**Roles and Challenges of University in Supporting Nuclear Education and Training in an Emerging Nuclear Energy Country**

P. Pengvanich1 and S. Chanyotha1

Department of Nuclear Engineering, Faculty of Engineering, Chulalongkorn University, Bangkok, Thailand

*E-mail contact of main author: phongphaeth.p@chula.ac.th*

**Abstract.** As more countries are planning to utilize nuclear technology for their electricity production, human resource planning is now recognized as one of the crucial issues for the implementation of nuclear power. Southeast Asia in recent years has become an emerging market for nuclear power technology. The first nuclear power plant in the region will start operating in Vietnam in the early 2020s. Several other countries, including Indonesia, Malaysia, and Thailand, have also been considering nuclear for power production, and have tentative plan to use nuclear in their energy mix in the late 2020s. University will have an important role to play in providing sufficient and qualified human resources for these growing demands. On the educational side, many new formal degree programs are now being created at several universities in Southeast Asia. Existing programs are also being updated to be able to support nuclear power education. Nuclear security courses/programs are also being implemented to reflect the global trend. On the training side, both regulatory body and utilities are now providing professional-development-type training programs for their staff. University is sometimes asked to support these programs by providing background knowledge prior to the practical training. As an emerging nuclear energy country, however, the overall number of trainers and training facilities in the country are usually limited. The challenge here is then to create synergy among the university, the regulatory body, and the utilities so that the limited resources can be fully utilized. Sharing of resources will be necessary, while making sure that all three organizations are developing together at the same pace. This paper will present the challenges faced by the university in this growing process, and suggest the way to cope with the challenges from the university point-of-view.

1. **Introduction**

Even after the Fukushima Accident in 2011, many countries are still pushing forward with their plan to introduce nuclear into their future energy mix. As of May 2014, there are 45 countries that can be considered *emerging nuclear energy countries* although the level of commitment from each country’s government may vary from just being seriously discussed to being fully committed [1]. These countries are geographically distributed in Africa, Asia, Europe, and South America.

Human resource planning is recognized as one of the crucial issues for the actual implementation of nuclear power in the emerging nuclear energy countries. Nevertheless among them, there exist various degrees of readiness in terms of technical knowledge and expertise. Some countries already have many years of experience utilizing variety of non-power nuclear technology, allowing them easier transition to become an emerging nuclear energy user as they already possess basic education and training in the nuclear field. Some countries, however, still have very limited experience utilizing nuclear technology, putting them at a disadvantage as they will need to build nuclear education and training framework from scratch.

Many emerging nuclear energy countries are in the Southeast Asian region, which is the region of focus in this paper. Southeast Asia in recent years has become an emerging market for nuclear power technology. The first nuclear power plant in the region will start operating in Vietnam in the early 2020s. Several other countries, including Indonesia, Malaysia, and Thailand, have also been considering nuclear for power production, and have tentative plan to introduce nuclear into their energy mix in the late 2020s. Countries can be divided by the status of their nuclear power programs as shown in Table 1. Vietnam is the only country with active nuclear power program that has already reached the second milestone [2]. Indonesia, Malaysia, and Thailand are still waiting for their governments to make the decision to commit to a nuclear power program despite having listed nuclear power as the future source in their energy plans [energy plans]. Philippines, although does not have plan for nuclear power at the moment, is still the only country in Southeast Asia that has experience in constructing a nuclear power plant despite never putting it into operation. The other countries in Southeast Asia do not have any plan to utilize nuclear power at the moment, although Singapore has recently expressed its interest in SMR technology.

*TABLE 1: STATUS OF THE NUCLEAR POWER PROGRAM IN THE SOUTHEAST ASIAN COUNTRIES*

|  |  |
| --- | --- |
| **Status** | **Country** |
| Active program | Vietnam |
| Semi-active program | Indonesia, Malaysia, Thailand |
| Inactive program | Philippines |
| Without program | Brunei, Cambodia, Lao PDR, Myanmar, Singapore |

This paper takes a closer look at the nuclear educational and training program in the emerging nuclear energy countries, especially those in the Southeast Asian region.

1. **E&T in Southeast Asia**

While the existence of nuclear and radiation facilities in Southeast Asia dated back to the 1970s, the usage of nuclear technology has been limited to the non-power applications, and there was never an urgency to develop a large number of human resources in the region. Only a few universities offered formal degrees in nuclear or nuclear-related fields. Most institutions opted to provide courses in nuclear and radiation only as part of other engineering or science programs. Overall, nuclear education was considered as “something to have” but not “something to promote”.

