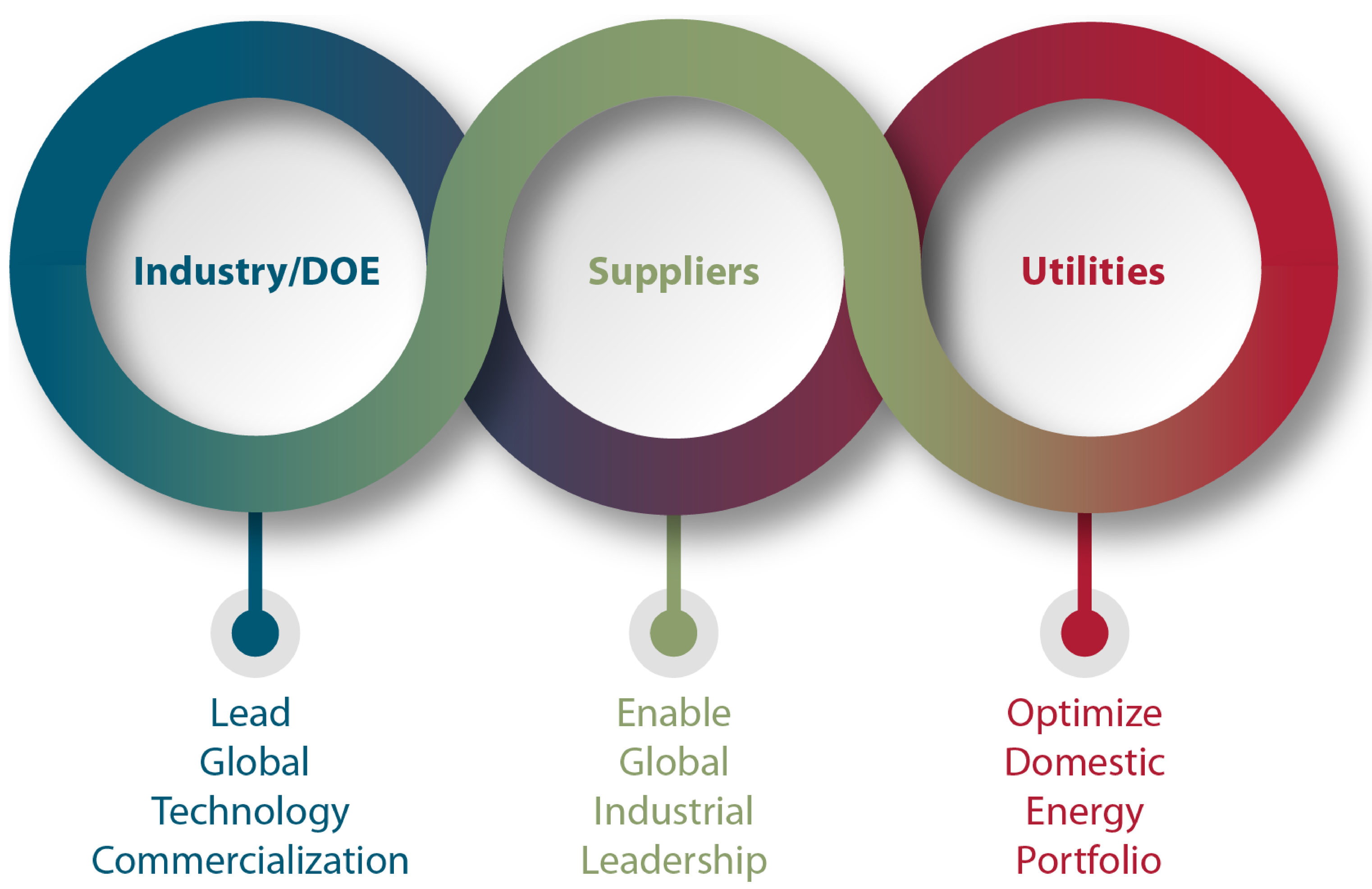
High Temperature Reactors

DOE-NE has established the Gateway for Accelerated Innovation in Nuclear (GAIN) to provide the nuclear community with access to the technical, regulatory, and financial support necessary to move innovative nuclear energy technologies toward commercialization while ensuring the continued safe, reliable, and economic operation of the existing nuclear fleet.



