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Toyota's Green Road to Growth

"Toyota is committed to sustainable development through innovation that balances economic growth with environmental protection"
- Katsuaki Watanabe

A murmur swept through the crowd of media representatives attending the Toyota press conference at the North American International Auto Show in Detroit on Jan. 13. Toyota Motor Corporation President Katsuaki Watanabe had just made a stunning announcement: "By 2010, we will accelerate our global plug-in hybrid R&D program. As part of this plan, we will deliver a significant fleet of plug-in hybrid vehicles powered by lithium-ion batteries to a wide variety of customers." The innovative new plug-in hybrids will be able to cover greater distances on electric power alone, while producing significantly less CO_2 than other hybrid vehicles.

Just days before the Detroit show, Watanabe set out his vision for Toyota's future at the company's headquarters: "Toyota cannot grow without improvements in quality. That means not only enhancing our technology, product quality and cost competitiveness, but also maximizing our contribution to sustainable development. Sustainability is key to our management policy."

Watanabe recognizes that economic growth must be coordinated with the needs of our planet and society in mind. "Innovative technology is the biggest key to achieving development that is balanced between economic growth and the environment," Watanabe says. "We are inspired by a core value of our company's management philosophy, *The Toyota Way*. It promotes respect for people, a reflection of our faith in human ingenuity. Our long-term plan, *Global Vision 2020*, declares our belief that we can open the frontiers of tomorrow through the energy of people and technology."

Toyota hybrid vehicles have reduced carbon dioxide output by over five million tons

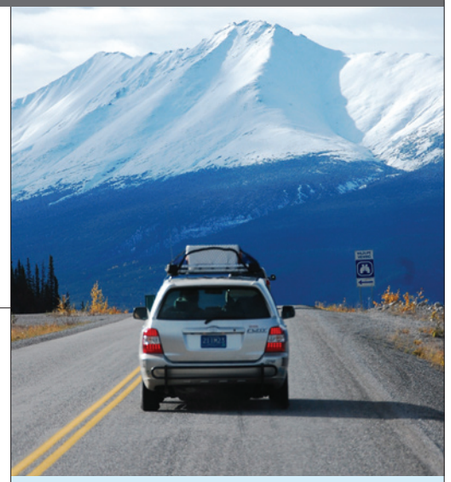
ABOVE: Katsuaki Watanabe envisions a green road to growth TOP RIGHT: A Toyota Fuel Cell Hybrid Vehicle (FCHV) delivered outstanding performance under cold conditions

Creating Sustainable Mobility

"We try to develop technology that minimizes the negative impact toward people and the environment while maximizing the enjoyment of driving"
- Katsuaki Watanabe

In his address to journalists at the Detroit Motor Show, Watanabe said, "Last year, as never before, industry, government and mainstream consumers came to grips with the need to address global climate change. I believe we will all remember 2007 as the year that the world responded to a wake-up call too long ignored." Watanabe pointed out that Toyota has long promoted what it calls 'sustainable mobility,' a vision of motor vehicles in accord with the environment. "Sustainable mobility recognizes that a wide variety of advanced technologies will be part of our future. But only if these technologies can appeal to, and reach, the mass market," Watanabe said.

Sustainable mobility addresses four key areas. First, the vehicles themselves and advanced technologies. Second, the urban environment, where these new technologies will be used. Third, the need for partnerships between energy and transportation companies along with government and academia to bring new technologies to market. Fourth, the energy challenges surrounding the use of advanced vehicles.



