Environmental Sciences
(ESI101)

21 April 2022

An Overall Plan for Sustainable Living

Lester R. Brown's five recommendations for sustainable living are:

1. Eliminate poverty and stabilize the human population
2. Protect and restore Earth's resources
3. Provide adequate food for all people
4. Mitigate climate change
5. Design sustainable cities

1. Eliminate Poverty and Stabilize the Human Population

- The ultimate goal of economic development is to make it possible for humans throughout the world to enjoy long, healthy lives.
- A serious complication lies in the fact that the distribution of the world's resources is unequal.
- Raising the standard of living for poor countries requires the universal education of children and the elimination of illiteracy.

- Population growth rates are generally highest where poverty is most intense.
- If we pay consistent attention to overpopulation and devote the resources necessary to make family planning available for everyone, the human population will stabilize.

2. Protect and Restore Earth's Resources

- To build a sustainable society, we must preserve the natural systems that support us.
- The conservation of non-renewable resources, such as oil and minerals is important and their better alternatives should be explored.
- Renewable resources such as forests, soils, and fresh water must be used in ways that ensure their long-term productivity. Their capacity for renewal must be understood and respected.

3. Provide Adequate Food for All People

- Globally, more than 800 million people lack access to the food needed for healthy, productive lives.
- Children are particularly susceptible to food deficiencies because their brains and bodies cannot develop properly without adequate nutrition.
- Most malnourished people live in rural areas of the poorest developing nations.
- One way to increase the productivity of agricultural land is through multi-cropping, or growing more than one crop per year.

- However, care must be taken to prevent a decline in soil fertility from such intensive use.
- Many strategies exist to retard the loss of topsoil, conserve water, conserve energy, and reduce the use of agricultural chemicals.
- For example, in **conservation tillage**, residues from previous crops are left in the soil, partially covering it and helping to hold topsoil in place.

4. Mitigate Climate Change

- A widely discussed human effect on the environment is climate change caused by the enhanced greenhouse effect.
- The most important greenhouse gas, CO_2, is produced when we burn fossil fuels-coal, oil, and natural gas.
- Stabilizing the climate requires a comprehensive energy plan to include phasing out fossil fuels in favor of renewable energy (such as solar and wind power), increasing energy conservation, and improving energy efficiency.

- Many national and local governments as well as corporations, colleges and universities, and environmentally aware individuals are setting goals to cut carbon emissions.
- Other nations, however, have not recognized the urgency of the global climate problem.
- We need a global consensus to address climate change.

5. Design Sustainable Cities

- Almost 50 percent of the world's population now lives in cities, and the percentage continues to grow.
- City planners around the world are trying a variety of approaches to make cities more livable.
- Many cities are developing urban transportation systems to reduce the use of cars and the problems associated with them, such as congested roads, large areas devoted to parking, and air pollution.

- Water scarcity is a major issue for many cities of the world. Some city planners think that innovative approaches must be adopted where water resources are scarce.
- For example, recycle some of the wastewater after it has been treated.

Power Plant

- **A power plant** is an industrial facility for the generation of electric power.
- Most power plants use one or more generators that convert mechanical energy into electrical energy in order to supply power to the electrical grid for society's electrical needs.
- The exception is solar power plants, which use photovoltaic cells (instead of a turbine) to generate this electricity.

