

POWERING CHANGE

White Paper on
Sustainability
2024

The Sand Battery Can
Power the Change
From Fossil Fuels to
Wind & Solar Energy

**POLAR
NIGHT
ENERGY**

Heat and power
without burning
www.pne.fi



Climate Action

To mitigate climate change, we need solutions for storing energy generated from weather-dependent renewable sources such as solar and wind.

These solutions must meet three critical criteria: environmental sustainability, social responsibility, and economic viability. Without all three of these qualities, the widespread adoption of such solutions on a large scale seems unrealistic.

This white paper delves into the performance of Polar Night Energy's high-temperature thermal energy storage system, the Sand Battery, across these categories. It highlights the potential for cleaner energy production, bringing us closer to the transition from fossil fuels to renewable energy.

Together, we can drive this transformative change.

Polar Night Energy

White Paper on Sustainability

"Powering Change – The Sand Battery Can Power The Change
From Fossil Fuels to Wind & Solar Energy"

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Watch
 "What is a
 Sand Battery?"
 via YouTube

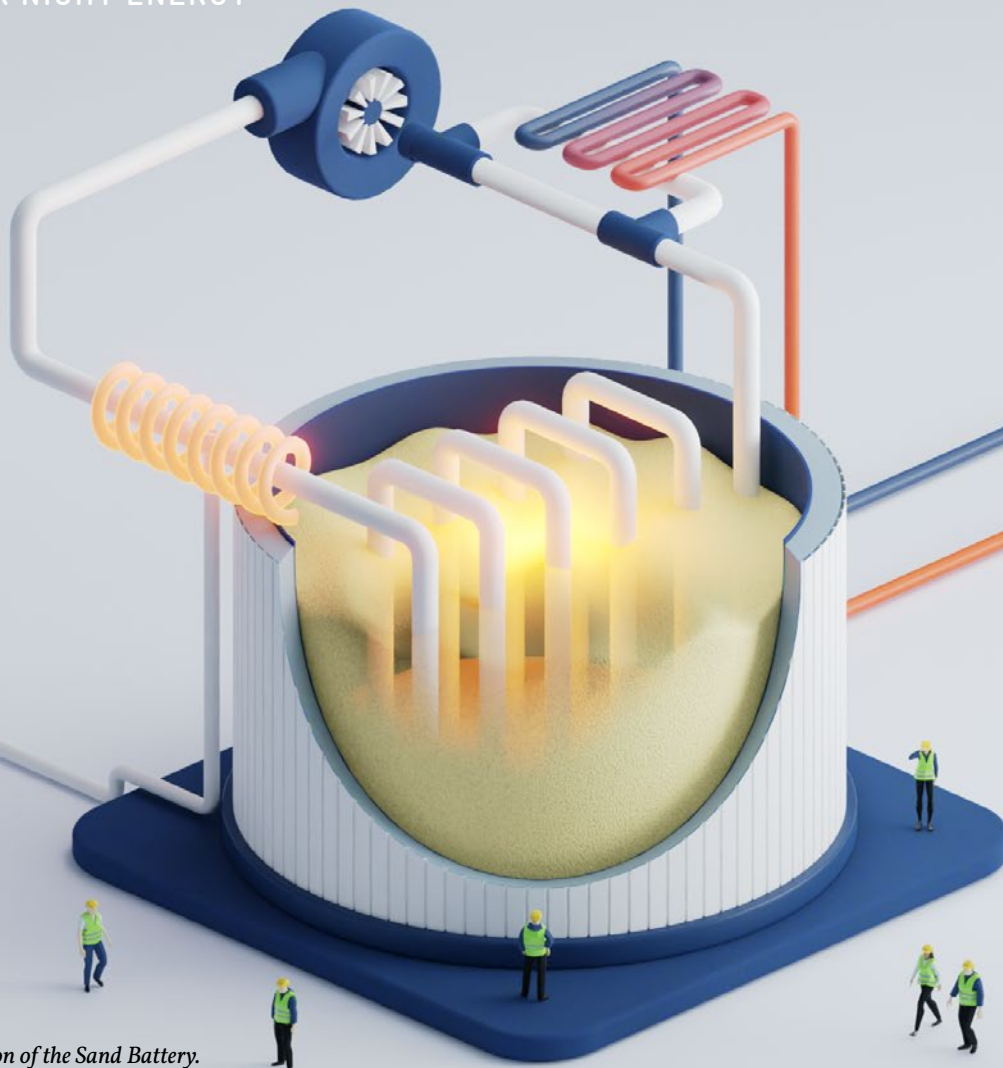


Illustration of the Sand Battery.
 IMAGE: SIMO HEIKKINEN

Heat and Power Without Burning

Polar Night Energy designs, develops and delivers large-scale high temperature thermal energy storages, called Sand Batteries, for wind and solar energy. Sand Battery refines clean and cheap surplus electricity to valuable heat, when needed most.

The Sand Battery enables the upscaling of solar or wind energy to up to 100% of clients heating and electricity needs. The core of the solution is a patented closed loop heat transfer mechanism in a massive solid material thermal energy storage.

The Sand Battery has three main purposes: to store excess wind and solar energy, to participate in grid balancing markets, and to produce heat and power without burning.

Energy utilities and industrial companies are shifting to climate-friendly options in energy production. The Sand Battery is a versatile solution that can easily be connected to

existing infrastructure, making it an ideal choice for a variety of industrial applications.

Polar Night Energy's clients are energy utilities, district heating providers, and light to medium industries that need high temperature process heat in the form of hot water, steam, or air. A product to convert the heat back to electricity is being developed.

Polar Night Energy was founded in 2018 and has already made an impact on the energy industry with the world's first commercial Sand Battery. The company is based in Tampere, Finland.

Upscale Solar and Wind Power, Downscale Combustion

Our sand-based thermal energy storage has the potential to significantly increase the capacity of intermittent renewables in the electrical grid like solar and wind power, while reducing our reliance on combustion-based technologies.

