

ENSURING ENERGY SECURITY IN FUTURE: A STUDY ON DIFFERENT STRATEGIC PLANS AND RELATED ENVIRONMENTAL IMPACTS

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Abstract – Energy is a pre-requisite for the civilization. However, usage of energy is not free of toll. Rising temperature by 0.44°C during the last thirty years and 13% rise in atmospheric CO₂ concentration surely indicating us to make a quick transition from this harmful usage of energy to a safer one. If global warming, melting of polar ice, rise in sea level and consequent flooding of coastal areas continues like present manner, then millions of lives would be in danger and hundreds of thousands would be turned into climate refugee. It is not impossible to secure human race from danger in the long run. However, it involves with long-term planning, innovative idea generation and common people awareness. In this paper authors discussed about the pattern of problem aroused from conventional energy usage, the future threat from this and its ultimate solution. We present three possible scenarios of using different sources to meet energy requirements with respective credibility and possible impacts in order to find out the best-fitted solution for future energy security and ensure sustainable development.

Keywords: Energy security, environmental impacts, fossil fuel, nuclear energy, renewable energy.

1. INTRODUCTION

World is now passing an energy constraint time. As an easily accessible source, we have been dependent on fossil fuel so far. Meanwhile, fossil fuel use continues to impose massive environmental and economic costs. Now, time has come to choose between paying to continue the status quo and investing in a new energy future. World population is assumed to expand from an estimated 6.7 billion in 2008 to 8.5 billion in 2035 and electricity demand grows by around 80% by 2035, requiring 5900 GW of total capacity addition [1]. Therefore, this upcoming huge demand is not possible to meet by our fossil fuel reserve. Nuclear energy can be a solution in this context, however, is not also a risk-free solution. So far little is known about the damages associated with nuclear energy plant accidents. Moreover, the brutal effects of these kinds of incidents

pass from one generation to another through radioactivity and can cause an everlasting suffering for human race. Therefore, we need to consider renewable energy as a viable alternative for energy security. Although it is more capital incentive than fossil fuel, we have to take some desperate measures in order to convert this into our main energy source. In addition, to make it possible we have to device a strategic plan with a combination of various types of energy in order to achieve energy security in future rather than exclusively depending on fossil fuel or nuclear energy.

2. CLIMATE CHANGE EFFECTS

Climate change is one of the most pressing environmental concerns of the 21st century. Developing countries are the most vulnerable to these risks [2] because of their generally low adaptive capacities [3]. No country alone can take interconnected challenges posed by climate change involving controversial political decision, daunting technological change, and far reaching global consequences. Emission of CO₂ is one of the main causes of global warming, melting of polar ice, rise in sea level, and consequent flooding of coastal areas. CO₂ is the main green house gas (GHG) emitted from various sources and power sector is solely responsible for 30% emission of CO₂ throughout the world [4]. Furthermore, the CO₂ emissions from power generation are projected to increase 46% by 2030 [5]. Man made CO₂ emission is closely linked to the combustion of coal, oil and gas. Moreover during past thirty years only coal consumption has increased by 48% [6]. According to International Energy Agency (IEA), projected CO₂ emission by 2020 will be 9927 Million tons. According to [7], in the 100 years span from 1880 to 1980, average global temperature has increased by 0.47°C. However, from then in only 30 years span, temperature increased by 0.44°C. If greenhouse gas (GHG) emissions continue to increase at the present rate, it is predicted that the average global temperature will increase by about 1°C by the year 2025 and by 3°C at the end of the century and the sea level will increase by 15 to 95 cm [8]. This will definitely engulf the coastal areas and low-lying countries and will make thousands of climate refugees. Key challenges to

tackling climate change in the world will be: Ensuring energy security; Ensuring food security and comprehensive disaster management; Addressing water scarcity and health; Dealing with forced migration and overall environmental degradation.

