Quiet But Not Dead: China's Nuclear Program Now Poised to Swing Back Into Full Gear

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TLG on is The Lantau Group's in-house journal addressing current energy issues, and their policy and economic implications, facing the Asia Pacific region. This special edition on the Chinese nuclear sector was prepared in partnership with Shanghai's Nicobar Group.

For more information on our newsletters please contact:
Mike Thomas (mthomas@lantaugroup.com)
Karen Brown (kbrown@lantaugroup.com)

For worldwide proponents of nuclear power as a low-emission, baseload power source, China's ambitious nuclear power deployment programme has served as a solitary beacon of light in an otherwise glum industry. Considering Japan's industry restart remains stuck in a policy and regulatory quagmire; Europe's previously seemingly resurgent industry has been beset by project slowdowns; Southeast Asia's ambitions have largely been set aside or cancelled; and a large portion of the US industry is teetering on the brink of insolvency due to unfavourable market and policy shifts, the tremendous build projections of the Chinese industry offer a tenuous lifeline to nuclear power technology firms around the world. Unfortunately, nuclear power projects remain notoriously vulnerable to cost and schedule overruns and shifting policies, and the Chinese nuclear power program in recent years has been no different.

Following a multi-year run of rapid and successful power project development from 2008-2013[1], the years since 2014 have seen China struggle with behind-schedule deployment of third generation reactor technologies, missed targets for capacity installation, and an expanding and already three-year gap since the last commercial power reactor broke ground (2016-present). Beyond this, China continues to face electricity oversupply problems complicated by slower economic growth and grid capacity constraints in various regions around the country– indeed The Lantau Group has covered solar and wind curtailment issues in China previously – which begs the question whether these projected new nuclear plants are even necessary. Accordingly, one could be forgiven for taking a bearish view on the future growth of the China nuclear program.

In this edition of *TLG On*, we put China's recent nuclear industry challenges in perspective. We note that China still appears committed to its nuclear programme and has made more progress behind-the-scenes managing technology shifts and deployment plans than might first seem. We acknowledge the slowdown in recent years, but consider an uptick in nuclear sector activity to be more likely looking ahead. We discuss some of the knock-on effects of the future growth in nuclear, including potential impacts on China's renewables targets and current power oversupply; as well as on the worldwide nuclear fuel supply ecosystem.

Key Points

- Chinese nuclear plant construction goals have missed their projections through to 2020, *but not by a lot*;

1 Excepting 2011, which saw the entire Chinese nuclear industry freeze construction to conduct post-Fukushima enhanced safety reviews.

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- The industry is now poised for a period of rapid expansion that will likely kick off in the early 2020s and see major grid additions through the mid- to late-2020s;
- Nuclear industry initiatives have generally mapped accurately to the objectives laid out in the 13th FYP, suggesting that the upcoming 14th FYP will provide a credible roadmap for the next phase of the industry's development;
- Although Chinese 4G nuclear technology deployment is more advanced than similar efforts in other nations, this technology remains at least a decade away from seeing true batch construction of plants that don't require enriched uranium, and these plants are not intended to become the core type of nuclear technology used in China for many decades yet;
- China's commitment to nuclear and to managing its own energy security are evident in China's stockpiling of uranium, reducing China's exposure to market volatility.

