

Feature—Building a Research Bridge to China



By Brent Barker

The Story in Brief

Nuclear power in China is on a steep growth trajectory. EPRI and the Chinese nuclear utilities have embarked on a major collaboration, bringing together EPRI's extensive research and technology and China's impressive advanced nuclear research facilities. The engagement has the potential to substantially bolster the safety and efficiency of nuclear power worldwide.

On a tour arranged by China General Nuclear Power Corporation (CGN), EPRI Fellow Rosa Yang was impressed as she entered the research laboratory in Shenzhen. "On the way to the lab, I was thinking that this is probably a facility I've seen before," said Yang. "But walking in was a revelation. The facility was marvelous, with some of the most advanced technology in the world for thermal-hydraulic and safety-related testing of nuclear fuels and components, including simulating severe accident conditions."

Yang, along with Neil Wilmshurst, EPRI's Nuclear vice president, and Shanshan Liu, EPRI's country manager for China, were escorted in March through the 13,000-square-meter, five-story Comprehensive Thermal Hydraulics and Safety Testing Facility. Its 17 experimental engineering stations are for testing existing plant performance and designs of new nuclear reactors, and for simulating both normal and off-normal operations. "The interesting thing about this facility is not only the large scale, but the fact that this is just Phase 1 for this lab," said Yang. "There are open fields next door where they intend to expand. Phase 2 is still undetermined."

EPRI's nuclear staff view this lab as a precursor of something larger in EPRI's future with China. Advanced laboratories such as the one in Shenzhen have largely closed in the United States, even as the expertise and knowledge remain with EPRI and its members around the world. During the past several years, EPRI and the Chinese nuclear utilities have come to appreciate the potential for collaboration and have embarked on a carefully managed engagement. This collaboration has the potential to substantially bolster the safety and efficiency of nuclear power worldwide.

"The nuclear utility CGN is already halfway to full participation in EPRI's Nuclear sector programs," said Wilmshurst. "We are continuing the relationship and want to get a better grasp of their research capabilities."

What we saw at Shenzhen is very promising—the kind of facility where we could place some of our future research.”

Nuclear Trends in China

China is one of the few places in the world where nuclear power is on a strong growth trajectory, with 27 operating reactors, 26 under construction, and 6–7 units projected to come online every year through 2040. CGN projects that Chinese nuclear capacity will grow from roughly 23 gigawatts today to 58 gigawatts by 2020 to 200 gigawatts by 2040. According to the U.S. Energy Information Administration, the nuclear portion of the generation mix in China is expected to grow from only 5% today to roughly 11% by 2040 (see chart). With a rapidly growing Chinese economy and power generation straining to keep up with surging demand, coal is believed to continue as the dominant resource.

Today, 87% of China’s electricity is consumed in the commercial and industrial sectors. Pent-up demand for power in the residential sector—currently just 13% of the country’s consumption—may foreshadow more rapid growth in generation in coming decades.

The recent climate agreement between China and the United States focused on capping carbon dioxide emissions. China’s commitment to cap carbon dioxide emissions by 2030—at a level not yet specified—will require building a staggering 800–1000 gigawatts of non-fossil generation in the next 15 years. 1000 gigawatts is equivalent to 80% of China’s installed generation capacity at the end of 2013. Based on CGN’s capacity projections, nuclear will account for 20–25% of this new generation by 2040.

Much of the nuclear technology in China is a mix of Chinese designs and Western designs modified by Chinese engineers. According to TG Lian, EPRI program manager for corrosion research and previous China country manager, China National Nuclear Corporation (CNNC), the country’s other major nuclear utility, built and operated the first Chinese-design reactor in the early 1990s. A year or two later, CGN built the first foreign-design nuclear plant near Daya Bay, which supplies most of Hong Kong’s electricity. CGN worked with the French firm AREVA to install its technology and adapt it to China’s needs.

The Chinese are moving fast to install reactors with passive safety features, including the Westinghouse AP1000, the European Pressurized Water Reactor (EPR), and the Chinese Hualong-1 Generation III design. The EPR is a French/German design, and the Hualong-1 was developed from the French Generation II design.



Data as of October 15, 2015

Roadmap for Engagement

EPRI engagement with China began in the early 2000s with a few in-country meetings with key nuclear industry personnel. In 2006, a plant management subsidiary of CGN at the Daya Bay plant joined EPRI's Nuclear Maintenance Applications Center (NMAC) program. This afforded the first formal, ongoing relationships between EPRI and CGN, the smaller and more internationally focused of the two nuclear utilities.

