OCR
Oxford Cambridge and RSA

Cambridge **TECHNICALS LEVEL 3**

Cambridge TECHNICALS 2016

# LABORATORY SKILLS

## Unit 15 – Sustainability and renewable energy

## DELIVERY GUIDE

Version 1

ocr.org.uk/science

# CONTENTS

# INTRODUCTION

**This Delivery Guide has been developed to provide practitioners with a variety of creative and practical ideas to support the delivery of this qualification. The Guide is a collection of lesson ideas with associated activities, which you may find helpful as you plan your lessons.**

OCR has collaborated with current practitioners to ensure that the ideas put forward in this Delivery Guide are practical, realistic and dynamic. The Guide is structured by learning outcome so you can see how each activity helps you cover the requirements of this unit.

We appreciate that practitioners are knowledgeable in relation to what works for them and their learners. Therefore, the resources we have produced should not restrict or impact on practitioners' creativity to deliver excellent learning opportunities.

Whether you are an experienced practitioner or new to the sector, we hope you find something in this guide which will help you to deliver excellent learning opportunities.

If you have any feedback on this Delivery Guide or suggestions for other resources you would like OCR to develop, please email resources.feedback@ocr.org.uk.

## OPPORTUNITIES FOR ENGLISH AND MATHS SKILLS DEVELOPMENT AND WORK EXPERIENCE

We believe that being able to make good progress in English and maths is essential to learners in both of these contexts and on a range of learning programmes. To help you enable your learners to progress in these subjects, we have signposted opportunities for English and maths skills practice within this resource. We've also identified any potential work experience opportunities within the activities. These suggestions are for guidance only. They are not designed to replace your own subject knowledge and expertise in deciding what is most appropriate for your learners.

English

Maths


Work

**Please note**

The activities suggested in this Delivery Guide **MUST NOT** be used for assessment purposes. The timings for the suggested activities in this Delivery Guide **DO NOT** relate to the Guided Learning Hours (GLHs) for each unit.

Assessment guidance can be found within the Unit document available from http://www.ocr.org.uk/. The latest version of this Delivery Guide can be downloaded from the OCR website.

## UNIT AIM

Renewable energy is a key element in the energy mix of nations. It is a key government tool in tackling climate change but is not without controversy.

In this unit you will explore the different technologies that produce renewable energy, you will explore the drivers for change and the different arguments about renewable energy. You will determine the environmental impact of different forms of energy production and suggest suitable mitigation and energy production activities.

You will learn how to measure energy transfer and calculate energy efficiencies of energy sources using real data sources and scientific equipment to take measurements such as voltage; current; mass; temperature; time.

| Unit 15 Sustainability and renewable energy | |
|---|---|
| LO1 | Understand the impacts of energy consumption |
| LO2 | Be able to measure energy transfer and calculate energy efficiencies of energy sources |
| LO3 | Understand renewable energy technologies |
| LO4 | Be able to recommend sustainable solutions to meet energy demands |

To find out more about this qualification, go to: http://www.ocr.org.uk/qualifications/vocational-education-and-skills/cambridge-technicals-laboratory-skills-level-3-introductory-diploma-diploma-05847-05849-2016-suite/

Cambridge TECHNICALS 2016

### *2016 Suite*

- **New suite for first teaching September 2016**
- **Externally assessed content**
- **Eligible for Key Stage 5 performance points from 2018**
- **Designed to meet the DfE technical guidance**

# RELATED ACTIVITIES

The Suggested Activities in this Delivery Guide listed below have also been related to other Cambridge Technicals in Laboratory Skills units/Learning Outcomes (LOs). This could help with delivery planning and enable learners to cover multiple parts of units.

| This unit (Unit 15) | Title of suggested activity | Other units/LOs | |
|---|---|---|---|
| **LO1** | Addicted to power | Unit 13 Environmental surveying | LO1 Understand environmental impacts of human activity and natural processes |
| | Fuelled by the Earth | Unit 13 Environmental surveying | LO1 Understand environmental impacts of human activity and natural processes |
| | | Unit 14 Environmental management | LO2 Be able to identify pollution in the environment |
| | Costing the Earth 1: cost of energy production | Unit 14 Environmental management | LO4 Understand environmental management assessments |
| | Costing the Earth 2: carbon emissions | Unit 13 Environmental surveying | LO1 Understand environmental impacts of human activity and natural processes |
| | Costing the Earth 3: pollution<br>Costing the Earth 4: finite resources | Unit 14 Environmental management | LO2 Be able to identify pollution in the environment |
| | I can make a difference!<br>Where are we heading? | Unit 14 Environmental management | LO3 Understand how legislation, regulation and agreements impact on managing natural and built environments |
| **LO2** | Designing experiments to determine power generation | Unit 1 Science fundamentals | LO6 Understand the structures, properties and uses of materials |
| | | Unit 2 Laboratory techniques | LO2 Be able to separate, identify and quantify the amount of substances present in a mixture |
| | | Unit 6 Control of hazards in the laboratory | LO2 Be able to use health and safety procedures to minimise the risk presented by hazards in a laboratory |
| | Wind power<br>Power from combustion (fossil fuels and biomass)<br>Hydro power<br>Solar power | Unit 14 Environmental management | LO2 Be able to identify pollution in the environment |
| | Energy usage<br>Climate change; can we stop it? Part 1 | Unit 13 Environmental surveying | LO1 Understand environmental impacts of human activity and natural processes |
| | True cost of energy | Unit 14 Environmental management | LO4 Understand environmental management assessments |
| | Climate change; can we stop it? Part 2 | Unit 13 Environmental surveying | LO1 Understand environmental impacts of human activity and natural processes |
| | | Unit 14 Environmental management | LO3 Understand how legislation, regulation and agreements impact on managing natural and built environments |
| **LO3** | Fossil fuels are not the only way<br>A new way of thinking about energy<br>Chemical technology: hydrogen fuel cells | Unit 13 Environmental surveying | LO1 Understand environmental impacts of human activity and natural processes |
| | | Unit 14 Environmental management | LO3 Understand how legislation, regulation and agreements impact on managing natural and built environments |

