Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Micro-Credentials

Information Sheet and Descriptor

Definition (working)

A micro-credential *is a proof of the learning outcomes that a learner has acquired following a short learning experience. These learning outcomes have been assessed against transparent standards. The proof is contained in a certified document that lists the name of the holder, the achieved learning outcomes, the assessment method, the awarding body and, where applicable, the qualifications framework level and the credits gained. Micro-credentials are owned by the learner, can be shared, are portable and may be combined into larger credentials or qualifications. They are underpinned by quality assurance following agreed standards* ***(working definition approved by HCI Steering, 11 February 2021).***

Micro-credentials – range of credits from 2.5* ECTS, 5 ECTS, 10 ECTS.

*Note: for the 2021/22 academic year micro-credentials will consist of 5 ECTS or 10 ECTS.

Micro-credentials:

- Consist of credit offered for continuing/professional development purposes.
- Are specifically designed to upskill the workforce.
- May be stackable.
- Offer flexible delivery to meet the needs of industry, business and employees.

MC = Micro-Credential

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HCI Pillar 3

Micro-Credentials: Descriptor

HCI Cluster and Work Package for the proposed micro-credential:	Cluster 1: Work-package 1
To whom will the micro-credential be offered?	Specify the *specific industry/profession targeted:* The MC targets relevant professionals interested in sustainable power generation technologies across industry and the public sector, including Mechanical and Electrical Engineers, Planners, Energy/Sustainability Consultants, Small Medium Enterprises.
Micro-credential title:	Low Carbon Power Technology
Is the proposed micro-credential a new or existing module (repurposed)?	New module/MC
(For Existing Modules Only)	
Existing module detail	***If this is an existing module to be repurposed as a micro-credential, please respond to the questions below.*** ***If not, proceed to the next section.*** State the name of the module and programme *(and enclose module descriptor if available)*: Click or tap here to enter text. Is the module shared with another discipline/School? If so, name the discipline/School: **Existing Module details:** Select UG or PG. State year group. No. of ECTS of module: Click or tap here to enter text. NFQ level: Click or tap here to enter text.

	School (owner and discipline): Click or tap here to enter text. Module coordinator: Code in SITS: *If changes are required to the existing module so that it can exist coherently as a micro-credential please give details (please also outline how the existing module will meet the criteria of a micro-credential in terms of meeting the needs of industry and, providing flexible delivery):* The module is new and flexible delivery building on experience gained in the COVID 19 period will be central to the module design. This is essential as the module will be shared with MC students and postgraduate students reading for certificate, diploma or full MSc with part-time options. As a 10 ECTs unit it can stand alone with independent project work integrated into its continuous assessment elements.
Micro-credential information	
NFQ level (if applicable)	9 PG
ECTS	*Note: 5 ECTS: 100–125 hrs student effort (PG: 1 ECT: 25 hrs student effort)* 10
School (owner) and discipline	School of Engineering, Discipline of Mechanical, Manufacturing and Biomedical Engineering
MC Coordinator (name) *(Must be academic / teaching staff)*	Professor Stephen Spence
State other Schools/external organisations involved in the delivery of the micro-credential (if applicable)	n/a
Industry/profession	**Specify the industry/profession targeted by the micro-credential:** Mechanical Engineering, Electrical Engineering, Mechanical & Electrical Building Services, Energy Industries, Electrical Power Generation and Distribution, Transport Engineers, Construction Sector (Energy efficient

	buildings), Alternative/Renewable Energy Sector, Planners, Energy/Sustainability Consultants and Analysts, Project Managers **What market need is addressed by the micro-credential:** Since the changes in technology and policy relating to environmental impact have been rapid in this area, even practising engineers with as little as five years' experience can expect to require significant CPD in this area. Topics for example as heavy electromechanical plant, hydrogen-based fuelling and energy storage, compact nuclear generators are rapidly emerging and repositioned fields in the light of dynamic climate threats. Planning and other climate change solution decisions must be made by technology leaders with the fullest information possible. **State the industry/employer-related skills addressed by the micro-credential:** Awareness of the most recent technologies for provision of low carbon energy, including power generation and energy storage. Capability to undertake fundamental analysis of complete energy systems from the perspective of both energy efficiency and carbon emissions. Capability to develop and adapt complex computational models of energy systems, using commercial software and developing own bespoke codes. Using simulations together with uncertain information to assess risk and inform decisions around energy systems. Ability to assess sustainable energy systems from economic and environmental perspectives. An ethical approach to delivering sustainable energy solutions. Presenting and arguing for certain proposals with robust data. **How will the delivery of this micro-credential facilitate industry/professional staff participation (flexible delivery – online/blended/face-to-face – evenings/weekends etc)?** Module delivery will be through a combination of blended face-to-face teaching that is also recorded and delivered online so that students can choose to physically join some of the teaching sessions, and they can also choose to join online either live or by watching subsequent recordings. This will allow part-time students to fit the learning around their other commitments. The balance of face-to-face teaching will be varied to suit the demands of the class. Live tutorial support will be available online, so that students can get direct support and answers without having to always be physically present on campus. The module assignments will be mainly computational and students can work on these in their own time using virtual teamworking tools to allow them to interact on group projects. All course material will be available to students on the module website on Blackboard.

