

DP IB Environmental Systems & Societies (ESS): HL



6.3 Climate Change Mitigation & Adaptation

Contents

- * Global Action & Decarbonisation
- * Climate Change Mitigation
- * Climate Change Adaptation
- * Responses to Climate Change (HL)
- * Greenhouse Gas Emissions Scenarios (HL)
- * Climate Technology & Geoengineering (HL)
- * Climate Management & Intervention Challenges (HL)
- * Climate Stakeholders & Perspectives (HL)



Your notes

Global Action & Decarbonisation

Global Action on Climate Change

Importance of global action

- Climate change affects the entire planet
 - Therefore, coordinated global action is essential
- Actions by individual countries and states are insufficient to address the global nature of climate change
 - This means that **international cooperation** is necessary for **effective** climate action

State sovereignty and international cooperation

- State sovereignty**: the principle that each country has the authority to govern itself without external interference
- Climate change crosses national borders, requiring countries to work together and often requiring countries to **compromise** some of their sovereignty
- International cooperation is achieved through negotiations, protocols, conventions and treaties

Key UN treaties and protocols

- United Nations Framework Convention on Climate Change (UNFCCC), 1992:**
 - Established at the Earth Summit in Rio de Janeiro
 - Framework for international efforts to address climate change
 - Encouraged developed countries to lead in reducing emissions and supporting developing countries
- Kyoto Protocol, 1997:**
 - First major international treaty to reduce greenhouse gas emissions
 - Set legally binding targets for developed countries to reduce emissions
- Doha Amendment to the Kyoto Protocol, 2012:**
 - Extended the Kyoto Protocol beyond 2012
 - Set new emission reduction targets for developed countries for 2013–2020



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- Encourages further international cooperation and support for developing countries on how to adapt to climate change
- **Paris Agreement (2015):**
 - Aim: limit global warming to well below 2°C above pre-industrial levels, with efforts to limit the increase to 1.5°C
 - Nearly all countries have committed to reducing their emissions
 - Countries submit Nationally Determined Contributions (NDCs) outlining their climate action plans
 - Set a mechanism for regular review and enhancement of NDCs every five years

International cooperation mechanisms

- **Negotiations:** countries discuss and agree on common goals, commitments and actions to tackle climate change
- **Protocols and conventions:** formal agreements that outline specific commitments and actions countries must take
- **Sanctions:** tools like **cross-border carbon taxes** can be used to encourage compliance and ensure countries adhere to climate policies
 - A cross-border carbon tax is a levy imposed on imported goods based on the carbon emissions produced during their manufacture
 - These taxes aims to equalise the cost of carbon between countries with different climate policies
 - They encourage global reduction of greenhouse gas emissions and help reduce carbon leakage

Decarbonisation

What is decarbonisation?

- Reducing or ending the use of fossil fuels (coal, oil, natural gas) that emit carbon dioxide when burned
- **Transitioning to renewable energy sources** such as wind, solar, hydro and geothermal energy

Carbon neutrality

- Achieving **net-zero** carbon emissions
- This means balancing the amount of emitted CO₂ with an equivalent amount of CO₂ removal
 - Methods to achieve this include:
 - Reducing emissions
 - Enhancing carbon sinks (e.g. forests)

- Using technologies like carbon capture and storage (CCS)

Targets for carbon neutrality

- Different countries have set varied dates for achieving carbon neutrality, for example:
 - UK: by 2050
 - China: by 2060
 - Germany: by 2045
- These targets are crucial for meeting global climate goals and are part of each country's NDC under the Paris Agreement

Steps towards decarbonisation

- **Transitioning to renewable energy:**
 - Solar, wind, hydro and geothermal energy
- **Energy efficiency:**
 - Improving efficiency of energy and lowering energy waste in buildings, transportation and industry
- **Electrification:**
 - Using electricity (preferably from renewable sources) for heating, cooking and transportation
- **Carbon Capture and Storage (CCS):**
 - **Capture:** capturing CO₂ emissions directly from sources like power plants and industrial processes
 - **Transport:** once captured, CO₂ is compressed and transported, typically via pipelines, to a storage site
 - **Storage:** CO₂ is injected deep underground, where it is securely stored

Real-world examples

European Union (EU) Green Deal

- **Objective:** aimed at making Europe the first climate-neutral continent by 2050
- **Policies:**
 - **Carbon border adjustment mechanism:** introduces a carbon tax on imports to prevent "carbon leakage" and ensure fair competition for EU industries that have stricter climate regulations
 - **Renewable energy expansion:** sets targets for increasing the share of renewable energy sources in the EU's energy mix



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- **Energy efficiency:** promotes energy-efficient technologies and practices across various sectors

Norway's renewable energy initiatives

- **Achievement:** Norway generates nearly 100% of its electricity from renewable sources, primarily hydropower
- **Incentives for electric vehicles (EVs):**
 - Offers incentives for purchasing electric vehicles, including tax exemptions, toll reductions and free parking
- **Climate policies:**
 - Plans to phase out fossil fuel-based vehicles by 2025, contributing significantly to reducing transportation emissions



Examiner Tips and Tricks

You should be able to cite current examples, such as the EU Green Deal or Norway's renewable energy initiatives, to illustrate points about global action and decarbonisation.



