AQUABATTERY

Lessons from commissioning pilot LDES at Deltares campus, the Netherlands

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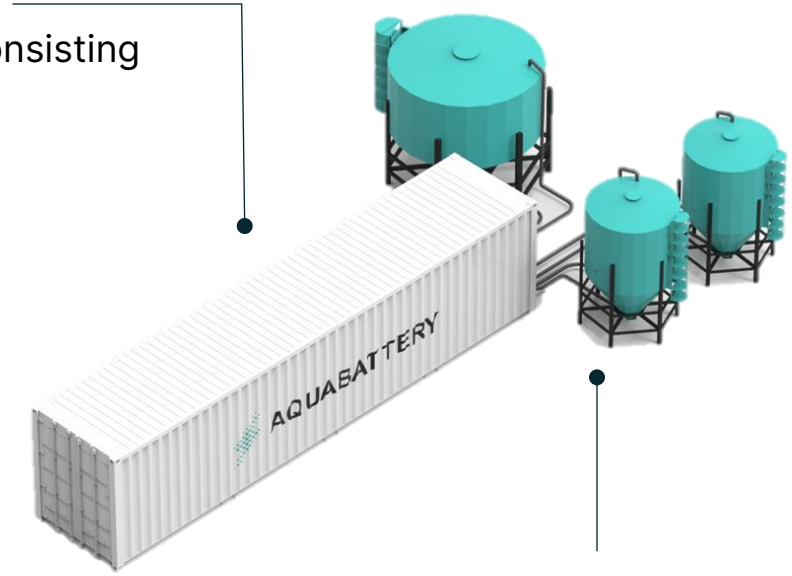
AQUABATTERY

AQUABATTERY IS A NOVEL, FLOW BATTERY THAT STORES RENEWABLE ELECTRICITY IN SALTWATER

POWER MODULE
Energy converter, consisting of membrane stacks



ENERGY MODULE
Energy storage, consisting of reservoirs with saltwater, base and acid solutions

SAFETY Eliminating fire, explosion, and toxicity risks to ensure safe operations and protect surrounding environments

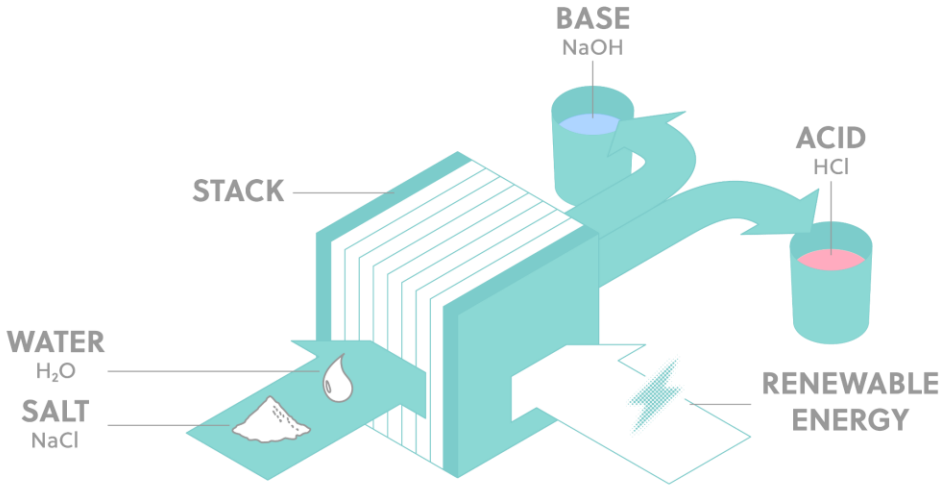
AFFORDABILITY Enabling energy capacity expansion at marginal cost through abundant, low-cost materials

FLEXIBILITY Adaptable to site-specific needs with flexible water storage solutions

SUSTAINABILITY Made in Europe from local resources, free from critical raw materials, and engineered for reuse with a significantly lower CO_2 footprint

