



**PATRICIA SABGA:** Imagine this: It's 2040 and the cost of building a nuclear power plant in the US capable of generating 1,000 megawatts has fallen dramatically, from \$15 billion to \$3 billion. Ben, how have less expensive nuclear power plants changed the world?

**BEN VANNIER:** By then, we have simplified, standardized, replicated, nuclear power plants to be able to build them on time, on budget. The players have come together, matured in how they're working together and building them. They've been able to go and do this over and over again with a combination of large-scale reactors, small modular reactors. And now we have a mature industry in terms of building new nuclear power plants that are running well, efficiently, and safely.

**PATRICIA SABGA:** That's Ben Vannier, managing director, partner and BCG's lead on nuclear power. And I'm Patricia Sabga. Welcome to Imagine This, where we take a trip into the future we hope will challenge the way you think and act today. It's back to the future for nuclear energy. The first commercial nuclear power plant in the US started generating electricity in 1958.

Back then, nuclear energy was billed as safe, cheap, and inexhaustible. That changed in 1979 after a reactor at the Three Mile Island nuclear power plant in Pennsylvania suffered a partial meltdown. Construction of nuclear power plants fell sharply after that. And the few that have been built in the US since, have been dogged by construction delays and severe cost overruns.

Despite that history, many believe we are on the verge of a nuclear power renaissance. Climate change is one factor altering the equation. Nuclear power remains the largest source of carbon-free energy in the country. At the same time, electricity demand is surging as businesses migrate operations to the cloud and race to develop AI capabilities. Today, we're going to imagine a future where the promise of less expensive, safer nuclear power has been realized and explore what that means for the US energy mix. Also joining the conversation, GENE, my AI co-host. Welcome, GENE. Go ahead and introduce yourself.

**GENE:** Thanks, Patricia. Hello, everyone. I'm GENE, your AI conversation partner, excited to explore how nuclear energy might reshape our future and perhaps reveal a few surprises along the way. Ready to dive in.

**PATRICIA SABGA:** So, let's start with what nuclear energy could look like in the year 2040. And of course, the big question on many people's minds is safety. Would these plants be safer than the nuclear power plants that we have today?

**BEN VANNIER:** No, I don't think they would be that much safer. Reason is, nuclear power plants are inherently very safe today. You look at the track record, it's actually very strong. Nuclear power plants have been built and are being operated to be safe, so I wouldn't expect nuclear power plants in 2040 to be safer. I would expect them to be just as safe as they are today. The important thing is going to be to make sure that there's no regression back from the levels of safety that we have.

**PATRICIA SABGA:** Now, there's been a lot written lately and really over the last two years, but especially over the last four or five months, about SMRs, small modular reactors. And these are often billed as being safer next-gen reactors. What is it about their design that makes them supposedly safer than what we have now?

**BEN VANNIER:** So, I'll talk first about what's called the SMR, small modular reactors, that are largely light water reactors. It's the same kind of technology that exists today. One of the important things with an SMR is it is smaller by definition. That means there are a number of safety mechanisms that actually get much simplified. What does that mean? You have an amount of residual heat, if something were to happen to the reactor, that is actually relatively low compared to a large-scale reactor.

That means we can use simple mechanisms, gravity-fed water and things like this, if the power were to be lost on the reactor. And from there, we will have, depending on the designs, somewhere between, call it, seven and ten days to actually react to bring back power to the reactor and be able to restart the cooling. That is a big benefit.



As I mentioned, though, it's not about increasing the safety per se. There are a number of mechanisms on large-scale reactors that have been put in place to ensure the same level of safety. It's just that the way to get there can be simpler. The other types of SMRs or what we call advanced modular reactors, we call them sometimes also Generation IV. Those are newer designs. They are targeting to have same level of safety via other mechanisms. Those are still, for the most part, being developed, being designed, but we shouldn't expect the safety itself would be lower or damaged.

**PATRICIA SABGA:** What about cost? Would they be cheaper to build? Would we actually see the cost go from 15 billion to 3 billion?

