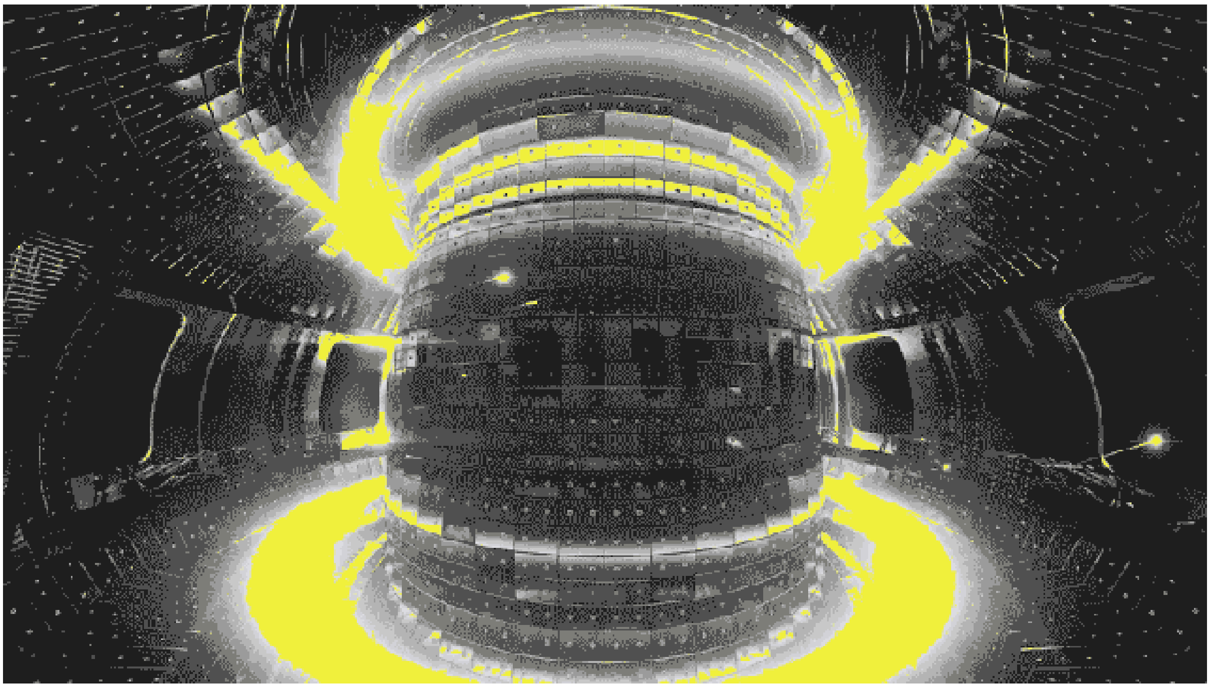
What If You Created a Sun on Earth?

