Is nuclear energy a natural reaction to oil prices?

In the face of sharply rising energy markets, small modular reactors could provide a more affordable, site-specific solution.
By Michael J. D. Rushton

Russia's invasion of Ukraine in February 2022 has sent shockwaves through world energy markets and supply chains, causing rapid increases in energy prices and triggering concerns over energy security. Countries with high levels of nuclear power in their energy mix have found themselves cushioned from this to some extent, leading to renewed interest in the technology.

The current situation echoes the 1973 oil crisis, when an embargo contributed to the largest contraction in the world's economy since the Great Depression. This resulted in an expansion of nuclear programmes, as nations affected by the embargo sought to break their dependence on foreign oil imports. In 1974, the French prime minister Pierre Messmer announced that all of France's electricity needs should be met by nuclear energy, and the country installed 56 reactors over the next 15 years. Today, France still generates most of its electricity from nuclear power, and despite this not being its original goal, has among the lowest CO_2 emissions from electricity production in Europe.

If we are to successfully limit climate change, nuclear may be a better alternative than increased oil prospecting. As fossil-fuel prices rise, the cost of nuclear power, which was once deemed too high, is now competitive. Even countries that withdrew from nuclear energy use after the 2011 Fukushima accident, such as South Korea and Japan, have stated their desire to recommit to the technology. In light of this, could we see modern versions of the Messmer plan being implemented?

In the near term, new reactors will be built from existing designs. These large, water-cooled reactors produce between 600 megawatts electric (MWe) (such as Canada's CANDU reactor), and 1,650 MWe (France's EPR). They have excellent operational characteristics with very low down time, meaning they generate electricity more than 90% of the time and have design lives of 60 years. But, they take an average of nearly eight years to construct, and sometimes longer – Finland's Olkiluoto 3 reactor, for example, took 16 years. The large up-front costs (in the order of billions of dollars) and long delay before investment is returned has deterred investors who want assets that can be built more quickly and cheaply.

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Small modular reactors (SMRs) aim to address these issues, and could be deployed by the end of the decade. The SMR concept puts an emphasis on factory construction, which enables advanced manufacturing methods and a reduction in on-site construction and consequent weather delays. These reactors target power levels of 200–500 MWe. Because construction timelines are half that of large reactors, SMRs reduce unit price to levels suitable for private investment – although multiple units will be required to produce the same output as a larger plant.

The main barrier to the success of SMRs lies in attracting sufficient orders to cover the cost of development and a factory. Even if this is achieved, siting and licensing may still be obstacles. Current national regulatory systems, which differ widely, are geared towards a small number of large projects, with each often taking years to be approved. This will need to be streamlined if the rapid development of an SMR fleet is to be practical.

SMRs can support processes such as desalination, paper production and drying, as well as domestic water heating through district-wide heating schemes. There is a long history of nuclear district heating in countries such as Switzerland, Sweden and Canada, but their high infrastructure cost has deterred widespread use.

It could become competitive, however, if gas prices fail to fall significantly. Recent projections for a scheme to heat Paris from large reactors estimated a cost of €42 per MWh (US$44.86 per MWh). This compares well to current gas prices. Cost could also be reduced further through the use of SMRs, which aim to allow siting closer to population centres, reducing the length and cost of the heat transmission network.

New-generation high-temperature reactors are also being developed by several countries, which suit applications such as iron smelting and efficient hydrogen production via steam electrolysis and thermochemical routes (the latter having been demonstrated at pilot scale already, with Japan's high-temperature test reactor).

Although new enthusiasm for nuclear power may be driven by the same factors of energy security and price as the oil shock of 1973, its ability to provide low-carbon electricity and process heat means it is perhaps an even more relevant choice for today's energy systems than it was back then. By doing more than just producing electricity, it can aid in deep decarbonization by displacing oil and gas, which also reduces the geopolitical power that can be wielded by those who control its supply.