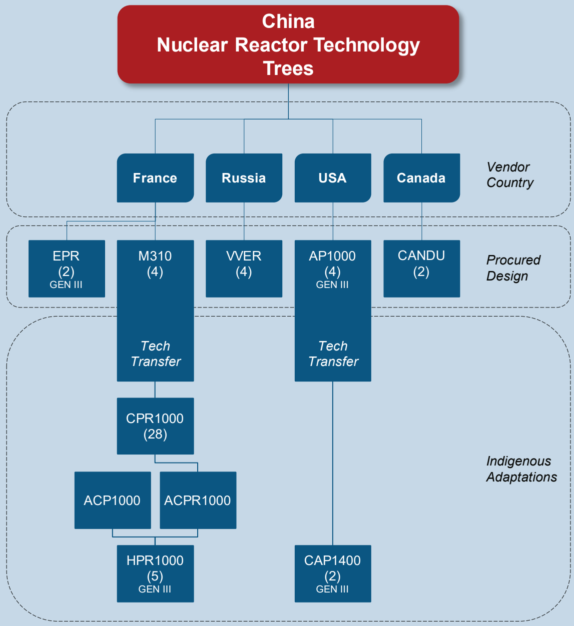
China's Nuclear Industry in 2019

In Q3 2019, the Chinese nuclear power industry comprised 47 operational power reactors, for a gross installed total of roughly 49 gigawatts of electricity. Three different companies are responsible for nuclear power plant development, with the majority of the fleet split between China General Nuclear (CGN) and China National Nuclear Company (CNNC) and the third company - the State Power Investment Company (SPIC) - just starting out with its first reactor sites. With a few exceptions, the fleet consists of multi-loop pressurised water reactors (PWRs) based on French, Russian, American, and indigenous Chinese designs. After years of delays, the first wave of 3G plants at the Sanmen, Haiyang, and Taishan sites have all successfully connected to the grid. The completion of the Sanmen and Haiyang NPPs serves as the crucial demonstration of concept for Westinghouse's AP1000 reactor technology, while the completion of the Taishan NPP serves the same purpose for Areva's EPR reactor design.

Chinese nuclear technology is a mixture of French, Russian, American, Canadian and indigenous Chinese designs.

In addition to the current operating fleet, another 12 power reactors are under construction, again mostly of PWR design. Among these under-construction reactors are China's first indigenously-developed 3G plants – the two pairs of demonstration HPR1000s at Fuqing and Fangchenggang NPPs, as well as the "Integrated Version" of this HPR1000 at Zhangzhou NPP. There are also two next-generation (4G) designs under construction - a high-temperature gas cooled reactor and a sodium cooled reactor, as well as a handful of older 2G designs.

Figure 1: China Nuclear Reactor Technology Trees



Source: Nicobar Group

Aside from under-construction units, a further 45 units have already secured site approval and are in various stages of pre-construction standby, including several that have already completed all necessary preparations to begin pouring concrete and are simply waiting for issuance of their construction license. Beyond this, the long-term pipeline includes at least 60 more reactor units proposed by provincial governments or local municipalities currently making their way through the regulatory requirements for site approval (seismic safety reports, environmental impact evaluations etc). Among the approved and planned reactors are at least 36 units located in inland regions where development has been frozen since the Fukushima accident in 2011. This includes approved inland sites that were just months away from pouring concrete in 2011 but will now have to wait until the next 14th FYP period begins in 2021 to start construction. All currently under-construction and future PWR reactors will be at the gigawatt level or larger.

Table 1: Operating, Under Construction, Approved, and Planned NPPs in China

Status	Number of Units	Gross Capacity (GWe)
Operational	47	49
Under Construction	12	12
Approved (including inland)	44	50
Planned (including inland)	60+	-65*
Total	163+	-176

*The installed total for Planned plants is less clear; some planned sites previously designated as AP1000 reactors are likely to be switched to HPR1000 reactors in the future.

Source: TLG/Nicobar Group Research

Clearing the Backlog of Approved Plants

Batch Construction of AP1000s Coming Soon

After a long wait for the first demonstration units to complete, more AP1000s are expected to break ground in the near future.

