LIGHT-WATER SMALL MODULAR REACTORs (SMR)

A Solution For Clean & Affordable Energy For The UK

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KEY SDGs: 7,11,12 & 13

SMRs aim to produce **clean and affordable energy** to **cities and communities** via **responsible consumption** of natural resources to help tackle **climate change** in the UK.

THE CHALLENGE

Fossil fuels are a non-renewable resource. They are the major source of energy production globally. The negative externalities of them are:

1. **Environmental:** Extracting fossil fuels **destroys** ecosystems and the natural landscape.
2. **Weather:** The disrupted carbon cycle has **increased** the **likelihood and severity** of weather events.
3. **Air Quality**: **CO_2**, **SO_2**, **N_2O,** and **CH_4** released from burning fossil fuels kill **8.7 million people** a year.
4. **Security:** Conflict over fossil fuels continues today, with many countries being **exploited** for their fossil fuels.

Fuel	Amount of Fuel (kg)	Usable Energy Produced (kWh)
Gas	1	15
Coal	1	8
Oil	1	12
Uranium	1	24,000,000

Table 1 – Fossil Fuel & Uranium Energy Density [euronuclear.org].

Why are fossil fuels so important?
They power the world. **64.2%** of the world's energy consumption is still generated by burning fossil fuels. This shows their importance, but it is **unsustainable** and becoming increasingly unstable. **Table 1** shows the relative energy density of fuels available. It shows that Uranium is **very energy dense** so this could replace fossil fuels if the right solution were available.

Figure 1 shows that since 2004 the UK has been a **net importer of electricity**. The country is at the will of market forces. The war in Ukraine shows how countries can be manipulated by energy giants such as Russia. The UK has become **dependent** on other countries for energy, leading to a **cost-of-living crisis** driven by increased energy costs. It has also meant dirtier fossil fuels such as coal have been burnt to compensate which sets back **net zero** ambitions. Our proposal would remove the dependence on fossil fuels and set an example of how the rest of the world can achieve **net zero** emissions as soon as possible.

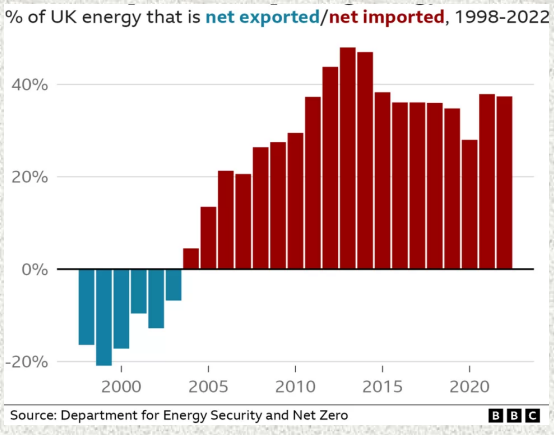

Figure 1 – UK Energy Imports/ Exports [BBC.co.uk].

The solution to fossil fuels should be an energy source that is currently available, sustainable, clean and affordable.

THE SOLUTION

Also, some SMRs can produce hydrogen to produce hydrogen fuel!

Our solution is to deploy light-water SMRs across the UK to provide a **clean** majority base load of electricity coupled with other renewables such as wind, solar, and tidal making the UK's energy production entirely sustainable. We can bring clean electricity to people's homes, allowing the UK to deploy more low-carbon energy and ensure greater energy independence. In addition, the **cost of electricity** will steadily **decrease over time** due to the ability to factory produce the SMRs. The maintenance costs are low and only a small amount of uranium will need to be mined to produce the fuel.

Mined uranium can be reused after treatment to **extract further energy** creating a **circular economy**. In addition, water is an available, renewable, and cheap resource. The safety of SMRs is far greater than traditional nuclear power plants as they are much smaller can be **regulated easily** and are almost impossible to melt down. They offer **a feasible and scalable** solution of an existing technology that can fight climate change whilst allowing countries to continue to develop.

What is an SMR?

Light-water SMRs extract heat from nuclear materials during nuclear fission reactions. It is moderated by light water, simply H_2O, to cool and control the reaction.

SMRs are modular, which means they can be combined to meet different power requirements. They utilise the tried and tested means of electricity production of a traditional nuclear power plant whilst being smaller, cheaper and safer than their larger counterparts. **Figure 2** shows a diagram of the process that is currently in the UK regulatory approval stages.

