**SAM-BOMS FORTUNE CHIMGOZIRIM**

**16/ENG07/033**

**PETROLEUM ENGINEERING**

**CHE 574**

## 1A. FORMS OF ENERGY

Energy exists in many different forms. Examples of these are: light energy, heat energy, mechanical energy, gravitational energy, electrical energy, sound energy, chemical energy, nuclear or atomic energy and so on. Each form can be converted or changed into the other forms.

Although there are many specific types of energy, the two major forms are Kinetic Energy and Potential Energy.

- **KINETIC ENERGY** is the energy in moving objects or mass. Examples include mechanical energy, electrical energy etc.

  This is energy possessed by an object in motion. The earth revolving around the sun, you walking down the street, and molecules moving in space all have kinetic energy.

  Kinetic energy is directly proportional to the mass of the object and to the square of its velocity:

  ***K.E. = 1/2 m $v^2$.***

  If the mass has units of kilograms and the velocity of meters per second, the kinetic energy has units of kilograms-meters squared per second squared. Kinetic energy is usually measured in units of Joules (J); one Joule is equal to 1 kg $m^2$ / $s^2$.

- **POTENTIAL ENERGY** is any form of energy that has stored potential that can be put to future use. Examples include nuclear energy, chemical energy, etc.

  This is energy an object has because of its position relative to some other object. When you stand at the top of a stairwell you have more potential energy than when you are at the bottom, because the earth can pull you down through the force of gravity, doing work in the process. When you are holding two magnets apart they have more potential energy than when they are close together. If you let them go, they will move toward each other, doing work in the process.

  The formula for potential energy depends on the force acting on the two objects. For the gravitational force the formula is

  ***P.E. = mgh***,

where m is the mass in kilograms, g is the acceleration due to gravity (9.8 m / $s^2$ at the surface of the earth) and h is the height in meters. Notice that gravitational potential energy has the same units as kinetic energy, kg $m^2$ / $s^2$. In fact, *all* energy has the same units, kg $m^2$ / $s^2$, and is measured using the unit Joule (J).

## OTHER FORMS OF ENERGY

## CHEMICAL ENERGY

Chemical energy is energy stored in the bonds of chemical compounds (atoms and molecules). Chemical energy is released in a chemical reaction, often in the form of heat. For example, we use the chemical energy in fuels like wood, coal by burning them. This type of energy is often represented in the form of the Rydberg constant, which is given as:

**R∞ = (Me × E4) ÷ 8eo2H3C**

**R∞ = 1.097 × 107 × $m^{-1}$**

'Me' is the mass at zero motion, 'E' is the charge, 'eo' is the space permittivity, 'H' is the Planck constant, and 'C' is the light speed.

## ELECTRICAL ENERGY

Electrical energy is the energy carried by moving electrons in an electric conductor. It is one of the most common and useful forms of energy. Example – Lightening. Other forms of energy are also converted to electrical energy. For example, power plants convert chemical energy stored in fuels like coal into electricity through various changes in its form.

The mathematical expression for electrical energy in a conducting circuit is:

**E(e) = P×t = V×I×t**

**MECHANICAL ENERGY**

Mechanical energy is the energy a substance or system has because of its motion. For example, machines use mechanical energy to do work. This is a hypothetical scenario, and in reality, forces like friction act on all bodies, though their values are very less. Thus, this energy can be simply represented as:

**Me = Ep + K**

Where, 'Ep' is the total potential energy, and 'K' is the kinetic energy. Numerous modern devices convert other forms into mechanical energy and vice-versa, like thermal power plants (heat to Me), electric generators (Me to electricity), and turbine (Kinetic energy to Me).

**THERMAL ENERGY**

Thermal energy is the energy a substance or system has related to its temperature, i.e., the energy of moving or vibrating molecules. For example, we use the solar radiation to cook food.

Thermal energy is the energy generated from heat. This heat is produced by the movement of small particles within an object. The faster the particles move, more the heat is generated.

Thermal energy is responsible for the temperature of the system and a part of total energy of the system which is the sum of potential energy and kinetic energy.

