Researchers use a range of advanced techniques, such as neutrons, x-rays and electrons, to conduct investigations into new materials for safer, lighter and more reliable energy conversion and storage technologies such as batteries or fuel cells.
Source: Canadian Nuclear Laboratories

The world needs better batteries. Curiously, nuclear science is helping to make this happen.

CLEAN ENERGY MATERIALS

Neutrons, a battery researcher's best friend

Electric vehicle company and battery superstar, Tesla, is rightly proud of how the island of Ta'u in American Samoa has been operating on nearly 100 percent solar energy for more than two years. This is thanks to a Tesla utility battery facility that stores the solar electricity for when it is needed.

But, there is a downside. The batteries can only store sufficient energy for this small population of 600 for three days.

This means that powering a larger population, such as a major city, on solar is going to need a lot more batteries. Even with rapid cost reductions in battery technology, this is still an impractical solution today.

We need better batteries

The solution is going to lie in the discovery of new materials. It all comes down to finding compounds that are inexpensive, that can safely take and dispense energy at a high rate, and that are able to store a lot of energy compactly (in other words, have a "high energy density").

"A 20 percent increase in energy density, for example, would produce about a 20 percent reduction in cost for an equal amount of energy storage," according to Jeff Dahn, a physicist and battery-research specialist at Dalhousie University, Canada.

It's still going to be a challenge however. "Increasing a battery's energy density is no easy feat because today's battery technologies are already pushing the limits of the materials' capabilities," says University of Waterloo chemist Linda Nazar, one of the world's most respected materials scientists.

In their quest for new materials that will improve our ability to store electricity, researchers employ one of the basic building blocks of matter: a subatomic particle called a "neutron".

Neutrons are found in the center of atoms. In a nuclear reaction, neutrons can be knocked out of an atom and fly off on their own. By firing a beam of these "free" neutrons at a material, researchers can measure how the neutrons scatter to learn more about the material's properties.

There are other ways of doing analyses like this, but just like your doctor might use an X-ray or MRI or CT, different tools provide different information. For some applications neutrons offer much greater sensitivity—they can penetrate deeper into materials and are better at identifying different atomic and isotopic properties. This gives researchers more information on materials that might bring them closer to a better battery.

"Neutrons are indispensable for the structural analysis of battery electrode materials that contain lithium, and are also very important for ones containing sodium," stresses Nazar.

Neutron beams aren't easy to come by. They can only be produced from nuclear installations such as reactors or particle accelerators. And battery research isn't their only clean energy application. Specialists around the world have used neutron scattering to:

- Improve the performance of hydrogen fuel cells;
- Increase the lifetime of wind turbine blades;
- Enhance hydrogen capture from industrial waste gas;
- Advance superconductor research for more efficient power lines and high-speed trains; and,
- Slash the energy requirements of aluminum production.

Nuclear reactions may be best known for the energy they produce, but neutrons are the unsung heroes of nuclear science and are making important clean energy contributions of their own.