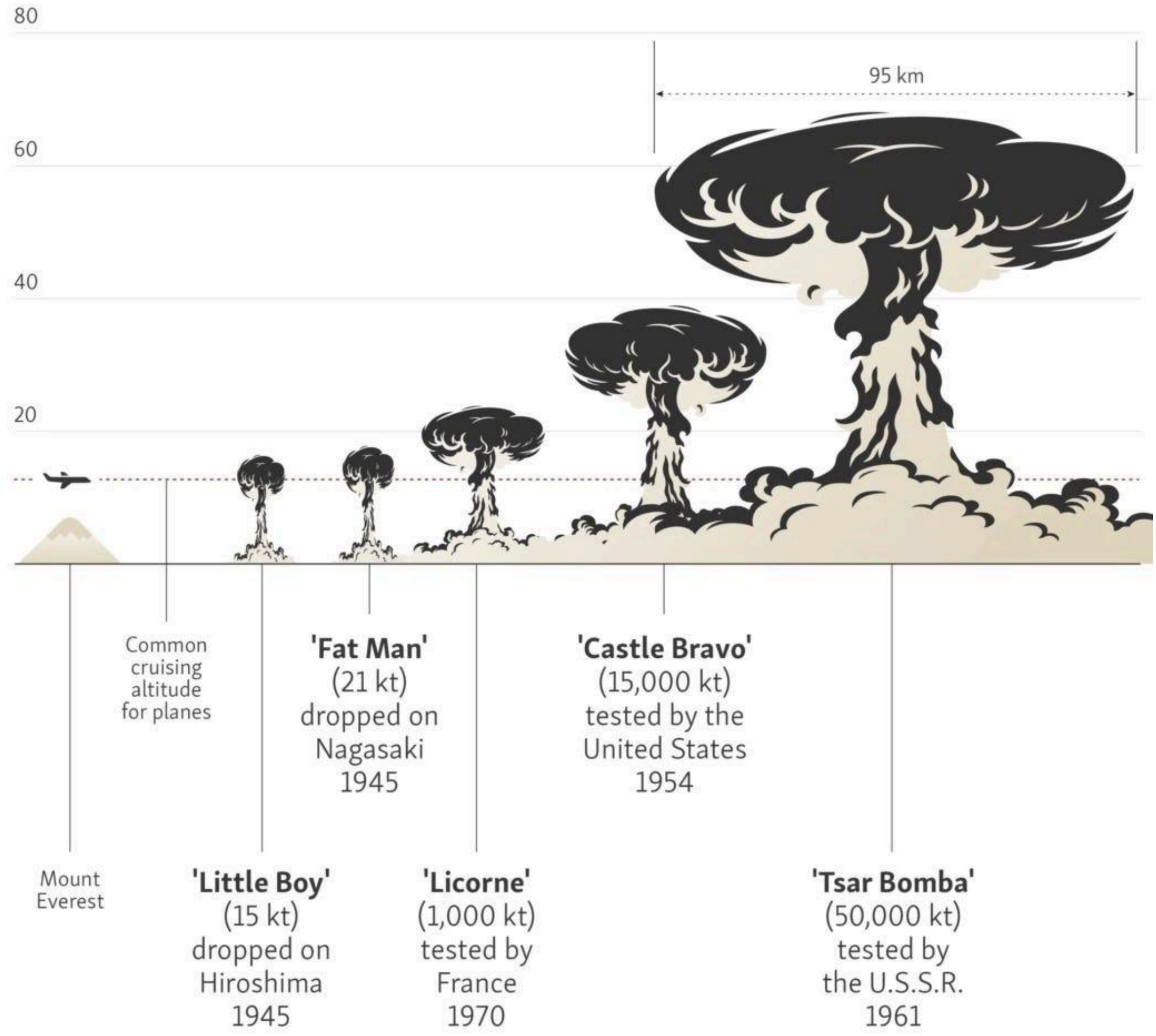
By Vlada Yarosh



Imagine a hot and sunny day, the sea, sand, and a cocktail in your hand. What do you see and feel? The beautiful tan that remains on your body after such a holiday, just like photosynthesis in plants, is provided by the sun. The Sun is perhaps the only astronomical body that we can not only see but also feel its influence. It has enormous power and energy.

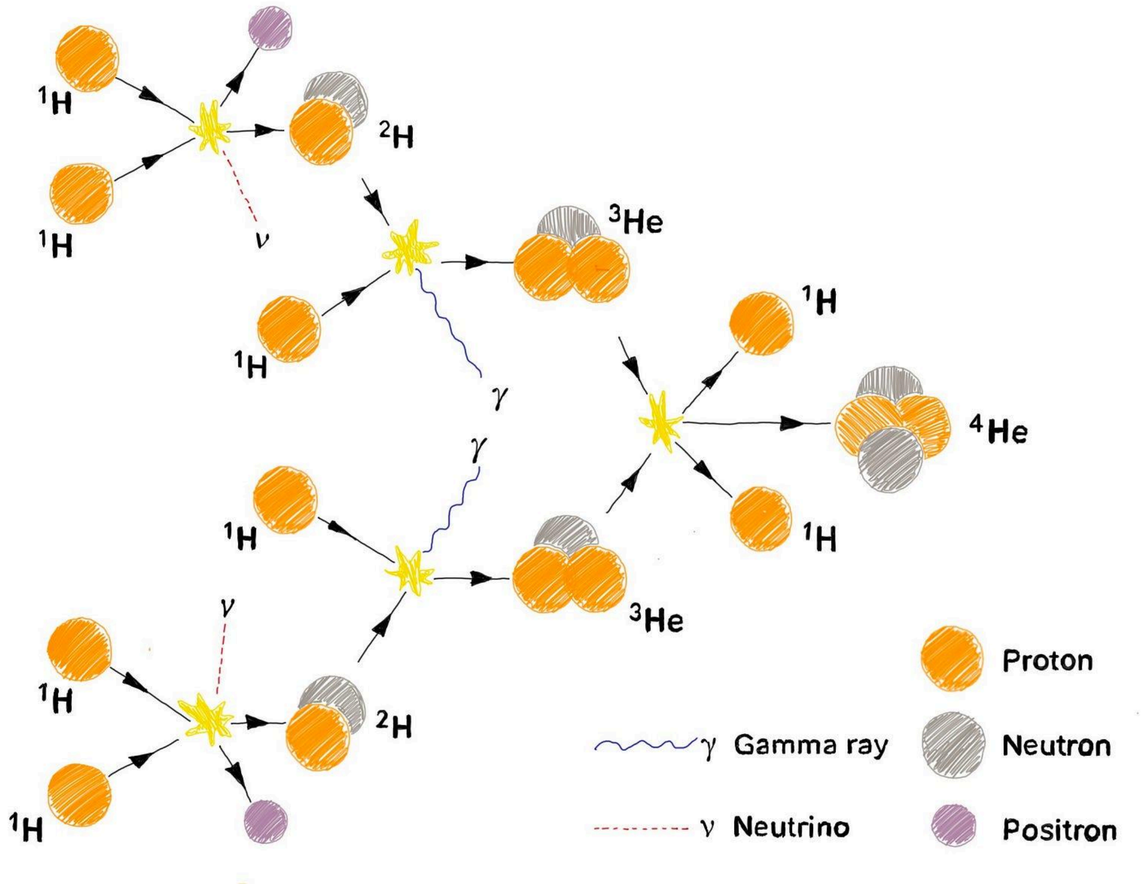
How can we feel the sun if it is 150 million kilometres away?

