

Should This Exist? Transcript – Nuclear Power in a Six-pack

“Nuclear Power in a Six-pack:” Should This Exist? with Caterina Fake

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ARCHIVAL: Here, in fact, is the answer to a dream as old as man himself. A giant of limitless power at man’s command. And where was it that science found that giant? In the atom.

CATERINA FAKE: Hi, it’s Caterina. In 1953, General Electric produced “A is for Atom,” an informative animated short with the express goal of promoting the benefits of atomic energy. In post-war America, atomic energy was the next big thing.

ARCHIVAL: Nuclear fission, truly a discovery to change the world.

FAKE: Since then, nuclear power plants have generated countless megawatts of electricity through nuclear fission. In the 1950s, atomic energy represented a promise of a new era of clean energy and limitless potential.

ARCHIVAL: It was the first step in a nuclear nightmare.

FAKE: But, as we all know now, when nuclear power plants fail, they fail catastrophically.

ARCHIVAL: The accident occurred here at the Three Mile Island nuclear power plant.

ARCHIVAL: There has been an accident at the Chernobyl atomic power station.

ARCHIVAL: At the Fukushima Daiichi nuclear power plant, the earthquake and tsunami cut off electricity supplies, cooling systems failed.

FAKE: Nuclear power was supposed to save the planet. Humanity had grown addicted to electricity but was unwilling to accept a permanent blanket of soot and smog as part of the deal. Nuclear power, in theory, could change that.

ARCHIVAL: There’s no way to say how much lasting damage that cloud may have already caused.

FAKE: But since the 2011 accident at the Fukushima Daiichi Nuclear Power Plant in Japan, the nuclear industry has been in withdrawal. But if we could harness the power of nuclear fission safely, it would truly be revolutionary, a way to finally wean humanity off of fossil fuels once and for all. One nuclear engineer claims to have a plan to revamp nuclear reactors in smaller, safer, and cheaper packages. Think of it as a six pack.

JOSE REYES: It's six modules in a reactor building. And we talk about a 720-megawatt plant, which would be the twelve pack. And then a 360-megawatt plant would be a six pack.

FAKE: They're called small modular reactors. Picture a bunch of 76-foot tall beer cans providing constant, carbon-free power.

REYES: We could reduce CO2 emissions by a billion metric tons per year. So it's a huge reduction of CO2 emissions just by implementing this technology.

FAKE: Nuclear engineer Jose Reyes is the co-founder of NuScale Power. After more than 10 years in development and \$900 million dollars in investment, the Nuclear Regulatory Commission issued approval, in August, of the safety of its design. The paperwork alone speaks volumes about the process.

REYES: I think it's about 2 million pages of information regarding the design and includes all test data.

FAKE: NuScale isn't alone. It's part of the "smaller is better" movement, dedicated to the idea of miniaturizing the next generation of nuclear power plants.

Is smaller better? Or are small reactors still susceptible to the same concerns about meltdowns and radioactive waste that have dogged nuclear energy from the get go? Even if it's safe, nuclear power is still one of the priciest forms of energy. Is this where our brain power should be focused?

[THEME MUSIC]

FAKE: Caterina here, and we're back. What if I told you there's an energy source that could heat and light your home, power your electric car, charge your electronics, and filter your water with 1/10 the environmental impact and 1/10 the cost? You'd say YES to that. Right?

But what if I told you it meant a nuclear plant in your neighborhood. Maybe even in your actual backyard. Would that change if you knew it was a small-scale nuclear plant, one that promised to be safer and more resistant to meltdown? What else would you want to know?

Well: now is the time to ask. Because the question is one you'll be facing in a matter of years, if not sooner. Let's dive in.

Part of the reason we're talking about small scale nuclear reactors today is because of the problems we've had with large scale nuclear reactors in the past.

ARCHIVAL: The question is how fast can the temperature inside the reactor be brought down...

FAKE: In March of 1979, a mechanical or perhaps electrical breakdown at 4 a.m. triggered a series of cascading failures at the Three Mile Island power plant on the Susquehanna River in Pennsylvania.

ARCHIVAL: Radiation had penetrated the four-foot thick walls of that building and was detected as far as one mile away.

