NSW Productivity Commission Research and Discussion Paper

Regulating emerging technologies

NSW GOVERNMENT

Acknowledgement of Country

The NSW Productivity Commission acknowledges that Aboriginal and Torres Strait Islander peoples are the First Peoples and Traditional Custodians of Australia, and the oldest continuing culture in human history.

We pay respect to Elders past and present and commit to respecting the lands we walk on, and the communities we walk with.

We celebrate the deep and enduring connection of Aboriginal and Torres Strait Islander peoples to Country and acknowledge their continuing custodianship of the land, seas and sky.

We acknowledge the ongoing stewardship of Aboriginal and Torres Strait Islander peoples, and the important contribution they make to our communities and economies.

We reflect on the continuing impact of government policies and practices, and recognise our responsibility to work together with and for Aboriginal and Torres Strait Islander peoples, families and communities, towards improved economic, social and cultural outcomes.

Artwork: 'Regeneration' by Josie Rose 2020

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Commissioner's Foreword

In May 2021 the NSW Productivity Commission released its White Paper which identified 60 opportunities to reboot economic growth in NSW. At this time, NSW was rebounding strongly following the onset of the pandemic in 2020 and the future was looking bright. But it wasn't long until, in June 2021, the State was in the grips of another health and economic crisis because of the Delta outbreak.

During this time, the Commission has been progressing opportunities identified in the White Paper to help our economy bounce back, as well as making the longer-term structural changes needed to boost our productivity and standards of living beyond pre-COVID-19 levels. This paper is the first of a series of research and discussion papers, following on from the White Paper.

Technological innovation is one of the biggest drivers we have available to improve living standards. In my lifetime alone, the internet, smart phones, and cheaper air travel have delivered enormous transformations in the way we communicate, travel, and work.

As we reopen the economy, emerging technologies can help us capitalise on new ways of working and living. Regulations that get the most out of emerging technologies will be critical to achieving this potential, but traditional regulatory approaches can struggle to keep pace with new or rapidly changing technologies.

For example, drones offer opportunities to make farming safer and more efficient. Personal mobility devices can help to get cars off our roads and provide an environmentally sustainable way to get people where they need to go more quickly. E-bikes and other types of emerging light electric vehicles have huge potential in the freight and logistics sector by cutting delivery time and costs. Yet in each of these areas, regulations are impeding, rather than supporting, new ways of doing things.

To keep pace with new developments, regulations should be outcomes-focused, regularly reviewed, and make use of regulatory trials. This paper examines some topical examples, but the principles can be applied more broadly.

The potential gains are large. Better regulation of drones in agriculture and personal mobility devices alone could bring net benefits of more than $580 million over the next 20 years.

We must consider economic benefits hand in hand with the health and safety of our community. Public debate and discussion, supported by the best available evidence, should be a key input into government decision-making on these issues.

Facilitating these discussions is a key part of the Commission's role. It is my hope that the release of this paper will spark debate and new ideas about how we regulate emerging technologies.

PETER ACHTERSTRAAT AM

NSW Productivity Commissioner

Executive Summary

Emerging technologies present opportunities to improve the way we live and work, and to boost NSW's productivity. Planes, cars and computers, to name a few examples, were once novel, disruptive technologies. Now they are an essential part of our lives—enhancing our productivity and standards of living in the process.

Where regulation of these new technologies is needed, it should be shaped in a way that maximises these opportunities while managing risks to society. Regulations that are based on particular technologies or business models are bound, eventually, to impede the benefits of dynamism and innovation as new technologies emerge.

A modern approach to regulating emerging technologies is required, underpinned by the following core principles:

Outcome-focused, tech-neutral regulation

- Focuses on underlying objectives that the regulation is designed to achieve e.g. high safety standards.
- Does not prescribe how these objectives are met—leaves it open for businesses to decide the technology or business models to be used.

Regular review of regulations

- Involves identifying barriers to the adoption of emerging technologies in current legislation.
- RegTech and other regulatory tools can assist in this task.

A culture of regulatory experimentation

- Involves trialing new rules in a real word setting, to obtain evidence on what works and what could be improved.
- Addresses some of the uncertainty in regulating emerging technologies.

Mobility involves the movement of individuals and goods from point A to point B. It presents a significant opportunity to apply the above principles, due to the rapid emergence of new mobility technologies and business models. This includes drones, autonomous vehicles, personal mobility devices (PMDs) and mobility as a service.

Applying the principles to three mobility technologies—drones, PMDs, and e-bikes—could transform the way we work, travel, and move goods, and unlock considerable economic benefits.

APPLYING THE PRINCIPLES TO DRONES, BEGINNING WITH AGRICULTURE

PROBLEM

Current regulations make it costly and time-consuming to operate drones beyond the line of visual sight and to fly drones at night. This creates a barrier for uptake in low-risk settings, such as agriculture, forestry and fishing, reducing the potential of drones where they could replace less productive and often less safe ways of working.

OPPORTUNITY

Across Australia, the economic benefit of drones has been forecast to grow GDP by $14.5 billion by 2040, with some of the largest benefits ($3.5 billion) obtained from use in agriculture, forestry and fishing (Deloitte Access Economics, 2020).

BENEFITS FROM REGULATORY CHANGES

Simplifying the regulations for drone use in an agriculture setting could save an average farmer up to $11,000 in upfront regulatory and training fees, as well as other significant time and cost savings (CIE, 2021a).

Overall, relaxing the regulatory environment for drones in agriculture could unlock up to **$500 million** in net benefits for NSW in today's dollars by 2041 (CIE, 2021a) from:

- **Reduced farm injuries and fatalities**, as high-risk farming activities such as equipment and livestock inspections are substituted by drones.
- **Increased efficiency of routine farm work** as drones perform tasks that would otherwise be labour-intensive. Examples include checking water troughs and locating livestock.
- **Improved yield** from enhanced crop monitoring and crop spraying efficiencies.

NEXT STEPS—APPLYING THE PRINCIPLES

Outcomes-focused regulatory experimentation

The NSW Government should engage with the Civil Aviation Safety Authority (CASA), industry, and the community to trial risk-based, simplified drone rules in priority low-risk sectors, starting with agriculture.

This should involve clearly defining the desired outcomes from the trials, developing rules to meet the outcomes, and setting regular dates to evaluate effectiveness.

Regular review

Task a minister with policy responsibility for drones and other emerging aviation technology to help NSW capitalise on opportunities from emerging uses of these technologies.

APPLYING THE PRINCIPLES TO PERSONAL MOBILITY DEVICES

PROBLEM	Many Australian and international jurisdictions regulate PMDs such as e-scooters and permit their use in public areas, while NSW laws restrict the use of all PMDs to private property. Regardless, innovation in PMDs is continuing and consumers are using them in public spaces in NSW. Devices capable of speeds of up to 100km/hr are now available in shops and online in NSW, presenting safety risks in the absence of appropriate regulation.
OPPORTUNITY	**Travel time savings**, where they replace short car or walking trips. **Better access to public transport** through reducing first and last mile transport problems. **Reduced urban congestion:** reduced congestion and demands on transport infrastructure where PMDs replace car trips. **Lower environmental impacts** where they replace moped, motorcycle, or car trips with tailpipe emissions.
BENEFITS FROM REGULATORY CHANGES	Revising laws to support the use of PMDs in NSW could unlock up to $87 million in net economic benefits in today's dollars by 2041 (CIE, 2021b). An appropriate regulatory framework could enable uptake of PMDs of between eight and ten million trips per year by 2041 (compared to 600,000 trips per year if regulations remain at their current settings). The greatest benefits of increased uptake arise from travel time savings, followed by vehicle operating cost savings. These benefits outweigh negative impacts on active transport, safety, and enforcement costs.
NEXT STEPS—APPLYING THE PRINCIPLES	**Regulatory experimentation** Implementing recent revisions to the Australian Road Rules to allow use of PMDs in public spaces in NSW could provide an opportunity to: • test the appropriateness of the regulatory framework in a local setting • collect and evaluate data on the risks and benefits • refine the final regulatory approach, such as speed limits, to maximise benefits while ensuring good safety outcomes are achieved. **Technology-neutral regulation** The technology-neutral definition of PMDs adopted in the Australian Road Rules would enable future innovation beyond e-scooters and shared e-scooter schemes seen today.

APPLYING THE PRINCIPLES TO E-BIKES AND E-CARGO BIKES

PROBLEM	**e-bikes:** Restrictions on the speed of e-bikes are not keeping pace with increased consumer demand for faster e-bikes in NSW and Australia. The online availability of high-speed e-bikes and conversion kits has created growing safety concerns for riders and pedestrians in the absence of appropriate regulation. **e-cargo bikes:** Australia and NSW apply the same power limits to e-cargo bikes for commercial uses as private use. This power limit is limiting their potential to carry heavier loads at a time where e-commerce delivery is booming.
OPPORTUNITY	**e-bikes:** Many international jurisdictions permit the use of e-bikes with faster maximum speeds and power outputs. Expanding the range of e-bikes available could encourage more people to use e-bikes, and to use them more regularly and for greater distances. Just five per cent of NSW bike rides were estimated to be undertaken by e-bike in 2021 (CIE, 2021b), whereas 40 to 50 per cent of bikes sold in Germany and Netherlands are e-bikes (Kennedy, 2021). **e-cargo bikes:** e-cargo bikes are already being used commercially by the freight and food delivery sectors. Australia Post uses a fleet of 2,500 e-cargo bikes to make more than 2.5 million deliveries of mail and small parcels to customers per day. The bikes offer a higher load capacity than postie motorcycles and there have been no serious accidents or deaths in the last decade (We Ride, 2020). This is an area of rapid innovation with new devices emerging. Starting the conversation about the right regulatory settings now will position us to benefit from future innovation.
BENEFITS FROM REGULATORY CHANGES	**Reduced delivery costs:** e-cargo bikes can be up to 60 per cent faster than vans for last mile deliveries in urban areas (Verlinghieri, 2021)—offering potential for significant cost savings given that over half of freight costs come from the last mile (McKinsey, 2016).
	Reduced urban congestion: e-cargo bikes take up less room than delivery vans on roads and some are cycle-way compatible.
	Lower environmental impacts where they replace delivery van, moped, motorcycle or car trips.
	Active health benefits from overcoming barriers to bicycle use, such as physical fitness or terrain, as opposed to sedentary use of mopeds, motorcycles, or cars.
	Travel time savings, where they replace conventional bicycle and walking trips.
NEXT STEPS—APPLYING THE PRINCIPLES	**Regular review** National review of regulatory options to safely support faster e-bikes and more powerful e-cargo bikes. **Technology-neutral regulation** Develop a technology-neutral regulatory framework for e-cargo bikes and other similar vehicles.

Emerging technologies can improve the way we live and work

Emerging technologies have provided economic opportunities and enhanced the quality of life for NSW residents once initial disruptions and resistance are overcome.

To spotlight a few examples:

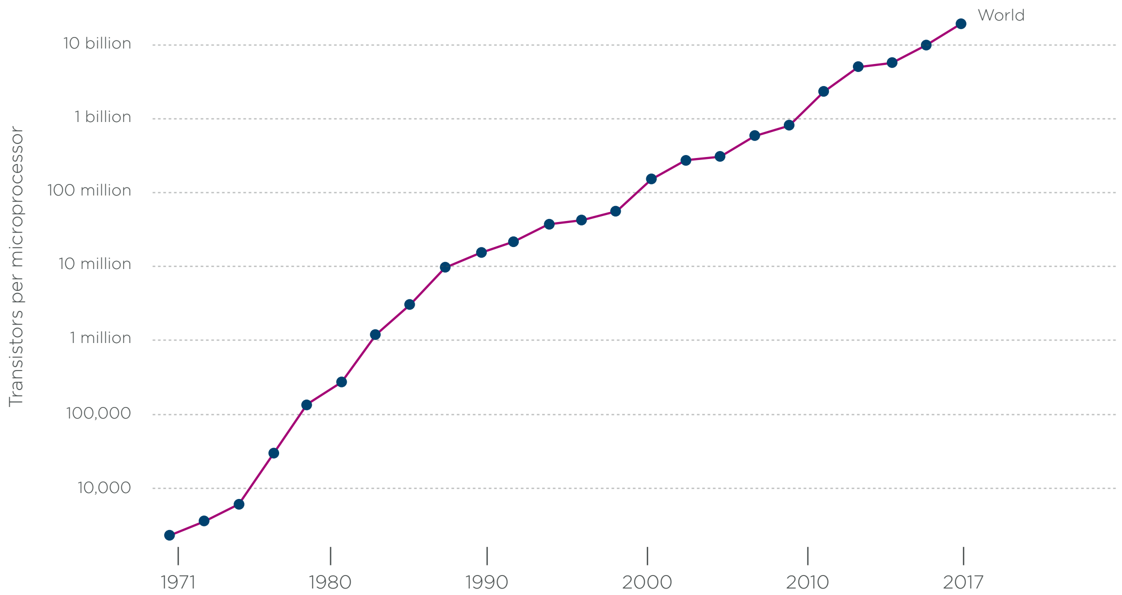
Bicycles were initially met with resistance when they first emerged in the 19th century. They were banned from public parks in New York following conflicts between cyclists and pedestrians. There were fears that cycling would cause health problems, such as "bicycle face" caused by holding your mouth in grimace and your eyes wide open with one journalist warning: "once fixed upon the countenance, [it] can never be removed" (Minneapolis Tribune, 1895). Today, bicycles are lauded as an environmentally friendly way to travel and good for our health.

