

Dutch Salt-Cavern Compressed Air Energy Storage (CAES)

A multi-day flexibility layer for the Northern Netherlands energy transition

Developed by an independent technical lead at pre-feasibility, with a PhD in aerothermal engineering (University of Cambridge) and 10+ years R&D. **Intent:** stress-test the thesis and assemble a development partnership if the concept clears feasibility.

The system need: an independently identified 24-hour storage gap

CE Delft's 2035 CO₂-free electricity-system study identifies **8.9 GW of 24-hour storage** in its reference scenario for the Netherlands, naming CAES as the example technology. This is an independent confirmation of the duration and scale this concept targets. The driver is visible today as roughly **7% of 2025 Dutch day-ahead hours cleared at negative prices** (TenneT), with curtailment rising as offshore wind scales toward ~21 GW by 2031. Lithium batteries cover the daily cycle; hydrogen covers seasons, transport, and high-temperature industry. In between sits a large multi-day layer – the gap this concept targets.

The thesis: the multi-day layer between batteries and hydrogen

Lithium batteries are hard to beat up to roughly 12 hours; **hydrogen** is the right answer for seasonal storage and hard-to-electrify end-uses. The multi-day layer in between – a day to several days – is where the case for diversification is strongest. At high power over many hours the economics favour storage that decouples energy from power – so adding hours costs far less than adding battery modules. That is where adiabatic **CAES** earns its place: a 30–50 year asset, no combustion, decoupled energy and power, broadening the storage mix beyond any single supply chain. I see CAES sitting alongside the region's emerging long-duration batteries (in flow and metal-air) and hydrogen plans.

Why the Northern Netherlands: geology, grid and storage operators are already there

The North combines the ingredients in one place: established system need, deep salt geology, and operators (EnergyStock, Nobian) already working the subsurface. **Cavern access is the single biggest open question, and it is treated here as a risk, not an assumption.** Suitable existing caverns may not be available on the right terms: cavern design matters, operators are incentivised toward new builds, and new caverns trigger the permitting and social-licence hurdles such as nitrogen limits and the Groningen earthquake legacy, which constrained earlier projects. Testing a realistic cavern-access pathway is the first feasibility-stage priority.

Learning from Corre Energy (Zuidwending, 2025)

My read from Corre is that the binding constraints were not mainly technical. The Dutch project needed **new caverns**, which pulled it into salt-extraction permitting and into local opposition tied to the Groningen earthquake legacy, and it lacked the Project of National Interest status that would have eased the permitting route. I've built those lessons in from the start: cavern access, the permitting pathway and community engagement are treated as first-order design choices, not afterthoughts. The adiabatic route also helps directly, removing the combustion step and with it the NO_x emissions that sit at the heart of the Dutch nitrogen-permitting problem.

Modern adiabatic CAES is scaling: ~2 GW all outside Europe

China has commissioned ~1.2 GW / 5.7 GWh in 24 months (Yingcheng, Feicheng, Huai'an). Hydrostor is advancing ~700 MW/5.6 GWh (Willow Rock, **California**, with a conditional DOE loan guarantee; Broken Hill, **Australia**, environmentally cleared). The major components: compressors, turbines, balance-of-plant, are all commercially proven and EU-suppliable. The maturing element is **system integration, particularly the thermal-storage layer**; Europe has the longest-running CAES references but no modern adiabatic project at scale. Closing that integration gap is the main job of a feasibility phase, and of a small demonstrator if one proves useful.

What the modelling indicates: 24h is where CAES becomes the economical long-duration choice

| Duration | What the modelling shows | Investor message |
|----------|--|---|
| 12h | Battery and CAES are close, battery typically wins on simplicity. | Battery competitive |
| 24h | CAES becomes the stronger long-duration platform. With existing-cavern access, the scenario approaches infrastructure-style returns. | Crossover zone. The case worth validating. |
| 48h | CAES improves materially vs. batteries but pure merchant arbitrage is not yet sufficient. | Multi-day fit; requires stacked or contracted revenue |

Based on conventional lithium battery vs. CAES cases at 2,400 and 4,800 MWh, dispatched against five years of hourly Dutch power prices. Headline: a 2,400 MWh / 24h CAES case with existing-cavern access shows ~10% IRR and positive NPV at an 8% WACC in the preliminary modelling. Assumptions and sources available on request.

What I am asking for: a 20-minute challenge conversation

I'm at pre-feasibility and I want a few people, from technical, regional and financial backgrounds, to stress-test this: tell me what would make it unfinanceable, and whether it's worth a scoped feasibility phase. I'm not asking for a commitment, just an honest 20 minutes on the go/no-go questions. I'm most interested in where you'd challenge the cavern-access, permitting and revenue assumptions.