Energy

In a lay mans' term, energy is the capacity of a physical system to perform work. Energy exists in several forms such as heat, kinetic or mechanical energy, light, potential energy, electrical, or other forms. Muthoka (1998) defines energy as the ability to do work. Energy is measured in Joules (J) or Calories (C).
In the context of sustainable development, energy refers to the source of power which can be used to drive machines, provide heat and make work simple.

Forms of energy

Chemical energy: This is energy stored in chemical bonds between atoms. Wood, maize, petrol and dry cell batteries contain chemical energy.

Heat energy: This is energy in fast moving molecules.

Mechanical energy: This is kinetic energy in moving objects such as those in Posho Mill or in a bicycle moving down hill.

Electrical energy: This is an adaptable form of energy contained in currents of moving electrons. It is used for lighting and powering machines. It can be converted into another form of energy such as chemical energy in batteries.

Radiant energy: This is energy contained in light waves; solar energy arrives as a radiant energy.

Plants store the sun's energy as chemical energy inform of sugar, starches, cellulose and other organic compounds. When any work is done, energy is concerted from one form to another. For example, a light bulb converts electrical energy to radiant and heat energy. Energy changes are governed by these rules:

- Every time Energy changes its state, it changes from its original state to more than one different state. Incase of a generator, mechanical energy is changed into both electrical and heat energy. This means that unless all of the forms of energy produced are used, some will escape in any conversion.
- Every time energy is transferred, some of it is lost. For example, if mechanical energy is transferred by means of belts or gears, some of it is lost as frictional heat in the gears.

Types of Energy

All sources of energy can be divided into two types: that is **Renewable** and **Non-renewable (Conventional)** sources of energy.

Renewable sources of energy are those that are constantly being replaced as they are used. They include: Solar energy, Wind power, Hydropower, Biomass energy, Nuclear energy and Geothermal power.

Conventional or non renewable energy sources are those which become less plentiful as they are used up. This includes mainly fossil fuels like oil, coal and natural gas.

Conventional or Non-renewable sources of energy

Most commercial energy comes from fossil fuels for example, coal, oil and natural gases. WHO (1992) commends that fossil fuels account for 90% of world's commercial energy. Developed countries with 25% percent of world's population account for more than 70% of world's fossil fuel.

Peat (Peat in the Oxford Advanced Learners Dictionary, is a soft black or brown substance formed from decaying plant just under the surface of the ground especially in cool wet areas. It can be burnt as fuel or used to improve garden soil) is a minor and localized resource.

Resources to be developed are Oils shales and tar sands. These are made of carbon compounds from organisms that have lived many years ago. Due to sedimentation and high pressure ancient plants and animal remains are fossilized to form fossil fuels.

Over very many centuries, the biomass changes into petroleum compounds cases in point are the fossil fuels in the Middle East, Northern and Southern Africa, North America, India and China.

Heavy use of these resources started with the invention of steam engine inthe18thcentury and combustion engine in 19thcentury. Fossil fuel form a base of modern industrial development that it industrialization in the post modern age (post modernism).

Oil is a liquid form of fossil fuel. Paraffin, petrol, diesel, motor oil and jet fuel are all made from crude oil. Oil is the world's major used fuel supplying about 40% of world's energy. Transport industry depends on liquid oil. (Except air craft: they use……..)

Coal is the most common form of fossil fuel. It is used in manufacturing of cement and for heating. It is the second largest used fuel source since it accounts for 30% of global energy.

Sulphur dioxide and carbon dioxide emission is the major constrain to the growth of coal consumption.

Oil shales and tar sands from which petroleum products are derived are also examples of solid fossils.

Natural gas provides 20% of global energy. It is made up of mostly butane and propane gases which are liquefied under pressure and stored in metal cylinders. It is the fastest growing energy source in the world today. This is because it minimizes the environmental problems associated with other fossil fuels. One combustion of natural gas emits one half the carbon dioxide of an equivalent amount of coal.

Environmental impact of fossil fuels

Fossil fuels when burnt releases waste products which can damage human health and environment at varying degrees depending on the quantity and composition of the fuel.

Muthoka (1998) says that fossil fuels account for 90% of global anthropogenic sulphur dioxides, 85% of nitrogen, 30-50% of carbon monoxides. The amount of emission varies from one country to another.

