Introduction

Westinghouse Electric Company is a world leader in the development and commercialization of nuclear power plants. Westinghouse has established technology innovation programs aimed at supporting operating plants to reduce cost and improve efficiency, and is developing next-generation technologies to address future global market needs. With this latter goal in mind, Westinghouse is developing a next-generation nuclear power plant based on lead-cooled fast reactor* (LFR) technology. The delivery of commercially competitive, reliable, zero-emission clean and sustainable energy, with unparalleled safety and flexible operations*, are Westinghouse’s key goals.

Background

With the objective of commercializing an advanced reactor technology that is cost-effective compared to other forms of electricity, Westinghouse has developed a technology roadmap that paves the way to a commercially viable next-generation nuclear energy technology using liquid lead as the coolant. LFR technology is being developed as part of our commitment to advance the world’s access to reliable and affordable electricity while satisfying carbon emission targets.

The Westinghouse LFR will achieve the following important objectives for its customers:

- Reduced capital/overnight costs*
- Competitive Levelized Cost of Electricity (LCOE*)
- Variable electricity output to complement renewables
- Non-electricity applications such as cogeneration* and desalination
- Reduction in nuclear fuel waste volume
- Walk-away safety*

These features will result in a carbon-free technology solution that can compete effectively in the most challenging economic climate. The goal is to develop a reactor that will succeed in a highly competitive, deregulated energy market in the 2030 timeframe.

The Technology

The LFR combines the favorable properties of lead coolant with design innovations that ultimately result in a safer and competitive plant. Scalability is a key design principle that allows the power output of plant evolutions to fit the needs of future diverse markets, while minimizing re-design efforts. The compact, non-pressurized reactor has a small containment suitable for underground, secure installation and operates at temperatures leading to much higher efficiencies than conventional nuclear plants. This, together with other operational features, allows for a more efficient use of natural resources, namely water and uranium. The result will be enhanced sustainability through a reduction in nuclear waste volume and the possibility of using reprocessed fuel, should local energy policy allow.

With growing renewable energy generation, the LFR allows for non-base load flexible operations, thereby complementing the intermittency of renewables by providing power when the grid demands, independent of weather conditions.

Commonalities with sodium fast reactors allow for leveraging the considerable experience accumulated in the U.S., and abroad, with this technology, with the significant advantages of being safer and simpler. Adequate technology readiness ensures technical viability and enhances licensing assurance.

* Defined in glossary at the end of document
Roadmap

This program’s ultimate objective is to support the development of an innovative reactor fleet that is based on lead technology with best-in-class safety, economics and operability performance. The first step toward commercialization is the deployment of a prototype lead fast reactor (PLFR) relying on proven materials to accelerate deployment, which will serve as the pilot for follow-on commercial plants. Focused research and development efforts, to be conducted simultaneously with PLFR development, will feed into the design of the commercial fleet, with the goal to enhance economics and operability performance. The collaboration among Westinghouse, and U.S. and international organizations with expertise in lead technology and fast reactor design will ensure the program’s success.

Benefits

Based upon a thorough and extensive comparison of alternate potential advanced reactor designs, Westinghouse selected LFR as the preferred advanced nuclear technology with the best potential for successful commercial deployment. The LFR selection was based on:

- Economics and marketability potential
- Unparalleled safety
- Technology Readiness Level (TRL) sufficient to reduce development risk and facilitate licensing
- Enhanced natural resource utilization and reduced waste generation which, combined with the near-zero carbon emissions typical of any nuclear technology, result in a sustainable, low environmental impact technology

LFR technology is responsive to the growing global mandate to replace carbon-emitting electricity sources and the goal for all future energy solutions to be environmentally friendly throughout their lifespan. The lifespan includes the impact from up-front processing of the initial materials to long-term waste management, plant disassembly and greenfield remediation* of any future power generation site. A key differentiator of LFR technology is its ability to meet these environmental and sustainability goals while ensuring economic competitiveness.

Glossary

**Cogeneration**: The use of a power station to deliver electricity and heat at the same time, with the latter to be used for applications such as industrial processes and district heating.

**Fast Reactor**: A category of nuclear reactors in which the fission chain reaction is sustained by fast neutrons, as opposed to thermal, or slow, neutrons like in traditional nuclear plants.

**Flexible operation (also known as load following)**: A power plant that adjusts its power output as demand for electricity fluctuates throughout the day.

**Greenfield remediation**: The return of an area previously occupied by a human-made installation to its original conditions before any construction had occurred.

**Levelized cost of electricity (LCOE)**: An economic assessment of the total cost to build and operate a power-generating asset over its lifetime, divided by the total energy output of the asset over that lifetime. The LCOE can also be regarded as the minimum cost at which electricity must be sold in order to break even over the lifetime of the project.

**Overnight capital cost**: The cost of a construction project, if no interest was incurred during construction, as if the project was completed "overnight."

**Walk-away safety**: The capability of a plant to be self-regulating and prevent radioactivity release in any accident scenario even without operator intervention.