Pearson BTEC Level _ Higher Nationals in Engineering (RQF)

Unit 51: Sustainability

Unit Workbook 1

in a series of 3 for this unit

Learning Outcome 1

Technical Challenges

Contents

INTRODUCTION

Determine the nature and scope of the technical challenges of ensuring sustainable development.

- *The scope and social context of sustainability:*
  - Sustainable development.
  - Brundtland definition.
  - Global demographics, trends and predictions.
  - Population growth.
  - Standard of living, actual and expected.
  - Urbanisation and the balance of urban/rural space.
  - Sustainable design.
- *Environmental issues:*
  - Climate change, planetary energy balance, carbon cycle science, the 2°C climate change obligation.
  - Carbon capture and sequestration.
  - Pollution, pollution prevention and management.
  - Carbon trading.
  - Eco-systems and habitat.
- *Resources:*
  - Food, water and energy.

GUIDANCE

This document is prepared to break the unit material down into bite size chunks. You will see the learning outcomes above treated in their own sections. Therein you will encounter the following structures;

Purpose

Explains *why* you need to study the current section of material. Quite often learners are put off by material which does not initially seem to be relevant to a topic or profession. Once you understand the importance of new learning or theory you will embrace the concepts more readily.

Theory

Conveys new material to you in a straightforward fashion. To support the treatments in this section you are strongly advised to follow the given hyperlinks, which may be useful documents or applications on the web.

Example

The examples/worked examples are presented in a knowledge-building order. Make sure you follow them all through. If you are feeling confident then you might like to treat an example as a question, in which case cover it up and have a go yourself. Many of the examples given resemble assignment questions which will come your way, so follow them through diligently.

Question

Questions should not be avoided if you are determined to learn. Please do take the time to tackle each of the given questions, in the order in which they are presented. The order is important, as further knowledge and confidence is built upon previous knowledge and confidence. As an Online Learner it is important that the answers to questions are immediately available to you. Contact your Unit Tutor if you need help.

Challenge

You can really cement your new knowledge by undertaking the challenges. A challenge could be to download software and perform an exercise. An alternative challenge might involve a practical activity or other form of research.

Video

Videos on the web can be very useful supplements to your distance learning efforts. Wherever an online video(s) will help you then it will be hyperlinked at the appropriate point.

1.1.2 Global Demographics, Trends & Population

Sustainability is a global, multi-layered concept, which is directly affected by the sheer numbers of people who inhabit the Earth. To put it simply, the more people there are, the more resources they will consume and the more that is produced.

The unsustainable consumption patterns of people have an effect on the capacity of the Earth to support life, resources and land, water, air and energy are all affected by these consumption patterns. People and population dynamics have a huge influence on development, and it is a major challenge to meet the needs of the growing population whilst influencing production and consumption patterns in order to attain sustainable development. All of the goals of sustainable development are affected by population growth, ageing and decline, along with migration and urbanisation.

Certain changes in **demographics** can lead to positive and negative effects, for example: a fall in fertility levels along with slowed population growth results in a larger proportion of the **population** within working age, which in turn leads to increased economic development. It is therefore important to track demographic trends and, based on this data, it is then possible to make predictions about future trends. Examples of commonly seen demographic trends are the population growth rate and the share of working age population, as represented below:

