2012 Preview: Impact of Fukushima Daiichi on global prospects for nuclear

BY DICK KOVAN

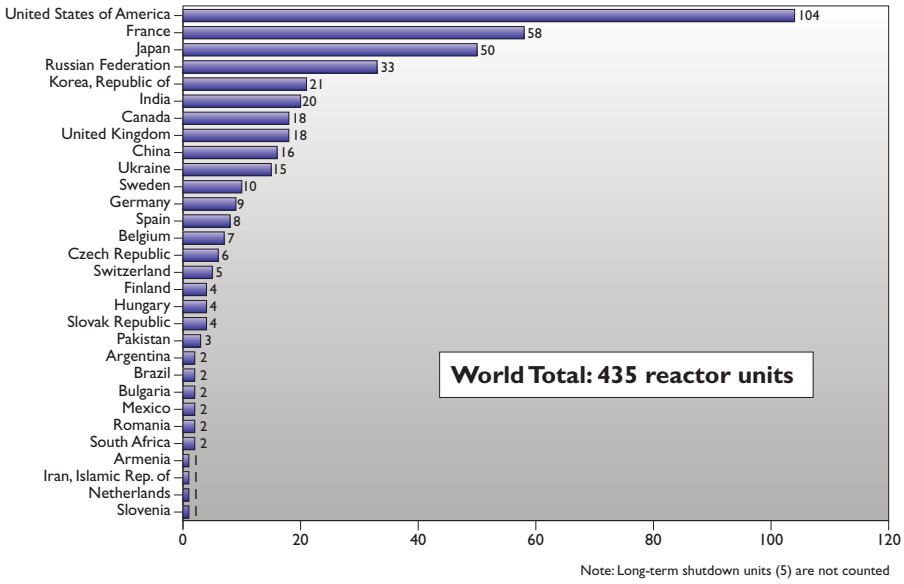
Although the accident at Fukushima Daiichi has had a dramatic effect on the nuclear industry worldwide, nuclear will remain an important energy option.

FOLLOWING THE NUCLEAR accident at Fukushima Daiichi, the prospects for nuclear power became much more uncertain and difficult to predict. Yukiya Amano, director general of the International Atomic Energy Agency, recently stated that "the accident caused deep public anxiety throughout the world and damaged confidence in nuclear power." While the impact on future nuclear power development was difficult to factor into projections, he said, nuclear power will remain an important option for many countries, although growth will slow.

After the accident, most countries with nuclear programs announced safety reviews of their plants and began to review their policies regarding nuclear power. A few countries made drastic political decisions, either to phase out nuclear power entirely (Germany and Switzerland), or to abandon plans to build new nuclear plants (Italy). Some countries that were working toward introducing nuclear power for the first time, or reviving inactive programs, announced that they will no longer do so, or that plans will be delayed. Looking into the near future, it is certainly possible that some governments may decide to cut back on or drop nuclear plans, particularly if nuclear power becomes a major political issue.

On the other hand, several countries have reaffirmed the importance of nuclear power in their energy mix, including some that plan to substantially increase nuclear capacity in order to meet rising baseload demand or to reduce their dependence on fossil-fuel imports.

These developments, alongside expectations of lower natural gas prices, have led to downward revisions in the projected growth of nuclear power, but not to any significant amount as of yet.



Reactors able to produce power as of the end of 2011 (the world total includes six reactors in operation in Taiwan, which is not displayed as a separate bar in the graph). (Graph: IAEA/Power Reactor Information System) [Because of differences in criteria, data in the graphs on this and the facing page may not agree with data in the *Nuclear News* World List of Nuclear Power Plants, to be published in the March issue.]

According to the IAEA, the continued growth in both its low and high projections suggests that the factors that had been driving interest in developing nuclear programs before the Fukushima Daiichi accident remain imperative for many countries: global energy demand is still expected to grow, concerns about climate change and other environmental pressures are rising, energy supply security is back on the political agenda, and there is a continued need for a reliable energy supply at predictable prices. Given these factors, said Hans-Holger Rogner, head of the IAEA's Planning and Economic Studies Section, "Nuclear power continues to offer a viable solution to many of these global issues." Moreover, the overall performance and safety of nuclear power plants continue to be good.

