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Toyota's hydrogen gamble

BLOOMBERG

A cross section of the Toyota Motor Corp. Mirai fuel-cell vehicle is displayed in the showroom of the company's headquarters in Toyota City

By Robin Harding and Kana Inagaki

Sakichi Toyoda, the founder of Toyota, once offered a one million yen prize to the inventor of his dream: an electric battery that would free Japan forever from its dependence on imported oil. Toyoda imagined cars running on abundant hydroelectric power. All he needed was a battery to provide 100 horsepower for 36 hours, with a weight below 225kg and a volume of less than 280 litres.

That was in 1925. Almost a century later the prize remains unclaimed. Toyota's engineers fondly refer to the elusive power source as a "Sakichi battery" and the very difficulty of making one has led them in pursuit of an alternative fuel to power its cars: hydrogen.

That pursuit is playing out in a small factory near the company's headquarters in Toyota City, central Japan, where an elite team of workers are hand-building a vehicle that represents a huge gamble for the world's second-largest motor manufacturer. The Mirai is either the future of the automobile or a technological trap about to swallow a prized swath of Japanese industry.

Every hour or so the workers wheel out two thin yellow cylinders, spun from carbon-fibre at an even-more-sensitive Toyota factory attached to its research and development centre, and bolt them into place. The tanks hold hydrogen, from which a fuel cell makes electricity to power the car. The Mirai is Toyota's - and Japan's - vision of low-carbon transport, a vision completely different to the battery-powered Teslas edging into the automotive mainstream.

It is fraught with obstacles. The technology is expensive: a petrol-powered vehicle at a Toyota plant rolls off the production line every 60 seconds but it currently takes 72 minutes to assemble a single Mirai. It needs a nationwide refuelling network that does not exist anywhere. Most troublesome of all: there is not yet any source of cheap, carbon-free hydrogen to justify the effort.

Yet for reasons of industrial strategy, energy security and physics, Japan and its biggest carmaker are placing a huge bet on hydrogen. Come the 2020 Tokyo Olympics, they want fleets of fuel cell cars and

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> JAPAN'S PRIME MINISTER

buses taking athletes from village to venue, before the vehicles head for the global mass market.

Shinzo Abe, the prime minister, has made hydrogen a symbol of Japan's ability to innovate despite the collapse of its vaunted consumer electronics industry. "Hydrogen energy holds the trump card for energy security and measures to address global warming," he said in January. "Japan will build an international hydrogen supply chain that extends from production to transportation and consumption ahead of the world."

The danger is not so much that hydrogen fails but that it succeeds just a little bit, luring Japan into a technology it cannot sell to other countries, and leaving its mighty carmakers led by Toyota and Honda stuck in a Galápagos ecosystem of their own making, just like the unique wireless standards that isolated the country's mobile phone industry.

"We see fuel cell vehicles as the ultimate eco-car," says Kiyotaka Ise, Toyota's head of advanced R&D. "Everyone is saying electric vehicles [are the future] but there is still a long way to go. EVs are far easier to make than FCVs and there's still going to be a lot of trial and error. Toyota is putting huge effort into fuel cell vehicles."

The carmaker aims to sell more than 30,000 hydrogen-powered vehicles a year by about 2020, 10 times its 2017 production target. It also plans to introduce more than 100 fuel cell buses in the Tokyo area ahead of the Olympics.

Toyota does not highlight it, but the very difficulty of making fuel cells is part of their attraction for Japan. The business for electric vehicles looks like that of mobile phones: simple, modular, easy to assemble and vulnerable to new entrants from China and Silicon Valley.

Fuel cell vehicles, by contrast, need all the manufacturing skills of a car company. "From the industrial strategy point of view, fuel cell technology is extremely difficult, it's in the world of chemistry not machinery," says Hiroshi Katayama at the advanced energy systems and structure division of the ministry of economy, trade and industry (METI). If auto technology goes down the hydrogen path, Japan will be well placed. But if it doesn't, Tokyo will have made a major miscalculation.

