be it in power generation, transportation, industrial processes or domestic use. This has in turn caused continuous exploration of the different types of fossil fuels and natural resources. However, other energy sources, especially renewable energy (RE), are beginning to take the forefront these recent times, owing to the fact that the conventional energy sources are known to cause environmental hazards, pollution and also in its depletion phase, hence causing drastic price hike in the global market – which is solely due to mismatched supply versus demand. This paper will be discussing the various energy sources, global trend, projection in energy demand and consumption, and Energy Efficient Technologies (EET) that could help in harnessing these new sources.

**Keywords**—Renewable Energy (RE), Energy Efficient Technology (EET), Energy Sources

## I. INTRODUCTION

Advancements in global economy and technology can be linked to evolution in energy sources [1], [2]. Before the discovery of coal in the mid 19th century, i.e. at the advent of industrial revolution, most works were done by human labour, animal effort and biomass sources. Search for higher energy content sources led to the discovery of oil and later, natural gas. With increased level of technical expertise, it became possible to obtain heat energy from the nuclear fission of matter, and by the end of the 20th century, many energy sources such as solar, wind, hydroelectric, biofuels were discovered.

Annual statistical review of global energy consumption shows an increasing demand for energy to run our factories and industries, vehicles and airplanes and keep our houses warm. Thus, it is estimated to be growing at an average of 2.3% per year [3]. This is chiefly due to the human desire to sustain and improve their well-being and reflects in higher production and manufacturing capacities, more people having access to electricity (especially the developing nations), increase in transportation systems and job creation, improvement in infrastructures, greater prosperity and ultimately; improved economic situation globally.

Energy which is needed in all human endeavours can be easily transformed from one form to another in order to carry out various works such as generating electricity, warming foods in a microwave, operating an electric fan for ventilation, and moving a vehicle.

## II. ENERGY SOURCES

### *Fossil Fuels*

Oil, Coal and Natural Gas which are the major forms of fossil fuels were formed millions of years ago from buried and decomposed remains of plants and animals [4]. Since they take millions of years to form, they are regarded as non-renewable or exhaustible resources. Thermal energy produced by burning these fuels, could be used to move a car, rotate a turbine, push a piston or heat a house as shown in Figure 1.

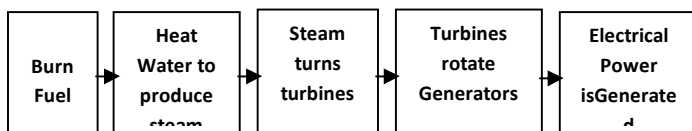


Fig. 1 Block diagram showing how fossil fuels could be used to generate electricity

Fossil fuels account for majority of primary energy consumption and according to EIA (2010) report, oil accounted for 35%, natural gas 23% and coal 26% of global energy consumption as shown in Figure 2. High dependence on these fuels could be attributed to its early discovery, which in turn made most technologies used for transportation, industrial processes and power generation, rely on them. However, growing concerns over environmental pollution, global warming, climate change and fast depletion of these fuels, arising from ever increasing demand for energy, necessitated the onward search for a sustainable solution [5].

This led to gradual shift to renewable energy (RE) options and development of energy efficient technologies (EET), which is confirmed by IEA (2006) report, stating that EET can reduce the world energy needs in 2050 by one-third.

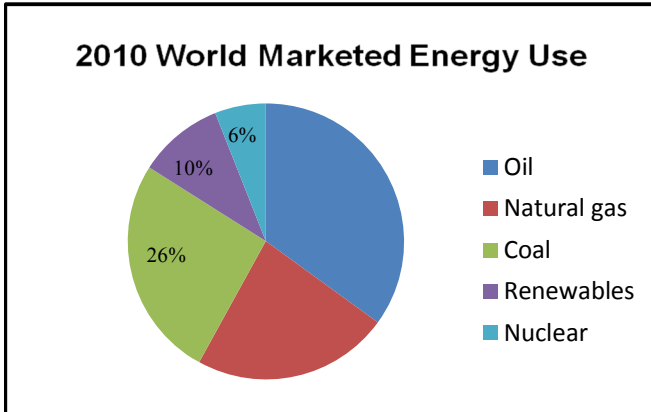


Fig. 2 Global Primary Energy Consumption for 2010 (Source: Energy Information Administration)

