

CORPORATE NEWS

VW considers BYD as battery source

A deal would bring the Chinese company its first big automotive partner for promising lithium-ion technology

BY CHRISTOPH RAUWALD
AND NORIHIKO SHIROUZA

Volkswagen AG said it is exploring options for teaming up with China's BYD Co. on hybrid and electric vehicles powered by lithium batteries—highlighting auto makers' efforts to secure battery supplies for alternative-energy vehicles.

The companies are exploring the possibility that Shenzhen-based BYD would supply a lithium-ion battery technology it developed for plug-in hybrid and all-electric battery-powered cars, people familiar with the negotiations said.

Volkswagen, based in Wolfsburg, Germany, would be the first major automotive partner for BYD, which moved into the spotlight last year when a company controlled by investor Warren Buffett invested \$230 million in the Chinese car maker, mainly because of BYD's cost-effective technology.

BYD—one of the world's biggest producers of cellphone batteries and a fledgling, fast-rising auto maker in China—caused a stir in December by launching a plug-in car ahead of

more-established foreign rivals.

"Hybrids and electric vehicles will play an increasingly important role," Ulrich Hackenberg, VW's executive board member for technical development, said in a prepared statement. "Particularly for the Chinese market, potential partners such as BYD could support us in quickly expanding our activities."

BYD also is talking to Ford Motor Co. and another European auto maker about similar arrangements, the people said. The status of those negotiations wasn't clear.

"We are always in discussions with many suppliers as a standard course of our business, but we have nothing to share at this time," said Whitney Small, a Ford spokeswoman in Bangkok.

Concerns over gasoline shortages and climate change have prompted a global race to commercialize affordable electric-battery cars and plug-in hybrids that get most of their power from batteries.

A big obstacle is insufficient industry capacity to produce lithium-ion batteries, which is pushing auto makers like VW to team up with mul-



Shenzhen-based BYD hopes to sell to other car makers the same lithium-ion batteries it uses in its F3DM, above. BYD began offering the vehicle in December.

iple lithium-ion battery suppliers. Aside from BYD, Volkswagen has signed letters of intent with Sanyo Electric Co. and Toshiba Corp., both of Japan. Volkswagen's premium Audi AG brand last year agreed to cooperate with Sanyo on

developing lithium-ion batteries, saying the new technology should be ready for large-scale production in 2012.

While lithium-ion batteries are widely seen as the technology that will ultimately power most plug-in

cars, the batteries' use has been hindered by a relatively high price, limited durability and safety concerns. BYD says it has largely resolved those issues by turning to a safer, more cost-effective technology: iron-phosphate-based lithium-ion technology.

Lithium-ion batteries produced in China are generally about half the cost of such batteries made in Japan and the West. Costs may rise as Chinese auto makers invest to improve their technology, however.

Germany's Daimler AG last week announced it will buy a 10% stake in Silicon Valley electric-vehicle start-up Tesla Motors Inc. for "a sum in the double-digit millions of euros." Daimler and Tesla already were moving to integrate Tesla's lithium-ion battery packs and charging electronics into the first 1,000 electric versions of Daimler's tiny Smart two-seater. As part of the closer relationship, Daimler and Tesla will intensify development of battery systems, electric-drive systems and individual vehicle projects.

U.S. sets off gold rush for electric-car battery funding

BY WILLIAM M. BULKELEY

The Obama administration has set off a gold rush to power new environmentally friendly cars.

In one of the government's biggest efforts at shaping industrial policy, the Energy Department has been soliciting applications for \$2.4 billion in funding aimed at turning the U.S. into a battery-manufacturing powerhouse. At the deadline last week, the department said it had received 165 applications.

Companies vying for the federal money include General Motors Corp., Dow Chemical Co., Johnson Controls Inc. and A123 Systems, a closely held battery maker backed by General Electric Co. and others. States including Michigan, Kentucky and Massachusetts are also weighing in with applications, usually in alliance with their favored battery makers.

When the winners are decided, as soon as the end of July, the Energy Department may anoint Livonia, Mich., or Indianapolis or Glendale, Ky., as the future U.S. hub of car batteries. A 2008 study by researchers at Alliance Bernstein forecast the current \$9 billion-a-year auto-battery market, based on lead-acid batteries, could reach more than \$150 billion by 2030.