Your notes



Your notes

Climate Change Mitigation

Climate Change Mitigation Strategies

- Climate change **mitigation** is now of crucial importance for human societies
- Mitigation strategies focus on **reducing** and **stabilising** greenhouse gas (GHG) emissions
- Climate change mitigation includes:
 - Reducing GHG emissions at their **source**
 - Developing techniques to **remove GHGs** from the atmosphere

Mitigation Strategies to Reduce GHGs

Mitigation Strategy	How to Implement Strategy
Reduction of Energy Consumption	Implement energy efficiency measures such as insulation, efficient lighting and higher efficiency appliances Promote smart grids and energy management systems Support energy-efficient industrial processes
Transport Policies	Implement fuel efficiency standards for vehicles Implement policies to promote electric vehicles, hybrid cars and fuel-efficient transportation systems Invest in public transportation infrastructure to reduce reliance on individual car usage Encourage sustainable transportation options like public transit, cycling, and walking
Reduction of Emissions from Agriculture	Implement agricultural practices to minimise nitrogen oxides and methane emissions Promote sustainable livestock management techniques such as improved feed quality, methane capture systems and rotational grazing
Use of Alternatives to Fossil Fuels	Transition to renewable energy sources such as solar, wind, hydro and geothermal energy



Your notes

	<p>Promote electric vehicles (EVs) and support the development of charging infrastructure</p> <p>Invest in research and development of biofuels, hydrogen and nuclear energy</p>
Geoengineering	Explore solar radiation management techniques like stratospheric aerosol injection to reflect sunlight back into space
Carbon Tax	Implement a tax on carbon emissions to incentivise reduction in GHG emissions
Natural carbon Sinks (e.g. forestation, rewilding)	Afforestation and reforestation, promote rewilding initiatives, restore degraded ecosystems, and protect existing forests to increase carbon sinks
Carbon Capture and Storage	<p>Carbon removal techniques such as direct air capture (DAC) to remove carbon dioxide from the atmosphere</p> <p>Develop and deploy technologies to capture carbon dioxide emissions from industrial and energy processes</p> <p>Store captured carbon dioxide underground or in other long-term repositories</p>



Your notes



Electric vehicles have the potential to play a significant role in mitigating climate change (Photo by Ernest Ojeh on Unsplash)



Examiner Tips and Tricks

Afforestation refers to the process of planting trees on land that has not been previously forested in order to create a new forest. It involves converting non-forest land into forested land through tree planting and establishment.

Reforestation involves restoring or replanting trees in an area that was once forested but has been deforested or degraded, typically due to human activities such as logging, agriculture or fire. It aims to restore the ecological function and biodiversity of a former forested area.



Your notes

Climate Change Adaptation

Climate Change Adaptation Strategies

- As the impacts of climate change increase, it is essential to implement adaptation strategies to **reduce adverse effects** and maximise any potential positive outcomes
 - Climate change adaptation strategies focus on **building resilience** and adapting to changing climate conditions

Climate Change Adaptation Strategies

Adaptation Strategy	How to Implement Strategy
Flood Defences	<p>Construct and reinforce flood protection infrastructure (levees, flood barriers, coastal defences)</p> <p>Implement sustainable drainage systems (SUDs) to manage and control excess water during heavy rainfall events</p> <p>Restore and preserve natural floodplains, wetlands, and mangroves as natural buffers against flooding</p>
Vaccination Programmes	<p>Develop and implement proactive public health measures, including vaccination programs</p> <p>Strengthen disease surveillance systems to monitor and respond to climate-related health impacts, such as the spread of vector-borne diseases in new regions</p>
Desalination Plants	<p>Invest in desalination technologies to increase freshwater availability in water-scarce regions</p> <p>Ensure sustainability through energy-efficient methods, renewable energy use and responsible environmental management</p>
Planting of Crops in Previously Unsuitable Areas	<p>Expand cultivation into areas now suitable due to shifting climate patterns</p> <p>Diversify crop varieties to adapt to new environmental conditions and enhance food security</p>



Your notes

<p>Adapting Agricultural Practices</p>	<p>Promote adoption of drought-resistant crops and resilient crop varieties</p> <p>Implement soil management techniques to conserve water and nutrients in changing climate conditions</p>
<p>Land Zoning and Building Code Changes</p>	<p>Update zoning regulations to consider climate risks like sea-level rise and extreme weather events</p> <p>E.g. restrict development in areas prone to flooding or require elevated construction; limit development along vulnerable coastlines</p> <p>Strengthen building codes to enhance resilience against hurricanes, floods, wildfires and heatwaves</p> <p>E.g. enforce building materials and landscaping practices that reduce fire risk; promote green spaces and reflective building materials to mitigate urban heat islands</p>



Mangrove forests act as natural buffers against flooding (Photo by David Clode on Unsplash)





Examiner Tips and Tricks

Mitigation Strategies aim to reduce or prevent the emission of greenhouse gases and lessen the severity of future climate change.