There were other factors, however, that made Rogner's job, which was to produce the 2011 nuclear power projections, challenging. For example, the economic crises that started in 2008 have not been overcome in many regions. Furthermore, until a replacement for the Kyoto Protocol on reducing greenhouse gases is agreed on, it will be difficult to factor in tougher climate change requirements when assessing the relative advantages of nuclear over other options.

According to Rogner, the Fukushima accident caused only a slight downward shift in nuclear power projections. The most notable reversal was Germany, not only for deciding to phase out nuclear plants over the next decade, but also for immediately shut-

Information for this article was gathered from a number of sources, most notably the International Atomic Energy Agency, the International Energy Agency's World Energy Outlook 2011, *and the World Nuclear Association.*

ting down for good eight of its plants. "But by and large," he said, "we have seen a lot of reflection about nuclear power, but we have not seen an overall retraction globally."

2011 IAEA projections

The 2011 projections faced the complex problem of balancing the factors that have traditionally driven nuclear expansion with the factors that potentially could adversely affect it. In the updated low projection, the world's installed nuclear power capacity grows from 367 GWe to 501 GWe in 2030, down 8 percent from what was projected last year. In the updated high projection, it grows to 746 GWe in 2030, down 7 percent from last year's projection.

The number of operating nuclear reactors increases by about 90 by the year 2030 in the low projection, and by about 350 in the high projection, from the current total of 433 reactors. Most of the growth will occur in countries that already have operating nuclear power plants.

Projected growth is greatest in the Far East. From 81 GWe at the end of 2010, capacity grows to 180 GWe in 2030 in the low projection, and to 255 GWe in the high. These levels, however, are lower than last year's projections by 17 GWe and 12 GWe, respectively.

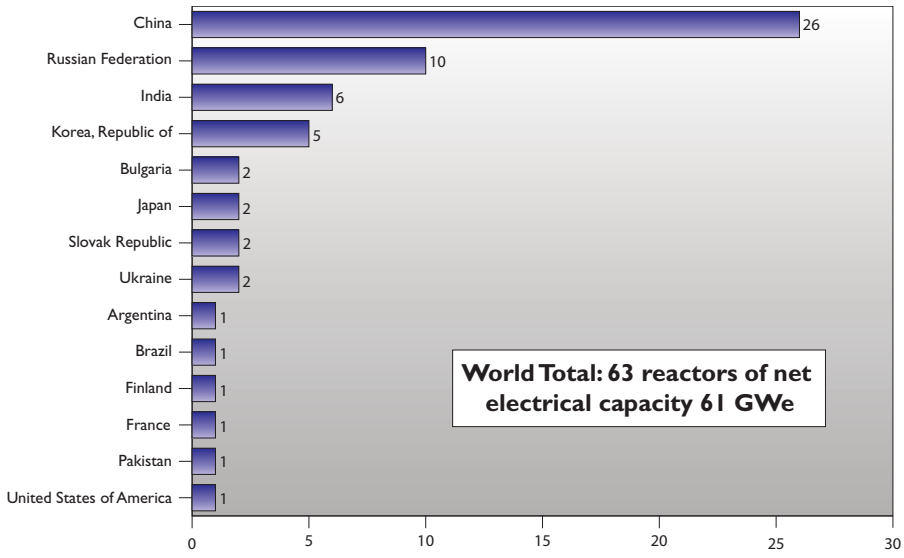
Western Europe shows the biggest difference between the low and high projections. In the low projection, Western Europe's nuclear power capacity drops from 123 GWe at the end of 2010 to 83 GWe in 2030. In the high projection, nuclear power grows to 141 GWe, but that is 17 GWe below the growth projected last year.

Nuclear power expands in Eastern Europe, which includes Russia, and the Middle East and South Asia, which includes India and Pakistan, in both the low and high projections, to only slightly lower levels than were projected last year. The same is true for regions with smaller programs: Latin America, Africa, and Southeast Asia.

