



Courtesy General Motors

**THE OPPORTUNITY**

Stored energy offers the world revolutionary potential – the potential to be energy secure; the potential to create highly resilient electrical grids; and the potential to address global climate disruption through increased adoption of renewable energy and electric vehicles. However, this tremendous potential doesn't come without challenges.

If we are to realize the full potential of energy storage, it requires us to solve challenges related to, for example, battery performance, manufacturing costs, environmental impact, and safety.

Recognizing this tremendous potential and the associated challenges, the U.S. Department Energy (DOE) has made a long-term investment in cutting-edge research that has yielded breakthroughs in multiple generations of energy storage.

**THE PIVOTAL DISCOVERY**

DOE's investment in energy storage research has resulted in numerous important breakthroughs, and among the notable achievements is the Nickel Manganese Cobalt (NMC) blended cathode structure that Argonne National Laboratory researchers developed in the early 2000's.

The development of NMC represented a major leap in lithium-ion battery technology from earlier cathode chemistries. NMC offers the longest-lasting energy available in the smallest, lightest package – a 50-100 percent increase in energy storage capacity over conventional cathode material. Further, its unique lithium- and manganese-rich mixed-metal oxide combination extends the operating time between charges, increases the calendar life, and improves the inherent safety of lithium-ion cells.

**THE IMPACT**

- NMC has been licensed to General Motors (Detroit), BASF Corporation (Florham Park, N.J.), TODA America, Inc. (Battle Creek, Mich.), and LG Chem.
- NMC is a key component in the Chevy Bolt, the 2017 Motor Trend Car of the Year and one of *Time* magazine's 25 Best Inventions of 2016.
- "NMC has been a game-changer in the industry," said Mike Fetcenko, Director of Battery Materials for BASF. "People are using this Argonne technology without even knowing it."

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