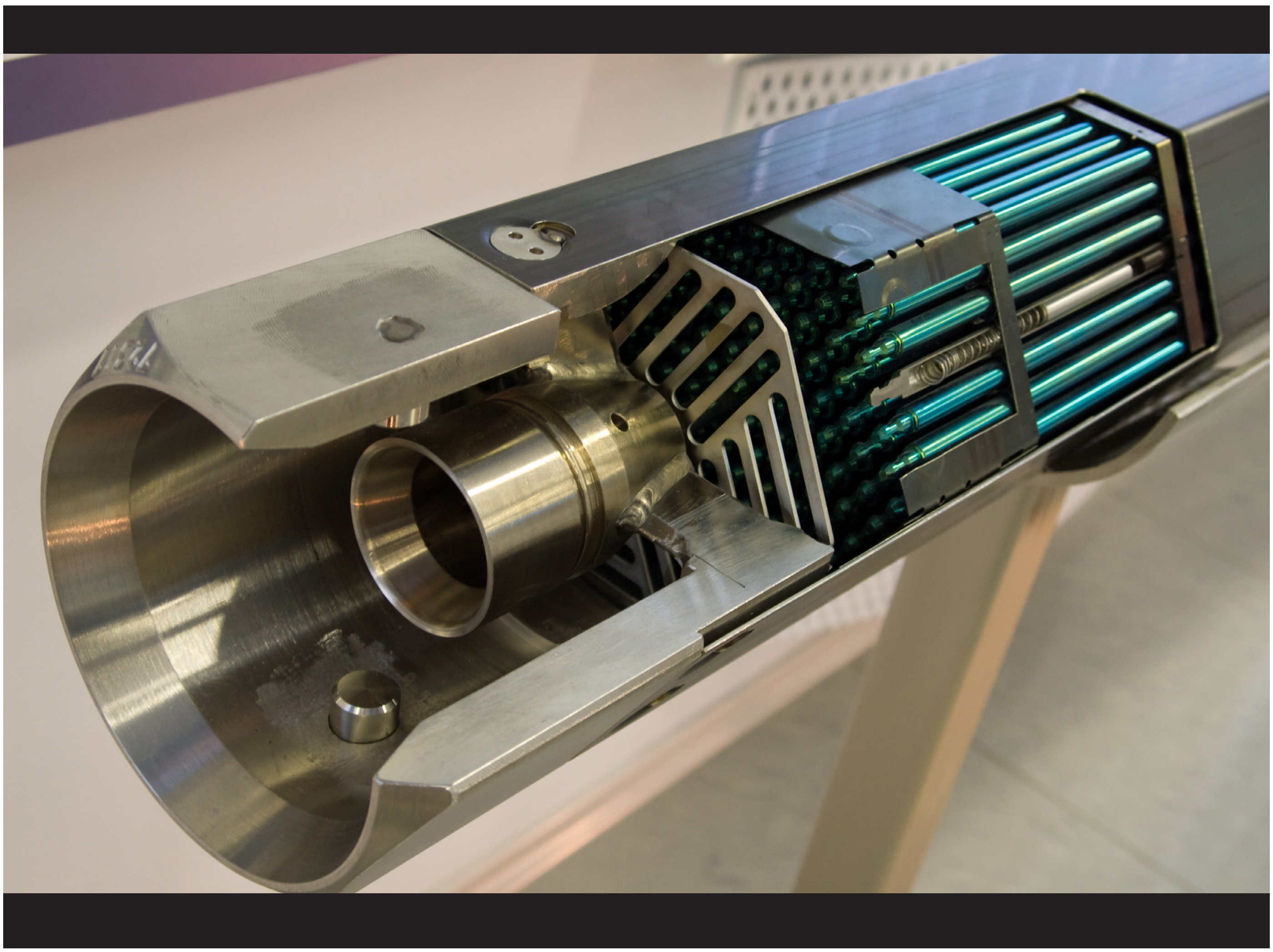
MICROREACTORS: MINIATURE NUCLEAR ENERGY SOURCES



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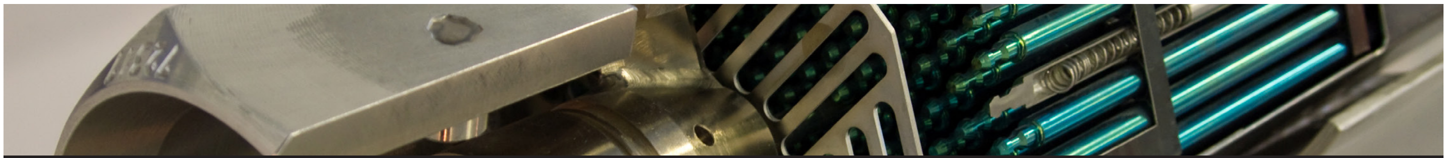

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KEY TERMS

Advanced Nuclear Reactor (AR) – Designs that employ fuels, coolants, technologies, deployment models, and other attributes and capabilities that extend beyond the current operating fleet of commercial nuclear (fission) reactors.

Microreactor – Size classification for nuclear reactors generating 150 MWt or less, corresponding to 50 MWe or less for LWRs. Most microreactor designs are targeting electrical power outputs from a few to tens of MWe.

Small Reactor (SR) – Size classification for nuclear reactor generating from 150 up to 900 MWt, corresponding to 50 – 300 MWe for LWRs.

Large Reactor (LR) – Size classification of nuclear fission reactor generating 1800–4500 MWt, corresponding to 600 - 1500 MWe for large LWRs.

