

Developing mobility solutions



Through innovation, partnership, advocacy and education, we are contributing to designing and realising a future of connected cars, autonomous driving, shared mobility, and freedom to move for all Australians.

Toyota Australia's vision of 'creating innovative mobility solutions for all Australians' aims to guide our transition from a traditional automotive company to a mobility company. We have a key role to play in technological innovation, as social shifts and climate change converge to impact the choices available to our guests in the years ahead.

We see mobility as comprising four main elements:

- sharing services a shift from ownership to usership
- automated driving and connectivity smart vehicles and infrastructure that can help reduce congestion and increase safety for all
- inclusive mobility a future in which all Australians have equal freedom to move
- electrified vehicles a future where low and zeroemission vehicles are widely adopted, with the necessary infrastructure to support them

Toyota is exploring this vision through research, collaboration, prototypes and trials, applying our fundamental principle of kaizen, or continuous improvement. Our progress towards mobility is overseen by our Connected Mobility Committee and our Advanced Planning Group (APG). Supported by Toyota's IT department, APG focuses on prototyping and trialling new mobility initiatives (see p. 35) utilising locally built architecture to support connected vehicle services.

Shared mobility

Our vehicles have always been about mobility, enabling guests to travel freely. However, population growth and urbanisation are constraining the benefits offered by the traditional model of driverowned and operated vehicles. Congestion and access to parking are becoming an issue in urban centres. At the same time, denser cities present an opportunity to diversify our transport options, taking advantage of rapidly developing technology platforms to share access to vehicles and move efficiently around the city and beyond.



In February 2019, Toyota Japan launched a new company, KINTO, which offers a car subscription service. Available in two pricing tiers, users have the option to drive either a Toyota vehicle or a selection of Lexus vehicles that can be changed every six months, for a monthly fee that includes all on-road costs. The vehicles include smart features that can monitor driving behaviour and reward guests for engaged, safe and ecological driving with points that can be applied towards payments.

In particular, the 'millennial' generation is leading a shift from ownership to usership of vehicles, with some electing not to even gain a driver's licence. They are comfortable with available technological solutions, and attracted by the perceived safety, transparency and social dimensions of ride hailing and car sharing services, as well as a lower overall cost. Car-pooling services can further reduce the cost per ride, as well as reducing the greenhouse gas emissions intensity of single occupancy vehicles.

Toyota is actively exploring shared mobility in Australia. We offer car sharing options to our business customers to help them maximise the utilisation of their fleet. A customisable mobile or desktop app manages bookings, and additional services are available, such as keyless entry, or telematics to track vehicle and driver behaviour. We are also trialling car sharing internally, facilitating transport between our office locations in Melbourne. We have applied learnings from these programs to further improve our fleet service offering, and to provide input to vehicle software and hardware enhancements globally.



As well as making substantial investments in ride-sharing service Grab in Singapore and Malaysia, TMC has initiated a joint venture with Uber to bring to market autonomous ride-sharing at scale. The 'Autono-MaaS' (Mobility as a Service) vehicles will combine Uber's Autonomous Driving System with Toyota's Guardian automated safety support system and Mobility Services Platform (MSPF), our core information

infrastructure for connected vehicles. Pilot-scale deployments are expected to begin in 2021.

Automated driving and connectivity

Automated, connected vehicles have been identified as an opportunity to improve road safety and traffic flow, reduce time on the road for drivers and reduce environmental impacts through the efficient use of fuel. Globally, Toyota is in investing in CASE (Connected, Automated, Shared and Electrified) mobility. We imagine a future in which our automated, zero-emission 'habitats on wheels' will convey guests to their destinations safely, with minimum fuss and maximum efficiency for all.

There are varying levels of automation, from alreadycommon forms of driver assistance such as cruise control, through to highly automated vehicles that require no input from a driver. Automated driving requires sophisticated decision-making software, connectivity and co-operation between vehicles and traffic infrastructure. These present complex practical, regulatory and ethical questions. In line with our Guiding principles (see p. 11), Toyota embraces innovation, but takes a cautious approach that always gives careful consideration to the safety and interests of our guests, other road users, and society more broadly. We are collaborating with others to work through these challenges, and playing an active role in education and advocacy around the emerging future of mobility.

