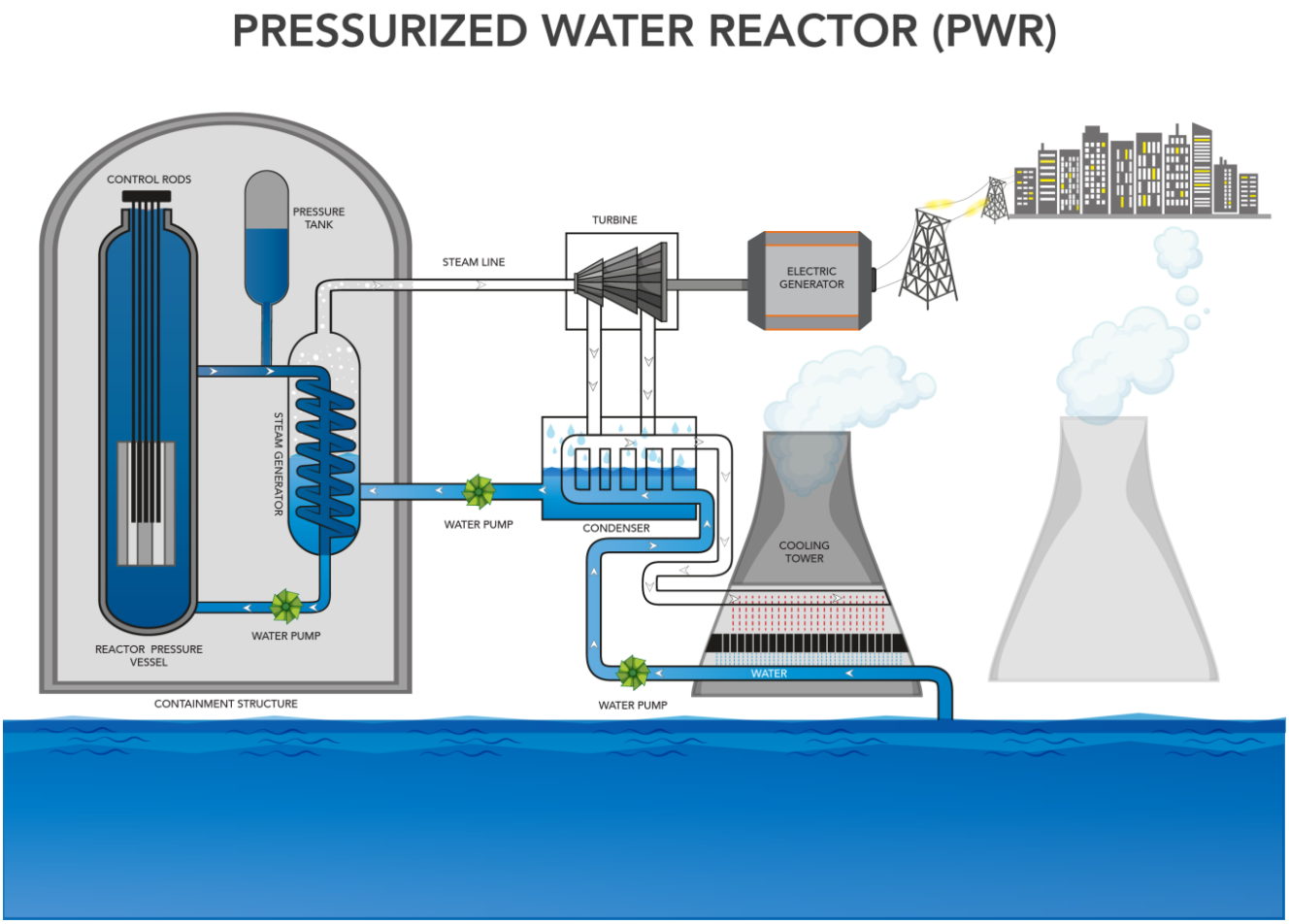
Nuclear Energy as a Clean Energy Source

Nuclear energy as a clean energy source remains a heavily debated topic. When we think of clean energy, many of us tend to think of wind or solar. We tend to overlook nuclear power, despite it being the world's second-largest source of low-carbon power.

Nuclear power is a clean energy source. This is because nuclear plants tend to produce minimal greenhouse gases. However, this does not mean it is renewable. Nuclear power plants use raw materials that are finite on Earth. Is there a place for nuclear energy in our power grids, or is it an ageing technology to be phased out by cheaper and smaller-scale renewables?

How Nuclear Reactors Work

Nuclear reactors use steam turbines. The reactors contain and control chain reactions. Fueled by uranium, these reactions split atoms, so they collide with other atoms, releasing heat and energy. This warms a cooling agent (such as water), producing steam that spins turbines to make electricity. The operating temperatures, pressures and loop cycles of these reactors vary greatly. Light water reactors are often used because of their many advantages in terms of corrosion and control. Other designs involve more complex mechanisms. These include different heat exchanging fluids and fuel varieties.



