Defense battery systems

Custom power and energy solutions for demanding defense applications

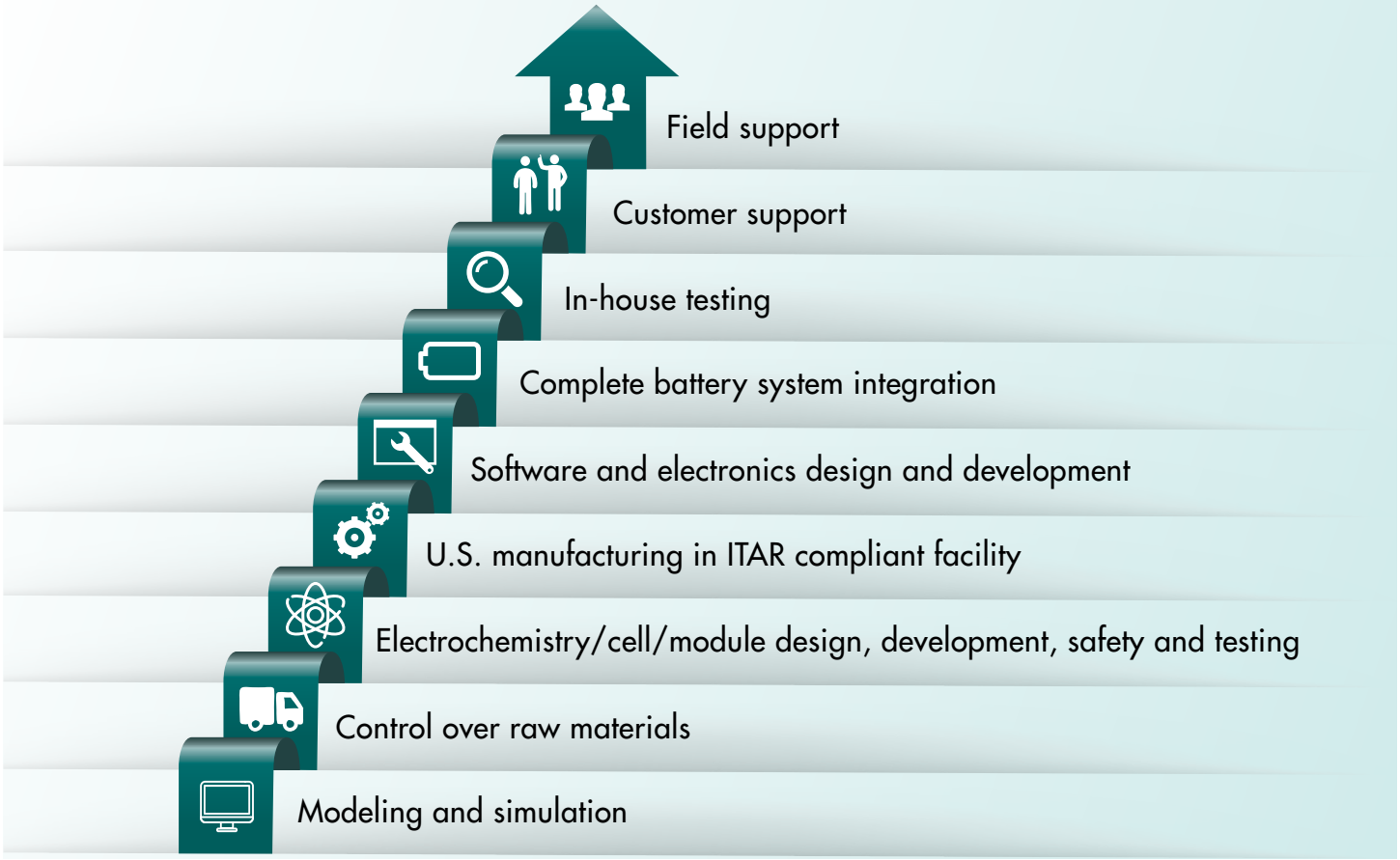
Total integration…
Saft expert battery systems capability

Saft is a recognized leader in the design and manufacture of complex custom Li-ion battery solutions for defense.

Experience

Saft's military battery heritage spans nearly four decades and includes applications from land, to air, to sea, to space.