For example, the Tsar Bomba is the most powerful bomb in the history of the world.



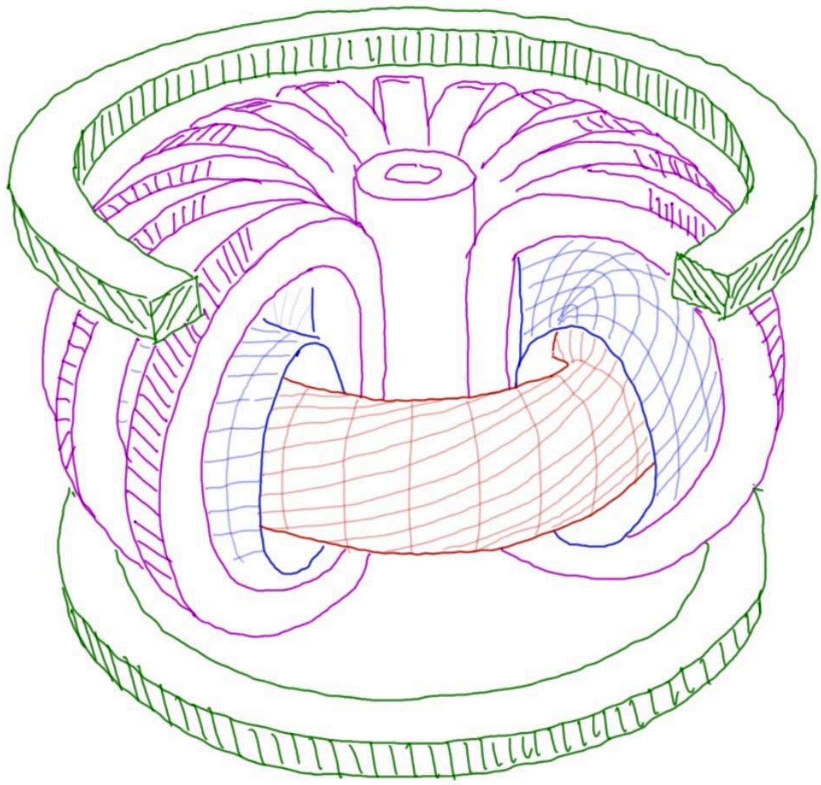
Note: Mushroom cloud heights are approximate.
The yield of a nuclear weapon is expressed in kilotons (kt). One kiloton equals 1,000 tons of TNT.

However, the Sun produces the energy equivalent of nearly **2 billion** of these bombs exploding in just **one second**. This incredible amount of energy is generated by **thermonuclear reactions** in the Sun's core. Inside the core, the temperature reaches hundreds of millions of degrees Celsius, causing atoms to shed all their electrons and enter a **plasma** state. Due to high pressure, the atoms come closer together, leading to a positron flying out of one of them. This results in the proton changing its charge and becoming a neutron, and another proton sticking to it. As a result, helium is formed, and energy is released, starting the thermonuclear reaction.



