



The Great Energy Debate

Is Nuclear Power the Solution to Climate Change?

Paul Dorfman and Staffan Qvist both want to save the climate. But one of them wants to rid the world of nuclear reactors while the other wants to build more of them. We brought them together for a debate.

Interview Conducted by **Philip Bethge** und **Rafaela von Bredow**
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Dorfman, left, is opposed to nuclear. Qvist, right, is for it. Foto: Horst Friedrichs / DER SPIEGEL

Dorfman, 64, of University College London, is founder and

International

Abo



Qvist, 34, completed his Ph.D. in nuclear engineering at the University of California at Berkeley and has since been conducting research in the U.S. and Sweden on the safety and economics of nuclear power. He currently runs an energy consultancy firm in Great Britain. He is the author of the book "A Bright Future: How Some Countries Have Solved Climate Change and the Rest Can Follow" together with the economist Joshua Goldstein.

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DER SPIEGEL: Mr. Qvist, do lobbyists view the climate crisis as an opportunity to reframe dangerous nuclear energy as a technology that could save us?

Qvist: Well, I would take objection to the framing of that question, because it suspects anyone who finds arguments in favor of nuclear power of being a lobbyist - and devalues his arguments. And there are good, factual arguments, such as nuclear power being an energy source which does not produce any greenhouse gas emissions during operation. Which has additional benefits of not being dependent on the weather. The fact that it is climate friendly is indisputably one of the main reasons we should look at nuclear power as a part of the energy system.

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DER SPIEGEL: How do you see it, Mr. Dorfman?

Dorfman: Why should anyone build a nuclear power plant? Renewables are much cheaper. The climate crisis is going to hit us hard and quicker than we planned for - but this actually speaks against nuclear power.

DER SPIEGEL: Why?

Dorfman: Climate change poses a number of unique challenges to humanity. One of the most difficult is that we have to be carbon neutral as soon as the middle of the century. Now, the unfortunate reality is that you could not build enough reactors fast enough even to replace the existing reactors that will reach the end of their lifetime before 2050.

DER SPIEGEL: So Germany made the right decision to phase out nuclear energy?

Dorfman: Absolutely. There is still no final repository for nuclear waste and economically viable operation is impossible. Many safety questions are unresolved. Even utilities in Germany are clear and blunt: They say they would not even consider getting back into nuclear. The only political party that is against the shutdown is the partly extreme-right-wing AfD, and AfD also denies climate change.

Qvist: I do not know German politics, but just because the wrong people agree with you doesn't mean the cause is wrong. To me, the German phase-out is a terrible decision, one of the worst decisions for the environment and the climate that anyone has ever made. One study shows that the phase-out led to the death of more than 1000 people every year – not even accounting for the millions of tons of CO₂ that have been released. And the phase-out isn't even done yet!

DER SPIEGEL: Let us explain this briefly: You're referring to the fact that because of the nuclear phase-out, we're burning more coal. And many people are being killed by coal smoke

and its pollutants - sulfur dioxide, nitrogen oxides, mercury, arsenic?

Qvist: Exactly.



A mothballed reactor in Stade: "One of the worst decisions for the environment and the climate that anyone has ever made." Foto: Robert Grahn / euroluftbild.de / picture alliance / dpa

DER SPIEGEL: The phase-out led to massive investments in clean energy, including wind and solar, which wouldn't have happened without that decision.

Qvist: True, Germany has done fantastic things for the climate, being an early investor that plunged a lot of money into wind and solar. Germany should be lauded for doing that, as well as for developing a lot of technologies that we need for the low-carbon future. This decision, however, to prematurely shut down nuclear power plants really is a blotch on the scorecard.

DER SPIEGEL: How so?

Qvist: By 2025, Germany will have spent more than 500 billion euros (\$591 billion) on its energy transition. The result has been climbing prices for electricity, CO2 emissions have hardly dropped at all and Germany's energy mix remains climate unfriendly. In 2022, when the last reactors will be decommissioned, problems will become even worse. At Germany's rate of adding clean energy, it would take the world more than a century to decarbonize. And the existing nuclear plants in Germany are not even uneconomical. They're wonderfully operating plants. Some of them.

