ISSN 2767-3901

Nuclear Micro Power Reactor: The New Generation of Innovative Small Reactors

International Journal of Theoretical & Computational Physics Short Communication

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Submitted : 21 Jun 2021 ; Published : 5 Jul 2021

Abstract
This short communication gives an overall account of small modular reactors and then walks through the nuclear micro reactors as the next generation of small modular reactors, which is the next wave of innovation for these SMRs. These next wave ride on the fact that future nuclear reactors are getting smaller and modular as well transportable. In this paper we are covering a summary and overall aspect of Generation IV (GEN-IV) or they are also known as Small Modular Reactors (SMRs) as well. In this book, we also, cover Nuclear Micro Reactor and its need and implementation within Department of Defense (DOD) military organizations.

Keywords: Small Nuclear Reactor, Svelte Nuclear Reactor, Carbon Monoxide, Transportable Nuclear Reactor, Combined Cycle.

Growth of population globally has direct impact on demand for energy. Almost 18% percent growth in population and their required daily life on energy and electricity demand presents a different dimension for production of electricity not only from renewable perspective, but also puts nuclear energy resource in different category. New generation of nuclear reactors in form of Small Modular Reactors (SMRs) or GEN-IV. With new safety factors built into these reactors, with better thermal out efficiency with innovative approach to Combined Cycle (CC) makes them more cost effective from Return On Investment (ROI) point of view [1-5].

Furthermore, the presence of new renewable technology and suggested solutions by expert in the field for source of energy and energy storage does not eliminate a demand and need for both present and near term Nuclear Fission Reactors in form of GEN-III (i.e. present) to GEN-IV (i.e. next generation of SMRs) to Nuclear Fusion Reactors in far term.

The rule of thumb for generating of electricity is falling into the following category. The requirement for production of electricity is that the electricity generation rate at all times equal the demand for electricity. Economically achieving this goal is easy with fossil fuels because the primary cost of producing electricity is the cost of the fuel, not the cost of the power plant. It is economically viable to operate a fossil plant at part load. As a consequence, in the United States and much of the world the preferred fossil fuel generating technology is the Gas Turbine Combined Cycle (GTCC)—a low cost machine with rapid response to variable electricity demand with heat-to-electricity efficiencies above 60% [1,2].

The major growth in the electricity production industry in the last 30 years has centered on the expansion of natural gas power plants based on gas turbine cycles. The most popular extension of the simple Brayton gas turbine has been the combined cycle power plant with the Air-Brayton cycle serving as the topping cycle and the Steam-Rankine cycle serving as the bottoming cycle for new generation of nuclear power plants that are known as GEN-IV. The Air-Brayton cycle is an open-air cycle and the Steam-Rankine cycle is a closed cycle. The air-Brayton cycle for a natural gas driven power plant must be an open cycle, where the air is drawn in from the environment and exhausted with the products of combustion to the environment. This technique is suggested as an innovative approach to GEN-IV nuclear power plants in form and type of Small Modular Reactors (SMRs). The hot exhaust from the Air-Brayton cycle passes through a Heat Recovery Steam Generator (HSRG) prior to exhausting to the environment in a combined cycle. The HRSG serves the same purpose as a boiler for the conventional Steam-Rankine cycle [5].

Given the climate change is real fact and low-carbon environment is a mandatory reality, a quest for a new source energy that provides electricity at zero carbon generation becomes a necessity. Thus, our choice of nuclear energy in form of either fission in near term or fusion in long term is there. In chapter 2 of this book we discus topic of “Why We Need Nuclear Power Plants” based new innovative techniques to make them more efficient as well as safety point of view and cost effectiveness. Safety aspect of operational version of generation four (GEN-IV) of these reactors in form of SMRs are number one priority of owners of these reactors given the aftermath of events such Fukushima Daiichi nuclear disaster (2011), the Chernobyl disaster (1986), the Three Mile Island accident (1979), and the SL-1 accident (1961) are few we can name [5,7].

The devastating impacts of climate change caused by burning fossil fuels are forcing countries around the world to look for zero-emissions alternatives for generating electricity.

One such alternative is nuclear energy as clean source of energy that is free of carbon dioxide or monoxide generation, and the International Energy Agency (IEA) — a group focused on energy security, development and environmental sustainability for 30-member countries — says the transition to a cleaner energy system will be drastically harder without it [6].

The next nuclear plants generation will be Small, Svelte and Safer. A new generation of reactors will start producing power in the next few years. They are comparatively tiny—and may be key to hitting our climate goals for better and free of carbon monoxide and dioxide and free of any greenhouse effects.