Small Modular Reactor (SMR) – A small reactor designed for factory-based fabrication and modular deployment. While often used to denote a light water design, the term SMR is technology agnostic.

Microreactors are a classification of advanced reactors which are designed to be significantly smaller than the existing fleet. A typical *large light-water reactor* (LWR) will generate around 3,000 megawatts of thermal (MWt) power and generate about 1,000 megawatts of electric (MWe) power using a Rankine power cycle with 34% efficiency. Another class of reactors, *small modular reactors* (SMRs), typically generate hundreds of MWt. Microreactors, on the other hand, will typically generate tens of MWt and can operate with different power cycles and higher efficiencies.

This white paper describes the different types of microreactors being developed, explains the potential uses for the technology, and provides an overview of the state of microreactor development today. Microreactors have several benefits over larger-scale nuclear installations. These include:

- Passive or simplified safety systems
- Factory construction and fueling for faster deployment
- Transportability
- Reduced infrastructure support requirements (no need for large bodies of water for cooling or grid connections for offsite power)
- Diverse market opportunities

Promising use cases for microreactors include:

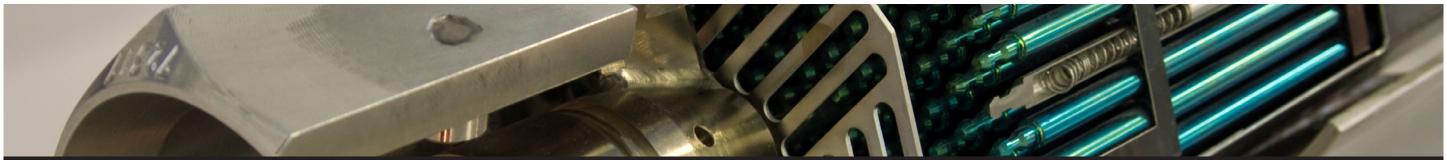
- Replacing fossil power generation in remote locations (i.e., mining towns, forward military bases, microgrid support)
- Supplying transportable power without the need for frequent refueling (i.e., natural disaster response)
- Power and propulsion in space (i.e., lunar or martian bases, or transport vehicles)

In May 2018, the United States National Aeronautics and Space Administration's (NASA) KiloPower microreactor was successfully demonstrated at full power. Numerous developers are working on their own microreactor designs, and other demonstration projects, like the Westinghouse eVinci in the U.S. or the USNC MMR in Canada, are scheduled to be deployed at lab sites as early as 2024.

Background

Nuclear reactor development started small, with some of the first reactors producing just a few megawatts of power. Quickly driven towards cost reductions envisioned from economies of scale, nuclear power plants were increased in size.

During the past 15 years, recognition of various advantages associated with designs rated at lower power have led to a renewed focus on the small. Small modular reactors were among the first ideas proposed for reducing reactor size and are being actively pursued by multiple developers. Microreactors are smaller still,



commonly producing a few kilowatts to tens of MWt. They are attractive power sources for a variety of reasons. The smaller design and lower resulting power allows for simplified systems with minimal moving parts, reduced costs, and improved passive safety. Microreactors can be deployed faster due to the reduction in size and complexity relative to traditional LWRs, and the use of factory fabrication or assembly in other controlled environments. Their potential radiological risk and site size are similarly reduced, which provides more flexibility in location, as shown in Figure 1 [23]. While site size itself is less of a barrier towards entering alternative markets, the emergency planning zone (EPZ) does limit what can be built close to the plant. For this reason, work is ongoing to prove that for SMRs, the EPZ can be defined by the boundary of the site. It should be similarly possible to demonstrate that the EPZ for a microreactor need not extend beyond the site boundary either.

Considering military, non-power, and test reactors, hundreds of 'microreactors' have been operated throughout the world already. However, many of the intended end-users of modern microreactors have never employed nuclear power, and advanced designs and technologies are being developed to effectively meet the needs of these applications. These designs broadly fall into two areas: heat pipe reactors and high-temperature gas-cooled reactors.

Heat Pipe Reactors

Heat pipes, originally developed in the 1960s at Los Alamos National Lab, are heat-transfer devices. They are used in spacecraft, to cool elements inside of computers, and along the Trans-Alaska Pipeline to dissipate heat (which is generated by friction from the oil moving through the pipe) to protect the permafrost [3].

A heat pipe consists of a sealed metal tube, with a wick affixed to the inner walls. At the center of the enclosure is a working fluid under vacuum. One side of the pipe serves as the evaporator where the working fluid, starting as a liquid, absorbs heat from an external heat source and vaporizes. The fluid, now a vapor, is forced to the other end of the tube. This condenser side rapidly dissipates heat out of the working fluid as it condenses. The now-liquid is absorbed into the wick and, via capillary action, is passively returned to the evaporator side for reheating. Figure 2 displays the working principle of a heat pipe [24]. In the case of a microreactor, the heat is generated by nuclear fission in the reactor core. The other side of the pipe is positioned away from the core, allowing for passive transfer of thermal power out of the core, which is then likely converted to electric power or used as process heat. Heat pipe technology is especially favorable in microreactors due to its simplicity; the heat transfer process is entirely passive. Thus far fewer components like pumps and valves are required for controlling fluid flow [4].

