

ENERGY, ENVIRONMENT AND SOCIETY

Chapter - 14

Environmental Impact of Energy Sources

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LEARNING OBJECTIVES OF THE LECTURE

- Emission hazards
- Battery hazards
- Nuclear hazards

EMISSION HAZARDS

- The combustion of fossil fuels for the production of heat and electricity results in emission of various kinds of pollutants such as fly ash, sulfur oxides, nitrogen oxides and volatile organic compounds.
- The emission is a major problem all around the world as they can affect human being as well as environment.
- Also, the emission resulting from the combustion of the fossil fuel can also degrade water and soil resulting to their pollution.
- The effects of the emission can range for adverse health effect among human beings to destruction of cultivated soil forests (Chmielewski, 1999).

CAUSES OF EMISSION HAZARDS

- The emission can be indoor as well outdoor, which causes indoor emission hazards:
- The causes of indoor emission hazards are:
 - Solid fuel use
 - Health damaging pollutants
 - Other sources

CAUSES OF EMISSION HAZARDS

SOLID FUEL USE

- Household combustion of coal or biomass (e.g.; dung, charcoal, wood, crop residues).
- These fuels are used for household cooking and heating.
- The inefficient combustion of fuels in simple stoves in poor ventilated conditions results in emission.
- The disease burden from solid fuel use is most significant in populations with inadequate access to clean fuels, particularly poor households in rural areas of developing countries.

CAUSES OF EMISSION HAZARDS

SOLID FUEL USE

- Women and their youngest children are most exposed because of their household roles.

CAUSES OF EMISSION HAZARDS

HEALTH-DAMAGING POLLUTANTS

- In simple stoves, biomass fuels emit substantial amounts of health-damaging pollutants, including respirable particulates, carbon monoxide, nitrogen oxides, benzene, formaldehyde, 1,3 butadiene, and polyaromatic compounds such as benzo(α)pyrene.
- Depending on their quality, coal fuels may also emit sulphur oxides and other toxic elements, including arsenic, lead and fluorine

CAUSES OF EMISSION HAZARDS

HEALTH-DAMAGING POLLUTANTS IN SOLID FUEL SMOKE

- **Biomass smoke**
 - Small particles, carbon monoxide, nitrogen dioxide
 - Formaldehyde, acrolein, benzene, 1,3-butadiene, toluene, styrene, and so on.
 - Polycyclic aromatic hydrocarbons such as benzo(a)pyrene.
- **Coal Smoke**
 - Depending on coal quality, sulphur oxides and such toxic elements as arsenic, lead, fluorine, and mercury.

CAUSES OF EMISSION HAZARDS

OTHER SOURCES OF INDOOR AIR POLLUTION

- Radon from the soil beneath buildings
- Tobacco smoke
- Cooking oil smoke
- Kerosene smoke
- Incense (set on fire) smoke

CAUSES OF EMISSION HAZARDS

OTHER SOURCES OF INDOOR AIR POLLUTION

- Mosquito coil smoke
- Natural gas combustion products
- Toxic elements from burning coals
- Pesticides and VOC from furnishings
- Biological pollutants: danger, spores and dust

CAUSES OF EMISSION HAZARDS

ENVIRONMENTAL IMPACT OF AIR POLLUTION

- Acid precipitation
- Destruction of global nitrogen cycle
- Ground level ozone
- Deforestation
- Diversion of agricultural residues
- Loss of visibility, property or crops

IMPACT OF AIR POLLUTION

ENVIRONMENTAL IMPACT OF AIR POLLUTION

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IMPACT OF AIR POLLUTION

EVIDENCE FOR AN ADVERSE EFFECT OF INDOOR AIR POLLUTION ON HEALTH

- ***Strong evidence***
 - ARIs (acute respiratory infections)
 - Chronic obstructive lung disease
 - Lung cancer
- ***Moderate evidence***
 - Cataract
 - TB (tuberculosis)

