



Power/Full Solutions

EnerSys Advanced Systems

**Issues and Potential Solutions for Domestic
Production of Lithium-Ion Cells**

- **EnerSys Advanced Systems Lithium Capacity**
- **Market Needs for Domestic Lithium Ion Capacity**
- **Manufacturing Capability and Vertical Integration**
- **Value of Domestic Capacity**
- **Cell Adoption Challenges**
- **Strategies for Success**
- **Next Steps**

- **Space**
 - Launch Vehicles
 - Satellites
 - Manned
 - Interplanetary & Landers
- **Aviation**
 - Fixed Wing & Rotary Aircraft including F16/18 & 777
 - UAV's & Target Drones
- **Munitions**
 - Missiles & Smart Weapons
 - Guided Bombs & Projectiles
 - Electronic Fusing
- **Land**
 - Combat, Tactical & Unmanned Ground Vehicles
 - Microgrids & Forward Operating Bases
- **Sea**
 - Submarines
 - Unmanned Underwater Vehicles
- **Medical**
 - Cochlear Implant Speech Processors
 - Neromodulation

Current EAS Markets



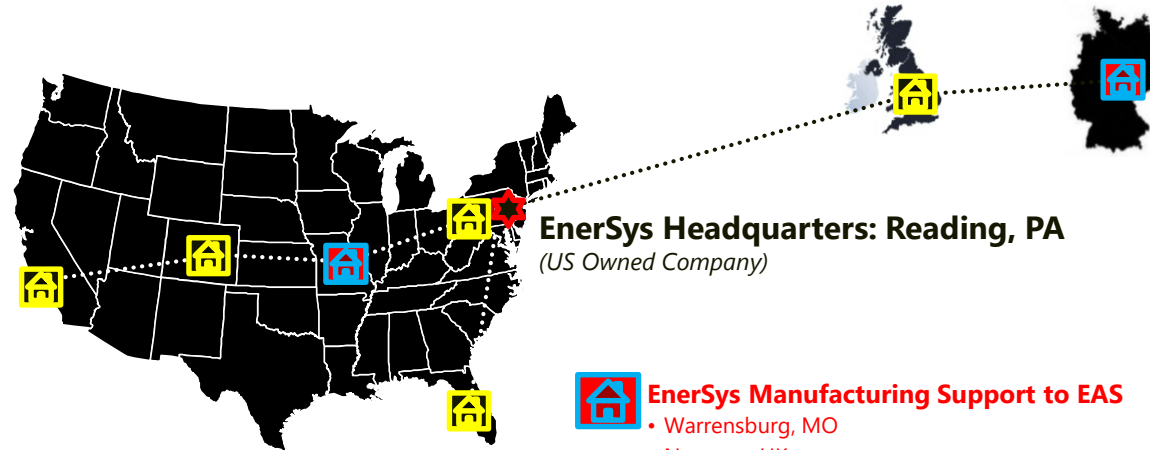
EnerSys Advanced Systems

EnerSys Advanced Systems



EAS Manufacturing Facilities

- Sylmar, CA
- Santa Clarita, CA
- Longmont, CO
- Horsham, PA
- Tampa, FL
- Culham Oxfordshire, UK



EnerSys Headquarters: Reading, PA
(US Owned Company)

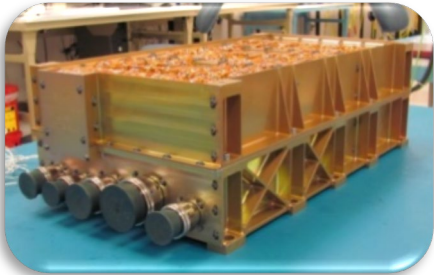


EnerSys Manufacturing Support to EAS

- Warrensburg, MO
- Newport, UK
- Zwickau, DE

Four Domestic EAS Battery Engineering Locations Serving Six Markets

Business Line	Brands	Technology	Main Manufacturing Locations
Aerospace	ABSL/Quallion	Lithium-Ion Materials, Cells & Batteries	Longmont CO, Sylmar CA, Culham UK
Medical	Quallion	Lithium-ion Cells & Batteries	Sylmar CA
Munitions	EAS, Enser	Lithium Primary/Liquid Reserve	Horsham PA, Tampa FL
Land & Sea	Hawker/Armasafe	Lead Acid (Thin Plate), NiZn	Warrensburg MO, Zwickau DE
Aviation	Hawker/Quallion	Lead Acid (Thin Plate), Ni-Cd & Lithium-ion	Warrensburg MO, Sylmar CA, Newport UK, Zwickau DE



