



WYOMING LEGISLATIVE SERVICE OFFICE

Research Memorandum

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SUBJECT Wyoming Natrium Reactor Demonstration Project

On June 2, 2021, TerraPower, Governor Mark Gordon, and PacifiCorp officially announced the Wyoming Natrium Reactor Demonstration Project, which aims to support the design, construction, and operational features of the Natrium sodium-cooled fast reactor technology.¹ In addition to PacifiCorp, members of the demonstration project team include GE Hitachi Nuclear Energy, Bechtel, Energy Northwest, Duke Energy, and approximately a dozen other industry, university, and national laboratory partners.² The U.S. Department of Energy (DOE) awarded TerraPower \$80 million in initial funding and the project will be built at a retiring coal plant in Wyoming that is currently operated by Rocky Mountain Power (division of PacifiCorp).³

U.S. DEPARTMENT OF ENERGY ADVANCED REACTOR DEMONSTRATION PROGRAM

In May 2020, the U.S. DOE launched the Advanced Reactor Demonstration Program (ARDP) within the Office of Nuclear Energy, to facilitate the development of U.S. private industry advanced nuclear reactor demonstrations.⁴ For the Fiscal Year 2020 Budget, Congress appropriated \$230 million to start the demonstration program⁵, and the Department will invest a total of \$3.2 billion over seven years, dependent on future appropriations, with industry partners providing matching funds.⁶

In October 2020, the DOE awarded TerraPower and X-energy \$80 million respectively in initial funding to build two types of advanced nuclear reactors that are expected to be operational within the next five to seven years. The DOE selected TerraPower and X-energy after reviewing competitive U.S. reactor design applications submitted according to the ARDP funding

¹ "TerraPower, Wyoming Governor & PacifiCorp Announce Efforts to Advance Nuclear Technology in Wyoming" (TerraPower, June 2, 2021).

² Ibid.

³ Ibid.

⁴ "U.S. Department of Energy Launches \$230 million Advanced Reactor Demonstration Program" (U.S. Department of Energy, May 14, 2020).

⁵ Ibid.

⁶ "U.S. Department of Energy Announces \$160 Million in First Awards under Advanced Reactor Demonstration Program" (U.S. Department of Energy, October 13, 2020).

opportunity announcement requirements.⁷ The TerraPower and X-Energy projects both incorporate design features that aim to enhance reactor safety, reduce construction and operation costs, and establish the U.S. as a leader in the development of new competitive nuclear technologies.⁸

TerraPower, based in Bellevue, Washington, will demonstrate a 345-megawatt electric (MWe) sodium-cooled fast reactor with co-developer GE Hitachi Nuclear Energy and engineering and construction partner Betchel.⁹ The Natrium technology works in conjunction with a molten salt energy storage system to integrate with renewable power sources, and it will also be one of the first advanced reactors to operate in the United States.¹⁰

X-energy, headquartered in Rockville, Maryland, will demonstrate a 320-MWe plant, the Xe-100, that utilizes specialized uranium-based pebble fuel.¹¹ X-energy announced in April 2021 that they will participate in the “Tri Energy Partnership” with Energy Northwest and Grant County Public Utility District to support the development and demonstration of X-energy’s advanced nuclear reactor.¹² Those involved in the Tri Energy Partnership will evaluate, develop, and build the Xe-100 reactor at a previously licensed site north of Richland, Washington.¹³

TERRAPOWER AND PACIFICORP PARTNERSHIP

Bill Gates founded TerraPower in 2006 to develop cost-competitive advanced nuclear technology to meet increasing electricity needs.¹⁴ PacifiCorp is a subsidiary of Berkshire Hathaway Energy, led by Chairman and Chief Executive Officer Warren Buffett. PacifiCorp serves approximately 2 million electricity customers in six states and is comprised of two divisions, Pacific Power (which serves California, Oregon, and Washington) and Rocky Mountain Power (which serves Idaho, Utah, and Wyoming).¹⁵

According to a U.S. Office of Nuclear Energy press release, Wyoming is an ideal location for the demonstration project due to the State’s existing energy infrastructure and power plant workforce.¹⁶ Governor Gordon also expressed his support of the project and stated Wyoming is

⁷ “Advanced Reactor Demonstration Funding Opportunity” (U.S. Department of Energy, May 14, 2020).

⁸ Rita Baranwal, “It’s Time for the United States to Demonstrate Advanced Reactors,” Office of Nuclear Energy (U.S. Department of Energy, October 14, 2020).

⁹ “U.S. Department of Energy Awards TerraPower \$80 Million to Demonstrate Advanced Nuclear Technology” (TerraPower, October 13, 2020).

¹⁰ Alice Caponiti, “Next-Gen Nuclear Plant and Jobs Are Coming to Wyoming” (U.S. Department of Energy, June 2021).

¹¹ Rita Baranwal, “It’s Time for the United States to Demonstrate Advanced Reactors,” Office of Nuclear Energy (U.S. Department of Energy, October 14, 2020).

¹² “Energy Northwest, Grant County PUD and X-Energy Announce Tri Energy Partnership” (X-energy, April 1, 2021).

