Rising Expectations for New Nuclear Power Programmes

A. Overview

In recent years, in every region of the globe, many countries have expressed a new or renewed interest in nuclear power. In the context of growing energy demands to fuel economic growth and development, climate change concerns, and volatile fossil fuel prices, as well as improved safety and performance records, some 60 countries are expressing interest in, considering, or actively planning for nuclear power. This comes after a gap of nearly 15 years, during which international markets, energy systems and strategic concerns have evolved. Countries introducing nuclear power now face different conditions than in the past, and are responding to them in new and creative ways. This annex explores these issues, with a specific focus on countries planning for a first nuclear power plant. However, countries planning expansion of existing nuclear power programmes, some of which have not built new reactors for more than a decade, may also share some of these issues.

Agency projections reflect the interest being expressed. The latest low and high projections, from 2009, indicate a global increase in installed nuclear generation capacity, by 2030, of between 35% and 120%. Most of that new capacity will be built in countries that already have operating nuclear power plants. But the projections also include between about 10 and 25 countries that will commission their first nuclear power plants by 2030. That is an increase from projections in 2008. It is important to note that Agency projections are not predictions. Additional information about how the projections are developed and their track record against historical data is presented in *International Status and Prospects of Nuclear Power* [VI-1].

Another indicator of increased interest is the three-fold increase in the number of Agency technical cooperation projects related to nuclear power (FIG. VI-1). There were 13 in the 2007–2008 cycle, and there are 35 in the current cycle, 2009–2011. As of 2009, 58 countries were participating in national and/or regional projects related to the introduction of nuclear power through the Agency's technical cooperation programme.

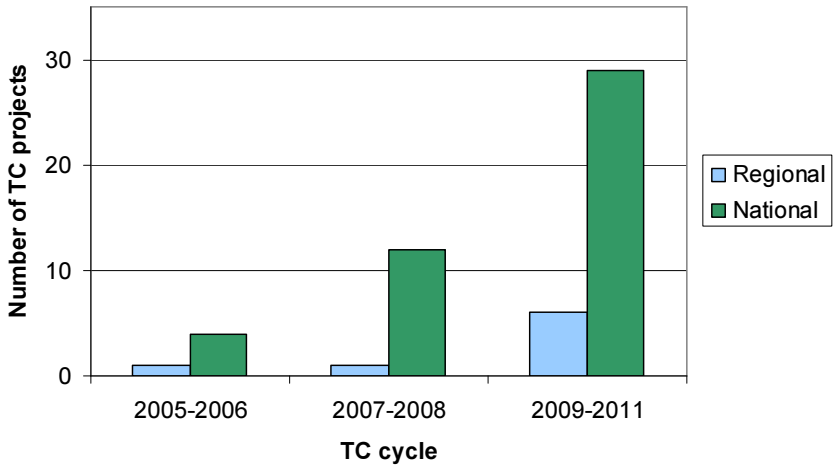


FIG. VI-1: The numbers of regional and national technical cooperation (TC) projects related to nuclear power in the three most recent TC cycles

Table VI-1 shows the numbers of countries at different stages of nuclear power consideration or development. Sometimes referred to as 'nuclear newcomers', some countries, such as Bangladesh, Egypt and Vietnam have in fact been planning for nuclear power for some time. Others, such as Poland, are reviving the nuclear power option after plans had been curtailed when Governments and public opinion changed. Countries such as Jordan, Mongolia and Uruguay are considering nuclear power for the first time. What they all have in common is

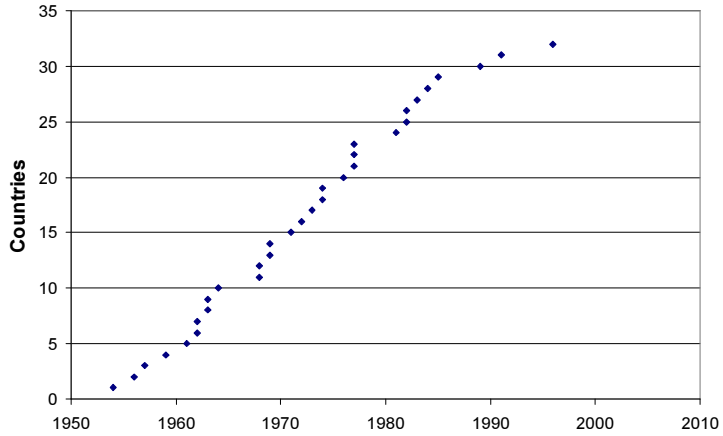
that they are considering, planning or starting nuclear power programmes, and have not connected a first nuclear power plant to the grid.