*Renewable Resources*

Solar, wind, biomass, hydroelectric, geothermal, which are the major sources of renewable energy, offer clean and sustainable alternatives to fossil fuels since they produce little or no pollution and could be easily replenished either through biological reproduction or naturally recurring processes. Unlike in fossil fuels, where thermal energy is got from its combustion, RE depends on the resource, i.e. energy from solar radiation, potential energy of flowing water, wind energy and thermal energy from burning bio-materials and heating water beneath the earth. Gradual shift to RE is becoming popular and is confirmed by the EIA (2010) report, in which it now accounts for 10% of global primary energy consumption, indicating continuous increase every year. However, the intermittent nature of some renewable resources, such as wind and solar, puts some limitations in its use [6]. Onward research and development of technologies that use RE will provide a niche for it in energy market.

*Nuclear Fuels*

Although others elements like Thorium are currently being explored, Uranium remains the only nuclear fuel available [7]. Despite being non-renewable, there are conflicting estimates of its reserve [8], [9]. Thermal energy generated by the nuclear fission of Uranium in a nuclear reactor could be converted to other forms of energy, especially mechanical energy used in rotating turbines at nuclear power stations as shown in Fig. 3.

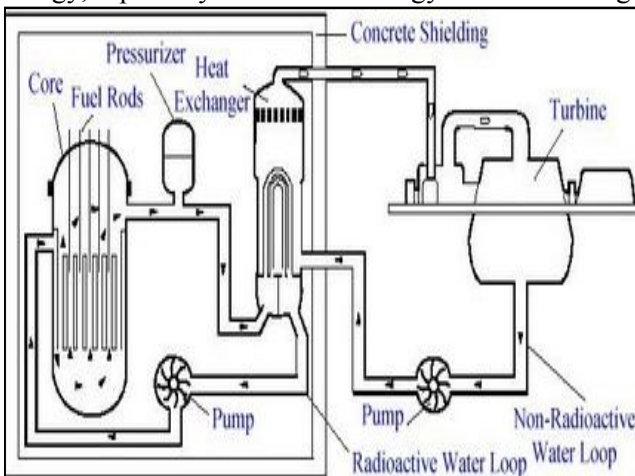


Fig. 3 Schematic Diagram of a Nuclear Power Plant (Source: Nuclear Institute)

Major nuclear accidents like Fukushima 1 (2011), Chernobyl (1986) and Three Mile Island (1979), led to the steady decline in the use of nuclear energy despite being cheap, pollution free, very efficient and reliable [10].

### III. GLOBAL TRENDS AND PROJECTIONS IN ENERGY DEMAND AND CONSUMPTION

Several factors affect the global energy map, i.e. the production, demand and consumption of energy, with potential consequences on energy trade and markets. This includes: prices of fossil fuels in international energy markets, changes in demography, development of new supply sources and upstream technologies, economic conditions, environmental pollution, innovations in RE and EET, political events, accident rates, climatic conditions, government policies, subsidies and incentives.

#### A. Demand on Energy Sources

Increase in world population (estimated to be about 9 billion in 2040), economic expansion and prosperity, are the major drivers behind the increasing demand for energy as shown in Fig. 4, projecting a 30% rise in 2040 than 2010. Despite the emissions from fossil fuels, they continue to have the highest share in global energy consumption, making about 80% in 2040. However, natural gas, being a less carbon-intensive fuel will overtake coal and become the second highest energy source on demand, as it is expected to rise more than 50% through 2040. This is because policies to reduce carbon dioxide (CO<sub>2</sub>) emissions by imposing a cost on higher carbon fuels will have the highest impact on coal, since it contains the largest source CO<sub>2</sub>. Although demand for RE will be increasing over the years, its overall share in global energy consumption through 2040 is projected to 12%.