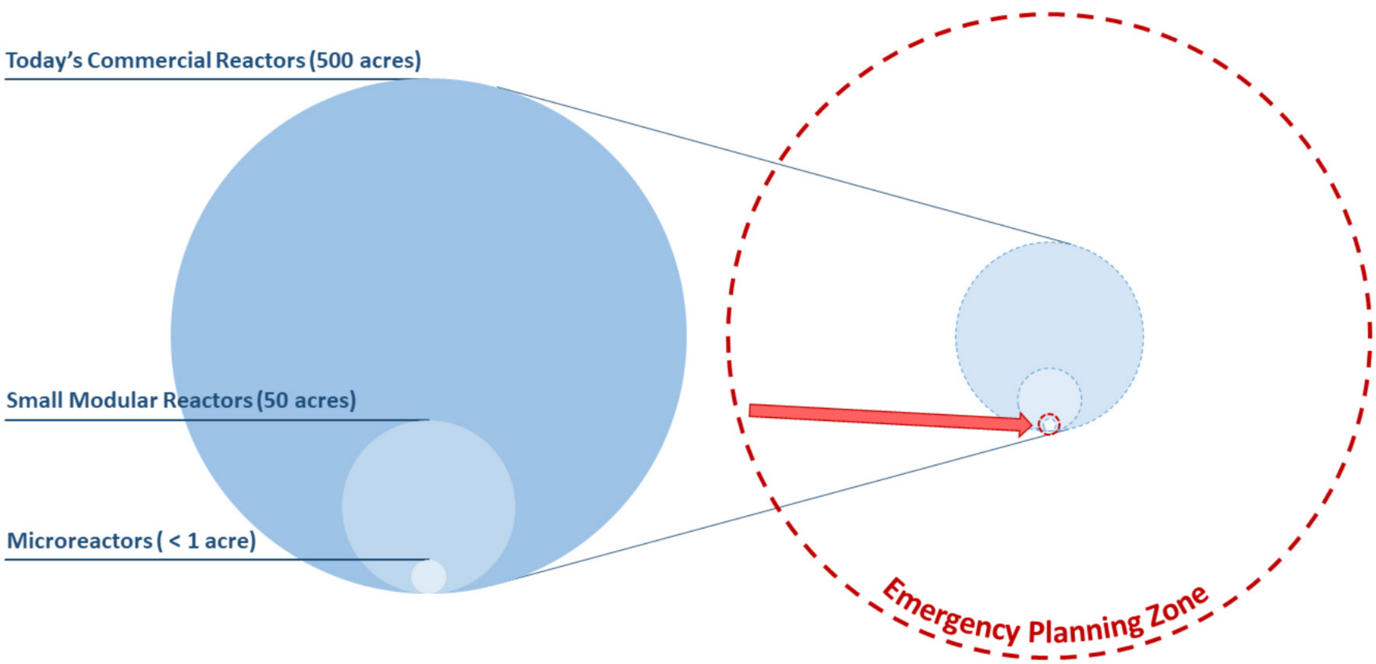
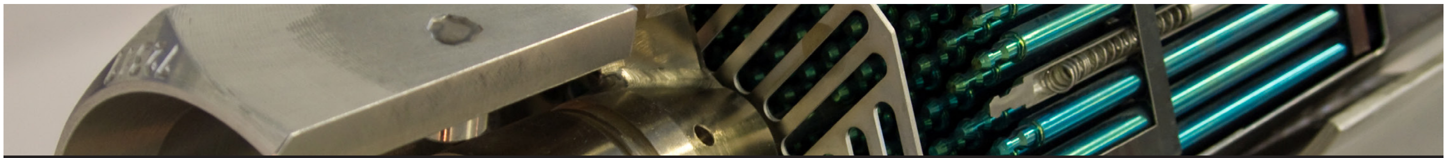


Figure 1 – Comparison of estimated reactor footprints and emergency planning zones (modified from [23])