With its reports and databases, followed by workshops and informal consultation, NMAC quickly proved its value, and by extension, EPRI's potential value. The relationship with NMAC continues.

"From 2006 to 2011, engagement stayed at the level of intermittent touch points," said Wilmshurst. "After the Fukushima accident, Mike Howard, EPRI's CEO, made it an increased focus to collaborate on R&D projects with China's nuclear generation companies to help ensure the safe and reliable operation of nuclear plants. At the World Association of Nuclear Operators (WANO) biennial meeting in September 2011, we met a number of key people from the Chinese nuclear utilities, and in 2012, we visited the companies to build these relationships."

At a subsequent international meeting focused on Fukushima, sponsored by the Institute of Nuclear Power Operations (INPO), Wilmshurst and Yang met with Zhu Minhong, the Deputy General Manager of one of CGN's operating subsidiaries, who reviewed the agenda and contact list for an upcoming meeting with CGN in China. He suggested higher level contacts, and that evening, Zhu and Wilmshurst used a whiteboard to devise a Four-Step Roadmap to guide future engagement.

"The first step was to elevate the NMAC relationship at CGN from the plant operations level to the corporate level," said Lian. "Step two was for CGN to identify and better understand the specific EPRI programs and to select the right programs to join. Step three was assessing the value of the EPRI engagement, quantitatively and qualitatively, including sending resident researchers. Step four would be full membership in EPRI's nuclear programs."

"What the Roadmap set in motion was a very deliberate and purposeful path of growth for CGN's engagement—one that can be controlled on both ends," said Wilmshurst. "It is controlled on their end by the speed with which they can digest what they are getting from us. From our end, the careful pacing helps us to understand their organization and culture and the capabilities they bring to our research program."

The Breakout Year

In 2013, CGN identified the five nuclear programs of greatest interest, and a visit to China was arranged to showcase the programs. "I took a team of seven to China to conduct parallel, in-depth, two-and-a-half-day workshops," said Yang. "We led off with a general meeting, then broke into five groups to discuss the specifics of each EPRI program with our technical counterparts from CGN. After the breakouts, we returned to the general meeting where their experts reported to their senior management what they had learned about the value of EPRI programs to their fleet."

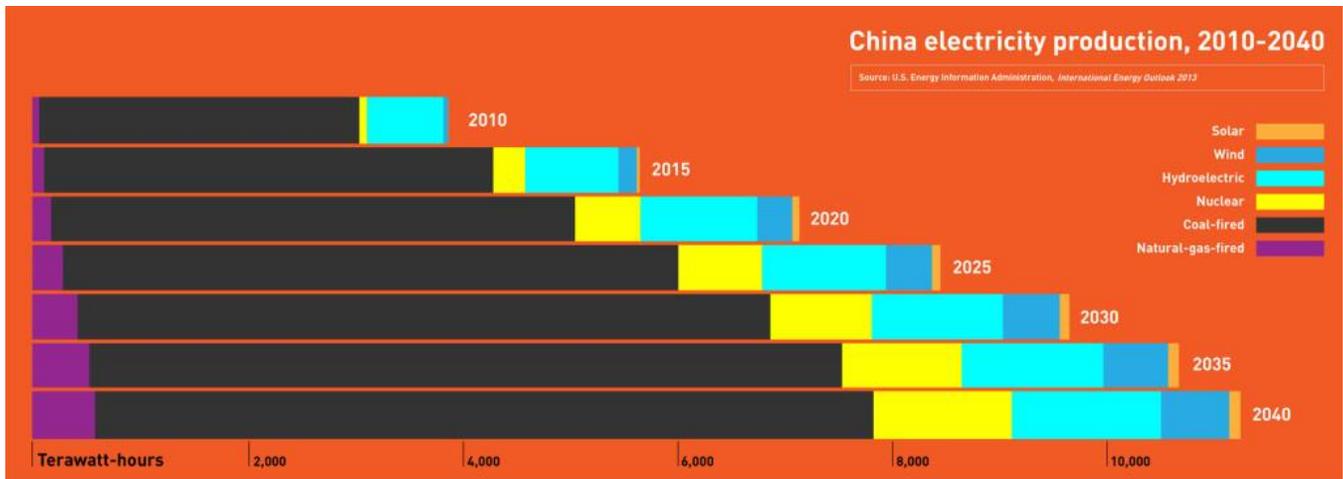
A fortuitous extension of this China trip was added at the last minute. "We thought that as long as we had the team together in China, we might as well build ties with the other nuclear utility, CNNC," said Yang. "We traveled to CNNC and gave them a shorter version of what we had presented to CGN."