- Coal combustion emits sulphur oxides, nitrogen oxides and carbon dioxides. This accounts for wide city air pollution. Muthoka (1998) cites examples of London smoke of 1950 and photo chemical smog in Los Angeles of 1960s. The major emitters of photochemical smog are vehicles. This may lead to acid rain. Acid rain is ……
- The discharges of oil from oil tankers and oil refineries and off shore platforms cause marine pollution. Oil spills cause damage to living resources in coastal zones. A local example can be car wash in the wet lands which affect the aquatic life in the wet lands. On an international scene, Muthoka (1998) presents the 1989 Exxon Valdez Oil spill in Alaska where 2000 km of shoreline were impacted by oil which caused the death of 36,000 birds, 1000 sea otters and 153 eagles and it heavily disrupted fishing.
- The aftermath the Gulf War not only presented with destruction of coral reefs, fish and turtle breeding ground, but also the mangrove swamp, large mammals like gazelle were adversely affected. This was due to oil fire and oil spills on the soil, water and vegetations and other life in the region.
- Coal mining especially strip mining disturbs large areas of land and renders it useless and unsightly. WHO (1992) states that there are often accidents in the coal mines in form of gas explosion or earth mass collapsing on the people. Muthoka (1998) confirms this by cite Ross (1987) saying that coal slag heaps can collapse and cause loss of life as it happened in Aberfan in October 1966 killing 147, 116 of whom we school children. To WHO (1992), coal mining is associated with many illnesses like pneumoconiosis and asthma from inhalation of dust. The process of coal processing cycle also exposes one to smokeless fuel and tar rich in polycyclic aromatic hydrocarbons. This causes lung cancer.

Renewable sources of energy

Many renewable or non fossil energy sources in use in various parts of the world are solar energy (solar thermal heating and solar thermal power), wind energy, hydropower, geothermal heat, wood and others derived from biomass.

Biomass is the most commonly used energy for the majority of the world's people. For commercial energy, nuclear and solar energy have the potential to make significant contribution.

Today, researchers are developing ocean energy source.

Solar energy

Byamugisha (2003) defines solar energy as energy taped direct from the sun's rays.

The sun is the primary source of energy, solar energy. The sun powers the cycles that produce hydro, wind and biomass energy. Solar radiation falls upon and heats the earth's surface. The actual amount of energy received at ground level varies between almost

1000watts per square meter mid-day at equator and zero watts per square meter at night. Dessert regions within the tropics receive 7.2 x 10^7 kilojoules per square meter of solar radiation per year.
The factors that affect the amount of solar radiation include;

- Latitude: At high intensity solar regions near the equator,
- Cloud cover: Long cloudy periods can significantly reduce amount of solar energy available.
- Humidity: High humidity absorbs reduces radiation.
- Atmospheric clarity: Reduced by smoke, smog and dust affects the incoming solar radiation.

Solar energy technologies make direct use of energy in sunlight to provide beat or generate electricity.
Solar heating devices capture solar energy and make the energy available as heat. This is then used to heat water, dry crops, and warm homes and even cook food.
Solar electric devices convert solar energy into electricity and may be used directly for radios, water pumps, refrigerators, lights, fences and other household appliances or it may be stored in batteries.

Solar electricity: this is electric power generated from sunlight using solar cells. These are thin slices of especially treated silicon which operates by a principle of light called photo electric effect. They transform sun light into electric energy generating electric current when placed at the presence of the sun light.

Advantages of solar energy

- It is ideal for small remote electrical applications because the electric generation involves moving parts.
- No fuel is used this means that it does not cause pollution
- Its installation is easy
- It little maintenance is required
- It is durable last very long time.
- It is then appropriate for rural area.
- It does not cause environmental pollution

All space satellites are powered by solar cells, including those used for international telephone, teletype communication and television broadcasts. In some developing countries photo voltaic (PV system) are used for providing light, running irrigation pumps, and domestic usage.

Solar energy present with the challenges

- Solar energy spreads over a wide area in a relatively low energy form.
- It is not available at night or during cloudy overcast weather.
- The forms of energy derived from solar power are difficult and expensive to store.
- The equipment used especially at initial installation is expensive; unaffordable to the poor.

