
phelas
Energy Storage Solutions


We make the sun shine at night.
Company Presentation
phelas
Energy Storage Solutions

A team of professionals united to push forward grid-scale energy storage

phelas Vision

We are here to make 100 % renewable electricity a “no-brainer” everywhere on this planet.

phelas Mission

phelas offers a scalable, cost-effective, and modular liquid air energy storage system for seamless integration of renewable energy in a co-located environment.

Founded
in 2020 with support of the TU Munich

Headquartered
in Munich, Germany

Team with
20+ people and more than 10 nationalities

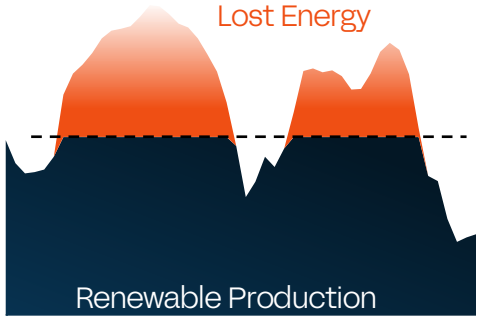
English
as main working language

OUR SUPPORTERS AND INVESTORS

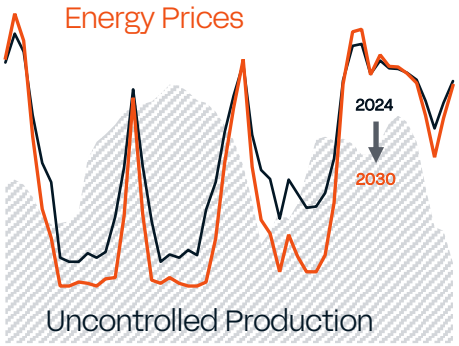
Ørsted · WIEN ENERGIE · E44 VENTURES · AXON · BNVpartners · hub:raum tech incubator of T · Technical University of Munich · esa business incubation centre Bavaria · Sponsored by Bavarian Ministry of Economic Affairs, Regional Development and Energy

Renewable Energy threatened to become **Stranded Assets**

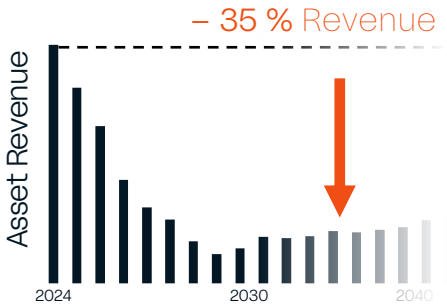
Technical Curtailment
due to increasing grid congestion



Cannibalisation
lowers Market Capture Rate

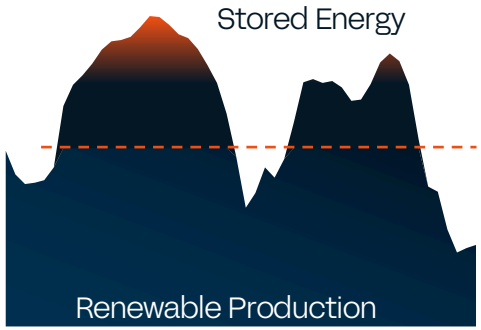


Revenue Decline
for renewable energy assets in the coming years



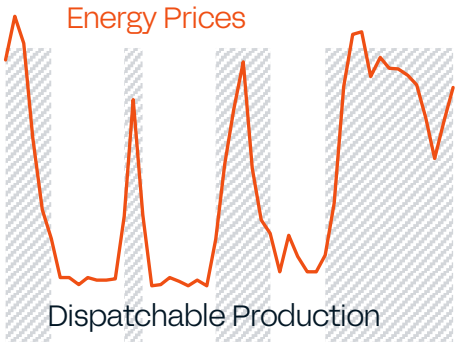
Keeps profitability high: **Co-Located Energy Storage**

Technical Curtailment
due to increasing grid congestion



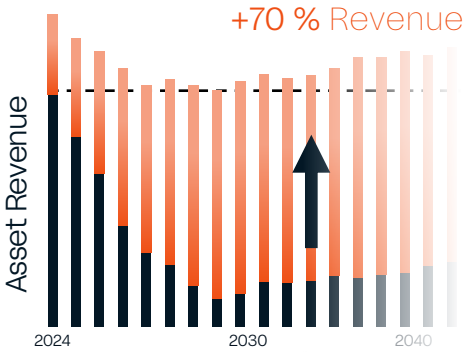
Avoid Curtailment and store the energy for later.

