

**What are the solutions to climate change?**

**1. Introduction**

Climate change is one of the most pressing challenges in the world today, threatening ecosystems, economies and communities around the world. Driven primarily by human activities such as greenhouse gas emissions and deforestation, the adverse impacts of climate change include rising global temperatures, an increase in extreme weather events (heatwaves, droughts, floods, hurricanes), ecological damage (loss of biodiversity) and socio-economic damage<sup>[1]</sup>. According to former research by experts and scholars, the main reasons causing climate change are listed below:

- 1) The burning of fossil fuels, agricultural activities, industrial activities and other operations lead to long-term emissions of greenhouse gases such as carbon dioxide, methane, and nitrous oxide<sup>[2,3]</sup>.
- 2) Activities such as land development and deforestation cause the reduction of carbon sinks, reducing the ability of the environment to absorb carbon dioxide while releasing carbon stored in plants and soil<sup>[4,5]</sup>.
- 3) Rapid development among countries has led to rapid industrialization and urbanization, which in turn has led to increased energy consumption and the heat island effect<sup>[6]</sup>.

Responding to the global crisis of climate change requires urgent and coordinated action, and according to the causes of climate change, there are three solutions that can effectively address the crisis - development of renewable energy sources, restoration of natural carbon sinks, and strengthening of international cooperation and policy development.

**2. Solution – Develop Renewable Energy**

The transition to renewable energy is one of the most effective ways to combat climate change. Fossil fuels, such as coal, oil and natural gas, are the main source of global greenhouse gas emissions. By replacing fossil fuels with cleaner sources of energy, such as solar, wind, hydropower and geothermal energy, we can dramatically reduce carbon emissions.

Currently, the application of renewable energy research is mainly in the following areas: For solar energy, the world has actively developed solar panels<sup>[7]</sup> for power generation and energy storage, which have been applied on a large scale in India, Africa and other countries for energy supply<sup>[8]</sup>; For wind energy, Norway, Denmark, China, the United States and other countries is vigorously developing floating wind turbines<sup>[9]</sup> and offshore farms<sup>[10]</sup>, to make full use of marine wind energy resources; For hydropower energy, Norway has made full use of its energy conversion technology and rich rivers and marine resources to achieve nearly 90% of the country's electricity<sup>[11]</sup>.

A shift to renewable energy not only reduces emissions, but also enhances energy security and creates economic opportunities, making it a win-win solution for both the environment and society.



**Fig 1. Solar Panels Array mounted on a rooftop<sup>[7]</sup>**



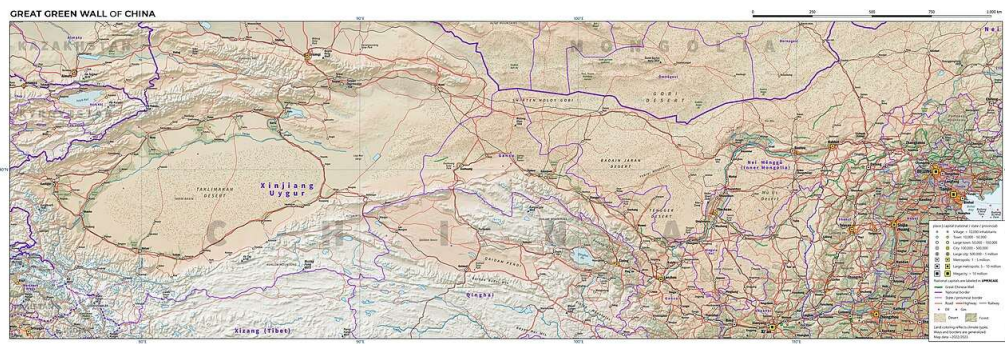
**Fig 2. Floating Wind Turbines<sup>[8]</sup>**

### 3. Solution – Restore Natural Carbon Sinks

Natural ecosystems such as forests, wetlands and oceans are important carbon sinks, absorbing large amounts of carbon dioxide from the atmosphere. However, human activities such as deforestation and land development have greatly reduced their capacity to store carbon. Restoring and protecting these ecosystems is a critical step in combating climate change.

Reforestation can restore degraded landscapes and increase the Earth's capacity to absorb carbon dioxide. For example, China's “Great Green Wall” project<sup>[12]</sup> has successfully planted millions of trees, captured large amounts of carbon while combatted desertification. Similarly, the protection and restoration of wetlands and seagrass beds<sup>[13]</sup> help to store carbon while also supporting biodiversity and protecting coastal areas from erosion.

