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Environmental and Health Implications of Processing, Harvesting, Distribution and Using both Renewable and Non-renewable Energy Sources

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Abstract
The harvesting, processing, distribution, and use of fuels and other sources of energy have major environmental implications. About half of the world's population use solid fossil and biomass fuels for domestic cooking and heating in simple devices that produce large amounts of air pollution, which is probably responsible for 4–5 percent of the global burden of disease. In this review, the principal environmental and health impacts of energy are discussed. Among the issues examined are the risk and health hazards posed from various forms of convectional energy such as coal, oil and gas exploration, while for renewable forms of energy, risk and hazards from biomass, hydro, geothermal as well as nuclear were also examined.
The review concluded that there are many damaging effects from the processing, harvesting, distribution and utilization of energy on both human and ecology. Notable among these are major land-use changes due to fuel cycles such as coal, petroleum based, biomass, and hydropower, which have implications for the natural as well as human environment. Other damaging effects are the routine and accidental release of pollutants, which disperse a wide variety of biologically and climatologically active elements and compounds into the atmosphere, surface waters, and soil at rates far beyond the natural flows of these substances. The review noted that some of the resulting diseases are asthma, malaria, tuberculosis, and lung cancer among others.
Keywords: - Disease, ecology, energy, environment, hazards, human health,

1. Introduction

The importance of energy to the social-economic and technological development of any nation cannot be overemphasized as general well being and standard of living of such nation depend on energy at her disposal. Hence, it could be said that energy is a key factor to the development of any nation (El-Saeidy, 2004). As environmental issues, in particular climate change, become increasingly important, energy use and supply come under intense scrutiny. The sheer magnitude of global energy use and its rapid growth have severe environmental implications (Hung, 2010). The global human population continues to grow, and countries are continuing to develop, causing steep increases in the demand for energy. At the current rate of increasing energy use, energy demand is expected to increase 65% from 2004 levels by 2030 (Sims and Schock, 2007). However, as important as energy is, its processing, harvesting and distribution as well utilization, most times bring untold hardship to both human and ecology. Such hardships vary, ranging from destruction of land, environmental pollution and health hazards to human (Hung, 2010). Many diseases being experienced are as a result of environmental pollution. A typical example of this is the outbreak of cancer as a result of nuclear accident in Chernobyl in defunct USSR (WHO. 1996). Also, global warming, which is responsible for most of the recent world's flooding, is as a result of abuse on our environment (Ristinen and Krushaar, 2006).

The recent nuclear accident in Fukushima in Japan also pointed to the danger posed by processing and harvesting of renewable energy (Oladeji, 2014). Generally, it can be said that the processing, harvesting, distribution and utilization of energy create significant risks at homes for users, work places for workers and have the largest impacts on populations among energy systems. In communities, fuel use is the main cause of urban air pollution, though there is substantial variation among cities in the relative contributions of vehicles and stationary sources (Crane, 1998). Diesel-fuelled vehicles, which are more prominent in developing countries, pose a growing challenge for urban health. The chief ecosystem impacts result from large-scale hydropower projects in forests, although surface mining causes significant damage in some areas (Dohan, 1974). At the regional scale, fine particles and ozone are the most widespread health damaging pollutants from energy use, and can extend hundreds of kilometres from their sources. Similarly, nitrogen and sulphur emissions lead to acid deposition far from their sources. Such deposition is associated with damage to forests, soils, and lakes in various parts of the world. At the global scale, energy systems account for two-thirds of human-generated greenhouse gas increases. Thus energy use is the human activity most closely linked to potential climate change. Climate change is feared to have significant direct impacts on human health and on ecosystems (Environment Canada, 1999). Therefore, the main objective of this study was to highlight the damaging effects from the processing, harvesting, distribution and utilization of energy on both human and ecology. Specifically, the review examined various forms of energy and risks involved in generating and utilizing such energies. The

dangers and risks posed to both human and ecology were also thoroughly examined. Some of the resulting sicknesses were also examined.

2. Methodology

The method adopted for the study involved extensive literature review on the subject matter. Sources used included internet, previous reports and publications of notable researchers (the present author inclusive) on renewable and non-renewable energy.

