

# MetILs: Metal Ionic Liquids for Flow Batteries

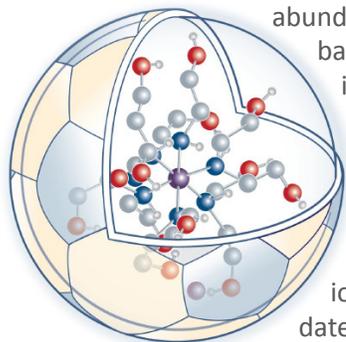
Sandia has created a family of liquid salt electrolytes, known as MetILs, that allow for higher energy density by incorporating an electro-active element (such as a transition metal) into the solvent's molecular formula.

## Flow Battery Technology

A flow battery is a rechargeable battery in which electrolytes containing one or more electro-active species flows through a cell that converts chemical energy to electricity. Additional electrolytes are stored in tanks and pumped through the cell. Flow batteries can be rapidly recharged by replacing the electrolyte liquid while simultaneously recovering the spent material for re-energization. Flow batteries work well in large-scale, stationary storage applications to mitigate the variability of wind/solar power generation (load leveling), minimize the electrical loads during peak demand (peak shaving), or act as an uninterruptable power supply during power outages.

## Reduction-Oxidation Ionic Liquids

Sandia has developed a method to produce reduction-oxidation (redox) active ionic liquids for redox flow batteries using inexpensive, non-toxic, and highly

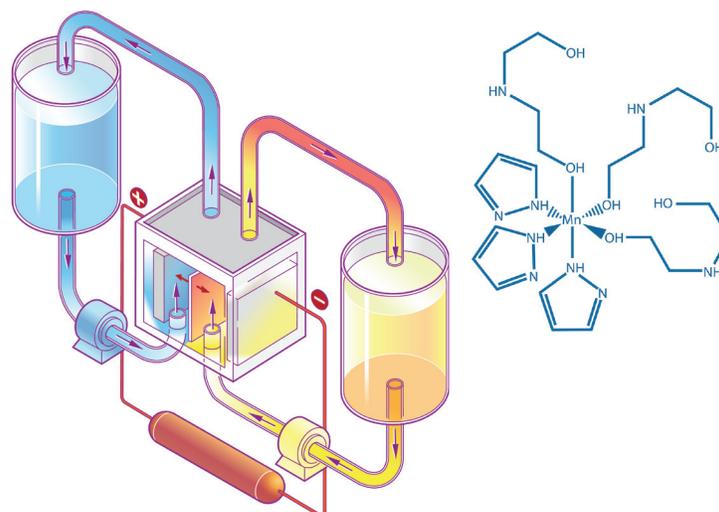


*The MetIL's cation complex evenly distributes its net charge across its surface—like a soccer ball has evenly spaced white/black panels. Because of this symmetrical charge distribution, no two complexes can come close enough to each other to initiate ion pairing/solid formation, but they can easily capture, release, and exchange electrons.*

abundant precursors. MetILs are based on readily available, inexpensive, non-toxic materials such as iron, copper and manganese. In addition, the electrochemical efficiency, or ability to reverse charge, is far better than any ionic liquid system reported to date. By incorporating the redox active species into the ionic liquid's molecular formula, we increase metal concentration and energy density well beyond the saturation point of most metals in both aqueous and nonaqueous systems. As ionic liquids, MetILs have negligible

vapor pressures and thus ameliorate cell pressurization issues that can lead to membrane rupture and cell leakage. As a non-aqueous system, we can improve efficiency by operating at higher voltages (well beyond the 1.5 V limit associated with the hydrolysis of water).

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND2012-3431P.



## Lower Cost Flow Batteries

MetILs have three metrics that allow for lower cost flow batteries relative to the allvanadium system:

1. Higher metal concentration
2. Lower cost precursors and
3. Higher operating voltages

The higher energy density, and thus lower cost make it competitive with zinc-bromine and related systems with the added benefit of higher safety as a result of using environmentally benign ionic liquids.

## Commercialization Path

Sandia looks forward to collaborating with partners to scale up materials for MetILs. Opportunities for research and development partnerships are available through Sandia's Corporate Research and Development Agreement (CRADA) process.

Please contact us to discuss company needs and collaboration goals.

For more information please contact:  
Travis Anderson  
E-mail: [tmander@sandia.gov](mailto:tmander@sandia.gov)  
Phone: (505) 844-4766  
Website: [energy.sandia.gov](http://energy.sandia.gov)