Creating Innovation Conducive to Energy and the Environment

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1. Preface

I would like to talk about what we should do now in our pursuit of the next innovation that will help us meet challenges regarding energy and the environment, looking back on how we developed the Prius, the first mass-produced hybrid vehicle in the world.

2. Invention of Prius and its Influence

The Prius made its debut as the year-end of 1997, which was seventeen years ago. It was launched with a catchword "Just in time for the 21st century."

Development of the Prius started in autumn 1993. I was appointed to lead the project, with only two orders to guide my R&D team. One was to "create a car for the twenty-first century"; the other was to "change Toyota's vehicle development process."

We foresaw that energy and the environment must be a serious problem in the twenty-first century, but no one had come up with the answers yet, no one was doing anything about that. So we became determined that Toyota should come up with an answer by bringing out a vehicle with an off the charts fuel economy performance. With this concept, we put a hybrid-vehicle system on Prius.

Through a trial and error process, we finally released the Prius in December 1997, which was four years after the embarkation of the project.

I am confident that the Prius achieved the status of a technological innovation, and created significant trend in the world. That is, we set a criteria for customers in choosing cars for their environmental performance. Today, auto

manufacturers are competing furiously to improve fuel efficiency of conventional gasoline or diesel vehicles. I believe it was Prius that set this positive trend.

3. Why the Innovative Prius was Applauded

There are three reasons why the innovative Prius turned out to be such a commercial success. First, we went to great lengths to make the vehicle from the point of view of our customers. I believe no technology will penetrate into society without considering customers' usability and comfort.

Second, we struggled to identify social needs where automakers are required. As the Prius hit the market near the end of 1997, the Kyoto Protocol was being signed, and awareness surrounding greenhouse gas emissions and other global environmental issues were surging worldwide. The Prius was a logical sequence of history, and an innovation for the times.

The third is management of the project. Doubling fuel efficiency — setting such a high bar fired up our engineers — created for those engineers an environment in which they could feel themselves grow and sustain their enthusiasm. Establishing a clear goal — to launch the vehicle as a commercial product in 1997 — made that goal dictate the process for the team.

There is another reason why Prius is worthy of being called an innovation. That is the hybrid technology is a core technology that is applicable to electric vehicles (EV), plug-in hybrids (PHV) and fuel cell vehicles (FCV).

4. FCV "MIRAI" and Hydrogen Society

Last year, we developed and introduced "Mirai", which is Fuel Cell Vehicle, to the world, incorporating that hybrid technology. The introduction of Mirai is explainable in the context that the hydrogen society is heralding a new era

in which we want to invent a new vehicle securing zero-emissions and riding comfort.

I can name a number of advantages of FCVs. The amount of CO_2 that is emitted in producing hydrogen, which is fuel for FCVs, varies depending on the primary energy source. Hydrogen can be created from a wide variety of primary energy sources.
FCVs do not produce any CO_2 while running. They also achieve excellent range with travelling performance as good as electric vehicles. The time for replenishment of hydrogen is on a par with conventional gasoline engine vehicles. Its ability to supply electricity in case of emergency is one unique advantage.

Today there are many ongoing efforts aimed at creating a low-carbon society, such as smart grid and renewable energy sources.
However, renewable energy sources are unevenly distributed due to unpredictable factors. Thus, stabilizing the supply of renewable energy is a challenge that must be overcome. Connecting this to hydrogen will lead to optimal energy use, which is what creating a hydrogen society is about.

The idea is to produce and store hydrogen using electricity generated from renewable energy sources, then use that stored hydrogen as necessary to generate electricity, or transfer it in bulk. This way by constructing a society where the electricity grid is connected to the hydrogen grid, we can move further in the direction of a low-carbon society.

The FCV should be able to make a major contribution to the achievement of a hydrogen society, where hydrogen is used in our daily lives and industrial activities. As such, it could be a major innovation that helps meet challenges on the global environment and energy fronts. If the FCV enjoys broad social acceptance and increases the use of hydrogen as an energy carrier, it will turn

out to be an impactful technology that is able to significantly alter the future of our society. The FCV has the potential to be a technological innovation with far greater potential than Prius.

5. How Should We Address the Next Innovation?

The Government of Japan is building a robust and innovation-friendly country, reinforcing *the Council for Science and Technology and Innovation*. With this background, the Government has been steering science and technology policy that will strengthen Japan's competitiveness, generate and uplift related industries, and increase income and employment, expecting fundamental researches to be put into practical use and commercialization, which is its destination.

As the Government moves forward with its undertakings, we in the private sector also bear the great responsibility of showing our own mettle to generate innovation and revitalize Japan as a science and technology powerhouse.

Hoping that I can be of help to that end, I will offer my thoughts on the factors that lead to successful innovation.

New technologies and services can only be called "innovative" if they are widely diffused. To put it another way, self-satisfaction on the part of the engineer will not produce such a technology. Positive stance is important, such as in-depth research into social needs.

Another key concept is "bridge building." It is also important to connect technological seeds to the goals at the other end of the process. For that purpose, it is necessary for universities, R&D institutions and businesses to enhance their respective global competitiveness. On that condition, it is of the utmost importance to reinforce this collaboration between academia,

government and industry; namely, generating dynamic flow of staff, products, and funds.

My final point concerns the social fabric of Japan today. It is necessary to make our society diverse where women can fulfill their potential. It is important to build an environment where a more flexible mindset as well as perspectives and thought processes that may differ from those of men can be integrated to create new ideas.

I must ask something of the government: consistency of policy, decentralization of administrative functions from Tokyo, and so on. We in the private sector will bring all our energy to work together with the government in order to generate innovation.