3. Renewable and Non-Renewable Energy

Non-renewable energy sources such as fossil fuels and nuclear ores have a rate of replenishment on the order of millions of years, and are currently being used a rate significantly greater than that of replenishment. Consequently, there is a finite reserve of non-renewable energy sources, and once these reserves have been emptied, alternative sources of energy must be used. Renewable energy sources are those which are replenished at a rate greater than they are consumed. Renewable energy sources include solar energy, some forms of biomass, tidal and hydropower and wind (Hung, 2010). Renewable energy sources are generally considered to be climate-friendly and allow countries with no fossil fuel reserves to gain energy security and independence (Asif and Muneer 2007). Critics of renewable energy, however, argue that the relatively low energy density of these energy supplies, or rather, of the low efficiency of the technologies used to convert the energy, render a world using exclusively or even primarily renewable energy impracticable (Ausubel 2007). In some cases they argue that renewable energies have poorer performance than the fossil fuel and nuclear energy sources used today (Ausubel 2007). Discussed in sections 3.1-3.9 are various forms of energy sources and the attendant impacts of processing, harvesting, distributing and using such energy sources.

3.1 Coal

Coal is currently the dominant fuel source for electricity production (Letcher 2008). Several forms of coal exist, which vary in carbon content. The energy density of coal increases with the carbon content. In addition, higher carbon content results in a cleaner-burning fuel (Ristinen and Krushaar 2006). Anthracite, or hard coal, is the cleanest burning and most energy-intensive form of coal. The fuel is combusted to produce steam, which turns a turbine to generate electricity. Coal is a major global energy source, accounting for 23 percent of total energy consumption. It was the primary energy source from 1900 until 1960, when it was overtaken by oil (WHO, 1997). Coal can be produced through surface (open cast) mining or underground mining. Like mining in general, both operations are inherently dangerous to the health of the workers. About 1 percent of the global workforce is engaged in mining, but these workers account for 8 percent of the 15,000 fatal occupational accidents each year. Underground coal miners are exposed to the hazards of excavating and transporting materials underground. These hazards include injuries from falling rocks and falls into mine shafts, as well as injuries from machinery used in the mine (Armstrong and Menon, 1998). Pneumoconiosis silicosis is a common health effect in coal miners and this is because much of the excavation involves drilling into silica-based rock, creating high levels of silica dust inside the mine (Jennings, 1998). The main environmental concerns associated with conventional coal combustion include the emission of CO_2, SO_2, NOx and mercury (Letcher 2008). Due to the prevalence of coal combustion and abundant supply of coal in the world, it is important that improvements be made to the coal combustion process. The most recent and significant advances include improvement to combustion efficiencies by using different combustion techniques, implementation of enhanced flue gas cleaning equipment, coal transformation technologies, integrated gasification combined cycle and carbon capture and storage (CCS) technologies (Chen and Xu, 2010).

3.2 Oil

Oil and gas exploration, drilling, extraction, processing, and transport involve a number of the same hazards as mining: heavy workload, ergonomic hazards, injury risk noise, vibration, and chemical exposures (Kraus, 1998). This work is often carried out in isolated areas with inclement weather conditions. The ergonomic hazards lead to risks of back pain and joint pain. Injury hazards include burns and explosions. Skin damage from exposure to oil and to chemicals used in drilling creates a need for well-designed protective clothing. In addition, many oil and gas installations have used asbestos to insulate pipes and equipment. Inhalation of asbestos dust in the installation and repair of such equipment creates a risk of lung cancer, asbestosis, and mesothelioma (WHO, 1998). A lot of exploration and drilling for oil and gas occur offshore. This involves underwater diving, which is dangerous. In addition, weather-related exposures can be extreme, particularly since the work often requires round-the-clock operations (Kraus, 1998). Substantial damage is also done to the environment. Farming lands and marine resources are destroyed. There is also water pollution, which creates drinking water problem to the immediate community where oil and gas are being produced. This is typical scenario in the Niger-Delta Region of Nigeria and this often creates social unrest and militancy (Oladeji, 2011).