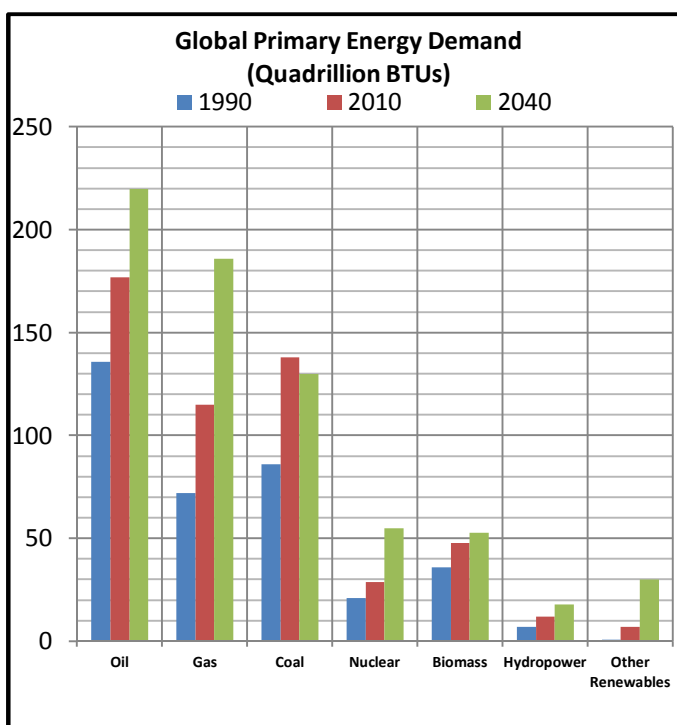


Fig. 4 Global Primary Energy Demand  
(Source: 2012 The outlook for Energy, Exxon Mobil)

#### B. End Use Sector Demands

Energy is needed to do virtually everything in our modern world – heating and air-conditioning our homes, moving our cars, answering a phone call, cooking our food, surfing the internet. Users of energy are usually narrowed down to three major economic sectors – residential/commercial, industrial and transportation. For our homes and businesses, energy consumption is majorly from electricity - for lightning, ventilation, laundry, refrigeration, computing, entertainment/relaxation and natural gas - for heating, cooling and cooking. Thermal, mechanical, electrical and chemical energy is required in the industry for production, manufacturing, mining, farming and construction. In addition, energy is required to move our cars, trucks, airplanes, submarines, trains and depends majorly on fossil fuels with oil having the highest use.

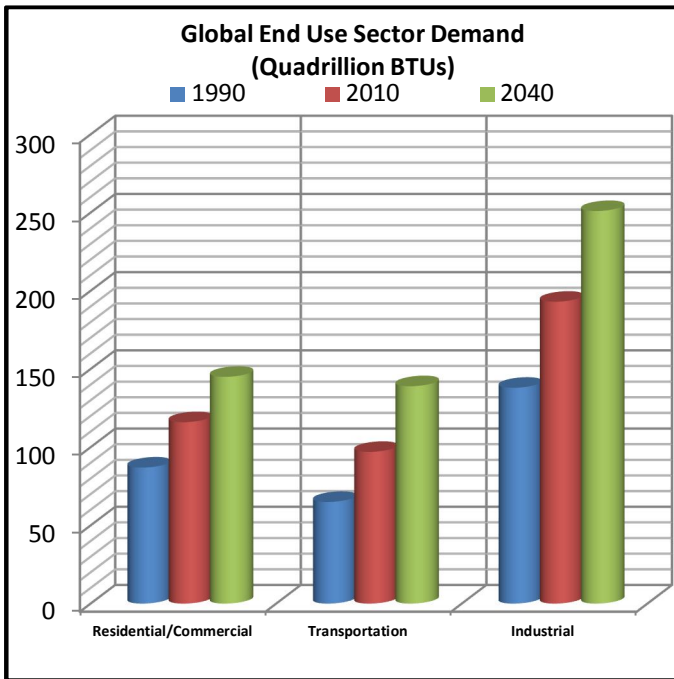


Fig.5 Estimates and Projection on Global End Use Sectors Demand (Source: 2012 The outlook for Energy, Exxon Mobil)

