



# **Climate Change & Energy Production**



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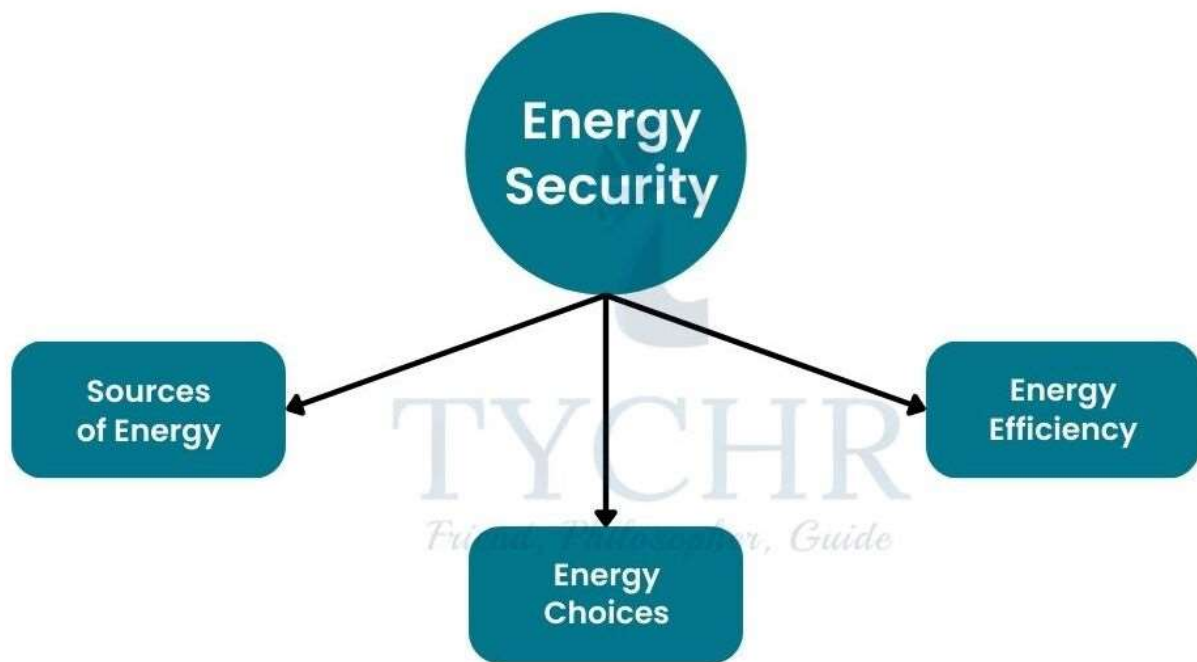
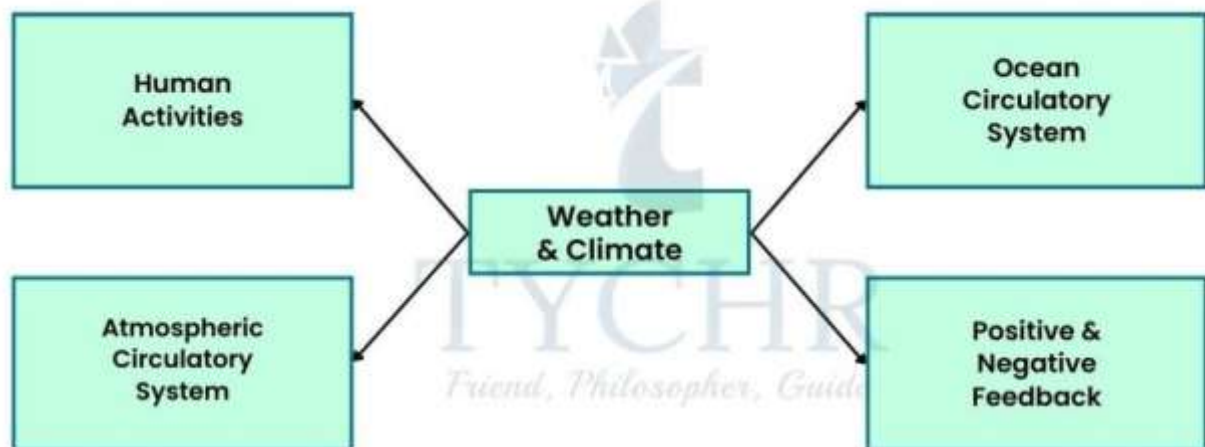


Figure 1 Understanding how sources of energy, energy efficiency and energy choices impact the energy security of a society of a country.



The Analysing how different factors may impact the weather and climate which enables us in understanding implications of global warming.

Figure 2 The Analysing how different factors may impact the weather and climate which enables us in understanding implications of global warming.

# 7.1 Energy Choices & Security

## 7.1.1 Range Of Energy Sources

Energy can be generated from both renewable and non-renewable sources. The majority of the world's fuel comes from non-renewable sources which is unlikely to change by 2030.