Toyota Australia is currently trialling cooperative vehicle technology in Victoria, in collaboration with VicRoads, and in Queensland, together with the Queensland Department of Transport and Main Roads. These realworld trials of Cooperative Intelligent Transport System (C-ITS) will be conducted over two years under normal driving conditions on public roads. Each trial consists of two Lexus SUVs outfitted with additional electronics that allows them to communicate with each other (vehicleto-vehicle or 'V2V'), with their drivers and to surrounding traffic control systems and their drivers ('vehicle to everything', 'V2X'). These systems complement existing active and passive safety features to advise drivers of traffic conditions (eg. hazards, congestion, roadworks etc) to improve safety and transit times. It is envisioned that data collected from the trials will form valuable inputs for the development of transport planning, integration and automated driving for Australian conditions.

Cyber security

In the networked future of mobility, connected technology offers safety and convenience for our guests; however, it also comes with significant risks, particularly when combined with biometrics such as fingerprint and facial recognitions. We take a precautionary approach to developing and releasing these technologies, with rigorous access controls and other measures to protect our guests and others. For more information about our approach to data privacy and security, see p. 29.

Mobility for all

Our vision of mobility includes freedom of mobility for everyone. Our ambition is for all Australians to be able to work and play wherever and whenever they want, and connect with others, regardless of their abilities. Our guests will continue to be at the centre of this vision, from assisted personal mobility to accessible vehicle choices.

Our global robotics research team is working to develop assisted mobility technology in homes and workplaces, such as the AI-powered Human Support Robot to help the elderly, and rehabilitation robots to assist people with lower limb injuries to walk again. Toyota aims to become a company that addresses mobility needs above and beyond building ever-better cars.

Autonomous, co-operative and connected automated vehicles



Collaborating for mobility

Realising our mobility vision will require significant, systemic shifts that no one company can bring about. Toyota has a leading role in this evolution, and we are seeking to bring others along through partnerships, advocacy and education. This includes working collaboratively with our peers, and partnering with start-ups, IT and telecommunications companies to develop the necessary technologies (see examples p. 35 and 52). We are also working with state and federal governments to think through complex questions of infrastructure and regulation. In parallel, we are continuing to educate the public about the possibilities of connected and automated transport systems.





Toyota's Research Institute Advanced Development (TRI-AD), based in Japan, brings together Toyota's global engineering, technology and design capabilities to develop multi-layered automated solutions that will define the vehicle of the future.

TRI-AD has developed three proof-of-concept systems that it expects to deploy in the early 2020s. 'Highway Teammate' and 'Guardian' provide assisted driving technology, while 'Chauffeur' is a fully automated vehicle.

To develop the complex technologies required to support autonomous and connected vehicles, TRI-AD is collaborating with others. An example is a partnership established in early 2019 with start-up Carmera, to develop an open-source Autonomous Mapping Platform. Our e-Palette and Concept-i platforms are rolling demonstrations of Toyota's thinking. As vehicle interior space is freed up from mechanical and safety systems due to electrification and connected, automated driving, we envision that vehicles will become highly personalised, with humanistic design and AI support that cater to guests' specific preferences, from vehicle interior settings to schedules, preferred companions and routes. They will also be able to communicate with guests as well as other vehicles and traffic management to ensure smooth and safe transits for all.

In February 2019, TMC launched a joint venture, MONET, with Japanese telecommunications company SoftBank, which plans to make Mobility as a Service a reality. On-demand bus and car services, including the E-palette, may be available to customers in Japan within a year.

Our Guiding Principles help us to navigate this future with a constant focus on our guests and careful consideration of how these innovations might impact society. Ideally, we are working towards a future with reduced congestion, improved safety, and freedom of movement for all Australians.



Toyota is the official mobility partner of the Olympic and Paralympics for 2017–24. The 2020 Tokyo Games will be a showcase for our new technologies.

Toyota engineers are working on technological solutions and equipment for Paralympic athletes, and accessible transportation for all participants and spectators. Our demonstrations at the Games will focus on three main pillars:

- 1. Mobility for all;
- 2. Sustainability, based on a hydrogen-electric society, harmony with the environment and safety as core principles;
- 3. Integrated transport of guests and athletes based on a cutting-edge version of Toyota Production System.

The e-Palette will help ferry guests and athletes around the Olympic Village, while a fleet of WelCab and personal mobility devices will provide last-mile support for guests with mobility needs.

A large fleet of fuel cell vehicles, including the Mirai sedan and the Sora bus, will be provided for official use, while fuel cell forklifts will support logistics. A mix of the latest low-emission and electric vehicles from across the Toyota and Lexus range will make up the rest of the Games' transport fleet, helping to deliver the Games with the lowest ever transport emissions footprint.