Wind Energy

This is energy from moving wind or currents of air. Wind resulting from movement of the atmosphere which are caused by uneven heating and cooling of the earth's surface. It can be capture by wind mill or moving boats.

In areas where there is constant flow of wind, wind mill can be used to pump water (e.g. Muthoka (1998) says that in Kenya, there are over 200 windmill pumping water for cattle), grinding, threshing grains and cutting wood. In some areas, wind generators are used to generate electricity for various purposed such as lighting, radios, television and advertisements screens e.g. along Entebbe road in Kampala.

Power generated can be stored in batteries because wind does not blow always.

In choosing wind power site, Muthoka (1998) says that the wind data (wind speed and wind direction) should be put into consideration before installation.

Advantages of wind power

- The cost of maintenance is low
- Locally available sources of energy are invaluable.

Hydro Power

This is the energy tapped from moving water as it descends towards sea level or at water falls. Large amount of energy contained in fast moving water can be harnessed in huge applications such as hydro-electric dams or in smaller applications such as hydraulic rams. Thus water wheels, hydraulic rams and turbines extract energy from moving water. The amount of power produced will depend on the rate at which the stream moves and the height at which the water is falling. Generators along the world's major rivers are the largest and most important sources of electricity.

Advantages

- As long as the stream flows, power is continuously available in predictable concentrated form.
- The machines are economical in that they are long lasting and require only little basic maintenance. They are efficient and have low running cost.
- They are cheap source of power for site or large firms.
- Water impounded in the dam controls flood, provided water reservoir for irrigation and domestic use [WHO (1992)]

Challenges

- Initial installation or dam construction is very expensive.
- Many deaths of dam constructers are registered in the process of installing the hydro power system.
- Many people are often displaced; this makes people suffer of stress owing to loss of occupation, relationship and disruption of normal ordinary life.

Biomass fuel

This is organic materials which are the products of photosynthesis, a plant activity that stores energy. Biomass therefore has its origin in solar energy.
Biomass fuel can be burnt or fermented in order to make use of the chemical energy they contain. Kichodo (2003) says that wood, charcoal and plant waste may be burnt directly as fuel while animal waste and sugarcane juice are fermented to produce combustible fuels.
To Byamugisha (2003) biomass can be used for cooking, curing tobacco, and lighting and can replace engine fuel. It can be later returned to the returned to the garden inform of manure and therefore serving more purposes.

Wood fuel
This is a major source of energy for more than 2,000 million people especially in developing countries. Muthoka (1998) says that 70% of Kenya's energy is supplied by fuel wood or charcoal.
In many areas, wood fuel is already a scarce commodity. It has been suggested by Muthoka (1998) that real energy crisis will not concern coal or nuclear but lack of wood fuel.

Making proper use of wood fuel as a renewable energy entails two separate initiatives:

1. **Increasing wood energy supplies:**
   This implies planting trees to replace those cut down. This can be done by promoting aforestation, reaforestation agro forestry and woodlot. Tree planting should be accompanied by wood fuel conservation if energy needs of the growing population are to be met.

2. **Using wood and charcoal fuels efficiently:**

This can be by using energy conserving stoves, the used of improved charcoal production technologies and energy efficient cooking methods.
A variety of improved stove that suit the needs of rural masses have been developed, for example, the Kenyan ceramic jiko which contains the heat of the fire, directs into the cooking pot and control the rate at which fire burns. Combined with energy efficient cooking methods (e.g. covering the food while cooking), these stoves can cut fuel use in half.

[See Muthoka (1998 p 170) figure 7.3]

The advantages of ceramic jiko
- Uses less charcoal
- Safe from contact burns
- Burns wood/charcoal for longer periods.
- Fast for cooking
- Last long and it is economical
- Produces less carbon monoxide

Wood and other plant materials can be processed to widen their use as fuels or to make them more economical to transport.

The reasons why Charcoal is more used especially in urban areas

- it has twice as much energy per unit weight,
- it burns at a higher temperature than wood
- It produces less smoke or ashes.
- It is easy to manage charcoal in Jiko stove.
- It takes less space for storage
- It is easy to buy or sell or transport

Charcoal is made by burning wood slowly in limited oxygen, 70% of the initial energy in the wood is lost during the conservation process. Charcoal can be made from other biomass besides wood e.g. sawdust, rice, coffee husks, and coconut shell.