## 7.1.2 Advantages And Disadvantages Of Fossil Fuel Consumption:

### Advantages

- Efficient source of energy which can be used as fuel and also to generate electricity.
- Oil and Gas can be delivered over long distances through pipelines.
- Relatively cheap and abundant for the present generation of users. They account for 80% of the global energy consumption.
- Advanced technology such as combustion engines have enabled safe extraction. The technology to control pollution from these fuels to a certain level also exists.

### Disadvantages

- They are made from dead organisms and therefore contain high amounts of carbons which are released as carbon dioxide when they are burnt. They are the most important contributor to global warming.
- Use of fossil fuels is unsustainable as there is only a finite stock of this resource. They cannot be replenished to the rate at which they are extracted.
- They are difficult to extract and can often cause extensive environmental damage owing to oil spillages, burst pipelines, habitat clearance on the surface of coal mines, deeper oil rigs, position of rigs closer to the sea.

### 7.1.3 Advantages And Disadvantages Of Renewable Energy Sources:

#### Advantages

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- They do not release pollutants such as greenhouse gases or chemicals that contribute to acid rain.
- They require less overall maintenance than generators that use traditional fuel sources.
- With renewable energy, one can produce energy locally. The more renewable energy one is using for their needs, the less they'll rely on imported energy, contributing to energy independence on the whole.

#### Disadvantages

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- Fossil fuel resources are still economically cheaper to exploit and remain the more feasible option for many.
  - The technologies to harness renewable sources are not available on a large scale partly due to geographic limitations and local political issues.
  - Many of these resources aren't available 24/7, year-round. These technologies may be disrupted by unpredictable weather. Fossil fuels can be turned on or off at any time and are not sporadic.
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## 7.1.4 Characteristics Of Particular Renewable Energy

### Sources:

#### **Hydroelectric Power:**

Is generated when water contained in an artificially made reservoir (created by damming a river) can flow through a turbine under immense pressure.

The water turns the propellers which cause rotation in the turbine shaft, which generates electricity in the turbine's motor.

- Cost is relatively low, making it a competitive source of renewable electricity.
- The hydro station consumes no water, unlike coal or gas plants.
- Project produces no direct waste, and it has a lower output level of greenhouse gases than fossil fuel powered energy plants.
- Vast areas may be flooded.
- Dams may restrict the flow of sediment thereby affecting ecosystems or farming.
- They may lead to increased erosion rates downstream.
- The cost of building dams is high, and dams may eventually silt-up, rendering them unusable.

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#### **Tidal Power:**

It produces energy by using the ebbing or flooding tide to turn turbines which produce energy. The turbines generate power as the tide comes in and again as it goes out.

- Tides are more predictable than the wind and the sun.
  - Total availability of tidal power may be much higher than previously assumed and that economic and
  - Such installations may interfere with navigation and can have an impact on wildlife.
  - They are expensive to set up.
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environmental costs may be

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**Solar Energy:**

Solar panels are large flat panels made up of many individual solar cells.

- Even on cloudy days, clean power from renewable sources is available every day of the year.
  - Solar panels last for more than 30 years, necessitating almost no upkeep.
  - It is very expensive to turn solar energy into high-quality energy needed for manufacturing (compared to using fossil fuels).
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**Wind Power:**

Is produced by wind turbines driven by wind—the wind turns the rotor blades which rotate a metal shaft that transfers the rotational energy into a generator.

- It's very cost effective and virtually free. It is one of the lowest price renewable technologies available.
  - Wind turbines use only a fraction of the land which causes no trouble in work for the farmers.
  - If there is no wind, no energy is generated.
  - Thus, placement of the turbines is critical: they need to be in areas of consistent high wind.
- 

**Biofuel:**

Is produced by burning plant material to produce heat. The gas is recycled.

- Biofuels are produced from wheat, corn, soybeans and sugarcane which can be produced again and again on demand, so
  - Biofuel crops are often planted at the expense of natural ecosystems, where new land clearance to create space for the biofuel crop has destroyed
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they are sustainable.

the natural ecosystem.

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**Wastes:**

is the primary treatment of waste into energy in the form of heat, electricity, or both, or the process of turning waste into a fuel source. It is a method of regaining energy.

- Resource used is readily available and its use does not deplete natural capital.
- A useful purpose is being served by waste that would otherwise have to be disposed of in some other way.

- Burning adds to global warming gases in the atmosphere (although it could be argued that decomposition of the waste would do this in any case).

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**Geothermal Energy:**

Mile-deep wells are dug into underground reservoirs to access the steam and hot water, which are used to drive turbines connected to electricity generators.

- This method of heat transfer is low impact and does not release any form of pollution.
- One can achieve savings of up to 80% over conventional energy usage.
- Use 25% to 50% less electricity than conventional systems for heating or cooling.

- High initial cost for individual households.
- Hard to be implemented for homeowners as a piece of land next to the house is required.
- Building geothermal energy plants can affect seismic stability to a large extent.