Batteries built from the ground up



U.S.- based **manufacturing capability**

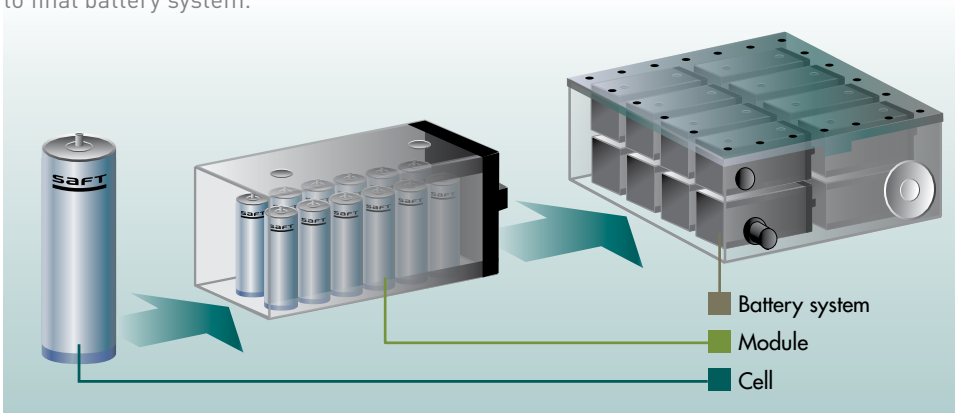
Saft has extensive experience creating custom, program specific power and energy system solutions with unsurpassed performance and durability.

Designed, developed and manufactured in the U.S.A

Saft has four manufacturing facilities in the U.S., all with unique capabilities to serve our customers. The Cockeysville, MD production site is an ISO:9001 certified site and fully ITAR compliant. From cells to batteries, to the integrated systems that support them, Saft provides a total solution for your power and energy needs.

Manufacturing Capability

Saft makes batteries from cell to module to final battery system.



Technology development timeline:

- 2017 — LMFP Development
- 2016 — LTO Develoment
- 2015 — Pouch Cell Development
- 2014 — High Power Iron Phosphate
- 2013
- 2012 — Ultra High Power NMC
- 2011 — Very High Temperature
- 2010
- 2009 — Ultra High Power NCA
- 2008 — Super-Phosphate
- 2007
- 2006 — Extremely Cold Operation for JSF F-35
- 2005
- 2004 — Very High Power NCA
- 2003
- 2002
- 2001
- 2000
- 1999 — High Power NCA
- 1998
- 1997
- 1996
- 1995
- 1994 — NCA Development

A pioneer in
Li-ion for large systems

Customer-driven design

Each military program is unique with a different set of power and energy requirements. A combination of extensive program experience, electrochemical expertise, world class manufacturing, and close working relationships with our customers allows Saft the capability to design each energy storage system to handle the most stringent requirements.

High-energy systems offer a combination of power and energy for military and space applications that need the benefit of high rate charge and discharge with significant energy requirements.

