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Why Are Nuclear Plants So Expensive, and What Should Be Done About It?

The U.S. nuclear energy industry is in decline and has been for decades. As of 2020, the U.S. has only witnessed two attempts at constructing new nuclear plants since the 1990s, one of which gave up, the other of which is severely stalled and fighting for its life (Eash-Gates et. al). What has so drastically changed since then? In short, it is ridiculously more expensive to construct a nuclear plant than it was during the nuclear heyday of the 1950s and 1960s. Since 1970, American nuclear plants have suffered from "an average overnight cost overrun of 241%" (Eash-Gates et. al), which, for megaprojects like nuclear plants that have projected costs in the billions, can be nigh insurmountable. So insurmountable, in fact, that nobody dares to even attempt the task anymore. Any discussion of how to reduce these costs and make building nuclear plants a more manageable task must begin with a discussion of where these absurd costs arise from.

There are a couple of main culprits—a study into the source of these cost overruns by MIT clean-energy specialist Philip Eash-Gates and others gives some insight into what they are. For one, nuclear plants have been upscaled over the decades to give plants a great capacity for energy production. A lack of design standardization, as well as the increased complexity of more contemporary plant designs, has also resulted in substantial cost increases. Stalling in construction and price overruns have plagued nuclear plant projects as far back as the 1970s, when a lot of this upscaling happened. This period of upscaling coincided with the Three Mile Island meltdown, which brought the risks of nuclear energy to the forefront of the American public's attention, and subsequently resulted in a new quality assurance (QA) and safety requirements. This makes the inflation in construction cost a multifaceted problem with no single, clear source. All must be addressed---it is simply a matter of how, and which issue takes top priority.

Nuclear engineers and research agencies have repeatedly projected cost decreases for each successive generation of nuclear reactors, though costs have continued to rise despite these projections (Eash-Gates et. al). A few factors, such as increased safety costs which will be discussed later, could be doing these new designs a disservice by hiding their potential cost reductions behind expenditures that aren't even direct results of the designs. However, these new designs have not yet succeeded in reducing costs. It stands, then, that something very new should be tried, something that not only makes sense in the context of tenuous projections, but also common sense. If a more cost-effective nuclear reactor were to be popularized, one that would be much less likely to suffer from cost overruns and stalls in construction would probably be the small modular reactor (SMR), for which these projections have the "[greatest] anticipated cost reductions" (Eash-Gates et. al). SMRs are gamechangers for many reasons. For one, many traditional large reactors suffer from cost overruns and delays because they require site-specific equipment and parts (Liou 2023). In other words, whereas large reactors must be adapted to where they're built, SMRs do not suffer from those requirements to such a great extent. As mentioned earlier, a lack of standardization in the nuclear energy industry has made it a major factor in construction costs. Retired nuclear engineer Jim Hopf's claims that if the parts used in nuclear plants were standardized, "the number of suppliers would increase dramatically" and that "costs for nuclear components could drop substantially" put the importance of this issue into perspective. SMRs, due to their smaller size, would also suffer less from costs due to supervising the project and making sure everything is going according to plan and temporary construction facilities which need to be erected to carry out the construction, which together contributed to about 30% of the construction cost increases between 1976 and 1987 (Eash-Gates et. al). SMRs are also much more marketable, as they can provide clean energy to areas with power grids that would ordinarily be insufficient to support a traditional, large nuclear reactor (Liou 2023), such as rural areas in the U.S., as well as energy-hungry developing nations. All-in-all, SMRs are much cheaper than traditional nuclear reactors, are more likely to make it through the mire of a construction process that usually leads to the death of these projects and can be built basically anywhere. As such, they are a plausible solution to the problem of increasing costs.

