NUCLEAR NH
STUDY COMMISSION

Advanced Nuclear Fuel Technologies

to impact the world's climate and energy security

NASDAQ : LTBR

June 19, 2023

What is Lightbridge?

Video Link

Lightbridge - Pioneering Advanced Nuclear Fuel

Leading developer of nuclear fuel technology for current and future reactors that is expected to **enhance the economics**, **proliferation resistance**, and **safety of nuclear power**, operating about 1000 °C cooler than standard fuel

Lightbridge surrogate rods used for a thermal-hydraulic flow experiment

Positioned to enable **carbon-free energy** applications that expand current use missions.

Incorporating Lightbridge Fuel™ with other advanced nuclear technologies can fast-track clean energy development to meet climate goals.

Lightbridge Fuel

Highlights of Lightbridge Fuel

Metallic **high-assay low-enriched uranium (HALEU)** fuel for power uprates and longer fuel cycles; improves flexibility of fleet operations

Lightbridge test assembly mockup used for a thermal-hydraulic experiment

Large Market
Lightbridge Fuel is designed to work in both new and existing ($20+ billion market) reactors.

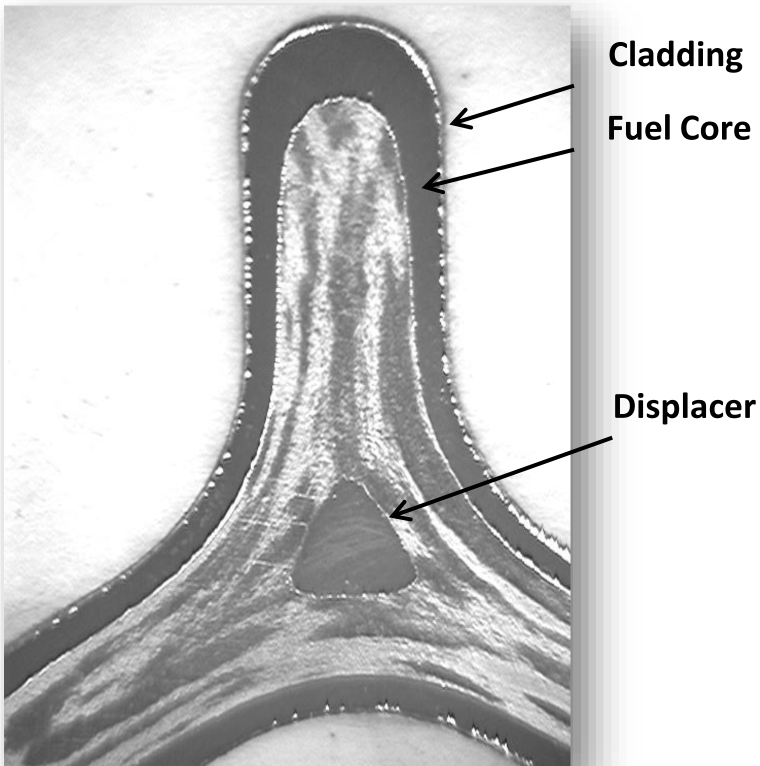
Anticipated Waste Reduction Benefits
There is less spent fuel created per plant output when using Lightbridge Fuel and the spent fuel is useless for weapons purposes.

Expected Safety Benefits
Lightbridge Fuel is expected to meet or exceed the performance of conventional fuel in many accident scenarios.

Anticipated Economic Benefits
Our fuel may be able to increase power output and extend the length of the fuel cycle. Lightbridge Fuel also may be able to offer the lowest cost to add reliable zero-carbon electricity to the grid.

Anticipated Quicker Ramp-Rate May Enable Load Following
Lightbridge Fuel is expected to offer nuclear plants a better solution for load-follow operations on a grid with renewables, potentially replacing natural gas plants and coal plants at their existing locations, with zero carbon emissions.