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<table>
<tr><td>Teaching staff & if appropriate institutional/industry affiliation</td><td colspan="3">Name all teaching staff involved and if external, the name of the organisation.

Professor Stephen Spence</td></tr>
<tr><td>Min. /max. number of students</td><td colspan="3">Min. number of students: 0

Max. number of students: 5</td></tr>
<tr><td>Mode of delivery</td><td colspan="3">Blended

Any further details:</td></tr>
<tr><td>MC entry & admission requirements/pre-requisites (if applicable)</td><td colspan="3">Level 8 award. 2.1 grade in Engineering or a cognate discipline</td></tr>
<tr><td>Proposed commencement date</td><td colspan="3">September 2021</td></tr>
<tr><td>Micro-credential frequency, duration and term</td><td>Frequency of delivery during the academic year:

Once per academic year</td><td>Duration of the MC (e.g. 6 weeks). If block delivery applies provide details:

Semesters 1 and 2 – 24 weeks</td><td>Indicate term(s):

Michaelmas ☒
Hilary ☒
Trinity ☐</td></tr>
<tr><td>Contact and independent study hours (include total)</td><td colspan="3">(1 ECTS = 25 hrs) Note: contact hours also relate to online delivery.

Contact hours: 66

Independent study hours: 84

Summative assessment hours: 50

Continuous assessment hours: 50</td></tr>
<tr><td>Micro-credential aims</td><td colspan="3">The key objectives are as follows:
To give students sufficient fundamental understanding of a wide range of low carbon power generation technologies to enable them to undertake energy and carbon analysis of such systems.
To enable students to critically judge the feasibility and. sustainability of power generation systems considering carbon emissions, fuel sources, energy efficiency, flexibility and cost.
To allow students to develop and use their own basic. computational models to analyse and compare energy systems.
To enable students to judge the technical, physical, economic impacts of energy systems and present clear arguments with supporting data for choosing appropriate energy systems.</td></tr>
</table>

Micro-credential learning outcomes (approx. 5)	Resources: Academic Practice and QQI *Note: Learning outcomes should stem from and align with the MC aims and start with an explicit and assessable verb.* On successful completion of this micro-credential, learners will be able to: MLO1.1. Articulate the importance of efficient low carbon energy systems for the sustainability of modern society MLO1.2. Evaluate and compare the efficiency, sustainability and carbon impact of various power generation systems MLO1.3. Use fundamental engineering science to analyse and predict the performance of various low carbon energy technologies MLO1.4. Develop a basic computational model and use it to analyse a power generation system MLO1.5. Analyse and compare different energy storage systems and justify their importance for a low carbon energy grid MLO1.6. Demonstrate an understanding of the balance between commercial and environmental sustainability and the time scales of investments and benefits MLO1.7. Quantitatively assess the potential for various renewable energy technologies to complement or replace conventional power generation systems
MC content areas. *(Bullet points can be used)* If the MC (or components) will be delivered in a blended format, identify the content that will be delivered online.	Development and implementation of sustainable electricity generation is a principal requirement for modern society. This requires reliable energy supply with minimal toxic or greenhouse gas emissions. Achieving this requires diversification of energy sources, more efficient energy conversion and large-scale energy storage to smooth daily variations in generation and demand. This MC will establish the foundational physical principles that enable the extraction of useful work / energy from various sources (thermal, fluid, chemical, nuclear, solar, tidal etc.), and present the current state of the art in power generation machinery. The important methods of power generation will each be examined, with foundational analysis, in the context of significantly reducing greenhouse gas emissions. The basic chemical and thermal analysis of combustion will be developed, to determine the energy release and carbon release from different fuels. Students will learn to analyse energy cycles for the important configurations of steam plants and gas turbines, including analysis of component performance including pumps, compressors, turbines, heat exchangers and combustors. The students will learn about and analyse advanced natural gas turbine power plants including cogeneration plants, trigeneration plants, hybrid GT Fuel cell plants and combined heat and power. Students will learn about technology relevant to waste-to-energy and renewable energies including gasification, anaerobic digestion, pyrolysis, cogeneration gas turbines, biomass combustors. The course will present alternative fuels and different ways of using those in thermal plant, including synthetic fuels, bio-fuels, hydrogen, ammonia and electrolysis.