The Islamic Republic of Iran, which has announced plans to complete commissioning of the nuclear power plant at Bushehr soon, is likely to be the next country to connect its first nuclear power plant to the grid.

Table VI-1. Status of countries planning for a first nuclear power plant

Not planning to introduce nuclear power plants, but interested in considering the issues associated with a nuclear power programme[1]	31
Considering a nuclear power programme to meet identified energy needs with a strong indication of intention to proceed	14
Active preparation for a possible nuclear power programme with no final decision	7
Decided to introduce nuclear power and started preparing the appropriate infrastructure	10[2]
Invitation to bid to supply a nuclear power plant prepared	
New nuclear power plant ordered	2
New nuclear power plant under construction	1

The rate at which the 32 countries that currently use, or have used, nuclear power connected their first nuclear power plants to the grid was fairly steady through the early 1980s (FIG. VI-2). Only three countries connected their first nuclear power plants to the grid in the post Chernobyl era — China, Mexico and Romania. The countries now planning for their first nuclear power plants are doing so after an experience gap of fifteen years.



[1] Based upon participation in the current TC Programme through regional/national TC projects or statements to IAEA General Conference

[2] This includes Lithuania which shut down its remaining NPP in 2009 and currently has no operating reactor. It has decided to build an NPP at a new site

FIG. VI-2: Cumulative number of countries having connected a nuclear power plant to the grid by the year shown on the horizontal axis.

The international context in which the current 'newcomers' are planning programmes is different than in the past. The Chernobyl accident had a major impact on public opinion regarding the use of civil nuclear power. In the aftermath, an expectation for transparency and openness regarding the nuclear power industry and nuclear safety were captured in the Convention on Nuclear Safety, which entered into force in 1996, and the subsequent Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, which entered into force in 2001.

Challenges to the non-proliferation regime associated with the discovery of clandestine programmes may also affect the introduction of nuclear power. International efforts to strengthen the non-proliferation regime and greater emphasis on nuclear security and control of nuclear material are important tools to mitigate possible negative impacts.

New construction starts on nuclear power reactors had, in fact, already been in decline prior to the events of the 1980s and 1990s, largely due to economic factors and the availability of alternatives in the energy sector. The number of reactors under construction peaked in 1979 at 235 after which began a precipitous decline (FIG. VI-3). A global recession in the late 1970s and government debt defaults in some developing countries in the early 1980s led to a decline in energy demand. At the same time, the expanded use of natural gas, hydropower and other renewables were all being explored.

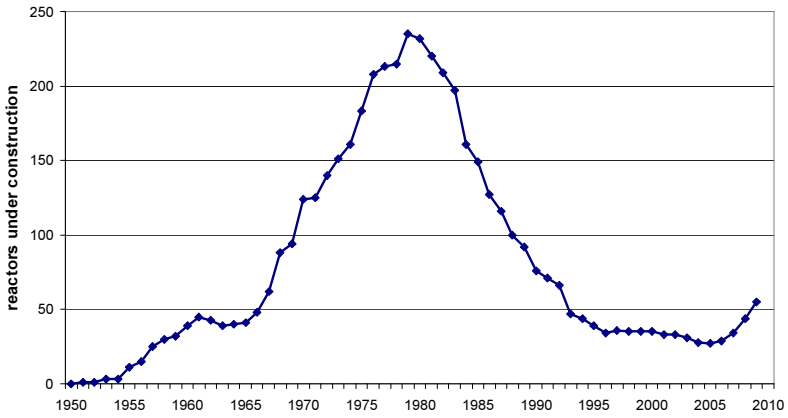


FIG. VI-3: Number of reactors under construction at the end of every year since 1950.

