

# 2013 Toyota Hybrid World Tour - Satoshi Ogiso

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*As prepared for:*

2013 Toyota Hybrid World Tour

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**Satoshi Ogiso, Managing Officer, Toyota Motor Corporation**

Good afternoon everyone. And thank you for joining us here today.

As Mr. Uchiyamada said in his welcoming remarks last night, this is the first time Toyota has gathered its current, full global fleet of hybrid vehicles. So it is also the first time that *I* have seen them assembled together as well. You can imagine how I feel... at such a family reunion. Very special.

As I am sure everyone understands, this event is focused on our entire lineup of hybrids. It is my job to give you a taste of what we have in store in our *hybrid future*. However, it's impossible not to begin with how it all **began**.

I was one of the lucky engineers to be assigned to the G21 program in October 1993. I had been working for Toyota for 10 years, and I was assigned to the product-planning department.

G21 stood for "Global 21st Century." Ironically, its goal was **not** to develop a hybrid vehicle. Instead, its goal was to develop an affordable five-passenger family car, that would address the fuel efficiency and environmental needs of the 21st century.

Our focus was not on the **next generation**. It was to be much further into the future.

Initially, the idea was to develop a car that delivered a 50% improvement in fuel economy... of a typical Toyota compact sedan powered by a 1.5-liter engine before the beginning of the 21<sup>st</sup> century.

At the time, a separate powertrain group was showing considerable progress on a gas-electric hybrid system that eventually became the key to achieving our cost and performance targets.

As the benefits of going hybrid became clearer, there was an important change in strategy. Instead of doing what we **could**, we would try to do what we **should**. A new goal was set.

Again, based on a typical compact sedan and 1.5-liter engine, we would double fuel efficiency, cut emissions in half and reduce development time by two years. To achieve these goals, many diverse elements would come into play, including things like aerodynamics, rolling resistance and lightweight.

Does anyone know what these numbers represent?

At the time, we identified 80 different hybrid configurations that could be considered. We narrowed it down to the top-20, then ran them through simulations seeking "*overwhelming fuel-efficiency...*" and found four prime candidates.

At this point we could assess degree of difficulty and cost.

The clear winner was a *series-parallel* hybrid design with fairly simple hardware of two motors and a planetary gear set... but **highly complicated** software.

Despite the complexity and up-front investment in the software, increased volume would not mean increased cost. This would be the most viable system with an eye to the future.

During G21 development of a single car... the Prius... it became clear that the series-parallel technology was adaptable to a broad range of vehicles.

In fact, there was no reason to think that every one of our passenger cars could, one day, offer a hybrid powertrain.

**Most importantly**, it seemed to be a system that held great potential... for constant improvement, for *many* years to come. Uchiyamada-san would be right. If this was a bridge technology it looked like a very long bridge.

About the time we launched Prius in the U.S., we set in motion just such a long-range hybrid development plan. Here in the U.S., we began with the simultaneous development of hybrid versions of the Toyota Highlander... and Lexus RX. In Japan, we added the Estima and Alphard.

Prius, which means “go before,” would be the first of many diverse takes on the basic hybrid concept.

Since the launch of Prius in 1997, we now have 23 Lexus and Toyota hybrid models in various global markets, including Prius Plug-in.

When the next generation Prius arrives, it will begin a new era for a broad range of Toyota and Lexus vehicles by marking the arrival of a substantially improved family of hybrid powertrains.

Think of it as, G21... point five.

These new hybrid powertrains will deliver significantly improved **fuel economy** in a more **compact** package that is **lighter** in weight and lower in **cost**.

The performance of this new generation of powertrains will reflect significant advances, in battery, electric motor and gas engine technologies...

And is part of Toyota’s larger portfolio strategy towards the *electrification* of the automobile including plug-in hybrid, battery electric and fuel cell technologies.

Toyota has a deep commitment to vehicle electrification and therefore, to advancing drive-battery technology. Our next generation of hybrids will feature improved batteries with higher *energy density*; that is... the relationship between the battery’s output and dimensions.

We have stepped up our research, development and production capacity... on both nickel-metal hydride and lithium-ion.

And looking to the future, we have ramped up development on new battery technologies like solid state... and lithium air, as well as devoting resources to new chemistries beyond lithium, such as magnesium and other low valence materials.

The next-generation Prius, specifically, will combine our advanced battery technologies with new electric motors that are smaller in size, and feature improved power density.