IMPACT OF AIR POLLUTION

EVIDENCE FOR AN ADVERSE EFFECT OF INDOOR AIR POLLUTION ON HEALTH

- ***Limited evidence***
 - Asthma
- ***Insufficient evidence***
 - Low birth weight and perinatal deaths
 - Heart disease

EFFORTS TO REDUCE AIR POLLUTION

Three factors determine the extent to which IAP impacts health:

- the degree of pollution, that is, the emission levels;
- the degree of exposure, that is, the amount of time spent in a polluted environment;
- personal susceptibility to the effects of IAP, that is, physiological factors that make some individuals more prone to the effects than others, such as children and asthmatics.

EFFORTS TO REDUCE AIR POLLUTION

Technical interventions can thus reduce IAP in three ways:

- by producing less smoke: improved stoves, improved fuels and fuel switching;
- by removing smoke from the indoor environment: chimneys, flues, hoods and ventilation;
- by reducing exposure to smoke: reducing cooking time, behaviour, kitchen design.

BATTERY HAZARDS

- The battery hazards can be categorized into 4 main categories:
 - Explosion
 - Leakage
 - Environmental concerns
 - ingestion

BATTERY HAZARDS

Explosion

A battery explosion is caused by the misuse or malfunction of a battery, such as attempting to recharge a primary (non-rechargeable) battery, or short circuiting a battery.

Car batteries are most likely to explode when a short-circuit generates very large currents.

Car batteries liberate hydrogen, which is very explosive, when they are overcharged (because of electrolysis of the water in the electrolyte).

BATTERY HAZARDS

Explosion

The amount of overcharging is usually very small and generates little hydrogen, which dissipates quickly.

However, when "jumping" a car battery, the high current can cause the rapid release of large volumes of hydrogen, which can be ignited explosively by a nearby spark, for example, when disconnecting a jumper cable (Wikipedia, 2022).

BATTERY HAZARDS

Explosion

When a battery is recharged at an excessive rate, an explosive gas mixture of hydrogen and oxygen may be produced faster than it can escape from within the walls of the battery, leading to pressure build-up and the possibility of bursting of the battery case.

In extreme cases, the battery acid may spray violently from the casing of the battery and cause injury.

BATTERY HAZARDS

Explosion

Overcharging, that is, attempting to charge a battery beyond its electrical capacity—can also lead to a battery explosion, in addition to leakage or irreversible damage. It may also cause damage to the charger or device in which the overcharged battery is later used.

In addition, disposing of a battery in fire may cause an explosion as steam builds up within the sealed case of the battery.

BATTERY HAZARDS

Leakage

Many battery chemicals are corrosive, poisonous, or both. If leakage occurs, either spontaneously or through accident, the chemicals released may be dangerous.

For example, disposable batteries often use a zinc "can" both as a reactant and as the container to hold the other reagents.

If this kind of battery is run all the way down, or if it is recharged after running down too far, the reagents can emerge through the cardboard and plastic that form the remainder of the container.

BATTERY HAZARDS

Leakage

The active chemical leakage can then damage the equipment that the batteries were inserted into.

For this reason, many electronic device manufacturers recommend removing the batteries from devices that will not be used for extended periods of time.

BATTERY HAZARDS

Environmental concerns

- The widespread use of batteries has created many environmental concerns, such as toxic metal pollution.
- Battery manufacture consumes resources and often involves hazardous chemicals. Used batteries also contribute to electronic waste.
- Some areas now have battery recycling services available to recover some of the materials from used batteries.

BATTERY HAZARDS

Environmental concerns

- Batteries may be harmful or fatal if swallowed.
- Recycling or proper disposal prevents dangerous elements (such as lead, mercury, and cadmium) found in some types of batteries can prevent them from entering the environment.