AQUABATTERY

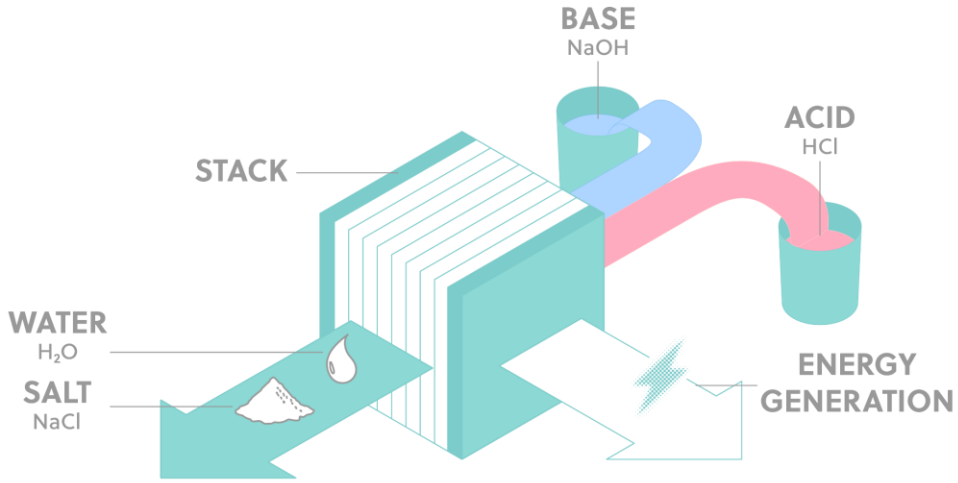
CUTTING-EDGE INNOVATION IN THE NEXUS OF WATER-ENERGY TECHNOLOGY



CHARGING

Breaking the bonding by electricity

Ions sorted in the stack to form Acid and Base



DISCHARGING

Combining Acid and Base together in the stack creates electricity

PILOT LDES AT DELTARES SERVES VARIOUS STRATEGIC GOALS

- Improve technology Enhance and optimize acid-base flow battery technology in real-world conditions over a 12-month, all-season period
- Develop LDES use cases Develop LDES use cases using market data for both behind-the-meter and front-of-the-meter applications
- Platform for engagement Engage key stakeholders across the policy, technology, and business ecosystem of the Rotterdam–The Hague–Delft region

Verbund

European Innovation Council

Deltares

Statkraft

THE LARGEST BATTERY SMALL ENOUGH TO ENABLE COST-EFFECTIVE LEARNING

- **12-month operational period** with dominantly R&D and optimisation profiles
- **Designed for 5kW/50kWh** (10-hrs durations)
- **First-time multi-stack operations** and continuous iteration on membrane and membrane stack design
- **Independent from roof solar PV** but enables the modeling of BMT and FMT use cases
- **Remote BMS monitoring and control** complemented by active presence on site
- **Local purchase** of raw materials and most of the BOM

PROJECT TO DATE IN PICTURES: PREP & INSTALLATION, LAUNCH, AND SAT & COMMISSIONING

Preparations & Installation (Jan – Nov 2024)

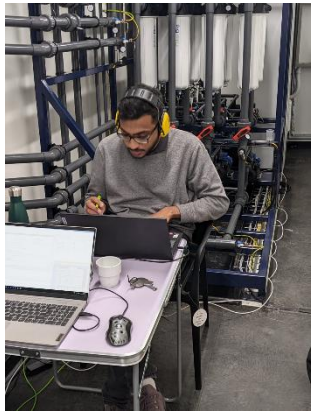







Launch (Nov 2024)

SAT & commissioning (Dec – Apr 2025)

SOME OF THE KEY LEARNINGS SO FAR

EPC partner selection

- Look for chemical system design experience at EPC partner to manage costs & timelines risks

System design

- Top suction causes air build-up in system, and proves suboptimal in operations

Electrolyte Rinse solution**

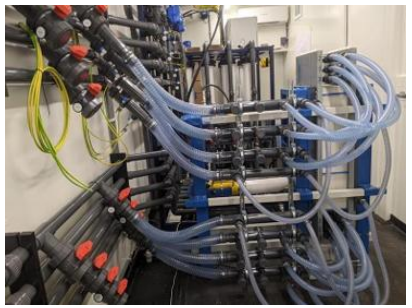
- Used solution (base) causes hydrogen build-up; required venting for hydrogen reduces efficiency & increases spillage risk

