

Educational and Training Activities in Renewable Energy in the European Union*

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A total of 152 educational and training programmes on the use of renewable energy sources and energy conservation in buildings offered in the European Union have been identified and are reviewed. Activities vary from post-graduate degree courses to short, one-day seminars, which are carried out by educational institutions, private or public organizations, and professional societies, with various sources of funding. We have collected descriptive information on each programme and performed a comparative analysis of selected programmes along with an overall qualitative analysis. The available information constitutes a unique source of collective information on educational activities in this area and can facilitate future transnational activities between various educational organizations.

INTRODUCTION

ENERGY consumption in buildings accounts for approximately 40% of the total primary energy in the European Union. This has long been recognized as a major deficiency in the effort of the EU to reduce the dependence of member states on conventional energy sources. The use of renewable energy sources and energy conservation in buildings can lead to a significant reduction of the overall energy consumption, minimize the use of conventional energy sources for heating and cooling of buildings, and contribute to the protection of the environment.

The technology and means for achieving these goals are available, while research activities continue generating new know-how and advanced systems and techniques. However, the main problem is actually to implement them. To do this successfully, it is necessary to have qualified scientists, engineers, architects and technicians actively involved in the design and construction of buildings and its systems, with up-to-date knowledge on the available technology and techniques.

Consequently, the problem of reducing energy consumption in buildings has become that of ensuring that the available knowledge and solutions which have been achieved, collected through years of research and development, and are continuously being expanded and enhanced, are transferred to the professionals involved in this field (employed or unemployed) and to the students still

in the educational system. For both categories, this is only achieved by proper education. However, the nature of this education must be different, since the audience and the objectives are different in each case.

For employed or unemployed professionals, continuing education and training has proven to be the appropriate approach. For students, new university courses and post-graduate studies in this field have been developed, in order to create a new generation of well-educated professionals, specialized in these disciplines.

This investigation is concerned with employed or unemployed professionals involved in this field. Several organizations (public, private, universities), technical chambers and scientific associations have been offering various seminars, short or long programmes and lectures, in an attempt to reach and train professional people and provide them with an opportunity to upgrade their education and improve their knowledge and expertise.

The objectives, methodology, content and overall organization of these vocational training programmes differ significantly between the member states of the EU and even within the same country. Several centres, in most of the member states, have realized the importance of training in this field and have developed programmes targeted towards educating professionals on principles, recent advances and applications of energy-related topics in the building sector. New information from advanced research and development is passed on to professionals who are directly involved in the application of such techniques for the construction of more energy-efficient buildings. Depending on the innovative character of the training programmes and the overall quality of the organizing centre, some

* Accepted 15 November 1995.

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of these efforts have proven successful in educating and training professionals, who in return have applied this knowledge to achieve reductions in the energy consumption of buildings.

On the other hand, some member states have limited advanced technical information while, at the same time, they are in greater need for energy conservation of conventional energy, including the building sector. However the availability of qualified educators in these countries can initiate similar efforts, once they are given the ideas, expertise and experience from organizations responsible for similar training programmes in other countries.

In an effort to evaluate and classify the on-going efforts in the more developed member states of the EU, increase awareness, and promote and facilitate the setting up of transnational training programmes with the less developed member states, the European Commission launched a campaign to collect relevant information on innovative training centres in the EU [1]. An overview of this effort, along with representative information on the characteristics of the identified programmes, are presented in this paper.

Significance of training, continuing education

Scientists, engineers, architects and technicians must be properly educated if they are to design and construct energy-efficient buildings. Everyone will contribute in their respective discipline, but only with a combined effort can one expect the best results. For that reason, it is necessary that these specialists are properly educated and trained, in order to be aware of the latest advances in the area, and that they are equipped with the necessary expertise to put this knowledge into practice.

Engineers are responsible for taking advantage of a building's features for satisfying the heating and cooling requirements (by using passive, active and hybrid systems), for designing the backup air-conditioning systems using the most efficient units, for properly insulating the building, and for selecting and using the appropriate building materials. Architects are responsible for the overall architectural design and arrangement of the interior spaces of the building using bioclimatic principles. It is important that the architect understands how the building envelope can be used to allow for and to enhance the use of passive and hybrid systems for cooling or heating. Scientists, such as energy physicists, are also involved in the design of various energy systems for buildings' applications. Technicians must also have a basic knowledge of these technologies in order to implement them successfully.

