

Assessment of the Human Resources Infrastructure for Nuclear Energy Program in Macedonia

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Abstract. Macedonia is a country with no nuclear power and research reactors. The nuclear application is currently only in the medical industry, agriculture and food industry, accompanied by radiation measuring and protection activities in these sectors. On the other side the energy needs have been increasing in the last ten years, which resulted in electrical energy import of about 20–30% (around 3000 GWh). Nuclear power is one of the options for satisfying energy needs in the next 50 years.

One of the crucial problems in nuclear energy implementation are human resources needs and educational infrastructure development in this field. No matter what will be the future energy scenario in the Republic of Macedonia, the nuclear educational program is the first step to have HR in the field of nuclear energy.

This paper presents the proposed direction for having HR in nuclear energy program in a small country such as the Republic of Macedonia. Taking into account the existing national education program related to nuclear topics and in particular to nuclear power, and following the guidance and recommendations from the international nuclear educational programs at the IAEA, EHRO and others, the planning of the educational nuclear programs and human resources development in the Republic of Macedonia has been carried out. This includes the enhancing the capabilities of the national regulatory body in the Republic of Macedonia.

Keywords: NEP (Nuclear Energy Program), HR (Human Resources), NEPIO (Nuclear Energy Program Implementation Organization), NRB (Nuclear Regulatory Body), NPP (Nuclear power Plant)

1 Methodology for HR Strategy in Macedonia

Figure 1 shows a schematic of the methodology for the development of human resources for the nuclear energy program in Macedonia*, which is based on:

- Recommendations of international organizations and associations such as the IAEA, the European Union and others.
- Experience of some countries regionally close to Macedonia, and similar in demographic terms, economic development, energy needs, geographical proximity.
- The existing educational system in Macedonia with a special emphasis on academic education, undergraduate, master's and doctoral studies.

Based on the comparison between the required educational level for the nuclear energy program that is recommended by international organizations, and the existing educational and institutional infrastructure in Macedonia, recommendations are made for the development of HR for NEP in Macedonia, as well as for the establishing of necessary institutional organizations, such as NEPIO and NRB.

To achieve the above goal, a systematic assessment of the existing educational and HR infrastructure has been undertaken, while keeping in mind international guidance on the number and type of resources required in each phase of the nuclear power program implementation. Some of the existing governmental regulatory bodies, such as Energy Regulatory Commission (ERC) (<http://www.erc.org.mk>), or directories dealing in some fields connected with energy or safety manners, such as Directory for Radiation Safety (DRS) (<http://drs.gov.mk>) and Crisis Management Centre (CUK) (www.cuk.gov.mk), can be used to establish appropriate departments for a nuclear power program. The existing staff in these organizations, complemented with new staff, can reach the appropriate knowledge level to support the new nuclear energy programme in the upgraded national bodies, such as the National Nuclear Regulatory Body, the National Nuclear Commission, and others.

2 Educational System in Macedonia

Figure 2 presents the existing educational system in Macedonia, which consists of three levels. The first level is the primary school of 9 years. The secondary level consists of 3 years of vocational courses, or 4 years

*The term Macedonia is used for the Republic of Macedonia in the remainder of this paper.

