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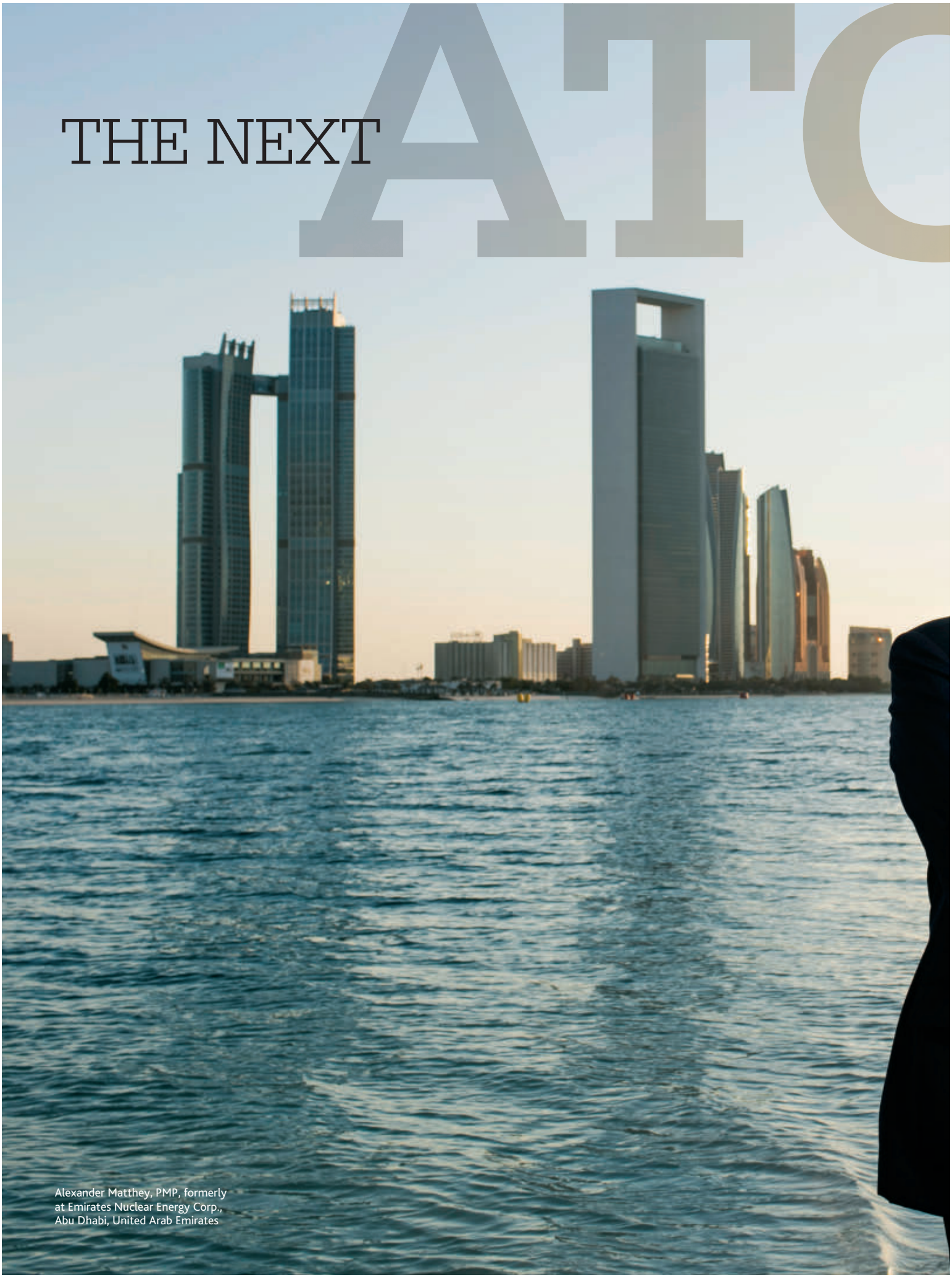

Alexander Matthey, PMP, formerly
at Emirates Nuclear Energy Corp.,
Abu Dhabi, United Arab Emirates

OMIC AGE

A new wave of nuclear power plant projects must overcome gaps in talent, the supply chain and public support.