Adaptation Strategies, on the other hand, focus on adjusting and preparing for the impacts of climate change that are already occurring or are inevitable.



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Adaptation Plans

- Adaptation plans are strategies designed to help individuals, communities and societies cope with the impacts of climate change
- These plans aim to:
 - Reduce vulnerability** to climate-related hazards
 - Increase resilience** to climate change impacts

National Adaptation Programmes of Action (NAPAs)

What are NAPAs?

- NAPAs are plans developed by Least Developed Countries (LDCs) to identify and prioritise urgent adaptation needs
 - These plans are submitted to the United Nations Framework Convention on Climate Change (UNFCCC)
- They focus on immediate actions to address climate change impacts, particularly in sectors like agriculture, water resources and health
- For example:
 - Bangladesh**: has implemented NAPA projects to improve flood forecasting and early warning systems
 - Malawi**: has developed strategies to enhance food security through drought-resistant crops and sustainable land management

Resilience and adaptation plans

- Resilience plans aim to strengthen the ability of communities and ecosystems to **recover from climate shocks**
- Adaptation plans focus on long-term strategies to **adjust** to changing climate conditions

- For example:
 - **New York City One NYC plan:** includes measures to protect against coastal flooding and enhance green infrastructure
 - **Netherlands Delta Programme:** involves constructing robust flood defences and adaptive water management systems to protect against sea-level rise
 - **UK Climate Change Risk Assessment (CCRA)** identifies key risks and adaptation priorities, such as flood risk management and resilient infrastructure



Your notes

UN Development Programme (UNDP) Assistance

Role of UNDP

- The UNDP helps developing countries create and implement adaptation plans
- Provides technical and financial support to address the most imminent impacts of climate change
- **Process:**
 - Assess local vulnerabilities and climate risks
 - Develop action plans prioritising urgent needs
 - Implement projects with community involvement
- For example:
 - **Samoa**, with UNDP support, has improved its coastal infrastructure to protect communities from storm surges
 - **Bhutan** has developed climate-resilient agricultural practices to adapt to changing weather patterns



Your notes

Responses to Climate Change (HL)

Governmental & Non-Governmental Responses

- Responses to climate change can be led by **governments** or **non-governmental stakeholders**, including businesses, communities, and individuals
- Responses aim to:
 - Reduce greenhouse gas emissions
 - Adapt to climate impacts
 - Promote sustainable practices
- Key **response types** include:
 - Economic measures
 - Legislation
 - Goal-setting commitments
 - Personal lifestyle changes

1. Economic measures

- Economic measures use **market-based strategies** to encourage low-carbon practices

Carbon pricing

- Carbon pricing assigns a cost to greenhouse gas emissions to **incentivise reduction**
 - E.g. the European Union's Emissions Trading System (EU ETS) places a cap on emissions and allows companies to buy or sell emission allowances
- Impact: promotes emissions reduction by making pollution **more costly for businesses**

Subsidies and tariffs

- Governments may subsidise renewable energy projects and impose tariffs on high-emission products
 - E.g. many governments offer subsidies for solar energy projects to increase renewable energy use.
- Impact: encourages a shift to clean energy sources and **supports renewable industry growth**

2. Legislative measures

- Legislative measures are laws or regulations designed to **enforce** emission reductions

National emissions laws

- Countries pass legislation to limit emissions from major sectors like transportation and industry
 - E.g. the UK's Climate Change Act sets legally binding targets to reduce emissions to net zero by 2050
- Impact: creates **accountability** for emissions reduction and long-term climate planning

3. Goal-setting commitments

- Goal-setting involves setting **measurable targets** to reduce emissions and adopt sustainable practices

Corporate sustainability goals

- Companies voluntarily set goals for **carbon neutrality** and **waste reduction**
 - E.g. the outdoor clothing company Patagonia aims to use only renewable energy in operations and minimise waste
- Impact: encourages the **private sector** to **lead** on sustainability and **inspire** similar actions in other companies

B Corp certification

- B Corporation (also known as B Corp) certification recognises companies that meet high environmental and social performance standards
 - E.g. Ben & Jerry's is B Corp certified and actively works on reducing its carbon footprint
- Impact: incentivises businesses to **operate sustainably** and gain consumer trust

4. Personal lifestyle changes

- Individuals can adopt lifestyle changes to reduce their **personal carbon footprint**

Reducing meat consumption

- Lowering meat intake reduces methane emissions associated with livestock farming
 - E.g. initiatives like "Meatless Mondays" encourage people to adopt more plant-based diets
- Impact: **reduces demand** for high-emission meat products and lowers emissions

Reducing energy use

- Conserving energy at home and opting for **energy-efficient appliances** can lower personal emissions



Your notes

- E.g. smart thermostats help households save energy by adjusting temperatures automatically
- Impact: **lowers household emissions** and energy costs



Examiner Tips and Tricks

Remember the difference between **market-based** (economic) and **legal-based** (legislative) responses. You should be able to explain how each response type contributes to reducing emissions or promoting sustainability.