The companies and state governments are proposing sites for plants that will make lithium-ion batteries, the technology that has emerged as the leading choice to power future electric cars.

The world-wide market for these types of power cells is now dominated by four big Japanese and Korean companies—including Sony Corp. and Panasonic Corp.—but their batteries are chiefly small ones used in laptops and cellphones.

Car makers currently use another technology—nickel-metal-hydrate batteries—in hybrid vehicles such as Toyota Motor Corp.'s Prius because they aren't as prone to fire as lithium-ion batteries are.



GM approached a Korean firm about batteries for the Chevrolet Volt, above, but U.S. firms are keen to join the business.

Lithium-ion batteries are lighter and more powerful than lead or nickel-metal hydride batteries. Several American companies have demonstrated technological improvements that make big versions safe and practical for use in cars and trucks.

While mass production of such batteries hasn't been demonstrated, U.S. companies "seem close to building a facility and getting a product out there," said Kent Furst, battery analyst for Freedomia Group, a market-research firm in Cleveland.

States are desperate to attract manufacturing plants that would boost employment while reducing greenhouse gases. Some officials argue a big battery factory will attract or preserve job-heavy auto assembly plants.

"If you're the place where the bat-

teries are made, there's an opportunity to spin it into other things as well," said D. Gregory Main, president of the Michigan Economic Development Corp., a state agency that has committed up to \$400 million in incentives for battery manufacturers.

Kentucky is promising \$110 million in aid and a 620-hectare site, in Glendale, that it assembled in an unsuccessful effort to land a Hyundai plant several years ago.

"We're not in that financial league," said Ian Bowles, the Massachusetts secretary of energy and environmental affairs. But Mr. Bowles said Massachusetts has a chance of landing federal funding because it has several in-state battery makers such as Boston Power Co.

would require a total capital investment of \$1.7 billion, though not all are likely to be funded.

Among them is A123, a Massachusetts company that makes batteries in China for Black & Decker power tools. It wants to build a \$600 million lithium-ion plant in Livonia, outside Detroit. GM said it was working with A123 on batteries for the planned Volt electric vehicle, raising the small company's profile. But earlier this year GM said it was working exclusively with LG Chemicals, a Korean battery maker.

A123 now says it has an agreement to supply batteries for future Chrysler cars.

"We think they're qualified, if you get past the notion of bankruptcy" for Chrysler and focus on its plan to be acquired by Fiat, said Michigan's Mr. Main. A123, which recently raised \$70

million from GE and other investors, declined comment.

Meanwhile, Johnson Controls, the Wisconsin auto supplier that is currently the industry's leading lead-acid battery supplier, has allied with Saft LLC, a French battery maker, with plans to build lithium batteries in an existing plant in Holland, Mich.

In Kentucky, part of the proposed 620-hectare site in Glendale will be occupied by the National Alliance for Advanced Transportation Batteries, a 51-company consortium, which plans a research campus.

"It's been a strategic decision to move in the direction of creating Kentucky as what we hope will be the epicenter of battery development," said Larry Hayes, the state's economic development secretary.

The consortium was started by Chicago lawyer James J. Greenberger, the head of the energy and project-finance team at Reed Smith LLP. He calls the venture a "law-firm-marketing exercise that got out of control."

After he ran a conference last year, companies signed up to form a group that would develop tools and manufacturing expertise to be ready when the technology is. He said the federal funding is "almost too much money," considering the early stage of the market. But he said winning a Energy Department grant is crucial to the prospects of building the research center.

In Indiana, battery maker Ener1 Inc. has applied for a grant to expand a lithium car-battery plant it already operates in Indianapolis. The company has an agreement to supply batteries to closely held Fisker Automotive, a California company with plans to build and sell \$88,000 luxury-hybrid cars in 2010.

Ener1 Chairman Charles Gassenheimer said the Energy Department grants would help it expand, but "it's not life or death," for the company, which has raised some \$250 million on its own. He said the grants can "accelerate the industry to develop two or three years faster" than it would on its own.

Heady theories to explain Einstein's genius

New study focuses on unusual contours of physicist's brain

BY ROBERT LEE HOTZ

Seeking signs of genius, a researcher recently reconstructed the shape of Albert Einstein's brain with techniques normally used to analyze fossils. This mold of thought, she believes, reveals the imprint of a rare intelligence that transformed our understanding of space, time and energy.

