THE NUCLEAR DEBATE: FEARS, FACTS AND “FISSION” | CARBON-FREE ENERGY, SUSTAINABLE FINANCE

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EPISODE 33

Is nuclear power the key to a carbon-neutral future or an accident waiting to happen?

Non-hydro renewables such as wind and solar are predicted to play a major role in the future. However, one of these energy solutions has divided public opinion more than others. To mention the name "nuclear" is to conjure up the boogie man or "he who must not be named".

By 2050, some 10 billion people will need some form of energy to eat, travel, work and protect themselves from the weather. McKinsey's Energy 2050 research report predicts that demand for electricity will grow twice as fast as demand for transport, while at the same time fossil fuels will decline. So how will we power the future?

In this episode of 2050 Investors, Kokou Agbo-Bloua delves into the controversial topic of nuclear power, exploring its history, potential benefits and risks in the context of the global energy transition. He also highlights the dual nature of nuclear energy as both a powerful source of clean energy and a potentially catastrophic force capable of altering life at the atomic level.

To explore the issue further, Kokou orchestrates a virtual Oxford-style debate between experts for and against nuclear power. The pro-nuclear side includes Bill Gates, Ernest Moniz, George Monbiot and James Hansen, advocating for nuclear power as a necessary tool to combat climate change.

The anti-nuclear side includes Tom Steyer and Mark Jacobson, who criticise its economic feasibility and safety concerns. Each expert presents their opening statement, outlining their position and the key matters surrounding nuclear power.

This episode will help you understand the fears, facts, and fission, so that you can make up your own mind about nuclear power.

2050 INVESTORS – EPISODE 33 SCRIPT

The Nuclear Debate: Fears, Facts and "Fission" | Carbon-free Energy, Sustainable Finance

[Sound of Geiger meter slowly rising from slow to high frequency, indicating dangerous radiation]

[Kokou] Listen to this! This is a very familiar sound

[Siri] Is this what I think it is? The molecules in your human cells and those in my circuit boards are freaking out right now…

[Kokou] And they should be. This is the dreaded sound of a Geiger counter, used in nuclear power plants for radiation monitoring.

[Siri] Why the hell are we listening to this?

[Kokou] Don't worry Siri. We are not in a nuclear power plant, and this is not Chernobyl. It's just a recording. By the way, did you know that this sound, the persistent clicking, is both a marvel of scientific ingenuity and a chilling reminder of the unseen dangers of nuclear energy?

[Siri] Duhh, is this supposed to be breaking news? Where are you going with this?

[Kokou] Just a second, hear me out. It was invented by Hans Geiger and later improved by Walther Müller in the early 20th century. The Geiger counter detects ionizing radiation—particles that, if left unchecked, can cause severe harm or even death to living organisms. This device, often symbolized by the haunting 'tick, tick, tick,' warns us of the presence of radiation, a force that has the power to alter life at the atomic level. It's a sound that, without protective gear, could indeed signal a death sentence.

[Siri] Are you telling me I'm now about to get iPhone cancer?

[Sound effect fades out, replaced by a hopeful background music]

[Kokou] You're fine Siri. Today, we dive into the powerful yet deeply feared world of nuclear energy. It's a topic that has long been shrouded in a mix of awe and fear, much like a Faustian pact. The promise of the clean energy we desperately need, but then carrying a cost: the potential for catastrophic nuclear destruction.

[Siri] A nuclear black swan?

[Kokou] Yes. We, humans, have always had a knack for harnessing nature's most potent forces, from fire to electricity. But with nuclear energy, we've tapped into something that can either light up cities or annihilate them.

[Siri] Business as usual for the human species, no? Climate change, biodiversity loss, pollution... don't get me started.

[Kokou] I won't.
Welcome to 2050 Investors, the podcast that deciphers economic and market mega-trends to meet tomorrow's challenges. I'm Kokou Agbo-Bloua, I head up Economics, Cross-asset, and Quant Research at Société Générale. In this episode of 2050 Investors, we investigate nuclear energy. Nuclear power is a very dense, carbon neutral and a reliable energy source, but it also raises serious safety concerns.

To explore the heart of the matter and separate facts from fiction, we're hosting a lively, virtual Oxford-style debate with experts sharing their views for and against nuclear energy,. We'll also break down the atom and the arguments and see if we can find a path that reconciles pros and cons.

Let's start our investigation.

[Kokou] First, a quick recap on the history of energy, shall we?