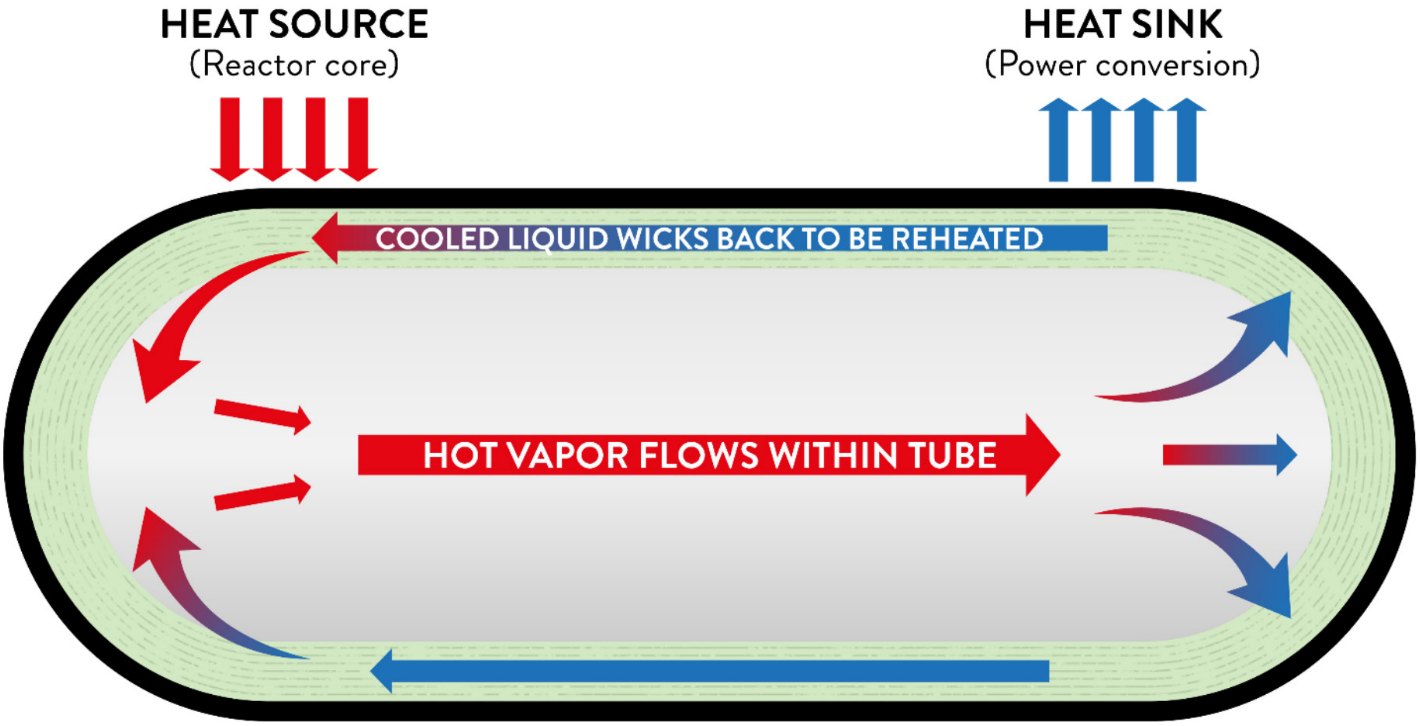


Figure 2 – Heat pipe working principle

High-Temperature Gas-Cooled Reactors

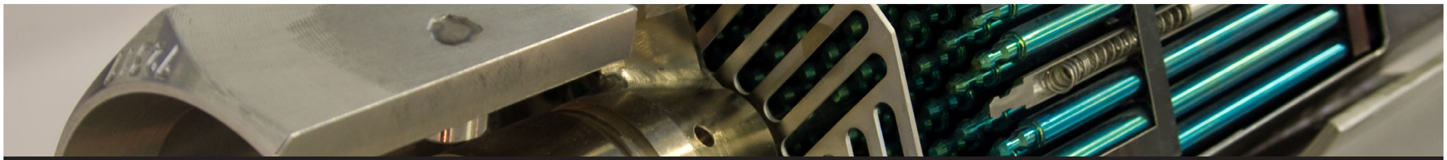
The high-temperature gas-cooled reactor (HTGR) is a technology first demonstrated in 1966 at Peach Bottom Atomic Power Station in the U.S. [1]. The working principle generally follows that of large-scale commercial reactors: nuclear fission occurs in the reactor core, generating heat. This is transferred to a working fluid that flows away from the core, at which point the thermal energy may be converted to useful work or used as process heat. HTGRs are characterized by the use of a high-temperature gas (helium for contemporary designs) as the primary working fluid. While first demonstrated decades ago, innovative fuel forms, materials, and technologies are being developed that set modern designs apart.

One fuel type that many HTGRs are designed to employ is tri-structural isotropic (TRISO) particle fuel. This fuel consists of particles, each made up of a uranium fuel kernel sheathed by layers of carbon- and ceramic-based materials. This fuel type is popular for use in HTGRs because of the level of safety it provides. TRISO particles have excellent fission product retention during normal operation, as well as the capability to withstand extremely high temperatures before the protective sheaths fail. This latter quality allows each particle to serve as its own containment system, with the outer layers minimizing release of radioactive fission products under many reactor accident conditions [2]. With TRISO particles embedded in a suitable matrix, the overall fuel system maintains its integrity against phenomena (e.g., temperature, irradiation, corrosion, oxidation) that can degrade existing fuel designs. For further reading on TRISO fuel, refer to the EPRI Topical Report approved by the NRC [22].

Microreactor Use Cases

Remote Communities and Operations

Remote communities and remote industrial operations are prime candidates for microreactor use. Energy users include arctic or island communities, mining and other remote industries, and forward and remote military bases. Typically, these users lack connection to a larger energy grid and employ diesel generators. This results in the need for frequent fuel shipments, which can be costly and can introduce higher risk of missed shipments, leading to extended loss



of power. Depending on the location, such shipments may require airlifting. With microreactors, power can be supplied for much longer periods of time (2 – 10 years), without requiring refueling, and carbon emissions from power generation can be eliminated.

Microreactors are also projected to be cost-competitive with diesel in remote applications. According to the Nuclear Energy Institute [5], the cost of power for the first installation is estimated to be 0.14 – 0.41 $/kWh, and 0.09 – 0.33 $/kWh for future installations. Meanwhile, diesel generation costs for remote communities can range from 0.15 $/kWh and 0.60 $/kWh, as shown in Figure 3.