Concerns about climate change have affected perceptions regarding the use of coal and other fossil fuels for electricity production. Some prominent environmentalists are now publicly supporting nuclear power. Policy discussions on climate change are inexorably linked to energy for sustainable development. Some who held the view that nuclear power could not contribute to sustainable development are now reconsidering nuclear power as an important contributor to meeting carbon emission limits and fuelling development [VI-2].

Some developing countries are running out of options. Chile, for example, has developed much of its hydropower potential. It recently experienced a 'perfect storm' of circumstances when a major drought reduced output from hydropower at the same time that imports of natural gas were disrupted, and it has begun to study the viability of the nuclear power option. Bangladesh expects to use up its stores of natural gas within the coming decade and has few options to meet its baseload energy production.

Of the countries actively planning for nuclear power, 24 have one or more research reactors. However, nuclear power can be implemented without first having a research reactor — for example, the United Arab Emirates is taking this approach — but the national experience with nuclear materials provided by a research reactor can also provide the basis for understanding the technical and legal requirements associated with operating nuclear facilities, and thus

contribute to the infrastructure necessary for nuclear power. Indeed, because the Agency's guidance in *Milestones in the Development of a National Infrastructure for Nuclear Power* (IAEA Nuclear Energy Series NG-G-3.1) was developed with countries with little or no nuclear experience in mind, some countries with research reactors have found, through self-assessments, that because of their experience with research reactors and other nuclear facilities, that they are able to meet the conditions for some of the nineteen issues for the first phase identified in the publication.

B. Common issues and examples from specific countries

B.1. Public opinion and public acceptance

Issues and trends in the public acceptance of nuclear power were discussed briefly in the *Nuclear Technology Review 2009*. Newcomers are facing issues of public acceptance similar to those faced by countries that are expanding existing nuclear power programmes. The general optimism in the 1960s regarding science and technology's contributions to solving the world's problems, eliminating poverty, and providing security has shifted to include more scepticism regarding science as a problem solver. Technology is often associated with negative impacts (on the environment, for example) as well as positive ones. Sustainable development is sometimes equated with small scale community-based development, micro-loans, and low-tech solutions on a limited scope at the expense of large scale investments, such as would be required for nuclear power. With a few notable exceptions, countries reviving or starting nuclear programmes are, in general, educating the public and providing unbiased information regarding the nuclear power option.

Chile is engaging its public in the consideration of nuclear power as an option. In 2007, when then President Bachelet decided to launch a study group to consider nuclear power, she announced that the process would be transparent to the public. She brought together a group of eminent national experts who produced a report concluding that Chile could not afford to exclude the possibility of nuclear power. This resulted in further study of the nuclear power option in the country, led by a newly appointed Minister of Energy, with special emphasis on public information. Opinion leaders and the general public were invited to a series of public seminars on nuclear power.

B.2. Sustaining support

Historical experience shows that the planning process for starting a nuclear power programme usually takes between 10 to 20 years or sometimes longer. Society generally must be able to maintain support for the planning process through changes in political leadership. Once a country makes a large scale investment, especially once the contract is issued and construction begins, it is easier to maintain momentum through reactor commissioning and operation. But in the period prior to the issuance of the contract the unrecoverable costs are related to planning and are relatively limited. Building broad government and public support for a nuclear power programme is one way of sustaining the planning process.

B.3. New approaches to contracting nuclear power plants: build–own–operate

Traditionally, nuclear power plants and other large scale investment projects have required government involvement, including financial guarantees. A wave of sovereign debt defaults in the early 1980s resulted in new difficulties with governments taking on such financial risk. Around that time, a new approach to financing large scale infrastructure projects was initiated in which government-backed utilities offered a guaranteed price for electricity, which could be used by the technology suppliers to secure commercial financing. According to this

approach, the power plant supplier would establish a project company that would build, own, and operate the plant for a fixed period of time, without putting its other financial assets at risk. This non-recourse financing has not been used for nuclear power plants, although it has become common in other parts of the energy sector. Experts are sceptical about whether investors would be willing to accept this approach without some direct government financing because of the economic risks associated with the project.