3.3 Natural Gas

Natural gas has gained in momentum as an energy source in recent years. As a fuel, natural gas combustion emits less pollution than other fossil fuels as it is generally low in impurities, and is versatile in its application. Natural gas combustion fuels the production of steam, which powers electricity generating turbines. In a combined-cycle natural gas power plant, different thermodynamic cycles may be combined to improve overall plant efficiency (Kehlhofer and Rukes, 2009). The first cycle operates at a higher-temperature, while the second harnesses the energy contained in the resulting waste heat. Due to the higher efficiency of these facilities, the environmental impact per unit of electricity or natural gas consumed decreases.

3.4 Hydropower

With a total capacity of about 640,000 megawatts of electricity, hydropower provides about one-fifth of the world's electricity (Gleick, 1992). In Central and South America hydropower provides about 60 percent of electricity; in Asia this figure is about 15 percent. There are more than 300 major dams world-wide, and nearly all have hydropower as a major component of their function. The environmental impact per unit of electricity production, however, can often be smaller for large than for small dams. Major hazards occur, when a hydroelectric power station is built, because this usually requires constructing a large dam, excavating underground water channels, and building large structures to house the generator. McManus (1998) lists 28 occupational hazards potentially involved in the construction and operation of hydroelectric power stations. These include asbestos exposure, diesel and welding fumes; work in confined spaces or awkward positions, drowning, electrocution, noise, heat, electromagnetic fields, vibration, weather-related problems, and chemical exposures from paints, oils, and PCBs (polychlorinated biphenyls). The following impacts of hydropower through construction of dams are discussed in sections 3.4.1-3.4.4

3.4.1 Direct Human Impacts

During the 20th century 30–60 million people were flooded off their lands by dams (Dunn, 1998). The World Bank, using Chinese government figures, estimates that 10.2 million people were displaced by reservoirs in China between 1950 and 1989 (World Bank, 1998). Given that a number of major dams are under construction or planned in developing countries, there will be no slackening in the pace of population displacement. China's Three Gorges Dam, for example, is expected to displace more than 1 million people, and the proposed Pa Mong Dam between Lao PDR and Thailand is expected to displace more than 500,000 (Gleick, 1998). Some 13,500 people have been swept to their deaths by the 200 or so dams (outside China) that have collapsed or been overtopped in the 20th century. In 1975 in Henan, China, about 230,000 people died from a series of dam bursts (Gleick, 1998).

3.4.2 Social and Health Impacts

The social and cultural stress, loss of income, disruption of traditional support services, and other problems facing displaced populations often lead to lowered health status. Disease can spread from vectors that thrive in secondary dam systems, such as irrigation canals and even dam reservoirs. Mosquitoes carrying malaria, for example, have thrived in conditions created by dams (Ojediran, 2003). The parasitic disease schistosomiasis has also become more prevalent through the creation of habitats for snails that act as the disease vector.

3.4.3 Ecosystem Impacts

An internal survey of World Bank hydroelectric dam projects found that 58 percent were planned and built without any consideration of downstream impacts, even when these impacts could be predicted to cause coastal erosion, pollution, and other problems (Dixon, 1989).

3.4.4 Dams and Greenhouse Gases

The most immediate changes are in the carbon flow between the flooded vegetation and the atmosphere. The decomposition of plants and soils causes the gradual release of their stored carbon (Rudd et al., 1993). However, because of the low-oxygen conditions near and in the bottoms of many reservoirs, a larger fraction of the biomass carbon is likely to be released as methane rather than as carbon dioxide. Since methane is a much more powerful greenhouse gas than carbon dioxide, the global warming impacts are greater than the same amount of carbon released as carbon dioxide.