Note that while governments **enforce laws**, non-governmental actions often rely on **voluntary commitments** and **consumer influence**.



Your notes

Global Strategies to Address Climate Change

The role of the United Nations (UN)

- The **UN** has led many global efforts to combat climate change
- The **United Nations Framework Convention on Climate Change (UNFCCC)** is the main UN body focusing on climate change action
 - Established in **1992**
 - UNFCCC works to stabilise greenhouse gas concentrations to limit severe impacts on the climate system
- The **Intergovernmental Panel on Climate Change (IPCC)** was created by the UN
 - Assesses scientific research and data on climate change
 - Releases reports that guide policies and actions based on the latest climate science

Conference of the Parties (COP) summits

- **COP** refers to the **Conference of the Parties**
 - These are annual meetings held by countries that are members of the UNFCCC
 - COP summits bring countries together to discuss, negotiate, and set international climate goals

Key COP agreements

- **Paris Agreement (COP21, 2015):**
 - Aims to limit global warming to **well below 2°C**, with an ideal goal of **1.5°C**
 - Countries pledged **Nationally Determined Contributions (NDCs)**



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- These outline their emissions reduction targets
- E.g. the **European Union** committed to reducing emissions by **55% by 2030**
- **Glasgow Climate Pact (COP26, 2021):**
 - Nations agreed to reduce coal use and methane emissions
 - Pledged funding for developing nations to adapt to climate impacts
 - E.g. the US and EU pledged to cut methane emissions by **30% by 2030**

Key outcomes of COP 28

- **Dubai, United Arab Emirates (COP 28, 2023):**
 - **Fossil fuel transition:**
 - Countries agreed to a "transition away" from fossil fuels, with discussions on carbon capture to support production while reducing emissions
 - **Renewable energy target:**
 - Nations committed to tripling renewable energy capacity by 2030, in line with limiting warming to 1.5°C
 - **Loss and Damage Fund:**
 - A fund (first established at COP 27 in 2022) was formalised to support climate-vulnerable countries, with contributions expected from wealthier nations

The Montreal Protocol and the Kigali Amendment

- The **Montreal Protocol (1987)** was an international treaty to phase out substances that depleted the ozone layer, e.g. **chlorofluorocarbons (CFCs)**
 - It successfully reduced CFCs
 - This has protected the ozone
- Initially, **hydrofluorocarbons (HFCs)** were introduced as safer alternatives to CFCs (they are not harmful to the ozone layer)
 - However, HFCs were later identified as **powerful greenhouse gases**, contributing to global warming

Kigali Amendment (2016)

- The **Kigali Amendment** to the Montreal Protocol focuses on these HFCs
 - Aims to reduce HFCs emissions by **85% by 2047**
 - This could potentially prevent up to **0.5°C** of global warming



Your notes

Greenhouse Gas Emissions Scenarios (HL)

Greenhouse Gas Emissions Scenarios

- **Purpose of scenarios:**
 - Greenhouse gas (GHG) emissions scenarios help **predict future climate outcomes**
 - They help to define **clear targets** to **reduce the risk of catastrophic climate change**
 - Different scenarios are based on different levels of **human actions** and **policies**
- **Developed by IPCC:**
 - The Intergovernmental Panel on Climate Change (IPCC) creates these scenarios
- **Uncertainty and variability:**
 - Scenarios can vary greatly due to uncertainties about:
 - Future actions
 - Technological development (e.g. green energy technologies, carbon capture)
 - Policy changes

IPCC emissions scenarios (SSPs)

- The IPCC has also developed five **Shared Socioeconomic Pathways** (SSPs) to model different future GHG emissions scenarios
- These scenarios combine potential emissions changes with a **range of socio-economic factors** to give slightly different potential pathways
 - E.g. global cooperation
 - Economic policies
 - Population growth
 - Technological development
- The SSPs reflect how choices in economic growth, energy use, and societal trends could shape GHG levels and climate change impacts by the end of the century

SSP1: Sustainability ('Taking the Green Road')

- **Description:** A sustainable, environmentally-focused future



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- **Features:**

- Strong global cooperation and reduced inequalities
- Investments in green technologies and low-carbon energy sources

- **Climate Impact:** Lower GHG emissions, likely to limit global warming to around 1.5–2°C

SSP2: 'Middle of the Road'

- **Description:** A continuation of current global trends without significant changes (i.e. 'business-as-usual')

- **Features:**

- Moderate economic growth with limited inequality reduction
- Balanced investments in both traditional and renewable energy

- **Climate Impact:** Moderate GHG emissions, leading to moderate levels of warming

SSP3: Regional Rivalry ('A Rocky Road')

- **Description:** A fragmented world with regional conflicts and minimal cooperation

- **Features:**

- Limited technology sharing, economic growth focused within regions
- High reliance on fossil fuels, with few environmental protections

- **Climate Impact:** High GHG emissions and a substantial risk of severe climate impacts

SSP4: Inequality ('A Road Divided')

