Westinghouse: eVinci™ Micro Reactor's Contribution to Flexible Energy

Prepared by Fabricia Pineiro and Ryan Blinn of Westinghouse Electric Company, a global company providing a wide range of nuclear power plant products and services to utilities throughout the world.

Westinghouse believes that the best energy policy is one that makes use of a balanced mix of generating sources. We're proud to be the leading supplier of nuclear power plants that are helping the world meet electricity demand without emitting harmful greenhouse gasses.

As part of these efforts, we have been developing the Westinghouse eVinci™ Micro Reactor design, based on demonstrated technology that can revolutionize how remote locations access clean, reliable energy. In co-development arrangements with national laboratories, design partners and utilities, Westinghouse is developing the eVinci Micro Reactor to serve remote residential, industrial and military energy consumers who are not connected to a national grid.

1.1 Introduction

The eVinci Micro Reactor's innovative design is a combination of space reactor technologies and 50+ years of commercial nuclear systems design, engineering and innovation. The eVinci Micro Reactor aims to create competitive and resilient power with superior reliability and minimal maintenance, particularly for energy consumers in remote locations. Its small size allows for standard transportation methods and rapid, on-site deployment in contrast to large, centralized stations. The reactor core is designed to run for three or more years, eliminating the need for frequent refueling.

Figure 1 eVinci Reactor Module

Source: Westinghouse

The key benefits of the eVinci Micro Reactor are attributed to its solid core and advanced heat pipes. The heat pipes enable passive core heat extraction, allowing autonomous operation and inherent load following capabilities. These advanced technologies together make the eVinci Micro Reactor a pseudo "solid-state" reactor with minimal moving parts.

Key Attributes of eVinci Micro Reactor:

- Transportable energy generator
- Fully factory built, fueled and assembled
- Delivers combined heat and power – 1 MWe to 5 MWe
- 40-year design life with 3+ year refueling interval
- Target less than 30 days onsite installation
- Autonomous operation
- Power demand load following capability
- High reliability and minimal moving parts
- Ability to supply high temperature process heat for applications such as district heating, greenhouse applications, desalination, hydrogen generation and other industrial applications
- Near zero Emergency Planning Zone with small site footprint
- Green field decommissioning and remediation

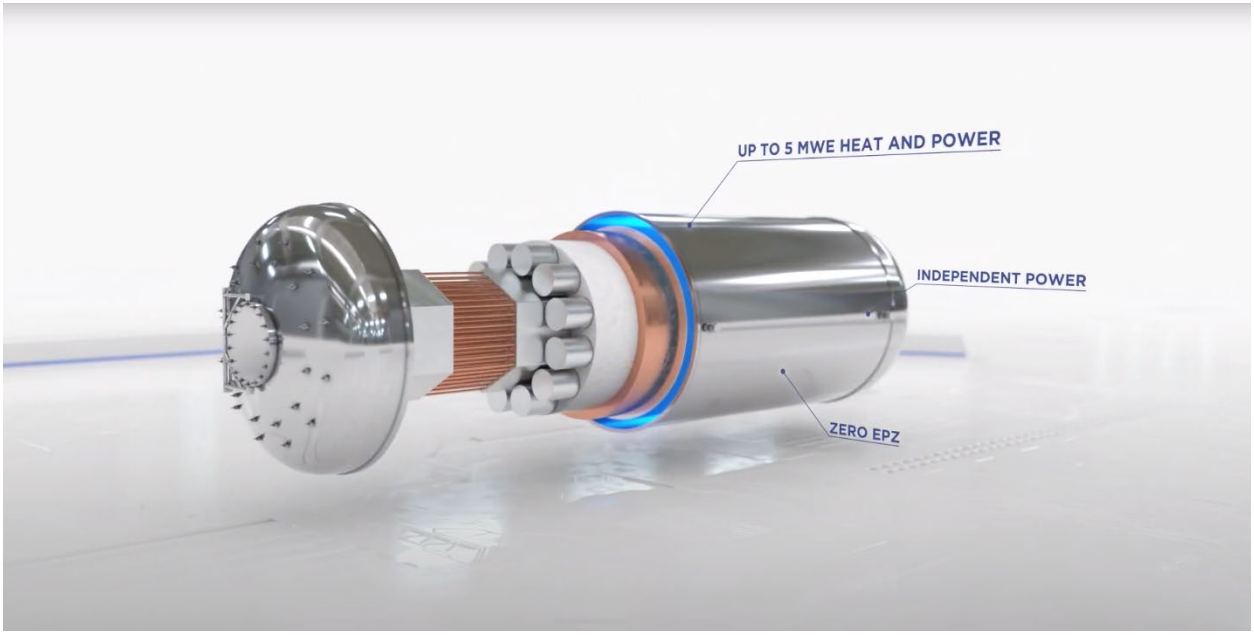

Figure 2 eVinci Reactor Module Cutaway

Source: Westinghouse

1.2 Flexibility through Innovation

The eVinci reactor load following philosophy is to approach fluctuations in demand with 3 mechanisms:

The reactor is designed to handle 20% power demand change events through inherent core reactor physics (heat pipes) and 60% load demand changes through active reactor control (control drums). These are slow changes that can be executed in 1 to 20 min depending on the demand/time change request. (Small to medium size power changes within minutes)

The second layer of response is within the power conversion system that can respond to smaller and faster load changes. Based on available data on these fluctuations, we expect up to 20% power changes within 1 to 60 seconds. (small changes within seconds time frame).