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**Nuclear Power:**

The process of using nuclear reactions to

- It does not emit carbon dioxide and so does

- Nuclear power plants produce radioactive
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produce heat and release nuclear energy to produce electricity in a nuclear power plant is known as nuclear power. Nuclear fission, nuclear decay, and nuclear fusion all have the potential to produce power from nuclear material.

not contribute to global warming.

- The technology is readily available.
- A large amount of electrical energy is generated in a single plant.
- It is very efficient, especially in comparison to fossil fuels: 1 kg uranium contains 20 000 times more energy than 1 kg coal.

wastes. When people are exposed to such radiation, the DNA in their cells can be damaged by mutation.

- How best to dispose of nuclear waste is still an unresolved problem.
- It is impossible to build a plant there will always be a small probability of failure (e.g. the Chernobyl disaster).
- with 100 percent reliability, and

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### 7.1.5 Energy Security

- Is a country's ability to secure all its energy needs whereas energy insecurity refers to a lack of security over energy sources.
- Energy insecurity can cause and be the result of geopolitical tension.
- For most consumers, a diversified energy mix is the best policy, rather than depending on a single supplier.

### 7.1.6 Factors Affecting The Choice Of Energy Generation

- The availability and reliability of supply
- Sustainability of supply



- Scientific and technological development
- Political & Economic factors
- Cultural attitudes
- Environmental factors

### 7.1.7 Ways To Achieve Greater Efficiency Through Energy Conservation

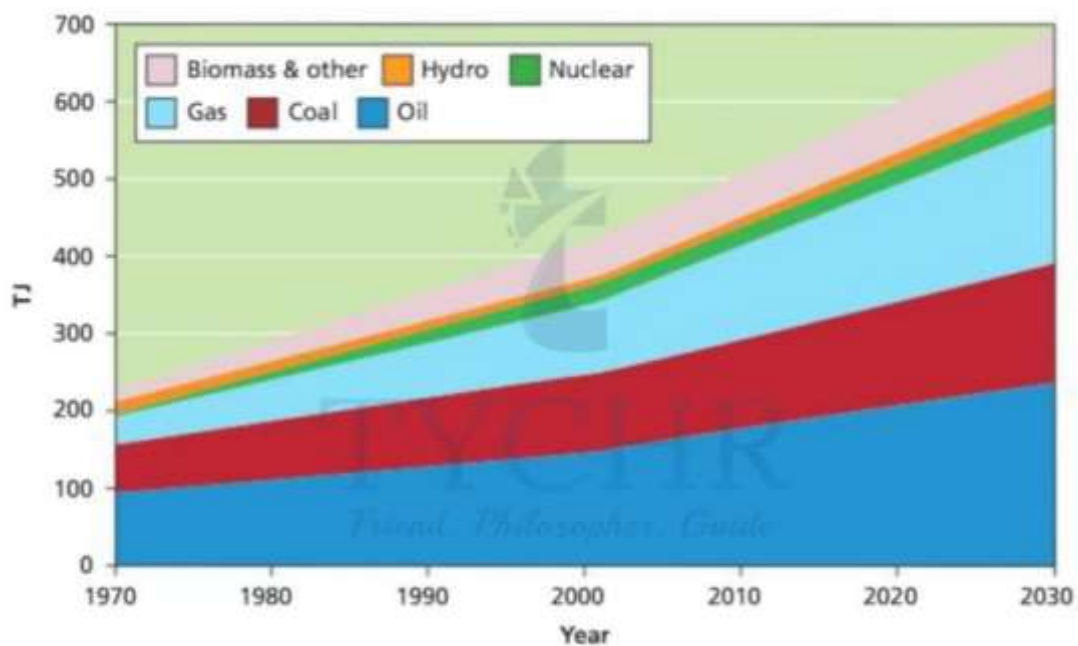


Figure 3 1 TJ = 1000 gigajoules. The world's energy sources, 1970–2030

- Smart meters
- Enhanced environmental standards.
- Reduced energy use and emissions of carbon dioxide
- Reduction of waste
- Improved thermal efficiency of walls and windows
- Reduction of heat loss between inner and outer walls
- Energy-efficient domestic appliances
- Improved daylighting by larger windows

## Sustainability

The use of resources at such a rate that allows natural regeneration and/ or minimises damage to the environment.

### Why Save?

Energy saving is the quickest, most cost- effective way of reducing greenhouse gas emissions. It also reduces the use of scarce resources.