IEA sees growth continuing

The IAEA projections are also backed up by the latest predictions of the International Energy Agency (IEA) in its report, *World Energy Outlook 2011*, released in November. Nuclear energy, the report says, will continue to play a key role in global electricity production despite Fukushima.

The IEA projections are based on what it calls its New Policies Scenario, which assumes that recent government commitments to move to low-carbon generation are implemented in a cautious manner. In this scenario, primary energy demand increases by one-third between 2010 and 2035, with 90 percent of the growth in countries outside the group of advanced economies of the Organization for Economic Cooperation and Development (OECD). The share of fossil fuels in global primary energy consumption falls from around 81 percent today to 75 percent in 2035. Renewables increase from 13 percent of the mix today to 18 percent in 2035.



Reactors under construction as of the end of 2011 (the world total includes two reactors under construction in Taiwan, which is not displayed as a separate bar in the graph). (Graph: IAEA/PRIS)

According to this scenario, despite recent announcements by some countries to cut back on their nuclear plans, nuclear power retains its share of global electricity generation through 2035, buoyed by expansion in China. In total, nuclear capacity rises from 393 GWe to 630 GWe by 2035, only slightly less than projected last year, as most countries with nuclear programs have reaffirmed their commitment to them—notably India and South Korea, as well as China.

Implications of reductions

It is still too early to arrive at a definite judgment on the extent of any reduction in nuclear power prospects resulting from Fukushima. For *World Energy Outlook 2011*, however, the IEA decided to consider the implications of a major reduction, and it prepared a special case: the Low Nuclear Case. In the report, the IEA makes it clear that its aim in presenting this special case was only to illustrate how the global energy landscape would look with a much smaller role for nuclear power. Nevertheless, the assumptions made seem to reflect possible responses to the accident.

Fatih Birol, the IEA's chief economist, warned that such a situation would have serious consequences for both climate change and energy security. "A shift away from nuclear would increase the share of electricity produced by renewable sources," Birol said, "but it would even more increase the share of fossil fuels such as coal and natural gas, thus increasing import bills, reducing the diversity in the energy mix, and increasing CO_2 emissions." Furthermore, he said, "It would also put additional upward pressure on energy prices, raise additional concerns about energy security, and make it more difficult and expensive to combat climate change."

The assumptions made in the Low Nuclear Case include the following:

- In the advanced industrialized countries of the OECD, no new reactors are built beyond those already under construction.
- In non-OECD countries, only 50 percent of the nuclear capacity additions projected in the new policies scenario proceed as planned, although all those already under construction are completed.
- Reactors built prior to 1980 are retired after an average lifetime of 50 years.

In this case, the total amount of nuclear power capacity drops from 393 GWe to 335 GWe in 2035—a decrease of 15 percent—as a result of the slower rate of new construction and a bigger wave of plant retirements. In other words, nuclear capacity is a little over half of what is projected in the New Policies Scenario. Consequently, the share of nuclear power in total power generation drops from 13 percent to 12 percent by 2020, and to 7 percent by 2035.

Impact of Fukushima

It is clear that this is a critical point for the industry, as many governments are reassessing their plans following a period of real growth in the number of plants that have been ordered, as well as in the number of countries planning to start, restart, or expand nuclear programs.

As noted above, most countries have affirmed their existing nuclear development plans, although more delays can be expected. Following are the highlights of some countries' programs and plans as a consequence of the Fukushima accident.

Continued

Japan

The Fukushima Daiichi accident has thrown the long-term role of nuclear power in Japan into doubt. The pre-crisis official target called for nuclear units to provide 53 percent of the country's total power supply by 2030 (up from about 27 percent in 2009), and before Fukushima, plans were in place to construct nine new reactors by 2020 and another five by 2030. Public resistance has now strengthened against these plans, and the government has announced that it will revise them. It has also announced immediate measures to boost nuclear safety and plans to undertake a stringent safety assessment at each reactor to check its capacity to withstand extreme natural events. Only 11 of Japan's 54 nuclear reactors were in operation as of mid-September. As Japanese reactors are required to be shut down at least once every 13 months for regular safety inspections, and the prefecture and other local authorities can veto the restart of a plant, there is a risk that the number of reactors continuing to operate could fall even lower.

