

Case ID:M15-057P^

Published: 2/26/2020

## Inventors

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# Low Operating Temperature Na-Fe Redox Battery for High Efficiency, Low-Cost Energy Storage

Even though green technologies such as wind and solar are currently dropping in cost, energy storage innovations are still needed to make sustainable energy solutions competitive within the consumer market. Providing a lightweight, high-energy-density power source, rechargeable lithium ion batteries are great for portable electronics. But they quickly drain, operate poorly in freezing temperatures, and are not necessarily the best choice for large scale energy storage. Given the low cost and favorable redox potential of sodium, molten salt batteries, that use liquid sodium as the anode, have been considered for powering electric vehicles and the load-balancing of solar and wind power plants. However, due to their high operating temperatures (greater than 300°C) and fire hazard from internal shorts, these batteries encounter problems with thermal management and safety, and impose stringent requirements on the other battery components that substantially increase material costs.

Researchers at ASU have developed a low-cost, high-energy-efficiency liquid sodium battery cell that safely operates at temperatures well below 200°C. A catholyte (liquid that can work as both cathode and electrolyte) with an Fe(II)/Fe(III) redox couple allows this battery to exhibit a much higher voltage than the other liquid sodium batteries, and deliver an open-circuit voltage of 3.31V with energy efficiency greater than 96%. The battery is fail-safe against internal short circuiting and is made of abundant, low-cost, and environmentally friendly materials. Additionally, the catholyte is a freely-flowing liquid at room temperature, giving it the potential to serve in a "gas station" type facility in which the spent catholyte is replaced with fully oxidized solution. High output voltage, low operating temperature, resistance to internal shorts, and low material costs make this battery suitable for small scale home energy units as well as large scale storage for grid load-balancing purposes.

### Potential Applications

- Electric Car Batteries
- Electric Golf Carts
- Grid/Home/Solar Energy Storage
- Uninterrupted Power Supply Systems

### Benefits and Advantages

- Economical – Made from earth-abundant, low-cost materials.
- Effective – Delivers an open circuit voltage of 3.31V with 96% energy efficiency.
- Environmental – Made from earth-friendly materials.

- Innovative – Operates at temperatures below 200°C.
- Safe – Fail-safe against internal short circuiting keeps this battery from being a fire hazard.

For more information about the inventor(s) and their research, please see

[Dr. Charles Angell's directory webpage](#)