



**KARNO™**

**Written Testimony Before the House Military  
Construction, Veterans Affairs and Related Agencies  
Appropriations Subcommittee**

**Innovative Technology Opportunities for Military  
Construction Hearing**

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**Hyliion's Innovative KARNO Modular Power Plant  
Utilizing Additive Manufacturing Creates Energy  
Resilience in Military Applications**

**WITNESS STATEMENT OF:**

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## **Introduction**

Chairman Carter, Ranking Member Wasserman-Schultz and distinguished members of this Subcommittee, it is an honor for Hyliion to be afforded this platform to discuss the benefits of the KARNO generator for military applications. We will describe how the KARNO generator can serve as a strategic asset to provide energy resiliency and contribute to national defense and security. We thank the chairman and the committee for this opportunity.

## **About Hyliion**

Hyliion was founded in 2015 and is committed to creating innovative solutions for flexible and affordable electricity production. The company's focus is providing modular power plants powered by an innovative new linear generator that can operate on a wide range of fuel sources and deliver significant advances in efficiency, operating cost, power density, emissions, and noise levels compared to conventional electricity generating technology. The KARNO generator achieves these remarkable advancements due to unique design elements that are enabled by advanced additive manufacturing or 3D printing. Headquartered in Austin, Texas, and with research and development in Cincinnati, Ohio, Hyliion is initially targeting the defense, data center, commercial and waste management industries with a locally deployable generator. Beyond stationary power, Hyliion is addressing mobile applications, including marine. Hyliion recently delivered the first 200 kW generator to the US Navy for further testing and validation to confirm its ability to be deployed as a power source in future unmanned naval vessels.

## **Hyliion's KARNO Technology Enabled by Additive Manufacturing**

An impressive example of American ingenuity and manufacturing, the KARNO generator represents a contemporary approach to modernizing 19th century-era Stirling technology. Stirling power system adoption has been hindered by conventional manufacturing

challenges such as design complexity, heat exchanger efficiency, and low power density.

Modern additive technology has now advanced to a stage where components can be efficiently produced with the intricate geometries and precise details necessary for crafting efficient, power-dense generators that also feature other advantages that are favorable for defense applications.

The KARNO generator is distinguished from conventional generating systems such as reciprocating internal combustion engines or gas turbines. In contrast, the KARNO generator harnesses the power of heat to propel a linear generating system, deriving its linear motion from temperature differences inside the engine. The generation of heat within the system occurs through flameless oxidation of fuels like natural gas, hydrogen, or propane. This thermal energy causes helium gas enclosed within a sealed chamber to expand and cause an oscillating motion of a connected piston-shaft system. A set of permanent magnets affixed to the shaft pass through electric coils to produce electricity.

The KARNO generator is expected to surpass the efficiency of conventional reciprocating generating systems of a similar size when employing various fuel sources. Notably, its high efficiency remains consistent across a broad range of output power levels.

An additional advantage of the KARNO generator is an expected reduction in maintenance requirements and cost. Conventional generators incur high usage-based maintenance expenses. The stresses and friction of internal combustion impose significant wear on components, necessitating the use of oil-based lubricants, filters, and the periodic replacement or refurbishment of key parts. The KARNO generator's advantage arises from having only a single moving linear actuator per shaft (4 shafts per 200 kW generator), which glides on low-friction helium bearings.

This innovative design significantly mitigates efficiency losses, enhances the system's operational longevity, and eliminates the need for oil-based lubricants. Consequently, the KARNO

generator is expected to operate much longer than a conventional generator before requiring periodic maintenance or an overhaul and require less manpower to maintain while in operation.

The KARNO generator is modular, allowing for a highly customizable power solution by stacking additional generator systems to meet specific power needs. This modularity enables tailored energy solutions for various operational requirements, ensuring optimal performance and efficiency. Hyliion is currently developing a 2 MW power solution that is suitable for military bases, data centers and other applications with larger power demands.

