Small Modular Reactors and why we don't need them

Small Modular Reactors are required in too great a number to be cost competitive even with expensive large reactors. None of the SMR designs can satisfactorily meet all the criteria that are widely considered necessary for nuclear power to expand: economic competitiveness, no risk of nuclear accidents, absence of radioactive waste production and not allowing for the proliferation of nuclear weapons.

What are SMRs?
Small Modular Reactors are a type of nuclear fission reactor, generally between 10MW and 300 MW in size, far smaller than a conventional light water reactor. They are intended to be manufactured on a factory-style assembly line in order to reduce on-site construction time. Many SMR designs with distinct characteristics have been proposed or are being developed. These designs vary in their power output, physical size, fuel type, refueling frequency, siting options, and status of development.[1]

Economics killed the early small reactors and likely will again
The first reactors ever constructed around the world were small. But these small reactors could not compete economically because they cost too much for the little electricity they produced. For example, the 50 MW La Crosse reactor in the US, which operated from 1968 to 1986, generated electricity at a cost that was an estimated three times as much as that from a coal plant next door.[2] Consequently, every country that built and operated small reactors scaled up to larger ones.

Smaller does not necessarily mean cheaper
All reactors are expensive and no longer cost-competitive. SMRs will be even more expensive because they cannot even benefit from the economies of scale that help large reactors save money. For example, a 1000 MW reactor does not require four times as much concrete as a 250 MW reactor.[3] Manufacturers claim that they can "learn" to save costs.[4] However, costs in the nuclear industry have only increased with time and "learning," as demonstrated in the two countries with the most nuclear plants, France and the United States.[5]

Cost predictions are unreliable
The nuclear industry has a long history of grossly under-estimating costs, which have already tripled at current reactor construction sites in Flamanville, France and Olkiluoto, Finland. With SMR designs not yet finalized, cost claims made by designers are not reliable. Actual costs will be far higher.

---

[1] Small modular reactors. A window on nuclear energy. Glaser, Ramana, Ahmad, Socolow. June 2015. https://acee.princeton.edu/wp-content/uploads/2015/06/Andlinger-Nuclear-Distillate.pdf

[2] The forgotten history of small modular reactors. M.V. Ramana. IEEE Spectrum. April 2015. https://spectrum.ieee.org/tech-history/heroic-failures/the-forgotten-history-of-small-nuclear-reactors

[3] Small modular reactors and the challenges of nuclear power. M.V. Ramana and Zia Mian, Princeton University. https://www.aps.org/units/fps/newsletters/201701/reactors.cfm

[4] Rolls Royce: UK SMR — A National Endeavour. https://www.rolls-royce.com/~/media/Files/R/Rolls-Royce/documents/customers/nuclear/a-national-endeavour.pdf

[5] Koomey, Jonathan G, and Nathan E Hultman. 2007. "A Reactor-Level Analysis of Busbar Costs for US Nuclear Plants, 1970–2005." *Energy Policy* 35: 5630–5642.
Grubler, Arnulf. 2010. "The Costs of the French Nuclear Scale-up: A Case of Negative Learning by Doing." *Energy Policy* 38 (9): 5174–88.

Every SMR design comes with drawbacks
There is no single SMR design, nor is there one kind of SMR. Designs include: The **integral pressurized water reactor (iPWR),** which is fueled with low-enriched uranium; The **molten salt reactor (MSR),** with fuel dissolved in corrosive salts that is circulated in and out of the reactor itself; the **high temperature gas-cooled reactor (HTGR)**, graphite moderated, whose fuel consists of uranium resistant to high temperatures and enriched to well above 5%; The **fast neutron reactor (FNR)**, which theoretically reduces radioactive waste production, but operates without a moderator; and the **battery-style SMR** which has a long-lived core and is designed to run "unattended," opening up safety and security questions. These tend to be fast reactors with fresh fuel containing high uranium enrichment levels.[6]

Mass production of SMRs has financial downsides
The economics of mass production of SMRs cannot be proven until hundreds or even thousands of units have been produced, a deterrent to investing in SMR "factories". Despite sustained advocacy from private firms and politicians, there is not enough of a market to justify manufacturing SMRs by these thousands. Rolls-Royce has already requested £200 million from the UK government before proceeding with its own development of SMRs.[7]