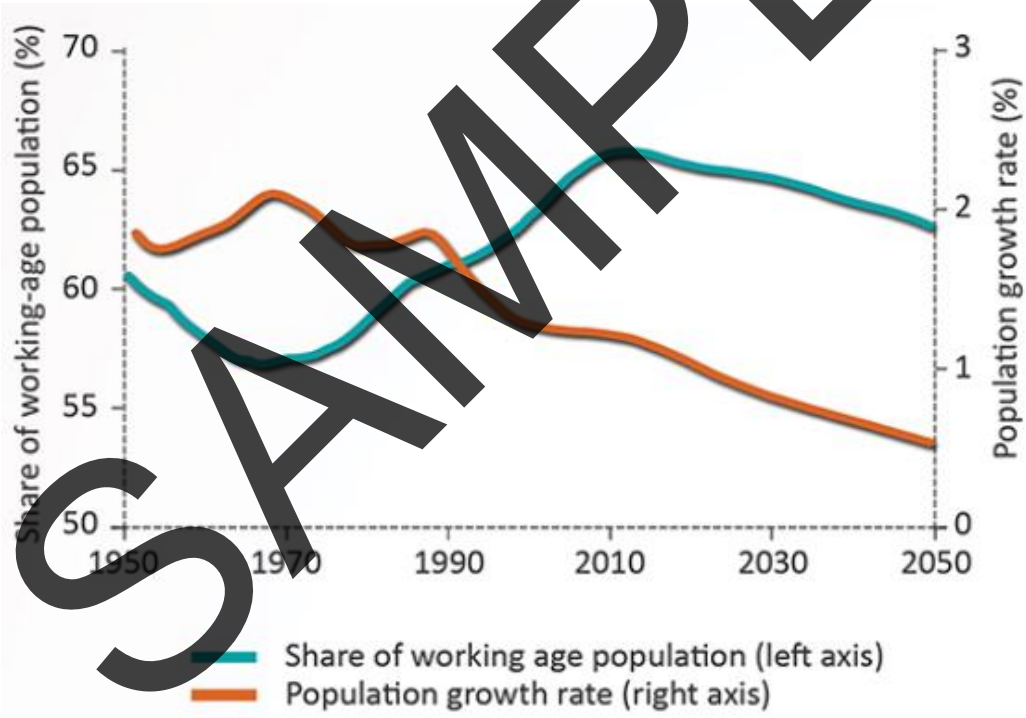

Figure 1.4: *Population Trends Graph*

1.1.3 Standard of Living, Urbanisation & Sustainable Design

The standard of living is a term that can be applied to either an individual person or to a general social/economic class of people. It is defined as the level of wealth and material comfort available to a person or group of people. There are several factors affecting the standard of living, including income, poverty rate, housing affordability, gross domestic product (GDP), inflation rate, access to quality healthcare, quality & availability of education & employment, class disparity, required hours of work to purchase necessities, amount of leisure time per year, life expectancy, disease incidence, costs of goods and services, economic & political stability, environmental quality, climate, safety and freedom.

Standard of living is very closely related to the quality of life; however, a person's quality of life is also affected by other intangible aspects such as cultural resources and social life. Both standard of living and quality of life are considered to be flawed indicators, in at least some sense because of such large variations within countries, communities and in even between individuals. These subjects are explored fully by professional social scientists. More recent terms have come to have similar meanings, the Human Development Index (HDI) ranks countries into tiers of human development, taking into account life expectancy, education and per capita income indicators.

There are several independent public organisations such as the Office for National Statistics and the Institute for Fiscal Studies which offer extensive records and predictions on a range of national statistics, each may use different factors in measuring standard of living so it is not always easy to find a definitive answer, often averages of all sources are taken as the best measure.

Predictions are made by social scientists about the likely future changes of factors affecting standard of living as well as the overall standard of living as a whole. An example of such a prediction can be seen below:

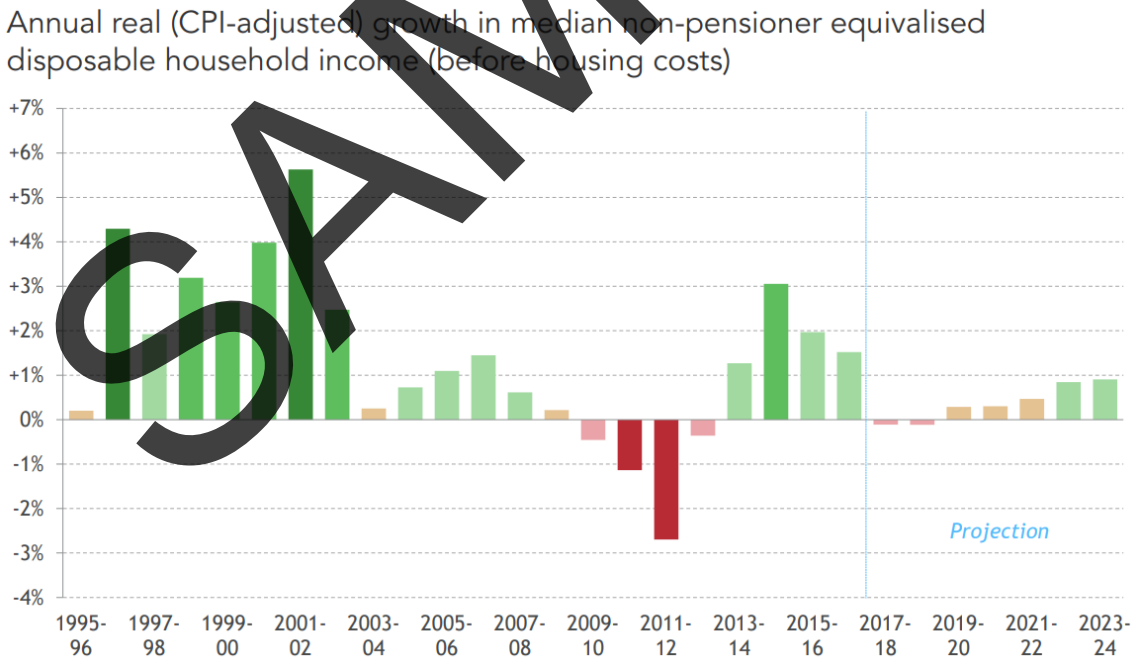

Figure 1.5: *Income Growth Graph*

Of course, the predictions can be compared to the real-life situation when it occurs and discrepancies can then be analysed, feeding this back in to future predictions to make them more accurate.

The effects of global warming will be felt differently in different areas of the world and even within different areas of specific countries. Of course, a rise in temperatures can actually have positive effects, the chances of a very cold frosty winter occurring are reduced, leading to an increased amount of time available to grow crops. However, with this increase in temperatures, comes an increased probability of droughts and heat waves, bringing about a reduction in soil moisture. Additionally, hurricanes will become stronger and more intense whilst sea levels will rise, and the arctic ocean will become virtually ice-free. Extreme weather has an economic impact, it damages property and infrastructure as well as impacts human health and productivity, whilst the knock-on effect of trade between countries is also negatively impacted.

Clearly these impacts have a detrimental effect to sustainability overall, if these impacts were allowed to continue unchecked then the eventual result would be an uninhabitable Earth, temperatures would simply be too high for animals, including humans to tolerate, whilst crops would not be able to grow successfully. Eventually the Earth's protective o-zone layer would also be ineffective and result in an atmosphere unsuitable for supporting life.

Planetary energy balance is an important element to consider within the context of environmental issues and provides a means to measure global changes. The concept of a planetary energy balance refers to the differences between the amounts of energy absorbed by the Earth, from the sun, and the amounts of energy that are emitted by the Earth back into space. The specific proportions of energy can be seen below:

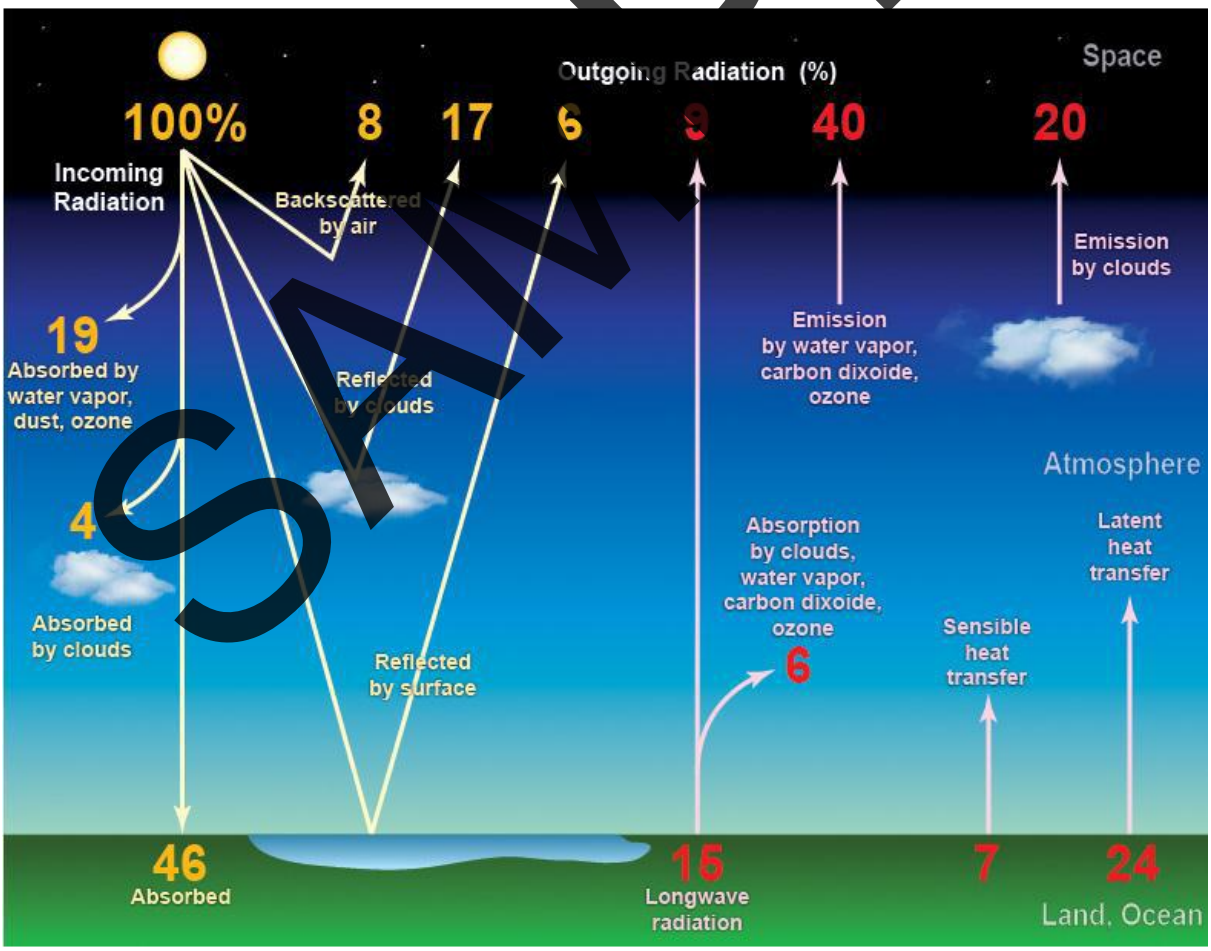

Figure 1.7: *Planetary Energy Balance Components*

Carbon capture and sequestration are terms that have similar meanings, sequestration is actually a process involved within carbon capture. As is evident in the carbon cycle, there are many biological process that capture carbon in various forms, however it is also possible to capture carbon artificially through the use of ocean water, againg oil fields, resevoirs and other carbin sinks. Carbon Dioxide can also be captured and then stored underground, meaning that it is not released into the atmosphere.

More recently, there have been developments in ways to trasform waste CO_2 into useful products, thus decreasing the amount that is released into the atmosphere. Examples can be seen in the biogas industry, where cow dung and maize are broken down by bacteria, CO_2 is added to act as a binding agent. Another example is in the beverage industry where manure is processed in a bio-digester and the clean CO_2 is extracted to make fizzy drinks. Finally, within waste incinerator plants there are chimneys which accumulate ash over time. When the ash is mixed with water and CO_2, and then heated, it can be formed into artificial limestone blocks which can be used for building and a variety of other purposes.

There are many innovations which seek to be carbon-neutral, however some now claim to actually be carbon -negative, i.e. they remove more carbon-dioxide then they produce. Some examples of these neutral and negative processes can be seen below:

Video

https://www.youtube.com/watch?v=QPC5_P2_Fu8

In fact, the entire country of Bhutan manages to maintain carbon-negativity:

https://www.youtube.com/watch?v=7Lc_dlVrg5M

On an international scale, the UN has set targets based on the 2°C climate change obligation, whereby countries have to limit the amount of carbon dioxide that they produce in order to affect global temperature levels. **Carbon trading** is a process whereby countries can buy and sell credits and permits to emit cerbon dioxide, a country with high carbon emissions is able to purchase the right to emit more, whilst a low carbon emission country is able to sell these same rights. These rights can can traded between counties or other entitiies and the intended effect is that of overall fewer emissions.

The results have been mixed, some countries use carbon trading to actually reduce their carbon emissions whilst others appear to have not reduced emissions at all. The whole idea has been critisised heavily and there are loopholes which some countries and individuals exploit in order to continue high carbon emission activities.

The European Carbon Market is an example of one such carbon trading scheme and an explanation of this can be seen bleow:

Video

https://www.youtube.com/watch?v=qxdxBfZKoa0