Now that the demonstration AP1000s at Sanmen and Haiyang have been connected to the grid and come up to full power, all subsequent AP1000 builds and derivatives are theoretically opened up for mass deployment. This includes some 10-12 reactor sites that have already been approved at the central planning level, not including inland plants. The explanation as for why construction on these plants isn't already underway hasn't been officially addressed anywhere but is most likely related to the ongoing and well-publicised problems with Sanmen Unit 2's primary coolant pump, requiring a replacement to be shipped from the US. If the primary pump issue can eventually be resolved to the satisfaction of the Chinese safety regulator, then construction licenses will ostensibly be issued for a slew of backlogged AP1000 projects, probably starting from 2020. Aside from the AP1000s, SPIC has developed its own design for a larger version of the AP1000, called the CAP1400. The demonstration unit for this plant in Shidaowan has already poured concrete for its first unit, with the second unit to follow soon.

HPR1000 Design Merger Opens Up More Possibilities

As mentioned previously, the first two sites for the 3G HPR1000 reactor (i.e. Fuqing for CNNC and Fangchenggang for CGN) are under construction and have thus far seen on-schedule construction and smooth development. A little-publicised fact about these two plants is that the CGN and CNNC variants of the HPR1000 reactor contain significant design differences, as they were originally developed independently and forced to merge into one brand name for resource efficiency and promotional purposes.

CNNC poured concrete for Zhangzhou Unit 1 in October 2019, the first new Chinese reactor in 3 years.

More recently, the two designs have been fully merged into a so-called "Integrated Version" HPR1000, a unified design that China hopes to export to the UK, Argentina, and others. Because China follows the industry principle of "demonstration plant first, batch deployment second", this new Integrated Version of the HPR1000 must now have its own demonstration units. CGN's first Integrated Version HPR1000 will be at Taipingling, in Guangdong Province, while CNNC achieved a major milestone by pouring concrete for its first Integrated Version HPR1000 at Zhangzhou in October of 2019. Essentially, development of the Integrated Version of the HPR1000 gave the Chinese industry a backdoor option to build more HPR1000 plants in 2019 before the first demonstration unit HPR1000s complete in 2021. Once those company-specific demonstration units demonstrate successful and stable operations, the backlog of approved HPR1000 units will also get the green light, likely from 2022 onward.

The status of each of the approved future sites is summarised in the table below.

Table 2: Approved Plants in China's Nuclear Build Pipeline

	Future Plant Phase	Owner	Location	Reactor(s)	Projected First Concrete Date
13th Five Year Plan Period	Taipingling I	CGN	Guangdong	HPR1000 x 2 (Integrated Version)	2019-Early 2020
	Zhangzhou I Unit 2*	CNNC	Fujian	HPR1000 x 1 (Integrated Version)	2019-Early 2020
	Shidaowan I-2 (Unit 1 under construction)	SPIC	Shandong	CAP1400 X 1	2019 -Early 2020
	Sanmen II	CNNC	Fujian	AP1000 x 2	2020
	Haiyang II	SPIC	Shandong	AP1000 x 2	2020
	Xuadapu I	CNNC	Liaoning	AP1000 x 2	2020
14th Five Year Plan Period	Xudapu II	CNNC	Liaoning	VVER1200 x 2	2021 at the earliest
	Tianwan III	CNNC	Jiangsu	VVER1200 x 2	2021 at the earliest
	Changjiang II	CNNC	Hainan	HPR1000 x 2 (CNNC Version)	2022 or later
	Ningde II	CGN	Fujian	HPR1000 x 2 (CGN Version)	2022 or later
	Lianjiang	SPIC	Guangdong	AP1000 x 2	2022 or later
	Haixing I	CNNC	Hebei	AP1000 x 2	TBD – May be cancelled
	Lufeng I	CGN	Guangdong	Originally AP1000 x 2	TBD – Will need redesign
	Bailong	SPIC	Guangxi	AP1000 x 2	TBD - Likely to be relocated

Source: TLG Research based on various sources; First Concrete Dates are TLG projections.

Note: * Zhangzhou Phase I Unit 2 had its FCD in October 2019.

Nuclear Policy Targets and Five-Year Plans

The 2020 nuclear capacity goal will be missed, but only by a small margin.

