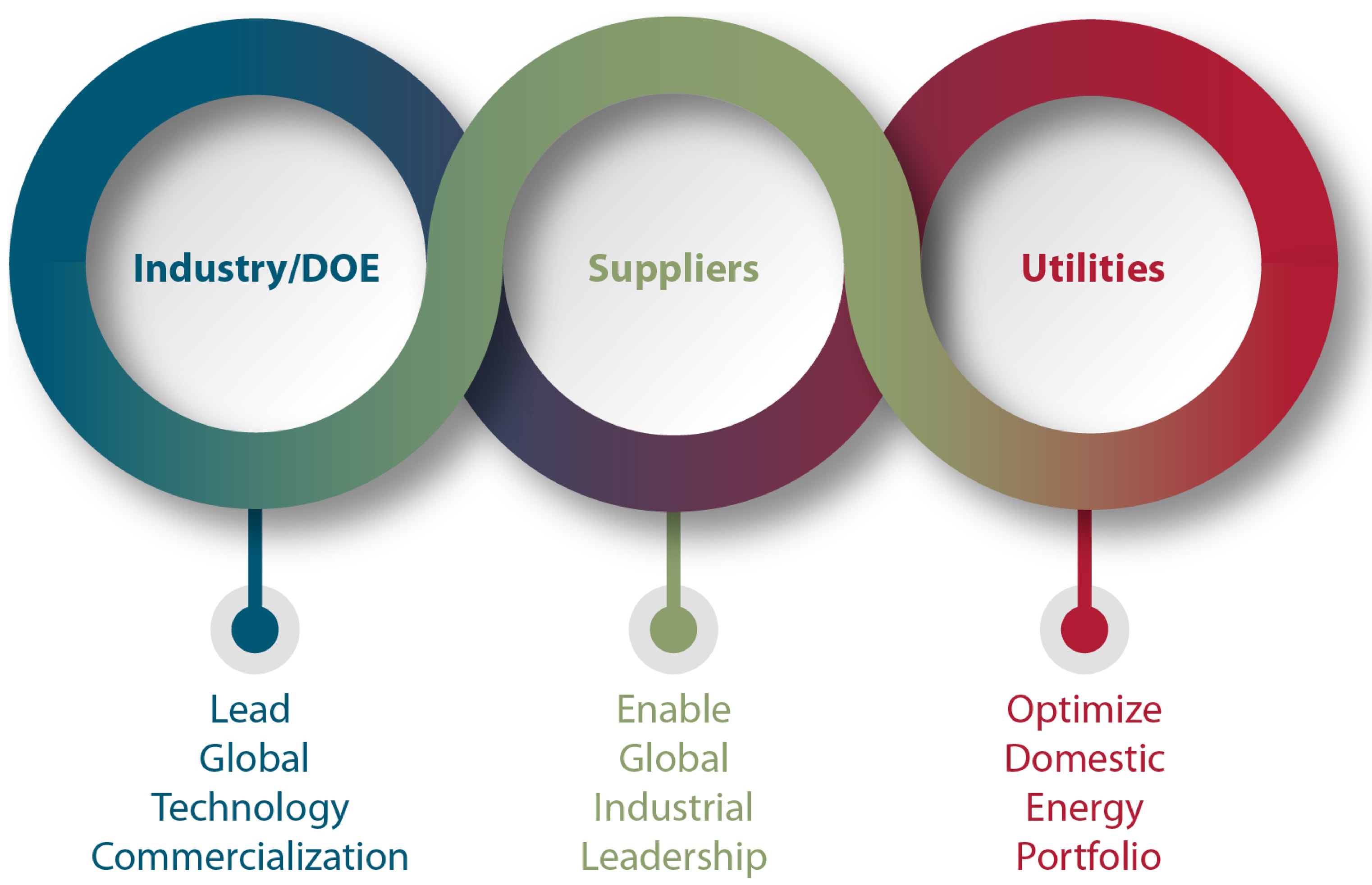
Fast Reactors

GAIN Gateway for Accelerated Innovation in Nuclear

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.



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Additional Fast Reactor Resources:

bit.ly/IAEA-FastReactor-Reference

bit.ly/GAIN-FastReactor

bit.ly/ANL-EBR2-History

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 Fast Reactors (FRs), a type of advanced nuclear reactor, to help meet that energy challenge.

Without a moderator, nuclear reactions occur at high energies, producing more efficient fission reactions. Developers of this reactor type offer increased safety, reduced proliferation risk, improved management of nuclear waste, and industrial applications, all at a lower cost than traditional reactors. In some designs the reactor can recycle waste from other reactors, or produce additional fuel.

Four types of FRs are being developed by US companies: the Sodium-Cooled Fast Reactor (SFR), Lead-Cooled Fast Reactor (LFR), Gas-Cooled Fast Reactor (GFR), and Molten Salt Fast Reactor (MSFR).

Inherently Safe by Design

By operating in the fast spectrum with a liquid metal coolant, FRs are able to provide both high power density and passively safe operation. FRs rely on "fast neutrons" to cause fission, and can be designed without a moderator (e.g. water) in the reactor core. A liquid metal coolant allows for efficient heat transfer at low pressure, promoting natural circulation and passive decay heat removal. In the event of a rise in temperature, the physics of the reactor provides reactivity feedback that inherently reduces the reactor's power. This inherent safety behavior prevents severe accidents, as demonstrated by Experimental Breeder Reactor-II (Image 1). FRs using gas and salts can achieve similar inherent safety performance by passively removing heat, and incorporating self-stabilizing reactivity feedbacks.

Fuel Cycle Features

The unique properties of FRs enable efficient fuel utilization and waste minimization. FRs can operate with a favorable neutron balance; fission reactions in FRs are capable of creating more neutrons than consumed. By converting these excess neutrons into usable fuel materials, some FRs are designed to produce more fuel. FRs are also flexible to accept a wide range of fuel materials, with many designs capable of recycling existing nuclear waste in a closed fuel cycle. The efficient fuel utilization of FRs can also enable some designs to operate for decades without refueling. FRs offer fuel cycle flexibility, providing a robust fuel supply and improved nuclear waste management.

(Image 1): *Experimental Breeder Reactor-II (EBR II) at the National Reactor Testing Station in Idaho.*

Load Following and Integration

By deploying FRs 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 allow a reactor to adjust to demand and intermittent supply. In times when less power is needed, fast reactors have a ramp-down rate of less than 15 minutes. When the demand for energy increases, it can be ramped up to full power within minutes.

Fast 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.
- Some FRs have a long-lived core, making the need for refueling infrequent; in some concepts, a reactor can operate for 30-60 years before it needs refueling.
- 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.
- FRs have demonstrated the ability to consume existing spent nuclear fuel from current generation reactors; most designs allow for the recycling of used fuel, limiting or reducing waste.
- Operation in the fast spectrum allows for more efficient fuel use than current generation reactors, reducing waste and fuel costs.
- FRs have demonstrated inherent safety under severe accident conditions.

		Thermal Output (per unit)	Electrical Output (per unit)	Total Plant Footprint	Primary System Water Requirements	Industrial Heat & Steam	Load Following
< 50 MWe	Micro Systems	< 150 MWt	< 50 MWe	Fast Food Restaurant	None	✓	✓
50 - 300 MWe	Small Systems	150 - 1000 MWt	50 - 300 MWe	Parking Garage	None	✓	✓
> 300 MWe	Large Systems	> 1000 MWt	300 - 1500 MWe	Industrial Factory	None	✓	✓