Toyota's faith in hydrogen is best understood by looking at a car it never made: a pure electric vehicle. For the 20 years since it invented the Prius hybrid, Toyota has been the carmaker best-placed to launch a fully electric vehicle. It had the batteries, the motors and the power electronics but chose not to deploy them because of concerns about ▶▶

Toyota's hydrogen gamble (continued)

range limits, refuelling time and the risk of batteries degrading as they age.

It has announced plans for its own electric vehicle to exploit the demand from the premium segment opened up by Tesla and to meet emissions standards in the US and China. Yet Toyota's fundamental doubts about battery-powered vehicles have not gone away.

The long dreamt-of Sakichi battery would store energy at the same density as the chemical bonds in petrol: roughly 10,000 watt-hours per litre - enough to power a family car for hundreds of kilometres on a single tank. The low energy density of the best batteries, about one-twentieth that of petrol, is why today's electric cars have limited range.

A battery breakthrough is not in prospect. Fundamental physics sets a limit on the potential of any given battery, so today's lithium-ion cells, and thus the range of current electric vehicles, cannot be greatly improved. There are theoretical battery chemistries, such as lithium-sulphur and lithium-oxygen, that could one day come close to petrol but no manufacturer is anywhere near putting them in a car.

At pressures used in the Mirai, hydrogen has an energy density of about 1,500 Wh/l, about three times today's batteries. Nor is there a fundamental barrier to extending the range. Refuelling is quick and nothing comes out of the exhaust pipe but water. "If you have the same convenience of a gasoline car, [in a hydrogen vehicle] that's good for the user," says Toyota's Mr Ise.

The majority of the 2,800 Mirais sold since its launch in 2014 have gone to Japanese and US companies and private consumers with access to refuelling infrastructure. Early adopters in Europe are mostly from public bodies. But the rollout suffered a setback in February when Toyota recalled its entire fleet of fuel cell vehicles due to a software glitch. The issue has been resolved, but analysts say any safety scare can be damaging when consumers are already wary of the reliability of hydrogen cars.

Toyota has to raise volumes and bring down costs. Making the fuel

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tanks is complicated and the fuel cell stack uses expensive materials such as platinum. Finding alternatives would help lower the Mirai's price of USD57,000 in the US and EUR66,000 in Europe. "If we can only manufacture about 2,000 vehicles, that's not mass production," says Yoshikazu Tanaka, chief engineer of the Mirai. "Bringing down costs is important, but the challenge is also how we can secure production capacity."

A few minutes from the Osaka headquarters of Iwataniis a hydrogen refuelling station - one of 22 operated by the energy group. Much like any other filling station there is a smartly uniformed pump attendant on the forecourt but there is little demand for the fuel.

"To build a hydrogen society, the first stage is to roll out hydrogen stations so it is not inconvenient for drivers," says Akiji Makino, Iwatani's chairman and chief executive. But he and other providers recognise that it is hard to build the infrastructure until there are cars to use it, while few will buy the cars until there are places to refuel them.

Iwatani has spent up to JPY500 million (USD4.5 million) on building each of its stations. There are now about 80 in total in Japan and Mr Makino plans to add about 10 a year towards a national target of 160 by the time of the 2020 Olympics. Tokyo is offering subsidies to reduce the burden but it is still an expensive rollout.

"Past a certain point growth will accelerate," says Mr Makino. "If we can just get past that tipping point then the move to a hydrogen society will suddenly pick up pace."

Tokyo estimates that 900 hydrogen stations will be needed to supply 800,000 vehicles nationwide by 2030 to make the scheme economical.

A bigger issue lies at another Iwatani facility - a sprawling chemicals complex in the city of Shunan that makes 10 percent of Japan's hydrogen as a byproduct of caustic soda. To do so, it burns large amounts of natural gas, which leads to the question: where will the carbon-free hydrogen come from?

