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Role of Hydrogen on Engineering Education: ICHET Example

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Abstract

International Center for Hydrogen Energy Technologies (ICHET) has been successfully supporting engineering students with practical experience on hydrogen and fuel cell systems built upon their theoretical engineering learning through classroom. A series of activities designed to increase the knowledge and awareness of engineering students and advanced-researchers has been implemented. These activities can be classified under meetings, system integration and training activities. Meeting activities include short courses, technology specific workshops and conferences, sponsorships and summer schools. System integration for prototype demonstrations forms the basis for hand-on practical learning through university-industry collaboration, demonstration activities and application specific supports. Training activities involve internships, part-time employment and laboratory educations. All these activities facilitate knowledge transfer, exchange of information at regional, national and international levels and involve academics, researchers, experts and service providers to further develop their knowledge and interest on hydrogen energy technologies.

1 Introduction

Implementation and widespread acceptance of hydrogen technologies at all levels will take several years of technology demonstration and educational effort. On one side politicians and policy makers are expected to take radical decisions to make hydrogen more competitive for the benefit of society and on the other side, scientists and engineers have to further come up with technological breakthroughs to advance the technology for social acceptance [1,2].

ICHET activities designed to increase the knowledge and awareness of society in whole targeting different audiences [3-5]. This is necessary to make ways toward hydrogen economy and place hydrogen energy into proper perspective for its effective and efficient implementation. Demonstrations and policy work targets government and local officials to educate and make them aware of hydrogen technologies and get commitment to advance such technologies with appropriate government policies. Engineers and scientists from various disciplines, including electrical, mechanical and chemical, are part of daily activities to implement projects to the end. Educational aspect of ICHET activities can be classified into three categories: Workshops, conferences and short courses; system integration and demonstration experience and trainings and laboratory activities (Fig. 1).

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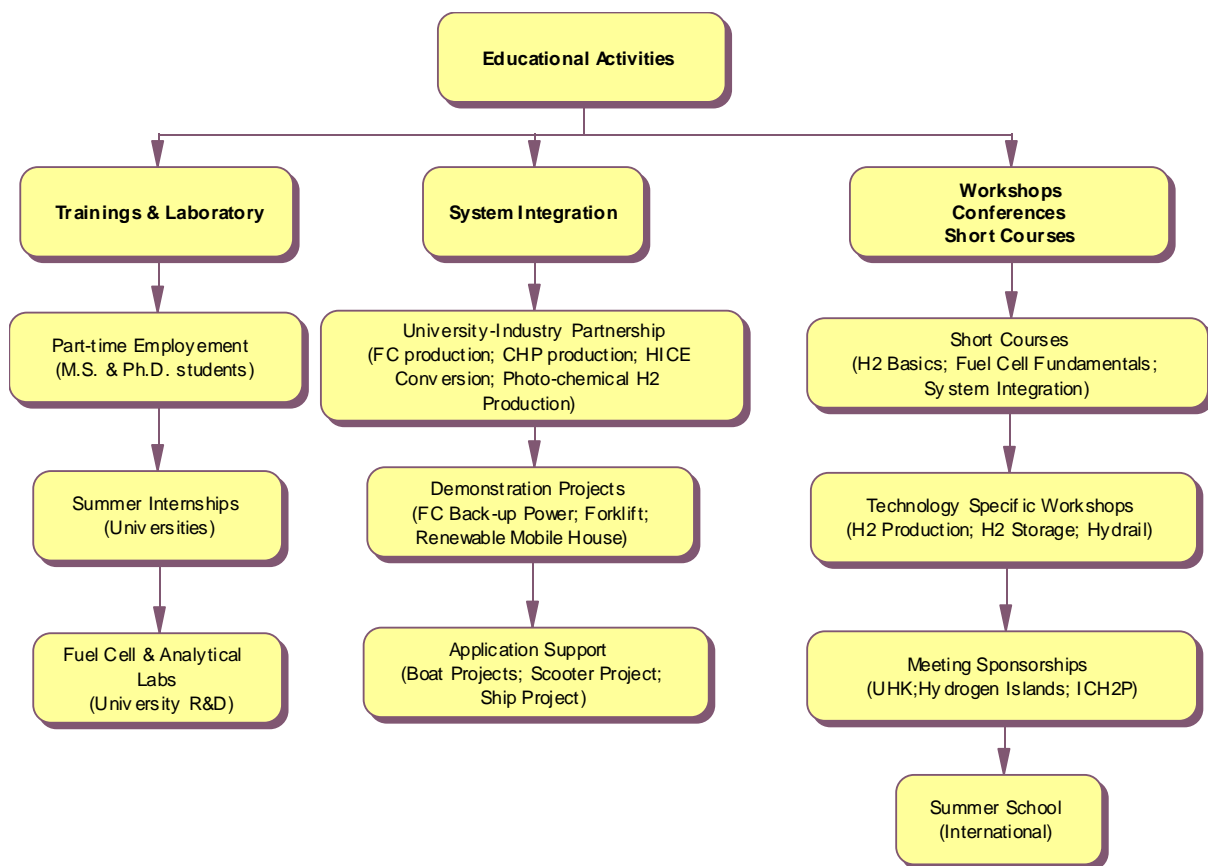


Figure 1: Various educational activities ICHET involved.

