1663: Transportation is a different storage need?
Thorn: Yes. The main obstacle there is the energy density of the storage medium. We're used to gasoline, which has a remarkably high energy density of about 11 kilocalories per gram (kcal/gm). When you burn an entire tank of gasoline, you liberate about 250,000 kcal of energy—a billion joules!
Migliori: Remember that only about 20 percent of that energy is used to move the car. The rest is lost in the form of heat and through inefficiencies in the car's power train. An electric car would have a much-higher efficiently.
Thorn: So given what Al said, and considering that the best lithium-ion battery has an energy density of at most 0.4 kcal/gm, we've got to develop an electrical storage device that has roughly five times the energy density of our best battery if we want an electric car that performs as well as a gasoline-powered vehicle. We don't know how to do that yet, but I'll wager it will happen not through engineering but through an understanding of fundamental science.
1663: What about using hydrogen?
Thorn: Hydrogen is an energy storage medium. A common scenario is to use electricity from a power plant to produce hydrogen through water electrolysis. Two electrodes are placed in water. When a current is run between them, the electrical energy overwhelms the chemical bonds, and the water separates into hydrogen and oxygen. You store the gases separately, then when needed, feed the hydrogen into a fuel cell to generate electricity.
Migliori: Hydrogen gas has such a low density that it's hard to imagine its becoming a commodity the way oil or gasoline is. For example, to carry enough hydrogen to power a car for 200 miles, you'd have to load it into a "bottle" at extremely high pressure, which raises all kinds of flags about safety, refueling, delivery, etc. So people have been looking at ways to store hydrogen not as a gas but as part of a molecular compound.
Thorn: Currently, one of our best hopes is ammonia borane, a relatively dense solid at room temperature that's about 18 percent hydrogen by weight. You chemically remove the hydrogen to run your fuel cell. Los Alamos established collaborations for working on ways to improve the efficiency and lower the cost of regenerating the spent material. We're also heavily engaged in research to make fuel cells less expensive, more robust, and more accommodating of fuels other than hydrogen. And across the Laboratory, scientists and engineers are working to improve power plant designs and researching grid stabilization, nuclear power, etc.