Space: Large Lithium Ion Packs

- Batteries Sizes Up to 280Vdc and 300Ah (>1000 in a battery)
- Commercial Cells / Large Prismatic Cells made in Sylmar, CA / Santa Clarita, CA
 - Zero-volt lithium ion chemistry demonstrated best in class cycle life (>50,000 cycles)
- Batteries manufactured Longmont, CO and Culham, UK facilities



Munitions: Thermal and Liquid Reserve

- Reserve batteries with 30 year shelf life and 30 minutes high power operation
- Vertically integrated power production (anode, cathode, separator, heat)
- Lithium Batteries built in Tampa, FL and Horsham, PA facilities



Medical: Zero-Volt Lithium Ion Chemistry and Lithium CFx (primary)

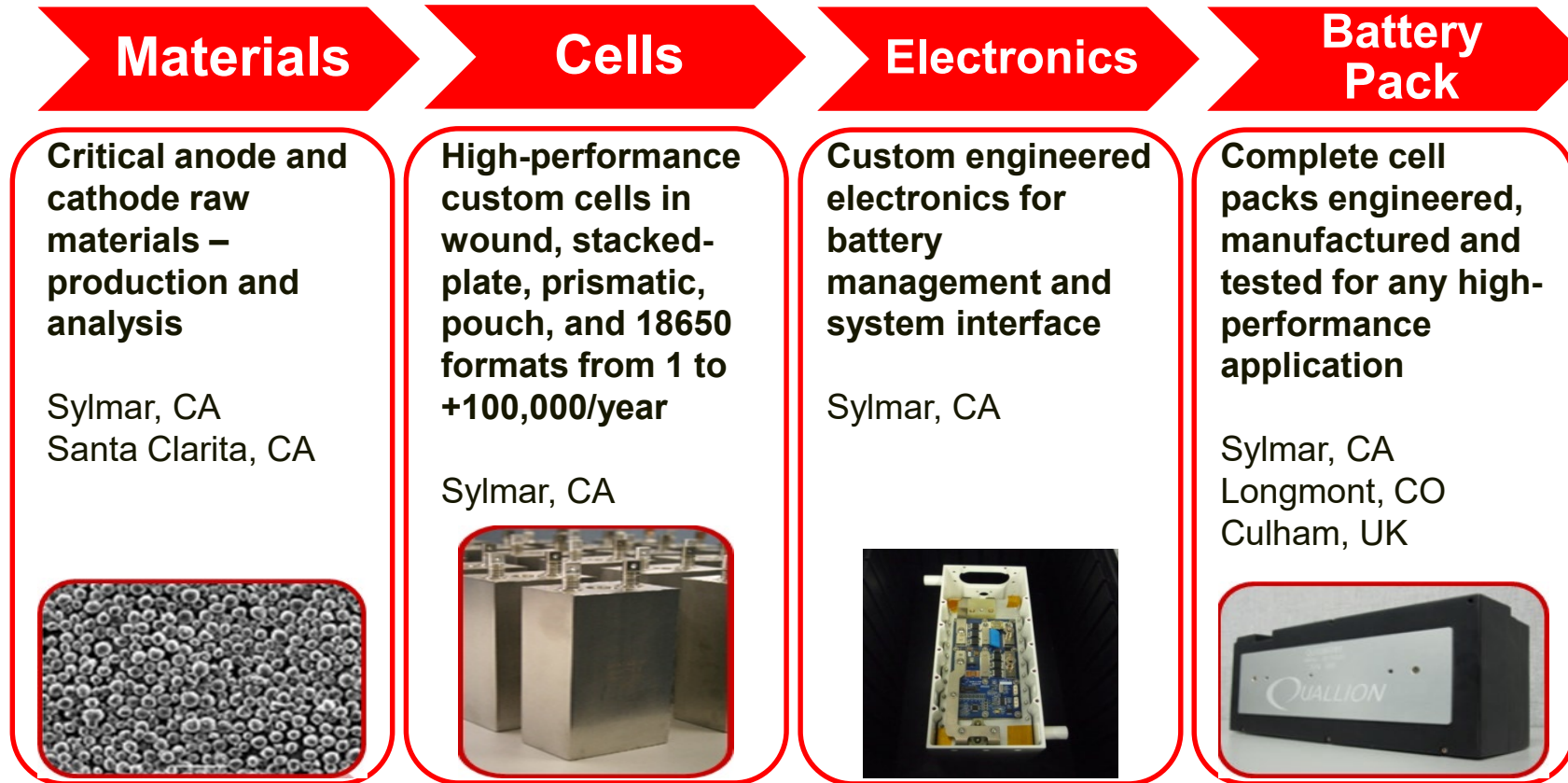
- Zero volt chemistry is an enabling technology for implantable medical devices
 - Cochlear implant and neuromodulation devices