Cannibalisation
lowers Market Capture Rate



Sell energy when prices are high.

Revenue Decline
for renewable energy assets in the coming years

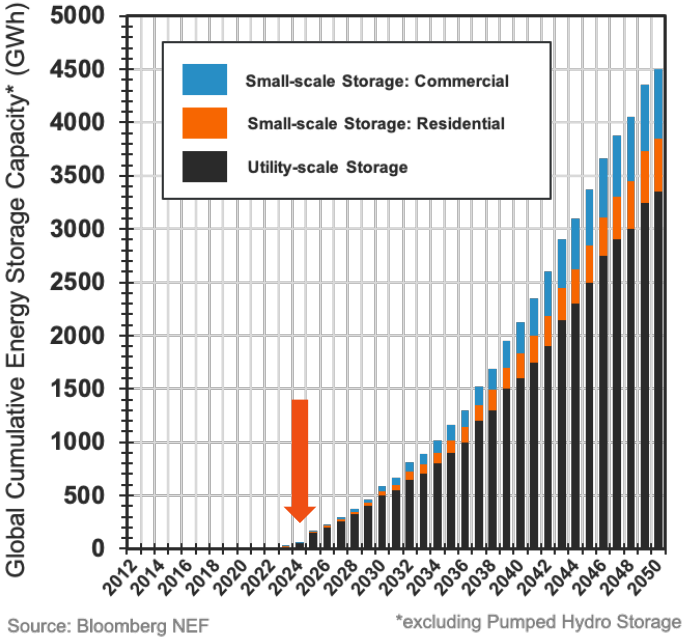


Restore the profitability of your plant.

Globally Huge Investment is Needed to Keep Renewables Profitable

$620 Billion - Bloomberg New Energy Finance

MARKET GROWTH AND MARKET CAP FOR UTILITY SCALE ENERGY STORAGE



Source: Bloomberg NEF

*excluding Pumped Hydro Storage

Year	**Market Size** by Bloomberg NEF	**Market Size** by IRENA
2020	5 GWh	-
2025	200 GWh	-
2030	500 GWh	370 to 745 GWh
2040	1600 GWh	-
2050	3400 GWh	3400 to 9000 GWh

Emerging need for large amount of **sustainable**, **scalable**, and **resource-efficient energy storage**

[1]https://about.bnef.com/blog/energy-storage-620-billion-investment-opportunity-2040/

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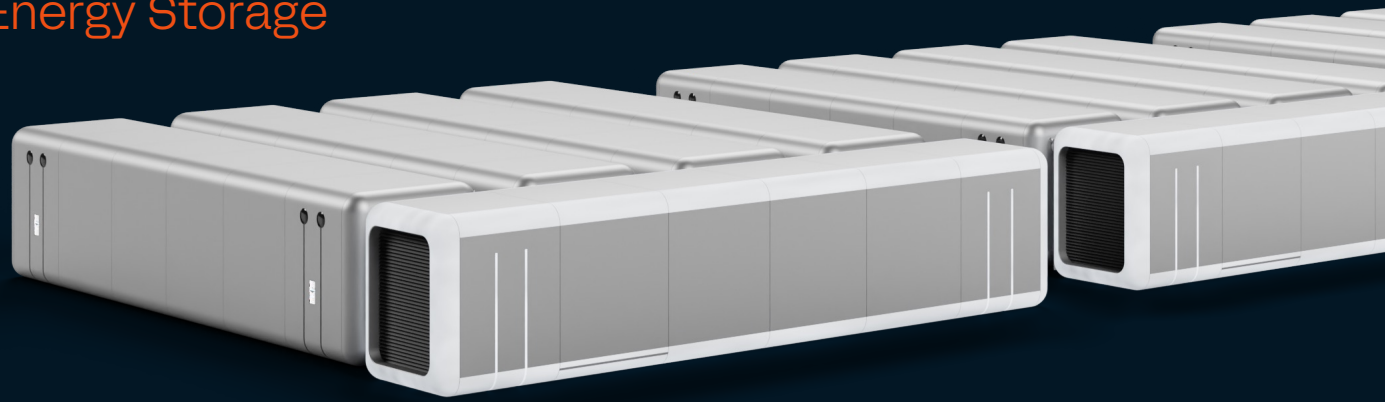
Advanced Storage Solutions for Clean Energy