Climate change is one of the biggest challenges of our time. It is a hard problem to solve because our whole society is built on the use of fossil fuels and growing consumption of material goods.

Emissions, be them CO₂ emissions or other emissions that are harmful for nature, should be at the level where the planet remains habitable indefinitely. Currently the best way to produce low-emission energy is by wind and solar power. They too are not zero emission, but they are the best we have.

Our technology is low-emission, and it can be efficiently used to promote renewable energy. The Sand Battery is already commercially available and economically viable – it's a potential solution for mitigating climate change and volatile energy prices.

An energy storage is an essential part of an electric grid that has significant amounts of intermittent electricity in it. Balancing such a grid is not easy. Reducing consumption when solar and wind is not available should be the number one goal. However, storages of different types will still be needed.

Most current energy storage technologies fail to provide the massive capacity that is needed when reaching a high solar and wind fraction in a grid. Our large-scale thermal energy storage answers to this need, as upscaling the capacity of our product is straightforward and cost-efficient. It is not the solution to all needs, smaller capacity storages have their benefits, but our storage answers the call when there's a need to take in days or weeks of excess wind or solar.

Our thermal energy storages can also participate in different grid balancing markets. This will deliver a new source of income for clients. Grid balancing markets are becoming more and more important as the fraction of intermittent energy like wind and solar energy is growing.

It is our guiding principle to ambitiously upscale solar and wind and even more ambitiously downscale combustion-based technologies.

By adopting a holistic approach to sustainability that incorporates environmental, social, and economic considerations, we can do our part and help to create a more resilient and sustainable energy system for the future.

Markku Ylönen

Co-Founder, CTO

Polar Night Energy



AWARDS & PRAISES



NET-ZERO COMPATIBLE
INNOVATIONS
INITIATIVE

According to Mission Innovation's assessment, Polar Night Energy's sand-based thermal energy storages may save over 100 Mt of CO₂e per year in 2030.

CARBON
HANDPRINT
AWARD



Polar Night Energy was awarded an honorary certificate in The High Potential Carbon Handprint Innovation category at The International Carbon Handprint Awards 2022.



Polar Night Energy was selected by One Initiative as one of the Nordic Top 50 Impact Companies in 2021.



According to World Economic Forum, Polar Night Energy's Sand Battery "could help to solve one of renewable energy's biggest challenges".



Junior Chamber International Finland selected the world's first commercial Sand Battery as the Finnish Innovation of 2023.