For example, the current Prius motor provides 4 times the power density of the first. The next Prius power density will be even higher.

Sometimes lost in the discussion of hybrids is the importance of the gasoline engine and its thermal efficiency. For example, the current generation Prius gasoline-engine has a thermal efficiency of 38.5 percent.

The new engine in the next Prius will be more than 40 %. A world's best.

So where do these advancements take us?

The current Prius has been America's fuel economy king for many years.

In its three generations, Prius MPG has improved on average... by about 10 percent, each generation. The challenge to continue to improve at this rate... *to beat your own record*... becomes very difficult, but makes it all the more motivating. I can tell you... that we are very motivated to beat our record.

To complement these substantial gains in powertrain development the next Prius will ride on a vastly improved chassis.

My background is chassis engineering. In fact, I chose to come work for Toyota when I was much younger because of the Corolla GT AE86.

The next Prius will feature the Toyota New Global Architecture or TNGA. It will have a lower center of gravity and increased structural rigidity. This, along with many other improvements will allow for beneficial gains in ride-and-handling... agility and aerodynamics.

Its interior will be roomier with significant refinements in design, layout **and** ease of operation. And...it will introduce key advanced safety technologies.

Developed in parallel with the next Prius will be the next-generation Prius plug-in.

We have been listening very carefully to Prius PHV owners over the past two years... and are considering their requests for additional all-electric range.

We have also heard from these owners, that they would like a more convenient charging operation. In response, we are developing a new wireless/inductive charging system that produces resonance between an on-floor coil and an onboard coil to recharge the battery without the fuss of a cable.

We will begin verification of the system in Japan, the US and Europe in 2014.

About as long as we have been selling Prius, we have been developing another form of hybrid technology of critical importance to future mobility. Delivering zero emissions, along with driving range and refueling time on

par with conventional vehicles, hydrogen will be in our future for a long time.

Toyota's first commercially available hydrogen fuel cell vehicle will go on sale in global markets in 2015.

At the 2011 Tokyo Motor Show, we unveiled the FCVR fuel cell concept. This year at the Tokyo Motor show, we will get a bit more specific, when we unveil a well-defined mid-size four-door sedan concept.

That vehicle will make its North American debut at the 2014 Consumer Electronics Show in Las Vegas in January... where Bob Carter will discuss the role of our US-based engineering team in its development... as well as a few of our preliminary plans for introduction into the US market.

For now, I can tell you that the hydrogen fuel cell stack is currently developing 3kw per liter of power density.

We believe that's a "world's best"... and about twice that of the fuel stack... we have been using for the Highlander fuel cell hybrid vehicle that many of you have driven. If you have not, please take the opportunity during our ride-and-drive segments.

Finally, I would like to address how hybrid technology is influencing motorsports... and how motorsports will help us develop better hybrid technologies in the future.

In 2007, with our passenger-car HSD serving as a starting point, we began work on high performance technologies and components needed to develop a hybrid drivetrain for elite competition: specifically, the TS-030 World Endurance Championship Le Mans prototype.

The challenge of the hybrid race car has been the added weight of the battery and electric motor. The TS-030 uses super capacitors instead of batteries, which show great promise for their ability to recover, store and release energy...very quickly.

This potent hybrid powertrain integrates a unique inverter, with a 300-HP electric motor/generator sandwiched between the 6 speed-transmission and the 530-HP V8 engine.

The extreme nature of racing, tests the durability and reliability limits of vehicle components, systems and software helping make TS-030 the world's fastest and possibly the most effective rolling hybrid laboratory program.

Bob Carter mentioned earlier today... that to take full effect, hybrid technology must be consumed in high volume. **Regulatory push** cannot, on its own, induce **consumer pull**.

To truly have an effect, our industry must develop a diverse array of products that consumers are willing to buy.

Where the cost premium is low convenience is high... and the benefits to the environment... and the pocketbook... are clear. Which is precisely where we believed hybrids **would** be, 15 years ago.

Today, patience and a long vision are still the cost of admission. Because consumer adoption of less convenient and higher cost technologies have been slow... and will continue so.

But fifteen years from now, I believe that plug-in hybrids, battery electrics, **and especially hydrogen fuel cells could be as common as hybrids are today.**

Perhaps members on my staff, working on fuel cells will be able to say they were in-on-it from the beginning the way I have been with hybrids.

I believe that will happen.

Thank you all for joining us today.