Modular Liquid Air Energy Storage

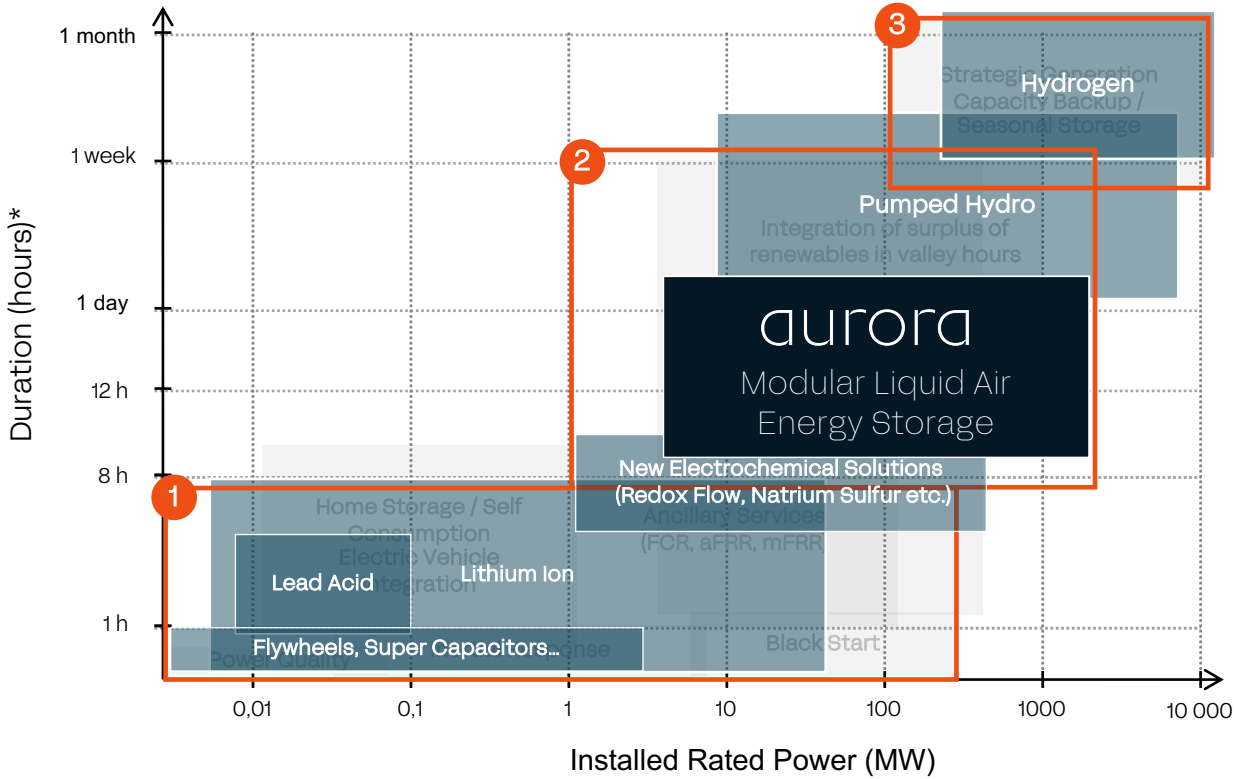
aurora



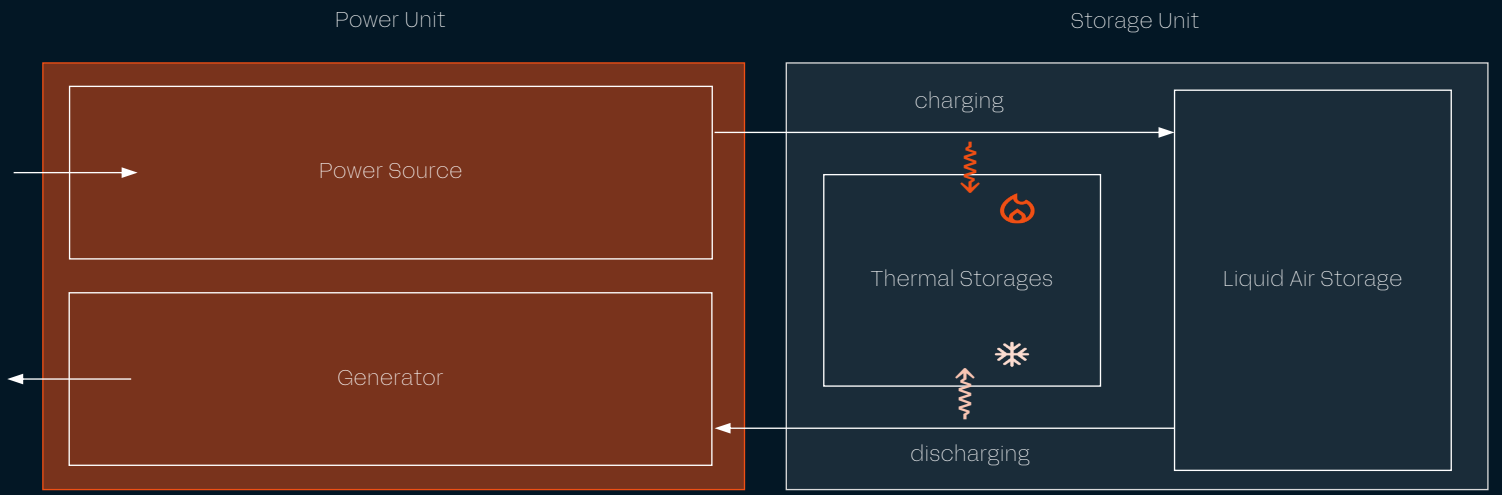
Aurora LAES bridges the gap in the energy market

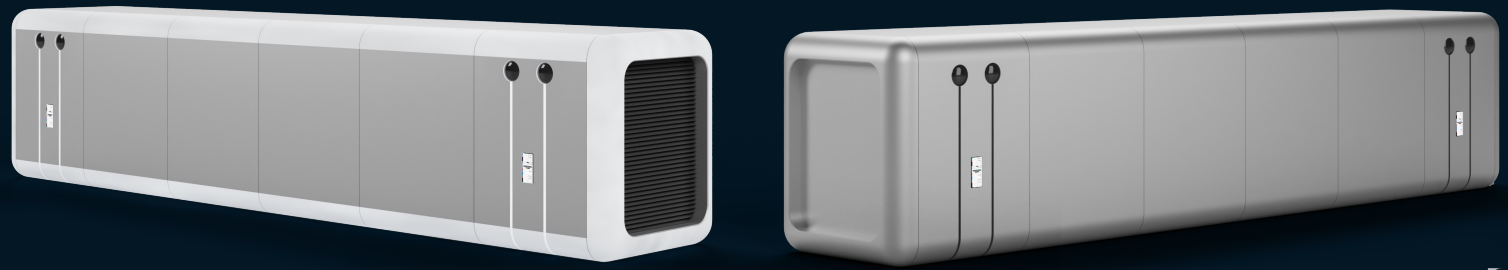
- Different Energy Storage Technologies are needed to feed the rising demand of energy flexibility
- It is **important to distinguish** between

1. Short-term,
2. Long-duration, and
3. Seasonal energy storage solutions



phelas Aurora: Scalable. Sustainable. Profitable.