2 Workshops, Conferences and Short Courses

Conferences, exhibitions, workshops and short courses forms ideal environment for face to face learning and idea exchange. ICHET sponsored workshops and conferences provide participants with better ideas about hydrogen technologies and motivate them for further actions. Activities targeting high school teachers take place every year with ICHET sponsorships (since 2005, more than 800 physics, chemistry and biology teachers were educated and motivated to implement high school project at their schools). National activities are mainly supported under national hydrogen conferences where participants, mostly academic, get together to discuss their research and demonstration projects. These meetings are first step to introduce ICHET to university community and give them further access into ICHET capabilities. Short courses accept targeted audience with people involved hydrogen in their research or activities (Fig.2). With participation of around 40 people in each activity, hydrogen, fuel cells and the technologies around them are discussed in 2 days (Since 2007, more than 150 participants were educated on electrochemistry, hydrogen production, storage and systems research, fuel cell fundamentals-applications and system integrations with renewable (solar; PV; electrolysis) supported by hands-on laboratory activities). Throughout the courses, the practical side of the technologies is emphasized with lectures being presented in the morning followed by afternoon sessions in the laboratory where the participants could assess some techniques for themselves. Laboratory hands-on

work is encouraged and given priority considering limited laboratory infrastructure in developing countries. One-week- long summer schools has been organized jointly with EC-JRC, Institute for Energy. This activity puts an international perspective into ICHET activities with participants and instructors coming from several different European countries.

Engineers were given every opportunity to participate national and international activities. Several conferences were attended as presenter or participant. ICHET exhibited at several exhibitions and engineers were allowed to participate to learn about state of the technology in various geographic locations.



Figure 2: Students following a lecture in one of the short courses.

3 System Integration

ICHET, university and industry partnerships are utilized to take R&D stage development into prototyping and eventually advancing towards commercial product introduction. Support of several universities in Turkey (METU, NU, EU, IU, SDU, GU, YU, AU) helped several M.S. and Ph.D. students to gain expertise on their subject field and helping capacity building in Turkey. Existence of several high class universities offering M.S. and Ph.D. degrees in electrical-electronics and mechanical engineering helped ICHET to recruit high quality individuals to realize projects.

Engineering students in mind, several external projects were initiated and supported with student clubs to help turning theoretical engineering knowledge into practical experience. Projects, including fuel cell boat construction with six universities, hybrid scooter and hydrogen vehicle constructions are all designed to benefit student from electrical, mechanical, chemical and even from ship-construction engineering departments.

Demonstration projects by themselves are great learning platforms to solve problems with real world applications. Fuel cell back-up power systems were installed and system diagnostics were carried out constantly to seamlessly integrate fuel cell power plant, converters, rectifiers and hydrogen supply system [6]. Forklift project required system

integration knowledge and utilized diagnostics tools to identify problems. On mobile renewable house project, development of the data acquisition and monitoring system plus implementation of automatic controls for power management is done by ICHET engineers (Fig. 3). MATLAB and LabVIEW were used constantly to develop models between the parameters and energy production [7]. Automatic controls are designed and installed to optimize the storage efficiency of the system. Demonstration projects implemented in Turkey and abroad have always relied on support provided by new graduates or M.S. and Ph.D. students for system integrations, maintenance, data acquisition and analysis. Electrical engineers worked on electrical connections and software issues while mechanical engineers have maintained system for continue operation by replacing filters, faulty pieces and necessary mechanical components. Electrical and mechanical engineers were always on site to make the first move.