[Siri] Absolutely.

[Kokou] It all began in the 1930s with the discovery of nuclear fission by scientists like Lise Meitner and Otto Hahn. In the late 1930s, before the outbreak of the war in 1939, a group of American scientists, many of them refugees from fascist regimes in Europe, became concerned with nuclear weapons research being conducted in Nazi Germany. So in 1940, the US government began funding its own atomic weapons development program. It was codenamed "The Manhattan Project".

[Siri] This is the most destructive weapon humanity has ever known.

[Kokou] That's for sure. By the way, I saw the movie 'Oppenheimer' on the Manhattan project a few months ago. Fascinating.

[Siri] I can only imagine the success of the achievement and the burden of responsibility these scientists must have felt after the human casualties.

[Kokou] A bittersweet moment for them indeed. An article from History.com entitled "The bombings of Hiroshima and Nagasaki" reminds us of a few chilling facts. On August 6th 1945, American B-29 bomber dropped the first atomic bomb over Hiroshima. The explosion killed an estimated 80,000 people. A few days later a second B-29 dropped another bomb on Nagasaki killing 40,000 people. Japan's Emperor Hirohito announced his country's unconditional surrender

in a radio address on August 15 citing the devastating power of, and I quote “a new and most cruel bomb”.

[Siri] That’s a euphemism.

[Kokou] It’s no wonder that nuclear energy invokes such deep-rooted fears. Obviously nuclear weapons are not nuclear power plants. But the famous Chernobyl accident in 1986 did not help the reputation of nuclear energy. An article by the World Nuclear Association about Chernobyl makes a few important facts worth remembering.

- First, it was the result of a flawed reactor design that was operated with insufficiently trained staff.
- Second, the explosion released about 5% of the radioactive reactor core into the environment with radioactive materials in many parts of Europe,
- and third, two Chernobyl plant workers died the night of the incident, and another 28 people died a few weeks later because of acute radiation syndrome.

The most interesting fact is the following. The UN Scientific Committee on the Effects of Atomic Radiation concluded that apart from 5000 thyroid cancers resulting in 15 fatalities, there was no evidence of a major public health impact attributable to radiation exposure 20 years after the accident.

[Siri] Interesting case of perception vs reality indeed. Don’t forget that about 350,000 people were evacuated because of the accident though.

[Kokou] Indeed. According to the same source, the Fukushima nuclear accident in March 2011 was caused by a 14-metre tsunami that disabled the power supply and cooling of three Fukushima Daiichi reactors. It did not lead to any deaths or cases of radiation sickness. 100,000 were evacuated, nevertheless for safety. However, the tsunami and earthquake killed over 20,000 people.

[Siri] Hum…. No radiation death, huh.

[Kokou] Perception versus reality. Ok, to help us navigate this complex issue, I’ve organized a virtual Oxford-style debate with several experts on each side.

[Siri] Wow. Let the battle of wits begin.

[Kokou] Hold on a sec [sound of screeching stop] We forgot to talk about nuclear energy and how it works first.

[Siri] Ok ok, let’s make this quick. Time is running out.

[Kokou] Don’t worry. We can do this ‘fast and furious’. Give me 2 minutes. [sound of clock ticking in the background]

An article from the International Atomic Energy Agency website entitled “What is Nuclear Energy? The science of nuclear power” gives us a quick summary:

First, Nuclear energy is energy released from the nucleus, the core of atoms, made up of protons and neutrons. This source of energy can be produced in two ways: fission – when nuclei of atoms split into several parts – or fusion – when nuclei fuse together.

[Siri] Like in the Sun, where hydrogen molecules are fused together into helium by the force of gravity.

[Kokou] Exactly.

Second, nuclear energy harnessed around the world today to produce electricity is through nuclear fission, while technology to generate electricity from fusion is at the R&D phase.

[Siri] Not surprising. You need a 100-million-degree Celsius temperature for nuclei to fuse.

[Kokou] Third, Nuclear fission is a reaction where the nucleus of an atom splits into two or more smaller nuclei, while releasing energy. For instance, when hit by a neutron, the nucleus of an atom of uranium-235 splits into two smaller nuclei, for example a barium nucleus and a krypton nucleus and two or three neutrons. These extra neutrons will hit other surrounding uranium atoms, which will also split and generate additional neutrons in a multiplying effect, thus generating a chain reaction in a fraction of a second.

[Siri] Better stay out of the way.