Priorities in Technology Transfer

EPRI's Chemistry and Fuel Reliability staff met with CGN counterparts at Daya Bay in 2014 to explore topics of priority for technology transfer. CGN has a particular interest in the chemistry involved in applying zinc to reduce radiation fields, and EPRI staff were able to draw upon their numerous engineering and laboratory assessments as well as fuel examinations at plants injecting zinc to ensure that zinc chemistry does not negatively impact the fuel. Other areas of interest included EPRI's water chemistry guidelines and the use of dispersants to reduce steam generator fouling.

The result: deeper involvement in EPRI research. CNNC joined two programs, NMAC and Nondestructive Evaluation (NDE) for 2013 through 2015. In 2013, CGN joined four of the five programs presented—Water Chemistry, Instrumentation and Control (I&C), Fuel Reliability, and Steam Turbines.

“CGN has assigned a technical lead for each program,” said Shanshan Liu, EPRI’s China country manager, responsible for EPRI’s growing relationship with the two Chinese utilities. “They also have appointed a manager of EPRI Technology Transfer to coordinate all the visits and requests.” Liu added that CNNC has established a special EPRI Collaboration Committee to ensure that the engagement is strong. “They are gaining confidence as evidenced by their decision to join two additional programs in 2015: Water Chemistry and I&C.”



Reciprocity of Interests and Resources

Strong reciprocal interests, resources, and capabilities drive EPRI’s growing engagement with the Chinese nuclear industry. “The Chinese utilities are finding value in EPRI research and technology through their participation,” said Yang. “They are building nuclear plants at a fast pace and see that our technology can improve the operational performance of their plants. EPRI can also provide a basis for them to use in training their less experienced engineers.” The growth of the country’s nuclear industry brings the potential for worker shortages and competition for skilled staff. “They are striving to maintain a corps of experienced engineers at their plants,” said Liu. “EPRI’s reports and technology transfer provide value through support and guidance for training. If they are working on a problem for which we have a solution, they can take the results and apply them, saving considerable manpower and time.”

On the other side, EPRI and its members are seeking access to advanced research facilities and testing grounds that can provide a deeper understanding of the performance of advanced nuclear plant designs. The Chinese are investing substantially in such facilities and seek the experience, knowledge, and data accumulated over decades by U.S. and European nuclear organizations. “It’s an ideal match,” said Yang. “China wants access to EPRI’s global network, and EPRI and its global members want access to China’s research capabilities and experience.”

Both EPRI and the utilities have conducted each step of the engagement under the auspices of the U.S. and Chinese export authorities.

A Human and Institutional Success Story

Continued growth of the EPRI-China collaboration is expected. The Four-Step Roadmap provides the structure, and the engagement’s cautious progression has instilled confidence. The commitment of the Chinese is evident in a recent statement by Chen Hua, president of a CNNC subsidiary called CNNP: “CNNP’s participation in EPRI

will enhance our mutual understanding, and I'm convinced that CNNP will expand its engagement with EPRI soon to become a full member in all of its nuclear research programs."

"Asia is in many ways at the center of the nuclear industry today, and we want to be part of it," said Wilmshurst. "We already have substantial engagements in Japan, Korea, and Taiwan, and now we have our growing engagement in China. The benefits to our members in the United States and Europe will be substantial."

These benefits will continue to grow as EPRI expands its engagement with China's extensive nuclear research. Yang believes that there could be more resources throughout China equal to the Shenzhen lab she saw earlier this year. Last year, Liu visited another lab—a materials testing facility in Shanghai. Neil Wilmshurst has asked Yang to organize a visit later in 2015 for EPRI technical staff to visit some of these laboratories where future EPRI research may be conducted.

"This has been an amazing success story in two ways," said Wilmshurst. "First, the human and institutional story: we have grown personal relationships into a much bigger engagement of major institutions serving the interests of everyone. Second, we have succeeded in strengthening collaborative research that will advance safe and operationally efficient nuclear power throughout the world."

Key EPRI Technical Experts

Rosa Yang, TG Lian, Shanshan Liu