BY MATT ALDERTON
PORTRAITS BY PHILIP CHEUNG

Government inspectors visit the Fukushima Daiichi Nuclear Power Plant in Japan in December.

PHOTO BY THE ASAHI SHIMBUN VIA GETTY IMAGES

IT'S BEEN FIVE YEARS

since tsunami waves triggered a meltdown at Japan's Fukushima Daiichi power plant. After radiation leaks forced 300,000 residents to evacuate their homes, the country chose to shutter all 43 of its nuclear reactors indefinitely—sparking a global debate over the future of nuclear power.

When the government began restarting reactors in August, it became clear the debate was far from over. Demonstrators were quick to swarm each site, protesting the reactors' perceived health and safety risks.

Yet despite its tepid public reception, many governments see nuclear energy as an important source of emission-free power. From China and India to France and the U.K., countries are investing in new nuclear construction to help reduce their reliance on carbon-based fuels. With 67 new nuclear reactors under construction in 15 countries, global nuclear capacity is expected to more than double by 2030, according to the International Atomic Energy Association. And by 2040, the number of countries that have at least one nuclear plant is predicted to increase from 30 to 36, according to the *2015 World Nuclear Industry Status Report.*

This sudden rush poses a problem for nuclear project managers, as the talent pool and supplier base struggle to keep up. Many of the businesses and specialists that supported the first wave of nuclear construction in the 1970s pursued other enterprises after the accidents at Three Mile Island in the U.S. and Chernobyl in the former Soviet Union put many nuclear projects on the back burner.

Today, as more organizations tap a limited talent pool, many nuclear projects are struggling to obtain the materials and experienced team members they need. In fact, 76 percent of the new reactors being built are experiencing construction delays, according to the *2015 World Nuclear Industry Status Report.*

"[Twenty-five] years is a big gap when it comes to building and commissioning a nuclear power plant. The knowledge of how to do that has slowly but surely eroded, and now it has to be rebuilt. It's like starting from scratch," says Alexander Matthey,

"Until the supplier base grows and comes out with new innovations to improve the manufacturing cycle of nuclear equipment, it's going to be really difficult to achieve faster progress on nuclear construction projects."

—Kalirajan Sivagnana, Larsen & Toubro Construction, Chennai, India

POWER SURGE

With 67 new nuclear reactors under construction in 15 countries, global nuclear capacity is expected to as much as double by 2030, according to the International Atomic Energy Association. Here's a close-up look at four nuclear reactor projects in play:

PMP, former corporate program management center of excellence manager, Emirates Nuclear Energy Corp., Abu Dhabi, United Arab Emirates.

SUPPLY CHAIN REACTION

Rebuilding the supply chain won't happen overnight. Sophisticated technologies and stringent safety standards create a high entry barrier for new manufacturers. As a result, few manufacturers are eager to fully commit their resources to producing nuclear equipment and technology out of fear that demand will soften again. That means nuclear project timelines might stay stuck in first gear, says Kalirajan Sivagnana, head of special initiatives, nuclear, Larsen & Toubro Construction, Chennai, India.

"Until the supplier base grows and comes out with new innovations to improve the manufacturing cycle of nuclear equipment, it's going to be really difficult to achieve faster progress on nuclear construction projects," he says.

To avoid unnecessary delays, project managers must be sure to allocate enough time for each project phase—especially procurement.

"Certain activities require a minimum amount of time and cannot be squeezed down," Mr. Sivagnana says. "For example, a reactor pressure vessel takes 34 to 36 months to manufacture from the start to finish."

A dearth of project talent can also cause delays in already lengthy schedules (See "Endurance Tests," page 44). Mr. Matthey estimates that nuclear power is a new discipline for a large majority of those working in the nuclear industry, but says even projects that employ experienced talent can expect slowdowns. Because team members often come from different countries where vocational and professional qualifications and work practices vary, it's important to start slow and make sure everyone is on the same page, says Greg Kaser, senior project manager, World Nuclear Association, London, England.

"If you've got someone who's been qualified in the Czech Republic working in France, or someone from Poland working in Finland—or if you work in the [United Arab Emirates], where there are four reactors being built by the Koreans—you want to make sure skilled workers are properly certified for the work. If they aren't, that could [cause delays]," he says.

