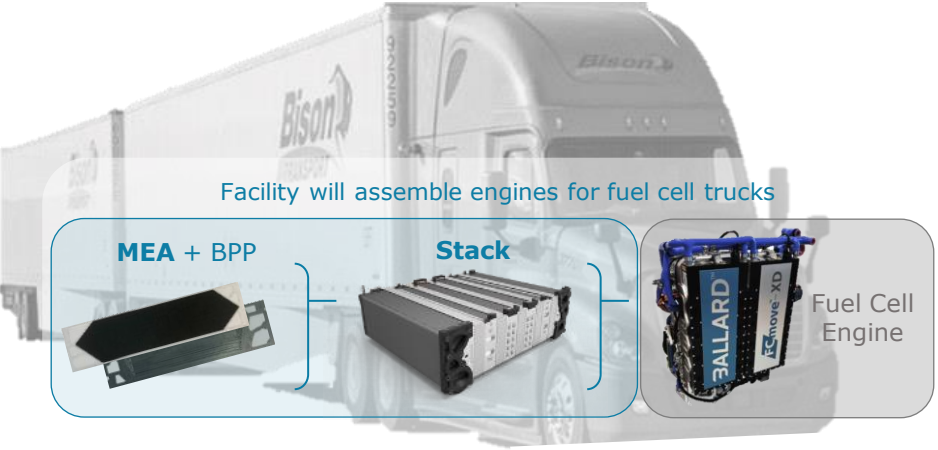
MAKE-IT Phase 1: Scope

Ballard's Fuel Cell Engine Assembly Facility



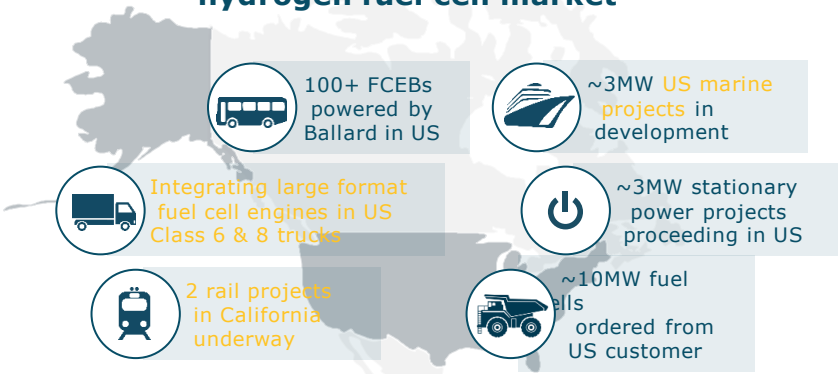
Ballard will **create a world class, fuel cell engine assembly facility to operate at costs & scale required to stimulate U.S. medium and heavy-duty vehicle H_2 fuel cell engine adoption**. This facility will enable the industry to reach critical cost and volume to drive cost parity inflection point with incumbent diesel technologies. The facility will produce the **120kW FCmoveXD** engine. Ballard's FCmoveXD is the next-generation heavy-duty fuel cell power module for use in zero-emission vehicles such as heavy-duty trucks, 18m buses and coaches. These engines will go to support leading US OEM bus manufacturers like **New Flyer**, who would benefit most from this large-scale US based fuel cell engine manufacturing facility.

Ballard has applied for USDOE DE-FOA 0002922 funding to support a **~US$163M MEA and BPP manufacturing facility,** including stack assembly. This facility is designed for **20,000 stacks/year** by end of 2026 and will demonstrate the potential to **meet $80/kW[1] production cost goal** by 2030

1 100,000 systems/year production volume, adjusted for 25,000 hours durability.

MAKE-IT prize funding would allow Ballard to expand the facility capability to include **fuel cell engine assembly** and accelerate the combined project. The total expansion costs are estimated at **~US$17M,** bringing the total investment to **~US$180M,** and will create over **100 highly skilled new U.S. jobs** & support additional job growth of planned U.S.-based suppliers & partners.

Ballard's strong presence in the U.S. hydrogen fuel cell market



Conformable Hydrogen Tanks for Production Capacity and Transport

Noble Gas Systems will build a conformable hydrogen fuel tank manufacturing facility in Southeast Michigan

- Shovel ready project - Immediately helps **"Production capacity for hydrogen-specific infrastructure"**
- Existing building, currently vacant, **we will claim it for Hydrogen economy, not Carbon**
- 50 high quality jobs in a disadvantaged and overburdened community
- TRL 9 technology, patented and shipping today
- Uses **no carbon fiber**