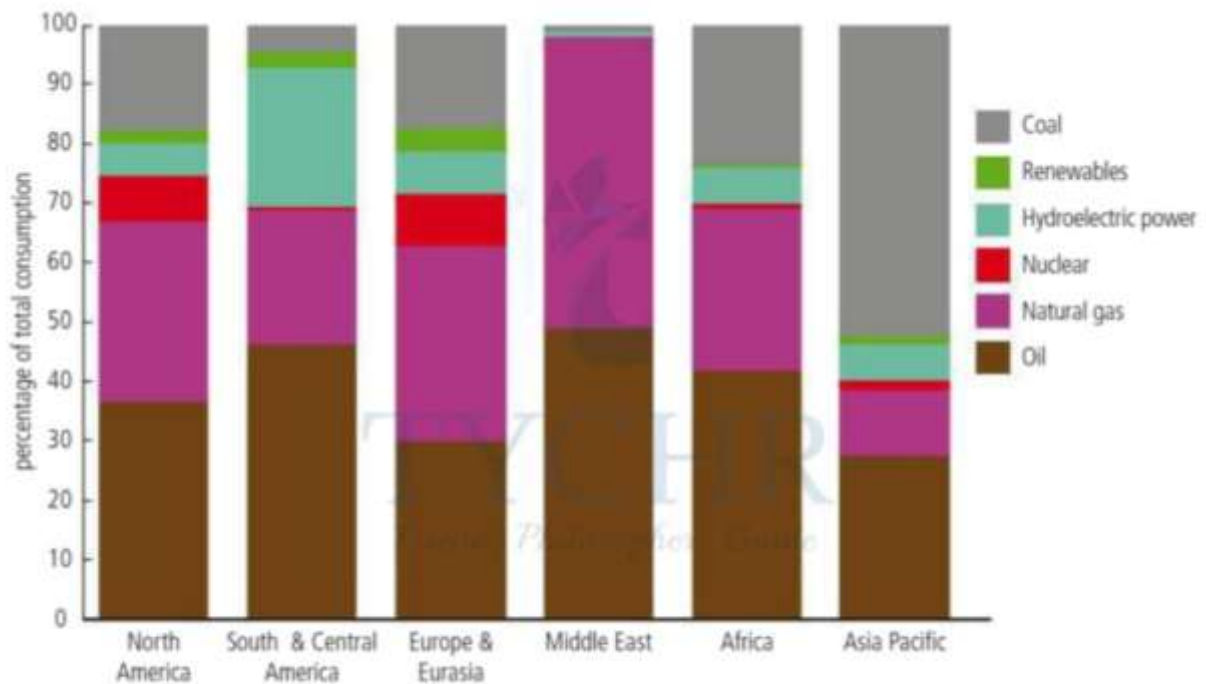


Figure 4 Relative contributions of different sources of commercial energy by world region.

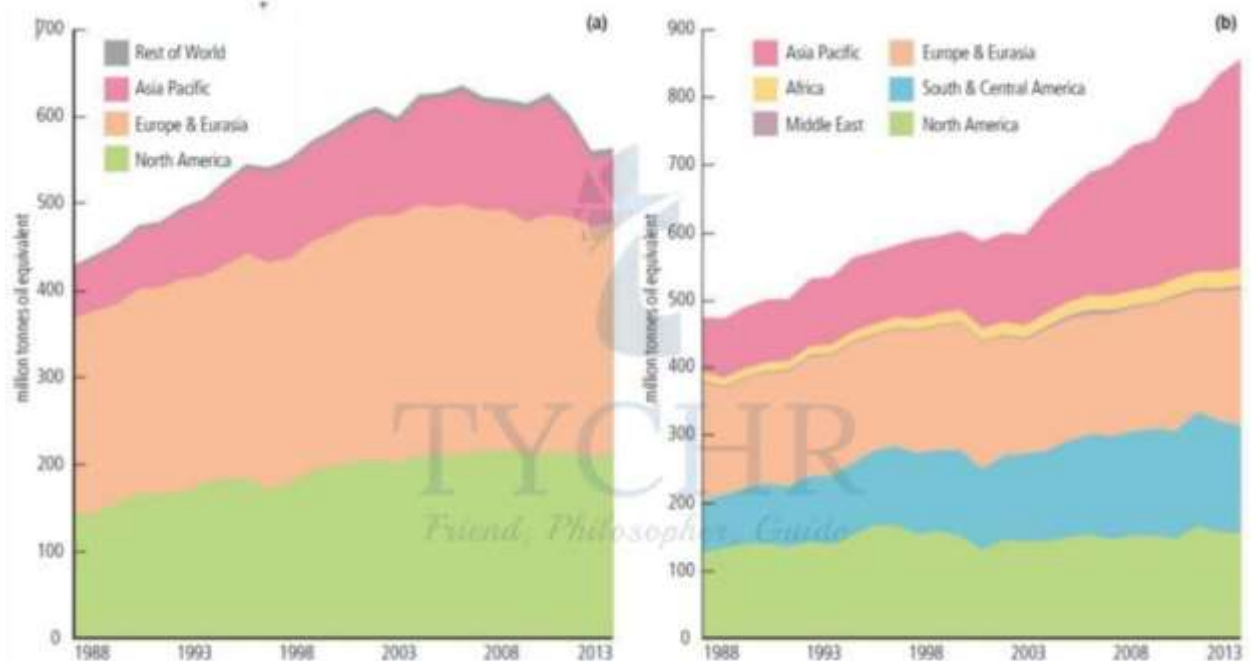


Figure 5 Nuclear (a) Nuclear energy consumption and (b) hydroenergy consumption by region.