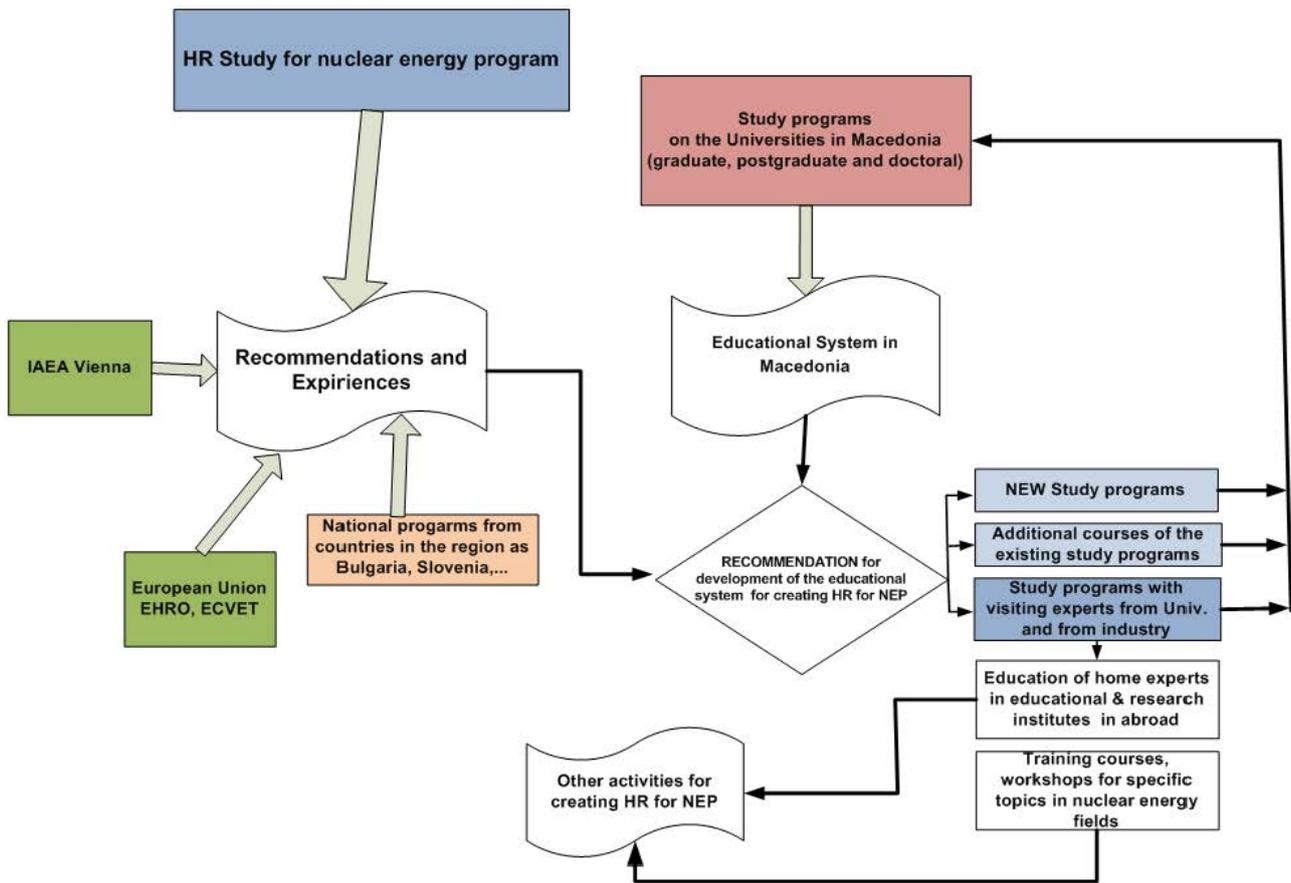


Figure 1. Schematic presentation of the methodology for HR in nuclear field.

for secondary school (gymnasium). The third level is the university education. The concept for university educa-

tion is 3 degree of studies: undergraduate studies, graduate studies and doctoral studies. The Ministry of educa-