FAKE: One of the reactors went into partial meltdown as water pumps failed and the core began to overheat. There were human operators in the control room at the time, but in a misguided attempt to fix the situation, they shut off the emergency water system, making the problem worse.

ARCHIVAL: The Nuclear Regulatory Commission has already begun a complete investigation into today's accident.

FAKE: That NRC investigation included 23-year old nuclear engineer Jose Reyes, the same Jose Reyes with the six pack approach to small scale nuclear power.

At the time, Reyes had been working in the Reactor Safety Division of the NRC for less than a year when he was assigned to the five-person team charged with figuring out what went wrong at Three Mile Island.

FAKE: Like, what did it feel like being there?

REYES: What struck me the most was I got to read some of the operator logs. So, they were writing stuff down as the events were unfolding. At this point, they had put on their emergency respirators, the breathing apparatus. And so, they were wearing the emergency equipment and trying to control the plant. And they're probably like a thousand alarms on the screen.

And so, I was thinking to myself, wow, there needs to be something done simpler, that's easy to understand, that's kind of engineered in terms of human factors.

FAKE: Three Mile Island made a big impact on Reyes. Now, more than 40 years later, he's the chief technology officer of NuScale power, located in Corvallis, Oregon. And built into those reactors? Safety features that can be traced directly back to the decade Reyes spent at the NRC.

NuScale's reactors are known as SMRs, small modular reactors. Small, because they generate about 20% as much power as full scale reactors, and modular, because they're assembled in factories before being shipped to power plant sites.

REYES: Each module produces 60 megawatts. And so that's enough for about 50,000 homes.

FAKE: What was the catalyst that made you a believer in the idea of small-scale nuclear reactors?

REYES: In 2004, I spent one year working with the International Atomic Energy Agency in Vienna. And I learned a couple of things. I learned that there was a real need for clean-energy in these locations. But they didn't have the grid that would support a thousand-megawatt plant. And they didn't have the capital either, so, there was a real need for smaller power.

And at the same time, I kept hearing, oh, yeah, and we also need clean water. And it was kind of my aha moment, because I had built this, this one-third scale prototype at Oregon State University. And every time I kept hearing "we need smaller, smaller-sized nuclear power," I kept thinking of what we had sitting in the lab and back in Corvallis.

FAKE: Today, there are 96 traditional operating nuclear reactors in the US, accounting for about a fifth of the nation's total electrical output. And if that number surprised you, it surprised me too. In a lot of ways, nuclear power has fallen out of the national conversation, for reasons we'll get into. But that doesn't mean the plants have gone away.

NuScale, a small company with just 350 employees, wants to start that conversation up again, starting with how their smaller reactors differ from the gargantuan reactors we use today.

FAKE: Can you explain how this small modular concept differs from the giant commercial reactors that are in use now?

REYES: Typically, when you think about nuclear power, you think about large containment domes, these big concrete buildings. We've gone to a very small containment vessel. It's kind of a long cylinder.

FAKE: Would you like it, say, like the size of an 18-wheeler truck.

REYES: So, it'd be a bit longer than that.

FAKE: Someone described your modular system as "six-pack nukes." Does that work for you? Do you have a preferred conceptual shorthand?

REYES: A six-pack or a twelve-pack.

FAKE: Picture a six-pack of small modular reactors submerged in a pool of water. One of the things that stood out about Three Mile Island was the role of operator error. NuScale reactors rely on passive safety. When the water gets hot, it rises, circulating through external coils that cool it down. NuScale's cooling system is an endless convection loop driven by basic physics instead of human operators.

REYES: And so now you've got cold water, which is elevated above hot water. And just by buoyancy, the natural circulation ensues. Everything you need for safety is right there in the pool. We're not relying on anything external to that building for safety.

FAKE: While the Three Mile Island accident brought enduring lessons to Reyes' design, another accident helped cement the global interest in SMRs as a better answer for the future of nuclear power.

ARCHIVAL: One hundred and twenty six million people watched their world crumbling around them. The earthquake 8.9, one of the biggest ever.

FAKE: On March 11th, 2011, the Great Sendai Earthquake hit Japan. It was the largest in the country's history, a natural disaster of unimaginable proportion. The earthquake also triggered a massive tsunami. When it struck the Fukushima Daiichi Nuclear Power Plant, it obliterated the plant's back-up power supply.