BATTERY HAZARDS

Ingestion

- Small button cells can be swallowed, particularly by young children.
- While in the digestive tract the battery's electrical discharge may lead to tissue damage.
- Such damage is occasionally serious and very rarely even leads to death

NUCLEAR HAZARDS

- Nuclear hazards are the risks or dangers to human health or the environment posed by radiation emanating from the atomic nuclei of a given substance, or the possibility of an uncontrolled explosion originating from a fusion or fission reaction of atomic nuclei.
- These unstable atomic nuclei on decomposition release ionizing radiation in the form of alpha, beta and gamma rays. These can be both beneficial as well as harmful depending on the ways they are used.
- X-rays are used to examine bones for fractures, treat cancer with radiation and diagnose diseases. Also nuclear power plants are one of the major contributors to the world electrical energy generation

CAUSES OF NUCLEAR HAZARDS

- Radioactive wastes
- Reactor accidents

CAUSES OF NUCLEAR HAZARDS

Radioactive Wastes from Nuclear Power Plants

- There is no suitable and cheap method of storing the radioactive waste.
- At any time, radioactivity is likely to escape from the waste in water bodies, concrete cases and salt formations in high mountains.
- The nuclear waste is thus likely to get leached into the biosphere.

CAUSES OF NUCLEAR HAZARDS

Reactor Accidents

A reactor is one in which fission of atomic fuel occurs.

The power plants are designed in a way that there is no leakage of radioactive materials in any form.

However, no nuclear plant is contamination proof.

During recent years nuclear power programs have been beset with problems.

These problems have reached a climax with two accidents - Three Mile Island in US in 1979 and Chernobyl in Ukraine (erstwhile USSR) in 1986.

CAUSES OF NUCLEAR HAZARDS

Reactor Accidents

These two major accidents have greatly shaken the public's confidence in the inherent safety of nuclear power.

Significantly both the accidents were due to human error.

The Chernobyl accident was relatively more serious.

EFFECTS OF NUCLEAR HAZARDS

The nuclear hazards can effect human beings by:

- Internal dose from inhalation of radioactive materials in air
- External dose direct from radioactive materials deposited on the ground
- External radiation direct from cloud
- Internal dose from eating and drinking radioactive materials in food and water

EFFECTS OF NUCLEAR HAZARDS

- Nuclear hazard effects can be either initial or residual.
- Initial effects occur in the immediate area of explosion and are hazardous immediately after the explosion whereas the residual effects can last for days or years and cause death.
- The principal initial effects are blast and radiation. Blast causes damage to lungs, ruptures eardrums, collapses structure and causes immediate death or injury.
- Thermal Radiation is the heat and light radiation, which a nuclear explosion's fireball emits producing extensive fires, skin burns, and flash blindness.
- Nuclear radiation consists of intense gamma rays and neutrons produced during the first minute after the explosion.

EFFECTS OF NUCLEAR HAZARDS

Physiological Effects of Nuclear Hazards

The nuclear radiation is measure in Gray (Gy). The effects of nuclear hazards can be classified according the amount of radiation one has been exposed to.

- No observable effect (< 0.25 Gy)
- White Blood Cell count drops (0.25 to 1 Gy)
- Mild Radiation Sickness (1 to 2 Gy)
 - Nausea, Vomiting, Headache, Fatigue, Weakness

EFFECTS OF NUCLEAR HAZARDS

Physiological Effects of Nuclear Hazards

- Moderate Radiation Sickness (2 to 3.5 Gy)
 - Nausea and Vomiting within 12 to 24 hours
 - Fever
 - Hair loss
 - Vomiting blood, bloody stool
 - Poor wound healing
 - Can be fatal

EFFECTS OF NUCLEAR HAZARDS

Physiological Effects of Nuclear Hazards

- Severe Radiation Sickness (3.5 to 5.5 Gy)
 - Nausea and vomiting within 1 hour of exposure
 - Diarrhea
 - 50% fatality
- Very Severe Radiation exposure (5.5 to 8 Gy)
 - Nausea and Vomiting
 - Dizziness
 - Low blood pressure
 - More than 50% fatality