¹³ Ibid.

¹⁴ “Bill Gates” (TerraPower, 2021).

¹⁵ “Berkshire Hathaway Energy” (PacifiCorp: Berkshire Hathaway Energy, 2021).

¹⁶ Alice Caponiti, “Next-Gen Nuclear Plant and Jobs Are Coming to Wyoming” (Office of Nuclear Energy, U.S. Department of Energy, June 7, 2021).

“... the perfect place for this type of innovative utility facility and our experienced workforce is looking forward to the jobs this project will provide.”¹⁷

The Legislature’s recent actions also situate Wyoming in a favorable position to accommodate the Natrium project. During the 2020 Budget Session, the Legislature enacted HEA No. 0060 (HB0074) – Small modular nuclear reactor permitting, which authorizes the Environmental Quality Council to issue permits for small modular reactors to replace retiring coal or natural gas power plants.¹⁸

PacifiCorp and TerraPower are currently evaluating potential project sites in Wyoming and plan to announce the project location by the end of 2021. Potential sites include four coal plants that are scheduled to retire under PacifiCorp’s 2019 Integrated Resource Plan: Jim Bridger near Rock Springs, Dave Johnston near Glenrock, Naughton near Kemmerer, and WyoDak near Gillette.¹⁹

In selecting a project site, PacifiCorp and TerraPower will assess a variety of factors such as community support, physical characteristics of the site, ability to obtain a license from the Nuclear Regulatory Commission, access to existing infrastructure, and needs of the grid.²⁰ Over the next few months, TerraPower and PacifiCorp plan to engage with communities in potential plant locations, conduct further project evaluation, provide education and outreach, and receive state and federal regulatory approvals.²¹

NATRIUM REACTOR TECHNOLOGY

The U.S. DOE maintains the Advanced Reactor Demonstration Program will reveal performance and cost improvements over existing nuclear reactors.²² To provide context, there are two types of nuclear reactors currently operating in the United States: boiling water reactors (BWRs) and pressurized water reactors (PWRs) – both BWRs and PWRs are categorized as light water reactors.²³ Notably, the U.S. operates the largest fleet of commercial nuclear reactors; roughly two-thirds are PWRs, and one-third are BWRs.²⁴ Uranium serves as the primary fuel source for PWRs and BWRs and these reactors use heat produced by nuclear fission in the reactor core to boil water to create steam, which turns an electric generator to produce electricity.²⁵

¹⁷ “TerraPower, Wyoming Governor & PacifiCorp Announce Efforts to Advance Nuclear Technology in Wyoming,” (TerraPower, June 2, 2021).

¹⁸ “HB0074 - Small Modular Nuclear Reactor Permitting,” Legislation - 2020 (State of Wyoming 65th Legislature, 2020).

¹⁹ “FAQ” (Wyoming Advanced Energy, June 2021).

²⁰ Ibid.

²¹ “TerraPower, Wyoming Governor and PacifiCorp Announce Efforts to Advance Nuclear Technology in Wyoming” (PacifiCorp, June 2, 2021).

²² “Nuclear 101: How Does a Nuclear Reactor Work?,” Office of Nuclear Energy (U.S. Department of Energy, March 29, 2021).

²³ Ibid.

²⁴ “Light Water Reactors - Technology Assessments,” Quadrennial Technology Review 2014 (U.S. Department of Energy, 2015).

²⁵ “Nuclear Explained - Nuclear Power Plants” (U.S. Energy Information Administration, April 6, 2021).

The construction of conventional nuclear power plants is an exceedingly capital-intensive process, while advanced reactors involve simpler designs intended to reduce capital costs and they are also more fuel efficient and inherently safer.²⁶

With respect to the Natrium Reactor Demonstration Project, the Natrium technology employs two significant design features: a 345-MWe sodium-cooled fast reactor and a molten salt-based energy storage system. Natrium technology operates at atmospheric pressure and uses liquid sodium instead of water as its coolant. TerraPower maintains that Natrium's sodium fast reactor is four times more fuel efficient than light water reactors.²⁷ Additionally, the reactor functions at a temperature more than 350 degrees Celsius below the boiling point of sodium, which allows the plant operator sufficient time to respond to an unusual event.²⁸

TerraPower and GE Hitachi designed the system to have considerable storage potential, as the heat generated from the reactor operates a molten salt storage system that can reserve more energy than the largest battery storage system currently deployed on the grid.²⁹ Natrium's simplified design of nuclear and non-nuclear systems further permits expedited licensing and construction and reduces the amount of space and nuclear-grade concrete required for the project.³⁰

²⁶ "Small Nuclear Power Reactors" (World Nuclear Association, June 2021).

²⁷ "Natrium Technology: Providing Flexible Clean Energy at a Competitive Cost" (Natrium, June 2, 2021).

²⁸ "FAQ" (Wyoming Advanced Energy, June 2021).

²⁹ Ibid.

³⁰ "Natrium Technology: Providing Flexible Clean Energy at a Competitive Cost" (Natrium, June 2, 2021).