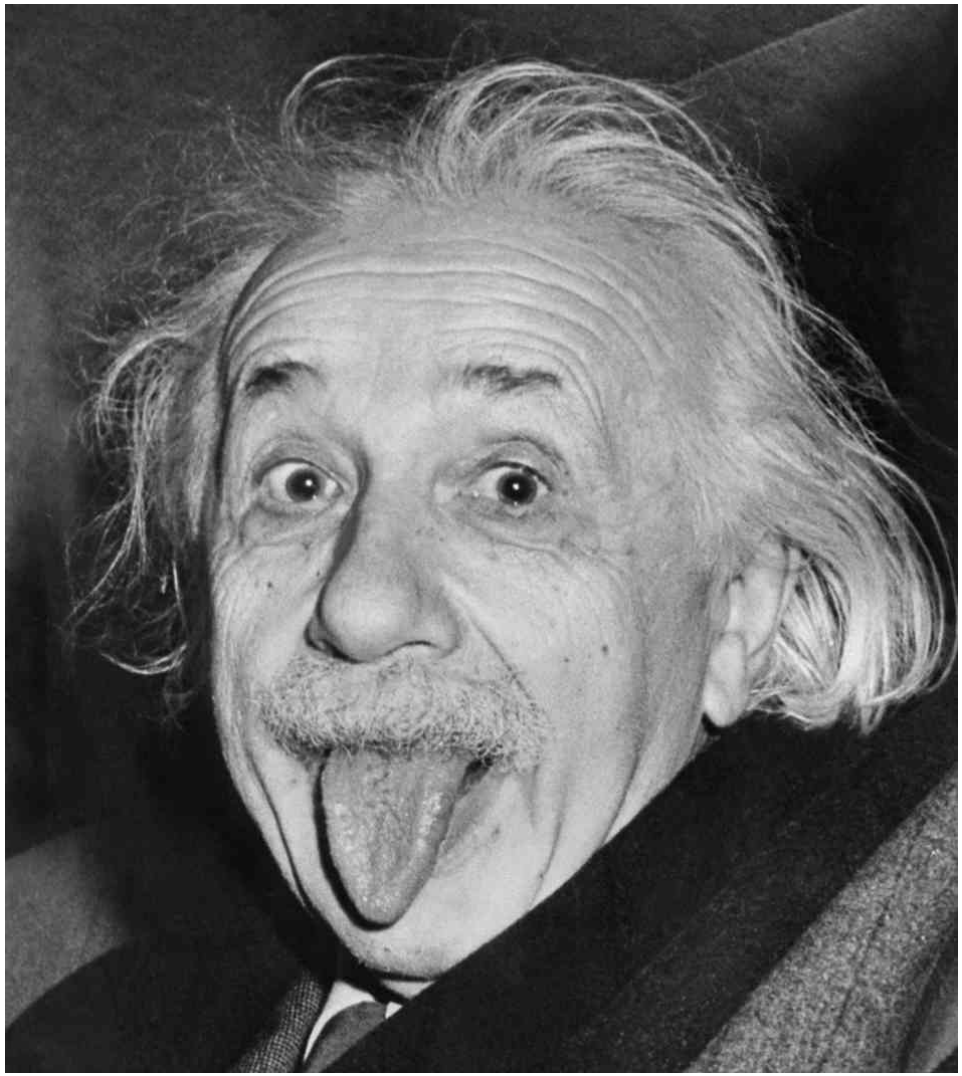
Hello everyone, thank you for being with us today!

I am now going to talk to you about Nuclear Energy. And more specifically about the interest of nuclear energy in our world today!

So yes, when we hear nuclear energy we are afraid! We say to ourselves that it is dangerous! We are immediately afraid with signs like this one:

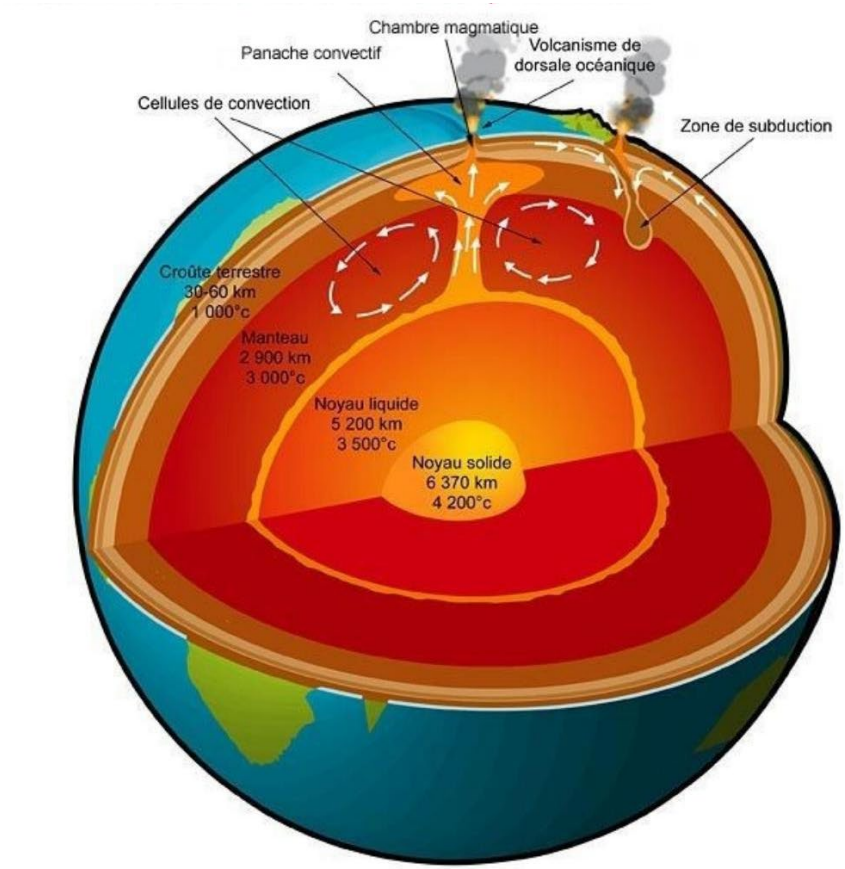
So I will start with a brief history of nuclear energy.

Radioactivity is a natural physical phenomenon, manifested by the fact that certain types of unstable atomic nuclei can dissipate part of their initial mass in the form of energy (transformed according to Albert Einstein's famous formula E=mc2). You know that very clever little man :

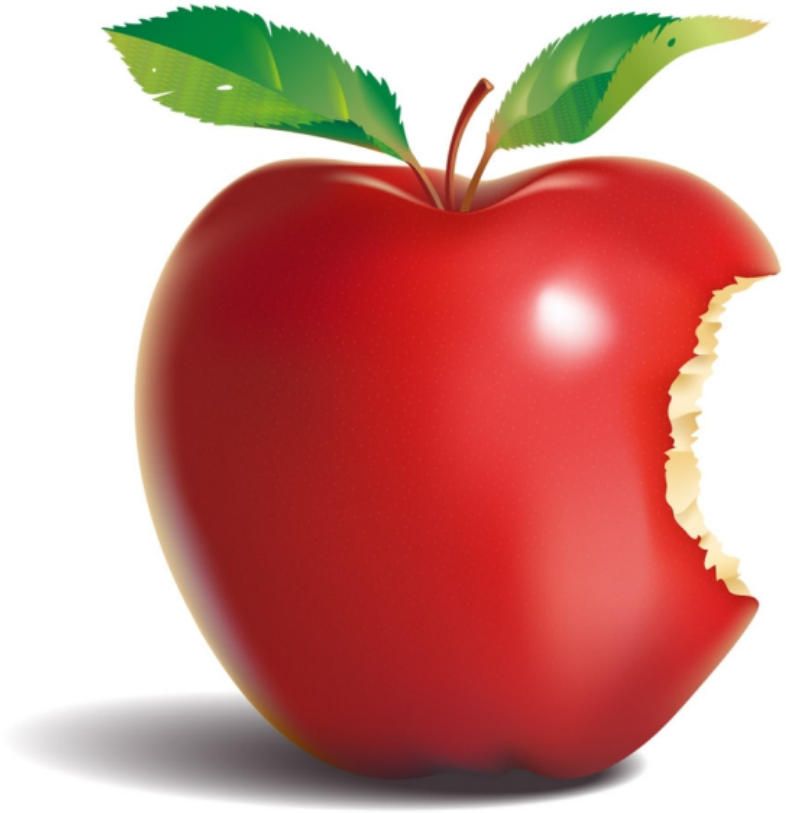


And thus spontaneously evolve into more stable atomic nuclei through disintegration.