Early **automobiles** (known as mechanical road locomotives) were subject to tough safety measures when they first emerged. The *Red Flag Act 1865* (UK) responded to concerns about public safety and noise by requiring a man to precede the road locomotive on foot, carrying a red flag by day and a lantern by night. Although the restriction was eventually lifted as social acceptance of the new technology increased, it impeded the early uptake of automobiles in the UK (Britannica, n.d.). Automobiles have since revolutionised the way we move, shaping the design of cities and countries. The advent of autonomous and electric cars promises further transformations.

In the late 1980s, the first **mobile phones** in Australia were about the size of a briefcase, cost over $4,000 ($8,600 in today's terms) and had a battery life of 20 minutes (Sydney Morning Herald, 2007). By contrast, a smartphone today can cost as little as $150 and weigh less than 200 grams. And it can do much more than just make calls: the apps that can be accessed through it have disrupted numerous industries. For example, ride-sharing and accommodation-sharing apps like Uber and Airbnb disrupted the taxi and hospitality industries and were initially met with resistance. Smartphones and other smart devices have also facilitated innovation and expansion in new industries, such as the health tracking industry and on-demand music streaming.

Technological change continues to gather pace. For example, Moore's Law has held with remarkable consistency over the past 50 years, driving exponential improvements in the capabilities of digital devices (see Figure 1 below). A mobile phone has more processing power today than a supercomputer of the 1980s.

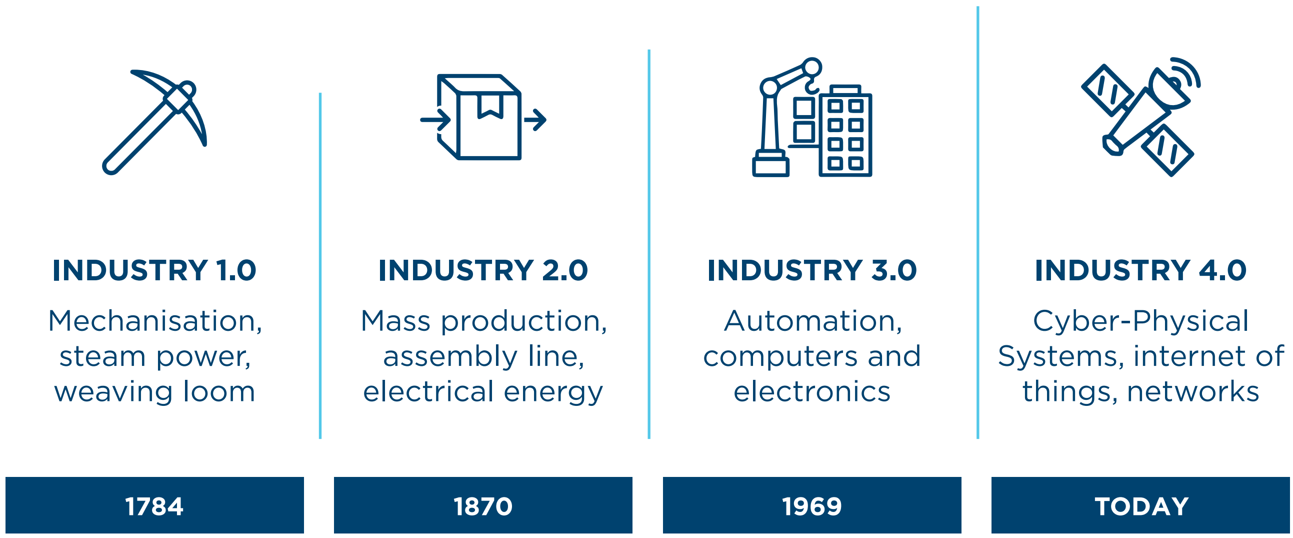
FIGURE 1: MOORE'S LAW: TRANSISTORS PER MICROPROCESSOR



Source: (Our World In Data, 2021).

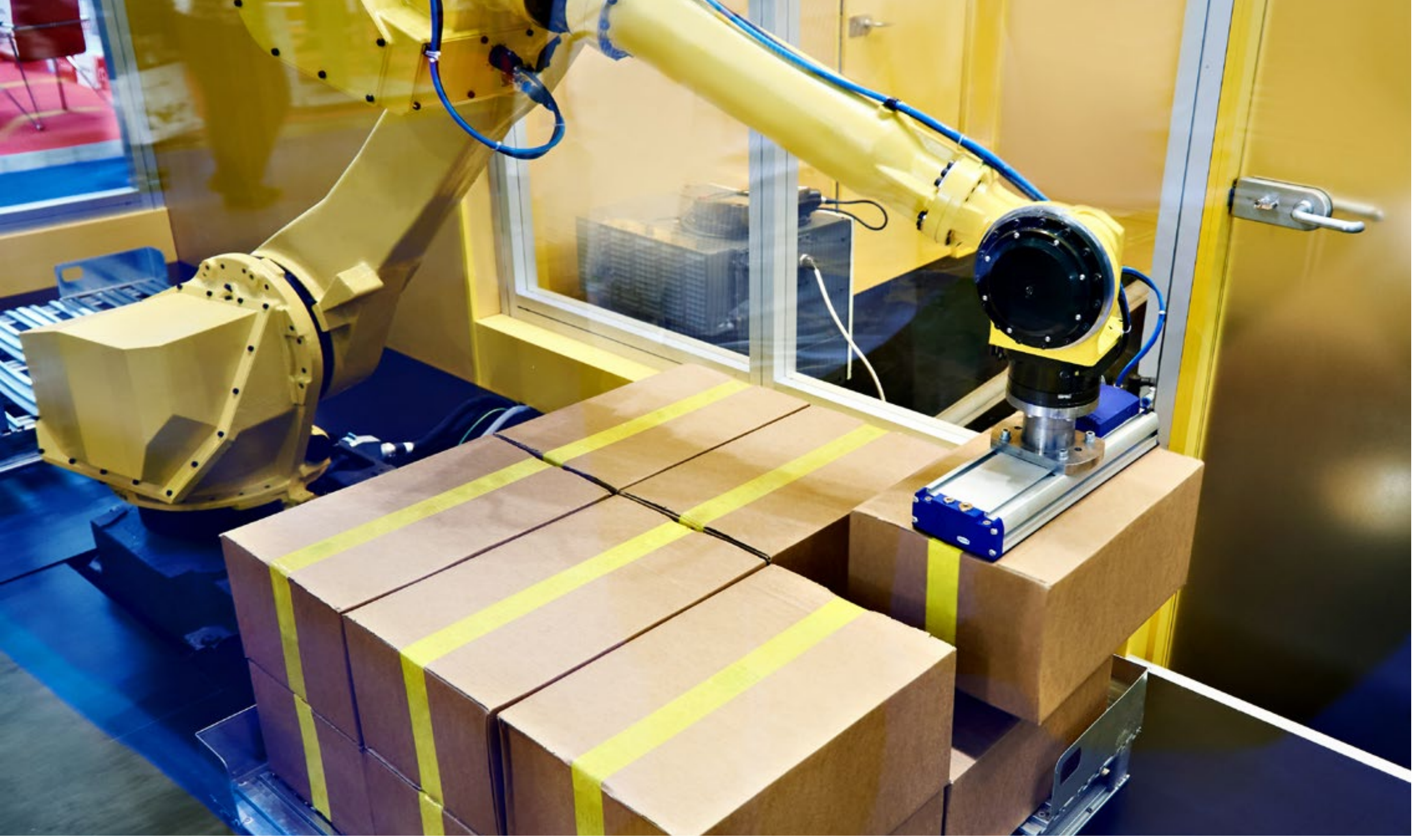
A fourth industrial revolution[1] is occurring from developments such as Artificial Intelligence (AI), robotics and biotechnologies. This will transform our economy. Applications we are already seeing include autonomous cars using AI and sensors to navigate city roads, and smart health devices that anticipate health issues based on daily health data.

FIGURE 2: INDUSTRIAL REVOLUTIONS HAVE TRANSFORMED PRODUCTION AND INNOVATION



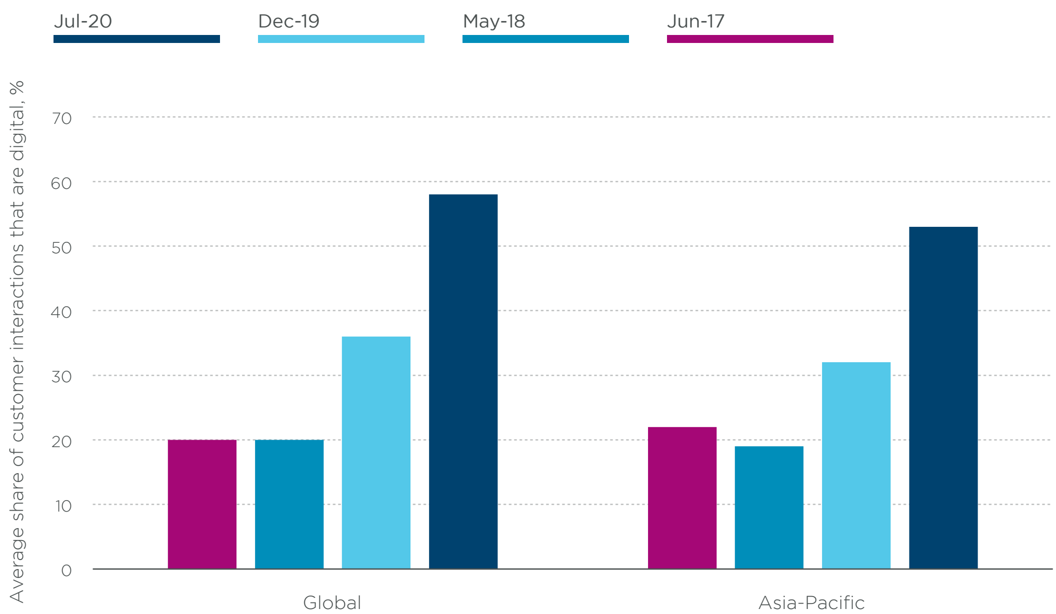
Source: (Schwab, 2016).

1 The Fourth Industrial Revolution is characterised by a fusion of technologies—such as artificial intelligence, gene editing, and advanced robotics—that is blurring the lines between the physical, digital, and biological worlds.



COVID-19 has accelerated this trend, with technology enabling us to work remotely during the pandemic. Recent research by McKinsey & Co found that the digitisation of consumer interactions has been accelerated by four years in the Asia Pacific region due to COVID-19 (see Figure 3). Online retail sales alone grew by 67 per cent from March to October 2020 (ABS, 2020b).

FIGURE 3: COVID-19 HAS INCREASED DIGITISATION OF CONSUMER INTERACTIONS



Source: (McKinsey & Company, 2020).

Three regulatory principles can help NSW seize the opportunities from new technologies

Stronger growth in productivity is the most important way we can sustain growth in standards of living. Technological innovation is a key part of this, as it is by far the largest long-term driver of productivity growth (Jones, 2015).[2]

The challenge facing regulators is striking a balance between promoting innovation, and addressing risks posed by emerging technologies. Regulations that seek to eliminate all risk impedes the productivity improvements from emerging technologies, as illustrated by the initial bans on bicycles and restrictive regulation of early automobiles.

Government and regulators need to make sure rules support the uptake of technology, rather than hold it back. A new, modern approach to regulating emerging technologies is required–underpinned by the following three principles:

FIGURE 4: PRINCIPLES FOR THE REGULATION OF EMERGING TECHNOLOGIES

1. Outcomes-focused, technology-neutral regulation

Traditional regulatory models take a 'top-down' prescriptive approach to managing risk, prescribing specific rules on how to act rather than the outcomes. While this approach can bring certainty, it is increasingly unable to keep pace with changes in technology, impeding the speed and benefits of innovation and by extension, productivity growth.

Outcomes-focused regulation concentrates on the underlying objectives that the regulation is designed to achieve, for instance, safety standards. It leaves it open to businesses to decide which technologies or business models they use to meet the objectives. This gives business greater leeway to innovate and can simplify compliance. It can also benefit government by ensuring legislation is sufficiently broad to incorporate developments in technology, future-proofing our regulatory systems in the process.

It does need to be acknowledged that while outcomes-focused regulation is likely to be most appropriate for businesses and consumers, a level of prescription can be necessary and beneficial for end users of some products and services. For example, road rules prescribe rules for safe driving (including the setting of speed limits) to avoid uncertainty, as interpretations of what is safe may differ depending on the driver and weather and road conditions. In other areas, it is appropriate for legislation to set expectations without prescription, to allow compliance and enforcement to keep pace with changes in technology and the economy. For example, NSW's work health and safety legislation establishes duties on employers and workers, which are supported by a range of codes and guides developed and able to be updated by SafeWork NSW.

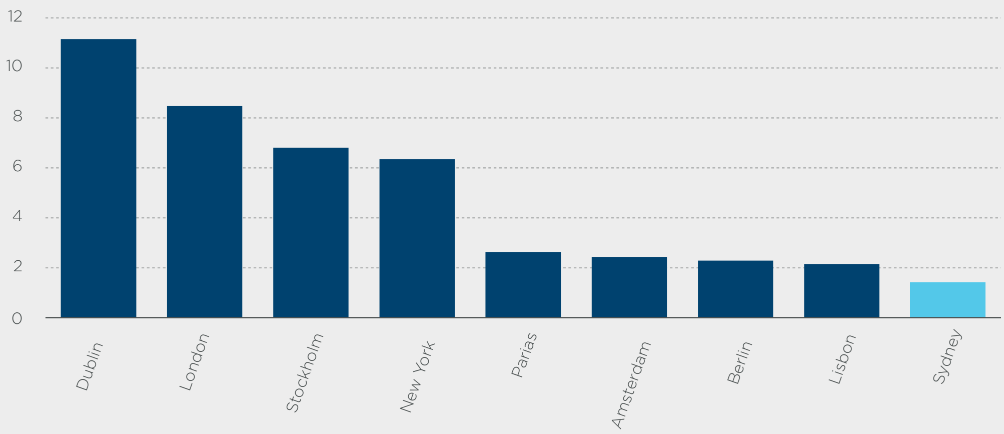
2 Technology's contribution to overall productivity growth has been estimated at 80 per cent (Jones, 2015).

