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Technical note

Undergraduate studies in energy education – A comparative study of Greek and British courses

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ABSTRACT

Undergraduate energy education in Greece is compared with relevant accredited courses of the United Kingdom, with the aim to transfer good practices applied in the latter for the development and improvement of the Greek courses. Despite the encouraging prospects for energy engineering courses, the situation in Greece seems declining, with only one course being offered in this period. The (unique) Greek course seems to share the same basis with the majority of the British accredited courses, but also a few peculiarities that could be amended for the improvement of the course.

1. Introduction

Undergraduate Energy Engineering courses (*EnE*) are very limited in Greece, in contrast to the strong dependence of the country on fuel imports, the significant renewable energy potential and the willingness of the State to follow a "green" mode of development [1]. Regarding education in emerging disciplines such as energy, it is very important to incorporate know-how and good practices that have already been successfully applied in other countries. Besides, employment is becoming increasingly globalized, therefore graduates are likely to work in more than one country during their working lives. Employers need to know that standards are comparable from one country to another and have confidence in the knowledge and skills of potential employees. In this context we compare the Greek energy course with courses running in the UK more specifically, for the following reasons:

(i) Many *EnE* courses are already operating in the UK, most of them accredited by national Professional Institutions and Organizations.
(ii) There is strong interest in energy education in the UK (a Centre for Research, Education and Training in Energy (CREATE), has been established since 1988 with the scope to assist in clarifying the directions and to identify future needs and developments in energy education in the country).
(iii) Several studies on energy education have been performed in the UK, covering all levels of education including highest undergraduate education [2–4].

2. Energy engineering courses in Greece

Energy Resources Management Engineering course was offered by the University of Western Macedonia. In the early years the graduates faced professional recognition problems. The discipline was later recognized as a branch of mechanical engineering, and the Department was finally renamed as Mechanical Engineering to offer a most secure professional "way-out" to the graduates [5].

An elective (multidisciplinary) course named Energy and Environmental Engineering was offered at T.E.I. of Crete in the frame of a relevant program subsidized by the State and encouraging interdisciplinary courses [6]. Unfortunately this course ceased as soon as funding sources for the program were exhausted.

The older one (established since 1985) – and unique at this period in the country – is offered by the Technological Educational Institute (T.E.I.) of Athens under the title "Energy Technology" (T.E.I. in Greece is quite similar to the German FachHochSchulen or Applied Universities, and the respective engineering courses have the characteristics of engineering technology courses). It is a four (4) years 240 ECTS program leading to certificate named in Greek "Ptychio", which is equivalent to BEng degree. The course includes

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Table 1
The Energy Technology curriculum at the T.E.I. of Athens.

1st Semester		**ECTS**
Mathematics I		6.0
Physics		5.5
Electrical Technology		6.0
Mechanics		4.5
Informatics		5.5
Engineering Drawing		2.5
3rd Semester		**ECTS**
Mathematics III		3.5
Energy Resources		4.5
Electrical Machines I		6.0
Hydrodynamic Machines		4.5
Heat Transfer		5.5
Environmental Protection		3.0
Energy Storage		3.0
5th Semester		**ECTS**
Automatic Control Systems		7.5
Electrical Power Generating Stations		5.5
Renewable Energy Sources I		4.5
Selection of one Group A or B		
A	Electrical Power Transmission & Distribution I	6.5
	Power Electronics	6.0
B	Internal Combustion Engines II	6.5
	Steam Boilers	6.0
7th Semester		**ECTS**
Economic Analysis & Entrepreneurship		4.0
Energy Management		4.0
Energy Systems Optimization		5.0
Cogeneration Systems		3.0
Selection of one Group A or B		
A	Study of Energy Systems	6.0
	Electrical Installations	8.0
B	Heating, Cooling & Air-Condition. II	8.0
	Environmental Technology	6.0