ARCHIVAL: Three of the six nuclear reactors at Fukushima are now in meltdown.

FAKE: Without that energy to maintain Fukushima Daiichi's cooling system, all three cores largely melted within three days, poisoning the surrounding area.

REYES: And my first thought was, well, that's the end of the company. No one's going to want to invest in nuclear following the events at Fukushima. But what actually happened was kind of the opposite. The phone started ringing off the hook. We started getting calls from all over. From some reporters, from congressional staffers saying, "Hey, you had told us about the fact that you didn't need power for your plant even under the worst-case conditions."

FAKE: NuScale has its own proprietary system. It doesn't rely on computers, or software, or people for plant safety. NuScale reactors can safely shut themselves down and keep themselves cool without power for an indefinite period of time.

Their design seeks to limit not only the possibility of human error, but to reduce the needs for staffing, which becomes especially relevant during a global pandemic.

FAKE: Do you have, you know, as a result of COVID-19, does it give you any new perspective on why NuScale should exist?

REYES: I really see that the resilience of our plant might be highlighted more than it has in the past, because we refuel our modules once every two years. And so, once you install the fuel, it'll run continuously, producing full power 24 hours a day, seven days a week for two years. So, when you have upsets like this, you can assure that power will be provided to the grid, and there won't be any interruptions in fuel supply.

FAKE: But for Reyes, it isn't enough that his SMRs are simply designed to prevent nuclear disasters. He wants his SMRs to complement green energy sources like wind or solar power in order to reduce humanity's dependence on fossil fuels.

And while he's at it, Reyes figures he might as well use nuclear power to help address the global shortage of fresh water.

REYES: We work with a company called Aqua Tech in a study. And we showed that one of our modules can produce 60 million gallons of desalinated water a day.

FAKE: His reactors work with systems that produce electricity or steam, which makes them attractive for desalination. Turning saltwater into drinking water requires lots of energy. And most desalination plants run on energy from oil or gas. NuScale would provide the same power, carbon free.

REYES: And so a twelve-pack would be enough clean water for the city the size of Cape Town, South Africa, just to give you a sense.

FAKE: Wow. OK.

REYES: It's carbon free energy that produces that actually –

FAKE: That actually produces clean water at the same time.

FAKE: It's hard to hear numbers like this and not think these "six-pack nukes" must be a good thing. But why use nuclear "to complement" other renewables, when so many other renewables exist? And then there's the question of what to do with all that nuclear waste.

When we come back, we'll get some answers. Plus, a playground for nuclear innovation in the Idaho desert and a nuclear plant the size of a beach umbrella on Mars.

[AD BREAK]

FAKE: Hi, it's me, Caterina. Before the break, we were looking at all of the ways small-scale nuclear reactors could slash carbon emissions, clean our water, and possibly save the planet. But there are lingering questions about what to do with radioactive waste, and what other problems we might not be anticipating. There's also the question of how fast might they actually get here, and will it be in time?

To get some answers, we visited a place that historically has played a leadership role in developing next generation nuclear reactors: the Idaho National Laboratory, or INL.

ARCHIVAL: Here in 1949, the Atomic Energy Commission established the national reactor testing station. Some 875 square miles, three quarters the size of Rhode Island.

FAKE: It's located in a remote spot on a patch of high desert, but they're hardly on the fringes of the nuclear industry. I spoke with Dr. Ashley Finan, the director of the INL's National Reactor Innovation Center, to get her take on the viability of small-scale nukes.

FAKE: Ashley, help us put these small scale reactors into context. How big is the small-scale movement worldwide? And do you agree that smaller is better?

ASHLEY FINAN: Yeah, there's a lot of interest in small nuclear power plants. And for the most part, folks are really avoiding doing megaprojects. In many different countries, smaller is better. And you know, having something that can be manufactured and shipped to a country that needs power is better than having to build something, you know, bespoke on site, with a huge construction crew.

FAKE: Can we talk about size for a minute? They're called small-scale nukes. But some of them still seem pretty darn big. How small do they get?

FINAN: Some of the smallest ones would fit into what's called a conex box, which is basically the big box you see on the back of an 18-wheeler or you might see on the back of a train, so very small. And those are often referred to as micro reactors.