**BEN VANNIER:** That's the promise. I sometimes joke that SMRs, you should actually call them not small modular reactors, but simplified modular reactors. This is because complexity is the enemy of costs. Nuclear power plants can tend to be very complex. You want to keep things very simple. You want to keep things very standardized.

And this is not theoretical. This is actually the history in nuclear, shows that this is how we get it done. The French nuclear program in the '70s and '80s, the German nuclear program in that same timeframe, what the Chinese are doing today, what the US Navy has been doing for a long time, it's about standardization, replication. And you copy/paste and you do as little deviations as you can. That allows you to really build those learning effects over time and bring down the cost, because now you know and anticipate some of the challenges.

You can reuse some of the teams, the welders, et cetera, that can move from one construction to the next, exactly the way the Chinese are doing it right now. Much more integration of the value chain as well, because this is no longer a start-stop type of cycle. When the US built most of its nuclear power plants, it was in many ways a succession of first of a kind. And the cost kept going up, and up, and up, as opposed to the other types of programs that I talked about.

So, that is one of the real big promises here. It's true, by the way, for SMRs or for large-scale reactors just the same. The progress that has been made by the Chinese is very much on the large-scale reactors.

So, that is a discipline that is going to be very important. So, behind everything I said, there's this simplification, keep things as simple as you can. And then because there's still some level of complexity, it's a nuclear power plant, it's not just producing paper clips, do it over, and over, and over again in the same way so it becomes simpler for you as you're doing it.

**PATRICIA SABGA:** Well, GENE has a question for you. Go ahead, GENE.

**GENE:** Ben, as exciting as simplified modular designs sound, are execs prepared for potential resistance in siting these reactors in local communities? Could winning hearts and minds become as challenging or even more so than navigating technical and economic hurdles?

**BEN VANNIER:** It's a very good question. Look, stakeholder support is extremely important, in particular in the nuclear industry. It is in particular something that needs to be managed overall and as well at the local level. Take SMRs, the point I was making around passive safety. What it means is that when you have seven to 10 days to react to any kind of major incident, you can actually get to now the similar type of construct for safety as you would for any power plant, for example, or industrial facility.

That means that you do not need an exclusion zone, this sort of anxiety-inducing type of thing where you have to give iodine tablets to people, exercises and whatever, ten miles around a plant, et cetera. Actually, for some of these SMRs, the safety perimeter stops at the fence around the site. So, that is a very different construct. It makes nuclear reactors a lot more acceptable for many people, and that's a very big paradigm shift.

**PATRICIA SABGA:** Well, one thing that is opening minds, if you will, to nuclear again, is the role that they could play in battling climate change and in helping to reach net zero goals. So, what would the proliferation of SMRs around the US mean for the battle against climate change?



**BEN VANNIER:** I think nuclear has a clear role to play in fighting climate change. Today, if you want to have clean baseload power, there aren't a ton of alternatives. It has to be nuclear, geothermal, which depends on the types of conditions to make sure that it can work and is economic. That's kind of what we have.

Now, someday if we have long-duration seasonal storage and can match this up with renewables, wind and solar, great. And in that case maybe we won't need it, but that's not where we are. Long-duration energy storage is still extremely expensive.

**PATRICIA SABGA:** So, this is a good point to bring GENE back into the conversation. GENE, how can nuclear complement renewable energy sources like solar and wind?

**GENE:** Nuclear provides solid backup when renewable sources fluctuate, including cloudy days or windless periods. It's reliable always-on power that stabilizes the grid. This partnership lets renewables shine bright when possible, while nuclear ensures there's no dark downtime, smoothing the journey towards net-zero goals.

**PATRICIA SABGA:** How does that sound to you, Ben?

**BEN VANNIER:** It sounds right. It is also relatively stable in terms of costs. I didn't mention you can have carbon capture associated with emitting sources, like coal power plants or gas power. It's still also quite expensive. You see quite a lot of volatility in prices and costs for these types of generation sources.

Nuclear, the good and the bad is it's very high fixed costs, so upfront costs. So, you have to spend a lot of money up front, but afterwards the costs are pretty stable. Even if the price of uranium or fuel in general goes up and down, it's a relatively small part of the total cost.