2nd Semester		**ECTS**
Mathematics II		6.0
Computer Programming		4.5
Thermodynamics		6.0
Fluid Mechanics		6.5
Electrical Networks Analysis		7.0
4th Semester		**ECTS**
Electrical Machines II		7.5
Thermal Turbomachines I		4.5
Internal Combustion Engines I		5.5
Measurement Systems		5.5
And one optional module from:		
A*	Analog & Digital Electronic	7.0
B*	Machining Technology & Tribology	7.0
6th Semester		**ECTS**
Technical Legislation & Safety at Work		4.0
Renewable Energy Sources II		5.5
Energy Efficiency in Buildings		3.0
Selection of one Group A or B		
A	Electrical Power Transmission & Distribution II	7.0
	Electrical Drives	6.5
	Electrotechnical Materials	4.0
B	Heating, Cooling & Air-Conditioning I	7.0
	Thermal Turbomachines II	5.0
	Machine Elements	5.5
8th Semester		**ECTS**
Dissertation		20
Practical Training		10

*Students are obliged to follow either all modules of stream A or all modules of stream B.

32 core modules and another 16 optional (Table 1), from which the student has to select half (8 modules) to reach a total of 40 modules for the acquirement of the degree. In the last semester a work placement and the elaboration of a Thesis are required. The optional modules are distinguished between those of group A which lead to the electrical *EnE* specialization, and those of Group B which lead to the mechanical *EnE* specialization.

3. Energy engineering courses in the United Kingdom

The number of *EnE* courses is constantly changing. At present, twenty seven (27) undergraduate *EnE* courses are offered by twenty (20) Universities, as shown in Table 2. According to the table, there are Universities offering solely *EnE* courses (e.g. Sheffield Hallam, Huddersfield) while at the other extreme there are Universities offering *EnE* as a sub-discipline only, for example Heriot-Watt which offers *EnE* as a sub-discipline for all three relevant disciplines namely Chemical, Mechanical and Electrical Engineering.

Among the courses of Table 2, we notice that four (4) *EnE* courses are offered, while another six (6) *EnE* courses additionally focus on sustainability and the environment. The other courses are mainly combined with the three relevant disciplines but also with Building Services Engineering and Materials Energy Engineering (roughly half of the offered courses are of this form).

Accreditation is important in order for the graduate to achieve chartered engineer status (this is regarded as the 'gold standard' of an engineer's competence in the UK), and it is interesting to note that accreditation is achieved through a number of professional bodies, chiefly the Institute of Mechanical Engineers (IMechE), the Institution of Engineering and Technology (IET) and the Energy Institute (EI), some courses being accredited by more than one of these bodies. Where an MEng degree is shown in Table 2 a BEng(Hons) is also normally available, the MEng providing the full academic requirement for CEng registration, and the BEng(Hons) partially fulfilling this (a 'top-up' equivalent to an MSc being required).

Much of *EnE* is covered by the topics normally included in a mechanical engineering degree, hence many *EnE* programs may be regarded as mechanical engineering programs focusing on energy. For instance, in the City University of London, the first two years of these courses are identical and the studies are distinguished in the 3rd year where e.g. the mechanical modules "Mechanical structures", "Mechatronics" are replaced by "Energy Management" and "Renewable Energies" in the *EnE* course.

4. Comparison between the Greek and British courses

The main goal of an *EnE* course is providing knowledge of fossil fuel and renewable energy resources and the basic skills of modern mechanical and electrical engineering, aimed towards the sustainable provision and utilization of energy. In the T.E.I. Athens course however, the main goal is rather to offer knowledge on mechanical and electrical *EnE*, with a view to sustainable energy use. As a consequence, the number of electives offered in the course totals sixteen (16) modules, which is more than usually offered.

All British *EnE* courses are based on modern mechanical and electrical engineering and only in a few cases include chemical engineering core modules (process engineering and materials science). Although these modules support the multi-disciplinary character of *EnE*, their inclusion in the courses is not the rule. In the same context, the T.E.I. Athens course is entirely based on electromechanical engineering and modules such as chemistry, materials science, mass transfer and processing are absent.