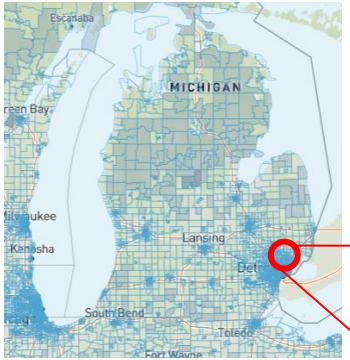
Noble Gas Systems: technology and manufacturing scale up

NextEnergy: community outreach, impact and training plan

Pratt Miller: potential off-taker, provides guidance on specifications and integration

DRP: input on location selection & municipal permitting

1 of 2 existing buildings being considered:



24401 Capital Blvd.
Clinton Township,
Michigan 48036-1343

Ceramic NaSICON membranes for LDES

Adena Power will partner with local manufacturing partner, Current Chemicals (Cleveland, OH), to rapidly scale manufacturing of a NaSICON ceramic electrolyte membrane, a critical component in several long-duration sodium battery technologies. This project addresses a manufacturing need identified in the DOE Energy Storage Grand Challenge roadmap for high-quality large-area NaSICON membranes.

ADENA POWER

- Leverages over 25 years of ceramic manufacturing expertise
- Pilot-scale manufacturing of large-area ceramic membranes for fuel-cell and solid-state batteries
- Developed sodium-ion battery technology that incorporates NaSICON ceramic electrolyte membrane
- Need to scale manufacturing, especially NaSICON membrane to deliver energy storage product

Current

- 250,000 ft² facility with over 70 years of operation &experience in manufacturing
- Leverage under-utilized infrastructure (e.g., continuous furnaces) to scale manufacturing of NaSICON membranes
- Sintering trials already run – de-risked transition to continuous furnaces
- Repurpose existing facility for clean energy manufacturing
- Rejuvenate the community by creating ~ 150 high-paying manufacturing jobs.

In addition to at least five emerging sodium battery technologies, the NaSICON membrane is the key component in Adena's long-duration sodium battery.

Using only low-cost, fully-recyclable domestic materials and manufacturing, Adena's battery energy storage system provides customers with a differentiating, longer duration, safe, and lower-cost solution.

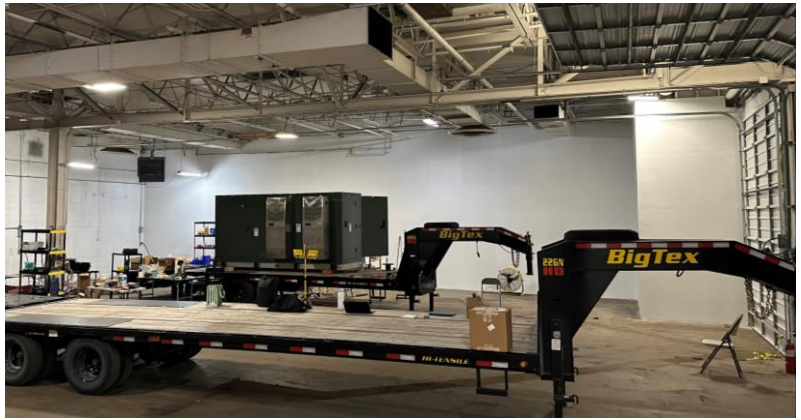
Adena Power
404 Enterprise Drive | Lewis Center, OH 43035 | adenapower.com

Hybrid Transformer – Power Electronics Equipment Manufacturing

Switched Source LLC

Technology/Project Summary

- Hybrid Transformer, leveraging power electronics for distribution automation through medium voltage power flow control (4kV-15kV)
- MAKE IT Prize will enable transition from 5K sqft low volume assembly-only facility *(pictured below)* to **~50K sqft manufacturing, high power test, and warehouse facility** capable of producing **200+ Phase-EQ units/yr domestically by the end of 2026.**



Project Impact

1. Promote **domestic manufacturing**, with creation of an estimated **+75 new direct jobs** in disadvantaged communities
2. Collaboration between Switched Source and its partners to harness power of community to **create up-skilling initiatives and enhanced workforce development** in electric power equipment manufacturing industry.
3. Each unit installed reduces need for multiple distribution transformers and one substation transformer, significantly mitigates grid vulnerabilities due to transformer shortages; and **enables more electric vehicle charging capacity** on each circuit.
4. Expedites interconnection and decreases upgrade costs for clean energy projects; **more than doubles the distributed energy resource hosting capacity of the grid**.

Project Team

MHUB
EPIC
MANUFACTURING RENAISSANCE
SWITCHED SOURCE
The DURHAM Company
WORLD BUSINESS CHICAGO
MD

SWITCHED SOURCE

Securing America's Vanadium Electrolyte Supply (SAVES)

Stryten Energy is a U.S.-based manufacturer with more than **130 years of expertise** in energy storage solutions, including manufacture of aqueous-based battery electrolyte solutions. Stryten employs over **2,500 people,** operates **10 manufacturing plants** and **2 R&D centers** across the U.S. Stryten Energy mixes **23 million liters of acid electrolyte** annually to manufacture over **14 GWh of energy storage cells**. Stryten will build upon this core competency to establish **large-scale production of vanadium electrolyte** to secure a steady and domestically produced supply and support the growing U.S. vanadium redox flow battery market for **long-duration energy storage applications**.