3. ENERGY SOURCES

The energy sources can be split into three categories: fossil fuels, renewable sources and nuclear sources. The fossil fuels are coal, petroleum, and natural gas. The renewable energy sources are solar, wind, hydroelectric, biomass and geothermal energy. The nuclear-powered sources are fission and fusion.

3.1 Fossil Fuels

These constitute the main forms of energy used worldwide. These are formed over a period of millions of years by the decomposition of animals and plants. These are not renewable sources as it would take too long to form these again in a natural process. These generally consist of carbon, sulphur and hydrogen and therefore, upon combustion form carbon dioxide, sulphur dioxide and water vapor (H₂O). Whilst the latter is relatively harmless the previous two are responsible for global warming and acid rain. Oil, coal and gas are the main forms of fossil fuel.

3.2 Nuclear Energy

Nuclear energy originates from the splitting of uranium atoms in a process called fission. Fission releases energy that can be used to make steam, which is used in a turbine to generate electricity. Uranium is a non-renewable resource that cannot be replenished on a human time-scale. Uranium is extracted from open-pit and underground mines. On average, uranium ore contains only 0.1% uranium. Most nuclear reactors require one specific form of uranium, uranium-235 (U-235). This form represents only 0.7% of natural uranium. To increase the concentration of U-235, the uranium extracted from ore goes through an enrichment process, resulting in a small quantity of usable ‘enriched’ uranium and huge volumes of waste. Today, the 439 commercial nuclear reactors in operation generate around 15% of the world’s electricity [9].

3.3 Renewable Energy

Renewable energy is sustainable as it is obtained from sources that are inexhaustible (unlike fossil fuels). Renewable energy sources include wind, solar, biomass, geothermal and hydro, all of which occur naturally on our planet. Renewable energy, generally speaking, is clean energy and non-polluting. It is a sustainable energy source which can be relied on for the long-term. Renewable energy is cost-effective and efficient. On a global scale, 19% of electricity comes from renewable in 2008 [1].

4. PROBLEMS WITH FOSSIL FUELS

Fossil fuels have been a widely used source of energy every since the industrial revolution just before the dawn of the 20th century. Fossil fuels are relatively easy to use to generate energy because they only require a simple direct combustion. However, a problem with fossil fuels is their environmental impacts. Not only does their excavation from the ground significantly alter the environment, however, burning fossil fuels such as oil, coal, and gas results in the production of carbon dioxide and other greenhouse gases, which cause global warming. This is a stark truth, but the scientific facts point to significant warming, indicated by sea levels rising, hotter temperatures and freakish storm weather patterns, like tsunamis and hurricanes, becoming more and more regular. The most important thing is that, fossil fuels are not plentiful and despite obfuscation by several countries, fossil fuels especially oil production is now at the peak worldwide. As each oilfield has been being mined and depleted indicates us, we are running out of fossil fuel supplies.

Table 1. Global crude oil reserves by region [10]

Country	bbl Mn	Percentage
Middle East	754,000	59.9
Africa	125,200	10
South and Central America	123,200	9.8
Euracia (excluding Central Asia)	101,000	7.6
North America	70,900	5.6
Asia-Pacific	42,000	3.4
Central Asia	40,000	3.2

Table 2. Global natural gas reserve by country [11]

Country	Proved Natural Gas reserve (million cubic meters)
Russia	47,570,000
Iran	29,610,000
Qatar	25,370,000
Saudi Arabia	7,807,000
United States	7,716,000
Turkmenistan	7,504,000
United Arab Emirates	6,453,000
Nizeria	5,292,000
Venezuela	5,065,000
Algeria	4,502,000
Iraq	3,170,000
Australia	3,115,000
Chaina	3,030,000
Rest of the World	35,216,543