# KEY TERMS

| Explanations of the key terms used within this unit, in the context of this unit | |
|---|---|
| **Key term** | **Explanation** |
| **DECC** | The Department of Energy and Climate Change, the government department responsible for energy. In July 2016, DECC became part of the new Department for Business, Energy and Industrial Strategy (https://www.gov.uk/government/organisations/department-for-business-energy-and-industrial-strategy). |
| **Low carbon energy** | A source of energy or technology that releases significantly less carbon dioxide into the atmosphere than traditional fossil fuels. This includes all renewable sources, nuclear energy, carbon capture and storage, ground source heat exchangers. |
| **Renewable energy** | A source of energy that is not exhausted by use, but is continually renewed. For example wind, solar and tidal power. |
| **Sustainability** | The ability to continue a practice or action indefinitely; this could be manufacturing, construction, energy production. Examples include the design of products for 100% recycling. |
| **Units of power** | Power and power usage are usually described in terms of watts and watt-hours. Watts are the amount of instant power required to operate things. A kettle for example requires around 2000 watts or 2 KW to run. A watt-hour is the amount of energy required to run a device requiring 1 watt for 60 minutes. So taking the kettle example, running a kettle for 60 minutes would require 2000 watt-hours or 2 KWhrs of energy. Or looking at it from another angle, if it takes 2 minutes to boil a kettle and it is used to make 30 lots of drinks in a day the power consumption would be 2000 × 2 × 30/60 = 2000 watt-hours or 2 KWhrs. In the UK the average energy requirement in a day is around 35 GW, which is 840 GWhrs a day or 300,000 GWhrs (300 TWhrs) a year.<br><br>1 KW = 1000 W, 1 MW= 1000 KW, 1 GW=1000 MW, 1 TW=1000 GW<br>1 TW = 1,000,000,000,000 W or a trillion watts |

# MISCONCEPTIONS

| Some common misconceptions and guidance on how they could be overcome | | |
|---|---|---|
| **What is the misconception?** | **How can this be overcome?** | **Resources which could help** |
| **Low carbon is the same as renewable** | In the media these two terms are often interchanged but use of clear definitions and examples can help. Renewable sources are ones which will not run out and are constantly renewed. Low carbon refers to energy sources that release little or no carbon into the atmosphere or are carbon neutral.<br><br>All renewable resources can be classed as low carbon but not all low carbon resources can be classed as renewable. | Low-carbon fuels<br>Committee on Climate Change<br>https://www.theccc.org.uk/tackling-climate-change/reducing-carbon-emissions/what-can-be-done/low-carbon-fuels/<br>This definition of low carbon fuels is a good place to start. There is a list of low carbon technologies. Renewables are shown as a subset of low carbon fuels.<br><br>Renewable energy<br>International Energy Agency<br>https://www.iea.org/about/faqs/renewableenergy/<br>This specific definition of renewable energy will help identify the differences. |
| **Energy and power** | Politicians often confuse the term energy with power. Energy refers to electricity, fuels and heat sources. Power is normally used to refer to electricity. The total energy production and use in the UK is far larger than the total power production and use. | We need a Plan B... on energy policy<br>Centre for Policy Studies<br>https://www.cps.org.uk/blog/q/date/2013/10/10/we-need-a-plan-b-on-energy-policy/<br>This web page has a quotation that shows what happens when the definitions are confused:<br>'At the 2007 EU Council, Tony Blair committed the UK to meet a staggering 15 per cent of total energy from renewables, up from around 1.2 per cent at the time. No economic impact assessment was put before Blair (or commissioned) before this draconian and destructive target was agreed. Prime Ministers would do well to recognise the difference between energy and electricity; if Blair thought he was signing up to 15 per cent of electricity from so called green sources then he was wrong – he had in fact committed the UK to sourcing 35 per cent of electricity from renewables by 2020.' |
| **Nuclear energy is renewable** | Nuclear energy uses nuclear material as a fuel; whilst this will last for a long time it is not renewable as it will be ultimately consumed. | Low-carbon fuels<br>Committee on Climate Change<br>https://www.theccc.org.uk/tackling-climate-change/reducing-carbon-emissions/what-can-be-done/low-carbon-fuels/<br>Describes low carbon fuels and technologies including nuclear power.<br><br>The Role of Nuclear Power in a Low Carbon UK Economy<br>The Royal Academy of Engineering<br>http://www.raeng.org.uk/publications/responses/the-role-of-nuclear-power-in-a-low-carbon-uk<br>This gives some useful industry insight into nuclear energy. |

| Some common misconceptions and guidance on how they could be overcome | | |
|---|---|---|
| **What is the misconception?** | **How can this be overcome?** | **Resources which could help** |
| **Fossil fuels are more efficient than renewables** | Renewable energy has the reputation for being unpredictable and not always available; this is not the same as inefficiency. Fossil fuels tend to convert between 30% and 40% of their potential energy into usable power which compares with the availability of wind power where a wind turbine is outputting its designed power output 35% of the time. | Energy Efficiency Indicators for Public Electricity Production from Fossil Fuels<br>International Energy Agency<br>https://www.iea.org/publications/freepublications/publication/En_Efficiency_Indicators.pdf<br>Figures for a range of countries in 2008 based on fossil fuel efficiencies.<br><br>Common concerns about wind power<br>Centre for Sustainable Energy<br>https://www.cse.org.uk/downloads/reports-and-publications/renewables/common_concerns_about_wind_power.pdf<br>This 2011 report has some useful reviews of public data. |
| **Climate change can be stopped or reversed** | There is much discussion about how action can be taken to stop climate change; however, the scientific community is convinced that the consequences of human action to date will lead to a 2 °C global temperature rise and that any action we take is to limit the rise beyond this. | The climate fact no one will admit: 2 °C warming is inevitable<br>New Scientist<br>https://www.newscientist.com/article/dn28430-the-climate-fact-no-one-will-admit-2-c-warming-is-inevitable/<br>There are a lot of articles and publications that look at climate change; this one from the New Scientist lends credibility to the debate. |
| **All renewable energy is unpredictable** | Some forms of renewable energy are dependent on the weather and so can be unpredictable, however sources such as bio-fuels, tidal and hydropower are entirely predictable. Learners can explore the live contribution of renewable energy from the National Grid data. | G.B. National Grid Status<br>Gridwatch<br>http://gridwatch.templar.co.uk/<br>Live National Grid data showing the energy consumption in the UK and the generation sources of that energy. The data is live and includes a database trending back a number of years. There is a link to equivalent data for France. |
| **Human behaviour is not proven to be responsible for climate change** | The challenge for tutors is that interested parties will present their views as fact and often views contradict. Learners should be encouraged to find a range of sources and comment on the reliability of the source. | IPCC climate report: humans 'dominant cause' of warming<br>BBC News<br>http://www.bbc.co.uk/news/science-environment-24292615<br>The IPCC report cites humans as the main cause of global warming.<br><br>Humans are NOT to blame for global warming, says Greenpeace co-founder<br>Daily Mail<br>http://www.dailymail.co.uk/sciencetech/article-2569215/Humans-not-blame-global-warming-says-Greenpeace-founder-Patrick-Moore.html<br>Patrick Moore denies scientific proof for climate change being manmade.<br><br>An illustrated book of Bad Arguments<br>https://bookofbadarguments.com/<br>A fun way to explore the reliability of arguments and the issue of bias. |