3.5 Nuclear Power

There are two main environmental concerns about nuclear power, both mostly with regard to its potential impacts on human health. One involves the highly radioactive products produced by nuclear fission inside power reactors. Such products require careful management at the reactor and during and after disposal. Furthermore, nuclear accident could be dangerous as exemplified by Chernobyl accident in defunct USSR and recent nuclear accident, which was triggered by tsunami in Fukushima, Japan (Oladeji, 2014). The other concern revolves around the weapons-grade plutonium or uranium that might be clandestinely derived from the nuclear power fuel cycle to make bombs or other weapons of mass destruction by nations or sub-national groups. The routine (non-

accidental) emissions of pollutants from the harvesting, processing, and conversion of nuclear fuels are not negligible (Haefele, 1990). Exposure to radiation is very dangerous and in case in case of nuclear accident, radioactive element can be felt several thousand kilometers away. The resultant health effect of too much exposure to radioactive elements is outbreak of cancer (WHO, 1996; Gupta, 1989). And more than many technologies, they are vulnerable to being enhanced by mismanagement. Still, the impacts of these emissions are generally substantially less than those involved with producing power with current coal technologies, the chief competitor in many areas. Although involving different pollutants, routine emissions from nuclear power systems are probably no more dangerous than those from new natural gas power systems with the important exception of carbon dioxide, which is not produced by nuclear power. If public concerns about reactor safety, proliferation, and waste disposal can be satisfied, nuclear power may be able to play a significant role in de-carbonizing the world energy system in the next 50 years.

3.6 Solar

Solar energy, as the name implies, exploits the energy from solar radiation to produce usable energy. There is significant potential in this source of energy: the total solar radiation intercepted by Earth is on the order of 8000 times greater than the human primary energy demand (Letcher 2008). Unfortunately, the ability of humans to effectively collect and transform this energy remains severely limited. The manufacture of solar power equipment involves the typical hazards in manufacturing: injuries, noise, chemical exposures, and so on. In addition, the technologies for solar electricity generation involve new chemical compounds, some based on rare metals with poorly known toxic properties (Crane, 1998).

3.7 Wind Energy

Wind energy is harnessed using wind turbines on land or at sea (offshore). Kinetic energy from the wind is converted to mechanical energy in a gearbox. The majority of modern wind turbines consist of three-bladed rotors. The rotors are connected to a low-speed shaft. In order to increase the speed of the shaft, the gearbox increases to shaft speed to match the rotational speed of a induction generator (Letcher 2008). While wind farms require a large area to produce a commercially viable quantity of electricity (Letcher 2008), very little of the land – approximately 3% – is actually occupied by the turbines. As a result, most of the land the wind farm officially occupies may still be used for grazing or tillage, as an example.

The advantage of offshore wind farms is that the effect of visual impact is reduced, and the open ocean provides a very good wind resource. However, since, these sites are isolated and at sea, they may be difficult and costly to construct and maintain (Letcher 2008). Furthermore, the manufacture of wind power equipment involves the typical hazards in manufacturing: injuries, noise, chemical exposures, and so on (Crane, 1998).

3.8 Environmental Implication of Geo-thermal Energy

Environmental aspects of geothermal energy use relate primarily to gas admixtures to the geothermal fluids such as carbon dioxide, nitrogen, hydrogen sulphides or ammonia and heavy metals such as mercury (Björnsson, 1998). The quantities vary considerably with location and temperatures of the feed fluid but are generally low compared to those associated with fossil fuel use. Because the chemicals are dissolved in the feed water, which is usually re-injected into the drill holes, releases are minimal.

3.9 Environmental Implications of Biomass Production

Forest energy plantations consist of intensively managed crops of predominantly coppiced hardwoods, grown on cutting cycles of three to five years and harvested solely for use as a source of energy. The site, local, regional, and global impacts of these crops need to be considered. For example, if short-rotation energy crops replace natural forests, the main negative effects include increased risks of erosion, sediment loading, soil compaction, soil organic matter depletion, and reduced long-term site productivity. Water pollution from intensively managed sites usually results from sediment loading, enhanced nutrient concentrations, and chemical residues from herbicides. In contrast, if short-rotation crops replace unused or degraded agricultural land, this reduces erosion, nutrient leaching, and so on.

3.9.1 Soil and Nutrients

The abundant use of fertilizers and manure in agriculture has led to considerable environmental problems in various regions. These problems include nitrification of groundwater, saturation of soils with phosphate (leading to eutrophication), and difficulties meeting drinking water standards. In addition, the application of phosphates has increased heavy metal flux to the soil.