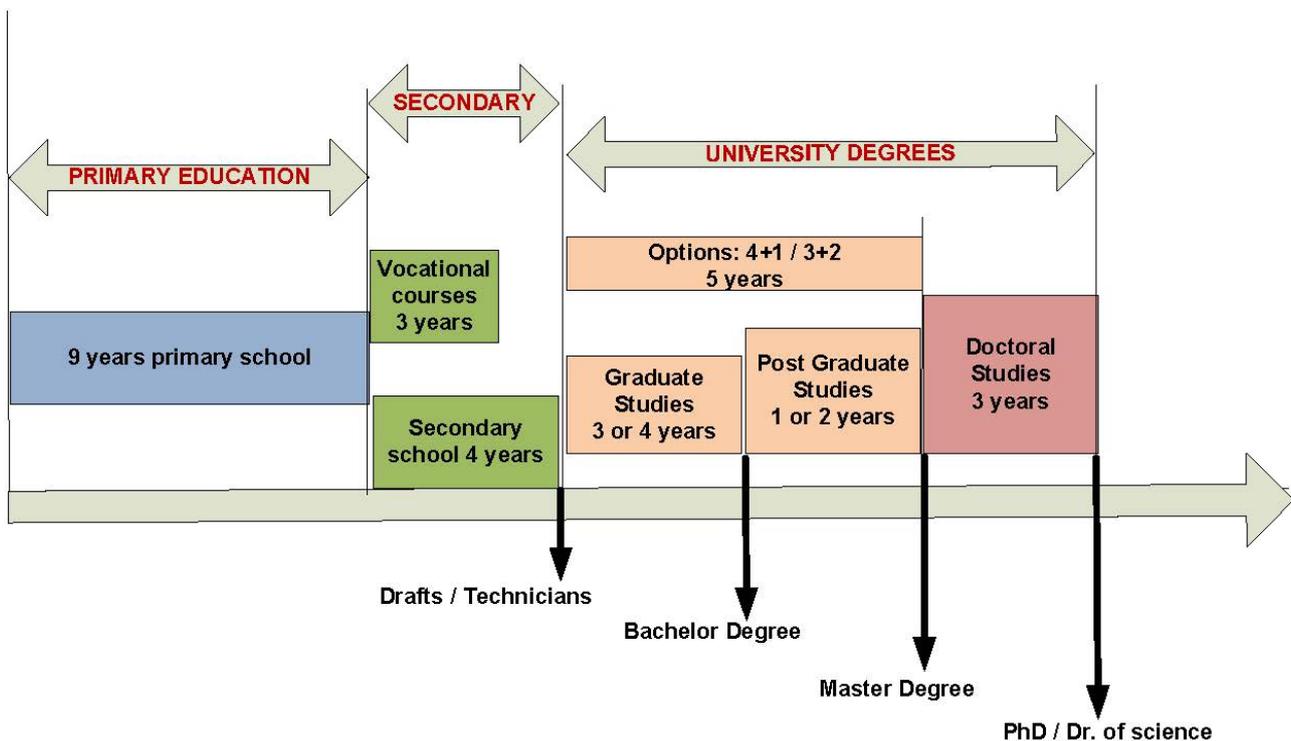


Figure 2. Concept of educational system in Macedonia.

tion in 2006 adopted the European Credit Transfer System (ECTS). Options for undergraduate studies are 3 or 4 years (180 or 240 credits) and for graduate studies are 1 or 2 years (60 or 120 credits), with the total of 300 credits (4+1 or 3+2). The doctoral studies in ECTS consist of 3 years with 120 credits.

The vocational courses are mainly for drafts and some schools (3 or 4 year's duration) can provide technologies' skills (electrical, mechanical, civil or others).

The first part of the review of the educational system in Macedonia consists of review of the existing secondary and university education infrastructure in terms of power engineering and other programs in the area of technical and related fields that will be needed for a nuclear energy program.

The curricula assessment of the existing undergraduate and graduate faculties of the universities in Macedonia have been performed in the following groups of profiles:

2.1 Group of technical sciences and engineering

The profiles in technical sciences and engineering include the following faculties: the power engineering study programs of electrical engineering, programs of the faculties of mechanical engineering, faculties in the field of information and telecommunication sciences, faculties of computer engineering, faculties of technology and materials, and faculty of civil engineering. Also in this group has been placed the Institute of Earthquake Engineering (IZIIS), which is a part of the University in Skopje and is focused on the field of seismology and seismic engineering.

2.2 Group of natural and medical sciences

This section covers the curriculum of the medical faculty with programs of nuclear medicine, radiation protection and health physics (HP), and faculties of physics and mathematics in the fundamental areas of nuclear physics, mathematics, statistics and data processing and faculties of chemical sciences.

2.3 Group of Social Sciences

This group covers the curriculum of the faculty of economics in the programs of the finance sector and accounting especially for the financing of large investment project in the energy sector, energy economics, financing and commercial expertise. Also in this group are placed law studies covering areas of international law and obligations, legal agreements with various entities for large investment projects in the energy sector.

These study programs include methodological units and

There are two other alternatives that are of lower importance, and therefore are not given a focus in this paper:

courses that are part of the curriculum with lectures and laboratory exercises.

The analysis of existing curricula of the undergraduate and graduate studies at universities in Macedonia will be denoted as the first step in the assessment process, used to make suggestions on the program for completion of the existing curricula. Based on the required educational structures in HR for nuclear energy [1-3], proposals will be made for new or modified programs and courses. Special sections and scientific areas that are required for a nuclear energy program can be organized as new additional graduate or doctoral studies with participation of experts and professors from Macedonia and internationally.

The other important point of the educational system is utilization of Macedonian experts who have professional experiences or scientific research experience in the nuclear institutes or appropriated facilities and companies around the world.

Specific parts of the educational courses needed for a nuclear power program that are not covered in the existing curricula and which for some reason could not be established in higher educational institutions in Macedonia, could be given by visiting eminent foreign experts. In the process for identifying such experts and institutions, the first step is a review of institutions in neighbouring countries, which cover scientific areas of nuclear energy and nuclear power engineering, especially those that have experience in nuclear power operation.