# SUGGESTED ACTIVITIES

| LO No: | 1 | | |
|---|---|---|---|
| **LO Title:** | **Understand the impacts of energy consumption** | | |
| **Title of suggested activity** | **Suggested activities** | **Suggested timings** | **Also related to** |
| **Addicted to power** | Learners could explore human dependence on power. Watching this video could lead to a discussion:<br><br>Future Earth – Addicted to Power<br>MSNBC Documentary<br>https://www.youtube.com/watch?v=lpx60pfSLK8<br>This 45-minute documentary takes a pessimistic view of our power dependence. Tutors could ask learners whether they think this is realistic. | 1.5 hours | Unit 13 LO1 |
| **Fuelled by the Earth** | Working either individually or in groups, learners could create an electronic presentation based on the demands for fossil fuel and the global impact of accessing the fossil fuels. There are many online resources learners can access for this activity. The following is a range of resources that could be signposted. Learners could use timetabled study time to access resources or additionally use the resources in personal study time. Tutors could allocated different resources to different groups to generate a combined presentation.<br><br>Leave it in the ground! How fossil fuel extraction affects biodiversity<br>The Conversation<br>http://theconversation.com/leave-it-in-the-ground-how-fossil-fuel-extraction-affects-biodiversity-19484<br>Learners could review the discussions on the effects of coal, oil and gas extraction on biodiversity.<br><br>How Fossil Fuels Are Extracted<br>Benjamin Himme<br>https://www.youtube.com/watch?v=zSOaXzKcxyg<br>This 14-minute YouTube video shows simply how fossil fuel extraction happens.<br><br>Shale gas is a controversial topic. Learners could compare some of the material about fracking, looking at how both the for and against arguments are presented. These two resources give opposing views:<br><br>Debunking the Anti-Fracking Fearmongers<br>Real Clear Science<br>http://www.realclearscience.com/blog/2014/09/debunking_the_anti-fracking_fearmongers.html<br><br>Questionable claims around fracking<br>The Wildlife Trusts<br>http://www.wildlifetrusts.org/blog/thewildlifetrustsblogger/2014/03/13/questionable-claims-around-fracking | 2 hours | Unit 13 LO1<br>Unit 14 LO2 |

| Title of suggested activity | Suggested activities | Suggested timings | Also related to |
|---|---|---|---|
| **Fuelled by the Earth (continued)**  | Shale gas and fracking infographic<br>Department of Energy and Climate Change<br>https://www.flickr.com/photos/deccgovuk/sets/72157635443509437<br>Gives an overview of the fracking process.<br><br>Shale Gas made simple<br>Department of Energy and Climate Change<br>https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/374718/Shale_in_Plain_English_booklet_Web_Final.pdf<br>A 2014 information leaflet explaining benefits of shale gas and regulatory environment.<br><br>Animation of Hydraulic Fracturing (fracking)<br>MarathonOilCorp<br>https://www.youtube.com/watch?v=VY34PQUiwOQ<br>This video provides more information on fracking. | | |
| **Costing the Earth 1: cost of energy production** | Learners could produce a graphical representation of the cost of energy production. This could be presented in a range of ways and learners should be encouraged to be creative.<br><br>Possible examples include:<br>• A balance sheet for energy production<br>• A cost benefit analysis<br>• A till receipt.<br><br>The three related activities that follow could provide the information to complete the graphical representation. All four elements together total 2.5 hours. | I hour | Unit 14 LO4 |
| **Costing the Earth 2: carbon emissions** | Learners could research the international performance on carbon emissions using the data from these resources:<br><br>CO2 emissions (metric tons per capita)<br>The World Bank<br>http://data.worldbank.org/indicator/EN.ATM.CO2E.PC<br><br>Emissions<br>Global Carbon Atlas<br>http://www.globalcarbonatlas.org/?q=en/emissions | 30 minutes | Unit 13 LO1<br>Unit 14 LO2 |

| Title of suggested activity | Suggested activities | Suggested timings | Also related to |
|---|---|---|---|
| **Costing the Earth 3: pollution** | Learners can review the impact and cost of pollution. Tutors could use this short emotional video as an introduction:<br><br>Every breath we take<br>European Environment Agency<br>http://www.eea.europa.eu/media/audiovisuals/every-breath-we-take-1/view<br>A one-minute video with links to relevant supporting resources.<br><br>Assessing the costs of air pollution<br>European Environment Agency<br>http://www.eea.europa.eu/media/audiovisuals/assessing-the-costs-of-air-pollution/view<br>Learners could then research the costs of air pollution using the resources on this European Environment Agency website.<br><br>Air Pollution in World: Real-time Air Quality Index Visual Map<br>World Air Quality<br>http://aqicn.org/map/world/#@g/50.2126/-4.6995/5z<br>Using this real-time, interactive map to get a real picture of air quality, learners could review the extent and concentration of pollution. | 30 minutes | Unit 13 LO1<br>Unit 14 LO2 |
| **Costing the Earth 4: finite resources** | In this final sub-activity learners could review the impact of consuming finite resources.<br><br>300 Years of Fossil Fuels in 300 Seconds<br>Postcarboninstitute<br>https://www.youtube.com/watch?v=cJ-J91SwP8w<br>Tutors could begin the review with this 5-minute, slightly cynical view of fossil fuels.<br><br>When Will Fossil Fuels Run Out?<br>CarbonCounted<br>http://www.carboncounted.co.uk/when-will-fossil-fuels-run-out.html<br>Learners can then review research on how long fossil fuels will last. | 30 minutes | Unit 13 LO1<br>Unit 14 LO2 |