"Analysts say scepticism about Japan's hydrogen push runs equally deep at home

There are no natural hydrogen deposits on Earth. You cannot dig for it, drill for it or harvest it. You have to make it. That uses energy, which is why Elon Musk, Tesla's chief executive, dismisses hydrogen vehicles as a "mind-bogglingly stupid" industrial dead end.

Analysts say scepticism about Japan's hydrogen push runs equally deep at home. "Toyota is making fuel cell vehicles but they are not the ones to supply hydrogen," says Hiroshi Hamasaki, senior research fellow at Fujitsu Research Institute. "There is no specific blueprint as to who is going to make the hydrogen, attach incentives and shoulder the costs of operating the infrastructure."

Industrial strategists at METI and the trading companies that source Japan's energy tend to agree with Mr Musk about making hydrogen from green energy via electrolysis. Their alternative vision is to make hydrogen from vast deposits of low-grade Australian coal, sequestering the carbon and burying it underground. They envisage fleets of hydrogen tankers plying the seas from Australia, bringing fuel just like today, but leaving the carbon behind.

"Japan has so few natural resources and it's hard to cover a population greater than 100 million with renewables," says Mr Katayama at METI. "The need for clean energy and energy security means hydrogen is getting attention […] in Germany and California and recently China as well. In Japan it's the environment plus energy security and industrial strategy - that is what's different from everywhere else."

A pilot project in Australia involves three commercially unproven technologies: producing hydrogen from coal at scale; shipping it thousands of kilometres in large volumes; and toughest of all, capturing and storing the carbon dioxide. Whether the cars use electricity or hydrogen, the problem of creating carbon-free energy remains the same.

For now, Toyota's priority is to get hydrogen cars on the road and drive down costs. Though they may not tackle climate change directly, fuel cell advocates point to the near impossibility of decarbonising heavy, long-distance transport without using the greater energy density of hydrogen.

"If we're told to emit zero CO2 in the future then either EVs or FCVs alone will fail," says Mr Ise. "Both of them will have to coexist."

Back at Toyota City, another Mirai rolls off the production line, bound for California. It carries a nation's hopes.

Industrial gas regulations impede swift rollout

Despite its heavy bet on hydrogen, Japan's strict safety regulations make it one of the most expensive countries in the world to build the infrastructure necessary to keep fuel cell vehicles on the road.

The cost of building a refuelling station in Japan - at about 500 million yen - is more than two times higher than in the US or Europe. The government is promising to reduce those costs and bring them into line with other countries by 2025, but industry experts say that, by that time, costs overseas will also have fallen, perhaps by as much as 30 percent compared with 2015.

Japan's problem is that hydrogen is still regulated as an industrial gas, with standards designed for large-scale chemical plants, full of explosive risks and other hazards.

The rules, for example, stipulate that there must be large amounts of space around a hydrogen car as it is refuelled and the filling station must be built with prohibitively expensive high grades of steel.

It also adds to what proponents of hydrogen regard as a false perception that the fuel is dangerous. Hydrogen is certainly highly flammable - just like petrol. Unlike petrol, however, the ultralight gas quickly disperses rather than pooling and burning.

Prime Minister Shinzo Abe has promised to overhaul some of the regulations and the revision is already under way, but industry experts say the effort is not going far enough, or moving fast enough, to make Japan globally competitive.

"Whether it's in the US, Europe or Japan, the regulations on how to handle hydrogen aren't properly in place and it's still a grey area," says Taiyo Kawai, project general manager at Toyota's R&D and engineering management division, who has spent a decade evaluating hydrogen cars.

"The [Japanese] government tends to go for the most stringent regulation to ensure the highest level of safety. But once the rules are in place, it takes tremendous energy to review them."

MANAGEMENT

Haier boss looks far beyond appliances

By Joe McDonald, Qingdao

AP PHOTO

Haier CEO Zhang Ruimin

AFTER Haier Group bought the General Electric Co. appliance unit last year, the Chinese company's chairman says he gave its American managers unusual orders: Ignore me.

