# Modular, Crushed-Rock Thermal Energy Storage Pilot Design

**Award Number: DE-FE0032017**

**Prime Recipient: Electric Power Research Institute (EPRI)**

**PI: Horst Hack**

**Sub-Recipients: Brenmiller Energy (technology developer), NYPA (host), AECOM/United (engineering vendor)**

**Location: EPRI in Palo Alto, CA (NYPA host site in Astoria, NY)**

**DOE:** $200,000
**Non-DOE:** $50,000

**Total: $250,000**

## Objectives

- Perform feasibility study on the integration of a 16 MWh-e crushed rock thermal energy storage system with an NGCC power plant to provide a facility capable of being viable and effective in a market with growing penetration of variable renewable energy (VRE) – target 4 MWe with at least 4 hours of storage duration
- Metrics: Effective plant integration, low installed cost (<$50 /kWth), high efficiency (80% thermal), and 5-fold increase in the demonstrated scale to support modular scalability.

## Relevance and Outcomes/Impact

Work proposed under the Phase I feasibility study is directly aligned with the objectives of the program announcement, including:

- Advance near-term, fossil-fueled asset-integrated, energy storage solutions toward commercial deployment.
- Mature promising mid-TRL, component-level, energy storage solutions toward eventual system integration with fossil-fueled assets. (Advance from TRL 5 to TRL 6, with goal TRL 9 by 2030)

# Modular, Crushed-Rock Thermal Energy Storage Pilot Design

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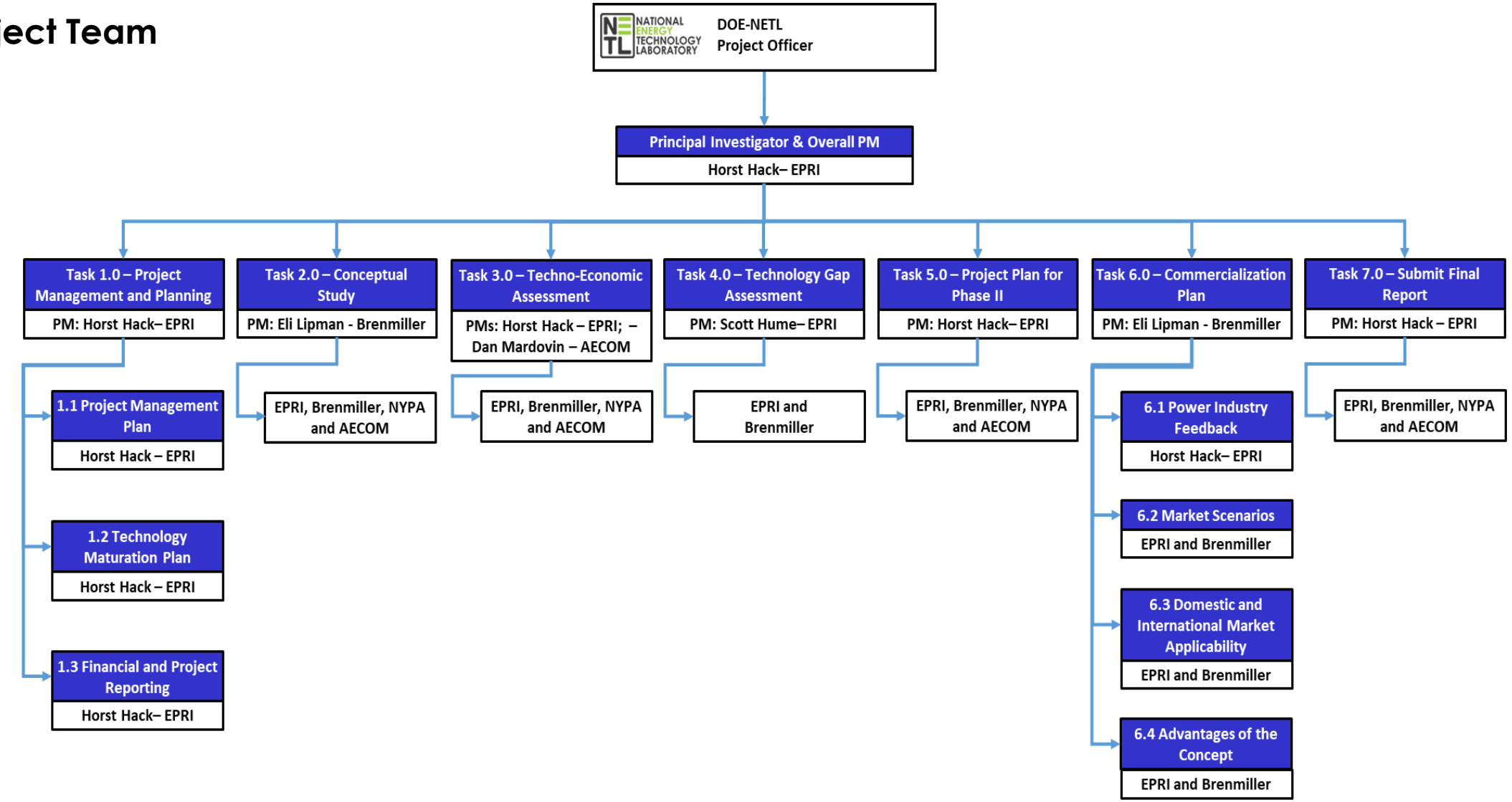
### Project Team