5. PROBLEMS WITH NUCLEAR ENERGY

Nuclear power is often described as “the most expensive way to boil water”. Despite its proponents now

claiming it to be cost-effective, cost estimates for proposed projects have consistently proved inaccurate. Nuclear reactors present too large a liability for insurance companies to accept. One major accident, costing hundreds of billions of Euros (the total Chernobyl cost is estimated at €358 billion) would bankrupt them. Governments, and ultimately their taxpayers, are forced to shoulder this financial liability. The cost of clean-up after a nuclear power plant closes and the safe management of nuclear waste for many generations is also largely carried by the states instead of the companies themselves. In addition to substantial capital costs for construction of power plants, nuclear energy includes significant external costs like applying safeguards to sensitive activities, such as fuel making, securing nuclear facilities against terrorist attacks, decommissioning reactors, storing highly radioactive waste and paying for insurance to cover the costs of an accident. The declining nuclear industry is attempting to latch on to the climate crisis and concerns about energy security, by promoting itself as a “low carbon” solution. The Energy Scenario produced by the International Energy Agency shows that, even if existing world nuclear power capacity could be quadrupled by 2050, its share of world energy consumption would still be below 10%. This would reduce carbon dioxide emissions by less than 4% [12]. Other radioactive products formed in nuclear reactors can be used to produce dirty bombs. A nuclear power plant produces 10-15 tons of Spent Fuel a year on average. One ton of spent nuclear fuel typically contains about 10 kilograms of plutonium – enough for a crude nuclear bomb. Therefore we can say that, a typical nuclear power plant produces sufficient plutonium every year for 10-15 crude nuclear bombs.

Table 3. Proved uranium reserves by country, 2008 [13]

Country	Amount (tonnes per year)	Global percentage (%)
Australia	1,243,000	23
Kazakhstan	817,000	15
Russia	546,000	10
South Africa	435,000	8
Canada	423,000	8
US	342,000	6
Brazil	278,000	5
Namibia	275,000	5
Niger	274,000	5
Ukraine	200,000	4
Jordan	112,000	2
Uzbekistan	111,000	2
India	73,000	1
China	68,000	1
Mongolia	62,000	1

6. STRATEGIES FOR FUTURE ENERGY SECURITY

Energy crisis is becoming more and more

threatening day by day. Fossil fuel can possibly meet the present energy demand, however, it is not abundant at all and we can not continue depending on this forever.

Table 4. Cost of electricity estimated by Massachusetts Institute of Technology (MIT) and University of Chicago report

Electricity Generation Type	MIT report (2003)	University of Chicago report (2004)
	Cost (cents per kWh)	
Coal	4.2	3.3 to 4.1
Natural Gas (Combined Cycle Gas Technology)	3.8 to 5.6	3.5 to 4.5
Nuclear	6.7	6.2

Most importantly, if we completely rely on this then the world would not be habitable because of pollution from fossil fuel and we would all die before running out of fossil fuel reserve. Nuclear energy can be considered as a solution because of the seemingly pollution free nature of nuclear plants. However, the construction cost, period of time required for construction and fatal accidental risks have to be considered before setting up a strategic plan to exploit nuclear energy as a viable option. Moreover, in this case, renewable energy can be considered as a viable option for future energy security. It is completely pollution free and abundant in nature. However, it is not possible to shift the pattern of energy source usage in a short period of time. It will definitely require time to change our traditionalistic view and be pro-active for a better and safe future in order to find out a sustainable solution for energy security. We have to go for a fossil-nuclear-renewable energy combination first then have to divert completely to a safe source of energy with adopting capability enhancement. The following sub-sections present 3 possible ways of facing our future energy demand with respective consequences:

6.1 Fossil fuel only

It is the worst case scenario. In this variant, we consider the scenario where fossil fuel is the only energy source. If we completely rely on fossil fuel then by the time being this usage will increase definitely as energy demand always increases day by day. Due to depending more on fossil fuels, more pollution will take place and the reserve will run out very quickly. Global warming will reach its peak and environment will turned out rough. At the end, we will have nothing left to use as fossil fuel is not abundant at all.

