AURORA ARCHITECTURE · A4

Zenith

8.5 MWe Distributed Clean Firm Hybrid Storage-Generator

NET POWER	CYCLE EFFICIENCY	AURORA TURNKEY	BEST-CASE IRR
8.5 MWe	**~50** %	**$25** M	**25.5** %

Distributed Firm Clean Power at Container Scale

Closed-cycle Brayton MHD · Cesium-vapor electrodes · Electric-preheat MOF-catalyst

A4 Zenith is Aurora's flagship commercial platform: a containerized 8.5 MWe distributed clean firm power solution that operates as a **hybrid storage-generator** rather than a fuel-burning generator. Charged with off-peak electricity through electric-preheat of an NH_3-MOF catalyst chemistry stage and a ceramic regenerator, A4 dispatches firm clean power on demand without combustion, sidestepping every failure mode that ended heritage Faraday MHD programs in 1989-1993.

WHY A4 ZENITH

A4 fits inside a 40-foot container, deploys at distribution voltage, charges off-peak and discharges firm clean power at a 25.5% project IRR for hyperscaler 24/7 CFE behind-the-meter buyers. Unlike utility-scale clean firm alternatives (Allam-Fetvedt, NuScale SMR), A4 doesn't require fuel infrastructure, doesn't require utility-scale interconnection, and qualifies for §45Y clean electricity PTC and §48E clean electricity ITC.

HERITAGE SIDESTEP — THE INNOVATION

A4's σ mechanism is **cesium-vapor electrodes** within a closed-cycle Brayton loop, not seeded combustion plasma. This sidesteps the four failure modes that doomed heritage 1980s/90s Faraday MHD programs:

- ✓ **No slag chemistry** — closed-cycle N_2+Cs working fluid means no fly ash, no sulfur, no electrode erosion from coal-fired combustion products
- ✓ **No alkali consumption** — Cs vapor is recovered closed-loop, not continuously injected as combustion seed
- ✓ **No FOAK utility risk** — distribution-scale (5-15 MWe) avoids the gigawatt-class CAPEX that ended heritage programs
- ✓ **No NH_3 supply chain dependency** — A4's NH_3 is internal working fluid, not fuel; no utility-scale NH_3 infrastructure required

TARGET BUYERS · TODAY

Hyperscaler data centers requiring 24/7 CFE compliance · Industrial host sites with off-peak electricity access · Distributed clean firm IPPs · Microgrid operators with grid-tie + critical load · Defense base resilience with islanding capability.

Technical Specifications

Power, Efficiency & Operating Envelope

Net electrical output	8.5 MWe	Continuous · grid-firm dispatch
Charge / discharge ratio	~50% round-trip	Electricity in (off-peak) → electricity out (on-peak)
Discharge duration (single cycle)	8-12 hours	Sized to grid arbitrage window · scalable with regenerator mass
Ramp rate	5 MW/min	Electric preheat enables fast startup · supports ancillary services
Operating temperature (peak)	~1,400 K	Brayton turbine inlet · ceramic regenerator hot side
Operating pressure	2.5-3.0 MPa	Closed-cycle Brayton · supercritical N_2 working fluid
Capacity factor (typical)	85-90%	Time-shifting between low-cost charging and dispatch windows
Grid voltage interconnection	12.47 / 13.8 / 25 kV	Distribution class · standard utility primary feeder

Working Fluid & σ Mechanism

MHD working fluid	N_2 + Cs vapor	Closed-cycle inert gas with cesium electrode vapor
σ generation mechanism	Cesium-vapor electrodes	Heritage sidestep · NOT seeded combustion plasma
Target conductivity (σ)	100-300 S/m	Sufficient for distribution-scale Faraday extraction
Cesium consumption	<0.5 kg/yr	Closed-loop recovery · no continuous makeup like heritage programs
Thermal storage chemistry	$NH_3 \leftrightarrow N_2 + 3H_2$	Reversible MOF-catalyst chemistry · electric-preheat charging
Storage medium	Ceramic regenerator	High thermal mass · high-temperature stable · multiple cycles
Combustion?	None	Zero direct emissions · qualifies §45Y / §48E without CCUS

Physical Envelope

System footprint	40-ft ISO container	12.2 m × 2.4 m × 2.6 m · standard intermodal · shippable everywhere
Total system mass	~38 tonnes	Includes regenerator · MHD module · controls · cooling
Site footprint (deployed)	~0.4 acre	Container + setbacks + cooling + interconnect equipment
Cooling requirements	Air-cooled or 200 gpm	Air-cooled standard · water-cooled option for hot climates
Aurora turnkey weight	~38 tonnes	Single trailer load · standard rigging · 30-day mechanical install

CONTAINERIZATION ADVANTAGE

A4 ships as a complete factory-tested module. Site work limited to foundation, electrical interconnect, and cooling. Compare with Allam-Fetvedt (multi-acre site, multi-year construction) or NuScale SMR (5-7 year permitting + greenfield build). A4 typical deployment: 6 months from PO to commercial operation.