CASE STUDY: HOW OUTCOMES-FOCUSED, TECHNOLOGY-NEUTRAL REGULATION SUPPORTED MARKET INNOVATION IN RIDE-SHARING SERVICES

When ride-sharing services[3] first arrived in Australia in October 2012, they fell outside the regulatory regime for taxis and private hire vehicles[4], which was based on a traditional fleet of cars and drivers. This regulatory vacuum posed a challenge to regulators, who had to rapidly contend with new business models. It also created regulatory uncertainty for operators and users. Uncertainty is a significant barrier to entry for startups as large businesses are often better able to cope with uncertainty than new startups. The longer the uncertainty persists, the greater the negative impact on competition (and the associated benefits for consumers, such as lower prices and innovation).

Heavy regulation of taxi and private hire vehicles, including restrictions on the number of taxis, had resulted in an undersupply of taxis and private hire vehicles in Sydney compared to other global cities (see Figure 5). Sydney taxi fares were among the most expensive in the world (Pearson, 2014).

FIGURE 5: TAXI AND PRIVATE HIRE VEHICLES PER 1,000 POPULATION PRIOR TO REGULATORY REFORM



Source: (Darbera, 2010), (IPART, 2013), (ABS, 2012-2013).

Note: Sydney data is for 2013, data for all other cities is for 2010. Private Hire Vehicles are included in the above chart as they are frequently used as a substitute for taxis, and even outnumber taxis, in cities such as London and New York.

3 Ridesharing involves a company matching passengers with drivers of private vehicles via websites and mobile apps.

4 These are non-taxi vehicles used to providing passenger services, such as limousines.

In 2016, the NSW Government introduced a new outcomes-focused regulatory regime for point-to-point transport[5] to support a more innovative and competitive market. The changes from the previous, prescriptive, regulatory regime are summarised in Table 1.

TABLE 1: REFORM OF POINT-TO-POINT TRANSPORT REGULATION IN NSW

BEFORE	AFTER
Prescriptive requirements for service quality and security	**Outcomes-focused**
This includes requirements that specified the size and minimum age of taxis, driver uniforms, and fixed methods of driver identification.	Under the new regulatory regime, service providers must still meet strict safety standards, but they have greater flexibility in how they ensure safety obligations. Service providers are also given more flexibility when it comes to service standards. For instance, any car may be used in booked point-to-point services, so long as it is roadworthy.
One business model	**Technology-neutral**
The previous rules only contemplated services with a traditional fleet of cars and drivers.	The new regime is designed to accommodate a range of business models and technologies. It recognises only two broad service types; vehicles hailed in the street or at a rank, and those that are booked.

The reforms have reduced regulatory costs for industry by over $30 million per year (NSW Government and Point to Point Transport Commissioner, 2020). It has also enabled additional choice and value for consumers, with consumers in Sydney benefiting from lower fares (see Figure 6), lower wait times, and higher standards of service, due to rideshare services.

FIGURE 6: AVERAGE FARE BY DISTANCE FOR TAXIS AND RIDESHARE IN SYDNEY[6]

AVERAGE FARE BY DISTANCE	TAXIS	RIDESHARE
Less than 5 km	$15	$12
5 km to under 10 km	$27	$20
10 km to under 15 km	$47	$26
15 km to under 25 km	$60	$52
25 km to under 50 km	$96	$63
50 km or more	-	$135
Total sample	**323**	**711**

Source: (Orima research, 2020).

5 Point to point transport is transport that takes consumers directly from one point to another via a route and time of their choosing. It includes taxis, hire-cars and rideshare services. These are non-taxi vehicles used to providing passenger services, such as limousines.

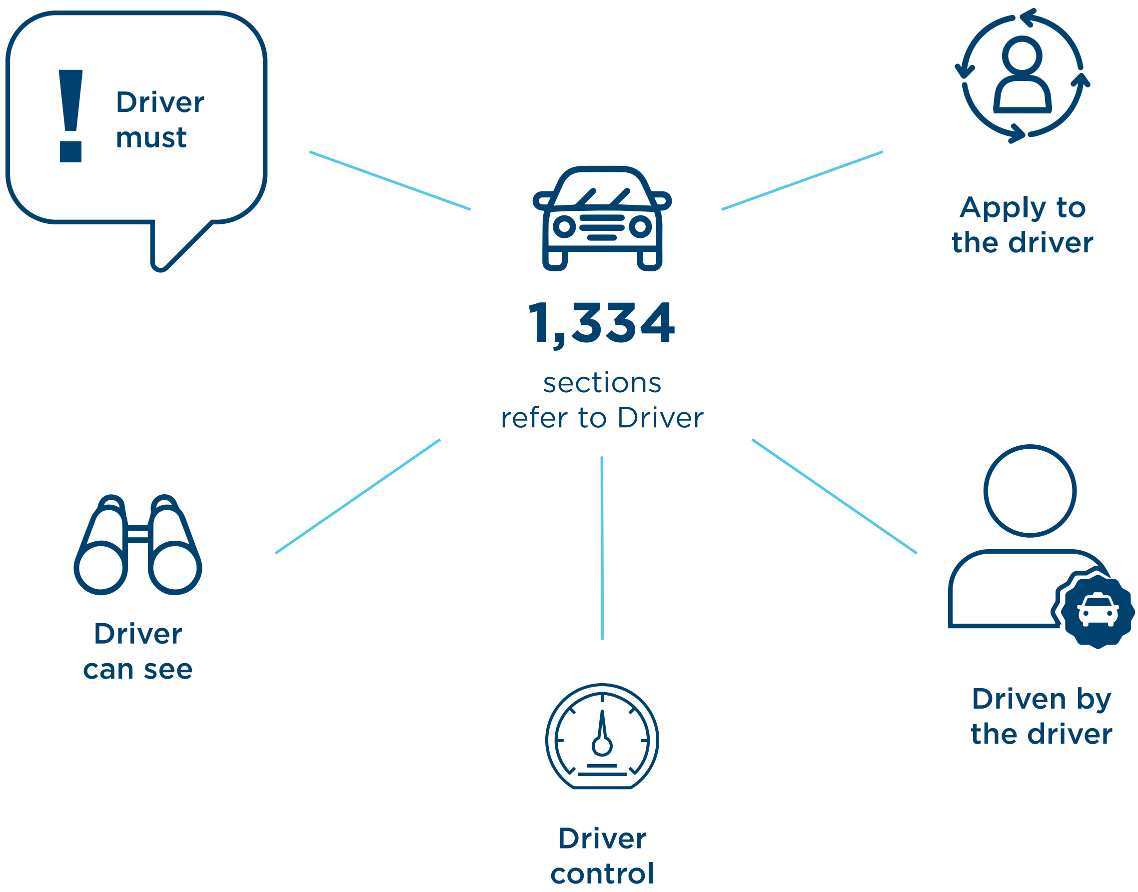
6 The survey samples were too small to draw conclusions for other areas.

2. Regular review of regulations

Regular review of regulations remains essential, as there is always room for improvement. This is true even with technology-neutral, outcomes-focused regulation. By its very nature, regulation is designed with assumptions, such as the organisational form of market participants. Changes in technology can challenge these assumptions; for instance, holiday accommodation is now provided by homeowners via online platforms, in addition to hotels, motels and other businesses. This highlights the need for regular review and horizon-scanning to ensure that regulations can keep pace with emerging technologies.

RegTech software and other regulatory tools can assist regulators in identifying barriers to the adoption of emerging technologies in current legislation. For instance, RegTech software was used to analyse how current NSW driving regulations could be reviewed to accommodate driverless vehicles.[7] There are 1,334 sections of NSW regulation that reference "driver" and 1,001 sections that reference "passenger" spread across 16 government departments (NSW Treasury, 2020). These are concepts that will be fundamentally transformed by the arrival of driverless vehicles.

FIGURE 7: SECTIONS REFERENCING DRIVER-RELATED WORDS IN NSW REGULATION



Source: (NSW Treasury, 2020).

As new technologies continue to emerge, regulations can no longer be 'set and forget' affairs. Regulatory adjustments may be needed to respond to new risks, such as those posed by 3D printing of illegal weapons (see Box 1) or new means of surveillance (see Box 2).

7 A number of different software solutions exist. In this case, Deloitte's RegExplorer tool was used.

BOX 1: UPDATING REGULATIONS TO RESPOND TO THE ADVENT OF 3D PRINTING

3D printing is used to create a physical object from a three-dimensional digital blueprint using Computer Aided Design software. It typically involves laying down multiple thin layers of a material in succession to build an object from its base. Advances in the efficiency and quality of 3D printing have led to its use in various areas including manufacturing, industry, medicine and arts and design (Parliament of Australia, 2015).

It has also, however, posed challenges for regulators and law enforcement authorities. The increasing availability of 3D printers has opened new pathways for illegal activity, including the manufacturing of 3D printed firearms components and accessories. These concerns led NSW to become the first jurisdiction in Australia to amend its firearm laws to make it illegal to possess digital blueprint files to 3D print firearms (Parliament of New South Wales, 2015).

This issue extends beyond firearms. 3D printing is making it easier to produce items that previously required expertise and specialised equipment, such as drugs, metals, and substances at an atomic level (Matthews, 2017). The production of such items using 3D printing or alternative manufacturing processes may evade the laws already in place, posing a risk to public safety.

BOX 2: UPDATING REGULATIONS IN LIGHT OF NEW MEANS OF SURVEILLANCE

The *Workplace Video Surveillance Act 1998* (NSW) arose out of industrial disputes over video surveillance by employers. It prohibited video surveillance in the workplace unless certain notice requirements are satisfied or where a Magistrate has authorised covert video surveillance. As the use of technology such as GPS tracking and computers grew, it became apparent that the legislation was not wide enough to protect employees from new modes of surveillance.

The *Workplace Surveillance Act 2005* (NSW) updated the previous regime, extending the definition of surveillance to encompass computer surveillance and tracking surveillance. The updated definition of surveillance was framed broadly to make it as technology-neutral as possible—for instance, it was not confined to a particular type of computer monitoring or tracking technology. It also extended beyond the traditional workplace to any place where an employee is working, to ensure the protections kept pace with new ways of working.

3. A culture of regulatory experimentation

A culture of regulatory experimentation can help address some of the inherent uncertainties involved with regulating emerging technologies. It involves deliberately deviating from the current regulatory framework to try out new or different rules in a real-world setting.

The key advantage of regulatory experimentation is that it provides policymakers with real-world evidence to help design effective and efficient regulations for emerging technologies.

There are two main types of regulatory experiments:

1. **Regulatory Sandboxes:** allow testing of emerging technologies by temporary exemptions from existing legal rules. Examples include modifications to current road rules for testing autonomous vehicles (see Box 3 below).
2. **Regulatory Innovation Trials:** these aim to test completely new regulatory options, beyond the scope of existing rules, and learn about their impact before introducing them on a permanent basis or a wider geographical area.

For example, several German municipalities trialled introducing a 'green arrow' traffic sign for cyclists at crossroads so that cyclists can always turn right. Following the experiences gained, permanent changes were made to German road traffic regulations to allow green arrows for cyclists across the country.

BOX 3: REGULATORY SANDBOXES FOR AUTONOMOUS VEHICLES

Autonomous vehicles have the potential to transform passenger mobility and freight services, making transportation smarter and more reliable. They will also change the way that cities and roads are designed. There are a range of benefits from autonomous vehicles, including safer travel, reduced congestion, decreased use of public space for parking and increased productivity. The benefits from adopting this technology for households in Australia have been estimated at up to $92 billion by 2050 (LEK, 2019).

As noted previously, the extensive use of terms such as "driver" and "passenger" in existing regulations could hinder the adoption of driverless vehicles.

The NSW Government has introduced a legal framework for trials of autonomous vehicles to address some of these issues. Under this framework, the relevant Minister can issue a declaration specifying how references in NSW legislation to the "driver", or to the "person in charge of a vehicle" are to be interpreted in the case of the use of a highly or fully automated trial vehicle. Options include replacing the word driver with 'no person', the 'vehicle supervisor' or 'owner of the trial vehicle'.

Automated bus-like vehicles have been trialled in Sydney Olympic Park, Armidale, and Coffs Harbour (Transport for NSW, n.d.). The outcomes from these trials are yet to be published.

FIGURE 8: AUTOMATED VEHICLE TRIAL AT PORT STEPHENS

Source: Transport for New South Wales, 2021.

Regulatory experiments can also arise in response to major economic, social, and environmental events such as natural disasters. At the onset of the COVID-19 pandemic, the NSW Government responded with temporary regulatory changes to protect citizens while allowing businesses to provide consumers with essential products and services. Many of these changes have supported businesses and the community to operate in new ways and to adapt to changes in consumer preferences. Examples include:

- allowing supermarkets and pharmacies to operate 24 hours a day
- allowing restaurants and bars to sell takeaway and home delivery alcohol
- ensuring deliveries to retail premises could take place 24 hours a day
- increased flexibility for home business operation
- supporting business to continue to operate or adapt with takeaway or delivery options for food and beverages, and increased flexibility for food trucks
- enabling a range of legal and compliance activities to take place digitally
- providing workers and employers flexibility in how they use long service leave.