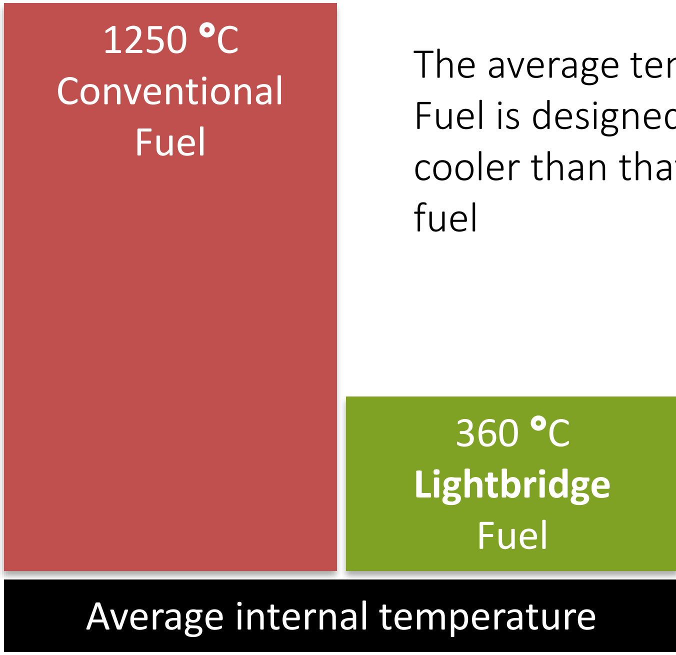
Lightbridge Fuel Features



Cross-section of tri-lobe fuel rod sample

- **Absence of spacer grids** reduces core pressure drop by up to 50% which improves natural circulation of the water coolant
- **Metallurgical bond** between fuel components significantly reduces cladding breach due to fuel-cladding mechanical interactions
- **Increased cladding thickness** at lobes increases the durability of the fuel at the contact points
- **Absence of fuel-clad gap** eliminates the mechanism for widespread coolant-cladding interaction on the inner cladding surface
- **Coextrusion fabrication process** eliminates several possible sources of manufacturing defects (e.g., pellet chipping)

Lightbridge Fuel is Designed for Safety



The average temperature of Lightbridge Fuel is designed to operate nearly 1000 °C cooler than that of conventional nuclear fuel

Anticipated Safety Benefits:

- ✓ Metal fuel has better heat transfer
- ✓ Reduces fuel operating temperature
- ✓ Does not generate hydrogen gas under design basis accidents
- ✓ Buys more time to restore active cooling during accidents
- ✓ Improves non-proliferation benefits of used fuel
- ✓ Enhances structural integrity of the fuel

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Accident Tolerant Fuel Regulatory Activities

"The company Lightbridge is developing a new fuel design that incorporates an extruded metallic bar composed of a zirconium-uranium matrix within a zirconium alloy cladding."

The potential benefits of extruded metallic fuel are:

- Significant increase in fuel thermal conductivity (compared to ceramics) promotes lower operating temperatures
- Complete retention of fission products means no burst release of those products upon cladding failure
- Supports higher power and longer fuel cycles

https://www.nrc.gov/reactors/atf/longer-term.html#metallic

Jan. 12, 2021

How We Design Safer Fuel

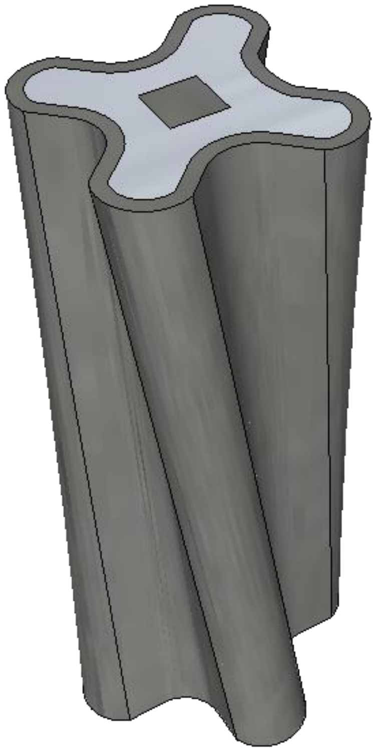
Fabrication

The three components of Lightbridge Fuel are metallurgically bonded during the fabrication process. This bonding **improves the structural integrity of the fuel rod and thermal conductivity** and **may reduce a potential radiation exposure to plant workers**.

Shape

Helically-twisted multi-lobe fuel rod – increased fuel surface area and shorter distance for heat generated in the fuel rod to reach the water **may improve coolability of the fuel**.

Swelling is expected to occur primarily in the valleys between the lobes and along the length of the rod.