The thermal energy is usually expressed by Q. It is directly proportional to the mass of the substance, temperature difference and the specific heat.

The SI unit of thermal energy is Joules(J).

The thermal energy formula is given by

$$Q = mc\Delta T$$

Where

***Q*** = thermal energy,

***m*** = mass of the given substance,

***c*** = specific heat, and

***ΔT*** = temperature difference.

## NUCLEAR ENERGY

Nuclear energy is the energy that is trapped inside each atom. Nuclear energy can be produced either by the fusion (combining atoms) or fission (splitting of atoms) process. The fission process is the widely used method.

Uranium is the key raw material. Uranium is mined from many places around the world. It is processed (to get enriched uranium, i.e. the radioactive isotope) into tiny pellets. These pellets are loaded into long rods that are put into the power plant's reactor. Inside the reactor of an atomic power plant, uranium atoms are split apart in controlled chain reaction. Other fissile material includes plutonium and thorium.

In a chain reaction, particles released by the splitting of the atom strike other uranium atoms and split them. The particles released by this further split other atoms in a chain process. In nuclear power plants, control rods are used to keep the splitting regulated, so that it does not occur too fast. These are called moderators.

The chain reaction gives off heat energy. This heat energy is used to boil heavy water in the core of the reactor. So, instead of burning a fuel, nuclear power plants use the energy released by the chain reaction to change the energy of atoms into heat energy. The heavy water from around the nuclear core is sent to another section of the power plant. Here it heats another set of pipes filled with water to make steam. The steam in this second set of pipes rotates a turbine to generate electricity.

## GRAVITATIONAL ENERGY

Gravitational energy is that energy held by an object in a gravitational field. Examples include water flowing down a waterfall. Consider an object of mass m, being lifted through a height h, against the force of gravity as shown below. The object is lifted vertically by a pulley and rope, so the force due to lifting the box and the force due to gravity, Fg, are parallel. If g is the magnitude of the gravitational acceleration, we can find the work done by the force on the weight by multiplying the magnitude of the force of gravity, Fg, times the vertical distance, h, it has moved through. This assumes the gravitational acceleration is constant over the height h.

Gravitational potential energy is expressed as: $\mathbf{U_g = F_g \cdot h}$

$$\mathbf{= m \cdot g \cdot h}$$

**B. SUSTAINABLE ENERGY (RENEWABLE ENERGY)**

Sustainable energy is the practice of using energy in a way that "meets the needs of the present without compromising the ability of future generations to meet their own needs. Renewable energy is energy which is generated from natural sources i.e. sun, wind, rain, tides and can be generated again and again as and when required. They are available in plenty and by far most the cleanest sources of energy available on this planet. For e.g., Energy that we receive from the sun can be used to generate electricity. Similarly, energy from wind, geothermal, biomass from plants, tides can be used this form of energy to another form.

- Solar, wind, and hydro are renewable and carbon-free, and effectively inexhaustible.
- Bioenergy is renewable and carbon-neutral. It emits $CO_2$, but no more $CO_2$ than was originally pulled from the atmosphere. Even though it is considered renewable, it is possible to use bioenergy unsustainably by harvesting it more quickly than it can be replenished.

**NON-SUSTAINABLE ENERGY (NON-RENEWABLE ENERGY)**

Renewable energy is energy which is taken from the sources that are available on the earth in limited quantity and will vanish fifty-sixty years from now. Non-renewable sources are not environmentally friendly and can have serious effect on our health.

They are called non-renewable because they can be re-generated within a short span of time Non-renewable sources exist in the form of fossil fuels, natural gas oil and coal.