EFFECTS OF NUCLEAR HAZARDS

Biological effects of radiations

- Radioactive substances are among the most toxic substances known. Radium is 25,000 times more lethal than arsenic.
- The cell, which is the fundamental unit of life, is the primary site of radiation damage.
- If too many cells are damaged, the symptoms show up in the growing tissues as in the case of loss of hair, ulceration of the mouth, the reddening and hemorrhaging of the skin and lowering of the blood count.
- If these symptoms grow more severe, death will result.

EFFECTS OF NUCLEAR HAZARDS

Somatic effects

- These are the direct results of action of radiation on the body cell and tissues. Uranium mineworkers, painters of radium dials and Radiologists suffer most. These effects may be immediate or delayed.
- More evidence of degree and kind of damage from radiation came from studies of the Nagasaki and Hiroshima survivors.
- If one survives the phase of radiation illness in the 50 to 500 rad. range, the other illness one is likely to become a victim are-cardiovascular disorder, cataract, leukemia, sterility, premature ageing and shortenings of life span. All these are somatic effects.

EFFECTS OF NUCLEAR HAZARDS

Genetic effects

There is another more serious type of effect of ionizing radiations, known as genetic effect. This arises from the damage to the sex cells.

If a sex cell is damaged and if that sex cell is one of the pair that goes into the production of a fertilized ovum, it will give rise to an offspring with various kinds of major or minor physical defects.

CONTROL MEASURES OF NUCLEAR HAZARDS

- Disposition of laboratory generated nuclear waste in safe and scientific manner.
- Nuclear power plants should be located only after careful considerations for potential tectonic activity and other conditions
- Occupational exposure should be protected against
- Leakage of radioactive elements from nuclear reactors, careless use of the radioactive elements should be prevented
- Provisions for any accidental release of radioactive elements must be ensured
- Regular provision for monitoring of the presence of radioactive substances in the high risk areas

CHERNOBYL DISASTER

- Worst nuclear accident till date
- Occurred in 1986 in Ukraine
- Killed thirty people directly and damaged approximately \$7 billion of property (Wikipedia, 2022)
- Study published by WHO in 2005 estimates that there may eventually be upto 4000 additional cancer deaths related to the accident among those exposed to significant radiation levels.
- Other studies have estimated as many as over a million cancer deaths from Chernobyl though the estimates of eventual cancer deaths are highly contested.

CHERNOBYL DISASTER

- Approximately 350,000 people were forcibly resettled away from these areas soon after the accident.
- Around 10,800 square miles were contaminated.

IMPACT OF FOSSIL FUEL

- Fossil fuels are the non renewable natural resources which were formed as a result of natural process of decomposition of organic materials, buried beneath layers of sediment and rock and has taken millions of years to become carbon-rich deposits (Nunez, 2019). Crude oil, coal and natural gas are the examples.
- The combustion of fossil fuel in various sector has major impact on environment.
- The use of coal, oil and natural gas from the stages of its extraction to transportation, refining and burning have various climate, environmental and health cost that are generally not reflected in their market prices. These costs are called externalities (EESI, 2022)

IMPACT OF FOSSIL FUEL

- Some of the impacts of the fossil fuel includes
 - Ocean acidification
 - Air pollution
 - Water pollution
 - Health issues
 - Extreme weather
 - Sea level rise
 - Plastic pollution
 - Oil spills

IMPACT OF FOSSIL FUEL

- Climate externalities
- As the fossil fuels are used in various processes by combustion, they release greenhouse gas such as carbon dioxide which contribute to the green house effect and hence are primary cause of climate change.
- The majority of the greenhouse gas emission is caused by the fossil fuels
- The climate externalities of fossil fuels includes
 - Ocean acidification
 - Extreme weather
 - Sea level rise

IMPACT OF FOSSIL FUEL

- Ocean acidification
- The carbon dioxide emitted from the combustion of the fossil fuels is absorbed by the ocean which changes its ph value. This impacts the marine organism. According to Environment and Energy Study Institute, over the last 150 years, the ocean acidity has increased by 30 percent which has directly posed as threat to coral reefs, fishing, tourism and the economy.
- The increased acidity of ocean also causes difficulty for the marine organisms to build shells and coral skeletons.