## 7.2 Climate Change, Causes And Impact

### 7.2.2 Ocean Circulatory Systems

Warm ocean currents move water away from the equator, whereas cold ocean currents move water away from cold regions towards the equator. The major currents transport enormous bodies of water over significant distances.

1. **Specific Heat Capacity-** Specific heat capacity is the amount of energy it takes to raise the temperature of 1 g of substance by 1 °C. It takes more energy to heat up water than it does to heat land. However, it takes longer for water to lose heat. Hence, land is hotter than the sea by day, but colder than the sea by night.
2. **Surface Ocean Currents-** Surface ocean currents are caused by the influence of prevailing winds blowing across the sea. The dominant pattern of surface ocean currents (known as gyres) is roughly circular. The pattern of these currents is clockwise in the northern

hemisphere and anti-clockwise in the southern hemisphere. The effect of surface ocean currents on temperatures depends on whether the current is cold or warm.

### 7.2.3 Atmospheric Circulatory Systems

- **Air Motion-** The basic cause of air motion is the unequal heating of Earth's surface. Variable heating of the Earth causes variations in pressure and this in turn sets the air in motion.
- **Pressure Variations-** Pressure is measured in millibars (mb) and is represented on maps by isobars, lines of equal pressure. The trend of pressure change is of more importance than the actual reading itself. Decline in pressure indicates wetter weather and rising pressure indicates drier weather.
- **General Circulation Models-** In 1735, George Hadley described the operation of the Hadley cell to explain atmospheric circulation. He suggested that direct heating of low latitudes forces air to rise by convection, the air then travels towards the poles but sinks at the subtropical anticyclone (high pressure belt). Hadley suggested that similar cells might exist in mid latitudes and high latitudes.

## 7.2.4 Greenhouse Gases And Human Activities

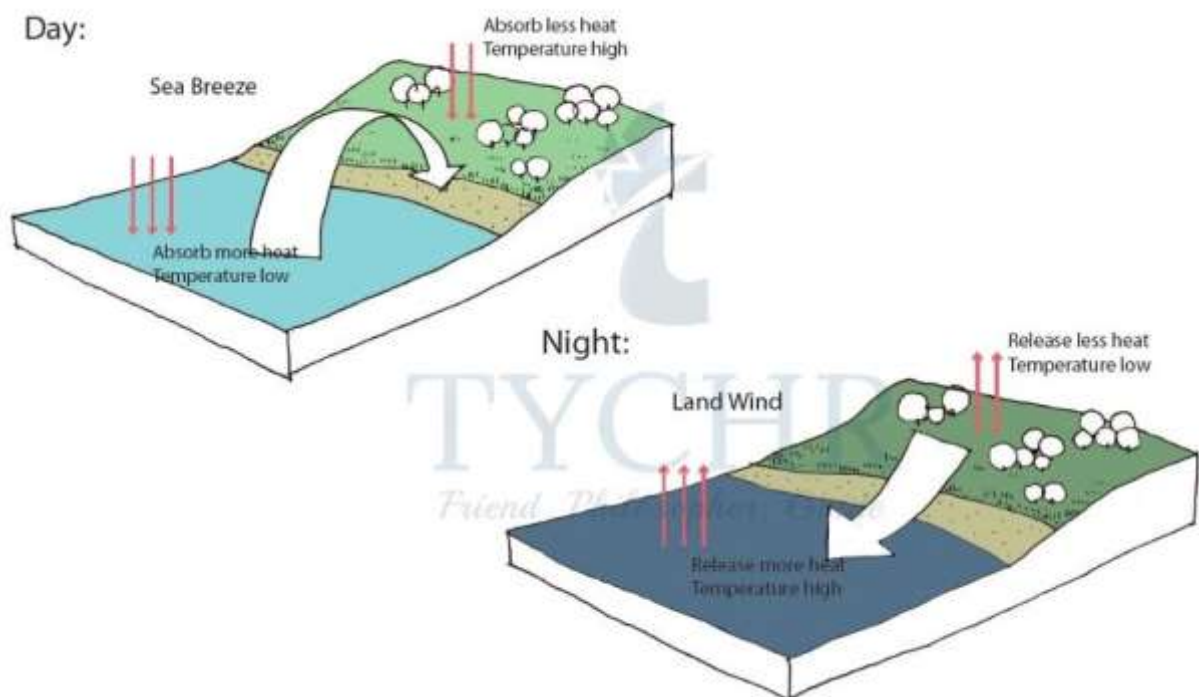


Figure 6 The effect of the sea on temperatures in coastal margins.

The quantity of greenhouse gases emitted by any individual country depends on its economy, level of development, and societal expectations. Transport, a lifestyle with expectations of air conditioning, and other high-energy demands at home and work all lead to the high fuel economy seen there. Over the past 100 years, atmospheric concentrations of these gases have risen dramatically.

