Developing Infrastructure for New Nuclear Power Programmes: IAEA Services for Member States

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Nuclear power can make an important contribution to meeting the growing global energy demand. While it is up to each country to decide whether or not to opt for nuclear power, the International Atomic Energy Agency (IAEA) has a key role to play in ensuring that the development of nuclear power programmes takes place in a safe, efficient, responsible and sustainable manner. This article summarizes the support and services that the IAEA offers to those Member States considering or embarking on a new nuclear power programme.

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As of today, 438 nuclear power reactors operating in 30 countries provide about 11% of the world's electricity. They have a combined capacity of about 380 Giga Watts. The IAEA's 2015 projections show that nuclear power is likely to continue to grow steadily, .with 2.4% in the low projection, and 68% in the high projection by 2030. Today there are 67 units under construction in 15 countries.

In addition to the 30 established users of nuclear power, about the same number of countries have decided or are considering adding nuclear to its energy mix — the so-called "newcomers". These countries are at different stages of development: the United Arab Emirates (UAE) and Belarus, the first two countries in nearly 30 years to start constructing their first nuclear power plants, are expected to start commissioning in 2016-2017. Turkey has ordered its first nuclear power plant under a Build-Own-Operate (BOO) approach with the Russian Federation, while Bangladesh, Egypt, Jordan, Kazakhstan, Nigeria, Poland and Viet Nam are preparing the necessary nuclear infrastructure following a national decision to develop a nuclear power programme. Several other countries are currently at the "consideration" stage and have not yet made a national decision. More developing countries may begin to explore the nuclear option when the UAE and Belarus start commercial operation. But the stakes are high: for several newcomer countries, the nuclear power programme represents the largest public sector investment in the country.

The resurgence of interest in nuclear power cannot be without challenges. The accident at Japan's Fukushima Daiichi nuclear power plant undoubtedly had an impact on public acceptance of nuclear power. A few countries even announced their intention to phase out nuclear power. But the overall increased interest is not surprising, since the main drivers of nuclear power remain. These include concerns about climate change, increases in global electricity demand, volatile fossil fuel prices and securing energy supply. Hence, providing support, upon request from Member States that are considering new nuclear power programmes, continues to be a high priority for the IAEA.

A DIFFERENT STRATEGIC ENVIRONMENT

The challenges of starting a new nuclear power programme are different today than in the past. The model from the time when the majority of programmes started was largely national: a research reactor was a starting point to gain experience, the government was the main investor, a public sector utility operating in a regulated electricity market relied on indigenous human resources, and a nuclear power plant was bought from a vendor through a turn-key contract.

This does not fit with the globalized nuclear industry of today. The financing and ownership models have become more complex with cross-border investments, strategic partnerships, and projects backed by government-to-government agreements. Newcomers lacking experience are hiring foreign nationals or exploring other possibilities to take advantage of their more experienced partners. Moreover, the expectations of the international community have increased along with the number of international conventions and treaties, safety standards, and security guidelines, to which countries are encouraged to adhere and which should be incorporated in national laws.

Figure 1. Construction of Unit 1 of the Barakah Nuclear Power Plant in the UAE. (Photo: ENEC, UAE).

IAEA PROVIDES NEUTRAL ADVICE AND SUPPORT

The IAEA is the first place that countries considering or starting nuclear power programmes approach for neutral, unbiased advice and guidance. The IAEA's assistance for nuclear newcomers is small, but strategic. Our role is to help connect newcomers with other countries to share experiences in building their infrastructure for nuclear power. The services which the IAEA offers to those Member States include advice on proper planning, building the required human resources and infrastructure, establishing legal and regulatory frameworks, and ensuring the highest standards of safety and security, without increasing proliferation risks. The IAEA offers independent know-how on the construction, commissioning, start-up and operation of nuclear reactors. Through its technical cooperation programme, the IAEA provides targeted support to newcomer countries in response to national development needs. The aim is for countries to be able to introduce nuclear power knowledgeably, profitably and safely.

One thing must be clear: it is the sovereign decision of every country whether to launch a nuclear power programme. The IAEA does not try to influence that decision. But when a Member State decides to go that route, the IAEA is there to help.

ENERGY PLANNING

Clearly, the first step for considering the potential contribution of nuclear power in a country is energy analysis and planning. This is vital to meeting future capacity needs in ways that are economic, clean, and socially and environmentally responsible. The IAEA's energy planning models and tools [1] are used by 130 Member States and 20 regional and international organizations. They assist countries in making informed decisions on future plans, irrespective of their interest in nuclear power.

THE IAEA MILESTONES APPROACH: A SYSTEMATIC APPROACH TO INTRODUCING NUCLEAR POWER

The decision to introduce nuclear power and the implementation of that decision requires much more than the outcome of energy planning. A nuclear power programme is a major undertaking that needs careful planning, preparation and investment in time, institutions and human resources. While nuclear power is not alone in this respect, it is unique due to the safety, security and safeguards requirements associated with using nuclear material. A nuclear power programme entails a commitment of at least 100 years, and planning for nuclear power can take 10–15 years until commissioning of the first plant.