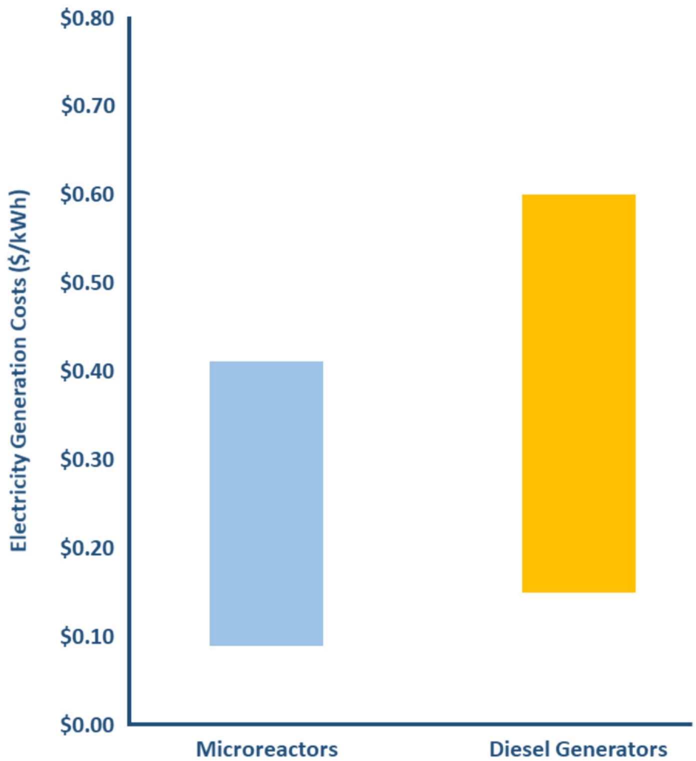


Figure 3 – Cost-comparison between microreactor and diesel power generation (adapted from [5], courtesy of NEI)

Disaster Response and Recovery

Natural disasters commonly result in damage of primary power supply systems. It would be beneficial in such situations to have access to a transportable source of back-up power to deploy in the affected region for use while the main grid is being restored. They could even act as blackstart generators to assist in repowering the grid. Microreactors have potential for use in disaster response as a result of their intended quick installation capabilities, portability, and reliability.

Extraterrestrial Applications

Microreactors also hold the potential to deliver propulsion and power generation on the way to, and while on, the Moon or Mars. Energy generation possibilities are limited in space, and small-scale nuclear power is a safe, efficient, and long-duration option, which could serve to power long term extraterrestrial human outposts [6].

Fission power has key advantages for off-earth applications, including the ability to provide base load power when solar power is insufficient (like during nights on the moon, which last two weeks), compactness, and an ability to operate with infrequent refueling. Many technical challenges exist, such as launch conditions, low gravity, abrasive dust, and obtaining launch approval (which requires specific U.S. Federal Aviation Administration review [19, 20]). Fortunately, there is precedent for addressing them, as the SNAP 10A in mission the 1960s operated a reactor in orbit for over 40 days sucessfully. Contemporary launches would need to overcome each of these challenges again, but will benefit from having the concept proven. Following the successful demonstration of the Kilopower Project's KRUSTY reactor (Figure 4), NASA, the Department of Energy, and industry partners are working together on a 10-kilowatt electric (kWe) fission power system for deployment on the Moon. This in turn will pave the way for sustainable operations and even basecamps on the Moon and Mars.

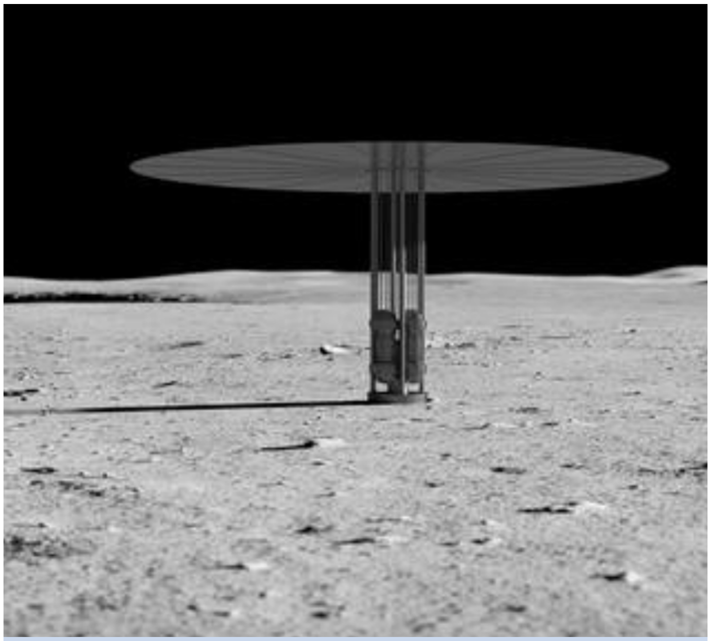
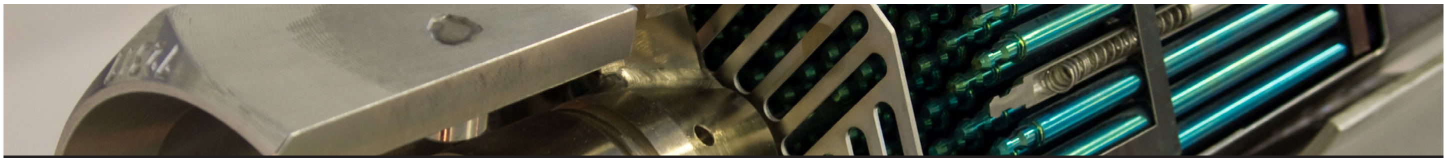


Figure 4 – A rendering of NASA's Kilopower concept, image in Public Domain, courtesy of NASA [6].



Process Heating

Microreactors could be implemented as electric power sources, heating sources, or as a cogeneration source of both. In terms of pure heating, the energy demand in the industrial heat market is in the tens of MWt at temperatures ranging from 200–750°C per application [25]. A traditional nuclear reactor or SMR would overwhelm this need, but microreactors pair well to these thermal power demands. Microreactors are also projected to be cost competitive for certain heating solutions, with one estimate from MIT pricing thermal energy produced by microreactors at ~ 7 $/MMBTU [7]. Various methods exist for process heating, including fuel-based heating, which accounts for the majority of process heat energy consumption. Microreactor thermal output estimated costs can be competitive with natural gas in some price ranges, but are broadly competitive with heating oil, another common fuel used for heating, which costs approximately 19 $/MMBTU. Electric heating does not account for as much of the process heat sector as fuel-based heating, but it is a relevant competitor with nuclear because carbon-free renewable generation would support electric (rather than fuel-based) heating. Microreactors can be highly competitive with electric heating, which currently costs approximately 20 $/MMBTU [16–18].