Polar Night Energy won the ÎNNO UP Energy challenge 2022 organized by Austrian Economic Chamber, The Austrian Research Promotion Agency, Microsoft, and The Stoelzle Glass Group.



TAMPERE

The City of Tampere Technical Creativity of the Year 2022 Award has been awarded to an innovative way of storing renewable energy in sand by Polar Night Energy.



"'Sand Battery' could solve green energy's big problem" by the BBC.



One of the eight "innovations solving renewable energy's biggest problem" by the CNN.



Junior Chamber International Finland selected the world's first commercial Sand Battery as the Finnish Innovation of 2023. The winning companies were featured on the billboards of New York's Times Square. PHOTO: NASDAQ

Thermal Energy Storages Are Essential

Polar Night Energy is part of the energy transition & sector-integration.

The energy transition means shifting energy production from fossil fuels to renewables. Polar Night Energy's goal is to produce energy with little to zero greenhouse gas emissions and to help the up scaling of wind and solar energy.

Sector integration means linking the various energy sectors to enable them to balance out each other's peaks in consumption and generation. Polar Night Energy connects the electricity sector to heating sector to replace combustion-based technologies.

Polar Night Energy's innovation will help clients to reach their climate goals and lower their energy costs. Polar Night Energy enables clean and affordable energy.

Polar Night Energy's innovation will help clients to reach their climate goals and lower their energy costs.

ENVIRONMENTAL SUSTAINABILITY



Polar Night Energy's thermal energy storage can be used to take in massive amounts of excess low-emission electricity, while retaining the energy in a useful form that can be used when most needed. This enables the upscaling of wind and solar production and reduce GHG emissions.

IMAGE: SIMO HEIKKINEN

Reducing Emissions and Pollution

Polar Night Energy designs energy solutions that can be used to reduce climate emissions and pollution as well as advance circular economy.

Environmental sustainability is a critical concern in the energy industry, and reducing the negative impact of energy production and consumption on the environment is essential. This includes reducing greenhouse gas emissions (GHG), protecting biodiversity, conserving natural resources, and minimizing pollution and waste.

To promote environmental sustainability, energy projects must be developed and operated in a way that prioritizes the use of renewable and clean energy sources, such as wind and solar.

Energy efficiency measures, such as improving insulation and using more efficient appliances, can also help to reduce energy consumption and minimize the environmental impact of energy usage.

Furthermore, it is important to engage in responsible resource management in the energy sector. This includes responsible sourcing of materials, reducing waste and emissions, and promoting circular economy.

By prioritizing environmental sustainability in the energy sector, we can help to create a more sustainable and resilient energy system that meets the needs of present and future generations while preserving our planet's natural resources and ecosystems.

Reducing Greenhouse Gas Emission

Climate change is one of the most pressing sustainability issues facing the energy industry. Reducing GHG emissions, particularly carbon dioxide, is essential to mitigate the negative impacts of climate change.

The latest report from the Intergovernmental Panel on Climate Change (IPCC) affirms that human activities, primarily the emission of greenhouse gases, have undeniably caused global warming. It reveals that global surface temperatures surpassed 1.1°C above the average for the period of 1850–1900 during 2011–2020. The crisis is getting greater and greater as GHG emissions continue to increase.¹

Climate change has already resulted in detrimental ef-

fects on food and water security, human health, economies, and societies, causing significant losses and damages to both nature and people. The severity of these risks largely depends on the actions taken in the near term. The IPCC emphasizes the urgent need for more ambitious climate actions, stating that by acting now, we can still ensure a sustainable and livable future for all.¹

Thermal energy storages can be used to take in massive amounts of excess low-emission electricity, while retaining the energy in a useful form that can be used when most need-

ed. This enables the upscaling of wind and solar production and reduce GHG emissions.

Indeed, without a considerable storage capacity, increasing the wind and solar production beyond a definite level leads to severe curtailment. Storage solutions enable the producers of renewable energy to get positive compen-

sation for all their production and the resources and energy are thus not wasted.

The overproduction of electricity in certain conditions is not the only problem of these clean energy sources. The nature of solar and wind energy includes a certain degree of non-predictability, leading to the need to balance the electricity grid when the production is higher or lower than what was expected.