Developing safe, reliable sources of carbon-free energy will be the next decade's greatest challenge for US power producers. Several US-based companies are developing High Temperature Reactors (HTRs), a type of advanced nuclear reactor, to help meet that energy challenge.

HTRs are a type of graphite-moderated thermal reactor employing TRISO fuels (see below), differentiating them from other advanced reactor concepts. HTRs use either inert gas or molten salt as a heat transfer medium. Developers of this reactor type offer increased safety, remote power, and industrial applications.

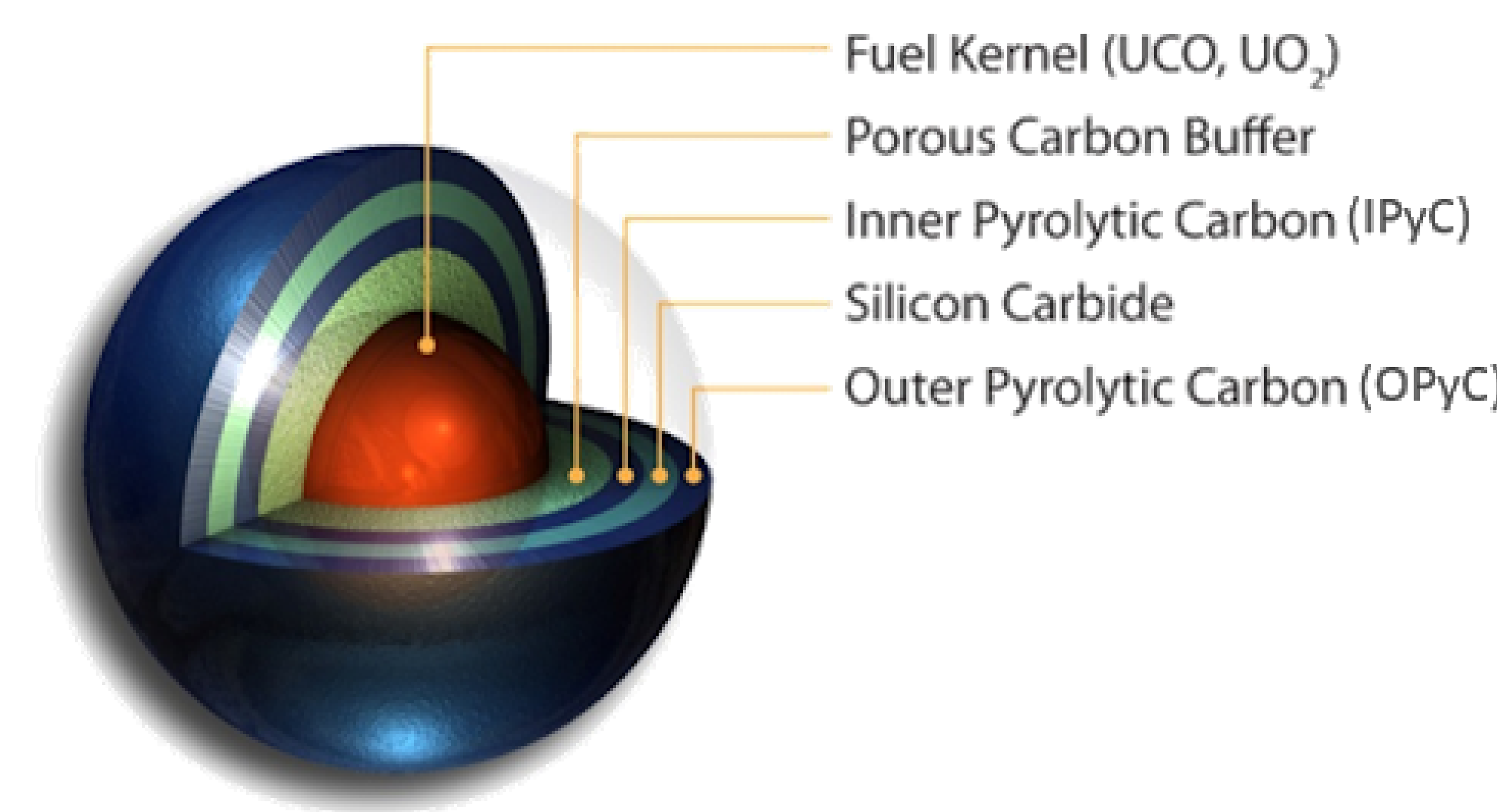
HTRs typically use low enriched uranium fuel to produce higher reactor outlet temperatures than other reactors. For this reason, developers of HTRs offer it as a viable replacement to industrial fossil fuel processes.