Going the Distance

Toyota's hydrogen fuel-cell hybrid powered vehicle made a landmark trip from Alaska to Vancouver, making a huge stride forward in the long distance operation of a hybrid fuel-cell system, which has no emissions other than water vapor. Driving 2,300 miles (3,700 km) on hydrogen alone, the Toyota Fuel Cell Hybrid Vehicle (FCHV) completed the trek from Fairbanks Alaska to Vancouver British Columbia in seven days, averaging more than 300 miles (480 km) between refuelings. The trial performed in the last quarter of 2007 confirmed substantial progress in reliability and durability, cold-weather operation and extended range capability of Toyota's hybrid fuel cell system. As with Toyota's hybrid technology, Toyota's fuel-cell program has been an entirely in-house initiative. All key components, including the next-generation fuel-cell stack, battery and power management system were solely developed by Toyota.

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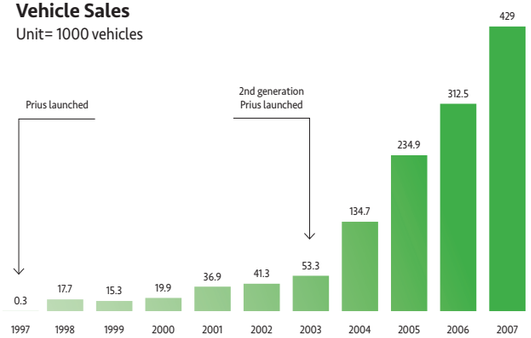
Worldwide Toyota Hybrid Vehicle Sales
Unit= 1000 vehicles



ABOVE: The new Toyota Highlander Hybrid
BELOW: The Toyota Biofuel division

With regard to the vehicles themselves, Watanabe notes that "Automobiles produce not only CO_2 but also NOx and other noxious emissions. The challenge is to come as close as possible to eliminating these. Our R&D team is continuously creating cleaner conventional engines, while exploring every alternative approach including ethanol, electricity and hydrogen. Hybrid technology is a core technology that can improve environmental performance in all energy and powertrain applications."

Unquestionably, Toyota is a pioneer in developing and marketing technology that addresses some of the causes of climate change. The automaker launched the world's first mass-produced gasoline-electric hybrid vehicle, the Prius, in 1997. By January 2008, global cumulative sales of Toyota hybrid vehicles had topped 1.32 million units. In terms of combating global warming, the effect of these Toyota hybrid vehicles has been to reduce carbon dioxide output by over five million tons. But rather than basking in its success as the hybrid leader, Toyota is pursuing sustainable mobility with even greater effort. Goals include annual sales of one million hybrids by the early 2010s, followed by hybrid versions of all vehicle models during the 2020s.

Engines of Change

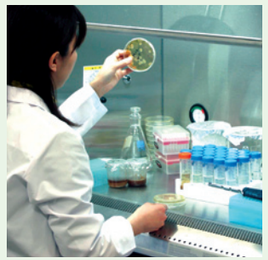
Toyota is revamping all of its conventional engines and transmissions over the next two years to achieve improved air quality, increased fuel economy and a reduction in CO_2 output. These efforts extend to Toyota's mass-produced diesel engines featuring a new diesel purification system called DPNR advanced catalytic converter technology. Toyota plans to expand and enhance its environmentally–friendly diesel engine range to meet increasing demand. At the Detroit show, Watanabe announced that a new clean-diesel V8 engine would be offered in both the Tundra full-size pickup and the Sequoia full-size SUV, sold in North America, in the near future.

The choice of alternatives for the future depends on local conditions. For example, Brazil, with its abundant sugarcane plantations producing raw material for fuel ethanol, is an ideal market for flex-fuel vehicles that can run on up to 100% ethanol. Next year, in North America, select 2009 Tundra models equipped with the 5.7-liter V8 will have flexible fuel capability to run on E85 ethanol. The latest technologies are being incorporated into specific product plans based on Toyota's concept of "the right vehicle, in the right place, at the right time."

Wood Chips: A Friendlier Biofuel

Biofuel is fuel that's developed from organic material, usually plant matter. Biofuels such as ethanol are considered to be 'carbon neutral,' that is, the CO_2 emitted into the atmosphere when the fuel is consumed is no greater than that taken from the atmosphere during the plant's growth. In other words, there is no net increase in carbon dioxide, one of the main gases implicated in global warming.