The final layer of response is meant to deal with all the other fast and large demand changes that can be expected on the grid or microgrid. This assumes the eVinci system is connected to a Microgrid with other power generating/storage resources (gas turbine, wind, solar, battery storage, etc.). The eVinci System manages this interface through a Microgrid Interface System (MIS) which would manage the various power sources, including the micro reactor to match the outstanding demands. (Typical power changes within one second and very large power changes) Westinghouse is partnered with PowerSecure, Inc. to develop the integrated eVinci reactor and micro grid interface solution.

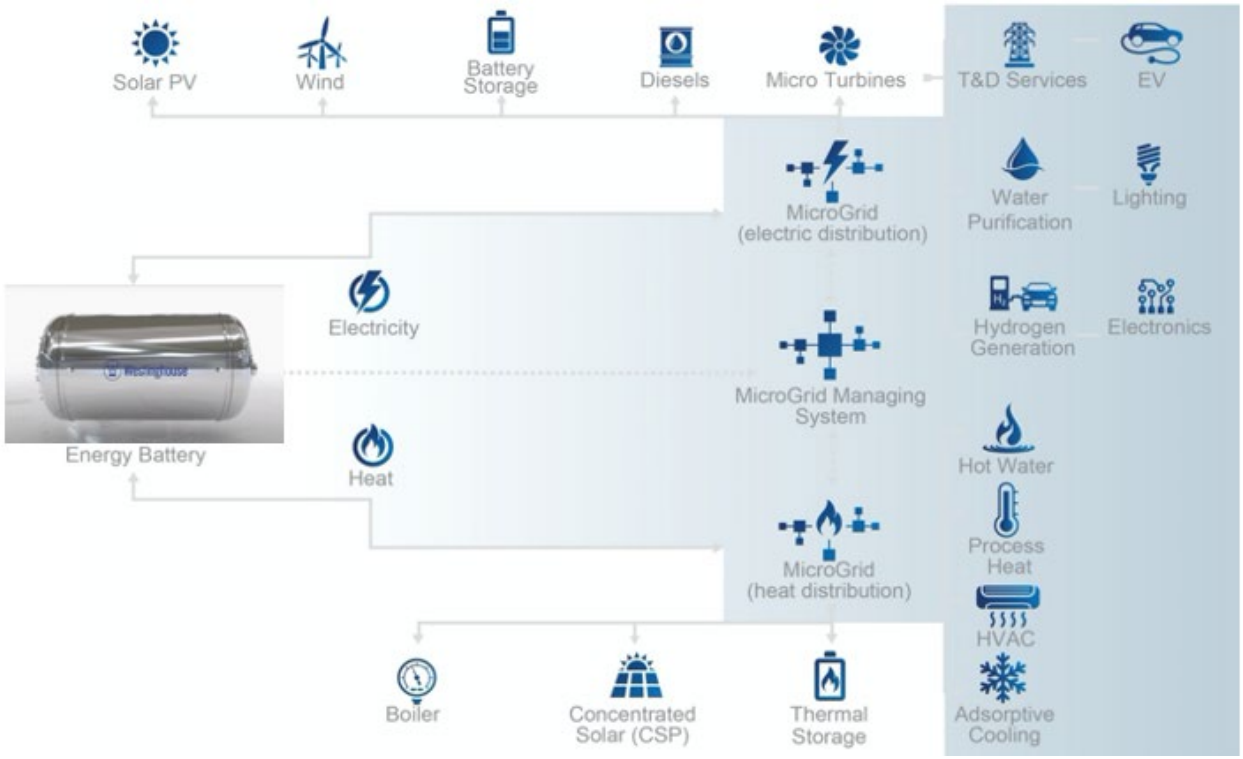

Figure 3 eVinci Reactor Module Energy Products

Source: Westinghouse

1.3 Site Implementation & Arrangement

There are three main systems that will be located onsite: the eVinci Micro Reactor system; the power conversion system; and the instrumentation, control and electrical system. Offsite, there is a remote monitoring system that can be used to monitor and operate either a single or multiple eVinci Micro Reactors.

Figure 4 eVinci Site Layout

Source: Westinghouse

The eVinci product is scalable in that multiple reactors and supporting systems can be located on one site. The associated size of the of the smaller, mobile design is around 1 MWe while the larger reactor design provides 4 MWe. Since the eVinci Micro Reactors can be arranged in multiple, independent but connected units, the power additions can be staged over time as power demand grows. Depending on the application, the eVinci Micro Reactor can be housed either in a concrete enclosure for fixed installations or a sub-grade trench for mobile applications to utilize earth as natural shielding. The concrete enclosure will be a bunker-type structure located at ground level, which facilitates rapid installation. For either scenario, shielding, protection and airflow paths for decay heat removal will be provided. Accommodations in the concrete enclosure design are being made for piping for power conversion fluid and cabling for signal and electrical power. The piping and cabling will travel to and from the power conversion system and the instrumentation, control and electrical system.

When the eVinci micro reactor core has reached the end of its operable lifetime, Westinghouse plans to replace the eVinci reactor container, swapping the entire container with a new reactor unit. The concrete vault and site systems may then be reused for another fuel cycle after minimal inspection and maintenance. The eVinci Micro Reactor module can be transported back to the factory where it can be refueled and its components can be refurbished.

1.4 The Road Ahead

Through numerous collaborations with utilities and specialized laboratories, Westinghouse expects to deploy the eVinci Micro Reactor technology in North America and globally over the next five years. The continuous engagement of local communities, regulatory agencies and relevant stakeholders will be imperative to ensure its success.

Due to its ability to manage demand fluctuations, interface with existing or new energy sources (wind, solar, gas, etc.) and increase power generation needs in a staged approach, the eVinci Micro Reactor is well positioned to address the needs of remote locations and growing communities.

Video:
https://www.youtube.com/watch?v=Sh6BKKFxN_g&feature=youtu.be