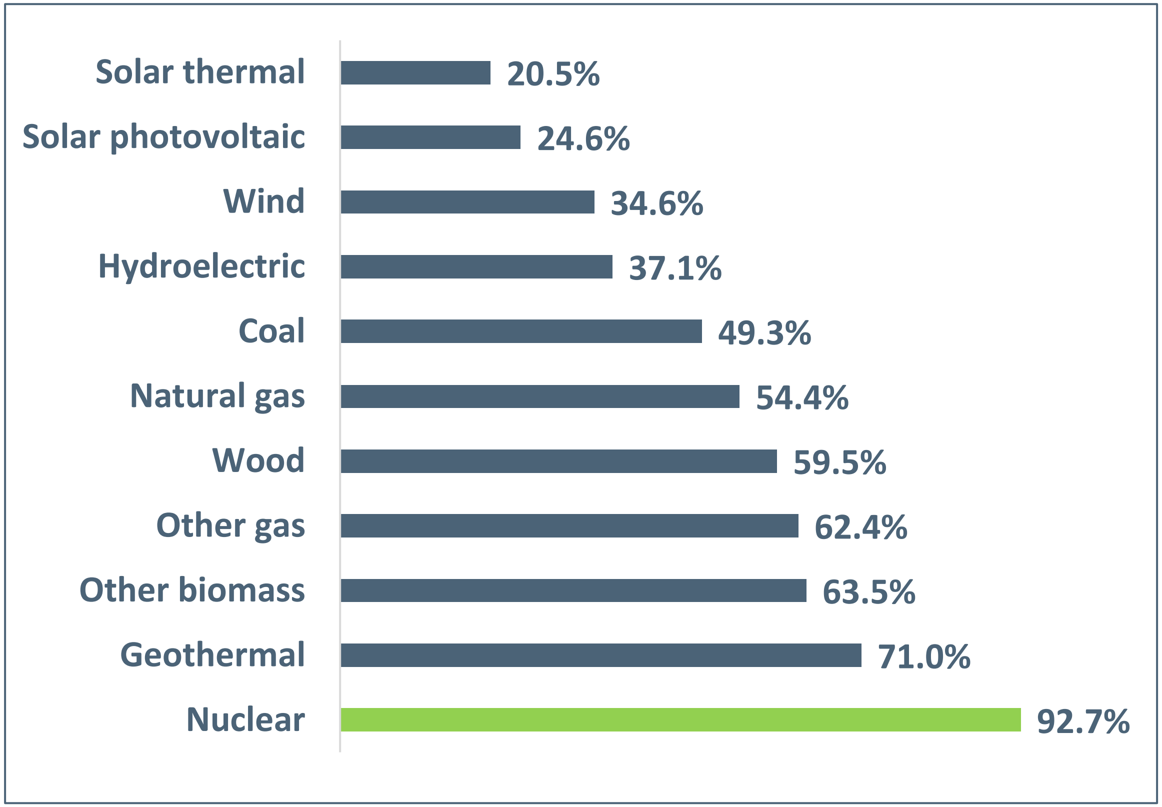
Operations

At low fuel operating temperature, fission products are expected to behave like solids (versus gases) and remain where they are created. **No fission product release is anticipated during design basis events.**

Materials

1. Displacer: helps to reduce centerline temperature and may contain burnable poison elements for reactor control.
2. Fuel core: made out of a uranium-zirconium alloy, which has high thermal conductivity.
3. Metallurgically bonded barrier made out of corrosion-resistant zirconium-niobium alloy that reduces cladding breach due to fuel-cladding mechanical interactions.

Increasing Capacity Factor



- Capacity factor measures how often a power plant runs for a specific period, indicating how fully a unit's capacity is used
- The U.S. fleetwide capacity factor is about 92.7%, topping out at over 98% in 2014
- Utilities would like to find ways to increase capacity factor but have been unable to do so economically

Ways Lightbridge Fuel could increase capacity factor

- Longer fuel cycles (lengthening from 18 to 24 months eliminates the need for one refueling outage in every six-year period)
- Quicker ramp-up when coming out of an outage (the thin tubes in current fuel require a longer period to ramp-up to full power without danger of cracking the tube)
- Quicker ramp-down into an outage

*Statista, 2021 figures

Lightbridge

Robust Patent Portfolio Protects Return on Investment

Lightbridge has invented and developed its technology to meet the needs of the growing energy marketplace, **backed by a powerful worldwide patent portfolio**

- Expanding our patent portfolio continues to be a strategic focus for Lightbridge
- These new patents will help safeguard the Company's intellectual property, which is an integral element of the Company's plans to monetize Lightbridge Fuel

Patents related to the following core areas:

- Fabrication method using the casting route
- Fabrication method using the powder metallurgic route
- All-metal fuel assembly design
- Multi-lobe metallic fuel rod design

Recent Fuel Development Milestones

Breakthrough Long-Term Strategic Partnership Project with Idaho National Lab (INL)