3 Recommendations for HR in Nuclear Energy Program

The first phase of building nuclear human resources infrastructure consists of implementation of several activities and training of personnel in the field of nuclear technology, nuclear engineering, protection and management of radioactive materials, funding models for the NEP and nuclear power plant legislation. This activity can continue for more than five years in parallel to gathering information and performing other necessary activities in preparation for making a decision on embarking on a nuclear power program in Macedonia. Several alternative can be envisioned:

Alternative 1 – Creating national human resources and educational infrastructure for supporting a national NEP;

Alternative 2 – Participation in regional programs with other countries in a new regional NEP; and

Alternative 3 – Participation in an already established nuclear energy program in a country with operating NPPs (sub-regionally or regionally based).

Alternative 0 – No entry in NEP (cancel or freeze the program), in which case there is no need for a NEP-driven activity to enhance Macedonian educational

and HR infrastructure.

Alternative 4 – Implementation of NEP in Macedonia by a country that assumes the role of the investor, owner and operator of a NPP in Macedonia, in which the resulting needs for a NEP implementation in Macedonia have very specific elements and time frames.

Selection of an option most suitable for Macedonia depends on two factors:

- The Macedonian position on nuclear energy implementation: required personnel for implementation of institutional infrastructure, energy policy and public opinion.
- The situation in the region: economic and political conditions for investment by international government-owned and private financial institutions, interest by the regional countries for entering NEP, interest in certain countries with the NPP technology and investment power, and others.

Depending on these factors, Macedonian institutions and government ministries need to make a decision on embarking on nuclear power. This decision needs to be informed, taking into consideration the recommendations provided by the NEPIO, along with the academia, and public support. Following the decision the the most suitable option for HR and educational infrastructure needs to be decided.

Alternative 1 is entering the NEP with national human resources and national institutions. This option is viable if it meets the requirements for implementation of NEP and financial, human and institutional aspects.

Alternative 2 is entering in the NEP with regional cooperation from one or more countries in the region that are comparable to Macedonia in terms of energy needs, economic and financial strength, and have an interest in the nuclear power utilization, for example Albania.

Alternative 3 assumes cooperation with a country that has an ongoing nuclear power program and operating nuclear power plants, and is interested in expanding its NEP to other countries. As an example, the possibility of participation in the Bulgarian NEP (NPP Kozloduj 7 and 8) or Romanian NEP (NPP Cernavoda 3 and 4) can be considered.

Alternative 4 is entering the NEP by cooperation with a country or a company that uses nuclear power technology and has an interest in investing and building NPPs in foreign countries, such as Macedonia. In this case, financial, human resources and institutional aspects of such a nuclear power and HR program would be driven by bilateral negotiations and agreements with such interested company or country.

The creation of the HR for a new NEP in Macedonia can be accomplished in several ways in line with the above alternatives:

Strategy 1 : Use of national staff trained exclusively in the national education system in institutions in Macedonia

Strategy 2 : Staff educated partly in the national education system, and partly in educational institutions outside Macedonia (regional or other neighboring countries).

Strategy 3 : Staffing strategy based on consulting and contracting services from foreign institutions which