- Forward Operating Bases
- Military Ground Vehicles
- Underwater Vehicles

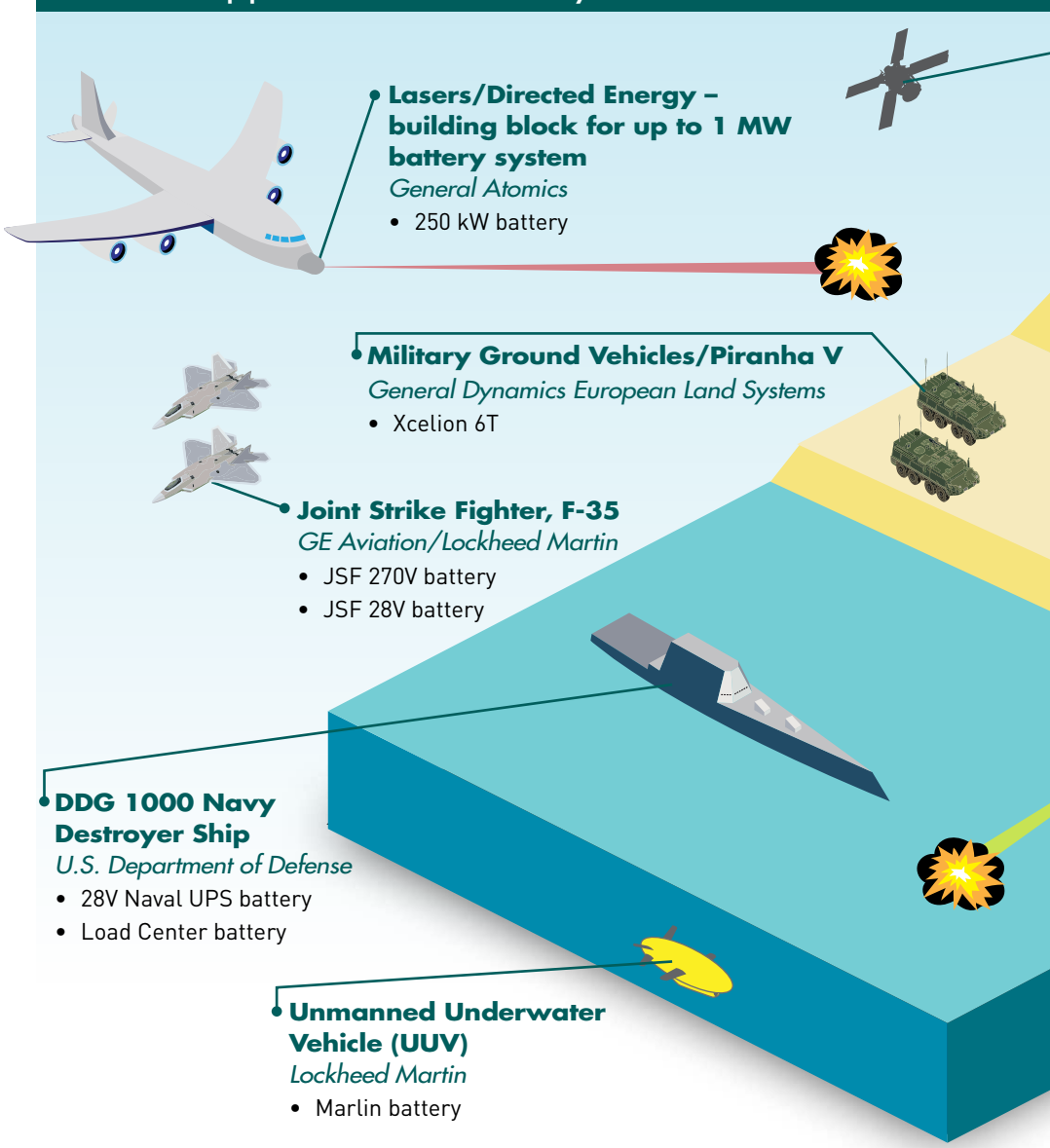
High-power systems are designed for military and space applications requiring longer operation times, combined with high power levels.

- Weapons Systems
- Navy Ships
- Control Stations
- Military Satellites

Very-high-power/ Ultra-high-power systems are offered for applications requiring either high discharge power, low temperature power or good regen capability.

