



**Asia-Pacific
Economic Cooperation**



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APEC ADVANCED VEHICLES REGULATIONS AND STANDARDS

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ACRONYMS

AC	Alternating Current
APEC	Asia-Pacific Economic Cooperation
AV	Autonomous vehicle
AVA	Act on Promotion and Support of Commercialization of Autonomous Vehicles
BAPPENAS	Ministry of National Development Planning
BEV	Battery Electric Vehicles
BSI	British Standards Institution
CARTS	Committee on Autonomous Road Transport for Singapore
CAV	Connected and Autonomous Vehicle
CEN	Committee for Standardization
C-V2X	Cellular-Vehicle-to-Everything Communication
CETTRAN	Centre of Excellence for Testing and Research of Autonomous Vehicles
CO ₂	Carbon Dioxide
DC	Direct Current
ETSI	European Telecommunications Standards Institute
EV	Electric vehicle
EVSE	Electric Vehicle Supply Equipment
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GM	General Motors
GSM	Global System for Mobiles
HDV	Heavy-Duty Vehicle
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
LDV	Light-Duty Vehicle
LP	Labor Productivity
MOLIT	Ministry of Land, Infrastructure and Transport
NO _x	Nitrogen Oxide
PHEV	Plug-In Hybrid Electric Vehicles

R&D	Research and development
SAE	Society of Automotive Engineers
TLS	Transport Layer Security
UNECE	United Nations Economic Commission for Europe
USABC	United States Advanced Battery Consortium
USAID	United States Agency for International Development
UL	Underwriters Limited
V2G	Vehicle-To-Grid
VHT	Vehicle Miles Travelled

INTRODUCTION

REPORT BACKGROUND AND PURPOSE

Electric vehicles (EVs) and autonomous vehicles (AVs) – together referred to as advanced vehicles – are among the most important global developments in energy and transportation. They are widely viewed as playing a pivotal role in addressing a range of important economic, environmental, and social issues: preventing climate change, reducing ground-level air pollution, increasing transportation access, reducing traffic accidents, relieving urban congestion, and facilitating economic development. Advanced vehicles are particularly relevant in the growing and rapidly urbanizing Asia-Pacific Economic Cooperation (APEC) region. More specifically, focus on regulations and standards related to advanced vehicle technologies responds directly to APEC’s broader goals, particularly the APEC Putrajaya Vision 2040’s innovation and digitization pillar, which encourages the fostering of an enabling environment that is market-driven and supported by digital economy and innovation. As part of its implementation plan, APEC has further identified actions that promote good regulatory practices and regulatory cooperation through integration of new and emerging sustainable transportation and mobility technologies and services. Indeed, APEC’s ongoing work on EVs and AVs provides an opportunity to further these commitments.

Appropriate regulations and standards are key to ensuring that advanced vehicles achieve their potential. The APEC Advanced Vehicle Technologies Technical Engagement Program supports needed harmonization and modernization activities for these regulations and standards. These efforts, under the APEC Automotive Dialogue, and supported by the APEC Transportation Working Group, aim to broaden technical coordination to support harmonized standards and regulatory approaches in the region for new auto technologies including a focus on connected and autonomous vehicle (CAV) and electric vehicle technologies. This current report builds on a 2014 study and a 2018 update which provided an overview of electric vehicle regulations and standards.¹ The following overview represents a further update and expansion of these earlier studies. It extends the overview to include autonomous vehicles, capturing the latest regulations and standards in a flexible database. In addition, it incorporates a self-assessment tool for APEC economies to identify areas with the greatest potential for improvement and focused technical assistance efforts. This report and the accompanying database and self-assessment tool are designed both to provide useful knowledge and inspire worthwhile action. Through ongoing regional efforts, APEC can continue to play a leadership role in reducing development and implementation costs in both developed and developing economies while also speeding up the introduction of these new technologies.

REPORT ORGANIZATION

This report is organized into six major sections following this introduction.

¹ Nathan Associates, [Electric Vehicles in APEC: Overview of Regulations and Standards 2018 Update](#), December 2018.