Distributed Energy Resources

Distributed energy resources (DERs) are smaller-scale energy sources, loads, and storage solutions that operate at the point of consumption, often "behind-the-meter". They operate at a very similar scale to microreactors, with one study by the Federal Energy Management Program out of the National Renewable Energy Laboratory defining DERs as producing less than 10 MW of power [26]. Like microreactors, DERs are an active area of study and development. One of the more common types of DER is renewable generation, such as roof-top solar installations. Though the use case is further from being realized than other DERs due to the need for technology maturation and resulting lower costs, microreactors have potential as a widespread DER solution [8].

Nuclear power is generally complementary to renewables as a dispatchable or firm generation source, enabling nuclear to balance the intermittent power production of solar or wind installations. Microreactors, in particular, have potential as DERs because they are more suitably sized to be incorporated directly into microgrids—small-scale electric grids which normally connect to the main grid but are usually designed to disconnect, or "island" themselves whenever power on the main grid is lost. As microgrid-connected resources, microreactors could directly balance renewable DERs on a shared microgrid, and aid in powering critical infrastructure (e.g., hospitals) or small communities whenever power to the main grid is lost.

District Energy

District energy systems produce hot water, steam, or chilled water from a central plant. This is then transported through insulated pipes to provide hot water as well as heating and air conditioning for nearby buildings [27]. A single nuclear energy facility could meet the needs of an entire campus of buildings, and provide control to the end-user to fine-tune output based on their specific needs. Using reactors for district energy has been already implemented successfully in multiple parts of Europe [28]. The potential for microreactors to have a reduced EPZ and enhanced safety features can allow for easier implementation into urban centers that heavily use these services.

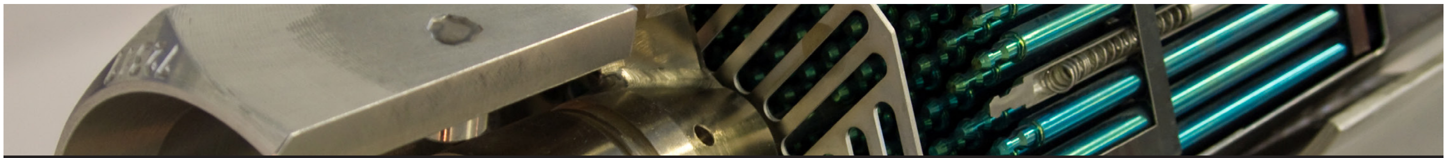
Additional Applications

There exist many other industrial processes with energy requirements that are not easy to decarbonize, but have demand in the range that microreactors produce. The heat produced from a reactor can be utilized for the desalination of salt water into potable water. Microreactors can be integrated into island communities that rely on desalination and provide heat, power, and clean drinking water to the residents. These microreactors can also be used to extract heavy oil from tar sands and cut down significantly on carbon emissions from the acquisition of oil [28]. As tar sands are generally in remote locations, the manueverability of microreactors make them ideal for this application.

Current Industry Progress

More than a dozen developers are actively working to demonstrate microreactor technologies. The first modern microreactor to be demonstrated was NASA's KRUSTY reactor from the KiloPower project, which was successfully completed in 2018. NASA is aiming to build from this success with a lunar demonstration of a 10 kWe microreactor in the late 2020's [9].

Other promising microreactor projects include Oklo's Aurora heat pipe reactor (Figure 5). It is rated for both heating (4 MWt) and electric power applications (1.5 MWe), and in licensing discussions with the U.S.'s Nuclear Regulatory Commission (NRC) [10], with intent to operate a demonstration unit by 2025 [11]. One other



developer looking to demonstrate their microreactor technology is BWX Technologies. They were recently selected by the U.S. Department of Defense to execute Project Pele. The purpose of the project is to design a transportable microreactor prototype with a generating capacity of 1 to 5 Mwe that can be installed (after off-site assembly) in under a week, and uninstalled in around three days [12].

Ultra Safe Nuclear Corporation (USNC) is another company maturing a microreactor design. They have partnered with the University of Illinois Urbana-Champaign (UIUC), which has submitted a Letter of Intent to apply for an NRC permit to construct a reactor on campus [21]. One more developer of note is Westinghouse with their eVinci heat pipe microreactor (0.5 – 6 MWe/2-20 MWt) [13]. Westinghouse is planning pre-application activities with the NRC, with a prototype demonstration targeted for 2024 and commercial deployment projected for the late 2020s [14, 15]. Table 1 provides a representative list of active microreactor developers, but is not intended to be exhaustive.

