

# Unit 4005: Renewable Energy

**Unit Code:** R/651/0714

**Level:** 4

**Credits:** 15

---

## Introduction

With the increasing concerns regarding climate change arising from increasing carbon dioxide levels and other adverse environmental impacts of industrial processes, there are widespread economic, ethical, legislative and social pressures on engineers to develop technologies and processes that have reduced carbon and environmental impact.

This unit aims to familiarise students with both established and emerging renewable energy resources and technologies. It will delve into current and future storage and generation systems, critically exploring their capabilities and constraints.

On successful completion of this unit, students will be able to determine the optimum combination of renewable energy technologies and evaluate their efficiencies, describe how to conduct a cost-benefit analysis to determine the most viable option between renewable and conventional energy sources, and consider the relevant political, socio-economic, and legal factors that influence the selection of appropriate energy technologies.

## Learning Outcomes

By the end of this unit students will be able to:

- LO1 Explore potential renewable energy resources and technologies
- LO2 Determine the optimum combination and efficiencies of renewable energy technologies for a particular location
- LO3 Conduct a cost-benefit analysis to determine the most viable option between renewable and conventional energy sources
- LO4 Analyse the socio-economic, legislative, and environmental factors in selecting appropriate renewable energy technologies.

## Essential Content

### LO1 Explore potential renewable energy resources and technologies

*Alternative energy resources, their respective merits, and drawbacks:*

Wind energy, ocean and tidal energy, biomass, geothermal energy, hydropower, solar photovoltaic, solar thermal energy, and waste-to-energy.

Energy storage and generation technologies (e.g., batteries, hydrogen).

### LO2 Determine the optimum combination and efficiencies of renewable energy technologies for a particular location

*Energy demand and security of supply:*

Energy consumption changes, intensity and trends (domestic, industrial, transport, and services sectors)

Factors affecting changes in energy consumption and demand

Future demand planning based on trends and needs analysis

Risk analysis for energy supplies for local areas and global regions

Energy capacity margins analysis related to changes in demand

Alternatives for locally used energy sources.

*Energy reduction and efficiency approaches:*

Energy systems available for a given location

Energy legislation and standards

Energy saving and reduction schemes, energy saving technologies available

Energy efficiency approaches for domestic energy use

Grants and government schemes, and the effects of such schemes on supply and demand.

*Grid Integration Requirements:*

Local Grid Code requirements and compliance for integration of the renewable energy assets

**LO3 Conduct a cost-benefit analysis to determine the most viable option between renewable and conventional energy sources**

*Financial and environmental implications:*

Cost-benefit analysis using appropriate tools and techniques

Socio-economic factors

Financial implications of renewable and conventional energy.

**LO4 Analyse the socio-economic, legislative, and environmental factors in selecting appropriate renewable energy technologies.**

*Set-up and operation of renewable technologies:*

Socio-economic factors (e.g. UN sustainability goals)

Legislative and commercial considerations, including carbon taxes and national and international climate change legislation

Environmental factors

Evaluation planning tools such as PESTLE analysis

Local environmental impact and considerations

Waste impact, waste management strategies

Contamination issues and society wellbeing.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Explore potential renewable energy resources and technologies		<b>D1</b> Evaluate a wide variety of renewable energy resources, with innovative insights into their potential future usage.
<b>P1</b> Explore potential renewable energy resources suitable for your local area and their working principles with the aid of diagrams.	<b>M1</b> Analyse storage technologies and their advantages and disadvantages in relation to at least three different forms of renewable energy.	
<b>LO2</b> Determine the optimum combination and efficiencies of renewable energy technologies for a particular location		<b>D2</b> Propose an innovative, well-justified combination of renewable energy technologies for the specific location, taking into account not only efficiency but also factors such as sustainability, cost-effectiveness and societal impact.
<b>P2</b> Determine the most efficient combination of renewable energy technologies for a specified location.	<b>M2</b> Analyse the location's specific environmental and geographical factors and how they relate to the efficiency of different renewable energy technologies.	

