Figure 2  An example of primary, delivered and useful energy

The energy released when the coal is burned is called the primary energy required for that use. The amount of electricity reaching the consumer, after conversion losses in the power station and transmission losses in the electricity grid, is the delivered energy (sometimes called final energy). After some losses in the local wires and light bulb, a quantity called the useful energy emerges as light.

Let’s now have a brief look at the world’s energy supplies.

1.1.6  1.4 Energy supply and demand: world and UK The energy used by a final consumer is usually the end result of a series of energy conversions. For example, as you can see from Figure 2, energy from burning coal may be converted in a power station to electricity, which is then distributed to households and used for lighting. 27 View larger image

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1.5.1 What are the causes of climate change? The surface temperature of the Earth establishes itself at an equilibrium level where the incoming energy from the Sun balances the outgoing infrared energy re-radiated from the surface back into space, as we will discuss in more detail later in the course. If the Earth had no atmosphere its surface temperature would be minus 18 °C, but its atmosphere includes ‘greenhouse gases’. The natural ‘greenhouse effect’ that these gases cause is essential in maintaining the Earth’s surface temperature at a level suitable for life – around 15 °C. Activity 4 What are principal greenhouse gases? Hide answer They are: water vapour carbon dioxide methane. These act like the panes of a greenhouse, allowing solar radiation to enter, but inhibiting the outflow of long-wave infrared heat radiation. Since the Industrial Revolution human activities have been adding extra greenhouse gases to the atmosphere, with the principal contributor being carbon dioxide (CO2) from the combustion of fossil fuels. So what will happen if this continues? Scientists estimate (IPCC, 2007a) that these human-induced emissions caused a rise in the Earth’s global mean surface temperature of approximately 0.7 °C between 1950 and 2005 (Figure 9). If emissions are not curbed they estimate that the temperature is likely to rise by between 1.4 and 5.8 °C by the end of the twenty-first century. Such rises would increase the frequency of climatic extremes – floods or droughts – causing serious disruptions to agriculture and natural ecosystems. Thermal expansion of the world’s oceans could also mean that sea levels would rise by around 0.5 m by the end of the century, inundating some low-lying areas. And beyond 2100, or perhaps before, much greater sea level rises could occur if major Antarctic ice sheets were to melt. 27 View larger image27 Figure 9 Observed changes in global average surface temperature 1860–2005 (source: IPCC, 2007b) The threat of these global climate changes is one of the main reasons why there is a growing consensus on the need to reduce greenhouse gas emissions. So what should we do to reduce emissions? Climate change experts advise that global
available on standby in case other electricity generation is insufficient to meet demand. In 2014 the EU decided on new targets, stipulating that by 2030: European carbon emissions should be reduced by 40% the contribution of renewable energy to EU supplies should reach 27%. A target to achieve a 30% improvement in energy efficiency was also agreed, but not specific renewable energy targets for individual member countries, such as the UK. However, the UK Committee on Climate Change in its 2011 report on Renewable Energy (CCC, 2011) envisaged four scenarios for UK renewables by 2030. As shown in Figure 13 it suggested that the renewable energy contribution could rise to: between 35% and 65% of electricity supplies between 35% and 50% of UK heat demand between 11% and 25% of transport energy needs. 27 View larger image27 Figure 13 Scenarios from the UK Committee on Climate Change illustrating the potential contribution of renewables to UK heat (H), electricity (E) and transport energy (T). Figure 13 also suggests that the total contribution of renewables to gross final consumption could be between 28% and 46%, and this, together with other similar analyses, suggests that the prospects for renewable energy in the coming decades look bright! You will examine in more detail the future prospects for renewables in the UK, the EU and the world as a whole later in the course. To conclude this week we look at a case study of a country that has adopted very ambitious renewable energy targets.

1.10 Week 1 summary

To sum up this first week, we:

- briefly described the historical evolution of renewable energy sources
- described the key characteristics of a ‘sustainable’ energy source and outlined some basic energy principles and terminology, along with some
definitions of ‘renewable energy’, explaining that the primary source of nearly all forms of renewable energy is the Sun

- explained the differences between primary energy, delivered energy and useful energy, and gave data on world energy consumption per person, plus some statistics on total world energy consumption and the proportion contributed by renewables
- looked at the UK and the contributions of renewables to delivered energy in all forms, and to electricity in particular
- looked briefly at climate change and the contribution to global warming that is being made by the carbon dioxide emissions from fossil fuel combustion
- overviewed renewable energy sources, starting with direct solar thermal energy and solar photovoltaics, followed by indirect sources – biofuels, hydropower, wind and wave energy
- looked briefly at UK and European targets for the contributions of renewable energy to be achieved by 2020 and by 2030, including projections of the potential renewable contributions to electricity, heat and transport fuel needs
- looked at a case study describing Scotland’s ambitious plans for a major expansion of its renewable energy supplies over the coming decade.

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