<table>
<tr><td></td><td>The main types hydraulic turbines and pumps will be presented and analysed in the context of hydroelectric power generation and pumped hydro storage. Other methods of large-scale energy will be presented, including thermal storage, compressed air and gas, batteries and electrolysis. Students will learn the importance of effective storage as part of decarbonising energy and will analyse these systems to determine the overall round-trip efficiency of energy storage to judge their viability.

Nuclear energy production will be presented, covering the history of nuclear, underlying physics, basic components, reactor types, neutron moderation, heat transfer and coolant system design.

Students will learn to evaluate the different power generation technologies in the context of carbon emissions, reliability, efficiency, cost, flexibility and the impacts of integrating renewable sources along with thermal power plant. [Other important energy technologies, including wind, solar, tidal, fuel cells, smart grids, and distributed power, are addressed in other modules]</td></tr>
<tr><td>Teaching and Learning Methods (state pedagogical approach).

Include the online environment(s) to deliver the MC e.g. Blackboard/Zoom, if appropriate.</td><td>Resources: Academic Practice

44 hours lectures (hybrid synchronous online and face-to-face), 84 hours independent student learning, 22 hours tutorials (face-to-face as appropriate), 50 hours summative assessment and 50 hours continuous assessment in the form of class tests and student assignments which require the design and analytical modelling of energy power plants and combined systems. The module will use Blackboard online environment, and all teaching will be recorded and made available through Blackboard.</td></tr>
<tr><td>MC assessment components

Please include the following…

How will the MC be assessed?

Indicate the LO assessed for each assessment (e.g. LO1 etc.)

Indicate the % of overall mark each assessment is worth.

Indicate if summative/formative (e.g. essay/research paper)</td><td>This module is assessed through 100 % Continuous Assessment (A single SITS component). There will be one assignment to be assessed every 4 weeks in the two semesters (hence 3 assignments per semester for 2 semesters in total). The last assignment consists of a 4-page technical summary of a computational model and its use to evaluate and compare several different energy systems. The students will provide a presentation of the results of their computational assignment to the class.

<table>
<tr><td>Mode</td><td>Assessment</td><td></td><td>LOs</td><td>%</td><td>Due Date</td></tr>
<tr><td>CA</td><td>Assignments and class tests</td><td></td><td>1,2,3, 5,6,7</td><td>50</td><td>Sem 1</td></tr>
<tr><td>CA</td><td>Assignments and class tests</td><td></td><td>1,2,3, 4,5,6,7</td><td>50</td><td>Sem 2</td></tr>
</table>
</td></tr>
<tr><td>State how the MC will be reassessed if failed</td><td>100% continuous assessment</td></tr>
</table>

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Pass standard & any special requirements for passing the MC	Resources: Calendar II and Calendar III 50% pass mark
Penalties for late submission	
Core reading (if applicable)	Comprehensive course slides will be provided. Students will be direct to supplementary information in relevant journals, e.g. IMechE Journal of Power and Energy, ASME Journal of Engineering for Gas Turbines and Power, Energy, Renewable and Sustainable Energy Reviews. These journals will be available through the TCD library.
Are there subject experts in other Schools/disciplines?	No If yes, name of School and discipline Click or tap here to enter text. Has the MC been discussed with the School/discipline and DUTL/DTLP? Choose Yes/No
Proposed student fee	External student fee €2,000

Faculty Dean and School Executive Approval:

Date of approval of the proposed micro-credential by the School Executive: 13/04/2021

Date of approval of financial information by Faculty Dean:

Signed by Head of School: Henry Rice Faculty Dean:

Date: 13/04/2021 Date: 11/06/21