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by Tom Flaherty, Joe van den Berg, and Nicolas Volpicelli

Within a few days of a tsunami striking Japan's Fukushima Daiichi nuclear reactors on March 11, a fierce debate had been fueled about the implications for energy policies around the world. Although the primary focus of most observers has rightly been on the immediate health risks in Japan and on stabilizing the reactors, some media commentators and political figures are already using the incident to argue that nuclear power is unacceptably risky. Some governments have made pronouncements that encourage the antinuclear lobby. Conversely, some observers are offering blanket assurances, saying that the industry's commendable safety record over the last 30 years should be enough, in itself, to counter the public's misgivings. Unfortunately, we will hear many such oversimplified, rhetorically heated arguments in the weeks and months to come.

As of April 2011, any debate about the implications of this crisis for the energy industry is premature. It will take into the summer to gather enough facts about the incident to draw reasonable conclusions about the safety and operating practices at this facility — and several more months to establish how those findings should apply to other nuclear plants and other countries. We cannot ignore the risk that a politicized overreaction would lead to hasty bans on nuclear power, and then to further energy shortages, just when the demand for electricity is growing rapidly around the world. The stakes are too high right now to base either political or business decisions on any rush to judgment.

But the events at Fukushima Daiichi do give us an opportunity for more thoughtful discussion on the role of nuclear power in general. This discussion should take into account the technical aspects of reactor design and operation, and the broader implications of energy supply and demand. It should acknowledge the extent to which nuclear energy has provided power that is free of greenhouse gases, while fully recognizing the concerns that people around the world have raised about this energy source.

Most of all, we need to look dispassionately at the trade-offs among the various options available for energy policy, and their impact on safety, cost, and the environment. A hasty, large-scale movement away from nuclear power at this juncture, even if it were practical and possible, would not resolve most of the issues. We can ask two questions as a good starting point for the needed discussion. First, how critical is nuclear energy as a long-term power source for countries around the world? Second, how should the energy industry and policymakers adapt in the aftermath of events at Fukushima Daiichi?

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Accepting the Source as Essential

Any sober analysis of the global energy situation would have to conclude that nuclear power is an essential fuel source for many geographies. In a growing global economy, new advances in other forms of energy generation are not sufficient to keep pace with demand, especially if there is a consensus that coal generation should be reduced. Put simply, we cannot afford to turn away from any single option at this point (other than the most aging and inefficient coal plants), and nuclear power must be part of the balance.

In many countries, a long-term shift away from coal to lower-emission fossil fuels and some renewables is in progress; this shift has already brought environment-related protests over natural gas drilling, changes in land use, and higher power prices. To turn away from nuclear energy now would require more use of all other fuels. New technologies such as renewables are viscerally and emotionally appealing; they will surely play an increasing role in power generation around the globe. But, at least for now, they can only contribute to meeting demand; they cannot supplant current sources. Even if solar and wind energy sources became far more prevalent and economically attractive, the sun and wind are intermittent and cannot ensure "always on" power. Widespread use of renewables will require dramatic technological developments in energy storage and production, which are not currently available or even foreseeable in the near term.

That leaves traditional fossil fuels, such as coal, gas, and oil. These all involve short- and long-term trade-offs among environmental concerns, costs, resource availability, and supply security. Certainly, there are many uncertainties that stymie clear decision-making; for example, it is not clear whether available oil and natural gas resources will be sufficient to meet the world's growing demand for transportation or electricity. In addition, in the developed world, a significant amount of coal generation is slated to be retired during the next 10 years, because of aging facilities and relative inefficiency, which further exacerbates future supply gaps.

Moving rapidly away from nuclear power would lead directly to higher power prices, unless a dramatic increase in coal (typically a cheaper option) is accepted. The most extreme price increases would result from forced early retirements of nuclear facilities, because utilities would have to replace lower-priced nuclear power with higher-priced power from other sources.

Given these factors, many nations — especially those where nuclear power is already prevalent — will continue to see nuclear power as a necessary component of their long-term energy portfolio. Though nuclear energy currently makes up only 15 percent of electricity generation worldwide, it constitutes 20 to 30 percent of the energy supply in the U.S., Japan, and Germany, and 75 percent in France. If these countries, and others that rely partially on nuclear power, decide that it should not be part of their long-term energy mix, they will need to engage in challenging and broad new efforts in pursuit of other forms of energy generation. Japan (with some units forced offline since the March 11 earthquake) and Germany (which has already opted to take its pre-1980 reactors offline temporarily to perform safety checks) will be interesting test cases to observe.

It is also important to watch rapidly growing countries such as China and India, which have relatively few good alternatives to meet their expanding energy needs. China, in particular, had planned to build 110 new

reactors during the next few years. Those plans have been scaled back for now; only the 27 units already under construction will continue, pending completion of new safety reviews in the wake of the Fukushima incident. Backing off on nuclear energy in any meaningful way would force China to rely more on energy imports and legacy coal production, and its high rate of GDP growth might be constrained.

In short, in every conceivable future, nuclear power is a necessary long-term power source, if only because so many nations count it as part of their short-term portfolio now.