European Union

Given the dependence that the European Union has on nuclear power, the European Commission acted quickly following the first days of the Fukushima disaster, succeeding in getting member countries to agree to conduct safety "stress tests" on all of the 143 reactors in the 14 EU countries that operate nuclear plants, plus Lithuania (which is currently decommissioning the last Ignalina unit). The tests will assess the ability of the reactors to withstand "extraordinary triggering events, like earthquakes and flooding, and the consequences of any other initiating events potentially leading to multiple losses of safety functions, requiring severe accident management." The results of the tests are expected in 2012, when individual member states will have to decide how to respond should any reactors fail the tests. It is expected that any such reactors will be shut down and decommissioned if upgrades prove to be technically or economically impracticable. The EU has also asked neighboring countries to commit to implementing the same stress tests on their own plants.

The EU has traditionally left all matters concerning nuclear power policies to members' governments, and this remains the case following the Fukushima accident. While Germany has decided to phase out its nuclear power program, most EU countries with small nuclear programs, such as the Czech Republic and Lithuania, have affirmed their plans.

France

French president Nicolas Sarkozy has continued his support of nuclear power in the wake of the Fukushima accident while implementing strong measures to demonstrate the high level of safety of the country's nuclear plants. France's Autorité de Sûreté Nucléaire (ASN) was charged with the task of carrying out safety assessments of the country's 58 reactors. Another consequence was the announcement by Electricité de France that the EPR unit being built in Flamanville will be delayed by two years, stemming in part from the need to carry out the safety tests.

In response to the order, ASN conducted a targeted inspection campaign that included more than 100 on-site inspections. To show ASN's transparency, the agency invited representatives from other French organizations and experts from other European nuclear regulatory bodies to attend the inspections. Its conclusions will be submitted to the prime minister and will be made public at the beginning of 2012. ASN stated that it will impose the appropriate requirements and, where necessary, will even recommend to the government the shutting down of any installations that do not meet the required safety standards.

There could be additional consequences for France's nuclear program if the Socialist Party wins this year's presidential election, as the party has said that it intends to shut down the country's oldest nuclear plants.

Germany

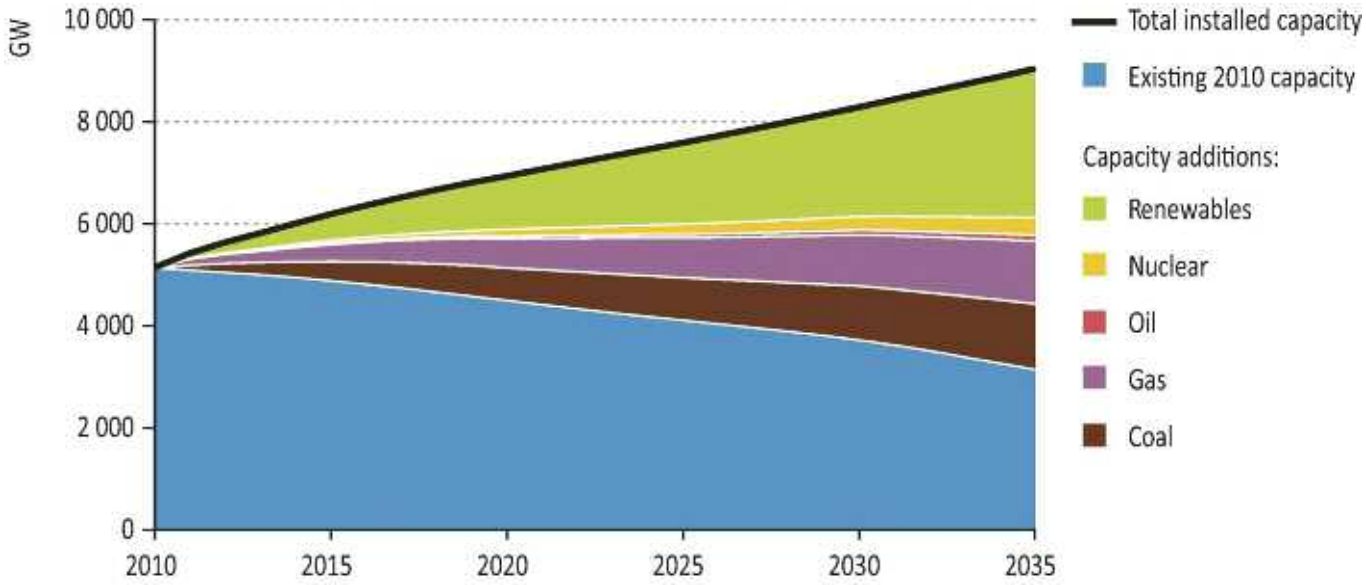
The country that has acted most comprehensively in response to the accident has been Germany, which decided to phase out its entire nuclear program over the next decade. Within days of the accident, the government ordered the suspension of operations at its oldest nuclear plants. A decision followed in May to completely abandon nuclear power in a step-by-step process that is to culminate in 2022.