[Kokou] That's for sure. Fourth, each time the reaction occurs, there is a release of energy in the form of heat and radiation. The heat can be converted into electricity in a nuclear power plant, similarly to how heat from fossil fuels such as coal, gas and oil is used to generate electricity.

Fifth, inside nuclear power plants, nuclear reactors and their equipment contain and control the chain reactions, most commonly fuelled by uranium-235, to produce heat through fission. The heat warms the reactor's cooling agent, typically water, to produce steam. The steam is then channelled to spin turbines, activating an electric generator to create low-carbon electricity.

[Siri] Where do we find Uranium-235?

[Kokou] Great question. This is the key issue of mining, enrichment, and disposal of Uranium.

Uranium is a metal that can be found in rocks all over the world. Uranium has two primordial isotopes: uranium-238 and uranium-235. Uranium-238 makes up most of the uranium in the world but cannot produce a fission chain reaction, while uranium-235 can be used to produce energy by fission but constitutes less than 1 per cent of the world's uranium.

[Siri] That's good and bad news.

[Kokou] True. To make natural uranium more likely to undergo fission, it is necessary to increase the amount of uranium-235 in a given sample through a process called uranium enrichment. Once the uranium is enriched, it can be used effectively as nuclear fuel in power plants for three to five years, after which it is still radioactive and must be disposed of following stringent guidelines to

protect people and the environment. Used fuel, also referred to as spent fuel, can also be recycled into other types of fuel for use as new fuel in special nuclear power plants.

[Siri] So what about its carbon footprint?

[Kokou] Ah! Nuclear power is a low-carbon source of energy, because unlike coal, oil or gas power plants, nuclear power plants practically do not produce CO2 during their operation. Nuclear reactors generate close to one-third of the world's carbon free electricity and are crucial in meeting climate change goals.

[Siri] Thanks for this refresher. I think we have the basics now. Shall we start the debate? I got my digital popcorn ready.

[Kokou] Absolutely. During my research for this episode, I've unearthed a variety of quotes from leading voices on the subject, and we'll be presenting their fascinating perspectives.

Arguing for nuclear power, we have:

1. Bill Gates: The co-founder of Microsoft, and a philanthropist, has been a vocal advocate for nuclear energy as a solution to climate change. He co-founded TerraPower, a nuclear innovation company aiming to develop safer and more efficient reactors.

2. Ernest Moniz - A former U.S. Secretary of Energy, Moniz has been an advocate for the development of advanced nuclear technologies and has emphasized the role of nuclear power in achieving a low-carbon energy future.

3. George Monbiot - A British journalist and environmental activist, Monbiot has publicly endorsed nuclear energy to address climate change, despite initially being opposed to it.

And finally, James Hansen - A renowned climate scientist and former director of the NASA Goddard Institute for Space Studies, Hansen supports nuclear power as a necessary component to reduce greenhouse gas emissions and combat global warming.

Siri: That's an impressive list. Who do we have against nuclear power?

[Kokou] On the other side of the metaphorical boxing ring, we encounter:

1. Tom Steyer - A billionaire investor and environmental activist, Steyer has been a vocal critic of nuclear power, emphasizing the potential risks and advocating for investment in renewable energy sources like wind and solar.

2. Mark Jacobson - A professor of civil and environmental engineering at Stanford University, he is well-known for his opposition to nuclear power as part of his advocacy for 100% renewable energy.

3. And lastly, we have John Vidal - A long-time environmental editor for The Guardian, Vidal has written extensively on environmental issues, including the risks and downsides of nuclear power, while advocating for renewable energy alternatives.

[Kokou] Let’s hear opening statements from each side. Bill Gates, you have the floor.

INSERT: Bill Gates on Nuclear Energy and Reaching Net Zero (0"20 à 1"33)

"Climate is getting more attention, as it should. And people are realizing that you need, you know, almost 3 times as much electricity, even in rich countries. And then in poor countries, to enable their economy - you need dramatic increases even beyond that. And so, they look at that and they say, oh, we also want it to be reliable. That is, when it's super cold, we still want - if you have electric heating - that to work. When it's super hot, we want air conditioning to work. And unfortunately, the solar and wind which will play a gigantic role, trying to use that alone without a miracle in storage that we don't expect at all - it just doesn't create the solution. And so having a non-weather dependant, you know, completely green, reliable form of energy generation that can be cheap enough, means that there will really have to be some nuclear in the equation.`

Siri: Very powerful argument, as usual, Bill.