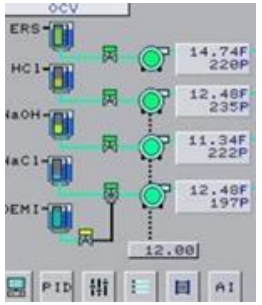
Stack interface optimization**

- Current connections to stacks require labor intensive hook-up
- Difficulty to couple also increase risk of leakage





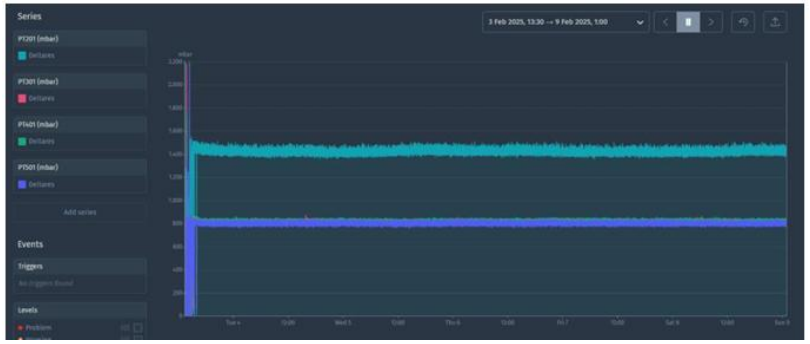



SAFETY & RISK MANAGEMENT IN FOCUS

NON-EXHAUSTIVE INITIATIVES RE. SAFETY

	Initiatives
HAZOP Assessment	• An extensive HAZOP assessment was performed and continuously updated to identify key risks and trigger appropriate mitigation measures.
Safety expert	• Before operating with chemicals, Altop* executed a safety inspection and pressure test. Example improvements following the inspections: leakage trays in container; marking of all piping, splash screens
Cybersecurity	• Data sent to own database, secured via TLS/SSL • Protocol with users & roles to secure one-way data • Database access for specific IP addresses only
Emergency response	• BMS controls in place to force shutdown i.c.o. incidents • BHV protocols in place • Deltares emergency contacts available & visible at pilot site
Validation compliance standards	• A full inventory executed on existing standards for flow batteries, based on which actions were identified to ensure compliance



* BRL- SIKB 7800 and BRL-K21009 certified company

COMPLIANCE W.R.T. PERMITTING, REGULATIONS, AND INSURANCE WAS CRUCIAL TO ENABLE GO-LIVE

Permits

- Environmental permit (‘omgevingsvergunning’) required and granted for 1 year, 9 months (until end Q1 2026)
- Total processing time: ~3 months from application to approval.
- Notification submitted for Class 8, PG II chemical liquid storage as per BAL* requirements.
- No approved safety plan needed, based on activity self-assessment.

Regulations

- Tanks are BRL SIKB 7800 certified with top connections; full system (tanks–piping–container) complies with BAL*.
- Flow battery development follows IEC 62932-1:2020, 62932-2-1:2020, and 62932-2-2:2020.
- Electrical work, control, and installation comply with NEN-EN-IEC60204-1, NEN11010:2021, and NEN3140

Insurance

- HDI Global conducted a quick-scan to assess insurer risk perception.
- Main risk identified: chemical leakage (acid/base) with potential harm to environment, assets, or people.
- Technology considered insurable due to familiarity with chemical storage risks in other industries.
- Current environmental damage insurance for Delft pilot confirms insurability (granted after inspection)

* Besluit Activiteiten Leefomgeving (The Environmental Activities Decree of the Netherlands)

AQUABATTERY AS BEHIND-THE-METER ASSET FOR DELTARES' PARIS PROOF CAMPUS

- **Paris-proof campus** by 2040
- **Rooftop PV** (5,725 panels, 2MWp)
- **Main objective**: boosting on-site PV self-consumption to increase self-sufficiency and cut grid offtake
- **Significant positive impact of a 12-hr AQUABATTERY** on Deltares self-consumption, reducing grid off-take, curtailment and rooftop PV expansion

WINNING THE EUSEW2025 AWARD CONFIRM EU'S NEED FOR FLOW BATTERIES

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