Toyota is developing cellulosic ethanol production capability based on its biotechnology expertise, which will enable biofuel to be obtained from non-food plant sources such as wood chips. Unlike today's biofuels, which are made from food crops such as corn, sugarcane and soybeans, cellulosic ethanol is made from inedible plant materials, which will not affect food supply and price.



Safety and the City

Safety is an important element of sustainable mobility which looks at the urban environment where these new technologies will be used. "I want Toyota to develop a dream car, a vehicle that cannot injure people, and to help create an urban infrastructure that can keep accidents from happening," says Watanabe. "We have developed a Pre-crash Safety System, which offers features that include front-end pedestrian detection and rear-end vehicle detection functions, which could be described as the first safety technologies of their kind."

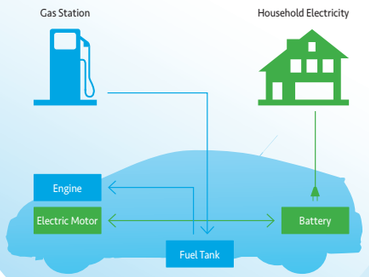
Going beyond vehicle design, Toyota is working with local governments and academic researchers to develop smart infrastructures that will enhance safety and reduce traffic congestion. This Intelligent Transport System (ITS) technology uses vehicle-to-vehicle and vehicle-to-infrastructure communication to reduce the burden on drivers and minimize the risk of accidents.

Plug-in, Drive Off

Toyota's Plug-in Hybrid Vehicle (PHV) offers an example of how progress in sustainable mobility can benefit from partnerships. In Nov. 2007, Toyota delivered prototype PHVs to the University of California's Berkeley and Irvine campuses, where researchers will work with industry and state partners to study user response to the technology and recharging infrastructure needs. Meanwhile, Toyota has teamed up with France's EDF Group, a leading player in the European energy industry, to evaluate plug-in hybrid vehicles in Europe. Toyota's PHVs are integrated into EDF's fleet for testing on public roads in France. EDF and Toyota are developing a system that will facilitate battery charging at a new generation of public charging stations on roads and in car parks. To maximize the PHV's potential, Toyota has formed a partnership with Matsushita Electric to begin developing high-performance lithium-ion battery technology, which offers higher energy and output densities compared to today's conventional nickel metal hydride (NiMH) battery type.

ABOVE: Pierre Gadonneix, President and CEO of EDF (L) and Masatami Takimoto, Executive Vice President, Technology, of Toyota (R) with plug-in hybrid road-test model in Europe

Plug-in Hybrid: How it Works



RIGHT: Whereas a regular hybrid can only charge its battery while driving, a plug-in hybrid can also be charged from an external electric power source, either in the home or on the road

TOYOTA

Making Manufacturing Sustainable

"Environmentally-friendly vehicles have to come from environmentally-friendly plants"- Katsuaki Watanabe

Toyota is integrating its vehicle-production plants with the environment—by applying innovative technologies to "make more with less," using renewable energy, planting forests around factories and encouraging interaction with local communities.

Toyota has positioned its Tsutsumi Plant, where the Prius is produced, as a model 'sustainable plant' for other Toyota sites worldwide. The plant has achieved a reduction in CO_2 emissions of approximately 50% compared to 1990 levels. Efficient use of resources and installation of a 2,000kW photovoltaic generation system help reduce the environmental footprint. The local ecosystem is improved by planting native tree species in and around the plant. At Toyota's Takaoka Plant, radically re-engineered assembly lines allow cars to be made faster with less energy.

By reducing the size of its plants and the amount of energy used in manufacturing, Toyota aims to slash waste and CO_2 emissions. Toyota Motor Thailand's Ban Pho Plant, which opened in Jan. 2007, was built with the aim of serving as an innovative model plant in the Asia-Pacific region. Its cogeneration system maximizes energy efficiency of conventional power, while its solar panels generate environmentally-friendly electricity. In addition, the plant recycles wastewater, employs water-borne metallic paint at vehicle body painting lines and has contributed no waste to landfill since the beginning of operations.