Some countries have expressed renewed interest in applying non-recourse financing to nuclear new construction for two additional reasons. First, in a country with little existing nuclear infrastructure, a consortium including an operator could bring to a new plant experience with plant operations, management systems and training for some period of time, allowing local staff to learn alongside experienced personnel. Second, the supplier consortium, which would have a track record in the nuclear industry, and would take responsibility for securing financing at perhaps more favourable rates than a new operating organization would be able to get.

B.4. Regional approaches

One way that countries are exploring reducing the national investment in the infrastructure necessary for nuclear power, and at the same time securing access to electricity, is through regional approaches to nuclear power development. The concept is that the nuclear power plant would be located in one country, under that country's national legislation and regulation, with shared responsibility for financing and other aspects of the plant operations, in exchange for guaranteed shares of the electricity produced by the plant. A regional approach differs from cross-border investment and operation of reactors by utility companies (as happens in many instances in Europe) by the level of responsibility for operations and waste assumed by the co-investors and by the backing of government-to-government agreements specifying responsibilities. One prerequisite for a regional approach would be cross-border interconnections of the electrical grid allowing the output of a nuclear power plant to benefit the partners. Negotiations on who hosts the nuclear power plant, the level of investment and responsibility of the partners, and the shares of benefits and liabilities to be assumed by the partners can be challenging and time-consuming. The Krsko plant is an example of a nuclear power plant being co-owned, in this case by Slovenia and Croatia.

The Gulf Cooperation Council (GCC) countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and UAE) have expressed interest in a regional approach and are working with the Agency through a regional technical cooperation project to understand the issues associated with nuclear power.

In July 2006, Lithuania invited Poland to join Estonia and Latvia in a regional approach for the implementation of a replacement for units being shut down at the Ignalina site in Lithuania. Lithuania, Estonia, Latvia and Poland have indicated their intentions at the government level, and the partners established a project development company, Visaginas. Final agreement regarding the levels of investment and electricity off-take among the partners has not yet been reached. One precondition for a regionally owned nuclear power plant is in place — the Baltic States have an interconnected grid, although a connection to Poland would need to be developed.

C. International cooperation and coordination

There is a sense of shared responsibility for assisting newcomers in developing safe, secure and effective nuclear power programmes that do not contribute to the risk of nuclear proliferation. Several countries that have operating nuclear power programmes or supply nuclear technology have launched national and international cooperative and coordinating efforts.

One example of an international effort is the Global Nuclear Energy Partnership (GNEP), launched by the United States of America in 2006 which now has 25 partner and 31 observer countries. GNEP (which is considering changing its name) currently has two working groups, one on reliable fuel services and another on infrastructure development. The Infrastructure Development Working Group assists participating countries in the development of the infrastructure needed for the expansion of nuclear energy in a safe and secure manner by identifying common interests and concerns, supporting information sharing and recommending practical measures. The Reliable Fuel Services Working Group carries out work towards the establishment of international frameworks which may ensure reliable, cost-effective fuel services and supplies for generating nuclear energy and fostering development by creating viable alternatives to the acquisition of sensitive fuel cycle technologies. The working groups are overseen by a steering committee and an executive committee at the Ministerial level.

Several efforts are also underway for national government-to-government cooperation. In 2008, France launched the France International Nuclear Agency (AFNI), under the Atomic Energy Commission (CEA), to provide assistance to countries launching nuclear power programmes. In November 2009, France and Poland inaugurated a training programme to assist Poland in the development of its national nuclear power programme.

In light of the number of international initiatives and bilateral cooperative arrangements currently ongoing and being developed, several Member States have asked the Agency to consider how to improve coordination among these efforts. The Agency identified three levels of coordination.