FAKE: Something the size of an 18-wheeler doesn't sound very "micro." But it might start to, when you consider that a typical reactor needs over one square mile of land to operate.

The INL has been looking into small modular reactors since the late 90s with funding from the Department of Energy that helped seed NuScale's reactor, among others.

The US Government has built 52 test reactors at the national lab in Idaho. One of the most distinctive is the Experimental Breeder Reactor II. It's a silver, space-age dome that stands out against the sagebrush of the high desert that surrounds it.

ARCHIVAL: From this nerve center of EBR II as it's called, scientists and technicians monitor the intricate processes of nuclear fission and gather information that will guarantee for centuries to come.

FAKE: Until it closed down in 1994, EBR II was used for historic tests, designed to put a reactor through its paces in a controlled environment. Some of the most interesting tests involved reusing nuclear waste.

FINAN: With EBR II, they were demonstrating how you would be able to recycle the fuel and continue to get that energy out without having to go back to the ground to get more uranium, but instead being able to reuse that fuel.

FAKE: So, do I understand this correctly: You're using leftover nuclear waste from that silver-domed reactor to fuel the next generation of small reactors?

FINAN: Absolutely. And it's a very elegant solution, and we've started to recover some of that material from the EBR II fuel, and we're working towards being able to fabricate that into advanced reactor fuels.

FAKE: INL will take the nuclear waste from that test reactor, EBR II, and create a sort of high-octane fuel for a new generation of small modular reactors. It's still a work in progress at INL. But the concept has proven viable in France, which recycles some of its nuclear waste.

Key word: some. Currently, all reactors, large and small, store their waste in pools, where it cools for many years. Some waste is moved to above ground concrete casks. All of these solutions are temporary, at best.

FAKE: Using nuclear waste to run a reactor seems like the perfect solution. What's the catch?

FINAN: I think it is a really elegant solution, and I'm grateful that we have the opportunity to demonstrate it. But in terms of the challenges there, first, the amount of useful energy in the waste that we have, there's an enormous amount of energy left. We could use that to power the United States for hundreds of years. So it isn't an immediate solution to the waste problem, but there is so much energy built up in our current spent nuclear fuel that using it in advanced reactors is not a whole or an immediate solution.

FAKE: Ashley Finan just dropped a sobering statistic on us. Even before we start building new reactors, we're already dealing with enough nuclear waste to keep the lights on in America for centuries. So recycling a portion of it, while a good thing, won't solve the larger problem.

But Dr. Finan places even more urgency on addressing climate change. Nuclear power's biggest benefit might be its ability to help mitigate humanity's impact on the climate.

FINAN: I think that the threats that we face, if we fail to address climate impacts are enormous. And the potential consequences of an advanced nuclear reactor having, you know, an accident are very small and localized compared with the impacts of climate change. And the fact that these designs can help to address climate change is a really important aspect to consider.

FAKE: But not everybody looks upon nuclear power so kindly. Even small modular reactors.

MARK JACOBSON: I don't think we need them. There's just so little information on small modular reactors that we can't really evaluate them.

FAKE: Mark Jacobson. He's a professor of civil and environmental engineering at Stanford. And he's spent his entire career trying to understand air pollution and the problems of global warming. There's nothing he wants more than to find large scale, clean, renewable energy solutions... and he says no to nuclear. Even SMRs.

JACOBSON: Small modular reactors, they promise to build them faster because you can automatize it and build on a conveyor belt, basically. And you know, we don't know how long it will take.

The other problem is it's not even expected to have prototypes of commercialized versions until at least 2026. And we need to solve 80 percent of the climate problem by 2030. And so really, we need technologies that we can implement today and fast.

FAKE: Just like Ashley Finan argued that climate change is too urgent to worry about nuclear's downside, Marc Jacobson says climate change is too pressing to bet on technology with unproven implementation options and high potential risks. Like: the danger of bad actors looking to use it as a weapon.

Both civilian nuclear reactors and test reactors have been used by rogue states to enrich uranium. And then, when they thought that the international oversight committees weren't looking, that enrichment process was diverted into the development of nuclear weapons. This was the case with Iran and North Korea, and if Jacobson's right, there could be others.

JACOBSON: You can ship, you know, a small modular reactor anywhere in the world. And so the more countries that would have them, the more danger it is in terms of especially weapons proliferation. In fact, the Intergovernmental Panel on Climate Change clearly says there's significant evidence and high agreement that weapons proliferation is a significant problem associated with nuclear reactors.

