Cooperation with the Energy Industry - the way to recruit more students to Electrical Power Engineering

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Abstract

This paper describes our cooperation with Danish energy producing companies in order to increase the recruitment for electrical power engineering. In the last 10 years the number of students choosing electrical power engineering education in Denmark has been decreasing year after year. At the same time, the demand for electrical engineers with competencies in energy development is increasing, and it is anticipated that in a few years a large number of engineers in the energy divisions will retire, so the expected demand for these types of engineers will be even greater. This situation made it necessary to develop close cooperation between universities, industry and national energy associations. The cooperation between power engineering departments of all Danish universities and colleges has been established, giving the students the opportunity to choose the courses at any university, and by this way to get more specialized knowledge. Many different activities were started at the same time. Some of them were: development of training programs for high school students, announcement campaigns in all kinds of media, training programs and projects for engineering students, summer camps, cooperation between universities, and more. In particular projects involving sustainable energy development, such as wind power and electrical vehicles, are very popular. In conclusion we describe the benefits from this program to all parts, companies, universities and students.

Introduction

Denmark is facing an enormous task in the field of energy production and the main reason is the global climate policy. In order to control green-house gas emissions from the various sectors of industry and individual heating in homes and the public sector, we have to move on with a new strategy to make energy consumption more efficient and energy production "more green" [1]. One of the sectors in focus is production of electric power and it is anticipated that this sector will grow about 40% in the near future. The demand for electrical engineers with competencies in the fields of green-energy development and production is actually increasing, and moreover in a few years a large number of engineers in the energy sectors will retire; the expected demand for engineers within specializations of energy and electrical power engineering will be even bigger [2,3]. At the same time, in the last 10 years the number of students choosing electrical power engineering education in Denmark has been decreasing year after year, and as we all know, the need for electric power is essential to the development of society and the welfare of the people. Ten years ago we had Electrical Power Engineering programs at the Bachelor level in five different engineering colleges and universities, and at the Master level in two universities [4]. The number of graduates on both levels was 300-400 per year. Over the last two years the number of all graduates in electrical power engineering, both in the bachelor and in the master levels, has not exceeded 220 per year. This was starting point for different activities in order to attract young people to study electrical engineering.

Energy Industry in Denmark

The Danish Energy Association has stated: "It is a matter of some urgency that we get a move on with a new energy strategy to recruit more students to electrical power engineering departments in Denmark". *Danish Energy Association* (DE) [5] is an industry association and umbrella organization for associations and groups of energy companies in Denmark. The Danish Energy Association is a commercial and professional organization for Danish energy companies. It is managed and financed by its member companies, mainly the electricity companies, and works to secure for them the freest and most favorable conditions for competition and development in order to ensure development,

growth and well-being in Denmark. The Danish Energy Association is a meeting point for three members' associations:

- Netcompanies - association for electricity grid and transmission companies (66 companies)
- Traders - an association for electricity trading companies (12 companies)
- Production companies - association for electricity production companies (9 companies)

Two groups of companies are also affiliated to the Danish Energy Association:

- Associated Member businesses (4 companies)
- Partners (16 companies)

The Danish Energy Association takes care of its member companies' interests and thus works to improve conditions and competition among these companies in order to ensure development, growth and well-being in Denmark.
This is done by:

- Regular contact with the government, authorities, commercial and professional organizations and other decision-makers nationally and internationally
- Participation in preparatory work for legislation nationally and within the EU
- Information on sector activities and opinions and open contact with the press and external parties
- Support for members' individual interests in questions of fundamental importance
- Collection, processing and publication of sector statistics
- Offering courses, conferences and theme days
- Helping with technical, financial, legal and administrative tasks of importance to members

The Danish Energy Association's vision has seven main goals:

- Energy production with minimum environmental impact
- Energy technology to create innovation and jobs
- Reduced total energy consumption and electricity as energy carrier
- Satisfied, aware energy customers
- Energy must be traded on a European market
- International and market-based price formation
- Energy must derive from a wide variety of sources

Employment within Energy Industry in Denmark

The Danish energy industry has a global leading position. Denmark has obtained a world-class position in several areas, especially within energy efficiency, wind power and accommodation of renewable energy in the power system, as seen on Figures 1&2. In recent years there has also been a strong focus on the interplay between supply and demand as well as increased integration of different energy sectors [4].