*Friend, Philosopher, Guide*



### Characteristics of Greenhouse Gases

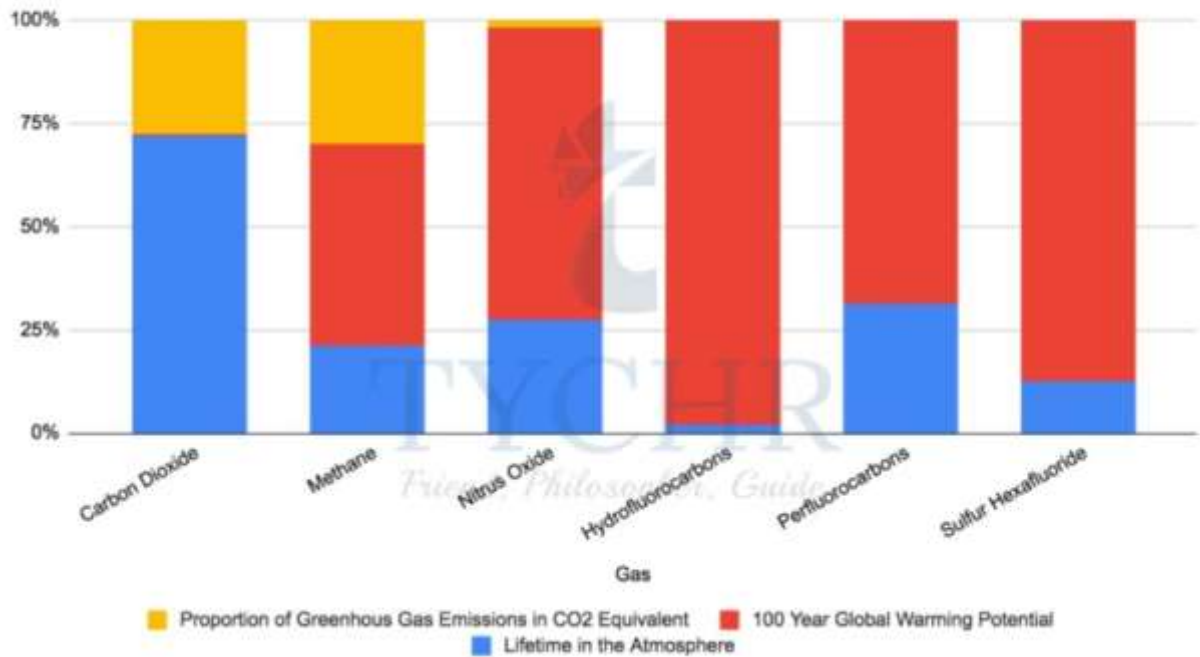


Figure 7 Characteristics of greenhouse gases.