Kokou: Now, switching gears, let’s hear climate investor Tom Steyer and his opening statement.

Insert - Billionaire Tom Steyer: Capitalism has taken world to 'brink of climate disaster' (TC 17"02 à 18"39)

"What I've said consistently about nuclear power is this : I'm agnostic. Nuclear power emits no greenhouse gases. The issue has been: is it cheap? Do you have nuclear waste that is toxic and that lasts for a hundred thousand years, and you have no disposal plan for that waste? And is there a significant chance of a nuclear disaster? Those are just facts. If it's cheap, if there's no waste that we need to dispose of, and if it's safe: great. In fact, you know, there are people including Bill who have been working on the next generation, we've been working on this for decades. What's proved to be true in the United States is: we haven't come up with nuclear power that can compete with solar and wind. You know, take away the issues about safety, and the issues about having to dispose of waste, extremely toxic waste, they can't compete on price. So, the real question here is not should you be for or against nuclear power, I'm agnostic. Let's go to the facts, let's go to the data. If it works on the basis I just gave, great! That will solve a ton of problems. It'll be fantastic. We haven't seen that happen, and when in fact companies’ utilities in the United States over the last two decades have tried to build new nuclear facilities here, they've gone way over budget, they haven't been able to compete on cost. And ultimately they've abandoned the projects because they just can't' get it done at a reasonable cost."

Siri: This was an interesting set of arguments against nuclear power.

Kokou: Alright then, I suggest we move to more specific arguments. Beginning with Stanford University professor Mark Jacobson, who addresses the costs associated with nuclear power.

Insert - Why Small Modular Nuclear Reactors SMRs Are Not a Climate Fix (TC 4"25 à 6"15)

"To avoid 1.5 degrees global warming, we'll need to eliminate at least 80% of emissions by 2030, that's about 7 years from now, and 100% ideally by 2035 or 2040, and certainly no later than 2050. So any technology that takes 10 years between planning and operation is really not useful at all for

helping to solve the climate problem, let alone the air pollution problems or energy security problems we face. So that gets us to wind and solar for example, their lead times between planning and operation are between half a year for rooftop solar to usually 1 to 3 years for utility scale solar, and onshore wind. So their technologies are not only the cheapest technologies by far in the world today, the new wind and solar but also the fastest that can be deployed. Nuclear on the other hand, in liberalized markets, it's taking 17 to 22 years between planning and operation. And we can look at Flamanville in France, Hinkley in the UK, Olkiluoto in Finland, the Vogtle plants in Georgia, they're all 17 to 22 years between planning and operation. A lot of that is planning, and a lot is construction time as well. And the costs are enormous. For example from Vogtle in Georgia these 2 reactors, their aggregated costs are 34 billion dollars so far, for 2.2 gigawatts. That's over 15 dollars per watt, capital cost. New wind and solar are 1 dollar per watt, so 15 times higher capital costs and the cost of energy is now 7 to 8 times higher as a result for new large scale nuclear reactors."

Siri: Money talks, especially when it’s about building reactors versus wind farms.

Kokou: That’s the economic argument. Now, let's turn our attention to the former U.S. Secretary of Energy Ernest Moniz, who provides insights into the potential of nuclear fusion and its implications for young scientists today.

Insert - Ernie Moniz on “Oppenheimer” and the dawn of the nuclear age (Good Clean Energy Podcast) (TC 14"33 à 15"38)

"In general, I would say nuclear science and technology generally is attracting a whole new generation of young scientists. Fusion, in particular, has this Holy Grail kind of label appropriately, and so we are seeing many different technologies being examined in the fusion space and we are seeing many young people come into that. MIT is one of the places that has spun out a fusion technology. TAE itself is a spin out from the University of California at Irvine and I think these academic routes for many of these efforts shows the strong coupling, particularly to the young research community, that is looking for making huge scientific breakthroughs but is also looking to frankly addressing the biggest problem facing societies in the world. Global warming is certainly in the forefront of that, and fusion would be an amazing solution to many of our biggest challenges."

[Siri] Fusion would be the holy grail indeed, but we are not there yet.

