

## Topic 7: Climate change and energy production (13 hours)

**Big questions:** This topic may be particularly appropriate for considering big questions A, B, C, D, E and F.

### 7.1: Energy choices and security

#### Significant ideas:

- There is a range of different energy sources available to societies that vary in their sustainability, availability, cost and sociopolitical implications.
- The choice of energy sources is controversial and complex. Energy security is an important factor in making energy choices.

#### Knowledge and understanding:

- Fossil fuels contribute to the majority of humankind's energy supply, and they vary widely in the impacts of their production and their emissions; their use is expected to increase to meet global energy demand.
- Sources of energy with lower carbon dioxide emissions than fossil fuels include renewable energy (solar, biomass, hydropower, wind, wave, tidal and geothermal) and their use is expected to increase. Nuclear power is a low-carbon low-emission non-renewable resource but is controversial due to the radioactive waste it produces and the potential scale of any accident.
- Energy security depends on adequate, reliable and affordable supply of energy that provides a degree of independence. An inequitable availability and uneven distributions of energy sources may lead to conflict.
- The energy choices adopted by a society may be influenced by availability; sustainability; scientific and technological developments; cultural attitudes; and political, economic and environmental factors. These in turn affect energy security and independence.
- Improvements in energy efficiencies and energy conservation can limit growth in energy demand and contribute to energy security.

#### Guidance:

- Strengths and weaknesses of the use of a fossil fuel, of a renewable source of energy, and of nuclear power should be considered.
- Use case studies to highlight the energy choices of different countries.

#### International-mindedness:

- Choice of energy sources can have impacts at both local and global level as emissions of greenhouse gases can contribute to global climatic change.
- Political and economic situations around the world can affect energy security and choice of options.

#### Theory of knowledge:

- The choice of energy sources is controversial and complex—how can we distinguish between a scientific claim and a pseudoscience claim when making choices?



### 7.1: Energy choices and security

#### Applications and skills:

- **Evaluate** the advantages and disadvantages of different energy sources.
- **Discuss** the factors that affect the choice of energy sources adopted by different societies.
- **Discuss** the factors that affect energy security.
- **Evaluate** the energy strategy of a given society.

#### Connections:

- ESS: Energy and equilibria (1.3); sustainability (1.4); resource use in society (8.2); human population carrying capacity (8.4).
- Diploma Programme: Social and cultural anthropology; chemistry (option C); design technology (topic 2); physics (topics 8 and 11); geography (topics 3 and 4); economics

## 7.2: Climate change—causes and impacts

### Significant ideas:

- Climate change has been a normal feature of the Earth's history, but human activity has contributed to recent changes.
- There has been significant debate about the causes of climate change.
- Climate change causes widespread and significant impacts on a global scale.

### Knowledge and understanding:

- Climate describes how the atmosphere behaves over relatively long periods of time, whereas weather describes the conditions in the atmosphere over a short period of time.
- Weather and climate are affected by oceanic and atmospheric circulatory systems.
- Human activities are increasing levels of greenhouse gases (GHGs, such as carbon dioxide, methane and water vapour) in the atmosphere, which leads to:
  - an increase in the mean global temperature
  - increased frequency and intensity of extreme weather events
  - the potential for long-term changes in climate and weather patterns
  - rise in sea level.

### Guidance:

- GHGs are those atmospheric gases that absorb infrared radiation, causing global temperatures to be higher than they would otherwise be.
- Students should be able to distinguish between the natural and the enhanced greenhouse effect and to identify a variety of human activities that contribute to GHG emissions. Students must understand the concept of tipping points and how it might be applied to climate change.
- A minimum of two different viewpoints should be considered.

### International-mindedness:

- The impacts of the climate change are global and require coordinated international action.

## 7.2: Climate change—causes and impacts

- The potential impacts of climate change may vary from one location to another and may be perceived as either adverse or beneficial. **These impacts may include changes in water availability, distribution of biomes and crop growing areas,** loss of biodiversity and ecosystem services, coastal inundation, ocean acidification, and damage to human health.
- Both negative and positive feedback mechanisms are associated with climate change and may involve very long time lags.
- There has been significant debate due to conflicting EVSs surrounding the issue of climate change.
- Global climate models are complex and there is a degree of uncertainty regarding the accuracy of their predictions.