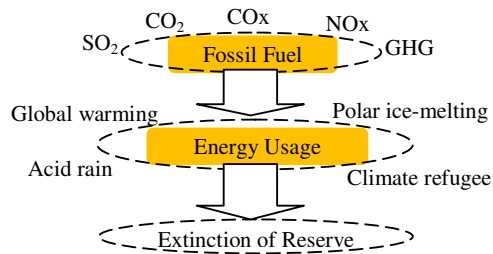


Fig. 1. Illustration of the effects and end result of using fossil fuel only.

6.2 Combination of fossil fuel and nuclear energy

In this scenario, we consider two sources for meeting the energy demand: one is fossil fuel and the other is nuclear energy. It would not be a wise decision to make this choice. In this case, we are allowed to meet our energy demand by fossil fuel and nuclear energy. By the time being, we will decrease our fossil fuel usage and increase nuclear energy usage. At one point of time, we will be running out of fossil fuel reserve. Then we have to rely on nuclear energy only for our total energy demand. However, it would not be free of toll. It has radiation and waste disposal problems, proliferation risk and fatal accidental fear. Most importantly, fuel of nuclear energy is not abundant. On average, uranium ore contains only 0.1% uranium. So one day it will be ended up also and then we would have nothing left to use.

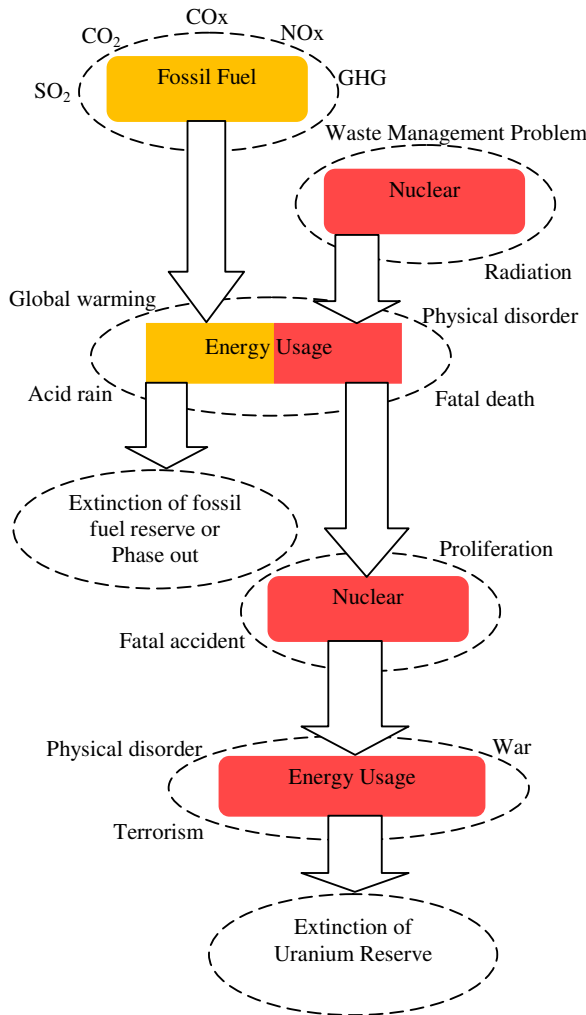


Fig. 2. Illustration of the effects and end result of using a combination of fossil fuel and nuclear energy.

6.3 Combination of fossil fuel, nuclear energy, and renewable energy sources

This is the scenario where a combination of fossil fuel, nuclear energy, and renewable energy sources will be exploited, and definitely is the most suitable option to get rid of the present energy crisis and ensure a sustainable

development for future. We have to start with these three types of fuel but gradually have to shift our consumption pattern from fossil fuel to nuclear energy and then to renewable energy completely. However, it is not possible to meet our entire energy demand from renewable sources over night. It is a continuous process involved with research and development, idea generation, and common people awareness. Initially, we have to face some problems caused by fossil fuel pollution and nuclear energy risks. However, we have to accept those as transitional effects and thus, gradually we will achieve the capability of harnessing all of our energy requirements from renewable energy sources.

