



# CLIMATE 2023

A Preview of the Year Ahead

## Nuclear Energy

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# Nuclear Energy



TERRESTRIAL  
ENERGY



CEZ GROUP

**Kateřina Bohuslavová** is the Chief Sustainability Officer of ČEZ Group, a company based in Prague that has one of the largest utility providers in central Europe, with two nuclear plants in its portfolio.

**Simon Irish** is the CEO of Terrestrial Energy, based in Ontario, Canada. Terrestrial Energy is developing an industrial co-generation plant that uses Generation IV reactor technology. For the first time, this provides a clean energy alternative to high-quality heat from fossil combustion.

## Summary

Is the world finally waking up to the potential of nuclear? We look at policy across the globe as the shock of Ukraine, and a re-think of the post-Fukushima era reinvigorates the sector.

Watch the full session [here](#).

## Key takeaways

- The perception towards nuclear is changing. While the concerns of NIMBY (not-in-my-backyard) remain, governments are coming around to the thinking that the safety record of nuclear, the zero-carbon output, and the energy self-sufficiency it creates trumps all previous concerns.
- Europe, especially countries like the Czech Republic, see nuclear as the ultimate source of decarbonized power. Landlocked European countries have limited use for wind, and solar and nuclear can move them away from Russian fossil fuel dependence.
- Conventional nuclear exists in a world where it effectively has a government seller and a government buyer. The opportunity for a new nuclear machine is to position itself so that it attracts private capital.
- Thermal energy is required for many core industrial processes, including ammonia production. Yet over the last 20 years, almost all low-carbon developments have focused on electrification. As a result, there is now a massive opportunity to have an impact in carbon terms by providing a low-carbon alternative to fossil combustion in the chemicals sector.
- A slew of private companies, including Terrestrial Energy, are working on smaller, safer, next generations technologies such as molten-salt coolants that will dramatically alter the range of commercial options. Nuclear won't just be for electricity production. Higher heat points will enable a dramatic expansion into hard-to-abate sectors like chemicals.
- Time remains the enemy of nuclear with the 2030s being realistic for wide-scale nuclear adoption.

## Paul's observations

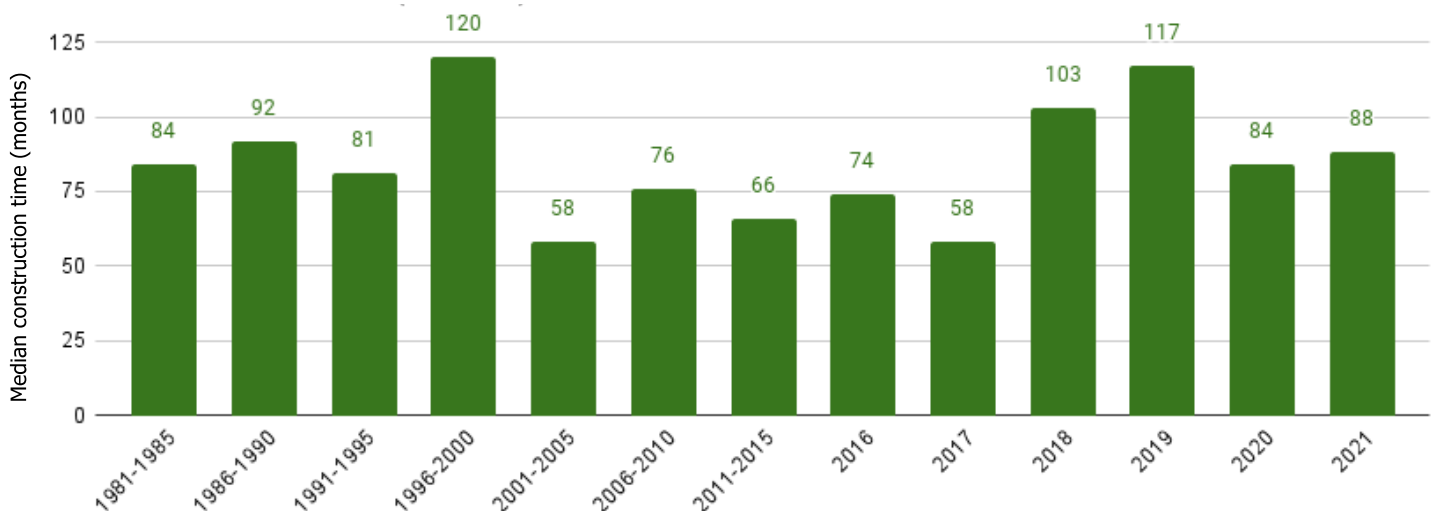
There is so much to be encouraged about when thinking about nuclear power. This interview was conducted before the announcement of a successful nuclear fusion test in the United States, but the private sector is embracing an array of new technologies designed to dramatically expand the use case for small-scale reactors in industrial processes. The holy grail for hydrogen, chemicals, steel, and cement is high-heat, small-scale reactors that can decarbonize many processes. The problem is we remain years away from this happening.