Figure 1: Turnover in Wind Power Industry in Denmark 1997-2007

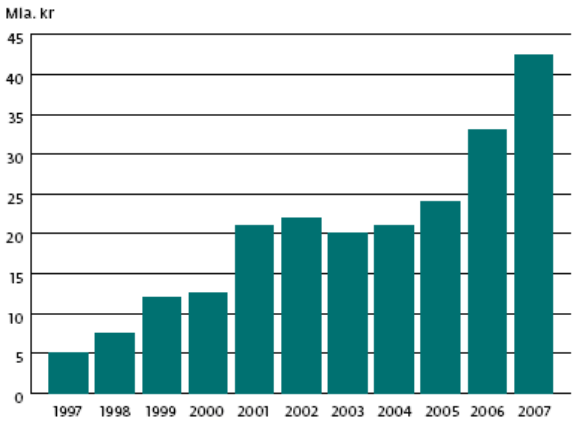
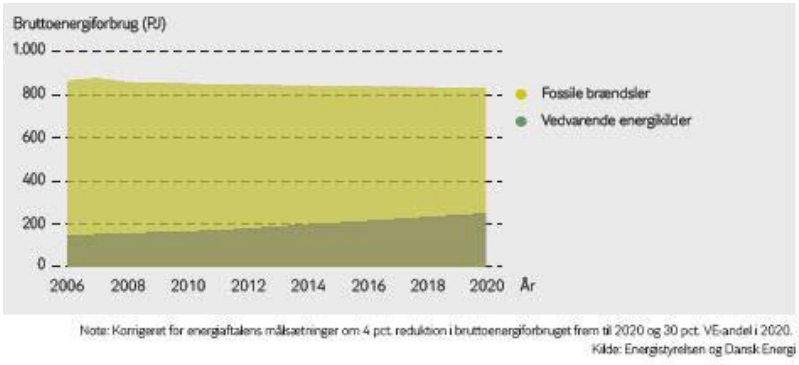
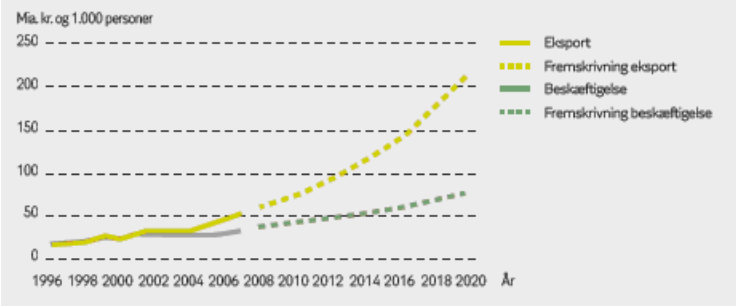


Figure 2. Sustainable energy share in Danish energy consumption



28,000 fulltime employees, equivalent to 7.5% of the total employed in industry, work in the energy industry, which is 50% more than the EU15 average. The Danish export of energy technology and equipment make up for approx. DKK 50 billion per year, which makes it larger than e.g. Danish export of agriculture products or medical/pharmaceutical products. The energy export has been tripled in the last 10 years which is more than twice the growth rate of the total Danish export as well as the EU15 average energy export (Energy Authority, 2008b; Statistics Denmark, 2007). Today almost half the world's wind turbines are produced by Danish manufacturers. The Danish energy industry and energy companies have a unique competence in establishing and operating sustainable energy plants and electric power systems with a very high share of renewable energy. The electricity production from wind power corresponds to 20% of the electricity demand. Denmark was among the first in the world to establish offshore wind farms. Existing offshore capacity is planned to be doubled by 2010/2011– bringing it up to 825 MW. Denmark has a very strong research society within the energy field. Technical universities in Denmark [6,7] employee approx. 1100 researchers in this field. Many very strong Danish research groups exist, and research consortiums and centers are formed within all fields of strength, including wind power (Danish Research Consortium for Wind Power [6,8]), fuel cells (The Partnership for hydrogen and fuel cells), renewable energy (VENet) and smart grids (Centre for Electric Technology [6]). At the same time we can see a growing tendency in the energy related industry. The development of the employment in the energy- industry is shown on Figure 3. In this perspective, the fact that the amount of graduates from electrical power departments of the existing colleges and universities in Denmark was decreasing by 10-25% each year over the last 5-6 years, made the energy industry start a number of activities in order to improve the students' recruitment.