These changes are now being evaluated. The NSW Productivity Commission White Paper recommended they be retained unless it is shown there is no net benefit (NSW Productivity Commission, 2021). The COVID-19 crisis is a reminder that a flexible approach to regulation can determine how quickly and how well we adapt as the world changes.

Australia's federal system also presents opportunities for organic regulatory experimentation. Challenges with emerging technologies are common across states and territories, while approaches taken may differ. There is scope to learn from approaches taken in other jurisdictions.

Applying the principles so NSW can benefit from innovations in mobility

Mobility encompasses a range of transport solutions to get individuals from A to B. It presents the biggest opportunity to apply the principles outlined above due to the rapid emergence of new mobility technologies and business models including drones, personal mobility devices, mobility as a service, electric vehicles, and driverless vehicles.

This section applies the principles for regulating emerging technologies to three technologies that can help mobility—drones, personal mobility devices (PMDs), and e-bikes. These technologies offer large potential productivity gains, by transforming the movement of people and goods. NSW is, however, yet to realise this potential, in part because our regulations have not adapted to the changes that they bring.

The section draws on economic modelling undertaken by the Centre for International Economics (CIE) relating to drones (CIE, 2021a) and PMDs and e-bikes (CIE, 2021b).

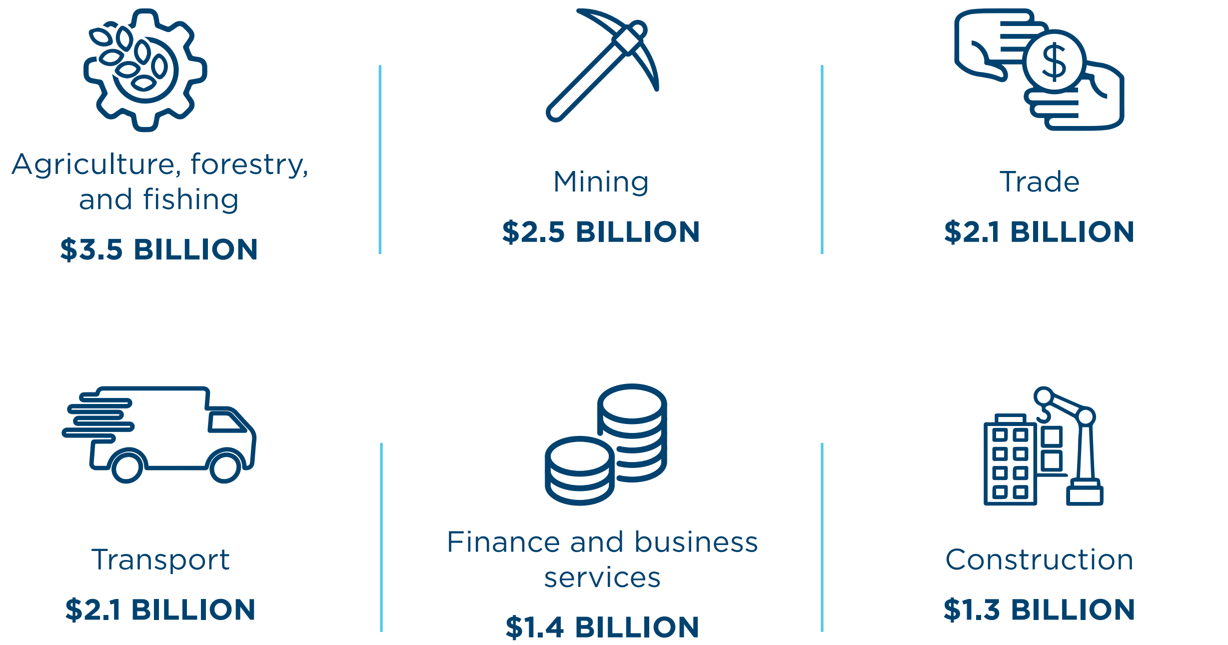
Risk-based drone regulations could deliver large economic gains, starting with agriculture

Modelling completed for the Commonwealth estimates that, across Australia, drones could increase GDP by more than $14 billion between 2020 and 2040 (Deloitte Access Economics, 2020).

Drones deliver:

- **Efficiency gains** where they undertake tasks more quickly, with greater accuracy and at a cheaper cost than humans or other technologies.
- **Safety benefits** where drones undertake tasks that pose safety risks for humans.

FIGURE 9: INCREASED GDP FROM DRONES BY INDUSTRY, AUSTRALIA, 2020-2040, NPV



Source: (Deloitte Access Economics, 2020).

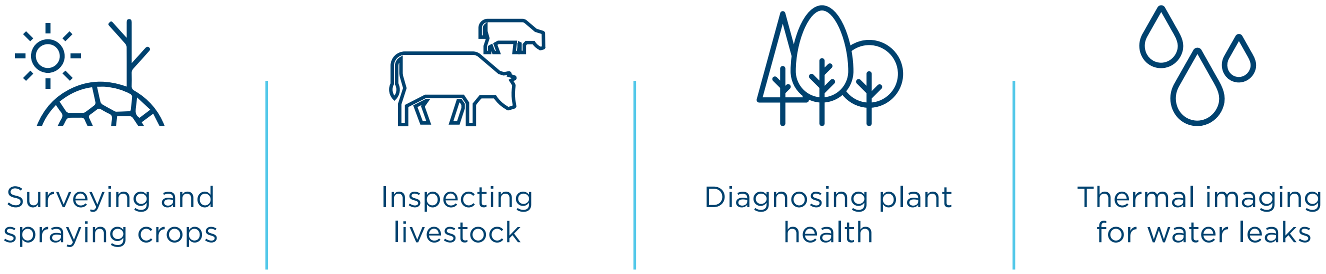
Uses include the delivery of goods and logistics, monitoring and maintenance of infrastructure, and the exploration and planning stages of mining.

The increasing accessibility and the expanding functionality of drones has, however, raised a host of challenges and risks, including:

- **safety** around people, animals, infrastructure, and other airspace users
- the application of **privacy and surveillance** laws (which are not always technology-neutral)[8]
- **amenity issues** such as noise and visual distractions
- **security management** (national security, illegal use etc)
- difficulties **enforcing breaches of rules**, particularly locating and charging offenders (Parliament of Australia, 2018).

Some of the strongest economic benefits from drones are expected to be seen in the agriculture industry, with drones predicted to drive a $3.5 billion increase in the sector's contribution to national GDP by 2040 (Deloitte Access Economics, 2020). Drones can help with a range of agricultural tasks, from simple applications such as pesticide treatment and stock monitoring, to more complex uses such as detecting early signs of plant stress and weed detection.

FIGURE 10: DRONES CAN PERFORM A RANGE OF FUNCTIONS ON FARMS



Innovative applications are also constantly emerging, with drones being used to:

- slow the NSW mouse plague by dropping poison bait (May, 2021)
- restore land following the 2020 Australian bushfires by carrying a customised spreading system to disperse seeds in a nutrient-rich pod (Airseed Technologies, n.d.)
- assess the damage to property, livestock and wildlife caused by the 2020 Australian bushfires, gaining access to areas that were not safe for humans to enter (Chanthadavong, 2020).

At the same time, agriculture is a relatively low-risk setting for drones as safety, noise and privacy issues are less prevalent in sparsely populated rural areas.

This section applies the regulatory principles for emerging technologies to drones in agriculture as a high-value, low-risk first step. But the opportunity from applying the regulatory principles is much bigger than just agriculture. For instance, fisheries and the forestry sector generally operate in areas with similar attributes to agriculture, such as low population density, away from airports and of a relatively large size.

Drones could be used in the forestry sector to inspect remote terrain and identify areas suitable for harvesting. The same technology could be used by regulators to inspect harvested areas and assess compliance with forestry regulations.

RISKS FROM DRONES IN AGRICULTURE ARE LIMITED DUE TO THE REMOTENESS OF MOST FARMS

The risk profile of operating a drone decreases the further the drone is from people, property, and restricted airspaces, such as airports. Analysis of the proximity of agricultural land to airports in NSW suggests there are minimal safety risks to aircraft from agriculture drone use. In NSW only 2.4 per cent of agriculture land is located within 10km of an airport. Drone use on farms is generally at altitudes below the operating heights of other aircraft. There have been no incidents with drones colliding with aircraft when used in an agricultural setting.

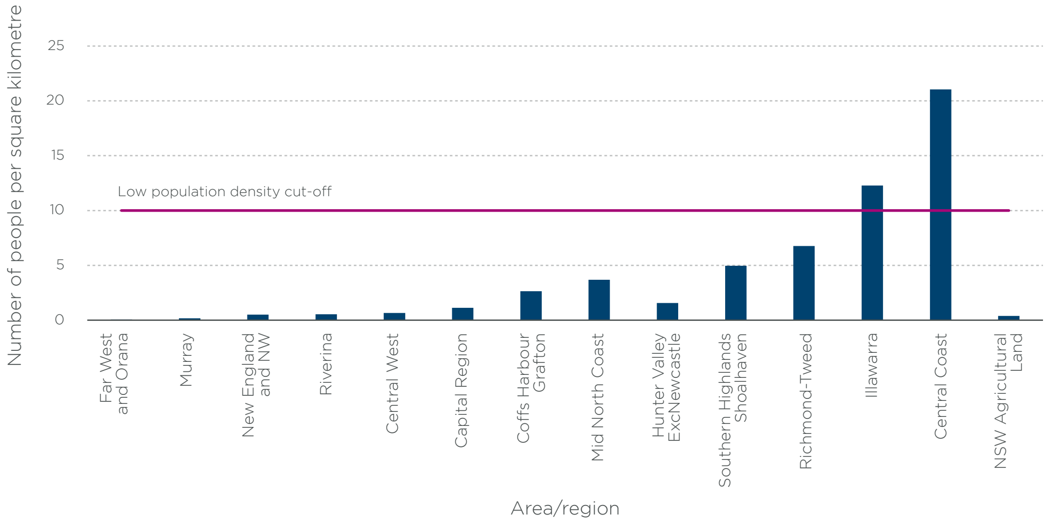
There are also limited risks to people and property from drone use in agricultural settings. CASA deems the risks of drone use as low in areas with average population density below ten persons per square kilometre and no town or settlements greater than 100 dwellings (CASA, n.d.).

8 For instance, the Surveillance Devices Act 2007 (NSW) effectively prohibits a person entering premises and recording activities occurring on the premises without owner/occupier consent. However, its application to drone technology is unclear as the legislation was drafted prior to the growth of drone use.

In NSW there are limited cases where agricultural land exceeds this population density. Only agricultural land in the Illawarra and Central Coast regions exceed the CASA population density for sparsely populated area (see Figure 11). These regions represent less than 0.05 per cent of agricultural land in NSW.

In total, only 0.7 per cent of NSW's 633,571 square kilometres of agricultural land had a population density of more than ten people per square kilometre in 2016. Further, less than ten per cent of land used for agricultural purposes has a town or settlement that exceeds 100 dwellings.

FIGURE 11: NSW AGRICULTURAL LAND POPULATION DENSITY BY REGION



Source: Treasury and CIE calculations based on ABS 2016 Census Meshblock and NSW 2013 Landuse maps.

DESPITE THE LOW RISKS, THERE ARE A RANGE OF REGULATORY BARRIERS TO EFFECTIVE DRONE USAGE IN AGRICULTURE

CASA (n.d.) has issued national rules in response to safety, amenity, and security issues. The rules contain stringent Standard Operating Condition requirements that drone users must abide by (see Box 4).

BOX 4: STANDARD OPERATING CONDITIONS FOR DRONES

- Within visual line of sight only—close enough to see, maintain orientation and achieve accurate flight and tracking.
- During daytime only.
- Height restrictions—no higher than 400 ft (122 metres) above ground level.
- Restrictions on proximity to people and restricted places (e.g. drones are prohibited within 5.5 km of a controlled aerodrome, populous areas or within 30 metres from people not associated with the flight).
- Weather restrictions—drone cannot be operated in or out of cloud.
- Pilot restrictions—drones cannot be operated autonomously, with only one drone flown per pilot at any one time.

It is possible to operate outside the Standard Operating Conditions but the process is costly and time consuming.

Drone operators must obtain a remote pilot's licence[9] and operator certificate.[10] An additional assessment is required if an operator wants to fly a drone beyond visual line of sight. The whole process can take as much as two months to complete and can cost between $24,500 and $26,500 in private training and support, CASA fees and extra costs.[11]

Additionally, a separate exemption application needs to be submitted to CASA each time a drone operator wants to operate a drone outside of the standard operating conditions, regardless of whether the exemption has previously been granted for that activity, with the exemption being decided on a case-by-case basis (CASA, n.d.).

Box 5 illustrates the significant time and financial costs posed by these requirements for an average farmer seeking to use a drone in a low-risk agricultural context.

BOX 5: CASE STUDY OF A FARMER SEEKING TO OPERATE A DRONE OUTSIDE OF THE STANDARD OPERATING REQUIREMENTS ON THEIR FARM

Farmer Jane would like to use a drone for small-scale spraying of crops beyond the visual line of sight on her crop farm.

She will need to undertake the five-day remote pilot course and other training, where she will be subject to the same level of assessment as someone who intends to fly close to people or over inhabited areas. After two months and $26,500 spent on private training and support, CASA fees and other costs, Jane will be ready to apply for an exemption from the standard operating conditions.