ABOVE: Thailand's Ban Pho Plant has solar panels on its roof to generate electricity
BELOW RIGHT: Toyota's sustainable plant program is expanding worldwide

In North America, the Toyota Motor Manufacturing, Mississippi, Inc. (TMMMS) Plant—now under construction—will also serve as a model sustainable plant. In addition to introducing innovative eco-efficient assembly line technology, TMMMS is also planting native trees as part of an effort to be in harmony with the environment and local community. In Europe, activities will be spearheaded by Toyota Motor Manufacturing (UK) Ltd. and Toyota Motor Manufacturing France S.A.S.

Sustainable plant activities involve people as well as technology. "A key goal is building the eco-consciousness of our team members in cooperation with the surrounding community," says Watanabe.

Worldwide expansion of Toyota's model plant

MIKI YOSHIHARA

Empowering Employees

To keep enhancing sustainability, Toyota's plants seek suggestions from employees. With Toyota's Eco-point System, employees who offer ideas that help to reduce energy and conserve the environment, or who take part in environment-related events (such as beautification activities around the plant), are awarded points and qualify for awards. The Tsutsumi Plant holds an autumn festival with environmentally-themed events to promote the plant's initiatives among employees, their families, and the local community. As a result, people take greater pride in their work and their workplace.

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Nurturing a Sustainable Society

"We want to foster the development of human resources and systems that contribute to sustainability worldwide"- Katsuaki Watanabe

As an automaker, it is natural for Toyota to contribute to sustainability through its vehicles and plants. But Toyota is also directly supporting many environmental and social-sustainability initiatives in other areas. A prominent example is the re-greening of thousands of hectares of land that had become deforested deserts. In China, this afforestation initiative has included the introduction of fruit-tree cultivation techniques, which contribute to the livelihood of local communities.

Toyota has also helped set up a center in China to foster afforestation expertise and disseminate information on greening technology. Applying the expertise gained in China, Toyota is expanding its tree planting activities to an area of the Philippines where logging for fuel and slash-and-burn agricultural methods have caused deforestation. There, it will help establish a renewable forest, harvested specifically for fuel, while encouraging residents to cultivate alternative cash crops like mangoes and cocoa beans.

"Our greatest desire is for our products to contribute to a better life for people around the world, both directly and indirectly" says Watanabe. "Rather than just trying to do good, we think deeply about how our technologies may be of wider benefit."

BEFORE

AFTER

ABOVE: Polish volunteers plant a community garden
BELOW LEFT: What was once desert is now green forest

Inspiring a New Generation

Toyota's contributions to society are diverse and global. Many programs focus on the next generation, involving schoolchildren in educational and environmental activities. A case in point is the Toyota Schools for Sustainable Development program supported by Toyota companies in Poland, the United Kingdom, and the Czech Republic. The program mobilizes volunteers and provides grants to schools and local community groups to identify, plan and carry out local environmental improvements. In Poland, participants have refurbished playgrounds, created community gardens, conserved historical and cultural assets, and conducted other projects at some 30 sites. Toyota plans to expand the program throughout Europe in the future.

Taking up the Challenge

Watanabe is eager for Toyota to make more contributions to sustainability. "It's all about taking up the challenge and not being afraid to make mistakes along the way. Through innovation, we believe that we can realize an ideal mobile society in which conservation of our natural environment is compatible with economic growth. The accumulated wisdom of generations of Toyota innovators, which we call *The Toyota Way*, instructs us to meet challenges with courage and creativity, and with respect for people and teamwork. These are the key principles that have fostered our corporate vitality for 70 years and that drive us toward a sustainable future for mobility, people and the planet."