In the short term, project managers can address the talent gap by asking retired workers to mentor their less-experienced peers or setting up formal knowledge transfer programs.

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—Greg Kaser, World Nuclear Association, London, England

VOGTLE UNITS 3 AND 4
Sponsor: Georgia Power
Location: Waynesboro, Georgia, USA
Cost: US$16 billion
Estimated completion: 2019-2020
Status: Vogtle 3 and 4 are three years behind schedule and US$2 billion over budget due to design and material procurement changes.

BARAKAH UNITS 1, 2, 3 AND 4
Sponsor: Emirates Nuclear Energy Corp.
Location: Al Hamra, UAE
Cost: US$20 billion
Estimated completion: 2017-2020
Status: So far, all Barakah units are on time and on budget.

HONGYANHE UNITS 5 AND 6
Sponsor: Liaoning Hongyanhe Nuclear Power Co.
Location: Donggangzhen, China
Cost: CNY25 billion
Estimated completion: 2019-2020
Status: Although the plants were approved in 2010, construction didn't start until 2015, when China lifted a four-year moratorium on nuclear project initiations following Japan's Fukushima Daiichi disaster.

FLAMANVILLE UNIT 3
Sponsor: Électricité de France
Location: Flamanville, France
Cost: €10.5 billion
Estimated completion: 2018
Status: Flamanville 3 is six years behind schedule because of issues related to procurement, regulations and safety.

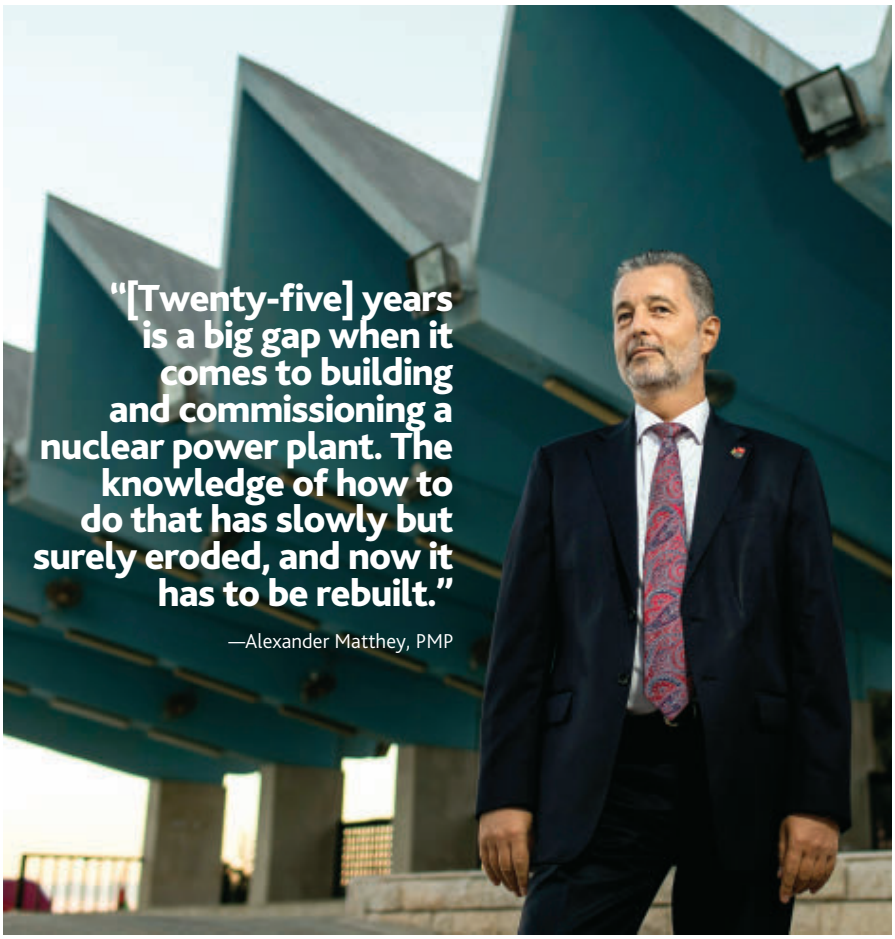
THE COOLING TANK

In the face of nuclear energy's mottled history, project managers must also be prepared to face public opposition. "Public concern is one of the major challenges all across the world," says Mr. Sivagnana.