Toyota will apply the renowned Toyota Production System, in combination with connected vehicle technologies, to co-ordinate the smooth, safe and secure transit of guests, officials and athletes during the Games.



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Our vehicles' emissions contribute to climate change and other environmental impacts. In line with the Toyota Environmental Challenge 2050, we are constantly working to reduce or eliminate these lifecycle impacts. We have been energetically promoting hybrid vehicles to the Australian market, and are helping to pave the way for a hydrogen mobility future.

Combatting climate change is one of the world's most pressing current challenges. Greenhouse gas (GHG) emissions from transport are a significant and rising contributor to climate change; in Australia, cars and light commercial vehicles contribute just over 11% of transport emissions.

Reducing emissions from vehicles is, therefore, a crucial action, and one that Toyota has embraced as part of the Toyota Environmental Challenge 2050 (see p. 64). We are determined to reduce greenhouse gas emissions from new Toyota vehicles during operation by 90% (from 2010 levels) by 2050.

Globally, Toyota aims for electrified vehicles to account for over 50% of new vehicle sales by the end of the next decade, representing more than 5.5 million electrified vehicles by 2030. By around 2025, every model in the Toyota and Lexus line-up around the world will be available as either a dedicated electrified model or have an electrified option.

Achieving these targets will require not only technological innovation, but also the right policies and infrastructure to support low-emission vehicles, and models that continue to meet the needs of our guests, including competitive pricing.

Drivetrain innovation

Globally and locally, Toyota is currently focusing its energies on bringing hybrid vehicles to market across our range. In the longer term, we are developing a full range of low-emission drivetrains, including exploring the possibilities of hydrogen fuel cell vehicles.



Toyota helps to increase the number of electric vehicles on roads by sharing technology.

In April 2019, our global parent, TMC, announced that it will grant royalty-free licenses on approximately 24,000 patents relating to electrified vehicles, and will provide fee-based technical support to other manufacturers that make use of Toyota's technologies. Toyota's aim is to help governments, automakers, and society to accelerate the shift to an electrified future and meet climate change goals.

Drivetrain technologies and supporting infrastructure



Hybrid vehicles

Hybrid vehicles provide an ideal transitional technology on the journey to a zero-carbon future. Combining a high-efficiency internal combustion engine with an electric motor, hybrid vehicles can be deployed today at an affordable price, and deliver significant fuel and CO_2 reductions without the need for new infrastructure, regulatory or supply chain changes.

Toyota introduced the Prius hybrid to the Australian market in 2001. Since then we have actively promoted hybrids, and have been steadily expanding the range of hybrid models to meet the needs of our guests. In April 2019 we reached a significant milestone of 100,000 hybrids sold in Australia, and hybrids now comprise over 10% of our sales in Australia.

We are working hard to continue ramping up the proportion of hybrids in our sales mix. In May 2019 we launched our first Hybrid SUV in Australia – the RAV4 – joining the Camry Hybrid, Corolla Hatch Hybrid, Prius, Prius C and Prius V to form the broadest lineup of electrified vehicles offered by any company in Australia. We expect to add another four hybrid models by the end of 2020.

The owner of a current Camry Ascent Sport Hybrid can achieve savings of more than \$800 and 1 tonne of CO_2 per annum compared with an equivalent petrol model.^{*}

To increase the uptake of hybrids, we have worked to make our hybrid vehicles more affordable, and we have engaged in an extensive marketing campaign to educate our employees, our dealers and the general public about the benefits of hybrid technology. Our research told us that while people were aware of hybrids, they had questions about the technology. We find that when people understand the simplicity of driving a hybrid, and when the price and specifications are right, our guests are willing to consider moving towards hybrid drivetrains. While pricing and consumer awareness have challenged the take-up of hybrids by our guests, our fleet customers are readily embracing hybrids. Like Toyota, many of our business and government customers are acting to reduce their impact on climate change, and have set internal carbon reduction targets for their procurement and their operations. We are pleased that our low-emission vehicles help provide solutions for these organisations.

The owner of a current Camry Ascent Sport Hybrid can expect to achieve savings of more than 800 and 1 tonne of CO₂ per annum compared with an equivalent petrol model.

*Source: Camry Spec Data, www.toyota.com.au

Plug-in vehicles

Plug-in hybrids supplement hybrid technology with a rechargeable battery pack. This significantly reduces emission by enabling the use of battery power for everyday commutes, while retaining a high-efficiency petrol engine for longer distances.

