Greenhouse Gas (GHG) Emissions: A Detailed Note

1. Introduction

Greenhouse gases (GHGs) are atmospheric gases that **trap heat** via the **greenhouse effect**, maintaining Earth's habitable temperature. However, anthropogenic emissions have **disrupted this balance**, causing global warming.

2. Major Greenhouse Gases

Gas	Sources	Global Warming Potential (GWP-100)	Lifetime
CO_2 (Carbon Dioxide)	Fossil fuels, deforestation, cement production	1 (baseline)	100-1000 yrs
CH_4 (Methane)	Livestock, landfills, natural gas leaks	28–36	~12 yrs
N_2O (Nitrous Oxide)	Fertilizers, combustion, industry	265–298	114 yrs
F-gases (HFCs, PFCs, SF_6)	Refrigerants, electronics	1000s–23,500	Decades–millennia

3. Sources of GHG Emissions

A. Natural Sources

- **Volcanic eruptions** (CO_2, SO_2).
- **Wetlands** (CH_4).
- **Ocean-atmosphere exchange** (CO_2).

B. Anthropogenic Sources (Human-Caused)

1. **Energy Sector (73% of emissions)**
   - Burning **coal, oil, gas** for electricity/heat.
   - Transport (cars, ships, planes).
2. **Agriculture (12%)**
   - **Livestock digestion** (CH_4).
   - **Rice paddies & manure** (CH_4, N_2O).
3. **Industry (6%)**
   - Cement, steel, chemical production (CO_2, F-gases).
4. **Land-Use Changes (9%)**
   - **Deforestation** reduces CO_2 absorption.

4. Impacts of GHG Emissions

- **Global Warming:** +1.1°C since 1850 (IPCC 2023).
- **Extreme Weather:** Hurricanes, droughts, heatwaves.
- **Ocean Acidification:** CO_2 dissolves in seawater → harms marine life.
- **Sea-Level Rise:** Thermal expansion + ice melt.

5. Mitigation Strategies

- **Renewable Energy:** Solar, wind, hydro to replace fossil fuels.
- **Carbon Capture & Storage (CCS):** Trapping CO_2 from power plants.
- **Afforestation:** Planting trees to absorb CO_2.
- **Methane Reduction:** Fixing leaks, dietary shifts (less beef).
- **Policy Tools:** Carbon taxes, Paris Agreement (limit to +1.5°C).

Schematic Diagram: GHG Emissions & Climate Impact

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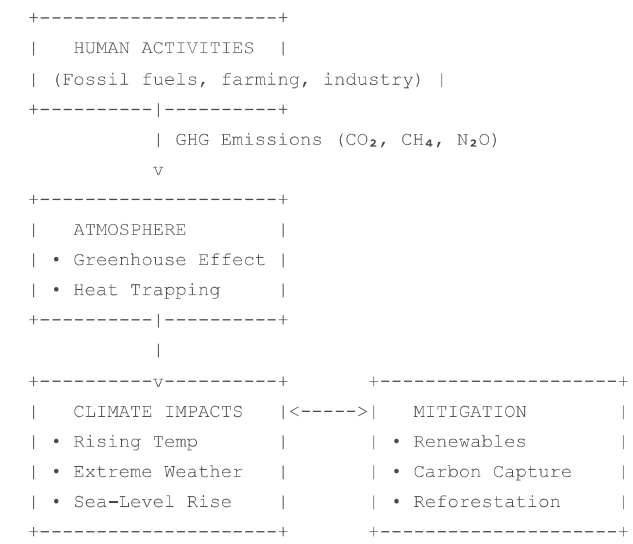

6. Key Data (2023)

- **Global CO_2 Levels:** 420 ppm (highest in 2M years).
- **Top Emitters:** China (28%), USA (15%), EU (9%).
- **Sector Breakdown:** Energy > Agriculture > Industry.

7. Future Challenges

- **Developing Nations:** Balancing growth vs. emissions.
- **Technological Gaps:** Scaling up CCS & green hydrogen.
- **Policy Enforcement:** Meeting Paris Agreement goals.

Conclusion

GHG emissions are the **primary driver of climate change**. Reducing them requires **global cooperation, innovation, and policy action** to avoid catastrophic warming.