



NUCLEAR POWER AFTER FUKUSHIMA

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Japan's tragic March 11 earthquake and tsunami have triggered the most serious nuclear emergency in 25 years and have raised questions about the future viability of nuclear power in the energy system around the world. Subsequent to the crisis at the Fukushima Daiichi nuclear power station, a number of countries have announced safety reviews of current nuclear facilities, with some announcing plans to shut down some of their older reactors. Others are also reviewing their plans to add new nuclear power plants.

Despite these reviews, the pressure to meet rising demand for electricity ensures that nuclear power capacity will continue to grow, especially in developing countries. The challenge will be to ensure that this expansion will occur with the highest levels of safety and security and that adequate safeguards can be put in place to minimize the risk of proliferation of nuclear weapons or materials.

While still unfolding, the crisis at Fukushima provides many important insights for the nuclear power industry. Events of this

magnitude and complexity are rare, and the world will need to take the time to absorb the lessons the crisis will provide. Some preliminary conclusions are possible.

First, the nuclear facility itself seems to have withstood a record 9.0 earthquake without critical damage because all of the reactors struck by the earthquake shut down as intended. The March 11 earthquake exceeded the design criteria and reinforces a lesson learned from an earthquake that damaged the Kashiwazaki-Kariwa reactors several years earlier—these facilities are very robust.

A second lesson is that the facility was vulnerable to compromise from damage to external elements of the plant brought about by a tsunami that was 150 percent larger than the design criteria.

Third, the crisis has shown the handling of radioactive waste at reactor sites still warrants attention, as do the risks that may be associated with current practices in the United States.

Finally, the crisis has highlighted the need to carefully review the contingency plans that are put in place to see if they actually work during times of large-scale crises whether or not they pertain to nuclear plants.

While the Fukushima crisis may cause the world to pause and consider the role for nuclear, the interest in nuclear power is likely to be sustained. At the beginning of 2011, approximately 440 nuclear power reactors were operating in 29 countries, providing about 14 percent of the world's electricity. An additional 65 reactors were under construction worldwide with 27 of these in China alone.

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Perhaps even more important is the growing interest in countries that currently do not have nuclear power plants. The International Atomic Energy Agency (IAEA) has said that more than 60 countries have expressed interest in nuclear power. The IAEA expects that by 2030, 20 new countries will have nuclear power on line.

The driver behind this interest is very clear. The demand for electricity is expected to continue to be strong, especially as developing countries become wealthier and more urbanized. Also, many countries, including in the developed world, are looking to expand the use of electric vehicles.

The IAEA's most recent *World Energy Outlook* projects that even under positive assumptions about

energy policies, the demand for electricity worldwide could grow by 75 percent by 2035 while total demand for energy grows by only 36 percent. The growth rates in developing countries are even more startling with electricity demand growing by 135 percent while total energy grows by 75 percent. Not surprisingly, the most rapid growth is in the developing countries of Asia, followed by the Middle East.

In this context the attractiveness of nuclear power is clear. Nuclear power generation is technologically and commercially proven and provides reliable base-load power at high operational efficiency levels and

at predictable costs. Also, once constructed, nuclear power has much shorter supply chains vulnerable to disruption or cost volatility. For countries experiencing rapid growth, these characteristics can be compelling.

In addition, while nuclear power must deal with the question of waste disposal, the footprint for other environmental pollutants is generally better than fossil fuels, and nuclear power is not subject to the intermittency that can plague power generation from renewable sources.

Expansion of nuclear power in countries lacking strong regulatory capacity or mature institutional experience has raised concerns about safety, security and proliferation risks for some time. The

Fukushima crisis has happened in a country with a long track record of involvement in international safety and safeguards practices. By highlighting the potential vulnerabilities of nuclear power plants, the Fukushima crisis has reinforced the safety and safeguards concerns in countries with civilian nuclear programs, old or new.

Ensuring the growth of nuclear power industry in a safe, secure, and proliferation-resistant manner will require enhanced international cooperation at both the governmental and private sector levels. To meet these challenges, governments and industry must strive to develop a framework that would raise the bar for an expanding nuclear industry. Essentially, a globally accepted set of standards governing safety, security, and proliferation must emerge if nuclear power is to deliver and fulfill all of its benefits.

Governments will need to evaluate whether the existing global institutions for nuclear power need to be modified to take on a broader role in addressing these issues. In particular, while the IAEA has nonproliferation as a core mission, its strength seems to lie more with materials protection, control, and accounting activities than in safety activities. The members of the IAEA may want to consider strengthening these services.

The Nuclear Energy Agency (NEA), under the Organization of Economic Cooperation and Development (OECD), provides a forum for member countries to exchange experiences in a wide range of nuclear energy issues including safety. As a part of the OECD, however, the NEA does not include the developing countries most interested in expansion and in need of capacity building.

Government action alone will not be sufficient. After the Three Mile Island accident, the U.S. nuclear industry organized the Institute of Nuclear Power Operators (INPO) to perform in-depth peer review of safety practices of U.S. nuclear power plants. The industry recognized that the behavior of each individual member directly affected the interests of all. As a consequence, INPO has been effective in setting best practices for the industry, significantly improving safety as well as operating performance. A global effort of peer review that drives toward high international standards for safety and security should be a central part of the evolution of the global industry.

The United States, joining with Japan, France, and others with established nuclear power industries, will need to take the lead in establishing this new, more comprehensive international framework. The world will likely see the sustained role for nuclear power in the global energy system regardless of how individual governments may react to the Fukushima crisis. Particularly for developing countries with a strong appetite for electricity, nuclear power holds much promise with its technological and commercial viabilities and limited carbon footprint.

Nuclear power is a principal source of growth for the clean electric power vital to economic development. It is left to the countries with established nuclear industries to decide whether to be proactive in shaping the future course of nuclear energy deployment beyond their borders that is already under way, albeit at a nascent stage. All countries share a strong interest in developing and maintaining the highest standards possible. ■