CURRENT STATE

- Continuous Reactor Vanadium Electrolyte Production Process validated at 5 MWh/year scale volumes
- Vanadium Electrolyte typically represents **> 40% of the cost** of a VRFB LDES system
- Vanadium Electrolyte small batch process **is inefficient and costly** at **$0.07/kWh contribution of LCOS**
- **MRL 7/8 today** with maturation to **9/10 by Q2 2024**

Phase 1: Scope

- Stryten evaluated 14 potential site locations and selected Augusta, GA which will allow for the re-development of shuttered facilities on a brownfield site in addition to improving transportation, including a rail-spur, which will benefit not only Stryten but also encourage the development of other manufacturing facilities in the community
- Stryten will ensure all permitting and approvals are in-place and shovel-ready
- Stryten will secure sourcing of raw materials with a priority emphasis on domestic or friendly nations including Canada and Australia
- Stryten will secure agreements for offtake of the vanadium electrolyte to ensure maximum production usage and diversity of the customer base

Phase 2: Shovel-Ready

- Stryten will build the production facility per the plans and permits developed in Phase 1
- Commissioning of the plant at the end of Phase 2 accompanied by first shipments of finished product that is produced with a continuous reactor production method
- Target up to 50 MWh/year at end of Phase 2 through Prize funding, with plans to further scale to GWh/year within 5 years using additional private and public grant funding
- Improvements to community transportation infrastructure will be made to support the supply of the facility while also benefiting other local manufacturers
- Community will be engaged at multiple levels including education, good paying jobs, and pride in local manufacturing

FUTURE STATE

- Supports **GWh of LDES** VRFB flow battery production
- Continuous Reactor will achieve an up to **80% reduction in production costs** to **$0.013/kWh** LCOS for the electrolyte portion of the LDES over a 20-year period, which needs to meet DOE target of **<$0.05/kWh**
- Replicable, scalable production model that can be **duplicated at additional sites**

MAKE IT #LikeABosch

Anderson, SC Electrolyzer Production

Project Overview: Robert Bosch LLC ("Bosch US"), plans to repurpose its manufacturing facility located in Anderson, South Carolina to begin domestic manufacturing of **1.25MW PEM Electrolyzer Stacks**. The $5M MAKE IT Prize will be used for facility upgrades to prepare >19k ft^2 for electrolyzer production, including design and construction of **cleanroom space.** This funding would enable Bosch Anderson to progress to a "shovel-ready" state in 2025, in support of domestic manufacturing of PEM electrolyzer stacks by 2027.

Bosch Anderson Team: **David Crews**: Director, Technical Lead | **Patty Stamey**: Project Manager | **Trish Hayner**: Senior HR Specialist | **Greg Arnold**: Director, Technical Engineering Functions | **Markus Hildenbrand**, Senior VP, Technical Plant Manager | **Suzana Cizmic**, VP, Commercial Plant Manager

Working in Our Community: H2 Hub Day | AIT Energy Camp | FIRST SC Scholarships | UFC Employability Boot Camp Participation | Public transportation project plan

Team Formation | Design	Permitting | Construction	Install | Release
2024	2025	2026

Industrialization of H2 Electrolyzers for North American Market

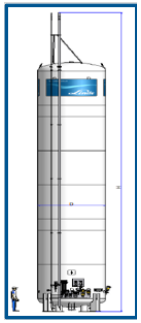
AMERICAN MADE CHALLENGES
U.S. DEPARTMENT OF ENERGY

Linde – Make It – Storage Vessel

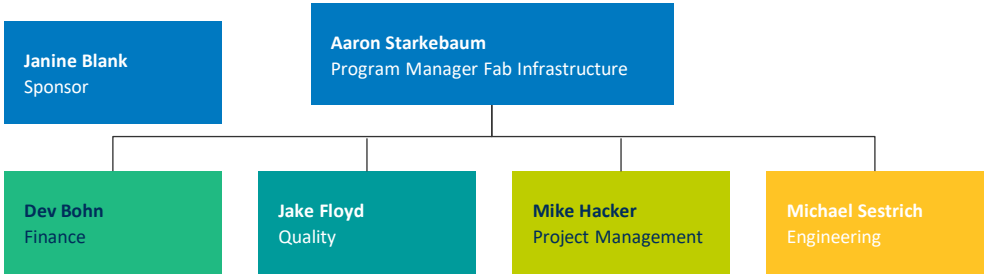
For public use

Technology components to be manufactured

In 2023, Linde experienced increasing cost and lead time concerning **storage vessels** for air gases and liquid hydrogen. Therefore, the need for US in-house fabrication was identified. Linde has fabricated **storage vessels** at its German location for more than 60 years. Therefore, the design and fabrication technologies are available and can be transferred to the US fabrication location. The planned investment to enable the US location for the fabrication of **storage vessels** will secure the supply chain and support the expected growth scenario – especially concerning liquid hydrogen.