- **EVs and AVs** – a brief introduction to EVs and AVs: what they are, why they are important, and how the ecosystem surrounding them works
- **Standards and Regulations** – a brief introduction to standards and regulations, what they are and why they are important
- **EV and AV Standards and Regulations** – highlights of current and planned standards and regulations for EVs and AVs, both among APEC economies and international organizations
- **Self-Assessment** – a description of the self-assessment document and tool for identifying areas with the greatest potential for improvement
- **Conclusions and Recommendations** – key takeaways from this work

The report also includes a list of additional resources, including a database of EV and AV standards and regulations, and the aforementioned self-assessment tool.

EVS AND AVS

WHAT ARE THEY?

There are a wide range of vehicles in use across the globe. Large and heavy trucks are used to transport large quantities of goods over large distances. Medium-duty trucks are used for smaller loads and/or shorter distances. Large and small buses carry anywhere from a handful of people to nearly 100 passengers at a time. Lastly, there are a variety of personal cars and trucks, three-wheelers, two-wheel motorcycles, scooters, and the like.

Since the introduction of motorized transport over 100 years ago, the great bulk of these vehicles have been powered by fossil fuels (diesel and gasoline) and driven by humans. EVs and AVs are changing this.

EVs are vehicles that are partially or fully powered by electricity. For the purposes of this report, the EV category includes vehicles that rely on externally charged batteries in whole or in part for propulsion – battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEV). We are not including hybrid vehicles whose batteries are charged within the vehicle by the engine or braking, or vehicles that use hydrogen or similar fuels to generate electricity within the vehicle for propulsion. AVs are vehicles that are partially or fully driven without human control. For this report, the AV category includes the full range of autonomy from no autonomy (Level 0) to full autonomy (Level 5), sometimes called a driverless or self-driving vehicle.² Level 1, the lowest level with some autonomy, is sometimes referred to as driver assistance.

² In its latest revision, SAE International defines six levels of vehicle autonomy. See <https://www.sae.org/blog/sae-j3016-update>

Even though both EVs and AVs make use of advanced technology, they are distinct but sometimes overlapping categories. There are EVs that are not AVs, AVs that are not EVs, and vehicles that are both autonomous and electric vehicles, or AEVs.

WHY ARE THEY IMPORTANT?

Fossil fuel combustion for powering vehicles or other uses creates two major environmental problems – climate change and ground-level pollution. Figure 1 below shows the estimated 2018 contribution of the transport sector, primarily land vehicles, to global carbon dioxide (CO₂) emissions.³ CO₂ is the dominant greenhouse gas (GHG). As the figure shows, transportation is responsible for more than one-quarter of these emissions.

Estimated CO₂ Emissions by End-Use Sector

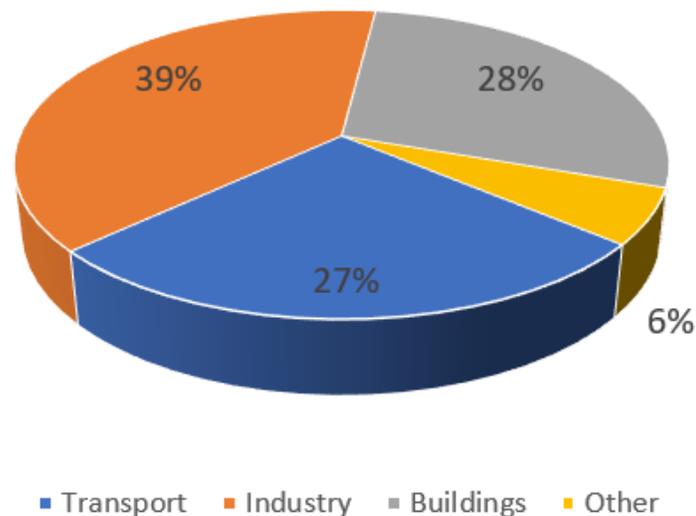


Figure 1: Estimated CO₂ Emissions by End-Use Sector

Figure 2 below shows the estimated 2015 contribution of the transport sector, again primarily land vehicles, to global nitrogen oxide (NO_x) emissions.⁴ NO_x is considered a significantly harmful ground-level pollutant. As the figure shows, transportation is by far the dominant contributor to these emissions.