Lightbridge

- ✓ Seven-year agreement
- ✓ INL to manufacture and irradiate coupon material samples consisting of enriched uranium
- ✓ Data will support fuel performance modeling and regulatory licensing efforts for commercial deployment of Lightbridge Fuel
- ✓ INL residency will lead to greater, more frequent fuel development milestones throughout the duration of the project

Lightbridge Announces Long-Term Strategic Partnership with Idaho National Laboratory

December 12, 2022

RESTON, Va., Dec. 12, 2022 (GLOBE NEWSWIRE) -- Lightbridge Corporation (Nasdaq: LTBR), an advanced nuclear fuel technology company, has entered into landmark agreements with Idaho National Laboratory (INL), in collaboration with the U.S. Department of Energy (DOE), to support the development of Lightbridge Fuel™. The framework agreements use an innovative structure and consist of an "umbrella" **Strategic Partnership Project Agreement (SPP)** and an "umbrella" **Cooperative Research and Development Agreement (CRADA)**, each with Battelle Energy Alliance, LLC (BEA), DOE's operating contractor for INL, with an initial duration of seven years.

INL's Advanced Test Reactor (ATR)

Idaho National Laboratory

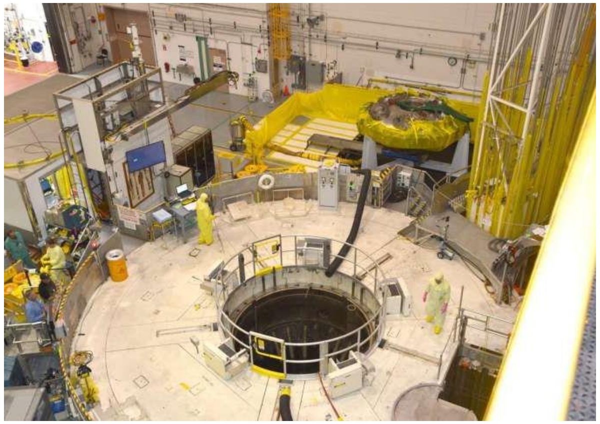
Strategic Partnership Project Data Results to Help Determine Commercial Pathway

- Lightbridge is working with Idaho National Laboratory (INL) to produce our fuel material samples and test/demonstrate the samples in the ATR

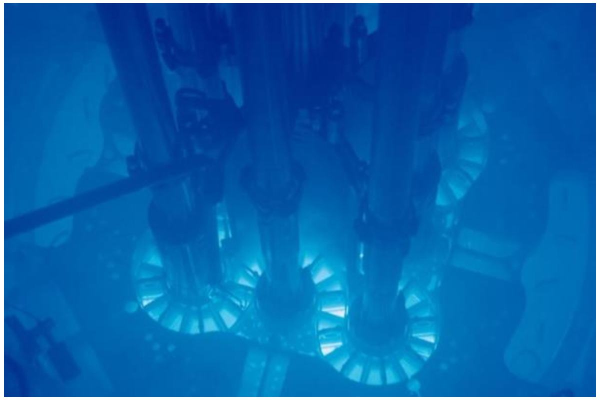
- The testing results will help us move forward toward commercializing Lightbridge Fuel in various reactor types.

- Commercial priority will depend on the results of testing and feasibility studies

- Prioritization for deployment to the types of reactors that can utilize our technology the soonest and with the greatest commercial value



Advanced Test Reactor (ATR) top



The ATR's core in operation

Potential Commercial Pathways – From Research Reactors to Commercial Reactors

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ATR canal

Pressurized Heavy-Water Reactors (PHWRs)

- CANDU reactors

- ~40 PHWRs in the world
- Uses fuel with uranium enrichment levels that are already commercially available
- Uses fuel rods up to 20 inches in length

Small Modular Reactors (SMRs)

- PWRs and BWRs

- Uses fuel rods up to 6 feet in length
- Half the length of large PWRs and BWRs
- We anticipate SMRs to be deployed in large numbers

Large Light Water Reactors (LWRs)

- PWRs and BWRs

- Virtually all the currently operating power reactors in the world are large PWRs (including VVERs and Russian-designed VVERs)

Lightbridge Collaboration with MIT and NuScale Power in DOE Funded Study of Accident Tolerant Fuels in SMRs

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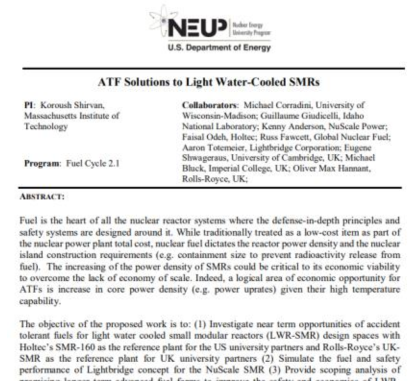
NEUP Nuclear Energy University Program