### Applications and skills:

- **Discuss** the feedback mechanisms that would be associated with a change in mean global temperature.
- **Evaluate** contrasting viewpoints on the issue of climate change.

### Theory of knowledge:

- There has been considerable debate about the causes of climate change—does our interpretation of knowledge from the past allow us to reliably predict the future?

### Connections:

- ESS: Systems and models (1.2); energy and equilibria (1.3); threats to biodiversity (3.3); access to fresh water (4.2); aquatic food production systems (4.3); terrestrial food production systems and food choices (5.2); introduction to the atmosphere (6.1); stratospheric ozone (6.2); human population carrying capacity (8.4)
- Diploma Programme: Social and cultural anthropology; chemistry (option C); physics (topic 8); geography (topics 3 and 4); economics; biology (topic 4)

**7.3: Climate change—mitigation and adaptation****Significant ideas:**

- Mitigation attempts to reduce the causes of climate change.
- Adaptation attempts to manage the impacts of climate change.

**Knowledge and understanding:**

- Mitigation involves reduction and/or stabilization of GHG emissions and their removal from the atmosphere.
- Mitigation strategies to reduce GHGs in general may include:
  - reduction of energy consumption

**Guidance:**

- CCS is carried out by carbon dioxide being compressed, transported and stored permanently underground (geological sites used as repositories) or chemically fixed to form a carbonate.

### 7.3: Climate change—mitigation and adaptation

- reduction of emissions of oxides of nitrogen and methane from agriculture
- use of alternatives to fossil fuels
- geo-engineering.
- Mitigation strategies for carbon dioxide removal (CDR techniques) include:
  - protecting and enhancing carbon sinks through land management; for example, through the UN collaborative programme on reducing emissions from deforestation and forest degradation in developing countries (UN-REDD)
  - using biomass as a fuel source
  - using carbon capture and storage (CCS)
  - enhancing carbon dioxide absorption by the oceans through either fertilizing oceans with compounds of nitrogen, phosphorus and iron to encourage the biological pump, or increasing upwellings to release nutrients to the surface.
- Even if mitigation strategies drastically reduce future emissions of GHGs, past emissions will continue to have an effect for decades to come.
- Adaptation strategies can be used to reduce adverse affects and maximize any positive effects. Examples of adaptations include flood defences, vaccination programmes, desalination plants and planting of crops in previously unsuitable climates.
- Adaptive capacity varies from place to place and can be dependent on financial and technological resources. MEDCs can provide economic and technological support to LEDCs.

- Mitigation is the use of technology and substitution to reduce resource inputs and emissions per unit of output.
- Adaptation is the adjustment of natural or human systems in response to actual or expected climatic stimuli or their effects, which either moderates harm or exploits beneficial opportunities.
- Two mitigation and two adaptation strategies should be considered.

**International-mindedness:**

- The impacts of climate change are global and require global mitigation.

**Theory of knowledge:**

- There is a degree of uncertainty in the extent and effect of climate change—how can we be confident of the ethical responsibilities that may arise from knowledge when that knowledge is often provisional or incomplete?

**Connections:**

- ESS: Humans and pollution (1.5); access to fresh water (4.2); photochemical smog (6.3)
- Diploma Programme: Physics (topic 8); economics

7.3: Climate change—mitigation and adaptation	
<ul style="list-style-type: none"> <li>There are international efforts and conferences to address mitigation and adaptation strategies for climate change; for example, the Intergovernmental Panel on Climate Change (IPCC), National Adaptation Programmes of Action (NAPAs) and the United Nations Framework Convention on Climate Change (UNFCCC).</li> </ul> <p><b>Applications and skills:</b></p> <ul style="list-style-type: none"> <li><b>Discuss</b> mitigation and adaptation strategies to deal with impacts of climate change.</li> <li><b>Evaluate</b> the effectiveness of international climate change talks.</li> </ul>	