Figure 3. Expected employment within energy industry



Programmes in Electrical Power Engineering at the Copenhagen University College of Engineering (CUCE)

At CUCE [9] we have following energy-related engineering programmes:

- BEng in Electrical Power Engineering (EP) [10]
- BEng in Sustainable Energy (BE, starts in September 2009) [11]

Both programmes are taught in Danish. Our Bachelor programs are organized to achieve a balance between subject and problem oriented work and between lectures, exercises and team work. Successful cross-college collaboration

between faculty members made it possible to develop courses, which combine different engineering disciplines with basic theory. The Electric Power division at CUCE has a long tradition of theoretical and practical (experimental) education, and close cooperation with industrial companies. The Electric Power Engineering division has high-quality laboratories for education and experimental-tests, which are used for training the students and by the industry. Studies in Electrical Power Engineering are aimed at preparing its students for activity in different electrical engineering fields of planning, designing and running electrical power plants and control systems. The area of studies covers a wide range of courses, tutorials, workshops and laboratory covering common and specialized subjects. The program covers the areas of high-voltage engineering, electric machines and drives, power electronics and power systems. The first three semesters are devoted to common courses, fundamental for the formation of an electrical engineer. After the first three semesters the students can choose one of the specializations and in some of the courses they work in teams with industrial projects. The practical training and final (bachelor) project are usually completed in industry with advisors both from industry and our university.

The Bachelor programme in sustainable Energy is developed in cooperation with Aalborg University [7], and will take place in both the Copenhagen and Aalborg campuses. The teaching principle of this program, as in all other programs offered by the Copenhagen University College of Engineering, is based on project-oriented teaching as well as problem-based learning in such a way that the individual courses are linked together to form a project based approach to learning.

Each semester has a theme that is closely related to the courses offered in the semester. All the themes have common ingredients; they should emphasize the innovative element, the design process and the ability to communicate. The teaching and learning approaches are based on semester themes. This means that all subjects cooperate on joint interdisciplinary semester themes. The practical training (internship) and final-bachelor projects will be run in industry, the same principle as for EP-program.

Energy Minds – project

The Danish Energy Association has started the program called [12]:

EnergyMinds – You've Got The Power

Energy Minds is a project which started in 2006 and runs for five years (it will finish in 2010). This program was started by Danish Energy Association (DE) in common with universities, colleges and energy producing companies. On the committee of Energy Minds are representatives from following companies and universities:

1. Companies:
   - Dong Energy A/S,
   - Dong Energy Generation,
   - Energinet-DK
   - Syd Energi Net
   - Vattenfall
2. Universities:
   - CUCE - Copenhagen University College of Engineering
   - DTU - Technical University of Denmark
   - AAU - Aalborg University
   - SDU - University of Southern Denmark
   - AU - Aarhus University

The program is financially supported by Danish Energy Association's members. This project aims to increase the awareness of energy and climate issues among school children and students, and to stimulate Danish and international collaboration among students, teachers, educational institutions, companies and communicators on energy-climate-related subjects. Since the program started in 2006 there have been about 5-6 committee meetings each year in order to plan the Energy Minds' activities. One of the most important activities is the so called Power Camp, which is described in the next section. The following are examples of the activities:

- Power Camp.
- Study-Tours for high school students to the power plants and companies.

- Internship in power plants and companies for school students at different levels.
- Financial support for advertising energy related educations.
- Financial support to universities and colleges to post-doc positions.
- Participation and financial support to produce the materials about energy production and engineering for high school students.
- Participation and financial support in education fairs.
- Financial support to projects involving sustainable energy, wind power and electrical vehicles for engineering students.