Although Figure 5 shows an increasing demand for energy in all sectors, with industrial being the highest, the gradual shift to EET is reducing the overall demand majorly in transportation, with the proliferation of vehicles that use other sources of energy (like ethanol, solar, electricity etc.), hybrid vehicles and improvement to conventional vehicles fuel efficiency. Also, energy efficient devices such as fluorescent lights are currently replacing conventional incandescent light bulbs in our homes and offices since it uses only one-third of its energy [11]. Combined heat power systems (CHP), variable speed drives are some EET used in industries.

*C. Electricity Generation Demand*

The need for energy to generate electricity has become the single biggest driver of demand and is confirmed by comparing Figures 4 and 6, which show that more than 35% of primary energy consumed globally, is used in producing electricity, because of the ease in converting electrical energy to other forms of energy for devices used in our homes, commercial places and industries, but with less impact on transportation, as electric vehicles are currently very expensive. Due to high levies on CO<sub>2</sub> emissions, fuels used in generating electricity is drifting away from coal and towards lower carbon sources such as natural gas, nuclear and renewables as shown in Fig. 6 [12].

Although it is estimated and projected that the demand on nuclear energy will continue to rise, the aftermath of the disaster in Fukushima-Daiichi nuclear plant in 2011, has considerably reduced its purported demand as many countries such as Germany, Sweden, Italy, Austria, Belgium and Switzerland has got a long term goal to discontinue the production of power from nuclear energy [10], [13]. Electricity generation has been the most fruitful means for harnessing RE, mainly with the high penetration of solar panels and wind farm to the power grid in the last decade. Despite this shift, third world nations - where large population have no access to electricity, are still heavily dependent on fossil fuel [14], [15].

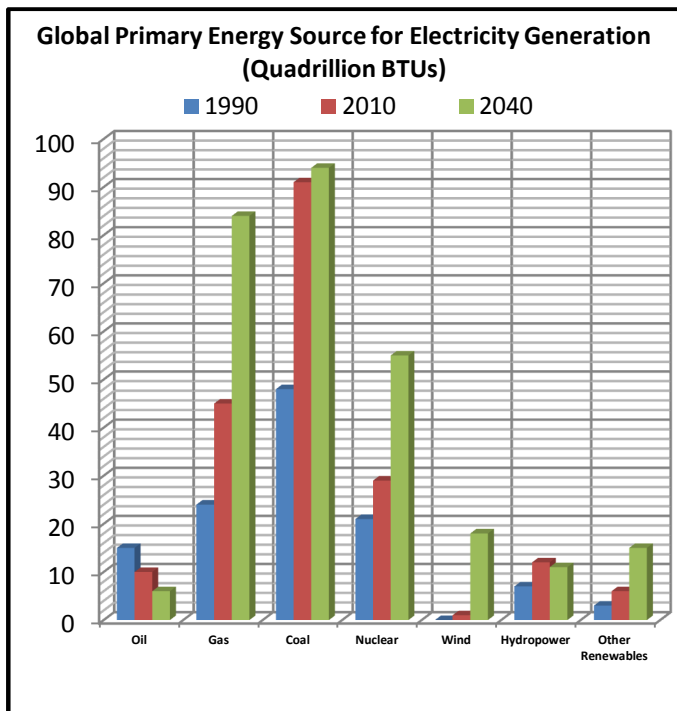


Figure 6 Estimates and Projection on Global Energy Source for Electricity Generation (Source: 2012 The outlook for Energy, Exxon Mobil)

#### D. Regional energy Demand

Growth in energy consumption will be significant in countries with growing economy with China and India taking the lead while North America and Europe will remain essentially flat as shown in Fig. 7. The Middle East, Africa and Latin America will continue to experience increase in demand as their economies grow and is confirmed by IEA (2011 WEO), which estimates that about 1.3 billion people – one-fifth of the world’s population – lack access to electricity and is mainly seen in Africa and other developing nations.