### Global Emissions by Gas in Percentage

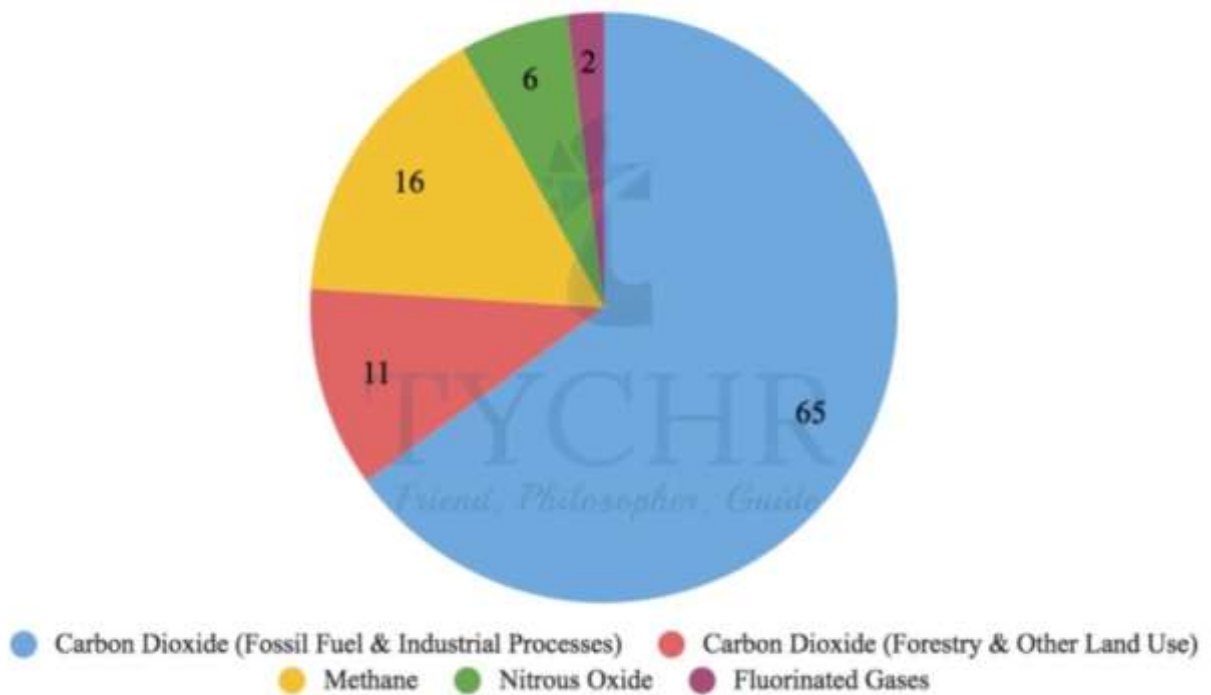


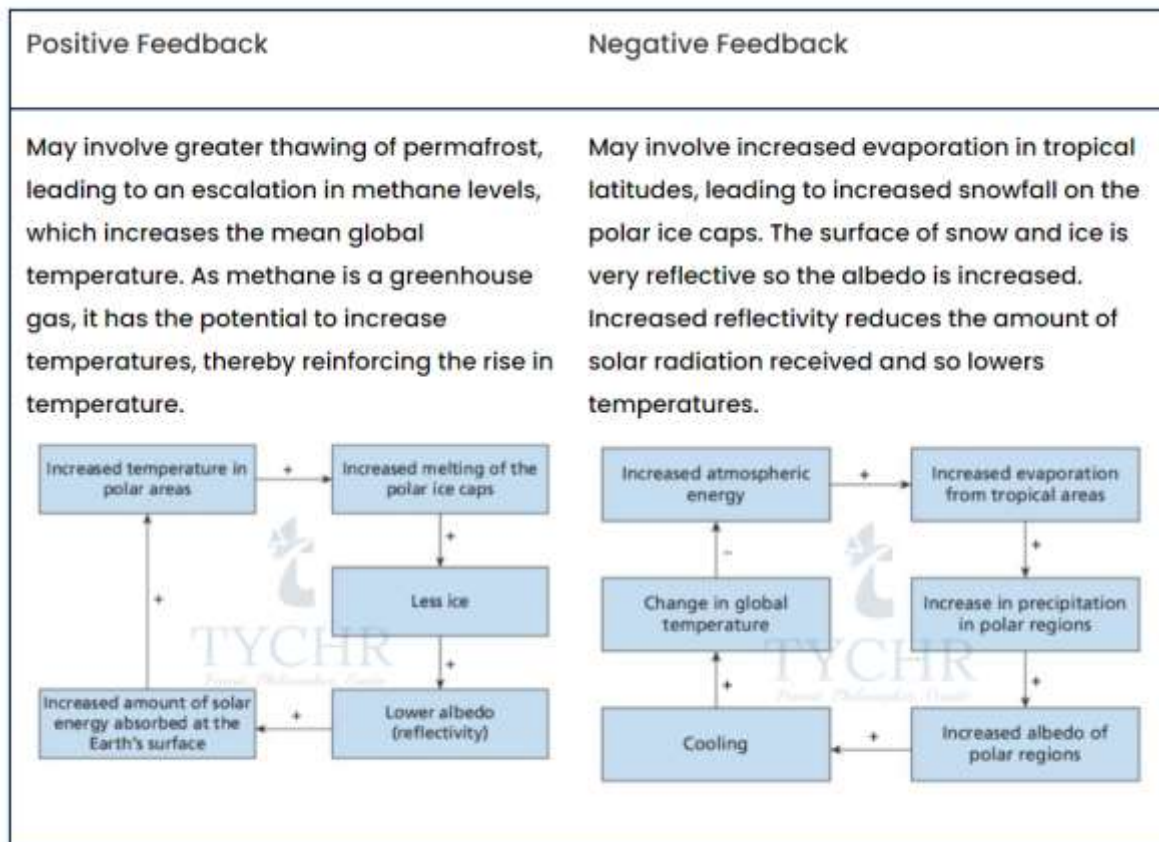
Figure 8 Global Emissions by Gas in Percentage. Source: IPCC, 2014



## 7.2.5 Effects Of Global Warming

<b>Feature</b>	<b>Effect Or Impact</b>
<b>Environmental Features</b>	
Ice & Snow	Melting of polar ice caps and glaciers
Coastlines	Increase in sea level causing coastal flooding
<b>Societal Features</b>	
Water Resources	Severe water shortages and possibly wars over supply; droughts and famines
Agriculture	May shift towards poles (away from drought areas); change in distribution of crop growing areas; food shortages; drop in crop yield
Coastal Residential Locations	Relocation due to flooding and storms
Human Health	Increased disease (e.g. risk of malaria)
Industries	Tourism, and other non essential industries may be affected

## 7.2.6 Feedback And Global Warming



## 7.2.7 Climate Sensitivity

Is a measure of how much the Earth's climate will cool or warm after a change in the climate system, for instance, how much it will warm for doubling in carbon dioxide concentrations.

## 7.2.8 Uncertainty Of Climate Models

These are very complex as they cover the whole of the Earth (and beyond) and try to integrate atmospheric, oceanic, terrestrial, lithospheric, hydrological, and human systems. In addition, the further forward in time scientists try to predict, the less accurate their estimates are.