Italy

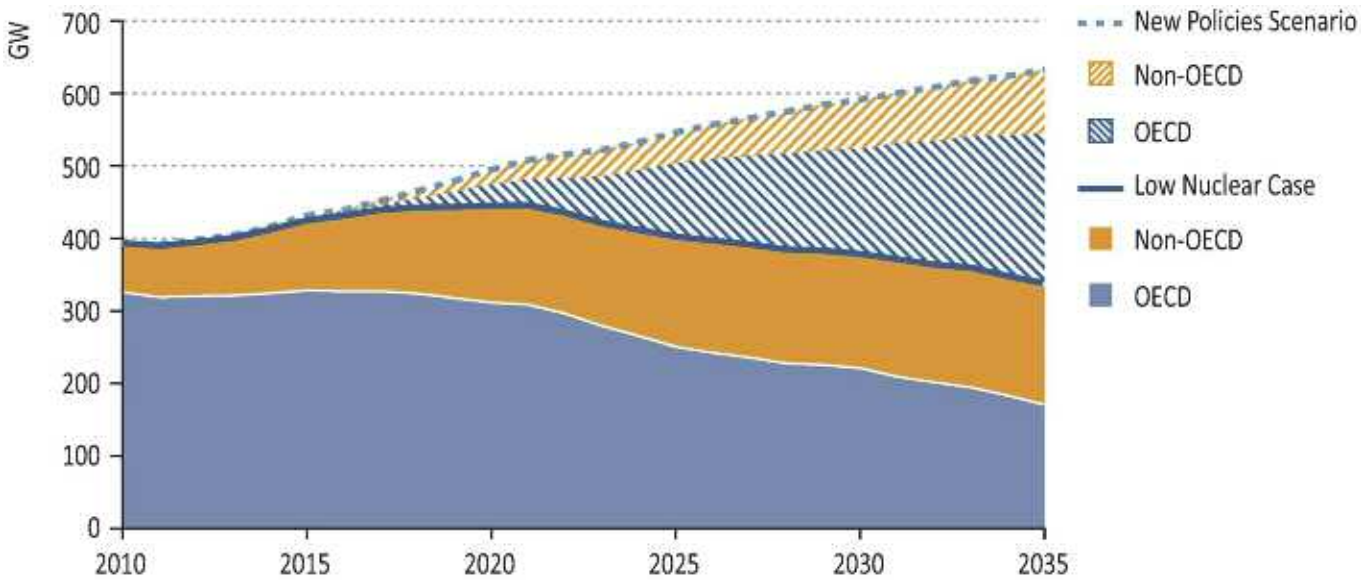
The Fukushima accident brought an end to the Italian government's efforts over the past two years to pass new legislation and make other changes in the organization of its nuclear activities to reintroduce nuclear power in the country. The accident gave nuclear opponents the chance to force the government to abandon its nuclear plans by demanding a referendum on the issue, which the government was unable to avoid. The unpopularity of what was then the government of Silvio Berlusconi meant that the pronuclear side had little chance of winning the June 2011 vote.

