



Project Title

Sand Battery – Industrial-Scale Thermal Energy Storage for Decarbonising Heat

Industry Partner

Polar Night Energy Oy

Industry Sector

Other Energy Intensive & Hard to Abate sectors

Technology Pathway (Primary)

Materials efficiency & industrial symbiosis

NIM Pillar

Technology Demonstration

Source

NIM Awards 2025

Description

Polar Night Energy's Sand Battery is the world's first commercial sand-based thermal energy storage system, designed to decarbonise industrial heat, one of the hardest-to-abate sources of emissions. By storing renewable electricity as high-temperature heat in abundant, non-toxic sand or industrial by-products, the Sand Battery enables industries and district heating networks to replace fossil fuels, cut emissions, and ensure grid stability.

Our latest 1 MW / 100 MWh installation in Pornainen, Finland, is the world's largest operational Sand Battery. It serves as the primary heat production plant for Loviisan Lämpö's district heating network, reducing greenhouse gas emissions by 70% and cutting 160 tonnes of CO₂e annually, while eliminating the use of oil completely and reducing the combustion of wood chips by 60%. The system uses 2,000 tonnes of crushed soapstone, a by-product of fireplace manufacturing, making it a strong example of circular economy in practice.

The Sand Battery is scalable: its current 60–400 °C operating range covers ~36% of all global industrial process heat needs. According to Mission Innovation, widespread deployment of Sand Batteries could save over 100 Mt CO₂e annually by 2030.

Polar Night Energy, founded in 2018 in Finland, has progressed from lab-scale to commercial-scale within a few years. Our first unit was commissioned in 2022, followed by the 10x larger industrial-scale installation in 2025. Future milestones include the development of Power-to-Heat-to-Power (P2H2P) technology, which will allow reconversion of stored heat into electricity, further enhancing flexibility and impact.

Innovations Employed

The Sand Battery is the first large-scale, high-temperature energy storage system based on sand, a cheap, safe, and abundant material. Unlike existing short-duration storage or chemical batteries, it provides long-duration thermal storage at industrial scale, with round-trip efficiency of over 80%. It eliminates the need for fossil combustion in district heating and enables the electrification of industrial heat.

The Sand Battery's profitability is enhanced by optimizing charging with low electricity prices and taking part in reserve markets; supporting the grid stability and thus enabling the growth of intermittent renewables like solar and wind power.

The first industrial-scale Sand Battery is already operational and providing affordable district heating for the clients in Pornainen, Finland. We've shown that cost-effective solutions for electrifying heating do exist, it just takes courage to invest.



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Project Title

Sand Battery – Industrial-Scale Thermal Energy Storage for Decarbonising Heat

The Sand Battery combines large-scale, long-duration storage with unmatched durability. It operates for 30+ years with minimal maintenance, stores energy for days to weeks (vs. hours for lithium-ion), and uses only safe, non-toxic materials. Unlike chemical batteries, it shows no performance degradation, ensuring reliable efficiency over its lifetime.

Dimension of Novelty

New for the company

New in Country

Finland

New on the international market

World's first

Innovation Collaboration

In house

Finland

Intellectual Properties

Polar Night Energy holds a patent for its Sand Battery's closed loop heat transfer mechanism.

IP Links

Timetable & Progress

Development commenced in 2018

Company was founded 2018 but the idea was first conceived when Polar Night Energy's founders met in Tampere University of Technology in 2014. They foresaw the trend of declining electricity prices and increasing volatility in the energy markets. They realized that decarbonizing heat would require more than renewables, it needs high-capacity energy storage. This insight sparked the invention of the Sand Battery and the founding of Polar Night Energy.

2018–2021: R&D and prototypes.

2022: First commercial installation in Kankaanpää (Vatajankoski).

2025: Industrial-scale 1 MW / 100 MWh system operational in Pornainen. 2025–2027: P2H2P pilot with Valkeakosken Energia.

Financing (Public/ Private)

Public funding

The Pornainen project received support from Business Finland's new technology energy aid. The P2H2P project has received support from Business Finland. The company has previously received Business Finland Tempo financing and The Centre for Economic Development, Transport and the Environment's company development grant.

Finance Links

Project Phase TRL

TRL 9

The Sand Battery has moved from demonstration (TRL 7) in Hiedanranta, Tampere (2020) to first-of-a-kind commercial system (TRL 8) with the Kankaanpää installation (2022), and further to industrial-scale proven in operational environment with the Pornainen installation (2025).



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Problems to be Solved and Risks to be Managed

Technology: Designing safe, efficient long-duration thermal storage with minimal heat loss.

Market: Convincing utilities and industrial companies to adopt a novel solution and integrate it into existing networks.

Know-how: Heat transfer, developing charging/discharging algorithms, and enabling participation in reserve markets via AI optimisation.

Risks included market acceptance, financing of first-of-a-kind projects, and proving durability at scale.

Preliminary or Final Results Achieved

First industrial-scale unit: 1 MW / 100 MWh in Pornainen, cutting 70% of network GHG emissions. Elimination of oil in local heating network. 160 t CO₂e reduction annually in one installation.

Demonstrated use of industrial by-products (soapstone) as storage medium.

Validation of over 80% efficiency and long operational life (30+ years).

Active negotiations and feasibility studies underway globally.

CO₂ Emissions Reduction Potential - Implementation and Future Market

The Sand Battery is applicable to both energy utilities and industrial heat users. Its current temperature range (60–400 °C) covers about 36% of global industrial heat demand. We are also planning to go to higher temperatures.

In Finland, two commercial projects are already operational; more are under development.

Internationally, Polar Night Energy has and is conducting feasibility studies in Europe, Asia, and North America.

Market potential is vast, as industrial heat accounts for about 20% of global emissions.

The 1 MW / 100 MWh Sand Battery can reduce about 160 t CO₂e annually in heating applications. In industrial sectors, the potential scales exponentially.

Mission Innovation's assessment from 2021 estimates savings of >100 Mt CO₂e annually by 2030 with global deployment.

Market Positioning

Polar Night Energy is positioned as a pioneer in thermal storage, bridging the gap between short-duration batteries and large-scale electrification of heat. We are the first-mover globally with operational industrial-scale projects, strong media visibility, and growing partnerships with utilities, municipalities, and investors.

The company's long-term mission is global: Nordic countries and Europe first, and ultimately, worldwide deployment of sustainable thermal energy storage solutions.

In addition to working with energy companies, Polar Night Energy is actively expanding its focus to industrial customers. Many industries rely on high-temperature heat for their processes, which is often produced by burning fossil fuels.

According to IEA, one-fifth of the world's greenhouse gas emissions come from industrial heat. A Sand Battery could significantly cut those emissions and help industries heat up without heating the planet.



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One of our key future milestones is the development of Power-to-Heat-to-Power (P2H2P) technology. We are building a pilot to test a next-generation version of the Sand Battery capable of converting stored thermal energy back into electricity.

Our Sand Battery has captured the attention of both local and international media, giving our customers exceptional exposure. We have been featured e.g. in BBC, ABC, ZDF, CNN, New York Times, Washington Post, Euronews, Deutsche Welle, World Economic Forum, TNW, and many others.

Project Location

Finland

Project & Technology Links

<https://polarnightenergy.com>

Technology Links

