

# Ammonia-Based Energy Storage Technology (NH<sub>3</sub>-BEST)

Award Number: DE-FE0032014

 Prime Recipient: University of North Dakota Energy & Environmental Research Center (EERC)

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Subrecipient: Vetri Labs

Participants and cost share providers:

 Basin Electric Power Cooperative  
Minnkota Power Cooperative  
Otter Tail Power Company  
North Dakota Industrial Commission

 Location: Grand Forks, North Dakota

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DOE: \$250,000

Non-DOE: \$176,390

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**Total: \$426,390**

## Objectives

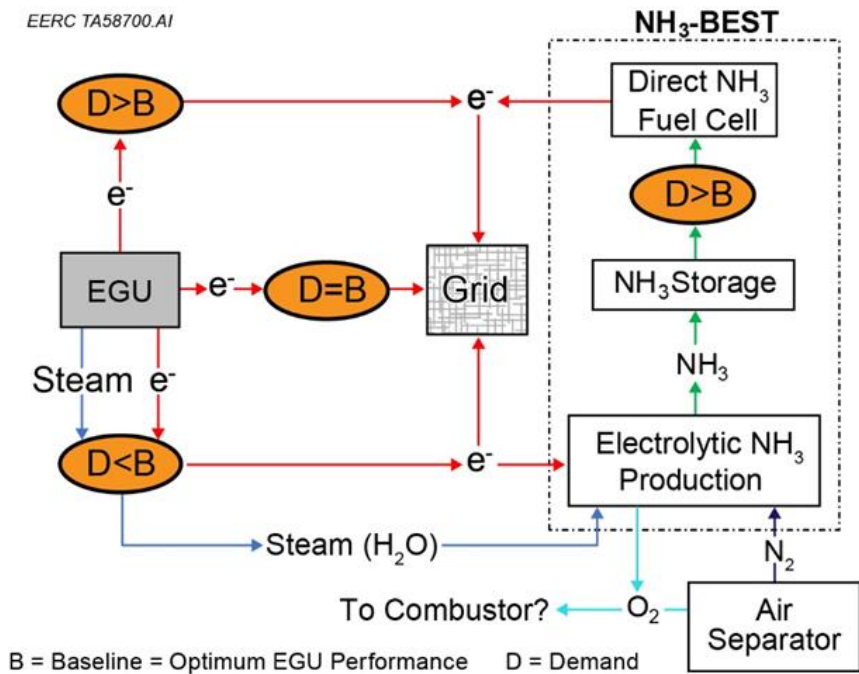
Model, validate, and advance NH<sub>3</sub>-BEST from TRL2 to TRL3, via following tasks:

- Define—with utility partners—NH<sub>3</sub>-BEST operational and performance targets based on power plant-specific energy storage objectives
- Using appropriate process simulation software, develop dynamic model of NH<sub>3</sub>-BEST
- Utilize model to:
  - Develop preliminary design of NH<sub>3</sub>-BEST subsystem
  - Identify work to advance to component-level engineering and validation testing
  - Define power plant system integration requirements
  - Establish performance requirements and their relationship to cost
  - Identify technical and nontechnical gaps to resolve for NH<sub>3</sub>-BEST commercial deployment