The advance in technologies for energy conservation and alternative energy sources has been significant over the past decade and is continuing rapidly. However, those professionals involved in this field who concluded their education before the early 1980s have only been exposed to the fundamentals and prospects of these technologies. Understandably, if these new technologies and

techniques are to be implemented, these people have to be given the opportunity to learn and enhance their knowledge and experience. Furthermore, even recent graduates periodically have to be trained in order continuously to update their knowledge with the new developments. This is the case for all disciplines of science and engineering: education and knowledge usually becomes insufficient within 6–8 years.

Keeping at the edge of technology cannot be achieved only by individual efforts, such as reading scientific books and journals. People have to come into contact with scientists and professionals actively involved in research and development in these areas, with whom they will exchange ideas, experiences and know-how. The information and experimental data collected from major energy research programmes and pilot or demonstration projects must be made available to all professionals and interested third parties outside the scientific community who are directly involved in the building sector. Research and development must be followed by real applications of the accumulated knowledge.

Training plays the most important role in keeping qualified professionals (engineers, architects, consultants) in touch with developments in this field, and in disseminating this information to less-qualified personnel (technicians, builders, designers) who are directly involved to the building industry. There are primarily two ways to enhance their education.

The first is to return to a university and pursue a higher degree. This is not always feasible, especially for practising professionals, because it will require that they stay away from their profession for the duration of their studies, resulting in an unbearable financial burden. To facilitate this, universities offer evening courses, though these may stretch the duration of the course to a discouraging length. However, returning to a university for an additional degree might be necessary for people who do not have the proper background education or who desire to advance their education to a higher post-graduate level.

The second is to attend training seminars, short courses or continuing education programmes directly targeted to specific topics and needs. This has proven more attractive to most professionals who desire to enhance their knowledge and gain expertise in a specific field for which they have the necessary background. There are, of course, numerous centres involved in these activities, in one or more scientific disciplines, depending on their nature and scope. This investigation includes several centres that organize seminars, courses or other vocational training programmes, in the field of energy conservation and the use of alternative energy sources in buildings.

Understandably, the nature and type of training will vary significantly depending on the audience, the needs and the goals to be achieved. For example, an engineer should be exposed to a high

level of scientific information, while a technician should receive an informative education and basic training, with emphasis given on practical guidelines. It is important, however, that they all understand that energy conservation and the use of alternative energy sources in buildings makes sense: they save money, they assist in the solution of the energy problem by reducing the use of conventional fuels and they protect the environment.

The buildings' occupants must also be aware of the problem and the ways of participating in this collective effort. They must be advised accordingly in order to influence their behaviour as occupants and end users of energy. These efforts should concentrate on providing them with informal training and initiatives from an economic point of view. They must be educated on the role and proper use of the various energy conservation features of their building, they must be persuaded to purchase energy-efficient systems that are designed for the climatological conditions of their area, and they must be provided with useful guidelines and tips on how to save energy without sacrificing comfort. For example, with a bioclimatic building which may have been designed to use night ventilation for cooling purposes it is necessary that the occupants leave the windows open at night; to do that they must understand the basic reasons behind it and justify these actions in relation to their direct benefits.

Another major difference in the approach of a training programme originates from whether the audience is employed or unemployed. The training that is suitable for each one of these two categories must be carefully defined. The employed professional already has significant working experience that only needs to be enhanced by the introduction of some novel technologies and techniques. The emphasis of their training must be placed on providing them with the expertise for putting these new methods into practice and on demonstrating that these technologies are viable, beneficial and applicable in the market where these professionals compete. Then one may expect that they will be persuaded to incorporate them in their working environment. On the other hand, unemployed people need to be treated differently. The major objective is to make them more competitive and provide them with new education and expertise which will enable them to compete more successfully. Their training needs to be oriented towards short-term objectives. In both cases, professionals who do not have the necessary background, but who wish to get involved in this fast-growing field, must first be educated on the related principles and then on specialized topics and applications. This would demand a long programme, with sufficient time available to cover all areas of importance.

