a variety of energy scenarios and options, but it should be noted that the deciding factor on the type and mix of any energy program will not be made on technology choice alone. Instead, the rate and direction of growth of any future energy program will depend on a complex mix of U.K. government policy, relative economics of nuclear power and other technologies, market decisions, public opinion, and of course, technology choice.

The U.K. pathway to an advanced, closed fuel cycle would necessarily include and begin with the current plans for 16 GWe of new nuclear build capacity on an open fuel cycle basis by the end of the next decade. Through these expansion studies, a number of power-generation and associated fuel-cycle options will be considered. This includes open and closed (partial and fully) fuel cycles and a variety of reactor technologies, including expansion of existing light water reactor capability, introduction of fast reactors, and the use of smaller modular reactor technology in combination with larger power plants. The bounding case for this pathway involves the construction of a series of fast reactor units with a combined installed capacity of up to 75 GWe by the middle of the 21st century, operating a closed fuel cycle involving the reprocessing of fast-reactor used fuels and multiple recycling of plutonium.

For open cycles, the key benefits can be summarized in terms of enhanced economics of the system, especially over shorter timeframes (60 years), and enhanced proliferation resistance, although this is subject to much debate at an international level. Within the U.K., however, the associated management of the used fuel inventory in an open cycle becomes more challenging with the higher energy scenarios (50,000 t and 100,000 t).

As such, closed nuclear fuel cycles could offer a potential solution to deal with large volumes of used fuel together with optimizing the sustainability of nuclear energy for decades to come. To achieve this, however, further advances will be required in reprocessing technologies that are more economical, generate less wastes, and offer greater proliferation resistance than traditional PUREX reprocessing technology.

This is also the case globally, where the renewed interest in nuclear energy as a safe, secure, low-carbon energy source has led to further research into optimizing the whole fuel cycle. For instance, the Generation IV Forum objectives include enhanced safety and sustainability of nuclear electricity generation. Furthermore, it should be noted that although the current global preference is for an open cycle, with continued reprocessing in France plus the growth in nuclear energy in Russia, China, and India, by 2050 advanced closed cycles may become the preferred choice for several nations once more.

For the U.K.'s future energy choices, the topic of an open versus a closed fuel cycle is one for continued debate but will depend on the energy required to be generated from nuclear, GDF availability, the reactor technologies of choice, and the economics of the system chosen. Whatever option or options might be chosen, however, further research will be required to understand the perceived benefits of open and closed (fully and partially) cycles. ■

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