Jane intends to fly her drone beyond the visual line of sight twice a week. She will have to apply to CASA for an exemption at least twice a week, as an exemption must be submitted each time she wants to operate outside of the standard operating conditions. To apply for an exemption, she must download and complete a four-page form and provide supporting documentation such as risk assessments, maps, and flight plans. A fee must be paid following review of the application, with an additional fee to be paid if an inspector must travel to complete the assessment.

There is anecdotal evidence that a significant amount of current drone usage on farms is likely to be non-compliant.[12] This suggests that the current regulatory approach is not effectively managing the safety risks it was designed to address.

More flexible regulations could assist farmers with managing risks when using drones on their property, rather than operating outside of the law. In particular, the regulations could be designed to make it easier for farmers to fly drones 'beyond visual line of sight' and at night, on their own private property.

Flying beyond line of sight: This would enable farmers to use small drones more effectively for small-scale spraying or other tasks like checking on livestock.

Flying at night: Drones could provide a safer substitute for driving at night on unpredictable and off-road terrain to check on livestock. It could also allow farmers to spray at night, which can be more effective than during other times in the day due to lower chance of wind (Farming Smarter Association, 2015).

9 A remote pilot licence allows commercial operation of a drone anywhere in Australia by the licence holder. To obtain this, drone training needs to be completed.

10 An operator's certificate allows the holders business to operate as a drone service provider. This allows the business to earn money for hire or reward, employ remote pilots (licence holders) and operate outside of the standard operating conditions, if an exemption is granted.

11 An applicant must undertake a 5-day course in a specific location to obtain their remote pilot licence. If the applicant is based in a regional area, this can involve fuel, accommodation, and time costs.

12 This non-compliance is likely reflecting day-to-day farming activities being undertaken by smaller consumer grade drones.

There is an opportunity to tailor training and risk assessment to suit lower-risk agricultural operations. CIE modelled the impacts of:

- Reducing the **timeframes for beyond visual line of sight applications** by performing one risk assessment of the entire property and allowing unlimited use going forward.
- **Condensed remote pilot license** training from e.g., five days to two days, with a portion to be completed online.
- **Shortened remote operator certificate training**, due to tailoring specifically to agricultural use.
- Reduced costs of the **beyond visual line of sight training** if drone operation is within own property and with consideration of nearby airfields and restricted airspace.

Such changes are estimated to save an average farmer up to $11,000 in direct costs ($9,000 in savings for flying beyond visual line of sight and $2,000 in savings for flying at night), as well as significant time savings. Further savings may be possible from alternative regulatory approaches, such as scope for general authorisations in particular low risk circumstances. Use of technology to support safety, for example by monitoring and enforcing the safe sharing of airspace could also be explored. Reduction of costs and more simplified processes would encourage the uptake of drones in agriculture. It could also encourage those operating in non-compliant ways to operate within the regulations.

RELAXING THE REGULATORY ENVIRONMENT FOR DRONES IN AGRICULTURE COULD UNLOCK UP TO $500 MILLION IN NET BENEFITS BY 2041

The NSW Productivity Commission White Paper recommended that NSW work with the Commonwealth regulator (CASA) to support greater take-up of drones in industry, beginning with the agricultural sector (NSW Productivity Commission, 2021).

The recommendation was supported by analysis from the CIE showing that relaxing regulatory settings for drones in agriculture could unlock up to $500 million in net economic benefits by 2041 (see Table 2). Greater benefits are achieved with greater levels of regulatory relaxation.

These benefits could be even higher as a more permissive regulatory environment encourages market growth and greater innovation in the use of drones. New applications could emerge, including new software that can integrate drones with other farming technologies.

TABLE 2: NET BENEFITS OF RELAXING REGULATIONS FOR DRONE USE IN NSW AGRICULTURE

NET BENEFITS OF DRONE USE IN NSW AGRICULTURE		
Category	**Low scenario ($m)[13]**	**High scenario ($m)[14]**
Benefits (NPV 20 years)		
Reduced farm injuries and fatalities	115	273
Increasing efficiency of routine farm work	94	157
Yield increase from increasing efficiency of spraying	37	79
Total benefits	**245**	**508**
Costs (NPV 20 years)		
Drone costs for routine farm work	4	4
Drone costs for spraying	2	4
Total costs	**6**	**8**
Net benefit	**239**	**500**

Source: (CIE 2021a)

13 The low scenario involves simplifying the remote operator certificate application process.

14 The high scenario involves significant reduction in the processes and costs for a beyond visual line of sight application.

Reduced farm injuries and fatalities

Drones could reduce injuries and fatalities as many high-risk farming activities, such as equipment and livestock inspection, could be substituted by drones. The safety benefits of drones compared to people on quad bikes, motorcycles and horses is likely to be highest in steep or rugged terrain.

Increased drone uptake was estimated to:

- reduce injuries by between five per cent and 15 per cent, leading to benefits of between $66 million and $199 million over 20 years
- reduce quad bike fatalities by between one and two per year, leading to benefits of between $49 million and $74 million over 20 years.[15]

Increased efficiency of routine farm work

Traditional farming is labour-intensive and involves vehicle use (quad bike or truck). Drones can be used to complement routine farm work such as checking water troughs, fencing and silos, and locating livestock to enable more efficient mustering. This can result in large cost savings, in terms of labour and fuel. For example, Calliope Station in central Queensland completed mustering using one person and a drone instead of three people on quad bikes (Bolton, 2020).

Increased drone substitution could save individual farms:

- labour costs of between $5,866 to $9,777 per year from reduced time spent doing routine work
- fuel costs of $91 to $182 per year due to reduced fuel usage.[16]

These benefits are mostly expected to accrue to livestock farms, which account for 73 per cent of farms in NSW.

Improved yield

Improvements in crop yield may be driven by two main uses of drones:

1. Crop monitoring: Drone technology offers a large variety of crop monitoring opportunities at a low cost. For example, drones can produce precise 3D maps that allow early soil analysis, assessment of plant health and help choose the right time to plant seeds and harvest. Drones are more competitive relative to satellite imagery on smaller landholdings, particularly where high resolution imagery is required.
2. Crop spraying efficiencies: drones can scan the ground, maintaining the right distance from the crops to spray the correct amount of liquid, while adapting spraying in real-time for even coverage. They can also be used to 'fill in' areas which a manned aircraft would be unable to access due to power lines or other infrastructure.

   Drone usage could lead to benefits of between $37 million and $79 million over 20 years, based on a conservative five per cent increase to yields for vegetable, fruit and nut farms.[17] Vegetable, fruit, and nut farms account for 14 per cent ($1,783 million) of NSW's gross agricultural production (ABS, 2018-2019).

15 With an assumed growth rate of drone uptake of five per cent per year.

16 The savings are based on a 300-acre Scotland livestock farm case study, adjusted for the greater size of Australian properties and greater drone utilisation (thrice weekly, rather than twice a week).

17 This estimate is conservative as Australian farmers of green vegetable, orchards, banana plantations and olive groves are reporting yield increases of up to ten per cent from the use of drones (Trowbridge, 2017).

NEXT STEPS FOR DRONES IN NSW—APPLYING THE THREE PRINCIPLES

Outcomes-focused regulation

Some level of prescriptive regulation will continue to be needed to guide end-users of drones. There is however an opportunity to apply a more risk-based approach to drone regulation by simplifying the process to fly outside of the standard operating conditions in lower-risk settings, beginning with agriculture.

The Drone Rule Management System (DRMS) will also provide an opportunity to apply an outcomes based approach to drone regulation. The DRMS is a planned web-based system to coordinate and manage the various rules applying to drones across Commonwealth, state, territory, and local governments, including non-safety rules related to noise, privacy, environmental impacts, and cultural sites. It will allow drone operators to view all the relevant operating restrictions in an area through mobile applications and other interfaces. The development of the DRMS was highlighted as a key initiative under the Commonwealth National Emerging Aviation Technology (NEAT) Policy Statement (Department of Infrastructure, Transport, Regional Development and Communications, 2021).

Regulatory experimentation

The NSW Government should engage with CASA, industry, and the community to trial alternative drone rules in priority sectors, starting with agriculture. Regulatory trials can help test and refine approaches to regulation while addressing safety and security concerns. A trial could be the first step in developing new simplified operational categories for lower-risk regional and remote operations, including beyond visual line of sight and autonomous operations. This was also highlighted as a priority initiative under the Commonwealth NEAT Policy Statement. The trials should be regularly evaluated to determine their effectiveness.

Drone trials are already happening around the country.[18] 'Wing Aviation' have been operating ongoing drone delivery trials in North Canberra in the ACT and Logan in Queensland since 2019. In early 2021, trials for the delivery of medicines by drone by Swoop Aero in partnership with Terry White Chemist began in Queensland. Meanwhile, the Northern Territory Government announced a three-year trial to test the delivery of medical supplies by drones to rural and remote communities in February 2021.

Regular review

Many NSW businesses across sectors are already using drones in innovative ways. Tasking a Minister with policy responsibility for drones would help NSW capitalise on opportunities arising from emerging drones use, while managing the risks and impacts associated with increasing drone applications. The Minister would be responsible for:

- Understanding the sector and taking stock of the existing use of drones across the state.
- Drawing together the wide range of drone-related challenges and working with the Commonwealth to effectively manage interrelated issues such as safety, privacy, noise, and security.
- Developing initiatives, sandboxes, and regulatory trials, in partnership with industry and the Commonwealth as needed, to support the adoption of drones in priority sectors.
- Providing strategic direction and targeted support for the adoption of drones in partnership with industry, with a focus on areas with the greatest potential to benefit the economy and addressing priority community needs.

The role should also extend to policy responsibility for other emerging aviation technologies, including Electric Vertical Take-off and Landing Vehicles (eVTOL) which, as the name suggests, use electric power to hover, take-off and land vertically.

18 These trials are occurring within the existing framework—operators apply to CASA to get special conditions and exemptions. Each time, CASA still must assess and give approval to the operator to do something specifically outside of the Standard Operating Conditions.

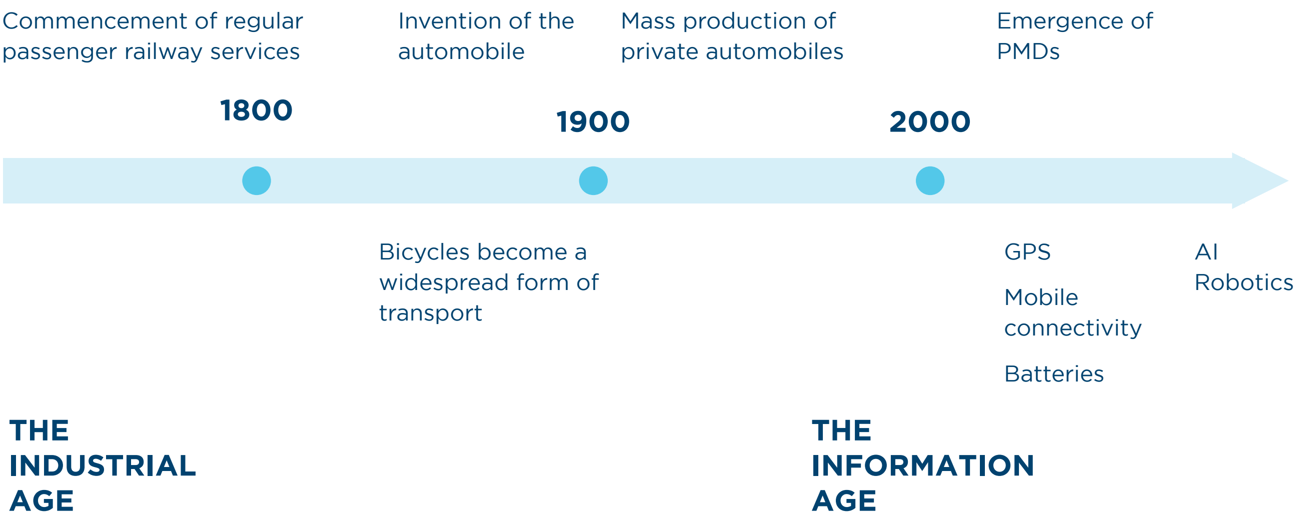
Allowing PMDs in public areas would provide a new, more efficient way to travel

PMDs are changing the transport landscape. Just as when bicycles and automobiles came about, technological innovation is providing consumers with new ways to move around their cities and communities. They are part of a general shift in mobility, fueled by technological advances such as GPS, connectivity, and advances in battery power, as well as the urban transportation challenges faced by rapidly growing cities around the world.

PMDs and other micro-mobility devices can also play a part in the post-pandemic shift towards 15 minute cities, where residents are able to shop, work, and live within a 15 minute catchment area.

An array of e-scooters, e-skateboards and other devices are already available, typically used for short commutes, as well as the first and last portion of longer public transport journeys. Yet devices on the market today likely only scratch the surface of benefits that their use may deliver in the future.