The production and consumption of electricity in the grid needs to be in balance at every moment; only that way the frequency of the grid is kept constant. Thermal energy storage can work as adjustable energy consumer that can increase and decrease its electricity consumption according to the needs of the grid.

The obvious need for this kind of operators has lead transmission system operators (TSOs) to create markets for ancillary services. In these markets, also known as grid balancing markets, the storage operators can get compensation from TSOs for helping to balance the electricity grid. The balancing is done by following precise automated instructions in response to the deviations in the grid frequency.

The resistive heating used by the thermal energy storag-

Storage solutions enable the producers of renewable energy to get positive compensation for all their production and the resources and energy are thus not wasted.

Heat source	Emissions kg CO ₂ /MWh
Sand Battery	0
Wood chip combustion	403
Coal	335
Oil	281
Natural gas	200

Table 1. Emission coefficients for different energy sources.

es is one of the fastest and easiest components to control in power, and this fact makes these markets especially appealing for the solution of Polar Night Energy.

In addition to these facts related to the electricity production side, there is also an important argument in the consumption side on how the high temperature thermal energy storages help the transition away from fossil fuels. Namely, there are several heat intensive industrial applications that require temperature levels of about 150 degrees centigrade and above.

In these applications the combustion-based technologies keep dominating and modern solutions other than high temperature thermal energy storages, such as heat pumps and other energy storage methods, are most often not feasible.

Moreover, such processes systematically need a steady and controllable heat production. Thus, it is a game changer to be able to use wind and solar as primary energy sources also in these applications, and that is achieved with the help of the solution of Polar Night Energy.

Beyond the high temperature applications, the solution is very flexible to provide heat in any lower temperature as well. Thus, almost the entire heat consumption sector can make the transition to clean energy with the help of thermal energy storages.

Mission Innovation made an assessment about the potential avoided GHG emissions per year in 2030 enabled by Polar Night Energy’s sand-based high temperature thermal

energy storage and other similar competing innovations. The result is over 100 million tons of carbon dioxide equivalents (CO₂e) per year in 2030.²

It means that, according to the estimate, Polar Night Energy’s thermal energy storages could potentially save almost double the CO₂e emissions of the New York City today, or approximately 3% of the current EU emissions. This shows that a simple, yet effective innovation can have an enormous positive impact if adopted globally.

The tables 1 and 2 present a more detailed estimate of the carbon dioxide emissions that Polar Night Energy’s standard 2 MW and 10 MW products can potentially save compared to traditional combustion methods. Table 1 contains emission coefficients for different fuels from the fuel classification by Statistics Finland.³ The Sand Battery is assumed to be charged with wind and solar energy

with zero emissions.

The corresponding produced and saved emissions per product per year are shown in Table 2. Here 100% efficiency coefficient for the compared combustion methods is assumed.

Reducing Pollution

The burning of fossil fuels like coal, oil, and gas releases pollutants like sulfur dioxide, nitrogen oxides, carbon monoxide, and particulate matter into the air. Biomass combustion

Almost the entire heat consumption sector can make the transition to clean energy with the help of thermal energy storages.

Polar Night Energy designs energy solutions that can be used to reduce climate emissions and pollution. PHOTO: MARJAANA MALKAMÄKI

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Polar Night Energy's CEO Tommi Eronen and the former Governor of California Arnold Schwarzenegger at the opening of The Austrian World Summit Solutions Hub, May 2023. During the summit, Mr. Schwarzenegger coined a powerful catchphrase—one that resonates deeply with our mission: “Let’s terminate pollution!” PHOTO: THE SCHWARZENEGGER CLIMATE INITIATIVE/LIPIARSKI

can also be a significant source of air pollution, particularly in areas with high levels of biomass burning for heating and cooking purposes.

According to the World Health Organization (WHO), almost the entire global population (99%) breathes air that exceeds WHO air quality limits and threatens their health. WHO has estimated that 7 million people die every year because of exposure to polluted air that causes diseases including stroke, heart disease, lung cancer, chronic obstructive pulmonary diseases, and respiratory infections, including pneumonia.⁴

WHO is highlighting the importance of curbing fossil fuel use and taking steps to reduce air pollution levels.⁴

Polar Night Energy's Sand Battery is heated only using electricity with electric resistors. Thus, the operation of it doesn't release any pollutants to the surrounding air.