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phelas Aurora: The Integrated Renewable System.

Combined up to **10 MWh**

10MWh

RE

1 Unit

aurora

Electricity

Heat

Cold

Electricity Grid

Heating Network

Cooling Network

100% RE
24/7

300°C

40°C

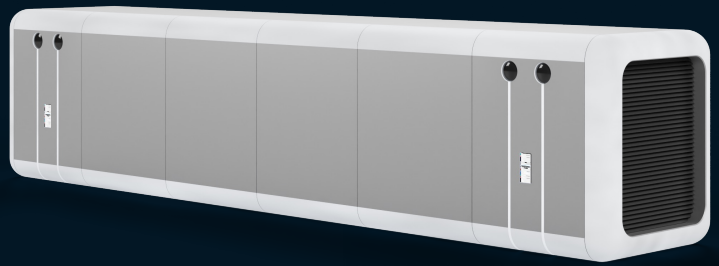
15°C

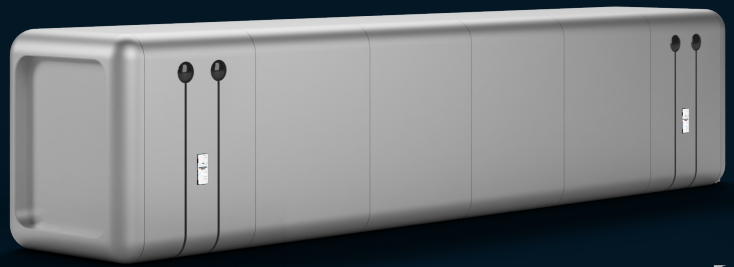
-20°C

Electricity up to
6 MWh

Heating
0.5 - 4 MWh

Cooling
up to **1.6 MWh**





60 % electrical roundtrip efficiency if no heat or cold synergies are leveraged.