FIGURE 12: TECHNOLOGY IS DRIVING RAPID CHANGES IN MOBILITY



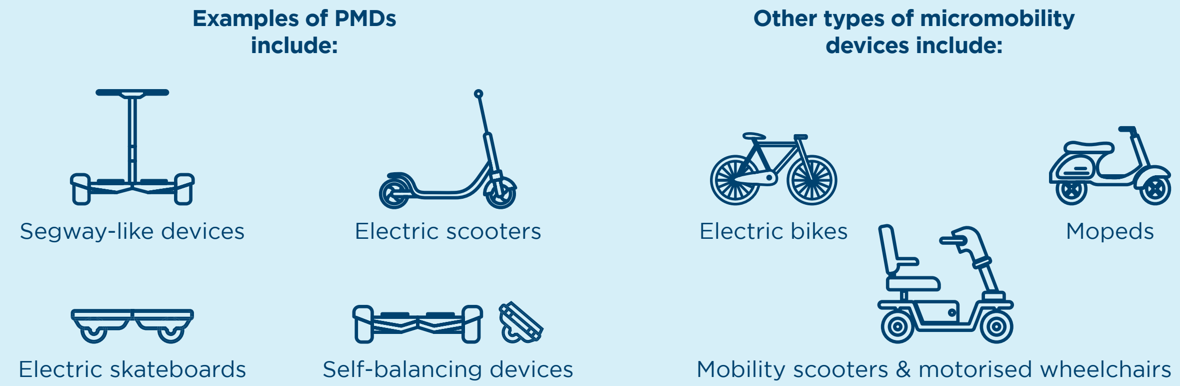
BOX 6: WHAT ARE PMDs?

The model Australian Road Rules (ARRs) were updated in 2021, following a national regulatory impact assessment process. The ARRs define PMDs as a device that:

- has one or more wheels
- is propelled by one or more electric motors
- is designed for use by a single person only
- has an effective stopping system controlled by using brakes, gears, or motor control
- when propelled only by the motor, cannot reach a speed greater than 25km/h on level ground
- is not equipped with any sharp protrusions
- measures no more than:
  - 1,250mm in length by 700mm in width by 1,350mm in height and weighs less than 25kg when the vehicle is not carrying a person or other load
  - 700 millimetres in length by 1,250 millimetres in width by 1,350 millimetres in height and, when the device is not carrying a person or other load, 60 kilograms in weight (Australian Parliamentary Counsel's Committee, 2021)

Figure 13 depicts a selection of PMDs that are currently available, of which e-scooters are the most prominent example. PMDs do not include e-bikes or motorised mobility devices, however these are part of a broader banner of micro-mobility devices.[19]

FIGURE 13: EXAMPLES OF MICRO-MOBILITY DEVICES



The NSW Productivity Commission's White Paper outlined how PMDs could drive productivity improvements for our cities and regions (NSW Productivity Commission, 2021).

Key opportunities include:

- **reduced travel time** for those that switch from walking or short car trips
- **better access to public transport** through reducing first and last mile transport problems
- **reduced congestion** and demands on transport infrastructure where PMDs replace car trips.

19 The ARR definition of PMD excludes power assisted pedal cycles, motorised scooters not capable of travelling more than 10km/h on level ground and motorised mobility devices e.g., motorised wheelchairs and mobility scooters.

NSW LAGS OTHER JURISDICTIONS IN ITS REGULATION OF PMDs

Many Australian and international jurisdictions regulate PMDs and permit their use in public areas, with the most prominent example being e-scooters (see Table 3). For instance, Queensland, the Australian Capital Territory, France, and the State of California permit the use of a variety of PMDs. NSW is, however, an outlier as our laws restrict the use of all PMDs to private property only.

The rapid emergence of PMDs challenged regulators and sparked trials of various regulatory frameworks. The interjurisdictional experience shows that a diverse range of approaches can work, but adjustments may be needed for the local context and regulators may not always get it right on the first try (see Box 7). This shows the value in testing, collecting data, and refining until we find what works.

TABLE 3: APPROACHES TO REGULATING E-SCOOTERS ACROSS JURISDICTIONS

	LEGAL STATUS—PUBLIC USE	MAXIMUM SPEED LIMIT USING POWER SOURCE[20]	PERMITTED ON FOOTPATHS
	Australia		
New South Wales	Illegal	n/a	n/a
Queensland	Legal	25km/hr	Yes
ACT	Legal	25km/hr	Yes
Victoria	Legal	10km/hr	Yes
Tasmania	Legal	10km/hr	Yes
Western Australia	Legal	10km/hr	Yes
South Australia	Shared trial only	15km/hr	Yes
Northern Territory	Shared trial only	15km/hr	Yes
	International		
United Kingdom	Shared trial only	25km/hr	No
France	Legal	25km/hr	No
Germany	Legal	20km/hr	No
New Zealand	Legal[21]	None (power limits apply)	Yes
New York	Legal	20km/hr	No
California	Legal	15km/hr	No

Source: NSW Productivity Commission analysis.

20 Maximum speed on level ground while being propelled by the motor alone.
21 Maximum power output must not exceed 300 watts.

BOX 7: E-SCOOTER TRIALS IN AUCKLAND

Auckland Council evaluated its rental e-scooter trial to help decide whether to continue the scheme (Auckland Council, 2019). It found the trial outcomes had been in line with the strategic goals of the council and Auckland Transport, and recommended the continuation of the scheme.

Recommendations for improvement, such as addressing poor or non-compliant parking, were also made. This included requiring a minimum level of compliance from operators, requiring operators to take reasonable steps to ensure e-scooters are properly parked and enforcement actions.

PERMITTED ON CYCLE PATHS	PERMITTED ON ROADS	MANDATORY HELMETS	MINIMUM AGE (years)
n/a	n/a	n/a	n/a
Yes	Yes (under 50km/hr)	Yes	12 with adult supervision, otherwise 16
Yes	No	Yes	None, <12 require adult supervision
Some	Yes (under 50km/hr)	Yes	None
Yes	Yes (under 50km/hr)	Yes	None
Yes	Some	Yes	None
Yes	No	Yes	18
Yes	No	Yes	18
Some	Yes	No	15 years 9 months
Yes	Yes (unless available cycle path)	Yes (required on permitted roads)	12
Yes	Yes	No	14
No	Yes	No	14
Yes	Yes (under 30-mi/hr)	Under 18s only	16
Yes	Yes (under 25mi/hr)	Under 18s only	>15.5 years

The National Transport Commission has updated the ARRs to include a model regulatory framework for PMDs. Under the new ARRs, PMDs can be used on shared paths, separated paths, and bicycle paths. States and territories have the flexibility to set the maximum speed limits and allow access to footpaths and local roads (with speed limit of 50 km/hr or less) (Australian Parliamentary Counsel's Committee, 2021). The model laws were endorsed by ministers on 30 May 2021. NSW, however, has not progressed with plans to implement a shared e-scooter trial (Transport for NSW, 2020) and has no plans to adopt the model laws.

THE PMD MARKET IS CONTINUING TO INNOVATE WHETHER WE REGULATE OR NOT

New ways of getting around bring challenges too. The safety and comfort of riders and pedestrians needs to be protected and changing transport patterns invariably change the infrastructure our cities need, such as cycling/PMD lanes. As outlined in the previous sections, history suggests that being slow to adapt regulation will not help solve these challenges.

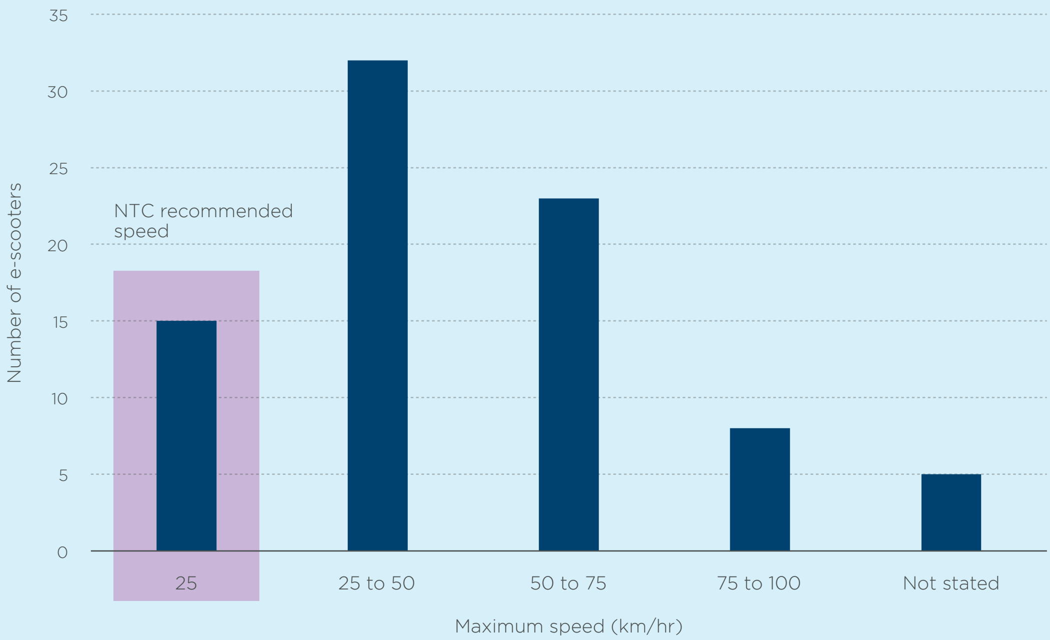
Devices such as e-scooters can be seen by a casual observer on the streets of Sydney's CBD every day. Reliable data about current uptake is limited, however, anecdotal evidence suggests e-scooter sales in NSW are growing.[22] Despite this, use is not governed by clear speed limits and safety requirements such as helmets, which may heighten risk of serious accidents and injuries for users who may be unaware of their illegality.

The market continues to innovate. High powered devices with speed limits of up to 100 km/hr, far beyond the regulated maximum speed limits in other jurisdictions, can be easily purchased in shops and online (see Box 8). The availability of such high-powered devices, combined with possible confusion from consumers about their legality in public spaces, could exacerbate safety risks. Providing an appropriate regulatory framework is the best way to manage these risks.

BOX 8: NSW'S CURRENT PMD PRODUCT OFFERING

A wide variety of PMDs are currently available to purchase in NSW. Examining e-scooters alone, devices with maximum speeds of up to 100 km/hr, and power outputs of up to 6,640 Watts are freely available to purchase. Out of a sample of 83 e-scooters, only 15 had a maximum speed of 25 km/hr or below (that is, below the National Transport Commission maximum speed limit), while sixty-three had higher maximum speeds (see Figure 14). These devices are currently legal to purchase but are only allowed to be ridden on private property.

FIGURE 14: MAXIMUM SPEEDS OF A SAMPLE OF E-SCOOTERS AVAILABLE IN NSW



Source: NSW Productivity Commission analysis based on a random sample of retailer websites. N=83.

22 One major Australian retailer noted its e-scooter sales had increased five-fold in the past year due to significant customer demand (Dye, 2021)

BETTER LAWS COULD UNLOCK UP TO $87 MILLION IN NET ECONOMIC BENEFITS BY 2041

The NSW Productivity Commission White Paper recommended revising laws to support the use of PMDs, with an appropriate regulatory framework that manages risks (NSW Productivity Commission, 2021). This recommendation was supported by CIE analysis which shows that PMDs could unlock up to $87 million in net economic benefits by 2041 (CIE, 2021b).

The analysis found that an appropriate regulatory framework could enable uptake of PMDs of between 8 million trips and 10 million trips per year by 2041 (compared to 600,000 trips per year if regulations remain at their current settings). The forecast range is due in part to uncertainties in how consumers will respond to PMDs and how external factors, such as availability of appropriate infrastructure and shared services, will promote uptake.

Increased uptake of PMDs has costs as well as benefits. To provide a more detailed look at the analysis completed for the White Paper, Figure 15 below outlines the main costs and benefit categories.

FIGURE 15: COSTS AND BENEFITS OF INCREASED PMD UPTAKE

	TRAVEL TIME	CAR USAGE	HEALTH	SAFETY	ENVIRONMENT	GOVERNMENT
Benefits	Faster travel where walking trips replaced	Reduced congestion	Increased active transport benefits where car trips replaced	Reduced road incidents where car users switch to PMDs	Avoided emissions from less car usage	
Benefits	Faster travel where last mile problem solved	Reduced vehicle operating costs				
Costs			Decreased active transport benefits where walking trips replaced	Increased incidents for PMD users	Additional emissions from PMD use	Additional costs for enforcement

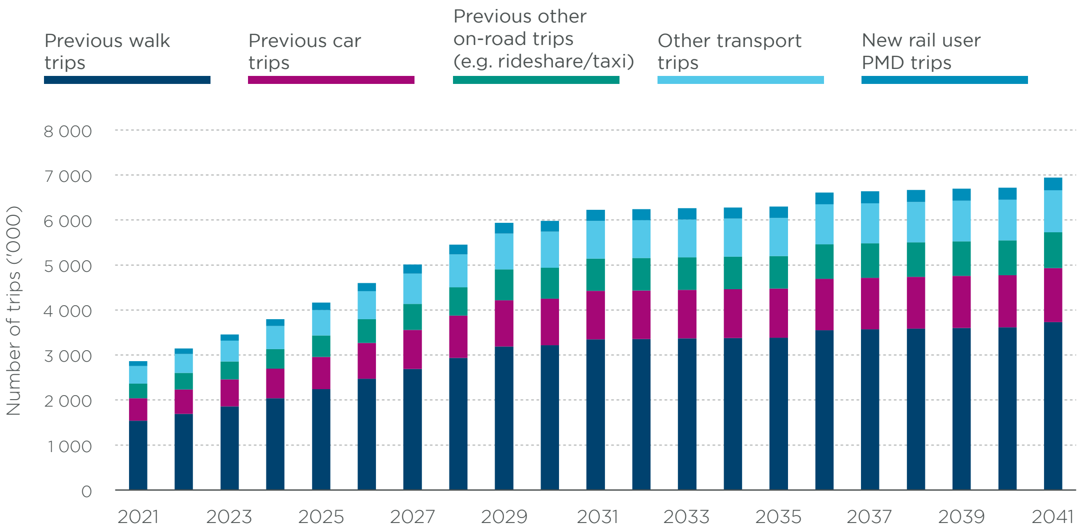
Source: NSW Productivity Commission, drawing on (CIE, 2021b).