In addition, all the materials used in the storage are safe. There are no toxic or harmful substances that could be leaked to the surrounding soil. This has a positive impact on the surrounding local environment as well as the near-by people.

Embracing Circular Economy

The energy industry has the potential to impact ecosystems and biodiversity, particularly through resource extraction and infrastructure development. Ensuring that these impacts are minimized is a key sustainability consideration.

According to the United Nations Environment Programme (UNEP), sand, including gravel, crushed stone and aggregates, is the second most used resource after water, and the most used solid material with estimated use of 40–50 billion metric tons per year.⁵

Current use of certain types of sand exceeds the replenishment rates of natural occurrence. To avert a sand shortage, UNEP is urging a move towards a circular future through substitution with other material and the inclusion of sand into sustainable infrastructure standards.⁵

Polar Night Energy prefers to use sand or sand-like materials that are not suitable for construction industry. High density, low-cost materials that are not from scarce sources are preferred. Someone else's dirt could be Polar Night Energy's thermal energy storage medium.

The technology of Polar Night Energy is flexible: the

Product	2 MW Sand Battery	10 MW Sand Battery	
Capacity	210	930	MWh
Energy stored per year	6 300	27 900	MWh
Saved emissions per year compared to:			
Wood chip combustion	2 500	11 200	t CO ₂ e
Coal	2 100	9 300	t CO ₂ e
Oil	1 800	7 800	t CO ₂ e
Natural gas	1 300	5 600	t CO ₂ e

Table 2. Produced emissions per year and comparison to other heating methods.

Sand Battery can use sand with varied mineral composition, with wide range of grain size distributions, and with no restrictions to microscopic characters of the sand grains. This enables the usage of materials that are locally and commonly available, or even considered as waste.

Mine waste volumes are overwhelming. Most of the substance extracted in mines needs to be disposed of. Only a small fraction of the material is utilized, and the rest is left to lie in heaps. Since mines can operate for decades, they are often accompanied with mountains of waste rock in their backyards.

In many cases this waste could be used to store energy in Polar Night Energy's Sand Batteries.

Based on the estimate of Mission Innovation, 737 TWh of solar and wind energy will need storage in 2030.² Covering all that storage capacity by Polar Night Energy's Sand Batteries would require 200 million tons of sand or sand-like material. For comparison, 500 million tons of mining waste was produced only in EU during the year 2020.⁶

Note that in this comparison, the Sand Batteries would serve for decades. Note also that building that many Sand Batteries would correspond to 100% of the storing need of renewable energy, and while the Sand Battery is great for many applications, most probably other storage solutions

will participate in this enormous task of storing energy.

All this should mean that 200 million tons of sand is a significant overestimate, and even then, it takes only half a year to produce it in just EU area as mining waste.

Mine waste is not only poorly utilized but causes many problems from land usage to soil contamination. The mining industry is now looking for solutions to this environmental hazard: ever larger portion of the wall rock streams is directed to circular economy, and Polar Night Energy is actively searching opportunities to collaborate.

Mine waste volumes are too large for Sand Batteries to completely tackle this problem, but Polar Night Energy can do a part. At very least, no new mines are needed to fill Sand Batteries.

Moreover, Polar Night Energy's system is robust. The design life of the storage is tens of years. All the materials used in construction of the system are recyclable and non-toxic. Even the storage medium will be reusable.

As our Sand Battery can be connected to existing infrastructure, building a combustion-free solution is straightforward and cost-effective. Only limited amount of new infrastructure is needed to build a combustion-free solution. This is especially the case with industrial-scale factories and district heating networks.

The operation of the Sand Battery doesn't release any pollutants to the surrounding air.



Polar Night Energy aims to be a great workplace for its employees.
PHOTO: MARJAANA MALKAMÄKI

Powering And Empowering Communities

Polar Night Energy designs energy solutions that offer affordable and clean energy. The solutions also support local communities and their energy self-sufficiency & security.

Social and cultural sustainability is an important aspect of the energy industry. Ensuring that energy projects are developed and operated in a way that respects local communities and cultures is essential.