Quality Process Heat for Industrial Applications

All HTR systems have the ability to reach higher and more precise temperatures than those that use fossil fuels. HTRs' ability to consistently produce clean, quality heat is especially important in industrial chemical processes, where a plant must maintain a set range of temperatures for successful production. HTRs, therefore, can reduce the margin of error for operators, resulting in greater cost efficiencies.

Inherent Safety that Starts at the Fuel Source

HTRs are built around safety, beginning with advances in nuclear fuel technology. All HTRs use "tri-structural isotropic" fuels, commonly referred to as TRISO fuels *(Image 1)*. TRISO fuel comes in different shapes and sizes; no matter the form, this advanced fuel source contains a small amount of low-enriched uranium fuel within three layers of protective graphite and silicon carbide. These TRISO particles are incorporated into a graphite matrix within spheres ("pebbles") the size of a golf ball or a tennis ball, or into blocks ("compacts"). The coatings around the TRISO particles fully contain fission products resulting from the nuclear reaction, eliminating the need for costly, concrete containment structures.



(Image 1): *A tri-structural isotropic, or "TRISO" fuel particle.*

Load Following and Integration

By deploying HTRs in an energy mix, power producers are able to provide reliable electricity to customers while integrating with other generation technologies, such as variable renewable energy resources. Flexible, load following capabilities of HTRs enable integration with intermittent renewable energy sources; moreover, the high-grade heat produced by HTRs make thermal energy storage or integration with industrial processes possible and attractive during low electricity demand intervals.

Additional High Temperature Reactor Resources:

bit.ly/INL-ART-GCR

bit.ly/NRC-Training-Course-HTR

bit.ly/IAEA-ARIS-Database

Contact GAIN:

GAIN.inl.gov
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High Temperature Reactors

COST EFFICIENCY

As utilities evolve to meet the challenges of a modernizing grid, advanced nuclear reactor technologies seek to provide economically viable solutions through simplified designs and reduced operational costs.

INTEGRATION & RELIABILITY

Flagging load growth and the rise of distributed generation sources are driving advanced nuclear developers to provide flexible, always on power to end users.

SAFETY & WASTE

The possibility of Fukushima-like events is eliminated by the inherent physics of the reactor through a failsafe design; fuel waste concerns are substantially reduced.

- Designs are intended for factory assembly and fixed modular construction, assuring on-budget projects while reducing overall costs.
- Many designs support online refueling, avoiding disruption in customers' energy demands.
- When compared with current reactor designs, passive safety features cut operational and maintenance costs.
- Reactors can achieve higher temperatures than fossil fuels, producing a high-quality steam cycle to meet commercial, industrial, and residential needs.
- Reactors are designed for a modern grid, capable of load following and integrating with variable renewable energy sources.
- HTR designs either utilize non-reactive helium gas or molten salts as a heat transfer medium, providing an added measure of safety.
- More efficient fuel usage than current generation reactors reduces waste and fuel costs for operators.
- Ceramic TRISO fuel, coupled with a large graphite and salt heat capacity, allows for a slow fuel temperature response in the event of cooling loss.

		Thermal Output (per unit)	Electrical Output (per unit)	Total Plant Footprint	Primary System Water Requirements	Industrial Heat & Steam	Load Following
< 10 MWe	Micro Systems	< 30 MWt	< 10 MWe	Fast Food Restaurant	None	✓	✓
10 - 300 MWe	Small Systems	30 - 1000 MWt	10 - < 300 MWe	Parking Garage	None	✓	✓
> 700 MWe	Large Systems	> 1000 MWt	> 700 MWe	Industrial Factory	None	✓	✓