Sustainable agricultural practices also play a role in restoring natural carbon sinks. Techniques such as reduced tillage, crop rotation and the use of organic fertilizers<sup>[14]</sup> can enhance soil carbon storage while maintaining agricultural productivity. By prioritizing the restoration of ecosystems, human-beings can harness nature's ability to mitigate climate change while protecting biodiversity.



**Fig 3. Topographic map of the Great Green Wall of China<sup>[12]</sup>**



**Fig 4. Wetlands Recovery**

#### 4. Solution – Strengthen International Cooperation and Policy

Climate change is a global issue that transcends national boundaries, making international cooperation and policy engagement essential. Through active cooperation and sound policies, countries can share resources, technologies and strategies to efficiently and rationally reduce emissions and adapt to the impacts of climate change.

In terms of international cooperation and policy, the Paris Agreements are an important framework for international climate action<sup>[15]</sup>, representing the direction of a global green and low-carbon transition and encouraging countries to set and achieve effective emissions reduction targets. China has also moved on from this agreement to propose a dual carbon goal<sup>[16]</sup> in 2020 (peak carbon by 2030 and carbon neutral by 2060). It is these policies, targets, and partnerships that are the fundamental source of power to unite people around the globe in addressing environmental climate issues.

Effective implementation of environmental policies requires countries to hold each other accountable and support each other, while providing financial and technological support to developing countries that lack the resources to effectively respond to climate change. By fostering global partnerships and implementing strong climate policies, we can ensure a unified response to one of humanity's greatest challenges.



**Fig 5. Heads of delegation at the 2015 United Nations Climate Change Conference in Paris**



## 5. Conclusion

Climate change is an urgent global crisis that requires immediate and concerted action. By developing renewable energy sources, restoring natural carbon sinks and strengthening international cooperation, we can mitigate the devastating effects of climate change and pave the way for a more sustainable future. These solutions will not only reduce greenhouse gas emissions but also protect ecosystems and enhance global resilience to the climate challenge. Although the road ahead is challenging, collective action and commitment can ensure a healthier planet for future generations. Addressing climate change is not only an environmental imperative, but also a moral and economic one.

## 6. Statement of AI use

Generation AI has been used for searching for the key information of climate change and the solutions, which was only for guiding the deeper search of academic contents that can be used in this essay.

### Current Status of Climate Change

Climate change refers to the long-term alteration of global climate patterns, particularly global warming caused by human activities. Here are some key facts about the current state of climate change:

1. **Global Warming:** Scientific data shows that the Earth's average temperature has risen by approximately 1.1°C since the Industrial Revolution. Without action, it could rise by 1.5°C or more by the end of this century.
2. **Increased Extreme Weather Events:**
  - More frequent and intense heatwaves, droughts, and floods.
  - Stronger hurricanes and rising sea levels, which make coastal areas more vulnerable to storm surges.
3. **Threats to Ecosystems:**
  - Accelerated melting of Arctic sea ice and ocean acidification harming coral reefs and marine life.
  - Biodiversity is declining, and many species are losing their habitats.
4. **Socioeconomic Impacts:**
  - Decline in agricultural productivity, threatening food security.
  - Increase in climate-induced migration.
  - Significant economic losses, particularly in low-income countries.

## Causes of Climate Change

The primary causes of climate change include:

### 1. Greenhouse Gas Emissions:

- **Carbon Dioxide (CO<sub>2</sub>):** Released through burning fossil fuels (coal, oil, gas) for energy, transportation, and industry.
- **Methane (CH<sub>4</sub>):** Emitted from agriculture (especially livestock), landfills, and natural gas extraction.
- **Nitrous Oxide (N<sub>2</sub>O):** Released from agricultural fertilizers and industrial activities.

### 2. Land Use Changes:

- Deforestation reduces carbon sinks (the ability to absorb CO<sub>2</sub>) while releasing stored carbon from plants and soil.

### 3. Industrialization and Urbanization:

- Rapid economic growth since the Industrial Revolution has led to increased energy consumption.
- Urban expansion has created higher energy demand and heat island effects.

### 4. Natural Factors (Minor):

- Volcanic eruptions and solar activity can temporarily influence the climate, but their effects are minimal compared to human activities.

## Four Solutions to Address Climate Change

### 1. Promote Renewable Energy

- **Why?** Reducing dependence on fossil fuels lowers greenhouse gas emissions.
- **How to Implement:**
  - Invest in clean energy sources like wind, solar, hydropower, and geothermal energy.
  - Provide government subsidies and tax incentives to encourage businesses and individuals to adopt renewable energy.
- **Example:** Denmark aims to achieve 100% renewable energy electricity generation by 2030.

