

## Techno-Economics of Energy Systems and Integration

### Purpose:

This module aims to introduce delegates to the fundamentals of technoeconomic assessment of energy systems and key aspects of their integration in future energy systems. As there are myriads of ways in which energy can be produced, stored, distributed for national, regional, local and individual consumption, key emphasis is given to wind energy systems and thermo-chemical conversion technologies, and their integration into national grid and district heat networks.

### Intended learning outcomes:

- Understand the main stages of a renewable energy project's lifecycle.
- Explore the links between energy systems, environmental systems and the economy.
- Identify key performance and cost indicators for renewable energy systems.
- Discuss variety of economic and policy scenarios, formulate optimisation problems and analyse objective functions and constraints in energy systems modelling, assessment and optimisation.
- Explain the role of emerging technologies in the development of future net zero energy systems.

### Who is this module/course for:

- Engineers and middle level managers interested to increase their understanding on how energy systems are modelled against engineering and non-engineering related factors, with a view to develop organisational strategy.

### Syllabus:

The course will cover the following topics:

- Energy conversion technologies and their key performance indicators
- Economics and policy of energy systems
- Links between energy systems, environmental systems and the economy
- Life cycle cost modelling of renewable energy technologies (DEVEX, CAPEX, OPEX)
- Energy system definition based on different policy scenarios (tools, scenarios and criteria)
- Optimisation of energy systems at different scales
- Net-zero energy systems (CCUS, Hydrogen, Storage, Power to X)
- Case studies (Wind Energy Systems to Power Grid; Biomass for District Heating)

### Delivery method:

The module will be delivered through a combination of online theoretical lectures, self-study and group activities. All online sessions will be recorded and remain available for 4 weeks after completion of the module. Delivery will span across 5 weeks of study, including a study week with no additional material, as follows:

0. Pre-study (week 0): Delegates will be provided with material relevant to the module, including open access reading and key references on next generation sustainable energy technologies.
1. Week 1 (4-hours):
  - Theoretical part: Basics of energy conversion technologies/systems, energy economics and policy governing the development of energy systems, techno-economics assessment and energy simulation.

- Practical part: Delegates will work in groups, analysing a hypothetical scenario of a potential energy system.
- 2. Week 2 (4-hours):
  - Theoretical part: Life cycle cost modelling of sustainable energy technologies. A generic life cycle cost model will be developed and the key cost components of different technologies will be identified, including DEVEX, CAPEX, and OPEX.
  - Practical part: Delegates working in groups, will select a technology and calculate relevant KPIs, such as LCoE.
- 3. Week 4 (4-hours):
  - Theoretical part: The fundamental problem of the design of an energy system will be formulated in the form of a standard optimisation problem, understanding objectives and constraints, and linking them with different scenarios.
  - Practical part: Delegates working in groups, will develop a plan for a hypothetical case study discussing in a qualitative manner the different factors affecting the decision.
- 4. Week 5 (4-hours):
  - Theoretical part: The emerging topics of CCUS, Hydrogen, Energy storage, Power to X will be discussed, with a focus on how they can affect future energy systems towards the net zero targets.
  - Practical part: Delegates working in groups, will discuss in a qualitative manner how priorities should change when considering net zero targets.

#### Timing:

In Week 0 we will introduce the module and the material through a 1-hour live session. Then, for each of the following weeks (1-4) there will be a 2-hour of recorded video to watch when it suits you, followed by 2-hour live sessions.

#### Assessment:

The course is at a postgraduate level and assessment will be via the group activities and end-of-module written work. Attendees who complete the assessments successfully will receive a CPD certificate from the University of Strathclyde. In the future, successful candidates may be able to earn credit points towards postgraduate qualifications through the Accreditation of Prior Learning route.

#### Registration:

The delegates can directly register on University of Strathclyde's MyPlace page for this module where there is a link available for online payment. For further information about registration please contact [lynn.obrien@strath.ac.uk](mailto:lynn.obrien@strath.ac.uk).