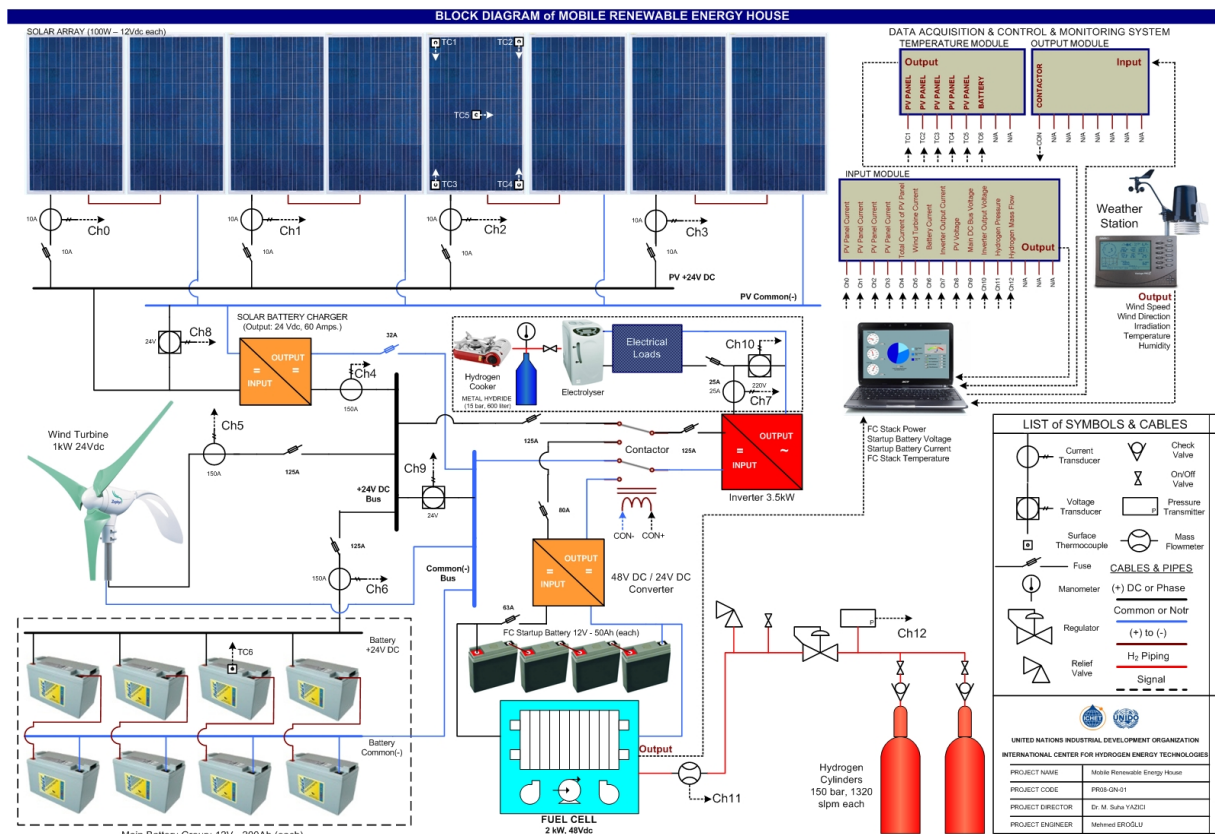


Figure 3: Power flowchart for renewable mobile house developed by engineering students.

4 Trainings and Laboratory Activities

Schools visits were the first stage to encourage engineers to take part in various activities. Presentations on several universities took place in events organized by engineering student clubs. ICHET projects were presented and discussed by fellow engineers on several occasions. Master and Ph.D. students from engineering disciplines are supported part-time basis to work at ICHET helping staff on hydrogen fuel cell related activities while working

towards their degrees. Since 2005, more than 70 students have been supported under this program. In the past ICHET has received visiting scientists from other institutions. ICHET had post-doctoral stays from India, Pakistan (2), Iraq, Germany, USA, Egypt and Turkey (2). ICHET has organized several training seminars about basic technology and research topics as well as analytical equipment use. "Fuel cell integration", "Fuel cell fundamentals, engineering and applications" and "Tools for the Characterization of Materials for Energy Applications" are some to mention with wide spectrum of coverage. Each training activity accepted around 40 participants from universities, companies and government. These trainings provided theoretical background on first day and laboratory experience on the second. Extensive use of the Centre's laboratory facilities and demonstration of the project vehicles were useful in providing real hands-on experience to the participants (Fig. 4). State of the art laboratories include several a few watt to 12 kW test stations, electrolyzers (500 cc/min to 1 m³/hr), various hydrogen storage options, analytical instruments such as gas adsorption analyzer, surface area and porosimetry, TGA-DSC and others.



Figure 4: Scenes from ICHET laboratory activities.

Under sponsorship and internship program, national and international students are given opportunity to participate in hydrogen and fuel cell related technology training and internships. Internship activities facilitate knowledge transfer, exchange of information at regional, national and international levels. Every summer ICHET accepts about 5-7 summer interns to work at ICHET. Various subjects are studied by undergraduate students during 20-30 days of stay.

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