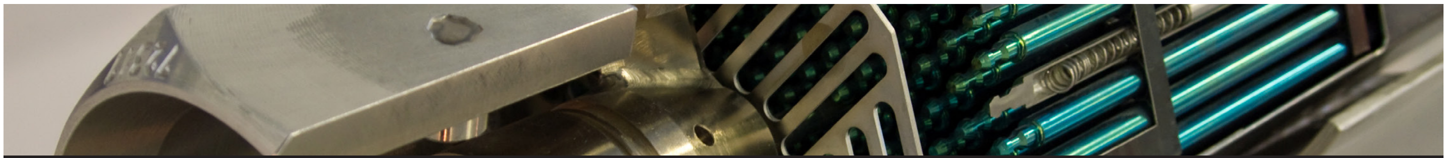
Table 1 – Developer landscape for microreactors[1]

Developer	Reactor Type	Capacity
BWX Technologies (U.S.)	HTGR	1 – 5 MWe
HolosGen (U.S.)	HTGR	3 MWe/5 MWt
NuGen (U.S.)	HTGR	1 – 3 MWe
Radiant (U.S.)	HTGR	1.2 MWe/3.5 MWt
U-Battery (UK)	HTGR	4 MWe/10 MWt
USNC (U.S.)	HTGR	5 MWe/15 MWt
X-Energy (U.S.)	HTGR	1 – 5 MWe
Los Alamos National Laboratory (U.S.)	Heat Pipe Reactor	2 MWe/5 MWt
NuScale (U.S.)	Heat Pipe Reactor	1 – 10 MWe
Oklo (U.S.)	Heat Pipe Reactor	1.5 MWe/4 MWt
Westinghouse (U.S.)	Heat Pipe Reactor	0.5 – 6 MWe/2 – 20 MWt
MicroNuclear (U.S.)	MSR[2]	5 – 10MWe/10 – 20MWt
LeadCold (Sweden)	LFR[3]	3 MWe/8 MWt

Notes:
1. List is not intended to be exhaustive; features primarily U.S.-based developers
2. Molten Salt Reactor (uses molten salt as the heat transfer fluid)
3. Lead-cooled fast reactor

Microreactors have the potential to address concerns that have limited the more widespread adoption of nuclear power with their many benefits, including:

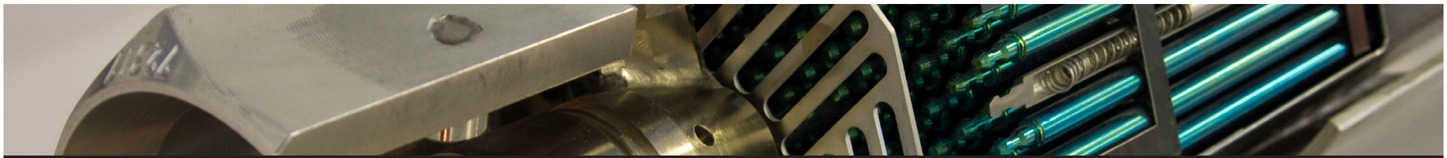
- ***Manageable capital cost*** – Studies out of MIT emphasize the cost effectiveness of factory fabrication at these scales using relatively conservative cost estimates [7]. Controlling the environment of production for the reactor system could allow for the same benefits shown in marine shipping production to be realized for nuclear energy.
- ***Predictable schedule*** – Through assembly line style production, these systems could become productized. This might result in installation at the end-user site as the driving risk factor in schedule duration. While installation hundreds of miles from a grid may be difficult, the simplification of these systems inherently reduces risk compared to a true site-based construction.
- ***Reduced size and complexity*** – The elimination of moving parts from some designs, and the reduced quantity of required safety systems could reduce the manufacturing, commissioning, and operating complexity. This could subsequently derisk production and installation, allowing for more consistent and desirable timelines.
- ***Reduced radiological risk*** – The large reduction in size, in some cases paired with lower energy-density fuel, can lead to a reduced radiological source term, which limits the impact of accident scenarios. This has resulted in an ongoing effort to shrink the EPZ to the site boundary for SMRs, and can be extended to possibly reduce the EPZ for a microreactor down to the container boundary it is transported within (for more mobile designs).
- ***Siting close to end users*** – A smaller EPZ could allow for closer geographic siting to some end-users. This could allow for residential energy users to power a microgrid locally.
- ***Flexibility in mission*** – The high temperatures reached by either design can support industrial customers all the way to the top of the demand spectrum. The mobility of some systems could allow them to serve remote end-users that would be difficult for a nuclear construction project to economically reach.



EPRI's Advanced Nuclear Technology (ANT) program performs research and development to evaluate and address the challenges of deploying new nuclear power plants, including microreactors. Due to the convergence of needs between microreactors and many other advanced nuclear technologies, ANT projects on topics such as material qualification and manufacturing optimization are able to support a wide range of designs. An example of this is the TRISO topical report that EPRI produced based on existing research by Idaho National Lab (INL) and Oak Ridge National Lab (ORNL) and which was approved by the NRC in 2020 [22]. Based on the extensive work of reactor developers, the nuclear industry, and EPRI, microreactors are expected to be deployable and cost-effective for certain applications in the next few years.