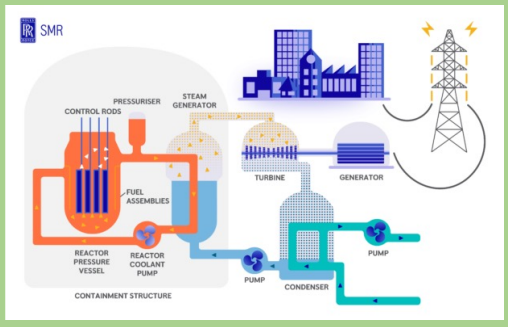

Figure 2 – Rolls Royce SMR Diagram [rolls-royce-smr.com].

WHY SMRs FOR THE UK?

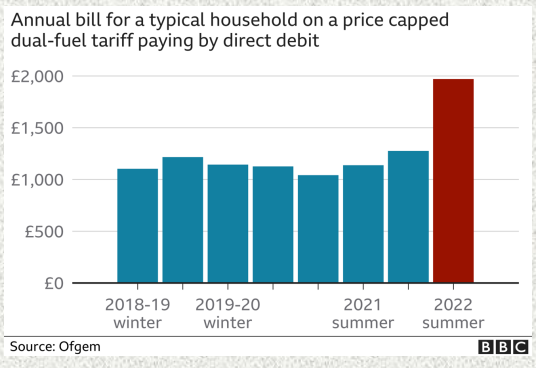

Figure 3 – Energy Price Increases [BBC.co.uk].

UK inflation reached **11.1%** in 2022, this is significantly above the Bank of England target of **2%** [bankofengland.co.uk].

As with all nuclear power plants, SMRs don't emit greenhouse gases and they support global efforts to reach net zero emissions.

Figure 3 shows the UK has been negatively affected by recent instability in energy prices, leading to a cost-of-living crisis. The UK regulator is in the **final stages** of approval for light-water SMRs, so it is uniquely placed to test the concept. The government has committed **£210 million** to develop SMRs in the UK.

Replacing all fossil fuel plants in the UK with SMRs would **offer energy independence** meaning stability in energy prices and affordability. SMRs produce **zero** greenhouse gas emissions**,** with a small amount of waste produced that can be **safely stored** in underground repositories. They are cheaper than traditional nuclear reactors and operate at lower pressure which makes them much safer. These take up much less area per megawatt of electricity than renewables such as wind and solar. SMRs **create more job opportunities** for people, which is vital **to decarbonise our economy.** They can be set up almost anywhere with relative ease.

IMPLEMENTATION AND SCALABILITY

Deploying SMRs across the UK will be easy as they can be produced in a **factory style**. They can be produced **on demand** to serve areas that are ready. They require a large initial financial backing however the costs are far reduced per megawatt in comparison to traditional nuclear reactors and will continue to reduce over time due to **economies of scale**. This is a scalable idea for the UK and sets the standard for the rest of the world to follow. This solution could be implemented in other countries ,once proven in the UK, as the UK can invest in creating the technology which can then be sold to other countries without them having to pay the initial research and development costs and they can reap the benefits of economies of scale.

SMRs will rapidly help the UK expand nuclear power and deliver **cheaper, cleaner** and **more secure energy** for families, create **well-paid** and **high-skilled jobs** and **grow the economy** in the UK. There are several initiatives already to deploy SMRs, such as partnerships with the UK government and countries around the world, which will be beneficial for the investment and research for SMRs.

Feasibility

- Rolls Royce estimated that **each SMR** could **power 1 million homes** this is equivalent to a city the size of Leeds.
- The nuclear sector in Spain has an installed capacity of 7,700 MW which generated almost twice as much electricity as wind power.
- More affordable than traditional nuclear power whilst also being smaller and modular.

Challenges

- **Regulatory Approval**: Approval from national and international authorities is required. Thus, regulators, governments and businesses need to work closely to provide the benefits of SMRs.
- **Public Opinion:** Nuclear energy has a negative stigma. A lot has been learnt from past incidents and is a well-regulated industry which can not be said of the fossil fuel industry. Public opinion is changing and SMRs will help this further.
- **Economical Factors**: High capital investment and land acquisition is needed. This investment is expensive however sites are much smaller than that of traditional nuclear or solar farms. The research and development costs are expensive, but they have very low running costs.
- **Skilled Workers**: Need professional and experienced engineers and workers to ensure the safety, and performance of SMRs. This means that the workforce can be trained in higher skilled jobs for greater pay.
- **Nuclear Waste:** Waste will be produced and needs to be disposed of. This can be safely deposited in underground repositories and sealed away indefinitely.

Electricity Demand and Air Pollution Related to SDGs

Creating and bringing **cleaner,** and **cheaper** energy.

Increasing access to electricity allows cities to have **more control** over their energy supply.

Environmental benefits such as decreased land use and resource waste.

Reducing **greenhouse gas emissions** to achieve **net zero target.**

Acknowledgements: Professor Paul Norman and Professor Julia Myatt.

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