Dorfman: Hang on, let's talk about the ageing nuclear plant issue here...

Qvist: ...some of the plants that will be shut down, like Emsland and Grohnde, are probably the best operated power plants of any kind that have ever been run on planet Earth. Shutting them down is an affront to good engineering, to climate, to people, to the environment, to humanity!

Dorfman: The opposite is true. Ageing nuclear plants pose a very real risk of serious accidents. They have little or no defense against terrorist attack, aircraft crashes and climate-change impact such as sea level rise, which weren't thought about when these reactors were designed.

DER SPIEGEL: Still, we have to decarbonize the energy system as soon as possible to prevent catastrophic consequences. How do we get there?

Qvist: The popular answer is renewables, but wind and solar alone at a reasonable system cost is a fantasy. They are becoming cheaper, but they are not available around the clock, and batteries that could power entire cities for days or weeks show no sign of materializing any time soon. But we actually have proven models for rapid decarbonization: France and my home country of Sweden decarbonized their grids decades ago - and Germany emits almost eight times as much carbon dioxide per kilowatt hour as France and more than 40 times as much as Sweden. But above all: over 40 percent more than the EU average.

DER SPIEGEL: Mr. Dorfman, the CO2 footprint of people living in France or Sweden is indeed only half that of Germans. Why is theirs not a model for the world?

Dorfman: Because it is not a sustainable solution. The key about nuclear is the cost of the bill. Take France: The majority of the French fleet is in relatively serious trouble. They don't have modern safety measures such as core catchers.

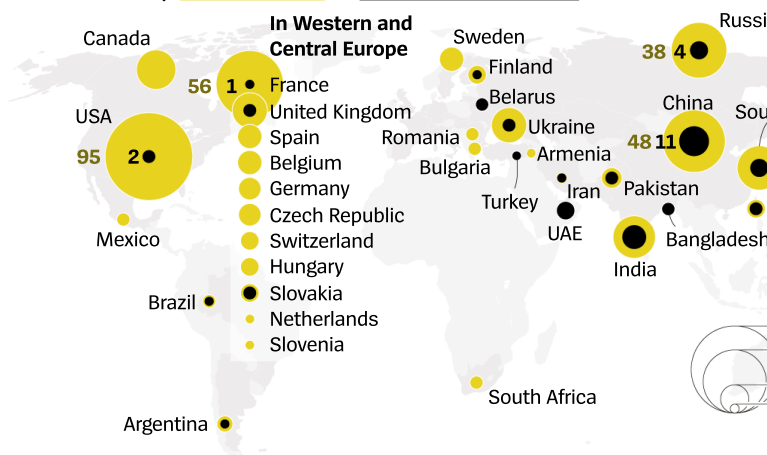
DER SPIEGEL: When they no longer meet the standards, they need to be retrofitted. Isn't that enough?

Dorfman: But partial retrofitting can do little to change this. An almost complete rebuild would be needed just to get through compliance with today's safety standards.

DER SPIEGEL: So France and Sweden will run into a really big problem in 20 years?

A Nuclear World

Reactors currently **in operation** or **under construction**



Source: IAEA

Dorfman: Yes. They will very, very soon. While France has committed itself to reducing the share of nuclear energy in electricity production to 50 percent by 2035, the estimated cost of the reactor fleet life extension in France is about 50 to 100 billion. And Sweden's booming wind power is surpassing its capped nuclear fleet this year. We must not build new nuclear plants but shut down old plants as fast as possible.

Qvist: I disagree. The German and the French nuclear plants are producing cheap and stable electricity. The absolute fastest option for decarbonizing the energy sector is not to shut them down.

DER SPIEGEL: And do what instead?

Qvist: Use a combination of renewables and nuclear - the most cost-effective combinations you can find of all low-carbon sources. In the world today we have around 20 electricity grids that are zero-carbon year-round. More than half of those are very poor countries that have one or two big hydroelectric power plants and use very little electricity. That's not a model anyone could follow. Then you have three or four countries with renewable systems that are based on geographical luck. Norway is a good example. They have ample hydro power. Or Iceland: They have both geothermal power in the ground and hydro power. Costa Rica is similar. But then you have four regions that are already across the finish line in terms of decarbonized power without completely relying on luck. Those four systems are Sweden, France, Switzerland and Ontario in Canada, all of them relying on a combination of renewables and nuclear.