The Energy Minds project makes it possible for universities to share their facilities, like giving support to transfer the engineering students from different location to the best laboratory facilities and arranging common courses, if there are not enough students in a single place to run the particular special course. They also provide us with specialists from different companies to give the lectures on particular issues. The disadvantage is the loss of time in transferring the students, but the alternative is to cancel some of the specialization courses because of the lack of enrolled students.

Power Camps

Up to now we have held two Power Camps; one in 2008 and one in 2009. Power Camp 2008 was a two full-days meeting, for representatives from industry and for staff and students from universities, colleges, and high-schools. There were 48 participants working in 6 groups for nearly 30 hours. The aim of this camp was to discuss and develop the plan for recruitment for energy related educations. Table 1 shows the results from the PowerCamp-2008 [13].

Table 1. The Power Camp 2008.

To develop teaching materials for high school teachers and students within physics, referring to energy and electrical power
To develop *Power Play* – the play for primary school children; the play presenting different energy sources
Girl Power Camp – to plan and carry out the summer camp for girls with the energy systems as main topic
To set up the committee for better cooperation between universities' electrical power departments
"From electrician to engineer" to develop the strategy to recruit more of skilled technicians for electrical engineering
Power Summer School – DE will support Summer school course in sustainable energy development for foreign students in Denmark
Power Show – the goal is to develop and design experimental equipment for K-12, within physics, electronics and electric energy systems.

In March 2009 the Power Camp-meeting was placed at Tycho Brahe Planetarium, which is Denmark's most advanced centre for popularizing astronomy and space research and promoting knowledge on natural science. The focus of 2009 meeting was to develop in details the activities described in Table 1, and especially Power Summer School, for Danish and foreign students. During the meeting the new activity was started - Climate Minds: "A new teaching concept for young people" (no details are available about this program at the moment).

Cooperation with Industry

CUCE has very strong tradition for cooperation with industry, especially for the students' final projects. As mentioned before almost all the bachelor projects in the Electrical Power department are made in industrial companies, and the students have both the supervisor in a company and in our college. Danish companies are traditionally active in discussions about development of the engineering education. This is actually part of the examination process in Denmark, where all the examinations on the university level involve, by law, an external examiner certified by the Ministry of Education. For engineering departments the external examiner is very often a company manager. The role of external examiner, among other things, is to keep the engineering curriculum up to date. The external examiner has a great opportunity to discuss the contents of the engineering courses including: pedagogical methods,

experimental work, and projects when he or she participates in the examination. The external examiner has to report his/her conclusions about the examination level, and level of education to the chairman of the external examiners, whom is approved by the Ministry of Education [14]. This procedure gives the industry the influence on the engineering education in Denmark. The industry can easily have an influence in changing the engineering departments' curriculum according to the needs of the industry. On the other hand the students meet their future managers, and get the knowledge of the requirements in industrial companies at the same time.
Moreover some years ago, we made an agreement with the biggest energy producing company in Denmark – DONG ENERGY A/S [15]. We made an agreement to employ two experienced electrical power engineers for a shared position: 50% of the time in DONG ENERGY and 50% of the time teaching engineering students in CUCE. At that time, several of our professors were about to be retired, and there was lack of available electrical power engineers in Denmark. This was a very beneficial agreement for both parts, because we have got many qualified applicants for these jobs, and we build up links between the energy industry and the students at our university, so called "pioneer-cooperation", Figure 4.

Figure 4. Engineers of the future think different.

Closing remarks

Our close cooperation with the energy industry, with companies and the Danish Energy Association, has given and will continue to give benefits to all parties. To us, CUCE, the possibility to offer courses even when there are only a few students enrolled to every course, because the financial support has made the cooperation with other universities possible. We can use each others' laboratories and equipment, and give students up to date knowledge passed on by specialists actively connected to the energy industry. However there are some disadvantages too. Not all the specialists are able to give their knowledge in a pedagogically correct manner, and that sometimes creates problems. Transferring students from place to place is not optimal, and this is a great waste of time.
But the overall conclusion is very positive, for all parties involved - industry, students and us-CUCE.
We hope that our work and efforts will create benefits from better recruitment to the electrical power engineering departments, and it will no longer be necessary to travel for projects, lectures and experiments, since cooperation with industry and between universities is now established for a long time in the future.

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