| Title of suggested activity | Suggested activities | Suggested timings | Also related to |
|---|---|---|---|
| **I can make a difference!** | Learners can explore specific actions that can be taken by individuals to reduce energy use. Using a range of resources learners can create a quantified personal action plan to reduce their energy use.<br><br>An introduction to sustainable energy: 5 Energy services and efficiency improvement<br>The Open University<br>http://www.open.edu/openlearn/science-maths-technology/science/environmental-science/introduction-sustainable-energy/content-section-5<br>The OU's OpenLearn resources are free to use and learners could access the resource on 'Energy services and efficiency improvement'.<br><br>An introduction to sustainable energy:<br>The Open University<br>http://www.open.edu/openlearn/science-maths-technology/science/environmental-science/introduction-sustainable-energy/content-section-0<br>Tutors could consider learners studying the 3-hour module. It covers a broader range of learning outcomes and could be set for personal study time.<br><br>Learners could use some of the wide range of resources aimed at supporting energy conservation to draw up their own personal action plan to reduce energy use. Three popular resources are:<br><br>Save energy — 19 free energy saving tips<br>uSwitch<br>http://www.uswitch.com/energy-saving/guides/free-energy-saving-tips/<br>Free energy saving tips from the switching site uSwitch.<br><br>Energy saving tips<br>British Gas<br>https://www.britishgas.co.uk/help-and-advice/save-energy-save-money/Energy-saving-tips/top-10-energy-saving-tips.html<br>Top 10 tips for saving energy in your home.<br><br>Energy saving quick wins<br>Energy Saving Trust<br>http://www.energysavingtrust.org.uk/domestic/energy-saving-quick-wins<br>Quick tips to see if you're saving as much energy as you could be. | 2 hours | Unit 14 LO3 |

| Title of suggested activity | Suggested activities | Suggested timings | Also related to |
|---|---|---|---|
| **Making and moving** | Learners could write a short article for the college website highlighting the energy cost of a global supply chain and distribution network.<br><br>Learners could explore the concepts of manufacturing and transportation and use their findings to produce an infographic based on the environmental impacts of globalisation focusing on manufacturing and transportation activities.<br><br>Transport and sustainability<br>The Open University<br>http://www.open.edu/openlearn/science-maths-technology/transport-and-sustainability/content-section-0<br>Part of the OpenLearn series looking at sustainable transport.<br><br>Environment: Climate Change<br>Apple<br>http://www.apple.com/uk/environment/climate-change/<br>Self-reflection on its carbon footprint by technology company Apple. | 2 hours | |
| **Where are we heading?** | Learners can create a view of the future of energy based on trends and evidence available. The view could be a narrative, movie, presentation or other form of expression and tutors could guide this to be either individual work or a group activity. There are many resources available and learners could be encouraged to consider the motivation and objectivity of the producers of the resources.<br><br>Earth 2100 with subtitles<br>What you can have<br>https://www.youtube.com/watch?v=LUWyDWEXH8U<br>A short YouTube video giving predications of where the human race is heading.<br><br>Future world energy demand driven by trends in developing countries<br>U.S. Energy Information Administration<br>https://www.eia.gov/todayinenergy/detail.cfm?id=14011<br>Projections of the growth in world energy use.<br><br>Energy Consumption in the UK<br>Department for Business, Energy & Industrial Strategy<br>https://www.gov.uk/government/collections/energy-consumption-in-the-uk<br>Review of energy consumption since the 1970s, with a particular focus on trends since 2000. | 2 hours | Unit 14 LO3 |

# SUGGESTED ACTIVITIES

| LO No: | 2 | | |
|---|---|---|---|
| **LO Title:** | **Be able to measure energy transfer and calculate energy efficiencies of energy sources** | | |
| **Title of suggested activity** | **Suggested activities** | **Suggested timings** | **Also related to** |
| **Designing experiments to determine power generation** | Learners could be asked to design and construct a range of energy generation experiments to measure the relative efficiency of different energy sources.<br><br>Learners will need to be taught about power and the relationship between voltage, current and resistance.<br><br>A planetary gear motor (the type found in drills) driven in reverse will generate electricity. They can be purchased with a range of gear ratios or an old drill can be turned into a generator. Learners should collect data on the power output of the generator. This can be achieved using a multi-meter and a known resistor.<br><br>*Please note, links to equipment sellers in this and subsequent activities are for illustration only and not a recommendation to purchase. There are many suitable alternatives to all the items shown.*<br><br>Maplin USB DC Voltage Data Logger<br>Maplin<br>http://www.maplin.co.uk/p/maplin-usb-dc-voltage-data-logger-n70dp<br>A data logger, such as this £15 model, can be used to capture DC voltage output up to 30V over a period of time and allow the results to be downloaded to a computer for analysis.<br><br>Learners could then design suitable experiments to generate power. For each experiment the learners should clearly state and justify:<br>• The equipment used<br>• The measurements being taken<br>• The objective of the experiment.<br><br>Learners should complete a risk assessment for each experiment, which they then should follow.<br><br>Results, reflections and conclusions should be recorded for each experiment. Learners can then use assumptions to scale up their findings and compare these to commercially available figures.<br><br>  <br><br>DUKES: calorific values<br>Department for Business, Energy & Industrial Strategy<br>https://www.gov.uk/government/statistics/dukes-calorific-values<br>This is a spreadsheet with common calorific values. It may be a useful source of secondary data. | 1 hour | Unit 1 LO6<br>Unit 2 LO2<br>Unit 6 LO2 |

| Title of suggested activity | Suggested activities | Suggested timings | Also related to |
|---|---|---|---|
| **Wind power** | Learners could create a suitable support for the generator built in the previous activity. They then design, attach and test a range of turbine blades using a fan as the wind source.<br><br>An anemometer can be used to calculate wind speed and a barometer to calculate the air density. With this information the actual energy in the wind can be calculated and compared to the power generated.<br><br>A moving fluid's kinetic energy<br>Web Design Studio<br>http://wdstudio.net/gulfstreamturbine/kinetic.htm<br>This web page explains how the kinetic energy of the wind can be calculated.<br><br>Wind Power Challenge<br>Practical Action<br>http://practicalaction.org/wind-power-challenge?gclid=CPWfkKzQ2c0CFZEy0wodRJYBfw<br>This link provides various teaching resources on how to make a wind turbine and challenges learners to make their own. | 2 hours | Unit 14 LO2 |
| **Power from combustion (fossil fuels and biomass)** | Learners could investigate steam generation through coal, gas or biomass. Learners can calculate the energy produced through combustion from an energy transfer experiment.<br><br>Learners then produce steam, using suitable lab equipment. The risk assessment for this experiment is essential.<br><br>How much energy comes from burning fuels?<br>Royal Society of Chemistry (RSC)<br>http://www.rsc.org/education/teachers/Resources/aflchem/resources/64/64%20resources/64-2%20worksheet%202.pdf<br>This document shows how to calculate the energy generated by burning a fluid. The experiment can be modified for other fuels. | 2 hours | Unit 14 LO2 |

