Nuclear power has been an important source of zero-carbon energy, though it has been plagued by other problems. Does it have a future in our effort to decarbonize the grid?

According to the Union of Concerned Scientists (UCS), a third of U.S. nuclear plants, or about twenty percent of the nation's total nuclear capacity, are unprofitable and some are already scheduled to close. Some states are subsidizing plants with Zero Energy Credits, and others are considering it. UCS projects that closed plants are likely to be replaced by natural gas generators, adding to carbon emissions. Instead, UCS proposes keeping the existing plants open for at least another fifteen years or so, provided they have high safety ratings.

What about new plants? Conventional new plants have gone expensive to insanely expensive. Two reactors being built in Georgia are five years behind schedule and $13 billion over budget. So the hunt is one for alternatives. The next planned wave of nuclear plants are smaller modular reactors that can be constructed elsewhere and moved to the generation site. According to E&E News, these reactors "are designed to be still more efficient, less expensive and meltdown-proof. [T]hey will come in several variations, and at least 18 U.S. companies are designing them. Some modules will be tiny, delivering as little as 2 percent of the power of current large reactors but able to be deployed to remote military bases or sent to the Arctic to power mines, small towns or other power-hungry but remote facilities. Others will be collections of modules." Many rely on water cooling but improve safety by including piping and generators inside the containment body.

For instance, NuScale's small reactors are cooled by natural water circulation, rather than pumps, eliminating one source or risk, and they are vacuum sealed in steel containment tanks that can be flooded for cooling in case of emergency. All of which sounds good, assuming it actually pans out. The government is promoting NuScale's idea in the hope of revitalizing the nuclear industry. Utilities in the U.S. are interested but cautious about the risk, and the best prospects for sales may be in other countries where cheap natural gas isn't an option.

Not everyone is bullish on small modular reactors. UCS raises safety, security, and cost concerns. Smaller reactors give up some of the economies of scale available to large reactor, so to keep prices down, they need to reduce other safety precautions required of large reactors. That's fine if the reactors really are as safe as designers hope, but that's going to take very careful examination.

Beyond the current wave of modular reactor designs, companies are experimenting with a range of new technologies Transatlantic is designing a molten-salt reactor, which should be highly resistant to meltdowns. If the reactor starts to overheat, the salt expands, spreading apart the fuel and slowing the reactions, allowing the salt itself to cool and crystalize around the fuel. The reactor would also use fast neutrons, which would reduce the amount of left-over nuclear waste.

Another possible new design uses thorium instead of uranium as fuel. Thorium can be used in liquid form, transferring its heat to a gas turbine without an intermediary like water or liquid salt. Thorium is also harder to weaponize, and advocates of thorium reactors say the waste would decay faster, making containment over very long time periods (thousands of years) less of a concern although short-term containment is correspondingly more of an issue. UCS is skeptical, however, believing that benefits are exaggerated or offset by other problems.

So, does nuclear power have a future? The answer is a big fat “maybe.” But if there is a way of building less expensive reactors that are also safe, produce less of a long-term waste problem, and aren’t prone to weapons diversion, that could be a very helpful complement to the decarbonzation effort. This raises something of a policy conundrum.

It seems to me, given this level of uncertainty, that it is worth putting a few billion dollars into the effort to develop better reactors. Renewables, combined with storage, seem very promising, but it’s worth hedging our technological bets. One caveat, however: The Nuclear Regulatory Commission has always had a tendency to be a little too cozy with the nuclear industry. Before we start a new wave of nuclear reactors, we need to be sure we have a trustworthy regulator.