Operating Cycle

A4 operates as a hybrid storage-generator with two-mode operation: **charging mode** (off-peak grid electricity) and **discharge mode** (firm clean power dispatch). The defining innovation is using electric preheat of a reversible MOF-catalyst chemistry to store energy thermochemically in a ceramic regenerator, then extracting it through a closed-cycle Brayton MHD turbine with cesium-vapor electrodes.

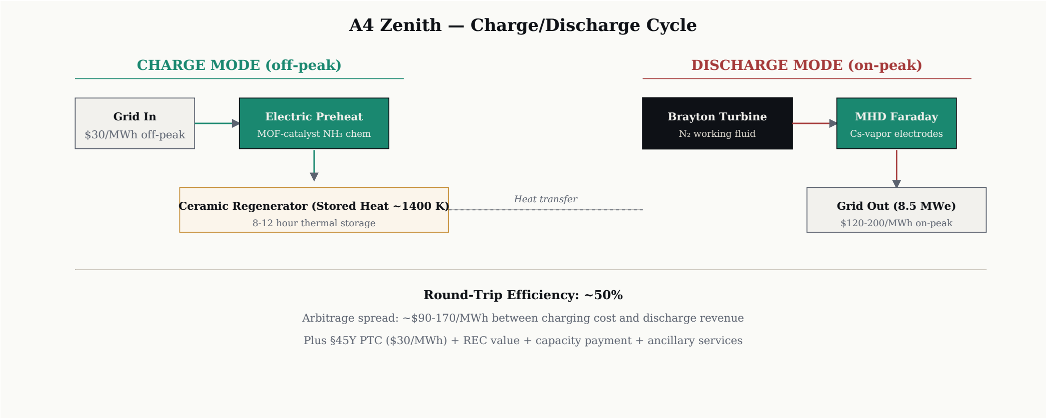

Figure 1 · A4 Zenith hybrid storage-generator operating cycle

Subsystem Architecture

A4-01 · Electric Preheat MOF-Catalyst	Charging stage	Resistive electric heating drives reversible $NH_3 \leftrightarrow N_2 + 3H_2$ chemistry on MOF catalyst · stores ~80 GJ thermal per cycle
A4-02 · Ceramic Regenerator	Thermal store	High-temperature ceramic mass stores heat between charge and discharge · multi-cycle durability target 30-yr life
A4-03 · Closed-Cycle Brayton Loop	N_2 working fluid	Recompression Brayton at 2.5-3 MPa · ~50% cycle efficiency · supercritical N_2 minimizes turbomachinery losses
A4-04 · MHD Faraday Channel	Cs-vapor electrodes	Ionic conduction via cesium vapor (not seeded combustion plasma) · 8.5 MWe net extraction · linear Faraday topology
A4-05 · Power Conditioning	DC → AC inverter	Grid-following or grid-forming · IEEE 1547 compliant · supports islanding for resilience applications
A4-06 · Aurora NeuroControl	Real-time AI/ML	Plasma control transferred from tokamak fusion · adaptive optimization across charge/discharge profiles

Operating Sequence

- **Charge phase (8-12 hr off-peak)**: Grid electricity drives MOF-catalyst NH_3 cracking endothermically · waste heat plus chemical enthalpy stored in ceramic regenerator
- **Discharge phase (4-8 hr on-peak)**: Stored thermal energy heats N_2 working fluid · Brayton turbine drives MHD generator with Cs-vapor electrode σ · power conditioned to grid
- **Standby**: Hot-standby with thermal losses ~2%/day · ramp from standby to full discharge in 8 minutes
- **NH_3 regeneration**: Reverse reaction ($N_2 + 3H_2 \rightarrow NH_3$) during cooldown completes the closed cycle · zero net consumption