IMPACT OF FOSSIL FUEL

- Extreme weather
- According to National Oceanic and Atmospheric Administration, US, climate change which is caused by the burning of fossil fuels, has been the reason of frequent and severe extreme weather events that lead to disasters which has resulted in loss of wealth.
- In US, the extreme weather events includes wildfires, hurricanes, wind storms, flooding and droughts

IMPACT OF FOSSIL FUEL

- Sea level rise
- With the increase in global temperature, as a result of the global warming caused by the emission of greenhouse gases from the burning of the fossil fuels, the oceanic and atmospheric warming has taken place.

IMPACT OF FOSSIL FUEL

- Environmental externalities
 - Air pollution
 - Water pollution
 - Plastic pollution

IMPACT OF FOSSIL FUEL

- Air pollution
- The combustion of fossil fuels results in the emission of sulfur dioxide, nitrogen oxides, particulate matter, carbon monoxide, and mercury.
- All of these are hazardous air pollutants which have significant effect of environment as well as human health.
- The air pollution from fossil fuels can result in acid rain, damage to crops and forests and also harm wildlife.

IMPACT OF FOSSIL FUEL

- Water pollution
- Fossil fuel can cause water pollution or impact water resources in numerous ways. Water pollution is caused when toxic chemical contaminate a either river, lake, ocean or any body of water, which results in degrading the water quality and makes it dangerous to humans or the environment.
- One of the way by which fossil fuel can cause water pollution is by oil spills. In many cases around the world there has been numerous accidents where millions of gallons of oil has been spilled in to oceans.
- This has resulted in the death of thousands of seabirds, otters, seals and even whales (History, 2018)

IMPACT OF FOSSIL FUEL

- Water pollution
- Fracking fluids also causes water pollution. Fracking well is used during the extraction of fossil fuels to facilitate the flow of the natural gas or petroleum. In the fracking well, high pressure fracking fluid, primarily water is injected into a wellbore to create cracks in the deep rock formations
- The resulting waster water from the process contains substances as arsenic, lead, chlorine and mercury which can contaminate drinking water as well as ground water (EESI, 2022)

IMPACT OF FOSSIL FUEL

- Plastic Pollution
- Majority (almost 99%) of plastics produced globally are made from fossil fuels (EESI, 2022).
- The annual global plastic waste are around 300 million tons, out of which 14 million tons end up in ocean killing various organisms and hence impacting the food chain. Also plastic causes the release of greenhouse gas in atmosphere. In US, it was predicted that the greenhouse emission from plastic would surpass the emission from coal fired plants by 2030.

IMPACT OF FOSSIL FUEL

- Oil spills
- Fossil fuel extraction, transportation and refining can lead to oil spills that can impact the communities as well as wildlife.
- They can result in destruction of habitat and erosion of shorelines.
- One of the largest oil spill occurred in 2010, the BP Deepwater Horizon spill released 134 million gallons of oil into gulf of Mexico killing 11 people and countless birds, turtles, fish, marine mammals and plants (EESI, 2022)

IMPACT OF FOSSIL FUEL

- Health externalities
- Air pollution resulting from the combustion of fossil fuels can cause asthma, cancer, heart disease and premature death as well.
- In US, 350,000 premature deaths in 2018 were attributed to fossil fuel related pollution.
- The ultra fine particles and aromatic hydrocarbon release from the combustion of additive found in gasoline can cause cancer.

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