| Title of suggested activity | Suggested activities | Suggested timings | Also related to |
|---|---|---|---|
| **Hydro power** | Hydro generation can be explored either by using water under mains pressure from a hose or by using a raised water tank to give a head of pressure.<br><br>Learners can calculate the kinetic or potential energy of the water and compare this to the power generated.<br><br>Learners can design their own generators or use a ready-made system designed for use on domestic hoses.<br><br>BQLZR Portable Micro-hydro Generator Water Charger High Efficiency 3.5W<br>Amazon<br>http://www.amazon.co.uk/dp/B00K74GPVM<br>This example of a ready-made system from Amazon costs less than £10.<br><br>A moving fluid's kinetic energy<br>Web Design Studio<br>http://wdstudio.net/gulfstreamturbine/kinetic.htm<br>This web page explains how to calculate the kinetic energy of water passing through a turbine.<br><br>Hydropower: Water – power potential, head and flow rate<br>Engineering ToolBox<br>http://www.engineeringtoolbox.com/hydropower-d_1359.html<br>This web page explains how to calculate the potential energy available in water. | 2 hours | Unit 14 LO2 |
| **Solar power** | Solar power can be tested by carrying out experiments using small solar panels. Learners can create experiments based on the power output.<br><br>Learners could connect multiple solar panels together to give a greater power output. They could also be given a range of devices that require different amounts of power to operate and then conduct experiments to determine how many panels would be required to achieve something useful.<br><br>Fun Solar Projects<br>Build It Solar<br>http://www.builditsolar.com/Projects/Educational/educational.htm<br>This website provides lots of fun activities for learners on solar energy.<br><br>9v110mah 1 watt Monocrystalline Resin Solar Panel<br>First Stop Solar<br>http://www.firststopsolar.co.uk/9v110mah-1-watt-monocrystalline-resin-solar-panel-49-p.asp<br>Find affordable equipment with an internet search for 1 W solar panels. This example costs around £13. | 1 hour | Unit 14 LO2 |

| Title of suggested activity | Suggested activities | Suggested timings | Also related to |
|---|---|---|---|
| **Energy usage** | Learners can explore energy usage in the home or school using energy monitors. There are many commercially available and two suitable types are those that monitor energy flow through the mains supply and those that measure the flow to appliances.<br><br>Learners could compare the impact of different appliances and equipment used. Experiments around the difference made by equipment being on stand-by or turned off and having charging units plugged in all the time could be devised. Learners could be asked to complete home surveys and compare the results.<br><br>Uni Trend Autoranging AC Digital Clamp Multimeter<br>Maplins<br>http://www.maplin.co.uk/p/uni-trend-autoranging-ac-digital-clamp-multimeter-n82cb<br>One example of a mains monitor is this clamp meter.<br><br>AC 230V UK Power Meter Energy Monitor Plug-in KWH Watt Volt Electricity Analyzer<br>Amazon<br>http://www.amazon.co.uk/dp/B01BDPW9JA<br>This is a plug-in appliance monitor.<br><br>Energy Consumption Calculator<br>RapidTables<br>http://www.rapidtables.com/calc/electric/energy-consumption-calculator.htm<br>This link can help learners explore the energy consumption of a range of general appliances. | 1 hour | Unit 13 LO1 |
| **True cost of energy** | Using the approach called 'life cycle analysis', learners could explore the true cost of energy by including the manufacturing, maintenance and transportation elements of energy production. This approach gives learners an alternative view to that of just comparing the energy value of a fuel with the energy output.<br><br>Life Cycle Assessments of Energy Technologies<br>National Renewable Energy Laboratory<br>http://www.nrel.gov/analysis/sustain_lca_about.html<br>The National Renewable Energy Laboratory website gives detail on the life cycle approach and shows how it is applied in practice. | 30 minutes | Unit 14 LO4 |

| Title of suggested activity | Suggested activities | Suggested timings | Also related to |
|---|---|---|---|
| **Climate change; can we stop it? Part 1**   | Learners could be presented with the question: Is climate change inevitable? After a short group discussion, the learners record the group consensus.<br><br>Once the resources have been reviewed in the next suggested activity, learners can be presented with the question again, and again the group consensus is recorded. Learners then discuss any differences between the group views before and after the research. | 30 minutes | Unit 13 LO1 |
| **Climate change; can we stop it? Part 2**   | Learners carry out individual or group research on the inevitability of climate change. Useful resources for this exercise include:<br><br>The climate fact no one will admit: 2 °C warming is inevitable<br>New Scientist<br>https://www.newscientist.com/article/dn28430-the-climate-fact-no-one-will-admit-2-c-warming-is-inevitable/<br>Article arguing that it is time to start preparing for a world more than 2 °C warmer than now.<br><br>Adapting to climate change: Facing the consequences<br>The Economist<br>http://www.economist.com/node/17572735<br>Article arguing that global action is not going to stop climate change and that the world needs to look harder at how to live with it.<br><br>C-ROADS; Climate Scoreboard; Climate Momentum Simulation<br>Climate Interactive<br>https://www.climateinteractive.org/tools/c-roads/<br>https://www.climateinteractive.org/tools/scoreboard/<br>https://www.climateinteractive.org/tools/climate-momentum-sim/<br>There is a range of interactive resources on the Climate Interactive website, including a climate change policy simulator, a UN climate pledge analysis tool and a climate momentum simulation. | 1 hour | Unit 13 LO1<br>Unit 14 LO3 |
| **Climate change; can we stop it? Part 3**   | Once the resources have been reviewed the learners can be presented with the question again, and again the group consensus is recorded.<br><br>Learners can then discuss any differences between the group views before and after the research. | 30 minutes | |