The IAEA has developed guidelines to help countries work in a systematic way towards the introduction of nuclear power. Using the IAEA "Milestones Approach", a methodology covering 19 key nuclear infrastructure issues, in three phases and with three milestones, can increase transparency both within a country introducing nuclear power, and between it and other States. The IAEA Nuclear Energy Series publication *Milestones in the Development of a National Infrastructure for Nuclear Power Nuclear Power,* originally issued in 2007, documents this approach. The activities associated with the document have generated a rich body of guidance materials and services, and the tangible results can be seen in Member States.

This Milestones publication was recently updated [2], taking into account lessons learned from the Fukushima Daiichi accident, the IAEA Action Plan on Nuclear Safety [3] (2011), more detailed IAEA guidance published since 2007, results from IAEA review missions and feedback from Member States. The revised version was published in September 2015.

INTEGRATED NUCLEAR INFRASTRUCTURE REVIEWS

One of the Agency's most requested services for newcomers is the Integrated Nuclear Infrastructure Review (INIR) mission. Building on a Member State's self-evaluation, it uses an evaluation methodology based on the Milestones approach to assess the national nuclear infrastructure status across all 19 infrastructure issues at each phase of programme development. Suggestions and recommendations are provided in a report to the national Government, enabling it to update its national action plan accordingly.

19 NUCLEAR INFRASTRUCTURE ISSUES

The IAEA Milestones approach outlines 19 infrastructure issues that

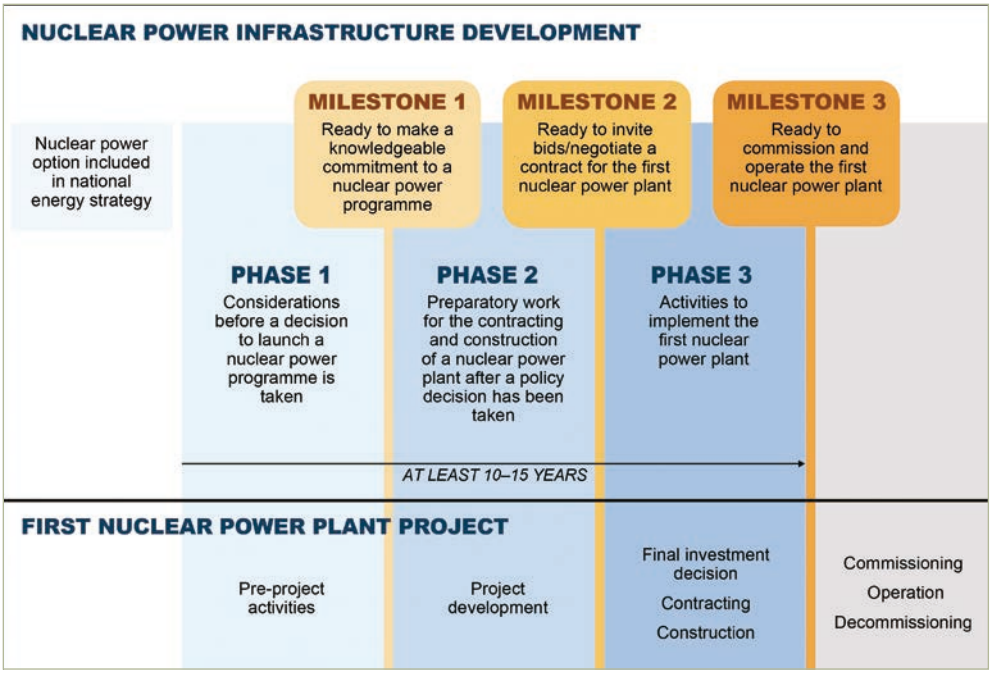

Figure 2. The IAEA Milestones Approach for Nuclear Power Infrastructure Development. (Graph: IAEA).

need to be addressed in developing a new nuclear power programme:

1. National Position
2. Nuclear Safety
3. Management
4. Funding and Financing
5. Legislative Framework
6. Safeguards
7. Regulatory Framework
8. Radiation Protection
9. Electrical Grid
10. Human Resource Development
11. Stakeholder Involvement
12. Site and Supporting Facilities
13. Environmental Protection
14. Emergency Planning
15. Nuclear Security
16. Nuclear Fuel Cycle
17. Radioactive Waste Management
18. Industrial Involvement
19. Procurement

Since 2009, 16 such missions have helped Bangladesh, Belarus, Indonesia, Jordan, Poland, Thailand, Turkey, the United Arab Emirates and Viet Nam assess their own status of nuclear infrastructure development, and benefit from recommendations by international experts on how to improve. South Africa, as an operating country, also saw the value of inviting an INIR mission ahead of their expansion plans. The most recent missions were conducted in Nigeria (June 2015) and in Kenya (August 2015). a further INIR mission is scheduled in Morocco later in the year. This indicates increased interest to add nuclear power to the African continent's energy mix.

Other IAEA review and advisory services include the Integrated Regulatory Review Service (IRRS), Pre-Operational Safety Review Team (Pre-OSART) review, Emergency Preparedness Review Service (EPREV), International Physical Protection Advisory Service (IPPAS) and the IAEA Safeguards Advisory Service Mission (ISSAS).