By studying photographs of Einstein's brain taken at his death in 1955, paleoanthropologist Dean Falk at Florida State University identified a dozen subtle variations in its surface that may have heightened his ability to see physics in a new way. Her research suggests how the brain shaped the inner life of the 20th century's most famous mind.

"Einstein's brain is really unusual," says Dr. Falk. "On the surface at least, it looks different than others. It's suggestive."

Like every human brain, Einstein's was an island universe of thought.

The insights that revolutionized physics were the product of 25 billion neurons linked by billions of connections—an essence of intellect so densely compacted that a thimble full of brain matter normally holds 50 million neurons and a trillion synapses. His ideas and impressions raced through a maze of 150,000 kilometers of insulated nerve fibers at about 322 kilometers per hour.

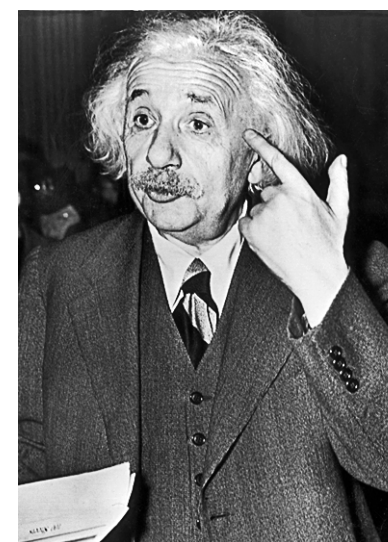
No one knows exactly how intelligence and originality arises from the action of so many special cells. Researchers at Drexel University in Philadelphia and Northwestern University in Evanston, Ill., recently discovered that patterns of electrical brain activity, as measured by electroencephalograms, usually are different among creative thinkers than among more methodical problem solvers.

An expert on ancient neural evolution, Dr. Falk is accustomed to studying brains that no longer exist. She reviewed 25 autopsy photographs. She could see that Einstein's brain had an unusual pattern of grooves and ridges along its parietal lobes, suggesting a rearrangement of areas associated with mathematical, visual and spatial cognition.

Although he published 300 scientific papers, Einstein couldn't easily describe the way his mind worked. "A new idea comes suddenly and in a rather intuitive way," he once said. His thoughts moved "in a wildly speculative way." As a theorist, he sometimes solved physics problems by imagining himself riding alongside a light beam or falling in an elevator. "I rarely think in words at all. A thought comes and I may try to express it in words afterwards ... I have no doubt that our thinking goes on for the most part without the use of signs and, furthermore, largely unconsciously."

Told that many people only think in words, he laughed.

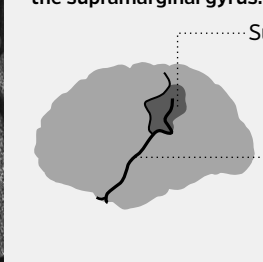
By studying Einstein's neural remains, researchers like Dr. Falk pursue an inquiry at the confluence of science, folklore and medical history. For a century, scientists have compared famous brains in hopes of finding the link between neural structure and talent. It's heady work. "The brain is as close as we can get to the physical essence of



Not as groovy

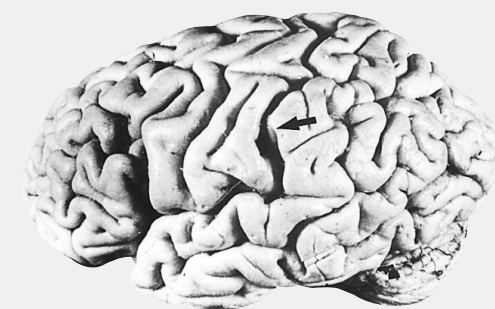
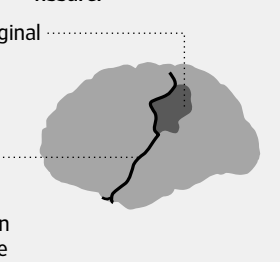
The part of Einstein's brain associated with visual and spatial reasoning was 15% larger than normal. Even more remarkable, Einstein's brain was missing a crevice present in typical brains.