Non-renewables

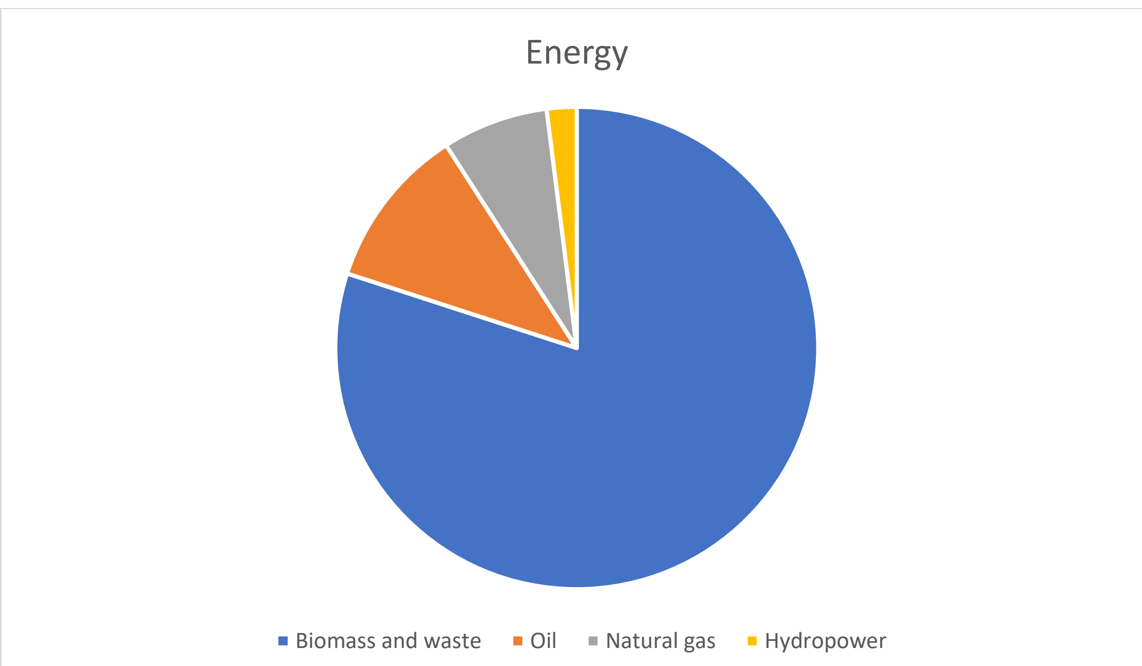
- Coal, oil, and natural gas are fossil fuels. Even though they all get their energy from the sun, none of them are renewable. They all emit $CO_2$ and other emissions when burned.
- Nuclear is also non-renewable, but not a fossil fuel. It is carbon-free, but causes radioactive waste.
- Most importantly, for all intents and purposes, whatever coal, oil, natural gas, and nuclear exists today is all that we will ever have.

**2. THE TYPICAL ENERGY RESOURCE MIX FOR SUSTAINABLE ENERGY DEVELOPMENT**

According to the statistics from the International Energy Agency (IEA), total Nigerian primary energy supply was 118,325 Kilotonne of Oil Equivalent (ktoe) excluding electricity trade in 2011. As depicted in the figure below, biomass and waste dominated with 82.2%. Renewable energy sources only accounted for a small share of the energy supply. For instance hydropower only accounted for 0.4%. Wind and solar are also utilized, but at an insignificant level at present.

Also according to the chart below, Biomass is the dominant energy source in Nigeria due to the huge reliance on the energy source for cooking and heating purposes by majority of the Nigerian people.

In my own view, wind turbines for water pumping should be installed in some parts of the country for testing and subsequent use in the country. Hydropower projects should be taken up mainly for electrification. Nigeria as a country is a mix of citizens with low-to-middle and also upper middle to high-incomes. Continued economic development in Nigeria will occur through industrialization as investment in renewables increases and dominance of fossil fuels within the energy mix declines.




Energy supply

**ASSIGNMENT 3**

1. The average ambient temperature between Monday 17th and Friday 21st February 2020 and the average daily thermal energy from the sun reaching land

Sam-Boms Fortune. C.
16/ENG07/033
Petroleum Engineering
CHE 574

Assignment 3

(1)

| Day | Average Ambient Temperature | |
|---|---|---|
| | Day | Night |
| Monday 17/02/2020 | 35°C | 25°C |
| Tuesday 18/02/2020 | 36°C | 25°C |
| Wednesday 19/02/2020 | 35°C | 25°C |
| Thursday 20/02/2020 | 36°C | 25°C |
| Friday 21/02/2020 | 37°C | 25°C |

The average daily thermal energy from the sun reaching land.