Figure 3. Turkey invited an INIR Mission in November 2013 to review the status of the country's nuclear infrastructure development. (Photo: MENR, Turkey).

MAIN ISSUES FACED BY NEWCOMERS

The top areas of recommendation from INIR missions provide a good snapshot of the main issues that newcomers face: (1) establishing a comprehensive national legal framework; (2) establishing a management system; (3) financing strategies and plans; (4) developing a public information and stakeholder engagement programme; (5) developing policies and strategies for waste management; (6) establishing a coordinating body in the Government for decision-making and preparing national policies; and (7) developing a national human resource plan.

The legal framework in most newcomer countries needs strengthening. The IAEA Office of Legal Affairs is responsible for the legislative assistance programme. Many newcomer countries have not yet adhered to all of the international legal instruments associated with a nuclear power programme, nor do they have a comprehensive nuclear law in place. Areas that are often identified as needing strengthening in the law are the independence of the regulatory body, provisions for spent fuel and waste management, nuclear security, and civil liability for nuclear damage. Several newcomer countries that have taken advantage

of this assistance are now in a final stage of the legislative process.

Managing new nuclear power programmes requires a combination of nuclear and industrial expertise; this is important for leadership in safety culture. The Government usually designates one of three kinds of organizations to be the future owner-operator: an atomic energy commission which has nuclear experience but not large scale industrial experience, a national utility which may have built large conventional power plants but does not have nuclear experience, or an entirely new organization. The current group of newcomer countries includes all three options. Even though the first task of the future owner-operator is project development and the operating team usually comes later, the institution's values and leadership for safety should already be present from its establishment.

The availability of financing is driving decisions on project structures and other aspects. It is assumed that national governments will play a role in financing nuclear power projects, for example through direct investments on the demand side and export credits on the supply side. Many factors, including restrictions on Government spending, have led to the use of strategic investor arrangements. Several newcomer countries have entered into Inter-Governmental Agreements (IGAs) which include vendor Government loans and other financial commitments. Most of these IGAs are for turn-key projects. Likely, the first build-own-operate project in the nuclear field is in Turkey, under an IGA with Russia.

Talking to the public about nuclear power and involving stakeholders leads to strong government commitment and policy stability. Encouraging newcomers to engage stakeholders and the public around the national decision making process and throughout the programme is an essential part of the Agency's guidance. Assistance centres on identifying stakeholders and national communication strategies. The technical community responsible for nuclear power plant development may find it difficult adapting a highly technical complex issue into language understandable by local communities in developing countries.

Newcomers find it hard to talk persuasively about radioactive waste. The guidance to newcomers on radioactive waste and spent fuel management is to consider it at the time of national decision making, and to prepare policies and strategies as the project is developed. As no country has yet offered to host a multilateral or international radioactive waste repository, newcomers are recommended to ensure that they develop safe, secure and sustainable solutions based upon national plans for disposal within their own territories. In addition, they may also include involvement in a multinational repository project as part of their national strategy. The IAEA assists newcomers in understanding the technical aspects and the messages for public communication.

A national position forms the basis of policy decisions that affect the planning and implementation of the infrastructure and nuclear power plant project. A "knowledgeable decision" is often a rolling series of decisions. Many countries find national decision making, which is a political decision involving technical considerations, national policies, and public opinion, challenging. A national decision may not be one fixed point in time, but rather, a series of steps involving an announcement of intention at the highest level of Government, an energy policy that includes nuclear, and a Parliamentary decision (or series of decisions) on a nuclear law, allocation of funding or ratification of an IGA.

A knowledgeable decision is a key step in whether a country will go forward, and a main determinant in how the IAEA's assistance is prioritized. Without a national decision, many aspects of the infrastructure cannot proceed—for example, national human resource development planning. Some countries without a decision receive IAEA assistance for a long time, while waiting for an optimal political environment. An IAEA report, which will describe some aspects of national positions and give examples of how they informed project development, is in the final stages of preparation.

Human resource development and capacity building is globalizing. Recruiting foreign experts into key positions and using international consulting firms is a common approach among newcomers who are successfully moving forward in their programmes. On-the-job-training abroad is an essential element of experience-building for future operators. When an existing utility will be involved in the nuclear programme, nuclear training for non-nuclear executives and engineers will be essential for building a strong safety culture. Bringing the educational, training, and knowledge management aspects together into a roadmap for capacity building is a high priority for the Agency.

TECHNICAL ASSISTANCE

The IAEA Technical Cooperation Programme is the main delivery mechanism for IAEA assistance. Nuclear power projects are implemented in the same manner as nuclear applications projects for food, health, agriculture and science, or nuclear safety and security. Activities are implemented through national, regional and interregional projects. The projects are a mix of expert missions, workshops, training courses, fellowships and scientific visits. The projects are designed around Member State requests. Regional and interregional projects are mostly used for training courses and sharing of experience.

In conclusion, by helping nations gain or extend access to nuclear power — one of the great applications of atomic energy — the IAEA fulfils the mandate it adopted six decades ago: to "seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world."

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