*"Ten years in the nuclear sector is a short time."*

This was one of Kateřina's closing comments, and for all the innovation, capital, and brain power being invested, this problem has yet to be solved. We are a decade away from broad-based adoption, and in the meantime, Europe has to find an alternative to Russian gas. It is not nuclear this decade.

There are many promising private nuclear companies raising billions and developing next-generation technology. The common theme is that none have a working reactor. Despite marginal improvement, government regulation is behind the curve. Nuclear energy remains an early-stage investment theme where free cash flow is a decade away.

### Median construction times for reactors since 1981



In 2021, the median construction time for reactors grid-connected was 88 months.

Source: World Nuclear Association





# Questions & Answers

## What is the significance of Terrestrial Energy's work?

*Simon Irish:*

Thermal energy is required for many core industrial processes, including ammonia production. Yet over the last 20 years, almost all low-carbon developments have focused on electrification. As a result, there is now a massive opportunity to have an impact in carbon terms by providing a low-carbon alternative to fossil combustion in the chemicals sector. Ours is 580°C. Conventional nuclear is 280°C. This gives us a high-quality source of direct heat and very efficient heat for generating electricity. High heat makes electricity more efficient, and in our case, 50% more efficient than a conventional reactor system.

## Nuclear: The changing perspective as a clean fuel

*Kateřina Bohuslavová:*

There are over 400 nuclear power plants worldwide, and safety track records have been incredibly good. We can compare nuclear's safety to that of air travel: remarkably safe, but any accident is seen as devastating.

In the case of the Czech Republic, I can only see a way forward with nuclear. Renewable energy is limited as we are landlocked, and the sun goes down by 4 p.m. in winter. So, we can choose fossil or nuclear, with fossil fuel supply coming mainly from Russia. For us, the choice is clear.

*Simon Irish:*

Nuclear energy is an extraordinary natural phenomenon associated with energy in the atomic nucleus. That energy is incomparable as an energy source to move human societies forward. So the fundamental question of the moment is: What machine will we use to safely and efficiently harness nuclear energy? We have now used the same nuclear machine for 75 years. The opportunity in front of us is to use many nuclear machines. We have used just one commercially, but many in national labs have been designed and demonstrated over the decades.

The nuclear industry was killed because the current nuclear machine cannot compete with cost innovation in wind, solar, or natural gas fracking. But, new generation nuclear machines are more designed and suited to societal and economic needs. In addition, its safety and waste profile are far more sympathetic to the softer needs associated with deploying nuclear energy.

## Are new machines necessary for nuclear to be relevant going forward?

*Kateřina Bohuslavová:*

Innovation is the key, and we have a research and development company that collaborates with smaller companies designing new reactors.

Large nuclear power plants are costly, but we can make them cheaper and better. We had cheap energy available in the past, but that also meant there was less money available for innovation, so if there is a silver lining to today's energy crisis, there is no more money available for investment. Smaller new reactors can appeal to commercial investors, even though state actors usually lead the deployment of conventional large-scale plants.