³ International Energy Agency (IEA), “Global CO₂ Emissions by Sector, 2018,” <https://www.iea.org/data-and-statistics/charts/global-co2-emissions-by-sector-2018>, last updated July 31, 2020, accessed May 30, 2021.

⁴ IEA, “Emissions of Nitrogen Oxide (NO_x) by Sector and Scenario, 2015 and 2040,” <https://www.iea.org/data-and-statistics/charts/emissions-of-nitrogen-oxide-nox-by-sector-and-scenario-2015-and-2040>, last updated December 5, 2019, accessed May 30, 2021.

Estimated NOx Emissions by End-Use Sector

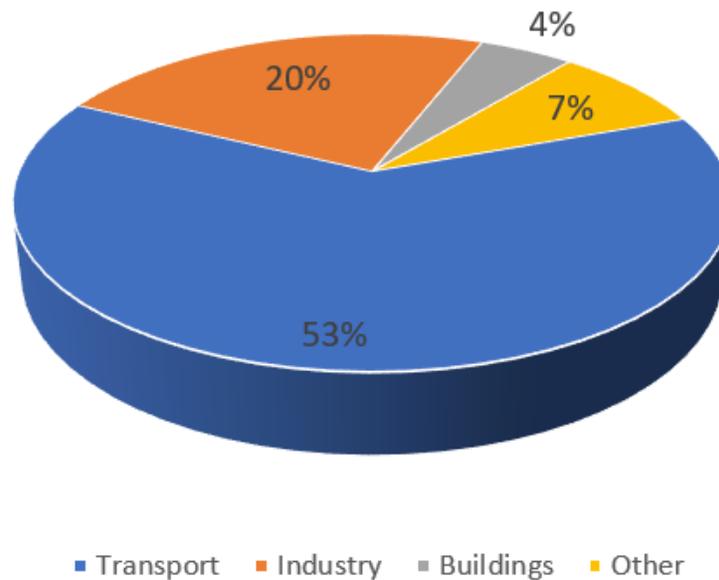


Figure 2: Estimated NOx Emissions by End-Use Sector

EVs are important largely because they can avoid these two problems. If powered by renewable-based electricity, EV operation produces essentially zero air pollution – neither GHG nor ground-level pollutants.⁵ If powered by natural gas-based electricity with suitable pollution controls, EV operation produces perhaps 50 percent of the GHG emissions of vehicles powered by other fossil fuels and a small fraction of the ground-level pollution. The same can also be true if the electricity comes from a mix of coal, natural gas, and renewables.⁶

In large part because of these and other potential government policy benefits, but also due in some measure to consumer preferences, a dramatic shift is underway from fossil fueled to electric vehicles. This shift is evident in both public and private actions. Many governments have announced plans to ban fossil-fueled vehicles entirely. For example, Sweden has a target date of 2030,⁷ Canada and Thailand of

⁵ Like other vehicles, EV's also produce a very small level of in-use emissions such as brake and tire dust.

⁶ If powered by coal-based electricity even with suitable pollution controls, on the other hand, GHG emissions are actually higher than for fossil-fueled vehicles. Ground-level pollution can be lower.

⁷ Electrive.com, "Sweden to Ban Sales of Fossil-Fuel Powered Cars by 2030," January 22, 2019, <https://www.electrive.com/2019/01/22/sweden-joins-nations-dropping-combustion-engines-target-2030/>, accessed July 27, 2021.

2035,^{8,9} Singapore of 2040,¹⁰ and Indonesia of 2050.¹¹ Many manufacturers as well have announced plans to greatly reduce or eliminate their production. For example, Jaguar plans to be all electric by 2025¹² and GM by 2035.¹³

Figure 3 shows how large this EV market is expected to become in dollar terms over the next decades.¹⁴ The annual market for EVs themselves could easily be over \$1.5 trillion globally by 2040. The charging infrastructure (electric vehicle supply equipment or EVSE) and electricity markets associated with these EVs could each be worth another \$200 billion annually.