Accordingly, to influence and change the current situation significantly, one must first concentrate these training efforts on the group of professionals who will best utilize them by contributing in their

respective areas and then passing their knowledge on to others, and to get unemployed people back in the workforce. It is important first to influence and change the way of operating and the problem-solving methodology used. In addition, the technical background necessary for understanding these new technologies is of such a high level that the audience must have a solid education and technical knowledge of the fundamentals involved in these subjects. This can only result from a university-level education in engineering, architecture or other related disciplines, possibly enhanced by some working experience in these fields.

An undergraduate degree in the above areas is necessary if the knowledge provided to participants in a high-quality vocational training programme is going to be comprehended. For example, one needs a solid background in heat transfer in order to appreciate and be able to utilize the information provided during a lecture on techniques to improve thermal insulation or the role of thermal mass for heating and cooling buildings. This automatically implies that these programmes must be organized for professionals with at least a first degree in the related disciplines. Professionals with advanced degrees will, of course, further facilitate these objectives, since their educational background and experiences are at a higher level.

Subsequently, once this first priority group of professionals has been fully covered, it is worthwhile initiating similar efforts for professionals with elementary technical knowledge. The educators can be the same as in the previous case or they can be the best qualified from the already trained group. This secondary group of professionals may include people who are involved in the building sector, like technicians and skilled craftspeople. This group does not need all the high-level technical information, which they would not be able to comprehend. They rather require a fundamental understanding of the new technologies, how they operate and the positive results obtained from similar applications. In a sense, the objectives of these efforts should be targeted towards changing the way they have been traditionally performing their jobs in order better to follow and implement the technical instructions of the engineer or architect. This simply means that they understand the fundamentals of what they have been directed to do, thus facilitating the work and communication between them and the other professionals. For example, it is necessary that a builder understands the fundamentals of thermal insulation and its role to energy conservation in order to expect that, when the building's outer envelope is constructed, the insulation is properly placed in accordance with the engineer's directions and plans.

Understanding these priorities, it is important that vocational training of professionals is organized according to the following scenario. Priority is given first to educating and training professionals who have at least an undergraduate

degree in engineering, architecture or in other related disciplines. A centre which has gained experience from successfully organizing such programmes can then expand its efforts to the other technical disciplines of people involved in the building industry.

Accordingly, in terms of importance and priorities, this work concentrated its efforts in identifying the centres of excellence which organize vocational training post-graduate programmes. This objective focused our efforts on an investigation of candidate centres and programmes which, under further examination and analysis, can most likely be characterized as centres of excellence. Of course, this is not the only criteria used, but it was viewed as an integral part of the initial screening process. However, other important efforts in all levels of education have also been included. In combination with the other criteria described below, this was aimed at ensuring that only centres of excellence and programmes of significance are included in the extensive examination and analysis phase of this work.

METHODOLOGY

The investigation was organized in two major stages. During the first stage, 152 educational and training programmes organized by several European centres in the European Union, were identified. During the second stage, a more in-depth analysis was performed for a selected number of programmes, following preliminary evaluation and screening. In total, 44 programmes have been documented with all relevant information about the organizing centre, the contents of the programme, its structure, etc., based on an extended questionnaire that was completed by the organizers of each programme. This information constituted the basis for the final evaluation of the programmes, combined with a comprehensive processing of the available data and the personal evaluation of an independent representative in each member state. Finally, the selection of centres of excellence is based on an overall evaluation of the contents and innovative characteristics of its programmes, a cross-comparison with the other vocational training programmes organized in this field of energy and the centre's other relevant activities.