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- bGen™ crushed rock TES technology developed by Brenmiller Energy
- Builds upon 8 years of development by Brenmiller including testing at a scale of 1.7 MWe (solar)
- Heat is stored in modular units filled with low-cost crushed rock
- Storage at high temperatures (500°C to 700°C) allows direct production of superheated steam
- The modular nature would allow this TES technology to be scalable to a wide range of fossil power plant sizes (from 0.5 MWh to 1 GWh)
- No direct contact between the charging fluid and crushed rock
- Simple design supports a lifetime of over 30 years
- Low installed cost (<$50 /kWth)

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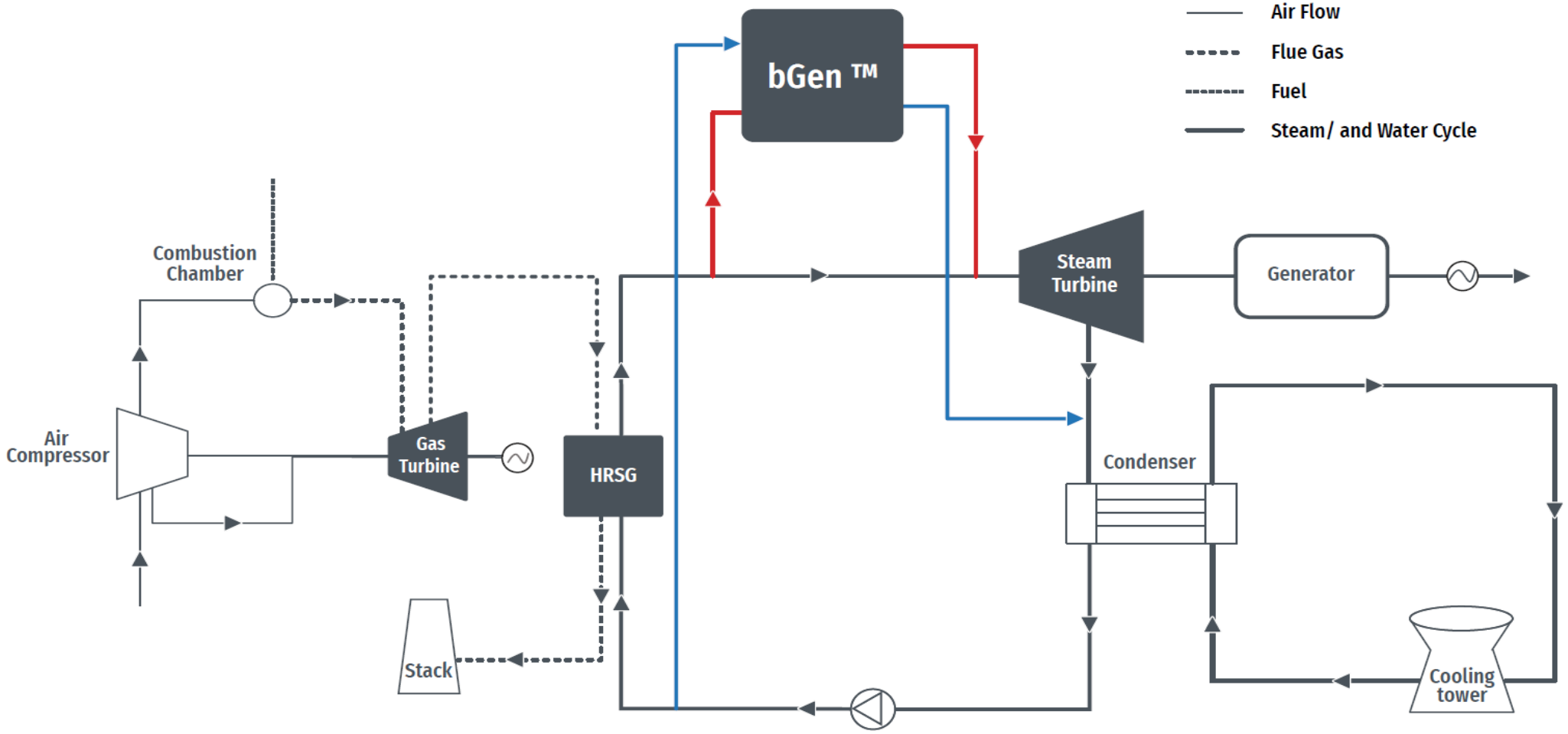
### Process Diagram for bGen™ Technology Integration with NGCC Power Plant