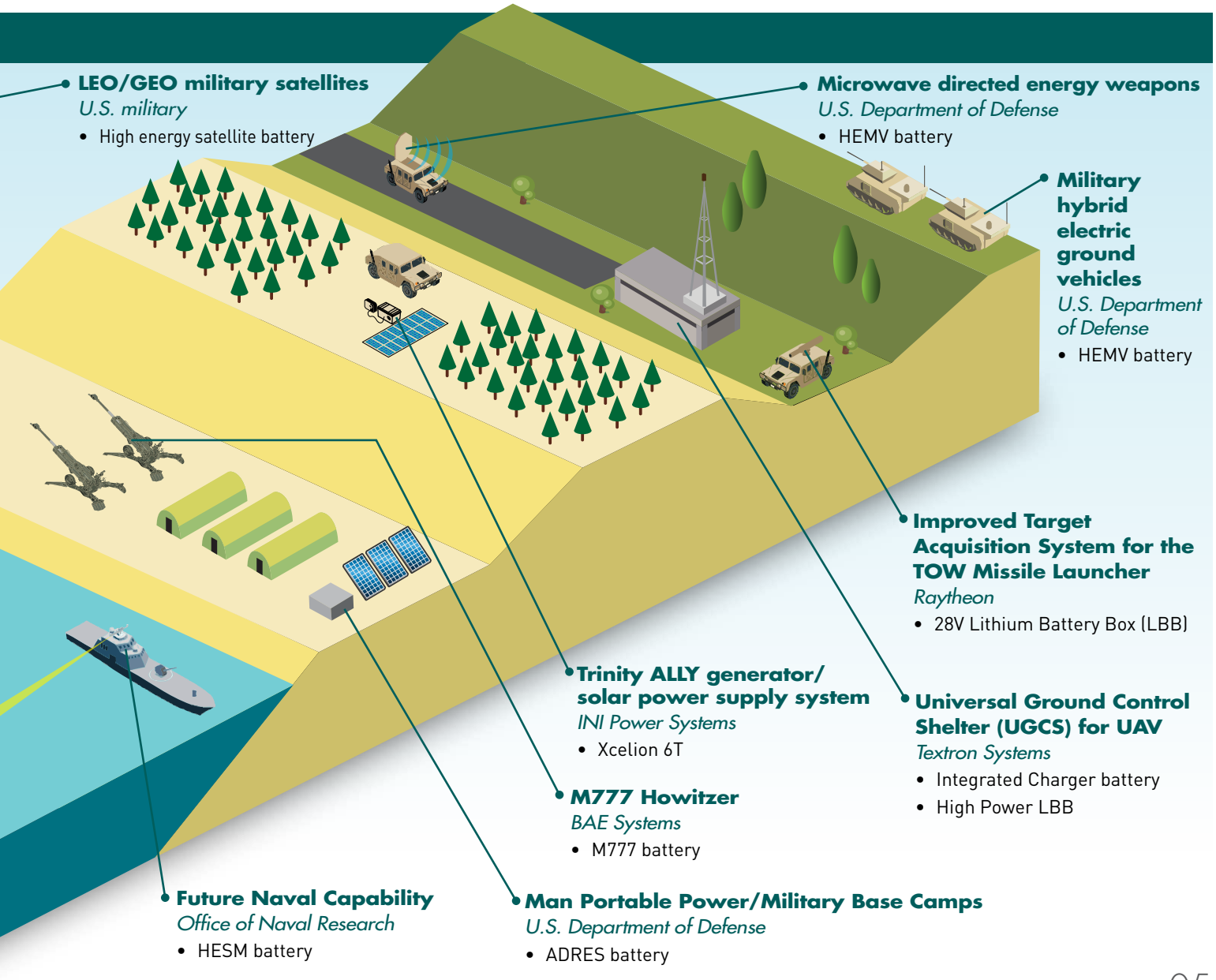
- Directed Energy Weapons
- High Power Microwaves
- Military Aircraft

Defense Applications Served by Saft Batteries

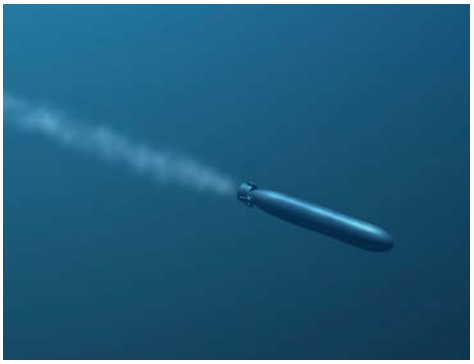


Saft delivers custom battery systems **with proven defense experience**



Customized
Li-ion battery systems



Saft has a proven track record of technology advancements, including best in power capabilities for Formula 1 and directed energy applications; best in low temperature power with Xcelion 6T; and longest calendar life for space applications. Saft Cockeysville is home to an R&D incubator that works on technology developments that benefit many industries, including space and defense.

