Climate Answers
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Small Modular Reactors: One component of a sustainable energy future?

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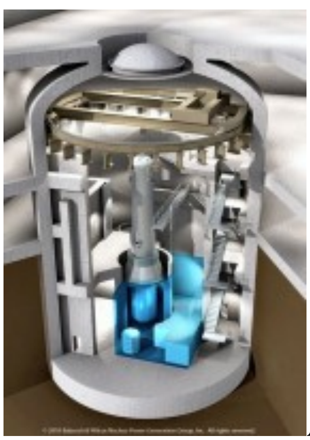

According to the US Department of Energy, global energy use and carbon emissions are set to increase more than 50% by 2025. Demand in China and India is expected to escalate a combined 91%, with other developing countries close behind. Industrialised states' needs' are expected to grow by approximately one-third. Governments' efforts to curb the resulting environmental effects are generally met with low expectations.

The world is at a vital crossroads. While wealthy countries' consumption will increase less rapidly, it will still do so substantially. Simultaneously, developing states will continue their ever-greater pursuit of resources as they aim to close the economic gap with their industrialised peers.

Ensuring a sustained healthy natural environment and energy-secure future requires a multifaceted approach. No single source can be relied upon too heavily. Of course, fossil fuels are the principal cause behind these grave issues. While nobody definitively knows when reserves will be depleted, it is apparent that, regardless of how long it takes, pollution and price volatility will continue to be commonplace, especially with regard to oil. Though natural gas offers a cleaner alternative and in most cases a cheaper one as well, procurement methods like fracking mitigate such benefits by worsening environmental conditions. Renewables, regularly touted as a solution, pose their own issues.

As evidenced by recent crises, biofuel use plays an integral role in raising food prices. Generally speaking, solar power is too expensive. Like its cheaper counterpart wind, solar energy is dependent on weather, limiting its use to certain places. Moreover, both of these energy generation forms are difficult and costly to store, though technology is improving.

Nuclear is frequently proposed as another alternative. However, its most commonly advocated form also has daunting challenges.

'Big' usually comes to mind when people think of nuclear power. Reactors regularly exceed 1,000Mw capacities. To reach economies of scale, conventional wisdom holds that bigger is better, a recurring theme in many countries' nuclear discourse. If such aspirations are realised, low carbon, extraordinarily profitable fuel can be produced for decades. Nonetheless, enormous obstacles can prevent these ambitions' fulfilment.

Capital requirements can easily exceed several billion dollars, often leaving even the most solvent bodies unable to finance projects alone. Construction costs vary widely, causing problems if funding estimates are too low. Safety, security, infrastructure, waste management and decommissioning also contribute significantly. Operation and maintenance expenditures, though one of the cheapest components, are expensive enough to cause problems for weak entities like developing countries. Moreover, liberalised energy markets in much of the world prevent prices from being guaranteed long into the future. Huge profits can result if these obstacles are overcome, but long construction times and vast total costs mean that investment returns, if ever attained, can take dozens of years. Nevertheless, as important as they are, nuclear power's economic risks are not its only ones.

Like construction costs, the potential levels of severity of nuclear accidents also vary widely. A large reactor's very existence carries with it the possibility of a catastrophic accident or terrorist incident capable of irreparable environmental, human and financial damage. Nuclear power, as we know it, has enormous intrinsic risks and no guaranteed benefits.

However, new nuclear technology is being developed. Several companies intend to put Small Modular Reactors (SMRs) on the market within the next decade. SMRs' sizes range from 10 to 300Mw for each reactor module. Plants will be able to accommodate as few as one or up to ten or more modules depending on the model. While no two SMR makes have the same energy generation capabilities, all are variations of similar design and operations concepts. They aim safely and securely to produce low cost, clean fuel while minimising the huge infrastructural requirements and environmental, human and financial risks associated with large nuclear plants.

Depending on the model chosen and the number of reactors installed, a single SMR plant could produce enough electricity for a hospital, university, refugee camp or even neighbourhoods, towns and cities comprising tens or hundreds of thousands of people. One of SMRs' key advantages is that capacity will have the ability to be modularly augmented or downsized if demand fluctuates, instead of being set permanently, as is the case with current technology.