# SUGGESTED ACTIVITIES

| LO No: | 3 | | |
|---|---|---|---|
| **LO Title:** | **Understand renewable energy technologies** | | |
| **Title of suggested activity** | **Suggested activities** | **Suggested timings** | **Also related to** |
| **Fossil fuels are not the only way**  | Learners could start this section by reviewing a range of resources highlighting the need for change in the UK energy system.<br><br>Evaluating Other Energy Sources<br>National Geographic Society<br>http://education.nationalgeographic.org/activity/evaluating-other-energy-sources/<br>A resource to explore the environmental effects of different electricity-generating sources.<br><br>A critical time for UK energy policy: what must be done now to deliver the UK's future energy system<br>Royal Academy of Engineering<br>http://www.raeng.org.uk/publications/reports/a-critical-time-for-uk-energy-policy<br>A 2015 report for the Council for Science and Technology.<br><br>UK energy system update is almost out of time, warns Academy<br>Royal Academy of Engineering<br>http://www.raeng.org.uk/news/news-releases/2015/october/uk-energy-system-update-is-almost-out-of-time#sthash.0SD4t2lw.dpuf<br>Article on the challenge facing the UK to meet future emissions targets. | 1.5 hours | Unit 13 LO1<br>Unit 14 LO3 |
| **A new way of thinking about energy** | The tutor could ask the group to name as many renewable energy sources as possible and estimate what they cost per unit energy and the contribution they could make to UK annual energy usage. This should be recorded in the form of a table for reference at the end of the section.<br><br>Learners could then explore the range of renewable technologies using the focus of 'biological', 'chemical' and 'physical' as prompts. For each of the areas learners should cover at least two technologies (six in total) and for each draw up a record of the following:<br>• Benefits of the technology<br>• Concerns or problems with the technology<br>• The extent to which it is currently used in the UK<br>• An approximate cost per megawatt hour of power using the technology.<br><br>Energy Technologies Institute<br>http://www.eti.co.uk/<br>The UK-based Energy Technologies Institute website would be a suitable starting point for research. | 1.5 hours | Unit 13 LO1<br>Unit 14 LO3 |

| Title of suggested activity | Suggested activities | Suggested timings | Also related to |
|---|---|---|---|
| **Biological technology: biomass** | Learners could explore biomass and review the cultivation, transportation and use of biomass in energy production.<br><br>Biomass energy<br>National Geographic Society<br>http://education.nationalgeographic.org/encyclopedia/biomass-energy/<br>This resource from the National Geographic magazine is a useful starting point. | 1 hour | |
| **Biological technology: biofuels** | Biofuels covers a range of fuels including biogas and bioethanol. Learners could explore how these fuels are created and could consider the ease and extent to which they could be integrated into the UK energy system.<br><br>Learners could consider the cost of production in terms of loss of agricultural land. Key resources include:<br><br>The Official Information Portal on Anaerobic Digestion<br>http://www.biogas-info.co.uk/<br>Website created in 2009 as an independent authoritative resource on anaerobic digestion. Creation of the site was supported by government and industry.<br><br>Anaerobic Digestion and Bioresources Association<br>http://adbioresources.org/<br>Trade association for companies involved in anaerobic digestion (AD) and in bioresources – technologies and processes that are complementary to the AD process.<br><br>Bioethanol Fact Sheet<br>BioNett<br>http://www.sts-technology.com/docs/Bioethanol-Fact-Sheet-Final.pdf<br>Useful information on bioethanol.<br><br>Statistical data set: Biofuels (ENV05)<br>Department for Transport<br>https://www.gov.uk/government/statistical-data-sets/biofuels-env05<br>Biofuel statistics tables, produced by the Department for Transport.<br><br>Biofuels carbon calculator RTFO year 8<br>Department for Transport<br>https://www.gov.uk/government/publications/biofuels-carbon-calculator<br>A software program for fuel suppliers to calculate the carbon saved on a batch of fuels. | 1 hour | |

| Title of suggested activity | Suggested activities | Suggested timings | Also related to |
|---|---|---|---|
| **Chemical technology: photovoltaics**  | Power from the sun is extensively used in low power environments. Learners could explore the technology in terms of how electricity is produced from solar power and also the extent to which photovoltaic power is used in the UK. Learners could also review the impact of solar power outside the UK. Resources include:<br><br>Solar photovoltaics deployment<br>Department for Business, Energy & Industrial Strategy<br>www.gov.uk/government/statistics/solar-photovoltaics-deployment<br>UK statistics on solar photovoltaics usage.<br><br>Solar<br>EDF Energy<br>http://www.edfenergy.com/future-energy/energy-mix/solar<br>Advice on solar power from EDF Energy.<br><br>Empowing the UK Solar Transformation<br>Solar Trade Association<br>http://www.solar-trade.org.uk/<br>Trade body website. | 1 hour | |
| **Chemical technology: hydrogen fuel cells** | Hailed as a clean future fuel for cars, fuel cells are becoming more prominent. Learners could explore the basics of the technology and research applications of the new generation source. Learners could investigate the production, storage and safety aspects of using hydrogen gas as a fuel source. Resources include:<br><br>Honda's video guide to Hydrogen fuel cell technology in cars (eg. FCX Clarity)<br>HondaVideo<br>https://www.youtube.com/watch?v=8rofx6Gaz40<br>Short (2:34) video on hydrogen fuel cell technology.<br><br>Hydrogen Fuel Cells<br>US Department of Energy Hydrogen Program<br>https://www.hydrogen.energy.gov/pdfs/doe_fuelcell_factsheet.pdf<br>Two-page illustrated leaflet on hydrogen fuel cells.<br><br>Clean energy now<br>UK HCFA<br>http://www.ukhfca.co.uk/<br>Hydrogen fuel cells trade body website. | 1 hour | Unit 13 LO1<br>Unit 14 LO3 |

