Pearson BTEC Levels 4 and 5 Higher Nationals in Engineering (RQF)

Unit 44: Industrial Power, Electronics and Storage

Unit Workbook 2

in a series of 4 for this unit

Learning Outcome 2

Technology and Policies of Energy Efficiency in Building and Transportation

Contents

INTRODUCTION

Exploring current energy efficiency measures, technologies and policies specific to the building and transportation sectors.

- *Energy auditing, management, costs, requirements, bench marking and optimisation:*
  - Energy management, planning, monitoring, policy, ecology and environment.
- *Energy and buildings:*
  - Overview of the significance of energy use and energy processes.
  - Internal and external factors on energy use and the attributes of the factors.
  - Status of energy use in buildings and estimation of energy use in a building.
  - Standards for thermal performance of building envelope and evaluation of the overall thermal transfer.
  - Measures and technologies to improve energy efficiency in buildings.
- *Energy and electric vehicles:*
  - Electrical vehicle configurations, requirements, and circuit topology; electric and plug in hybrid vehicles.
  - Policies, measures and technologies to support more sustainable transportation.
  - Use of MATLAB/Simulink or alternative appropriate software to model, simulate and analyse the energy efficiency of a typical standard house or electric vehicle.

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.

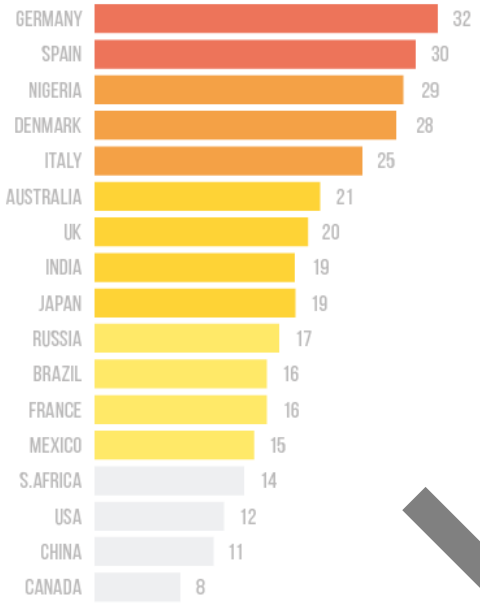

Fig.2.1: Average Electricity Costs Around the World

Germany and Spain have expensive electricity. Canadian electricity is cheap at 8 US cents per kilowatt hour, and this is reflected in their high average electricity usage. US electricity prices at 0.12 $/kWh are also quite cheap internationally. In India and China, they are very cheap. The UK is in the middle at 20 cents/KWh. It's relatively expensive globally but not too bad for Europe, where most countries pay a high share of tax on their power.

In the UK in the last ten years the real price of electricity has risen by 63%, while for gas it has gone up a staggering 115%. These are real prices, so these are the changes after having adjusted for inflation. If you were to look at it nominal prices you'd understand how energy prices became such a hot issue. Ten years ago, a unit of electricity used to cost 7 pence, but today it might be in the region 15p. Likewise, gas went from 2p to 5p. What this meant that was the average dual fuel bill rocketed from £600 to £1,300 over the course of a decade. As our demand for energy grows, so, in all likelihood, will the cost.

Fig.2.1 includes the cost of electricity provided by both renewable and conventional power generating technologies. However, the cost range across the renewable energy technologies is wide, considerably wider compared with conventional energies. The most mature and widely deployed clean energy technologies such as hydro and onshore wind are today close to reaching parity with traditional sources, while emerging technologies such as marine tidal and wave are still at the early phases of cost discovery.

For technologies that are widely deployed across the globe, such as onshore wind, crystalline silicon PV and hydropower, there are significant cost variations between the regions. The costs in Western Europe, the US and most notably Japan are typically several times larger than those in China and India due to limited access to cheap components and higher O&M costs.

Many of the other technologies are currently only deployed in specific regions, depending on the characteristics of the technology and local policy support. However, in line with the continued growth in

clean energy investment, the geographic spread of the technologies is likely to increase in the future into countries such as Brazil and South Africa.

2.5 Energy Requirements

According to the International Energy Outlook 2017 (IEO2017) Reference case, total world energy consumption is set to rise from 575 quadrillion British thermal units (Btu) in 2015 to 736 quadrillion Btu in 2040, an increase of 28%. Most of the world's energy growth will occur in countries outside of the Organization for Economic Cooperation and Development (OECD), where strong, long-term economic growth drives increasing demand for energy. Non-OECD Asia (including China and India) alone accounts for more than half of the world's total increase in energy consumption over the 2015 to 2040 projection period. By 2040, energy use in non-OECD Asia exceeds that of the entire OECD by 41 quadrillion Btu in the IEO2017 Reference case (Fig.2.2).