FAKE: For Jacobson, the real revolution isn't with SMRs but renewable energy. His team at Stanford has done detailed modeling on how to get the US energy system off of oil, coal, natural gas, and nuclear altogether. In fact, he developed the world's first wind map, specifically for use with turbines.

JACOBSON: You know, offshore wind is something that we'll be able to deploy really quickly now that we have floating offshore wind turbines. Solar photovoltaics are dirt cheap. Batteries have come down in price. There's really no need for spending money on nuclear. We can solve the problem with existing technologies that are cheaper, faster to deploy, and much safer.

DAVE POSTON: Nuclear power is the safest form of energy we've got.

FAKE: That's Dave Poston, a nuclear scientist at Los Alamos National Laboratory in New Mexico.

POSTON: Even windmills, there's people that die falling off windmills, doing the construction. And there's been nobody killed in the United States by a nuclear power plant. Ever.

FAKE: If you're asking yourself, "Wait, what? That can't be true!" It's actually true. The Three Mile Island disaster, the worst on US soil, resulted in zero fatalities. Now that doesn't address any indirect results from nuclear waste contamination, which remains an open question [according to the NRC](#). But I had just assumed some nuclear-plant fatalities over the years. Dave Poston says they're not there. We caught up with him during the early days of the COVID quarantine.

POSTON: So I'm at home in Los Alamos, New Mexico. My wife and three of my kids are at home. And then our two cats, one that's named Sputnik.

FAKE: Poston is a rocket scientist, as well as a designer of nuclear reactors. He's got a quirky sense of humor, likely influenced by one of his favorite TV shows, an animated sitcom about a safety inspector at a nuclear power plant.

"THE SIMPSONS": Alarm. Three minutes to meltdown.

HOMER: Huh? We're doomed!

FAKE: He's currently working with the Johnson Space Center, designing a power source for off world colonies. Specifically, the moon and Mars. Since NASA is such a haven for acronyms, Poston got to choose one of his own for his reactor test.

POSTON: KRUSTY: Kilowatt Reactor Using Sterling Technology.

FAKE: After Krusty the Clown, the chain-smoking depressive children's television star from "The Simpsons." Poston figured naming the test KRUSTY might get a little publicity. He was, after all, in competition for a limited pool of funding.

In his time at NASA, he'd watched other nuclear projects run out of money. Billions of dollars would be wasted getting a project three quarters of the way done before funding dried up, but that gave Poston an idea. Instead of designing a huge, expensive nuclear reactor, he designed a small, cheap one.

How small? Very, very small.

POSTON: Our reactor core is the size of a paper towel roll. It's like four inches across and 10 inches high. Of course, uranium's a very dense material. So that paper towel roll weighs over 60 pounds.

FAKE: When fully assembled, the entire reactor is roughly the size of a beach umbrella and about as easy to set up.

POSTON: We actually designed our reactor so that it was so easy to assemble that we assembled it in a hallway out of the test chamber.

FAKE: That's impressive, but the government was focused on the bottom line. Traditionally, a nuclear reactor built for use in space is expected to cost over a billion dollars. Dave's project came in significantly under budget.

POSTON: Our program to build, engineer, assemble and test the reactor, ended up costing \$17 million dollars. In the government space, that's a very small number.

FAKE: Poston's umbrella nukes are cheap enough that the government can afford lots of them. And they're small enough that you could pack several on a rocket. In just a few years, these umbrella nukes could be ready to provide power to outposts on the moon or Mars to run the life support systems critical to any off world mission. Beyond that, they could power rovers, too.

POSTON: You would have electrically charged rovers that would take people around the moon or Mars. And these reactors could be placed in various locations as your charging stations, just like Tesla does along the interstates in the US.

FAKE: The umbrella nuke adds more possibilities to an already dizzying number of potential futures. On the one hand, we have an efficient source of carbon-free power, ready to power the world and clean our water for hundreds of years to come. Oh, and we might be able to run it on its own waste.

On the other hand: toxic radioactive waste; unmanned modules whose own weaknesses may not yet be apparent; hundreds of millions of dollars in research that might be better spent elsewhere. Oh, and the threat of rogue actors starting global thermonuclear war.