Solution

$P = \Delta Q / \Delta t$

$$P = \frac{K \cdot A \cdot \Delta T}{L}$$

$$Q = P \times \Delta t$$

where $P$ = rate of energy transfer (in Watts)

$Q$ = energy transfer (J)

$\Delta t$ = change in time (s)

$K$ = thermal conductivity

$A$ = area

$L$ = thickness of material

$\Delta T$ = difference in temperature

Assumptions

$K_{air}$ at (35°c - 37°c) = 1·4

$A$ = area of land in ABUAD = 1,300,000m²

$L$ = average thickness = 0·991m

For Monday, $\Delta T = 35 - 25 = 10°C$

Tuesday, $\Delta T = 36 - 25 = 11°C$

Wednesday, $\Delta T = 35 - 25 = 10°C$

Thursday, $\Delta T = 36 - 25 = 11°C$

Friday, $\Delta T = 37 - 25 = 12°C$.

Monday $P = \frac{1.4 \times 1300000 \times 10}{0.991}$

$= 18365287.59W$

$Q = P \times \Delta t$

$\Delta t = 6\text{ hrs} = 6 \times 3600$

$= 21600S$

$Q = 18365287.59 \times 21600$

$Q = 396700MJ$

Tuesday $P = \frac{1 \cdot 4 \times 1300000 \times 11}{0 \cdot 991}$

$= 20201816 \cdot 35\, W$

$Q = 20201816 \cdot 35 \times 21600$

$Q = 436.359\, MJ$

Wednesday $\cdot P = \frac{1 \cdot 4 \times 1300000 \times 10}{0 \cdot 991}$

$= 18365287 \cdot 59\, W$

$Q = 18365287 \cdot 59 \times 21600$

$Q = 396700\, MJ$

Thursday $P = \frac{1.4 \times 1300000 \times 11}{0.991}$

$= 20201816.35W$

$Q = 20201816.35 \times 21600$

$Q = 436359MJ$

Friday $P = \frac{1.4 \times 1300000 \times 12}{0.991}$

$= 22038345.11W$

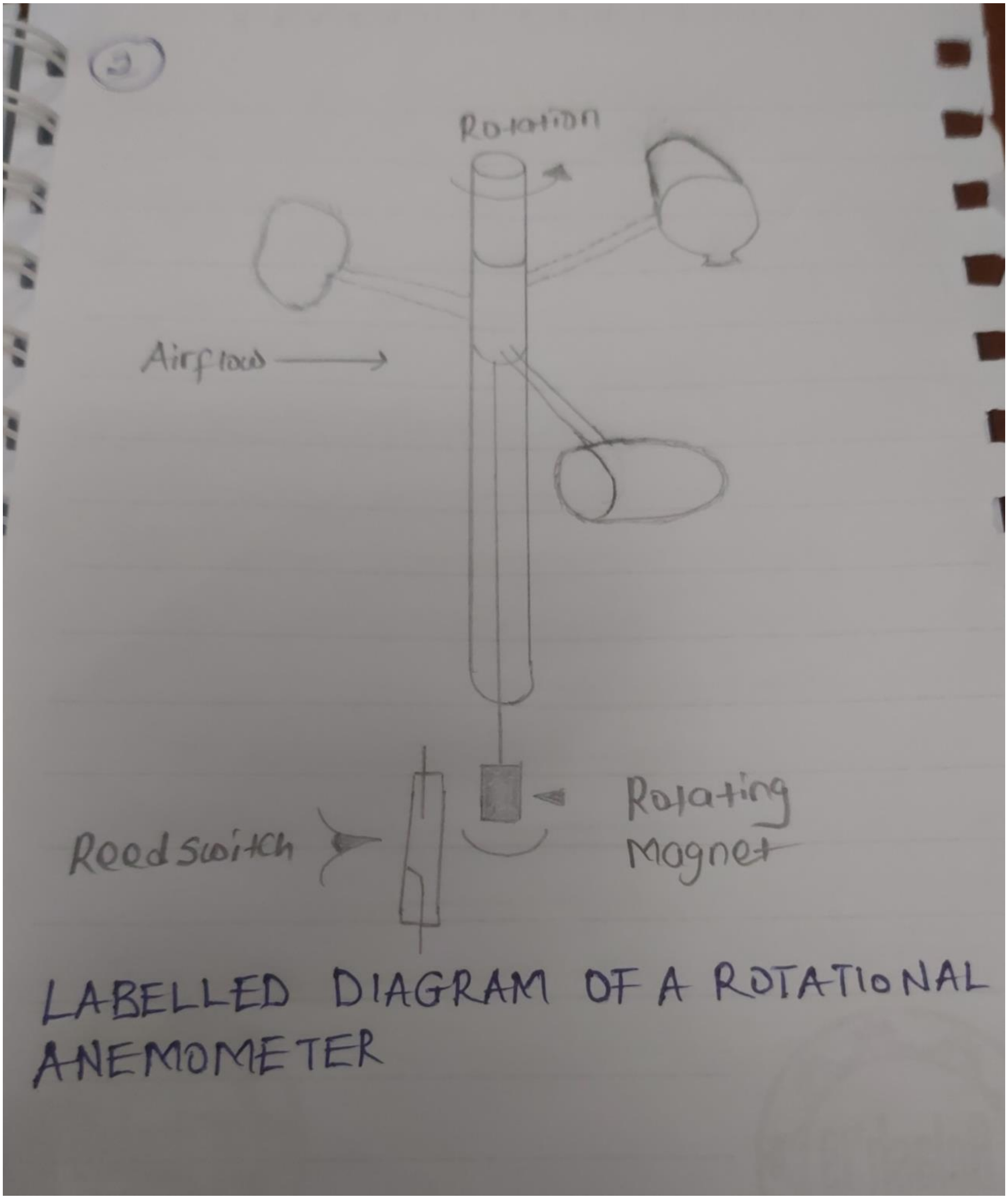
$Q = 22038345.11 \times 21600$

$Q = 476028MJ$

$$\text{Average} = \frac{396700 + 436359 + 396700 + 436359 + 476028}{5}$$

∴ The avergge daily thermal energy from the Sun reaching ABUAD is 428429 MJ