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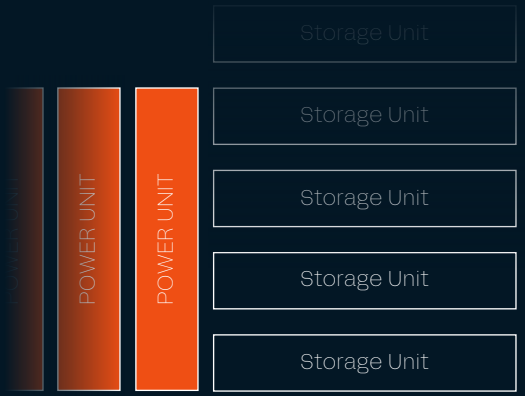
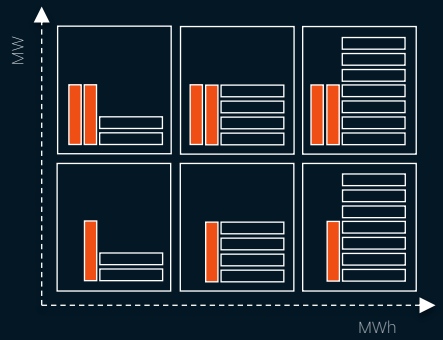
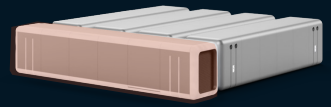
phelas Aurora: Scalable to GWh Storages.

Power and Storage are independent

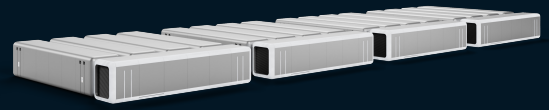
Scale to the Size fitting your Demand







1 Power Unit: 1.5 MW
4 Storage Units: 18 MWh



4 Power Units: 6 MW
16 Storage Units: 72 MWh

100 MW +
1 GWh +

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phelas Aurora: Scalable. Sustainable. Profitable.

Total System Performance Generation 1

Electrical Roundtrip Efficiency	50-60%
Capacity Degradation	None
Depth of Discharge	100 %
Design Discharge Duration	4 hours to 24 hours
Size per 40 Foot Container	12 x 2.5 x 2.6 m
Ambient Temperature	-20 to +50°C
Maintenance	Annual, 99% Uptime
Lifetime	30 years >30 000 Cycles

Power Unit (1.5 MW)

Power Source and Generator

Charging Power	2 MW_{el} per Unit
Discharging Power	1.5 MW_{el} per Unit
Response Time (Cold Start)	< 30 Seconds
Black Start Capability	Yes
Inertia Provision	Yes

Storage Unit (4.5 MWh)

Liquid Air Storage and Thermal Storage

Storage Technology	Liquid Air + Thermal
Capacity	4.5 MWh_{el} per Unit
Self-Discharge Rate	1 $\%_{relative}$ per day

Services

- Heat
- Cold
- Electricity
  - Intraday
  - Day-Ahead
  - aFRR
- Grid Inertia
- Black Start Backup

Preliminary Specifications. May change without notice.

phelas Aurora: Safe properties.

Steel, Gravel, Air	Low-Cost of Storage Environmentally friendly Safe and Recyclable
Off-the-Shelf Components	Long-life-time Easy Replacement Proven, predictable behavior
Containerized	Standard Logistics Easy Deployment Stays in Time and Budget Easy Replacement
Modular	Scalable to GW Adjustable Power & Storage Flexible Operation & Maintenance
Local Supply Chain	Fast Service Response Available Spare Parts Compliant with Regulations Robust ESG Ratings