Zhang Ruimin built Haier from a failing refrigerator factory in the 1980s into the biggest maker of major appliances. Now, he is trying to transform a traditional manufacturer with 60,000 employees in 25 countries into a nimble, Internet Age seller of consumer goods and services from web-linked washing machines to food delivery.

To do that, Zhang has broken up Haier into a "networked company" of hundreds of independent business units with orders to act like customer-focused startups. He says GE Appliances will be given almost total autonomy.

"One of their senior managers asked, how are you going to control us?" said Zhang in an interview at Haier headquarters in this eastern Chinese city. "I said, I'm not your boss. I'm not your leader. The leader is one person: The user."

Zhang, who at 68 is still on the job a decade after many Chinese CEOs have retired, is leading Haier through radical changes to compete in a fast-evolving global market — changes that now include GE Appliances and its 12,000 employees, most of them in the United States.

Haier's approach is a high-profile example of a wave of management experiments by Chinese companies as they expand into global markets.

The founder of e-commerce giant Alibaba Group, Jack Ma, announced plans in 2013 to split it into 25 divisions to revive the innovative spirit of its startup days. After buying Volvo Cars in 2012, automaker Geely Holdings left Swedish managers to run the company while they also cooperate on developing cars its Chinese brands might export.

Companies that grew rapidly during China's boom of the past decade also are spending heavily to invent or buy technology to improve their competitive edge as the economy cools.

Midea Group, another Chinese appliance maker, bought one of the leading makers of industrial robots, Germany's Kuka, last year.

Haier's tie-up with GE Appliances should help both companies, said Dinesh Kithany, the chief appliance industry analyst for IHS Markit. Haier gets GE technology while the American brand gets access to Haier's distribution network to expand its global presence and can learn from faster-paced Chinese product development.

"GE Appliances is a perfect decision for them," said Kithany.

Zhang launched his overhaul of Haier in 2005, splitting structures with thousands of employees into units sometimes as small as a few dozen people to focus on a single appliance or service.

Headquarters acts like a venture capital investor: Employees propose new businesses and, if Zhang and other executives like them, receive financial backing. They have to hit financial targets but are left to manage the venture.

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>
> ZHANG RUIMIN

That network has expanded to include ventures launched with outside entrepreneurs who get money and other support from Haier.

"We don't want just to produce products," said Zhang. "We want to produce creators."

In person, Zhang is amiable and quiet. With bushy, salt-and-pepper hair, he seems more like a popular high school teacher than one of Asia's most acclaimed executives — a striking contrast to some of the forceful egos of the Chinese business world. He chuckles and shrugs as he talks about challenges Haier faces.

At GE Appliances, no managers from China moved in after the USD5.4 billion acquisition closed in June. The only public change was three words added to the bottom of the U.S. brand's website: "A Haier Company."

Haier took a similar approach at Fisher & Paykel, a New Zealand appliance brand acquired in 2012.

Haier has tried to speed up product development by using the internet to ask potential customers for suggestions and feedback, an approach taken by Chinese smartphone brands. The company says a new appliance can go from drawing board to market in as little as one year, down from more than three.

Zhang's management changes "are more impressive than we see anywhere," said William A. Fischer, a professor at the IMD business school in Switzerland who has followed the company for a decade. He co-wrote the 2013 book, "Reinventing Giants: How Chinese Global Competitor Haier Has Changed the Way Big Companies Transform."

"He trusts his employees to play more of a leadership role," said Fischer.

Fischer said a group of European executives he took to Haier headquarters two years ago refused to believe its decentralized style could work.

"I was struck by how daring Haier was in their thinking. And the people I was working with were hostages to very traditional ways of working," said Fischer.

The strategy appears to be paying off. Last year's profit rose 12.8 percent from 2015 to 20.3 billion yuan ($2.9 billion) on revenue that increased 6. 8 percent to 201.6 billion yuan ($29.3 billion). Transaction volume on its business-to-business and consumer-oriented internet platforms rose 73 percent to 272.7 billion yuan ($39.6 billion).

