



# Nickel-Metal-Hydride Batteries

High Energy Storage for Electric Vehicles

ENERGY  
EFFICIENCY AND  
RENEWABLE  
ENERGY

OFFICE OF  
TRANSPORTATION  
TECHNOLOGIES



## Transportation FOR THE 21ST CENTURY

### Background

The key to making electric vehicles (EVs) practical is the development of batteries that can provide performance comparable with conventional vehicles at a similar cost. Most EV batteries have limited energy storage capabilities, permitting only relatively short driving distances before the batteries must be recharged. In 1991, under a cooperative agreement with The U.S. Department of Energy (DOE), the United States Advanced Battery Consortium (USABC) initiated development of nickel-metal-hydride (NiMH) battery technology and established it as a prime mid-term candidate for use in EVs. DOE funding has been instrumental to the development of NiMH technology at two manufacturers, Ovonic Battery Company and Saft America. DOE national laboratories have provided critical testing and evaluation of NiMH prototypes, as well as identification of potential failure mechanisms.

### The Technology

During the past decade, nickel-metal-hydride batteries have proven themselves in laptop computers, cellular phones, video cameras and other products in use worldwide. But adapting NiMH technology for electric vehicle application has been challenging for battery developers because of the need to provide electric vehicles with the same performance as conventionally-powered vehicles at a significantly lower cost per unit of energy compared to the smaller consumer batteries. Battery developers have had over one hundred years of experience working with lead acid technology,

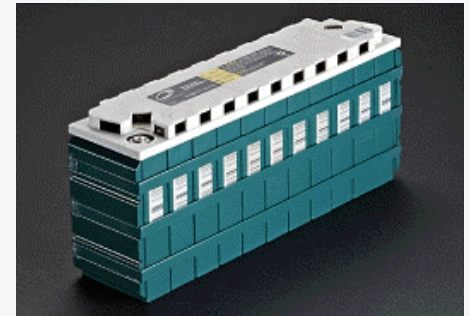
whereas NiMH were invented just 12 years ago. These and other factors explain the high cost of the new batteries, which at pilot production levels still are several times more expensive than USABC's commercialization cost target.

### Commercialization

In the mid 1990s, DOE national laboratories evaluated over 35 nickel-metal-hydride modules and three full-size EV batteries for further development. The success of NiMH batteries attracted the attention of General Motors Corporation (GM) and DaimlerChrysler to evaluate the use of these batteries in their own EVs. GM was so pleased with Ovonic Battery Company's NiMH technology, that in 1994 GM and Ovonic Battery Company formed a manufacturing joint venture; GM Ovonic, to commercialize NiMH batteries for EVs. GM has subsequently incorporated GM Ovonic's NiMH batteries in over 400 of their 1999 model EV-1 cars and S-10 pickups, in which driving range was doubled for both vehicles. In 1997, DaimlerChrysler announced its decision to equip its Electric Power Interurban Commuter with NiMH batteries made by Saft, which marks the first use of NiMH batteries in a minivan. The Saft NiMH battery helped reduce the weight of the minivan by 150 pounds and increased its driving range up to 150 km. Both manufacturers are now working on the production of second-generation NiMH batteries.

### Benefits

- **An EV displaces approximately 450 gallons of petroleum per year**
- **Well-to-wheels energy efficiency is nearly double that of conventional vehicles**
- **Zero tail-pipe emissions**
- **Non-toxic materials, 100% recyclable**
- **Battery lifetime expectancy of over 100,000 km**



### Contacts:

#### Raymond Sutula

Office of Transportation Technologies  
(202) 586-8064  
Raymond.Sutula@hq.doe.gov

#### Ken Heitner

Office of Transportation Technologies  
(202) 586-2341  
Kenneth.Heitner@ee.doe.gov