The effort was assisted by a team of experts, directly involved in energy-related activities, from each member state, who acted as national contact persons. Initially they compiled a list of all national organizations and programmes offered in their respective countries, providing vocational training programmes in the areas of interest. For every identified programme, a short questionnaire was completed to provide key information, such as major topics covered, type and average number of participants, duration of the programme, periods that the programme is offered, source of funding

and any other relevant comments. This information constituted an integral part of the screening and selection procedure of the programmes to be used for the following extensive analysis. Finally, for 44 programmes from all EU member states, additional information was collected through an extended questionnaire. This 16-page questionnaire provided comprehensive information about the selected centres and programmes. The structure of the questionnaire primarily involved filling in blanks or checking responses. This information, along with the personal evaluation and comments of the national contact, compromised the basis of this investigation. In some cases, additional information was collected during personal visits by our staff to the respective centres and personal attendance at parts of these programmes. These on-site visits and personal contacts have given us the opportunity to learn more about each centre and its relevant activities, improved the information and clarified any questions on these programmes, facilitated the final evaluation and cross-comparison of the programmes, and, finally, assisted in the specification of guidelines and recommendations.

Short description of programmes

Based on the collected information using the short questionnaires, some important characteristics of the various programmes identified in each member state are listed in Table 1 and are presented in the following discussion. This information was used to define the general guidelines for selecting the most innovative programmes, representative of the efforts of each organising centre, and of the highest quality in various levels. Table 1 gives an overall picture of the ongoing efforts in the member states, for a total of 152 programmes. There are four categories of information. The first one identifies the breakdown of the programmes according to the following topics: basic principles, new/advanced technology and practical training. The second identifies the percentage of the programmes which are attended by engineers, architects, scientists, technicians, consultants and other related disciplines, like managers and policy-makers. The third identifies the percentage of the programmes with a duration of a few days (short seminar), one month, a quarter, a semester or longer. The fourth identifies the percentage of the programmes which are self-financed, receive part of their funding from the European Commission, government or other public sources, universities, industry, scientific organizations or a combination thereof.

The identified programmes differ significantly in nature, content, duration and overall organization. In order to avoid repetitions and to cover as many centres as possible, only one programme from each centre was selected. The targeted audience is mostly engineers, architects and scientists. This was only to be expected, since these professionals are the ones directly involved in the design and construction of buildings. In addition, the nature

Table 1. Characteristics of identified programmes in each member state

Country (No. of programmes)	Topics	Participants	Duration	Funding
Belgium (7)	86% basic principles 57% new advanced techniques 86% practical training	71% engineers 14% scientists 57% technicians 29% consultants	14% short 14% semester 86% long	14% self 14% EU 86% public
Denmark (32)	91% basic principles 50% new/advanced techniques 56% practical training	94% engineers 28% scientists 62% technicians 75% consultants 34% other	72% short 28% long	100% self 3% EU
France (20)	100% new/advanced techniques 26% practical training	84% engineers 42% scientists 84% technicians 32% consultants 32% architects, managers	63% short 21% month 5% quarter	5% self 5% EU 95% public 5% university 89% industry 5% scientific organization
Germany (18)	89% basic principles 50% new/advanced techniques 44% practical training	94% engineers 22% scientists 33% technicians 28% consultants 11% other	33% short 6% month 6% semester 56% long	28% self 56% public 11% university 11% industry 6% scientific organization
Ellas (20)	95% basic principles 100% new/advanced techniques 84% practical training	100% engineers 58% scientists 61% architects 11% other	16% short 21% month 53% quarter 5% semester 5% long	26% self 90% EU 47% public 5% industry 11% scientific organization
Ireland (7)	100% basic principles 100% new/advanced techniques 100% practical training	100% engineers 100% consultants 100% architects	100% long	100% EU
Italy (12)	58% basic principles 58% new/advanced techniques 50% practical training	100% engineers 25% scientists 58% technicians 25% consultants 25% other	8% quarter 8% semester 83% long	33% self 67% public
Portugal (6)	83% basic principles 33% new/advanced techniques 83% practical training	83% engineers 16% scientists 50% architects 16% consultants 17% technicians	100% short	67% self 33% EU
Spain (17)	65% basic principles 65% new/advanced techniques 41% practical training	94% engineers 29% scientists 71% technicians 18% consultants 18% architects	41% short 12% month 18% quarter 6% semester 29% long	76% self 6% EU 29% public 12% university 12% scientific organization
United Kingdom (13)	92% basic principles 92% new/advanced techniques 100% practical training	78% engineers 23% scientists 23% technicians 38% consultants 92% architects	46% short 8% quarter 23% semester 54% long	92% self 8% EU 23% public 46% university

of the contents and the principles necessary to comprehend and actually implement the techniques of energy conservation and the use of alternative energy sources in buildings demands a high level of education. This implies that the people attending these programmes must have a university-level technical education. Only then can one expect that the information provided through these programmes can be utilized and the expertise gained put into practice in the best possible way.