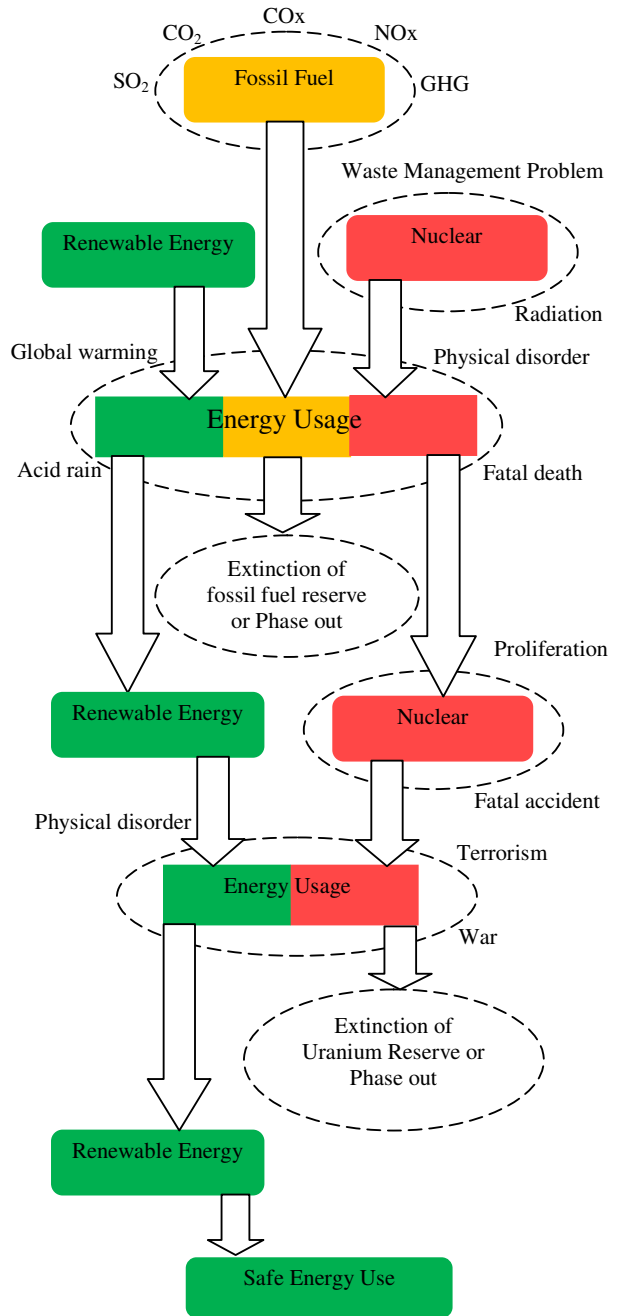


Fig. 3. Illustration of the effects and end result of using a combination of fossil fuel, nuclear energy, and renewable sources.

7. CONCLUSION

Modern age is passing an energy deficient time and the coming days, people will definitely be hungry for energy. Today, more than 1.4 billion people worldwide lack access to electricity: 585 million people in sub-Saharan Africa (including over 76 million in Nigeria and some 69 million in Ethiopia) and most of the rest in developing Asia (including 400 million in India and 96 million in Bangladesh) [1]. This scenario urges us to take drastic actions in order to ensure energy security for future as well as for sustainable development. This issue needs to be addressed considering a compact energy policy includes: security of supply, environmental impact, world competitiveness and social concerns. Subsidy artificially lowers energy prices, which encourages wasteful energy consumption, exacerbate energy price volatility by blurring market signals, incentivize fuel adulteration and smuggling, and undermine the competitiveness of renewable sources. Therefore, we have to eradicate subsidies to fossil fuel, stop further exaggeration regarding nuclear energy and think about renewable energy with a broader mind.

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