Pass		Merit	Distinction
<b>LO3</b> Conduct a cost-benefit analysis to determine the most viable option between renewable and conventional energy sources			<b>D3</b> Present a thorough and nuanced cost-benefit analysis that considers both short-term and long-term impacts, as well as contingencies and uncertainties, with a well-argued recommendation based on the analysis.
<b>P3</b> Conduct cost-benefit analysis that considers the direct costs and benefits of both renewable and conventional energy sources.	<b>M3</b> Effectively incorporate indirect costs and benefits such as environmental impacts and potential societal benefits and drawbacks into the cost-benefit analysis.		
<b>LO4</b> Analyse the socio-economic, legislative, and environmental factors in selecting appropriate renewable energy technologies.			<b>D4</b> Evaluate the impact of socio-economic, legislative and environmental factors on selecting renewable energy technologies, using relevant, real-world examples and forecasting potential future trends.
<b>P4</b> Analyse how socio-economic, legislative, and environmental factors influence the selection of appropriate renewable energy technologies, for a given local context.	<b>M4</b> Provide a detailed analysis of specific socio-economic, legislative, and environmental factors and their impact on selecting renewable energy technologies in a global context.		

## Recommended Resources

*Note: See HN Global for guidance on additional resources.*

### Print Resources

Andrews, J. and Jelley, N. (2013) *Energy Science: Principles, Technologies and Impacts*. 2nd Ed. Oxford University Press.

Boyle G. (2012). *Renewable Energy: Power for a Sustainable Future*. 4th Ed. Oxford, UK: Oxford University Press.

Kolhe M.L. (Editor) (2022) *Renewable Energy Systems in Smart Grid: Select Proceedings of International Conference on Renewable and Clean Energy (ICRCE) 2022 – Lecture Notes in Electrical Engineering 938 (Paperback)*. Springer Verlag.

Kularatna N. (2020) *Energy Storage Devices for Renewable Energy*. Elsevier.

Manwell J.F., McGowan J.G., and Rogers A.L. (2009) *Wind Energy Explained: Theory, Design and Application*. 2nd Ed. Wiley.

McCartney D. (Editor) (2023) *Renewable Energy Sources: Engineering and Technology (Hardback)*. States Academic Press.

Moore E.A. (2022) *Explaining Renewable Energy (Paperback)*. Taylor & Francis Ltd.

Nahhas A.M.A. and Ibadode A.O.A. (Editors) (2023) *Renewable Energy: Recent Advances (Hardback)*. IntechOpen.

Nelson V.C. (2011). *Introduction to Renewable Energy*. 2nd Ed. CRC Press.

Olabi A.G.(Editor) (2023) *Renewable Energy – Volume 2: Wave, Geothermal, and Bioenergy: Definitions, Developments, Applications, Case Studies, and Modelling and Simulation (Paperback)*. Elsevier.

Shere J. (2013) *Renewable: The World-Changing Power of Alternative Energy*. St. Martin's Griffin.

Smets A. Jäger K., Isabella O., Swaaij R.V., and Zeman M. (2016) *Solar Energy: The Physics and Engineering of Photovoltaic Conversion, Technologies and Systems*. UIT Cambridge Ltd.

### Journals

*Note: Example journals listed below provide a broad range of articles related to unit content and those relevant for the qualification. Staff and students are encouraged to explore these journals and any other suitable journals to support the development of academic study skills, and subject specific knowledge and skills as part of unit level delivery.*

[Renewable Energy Focus Journal](#)

[Journal of Renewable and Sustainable Energy](#)

[Renewable and Sustainable Energy: An International Journal](#)

## **Links**

This unit links to the following related units:

*Unit 4004: Managing a Professional Engineering Project*

*Unit 4089 Net Zero Energy Technologies I: Systems and Demand*

*Unit 5011: Industrial Power, Electronics and Storage*

*Unit 5018: Sustainability*

*Unit 5054: Net Zero Energy Technologies II: Infrastructure and Pathways.*