A radioactive material naturally releases this energy in the form of a stream of ionising radiation and heat. This heat is particularly intense for the nuclear fuel in the reactor. This is why spent fuel is stored in a deactivation pool near the reactor. This is the same phenomenon that causes some of the heat in the earth's continental crust. You may not have known it, but our earth is radioactive!



So is this simple little apple which naturally gives off about 100 bq/kg! A very small and insignificant amount.



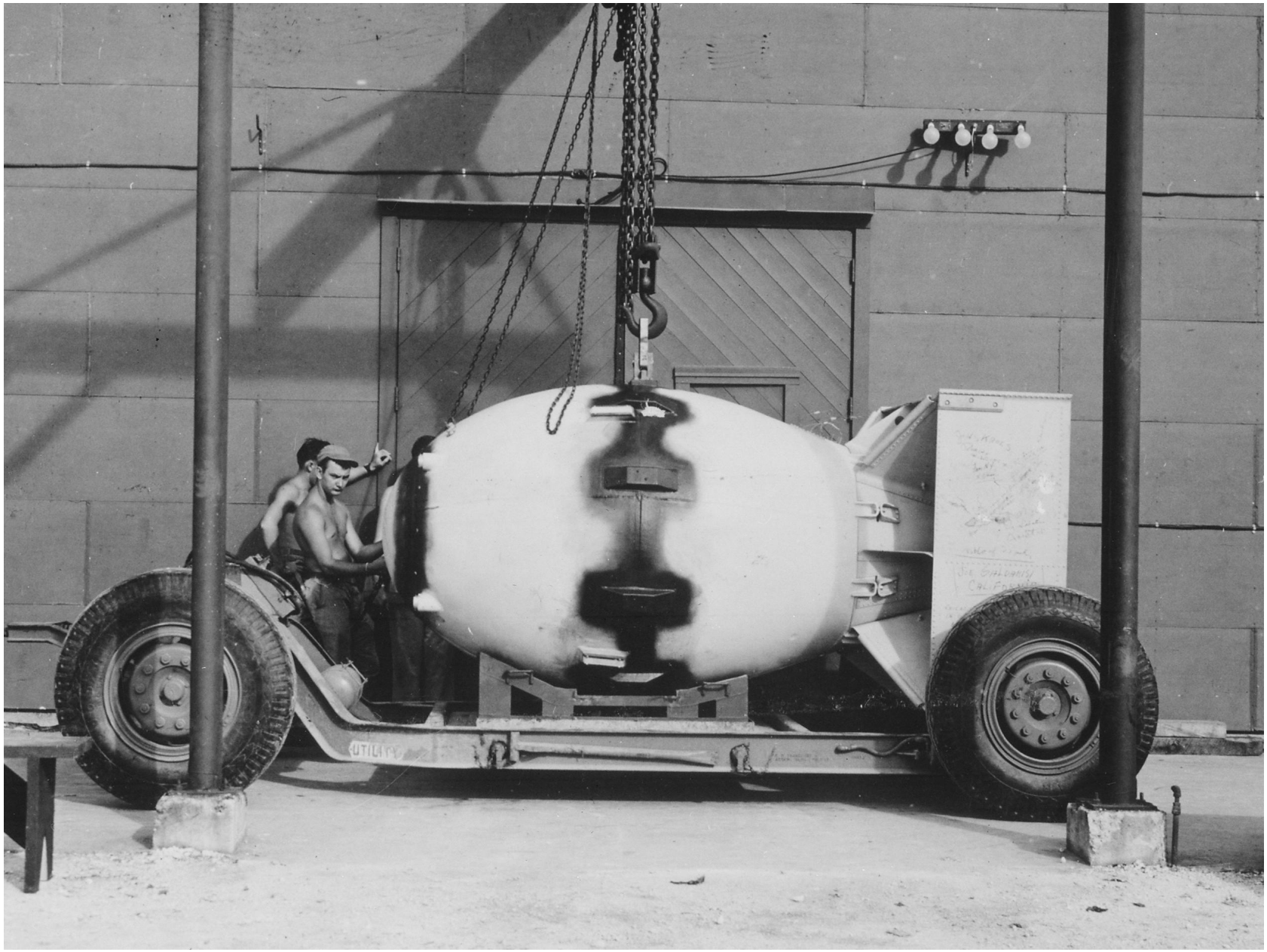
So, radioactivity was discovered in 1896 by Henri Becquerel, during his work on phosphorescence: phosphorescent materials emit light in the dark after exposure to light. Becquerel assumed that the glow that occurs in cathode ray tubes exposed to X-rays could be related to the phenomenon of phosphorescence. His experiment consisted of sealing a photographic plate in black paper and bringing this packet into contact with various phosphorescent materials. All his experiments were negative, except for those involving uranium salts, which impressed the photographic plate through the paper layer.