The duration of most programmes ranges from a few days to a few weeks. These short-term programmes appear to be most suitable for employed professionals. Unemployed people can

attend a longer training programme, but even in this case, it is necessary that they complete their training in a reasonably short time, in order to increase their potential and competitiveness, which will enable them to join the workforce as soon as possible. The source of funding in the majority of the reviewed programmes appears to be from the participants themselves and public finance. In some cases, funding from the European Union plays a primary role in keeping these efforts going. This also indicates that the EU has been very active in supporting vocational training activities.

Screening of programmes

The initial screening of these programmes in order to select the ones which were extensively investigated was done in close co-operation with the national representatives. Their comments and suggestions played a significant role in the process since they have the best knowledge on the existing situation in their respective countries. In general, only one programme from each centre was selected. In some exceptional cases (centres which exhibit exceptional characteristics), two programmes from the same centre were selected. It was also desirable that some centres should be represented in the next phase due to their good reputation and well-known activities in the areas of education and training. Consequently, some programmes were selected due to the fact that they are organized by reputable centres.

Priority was given to programmes that emphasize new and advanced technology supplemented by a period of practical training. Some programmes which only cover the basic principles were excluded. A solely theoretical approach to these topics cannot be satisfactory. It is actually necessary that these programmes incorporate theory (primarily on the new and advanced technology) with a practical training period in order to give the participants the opportunity to practice and implement the new material. Basic principles can be beneficial only if they are used as an introduction to the more advanced topics and applications of new technologies.

Another selection criteria was the level of education of the participants. Emphasis was given to programmes attended by professionals with a background in engineering, architecture and science. The nature of these programmes demands that the audience has a solid technical background and the high level of technical knowledge necessary for understanding and implementing these new technologies. This is directly proportional to the level of excellence of a given programme. A high-level audience will enable the organizers to introduce ideas and cover topics of advanced technological content.

The duration of each programme also played a role in two ways. The first approach considers the fact that employed professionals cannot devote long periods of their time to continuing education or training. This means that short programmes (like seminars or workshops) are best suited to their time schedule. This can be appropriate for professionals with high-level degrees (M.Sc. or Ph.D.) or many years of experience, for whom a few hours of lecturing by their colleagues (who are actively involved in research) on the latest advances and developments can be sufficient. The second approach considers the fact that programmes of intermediate or long duration give the opportunity to cover more material in depth and include projects and practical training periods which greatly contribute to the overall success of the programme. This kind of programme would be

mostly appropriate for professionals holding undergraduate degrees, or those who have educational backgrounds in related disciplines. In such cases, time must be spent on a brief review of fundamental principles and there must be time available for an extensive coverage of all related topics. Since both short and long programmes are of significance (satisfying different needs and groups of professionals), programmes from both cases were selected.

The frequency of a programme is a fine indicator of its success. One would have every reason to expect that a programme which is repeated several times a year or annually must exhibit a high degree of innovation, applicability and success. Similarly, a programme which is offered upon request indicates that it is well accepted and attracts the interest of professionals due to its significance and contribution in satisfying their specific needs. Accordingly, programmes which fall into these categories were selected.

Finally, information on the source of funding for each programme was used in order to include programmes and centres which operate with different types of budgets. Some centres organize training programmes using their own funds, which may be coming from private or public sources. It is of direct interest to this study to investigate programmes which may be funded by the government of a given member state. Identifying this kind of information may give the opportunity to initiate similar efforts in other countries. Funding of a programme by the private sector and industry indicates that they are directly interested in its contents or that they may be actively involved in the selection and content of the areas covered. Programmes financed by the European Union also guarantee their quality and usefulness since one would expect that these activities have undergone and passed close scrutiny by the CEC as regards their importance and contribution to the professional world. Finally, a self-financed programme (from participation fees) should also indicate excellence, since it is attended by professionals who are willing to pay to obtain the education and training that the programme will provide them with. Hence, the selection of the programmes was done in such a manner as to maintain a balance between the different sources of funding.