2. Diagram of an anemometer



**ASSIGNMENT 4**

**How much energy is being produced from the dams in Nigeria?**

Nigeria is bestowed with large rivers and natural falls. The main water resources that provide rich hydropower potential are the Niger and Benue rivers as well as Lake Chad basin. With an estimated 1,800$m^3$ per capita per year of renewable water resources available, this is not a water poor country, yet it is ranked as an economically water scarce country due to a lack of investment and management to meet demand.

The total installed capacity is 12,522 MW, not including off-grid generation, of which 2,062 MW is hydropower. The total exploitable potential of hydropower is estimated at over 14,120 MW, amounting to more than 50,800 GWh of electricity annually. The roughly 85 percent of hydropower yet to be developed therefore offers solutions to address existing power shortages.

Nigeria's 2015 National Renewable Energy and Energy Efficiency Policy set out the government's priority to "fully harness the hydropower potential in the country, promoting private sector and indigenous participation in hydropower development". This involves extending electricity to rural and remote areas and pursuing hydropower production in an environmentally friendly and sustainable manner. These goals are aligned with the Sustainable Energy for All (SE4ALL) initiative, of which Nigeria was one of the first countries in the world to embrace. Towards this end, in 2016 a Memorandum of Understanding was signed with Power China International Group for the overall planning of Nigerian irrigation and hydropower resources.