| Title of suggested activity | Suggested activities | Suggested timings | Also related to |
|---|---|---|---|
| **Physical technology: wind** | Wind turbines have been contributing to the UK energy grid for over 25 years; with improvements in technology and government commitment the industry is growing.<br><br>Learners could explore the history and potential of wind energy, comparing on- and offshore along with domestic and medium scale generation.<br><br>Wind Energy: implications of large-scale deployment on the GB electricity system<br>Royal Academy of Engineering<br>http://www.raeng.org.uk/publications/reports/wind-energy-implications-of-large-scale-deployment<br>This study examines the engineering issues that need to be addressed with this form of generation.<br><br>There are many industry publications with regards to wind energy; the UK and Europe trade bodies are a good place to begin the search.<br><br>RenewableUK<br>http://www.renewableuk.com/<br>Trade organisation for the renewables industry in the UK.<br><br>Wind Energy Projects<br>RenewableUK<br>http://www.renewableuk.com/page/UKWEDSearch<br>Learners could use the Wind Energy Database (WED) to carry out some statistical analysis of the UK wind industry.<br><br>WindEurope<br>https://windeurope.org/<br>Trade organisation for the renewables wind industry in Europe.<br><br>About wind<br>WindEurope<br>https://windeurope.org/about-wind/<br>On this page there are links to reports, and graphical and statistical tools, that students can use to investigate the industry.<br><br>Global Offshore Wind Farms Database<br>4C Offshore<br>http://www.4coffshore.com/offshorewind/<br>4C Offshore maintains a detailed database of all the offshore wind farms around the world. | 1 hour | |

| Title of suggested activity | Suggested activities | Suggested timings | Also related to |
|---|---|---|---|
| **Physical technology: water** | Norway is the European capital of hydro power but the UK has a significant number of hydro power stations. Often referred to as 'Green Batteries', pumped storage is an effective way of storing energy. In addition to traditional hydro, the UK also has a vast potential for wave and tidal energy.<br><br>Learners could explore the current situation and future potential of energy generated through hydro sources. Useful resources include:<br><br>British Hydropower Association<br>http://www.british-hydro.org/<br>Trade association for hydro power in the UK.<br><br>European Marine Energy Centre (EMEC)<br>http://www.emec.org.uk/<br>The European Marine Energy Centre is based in the UK on Orkney. A range of resources are available from the site including details of a variety of marine technologies.<br><br>Working for a Green Britain & Northern Ireland<br>RenewableUK<br>http://www.renewableuk.com/news/293536/Working-for-a-Green-Britain--Northern-Ireland.htm<br>Learners could explore this online report. The report estimates the potential for wave and tidal energy production in the UK. | 1 hour | |
| **Where does the energy come from?**<br><br>  | To get a picture of the current energy mix in the UK, learners could use the National Grid database at:<br><br>G.B. National Grid Status<br>Gridwatch<br>http://gridwatch.templar.co.uk/<br>This gives current and historical data on UK energy use, production and sources.<br><br>Learners could use the database to add detail to their notes on the renewable energy technologies studies.<br><br>Learners could download a section of the database to carry out statistical analysis of the UK energy usage and compare specific dates and events.<br><br>Tutors could ask learners to compare Christmas Day demand with a major event such as the World Cup final. Learners could explore and try to explain the sudden changes in demand. | 1 hour | |

| Title of suggested activity | Suggested activities | Suggested timings | Also related to |
|---|---|---|---|
| **What can renewable energy technologies do for us?**   | After researching the range of renewable technologies learners can combine the research from the six technologies they covered, creating a table of energy production.<br><br>The table can be compared to the original table created at the start of the section. This table can then be used to generate a range of scenarios for renewable energy in the UK energy system. Information from the National Grid website could be useful here.<br><br>What we do in the Electricity Industry<br>National Grid<br>http://www2.nationalgrid.com/uk/our-company/electricity/<br>Explains the work of the National Grid. | 2 hours | |

# SUGGESTED ACTIVITIES

| LO No: | 4 | | |
|---|---|---|---|
| **LO Title:** | **Be able to recommend sustainable solutions to meet energy demands** | | |
| **Title of suggested activity** | **Suggested activities** | **Suggested timings** | **Also related to** |
| **What are the differences between low carbon energy and renewable energy?** | Tutors could begin this topic by asking the learners to list as many low carbon sources of energy as they can. Once the list is complete tutors could then ask the learners to identify which of the sources are renewable sources.<br><br>The follow-on discussion will depend on the sources of energy identified:<br>• If learners only identified renewable sources of energy in the first pass, then the tutor can explain what low carbon means and ask learners to add to the list. Once this list is complete the tutor can progress to the next step.<br>• If the learners identified a good range of both low carbon and renewable sources of energy, then the discussion can proceed to the next step.<br><br>The tutor could lead the learners in a class discussion to determine the characteristics of low carbon energy and renewable energy. An annotated diagram clearly showing the differences could be produced either by individuals or by the group.<br><br>The key conclusion to reach is that all renewable energy is low carbon, but not all low carbon energy is renewable. | 1.5 hours | |

| Title of suggested activity | Suggested activities | Suggested timings | Also related to |
|---|---|---|---|
| **Low carbon but not renewable technologies** | Learners could research a range of low carbon technologies that are not renewable. For each technology the learners could produce a see-saw diagram or a balance diagram comparing the benefits and issues of each technology.<br><br>Tutors could decide to have all learners research all the technologies listed or allocate different technologies to different groups.<br><br>A to Z Glossary<br>Nuclear Industry Association<br>http://www.niauk.org/a-to-z-glossary<br>To research nuclear energy, the Nuclear Industry Association (NIA) is a good place to start. This web page has links to many maps and educational resources that can be used.<br><br>Nuclear energy<br>National Geographic Society<br>http://education.nationalgeographic.org/encyclopedia/nuclear-energy/<br>National Geographic has a good range of resources on nuclear energy.<br><br>Energy from waste is the energy recovered by using waste to produce fuel. This could be the gas released in a decomposing landfill site, it could be animal waste being used as fuel or processed to release gas or it could be straight incineration. In the UK 1% of the electricity used comes from waste; the potential is much higher. The Renewable Energy Association has some useful resources on its website:<br><br>Waste to Energy<br>Renewable Energy Association<br>http://www.r-e-a.net/renewable-technologies/energy-from-waste<br>Information on waste to energy.<br><br>Carbon capture and storage is a technology that does not produce energy but rather removes the carbon dioxide from the outputs of other technologies. It is similar to a catalytic converter on a car. The carbon is trapped and then stored underground or used for other purposes. This website has extensive detail on carbon capture and storage:<br><br>CAMEL Climate Change Education<br>Science Education Resource Center, Carleton College<br>http://camelclimatechange.org/index.html<br>The site includes diagrams, lesson plans and lecture notes. | 2 hours | |