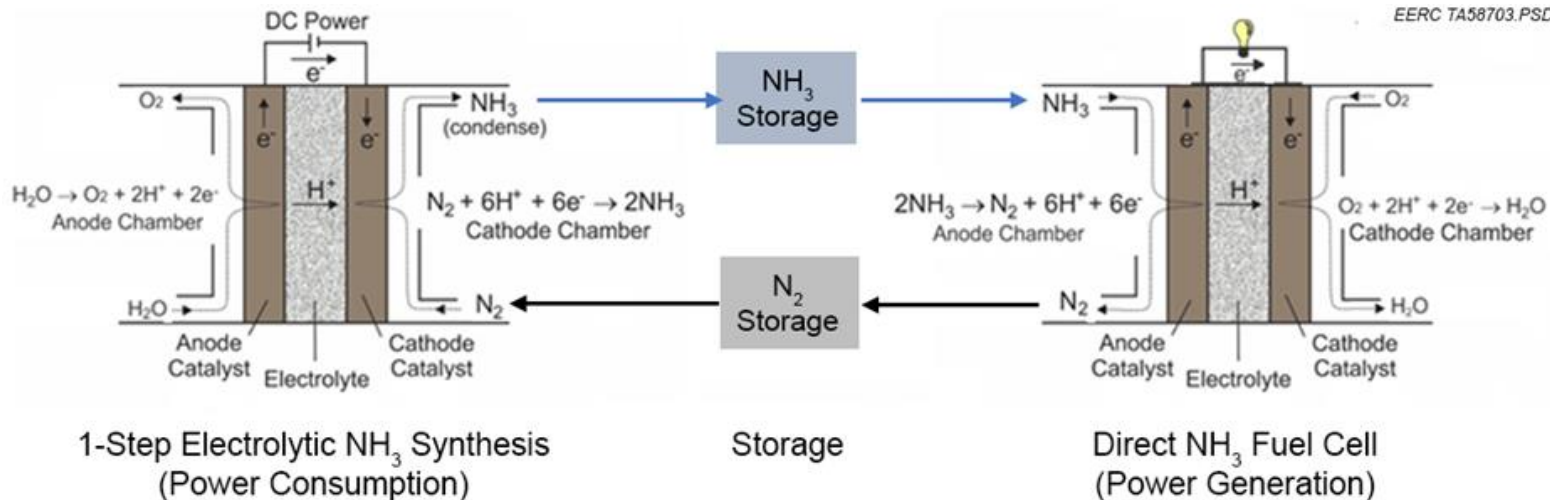
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NH<sub>3</sub>-BEST integrated with electricity generation unit (EGU)



NH<sub>3</sub>-BEST unit operations



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## Relevance and Outcomes/Impact

**As energy storage medium, ammonia offers the following benefits:**

- High hydrogen content (18 wt%), energy content (23 MJ/kg), and stability
- Low storage cost
- Near-zero explosivity hazard
- Carbon-free composition

**And....because ammonia is a long-established globally fungible commodity, the highly developed ammonia industry represents an NH<sub>3</sub>-BEST economic flexibility attribute, since it opens possibilities for selling and/or buying ammonia to capitalize on market conditions or address production or supply challenges**

**Major project outcomes include:**

- Preliminary design of NH<sub>3</sub>-BEST subsystem and associated EGU integration requirements
- Modeled demonstration of NH<sub>3</sub>-BEST performance, including estimated round-trip efficiency and preliminary economics when integrated with an EGU
- A road map for bringing ammonia energy storage to commercial deployment, including identification of work needed to advance to component-level engineering and validation testing documented in TMP, and technical and nontechnical gaps to resolve for eventual implementation at system level
- Demonstration of 1-step low-pressure electrolytic ammonia production from air, water, and electricity

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- 1) What is needed to be able to pilot **a demo plant by 2025?**  
*Convince utility that NH<sub>3</sub>-BEST deployment offers major economic benefit, based on:*
  - *Model-generated data*
  - *Demonstrated commercial viability of 1) low-pressure electrolytic ammonia synthesis and 2) ammonia-powered fuel cell*
- 2) What does NETL need to consider in regard to a **low-carbon future?**  
*When produced via low- or zero-carbon process, ammonia co-combustion with coal and/or natural gas can reduce CO<sub>2</sub> emissions without increasing NO<sub>x</sub> emissions*
- 3) How can NETL help **transition coal assets** as they retire over the next 10-15 years?  
*Help define pathways for economically transitioning coal mining and conversion infrastructure to producing and processing coal as carbon ore*
- 4) **Dealer's choice** – Is there a particular topic, issue, or area of need that NETL should be aware of?  
*Japanese have been doing utility-scale (120-MW) coal–ammonia co-combustion for several years, and are targeting coal/ammonia feed ratio (Btu basis) of at least 80/20*

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Include your contact information if you would like to be contacted directly for additional questions. We intend to summarize key points from the prior 3-5 speakers and hope to have some time to answer questions received in the chat.

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