ČEZ Group is undertaking a study for a small nuclear reactor to be built near one of our existing power plants because we already have geographical data.

### **The cost curve of new nuclear technology**

*Simon Irish:*

Even conventional nuclear projects would implement new designs; we have seen spiraling costs associated with those projects. Nevertheless, the cost analysis of constructing a new-generation nuclear machine is sufficiently compelling to accept some risks. The opportunity for a new nuclear machine is to position itself so that it attracts private capital. Conventional nuclear exists in a world where it effectively has a government seller and a government buyer. The value proposition for nuclear has always been strong. Even conventional nuclear is safe, clean, efficient, and great for national energy security. In the 1970s, France decided that they would not tolerate the insecurity of supply as a nation and built a generation of nuclear plants. It was a vigorous program, and they effectively decarbonized their grid in 15 years.

*"The cost analysis of constructing a new-generation nuclear machine is sufficiently compelling to accept some risks." – Simon Irish*

### **How does nuclear power relate to energy independence?**

*Kateřina Bohuslavová:*

Nuclear is reliable and more predictable than any other source of energy. Nuclear fuel can be flown to where it is needed, unlike other fuels, so there are more options for supply, and it is easier to avoid overdependence on a single supplier. Energy is critical infrastructure, and each state must have a secure independent supply. Furthermore, there is fear and some strong opinions around nuclear, so honest communication and science-based discussion are essential. The term "nuclear waste" is misleading as it can be recycled for use and potentially used in nuclear fusion in the future.

It is important to invest now to develop solutions because of the known potential benefits of nuclear.

### **Molten salt versus water coolants**

*Simon Irish:*

The Terrestrial nuclear machine does not use water as a coolant, whereas conventional nuclear inevitably

must use water as a coolant at high pressure and operate the plant at a relatively low temperature. That has profound limiting commercial consequences. We also use molten salt as a coolant, which allows us to operate at a higher temperature, low pressure, and with high health and safety.

In terms of climate change, we have done things at the margin for 25 years, and now we need to do transformational things because we are barely even treading water on the problem.

Nuclear innovation has never been driven by young high-tech companies, but by governments. It does not need to be left to national labs and governments now because we have 60 years of experience in the supply chain and powerful analytical tools. The support of government policy remains critical, of course. The principles of nuclear safety are agnostic to whether it is molten salt or water used as a coolant. After 75 years, these principles are similar wherever you go, though they may be articulated with a different vernacular at the state level, with different terms and regulatory documents. Nuclear regulation is sovereign to the state and will remain so for a while. The regulators in major nuclear markets are increasingly capable of analyzing and understanding, ultimately acting on a license to construct a power plant with one of these new technologies.

### **How long does it take to build a nuclear plant?**

*Kateřina Bohuslavov:*

EZ Group is going through the tendering process for constructing a new plant, and we have received offers from America, France, and South Korea. The evaluation of bids has just begun, but it is a long process due to security and cost. The files are so thick that it is hard to summarize, but we hope to process all of that to decide by the end of next year.

Due to the war in Ukraine, we are particularly motivated to accelerate the development of new plants. At the same time, we are modernizing existing plants and looking at innovating smaller plants. We launched a project a couple of weeks ago for one of our plants to supply heat to a regional capital city in the Czech Republic by the end of 2023. I would be cautious about timelines because every project takes longer and more money than planned. However, there is a greater sense of urgency in crisis, albeit without jeopardizing safety.

### **Are you expecting any changes in European or other international legislation to make developing nuclear plants easier?**

*Kateřina Bohuslavov:*

I see more openness and a more data-based approach to nuclear energy, considering sustainability and net zero targets such as Fit for 55. So I don't expect any legislative changes in favor or against nuclear.

*Simon Irish:*

There is a standard set of permitting requirements for any industrial plant or infrastructure construction, which all take a long time to achieve. For example, a transmission line from Quebec down to New York State goes through the permissions process. We are now 20 years into that. In this instance, it is a linear permitting problem that is complicated in western markets.