"Some of my contacts at Fisher & Paykel say they are better off now under Haier than they were on their own," said Kithany.

Haier's decentralization could help at a time when President Donald Trump is promising to raise U.S. duties on Chinese goods and pressure for trade restrictions is growing in Europe.

Years ago, Haier identified seven "economic protection zones" including North America and the European Union that might limit trade, Zhang said. It set up factories in each one.

Haier gained a U.S. foothold in the 1990s when its mini-refrigerators became a hit with college students. In 2000, it became one of the earliest Chinese manufacturers with U.S. operations when it opened a factory in Camden, South Carolina.

"I noticed talk about such things as Trump's desire for a border tax. But for Haier, there is little impact," said Zhang. "We have factories in more than 20 countries, so we have become a localized brand."

Haier was an early promoter of the "Internet of Things," a strategy of linking appliances and other consumer electronics that GE Appliances says it wants to pursue.

During the 2008 Summer Olympics, Haier displayed a model house in a Beijing park with lighting, appliances, entertainment and other features linked by internet.

Haier is using such networked appliances as springboards into faster-growing e-commerce and other services.

Zhang emphasizes that by distinguishing between customers, who make a one-time purchase of an appliance, and users, with whom Haier will form long-term relationships. He points to the example of a refrigerator sold in China with a touchscreen on the door that has links to 400 suppliers of organic food.

Haier is starting to act like a smartphone manufacturer, treating its appliances as a channel for selling a steady stream of revenue-generating services, said Kithany.

A $500 refrigerator could make far more money for its seller if it includes an e-commerce connection that can reap a share of the $20,000 a family might spend on groceries during its 15-year life span, said Kithany.

Zhang said he launched Haier's overhaul after concluding it was handicapped by the "thick chunk" of middle management focused on planning, finance and other functions.

The change was painful, wiping out 10,000 jobs.

"We gave them two options: they can be like anyone else and look for someone in Haier to form a team to create a product," he said. "If they cannot become an entrepreneur, they have to leave. A lot of people left."

The more than 1,000 "micro-enterprises" launched by Haier include 47 that have raised money from outside investors, Zhang said.

Employees of those units were required to put in their own money "to make sure everyone shares in the success," he said. One team raised 11 million yuan ($1.6 million) and some employees sold their homes to make their contribution.

"Once I am sure this process is a success, then I can retire," he said. **AP**

AP PHOTO

Haier factory in Jiaozhou near Qingdao

Norway kicks off minke hunt, raises quota to 999 whales

Norway on Saturday kicked off its annual six-month whale hunting season with whalers allowed to kill an increased quota of 999 minke whales, up from 880 animals in 2016.

The International Whaling Commission imposed a commercial ban on whaling in 1986, but Norway objected. Norwegian officials estimate there are more than 100,000 North Atlantic minke whales — which are not an endangered species — off the long ragged western coast of Norway where the hunt takes place.

Despite the new kill quota, officials say that quota of whales has not been fully taken in recent years because demand is scant for whale meat and the industry has seen its numbers decrease because of retiring whalers. They say Norwegian whalers have killed between 30 and 60 percent of their quota in recent years.

Greenpeace called Norwegian whaling "a dying industry" and said it was wrong of Norway to violate international agreement. A documentary recently aired on Norway's public broadcaster NRK reported that most of the minke whales hunted in Norwegian waters are female and many are pregnant.

On Friday, Japan's whaling fleet returned home after killing 333 whales in the Antarctic, achieving its goal for the second year under a revised research whaling program.

The Fisheries Agency said the five-ship fleet finished its four-month expedition without major interference from anti-whaling activists.

The International Court of Justice ruled in 2014 that Japan's Antarctic whaling program should stop because it wasn't scientific as Tokyo had claimed. Japan conducted non-lethal whaling research in the Antarctic in 2015, and revised its program in 2016 by reducing the catch quota to about one-third of what it used to kill. **AP**

China plans panda preserve 3 times size of Yellowstone park

AP PHOTO

CHINA is planning to create a preserve for the giant panda that will be three times the size of Yellowstone National Park in the western U.S.