Safe

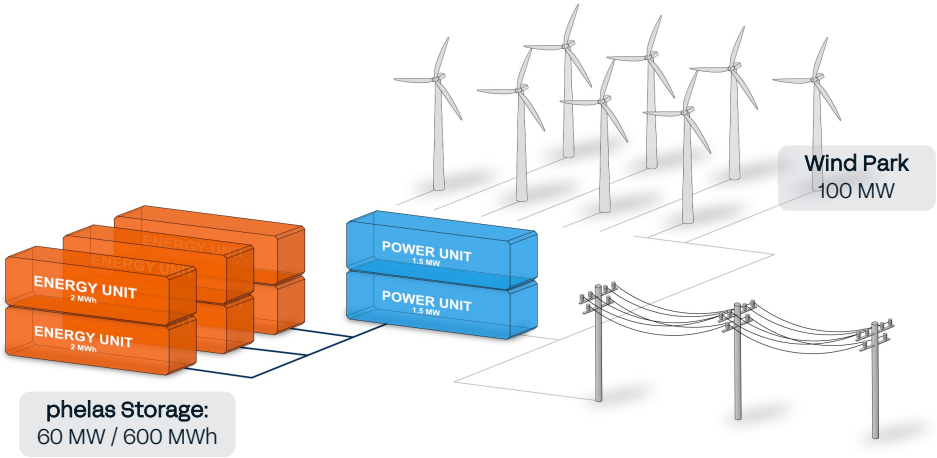
Reliable

Non-hazardous

Predictable

Economical

Power-to-Power Use Case: Wind Park in Spain

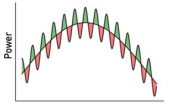


phelas Catalyst Analytics results:

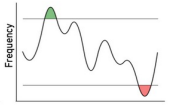
- Simulated in 15 mins intervals over 20 years generation data
- Location of Case Study: Portugalete Spain

phelas Aurora provides value by..

1. ..charging electricity at low prices and discharge when wholesale electricity prices are high.



2. ..avoiding grid curtailment and provide smoothed output.



3. ..providing grid stability services (ancillary frequency services)

	without Storage	with phelas Aurora	
Average Yearly Revenue	26 m€	46.8 m€ (+80%)	1
Curtailment Cost p.a.	- 0,3 m€	-	
Additional Revenues p.a.	-	05.6 m€	2
Total yearly revenue	25,7 m€	**52.4 m€** (+100%)	3

SIMULATED WITH catalyst

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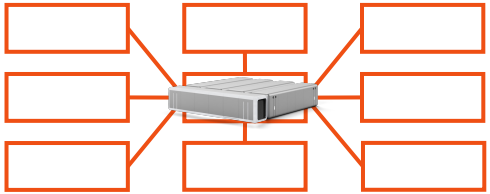
VALIDATING USE CASES WITH: bp Ørsted WIEN ENERGIE Entelios SALZ

District and Industrial Heat: Enabled in Power Plant Size

50 MW
Residential Heating Network



Decentralized Heating for residential areas subsituting combined heat and power plant.

100 MW
Industrial Heat

Local heat supply for energy intensive companies and industry areas

300 MW
Semi-Centralized Plant

Central thermal and electrical energy storage for cities. Located within or outside

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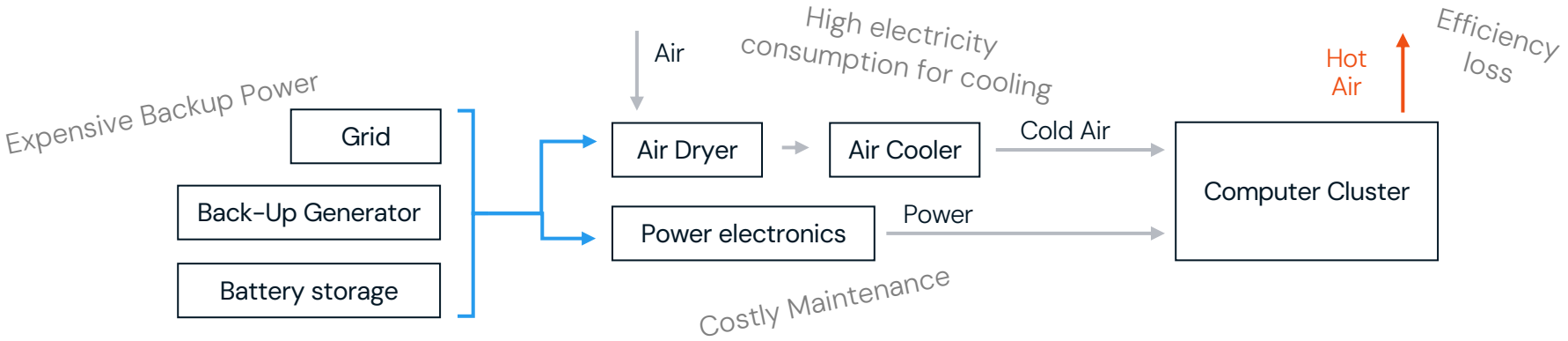
The One-Stop Solution for **Data-Centers.**