Using social media, TV and radio can help project teams educate the public about the benefits of nuclear energy—and the steps that will be taken to mitigate safety risks during construction and operation, he says.

"In India we have a system: When a project is launched, there is a public consultation that takes place that clearly brings out the opinions of the public," Mr. Sivagnana says. That feedback is then incorporated into final design changes, when possible.

In India, for example, a common concern is the potential impact of radiation on local agriculture and wildlife. Fishing villages, in particular, worry about the impact of hot water released by nuclear power plants into the ocean. "A lot of reactors are built on the coastline because they need water for cooling," explains Mr. Kaser. "Fishing villages may be concerned that the water temperature will change because of the reactor using water as coolant, so [plant designers] must put in controls to ensure there isn't an impact."



Because of such concerns, the Indian government appoints local committees whose members include local villagers who monitor the progress of projects. "If the public feels part of it, it won't act against the project," Mr. Sivagnana says.

To make new nuclear projects as safe as possible, project managers must follow strict regulatory requirements that span multiple levels of government. And these regulations are always evolving. For instance, a combined construction permit and operating license (COL) requires all potential safety issues to be resolved during the design phase as part of the licensing process. Global implementation of this best practice means a new reactor's operating license must be approved before funding and resources are committed, rather than after construction is complete. The result is a more tightly controlled design—but a more volatile schedule, as project teams lose the flexibility to solve design challenges on the fly.

"One of the risks of having a combined operating and construction license is that you have to build things exactly the way you say you're going to build them," says Andrew R. Cato III, PMP, construction compliance supervisor at Southern Nuclear Operating Co., which is building two reactors in Waynesboro, Georgia, USA. "Any time you deviate from your design, you have to go back to the regulator for

NUCLEAR PAST, PRESENT AND FUTURE

Nuclear power by the numbers:

	2004	2015	2040 (projected)
Global nuclear power capacity (in gigawatts):	365.5	337	624
Global number of operating nuclear power plants:	440	391	n/a
Number of countries operating nuclear power plants:	31	30	36
New nuclear power plants under construction globally:	26	67	n/a
Percentage of global electricity generated by nuclear power:	16	10.8	12

Source: *2015 World Nuclear Industry Status Report*

a licensing change, and that can add six months to a year to your schedule."

Project managers can mitigate COL risks by completing design work early, but that's not always an option. That's because nuclear design standards tend to be updated each time there's a safety incident anywhere in the world, Mr. Sivagnana says.

"If a small incident happens in any nuclear power plant, all across the world technology owners start thinking about how to improve their technology so that even a small incident doesn't happen again."

PROJECT ENRICHMENT

This dynamic makes design standardization extremely difficult—and increases the risk of delays as teams apply new lessons learned at every turn.

Any tweaks to design typically add time to the schedule, Mr. Cato says. But in his project's case, multiple reactors are being built, "so we're able to take lessons learned from one unit and input them into its sister unit," he says. "Earned value of the twin unit is always much lower." The result has been fewer construction delays.

Some of today's reactors are being built with modular components—meaning that large prefabricated sections are built off-site. Over time, this approach likely will move the industry further toward standardization because it allows for increased control of manufacturing risks and processes. As modular design scales up, this new approach can mitigate the likelihood of delays, Mr. Kaser says.

"Japanese and U.S. manufacturers have redesigned their reactors to have a certain number of modules that can be assembled in a factory setting rather than outdoors," he says. "That provides better control of your processes, but it's been challenging at first because with the first four or five reactors you're learning as you go along."

Over time, sustained demand for nuclear projects could reduce many of the construction challenges that project managers must navigate today. With the completion of each nuclear power plant, gaps in construction technology, talent and supply chains will narrow—and the need for project managers with nuclear experience will expand, says Jerry D. Lainhart, PMP, turnover manager, China site startup—Haiyang AP1000, Westinghouse Electric Co., Haiyang, China.

"As nuclear construction projects increase, so, too, will the need for project managers who are well-trained, formally qualified and sufficiently experienced to lead this type of large, complex project successfully." **PM**

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