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**Multiple Thermal and Electrical Inputs are Supported for Flexibility**

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**Use Case:** Integration of a crushed-rock thermal energy storage (TES) with a fossil plant (e.g., NGCC for the pilot) can provide a facility capable of being viable and effective in a market with growing penetration of variable renewable energy (VRE).

**Target Scale:** Modular design of technology supports scalability across a wide range of fossil power plant sizes (from 0.5 MWh to 1 GWh), with 24+ hours duration.

**Gaps / Challenges:** The feasibility study will include a technology gap assessment (TGA) to identify any key shortcomings, limitations, and challenges and how these may be overcome in future work. The next step16 MWh-e pilot testing would serve to move the technology from TRL 5 to TRL 6, helping to support the goal of being at TRL 9 by 2030.

**Commercialization/Market Consideration:** Low capital cost, high efficiency and reliable operation are important commercialization of large-scale TES systems. The feasibility study will obtain power industry feedback, assess market scenarios, including variability in fuel pricing, $CO_2$ constraints, and penetration of VRE.

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1) What is needed to be able to pilot **a demo plant by 2025?**

The prior testing of the modular crushed rock TES system at 1.7 MWh-e scale, together with separate parallel development activities, make a 10+ MWH-e pilot plant the next logical step. If the next-step proposed pilot project receives DOE funding in the 2023 timeframe, the 10+ MWh-e demo can be implemented by 2025, leading to commercial readiness for a GWh-e plant by 2030.

2) What does NETL need to consider in regard to a **low-carbon future**?

Continued growth in VRE sources challenges the stable operation of the power transmission and distribution system. The addition of energy storage to increase the flexibility of the fossil generation assets can help to address this challenge. The increased flexibility could support the further growth in integration of VRE sources, while maintaining stability and backup reserves for the electrical grid. Scalable crushed-rock TES provides the opportunity for direct application to NGCC and other fossil generation assets that would benefit from increased flexibility due to VRE, across a wide range of plant sizes.

3) How can NETL help **transition coal assets** as they retire over the next 10-15 years?

The flexibility of crushed-rock TES to use both thermal and electrical inputs supports integration with fossil assets in the near-term, while continuing to provide power generation using existing power island infrastructure using electricity from VRE sources in the future, after fossil assets are retired.

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