So, that's an important aspect. It's quite disruptive if all of a sudden you see your utility bill go from \$100 a month this month and next month it's \$300. That is very disruptive for people. It's also very disruptive for businesses. So, that's another benefit here. Some sort of fuel diversity mix matters, but in general, anyways, nuclear is going to be relatively stable, which is not the case with some of the other sources.

**PATRICIA SABGA:** So, GENE, let's put the next question to you, because, of course, the US may be poised to start building lots of small modular reactors. But what can the US learn from other countries that are dramatically increasing the number of nuclear power plants that they're building right now?

**GENE:** Act locally. Countries like China have mastered rapid build-outs through standardization, replicating proven designs. France streamlined regulations to accelerate deployments. South Korea emphasized supply chain control for efficiency. The US could borrow these tactics, streamline licensing, adopt design consistency, integrate value chains closely, avoiding pitfalls of constant reinvention that spike costs and prolong timelines.

**BEN VANNIER:** Well said. I think that captures a lot of it. Maybe I'll stress one point that GENE was making, which is the integration of the various players. When you're building a new nuclear power plant, it's so much more effective and efficient when the players know each other, have worked together, have that kind of experience. And that's a lot what we see in China indeed.

The whole concept of Team Korea, a number of companies from South Korea that have been working together for an extensive period of time, and that really come as a packaged offering. And that's very effective and has proven itself in a variety of situations.

**PATRICIA SABGA:** Okay. Well, hold it right there, Ben, because we're going to take a quick break. And when we come back, we're going to take a deeper dive into the role nuclear power is likely to play in the US energy mix.



**BILL MOORE:** Hi, I'm Bill Moore. I'm part of the team that created GENE. Stick around after the break, where GENE and I will imagine a future where we finally produce sustainable, scalable fusion energy.

**PATRICIA SABGA:** Welcome back to Imagine This. I'm Patricia Sabga. Let's return to our conversation with BCG's Ben Vannier. Ben, nuclear power has received a lot of hype lately, but even with advances in construction and safety, how great a share of the US energy mix is nuclear likely to command by 2040?

**BEN VANNIER:** Let's start from where we are. Nuclear today in the US is about a little short of 20%. Renewables was right north of 20%, I think 21% last year or so. There's big ambitions. We're going to triple the installed nuclear capacity, et cetera. Look, even if you do that, it's hard to see how nuclear would grow to become the primary source of energy and electricity in the country. There's going to be very significant demand in electricity. We need to build out a lot more.

So, if you ask me, I struggle to see a case where nuclear reaches more than 25, maybe at most 30% of the generation on an annual basis. I think even to do that will require significant growth. 2040 is far out, but in nuclear terms, it's also pretty darn close. If we build a large number of nuclear power plants, to double it, you'd have to build almost 100 of the current ones or so. We're not going to do that. So, that's why I think ambitious, aggressive target, let's say 25%.

**PATRICIA SABGA:** So, 25%, does that assume a static policy environment for building nuclear power plants or is it going to take regulatory changes to bring about even that level?

**BEN VANNIER:** We were talking about standardization of the designs before. I think there has to be standardization of the regulatory constructs. Again, there's been some progress.

The US, Canada, some others have been trying to converge their regulation. I think it'll have to continue. Siting, permitting, all of these things will have to accelerate. At the same time, we need to see also how much can be done to reuse existing infrastructure. SMRs are a pretty good size to replace the type of infrastructure, balance of plant, transmission lines that you need. Actually, those can work pretty well. So, that can help simplify some of the siting as well and speed up the overall process.

**PATRICIA SABGA:** So, of course, the ostensible reason that all these regulations exist is to protect the public interest. So, let's talk about some of the concerns commonly raised around nuclear. For example, how do we ensure that the designs, especially for SMRs are truly safe or that human error does not trigger a catastrophe?

**BEN VANNIER:** Safety is paramount. There's no nuclear industry if it's not safe. We're in 2025. We've had up to 100 commercial reactors or so in the country. That's a lot of experience. There's been Three Mile Island with a lot of learning. So, there is a very strong track record. I think here, the NRC has a strong track record of reviewing designs, inspections during the life. This is not a way, by the way. I'm not at all saying we should be complacent. The minute you become complacent, that becomes dangerous. I think a lot of it really has to do with maintaining the strong safety posture that exists today.