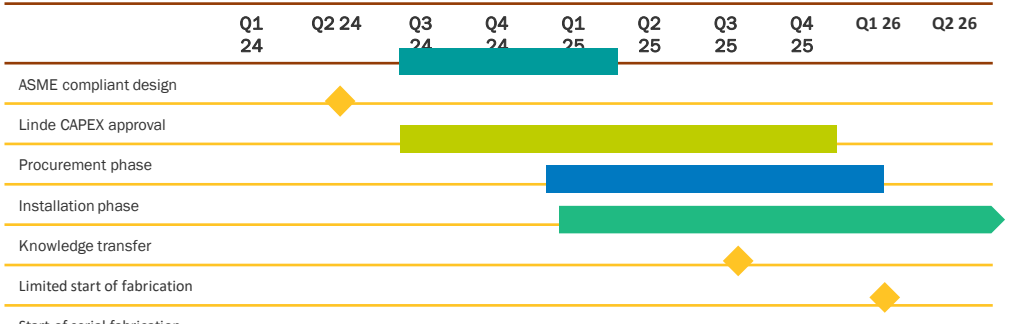
Project team organizational chart



Current project status

Design	Existing; needs to be adjusted to comply with ASME requirements
Infrastructure installation	Start expected Q1 25
Knowledge transfer	Start expected Q1 25
Start of serial production	Start expected Q1 26

Project timeline



Project location in census tract 40131050408 is considered disadvantaged. Completely surrounded by tracts that are disadvantaged AND meets an adjusted low-income threshold.

CellCube Lean Energy Assembly Network (CCLEAN)

Positioning for >5X U.S Market Growth in 2024

- CellCube's Gen 4.2 Commercial Product built upon 19 years of field-tested performance
- Commissioned large system installs = 4.6MW/18MWh
- Secured > $20M order book to date in 2023
- Establishing US assembly operations in 2024
- Implementation of the CellCube Lean Energy Assembly Network production system
- Partnering with technical college to develop training and apprenticeship program for production associates, field service technicians, and customers maintenance technicians
- Sourcing and qualifications of ≈ 20 U.S. suppliers
- Expansion potential for stack manufacturing

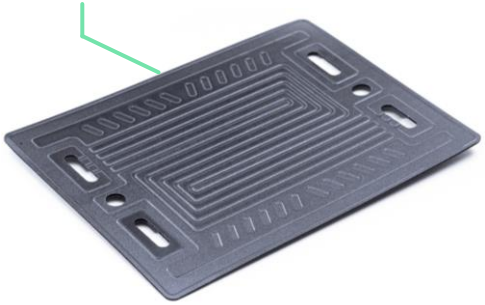
Market sector: Industrial Microgrid
Location: Bolingbrook, IL USA
CellCube Product: 4 x FB 500-2000
Key Applications: Energy shifting, peak shaving, UPS, PJM
Rated power / capacity: 2MW / 8MWh

Components for Fuel Cell Trucks: 100% Made in US

Decarbonize Heavy-Duty Vehicles with 100% U.S. Supply Chain & Technologies

- Boston Materials manufactures hydrogen PEM fuel cell components, specifically bipolar plates, that have the potential to survive 30,000 hours and are 60% lighter and 30% lower in cost than incumbent metallic bipolar plates.
- 30,000-hour duration is the Department of Energy's target to enable 1-million-mile capable fuel cell electric vehicle (FCEV) trucks powered by low- to no-carbon hydrogen.
- Meeting this threshold enables FCEV trucks to effectively decarbonize long-haul transportation.

ZRT Bipolar Plate produced by Boston Materials



This is a Shovel Ready Project – All Permits are Ready

- Boston Materials will supplement its existing manufacturing factory in Massachusetts (Billerica MA 01821-3570) to produce proprietary ZRT® Bipolar Plates while using a 100% U.S. supply chain.
- Enabling technology developed by Boston Materials is a non-metallic bipolar plate made with a patented composite material. The nature of this material allows for very thin parts (0.2mm) that are non-metallic so that are corrosion-proof, unlike metallic bipolar plates.
- Boston Materials has already commercially deployed this technology in fuel cell applications with leading U.S.-based fuel cell OEMs. Proof of customer support is included in the Phase I proposal.