Wood resources should be conserved through energy-efficient kitchen management. In preparing for cooking, there are safe ways to safe fuel wood. First, they should be care fully chosen and prepared. Cook using energy wise methods e.g. covering the food.

Wood Gasification: this has some potential for the future. Muthoka cite Dudley (1983) saying that Wood gas was used to drive a car in India and several European countries during the Second World War when fuel was scarce.

Certain plant materials such as sugarcane are fermented and distilled to produce ethyl alcohol which can be mixed with petrol to make a motor fuel or gasohol. Vehicles readily adapted to the use of alcohol mixtures are in use in countries like Brazil, Zimbabwe and Kenya. In Uganda, a bicycle that uses this fuel was first used by MP Akena Obote in the parliament of Uganda.

Biogas: these are made from decaying materials including cow dung, pig waste, chicken droppings, and rice husk, straw and coffee waste. Plant and animals waste in the process of anaerobic digestion produces gases mainly methane which can be used as fuel. The process of decomposition kills all disease causing organism.
It can also be got from special energy crops like seaweeds from oceans or timber crops. People should however take care to balance between producing energy crops and food crops because in many countries, food is already in short supply.
Biogas can be burnt directly or carbonized to form briquettes of coal or fermented to produce alcohol or methane.

Advantages of biogas

- Increases sanitation standards by removing waste and reduces the number of flies and warms which could breed disease.
- It provided high quality fertilizer for field.
- They produce a clean burning gas fuel (biogas) that can be used for cooking, lighting and running engines.

Geothermal power

This makes use of heat energy form the mantle of the earth stored in underground pocket. Bodies of steam collected underground at high temperature from about $150^{O}C$-$400^{O}C$ can be tapped and used to drive turbines to generate electricity. The heat can be used for drying and other industrial purposes. They are mainly found in areas with history of volcanic activities. Examples are in North America. Muthoka (1998) posit that in East Africa, thermal power is also being tapped and used for example at Olkaria, South East of lake Naivasha, Eburu, Menengai crater, Lake Bogoria, Lake Magadi and Lake Turkana where by Kenya produces up to 30MW. Byamugisha (2003) affirms this fact by saying that in Uganda, districts using thermal diesel or fuel include Arua, Kitgum, Moroto, Kapchorwa, Mubende, Koboko, Rukungiri, and other major hospital.

Ocean energy source

Oceans store and circulate energy from the sun in form of warm water and indirectly as wave energy generated by wind and tides.

Tidal power is the best form of ocean energy with several already in operation. The constant motion of waves is used to drive the turbines

Ocean thermal energy: this is energy got and converted from the heat that the water gets and stores from the sun. the process of ocean thermal energy conservation converts solar energy got from the surface of the tropical sea in to electricity using heat exchanger which is placed at the boundary between warm, shallow water and much colder, deep water. To Dudley (1983), this method is inefficient but yet capable of producing/ generating a large amount of energy.

Disadvantages of using ocean energy

- It causes large environmental effect since it removes a large fraction of wave fraction of natural wave energy affects the coastal erosion, disposition and sea water turbidity.
- It also interferes with the coastal navigation, fishing and recreation.
- Coastal areas would require special protection against storms.
- For Tidal energy, the generation of electricity varies (unreliable) because it depends on the tide conditions
- It is limited to specific sites in selected nations.

Environmental impact of renewable energy

Since sustainability is the main advantage of the renewable sources of energy, the general assumption is that renewable energy is clean, environmental friendly and cheap. Muthoka (1998) citing Khamati (1990) says that this is however not true.

Solar power

- Solar ponds take up much land; the generators are expensive and noisy.
- They interfere with radio waves
- They can alter the migratory patterns of the birds.

Wind power

- Wind machines seem attractive but are noisy and can cause interference with television broadcasts and can be hazard due to flying ice in winter and broken blades.