Nigeria has envisioned growing its economy at a rate of 11 to 13 percent in order to be among the 20 largest economies in the world by 2020. To meet this ambitious growth target, the government has hydropower development targets of 6,156 MW for 2020 and 12,801 MW for 2030. It has a target to reach 30 percent renewable energy by 2030 as well as to have 70 percent of the energy consumed produced on-grid, compared to the current 74 per cent self-generated. The Energy Commission of Nigeria aims to reach 20,000 MW of grid capacity by 2022.

Since 2005, a privatization programme has been underway to boost electricity demand and supply, leading to the Transmission System Provider of Nigeria (TSP) being handed over to Manitoba Hydro International of Canada under a three to five year management agreement.

The African Development Bank has been investing USD 100 million in hydropower plant maintenance, repairs and investment. As a result, in 2017 the proportion of hydropower on the grid went up to 26 percent from 15 percent in 2015. Under this programme, the 760 MW Kainji and 578 MW Jebba projects were rehabilitated.

The Ministry of Power and Ministry of Water Resources have established a partnership for the development of several existing hydropower plants, including the 30 MW Gurara 1, the 10 MW Tiga, 10 MW Oyan, the 8 MW Challawa and the 6 MW Ikere plants. In addition, the 700 MW Zungeru and the 40 MW Kashimbila hydropower plants are currently under construction.

A consortium from China constructing the 3,050 MW Mambilla plant began preparations after an agreement between the Minister of Power, Works and Housing of Nigeria and the consortium was signed last November. Nigeria's so-called 'Three Gorges Project' will include four RCC gravity dams (Nya dam, Sumsum dam, Nghu dam and Api weir) with over 700 km of transmission lines

**Compare with the energy produced from crude**

Oil is the largest source of energy in the United States, providing close to 40 percent of all of the nation's entire power needs. Though most oil is used for transportation or home heating purposes, a small percentage is still used as a fuel for electricity generating plants.

While oil continues to decline in popularity as an electricity fuel, in places such as New York, oil still comprises about 8 percent of the state's electricity fuel mix.

Oil sits in deep underground reservoirs. Like other fossil fuels, this liquid is the end-product of millions of years of decomposition of organic materials. Since the ultimate amount of oil is finite -- and cannot be replenished once it is extracted and burned - it cannot be considered a renewable resource. Once extracted, oil can be refined into a number of fuel products -- gasoline, kerosene, liquefied petroleum gas (such as propane), distillates (diesel and jet fuels) and "residuals" that include industrial and electricity fuels.

**Three technologies are used to convert oil into electricity:**

- Conventional steam - Oil is burned to heat water to create steam to generate electricity.
- Combustion turbine - Oil is burned under pressure to produce hot exhaust gases which spin a turbine to generate electricity.
- Combined-cycle technology - Oil is first combusted in a combustion turbine, using the heated exhaust gases to generate electricity. After these exhaust gases are recovered, they heat water in a boiler, creating steam to drive a second turbine.

**What are the environmental impacts?**

Burning oil for electricity pollutes the air, water and land but some of the worst environmental woes associated with oil are linked to drilling, transporting and refining.

Burning oil to generate electricity produces significant air pollution in the forms of nitrogen oxides, and, depending on the sulfur content of the oil, sulfur dioxide and particulates. Carbon dioxide and methane (as well as other greenhouse gases), heavy metals such as mercury, and volatile organic compounds (which contribute to ground-level ozone) all can come out of the smoke stack of an oil-burning power plant.

The operation of oil-fired power plants also impacts water, land use and solid waste disposal. Similar to the operations of other conventional steam technologies, oil-fired conventional steam plants require large amounts of water for steam and cooling, and can negatively impact local water resources and aquatic habitats. Sludges and oil residues that are not consumed during combustion became a solid waste burden and contain toxic and hazardous wastes.

Drilling also produces a long list of air pollutants, toxic and hazardous materials, and emissions of hydrogen sulfide, a highly flammable and toxic gas. All of these emissions can impact the health and safety of workers and wildlife. Loss of huge stretches of wildlife habitat also occur during drilling. Refineries, too, spew pollution into the air, water and land (in the form of hazardous wastes). Oil transportation accidents can result in catastrophic damage killing thousands of fish, birds, other wildlife, plants and soil.