Other principal benefits include factory assembly rather than on-site construction, allowing SMRs to be deployed much faster than large plants. Manufacturers also assert that SMRs' compactness will allow them to be easily shipped worldwide. Moreover, most models' operations sites will be housed underground. Many will also store waste in underground spent fuel pools during the plant's operating life, while others aim for off-site storage and reprocessing as soon as possible.

Although the majority will embrace refuelling methods taking place at the operating site, some will ship spent modules back to the factory and replace them with new, pre-fuelled reactors. These manufacturers argue that this will greatly simplify the decommissioning process while allowing for power supplies to continue uninterrupted.

Concerning safety and security, SMRs' underground operating sites are intended to address post 11 September and Fukushima concerns by making reactors more difficult to sabotage, while also requiring less personnel, thereby aiming to drive down associated costs. Passive cooling systems not requiring offsite power will also be utilised. Industry professionals believe that these innovations could, in the event of an accident, keep fuel cool enough to prevent a meltdown for at least several days, more than enough time to respond. Any accidents that do occur, manufacturers assert, would be minimised due to SMRs' small-size and underground location, preventing off-site evacuations and surrounding areas' contamination.

Some estimates suggest that SMRs may be able to produce power significantly cheaper than fossil fuels. They could be particularly useful in sparsely populated, isolated areas where connecting to existing grids is a problem. However, despite their significant potential benefits, SMRs are not free of concerns. Though much less costly to finance and construct than large plants, SMRs are not cheap. Depending on the design and size of the module, they could cost anywhere from 25 to 500 million dollars for each reactor.

Furthermore, SMRs' economic concerns do not end once a plant is operational. Detractors suggest that it will be impossible for SMRs to reach economies of scale. Due to their smaller size, some argue that it will be much more expensive for SMRs to produce energy. Supporters counter with an assertion that because SMRs are less expensive to construct, they will be able to run operation and maintenance costs equal to or higher than large nuclear plants and still be extraordinarily profitable. Supporters also claim that due to SMRs' smaller size, much less personnel will be required to staff and guard them, offsetting any steep operation and maintenance costs.

SMRs' uncertain economic prospects necessitate prudence before endorsing their use, especially for weak financial entities like developing countries. However, they are not the only reason for caution. While innovations like underground operations and spent fuel storage represent considerable safety and security improvement over large plants, they do not inherently merit the immediate use of further cost-saving measures in those areas, contrary to manufacturers' indications. Nor do they justify the dismissal of disaster's possibility, as some have a tendency to do.

While proponents may be correct that SMRs' underground containment would insulate the local environment from accidents, making off-site evacuations unnecessary, meltdowns are never a positive occurrence and the scale of any repercussions is difficult to predict. Therefore, such events must be prepared for even if they are mild or unlikely. These issues must especially be considered if units would be housed near population centres.

Furthermore SMRs, though small, still have enough radioactive material to pose a terrorist threat. While design features go a long way in protecting against such incidents, it is ill-conceived to think that they would justify significantly less operations and security staff as an initially viable option because certain aspects of SMR security are particularly uncertain. For example, SMRs' size might make them easier to guard. However, it could also be easier to steal or sabotage reactors, especially if off-site refuelling is utilised along with reduced personnel details guarding operating sites and radioactive transports.

Regarding waste, individual SMRs provide advantages over large plants, as they would create much less. However, widespread use would work against this. Moreover, while underground, spent fuel pools are an improvement over current waste management techniques, they are only a temporary solution that defers the impending, crucial necessity of a permanent disposal method.

Because SMRs pose challenges, some unique and others similar to conventional nuclear plants, convincing the public that they are different might prove incredibly difficult. However, as with other energy generation techniques, SMRs' benefits must be weighed against their drawbacks, so that informed decisions can be made about their potential. A sustainable environment and energy-secure future will require a set of diverse, innovative solutions. It is time to seriously consider whether or not SMRs should be added to the mix.

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