Chinese nuclear power capacity targets for 2020 have increased over the years, starting at 30 GWe in 2008 and seeing adjustment upward to 70-80 GWe in the period just before Fukushima. In the post-Fukushima *Energy Development Strategy Action Plan 2014-2020*, issued in November 2014, the nuclear capacity target for 2020 was revised downward to 58 GWe, a number that was reaffirmed in the 13th FYP documents in 2015. This number was repeated consistently by Chinese industry, policymakers, and media from 2014 onward, despite the fact that achieving this goal became a mathematic impossibility somewhere around 2016. In 2019, the China Electricity Council formally acknowledged that 53 GWe by 2020 is a more realistic figure, which matches with TLG's independent build tracking efforts. Thus, the final tally will thus miss the mark, but not by far, with a shortfall of less than 10 percent.

The 14th Five Year Plan will serve as a crucial bellwether for policymakers' continued sup-port for the nuclear programme.

Missing this target was surely an industry setback, but it is also easy to read too much into it. There was no associated weakness or failure of Chinese construction capabilities or a loss of policy support for nuclear in general. Meeting the 2020 goal would have required a significantly higher number of new reactors to pour concrete back in 2014-2016, but this didn't happen. The shortfall was caused by two specific industry initiatives working in tandem:

- Firstly, China's post-Fukushima nuclear plan designated safer 3G technology to be preferred over 2G or 2G+ units, and that no further 2G+ units would be approved (several 2G+ units began construction in 2015, but they were grandfathered in from approval prior to 2013).
- Secondly, the Chinese industry follows a *"demonstration plant first, mass deployment second"* development model, meaning that all under-construction first-of-a-kind (FOAK) plants are required to prove successful commercial operation before they could proceed with what the industry calls "Nth of a kind" (NOAK) construction.

Taken together, this meant that China's already under-construction 3G units needed to be completed before any new builds could be approved. Unfortunately, the FOAK 3G reactors under construction at the time in China met with numerous schedule overruns, supply chain hiccups, and technological hurdles – hardly atypical for FOAK technology. FOAK reactors have greater risk of taking longer and costing more to build than NOAK reactors, and particularly in this case, where the underlying technology shift is major (e.g. from 2G to 3G).

When the Chinese-designed 3G reactor HPR1000 had its design finalised and approved in 2015, it was allowed to swiftly begin construction of demonstration sites. Thus, from 2013-2019, the entirety of China's under-construction fleet consisted of either grandfathered 2G+ reactors that would be the last of their kind, or demonstration plants for 3G designs that were the first of their kind. With no proven 3G technologies available for batch deployment, it was inevitable that China would miss its 2020 deployment goals, but without any kind of policy shift or change of leadership commitment to nuclear energy.

Within the next year, China should release a draft version of the 14th Five Year Plan, which will set out policy for goals and plans across the entire economy from 2021-2025, including energy development. For the Chinese nuclear industry specifically, the 14th FYP should provide insight into several more key questions:

- What are the new, realistic industry construction goals to 2025 and beyond, and will they demonstrate continuing strong commitment to the nuclear power program? Will the inland plant sites finally be opened up for development after going into long-term stasis following the Fukushima accident?
- Will new Westinghouse-designed AP1000 still be added into China's nuclear fleet once the Hualong One demonstration reactors are finished and ready for batch deployment?
- Will the domestically-developed extension of the AP1000 (the CAP1400) be treated as a legitimate domestic and/or export competitor for the domestically-developed Hualong One? Will Chinese nuclear firms compete head-to-head for export opportunities?
- What attitude will be adopted with regard to the 4G technologies currently applied in China? How much will energy policymakers prioritise diversification into reactor technology that does not use enriched uranium?

Aside from the nuclear-specific goals, the narrative on broader energy climate goals for the country will also be relevant. For instance, the 13th FYP (2016-2020) included a commitment to achieve 20% of primary energy consumption and 50% of electricity consumption from non-fossil sources by 2030 – this figure will likely be updated for the 14th FYP, with nuclear to play an important role in that transition.