The agricultural use of pesticides can affect the health of people as well as the quality of groundwater and surface water and, consequently, plants and animals. Specific effects depend on the type of chemical, the quantities used, and the method of application

3.9.2 Erosion

Erosion is related to the cultivation of many annual crops in many regions and is a concern with woody energy crops during their establishment phase.

3.9.3 Risks and Health from Biomass Energy

As noted, wood, crop residues, dung, and the like are common energy sources for poor households in developing countries. Wood is also still widely used in industrialized countries, in some cases promoted in the interest of reducing greenhouse gas emissions. Wood and agricultural waste are often collected by women and children (Sims, 1994). Such collection is part of daily survival activities, which also include water hauling, food processing, and cooking. Musa (2007) noted that women and children suffered more than men from health effects of using fuel woods because they are largely involved in kitchen activities.

4. Estimated Health Effects

Four main types of health effects are thought to occur, based on studies in households that use solid fuels and corroborated by studies of active and passive smoking and outdoor air pollution (Smith, 1998): These are:

- Infectious respiratory diseases such as acute respiratory infections and tuberculosis.
- Chronic respiratory diseases such as chronic bronchitis and lung cancer.
- Adverse pregnancy outcomes such as stillbirth and low birth weight in babies born to women exposed to pollution during pregnancy.
- Blindness, asthma, and heart disease.

The best estimates of such effects for developing countries have been done for India. These indicate that household solid fuel use causes about 500,000 premature deaths a year in women and children under 5 (Smith, 2000). Given that India contains about one-quarter of the world's solid-fuel cooking stoves, the global impact could be expected to be about four times larger or about 2 million deaths a year in women and children. This is roughly compatible with World Health Organization estimates of about 2.5 million, estimates that were generated by extrapolating studies from industrialized country cities to developing country conditions (WHO, 1997).

5. Greenhouse gases

The same incomplete combustion processes that produce emissions of health-damaging pollutants from household solid-fuel stoves also produce greenhouse gas emissions. A large amount of fuel carbon is typically diverted to gaseous products of incomplete combustion, all of which cause greater global warming per carbon atom than would be the case if complete combustion occurred and all the carbon was released as carbon dioxide. The most powerful of these is methane, which over a 20-year period causes more than 20 times the global warming from the same amount of carbon as carbon dioxide.

Conclusions

From this review study, the following conclusions among others can be drawn:-

- As important as energy is, its processing, harvesting and distribution as well utilization, most times bring untold hardship to both human and ecology.
- There are many damaging effects from the processing, harvesting, distribution and utilization of energy on both human and ecology.
- Global warming, which is responsible for most of the recent world's flooding, is as a result of abuse on environment as a result of processing, harvesting, distribution and utilization of energy.
- There are major land-use changes due to fuel cycles such as coal, petroleum based, biomass, and hydropower, which have implications for the natural as well as human environment.
- Notable diseases such as asthma, malaria, tuberculosis, and lung cancer among others are as a result of processing, harvesting, distribution and utilization of energy.

References

Armstrong, J., and Menon, R., (1998) "Mining and Quarrying" In J.M. Stellman, ed., Encyclopedia of Occupational Health and Safety. 4th ed. Geneva: International Labour Organization.

Asif, M. and Muneer, T., (2007) "Energy supply, its demand and security issues for developed and emerging economies" Renewable and Sustainable Energy Reviews **11**: 1388-1413

Ausubel, J. H. (2007). "Renewable and nuclear heresies" International Journal of Nuclear Governance, Economy and Ecology **1**: 229

Björnsson, J., (1998) "The Potential Role of Geothermal Energy and Hydropower in the World Energy Scenario in Year 2020" Paper presented at the 17th Congress of the World Energy Council, 13–18 September, Houston, Tex.