There is a case to be made that quality assurance requirements are too strict in the nuclear sector. It's not to say that nuclear plants should not be of excellent quality, but rather that the specific policies have too heavy of a hand. (It's important that quality assurance requirements and new safety features are differentiated from one another—in this paper, the former refers to requirements pertaining to the integrity and quality of parts so that the parts themselves are safe to use, whereas the latter refers to new standards that are being implemented to make plants even safer than they were initially.) For example, Hopf relates that construction of the Vogtle plant in Georgia was set back by eight months due to a failure to follow precise procedure for construction of the "concrete pad that the reactor will sit on". Manufacturers of parts used in nuclear plants must meet the standards of the U.S.'s quality assurance program, meaning that, in some cases, there are only a few suppliers for specific parts and multiple plants trying to obtain said parts, resulting in "bidding wars" (Hopf 2014) that inflate costs. It should be noted that designs that don't directly adhere to QA requirements aren't necessarily unsafe. According to the Appendix of the U.S. Nuclear Regulatory Commission's regulations, reactor designs are checked against "specified" standards that are "included in design documents"—any deviations will be "controlled". The U.S. NRC also requires "testing" of all equipment. Thus, the question arises: should these "specified" standards be so strictly enforced if the safety of the equipment will be tested anyway? It is perfectly conceivable that Vogtle's concrete pad was perfectly safe and would have passed extensive safety testing despite not meeting these "specified" requirements. In the end, Vogtle was allowed to keep the pad, but only after serious delays and an estimated $16 million in expenditures (Hopf 2013). Mistakes are bound to happen when constructing such complex facilities, so some lenience needs to be given to the process for any construction to be completed at all.

Finally, additional safety measures that have sprung up, especially in the wake of the Fukushima meltdown, make plants way more expensive to build even without delays and difficulties in acquiring parts. In 2017, a Westinghouse plant adopted a new reactor design (the AP-1000) which introduced an extremely expensive containment vessel (Eash-Gates et. al). The vessel's steel shell was five times thicker than the typical vessel shell in 1987 and had a 70% contribution to the plant's cost increase. The U.S.'s two swamped projects, Vogtle and VC Summer, are also attempting to use this design (Eash-Gates et. al).

The most effective problem to tackle is the strictness of quality assurance programs in the U.S. Addressing the issue of quality assurance simultaneously addresses the costs of all reactors, no matter their model, large or small, and additional safety features that have new plants are tacking on. For one, while these plants will remain very expensive even if the NRC's regulations become less stringent (and using SMRs or not tacking on costly safety features that plants have historically done just fine without would significantly reduce those costs), the main issue is delays and overruns. Despite the adversity such a challenge produces, the Vogtle and VC Summer projects must have been initiated because there was belief that they would succeed and that the costs of construction were manageable. If projected costs were too much to bear, the projects would not have been taken on in the first place. It then reasons to claim that being affronted with the unexpected—in the form of delays and overruns—is the most pressing issue that immediately stands in the way of these projects reaching completion. As such, QA requirements are what are holding back nuclear plants the most now.

The only thing that can realistically be done about these regulations is to convince the U.S. NRC to tweak them. This could possibly be achieved by a large group of nuclear engineers petitioning the NRC or some form of meeting between engineers and the NRC taking place to discuss the topic. The NRC is also open to civilian discussion and says on its official page that it "is committed to providing opportunities for the public to participate meaningfully in the NRC's decision making process", and so it's not out of the question that a civilian, non-professional group could also petition for some changes. The NRC's self-proclaimed purpose is "protecting people and the environment", and so if a group of people without skin in the game (such as nuclear engineers) expressed that the NRC's regulations would be safe enough even if a little looser, and that they were also failing to protect the environment by making a valuable clean energy source too hard to utilize, there's a greater chance they would be swayed. A broader acceptance of nuclear energy by the American public could have this effect. The practical solution to the NRC's strict regulations then becomes a matter of political action by people in this country who wish to see the further utilization and success of nuclear energy.

American citizens must accept nuclear if it is to succeed in the U.S. What is popular with the American populace becomes what's popular with the people who do the decision-making in this country. Politicians try and appeal to public sentiment to keep their jobs, and, though not for as cynical a reason, the NRC is likely also very responsive to public sentiment. However, right now nuclear is not popular in this country, and there is not enough pro-nuclear sentiment to warrant a change in the NRC's regulations anytime soon. It is my job as an American citizen to try and convince others of what I believe is right and to try and spread my advocacy for nuclear energy. Likewise, anyone else who wishes to see nuclear become successful has a duty to be politically active and try and convince others. There are big pictures solutions that answer questions like "what is to be done"", and then there are small picture solutions that answer, "how is it to be done?" If all we do is answer "what is to be done?", nothing will change. There must an impetus, "how is it to be done", to bring a solution to reality.

References

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