The panda preserve will link parts of three western provinces to provide an unbroken range for the endangered animals in which they can meet and mate in the interests of enriching their gene pool, the Xinhua News Agency said Friday.

Xinhua said about 170,000 people will have to be moved elsewhere to make way for the 27,134-square kilometer preserve.

Giant pandas are China's unofficial national mascot and live mainly in the mountains of Sichuan, with some in neighboring Gansu and Shaanxi provinces. An estimated 1,864 live in the wild, where they are threatened chiefly with habitat loss, and another 200 in captivity.

Residents of the future park area will be offered homes and jobs, some as guides. Although they had lived in the area for generations, they were disrupting the lives of the pandas with their bamboo harvesting and livestock grazing, Xinhua said.

Preservation of the species was further hindered by provincial borders between Sichuan, Gansu and Shaanxi that enforced different standards on protected land.

The new preserve will merge 67 smaller reserves for pandas and protect another 8,000 endangered animals and plants, Xinhua said.

"Unlike nature reserves, the park does not stand alone. China will formulate an overall plan for the national park system. It will be a haven for biodiversity and provide protection for the whole ecological system," Hou Rong, director of the Chengdu Research Base for Giant Panda Breeding in Sichuan province, was quoted as saying.

The giant panda preserve will join eight other existing national parks aimed at protecting endangered species and the ecology of land lying at the headwaters of major rivers such as the Yellow and Yangtse. **AP**

ASK THE VET

by Dr Ruan Du Toit Bester

7 Common Dog Ear Problems and Symptoms

Dog ear problems are easy to spot, but you must be able to differentiate between them to determine the best treatment. Floppy-eared dogs are more vulnerable to ear problems, but a dog ear problem can affect any dog.

Seven common dog ear problems

- **Allergies:** The most common cause of dog ear problems is an allergic reaction of some sort. Allergies can be caused by food ingredients or environmental irritants such as pollen or dust. Itchy, inflamed ears and paws are symptoms of an allergy. Switch to a low-allergen food that does not contain wheat, soy or corn. Often, switching to a higher quality dog food reduces allergic reaction ear problems. Keep the environment as dust free and clean as possible.

- **Ear infections:** If you have a drop-eared dog, ear infection may be on ongoing problem. The warm, moist environment created by the fold in the ear flap is ideal for bacterial growth. Yeast and bacterial growth will cause odor in the ears. If the infection is confined to one ear, your dog may tilt her head in an attempt to equalize pressure. The ears may feel warm to the touch.

- **Debris in ears:** Foxtails, plant awns and other debris can get inside a dog ear. Look inside your dog's ear with a flashlight; debris can wedge itself quite deeply. Do not insert anything inside your dog's ear - you may cause further damage.

- **Parasites:** Ear pain and itching associated with parasites can cause ear problems in your dog; tick bites, mites and fleas can cause swelling, hair loss and crusty skin.

- **Trauma:** An ear injury can cause swelling or a dog ear hematoma. An animal bite or other trauma can allow blood and fluid to accumulate between the cartilage and the skin of the ear flap. Even vigorous scratching or head shaking can cause this condition. The ear will become swollen and disfigured. An ear hematoma should be drained and surgically corrected. If untreated, the ear will be permanently disfigured. Go see your vet immediately if this happens.

- **Hormone disorders:** Certain hormonal conditions such as hypothyroidism and adrenal malfunctions can cause ear problems. You may notice poor coat quality, behavioral changes and hair loss in addition to itchy, reddened skin around the ears.

- **Other causes:** In rare cases, ear problems are the result of a hereditary disorder such as dermatomyositis (a connective tissue disorder in Collies and Shelties) or seborrhea which causes hair loss and scaly skin. Cancerous condition such squamous cell carcinoma or malignant melanoma may also affect the ears; check for darkened or scaly patches of hairless skin.

Hope this info helps
Till next week
Dr Ruan

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