Another advantage of the KARNO modular power plant is its ability to achieve near-zero emission of pollutants, regardless of the type of fuel used. This is a result of advanced technology that automatically recirculates exhaust gases, enabling the elimination of pollutant gases such as nitrogen oxides, carbon monoxide and volatile organic compounds. This feature also enables the KARNO generator to operate without the need for the complex and costly aftertreatment systems typically required by conventional generators to meet environmental standards.

### **Military Applications**

In today's complex global landscape, energy resiliency and power stability are needed for the operational success of the US military around the world, particularly within the Indo-Pacific Command (INDO PACOM). This region, characterized by vast distances, diverse terrains, and a range of geopolitical challenges, necessitates a robust and reliable energy infrastructure to support military activities, particularly in the face of natural disasters, cyber-attacks, and adversarial actions aimed at disrupting power supply.

The KARNO generator is designed to provide flexible and resilient electricity with a low heat signature, minimal sound, and low maintenance needs while in operation. Its ability to

utilize a wide range of fuels, including contaminated fuels, ensures functionality in unpredictable environments. The KARNO generator can operate in any orientation and its compact form factor allows for easy deployment and integration into mobile platforms, offering versatile and reliable power solutions for diverse military needs.

The KARNO generator's simple design enables straightforward serviceability when required, and in the case of multi-KARNO power arrays, allows for individual generators to be removed and replaced without taking down the entire power system. Additionally, since key components of the KARNO generator are additively printed, service and replacement parts can be readily fabricated when needed. This design approach ensures that repairs and maintenance can be conducted swiftly and efficiently, minimizing downtime and enhancing the overall operational readiness of military forces.

### **KARNO Generator Powered Autonomous Vessels and Other Applications for the US Navy**

Since 2023, Hyliion has been working with the Office of Naval Research to create a power solution for Navy ships and stationary power applications. The KARNO generator is highly versatile, providing adaptable power solutions to meet the unique demands of US Naval operations in maritime environments including the Unmanned Surface Vessel cross-platform requirements in a megawatt-scale modular system.

### **KARNO Powered Microgrid for Military Bases**

The vulnerability of electrical grids to cyber-attacks can jeopardize the functionality and security of military installations, making a robust and reliable energy solution imperative. The KARNO generator's advanced capabilities ensure a steadfast power supply, safeguarding critical operations even in the face of infrastructure disruptions. Its ability to operate independently from

the main grid, coupled with its ability to use a wide range of fuels, make the KARNO generator a strategic tool in maintaining operational readiness and security for military bases globally.

### **Tactical, Ruggedized, Mobile KARNO Generator for Forward Operating Bases (FOBs)**

Hyliion has begun initial discussions with the US Army to create a mobile KARNO generator power solution that would have the capability to be deployed anywhere in the world. FOBs are often situated in remote and hostile environments where traditional power sources are unreliable or impractical. The KARNO generator excels in such scenarios, overcoming challenges related to unknown fuel types, potential fuel contamination, harsh environmental conditions and the need to have a small footprint that can be transported around the world.

### **Challenges and Opportunities**

Recent advancements in additive manufacturing are enabling the fabrication of larger, more complex parts with greater speed and precision. Additive manufacturing is commonly used today in a broad range of applications, including aerospace, medical implants and automotive. The technology is enabling component manufacturing to move from prototyping to large scale production. KARNO generator technology is an example of these advancements. While additive presents a groundbreaking advancement in manufacturing technology, further increases in capabilities are possible and being pursued by GE and other manufacturers of this equipment.

### **Conclusion**

Chairman Carter, Ranking Member Wasserman Schultz, and members of this Subcommittee, we are grateful for having this opportunity to present the groundbreaking capabilities of the KARNO generator. The KARNO generator, with its innovative use of additive manufacturing, is a testament to American-made ingenuity and our dedication to providing reliable, scalable, and cutting-edge energy solutions to our military.