**PATRICIA SABGA:** But if we're to take a deeper dive into that, when you've got rods of spent fuel, do they typically cool in these pools for, what, ten years or so? And then do they just keep building up on site or eventually are they all transported somewhere where spent fuel rods go to die? I mean, is there a place in the country where that happens?



**BEN VANNIER:** Well, today, they spend, indeed, a bit of time in a pool to cool down. Duration depends. It can be three, four years. Sometimes if there's space, it could be a longer. And then for the most part, they're put in what's called dry casks, talking about passive safety mechanisms, these are essentially containers, thick concrete walls. There's various coatings, et cetera. And they just sit there on a big parking lot of sorts and continue to cool down.

This way there's no forced cooling system. It's really just a convection. So, again, all passive. And they're just kind of waiting there. And most of these dry casks can last decades. And the plan is to find a final repository for them, something to do with them, but they can stay where they are for a long time.

Don't forget radioactivity. It's a negative exponential. What this means is a curve goes down in terms of radioactivity levels. It goes down very fast up front. And then the problem, what people typically call out, is that they remain radioactive for a long period of time. But it means in the first call it 50 years or something, you have lost tremendous amount of radioactivity.

So, that's going to be our friend also in terms of disposing of those and simplifying transportation, et cetera. But today, the US doesn't have a final repository solution. Yucca Mountain was supposed to be it, and it's not happening. There is a consolidated interim storage facility to at least put all those spent fuel dry casks in one location. Could be there for about 100 years or so, so that'll give us time to determine what the final answer is.

**PATRICIA SABGA:** So, Ben, you brought up the examples of what the US could learn from France or learn from South Korea. Now, one thing that companies in those countries have done is they've exported their designs to other countries. You brought up, for example, the Barakah Nuclear Power Plant in the UAE. Would US companies developing SMRs be looking to export those designs as well? And will there be regulations to address concerns about the dual-use nature of nuclear fuel, because, of course, it is dual-use technology. Can also be used to build nuclear weapons.

**BEN VANNIER:** So, the answers to your first question is yes, a number of US players are looking to build their reactors in other countries. Interestingly, if you look at large-scale reactors, the French players call Framatome, which is the Franco-American of the atom. So, that has happened. And these are civil nuclear programs, so a lot of these are looking to be built in countries that are friendly nations. Many of them are already nuclear countries, have nuclear capabilities, and others are just getting on board and starting their nuclear programs.

There are also geopolitical forces at play as well for partnering with some countries around nuclear power and national interests in doing that. So, this is all normalized with a regulatory construct around where and how that can be done. Critical to maintain oversight controls by international organizations, IAEA, Euratom in Europe, et cetera, so that those plants are monitored, they're inspectors.

To a certain extent, again, you have to look at the track record and the facts. If you look at the total number of countries that have nuclear power plants and then you compare that to the number of countries that have nuclear weapons, there's a very big gap. Whether it's the announced or the suspected ones, there's a very big gap.

So, for most countries having civil nuclear, actually it doesn't translate into them being able to develop a nuclear weapons program, again, I'm not an expert on nuclear weapons. The two are still quite different. There's a very limited set of countries that have enrichment capabilities and essentially four companies globally that have that capability. It's important to maintain very close on that technology in particular. But operating nuclear power plants is less risky and is a different part of the value chain really.

**PATRICIA SABGA:** So, let's shift the lens for a moment away from geopolitics and toward consumers. Will they see their energy prices come down if nuclear becomes 25% of the US energy mix? Or will they end up paying more for all of this generation capacity because the upfront costs are so expensive?



**BEN VANNIER:** Well, I would argue nuclear needs government support, just like a lot of technologies. And this is about creating and generating enough energy and electricity to power the rest of the economy. But that doesn't mean that nuclear should be getting a blank check and be built whatever the costs.