U.S. Department of Energy

Massachusetts Institute of Technology


NEUP Nuclear Energy University Program

U.S. Department of Energy

ATF Solutions to Light Water-Cooled SMRs

PI: Koroush Shirvan, Massachusetts Institute of Technology

Program: Fuel Cycle 2.1

Collaborators: Michael Corradini, University of Wisconsin-Madison; Guillaume Giudicelli, Idaho National Laboratory; Kenny Anderson, NuScale Power; Faisal Odeh, Holtec; Russ Fawcett, Global Nuclear Fuel; Aaron Totemeier, Lightbridge Corporation; Eugene Shwageraus, University of Cambridge, UK; Michael Bluck, Imperial College, UK; Oliver Max Hannant, Rolls-Royce, UK;

ABSTRACT:

Fuel is the heart of all the nuclear reactor systems where the defense-in-depth principles and safety systems are designed around it. While traditionally treated as a low-cost item as part of the nuclear power plant total cost, nuclear fuel dictates the reactor power density and the nuclear island construction requirements (e.g. containment size to prevent radioactivity release from fuel). The increasing of the power density of SMRs could be critical to its economic viability to overcome the lack of economy of scale. Indeed, a logical area of economic opportunity for ATFs is increase in core power density (e.g. power uprates) given their high temperature capability.

The objective of the proposed work is to: (1) Investigate near term opportunities of accident tolerant fuels for light water cooled small modular reactors (LWR-SMR) design spaces with Holtec's SMR-160 as the reference plant for the US university partners and Rolls-Royce's UK-SMR as the reference plant for UK university partners (2) Simulate the fuel and safety performance of Lightbridge concept for the NuScale SMR (3) Provide scoping analysis of

Lightbridge

NUSCALE™ Power for all humankind

Total project is $800,000 paid by DOE to MIT

Objectives include:

- ✓ Investigate near term opportunities of accident tolerant fuels for light water cooled small modular reactors (LWR-SMR) design spaces
- ✓ **Simulate the fuel and safety performance of Lightbridge Fuel for the NuScale SMR**
- ✓ Provide scoping analysis of promising longer term advanced fuel forms to improve the safety and economics of LWR-SMRs

Timeline of Events & Milestones for Lightbridge Fuel

2010 Lightbridge announced initial concept of metallic fuel as the optimal way for power uprates and longer fuel cycles

2012 Siemens Industry completed an independent economic study confirming the economic benefits of Lightbridge Fuel for power uprates and longer fuel cycles

2013 Lightbridge began developing fuel rod fabrication methods

2014 Lightbridge is granted first key U.S. patent for its metallic fuel rod design

2019 Lightbridge awarded **GAIN** voucher with **INL**

2021 Lightbridge awarded second **GAIN** voucher with **PNNL**

2022 Enter into SPP umbrella agreement to acquire HALEU samples for testing in a reactor

2023 -2025 Fabrication of fuel material samples for irradiation testing in the Advanced Test Reactor

Lightbridge’s Role in the Global Energy Transition

Small Modular Reactors and Existing Large Reactors

We expect the significant government funding for SMRs and clean energy in the coming years may help accelerate our fuel development for SMR applications.

- Lightbridge Fuel is expected to provide SMRs the same benefits our technology brings to large reactors, but the benefits may be more meaningful to the economic case for deploying SMRs
  - Generate more power, reducing the cost per unit of electricity generated by the SMR
  - Enhance ability of SMRs to ramp up and down in power quickly, to pair with renewables on a zero-carbon electric grid

- Existing light water reactors
  - Our work today is applicable for fuel in large reactors as well as shorter length version of fuels for SMRs
  - Lightbridge Fuel is expected to provide significant safety and economic benefits to utilities

Our ongoing R&D initiatives are entirely compatible with Lightbridge Fuel powering SMRs for multiple purposes