Adaptation and Evolution

How, then, should the energy industry and policymakers adapt after Fukushima Daiichi? First, the public will certainly place a high burden of proof on the industry to demonstrate that nuclear reactors will stand up to human-induced catastrophes or unavoidable forces of nature more effectively — even extraordinary "black swan" events like the tsunami that struck Japan. This must, however, be considered in the context of the existing industry. Continuous safety improvement is already entrenched in its culture. For example, as a response to the events in Japan, the U.S. nuclear industry has begun a self-imposed review of all existing American reactors, without waiting for regulators to mandate one. This includes inspections of equipment and verification of plants' capability to handle a prolonged loss of power during and after seismic and flooding events, and reassessment of storage protocols for spent fuel to help plants avoid the unexpected dangers that stymied Japanese authorities. In that context, one lesson to draw from the events in Japan is the capability of the industry (and its regulators) to mitigate and recover from adverse events, even in those rare cases when catastrophe is not prevented.

That does not mean we can be complacent about future risks. Both government regulators and the industry should be prepared to improve plant designs and operating protocols still further, with the aim of strengthening long-term safety and reliability. Industry participants need to step back and approach self-assessment and public scrutiny with an open mind, as a welcome step toward an even safer operating environment and thus a more secure long-term industry. They may also need to accept that for current designs and projects, despite significant investments and licensing progress, delays for regulatory review and analysis of potential safety concerns are likely. Even if this adds a few months to the certification and licensing process, the industry has plenty to focus on in the meantime to ensure preparedness for planned construction and to mitigate future delays.

Transparency will be a major factor in gaining acceptance. Safety improvements and focused design enhancements will require open collaboration and meaningful cooperation among all stakeholders, including the public. Risk mitigation of low-probability, high-impact natural disasters needs to be openly assessed and improvements incorporated into site protection and reactor design evolution, where practical. Policymakers and regulators will need to emphasize solutions that genuinely advance the state of industry performance and reduce risk, rather than simply layer on new requirements with dubious safety and public benefits.

Regulators and industry leaders also need to make greater distinctions among different facilities, because risks vary from one location and one plant design to another. Not all nuclear reactors are alike; the lessons gleaned from Fukushima Daiichi will not apply to all plants in Japan, let alone across the globe. Safety reviews should factor in reactor age, geographic context, and the type of technology — several different types of water-cooled and gas-cooled reactors are in use now — to avoid painting all plants with the same brush. The first facilities to review should be those that are most susceptible to high-impact, low-probability events such as hurricanes and earthquakes, and those with the least passive safety in their design. (Passive safety features are those that make use of designed-in operational and equipment controls, rather than relying on human intervention.) At the same time, industry should recognize the global nature of the market and explore ways in which lessons can be shared effectively across geographies. For example, some practices already prevalent in the U.S.

(such as having diverse backup power sources and improved spent fuel storage protection) could be more widely applied to the benefit of the industry at large.

Where possible, safety reviews should accelerate a shift to newer technologies. Existing plants have proven to be safe, but the most current "Generation 3" and the proposed "Generation 4" reactor designs have incorporated further significant safety improvements. For example, passive decay cooling, found in the new generation of light water reactor designs, would have broken the chain of cascading failures (of backup power systems and coolant pumps) at Fukushima Daiichi and thereby eliminated some of the factors that precipitated problems there. It will still take several years to bring new plants online, and all existing power sources will be needed in the meantime — but it would be beneficial if the crisis could lead to a measured, well-designed plan to further enhance the world's nuclear energy footprint. Conversely, if the crisis results in a slowdown in new nuclear plant construction, it could paradoxically result in extending the operating lives of older plants.

For the long term, countries will need to intensify emerging energy technology research and development. Because R&D investment in a single, unproven technology is risky, countries will likely have to invest in a wide range of alternatives, including renewable energy and storage options, as well as coal with carbon sequestration.

Finally, public communication about nuclear power — on the part of both government and industry — will need greater effort. No matter what specific technical outcome emerges, increased investment in nuclear safety will increase the costs of capital investment and operations. To be sure, the economics of new nuclear investment, at least for the first few facilities (which, by definition, face the steepest learning curves), are currently challenged by low natural gas prices. But taking a longer-term view on energy supply — in which a balanced portfolio is a preferred outcome — shows us that it would be premature and risky to turn away from nuclear power. The cost of investing in increased safety will probably force energy prices somewhat higher, but not nearly as high as would a wholesale shift away from nuclear power. Ultimately, energy customers and regulators alike will need to better understand the causes of price changes, the trade-offs involved among energy supply sources, and the recognized risks of related policies.

One potential positive legacy of this situation — a way to commemorate those who have been personally affected by it — would be a comprehensive and thoughtful energy policy that would align government objectives, industry development, and consumer impact. Such a result is going to require more tempered and extended conversation than the current debate has elicited. Instead of arguing for immediate advantage, energy advocates and industry leaders have a chance to think pragmatically about the future. Crises have sometimes led to breakthroughs in capability. Is there some similar possibility here? If so, it must include a recognition of the platform that nuclear power provides for the world's economy already — and all the ways in which the world's energy mix needs to develop over the next 15 to 20 years. ✚

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