



Short communication

## Reshaping the education of Energy managers

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## ABSTRACT

Newly educated Energy managers will play a key role in the unfolding global transition to renewable energy and sustainability. We describe a new approach to energy management education via a cross-disciplinary postgraduate course ('Lean and Green') targeting management, economy, physical science and engineering graduates with the objective to shape Energy managers working in the top management of service and manufacturing organizations to effectively achieve higher levels of energy efficiency and renewable energy penetration, while improving the levels of quality, work and service.

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### 1. Background

The transition to energy efficient societies in which, furthermore, energy is massively generated from renewable energy sources, requires a better, multidisciplinary education of engineers, managers and policy makers [1]. For example, a clear gap between the solutions available for integrating energy efficiency in industrial companies and their actual implementation was found in Europe in 2001 [2], when it was concluded that effective energy management requires to consider energy efficiency as a strategic factor alongside with technical measures.

In 2010, a concomitant shortage of managers with energy efficiency experience, as well as of energy efficiency engineers was found by scholars in the US [3]. The team concluded warning Universities planning new energy efficiency-related programs that "while many PhDs in other disciplines stay in academia, most of the PhDs with energy efficiency expertise find jobs in industry, due to high demand and excellent compensation" [3]. Several other examples testify to the well known, but ongoing, 'energy-efficiency gap' [4].

Improving energy efficiency and promoting the widespread use of renewable energy directly lowers the energy cost faced by an organization, by making its use more affordable [5]. Yet, until the oil (and thus energy) supply has been available at low cost, namely until the end of the 1990s, the energy management profession has

suffered the low status identified in several studies as one of the main barriers to energy efficiency [6].

When, in the subsequent decade, the price of oil surged from around \$12/barrel in 1998 to \$147/barrel in July 2008 [7], the profession of Energy manager suddenly acquired strategic relevance, first at energy-intensive organizations, and then also at service organizations including cities, government offices, hospitals, and large buildings.

That of today's Energy manager has become a very complex figure with updated knowledge and skills crossing many fields beyond energy, including people management, environmental science and technology, finance, personal and enterprise communication, information and communication technologies, and even teaching skills.

The education of today's Energy managers needs to be widened accordingly, for two main reasons. On one hand, the concomitant accelerated development in digital, energy efficiency and renewable energy technologies requires to widen and update the curricula. On the other, and perhaps more fundamentally, there is the need to integrate the study of energy efficiency and renewable energy along with that of management so as to make energy management education consistent with the managerial role of today's Energy manager.

After reviewing current educational practices in Europe and in the US, in this study we identify the requirements of a postgraduate course ('Lean and Green') targeting physical science, engineering and management graduates aimed at shaping managers capable to effectively manage energy at industrial and service organizations.

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**Table 1**  
List of the subjects for the CEM exam.

Topics	Percent of Exam
Codes and Standards	4–6%
Energy Accounting and Economics	11–14%
Energy Audits and Instrumentation	11–15%
Electrical Systems	5–7%
Heating, Ventilating, and Air Conditioning Systems	5–7%
Motors and Drives	5–6%
Industrial Systems	4–6%
Building Envelope	4–5%
Combined Heat and Power Systems and Renewable Energy	4–5%
Fuel Supply and Pricing	4–5%
Building Automation and Control Systems	4–6%
High Performance Buildings	4–5%
Thermal Energy Storage Systems	3–4%
Lighting Systems	5–7%
Boiler and Steam Systems	4–6%
Maintenance and Commissioning	4–6%
Energy Savings Performance Contracting and Measurement and Verification	4–5%

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## 2. Energy manager training

The first educational programs for Energy managers go back to 1981 when the based Association of Energy Engineers (AEE) created in the US the Certified Energy Manager (CEM) credential as a measure of professional accomplishment within the energy management field [8]. Today the CEM status is widely recognized as an important standard for qualifying energy professionals, and the AEE reunites over 17,000 professionals from 90 countries.

Between 2011 and 2013, the three reference books used at courses propedeutic to grant the CEM status, namely *Energy Management Handbook* [9], *Handbook of Energy Engineering* [10], and *Guide to Energy Management* [11], had reached the eighth or the seventh edition.

In general, the educational requirements for Energy managers are broad and take into account the range of educational degrees and years of experience candidates may have. Students of CEM courses have a combination of education and experience. They usually have Bachelor's degrees in engineering, physical sciences, architecture, or have business backgrounds as facility and information and communication technology managers.

It is relevant, for the purpose of this study, to compare the typical curricula of energy management courses granting the credential of certified Energy manager in Europe and in the US. In America, students are examined with respect to 17 mandatory topics (Table 1) [12].

In Europe, EUREM ('European EnergyManager') is a standardized training course offered in 30 countries consisting of 160 units (45 min) of classroom training held by experienced trainers with a professional background, followed by a final project work (80 units) [13]. The training contents include engineering and management topics (Table 2). The basic knowledge (and current role) requirements for participants to the EUREM course are displayed in Table 3. Noticeably, they include 'Access to top management, be able to introduce meaningful suggestions'.

In the US, if the CEM candidate has a 4-year degree in technology, environmental science, physics, chemistry or earth science then a minimum of 4 years of experience in energy engineering or energy management is required to apply. Viceversa, if the candidate has a 4-year degree in business, management or related field, then she/he should have a minimum of 5 years of experience in energy engineering or energy management

**Table 2**  
Training contents of the EU EUREM course.

Engineering	Management
Basics of energy engineering	Energy management systems
Building physics	Economic calculation
Energy-conscious building and renovation	Energy contracting
Heating engineering/geothermal energy	Project management
Process heat	Energy purchasing, energy trade
Ventilation   Air conditioning	Energy legislation – rules and standards
Refrigeration engineering	Climate protection management – emissions trading
Compressed air	
Lighting	
Electrical drives	
Green-IT	
Process and load management	
Monitoring and control systems	
Cogeneration	
Solar technology	
Energy from biomass	

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**Table 3**  
Qualification profile of EUREM training participants.

Basic knowledge of energy technology
Established function on management level
Decision competences
Good knowledge of the production and energy relevant processes
Access to top management, be able to introduce meaningful suggestions
Experience in operational energy concept
EDP knowledge (Windows, Word, Excel)
Intensive professional experience

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After completing the course both in the case of the CEM or EUREM programs, participants should have acquired three main skills, namely i) analyzing the energy situation, ii) develop a technically sound energy savings roadmap, and iii) sell it to top management.

The EUREM certificate is awarded to participants who have attended at least 80% of the training sessions, after having successfully passed a written exam and completed an 'energy concept'. The written exam addresses five subject area (3 for efficiency technologies, one for management, and one for renewable energy).

The 'energy concept' is a unique feature of the EUREM course through which every participant presents in 7–10 min to an evaluation group the outcomes of her/his analysis of the energy situation of the candidate's work environment, illustrating in 5–10 slides how to improve it. The idea is trying to sell the investment proposal to top management. The overall mark is the mean of the values got in the written test and in the energy concept (50:50 ratio).

In fifteen years (2000–2015), the number of certified European EnergyManagers has reached 4500. By early 2016, another 500 EUREM candidates were enrolled in courses outside Europe, as the EUREM training expanded to include India, Chile, China, Mexico and other countries.

## 3. Energy manager: a young and rapidly changing profession

That of Energy manager is a relatively young job. For example, the US job market surveyed in 2015 by the AEE, reveals that 53% of the Energy managers had between 0 and 10 years of energy man-

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