| Title of suggested activity | Suggested activities | Suggested timings | Also related to |
|---|---|---|---|
| **Latest thinking on renewable energy** | Research and discussion on renewable energy is ongoing. Tutors could ask learners to research the latest information on renewable energy, running this as a competition with criteria such as:<br>• Most recent publication<br>• Most controversial publication<br>• Most inaccurate publication<br>• Most surprising publication.<br><br>A good starting point would be The Open University website where the latest research from the academics is published.<br><br>OU Energy Research Themes<br>The Open Univesity<br>http://energy.open.ac.uk/themes.php<br>Current research carried out at The Open University on energy. | 2 hours | |
| **Balancing renewables** | Learners could produce a Balanced Scorecard for renewable energy as a whole. The four aspects of the scorecard would be:<br>• costs of renewable energy (e.g. construction, running)<br>• predictability and reliability of renewable energy<br>• percentage contribution made to the National Grid<br>• the acceptability of renewable energy (social and environmental impact).<br><br>Gridwatch uses live National Grid data to show the energy consumption in the UK and the generation sources of that energy.<br><br>G.B. National Grid Status<br>Gridwatch<br>http://gridwatch.templar.co.uk/<br>This gives current and historical data on UK energy use, production and sources. There is also a link to the equivalent data for France.<br><br>The Balanced Scorecard is a management tool for assessing things from a range of views. The internet has many examples of how to use this tool.<br><br>Balanced scorecard<br>Businessballs<br>http://www.businessballs.com/balanced_scorecard.htm<br>Businessballs is a reliable source for defintions and explanations of management and business concepts. | 1.5 hours | |

| Title of suggested activity | Suggested activities | Suggested timings | Also related to |
|---|---|---|---|
| **The role of renewables** | Renewables will not be able to supply the total energy requirements in the UK (unlike Iceland where 100% of energy is provided using geothermal sources). The UK must have a mix of energy sources.<br><br>Learners could work to produce an annotated pie chart representing the energy mix in the UK that deals with the following key aspects:<br>• Oscillating energy demands<br>• Energy security<br>• Energy storage.<br><br>Tutors could guide learners to resources from different perspectives in this research:<br><br>UK energy security<br>Gov.uk<br>https://www.gov.uk/government/policies/uk-energy-security<br>Site with links to material explaining what government's doing about UK energy security.<br><br>Electricity security of supply<br>Ofgem<br>https://www.ofgem.gov.uk/electricity/wholesale-market/electricity-security-supply<br>Ofgem is the regulator for the energy industry and its website covers a range of issues on electricity demand. The infographic on the National Grid is very helpful.<br><br>Most of the electricity in the UK comes from one of the 'big six' companies.<br><br>Energy challenges: security<br>EDF Energy<br>http://www.edfenergy.com/future-energy/challenges/security<br>EDF Energy is a French company with useful resources on its site. All the other large energy companies have similar information. | 1.5 hours | |

| Title of suggested activity | Suggested activities | Suggested timings | Also related to |
|---|---|---|---|
| **Getting power where it is needed**<br>  <br> | Renewable energy tends to be produced in more remote areas and there is challenge in getting any power produced to the people who need to use it.<br><br>Learners could be asked to design an energy grid that incorporates the full range of energy production from the energy mix they identified.<br><br>Tutors should guide learners to consider localised energy production (solar panels on domestic roofs etc) and the impact of millions of small generators connected to the power infrastructure. Considerations of combined heat and power systems should also be encouraged.<br><br>Learners will need to demonstrate the range of issues considered when making their choices.<br><br>British retailers need more clarity on energy efficiency tax landscape<br>npower<br>https://www.npower.com/large-business/energy-news/npower-news/WCMS_161559<br>RWE npower, another one of the 'big six' energy companies, has a report on the energy infrastructure needs by 2030. | 2 hours | |
| **Challenging the thinking** | Once designed the learners could take it in turns to present their preferred solutions to the group, answering challenges.<br><br>The tutor could run this as a Dragons' Den type activity. | 1.5 hours | |

The small print

We'd like to know your view on the resources we produce. By clicking on the 'Like' or 'Dislike' button you can help us to ensure that our resources work for you. When the email template pops up please add additional comments if you wish and then just click 'Send'. Thank you.

Whether you already offer OCR qualifications, are new to OCR, or are considering switching from your current provider/awarding organisation, you can request more information by completing the Expression of Interest form which can be found here: www.ocr.org.uk/expression-of-interest

**OCR Resources:** *the small print*
OCR's resources are provided to support the delivery of OCR qualifications, but in no way constitute an endorsed teaching method that is required by OCR. Whilst every effort is made to ensure the accuracy of the content, OCR cannot be held responsible for any errors or omissions within these resources. We update our resources on a regular basis, so please check the OCR website to ensure you have the most up to date version.

This resource may be freely copied and distributed, as long as the OCR logo and this small print remain intact and OCR is acknowledged as the originator of this work.

OCR acknowledges the use of the following content:
Cover image: GlobalStock/istockphoto.com
Square down and Square up: alexwhite/Shutterstock.com

Please get in touch if you want to discuss the accessibility of resources we offer to support delivery of our qualifications: resources.feedback@ocr.org.uk

## Looking for a resource?

There is now a quick and easy search tool to help find **free** resources for your qualification:

www.ocr.org.uk/i-want-to/find-resources/

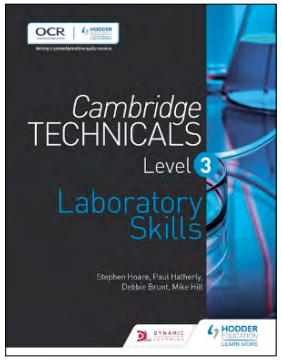
**Cambridge Technicals Level 3**

## *Laboratory Skills*

**textbook**

Developed in partnership with Hodder Education this book covers a range of units within this qualification. http://www.hoddereducation.co.uk/Product/9781471874826.aspx

Publication date: 24 Feb 2017




OCR Oxford Cambridge and RSA | HODDER EDUCATION LEARN MORE

Working in partnership to deliver quality resources

## ocr.org.uk/science

OCR customer contact centre

OCR is part of Cambridge Assessment, a department of the University of Cambridge. *For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored.*



A DIVISION OF CAMBRIDGE ASSESSMENT

LLOYD'S REGISTER · LRQA ISO 9001 | UKAS MANAGEMENT SYSTEMS 001