EAS Lithium Ion Capability

- **Active Negative and Positive Li-Ion Material Production**
 - **Location:** Sylmar and Santa Clarita, CA
 - **Product:** LCO, LNCAO and MCMB
 - **Advantages:** *Locked chemical control to ensure consistent product with no threat of obsolescence or need for expensive re-qualification*
- **Lithium-Ion Cell Production**
 - **Location:** Sylmar, CA
 - **Product:** Small prismatic wound cells, prismatic cells & cylindrical cell designs
 - **Advantages:** *Multiple different types of form factors to meet customer battery requirements*
- **Lithium-Ion Module & Battery Production**
 - **Location:** Sylmar, CA; Longmont, CO; Culham, UK
 - **Product:** Module and battery assembly with cylindrical and prismatic cells
 - **Advantage:** *Flexibility in battery designs, semi-automation for module assemblies*



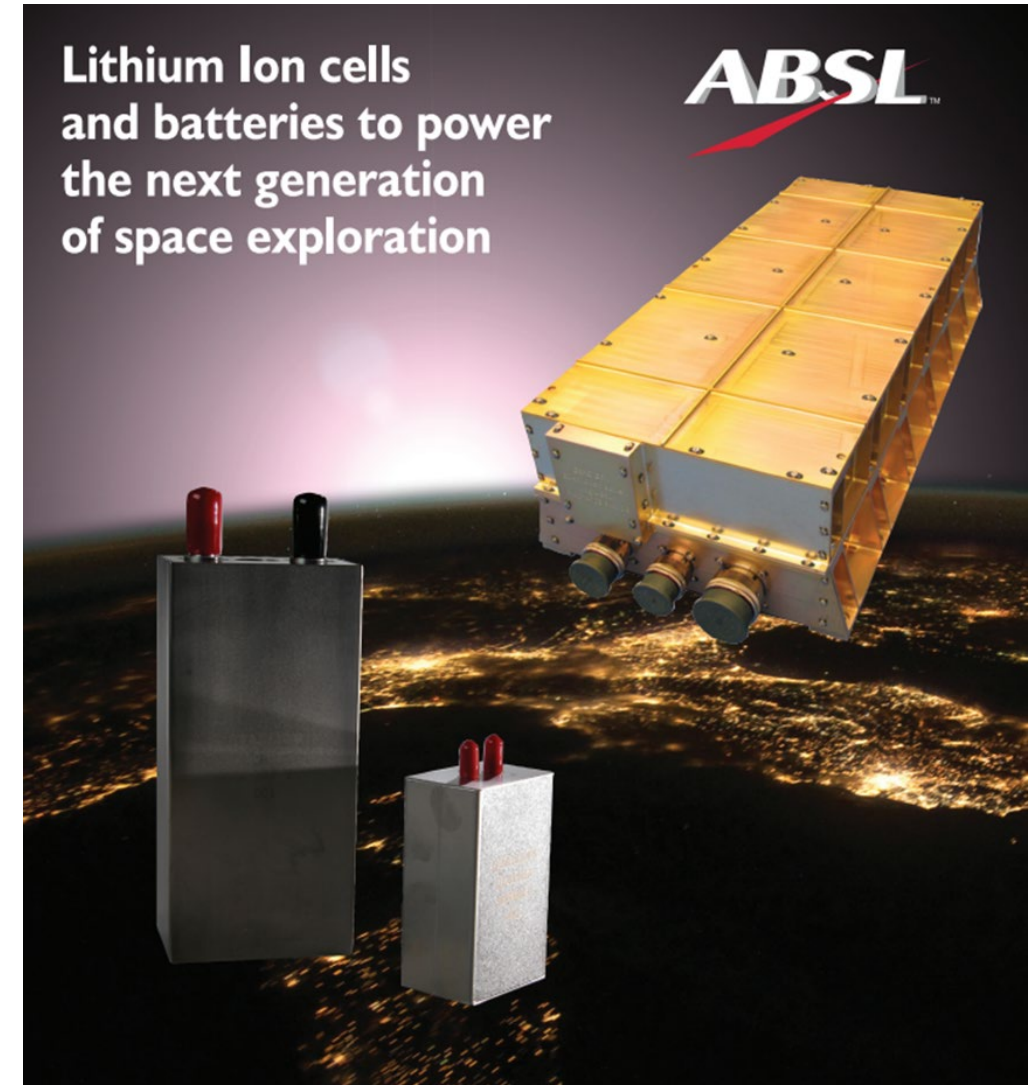
- Mitigates Supply Chain Risk



Product flexibility and supply-chain stability / Purpose Built Cells

EAS Large Format Cell

- 72 Amp-Hour Cell
 - EnerSys has recently completed space qualification of its industry leading Large Format lithium-ion Space cell and has moved into flight production.
 - We are now offering the market large cell solutions based on our heritage in small cell design.
 - This 72Ah cell utilizes long life chemistry designed for Low Earth & Geosynchronous Orbit applications.
- Long life chemistry characteristics:
 - Multiple small and large cell form factors
 - Zero Volt™ technology
 - 30°C operation
 - 80,000 cycles
 - 20% DOD
 - 20% fade

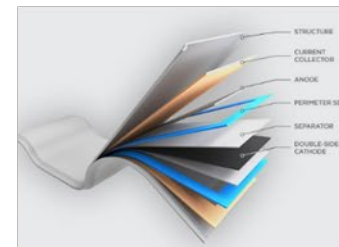
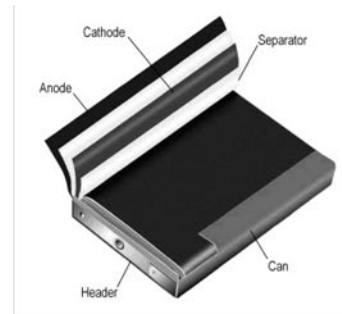


Value of Domestic Capacity

- **Guaranteed Source of Supply**
 - Vertically Integrated from Materials, Cell Manufacturing and Formation
- **Design for military / US DoD specific requirements**
 - Example: Zero Volt, extreme cycle life (50,000+ cycles), bullet penetration, high rate, unique form factors
- **Design stability**
 - Control to lock in design and prevent need for cost and risk associated with re-qualification
- **Reduces reliance on foreign supply and associated embargo risk (China)**
- **Provides additional security when handling Controlled Classified and Unclassified Data / Information**
- **How does the US DoD value this capability?**