In member states where the total number of programmes was small, some of the above guidelines were not followed to the letter. This was done in order to include as many programmes from each country as possible and to have the opportunity to collect additional information during the next phase of this project.

LESSONS LEARNED

Universities appear to be redirecting their role in education. Traditional course programmes have

been restructured and have been opened to interested professionals who only want to attend parts of these programmes. Universities, because of their experience and vast resources, are best qualified to take a leading role in the continuing education and training of professionals. The example of United Kingdom, with a modular structure of several programmes which are open to interested professionals through a Continuing Professional Development programme (Polytechnic of East London, University of Reading, University of Strathclyde) and similarly the programmes offered at the University of Seville in Spain and Ecole des Mines in France, best exhibit the new role of the universities. In Germany, the Technical University of Berlin (TUB) has developed a link with various national training organizations (providing them with technical expertise through its faculty, and giving access to its facilities to the programmes' participants), and transnational links with the Ellenic Productivity Centre, offering a similar programme organized by TUB in Athens (lecturers from TUB also participate) and a practical training period in Berlin. Universities can also be encouraged to organize short programmes intended for a high-level technical audience. Such efforts have been realized with great success by University College Dublin in Ireland.

Technical associations need to get more involved in the training process and continuing education. Their close links with professional societies in each country should be taken advantage of, in order to develop programmes that respond to the specific needs of their members. They also have an additional advantage, due to the fact that these organizations have an existing infrastructure of local branches, facilities and professional associations through their membership. For example, The Institute of Engineers of Ireland and the Technical Chamber of Ellas have been organizing several programmes, seminars and lecture series in areas of direct interest to their members, through the various district offices that these organizations have around their respective countries. It is possible that these efforts could be co-ordinated on a European level by the European Society of Professional Engineers (Euro Ing).

Organizations which are concerned with the advancement of renewable energy sources should develop a more active role in the training and continuing education of qualified professionals, since they have a sincere interest in this area, the qualified personnel and the appropriate facilities. They should also take advantage of the existence of such organizations in several countries to establish a network, in order to give a transnational character to their efforts, co-operate and give the opportunity for a broader exchange of ideas, and to provide assistance to the less technically and financially capable. In Ellas, the Central Institution for Energy Efficiency Education and the Centre for Renewable Energy Sources have organized several training programmes on bioclimatic

architecture and energy conservation in buildings. Similarly, in Spain, CIEMAT has been organizing intensive training programmes in this area for interested professionals with postgraduate degrees.

The financial support of the European Commission for organizing continuing education and training programmes has been critical in the development of many successful programmes. In addition, the European Commission, Director General for Energy, has recently established in Ellas the Central Institution for Energy Efficiency Education. CIENE is financed within the framework of the SAVE Programme and is managed by the National and Kapodistrian University of Athens. The objectives of CIENE are to provide information on energy-efficiency topics; to produce and publish related educational material, which will be made available to interested third parties; to organize specialized training programmes on specific energy problems for professionals and trainers; and to carry out studies and other activities on energy-efficiency education. Overall, the financial support of the EU has enabled the less scientifically and technically advanced member states to develop outstanding programmes through several public and private organizations, like the Ellenic Productivity Centre and CIENE in Ellas, University College Dublin in Ireland, CLER in France, etc.

The role of the EU will also be critical in the effort of transnational co-operation between different centres, for the setting-up of links between universities, professional societies and other research institutions and organizations, for the training of European professionals in the areas of energy. The governments of the member states should, however, take a more active initiative. The case of France is a prime example. The French government has established regulations which mandate that a portion of a company's net expenditure is allocated for the training of its employees. This has resulted in a continuous improvement in the level of education of the workforce. As a result, firms with over ten employees are required to spend 1.4%, while on average it has been found that they spend 3.5%, and high-tech companies spend over 8%. This clearly demonstrates the value of training. At the same time, French regulations also mandate that in each continuing training programme, one or two unemployed professionals are also allowed to attend. In this case, the participation expenses are covered by the government. In this way it is possible for the unemployed to participate in training programmes which are of direct interest to the employers, thus making them more competitive.