Hydro power

- The construction of large scale hydro electric projects can have far reaching environment and social consequences:
- It affects the flow of rivers and alteration of biosystem down stream.
- The lifestyle of people can be drastically affected, for example, they receive less water for irrigation, fishing activities can be curtailed, siltation and reduction of fertility of the down stream.
- Stagnant water creates favorable ecological environment for water bone diseases such as malaria, river fluke infections and Schitosomiasis. Talla et al (1990) reports that with the construction of DIMA dam in Senegal, there was 71.5% increase in the occurrence of intestinal Schistosomiasis.

Geothermal power

- Geothermal plants produce more radioactive emissions in form of radon than a stable nuclear plant and more sulphur per kilowatt than coal power station. This puts the nearby ecosystem at risk. Besides, artificial expansion of geothermal outlets affects geodynamics.

Biomass power

- Uncontrolled use of the biomass burnings produces various noxious gases such as carbon dioxide, methane, ammonia, sulphur oxides and particulate matters. Such pollutants are health threats to people especially women and children who make use of wood, agricultural residues, charcoal and dung for domestic purposes. WHO (1992) says that indoor air pollution increases respiratory disease and cancer due to emission of biomass fuel due to inhalation of the smoke.
- Biomass fuel also leads to desertification due to deforestation. It also creates soil erosion, climate change, flooding and destabilization of ecosystem.

Nuclear energy

This is an important source of energy and one of the newest of the world's major energy source. In the 1930s, the idea that energy locked in an atom could be released and used for practical purposes was conceived. The discovery and development was in 1939 and in 1945, it was firs exploited for military use. But by 1950, it was being use for civil purposes.

It is found from natural uranium occurring in every part of the earth's crust with an average concentration of 2.3 ppm.

It is crucial to the nuclear industry because it is the only naturally occurring materials to contain fissile atoms of U-235 and U-238. A fissile atom is one that can undergo fission under slow thermal reactors such as the pressurized light water reactors. Muthoka (1998) cites Wri (1990) asserts that 1 tonne of nuclear can produce 25,000 tonnes of coal or 15,000 tonnes of oil.

99.28% of natural uranium consists of atoms of non-fissile isotope U-238 and only 0.72% is U-235.

U-238 can be converted by reactors to fissile plutonium and produce 60 times more energy. This is highly toxic and can be suitable only for the manufacture of nuclear weapons.
U-235 is used to generate nuclear electricity. This is ideal for capital intensive technology. It can also be used for marine propulsion especially for naval vessels.
Nuclear power stations have a useful life of 25years, afterwhich they have to be dismantled or decommissioned.

Advantages

- It helps to fill the gab created by rising demand for energy with depletion or reduction is fossil fuel.
- It is generally clean and safe for future since it is without limit in its abundance.
- Nuclear energy produces electricity more cheaply than other sources of energy.
- It has better safety records than other sources of energy.

Disadvantages

- It is a threat to health, environment and society.
- It demands a lot of scientific, technical and financial resources as nuclear power stations are extremely costly to design, build and repair.
- It can land into the hands of wrong element who can use it as terrorists for destruction of life by producing weapons of mass destruction called nuclear weapon or chemical weapon.

Environmental impacts of nuclear power

The environmental impact of nuclear power revolves around fears of environmental contamination and the resulting health hazards, the safety of nuclear installation possible accidents and the efficiency of evacuation processes; the sitting nuclear power station and the disposal and storage of nuclear waste.

- Exposure of people to very high levels of radiation which can destroy body tissues, cause cancer and lead to genetic effects in future generation. This is dangerous because at every stage of the nuclear cycle, that is, from mining, milling of uranium ores to fuel, power plants operation, eventual reprocessing of irradiated fuel and disposal of nuclear waste, radioactive waste are disposed into the environment. The radio nuclides not only decay at different rates but also behave differently to the environment. They contribute 0.04% of all radiation to which people are exposed. UNEP (1992) says that natural sources account for 83% while anthropogenic medical sources contribute 17%. In spite of the fact that human evolved in this environment which is exposed to cosmic rays fro space and radioactivity from rocks, soils, medical diagnosis and treatment, television sets, those living near nuclear installations do receive much higher dozes of radiation than from other sources.
- The danger of nuclear accidents is a major concern, particularly after the Chernobyl accidents in 1986 in Kiev (Ukraine) which caused alarm around the world. There was an explosion of one of the four units during a scheduled shutdown which resulted into fuel fragmentation, steam and hydrogen explosion, a raging fire and release of radio active material over 10days. The emitted material travelled long