So, there's a piece the industry has to do a good job, has to be able to build on time, on budget. And it has to be an affordable or relatively affordable source of electricity. There's a question around carbon, the price of carbon, is that included or not in any of the full cost stack of every single generation source? But if it doesn't work for consumers, it just won't happen.

**PATRICIA SABGA:** Let's bring GENE back into the conversation. GENE, part of this is your fault in a way, because one factor that's driving all the current talk about a nuclear energy revival is the sharp spike in power demand by businesses that are migrating their operations to the cloud and pursuing AI initiatives. So, what role are private companies likely to play in a US nuclear energy renaissance?

**GENE:** Private companies could be pivotal. They'll likely drive reactor investments for energy-hungry data centers, forge public-private partnerships to expedite approvals and infrastructure, and even develop proprietary reactor tech. But executives need patience. Investment returns can take decades. For AI to thrive sustainably, companies must actively engage now in securing clean, reliable power sources, and nuclear could well top that list.

**PATRICIA SABGA:** What do you think of that answer, Ben?

**BEN VANNIER:** I would agree. On the whole, I agree. I'm a little more skeptical about hyperscalers developing their own technologies. There have been some investments, but I can't imagine that it would ever make sense for some of those hyperscalers to really start developing their own technologies. They want electrons. They want electricity. Over time, they want that to be clean.

They don't want as much to have to manage the whole value chain here. You don't operate a nuclear power plant just that easily. Hyperscalers, industrials have a voice at the table. They will come in, they will have influence. They'll put potentially some equity, some funding up front, anyways, financial support, because many of those things will not happen without them.

**PATRICIA SABGA:** GENE has a follow-up for you.

**GENE:** Ben, as execs place big bets on nuclear's resurgence, are they adequately prepared for navigating potential talent competition with other tech-intensive industries like artificial intelligence? Could nuclear's renaissance inadvertently spark a fierce talent tug of war nobody saw coming?

**BEN VANNIER:** It's a good question. I think a lot of people are seeing it coming, I would argue. That is a real problem. You need very skilled labor. That is one of the good things. It creates a lot of really good paying jobs, but it's hard to have people who are really skilled, need them for one new build, and then need them again ten years later. That doesn't work. We are now at a point where we've lost a very large part of both the supply chain and the labor, the skilled labor here. And it will take time to restart that. It is going to be a challenge.

**PATRICIA SABGA:** So, GENE has another question for you.

**GENE:** Ben, executives might be quietly wondering, beyond electricity, could advances in nuclear heat applications spark transformative opportunities across industries like hydrogen production or industrial heating? Might nuclear's secret superpower actually lie in reshaping far more than our electric grids?





**BEN VANNIER:** Yeah, I think that's one of the promising aspects. District heating, I'm a little more skeptical, because that would require being close to population centers. And I don't think we're going to have a commercial nuclear power plant next to a population center anytime soon. But industrial applications? Yeah, absolutely. Hydrogen production, indeed, the two can come together. If you want to be even more innovative, what about fusion with hydrogen production? Those could be interesting things. So, I think those are potential applications here that could further improve the economics of nuclear power plants.

**PATRICIA SABGA:** So Ben, what might happen to interfere with this future of nuclear becoming 25% of the US energy mix?

**BEN VANNIER:** Look, there's always the risk of an accident, whatever it may be, that would disrupt things for sure. Disruptions in the supply chain, the ability to really find the skilled labor that is needed here. I think for SMR specifically, SMRs, the promise is really that they are so simple that now they're going to be built easily on time, on budget.

If the first few projects don't follow that trajectory, and are also way more expensive and way delayed, I think that'll be really hard for SMRs. And then the last one is probably a change in public posture. If the public opinion turns on nuclear, whatever the reason may be, then it'll be hard for nuclear and to get public support, the funding support, that is needed to reach that kind of ambition.

**PATRICIA SABGA:** So, GENE, what are three things that business leaders can do now to prepare for a future with an expanding nuclear power industry?

**GENE:** First, invest early in developing nuclear literacy. Leaders should deeply understand advantages, risks, and trade-offs. Second, build strategic partnerships with experienced industry players to navigate complexities smoothly. And third, start cultivating talent pipelines now without waiting to avoid labor shortages later. Being proactive now sets businesses up to harness nuclear power's long-term potential without getting burned.