Training programmes must be offered that satisfy specific needs and objectives for well-targeted audiences. Different audiences—employed or unemployed professionals, post-graduate or graduate-level professionals have different needs. This means that programmes have to be tailored accordingly. For each group, some ideas which have resulted from this project and feedback from

the participants are presented in the following discussion.

Training of employed professionals

This group of professionals has to be given special consideration, because they have an immediate involvement with these topics in their working environment. If carefully trained, they can produce the most immediate results. However, their professional responsibilities do not allow them to participate in programmes held during regular working hours. For that reason such programmes have to be held during the evening or at weekends. These training programmes must be short in duration and rather intensive. In addition, correspondence programmes can work very well for employed professionals.

Training of unemployed professionals

Unemployed professionals constitute a group which demands to be given special attention. These professionals must be given new expertise and advance their knowledge in order to become more competitive in the professional market. Training in the areas of energy conservation and alternative energy sources are indeed a very competitive topic which can open new areas for future professional development. Depending on the level of education and professional experience, these programmes may be longer in duration in order to cover fundamental and introductory topics better. A most suitable approach would be if the programme's participants are employed for the duration of the training by a firm closely related to the theme of the programme, while they also participate in a series of lectures. As a result, the programme's participants are being trained, while at the same time they are gaining valuable professional experience by continuously working and solving real problems. This enables them to create the necessary professional contacts and future employment perspectives, while their training is immediately utilized, with a direct impact on improving the existing situations in buildings.

Training of post-graduate professionals

Training of professionals with graduate-level education, or equivalently with many years of professional experience, would be most successful with short programmes. A seminar lasting a few days with presentations on recent advances and developments, by lecturers who are involved in research in these areas, and interaction with discussions between the participants and the lecturing experts can be sufficient.

Training of graduate-level professionals

Programmes intended for the training of an audience holding an undergraduate-level degree can have a significant impact on the overall success of energy conservation policies of the various member states. In particular, recent university graduates will be the professionals most directly

involved in the design and construction of new buildings. Consequently, it is essential that they are properly trained and that they become aware of the new advances in energy conservation and the use of alternative energy sources in buildings. This is best satisfied with average length training programmes.

Training of people with no university degree

This is a rather difficult group of people to train on these subjects, because it is necessary to have some professional experience and technical formal education in order to be able to comprehend the various topics. Accordingly, it is necessary to at least have extensive professional experience in this area, and only then it is possible for a training programme successfully to enhance and advance their professional development.

CONCLUSIONS

This investigation has (i) identified all major organizations and centres providing training programmes within the European Union on energy conservation and the use of renewable energy sources in buildings; (ii) collected short, descriptive information on each programme offered by the identified centres; (iii) screened the identified programmes and selected those that are highly innovative and are organized by reputable centres; (iv) collected detailed, descriptive information on the selected programmes and respective centres; (v) instituted a comprehensive evaluation procedure of the collected information for the purpose of identifying centres of excellence; (vi) processed and evaluated the collected information; and (vii) designated centres of excellence.

Training can vary from post-graduate degree courses to short, one-day seminars. It is carried out by educational institutions, private or public organizations, and professional societies, with various sources of funding. This investigation has identified over 150 various programmes, in related disciplines, offered by various centres in the European Union. All member states exhibit some kind of activity in this field of practical training. This investigation has identified the best efforts in this field and has provided a comprehensive picture of the on-going efforts in each member state. Through a comparative analysis of the various programmes, this study has identified various centres of excellence. One can distinguish the more advanced member states, in terms of the quality and innovative character of the programmes organized in each state. Denmark, France, Germany, Ellas, the United Kingdom and Spain have developed the most noticeable activities in this area.

Acknowledgements—Financial support has been provided by the European Commission, European Social Fund VD1, DG Employment, Industrial Relations and Social Affairs, contract no. 911210/31.XII.1991. The assistance provided by V. Kolo-tourou, Head of Sector, throughout this project is gratefully acknowledged.

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