Small Modular Reactors – Nimble Nuclear

NuScale VOYGR ™ SMR Plant

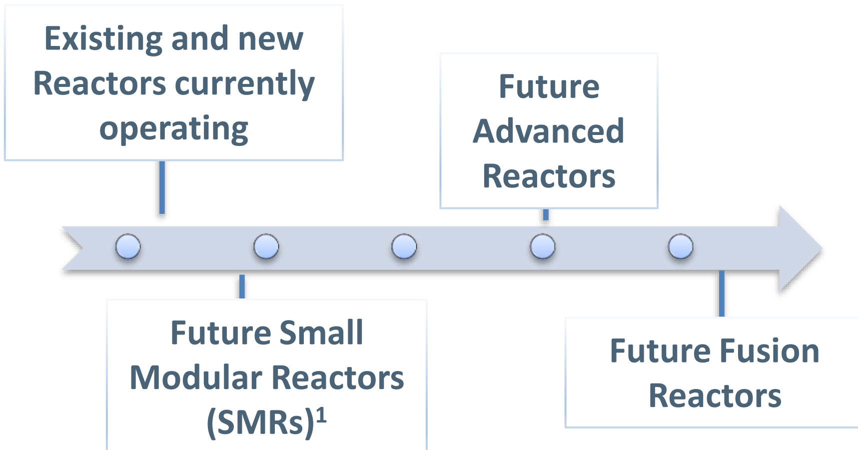
Strategic Advantages

- Relatively small physical footprints
- Reduced capital investment vs large reactors
- Ability to be sited in locations not possible for larger nuclear plants
- Provisions for incremental power additions
- Security and nonproliferation advantages.

- SMRs currently under development represent a variety of sizes, technology options, capabilities, and deployment scenarios.
- These advanced reactors vary in size from tens to hundreds of megawatts
- Can be used for power generation, process heat, desalination, or other industrial uses.
- SMR designs may employ light water as a coolant or other non-light water coolants such as a gas, liquid metal, or molten salt.

Lightbridge Fuel in Small Modular Reactors of the Future

Reactor Timeline



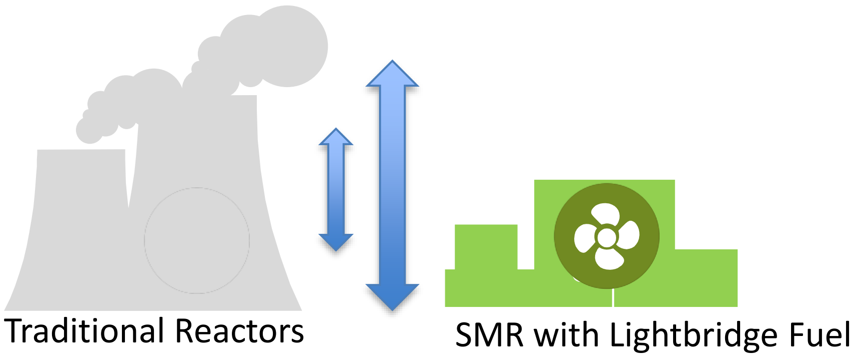
SMRs have several potential benefits compared to existing large power plants

- Emergency planning zone limited to site boundary (rather than paying for emergency services for a much larger radius)
- Fewer personnel in control room
- Fewer security personnel

Lightbridge Fuel is expected to **significantly improve the economics for water-cooled SMRs**. An SMR can replace coal power plants and utilize the existing electrical switchyard already on the site, bringing employment back to the region. The US can support manufacturing of SMRs and fuel for domestic and export markets.

[1] Pressurized water reactors and boiling water reactors

Lightbridge Fuel May Offer Superior Ramp Rate for Load Following in SMRs – Facilitates Versatile and Efficient Use of Carbon-Free Energy at Greater Scale

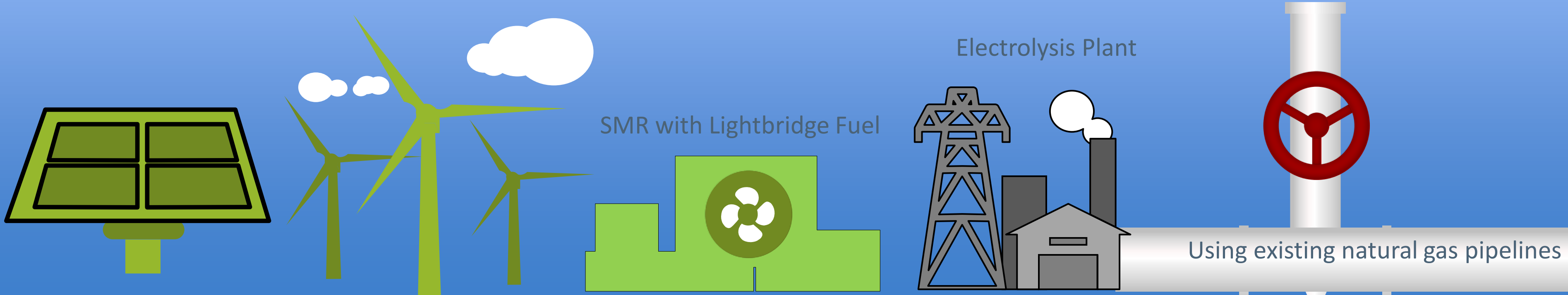


- SMRs powered with Lightbridge Fuel are expected to have a vastly improved load following capability compared to traditional reactors
- May allow SMRs to work more efficiently in different missions, including replacing natural gas plants to back-up renewables