- **Description:** A world with significant social and economic inequality

- **Features:**

- High disparities between rich and poor countries and within societies
- Wealthy nations adapt well, while poorer regions struggle with climate impacts

- **Climate Impact:** Moderate to high GHG emissions with variable adaptation and mitigation success

SSP5: Fossil-fuelled Development ('Taking the Highway')

- **Description:** high fossil fuel use and technological advancement are driving rapid economic growth

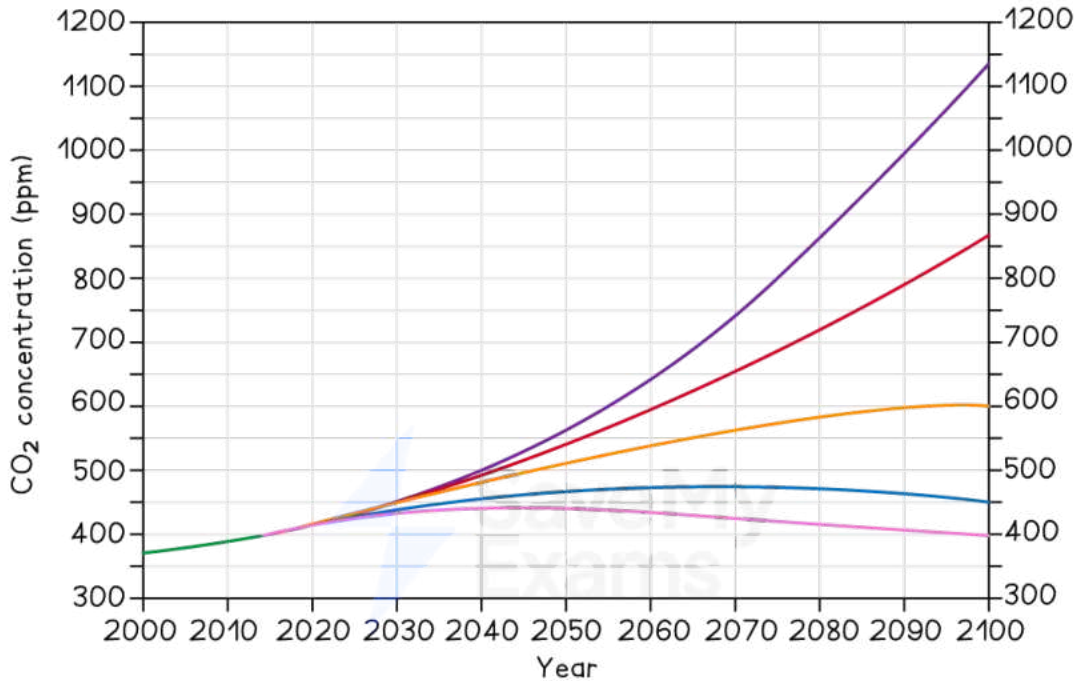
- **Features:**

- High energy consumption, widespread reliance on fossil fuels

- Innovation and economic growth prioritised over environmental protection
- **Climate Impact:** Very high GHG emissions, leading to significant warming



Your notes



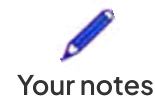
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Predicted atmospheric CO₂ concentrations for different Shared Socioeconomic Pathways (SSPs) across the 21st century (Wikimedia Commons, CC BY-SA 4.0)

IPCC Shared Socioeconomic Pathways (SSPs)

SSP	Scenario	Estimated warming (2041–2060)	Estimated warming (2081–2100)	Very likely range in °C (2081–2100)



SSP1-1.9	very low GHG emissions: CO ₂ emissions cut to net zero around 2050	1.6 °C	1.4 °C	1.0 – 1.8
SSP1-2.6	low GHG emissions: CO ₂ emissions cut to net zero around 2075	1.7 °C	1.8 °C	1.3 – 2.4
SSP2-4.5	intermediate GHG emissions: CO ₂ emissions around current levels until 2050, then falling but not reaching net zero by 2100	2.0 °C	2.7 °C	2.1 – 3.5
SSP3-7.0	high GHG emissions: CO ₂ emissions double by 2100	2.1 °C	3.6 °C	2.8 – 4.6
SSP5-8.5	very high GHG emissions: CO ₂ emissions triple by 2075	2.4 °C	4.4 °C	3.3 – 5.7

The names of these scenarios consist of the SSP on which they are based (SSP1–SSP5), combined with the expected level of radiative forcing in the year 2100 (1.9 to 8.5 W m⁻²). SSP4 has not been included.



