

# Paving the Way for an Electrified Future

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One of the questions I'm frequently asked is, "When will electric vehicles become mainstream?" to which I reply, "They already are."

The electrification of automobiles is arguably the greatest force transforming our industry. Appearing as early as the 1800's, electricity has served us increasingly well across the automotive spectrum, giving rise to continuous advances in lighting, ignition, communications, processing, propelling, regenerating, all manner of efficiencies, and more. Today, electricity—along with the connectivity and autonomy that it enables—is powering the industry's transformation towards sustainable mobility for all.

So, electrification is with us, and it is the future. And it's also a core strength of what we do at Toyota. Three exciting examples help illustrate this. The first is Toyota's development of electrification initiatives with worldwide collaborators like Aurora, Shell, Panasonic, SoftBank, and Mazda. The second is Toyota's commitment to offer an electrified version of every vehicle model in the Toyota and Lexus lineup around 2025. This is the equivalent of approximately 5.5 million vehicles globally. The third is to sell over 1 million zero-emissions vehicles by 2030.

And we're not stopping there. In fact, as revealed earlier this year, Toyota is teaming up with the Japan Aerospace Exploration Agency (JAXA) to develop what many might call the ultimate, out-of-this-world, electric SUV—a pressurized, manned lunar expedition rover—to take our advanced, versatile and durable Toyota fuel cell electric technology to the moon.

## **Hybrid Vehicles**

Our electrification roots themselves are grounded in another history-making launch—that of our very first hybrid-electric, the Toyota Prius, over 20 years ago. With revolutionary vehicles like the Prius, and every other class-leading hybrid-electric vehicle launched since, and evolutionary descendants like our zero-emissions fuel cell electric Mirai, Toyota has long helped pioneer the path to electrification, providing a range of products intelligently engineered to meet our customers' diverse needs via varying levels of electric generation, regeneration and propulsion.

This electrification journey is perhaps best illustrated by its efficiency and emissions benefits. If we begin with a vehicle powered by a conventional internal combustion engine, adding an initial layer of electrification via a regenerative braking, battery and motor system enables virtuous reductions in fuel consumption, engine size and harmful emissions.

## **Plug In Hybrid Vehicles**

Adding a second level of electrification—in the form of expanded battery, electric motor, power control and operating capabilities—enables even greater performance, efficiency and emissions gains. An example of a vehicle incorporating such advantages is the Toyota RAV4 Prime hybrid-electric plug-in, which allows customers to have their cake and eat it, too. Simultaneously possessing both electric and conventional fueling capability, the RAV4 Prime provides exceptional range, rapid acceleration and the commute-changing ability to serenely operate on battery power alone for up to 42 miles of zero-emissions driving. Overall, the RAV4 Prime offers owners a persuasive package of over 300 horsepower, EPA-estimated 94 MPGe efficiency and 600 miles of total driving range.

## **Battery Electric Vehicles**

Highest on our efficiency scale is the third stratum of electrification—pure electric vehicles. These completely replace carbon-emitting internal combustion engines with electric motors to provide silent, smooth, clean propulsion. Traditional pure electric vehicles are powered by batteries upsized to provide sufficient performance, range and longevity.

## **Fuel Cell Electric Vehicles**

An even more promising form of pure electric mobility is the fuel cell electric vehicle, such as the trailblazing Toyota Mirai. Like the original Prius, the Mirai has pioneered a new era of electrification for Toyota, and in its initial generation has now sold over 10,000 global units. The second-generation Toyota Mirai launched in 2020 with dramatic advancements in style, volume, versatility, features and performance—including a leap to over 400 miles of pure, clean, zero-emissions driving range.

Vehicles like the Mirai utilize hydrogen to generate their own electricity onboard, while emitting nothing but water vapor from the tailpipe. Fuel cell electrics overcome many issues associated with battery electrics — lengthy recharging times, reduced range, diminished performance and lower infrastructure throughput. Fuel cell electric vehicles do require hydrogen fueling stations, but over 40 such retail stations and counting already exist in California to serve a growing population of thousands of vehicles. Many more hydrogen fueling stations are under development with the prioritized support of the state, and station development in the Northeast is also underway. For fundamental reasons such as these, our fuel cell electric vehicle program — based on our core, layered, hybrid-technology strength — is a central thread woven into Toyota’s global electrification strategy (see Figure 1).

## **FIGURE 1 / TOYOTA’S GLOBAL ELECTRIFICATION STRATEGY**



Perhaps the most exciting aspect of fuel-cell-driven electrification, however, is its scalability. The need to reduce emissions across the transportation, commercial and community sectors is dramatic, increasing and global. And where these sectors converge, such as in the teeming goods-movement and power-distribution confluences of port communities and their surrounding regions all over the world, this emissions issue has become critical.

A key means of addressing this problem is to electrify commerce, converting aging and polluting diesel facilities and fleets to pure, zero-emissions, electric generation and propulsion. And Toyota is helping directly architect this transformation through groundbreaking efforts like our holistic Woven City for a greener future and through

our pioneering Project Portal Class 8 fuel cell electric truck initiative.

Established as a feasibility study to explore the potential application of our light-duty Toyota Mirai fuel cell electric technology to the high-emission heavy-duty truck sector, Project Portal has progressed rapidly from concept phase, to the development of a large-scale, \$82 million pilot program featuring 10 trucks in conjunction with the State of California, the Los Angeles ports, Kenworth, Shell, UPS and many more. Through this transformative “Shore to Store” pilot and additional synergistic collaborations such as with Hino Trucks, Toyota’s Project Portal is opening green gateways and helping prove that heavy-duty hydrogen fuel cell electrics—with their range, weight, performance, refueling time, cargo capacity (to the maximum 80,000 GVWR) and infrastructure scalability advantages beyond battery electrics—have the potential to be the optimal solution for electrifying — and revolutionizing — global transport.

The potential of hydrogen fuel cell electric power, and the gathering global momentum behind it, is visually summarized in Figure 2 below. Overall, fuel cell electric vehicles offer a compelling combination of market and societal benefits, particularly at scale, and, therefore, are an emerging core of Toyota’s layered, global, customer-needs-based portfolio approach to electrification.

So, in summary, when someone asks you, “When will electric cars become mainstream? And how is Toyota participating?” you’ll be able to smile and reply, “They already are, and we’re helping lead the way.”

**FIGURE 2 / ELECTRIFICATION VIA HYDROGEN FUEL CELL IS A COMPELLING COMBINATION**

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