An SMR designed to produce 30% more power uprate with Lightbridge Fuel may be used to produce liquid hydrogen-based fuels and utilize existing oilfield pipeline infrastructure to support the zero-carbon energy transition

Zero carbon energy production

Can be used in hard-to-decarbonize sectors, including aviation, shipping, cement and steel production, heavy trucks, and trains



The Coal to Nuclear Transition

In September 2022, the DoE published a study* that explored converting retiring coal plants into nuclear plants throughout the United States:

- It is estimated that 80% of retired and operating coal power plant sites have the basic characteristics to be considered amenable to host an advanced nuclear reactor.
  - 190 sites throughout the U.S.
  - 198.5 GWe capacity potential
- Repurposing coal plant infrastructure may lead to savings on capital costs that range from 15% to 35%
- Depending on the nuclear design under consideration, job growth could increase by over 650 new, permanent jobs, leading to nearly $270 million in new economic activity, with GHG emissions in a community falling by as much as 86%

A coal-to-nuclear transition means siting a nuclear reactor at the site of a recently retired coal power plant.

*U.S. DOE, "Investigating Benefits and Challenges of Converting Retiring Coal Plants into Nuclear Plants, 2022
H.R.5376 - 117th Congress
(2021-2022): Inflation Reduction Act of 2022

Compelling Economics Surrounding Large Water Reactor Market (PWR, BWR & PHWR)

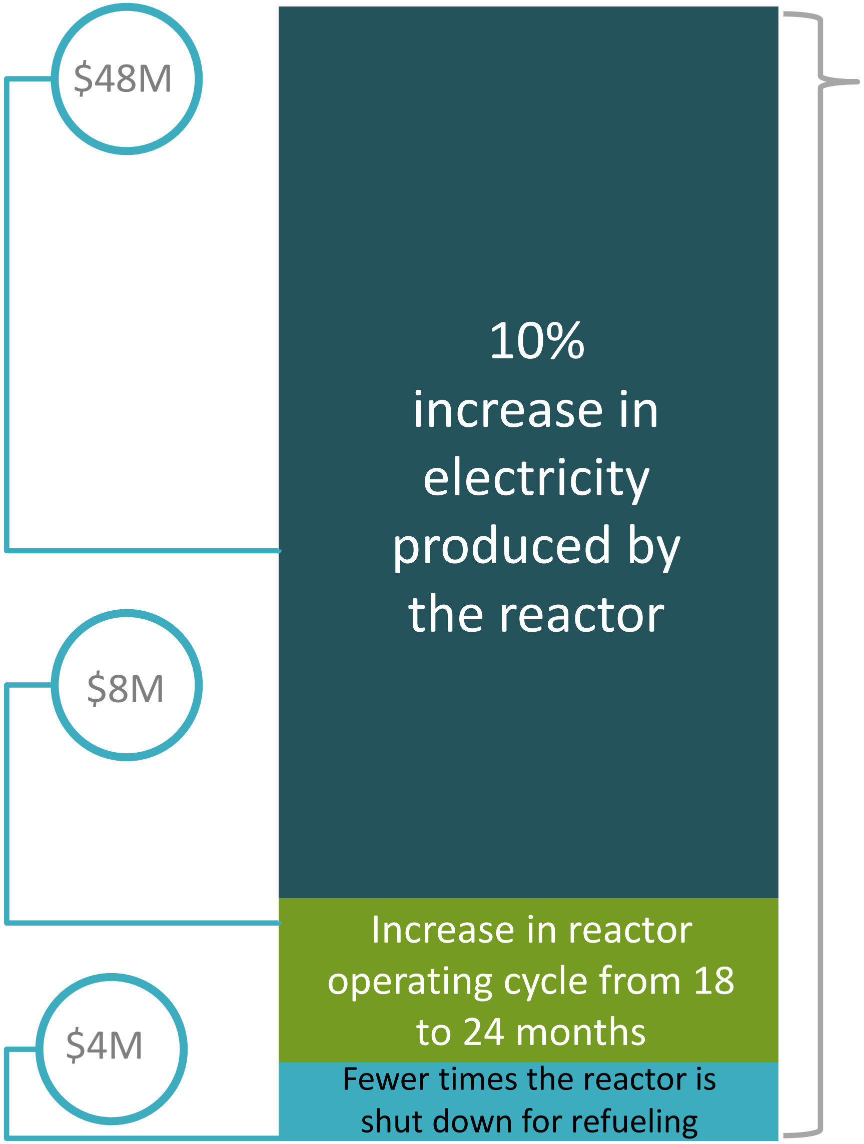
Nuclear fuel supply agreements are expected to generate long-term, high margin recurring revenue.