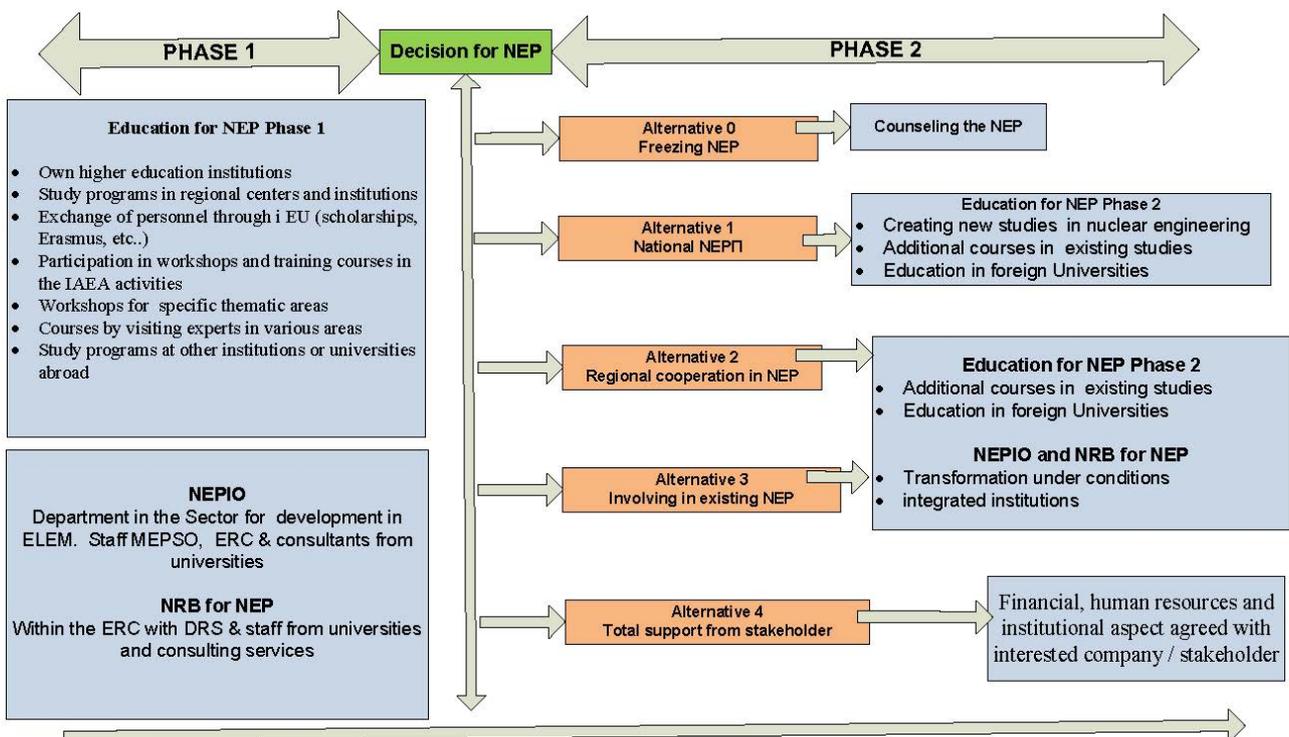


Figure 3. Alternatives for HR in NEP for Phase 1 and Phase 2.

have experience in NEP implementation and NPP construction and operation.

All of these strategies have advantages and disadvantages, which are considered and elaborated in the study currently being performed in Macedonia.

3.1 Strategy 1

This strategy focuses on using national staff trained exclusively in the national education system in Macedonia. This approach requires upgrading the national education system with university courses, colleges and professional training in areas needed in nuclear power program. For this purpose the government needs to support upgrading the education system at various levels, including high schools, colleges, university and other institutions that will be used in training of nuclear specialists in various fields. At the university level, students will complete the basic curricula (already existing), and take new courses in various nuclear fields. The government needs to support establishment of new degree programs (undergraduate, master's and doctoral) of certain faculties or institutes. This strategy requires the government to create a program of local educational institutions (universities and institutes) for education in the area of skills needed to support the NEP. At the beginning of this program, adequate staff experienced in nuclear engineering training and other fields of the NEP need to be engaged from highly qualified pool of staff mainly in foreign institutions.

From a financial point of view this strategy means significant investments in the education system in Macedonia for purchases of expensive equipment for laboratories, and for engaging foreign top level professors and specialists. However, in terms of long-term and sustainable development of HR in nuclear energy, this strategy provides continuing education for its national staff, and thus it contributes to elevating the national educational and professional level, that will be useful to many other areas in addition to the NEP.

3.2 Strategy 2

This strategy is based on a mixed approach of education in the national education system, and in international educational institutions outside Macedonia (with a focus on using regional centres in countries with ongoing nuclear program). This strategy is based on a cooperative approach with countries in the region, and it assumes that there are regional centres of a certain specialty in certain countries that will take the initiative to cooperate in the regional nuclear education program. Therefore, part of the nuclear education and training will be performed in Macedonian

national education centres, and partly in foreign regional educational institutions. This means:

- Performing basic university education and industrial training in Macedonia.
- Education of staff using study programs in regional countries that have developed nuclear education capabilities (education staff, research reactors, laboratories for nuclear physics, nuclear chemistry, etc.).
- Cooperation with international institutions (IAEA, EU) and national institutions abroad for the use of certain educational packages (providing scholarships, training and other ways for educational goals in specific areas of nuclear energy).

From a financial point of this alternative means investing in the education of national staff in foreign educational institutions, which can be a cheaper alternative instead of creating their own educational infrastructure for new study programs. Also, this alternative assumes using national educational institutions in areas for which extensive experience and knowledgebase exists, such as seismic engineering. Therefore, this strategy is most realistic as the financial burden is lower, and the time frame for reaching the required level of education shorter.

