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Small Modular Reactors

Opportunities and Risks of Investment and Deployment

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As the climate crisis becomes increasingly urgent, governments and industries are looking to decarbonise, in order to meet net-zero targets. In light of this mandate, in recent years, there has been a renewed interest in nuclear power from private and public sectors around the world. A significant portion of the interest has been directed towards a new generation of nuclear reactors – Generation IV – which promise to be more efficient and use improved safety features.

The aim of this paper is to provide an independent framework for understanding the nuclear landscape, and, specifically, Small Modular Reactors (SMRs). We discuss the nuclear landscape from technical, safety, waste management, geographical, and geopolitical perspectives. Each of these aspects must be acknowledged and understood, if investment into nuclear power, and SMRs specifically, is to be profitable, ethical, and safe.

Crucially, at Stirling Infrastructure, we believe that SMRs (and other types of nuclear reactor) are not competitors to renewables; rather, they are complements to them. In the future energy mix, we envisage nuclear and renewables working in combination to decarbonise electricity grids and industry. We believe that, SMRs specifically, have a variety of use cases in the energy mix of the net-zero future; and, further, that different types of SMR system will serve different use cases.

FEASIBILITY STUDY

There are, currently, over 70 SMR designs, each of which fall into several types of reactor technology. We assessed of the main 7 types, through an in-house feasibility study, which selected the reactors which pose the most sensible investment opportunity, based on 6 criteria:

- Maturity and Timescale
- Variability and Cogeneration
- Economic Prosperity
- Regulation
- Waste Storage and Disposability
- Deployment

Based on these criteria, we found that 3 reactor systems – the pressurised water reactor (PWR), high temperature gas-cooled reactor (HTGR), and sodium fast reactor (SFR) – provide, in descending order, the most viable short- and medium-term investment opportunities. These reactor systems score highest across our 6 metrics.

Due to the imminence of net-zero targets, we prioritised maturity and timescale for each reactor system. The more technologically ready the reactor system, the sooner it can be in operation and helping to decarbonise industry and/or electricity production.

INVESTMENT OUTLOOK

Our analysis suggests that two types of SMR technologies – pressurised water reactors (PWRs), and high temperature gas-cooled reactors (HTGRs) – represent the most feasible investment opportunities. Both offer the prospect of significant returns for investors, and can have a positive long-term impact on society, through their contributions to achieving net-zero emissions.

PWRs represent an excellent short-term and lower risk investment opportunity, because they are a proven technology with a very high technology readiness level (TRL). Additionally, there is strong support and approval for PWRs from governments and private companies around the world; consequently, investment risk here is low, and there is an existing market for these reactors. PWRs can be used for electricity generation and water desalination, so can be useful for the decarbonisation of electricity grids and industry; however, they are not suitable for other cogeneration functions, such as hydrogen production.

HTGRs are a higher risk investment option, because the technology is at a lower TRL. So far, tangible results have been achieved only in China; consequently, more R&D is required, in order to assess the true cost and capability of this technology. However, unlike PWRs, HTGRs have wider cogeneration capacities. This could include heating, hydrogen production, decarbonisation of heavy industries like glass- and steel-making; consequently, if used on the global scale, HTGRs could provide great societal value, through their variety of use cases.

SAFETY & WASTE

We do not take the issue of nuclear waste, and its disposal, lightly: they remain the largest barriers to widespread adoption of, and public support for, nuclear power. And, further, these problems are universal to nuclear, not specific to SMRs or conventional-sized nuclear power plants (NPPs). Whilst there is often public support for nuclear power, the overriding concern is waste disposal and safety – memories of Chernobyl and Fukushima make many very cautious or resistant. However, the main issue is that nobody wants a disposal site in their backyard. This must be overcome, if nuclear power is to be widely used in the future.

Currently, there is no permanent disposal solution for nuclear waste. However, deep geological disposal facilities (GDFs), which bury waste deep underground in boreholes, present a viable option. This is a passive solution – no active human maintenance is required –, and it is designed to seal the waste away, so that no civilisation could discover it. Nevertheless, without public support for these programmes – and this is lacking in most countries – these facilities will not be set up, and nuclear waste will remain an issue.

USE CASES FOR SMR SYSTEMS BY GEOGRAPHY

Due to the different features of the reactor systems, their use cases will vary dramatically. As part of our detailed analysis in our full report, we conducted a geographical analysis of 5 different geographies and regions: Africa, Asia, Industrialised Nations, Polar Climates and the Ring of Fire.

From our geographical analysis, we concluded that all three of our chosen reactor types (HTGR, PWR, SFR) are good investment opportunities. However, the reactor chosen should depend upon, and be tailored to, individual markets, according to geographical realities and political situations.

In developing countries with growing populations, nuclear power can provide a solution to a lack of sufficient grid access and electricity supply. Diesel generators or coal are the norm for many regions without sufficient grid electricity. Net-zero targets, and the danger of air pollution – with which China, in particular, has suffered greatly, due to their huge coal usage – are pushing these nations to invest in low-carbon alternatives, which will provide adequate, reliable power to their growing populations. SMRs, which require lower grid capacity than conventional sized NPPs, and so lower the bar of entry into nuclear power, are an excellent option in these locations.

In areas with coastal access, PWRs would be an excellent choice, because they require water for coolant, can generate grid electricity and desalinate sea water, which can be important if the country is susceptible to droughts – an increasingly pressing concern for many areas as the climate warms.

HTGRs will be most useful in:

- Dry, remote areas with little water access, no grid connectivity, and a need to move away from polluting diesel generators.
- Heavily industrialised nations, where there is an urgent imperative to decarbonise heavy industry.

HTGRs use gases, such as helium, for coolant, so need not be sited near water, and will not take essential water from communities around their sites. Further, due to their high temperatures, HTGRs are ideal for cogeneration, such as hydrogen production, paper, glass and steel-making, district heating, and other industrial processes. This market, in particular, is set to grow dramatically, in the coming decades, because, while intermittent renewables, such as wind and solar, can be used for grid electricity production, the quantities of reliable electricity and high temperatures required for heavy industrial processes make HTGRs an attractive option.

GEOPOLITICS

On the geopolitical level, interest in SMRs is widespread, and due to several factors – e.g., net-zero targets, increased electricity requirements, the current gas crisis.

However, nuclear, unlike other energy types, is not a free market, as such it has, and always will be, informed by politics. The types of reactors used in different countries will depend upon investment sources, as well as the suitability of technologies. Countries with domestic nuclear programmes can develop whichever reactors they so choose; however, those purchasing systems on the international market will need to purchase from a willing vendor. As such, the political and financial standing of purchasing countries will dictate the reactors available to them: higher status, and financial trust, on the international stage will allow for increased choice. Investors must be aware of, and sensitive to, the geopolitical realities of the nuclear market, if their investments are to be profitable, ethical, and safe.

FOR FURTHER INFORMATION

At Stirling Infrastructure, we aim to provide advice on growth strategies to, and help raise capital for, companies enabling the energy transition. This would involve analysis of clients' business models, in order to advise on how to raise capital and form strategic partnerships.

Our expertise will also enable us to provide introductory and broad-perspective advice to those wanting to invest in nuclear technologies, such as governmental energy agencies. This would include helping clients think through the key processes and issues involved in nuclear adoption and investment. In terms of suitability, we aim to provide assessment on where nuclear would fit into the energy mix and the risks and benefits of adopting particular technologies. Then, in terms of financial considerations, we aim to assess the commitments necessary in particular use cases.

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