For the last 20 years, the future of nuclear power has stood in a high bay laboratory tucked away on the Oregon State University campus in the western part of the state. Operated by NuScale Power in form of Small Modular Reactors, an Oregon-based energy startup, this prototype reactor represents a new chapter in the conflict-ridden, politically bedeviled saga of nuclear power plants. Or even old companies such as Westinghouse with many years of experience in nuclear power plant in form Generation III and now with introduction of transportable Nuclear Micro Reactor eVinci, which has both space exploration into terrestrial domain and military application for a mobile brigade for a rapid deployment process.

NuScale's reactor will not need massive cooling towers or sprawling emergency zones. It can be built in a factory and shipped to any location, no matter how remote due to its modulization technical approach and it is built around old and traditional knowledge of Light Water Reactor technique. Extensive simulations suggest it can handle almost any emergency without a meltdown. One reason is that it barely uses any nuclear fuel, at least compared with existing reactors. It's also a fraction of the size of its predecessors.

eVinci Micro Reactor cooling system is designed and its cooling system is based on Advanced Heat Pipe technology which is a very dynamic yet as passive cooling system with most safe way without any meltdown disasters either man made or natural threats.

NASA's approach with heat pipe cooled of Kilo power reactor for space exploration and Mars mission in near future is another application of these small reactors yet big energy source for such application that allows to travel beyond terrestrial space. This is good news for a planet in the grips of a climate crisis. Nuclear energy gets a bad rap in some environmentalist circles, but many energy experts and policymakers agree that splitting atoms is going to be an indispensable part of decarbonizing the world's electricity. In the US, nuclear power accounts for about two-thirds of all clean electricity, but the existing reactors are rapidly approaching the end of their regulatory lifetimes. Only two new reactors are under construction in the US, but they are billions of dollars over budget and years behind schedule.
Enter the small modular reactor, designed to allow several reactors to be combined into one unit. Need a modest amount of energy? Install just a few modules. Want to fuel a sprawling city? Tack on several more. Coming up with a suitable power plant for a wide range of situations becomes that much easier. Because they are small, these reactors can be mass-produced and shipped to any location in a handful of pieces. Perhaps most importantly, small modular reactors can take advantage of several cooling and safety mechanisms unavailable to their big brothers, which all but guarantees they will not become the next Chernobyl or Fukushima.

Nuclear is getting smaller… and it is opening up some big opportunities for the industry. A handful of microreactor designs are under development in the United States and they could be ready to roll out within the next decade.

These plug-and-play reactors will be small enough to transport by truck and could help solve energy challenges in a number of areas, ranging from remote commercial or residential locations to military bases.

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Canada's government appears to be on board, saying nuclear innovation plays a "critical role" in reducing greenhouse gas emissions as Canada moves toward a low-carbon future.

While husky CANDU reactors a Canadian design, have powered some Canadian communities for decades, governments are now eyeing technology of a different scale. The federal government describes small modular reactors (SMR), as the "next wave of innovation" in nuclear energy technology and an "important technology opportunity for Canada".
Here's what you need to know about them.
What is a small modular reactor?
Traditional nuclear reactors used in Canada can typically generate about 800 megawatts of electricity, or about enough to power about 600,000 homes at once (assuming that 1 megawatt can power about 750 homes).

The International Atomic Energy Agency (IAEA), the UN organization for nuclear co-operation, considers a nuclear reactor to be “small” if it generates under 300 megawatts.

References

1. B. Zohuri (2020) “Nuclear Micro Reactor The Next Generation of Small Modular Reactors” *Springer Publishing Company April* 2020.
2. B. Zohuri and P. McDaniel (2019) Advanced Smaller Modular Reactors: An Innovative Approach to Nuclear Power 1st Edition, *Springer* 2019, https://www.springer.com/us/book/9783030236816
3. B. Zohuri and P. McDaniel (2018) Combined Cycle Driven Efficiency for Next Generation Nuclear Power Plants: An Innovative Design Approach, 2nd ed., *Springer*, 2018, https://www.springer.com/gp/book/9783319705507
4. B. Zohuri, P. McDaniel and C. R. De OLIVERIA (2015) “Advanced Nuclear Open Air-Brayton Cycles for Highly Efficient Power Conversion”, *Nuclear Technology, 192 (1)*, 48-60, (2015), http://dx.doi.org/10.13182/NT14-42
5. B. Zohuri (2001) Combined Cycle Driven Efficiency for Next Generation Nuclear Power Plants: An Innovative Design Approach, Mar 15, 201.
6. https://en.wikipedia.org/wiki/Nuclear_and_radiation_accidents_and_incidents
7. https://www.cbc.ca/news/technology/nuclear-capacity-climate-goals-power-supply-iea-1.5152080