Aurora Liquid Air provides value by

- Increased Energy Efficiency
- Low-Cost Cold
- Usage of Excess Heat
- Decarbonising Energy Demand
- Fossil-free Back-Up Power

Today, data centers require multiple subsystems to supply cooling, air and electricity. This is costly and inefficient.

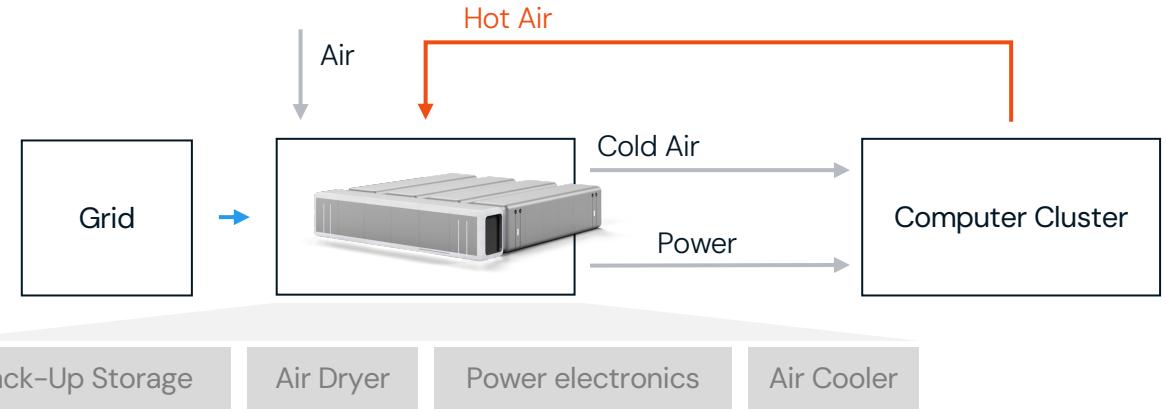


35% of total electricity consumption is used for cooling. In the Black-Out case, expensive backup power is used for this.

Many subsystems require continuous maintenance from different parties **increasing cost and decreasing reliability.**

Thermal energy in exhaust air is **annihilated by expensive air conditioning**. This energy is wasted instead of utilized.

Use one system. Reduce complexity. Reduce cost. Reduce risk.



All Subsystems are integrated:

- 35% Electricity

Cooling is completely supplied by Aurora, so you can save electricity.

- 20% Cooling Cost

Cold supplied by aurora is 20% cheaper than regular AC-Cold. This is possible by using heat from the cluster.

Integrated Backup

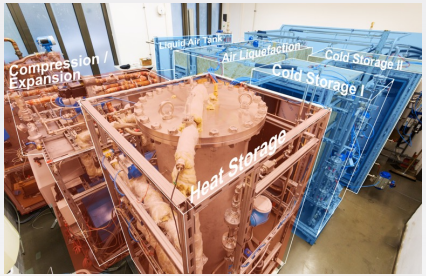
- ✓ Clean Backup-Power
- ✓ w/ Backup Cooling
- ✓ Reduced OPEX
- ✓ No added CAPEX!

Aurora is uniquely positioned to revolutionize the data center industry by making use of heat and cold.

High-tech data centers solve energy challenges with 20th century solutions:		**Aurora** brings 21st-century technology to the energy supply: Clean, Integrated, and smart!
Dirty and Expensive Gen-Sets	**Backup-Power**	**100s MWhs Stored** in Liquid Air
100% RE impossible	**Electricity supply**	**100% Renewable** Integration
High connection cost	**Electricity Cost**	**Reduce Cost** by Demand Shifting
Inefficient AC	**Cooling**	**Integrated cooling capacity** for MWs
Expensive Backup-Power for AC	**Emergency Cooling**	Cooling **without electricity**
Waste Heat is Wasted	**Waste heat**	Used to increase energy efficiency.