Dorfman: The market seems to think otherwise. U.K. offshore wind projects are projected to produce electricity at 47 pounds per megawatt hour. The current projected electricity price for Hinkley Point C, a new nuclear plant being built in the UK, is 109 pounds per megawatt hour. The difference is just astonishing, isn't it?

DER SPIEGEL: Other so-called Generation 3 plants are currently under construction, including Olkiluoto in Finland and Flamanville in France. Mr. Qvist, all of them are hugely expensive, years behind schedule, and without massive subsidies, they would not exist. Do they really make sense?

Qvist: Europe has not built any nuclear power plants for a very long time, it's not very surprising that the first of their kind get expensive.

Dorfman: You can say that Olkiluoto was first of a kind, but this isn't true for Flamanville, which is also years behind. If the French can't build to cost and time, then where can you build? Nuclear is now conclusively shown to be seriously more expensive than renewables.

DER SPIEGEL: Which figures are you thinking of?

Dorfman: The rating agency Standard & Poor's reports that investment in renewables is at \$350 billion per year. For nuclear, it fell to 17 billion last year. And this trend is likely to continue. The International Energy Agency reports an annual global growth of 35 percent in solar and 17 percent in wind energy. Nuclear growth is less than 1 percent! The only way that you're seeing new nuclear being built is with vast public subsidy, in China, in Russia, and amazingly, as a mad outlier, in the U.K. Nuclear plants cost so much; they take so long to build that they really cannot help us to slow down climate change. Renewables, on the other hand, get cheaper all the time.

Qvist: In every case where nuclear power was shut down, renewables have not filled the gap. Why is Germany not decarbonized, although it is going full-on with renewables? Its CO2 emissions intensity from electricity production is many times higher than that of France and Sweden, and its electricity costs to consumers are also vastly higher. You cannot find a better climate investment than maintaining and modernizing the existing European reactor fleet to keep it in operation.

DER SPIEGEL: Although 54 reactors are currently being built worldwide, the share of nuclear energy in electricity-generation is only ten percent and will continue to decline. If the nuclear renaissance you are praising was happening, why aren't more countries expanding their capacities?

Qvist: The reasons are economics and fear. In recent decades, the United States and some European countries created ever more complicated reactors, with ever more safety features in response to public fears. This has driven up costs. China and South Korea can build reactors right now at one-sixth the current cost of what they are in the United States. In the longer term, dozens of start-ups are developing new reactors that can be mass-produced, potentially generating electricity at lower cost than fossil fuels. The key is standardization and repetition.

Dorfman: That's a pipe dream, none of these innovations have worked so far. France's sodium-cooled ASTRID-reactor for example has been cancelled.



Solar power plant in Nevada: "Renewables and energy efficiency reduce emissions more and faster." Foto: E+ / Getty Images

Qvist: ASTRID is a failure, yes, but there are probably 30 new reactor designs being put forward right now, some of them with serious venture capital backing. You have, for example, the whole variety of so-called Small Modular Reactors, SMR.

DER SPIEGEL: They have nothing to do with the gigantic nuclear power plants of the past ...

Qvist: That's right, these are small conventional reactors that will be commercialized by the late 2020s. This is happening. NuScale, a U.S. company, is about to finalize its licensing process for its SMR and already has a customer. It would be insane to not give them a chance to see if they can deliver on their promises.

DER SPIEGEL: Ursula von der Leyen, President of the European Commission, excluded nuclear from EU's new Green Deal...

Qvist: ...yes, and that is very, very damaging. Pressured by countries such as Germany, Luxembourg and Austria, the EU is torpedoing anything that could have a positive impact on nuclear.

Dorfman: For good reasons, to not harm the EU budget. Look, in the past, nuclear went bigger so that the costs would come down. It's called economy of scale. Now, all of a sudden, you're saying that the economy of scale is not important and can be magically replaced by the economy of replication?