Lithuania

Lithuania confirmed that its plans to build a nuclear plant at Visaginas—adjacent to the Ignalina site, where two Soviet-era



Global installed power generation capacity and additions by technology in the International Energy Agency's New Policies Scenario. In this analysis, renewables and nuclear power account for more than half of all the new capacity added worldwide to 2035. (Graph: OECD/IEA)



Nuclear power capacity in the Low Nuclear Case. In this scenario, nuclear power capacity drops by about 15 percent from 2010 to 2035 because of plant retirements' outnumbering a slower rate of new construction than presented in the New Policies Scenario. (Graph: OECD/IEA)

reactors are being decommissioned—would go ahead despite the Fukushima accident. In July 2011, the government announced the selection of Hitachi, along with Hitachi-GE Nuclear Energy, as the strategic investors for the planned Visaginas project, which will house an Advanced Boiling Water Reactor. At the time, the two other Baltic countries, Estonia and Latvia, along with Poland, were taking part in the project. Since then, however, Poland announced that it was withdrawing from the project.

Poland

In December 2011, the state-owned Polish Energy Group (Polska Grupa Energetyczna, PGE) announced that it was suspending its participation in the Visaginas project to focus on its own nuclear development plans. The government designated PGE as the lead organization to set up and implement a national nuclear program that initially calls for the construction of two 3000-MWe capacity stations.

United Kingdom

In his report on the Fukushima accident and its implications for the nuclear industry, Mike Weightman, the United Kingdom's chief inspector of nuclear installations, concluded that there is no need to alter the operation of the country's nuclear plants or to change plans for adding new nuclear capacity. The government has announced a list of eight sites that are considered suitable for the first group of new-build nuclear plants and continues to press ahead with its legislative program, which includes energy market reforms that should provide considerable support for new nuclear projects.

Other nuclear countries

China

China, with 28 reactors under construction in 2010, initially froze approvals of new projects and ordered safety checks on existing plants and those under construction. In June 2011, all of China's operating nuclear reactors were reported to have passed their safety inspections. According to the World Nuclear Association, the review of those under construction was completed in October, while the resumption of approvals for further new plants will remain suspended until a new nuclear safety plan is in place.

India

India ordered emergency safety checks to be carried out on all nuclear plants while also indicating that there will be no change to its target of quadrupling nuclear capacity to 20 GWe by 2020 and to reaching 63 GWe of installed capacity by 2032. The Fukushima accident, however, has raised concerns from local communities about new-build projects, leading to antinuclear demonstrations.

Russia

Russia has announced that while it will not be altering its nuclear power expansion plans, Rosatom, the state atomic energy corporation, has been instructed to review plant safety at the country's nuclear plants in response to the Fukushima accident. Following these reviews, Rosenergoatom announced in mid-June a major safety upgrade program focusing on providing additional backup power and water supplies at plant sites. Rosatom has also affirmed its plan to double Russia's nuclear capacity by 2020.

Switzerland

While joining its EU neighbors in conducting the safety stress tests planned by the European Commission, Switzerland terminated its new-build licensing process, which was expected to approve the replacement of the country's five nuclear power plants starting early in the next decade. Switzerland also announced its intention to phase out nuclear power by 2034.

Emerging nuclear countries

Turkey

The Turkish government has affirmed its plan to commission the first of four reactors at the Akkuyu site by 2018 under a build, own, and operate agreement signed with Russia's Rosatom. Discussions being held with Japan about a possible nuclear plant bid were suspended after the Fukushima accident. Since then, Japan has indicated that it is still interested in building a plant in Turkey.

UAE

The United Arab Emirates has said that there will be no change to its project to construct four nuclear units at Braka, on the Persian Gulf, as a consequence of the Fukushima accident. The country's Federal Authority for Nuclear Regulation instructed the Emirates Nuclear Energy Corporation to conduct an overall safety assessment of the project by December 31, 2011, taking into account the lessons learned from the Fukushima accident.

Vietnam

Vietnam has affirmed its nuclear power plans, which include the construction of reactors at two sites, with the first to be operating by 2020. The country will also continue to develop the necessary legal and regulatory infrastructure to support its new nuclear industry. The first two units will be a turnkey project built by Russia's Atomstroyexport, and the second two units are to be constructed by Japanese companies. NN