Your notes

Climate Technology & Geoengineering (HL)

Climate Mitigation Technology

- Climate mitigation technology refers to innovations designed to:
 - Reduce greenhouse gas emissions
 - Limit the effects of climate change
- These technologies include:
 - Carbon **reduction** technologies (decrease carbon emissions from human activities)
 - Carbon **removal** technologies (capture and store carbon already present in the atmosphere)

Key areas of climate mitigation technology

1. Renewable energy technologies

- Renewable energy sources provide cleaner alternatives to fossil fuels
- They utilise natural resources to produce energy with minimal emissions, e.g.
 - Solar power
 - Wind energy
 - Hydropower
 - Geothermal energy
- Renewable energy technologies are **continuously advancing**
 - This is making solar, wind, and other renewables **more efficient** and **affordable**
 - This is increasing their potential to replace fossil fuels on a **large scale**

2. Carbon capture and storage (CCS)

- CCS technologies capture carbon dioxide emissions from sources like power plants
 - This carbon is stored underground to prevent release into the atmosphere
 - E.g. Direct air capture (DAC): removes CO₂ directly from the air

3. Energy efficiency technologies

- Energy-efficient technologies aim to reduce energy consumption in buildings, vehicles, and industries



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- **Smart buildings:** use sensors and AI to manage lighting, heating, and cooling, lowering energy use
- **Electric vehicles (EVs):** reduce emissions from traditional petrol and diesel cars

4. Smart cities and digital technologies

- **Smart cities** integrate technology to improve urban sustainability and reduce emissions
- **Apps and sensors** help citizens make eco-friendly choices, e.g. finding nearby charging stations or recycling points
- **Public transportation apps** encourage the use of buses, trains, and bikes over personal cars, helping to cut emissions

5. Agriculture and forestry innovations

- Technology in agriculture and forestry can increase carbon sequestration and reduce emissions from land use
- **Precision agriculture:** uses sensors and drones to monitor crop health and minimise fertiliser use, reducing nitrous oxide emissions
- **Sustainable forestry:** uses science-based methods to grow forests sustainably, increasing their carbon storage potential



Examiner Tips and Tricks

Make sure you understand some key examples of mitigation technologies and **where they are applied**. Do a bit of your own research: specific examples can be helpful in longer exam questions!

Geoengineering

- Geoengineering is a strategy aimed at mitigating climate change by **intentionally altering the Earth's climate systems on a large scale**
- **Purpose:**
 - To treat the **symptoms** of climate change, **not its root causes** (such as greenhouse gas emissions)
- Two main types of geoengineering:
 - **Solar Radiation Management (SRM):** reflects sunlight to cool the Earth
 - **Carbon Dioxide Removal (CDR):** removes CO₂ from the atmosphere

Types of geoengineering approaches



Your notes

Solar Radiation Management (SRM)

- **Stratospheric aerosol injection:**
 - Releases reflective particles (such as sulphates) into the stratosphere
 - This reduces sunlight reaching Earth
- **Space mirrors:**
 - None currently in operation (there have only been proposals and experiments)
 - Uses large mirrors in space to reflect sunlight away from Earth
 - **Highly expensive and technologically complex**
 - However, it could theoretically provide global cooling
- **Cloud brightening:**
 - Sprays sea salt into clouds over oceans, making them **brighter** and **more reflective**
 - Intended to reduce ocean surface temperatures
 - E.g. this could help slow coral bleaching

Carbon Dioxide Removal (CDR)

- **Ocean fertilisation:**
 - Adds nutrients like iron to oceans to boost algae growth
 - Photosynthetic algae **absorbs large amounts of CO₂** during photosynthesis
 - Concerns include potential disruption of marine ecosystems and unknown long-term impacts
- **Direct Air Capture (DAC):**
 - Uses machines to pull CO₂ directly from the air
 - This CO₂ is then stored (e.g. underground) or used
 - Currently high-cost and energy-intensive but is developing as a viable technology
- **Bioenergy with Carbon Capture and Storage (BECCS):**
 - Combines biomass burning for energy with carbon capture and storage
 - Can effectively create 'negative emissions' by removing CO₂ from the atmosphere

Arguments for Geoengineering



Your notes

- **Rapid cooling potential:**
 - SRM methods like stratospheric aerosols could theoretically cool the Earth quickly, helping prevent immediate climate crises
- **Backup strategy:**
 - Provides an alternative if emissions reduction efforts fail to control warming effectively
- **Offsets global warming effects:**
 - Reduces extreme heat, potentially slowing down impacts like polar ice melting and sea-level rise
- **Innovation in climate action and policy:**
 - Stimulates technological advancement and discussion on global climate action strategies

Arguments against Geoengineering

- **High uncertainty:**
 - Effects on weather patterns, ecosystems, and human health are not fully understood
- **Potential for unintended consequences:**
 - For example, stratospheric aerosols may alter rainfall patterns, potentially leading to droughts in some regions
- **Geopolitical issues:**
 - Changes in climate conditions could impact countries differently, leading to conflicts over who controls geoengineering efforts
- **Potential to slow genuine climate efforts:**
 - May reduce incentives for countries to cut emissions if they believe geoengineering can “solve” climate change
- **High costs:**
 - Many techniques, like space mirrors and DAC, are currently too expensive to implement on a large scale

Climate Management & Intervention Challenges (HL)



Your notes

Climate Management & Intervention Challenges

- Climate management and intervention strategies aim to **mitigate climate change effects**
- Implementation faces several barriers, including social, economic, and political challenges