What About the Capacity Oversupply Problem?

Depending on the province, Chinese regional electricity markets generally range from moderately to severely oversupplied. Although curtailment of renewable assets has reduced in recent years due to restrictions on capacity additions and other favourable policies, the power sector remains largely oversupplied, with aggressive coal capacity additions approved back in 2015 still coming online through 2019 and more projects in the pipeline. Although the growth in power demand has remained strong over the past few years, the first half of 2019 saw industry-wide demand slow to just 4.6% YoY, with the industrial sector growing just 2.8%. With China's notable power oversupply issues unlikely to resolve themselves anytime soon, those bearish on the Chinese nuclear power program may understandably wonder whether these future planned plants will ever see the light of day.

Fortunately, from the perspective of the Chinese nuclear industry, there are several supportive conditions that contribute to the protection of the industry's future, even in severe electricity oversupply conditions:

Maintaining a robust domestic build program and healthy supply chain is crucial to China's efforts to export nuclear reactor technology abroad.

1. Maintaining a robust domestic build program and healthy supply chain is crucial to China's efforts to export nuclear reactor technology abroad, especially to developing nations with extremely limited domestic manufacturing capabilities;
2. A healthy, well-maintained reactor will supply clean baseload power without additional carbon or other air emissions for 40-60 years (and even longer with life extension). This means nuclear builders are inevitably more long-term focused and less inclined to be deterred by near-term economic disruptions or short-term supply demand balance issues.

Although there are other reasons, it is mostly for these two that nuclear power enjoys prioritised dispatch in many regions of China, usually to the detriment of local coal. This prioritised dispatch was reaffirmed in the NDRC's Clean Energy Consumption Plan for 2018-2020, issued in late 2018. Despite this, nuclear is not totally immune from restrictions on loading; for instance, in freezing northern Liaoning Province, combined heat and power plants still enjoy the highest priority of dispatch through the cold months. Load cycling is considered to be a highly undesirable way to operate nuclear power plants, owing to certain operational/technical features of the nuclear fission fuel cycle, so it's generally not done if possible (France is a notable exception, owing to nuclear power's majority percentage of electricity generation in that country).

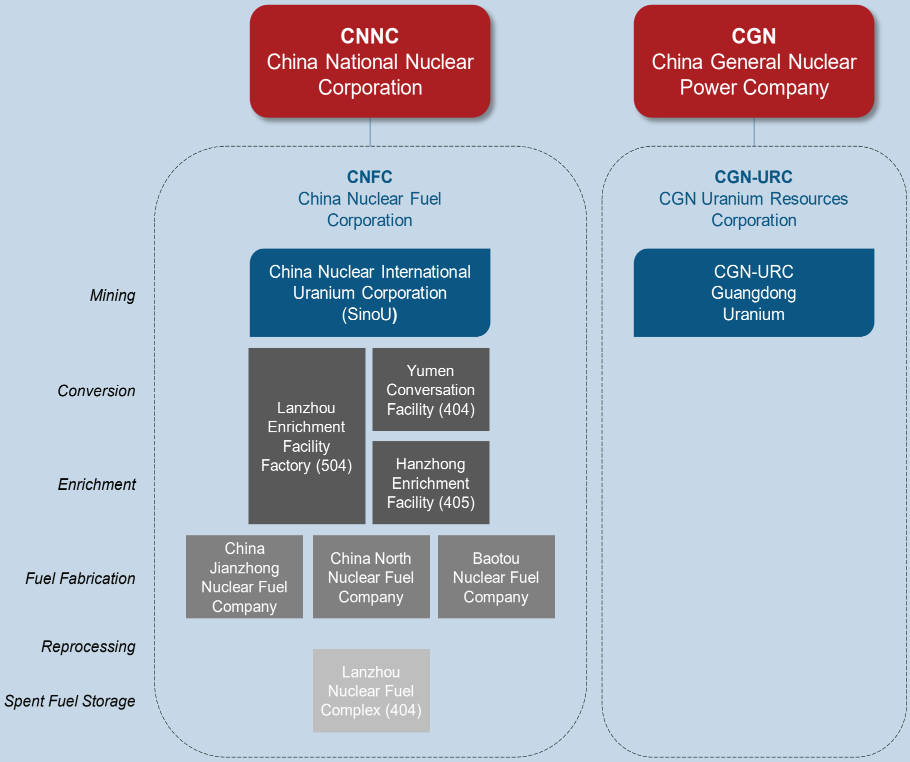
Nuclear power in China is largely unaffected by power oversupply and curtailment issues.