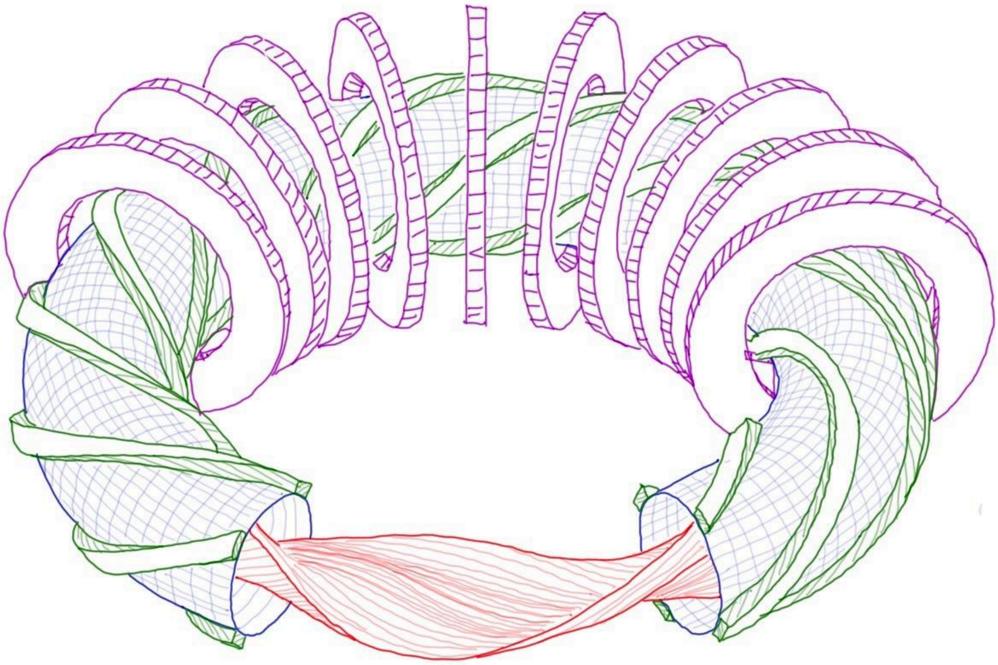
One of the main challenges in creating plasma on Earth is achieving the high temperatures and pressures needed to trigger nuclear fusion. In contrast, on the Sun, these conditions are naturally provided by enormous **gravitational pressure.** To replicate these conditions, scientists are working on creating several fusion reactors. One such project is **ITER** (International Thermonuclear Experimental Reactor), which has been in development since 1985. ITER will be built in the south of France, near Marseille, and involves 35 countries contributing to the construction and supply of reactor components. The total cost of the project is already approaching €20 billion, making it the largest thermonuclear reactor ever built. It will be as tall as a nine-floor building and will use a type of reactor called a **Tokamak** (toroidal chamber with magnetic coils), which was developed in the USSR in 1957.

The Tokamak reactor uses hydrogen isotopes, **deuterium**, and **tritium**, to produce fusion. These isotopes are injected as a gas into the vacuum chamber of the reactor. The gas is then heated to 150 million degrees Celsius using electricity and microwave radiation, which transforms it into plasma. A strong magnetic field keeps the plasma inside and out of contact with the walls of the reactor. The scientists' main goal is to achieve more energy than was used to start the reactor. Researchers plan to launch ITER in France in 2025 to begin receiving plasma. If the experiments are successful, the next step will be to build a prototype fusion reactor for power stations, called **DEMO**.