Pressurized Water Reactor. Source: Energy.gov

Nuclear power stations produce waste. This is sorted by radioactivity:

- **Low-level** – Around 90% of waste gives out little radiation. This includes work clothing, papers, and tools. These do not need shielding to dispose safely.
- **Intermediate-level** – This emits enough radioactivity to need shielding. It includes filters, steel parts and reactor chemicals.
- **High-level** – 95% of radioactivity exists within a small amount of waste. This includes used fuel and waste from fuel processing. Unlike intermediate-level waste, this is radioactive enough to heat anything nearby. Cooling and shielding is vital to keep it from contaminating its surroundings.

Arguments Against Nuclear Power

While nuclear energy can reduce dependence on fossil fuels, there are several drawbacks to consider. Some major ones include:

1. Risk of Nuclear Weapons Proliferation

Building nuclear energy reactors in countries that lack these can provide access to uranium. However, there is a risk that this may be secretly extracted to create nuclear weapons. While not every country will do this, it is an issue to consider when building new facilities. The Non-Proliferation Treaty was made in an attempt to prevent this, in which participating states agreed not to manufacture or acquire nuclear weapons (or other nuclear explosive devices). There are several countries that have not joined, some of which are building (or progressing to) nuclear weapons.

2. Nuclear Waste

Radioactive waste such as uranium mill tailings and spent reactor fuel can harm humans and the environment for thousands of years. Worldwide, nuclear power plants produce 12,000 cubic metres of high-level waste every year. All of this must be stored. At present, waste is stored in sealed containers or within pools of water.

3. Nuclear Disasters

Human errors and natural disasters can result in tragic and costly disasters. Some examples include:

- **Chernobyl (1986)**: An experiment in one of the plants' reactors lead to a violent explosion. This blew open the reactor and released a deadly cloud of radioactive material and vapour. 31 people died as a result of the initial steam explosion, exposure and burns and one person from cardiac arrest. The radiation also started a thyroid cancer epidemic.
- **Fukushima (2011)**: A massive tsunami bypassed several power plants' safety mechanisms, causing three nuclear meltdowns. This released radioactive material into the surrounding area. As a result, over 150,000 people would be evacuated. The clean-up, which has already cost Japan trillions of yen, will likely take another 40 years to complete.

The consequences of these meltdowns helped erode people's faith in nuclear power plants. Is the generation of 10% of our energy requirements worth the risk of catastrophic events and fallout? Many would say no. However, the benefits of

nuclear power cannot be ignored.

Arguments for Nuclear Power

1. Nuclear Energy is Safe

Nuclear energy tends to be much safer than fossil fuels, owing to reduced air pollution and fewer accidents. One study on deaths from greenhouse gas emissions found that nuclear power contributed to 0.074 deaths per terawatt hour. In comparison, coal and natural gas lead to 28.67 and 2.821 deaths per terawatt hour respectively. These included deaths by construction and operation accidents (including nuclear disasters), and deaths from air pollution-related effects. As such, nuclear power can result in fewer deaths and decreased greenhouse gas emissions compared to fossil fuels.

Source: Our World in Data

2. Nuclear Energy is Clean

Nuclear reactors produce few carbon dioxide emissions while operating. This stands in contrast to fossil fuels, which emit large amounts of pollution. In 2019, the United States avoided 476 million metric tonnes of carbon dioxide emissions by using nuclear energy instead of fossil fuels. That's the equivalent of removing 100 million cars from the road. Though mining and manufacturing can still produce emissions, nuclear plants themselves rarely pollute the atmosphere.

3. It is a Reliable Energy Source

Nuclear power plants can run 24 hours a day, seven days a week. They usually need little maintenance and can often run for one and a half to two years without refuelling. While renewables are useful in creating energy, they tend to be weather dependent. In contrast, nuclear energy generates power constantly, giving society a baseload power supply.

4. Technological and Reactor Design Advancements May Solve Issues

While the nuclear debate continues, new projects looking to provide safer nuclear alternatives are underway. Companies such as TerraPower (where Bill Gates sits as Chairman of the Board), are developing modular Traveling Wave and Molten Chloride Fast Reactors. These aim to help decarbonise the energy sector by:

- Using a lower grade feed material that cannot be used for nuclear weapons, preventing them from being made.
- Reducing waste by operating at higher efficiencies and producing waste that decays more quickly than traditional methods.

What does the future look like for nuclear?

Nuclear energy is not without its challenges, but it is clean energy. Although it produces next to no emissions, the risk of environmental harm from radioactive waste remains a major issue. However, it is unlikely that we will reach our global climate goals without it. Hence, we can no longer afford to leave it out of the discussion.

For more information about climate change, the sectors that require innovation and further details on renewable energy advancements, visit The ***THRIVE*** Project, designed to guide you towards a ***THRIVE***able future.