Typical brain
The Sylvian fissure divides a part of the brain called the supramarginal gyrus.



Source: Prof. S.F. Witelson, Michael G. DeGroot School of Medicine, McMaster University; Photos: Everett Collection (left), S.F. Witelson et al., Lancet (above)

Einstein's brain
The supramarginal gyrus is not divided by the Sylvian fissure.



The arrow above points to the Sylvian fissure in Einstein's brain.

what makes us human," she says.

To this end, Soviet scientists once conducted top-secret studies of Lenin's brain, seeking in its dead cells the intellectual seeds of social revolution, says University of Houston political economist Paul Gregory, who discovered the 1936 medical report hidden in Communist Party archives. More recently, researchers at the Institute of Medicine in Juelich, Germany, took apart the brain of a translator fluent in 60 languages, in hopes of finding the secret of his exceptional language ability. In both cases, the findings were inconclusive.

By itself, brain size is no true measure of intellect, comparative studies confirm. Einstein's brain weighed 1.2 kilograms, less than most men. The brain of 1921 Nobel laureate Anatole France weighed just under one kilogram. At 1.4 kilograms, Lenin's brain was exactly average. The brain of Russian novelist Ivan Turgenev outweighed them all at two kilograms.

To understand the anatomical reasons our mental capacities often differ, researchers must look instead for subtle distinctions among neurons and synapses in structures associated with specific abilities. Nonetheless, the effort to study Einstein's brain was controversial from the start.

When Einstein died in New Jersey at the age of 76, an eccentric hospital pathologist named Thomas Harvey conducted a routine autopsy. But he removed the physicist's brain for later study—apparently acting on his own authority. He soaked it in preservative and cut it into 240 pieces, each containing about two teaspoons of cerebral tissue. He mounted 1,000 slivers on microscope slides for study.

It was decades, though, before Dr. Harvey could persuade anyone to seriously examine them. Einstein's brain samples languished in a cider box next to the beer cooler under his desk.

Not until 1985 did the first scientific analysis appear. Pioneering neuroscientist Marion Diamond at the University of California, Berkeley, discovered that, in some tissue samples, Einstein's brain had more cells nurturing each neuron than normal. These well-tended cells, located in a region associated with mathematical and language skills, might help explain the physicist's "unusual conceptual powers," she speculates.

Then Dr. Harvey contacted neuropsychologist Sandra Witelson at McMaster University in Hamilton, Ontario. An authority on cognition and comparative neuroanatomy, Dr. Witelson had assembled the world's largest collection of normal brains, all cross-matched and cataloged by

intelligence tests and behavioral surveys conducted while the donors were still alive.

"Unannounced, he sent me packages—packets of slides—just addressed to me without a return address," Dr. Witelson recalls. "These slides of Einstein's brain kept coming through the mail, unannounced and uninsured."

She compared Einstein's brain samples with dozens of normal men and women in her brain bank. Most of his brain was unremarkable, but she found that one area associated with visual and spatial reasoning—the inferior parietal region—was 15% larger than normal. Even more unusual, his brain lacked a special fissure there, effectively fusing two key

brain regions into one.

"I can't prove that those were the regions that Einstein was using when he was thinking about relativity," says Dr. Witelson. "We suggested that anatomy could have given him an advantage in three-dimensional thinking."

No one knows whether the quirks of Einstein's brain structure were the cause or effect of his genius. Some of his gift, no doubt, was hereditary. But his research required intense study, and such concentrated effort can alter the brain physically. Regular meditation, for example, can increase the size of brain areas that regulate emotion, researchers at the University of California, Los Angeles, Laboratory of Neuroimaging re-

ported this month in the journal *Neuroimage*.

Indeed, a curious knob-like feature that Dr. Falk saw in pictures of Einstein's motor cortex might be due to his early musical training. It resembled a structure detected in neural studies of experienced pianists and violinists, caused by hand exercises.

"I wish Einstein were alive," says Dr. Falk, "and we could ask a little more about how he thinks."

See a video on the structure of Einstein's brain at WSJ.com/Currents, where Robert Lee Hotz also shares recommended reading and responds to reader comments. Email him at sciencejournal@wsj.com.

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- Karim Khoja, CEO of Roshan Telecom, Afghanistan

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