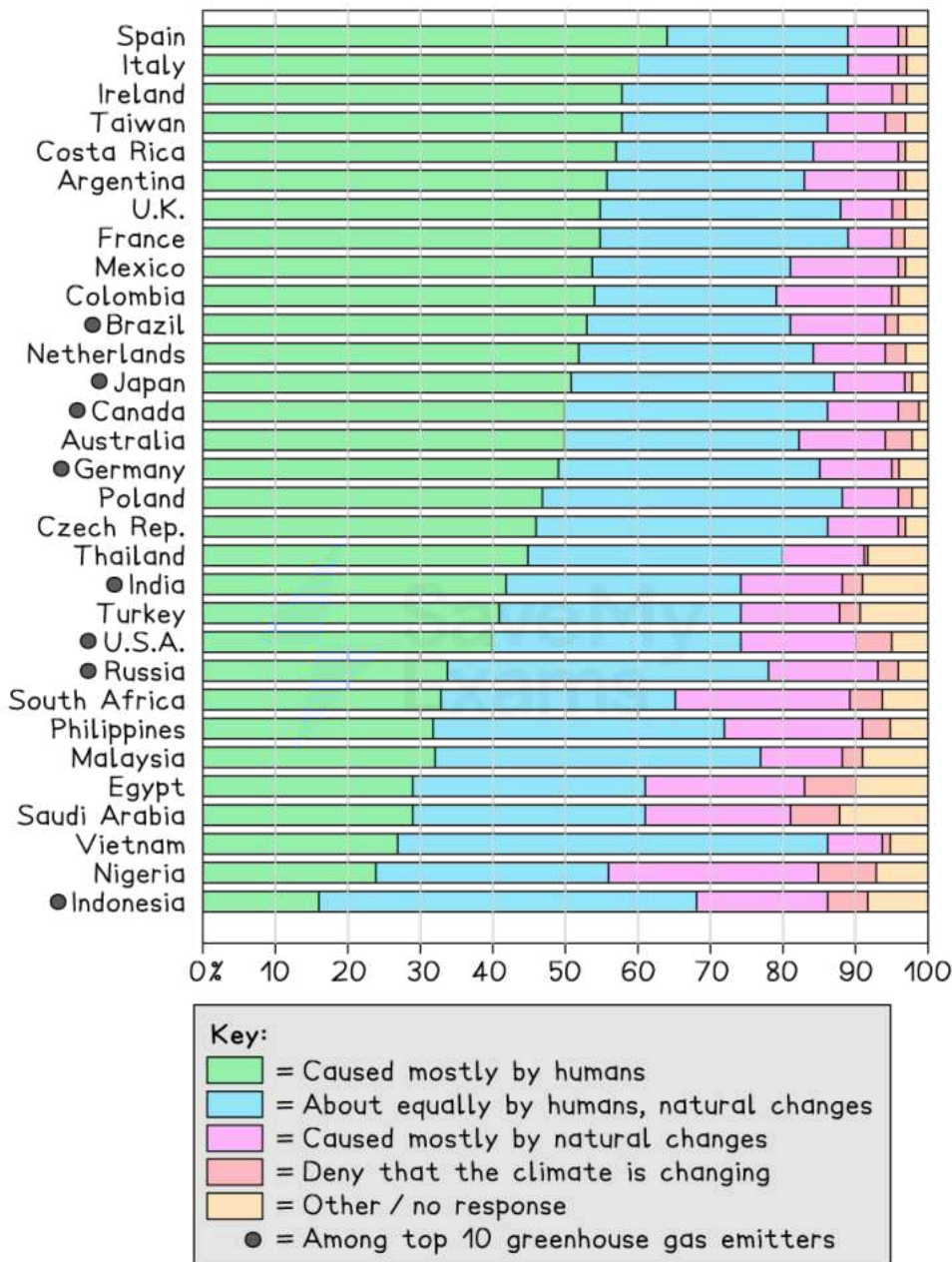
Key challenges in implementing climate management strategies

1. Belief in the seriousness of climate change

- Some individuals and groups do not view climate change as a **serious** or **immediate threat**
- This lack of belief can:
 - Hinder public support for climate initiatives
 - Reduce pressure on governments to act



Your notes



Graph showing public opinion on the causes climate change, based on the results of a 2021 survey of public opinion in 31 countries, specifically among Facebook users

2. Financial constraints

- Many national governments lack the financial resources needed for **large-scale climate action**
 - E.g. developing countries may struggle with financing renewable energy infrastructure

- Limited budgets can also affect research, development, and use of climate-friendly technologies

3. Lack of leadership from key stakeholders

- Effective climate action requires leadership from a wide range of stakeholders, including:
 - **Individuals** making environmentally friendly choices
 - **Non-governmental organisations** (NGOs) promoting climate awareness
 - **Political leaders** passing and enforcing climate policies
 - **Transnational companies** investing in sustainable practices
- Without strong leadership, climate initiatives **lack coordination** and **impact**

4. International inequalities

- Economic and geographical inequalities affect the ability to manage and adapt to climate change
 - Countries with economies dependent on fossil fuels face challenges in transitioning to renewables
 - Low-income countries are often more vulnerable to climate impacts but have fewer resources for adaptation
 - High-income countries may have more resources to mitigate and adapt to climate change
 - However, they often contribute the most to emissions