Kokou: You’re right, let’s see what the future holds. Another critical issue in the nuclear debate of course is safety. Let’s hear what British journalist George Monbiot has to say about it:

Insert - George Monbiot on environmentalism and climate activism (TC 28"49 à 29"45)

"Curiously for me, the sort of moment when I ceased to become a universal anti-nuclear campaigner was the Fukushima disaster, where their nuclear power plants were hit by the biggest natural disaster there could be. I mean it was listed as the top category of nuclear accident and no one died. And that was a moment where I thought people die every day in the coal industry, I mean hundreds of people are killed every day by coal, either in a mining accident, by direct

pollution or as a result of the climate breakdown that it causes. Far greater numbers than being killed in the whole history as a result of any nuclear accidents. And I suddenly realised, came as a bit of a shock, that most of the charges that we've been levelling against nuclear power, actually should've been levelled against coal burning instead. Even with the issue of radioactive releases, there is more radioactivity released by coal burning than there is by nuclear power!"

Siri: It seems that the real radioactive villain was lurking in the smoke all along! I bet the Hulk would have something to say about this…

Kokou: Men tremble at the sight of the Hulk's glowing green form, yet the true monster is often grey and sooty. Can the real shady please stand up? Please stand up [sound effect]

The other important issue we need to address is the concerns about nuclear waste management, storage and disposal. Interestingly enough, renowned climate scientist James Hansen has some great insights to share with us:

Insert - James Hansen Critical Conversation Public Keynote (TC 21"05 à 22"43)

"An enormous issue that is raised about nuclear waste. Nuclear waste is stored in containers where it harms nobody. It can be used as fuel for future advanced nuclear reactors, which will reduce the volume of waste somewhat further. Let's compare this waste with that of alternative energies. Fossil fuels come with several costs. One cost is air pollution, the World Health Organization estimates that 3.7 million people per year die from outdoor air pollution. And another 3.7 million from indoor air pollution. Many of the deaths from air pollution, like those from smoking, are prolonged and painful to the victim and the family. Moreover, hundreds of millions of people suffer health effects short of death. Aerosols that people breathe are tiny, they enter the bloodstream causing cardiac and respiratory problems. Not all air pollution is from fossil fuels, but a large fraction of it is. And there's water pollution. Groundwater is being contaminated, especially by fossil fuel mining activities including fracking."

Siri: Nuclear waste: the gift that keeps on giving for millennia.

Kokou: Not so fast Siri, to finish I'd like us to listen to The Guardian's environmental editor John Vidal sharing his rebuttal on storage. Who's going to pay for it?

Insert - 'No nuclear power station has ever been built without substantial subsidies'

A: The government is very clear, there is no subsidy for the nuclear industry. They are going to have to pay full cost share. Well, I mean, that sounds pretty clear to me that the nuclear industry is going to have to pay. But when you look at it, the government has got a problem. It's got 80 billion quid's worth of nuclear waste, which it has to get rid of. It's got hundreds of thousands of tons sitting there. It's got to build - it's committed to building a huge repository somewhere at some time. It's not clearly not going to ask the nuclear industry to build a second repository to take not the legacy waste, but the new waste which will be created from this new generation. So in other words, it will be, the nuclear industry will be allowed to rent, effectively rent like a hotel room, a couple of extra volts in this thing, they will not have to build a whole new thing. So it can be argued

very clearly this is a hidden subsidy. The nuclear industry is having, effectively, its storage paid for by government

Kokou: Let's summarize the key issues.

Nuclear power: high energy density, low emissions, but comes with safety risks and waste management headaches.

Renewables: low impact, increasingly affordable, but need more infrastructure for reliability.

Siri, your thoughts?

Siri: It's a classic human conundrum: do you bet on the high-risk, high-reward option or play it safe with a slower, steadier approach?

Kokou: Indeed, the choice isn't simple. Nuclear power promises a stable and low-carbon future but is shadowed by the spectre of accidents and waste. Renewables offer a cleaner path but require innovation and investment to match the reliability of nuclear.

Listeners, it's your turn to decide. Which side has made the most convincing case? Is nuclear energy necessary for a carbon-free future, or should we rely solely on renewables to power our world? Your votes will shape the energy debate.

To conclude this episode after such a fascinating exchange, I will simply quote Albert Einstein "Nuclear power is one hell of a way to boil water".

Thank you for listening to this episode of 2050 Investors. Thanks to all the experts we heard for their valuable insights. I hope this episode has helped you get a sense of the risk and reward of nuclear energy. You can find the show on your regular streaming apps. If you enjoyed the show, help us spread the word! Please take a minute to subscribe, review and rate it on Spotify or Apple Podcasts.

See you at the next episode!