Qvist: Well, would you like to see those innovations succeed?

Dorfman: For me that's not the point. There is just not the capacity to build sufficient nuclear plants to help us solve the climate crisis. Even if you're willing and able to overcome all the other unsolved problems - affordability, accidents, waste

management, proliferation, and system inflexibility – we just do not have an unlimited amount of money.

DER SPIEGEL: The International Energy Agency has just acknowledged that the growth of renewable energies has slumped, as of late. Can the world still rely on them alone?

Dorfman: Look, we need to use the capital that we have for decarbonization in a way that gets the best emissions reduction for every euro spent in the shortest time. Nuclear is not competitive on both criteria. Renewables and energy efficiency reduce emissions more and faster. It's not a question of doing renewables and nuclear, it's a question of doing renewables or nuclear.

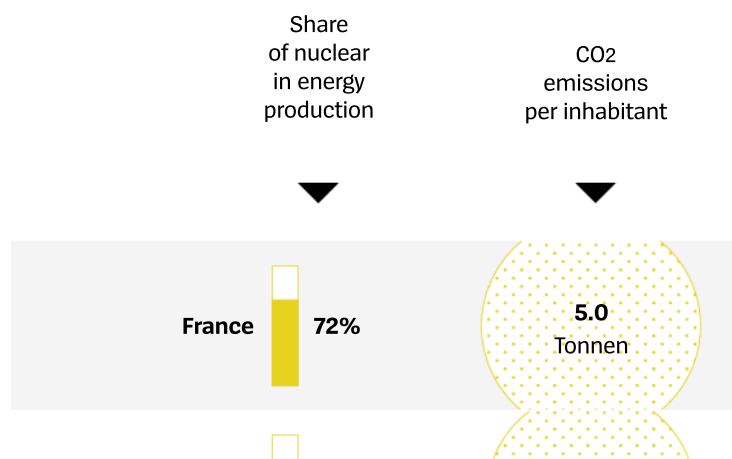
Qvist: Renewables and nuclear is a proven success story, renewables alone is not. Beyond decarbonizing today's electric grid, we must replace fossil fuels in transportation, industry and heating. We must provide for the fast-growing energy needs of poorer countries and extend the grid to a billion people who now lack electricity. That's just not possible without nuclear!

DER SPIEGEL: More than 80 percent of the world's primary energy still stems from fossil sources. Wind and the sun provide less than 2 percent. Worldwide energy consumption 30 years from now is projected to be about 50 percent higher than it is today. How can we get there?

Dorfman: We need to create a green hydrogen economy with all its components, energy efficiency, storage and interconnectivity between electric grids. The last thing that you need in such a system is nuclear, because nuclear is either on, or it is off. It is very bad at what we call load following...

DER SPIEGEL: ... you're talking about the process of flexibly starting them up and shutting them down when renewables fail.

Coming Clean Energy footprint 2018



Qvist: Obviously, wind and solar are wonderful. I am not here to be against anything. I'm for everything. But it is a fact that nuclear is the only scalable low-carbon heat source that we have. With that heat, we can provide district and industrial-process heating, and more effectively produce hydrogen. Things like that will make nuclear flexible for the grid while churning out 100 percent core power all the time.

Dorfman: Germany and other countries are eyeing new offshore wind farms dedicated to green hydrogen production. We don't need nuclear to do this.

Qvist: But let's say you have a week of lull. You don't have much sun because it's winter. You don't have a lot of hydro. Where is your power coming from?

Dorfman: It's a combination. We have to talk about hydrogen, interconnectors and load balancing. Even solar energy produced in the Sahara could be used to power parts of Europe. And we need storage...

Qvist: ... what kind of storage? If it's batteries, that's just an unimaginable cost on a grid level. If it's hydrogen, you have to build electrolyzers and hydrogen storage. That's what I mean when I talk about system costs. You have to pay for all these things.

DER SPIEGEL: Gas plants are very flexible. Why not use them in addition to renewables?

Qvist: This works, but it's a fossil energy source that emits a lot of CO₂ and pollutes the air.