Prioritised nuclear dispatch is unlikely to bump heads with prioritised renewables dispatch in the near future, primarily because Chinese nuclear plants are all located in eastern coastal regions while the most severely oversupplied renewables regions are mostly located in the north, northwest, and western parts of the country. If inland plant sites are opened up for development in the 14th FYP, this may become more of a relevant issue. For the time being, however, they are treated as virtually "different but equal" forms of clean energy options for consumers. An example of how this is borne out in policy was seen in June 2019, when the power supply and consumption plan for commercial and industrial users was issued by the NDRC. This this plan, nuclear power as highlighted as a power source that would enjoy prioritised dispatch and end-users were encouraged to procure nuclear power via clean energy trading exchanges.

What Does this mean for Nuclear Fuel Supply?

China's nuclear industry is divided in three major nuclear conglomerates each of which boasts a full complement of subsidiary companies to specialise in individual scopes of work, including research and design, EPC, construction, O&M, technical services, etc. Fuel cycle services, however, are unique in that they are mostly concentrated with one company: China National Nuclear Corporation (CNNC), which sets CNNC up to be the only Chinese nuclear player that can claim a complete nuclear fuel cycle solution for its plants. While China General Nuclear (CGN) does have some upstream investments in uranium mining, and the State Power Investment Company (SPIC) has an equity stake in a Kazakh facility that produces EPR reactor fuel assemblies for the Taishan plant, the rest of the fuel cycle activities are monopolised by CNNC (see Figure 2 below). CNNC fabricates almost all the fuel assemblies used within the Chinese industry as a licensee of the various countries where the technology originated and sells them to CGN and SPIC fuel buyers. Some fuel assemblies for the Russian-supplied Chinese reactors are still imported from TVEL.

Figure 2: China's Nuclear Fuel Cycle Value Chain



Source: Nicobar Group

Chinese stockpiling efforts have been significant in recent years, taking advantage of historically low spot market prices.

Although China's officially stated goal is to diversify its uranium sourcing among domestic production, equity stakes in foreign mines, and spot market purchases in a 1/3-1/3-1/3 split, in practice, domestic mining is likely to lag significantly behind the other two areas. Chinese domestic uranium resources are fairly modest, with production from CNNC's SinoU totalling just 1650 tonnes in 2018 and further exploitable resources fairly limited. In contrast to other power fuels, nuclear power plants reload their fuel at highly predictable intervals and with highly precise volumes. Historically, this has meant that the majority of uranium fuel contracts were signed for very long periods and extremely little or no volume was traded on spot markets, which was traditionally also true for China as well. In recent years, however, global industry disruptions and slower than expected growth have opened up attractive spot market trading and sourcing opportunities. Since the early 2010s, Chinese fuel buyers have taken advantage of low spot uranium prices to stockpile significant quantities, serving as a hedge against future price fluctuations.

Chinese equity participation in overseas mining projects has also been significant in recent years, with both SinoU and CGN-URC snapping up stakes of mines in Niger, Namibia, Kazakhstan, Uzbekistan, and Canada. With the spot price of uranium well below the cost of recovery and uranium miners in the USA and Canada already shuttering unprofitable mines, these are not profit-driven investments for SinoU and CGN-URC, but, rather, efforts to ensure the stability and security of their current and future nuclear fuel supply. Uranium mined at locations with Chinese equity are almost always earmarked for China via long-term supply contracts. So, while Chinese nuclear deployments will continue and even pick up in pace, it may not be prudent to infer a short-term recovery in the price of uranium.