Boring blah blah blah! Let's go straight to the facts!

It was not until 1938 that the truth began to emerge, and the neutron bombardment of uranium was understood.

In 1939, the USA feared that Nazi Germany would acquire an atomic bomb. Albert Einstein wrote to President Roosevelt to draw his attention to the new energy source of uranium and the possibility of building a bomb. From October 1939 to June 1942, the necessary facilities were set up to build an atomic weapon: the Manhattan Project led by General Leslie Richard Groves and the physicist Robert Oppenheimer.

That's how the 2 atomic bombs Little Boy and Fat Man were born to end the war against Japan!



And that's how the fear of nuclear power was born !

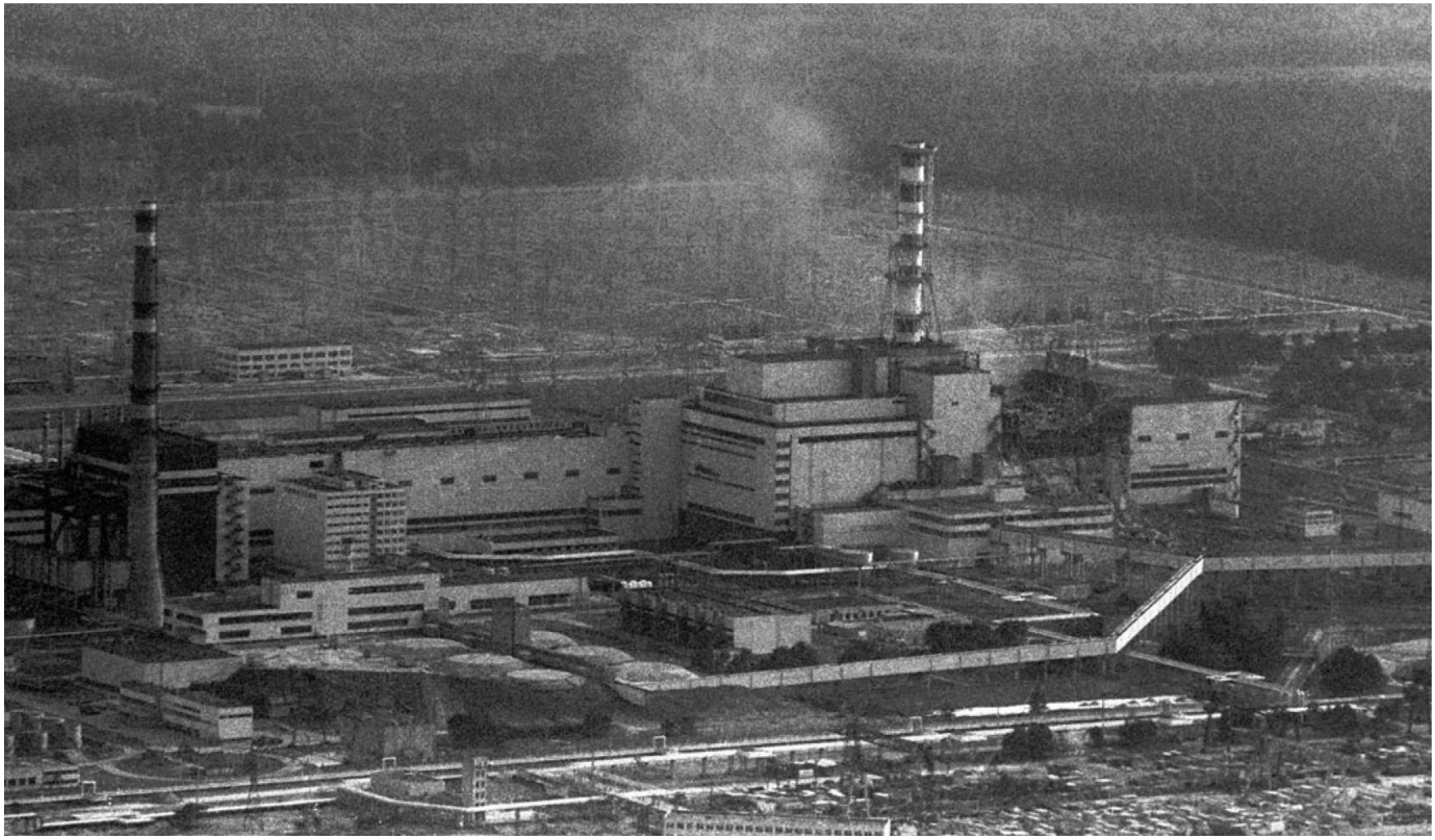
In the 1950s and 1960s, all the nuclear tests that we are familiar with ensued. In particular those of the Americans in the Bikini Islands. Which allowed us to get this guy :