Development and Scaling Timeline

PREVIOUSLY
Proof of Concept



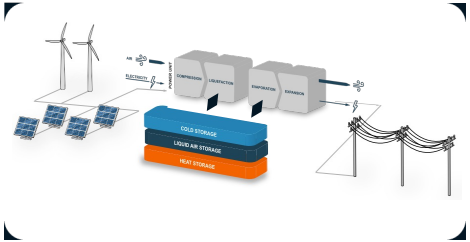
2021

- Concept **System Design** done
- Detail engineering of the first demonstration system

2022

- **Complete construction** and testing of the first **lab-scale demonstrator** of the core concept.

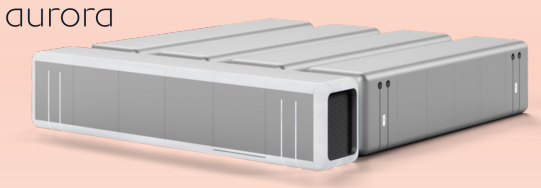
CURRENTLY EXECUTING
Generation 0



2025

- Demonstration plant with **~1 MW / 8 MWh**
- Deployment by **2025** in **Bavaria**
- Deployment at **electrical substation** for grid **congestion management**.

COMMERCIAL SYSTEM
Generation 1



2026

- **Four** projects with each **1.5 MW / 18 MWh**
- Deployment **EU-wide**
- **Co-Location with Wind / Solar** for Revenue Increase and Curtailment Reduction
- 30 year Lifetime, Optional **All-Part Warranty**
- **95 % Uptime**

Two Projects Left

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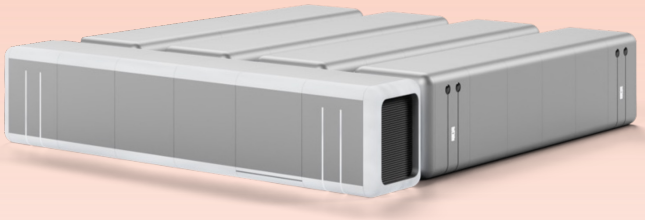
bayernwerk FICHTNER

Ørsted undisclosed

Become the visionary in large scale LDES deployments.

Pilot Systems – Generation 1

2026



Easy deployable and flexible systems. Gain Experience with the next generation of LDES.

1.5 MW / 18 MWh System
Pre-Order 2024 – Deployment Start 2026

250+ MWh Systems

Large economic plants. Be the first to deploy power plant-scaled storage systems.

Project Start 2025 – Deployment 2027/28

Let’s start now!

Milestone - based Execution

Deployment 2026 (EU) / 2027 (Non-EU)

FEASIBILITY STUDY	PRE-ORDER	PROJECT PLAN	FINAL INVESTMENT DECISION
Detailed technical and **economic feasibility** analysis of the Aurora System for your application.	**Secures a spot** for the Aurora System. **Refundable** until Final Investment Decision (FID).	Development of a detailed **project plan**, including **timeline**, resources, and **budget** for Aurora System implementation.	Final decision based on previous milestones and determination of technical specifications and overall budget. **Start of Execution**

COMMERCIAL SYSTEM

Generation 1

2026

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Let’s start now!

Potential Applications

Data Center Cooling and Backup
(Lower Cost by Integration)

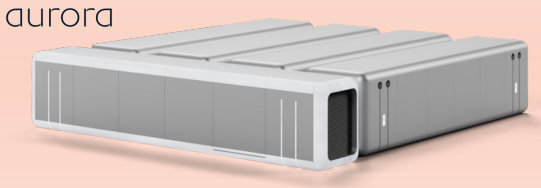
District Heating Networks
(Decarbonisation through Flexibilisation)

24/7 RE Power Purchase Agreements
(Co-Location with Wind/Solar Power)

Low-Cost Green Hydrogen Production
(Increasing Utilisation of Electrolyser)

⋮

COMMERCIAL SYSTEM
Generation 1



2026

- **Four** projects with each **1.5 MW / 18 MWh**
- Deployment **EU-wide**
- **Heat and Electricity Use-Cases**
- 30 year Lifetime, Optional **All-Part Warranty**
- **95 % Uptime**

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Wind and Solar.
All Day. Every Day.

Get into energy storage today:
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