Battery electric vehicles are exclusively batterypowered, and can produce zero emissions if charged using energy from renewable sources. Toyota globally is exploring both these technologies, but we have not yet introduced them in Australia. Plug-in vehicles require public and private charging infrastructure. While this is starting to develop in Australia, it has not yet reached critical mass, and we believe the Australian market has a preference for hybrids that provide the same experience as a traditional vehicle.



In March 2019, Toyota Australia unveiled plans to build a \$7.4 million Hydrogen Centre at our former manufacturing site in Altona. The project will be supported by \$3.1 million in funding from the Australian Renewable Energy Agency (ARENA).

The centre will be Victoria's first integrated hydrogen site, complete with electrolyser, commercial grade hydrogen refuelling station and an education centre with live demonstrations. Construction will commence in 2019, with the education centre expected to be open by March 2020, and the electrolyser and hydrogen refuelling station fully operational by late 2020.

Once up and running, the hydrogen refuelling station will be able to fill a vehicle, like Toyota's Mirai Fuel Cell Electric Vehicle (FCEV), in between three and five minutes.

Hydrogen fuel cell vehicles

Toyota believes that Fuel Cell Electric vehicles (FCEVs), powered by hydrogen from renewable sources, have great potential to lower harmful emissions in the transport sector. Since the drivetrain is electric, FCEVs are quiet, can be refuelled quickly like a petrol or diesel vehicle, and have a similar range, but emit only water. The key challenge with the introduction of fuel cell technology into Australia is a requirement for the widespread deployment of refuelling infrastructure.

FCEVs are already a commercial reality in Japan, Korea, Europe and California. Despite not yet being commercially available in Australia, we are actively paving the way for FCEV introduction with demonstration vehicles, significant investment in hydrogen generation technology, and advocacy and education. We are a founding member of Australian Hydrogen Council, which aims to accelerate the commercialisation of hydrogen and fuel cell technologies in Australia and progress the shift to a hydrogen society built on clean and renewable energy technologies.

Petrol and diesel drivetrains

While we pursue a future of electrified vehicles, we maintain a focus on continuous improvements in fuel efficiency across our entire range. We aim to reduce GHG emissions from combustion drivetrains, along with air pollutants such as nitrogen and sulphur oxides, particulate matter and other hydrocarbons.

However, emissions are closely linked to fuel quality. Toyota supports appropriate and practical emissions standards for Australia that are supported by fuel standards aligned to global standards, so that we move to high-octane, low-sulphur fuel. We also advocate for emissions standards to distinguish between passenger cars and light commercial vehicles as well as off-road SUVs.

With all low-emission technologies, we advocate for a balanced approach that delivers CO_2 and pollution reduction, provides choice and support for consumers through appropriate price signals, and allow manufacturers to respond in a timely manner.



How a fuel cell electric vehicle works



Toyota Australia has been testing hydrogenpowered vehicles in local conditions by loaning its demonstration fleet of 10 Toyota Mirai FCEVs to organisations including AusNet Services/Mondo, Australian Hydrogen Council and Hobsons Bay City Council.

Council staff used the vehicles as part of their everyday duties for 12 weeks from November 2018. The trial has contributed to the Council's commitment to become net zero carbon by 2020, and provided valuable feedback for us on the Mirai's performance and driving experience. The vehicles were refuelled at our Altona site using Toyota Australia's mobile hydrogen refueller.

Advocacy, education and collaboration

We seek to engage constructively with governments and industry to work towards a low-emission future. In July 2018 we made a submission to the Australian Senate's Select Committee for Electric Vehicles. In a similar vein to the Federal Chamber of Automotive Industries (FCAI) and the Electric Vehicle Council, we called for comprehensive policy and regulatory support for electrified transport in Australia.

Our ambitious targets for electrified vehicle sales can only be achieved through collaboration with our large market partners – fleet buyers for governments, large organisations, car rental companies and mobility services. Ultimately, we want all our guests to have access to these technologies at reasonable price points, and to have ease of use and peace of mind while using them. We continue to work with our partners to introduce these platforms to the market and use our collective voice to advocate for the appropriate regulatory framework that will allow this to gain traction in Australia.

Our position includes calling for investments and regulations that will support low-emission vehicles, such as a national charging network as called for by Infrastructure Australia, and favourable policy settings for accelerating private investments in a hydrogen economy. Governments can also accelerate adoption of new drivetrains – and the supporting infrastructure – through their fleet purchases.

We also suggest that a range of financial and nonfinancial incentives would help to promote guests' adoption of electrified transport. Examples might include preferential stamp duty and registration costs, trade-in rebates, tax incentives, and preferential access to transit lanes or parking.