Pricing & Project Economics

Aurora turnkey contract	$22-28M	Mid-range $25M · containerized deployment · 6-month delivery
Total project CAPEX (typical)	$30-38M	Includes site civils, interconnect, owner's costs, financing IDC
$/kW project basis	$3,500-4,500/kW	vs Allam-Fetvedt $2,000-3,000/kW (utility scale) · vs SMR $5,000-10,000/kW
LCOE (S1 hyperscaler BTM)	~$95-125/MWh	Includes off-peak charging cost and §45Y PTC

THREE-SCENARIO PROJECT IRR (20-YEAR HORIZON)

S1 Hyperscaler 24/7 CFE BTM	**25.5%**
S2 Industrial Cogen Host	**21.4%**
S3 Merchant IPP (stress test)	**9.0%**

Scale: 0% → 30% IRR · S1 captures hyperscaler clean firm premium + arbitrage spread + capacity payments · S3 stress test still clears merchant hurdle, demonstrating broad commercial viability

Best-fit buyer: A4 fits S1 hyperscaler 24/7 CFE BTM precisely — 8.5 MWe matches single-substation BTM colocation, distribution voltage avoids transmission interconnection delays, charge/discharge cycle aligns with data center load profile, and hyperscaler clean firm premium pricing rewards the architectural innovation. **S1 Project IRR: 25.5% with 4-year payback on $33M total project CAPEX.**

Revenue Streams (S1 Hyperscaler BTM)

Energy arbitrage	$8.5M/yr	Discharge revenue minus off-peak charging cost
§45Y Clean Electricity PTC (Y1-10)	$2.0M/yr	$30/MWh × 67,000 MWh-e/yr
Demand charge avoidance	$1.5M/yr	BTM hyperscaler load · $20/kW-mo demand × 8.5 MW
Capacity (firm clean) value	$0.8M/yr	Hyperscaler CFE compliance value or PJM-style market
Ancillary services	$0.4M/yr	Frequency regulation · spinning reserve · 5 MW/min ramp capability

Why Aurora · Competitive Positioning

vs Lithium BESS (4-8 hr)	10-30× longer life	No battery degradation · no fire risk · no cobalt/lithium supply chain
vs Allam-Fetvedt (50 MW)	No CO_2 infrastructure	A4 is zero-emission · no CO_2 capture or sequestration required
vs NuScale SMR (60 MW)	No nuclear permitting	A4 deploys in 6 months · SMR requires 5-7 years
vs Hydrogen fuel cells	No H_2 infrastructure	A4 charged from grid · no hydrogen production, storage, or transport
vs CCGT (1×8.5 MW)	Zero direct emissions	No NOx · no methane leakage · no CO_2 · qualifies §45Y

AURORA'S IP & HERITAGE SIDESTEP ADVANTAGES

- ✓ **Cesium-vapor electrode σ mechanism** — 4× one-way sidestep of seeded combustion failure (US patents pending DI-A4-001 through DI-A4-007)
- ✓ **Electric-preheat MOF-catalyst chemistry** — proprietary catalyst formulation for reversible $NH_3 \leftrightarrow N_2 + 3H_2$ reaction at scale
- ✓ **Ceramic regenerator design** — high-temperature multi-cycle stability based on Aurora's Stage 1 materials qualification
- ✓ **Aurora NeuroControl** — AI/ML plasma control transferred from tokamak fusion · 32-month head start on competitors
- ✓ **Containerized deployment** — factory-tested integration · 30-day site install · 60-day commissioning

PATH TO COMMERCIAL OPERATION

- **Stage 1 (2026)** — Pre-hardware validation · component-level test · CAD/IP completion · $20-32M Aurora budget
- **Stage 2 (2027-2028)** — FOAK build · DOE/DoE pilot · 6-month integrated testing
- **Stage 3 (2029+)** — Volume production · 5-10 units/year by 2030 · cost-down to $22M turnkey through Stage 4 manufacturing

Discovery Items Register: A4 has 12 active discovery items (DI-A4-001 to DI-A4-012) covering MOF catalyst durability, Cs vapor recovery efficiency, regenerator multi-cycle stability, and turbomachinery materials qualification. All 12 items have explicit Stage 1 retire criteria and are tracked in Aurora's portfolio risk register. See Aurora Discovery Items Register for detail.

NEXT STEP

Contact CDW Research at Drumheller, AB to schedule a technical briefing or request a Stage 1 deployment quote. Aurora is currently accepting Stage 1 NRE commitments from anchor customers in the hyperscaler 24/7 CFE BTM, industrial cogen host, and distributed clean firm IPP segments.