References

1. W. Scheffel, N. Baldwin, R. Tomlin. *Operating history report for the Peach Bottom HTGR.* GA A- 13907(Vol.1). General Atomics, San Diego, CA: August 1976. https://inis.iaea.org/search/search.aspx?orig_q=RN:8307201.
2. "TRISO Particles: The Most Robust Nuclear Fuel on Earth," U.S. Department of Energy, Washington, DC: July 2019. https://www.energy.gov/ne/articles/triso-particles-most-robust-nuclear-fuel-earth.
3. "Inspired Heat-Pipe Technology," National Security Science Magazine, Los Alamos National Laboratory, Los Alamos, NM: 201 Accessed July 19, 2021. https://cdn.lanl.gov/files/NSS-Issue1-2011.pdf.
4. *Full-Power Microreactor Demonstration Expands Horizons for Nuclear Energy.* EPRI, Palo Alto, CA: 2018. 3002014871. https://www.epri.com/research/products/000000003002014871.
5. *Cost Competitiveness of Micro-Reactors for Remote Markets.* Nuclear Energy Institute, Washington, DC: April 2019. https://nei.org/CorporateSite/media/filefolder/resources/reports-and-briefs/Report-Cost-Competitiveness-of-Micro-Reactors-for-Remote-Markets.pdf.
6. "Kilopower," NASA, Washington, DC: January 2021. https://www.nasa.gov/directorates/spacetech/kilopower.
7. J. Buongiorno, R. Freda, S. Aumeier, K. Chilton. "A Strategy to Unlock the Potential of Nuclear Energy for a New and Resilient Global Energy-Industrial Paradigm," *The Bridge.* Vol. 51.2. National Academy of Engineering, Washington, DC: June 2021. https://www.nae.edu/255810/A-Strategy-to-Unlock-the-Potential-of-Nuclear-Energy-for-a-New-and-Resilient-Global-EnergyIndustrial-Paradigm#_ftn2.
8. A. Gilbert, M. Bazilian. "Can Distributed Nuclear Power Address Energy Resilience and Energy Poverty?" *Joule*, Vol 4.9, 1839-1843. September 2020. https://doi.org/10.1016/j.joule.2020.08.005.
9. "Fission Surface Power," NASA, Washington, DC: May 2021. https://www.nasa.gov/mission_pages/tdm/fission-surface-power/index.html.
10. "Aurora – Oklo Application," U.S. Nuclear Regulatory Commission, Washington, DC: March 2021. https://www.nrc.gov/reactors/new-reactors/col/aurora-oklo.html.
11. "Oklo submits first advanced reactor licence application." World Nuclear News, London, UK: March 2020. https://www.world-nuclear-news.org/Articles/Oklo-submits-first-advanced-reactor-licence-applic.
12. "Strategic Capabilities Office Selects Two Mobile Microreactor Concepts to Proceed to Final Design," U.S. Department of Defense, Washington, DC: March 2021. https://www.defense.gov/News/Releases/Release/Article/2545869/strategic-capabilities-office-selects-two-mobile-microreactor-concepts-to-proce/.
13. *Advanced Nuclear Directory*, 7th Edition. Gateway for Accelerated Innovation in Nuclear, Idaho Falls, ID: July 2021. https://gain.inl.gov/SiteAssets/Funding%20Opportunities/GAINAdvancedNuclearDirectory-Seventh%20Edition_07.01.2021-R1.pdf.
14. "eVinci," U.S. Nuclear Regulatory Commission, Washington, DC: June 2021. https://www.nrc.gov/reactors/new-reactors/advanced/ongoing-licensing-activities/pre-application-activities/evinci.html.
15. "5 Advanced Reactor Designs to Watch in 2030." U.S. Department of Energy, Washington, DC: March 2021. https://www.energy.gov/ne/articles/5-advanced-reactor-designs-watch-2030.



16. "Electric Power Monthly," U.S. Energy Information Administration, Washington, DC: 2021. https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=table_es1b.

17. "Natural Gas," U.S. Energy Information Administration, Washington, DC. Accessed 2021. https://www.eia.gov/dnav/ng/hist/rngwhhdm.htm.

18. "Heating Oil and Propane Update," U.S. Energy Information Administration, Washington, DC. Accessed March 2021. https://www.eia.gov/petroleum/heatingoilpropane/#itn-tabs-2.

19. United States Department of Transportation and Federal Aviation Administration. Code of Federal Regulations, Title 14. Accessed 2021. https://www.ecfr.gov/current/title-14.

20. D. Trump. *Presidential Memorandum on Launch of Spacecraft Containing Space Nuclear Systems*, The White House, Washington, DC: August 2019. https://trumpwhitehouse.archives.gov/presidential-actions/presidential-memorandum-launch-spacecraft-containing-space-nuclear-systems/.

21. "University of Illinois at Urbana-Champaign and USNC Will Collaborate to License and Construct Next-Generation Micro Modular Reactor," Ultra Safe Nuclear Corporation, Seattle, WA: June 2021. https://usnc.com/university-of-illinois-at-urbana-champaign-and-usnc-will-collaborate-to-license-and-construct-next-generation-micro-modular-reactor/.

22. "Uranium Oxycarbide (UCO) Tristructural Isotropic (TRISO) Coated Particle Fuel Performance: Topical Report EPRI-AR-1(NP)-A." EPRI, Palo Alto, CA: November 2020. 3002019978. https://www.epri.com/#/pages/product/3002019978/.

23. "Four Types of Reactors to Power the Nuclear Future," Idaho National Laboratory, Idaho Falls, ID: 2021. https://public.inl.gov/public/pdfs/Reactor_types.pdf.

24. "The Heat Pipe," Dutch Knowledge Center for Heat Pipe Technology: 2010. http://www.heatpipe.nl/index.php?page=heatpipe&lang=EN.

25. IRENA/IEA-ETSAP, Solar Heating and Cooling Program. 2015. Potential for Solar Heat in Industrial Processes. https://www.irena.org/publications/2015/Jan/Solar-Heat-for-Industrial-Processes.

26. "Using Distributed Energy Resources: A How-To Guide For Federal Facility Managers." Federal Energy Management Program, Washington, D.C: May 2002. DOE/GO-102002-1520.

27. "District Energy Fact Sheet." U.S. Department of Energy, Washington, DC: September 2020. https://www.energy.gov/sites/default/files/2021/03/f83/District_Energy_Fact_Sheet.pdf.

28. "Nuclear Process Heat for Industry." World Nuclear Association, London, UK: September 2021. https://world-nuclear.org/information-library/non-power-nuclear-applications/industry/nuclear-process-heat-for-industry.aspx.

Note

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