With the growing demands for nuclear energy in the region, university and training institutions will have an important role to play in providing sufficient and qualified human resources. On the educational side, many new formal degree programs are now being created at several universities in Southeast Asia. Existing programs are also being updated to be able to support nuclear power education. Nuclear security courses/programs are also being implemented to reflect the global trend. On the training side, both regulatory body and utilities are now providing professional-development-type training programs for their staff. University is sometimes asked to support these programs by providing background knowledge prior to the practical training.

To achieve the safe and secure utilization of nuclear technology, three elements are required to be present: safety, security, and safeguards. Nuclear education and training program should reflect this requirement in some ways. For a long time, nuclear education and training focus on the technological aspect of nuclear technology. In many institutions with a well-established nuclear education or training program, the safety element of nuclear technology seems to be well covered. However, the security and safeguards elements are still inadequately mentioned.

Around 800 workers are required to operate a single 1000 MW nuclear power plant. Not all of them must be nuclear experts, but all of them must have certain degrees of awareness and knowledge of nuclear [3]. For instance, the nuclear engineer must have extensive knowledge of the nuclear reactor and the reactions inside the reactor, but the electrical engineer may only need to have knowledge about the nuclear environment surrounding the system that he is responsible for. Nuclear education and training therefore must exist in variety of forms to provide the right nuclear competency for different workers. Table 2 gives examples of education and training programs that a university may provide.

*TABLE 2: EXAMPLES OF EDUCATION AND TRAINING PROGRAMS THAT A UNIVERSITY CAN PROVIDE*

|  |  |  |
| --- | --- | --- |
| **Type of E&T** | **Length** | **Characteristics** |
| Formal university degree program (undergraduate) | 4 years | Provide fundamental and comprehensive nuclear knowledge, as well as basic skills for university student |
| Formal university degree program (graduate) | 2+ years | Provide specific nuclear knowledge and the research skill (depending on the research topic selected) for university student |
| Diploma program | 1 year | Provide fundamental nuclear knowledge for non-nuclear worker |
| Nuclear introductory course | 40 hours | Provide general nuclear knowledge for non-nuclear student |
| Certificate program | 80 hours or varies | Provide nuclear knowledge on selected topics for non-nuclear worker |
| Outreach program | Varies | Provide basic nuclear knowledge to the community based upon the issues concerning the community |

It should be noted that even without a nuclear power program, nuclear education and training are still very important as more and more nuclear knowledge and technology are being utilized in many aspects of modern living.

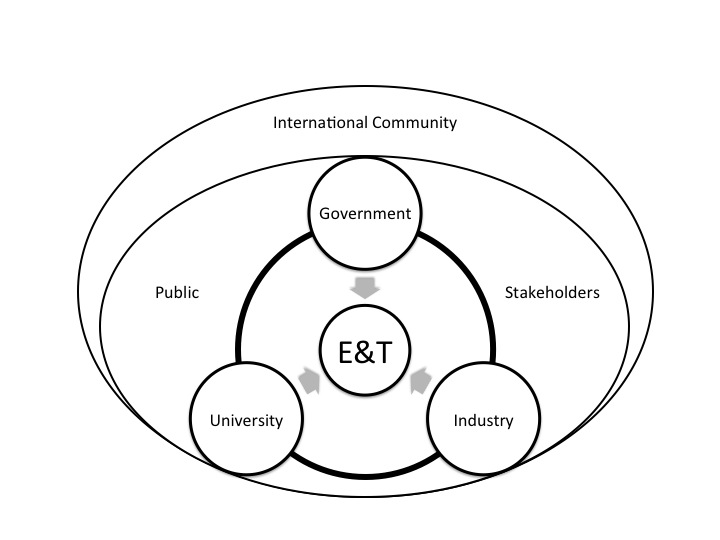
1. **E&T Challenges**

Emerging nuclear energy countries may face several challenges regarding the nuclear education and training:

* Educator and trainer – In many countries, nuclear science and engineering are not new subjects, and there may already be well-established education and training programs in universities and various institutions. Nevertheless, the size of the program is usually small and the focus is often on the non-power aspect of the technology. Countries with research reactor have some advantage in that they already possesses several nuclear scientists and engineers with knowledge and expertise in nuclear reactor technology, and most likely have education and training programs in reactor physics and related areas available.
* Funding – Many emerging countries are still waiting for the decision of their governments to commit to the nuclear power program. Funding for education and training at this stage reflects the uncertainty of the government’s decision.
* Curriculum – It takes time to establish a new university program as it involves many steps such as faculty planning, facility planning, and curriculum writing. The question is often when is the right time to establish the program. One of the deciding factors is the prospect of jobs for students after they finish their study. Thus, without the government’s commitment on the nuclear power program, the educational program is difficulty to take off.
* Focus – Activities related to nuclear in many developing countries usually focus on utilization of the technology, rather than development of new technology. Thus, nuclear research that is an essential part of nuclear education usually takes a back seat when it comes to distribution of the resources. In order to develop a sustainable nuclear industry, country needs to shift its mindset from merely being a *user* of technology to being a *developer* of technology.
* Cooperation – Nuclear education and training can be expensive and often require tools, facility, and expertise that may not all exist in one institution. Cooperation among various organizations, both domestic and international, is the most efficient way to share resources, but can be very complicated because different organizations have different visions and goals.

1. **Synergy Model**

In order to effectively use the limited resources for education and training available in a country that just starts or is about to start a nuclear program, we may consider the following synergy model shown in Figure 1. There are three entities that are capable of offering education and training: the university, the government, and the industry. The targets for education and training are the public and various stakeholders that utilize nuclear knowledge and expertise. These stakeholders also include university, government, and industry as they share the same pool of human resource.



*FIG. 1 Synergy Model*

Traditionally, a university will take on its main role to provide formal education to its students. The government, which may includes regulatory body and other technical supporting organizations, and the industry, which may includes utilities and other companies utilizing nuclear technology, will need to build their own knowledge and expertise through in-house training programs.

In the synergy model, university can interact with the government and the industry by offering various customized programs such as the ones given in Table 2. It can also invite expert from the government and the industry to give industrial lessons to the students. Some expensive facilities and equipment such as research reactor and irradiator that are rarely available at the university can be made accessible to students through specific cooperation with the government and the industry. University can also interact directly with the public through outreach-type programs. As an educator, university can play an important role in both public education and public communication.

Throughout a nuclear program, it is important to make sure that that university, government, and industry advance proportionally. For this to happen, the government needs to invest sufficient resources to all entities and make sure to include the development plan for all three into the nuclear program.

Forging linkage with the international community is also another important aspect of this model. (See “Nuclear Education Network” in Part 6 of this paper). The international counterparts, which include countries in various phases of their nuclear program, can participate in knowledge sharing and transfer as well as act as a benchmark for the education and training programs, e.g. standardization of curriculum.

1. **Modern Learning**

Learning in the 21st century has significantly changes not only in the pedagogy, but also in the learning tools that has become available due to the advance in IT and communication technology. E-learning tools, such as the learning management system (LMS) and long-distance learning, allow learners to repeat their lessons whenever they want, acquire new knowledge faster and with ease, and learn without having to be physically present in a classroom. These tools make sharing of knowledge easier and can be used to facilitate the interrelationships among various entities in the synergy model.

1. **Nuclear Education Network**

With limited resources, it is difficult for a single organization or sometimes organizations within a single country to face all the challenges individually. Various nuclear education networks have been established in various regions of the world in order to share knowledge and experience in nuclear education and training among their members. Some of these networks are the Asian Network for Education on Nuclear Technology (ANENT), the African Network for Education in Nuclear Science and Technology (AFRA-NEST), the European Nuclear Education Network (ENEN), and the Latin American Network for Education in Nuclear Technology (LANENT). Members of the these networks are not just the nuclear emerging countries, but also countries that have already been using nuclear power who are willing to share and transfer their knowledge and experience. Many of them are also developer countries.

**References**

1. WORLD NUCLEAR ASSOCIATION, Emerging Nuclear Energy Countries (2014), <http://www.world-nuclear.org/info/Country-Profiles/Others/Emerging-Nuclear-Energy-Countries/>.
2. INTERNATIONAL ATOMIC ENERGY AGENCY, Milestones in the Development of a National Infrastructure for Nuclear Power, IAEA Nuclear Energy Series NG-G-3.1, Vienna (2007).
3. NUCLEAR ENERGY AGENCY ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, Nuclear Education and Training: From Concern to Capability, OECD (2012).