distance to Poland, Finland, Norway and Sweden. It killed 31 people, over 200 hospitalized (with severe vomiting, internal bleeding diahorea etc due to the radiation burn), 90,000/= evacuated from a 30km radius and all livestock within 19.2 km were slaughtered because of contamination. Leafy green vegetables and fruits destroyed. People experienced food shortage, lost homes, jobs. There was over 50% increase in Leukemia, miscarriage, stillbirths and children born with genetic changes. Sometimes, improper experimentation can also cause accidents in the nuclear plant.

- Threat to landscape: nuclear power station needs a level area of about 2 hectors with good foundation and abundant supply of cooling water, easy access roads, rail or sea transport and connection to power lines. These facilities may not be available or used for other purposes.
- Most energy production gives rise to waste that require controlled disposal but most hazardous waste arise from nuclear.
- Water used for cooling nuclear power plant can cause thermal pollution. Muthoka (1998) says that discharged waters are usually 7 ^{o}C warmer than the receiving water bodies. This affects aquatic life or aquaculture.

Nuclear power has a potential to make significant contribution in the long run if the existing problem of its waste disposal and proliferation is resolved.

Distribution of energy

Energy is not evenly distributed. The use/consumption patterns of energy are not also even across the world. The industrialized countries tend to use more commercial sources of energy than the developing world. Muthoka (1998) extorts that in 1990, about 22% of the world's population consumes 82% of world's commercial energy. This leaves 78% of the world's population consuming only about 18%. On average, a person living in high income country consumes 15 times more energy that on living in a low income country and about 4 time more than one living in a middle-income country. However, wide disparities exist among different groups of people in the same country.

Energy storage

Many renewable energy systems like wind, waves and solar are by nature very intermittent and may not be able to produce power continuously 24 hours each day, each year. This call for their proper storage. There are three methods of storing energy:

Batteries: this can store energy inform of electricity and can be used to power vehicles and for domestic use.

Pump storage: this is another method of storing surplus energy

Heat store: here, surplus energy or electricity can be stored in well insulated store capable of retaining heat fro along period of time. Heat can be made available for space heating in this was with battery insulation and by taking advantage of the latent heat properties of certain salts which allow the use of much smaller, more efficient heat stores.

Energy conservation

Energy conservation is process of optimizing the available energy resources for present and future sustainable development. Energy conservation and energy efficiency are the most promising options for mitigating the various risks associated with the current global energy production and consumption patterns in both industrial and developing countries. They are very crucial for sustainable development, promoting better personal life and enhancing economic growth.

In industrial sector, significant energy saving can be realized by improving boiler efficiency and putting stack heat to productive use.

Saving energy can be made in residential and commercial building by equipping them with more efficient lighting, heating and cooling appliances which do not gallop power.

Transportation sector is the largest and most rapidly growing drain of world's oil supplies. Muthoka (1998) says that auto mobiles and light trucks can save energy by keeping their tubes inflated at the required capacity.
The agricultural sector, efforts must be made to use renewable sources of energy especially in the provision of water e.g. using wind power or biomass.

Importance of energy
Energy is a crucial resource in modern society today and its central role of energy in economic and social development has long been recognized and a great deal of efforts has been devoted to developing technologies for the extraction, production and use of all types of energy. Wealth is dependent on the availability of energy; the wealthiest countries and households within countries have the highest per caput level of energy consumption.
Every thing people do today require energy

- It is needed to power industries to increase and maximize production.
- It is used in the transport sector e.g. in powering vehicles, water vessels and air bags or airbuses.
- It is used for heating house especially in cold seasons

Besides these uses of energy, it is the leading cause of environmental degradation from deforestation, air pollution up to acid rain. This brings about change in global climatic regimes, greenhouse effects.

Environmental healthassement should be anessential component of decisionmaking inrelation to new energy development.

According to the law of conservation of energy, the total energy of a system remains constant, though energy may transform into another form. Two billiard balls colliding, for example, may come to rest, with the resulting energy becoming sound and perhaps a bit of heat at the point of collision.

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