- Issue-specific coordination: For example, countries providing training and support for safeguards implementation are coordinating their activities to improve delivery of assistance to countries introducing nuclear power.
- Country-specific coordination: For example, if a country is receiving support from multiple countries and the Agency, it may wish to improve coordination among its assistance providers to improve efficiency.
- International coordination: The international community also benefits from having workshops to identify common challenges that countries are facing in order to focus on the development of new approaches.

D. Regulators

Developing competent regulators to oversee new nuclear power programmes is an issue that has been gaining attention in the international nuclear safety community. It has been raised in recent years in the Senior Regulators' Meeting, the International Nuclear Safety Group (INSAG), and the G8 Nuclear Safety and Security Group. The regulatory body needs to establish the regulatory framework and develop the licensing process in advance of the bidding process. Although the owner-operator organization in a newcomer country has access to training and experienced personnel through the contract, the regulatory body may not have the same contractual arrangement. The regulatory body could benefit from the experience of well established regulatory bodies that have licensed similar facilities. Experienced regulators are discussing how to coordinate support, training, and assistance for countries introducing nuclear power.

E. Agency assistance on planning and building nuclear power infrastructure

If expectations of a surge in introducing nuclear power materialize, several questions arise. How will newcomer countries develop human resources to operate nuclear power plants? How do they build the appropriate nuclear power infrastructure to support the first nuclear

power plant? How will emerging nuclear power countries build the relevant national trust and international confidence in their nuclear power programmes?

In this context, countries considering the introduction of nuclear power are increasingly seeking the support of the Agency. The Agency's assistance is intended to encourage emerging nuclear power States to build a solid infrastructure and make the best use of available technology, with high levels of safety, security and non-proliferation. As noted earlier, the Agency published *Milestones in the Development of a National Infrastructure for Nuclear Power*, identifying a phased approach for the progressive development of infrastructure and outlining 19 infrastructure issues to be addressed in each phase. The Agency supports Member States in each of these three phases through technical assistance provided through the technical cooperation programme and development of publications and guidance documents.

The Agency's assistance is designed to help Member States in their work to plan properly, to build the nuclear power infrastructure, to establish independent and effective regulators, and to adhere to international safety, security and non-proliferation instruments.

Several Members States are in the first phase described in *Milestones in the Development of a National Infrastructure for Nuclear Power* and are developing national strategies. Agency assistance is available for these States to aid them in developing an understanding of the issues needed to make an informed commitment to nuclear power.

A competent workforce plays a key role in building required infrastructure and regulating and operating nuclear power installations. Agency assistance is available to newcomer States for establishing policies for training and workforce planning. Support is also provided for assessing the national education system to develop appropriate programmes to support the nuclear power programme. The Agency published *Managing Human Resources in the Field of Nuclear Energy* (IAEA Nuclear Energy Series NG-G-2.1) in 2009 and is preparing a publication entitled *Workforce Planning in the Field of Nuclear Energy*.

One important aspect of the Agency's milestones approach is self-evaluation of infrastructure development, which can help a Member State establish its priorities, target its resources, and make the best use of international cooperation. The Agency also offers Integrated Nuclear Infrastructure Review (INIR) missions, which are external expert reviews of Member States' infrastructure development according to the milestones approach. Self-evaluation and external reviews, which cover both the 'hard' infrastructure (grid, facilities, etc.) and 'soft' infrastructure (legal, regulatory, training, etc.), reinforce continual improvement in the planning process, identify gaps, focus resources, and build confidence in a country's infrastructure development. INIR missions took place in 2009 to Jordan, Indonesia and Vietnam. Five INIR missions are expected in 2010.

REFERENCES

[VI-1] INTERNATIONAL ATOMIC ENERGY AGENCY, *International Status and Prospects of Nuclear Power*, originally GC(52)/INF/6, Vienna (2008).

[VI-2] INTERNATIONAL ATOMIC ENERGY AGENCY, "Nuclear Power and Non-Power Applications in the Context of Climate Change," Annex VII in *Nuclear Technology Review 2008*, Vienna (2008).