### 2. Improve Energy Efficiency

- **Why?** Reducing energy consumption directly lowers carbon emissions.
- **How to Implement:**
  - Promote energy-efficient buildings by using advanced insulation materials and smart lighting systems.
  - Improve energy efficiency in transportation, such as adopting electric vehicles and expanding public transit systems.
- **Example:** Germany's "Energiewende" (Energy Transition) program has achieved significant progress in building energy efficiency.

### 3. Restore Natural Carbon Sinks

- **Why?** Forests, wetlands, and oceans are crucial for absorbing CO<sub>2</sub>.
- **How to Implement:**
  - Launch large-scale reforestation and forest conservation programs.
  - Restore degraded wetlands and seagrass beds.
  - Support sustainable agriculture practices, such as reducing over-tilling and excessive fertilizer use.
- **Example:** China's "Green Great Wall" project has reduced desertification and absorbed significant amounts of CO<sub>2</sub> through reforestation.

### 4. Strengthen International Cooperation and Policy

- **Why?** Climate change is a global issue that requires collective action.
- **How to Implement:**
  - Adhere to the Paris Agreement and set ambitious carbon neutrality goals.
  - Establish global carbon trading markets to incentivize emission reductions.
  - Provide financial and technological support to developing countries to help them address climate change.
- **Example:** The United Nations Climate Change Conferences (COP series) encourage countries to set stronger emission reduction targets.

## 7. Reference

- [1] Change C. Mitigating Climate Change[J]. Working Group III contribution to the sixth assessment report of the intergovernmental panel on climate change, 2022.
- [2] Jeffry L, Ong M Y, Nomanbhay S, et al. Greenhouse gases utilization: A review[J]. Fuel, 2021, 301: 121017.
- [3] Ritchie H, Rosado P, Roser M. CO<sub>2</sub> and greenhouse gas emissions[J]. Our world in data, 2023.
- [4] Myers N. Tropical deforestation: rates and patterns[J]. The causes of tropical deforestation, 2023: 27-40.
- [5] Lawrence D, Vandekar K. Effects of tropical deforestation on climate and agriculture[J]. Nature climate change, 2015, 5(1): 27-36.
- [6] Li K, Lin B. Impacts of urbanization and industrialization on energy consumption/CO<sub>2</sub> emissions: does the level of development matter?[J]. Renewable and sustainable energy reviews, 2015, 52: 1107-1122.
- [7] Durganjali C S, Bethanabhotla S, Kasina S, et al. Recent developments and future advancements in solar panels technology[C]//Journal of Physics: Conference Series. IOP Publishing, 2020, 1495(1): 012018.
- [8] Khanna M K, Malik S, Kumar H. Indian solar panel initiatives in reducing carbon dioxide emissions[J]. Energy and Power Engineering, 2023, 15(4): 191-203.
- [9] McMorland J, Collu M, McMillan D, et al. Operation and maintenance for floating wind turbines: A review[J]. Renewable and Sustainable Energy Reviews, 2022, 163: 112499.

- [10] Yang B, Liu B, Zhou H, et al. A critical survey of technologies of large offshore wind farm integration: Summary, advances, and perspectives[J]. *Protection and Control of Modern Power Systems*, 2022, 7(2): 1-3.
- [11] Haddeland I, Hole J, Holmqvist E, et al. Effects of climate on renewable energy sources and electricity supply in Norway[J]. *Renewable Energy*, 2022, 196: 625-637.
- [12] Turner M D, Davis D K, Yeh E T, et al. Great green walls: hype, myth, and science[J]. *Annual Review of Environment and Resources*, 2023, 48(1): 263-287.
- [13] Liu N, Ma Z. Ecological restoration of coastal wetlands in China: Current status and suggestions[J]. *Biological Conservation*, 2024, 291: 110513.
- [14] Bamdad H, Papari S, Lazarovits G, et al. Soil amendments for sustainable agriculture: Microbial organic fertilizers[J]. *Soil Use and Management*, 2022, 38(1): 94-120.
- [15] He R, Luo L, Shamsuddin A, et al. Corporate carbon accounting: a literature review of carbon accounting research from the Kyoto Protocol to the Paris Agreement[J]. *Accounting & Finance*, 2022, 62(1): 261-298.
- [16] Jia X, Zhang Y, Tan R R, et al. Multi-objective energy planning for China's dual carbon goals[J]. *Sustainable Production and Consumption*, 2022, 34: 552-564.