Polar Night Energy's thermal energy storages are constructed together with local partners and contractors. The storage medium will also be locally sourced in most cases. This is likely to support local communities and create jobs.

Polar Night Energy wants to be the best possible workplace for its employees. Employees are not viewed as just resources, but human beings treated with equal respect. This helps to foster a culture of creativity, trust, and collaboration within the company. With this same respect Polar Night Energy treats its clients and partners.

Polar Night Energy obeys the Finnish law and pays taxes. Polar Night Energy acts to ensure human rights and labor standards in all its projects.

Moreover, ensuring access to energy for all members of society is an important goal for social sustainability in the energy sector. This includes improving energy access in developing countries, as well as ensuring that vulnerable populations, such as low-income households or those in remote areas, have access to affordable and reliable energy services.

In the next section about economic sustainability, we will explain in detail why a thermal energy storage can make the heat costs low for the end-user.

According to Mission Innovation's assessment, Polar Night Energy's thermal energy storage innovation has

strong positive impact on United Nations' Sustainable Development Goal (SDG) number 7: Affordable and clean energy. Thermal energy storages also increase local energy security and self-sufficiency. Polar Night Energy's innovation also impacts the SDG target 9: Build resilient

infrastructure, promote inclusive and sustainable industrialization and foster innovation.²

People have greeted Polar Night Energy's climate innovation with enthusiasm. For example, after Polar Night Energy's Sand Battery went viral in the summer of 2022, there were social media posts and videos about people who were designing and building their own domestic versions of the Sand Battery. This shows that there is a need for forerunners in energy innovations and climate actions.

Sand Battery has been featured in many major media outlets, but also in blog posts, news for kids and young people, and student projects. It has sparked an interest for clean energy for many people around the world.

The Sand Battery has sparked an interest for clean energy for many people around the world.

SOCIAL SUSTAINABILITY

Polar Night Energy's thermal energy storage innovation has strong positive impact on United Nations' Sustainable Development Goal (SDG) number 7: Affordable and clean energy.

PHOTO: MARJAANA MALKAMÄKI





We joined forces with Ilmatar to store excess wind and solar energy in large-scale Sand Batteries. PHOTO: MARJAANA MALKAMÄKI

Balancing Grids for Profits

Polar Night Energy designs energy solutions that bring economic benefits to clients and their customers.

Economic sustainability is a key consideration in the energy industry, as it impacts the long-term viability and stability of the sector. To ensure economic sustainability, energy projects must be developed and operated in a way that creates value for all stakeholders, including clients, investors, consumers, and local communities.

Polar Night Energy focuses on creating a business model that is financially viable and generates long-term value for all stakeholders. We leverage cost-saving opportunities throughout the product's long lifecycle, optimizing manufacturing processes and reducing maintenance costs as the system is practically maintenance free and automated.

Compared to other energy storage methods of similar applicability, the solution of Polar Night Energy has low cost for capacity unit, due to simple and robust design using standard industrial components.

Polar Night Energy's innovation has the potential to deliver significant economic benefits. By enabling more efficient use of renewable energy, the technology can help reduce the reliance on fossil fuels and lower energy costs. The Sand Battery can also maximize the utilization of a client's own solar or wind power. This helps optimize energy

self-sufficiency and reduce reliance on external sources.

Another main economic benefit of the Sand Battery comes from the fact, that the Sand Battery can be charged with electricity when spot prices in electricity market are low, avoiding peak hours. This approach results in significantly lower costs compared to both direct electricity (average of spot price) and traditional combustion methods.

Grid balancing markets are becoming more and more important as the fraction of intermittent energy like wind and solar energy is growing.

Polar Night Energy's sand batteries can also participate in different grid balancing markets where applicable. This will deliver a new source of income for clients and lower the final cost per heating. Grid balancing markets are becoming more

and more important as the fraction of intermittent energy like wind and solar energy is growing.

Additionally, Polar Night Energy's innovation has the potential to create new jobs and contribute to local economic development, particularly in regions with abundant renewable energy resources.

The Sand Battery can help companies meet their sustainability goals and improve their social and environmental impact, which can enhance their reputation and attract new customers. The solution creates a lot of brand value for clients.