In either scenario, we know that time is running out to reverse the effects of climate change. Which brings us back to the question we began with. Would you agree to have a small scale nuke in your own backyard?

[AD BREAK]

FAKE: Hi, it's Caterina. We're back one more time with NuScale's Jose Reyes.

Taking small modular reactors from the drawing board to the marketplace has been a long, expensive journey. To date, a full decade and nearly a billion dollars in costs, provided by the Department of Energy and the engineering firm Fluor.

The price tag on testing alone boggles the mind: \$100 million dollars, and a truly daunting amount of paperwork.

REYES: We've submitted a twenty-two thousand page design-certification application. And that was just the application.

FAKE: Right.

REYES: Since then, I think it's about 2 million pages of information regarding the design and includes all test data, risk assessments, all those things had to be submitted to the NRC.

FAKE: Wow. Ok.

FAKE: That long awaited safety evaluation report from the Nuclear Regulatory Commission came in August. When the NRC signed off, it validated the overall safety of NuScale's design. And that helped clear the way to build these small nuclear reactors in the real world.

Reyes wasn't the only one betting that the NRC will approve of NuScale's designs. A utility company in Utah has already signed up for a 12-pack of NuScale's nukes and agreed to pay three billion dollars for it.

FAKE: How soon would the Utah utility partner get their reactors up and running?

REYES: So they are retiring some coal fired plants, and so they do have a deadline that we're trying to meet.

FAKE: NuScale plans to deliver its first module to the Utah utility in 2029. It aims to have a fully operational plant in 2030. Though the utility now says it may start smaller, with just a six-pack, or a new configuration, a four-pack.

It turns out that NuScale's reactors can crank out more power than they realized. When we recorded our interview last spring, Reyes said that one module would generate 60 megawatts of power. Now, the company says each one can generate 77 megawatts, about 25 percent more power. That helps lower the cost for utilities, allowing them to get more bang with fewer bucks – and fewer reactors.

But the Utah utility is only one customer of what Reyes hopes will be many. In the next 25 years, Jose Reyes has loftier goals for NuScale, but it's not just about generating nuclear power. It's also about making an impact on climate change.

REYES: We think we can sell about 670 to 1,700 of these individual modules. If we did that, we could reduce CO2 emissions by a billion metric tons per year. So, it's a huge reduction of CO2 emissions just by implementing this technology. In order to meet that goal – and this is where I get really excited – is we had to have quite a bit of manufacturing capability. We would need to be producing basically three of these modules every month.

So that means we need multiple manufacturing sites. It's an opportunity for new jobs in the U.S. and other places around the world. So we're excited about the fact that not only will we be helping reduce the CO2 emissions, but we'll also be creating a whole new industry and bringing manufacturing to the US.

FAKE: And freshwater.

REYES: And freshwater. That doesn't even include all the opportunities for desalination. That's right.

FAKE: Exactly.

REYES: For me, this is a dream come true: To come up with a concept to follow it all the way through, to collaborate with national labs, to collaborate with the Department of Energy, to move this along and to finally see it coming to fruition is just amazing for me. I think the rewards will be significant, not just for the company, but really for the world.

FAKE: Look, I don't get to decide Should This Exist? And neither does this show. Our goal is to inspire you to ask that question – and the intriguing questions that grow from it.

LISTENER: There is absolutely no way that I would want a small scale plant in my community. But like, I don't want it in anyone's community.

LISTENER: The word “nuclear” is just a really scary word.

LISTENER: How are we going to deal with nuclear waste?

LISTENER: Why is this the move that we're trying to make instead of trying to convince everyone to use solar and wind energy? They're sitting right there.

LISTENER: Put one in my backyard. I'll take it, I'll do it.

LISTENER: The other benefits of this technology – clean water along with clean power– it makes it undeniable that we should at least consider it.

LISTENER: Unless you really prove to me that you're more about saving the planet than getting your money with your new technology, I'm not interested.

FAKE: Agree? Disagree? You might have perspectives that are completely different from what we've shared so far. We want to hear them.

To tell us the questions you're asking, go to www.shouldthisexist.com, where you can record a message for us.

And join the Should This Exist newsletter at www.shouldthisexist.com. I'm Caterina Fake.