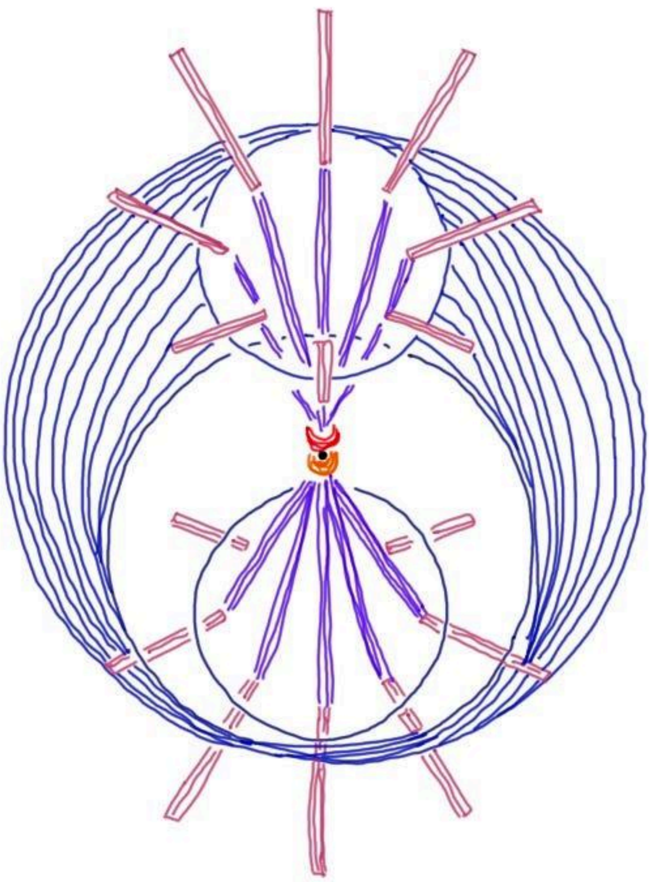


There are several other types of reactors in the world besides the Tokamak fusion reactor.

One of these options is the **Stellarator**, which was invented by American physicist L. Spitzer in 1951. The principle behind the Stellarator is very similar to that of the Tokamak – it is also a closed magnetic trap used to hold plasma. However, the magnetic field in the Stellarator is generated by **external electromagnets,** making it a very reliable and stable device. Its design, however, is so complicated that previous technology was not advanced enough to build it. With the advancement of programming and modelling, scientists are now building a new generation of stellarators.



Another type of reactor is the inertial confinement fusion reactor, which has been successfully experimented with in the USA. The **National Ignition Facility** (NIF) is a ten-floor building that houses this reactor. Inside the NIF, 192 high-powered lasers are aimed at a long tunnel. After travelling the length of the tunnel, the lasers hit a series of mirrors which then reflect the rays onto a tiny target made up of deuterium and tritium. The target is heated to a temperature of 100 million degrees, causing it to vaporize rapidly. The resulting shockwave from this explosion compresses the target and triggers the fusion reaction. This reactor is not designed to produce electricity, as the development of such a reactor requires extreme precision. The purpose of the reactor is to demonstrate that it is possible to initiate a fusion reaction and **produce more energy than is consumed**.



But why do we need a way to generate energy through a fusion reaction?

Today, the world produces energy by burning fossil fuels, splitting atoms, or using solar panels. However, these methods have drawbacks. Burning fuel is extremely harmful to the environment and produces toxic emissions. Nuclear waste from splitting atoms emits dangerous levels of radiation, which can harm living beings and the environment. Solar panels, on the other hand, are a renewable and clean source of energy, but their output is limited, and they are not efficient enough to provide the amount of electricity needed on a large scale.

If fusion were widely used, it could offer a **revolutionary solution to the world's energy needs**. For example, a glass of seawater could produce as much energy as a barrel of oil. Additionally, a fusion reactor is considered to be much **safer** than a traditional nuclear reactor. If a fusion reactor malfunctions, there is no risk of an explosion or radiation leak, and the reactor simply stops working.

Unfortunately, these technologies still require a lot of testing because there are already a couple of problems that scientists are working on. The first problem is that simple hydrogen is **not suitable as a fuel**; instead, deuterium and tritium are used. Deuterium is stable and can be found in seawater, while tritium is rarer and radioactive, and there are only a few kilograms of it in the world. It costs about $30 million to create one kilogram of it. However, it is possible to replace tritium with **helium-3**, an isotope of helium, which is also a very rare element on Earth. But that's where the Moon could help. There's a theory that the solar wind could have created huge deposits of helium-3 on the Moon over billions of years. So, instead of making helium-3, we could mine it from the Moon. If we learn how to extract helium-3 from lunar dust, we could **supply humanity with energy for thousands of years**.

In conclusion, discovering a way to produce energy through fusion would be a monumental breakthrough in science. It would provide a nearly infinite source of clean energy capable of producing electricity for centuries to come. The challenge of generating electricity still hinders humanity from making new scientific discoveries. Every project created requires electricity, and the production of it through current methods is highly detrimental to the ecology of our planet. Developing alternative energy sources is the way forward for the global energy industry. The man-made sun is the key to unlocking new possibilities. The future is in our hands!