#### IV. CONCLUSIONS AND RECOMMENDATIONS

In order to keep our planet secure and sustainable, the global energy map must be kept at equilibrium by onward research for new supply sources as demand for energy is ever increasing, with the probability that fossil fuels will be depleted. Development of EET such as hybrid vehicles and technologies that can harness the abundant renewable resources without endangering our environment, are possible solutions. This could be facilitated by appropriate subsidies and policies by various governments such as the climate change levy (CCL) in the UK and EU 20-20-20 policy on RE.

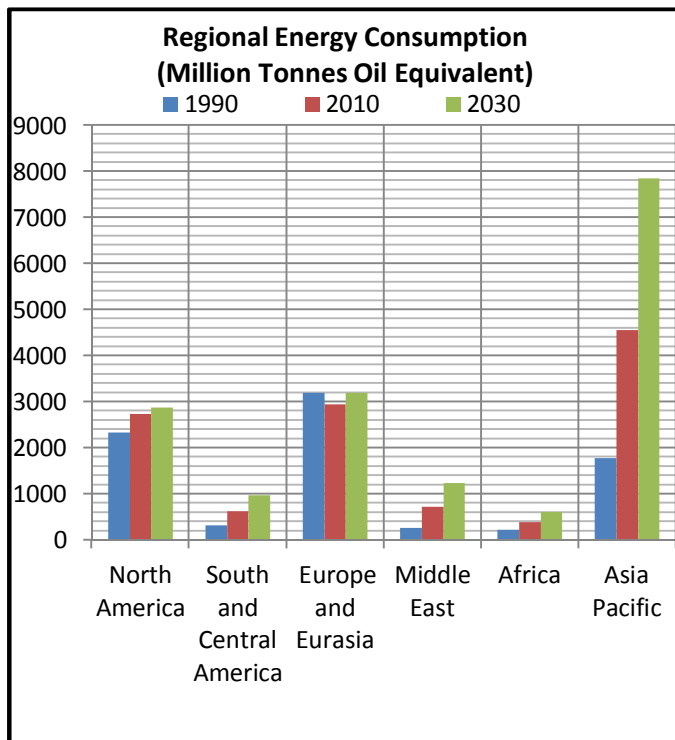


Fig.7 Estimates and Projection on Regional Energy Consumption (Source: BP Energy Outlook, January 2013)

On a bigger scale, the DESERTEC project, a European Union (EU) initiative to harness solar energy by means of Concentrated Solar Power (CSP) from Africa for use in Europe, shows the enormous potential that exists in alternative energy sources for the sub-region once there is political will. DESERTEC is an ambitious contraction developed in North Africa by the DESERTEC Foundation and managed by the Club of Rome and Trans-Mediterranean Renewable Energy Cooperation (TREC) – an international network of scientists, politicians and other experts in the development and implementation of renewable forms of energy [16].

There are also a host of intriguing new developments in rapidly evolving energy to cater for the adverse impacts of fossil fuels on the environment. Such novel technologies that are being developed with ideas to tap new sources of power are: solar roadways which should turn concrete roads and parking lots into glossy solar surfaces, electric vehicles, increased funding for renewable energy projects, tidal power with revolutionary underwater turbine design, volcanic-adapted geothermal energy, hydrogen house which uses solar power to run an electrolyzer that splits water into hydrogen and oxygen, carbon capture technology, space-based solar power, and the grand mining asteroids [17]. Others are marine renewable energy (MRE), which can recover, using ocean thermal conversion technology, the hydrokinetic energy of tidal and ocean currents, as well as converting waste heat to electrical energy using a rectenna, a high frequency antenna and of tunnel diode. The future of global energy demand is indeed bright!

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