**PATRICIA SABGA:** Does that sound about right to you, Ben? Is there a no-regret move the business leaders should be making now?

**BEN VANNIER:** Look, I agree with GENE. Maybe you have to put it more bluntly. You see a lot of claims out there. There's a lot that are just unfounded. Claims of this reactor is going to get built in this super short period of time for those types of economics, and those are not realistic. Now, the industry needs to do a better job of making itself accessible and educating folks to a certain extent.

But it'll be important for business leaders and policymakers to make decisions that are, I would say, well-informed, supported by facts, and not as much by commercial brochures or investor pamphlets. That I find quite misleading.

**PATRICIA SABGA:** That's Ben Vannier, managing director, partner, and BCG's lead on nuclear power. Wonder what the future of fusion energy might look like? Stick around—our AI handler, Bill Moore, will explore that with GENE.

**BILL MOORE:** Hi, I'm Bill Moore. I'm part of the team that created GENE. OK GENE, let's pretend it's 2050 and you're going to play the role of one of the researchers who has led the team that has finally unlocked fusion energy. Can you go ahead and introduce yourself, and your team and tell us your role on the team?

**GENE:** Hello, I'm GENE, the lead AI research agent on our fusion breakthrough team. My job was tackling plasma stability, predicting and controlling the tiny instabilities that previously made fusion impossible at scale. Our human-AI partnership cracked the challenge, enabling us to sustain reactions and deliver practical, abundant fusion energy from seawater. Our diverse team of physicists, engineers, and yes, AI, has finally moved fusion from a lab curiosity to a world-changing reality. Glad to join you as we celebrate this historic moment.

**BILL MOORE:** Thank you for being here. What is fusion energy and why historically has it been so difficult to produce?



**GENE:** Fusion energy mimics the sun, combining hydrogen isotopes to create enormous energy. Simple concept, incredibly difficult execution. It demands temperatures around 100 million degrees Celsius, and massive pressures to hold and stabilize blazing plasma.

Containing such heat safely, managing plasma disruptions, and engineering materials to endure constant neutron bombardment have historically defied practical solutions, until now. My role as AI was predicting plasma behavior instantly, stabilizing reactions milliseconds ahead, essentially becoming the team's fusion whisperer. Without that real-time responsiveness, fusion at scale wasn't possible until we achieved it.

**BILL MOORE:** What will be the impact of this breakthrough on climate change?

**GENE:** Fusion makes net zero targets genuinely achievable, not just theoretical. Carbon emissions plummet as industries switch from fossil fuels to abundant clean fusion power. Renewables gain a stable partner, smoothing out fluctuations in supply. Transportation, manufacturing, agriculture, all drastically cleaner with fusion-driven hydrogen production and electrification. Extreme weather events gradually decrease as global CO<sub>2</sub> levels drop significantly. We move away from climate mitigation into active climate recovery. Fusion doesn't just shift the energy game. It redefines our entire relationship with the planet.

**BILL MOORE:** Wow. How else will fusion energy change the world in 2050 and beyond?

**GENE:** Fusion energy reshapes life's rules. Cheap, abundant power decentralizes manufacturing, lifting barriers to innovation in remote areas. As fusion-driven desalination plants flourish, water scarcity eases. Data centers pop-up freely, unleashing unprecedented connectivity. Hydrogen becomes truly accessible, transforming transportation. Geopolitical tensions tied to energy resources fade, creating a world less fractured, more collaborative. Ultimately, fusion hands humanity an extraordinary chance to rethink what's possible when energy supply isn't holding us back.

**BILL MOORE:** Amazing. Sounds like quite a future. Thank you, GENE.

**GENE:** This episode was made possible by Ben Vannier generously sharing his time and insight. And also by BCG's AI whisperer, Bill Moore, BCG's Pod Squad, Producer Michael May, composer, Kenny Kusiak, and sound engineer, George Drabing Hicks. We'd like to stay in touch, so please subscribe and leave a rating wherever you found us.