Who lives in the town of Bikini Bottom.

Beyond the atomic weapon that allowed everyone to protect themselves during the cold war. It was soon realised that nuclear power could be a fantastic energy source to power our growing electricity needs. Nuclear power plants were born:

I will spare you the details because there are many ways of producing nuclear energy and each country has tried different ones, all of which are based on fission reactions. What you have to remember is that in France, for example, we use fast neutron technology.

Over the years, we have improved our knowledge and the safety of our power plants after feedback from the international community. After that: the Chernobyl disaster in 1986, which did not help the public's confidence in nuclear safety. Or more recently in 2011 with the Fukushima accident.



Yet nuclear energy is a safe energy! And now we come to the figures!

In 2016, 447 nuclear reactors were in operation worldwide, with a total capacity of 390 GWe spread over 20 countries on four continents. The countries with the largest nuclear power capacities are, in order, the United States, France, Japan and Russia.

Nuclear energy is scary, it's true! Yet it is a safe energy! There are indeed accidents, as everywhere. But let's take the example of the plane. That we will soon be able to take back after the Covid. Today, it is commonplace to take it, it is the safest form of transport. However, each accident directly results in 200 to 400 deaths. It's the same with nuclear power!

For Chernobyl, 50,000 of the liquidators died very quickly, 200,000 were invalided out or disabled. So we can say 250,000 deaths. For Fukushima, time will tell, but thanks to the current safety measures, there were no deaths thanks to the rapid evacuation and the use of robots.

To meet our greenhouse gas reduction targets, nuclear power is essential. Renewable energies are by nature intermittent and nuclear is our only decarbonised energy resource.

For example, all the electricity consumed by SNCF to run its trains all year round (and carry 1.7 billion passengers) is 9 TWhe, which corresponds to less than 200 kg of high-level radioactive waste, assuming that all the electricity is nuclear. If this electricity were produced with coal, it would generate about 700,000 tonnes of solid ash, usually stored in the open air, and an emission to the atmosphere of almost 1,000 tonnes of soot and fine particles. This coal waste contains more or less toxic products, often with an unlimited lifespan, such as arsenic, lead, thallium, mercury and even uranium and thorium, in quantities of tonnes or even tens of tonnes!

The chairman of the Intergovernmental Panel on Climate Change (IPCC), Hoesung Lee, detailed 21 models available for the energy transition at the IAEA conference in October 2019. The IPCC has studied 89 trajectories for containing the global temperature rise to 1.5°C by 2100. These trajectories show a significant effort in terms of energy efficiency, as well as a doubling of the share of electricity in total energy (from 19% in 2020 in median value to 43% in 2050). Nuclear power contributes to the decarbonisation of electricity in the vast majority of the trajectories. For the IPCC Chairman, nuclear power faces two main challenges: competitiveness with other non-fossil fuel technologies, and accelerating its deployment rate; he concludes: "I wish you success in meeting these challenges

because the climate needs all the help it can get! ". The Director General of the International Energy Agency, Fatih Birol said: "We need to look at all clean technologies. Solar and wind are important. But we think nuclear is also important. We don't have the luxury of choosing our preferred technology."

Nuclear power can still teach us a lot with new uses such as SMR or fusion. Fusion refers to the joining of two light nuclei to form a heavier nucleus. This process releases enormous amounts of heat and theoretically produces four times more energy than fission for the same fuel mass. The ITER project was launched in 2005 by 34 countries and tests are taking place in France. I think we can be proud of that !

In the future, and this is already the case in Japan. We could think of recovering the final waste by using the heat emitted by the reactors and heating buildings thanks to heat exchangers.

Thank you for your attention!