Chen, W., and Xu, R., (2010) "Clean coal technology development in China." Energy Policy **38**: 2123-2130.
Crane, M., (1998), "Power Generation and Distribution-" In J.M. Stellman, ed., Encyclopaedia of Occupational Health and Safety, 4th edition Geneva: International Labour Organization.
Dixon, J.A., (1989) Dams and the Environment: Considerations in World Bank Projects. Washington, D.C.: World Bank.
Dohan, M.R., (1974), "The Effect of Specific Energy Uses on Air Pollutant Emissions in New York City" Brookhaven National Laboratory, Upton, NY.
Dunn, S. 1998. "Hydroelectric Power Up Slightly." In Vital Signs New York: Norton and Co.
El-Saeidy, E. A., (2004) "Technological Fundamentals of Briquetting Cotton Stalks as a Bio-fuel" An Unpublished PhD Thesis, Faculty Agriculture and Horticulture, Humboldt University, Germany
Environment Canada, (1999), "A Primer on Environmental Citizenship" http://www.ns.ec.gc.ca/aeb/ssd/acid/acidfaq.html
Gleick, P.H. (1992) "Environmental Consequences of Hydroelectric Development: The Role of Size and Type". Energy 17:735–47.
Gupta, N., (1989) "Health Implications of Nuclear Energy" Economic and Political Weekly 24 (39): 2166.
Haefele, W., (1990) "Energy from Nuclear Power" Scientific American 9:136–44.
Hung, C., (2010) Environmental Impacts of Renewable Energy: A Overview of Life-Cycle Results- An unpublished Master Thesis of the Department of Energy and Process Engineering, Norwegian University of Science and Technology
Jennings N.S. (1998) "Mining: An Overview" In J.M. Stellman, ed. Encyclopedia of Occupational Health and Safety. 4th ed. Geneva: International Labour Organization.
Kehlhofer, R., and Rukes, B., (2009). Combined-Cycle Gas & Steam Turbine Power Plants Tulsa, PennWell.
Letcher, T. M., Ed. (2008) Future Energy: Improved, Sustainable and Clean Options for Our Planet. Oxford, Elsevier.
McManus, N., (1998) "Hydroelectric Power Generation." In J.M. Stellman, ed., Encyclopedia of Occupational Health and Safety 4th ed. Geneva: International Labour Organization.
Musa, N.A., (2007) "Comparative Fuel Characterization of Rice Husk and Groundnut Shell Briquettes" NJRED, Vol. 6, No. 2.pp 23-26.
Ojediran, J. O. (2003) "Effects of Irrigation Development on Some Climatic Factors of the immediate Environment: A case study of an Irrigation Scheme in Nigeria. Journal of Science and Technology Research 6 (1) 116-121
Oladeji, J.T. (2014) Workshop Technology I Graceful Heights Prints, Ibadan, Nigeria ISBN 978-978-917-017-4
Oladeji, (2011) "The Effects of some Processing Parameters on Physical and Combustion Characteristics of Corncob Briquettes" An Unpublished PhD Thesis of Mechanical Engineering Department, Ladoke Akintola University of Technology, Ogbomoso, Nigeria
Ristinen, R. A., and Krushaar, J.J., (2006), Energy and the Environment New York, John Wiley and Sons
Rudd, J., (1993) "Are Hydroelectric Reservoirs Significant Sources of Greenhouse Gases?" Ambio, *22*(4)
Sims, J., (1994) Women, Health and Environment: An Anthology. WHO/EHG/94.11. Geneva: World Health Organization
Sims, R. E. H., and Schock, R. N., (2007) Energy Supply. Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge, United Kingdom and New York, NY USA, Cambridge University Press.
Smith, K.R., (1998), The National Burden of Disease from Indoor Air Pollution in India Mumbai: Indira Gandhi Institute of Development Research
Smith, K.R., (2000) "National Burden of Disease in India from Indoor Air Pollution" Proceedings of the National Academy of Sciences 97.
WHO, (1996) "Health Effects of the Chernobyl Accident" WHO/EHG/96.X. Geneva
WHO, (1997) "Health and Environment in Sustainable Development: Five Years after the Earth Summit." WHO/EHG/97.8. Geneva.
WHO, (1998) "Chrysotile Asbestos" Environmental Health Criteria 190, Geneva

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