Mass production of SMRs has safety downsides
"Modular" may sound appealing. But mistakes on a production line mass producing SMRs could lead to generic defects that propagate throughout an entire fleet of reactors and would be costly to fix.[8]

SMRs pose a danger to public safety
No reactor is inherently safe under all accident conditions. While a single SMR contains less radioactivity than a large reactor, many more SMRs would have to be constructed to meet the same electricity demand. So the risk per MWh of electricity generated could well be higher. In order to save money, SMR advocates want a single control room for multiple small reactors in one location. But the Fukushima nuclear disaster demonstrated that multiple reactor plants that experience severe accident conditions present extreme challenges that cannot be managed by a skeleton staff.[9]

SMR cost-cutting depends on weaker safety and security regulation
SMR proponents hope to convince regulators to relax existing safety standards to bring down costs. These reductions include building SMRs without having an emergency planning zone —where local government authorities have to rehearse how to act in the event of an accident — that extends outside the plant site boundary. This reduction would compromise public safety. Proponents also want security measures reduced to lower the cost of producing electricity, even though SMRs contain dangerous radioactive inventories that must be protected from attack, sabotage and theft of nuclear materials.

---

6 Ibid. Small modular reactors and the challenges of nuclear power.

7 Rolls-Royce seeks government funds for nuclear power project. *Financial Times*. January 27, 2019.

8 Small isn't always beautiful. Safety, security and costs concerns about small modular reactors. Edwin Lyman. Union of Concerned Scientists. 2013. https://www.ucsusa.org/sites/default/files/legacy/assets/documents/nuclear_power/small-isnt-always-beautiful.pdf

9 Ibid.

SMRs still present nuclear proliferation risks
The various SMR designs, and the large scale on which they would need to be produced, all lead to proliferation risks, whether due to the use of higher levels of enriched uranium or the production of plutonium which could then be separated or extracted from the irradiated reactor fuel.[10] Even the pro-nuclear European Nuclear Energy Forum recognizes that larger scale production of small modular reactors introduces "the increased risks for malevolent attack when reactors are more widely geographically spread, and increased risks for nuclear proliferation".[11]

SMRs don't solve the radioactive waste problem
All SMRs will generate post-fission radioactive wastes of all varieties: the high level waste which is the irradiated nuclear fuel, and the low and intermediate level wastes such as decommissioning wastes. Any amount of nuclear waste is a problem as its safe, longterm storage or disposal has not been solved. Repository proposals have been met with local resistance regardless of the amount of waste designated. No scientifically suitable high-level radioactive waste repository has been found anywhere in the world that can guarantee containment of its inventory from the environment for the hundreds of thousands of years that it will take for the radioactive elements in the irradiated fuel to decay.

SMRs will be difficult to dismantle and involve high risks to workers
The irradiated core of an SMR will be difficult to extract and transport off site due to extremely high rates of gamma radiation and neutron radiation, and a dangerous inventory of hundreds of human-made radioactive fission products inside the irradiated core. Some structural materials surrounding the core area will also become radioactive due to neutron "activation" and will pose separate radioactive exposure problems during dismantling, packaging and removing and/or storing the radioactive rubble on site.[12]

SMRs aren't going to solve — or even help with — climate change
SMRs are by definition small. Even if one or two SMRs get built somewhere in the world, their small size will contribute little to reducing greenhouse gas emissions. New SMR designs are decades away from reality, too late for climate change. The time and immense cost spent developing SMR designs takes away from what is really needed — funding, design, and deployment of decentralized, cheaper, safer renewable energy technologies. The floating SMRs recently deployed by Russia are actually contributing to climate change because they are being used to power oil and gas drilling in the Arctic.

---

[10] Ibid. Small modular reactors and the challenges of nuclear power.

[11] 13th European Nuclear Energy Forum, June 2018, ENEF Secretariat's Conclusions. https://ec.europa.eu/info/sites/info/files/2018_10_01_enef2018conclusionsfinal.pdf

[12] Nuclear submarines and small modular reactors for isolated communities. Gordon Edwards. January 17, 2019.http://www.ccnr.org/Submarines_&_SMNRs_2019.pdf