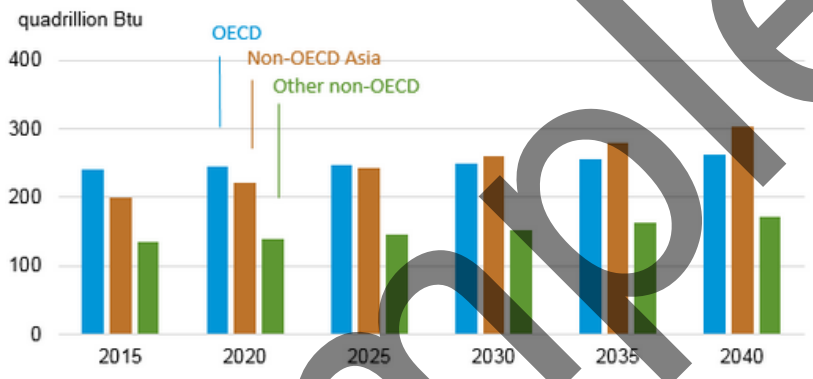

Fig.2.1: World Energy Consumption by country grouping

Economic growth, as measured by gross domestic product (GDP), is a key determinant in the growth of energy demand. The world's GDP (expressed in purchasing power parity terms) rises by 3.0%/year from 2015 to 2040. The fastest rates of growth are projected for the emerging, non-OECD regions, where combined GDP increases by 3.8%/year, driving the fast-paced growth in future energy consumption among those nations. In the OECD regions, GDP grows at a much slower rate of 1.7%/year between 2015 and 2040, at least in part, because of slow or declining population growth in those regions. Economic growth, as measured in GDP, is also a key determinant in the growth of energy demand. The world's GDP (expressed in purchasing power parity terms) rises by 3.3%/year from 2012 to 2040. The fastest rates of growth are projected for the emerging, non-OECD countries, where combined GDP increases by 4.2%/year. In OECD countries, GDP grows at a much slower rate of 2.0%/year over the projection as a result of their more mature economies and slow or declining population growth trends. The strong projected economic growth rates in the non-OECD drive the fast-paced growth in future energy consumption among those nations.

2.5.1 World energy markets by fuel type

In the long term, the IEO2017 Reference case projects increased world consumption of marketed energy from all fuel sources (except coal, where demand is essentially flat) through 2040 (Fig.2.3). Renewables are the world's fastest-growing energy source, with consumption increasing by an average 2.3%/year. The

world's second fastest-growing source of energy is nuclear power, with consumption increasing by 1.5%/year over that period.

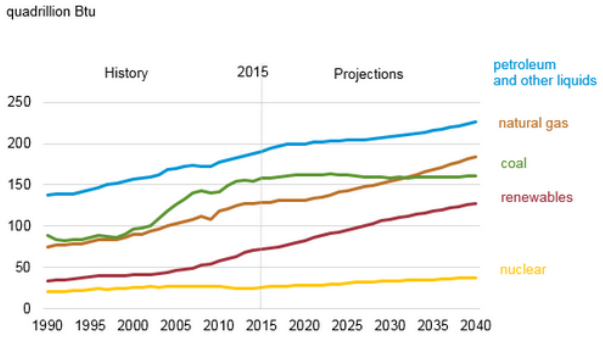

Fig.2.2: World Energy Consumption by Energy Source

Although consumption of non-fossil fuels is expected to grow faster than fossil fuels, fossil fuels still account for 77% of energy use in 2040. Natural gas is the fastest-growing fossil fuel in the projections. Global natural gas consumption increases by 1.4%/year. Abundant natural gas resources and rising production (tight gas, shale gas, and coalbed methane) contribute to the strong competitive position of natural gas. Liquid fuels (mostly petroleum-based) remain the largest source of world energy consumption. However, the liquids share of world marketed energy consumption falls from 33% in 2015 to 31% in 2040, as oil prices rise steadily, causing users to adopt more energy-efficient technologies and to switch away from liquid fuels when feasible.

Compared with the strong growth in coal use in the 2000s, worldwide coal use remains flat in the IEO2017 Reference case. Coal is increasingly replaced by natural gas, renewables, and nuclear power (in the case of China) for electric power generation, and demand for coal also weakens for industrial processes. China is the world's largest consumer of coal, but coal use is projected to decline in China by 0.6%/year, and also in the combined OECD countries by 0.6%/year. With coal consumption in India and other nations in non-OECD Asia growing over the projection period, worldwide coal consumption is not as low as it would otherwise be in 2040. The coal share of total world energy consumption declines significantly over the projection period, from 27% in 2015 to 22% in 2040.

2.5.2 Electricity

In the IEO2017 Reference case, world net electricity generation increases by 45%, rising from 23.4 trillion kWh in 2015 to 34.0 trillion kWh in 2040. Electricity is the world's fastest-growing form of end-use energy consumption, as it has been for many decades. Power systems continue to evolve from isolated, non-competitive grids to integrated national and international markets.

The strongest growth in electricity generation is projected to occur among the developing, non-OECD nations. Increases in electricity generation in non-OECD countries average 1.9%/year as rising living standards increase demand for home appliances and electronic devices, and for commercial services, including hospitals, schools, office buildings, and shopping malls. In OECD nations, where infrastructures are more mature and population growth is relatively slow or declining, electric power generation increases by an average of 1.0%/year from 2015 to 2040 in the IEO2017 Reference case.