Kankaanpää Sand Battery

Polar Night Energy constructed and operates the world's first commercial sand-based thermal energy storage for Vatajankoski Oy.

The storage provides heat for the district heating network in Kankaanpää, Finland, with a 200 kW heating power and 8 MWh capacity.

91 000 CO₂e kg

Of saved emissions compared to traditional wood chip combustion (403 kg CO₂/MWh, see Table 1) in the operational period 8/2022 to 7/2023. The emissions for the Sand Battery are calculated using the measured electricity consumption data from the Kankaanpää site 8/2022-7/2023, the corresponding real-time electricity emissions data from Fingrid⁷ and measured heat production data. The resulting emission coefficient for produced heat from Kankaanpää site from this period is 61 kg CO₂/MWh.

100 tons

Of locally sourced sand as the storage medium.

5.3 billion

Potential media reach. Media attention to Polar Night Energy, the client, the city, and local community.

Perfect Solution

“We are actively developing our energy production portfolio towards a 100% sustainable and emission-free future. Polar Night Energy provides a perfect solution for our needs.”

– Pekka Passi, Managing Director, Vatajankoski

The world's first commercial Sand Battery at Kankaanpää, Western Finland. PHOTO: RAMI MARJAMÄKI





Polar Night Energy's team.
PHOTO: RAMI MARJAMÄKI

Profitable Energy Transition

Polar Night Energy's Sand Battery is a profitable breakthrough in emissions reduction.

To mitigate climate change, we desperately need solutions to store energy from weather dependent renewable sources, such as solar and wind. In order to thrive, these solutions need to be environmentally and socially sustainable as well as economically viable – like Polar Night Energy's Sand Battery.

Polar Night Energy specializes in creating sustainable energy solutions that reduce emissions, pollution, and support circular economy principles. The technology efficiently stores excess renewable energy, significantly cutting greenhouse gas emissions and air pollution.

By repurposing materials and waste, Polar Night Energy contributes to resource sustainability. The system's robust design, recyclable materials, and compatibility with existing infrastructure make it a cost-effective, ecological choice for a cleaner energy future.

Polar Night Energy focuses on social sustainability by providing affordable, clean energy solutions that empower local communities and enhance energy self-sufficiency and security. That is done by collaborating with local partners and contractors, supporting job creation and community development. Polar Night Energy upholds ethical governance and human rights standards.

Polar Night Energy's Sand Battery innovation has

sparked enthusiasm and inspired individuals worldwide to explore clean energy solutions, making them pioneers in climate action and energy innovation. The Sand Battery has garnered attention across various media outlets, further raising awareness about clean energy.

Polar Night Energy designs economically sustainable energy solutions that benefit clients and customers. The Sand Battery technology maximizes the use of renewable energy, reduces costs, and generates income through grid balancing markets. It also contributes to local economic growth and enhances brand value for clients.

The future of the Sand Battery holds immense promise as Polar Night Energy plans to scale this technology globally. Polar Night Energy recognizes that this innovative solution not only transforms the energy landscape but also plays

a pivotal role in shaping a sustainable future. The vision is to expand the reach of the Sand Battery to communities and industries worldwide, capitalizing on its economic, environmental, and social benefits.

Polar Night Energy is committed to fostering strategic partnerships with all stakeholders. Cleaner energy production is possible. Together, we can power the change from fossil fuels to renewable energy.

Together, we can power the change from fossil fuels to renewable energy.

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The First Step: A Feasibility Study


Are you interested in our thermal energy storage system?
Take the first step and order a feasibility study.

We will inspect and evaluate your energy systems and processes. The goal of the feasibility study is to investigate how a high temperature thermal energy storage would operate as part of your energy system and how low energy prices could be achieved with a storage solution.

We will determine optimal design for a thermal energy storage solution to satisfy your heating requirements and find out whether our Sand Battery would be the best solution to fulfill them.

Check out more details and price of the study at www.pne.fi/study.





To mitigate climate change, we desperately need solutions to store energy from weather dependent renewable sources, such as solar and wind. In order to thrive, these solutions need to be environmentally and socially sustainable as well as economically viable – like Polar Night Energy’s Sand Battery.

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