The tragedy of the commons and global climate responsibility

Concept of the tragedy of the commons

- The '**tragedy of the commons**' is a situation where shared resources are **overused** and **depleted** due to **individual self-interest**
- In climate terms:
 - The atmosphere is a **shared resource**
 - This means that when one nation benefits from an action that harms the atmosphere (e.g. burning of fossil fuels), **all nations** and their ecosystems **share** the **costs**
 - The reverse scenario is also true:
 - The costs of restoring the atmosphere (e.g. carbon capture and storage) might be paid by a single nation, but the **benefits are gained by all nations**

Importance of global cooperation

- Climate change is a global issue requiring **unprecedented levels of international cooperation**



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- No single nation can fully resolve climate change alone
- Coordinated efforts are essential.
 - E.g landmark agreements like the Paris Agreement aim to unite nations in setting emissions reduction targets
- Without cooperation, the 'tragedy of the commons' predicts that climate change impacts could become **catastrophic** due to overuse of atmospheric resources



Your notes



Your notes

Climate Stakeholders & Perspectives (HL)

Climate Stakeholders

- Climate stakeholders include individuals and groups who influence and shape perspectives on climate change
- Climate stakeholders:
 - Have **varying levels of influence**
 - May support **different actions** or **views** on climate change

Types of stakeholders influencing climate perspectives

1. Charismatic individuals

- Charismatic individuals, such as **activists**, **public figures** or **celebrities**, can use their influence to promote awareness and action on climate change
 - E.g. **Greta Thunberg**, a young climate activist, has inspired global youth movements and raised awareness of the urgency of climate action
- Charismatic individuals can inspire others by making climate issues **relatable** and **urgent**

2. Local community groups

- Community groups often address climate issues **specific to their area**
 - This can make smaller-scale climate issues more **relevant** and **actionable**
 - E.g. **local recycling initiatives** or **tree-planting groups** help communities understand their role in reducing emissions
- They often advocate for **practical actions** that people can take locally to make a difference

3. Non-governmental organisations (NGOs)

- NGOs play a very important role in researching, educating, and advocating for **climate policies** and **actions**
 - E.g. **Greenpeace** campaigns for environmental protection and is influential in shaping public opinion on climate issues
- NGOs often work **internationally** to influence both public awareness and government policies

4. Media

- Media sources, such as news outlets, social media platforms, and documentaries, can shape how climate issues are perceived
 - Media can either **increase awareness** or **create confusion**, depending on the reliability of the information presented
 - E.g. the documentary **An Inconvenient Truth** highlighted climate science and global warming
 - This helped shift public perception towards recognising the importance of climate action



Your notes

5. Educational institutions

- Schools, universities, and other academic organisations play a role in educating students and the public on climate science and solutions
 - E.g. university courses and school programmes on **environmental science** and **sustainability** increase knowledge about:
 - Climate issues
 - Possible interventions
- Education helps develop a **scientifically accurate understanding of climate change** and can motivate students to become involved in climate action
 - E.g. students studying **IB ESS** may go on to become climate scientists, campaigners or work for environmental NGOs



Examiner Tips and Tricks

In your exam, be prepared to identify, explain and compare the roles of various stakeholders in relation to climate change issues.

Climate Perspectives

Different perspectives on climate action

Perspectives based on age

- Younger generations** often view climate change as a **more urgent issue** than older generations
 - Young people are more likely to support **immediate action**
 - They are more aware of the potential **long-term effects** they may experience

- Older generations may view climate policies with caution, concerned about economic or lifestyle impacts

Perspectives based on economic development

- Perspectives can differ between developed and developing countries
 - **Developed countries:**
 - Often have more resources to invest in **climate mitigation** and **adaptation**
 - Their focus may be on reducing emissions and transitioning to renewable energy
 - **Developing countries:**
 - May prioritise **economic growth** and **poverty reduction** over climate action due to limited resources
 - However, they are also often more vulnerable to climate impacts, so may want developed nations to **act** and **take more responsibility for historical emissions**

Perspectives based on location

- **Coastal communities** may be more concerned about climate change due to direct threats like sea-level rise and increased storms
 - E.g. the Maldives, a low-lying island nation, is threatened by rising sea levels, making climate action an urgent priority
- **Inland communities** may feel less immediate risk from these direct impacts
 - This can lead to a perceived **lower urgency**

Perspectives based on economic interests

- Countries or communities that benefit economically from **fossil fuel industries** may have mixed views on climate action
 - E.g. **oil-exporting nations** may be hesitant to reduce fossil fuel production due to economic dependence on oil revenues
- Economies not reliant on fossil fuels may be more supportive of renewable energy policies
 - These economies see renewable energy as beneficial for both their economic growth and the wider environment



Your notes



Examiner Tips and Tricks

Taking different perspectives into account is complex—remember that perspectives can vary **within** and **between** countries, communities, and age groups. You should be able to explain how this creates **challenges** for achieving **unified climate action**.



Your notes