What About the Next Generation of Nuclear Tech?

4G technology is coming, but is unlikely to see widespread commercial adoption within a decade.

The next generation (i.e. the 4th Generation) of nuclear fuel technology primarily focuses on technology types that will either move away from fission as a thermal heat source entirely (e.g. fusion reactors) or apply nuclear physics in an advanced way to allow fission reactions to release so-called 'fast neutrons" that will be able to sustain a chain reaction in normally non-fissile materials like natural uranium or thorium. The basic premise invigorating the development of 4G technology is that enriched U-235 as a fuel is problematic, because:

1. Natural uranium is relatively scarce in the earth's crust, and the fraction of natural uranium that is the most usable isotope (i.e. U-235) comprises only a very small percentage of what is available. The majority of naturally occurring uranium is the more stable U-238 isotope.

2. Consequently, enrichment of natural uranium is necessary to create a concentration of U-235 sufficient to sustain a chain fission reaction. Unfortunately, enrichment technology that works to produce low enriched uranium (LEU) for nuclear reactors works just as well to create highly enriched uranium (HEU) for use in a fission bomb.

3. The inevitable consequence of the LEU PWR fuel cycle is a mass of mostly useless, highly radioactive spent nuclear fuel, comprised of an unpleasant cocktail of fission products, natural uranium, and various transuranic elements, including plutonium. Reprocessing is possible, but technologically tricky and very expensive.

4G technologies seek to alleviate one or more of these three issues, and some claim to be able to resolve all three at once. Sodium-cooled fast reactors, for instance, are theoretically capable of utilizing natural uranium, plutonium, and other transuranic elements, or even the non-fissile and far more common element thorium as a fuel source. China's demonstration sodium-cooled fast reactor has been running for several years in Beijing and a commercial scale prototype is now under construction in Xiapu. Another Chinese 4G project, the high-temperature gas-cooled reactor (HTGR), will be capable of utilizing LEU fuel up to 100% more efficiently than traditional PWRs, while also maintaining the capability to employ thorium or plutonium as a fuel source. The demo high temperature reactor plant in Shidaowan has already loaded fuel and is in its final rounds of testing.

China's 4G technology holds significant export potential for developing nations.

While 4G technologies hold great benefits for non-proliferation as well as the efficiency and safety of nuclear power, their rise would theoretically not bode well for companies with extensive or exclusive exposure to the continued use of the uranium fuel cycle. Fortunately, from the perspective of those companies, China's 4G technology push is intended to be complementary to its fleet of PWRs, not a replacement, at least not in the first half of the 21st century. The rise of 4G technology in China is not expected to play a significant role in fuel demand in the near future, and mid-term deployments in China will likely be modest, with 4G technologies not expected to truly take over until 2050 or beyond, according to some conceptual planning documents. Thus, the more compelling story associated with China's 4G technology in the coming years will probably not be the domestic deployments, but rather the export potential. If the HTGR can see a successful demo run in Shidaowan, true export opportunities for this technology will immediately solidify, with Saudi Arabia and Indonesia currently showing the most promise.

Closing Thoughts

Despite the relatively unexciting performance of the Chinese nuclear industry over the past few years, the case for nuclear in China remains attractive, with continuing policy level support. The expansion of the industry over the coming years is likely to pick up and gain even more focus upon publication of the 14th FYP, which should be good news for investors with exposure to the utilities and heavy manufacturers. Zhangzhou NPP pouring concrete in October 2019, the first new Chinese plant in over three years, is just the first instance of what will be a major wave of new build over the next few years It will be important to keep an eye on the development of inland sites, as the deployment of more nuclear in relatively economically depressed regions already oversupplied by wind or hydro would create a scenario where nuclear and renewables compete for dispatch.