A competitive advantage for nuclear is that there are many existing nuclear brownfield sites where we could build additional reactors. Commercially, we are looking at this as a wave of replacements for existing plants that may be coming to the end of their service lives. This usually has local political support, a fewer not-in-my-back-yard (NIMBY) objections.

**Does it make sense to extend the service life of existing plants?**

*Simon Irish:*

Where there is an economic case to extend a plant's life, it makes sense to do so. These nuclear plants are on expansive sites where there is plenty of space for building additional plants. There is plenty of room to be new reactors on existing sites.

*Kateřina Bohuslavová:*

This year, the EU taxonomy for sustainable activities included nuclear as a transitional activity, which I see as a significant victory from a legislative perspective, and a strong signal that the perception of nuclear may change. A renewed sense has brought up that nuclear is necessary for meeting net-zero targets.

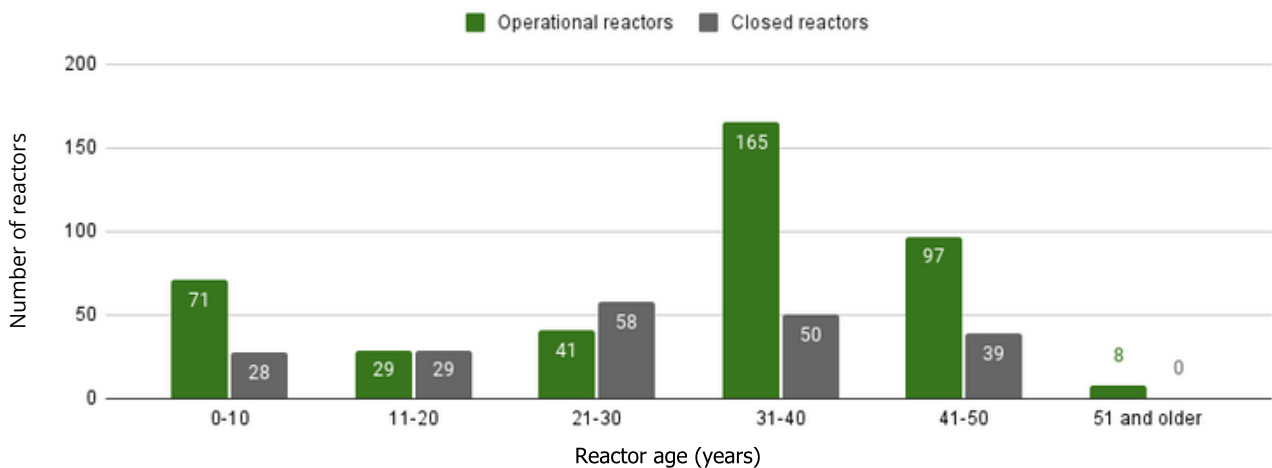
**Where will nuclear be in 20 years from now?**

*Kateřina Bohuslavová:*

Ten years in the nuclear sector is a short time, but the progress in the previous 20 years of mobile phones and computers gives me hope for the next generation of nuclear. Perhaps we'll crack nuclear fusion in that time. I hope that we'll find innovative solutions and demystify nuclear.

Cheap and abundant energy can improve lives and raise millions out of poverty.

**Age distribution of nuclear reactors in the world**



The mean age of the 411 operational reactors was 31 years, and that of the 205 closed reactors was 27.7 years.

*Source: World Nuclear Report*



## **How can we be sure that the innovation that you are talking about will deliver on price, ease of construction, and more?**

*Simon Irish:*

The light water reaction was designed as part of a military mission, which drove the design decisions and the technology that went into those early plants. The nature of this system is that we have had to use water inefficiently. Following a first principles approach to design a nuclear plant for a safe, stable, civilian power supply, water would not be used as a coolant, which has been known for 60 or 70 years.

Terrestrial Energy is a group of young companies that sit apart from the military-entangled nuclear industry, pursuing a single objective to produce zero carbon, safe, secure energy for civilian use, using technologies that have been tried and tested in national labs. We can do so much better than existing nuclear technologies.





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