Examples of Power Plants

Coal Power Plant

Nuclear Power Plant

Wind Power Plant

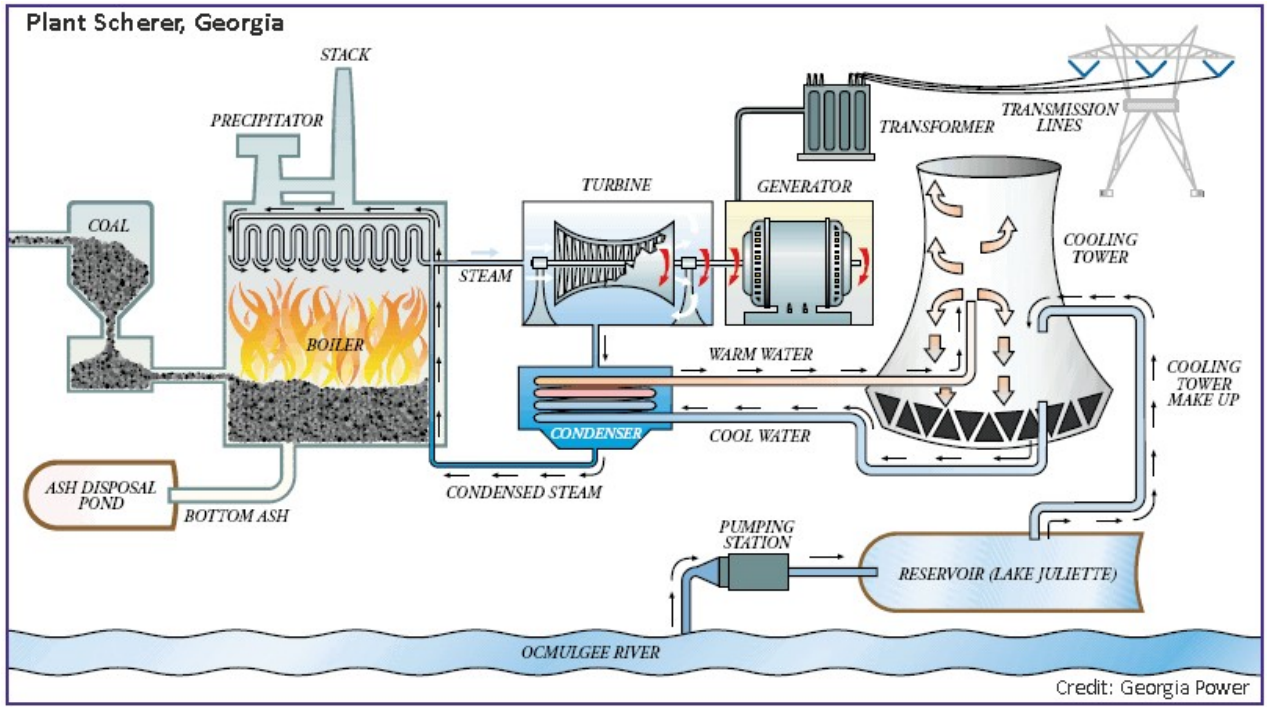
Hydroelectric Power Plant

Natural Gas Power Plant

Solar Power Plant

Coal Power Plant

A **coal-fired power station** or **coal power plant** is a thermal power station which burns coal to generate electricity.



- Coal-fired power stations generate over one third of the world's electricity but cause hundreds of thousands of early deaths each year, **mainly from air pollution**.
- In coal power plants, the coal is usually pulverized and then burned in a pulverized coal-fired boiler.
- The furnace heat converts boiler water to steam, which is then used to spin turbines that turn generators.
- Thus, **chemical energy stored in coal** is converted successively into thermal energy, mechanical energy and, finally, **electrical energy**.

Environmental Impacts of Coal Power Plants

Coal and Air Pollution

- The electrical energy from the coal power plants comes with tremendous cost because it is incredibly dirty.
- When coal burns, the chemical bonds holding its carbon atoms in place are broken, releasing energy.
- However, other chemical reactions also occur, many of which carry toxic airborne pollutants and heavy metals into the environment.
- **Air pollution** from coal-fired power plants is linked with asthma, cancer, heart and lung ailments, neurological problems, acid rain, global warming, and other severe environmental and public health impacts.

Coal power plant releases following pollutants:

Mercury: A toxic heavy metal that can damage the nervous, digestive, and immune systems, and is a serious threat to the child development.

Sulfur dioxide (SO_2): Produced when the sulfur in coal reacts with oxygen, SO_2 combines with other molecules in the atmosphere to form small acidic particulates that can penetrate human lungs.

It is linked with asthma, bronchitis, smog, and acid rain, which damages crops and other ecosystems, and acidifies lakes and streams.

Nitrogen oxides (NO_x): Nitrous oxides are visible as smog and irritate lung tissue, exacerbate asthma, and make people more susceptible to chronic respiratory diseases like pneumonia and influenza.

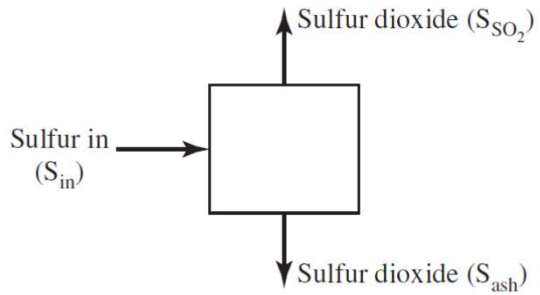
Particulate matter: It is the ashy grey substance in coal smoke and is linked with chronic bronchitis, aggravated asthma, cardiovascular effects like heart attacks, and premature death.

Other harmful pollutants emitted by the coal power plant include:

- **Lead, cadmium,** and other toxic heavy metals.
- **Carbon monoxide**, which causes headaches and places additional stress on people with heart disease.
- **Arsenic** It causes cancer in one out of 100 people who drink water containing 50 parts per billion.

Example An Illinois coal is burned at a rate of 1.00 kg per second. If the analysis of the coal reveals a sulfur content of 3.00 percent, what is the annual rate of emission of SO_2?

Solution: Using the mass balance approach, we begin by drawing a mass balance diagram:



The mass balance equation may be written as

$$S_{in} = S_{ash} + S_{SO_2}$$

S_{in} = 1.00 kg/s X 0.03 = 0.03 kg/s

In one year,

$\mathbf{S_{in}}$ = 0.03 kg/s ×86,400 s/d ×365 d/y

= 9.46 x 10^5 kg/y

Assumption: The sulfur in the ash is 5 percent of the input sulfur. Therefore,

$\mathbf{S_{ash}}$ = (0.05)(9.46 ×105 kg/y)

= 4.73 × 10^4 kg/y

The amount of sulfur available for conversion to SO_2:

$\boldsymbol{S_{SO_2}}$ **= $\mathbf{S_{in}}$ - $\mathbf{S_{ash}}$**

= 9.46 × 10^5 - 4.73 × 10^4

= 8.99 × 10^5 kg/y

The amount of sulfur dioxide formed is determined from the proportional weights of the oxidation reaction

$$\mathbf{S + O_2 \rightarrow SO_2}$$

GMW of SO_2 = 32× 1 + 16×2 = 64

where, GMW is the gram molecular weight of the pollutant.

The amount of sulfur dioxide formed is then 64/32 of the sulfur available for conversion:

$SO_2 = \frac{64}{32}$ $(8.99 \times 10^5$ kg/y)

= $\mathbf{1.80 \times 10^6}$ **kg/y**

Thank You