The economics of PMD usage depends not just on uptake, but also what the use patterns look like. For example, replacing walking trips will bring travel time benefits for users and provide enhanced mobility for people who have difficulty walking. Replacing walking trips may also lead to worse active health outcomes as walking requires greater physical movement.

On the other hand, replacing car trips will lead to better active health outcomes, as well as reducing the number of cars on the road, leading to better road journeys for other users. There may also be travel time savings by avoiding costs associated with the need to find parking for shorter car journeys.

Analysis shows the majority (54 per cent) of PMD trips would replace walking trips, followed by road-based travel (30 per cent, including cars and rideshare/taxi) and other transport trips. A small number of users are expected to be new public transport users, induced by the lower station access costs facilitated by PMDs (see Figure 16).

FIGURE 16: ESTIMATED MODESHARE FOR TRANSPORT TRIPS—HIGHER GROWTH SCENARIO



Source: (CIE, 2021b).

The higher the uptake, the higher the net benefits, with the greatest benefits coming from travel time savings, followed by vehicle operating cost savings. These are offset to some extent by worse active transport outcomes, safety impacts and enforcement costs. Overall net benefits of regulating PMDs are anticipated to be between $58 million and $87 million.

Higher PMD use may also increase demand for, and ultilisation of, cycling infrastructure. This could support additional investment and lower the use of more expensive road infrastructure. More appropriate infrastructure provision may help encourage greater levels of uptake by ensuring a safe environment for riders.

TABLE 4: NET BENEFITS OF REGULATING PMDs

CATEGORY	Status quo ($million, NPV)	Central ($million, NPV)	Higher growth ($million, NPV)
Benefits			
Travel time savings	3.7	49.5	70.8
Vehicle operating cost savings	1.2	16.8	23.7
Decongestion benefits	0.6	7.8	11.0
Environmental impacts	0.2	2.3	3.4
Health benefits	-1.0	-13.7	-18.1
Safety impacts	-0.2	-2.4	-1.5
Total benefits	**4.5**	**60.3**	**89.3**
Costs			
Enforcement costs	-0.2	-2.1	-2.7
Total costs	**-0.2**	**-2.1**	**-2.7**
Net benefit	**4.3**	**58.3**	**86.6**

Source: (CIE, 2021b).

Additionally, recent research into tourists' use of an e-scooter share scheme in Townsville, Queensland found that e-scooters can provide tourism benefits (Leung, et al., 2021). Notable findings included:

- The more avid tourist e-scooter users (the top third by distance travelled) spent 41 per cent more money per day than those in the bottom third for use.
- The avid tourist users completed a median of 11 e-scooter trips, covering nearly 26km each. These trips were completed over dispersed geographic locations, meaning that they experienced more local destinations in the city.
- 60 per cent of these trips would have otherwise been completed by walking, taking longer to complete, and limiting the total number of destinations visited.
- Other trips wouldn't have occurred at all, with one user commenting: *"We enjoyed being able to travel to areas that we would not normally have seen or were too far to walk in a reasonable amount of time."*

APPROPRIATE REGULATION AND SAFEGUARDS ARE NEEDED TO MANAGE THE SAFETY RISKS OF PMDs

The CIE quantified the safety impacts of PMDs by reviewing evidence from other jurisdictions about likely incidence rates and injury severity. Adjustments were also made according to where trips were likely to take place, with trips in places such as cycleways assumed to be less prone to accidents. In all scenarios the safety benefits of avoided car accidents were outweighed by the safety costs of increased PMD incidents, leading to a small net cost over 20 years of up to $2.4 million. These results are somewhat uncertain as evidence on the safety impacts of PMDs is still developing (see Box 9).

BOX 9: EVIDENCE ON THE SAFETY IMPACTS OF PMDs

The International Transport Forum (2020) has undertaken a comprehensive review of the safety of micro-mobility devices. They found that a trip by a car or a motorcycle in a dense urban area is more likely to result in a death of a road user than a trip on a small micro-mobility device, such as a PMD or e-bike.

When comparing the risks associated with e-scooters and cycling it found that they present similar risks. Specifically:

- E-scooter fatality risk ranges between 78 and 100 fatalities per billion trips, whereas cycling risks ranges between 21 and 257 fatalities per billion trips.
- E-scooter injury risk ranges between 87 to 251 emergency department visits per million trips. In comparison the 2009 cycling injury rate in the United States is 110 to 180 emergency department visits per million trips.

These data points do, however, need to be interpreted with care. Safety evidence remains weak, and data may not be comparable between different modes and locations. For example, mandatory helmet requirements in Australia are likely to lower these costs. Further, e-scooter safety studies conducted within the first few years of roll out will not reflect gradual safety improvements over time, as devices are designed better, infrastructure improves, compliance is lifted and users improve their riding ability.

What we can say with certainty is that PMDs have safety risks that need to be considered, and there is scope for regulatory design to improve safety outcomes. Evidence from other jurisdictions suggests there is room for improvement. The International Transport Forum (2020) found that helmet use across a range of international studies was only four per cent. In Auckland, in a sample of injured e-scooter riders presenting to emergency departments, only ten per cent were wearing helmets, and 48 per cent were under the influence of alcohol (McGuinness, et al., 2021).

In contrast, in Santa Monica a flexible regulatory approach which could respond to community needs and expectations was applied. The pilot resulted in 122 total collisions out of 2.67 million trips, only ten per cent of which resulted in serious injuries (City of Santa Monica, 2019). The evaluation found that rider behavior improved significantly during the pilot, however sidewalk and tandem riding remained an issue, highlighting the importance of investment in appropriate infrastructure, rider education and enforcement.

NEXT STEPS FOR PMD REGULATION—APPLYING THE THREE PRINCIPLES

The future of mobility includes a key role for micro-mobility devices. Regulation, however, is holding back their potential in NSW, while other jurisdictions revise laws to safely embrace them. The NSW Productivity Commission White Paper recommended revising NSW laws to support the use of PMDs and e-bikes in an appropriate regulatory environment that manages safety risk (NSW Productivity Commission, 2021).

Regulatory experimentation

A regulatory innovation trial of PMDs, would provide an opportunity to:

- test the appropriateness of the regulatory framework in a local setting
- collect and evaluate data on the risks and benefits
- refine the final regulatory approach to maximise benefits and safely manage risks.

The National Transport Commission's model laws for PMDs under the ARRs provide an appropriate base from which to design and implement a trial. The framework is focused on the overall regulatory framework for use of devices by private individuals in public spaces. There may, however, be opportunities to trial shared use schemes within the overall regulatory framework.

Regular review

The national model laws for PMDs should be reviewed periodically in light of emerging technological developments and the experiences of jurisdictions, both locally and internationally.

Technology-neutral regulation

The definition of PMDs proposed by the National Transport Commission is technology-neutral, setting limits in terms of weight, power, number of wheels etc., rather than specific devices. It should be used in any regulatory trial, rather than restricting the trial to a particular technology, such as e-scooters or a specific shared e-scooter scheme.

Updating e-bike and e-cargo bike regulation could change the way we move people and goods

Electric bikes (e-bikes) are designed to assist the rider to maintain speed with less effort. In NSW, e-bikes which are designed to be driven primarily by the rider, with a power output of up to 250 watts, are permitted in public areas (see Table 5).[23] Speeds are capped by law at 25 km/h while assisted by the motor.[24] Other powered bicycles that do not meet the NSW e-bike requirements may only be used on private property (Transport for NSW, 2021).

TABLE 5: REGULATIONS FOR SELECT BICYCLE-TYPE DEVICES IN NSW

DEVICE	Conventional bicycles	E-bikes	Mopeds
Maximum speed in public areas using power source	Governed by road speed limit[25]	25 km/h	50 km/h
Power source	N/A	Electric motor	Internal combustion engine or electric motor
Power method	N/A	Pedal-assisted	Throttle[26]
Permitted on NSW roads	Yes	Yes	Yes (with registration and licence)
Permitted on NSW cycle ways	Yes	Yes	No
Permitted on footpaths	No (unless under 16 or accompanying a minor)	No (unless under 16 or accompanying a minor)	No
Minimum age	No	No	16 years and 9 months

Source: (Transport for NSW, 2021).

As with PMDs, technology is driving rapid innovation in e-bikes. More efficient and capable e-bikes continue to emerge but are not addressed by the current laws. These can be broadly grouped in two categories:

- e-bikes for personal use, such as commuting
- e-cargo bikes, which form one type of a growing category of 'light electric vehicles' with a variety of commercial uses such as food delivery, freight and logistics.

E-BIKES: TRANSFORMING MOVEMENT OF PEOPLE

NSW's speed and power limits are modest by international standards

Many international jurisdictions permit the use of e-bikes with maximum speeds of up to 45 km/hr, and power limits of up to 1,000W (see Table 6). In NSW, however, speeds over 25 km/h must be maintained by human effort, a difficult feat on a bike laden with a battery and motor, especially on hilly terrain or in a headwind.

23 Two types of devices are permitted: power-assisted cycles with an output of up to 200 watts and electrically power-assisted cycles with a maximum output of 250 watts (Transport for NSW, 2021).

24 For electrically power-assisted cycles the motor cuts off at 25 km per hour. For power-assisted cycles no automatic cut off applies, however the lower power output of 200 watts means higher speeds cannot be reached.

25 Some bike paths and shared paths may have enforceable speed limits.

26 While certain mopeds can be pedaled by the rider for short distances, the primary source of power is typically from the motor using a 'twist and go' system.

TABLE 6: MAXIMUM SPEED AND POWER OUTPUT LIMITS FOR E-BIKES IN SELECT JURISDICTIONS

JURISDICTION	E-BIKES	
	Maximum speed limit using power source	**Maximum power output limit by watts (W)**
Belgium	45 km/h	1000 W
Switzerland	45 km/h	1000 W
Numerous states in the USA[27]	45 km/h	750 W
Canada	32 km/h	500 W
New Zealand	32 km/h[28]	300 W
Australia / NSW*	25 km/h	250 W

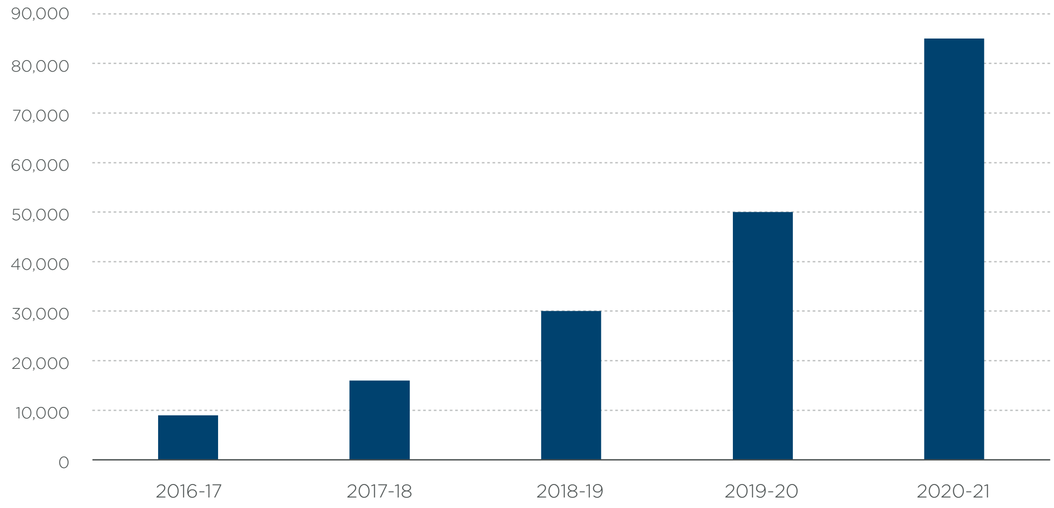
*Similar requirements apply across Australia through a mix of Australian and state-based regulation. The *Road Vehicle Standards (Classes of Vehicles that are not Road Vehicles) Determination 2021 (Cth)* defines the types of e-bikes which are considered to not be road vehicles. Where these requirements are met, individual states and territories exempt these devices from registration requirements.

Source: NSW Productivity Commission analysis.

Increasing speed and power limits could help accelerate e-bike use, with a range of benefits

E-bike imports to Australia are expected to reach 85,000 in the year to July, 2021, an 800 per cent increase in demand over the past five years (see Figure 17). This rapid growth has us catching up to the rest of the world. In the Netherlands 50 per cent of bikes sold are e-bikes, while in Germany the figure is 40 per cent (Kennedy, 2021). By comparison, in NSW, a mere 4.7 per cent of all bicycle trips in 2021 were estimated to be undertaken by e-bike (CIE, 2021b).

FIGURE 17: E-BIKE IMPORTS INTO AUSTRALIA



Source: (Bicycle Industries Australia, 2021).

Note: 2020-21 based on expected figures.

27 These states are: Arizona, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Idaho, Illinois, Indiana, Louisiana, Maine, Maryland, Michigan, New Hampshire, New York, Ohio, Oklahoma, South Dakota, Tennessee, Texas, Utah, Virginia, Washington, Wisconsin, and Wyoming.

28 The maximum speed is capped by the 300W power output limit, however, the NZ Transport Agency recommends a maximum speed of 32 km/h for experienced riders and 25 km/h for beginners.

This enormous potential for increased use of e-bikes by commuters offers a range of benefits, such as:

Travel time savings, where they replace conventional bicycle and walking trips.

Replacing car trips that are less suitable to take with conventional bicycles or PMDs, such as longer distanced, hillier routes, or loaded trips (e.g., groceries or children) with the added benefit of reduced congestion.