As for knock-on effects, the outcome for the uranium future cycle is complex, as Chinese demand for refuels and new reactor cores will certainly grow, but will be mitigated to some extent by Chinese stockpiling and equity acquisition efforts. 4G nuclear generation technology will emerge on the scene within the next 3-5 years, but will realistically fill only a niche role in the near term given the size of the overall fleet or be tapped for export to new nuclear economies.

As China's nuclear future continues to evolve and receive more clear definition from policymakers, the Lantau Group will continue to apply our expertise in economic modelling, nuclear energy development, and Chinese national energy policy to deliver timely and comprehensive forecasting of this sector for our clients.

A Glossary of Nuclear Power Terms in this Paper

Term	Definition
CGN CNNC SPIC	China General Nuclear Power Company China National Nuclear Company State Power Investment Company
FYP	Five Year Plan, a Chinese government planning document that sets initiatives and objectives for the economy's development and includes specific sub-plans for topics like Energy. We are currently in the period of the 13th FYP (2016-2020) and are preparing for the release of the 14th FYP which will cover 2021-2025.
PWR	Pressurised Water Reactor, a type of nuclear reactor core technology that holds superheated water in a highly pressurised loop until it is allowed to turn to steam and drive a turbine for power.
Nuclear 2G, 3G, and 4G Technology	**2G** is the standard of nuclear power technology developed between the 1970s and 1990s, used in most currently operating nuclear power plants around the world. **3G** is the current "best available" technology standard, boasting enhanced safety features and fuel efficiency, under commercial deployment around the world. **4G** is the future of nuclear power technology, currently in theoretical/pilot stages around the world, include technologies that do not require enriched uranium such as sodium cooled fast reactors, high-temperature gas-cooled reactors, and fusion reactors.

The "Big Three" nuclear power developers in China.

Term	Definition
AP1000	The flagship 3G reactor design from Westinghouse Electric Company, licensed for broad deployment in China, currently operating in China and under construction in the United States.
CAP1400	A 3G SPIC-designed derivative/upgrade to the AP1000 reactor design, currently under construction in China.
HPR1000/ Hualong One	A flagship 3G reactor design from Chinese nuclear companies, currently under deployment in China and Pakistan. Was original two separate designs from CNNC and CGN but has now been merged into a single integrated version.
EPR	A flagship 3G reactor design from the French nuclear industry, currently operating in China and under construction in Finland, France, and the UK.
NPP Phase	A single phase of a Chinese NPP usually comprises two units, although older plants may have just one. Most Chinese plants are planned to have 2-4 phases.

About the Author

David Fishman

Consultant

dfishman@lantaugroup.com

+852 9226 0615

+86 185 1619 4400

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David joined TLG from Nicobar Group, where he was a managing partner and co-director based in Shanghai, China. David's areas of expertise cover regulatory and commercial intelligence for China's energy sector, with a particular focus on nuclear and new technologies; China business matchmaking and partnership support services; China market entry consulting and entity formation advisory; China technical business development for Western firms; and China nuclear certification advisory. He holds a joint MA from Nanjing University and Johns Hopkins University in International Relations and Energy Policy. David is fluent in Mandarin.

About Nicobar Group

Established in 2004, Nicobar Group is a consulting and advisory firm headquartered in Shanghai, China with a strong focus and specialization on the Chinese nuclear sector. With a team that includes experts in commercial transactional support, regulatory guidance, market forecasting, supply chain development, partnership develop and more, Nicobar offers specialised on-the-ground support for clients operating in China's energy sector, particularly for state-dominated sectors like nuclear or emergent sub-sectors including distributed energy and storage.

In October 2019, Nicobar Group entered into an exclusive teaming partnership with TLG, merging two teams with deep and comprehensive sector experience into a single integrated China energy team.