A New Class of Nuclear Reactor

Since the first nuclear reactors were connected to power grids in the 1950’s, new tools and vast operational knowledge have moved the idea of the Traveling Wave Reactor (TWR), a concept for a self-fueling source of energy, into reality. TerraPower’s mission is to develop this nuclear energy system and support the expanded use of nuclear energy to meet growing global electricity needs. The goal of the TWR design is to greatly reduce proliferation risks and create new options for converting low-level waste into energy resources.

Innovative Core Physics

Nuclear power plants produce electricity from the heat generated when suitable atoms, such as uranium-235, are split apart into smaller atoms. Each time one of these atoms splits (or “fissions”) it releases neutrons and heat. These neutrons cause other fissions, allowing for a sustained chain reaction. Sustaining that chain reaction is the key to providing reliable electricity.

In conventional light water reactors (LWRs), enriched uranium fuel is refreshed every 18-24 months to sustain the reactor’s power production. In contrast, the first TWR will use depleted uranium (uranium-238) along with an “igniter” (U-235) and will not require refueling. The TWR’s main fuel material is currently set aside as waste at enrichment plants. It is produced when uranium-235 is separated from natural uranium for conventional LWR fuel.

The unique core physics of the TWR allow the reactor to convert depleted uranium to usable fuel as it operates. Using a discrete amount of enriched uranium, a fission reaction is ignited, beginning a slow-moving chain wave reaction. Two parallel waves of fission move slowly through the core, splitting uranium atoms and using fuel more efficiently than conventional reactors. The first wave travels through the fuel, creating fissionable material. The second wave follows behind the first, consuming the created material. Under the right conditions, this reaction can be sustained for decades.

The Evolution of the Traveling Wave Concept

1958 Saveli M. Feinberg proposes a “breed-burn” reactor in which unenriched fuel is moved around the core to sustain fission.

1979 Michael J. Driscoll and others at MIT further evaluate breed-burn reactor ideas.

1988 Lev Feoktistov works on the concept in Russia and publishes an analysis of a concept of a physically safe reactor.

1996 Edward Teller, Lowell Wood (now at Intellectual Ventures), and others at Lawrence Livermore Lab detail ways to make breed-burn waves travel through a stationary fuel supply.

2000 Hugo van Dam publishes mathematical analyses of waves of fission moving inside nuclear fuels.

2001 Hiroshi Sekimoto begins a series of conceptual studies of various kinds of TWRs.

Early 2000s Sergii Fomin and N. Shul’ga study the burning wave in fast reactors in the Ukraine.

2006 Intellectual Ventures begins detailed physics and engineering studies of the feasibility, cost, and features of various TWR designs.

The Traveling Wave Reactor is currently under development, with the goal of commercialization by 2025.