

Revisiting Nuclear Renaissance

by Jone-Lin Wang and Christopher J. Hansen

Critical milestones in the first wave of new nuclear development in the USA may prove decisive.

Governments and businesses around the globe have moved beyond talking to real action to renew development of nuclear power, and have created good prospects for a major nuclear expansion over the coming decades. Over the past few years, high fossil fuel prices, energy security and climate change concerns and increasing urgency about reducing greenhouse gas (GHG) emissions have all converged to improve the position of nuclear power relative to other options.

In the USA, where no new reactor has been ordered in 28 years, these trends, plus excellent performance of the existing nuclear fleet and financial incentives in the Energy Policy Act of 2005, have led to a race to develop new nuclear power reactors. In Asia, where the building of new nuclear plants never stopped, several countries have recently upped their target for new nuclear capacity. In Western Europe, a new reactor is under construction for the first time in more than a decade, and a second one is not far behind.

In the near-term, our assessment is that limits on nuclear component manufacturing capacity and skilled personnel could constrain nuclear capacity growth over the next several years. But these are short-term growing pains similar to those faced by other industries and other segments of the energy industry.

Longer-term issues, involving spent fuel storage and the risk of proliferation, need to be addressed and will require implementation of international conventions. Development of convincing long-term solutions must make continuing progress or public support for the upcoming expansion may decline.

Expansion plans

The global political, environmental, economic and business situation is favourable for expansion beyond the current base of nuclear power reactors, which together provide 16% of total worldwide electricity generation. Twenty countries now have new plants either under construction or under development, with well over half of new nuclear plants likely to be built over the next two decades in five

countries — China, India, Japan, South Korea and the USA.

In the USA, several dozen reactors are in various stages of proposal development, while international nuclear vendors and service providers are forming new alliances. Finally, rising uranium prices have led to development of new mines.

However, critical milestones in the first wave of new nuclear development will provide insights into whether and how well new nuclear development is proceeding. Such key near-term milestones are:

- ❖ Late 2007–2008 — Submission of construction and operation license (COL) applications;
- ❖ 2007–2008 — Ordering long lead-time items such as large forgings;
- ❖ Around 2010 — COL approval, final board decisions, site preparation, ordering major components; and
- ❖ After 2010 — Pouring first concrete.

The cost factor

In the competition with combined-cycle gas turbines (CCGT) and coal-based power plants for base-load power generation, the relative cost of nuclear generation varies substantially around the globe. Coal-fired generation is typically more economic in areas such as northern China, the US Midwest and Australia where coal is abundant and there is no penalty for carbon emissions. In areas distant from fossil fuels such as Japan, coastal China and France, high fossil fuel transportation costs make nuclear power attractive.

Recent worldwide trends toward higher fossil fuel prices, combined with low interest rates, low inflation, and the increasing importance of carbon emissions as a direct power generation cost, have improved the relative economics of nuclear power.

There are several key factors that will determine nuclear power's competitive position in relation to other energy sources over the next few years:

- ❖ Capital costs have a significant bearing because they represent two-thirds to three-quarters of the per-kilowatt-hour cost of nuclear generation;
- ❖ High capacity factor — 90% for the best run fleet — is more important to nuclear than other types of plants due to nuclear's high initial capital costs and high fixed costs;
- ❖ Cost of capital affects nuclear more than other types of plants. Government funding or loan guarantees can cut unit cost of nuclear generation by 10% to 15%;
- ❖ Carbon emissions charges favour nuclear power. A \$10 per ton charge on carbon dioxide (CO₂) raises the cost of coal- and gas-fired generation by an amount equivalent to 7% to 15% of nuclear's costs; and
- ❖ Secure access to inexpensive fossil fuels reduces nuclear power's advantage.

In North America, the cost of new nuclear power is uncertain due to the lack of recent experience in building plants, new licensing processes, and the use of new designs. If new plants can be built at \$2,200 to \$2,550 per kilowatt, nuclear is competitive with natural gas when natural gas price is at least \$6 per million British Thermal Units (BTU). To be competitive with supercritical coal, nuclear needs to come in at the low end of the capital cost range, or a modest CO₂ cost needs to be added.

The ultimate factors of influence

Policy debates in North America, Europe and Asia all reflect the common recognition that nuclear plants contribute carbon-free power and reliable base-load supply while simultaneously diversifying the fuel mix. Governments and businesses are taking action and it can well be argued that the much-talked about nuclear 'renaissance' is real.

However, such nuclear renaissance is by no means a *fait accompli*. There are several issues that will ultimately influence the development of nuclear power generation over the coming years. These include the following:

- ❖ Climate change policies support nuclear expansion — a long-term scenario work indicates it is very difficult to curtail rapidly rising global CO₂ emissions without expanding nuclear power generation;
- ❖ Supportive government policy is essential for nuclear development — success in capital-intensive projects like nuclear power requires a stable and predictable investment

climate, which in turn requires efficient and stable government licensing and regulatory processes as well as a predictable structure for power markets;

- ❖ License renewals and extensions will be used to more fully utilize existing plants — in the US, 48 reactors have been granted 20-year life extensions, with the remaining 56 likely to follow, as will many European reactors;
- ❖ Nuclear plant costs will be higher for initial units — because many leading reactor designs have never been built before, first-of-a-kind engineering and the need for experience to move down the cost curve will mean higher costs and, often, government subsidies as in the Energy Policy Act 2005;
- ❖ Successful demonstration of cost and performance in new designs is important for fast nuclear expansion;
- ❖ High uranium prices reflect short-term market tightness;
- ❖ Nuclear fleet expansion may be held-back by limits on component manufacturing capacity;
- ❖ High-level waste storage solutions need to move toward resolution. While on-site storage of spent fuel is a technically viable solution for most nuclear plants, progress toward a permanent waste disposal plan is important for public support;
- ❖ Resolving concerns about links between the expansion of nuclear power and the proliferation of nuclear materials will be crucial as nuclear power expands its role in developing economies. Failure to resolve this dilemma may hamper peaceful nuclear applications at a time when there are few effective options for carbon-free electricity production. The current geopolitical struggles to contain nuclear weapons technology and the threat posed by non-State actors in possession of nuclear materials, which are unlikely to respond within the paradigm of deterrence, make this an issue of unequalled importance; and
- ❖ A major nuclear accident or incident of nuclear terrorism anywhere in the world would put the brakes on new plant development — a low-probability but high-consequence event.

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*This article summarizes findings of CERA's 2007 report, "Is the Nuclear Renaissance Real?"
Website: www.cera.com.*