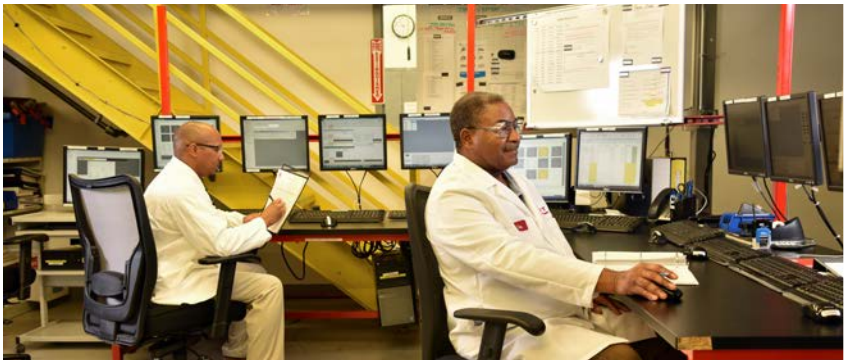
Silver-based technologies

Saft also makes batteries based on aqueous (silver-based) chemistries for defense, specifically for torpedoes and other applications requiring long storage life and no maintenance. These batteries are very high in energy density, very safe and have an infinite shelf-life because they are activated, either by electrolyte injection or sea water, at the point of use. They can be either rechargeable or primary (one-time use). Saft is one of the battery industry's few experts in this specific type of technology.

Types of Li-ion Chemistry

Electrochemistry	Cell Format	Features / Benefits	Applications
Lithium Cobalt Aluminum Oxide (NCA)	Prismatic, Cylindrical	• Sloped voltage vs. SOC affects overall energy of cell • Best power among all cathode materials • High capacity • Great stability in calendar and cycle life	Defense, Space, Energy Storage, Grid
Lithium Nickel Manganese Cobalt (NMC)	Prismatic, Cylindrical, Pouch	• Slightly higher operating voltage offsets slightly lower specific capacity to yield about the same energy as NCA • Good power and energy, less total heat generation during abuse	Vehicles, Motive Power
Lithium Iron Phosphate (SLFP)	Cylindrical	• Flat voltage profile give constant power across SOC • Lower average discharge voltage, 3.3V, results in an 8% energy reduction strictly from the operating voltage • Lower specific capacity results in an additional 12% drop in energy • Excellent cycle life with very stable impedance, good calendar life and additional safety benefits	Naval, Marine, Defense, Motive Power

In-house
research and development



Software & Electronics

Saft Cockeysville has a dedicated in-house software and electronics team continuously developing and improving upon electronics to ensure the safe operation of our batteries.

Future technology development

1. Lithium Titanate (LTO):

- Very fast charge
- 10x longer cycling than traditional Li-ion
- 30-40% less energy but inherently safer than other Li-ion technologies
- Applications: robots, electric buses, energy storage frequency regulation (cylindrical format)

2. Solid State Batteries:

- Eliminates liquid electrolyte (solid polymer or lithium conductor)
- Safety benefits – removing flammable electrolyte can achieve very high energy (400 Wh/kg) by using metallic lithium instead of carbon in the anode

3. Manganese Phosphate:

- Same as iron phosphate but works at 4V instead of 3.3 V, so power and energy are both increased
- Potentially less expensive than traditional Li-ion because it does not use nickel or cobalt, but just as safe as iron-phosphate
- More energy without compromising safety

Bypassable Module Power Board (U.S. patent 9525290)

- Integrated into the module with a CANProbe™
- Provides electronic bypassing capability for each module within the battery
- Provides N+1 or better redundancy within the battery
- Supports safe handling, maintenance and assembly of high voltage battery systems
- Overload protection built-in

Modern ARM-based Battery Management System

- Ethernet, WiFi, Bluetooth, USB, dual CAN communications
- MicroSD storage
- Communicates with CANbot to manage multiple battery strings
- Linux operating system

CANbot

- Battery string controller
- Performs pre-charge, controls contactors, coulomb counts the SOC, and monitors battery and load voltages
- All-in-one

New High Voltage Graphical User Interface Tool

- Communicates with multiple batteries at the same time
- Logs data into a database with metadata (data exportable to CSV)
- Cross-platform/product architecture

Saft is committed to the highest standards of environmental stewardship

As part of its environmental commitment, Saft gives priority to recycled raw materials over virgin raw materials, reduces its plants' air and water releases year after year, minimizes water usage, reduces fossil energy consumption and associated CO2 emissions, and ensures that its customers have recycling solutions for their spent batteries.

Regarding industrial batteries, Saft has had partnerships for many years with collection companies in most EU countries, in North America and in other countries. This collection network receives and dispatches our customers' batteries at the end of their lives to fully approved recycling facilities, in compliance with the laws governing trans-boundary waste shipments.

Saft has selected a recycling process for industrial lithium-ion cells with very high recycling efficiency. A list of our current collection points is available on our web site. In other countries, Saft assists users of its batteries in finding environmentally sound recycling solutions. Please contact your sales representative for further information.

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