Active health benefits from overcoming many traditional barriers to bicycle use, such as physical fitness or terrain, as opposed to sedentary use of mopeds, motorcycles, or cars.

Lower environmental impacts where they replace moped, motorcycle, or car trips with tailpipe emissions (see Box 10).

Expanding the range of e-bikes available could encourage more people to use e-bikes, and to use them more regularly and for greater distances, increasing the benefits offered.

BOX 10: MICRO-MOBILITY DEVICES HAVE A ROLE IN THE SHIFT AWAY FROM FOSSIL FUELS

In NSW, the transport sector accounts for 22 per cent of all greenhouse gas emissions. It is the second largest source of emissions. In fact, road transport contributes to 86 per cent of all NSW transport emissions (AdaptNSW, 2018). This reflects an over-dependence on fuel-intensive passenger, commercial, and freight vehicles on our roads.

Micro-mobility devices do not emit tailpipe emissions during use and require relatively little energy to charge[29]. These devices are more energy efficient and emissions per kilometer are lower than petrol scooters and cars (Cherry, et al., 2009). A report by the European Cyclists' Federation found that e-bikes have a lifecycle emission rate[30] of approximately 22 grams of carbon dioxide per passenger kilometre[31], compared to 271 grams for passenger cars (Blondel, et al., 2011).

An estimated 54 per cent of weekday car trips in Greater Sydney cover less than 5 km (Transport for NSW, 2019). Micro-mobility devices could replace many of these trips and get consumers to their destinations faster due to time saved finding parking. E-bikes with faster maximum speeds could replace longer car trips or where routes face challenging terrain for conventional bikes.

Micro-mobility devices have a central role to play in NSW's net zero emissions future, consistent with the Government's stated objectives for public transport. The NSW Minister for Transport has announced a vision for the entire public transport fleet to be electric, beginning with the rail network being powered by renewable energy by 2025, with the NSW bus fleet transitioned to zero emissions by 2030.

Getting the policy settings and regulation to support this transition should be regarded as a priority.

29 Fully charging an e-scooter battery uses as much energy as running an average clothes dryer for five minutes (Johnson, 2019)

30 A lifecycle emission rate is used to assess the overall greenhouse gas impacts of a product over its lifetime.

31 "Passenger kilometre" is a common unit, based on the average number of people using the mode of transport at a given time.

Regulation has not kept up with consumer preferences

Industry is reporting demand for faster e-bikes in NSW and across Australia. High-powered e-bikes[32] or modification kits[33] are available from online retailers such as eBay, Amazon, and Alibaba. Imported conversion kits (which increase speed) can be fitted to bikes with insufficient braking capacity that are not designed to handle the increased power and speed. This has created growing safety concerns for both the rider and pedestrians (Kennedy, 2021). One anecdotal report from a Bendigo bike shop was that of 16 e-bikes sold, nine had been modified when later returned to the shop for servicing.

A variety of approaches have been adopted to accommodate growing demand for faster e-bikes internationally. For instance, speed pedelecs are a type of e-bike capable of travelling at up to speeds of 45 km/h while being assisted by the motor. Belgium, Switzerland, and California have introduced a separate class for speed pedelecs and subject them to adapted traffic rules compared to conventional bicycles and standard e-bikes (see Table 7).

A range of regulatory details would need to be considered that balance the benefits of increased e-bike usage against the potential safety risks of faster maximum speeds. More detailed analysis on appropriate regulatory settings in Australia is required. There is, however, opportunity to learn from the experiences of other jurisdictions. For example, Belgium and Switzerland require speed pedelecs to be registered and licensed, whereas California does not. It is important that the costs and benefits of such policies are carefully assessed and a variety of options to achieve the desired outcomes are considered.

TABLE 7: COMPARISON OF SPEED PEDELEC REQUIREMENTS IN BELGIUM, SWITZERLAND AND CALIFORNIA

	BELGIUM	SWITZERLAND	CALIFORNIA (US)
Permitted on bike lanes	Yes	Yes	No, unless approved by local authority
Permitted on roads	Yes	Yes	Yes
Minimum age restriction	16 years	14 years	16 years
Registration required	Yes	Yes	No
Licence required	Yes	Yes	No

Source: NSW Productivity Commission analysis.

32 For example, the Cullen, Kristall E5 Pro and Vamos El Diablo e-bikes are capable of top speeds of 55-65 km/h, 45-60 km/h and 35-40 km/h respectively. These devices can be purchased for as little as $A112 (excluding shipping).

33 Tuning kits allow users to remove the speed limitations imposed by manufacturers on existing e-bikes, while conversion kits can transform conventional bicycles into e-bikes.

E-CARGO BIKES AND OTHER LIGHT ELECTRIC VEHICLES: TRANSFORMING MOVEMENT OF GOODS AND SERVICES

Rapid e-commerce growth is driving delivery demand

Online shopping expenditure in Australia grew 57 per cent in 2020 (Australia Post, 2021). COVID-19 accelerated existing trends towards e-commerce, with more people shopping online and doing so more regularly. Consumers shifted their behaviour in response to the pandemic, but for many these changes will be permanent. In NSW, there has been a 35 per cent increase in people who prefer to do more shopping online, compared to before COVID-19 (ABS, 2020c).

Growth in demand for the distribution of goods is having flow on impacts for our cities. More deliveries means more delivery vans on our streets, and more congestion and greenhouse gas emissions. In Sydney light commercial vehicles, such as delivery vans, accounted for 18 per cent of total vehicle kilometers travelled in 2020; an increase from 14 per cent of total vehicle kilometers in 2016 (ABS, 2021).

E-cargo bikes offer a fast and sustainable last mile delivery solution

E-cargo bikes provide a more nimble and sustainable option for short deliveries compared to traditional vehicles, such as motorbikes and vans. One Dutch study found that Light Electric Freight Vehicles have potential to replace ten to 15 per cent of vehicle-based deliveries, particularly in urban areas where vehicle access or speed is limited (Ploos van Amster, 2018).

This shift could bring a range of benefits:

- **Reduced last mile delivery costs:** The last mile has a hefty share in total parcel delivery cost—often reaching or even exceeding 50 per cent of the total cost (McKinsey, 2016). Labour drives the majority of these costs. In London, deliveries by cargo bikes have been found to be up to 60 per cent faster than those completed by vans (Verlinghieri, 2021), suggesting cost savings, and potential benefits for consumers, could be considerable.
- **Reduced urban congestion:** e-cargo bikes and other light electric vehicles (LEVs) take up less room than delivery vans on roads and some are cycle-way compatible.
- **Sustainability:** As discussed in Box 10, PMDs and e-bikes have a role in our shift to net zero emissions, and the opportunity is greatest where vehicle trips, such as van deliveries, are replaced.

E-cargo bikes are already in use by the freight and logistics sector. For example, Australia Post uses a fleet of 2,500 e-cargo bikes to make more than 2.5 million deliveries of mail and small parcels to customers per day. Each bike averages 10,000 km per year. The bikes have primarily replaced 'postie' motorcycles, which have been associated with safety concerns over the years. In comparison, e-cargo bikes offer a 55kg higher load capacity and there have been no serious accidents or deaths in the last decade (We Ride, 2020).

Food delivery is another sector where e-bikes are already in use. A lack of appropriate capabilities for e-bikes is however limiting potential, as well as pushing couriers towards unsafe illegal and modified e-bikes.

Growth in commercial uses is being hampered by regulation

In Australia and NSW, no specific regulation exists for commercially focused e-bikes, meaning that they are governed by the same limits that apply to general e-bikes (see Table 6). Application of an already low 250W power limit that was designed for private commuter uses severely limits carrying capacity and potential growth in the market. In contrast, in Europe a separate regulatory category 'L1eA-powered cycles' allows for two-, three- and four-wheeled devices with power between 250W and 1,000W and a maximum speed of 25km/hr. These settings enable devices with a carrying capacity of around 300kg, and over a cubic square metre, expanding commercial possibilities.

Beyond traditional e-cargo bikes, the light electric vehicle market is evolving rapidly with emergence of a variety of two-, three- and four-wheeled devices such as those shown below. The future presents even more possibilities, with some analysts claiming that delivery of up to 80 per cent of deliveries by Autonomous Ground Vehicles is a mere ten years away (McKinsey, 2016).

FIGURE 18 : EXAMPLE LIGHT ELECTRIC VEHICLES

Source: (Cargo Craft, 2021), (Velove, 2021).

This rapid innovation opens potential in a broad range of sectors, including use by:

Agriculture, forestry, and mining industries to transport people and materials

Trades for carrying tools and building materials

Delivery of **takeaway food**

Supermarkets for home grocery deliveries

Emergency services for compact paramedic vehicles that don't face regular traffic constraints

Tourism and events applications, such as velotaxis and mobile food carts.

There will inevitably be challenges to realising these opportunities. Our urban infrastructure and cycleways have not been designed with heavier e-cargo bikes and light electric vehicles in mind. It is an open question around which part of the road space these vehicles should occupy, and new traffic rules would need to be developed. The technology is still developing and there will be a need for consistent and appropriate safety standards.

We are only at the start of this conversation. Even in Europe, which already has more permissive regulations, there are calls to develop a more appropriate regulatory framework for light electric vehicles (Sutton, 2021). Given that this is an area of state and federal regulatory overlap, a national conversation is needed. Starting the conversation now, however, will ensure that NSW and Australia are well positioned to unlock the economic and social benefits from greater use of these vehicles.

NEXT STEPS FOR E-BIKES AND E-CARGO BIKES IN NSW—APPLYING THE THREE PRINCIPLES

Regular review—e-bikes

Australian Governments should review e-bike regulation to support the use of faster e-bikes while managing safety risks.

A national review of e-bike regulations would deliver the greatest benefits as it would encourage national consistency, with Commonwealth regulations on what types of devices may be imported into Australia and state-based regulation of what devices are permitted on roads, and across state borders. This would reduce the regulatory burden for riders who move across borders and for businesses who operate across borders. If progress is not achievable at the national level, a review should be conducted at the state level.

Short term options which could be considered include:

- Regulating the use of e-bikes on private property (currently unregulated) to ensure that e-bikes are ridden safely, regardless of location.
- A modest increase in the maximum speed and/or power output for private use e-bikes in public areas.

In the medium term, an option would be to regulate more powerful private use e-bikes (such as speed pedelecs), in recognition of the heightened safety risks—either as their own class of e-bike or as part of a broader 'moped' class. This could involve consideration of:

- appropriate speed and power limits
- registration and insurance requirements
- licensing of riders
- age restrictions
- which areas (e.g., cycle paths, roads) they can be used.

Further research would need to be undertaken into the benefits and costs of each option. This could draw on the experience of overseas jurisdictions that have already modified their laws for e-bikes.

Technology-neutral regulation: e-cargo bikes and other light electric vehicles

As an immediate step, Australian Governments should consider adapting the current e-bike regulatory framework to enable more powerful e-cargo bikes for commercial uses.

A national process to develop an appropriate, technology-neutral regulatory framework for light electric vehicles more broadly should also commence, similar to that led by the National Transport Commission for PMDs. This process could be expected to take several years, including detailed stakeholder consultation and analysis of the costs and benefits of regulatory options.

Regulatory experimentation: e-bikes and e-cargo bikes

Once preferred regulatory options have been identified from the review of the e-bikes and e-cargo bikes regulations, governments could undertake regulatory innovation trials to test the options in a real-world setting and further refine the rules as needed.

Keeping pace: conclusions

Technological change is continuous, bringing new products and services to markets. Artificial intelligence, augmented reality, autonomous vehicles, blockchain and the Internet of Things are all potential game changers for consumers and regulators.

Where regulation of these new technologies is needed, it should be shaped in a way that maximises these opportunities while managing risks to society. This will require governments to be bold and proactive in their regulatory settings.

- Regulations that are **outcomes-focused and technology-neutral** will help future-proof our regulatory systems and maximise innovation opportunities.
- Governments should be **regularly scanning the horizon** for new technologies and updating regulations to respond to the opportunities and risks posed.
- Governments should also embrace a **culture of regulatory experimentation** by not being afraid to implement regulatory trials and refine the rules based on these trials. A no-risk, no-reward mentality will be required if we are to continue benefitting from the innovation spirit that has delivered the high standards of living we enjoy today.

Drones, personal mobility devices and e-bikes provide three examples where application of these three regulatory principles could unlock considerable economic gains (up to $500 million for drones and $87 million for PMDs) and deliver better economic, social, and environmental outcomes for the people of NSW.

PRINCIPLES FOR REGULATING EMERGING TECHNOLOGIES	NEXT STEPS–APPLYING THE PRINCIPLES		
	Drones	**PMDs**	**e-bikes and e-cargo bikes**
Outcomes-focused, technology-neutral regulation	• Regulations should be risk-based • Simplified processes for lower-risk settings like agriculture	• Adopt the technology-neutral definition of PMDs in the model Australian Road Rules	• Develop a technology-neutral regulatory framework for light electric vehicles
Regular review of regulations	• Appoint a minister with policy responsibility for drones	• Review NSW's PMD laws to ensure they are not unnecessarily inhibiting innovation	• Review regulatory options to support faster e-bikes and more powerful e-cargo bikes
Regulatory experimentation	• Work with Commonwealth to trial alternative drone rules, starting with agriculture	• Use a trial for PMDs to refine the rules to maximise benefits and safely manage risks	• Trial preferred options arising from regulatory review

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PUBLISHED BY NSW TREASURY

treasury.nsw.gov.au

FIRST PUBLISHED NOVEMBER 2021.

T21/54049

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