## 7.3 Climate Change- Mitigation And Adaptation

### 7.3.1 Mitigation

Mitigation involves reduction and/or stabilisation of greenhouse gas (GHG) emissions and their removal from the atmosphere. It aims to reduce the causes of climate change. Mitigation can be achieved through:

- Reduction of Energy Consumption- Energy consumption could be reduced in many ways, e.g. by using public transport, using locally produced foods, turning off appliances when not in use, becoming vegetarian/vegan, installing better insulation in homes.
- Decarbonization- It refers to a large reduction of carbon dioxide per value of gross world product. Since most of the carbon dioxide comes from burning fossil fuels, a sharp reduction in the use of fossil fuels or a large-scale system to capture and sequester the carbon dioxide is needed. There are three key steps to decarbonization:
  - Energy efficiency
  - Reducing the emissions of carbon dioxide per megawatt hour of electricity generated
  - Fuel shift- from direct use of fossil fuels to electricity based on clean primary energy
- reductions in agricultural methane and nitrogen oxide emissions- $\frac{3}{4}$ th of all agricultural land is used for livestock production which is the single biggest source of habitat destruction. The livestock sector is also responsible for 15% of global man made emissions.
- Alternatives to fossil fuels- The use of alternative energy sources would reduce emissions of carbon dioxide. These alternative energy sources include hydroelectric power and solar power. They do not produce carbon dioxide when they are operating although carbon dioxide is released during the construction of the facilities. However, only certain places have the potential to produce alternative energy supplies.
- Geoengineering- Using the sulphate aerosol particles in the air to dim the incoming sunlight and thereby cool the planet to offset the warming effects of carbon dioxide; or placing giant mirrors in space to deflect some of the incoming solar radiation are some radical ideas suggested by scientists.
- Carbon dioxide removal (CDR) techniques

- UN-REDD Programme
- Biomass
- Carbon Capture and Sequestration (CSS)
- Enhancing carbon dioxide absorption

### 7.3.2 Adaptation



Figure 9 Thames Barrier which protects London from tidal flooding. Rising sea levels will mean the Barrier is closed more frequently.

Adaptation refers to efforts to live with the consequences of climate change. Adaptation includes measures such as protecting cities from storm surges and protecting crops from high temperatures and droughts.

### 7.3.3 Policy Changes

While carbon dioxide emitters do not bear the social costs they cause, society, including future generations, bears the brunt of its

high costs. As a result, there is no incentive on the market to switch from fossil fuels to alternatives.

### Carbon Taxes

- Some countries are introducing taxes to encourage producers to reduce emissions of carbon dioxide.
- These environmental taxes can be implemented by taxing the burning of fossil fuels in proportion to their carbon content.
- These taxes are most effective if they are applied internationally, but are also valuable nationally.

### Carbon Trading

- Carbon trading is an attempt to create a market in which permits issued by governments to emit carbon dioxide can be traded.
- Governments set targets for the amount of carbon dioxide that can be emitted by industries; they are divided between individual plants or companies. Plants that exceed that limit are forced to buy permits from others that do not.
- The system works by putting a limit on total emissions.

### Carbon Offset Schemes

- Carbon offset schemes are designed to neutralise the effects of the carbon dioxide that are produced by human activities by investing in projects that cut emissions elsewhere.
- Carbon credits are typically purchased by businesses from initiatives that encourage the use of renewable energy sources or the planting of trees.
- Because they prevent people from changing their behaviour, offsets are dangerous.



### 7.3.4 Politics Of Carbon Dioxide Mitigation & Adaptation

- **Kyoto Protocol**  
Is an agreement signed by 183 countries in Kyoto, Japan in 1997. The countries aimed for the stabilisation of greenhouse gas emissions at safe levels that would avoid serious climate change. They concurred to cut greenhouse gas emissions by 5% of their 1990 levels by 2012. It is currently the only legally binding international agreement that seeks to tackle the challenges of global warming.
- **Paris Agreement**  
The Paris Agreement, which was signed in 2016 and is a component of the United Nations Framework Convention on Climate Change (UNFCCC), addresses mitigation, adaptation, and financing of greenhouse gas emissions. The key objective is to limit global warming to 2°C compared with pre-industrial levels. It also seeks for zero net greenhouse gas emissions between 2050 and 2100. However, there is neither a mechanism to penalise nations if their targets are not met nor a mechanism to compel a nation to set a specific goal.
- **Climate Change Intergovernmental Panel.**  
The international body responsible for evaluating climate change science is the IPCC. It was established by the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP) to provide regular assessments of climate change, its effects, and potential future threats to policymakers. IPCC evaluations give a logical premise to legislatures at all levels to foster environment related strategies. The report also says that behavioural changes, like eating less meat or changing one's diet, can help reduce emissions.
- **National Adaptation Programmes of Action**  
A NAPA is a plan that an LEDC sends to the UNFCCC to explain how the country thinks it needs to adapt to climate change right away. Completing a NAPA makes LEDCs eligible for project funding from the Global Environment Facility (GEF).





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