DER SPIEGEL: The idea is to eventually replace the fossil gas by synthesized gas produced from hydrogen.

Qvist: Again, you would have to invest in all the infrastructure, and you need to include that in the costs. We don't have a hydrogen economy yet. And by the way, do you think it would be safer than nuclear? I am not so sure.

DER SPIEGEL: Are you kidding?

Qvist: Not at all. Statistically, nuclear power is the safest form of large-scale energy humanity has ever used. Mining accidents or gas explosions kill people, sometimes in large numbers, and smoke from coal-burning kills us, as I've mentioned before, in enormous numbers. By contrast, in about 60 years of nuclear power, only three accidents have raised public alarm, Three Mile Island, Chernobyl and Fukushima, and even during these catastrophic events not many people have been killed directly through radiation. I mean, we have hydroelectric power, which is a wonderful zero-carbon electricity source. But it has got a far worse safety

record than nuclear. Dams burst, thousands of people have died.

Dorfman: The problem with nuclear is that, if and when it does go wrong, things go really, really go wrong. I'm an advisor to the Irish government on radiation risk. We commissioned a study that stated clearly that if there was severe contamination from a nuclear accident, it would largely bankrupt Ireland because of impacts on agriculture. So, reducing risk to body counts is really problematic.

DER SPIEGEL: But don't we have to balance this risk against the existential risk of climate change?



Dorfman und Qvist with DER SPIEGEL reporters Philip Bethge (left) and Rafaela von Bredow (right) at University College London: "This is fear-mongering." Foto: Horst Friedrichs / DER SPIEGEL

Dorfman: The problem is that we all make different assumptions and come to different conclusions. Let's stick to what we know, and that is that radiation is dangerous to human health. An influential study in Germany, the KiKK study, showed that clusters of leukemia cases in little children and infants were more likely to be found near nuclear plants...

Qvist: ... this study has been debunked because it did not fully assess factors other than radiation. There is just no correlation between radiation and leukemia close to nuclear plants.

Dorfman: Every radiation-protection organization in the world will tell you that there is no safe dose of radiation. And when you talk about a nuclear accident, you're not simply talking about cancers such as leukemias. You are talking about a whole raft of other things that happen way down the line, including probably genomic instability in generations to come. The complexity of the debate is mind-boggling. Why would you want to invest money in a such a highly dangerous technology? And I haven't even started with the risks of nuclear waste.

Qvist: Civilian nuclear waste has never harmed anyone. We have stored it for 60 years in more than 30 countries and nothing happened. Highly radioactive nuclear waste is a tiny component in the vast mass of hazardous materials that we as a society produce, including toxic arsenic, mercury and lead, which last forever. And in the future, we will be able to burn nuclear waste as fuel in new types of reactors.

Dorfman: It's not that simple. We have high-level radioactive waste, intermediate and low-level waste. There is the idea that we can dig a deep hole and get rid of it. However, new research shows that the materials that the U.S. and other countries plan to use to store high-level nuclear waste will likely degrade faster than anyone previously knew.

Qvist: This is fear-mongering, I am sorry. How many people have died from civilian nuclear waste? None. It's a solved problem. The Finnish nuclear regulatory agency has approved the plans for a repository near Olkiluoto. It is being built and will be ready soon...

Dorfman: ... will it work? That's still open to debate. We will only know in about a thousand years.

DER SPIEGEL: Mr. Dorfman, you are 64 years old, Mr. Qvist, you are 34. Do you think that our discussion is an intergenerational dispute?

Qvist: I believe so. In Sweden, for instance, you see the young generation being increasingly pro nuclear because they see it as an efficient measure against climate change. We see that once misconceptions are being fought by facts, opinions can change rapidly. In polls, only 11 percent have an anti-nuclear stance.

Dorfman: If you were to ask that question in Germany, you may well receive a very different answer. I don't believe that it is a generational issue. Everybody's worried about climate change. The key is how we can respond to it. And therein lies the discussion.

Qvist: Just for kicks, I might agree with you.

DER SPIEGEL: Mr. Qvist, Mr. Dorfman thank you very much for this interview. **S**

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