Water reactors: worldwide	419
Water reactors: U.S.	100
*Average annual fuel spend per reactor, per year:	$40 Million
Total addressable market: U.S.	$4 Billion
Total addressable market: worldwide	$16.7 Billion

Lightbridge Fuel™ is designed to operate with nearly every reactor in the world, including those under construction and planned.

*World Nuclear Association data based on fuel costs of $1,663 per kg of UO_2, 35-40 metric tons of UO_2 in an 18-month batch reload in a 1,100-Mwe, resulting in approx. $60-65M fuel costs per 18 months or $40-45M/year.
https://world-nuclear.org/information-library/economic-aspects/economics-of-nuclear-power.aspx

$60 Million Projected Annual Gross Revenue Increase to Utility Per Large Pressurized Water Reactor



$60 million*

per 1,100 MWe reactor

Projected incremental annual revenue to utility with Lightbridge 10% power uprate

Does not include the added economic benefits of carbon credits or cost to utility of buying replacement power during an outage

- Assumes wholesale power price of $55/MWh, which is the average wholesale power price in the U.S. over the past decade. Utilities are now exploring with the US Nuclear Regulatory Commission extending operating licenses to 100 years.

Leveraging Bipartisan Support for Advanced Nuclear Energy

The Political Landscape Has Shifted in Favor of Nuclear Power

- Russia’s invasion of Ukraine has caused countries everywhere to seek to ensure their energy security from now on
- Nuclear power plants soon to be decommissioned are having their operating licenses extended
- The European Union has designated nuclear as a “green” energy source
- Countries that were moving away from nuclear, such as Japan, are now reversing course
- The recently enacted U.S. Inflation Reduction Act provides nuclear production tax credits to help preserve the existing fleet of U.S. nuclear plants and significant money for advanced reactors

Advanced Nuclear Technology Race Poses Unique Opportunities for Lightbridge

Government support through legislation, financial investment and policy change has spurred **A RACE FOR NUCLEAR INNOVATION**

The reasons for this are bipartisan, forward thinking, and highly lucrative for the winner

STRATEGIC		GLOBAL LEADERSHIP ON CLIMATE CHANGE
• Critical infrastructure resilience enabled through nuclear energy • 100-year foreign policy relationships • Workforce and supplier base	**Advanced nuclear technology firms, including Lightbridge poised to benefit**	• Climate goals can only be met with an energy generating mix that includes growth in nuclear power • US companies poised to be global suppliers of solutions to prevent climate change • US manufacturing jobs

According to the Nuclear Fuel Working Group report, “The United States is missing out on a nuclear reactor market that the US Department of Commerce (DOC) estimates is valued at $500-740 billion over the next 10 years.”

Robust Bipartisan Federal Legislation for Nuclear

The Infrastructure Investment and Jobs Act of 2021 and the Inflation Reduction Act of 2022 included key federal commitments for the nuclear industry

Bipartisan Infrastructure Bill

Civil Nuclear Credit Program
$6B to support financially challenged plants

Advanced Reactor Demonstration Program (ARDP) Funding
$2.5B funding for two projects

Nuclear Hydrogen Hub
$8B total in the bill

Inflation Reduction Act

Production Tax Credit (PTC) for Operating Plants
Up to $15 per MWh

Technology-Inclusive PTC for Clean Electricity
$30 per MWh

Technology-Inclusive Investment Tax Credit (ITC) for Clean Electricity
30% + 10% in energy communities + 10% using U.S. components

Clean Hydrogen Credit
$3 per kilogram

Lightbridge's technology is aligned with US government goals, enabling policies outlined in the report because of the design of Lightbridge Fuel

Lightbridge

Advanced Nuclear Fuel Technology for Large and Small Modular Reactors

Improving reactor safety and economics

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