3.3 Strategy 3

This strategy is based on using staff, consulting and contracting services from foreign institutions which have experience in nuclear education. Developed countries are usually motivated to participate in nuclear education in countries that are embarking on nuclear power because of the potential of exporting their technology in undeveloped countries. Some countries have abundance of experience and potential in this area, such as USA, France, Germany, England, Canada, Japan, etc. The level of assistance they might be able to offer depends on the details of the contract for purchasing their technology. In this case, educational assistance is offered at the organizational level

Developed countries have abundance of staff at individual level, or in consulting and contracting organization that may be engaged in education and training of nuclear specialists. However, this option is quite financially demanding, and could be considered only by countries that are financially and economically powerful (such as the United Arab Emirates (UER)). In situations where very fast upgrading of a country expertise level is required to support an ambitious NEP development, such as in the EUR, according to this strategy, the NEP development can be achieved by hiring a technology company which stands behind state and its facilities and provides staff to run the NEP and NPP.

port the HR development in this area. The organizational and management structure of these institutions needs to be decided by the Government based on assessments and studies of the existing staff in Macedonia and the required

4 Needs of Additional Activities for HR in Nuclear Energy Program

For the establishment of the NEPIO and national safety regulatory body, the government has a crucial role to sup-

resources for NEPIO and NRB. As mentioned above, it is recommended by the IAEA that NEPIO can best perform its role and function if it is part of a government institution, or of government-owned institution. Considering the current level of effort of the NEPIO in Macedonia, and its work plan and schedule, this is achieved by placing the NEPIO within the development sector in the Macedonian Power Plants (ELEM), with the staff of about 10 experts. These experts can be hired from existing public companies, ministries, universities and consultants from abroad.

Macedonia already has a regulatory body for radiological protection in the medical industry. This regulatory body needs to be upgraded with resources that are knowledgeable in nuclear power regulation. This can be achieved by using one of the above mentioned strategies.

Workforce planning is an essential, ongoing human resources management process. Each organization involved in the nuclear energy programme should develop and maintain its own workforce plan; at least for the Phases 1 and 2. The NEPIO should maintain an overall plan to enable an integrated national approach to resource utilization and development.

To develop a realistic and adequate HR plan, in the first step it is very important to perform an assessment of weaknesses in the HR area, and to identify the gap to the HR level required for launching a nuclear power program. From preliminary studies in Macedonia, the main gap is in the following fields: nuclear regulatory expertise in review, licensing and enforcement process, nuclear engineering, reactor engineering, fuel cycle, waste treatment, etc.

In terms of additional HR supportive activities, Macedonia is already engaged, and needs to continue to be, in international programs offered in the field of nuclear energy via the International Atomic Energy Agency (IAEA). In addition, HR development help can be achieved via cooperative projects with other countries, participation in regional or international workshops or training courses on certain areas, visiting research institutes and nuclear laboratories and others. Macedonia is already involved in such activities.

5 Conclusion

A nuclear power program is a very demanding national undertaking that needs a comprehensive and systematic national planning and preparation, along with a major investment in time, human and financial resources. Therefore, an informed decision to enter a national nuclear pro-

gram needs to be made at the national government level, with complete understanding of the risks, consequences and possible outcomes of such decision. To prepare for such step, a national government must be completely informed and familiar with the international regulations, obligations and laws that must be complied with.

Development of human resources for a nuclear power program is a long and challenging process that requires significant financial resources and government support. Several alternatives and strategies were identified in this paper that are applicable to embarking countries. Some of these alternatives require a long term activities and financial resources to commit by a country. In this paper a recommendation was made for a human resourcing strategy that is applicable for a small country such as Macedonia. This strategy is based on using a combined approach of partly developing educational capabilities at the national level, and partly using regional and international organizations.

Certain activities in the above direction have already started in Macedonia, although a decision to embark on nuclear power has not yet been made. Macedonia has a very developed basic education system at the university level for undergraduate, graduate and doctoral studies in all fields of engineering, with some capability in nuclear engineering. A project is ongoing of assessing national capabilities, weaknesses and gaps that need to be addressed. This paper represents an initial part of the work and thinking in this area. In the coming years, further studies will be conducted in Macedonia to better define the human resources and educational strategy for a nuclear power program, and to start its implementation.

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