http://batteryuniversity.com/learn/article/types_of_battery_cells



<https://www.wyon.ch/en/home.html>



<https://www.wyon.ch/en/home.html>

Cell Adoption Challenges

- **Costs**
 - Cannot compete with commercial cells on a \$/Wh basis
 - DoD Prime contracts awarded on “value” and domestic supply is rarely perceived as high value
- **Source of R & D investment for continual development**
 - Desire for high capacity cells equivalent to commercial market
 - Little investment in ongoing R & D as compared to commercial cell manufactures
- **US DoD battery designs result in the need for multiple / unique cell design and creates SKU proliferation**
- **US DoD cell volume drivers (soldier power, communications) are not willing to pay for US made cells**
 - Only low volume niche markets currently see potential value domestic sourcing



Government Strategies for Success

- **US DoD excellent job in investment in domestic capability**
- **Procurement strategy does not align US DoD, Prime Contractor and Cell Manufacturers**
 - Low cost technically acceptable procurements
 - Often no requirement to use domestically produced cells
 - System Performance and best value procurements drive COTS cells
- **Little investment made to ensure domestic cell performance remains relevant with quickly evolving global lithium ion market**
 - Large investments in commercial market
 - Commercial requirements / developments may not align with US DoD needs
- **Production capacity in place with little US DoD demand**
 - Creates a continual financial strain on a company to maintain under-utilized manufacturing capacity
- **Procurement at DoD level must drive domestic supply requirement in procurement strategy and determine a real “value” of US Lithium Ion capacity at all levels in supply chain**

Next Steps / Summary

- **Li Ion cell production capability for specialty applications has been installed giving complete vertical integration from raw material to pack manufacture.**
- **Industry and DoD must work together to continue development of cell capability and evolve production infrastructure to keep pace with the commercial markets**
- **Procurement at DoD level must drive domestic supply requirement in procurement strategy and determine a real “value” of US Lithium Ion capacity at all levels in supply chain**