⁸ Luke Sarabia, “Canada Mandates New Car and Passenger Truck Sales to be 100 Per Cent Zero-Emission by 2035,” *Electric Autonomy Canada*, June 29, 2021, <https://electricautonomy.ca/2021/06/29/federal-zev-mandate-2035/>, accessed July 29, 2021.

⁹ Randy Thanthong-Knight, “Thailand Lays Out Bold EV Plan, Wants All Electric Cars by 2035,” *Bloomberg*, April 22, 2021, <https://www.bloomberg.com/news/articles/2021-04-22/thailand-lays-out-bold-ev-plan-wants-all-electric-cars-by-2035>, accessed July 27, 2021.

¹⁰ Land Transport Authority, “Electric Vehicles, Our EV Vision,” webpage, https://www.lta.gov.sg/content/ltagov/en/industry_innovations/technologies/electric_vehicles.html, accessed July 27, 2021.

¹¹ Reuters, “Indonesia Aims to Sell Only Electric-Powered Cars, Motorbikes by 2050,” June 14, 2021, [https://www.reuters.com/business/sustainable-business/indonesia-aims-sell-only-electric-powered-cars-motorbikes-by-2050-2021-06-14/#:~:text=JAKARTA%2C%20June%2014%20\(Reuters\),to%20reduce%20its%20carbon%20emissions](https://www.reuters.com/business/sustainable-business/indonesia-aims-sell-only-electric-powered-cars-motorbikes-by-2050-2021-06-14/#:~:text=JAKARTA%2C%20June%2014%20(Reuters),to%20reduce%20its%20carbon%20emissions), accessed July 27, 2021.

¹² Nick Yekikian, “Jaguar Swats Its Paw at Tesla, Going All-Electric by 2025,” *MotorTrend News*, February 16, 2021, <https://www.motortrend.com/news/jaguar-land-rover-electrification-plans-2025/>, accessed July 27, 2021.

¹³ Paul A. Eisentsein, “GM to Go All-Electric by 2035, Phase Out Gas and Diesel Engines,” January 28, 2021, <https://www.nbcnews.com/business/autos/gm-go-all-electric-2035-phase-out-gas-diesel-engines-n1256055>, accessed July 27, 2021.

¹⁴ Nathan Associates analysis.

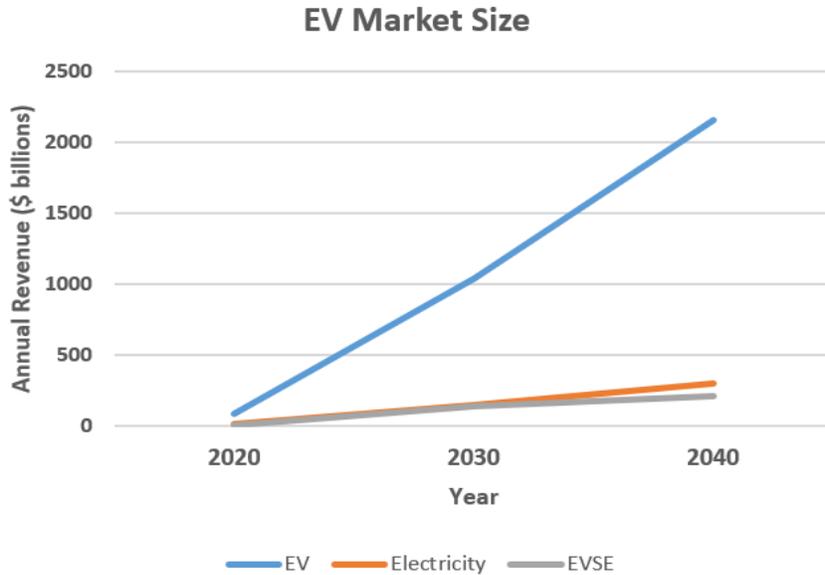


Figure 3: EV Market size

Traffic accidents and urban congestion are serious problems in much of the world. These issues are getting worse as more and more vehicles take the road along with pedestrians and cyclists. Figure 4 shows global annual vehicle fatalities from 2000 through 2016.¹⁵ As the figure shows, well over 1 million people are killed each year in traffic accidents, and the number of deaths continues to climb.

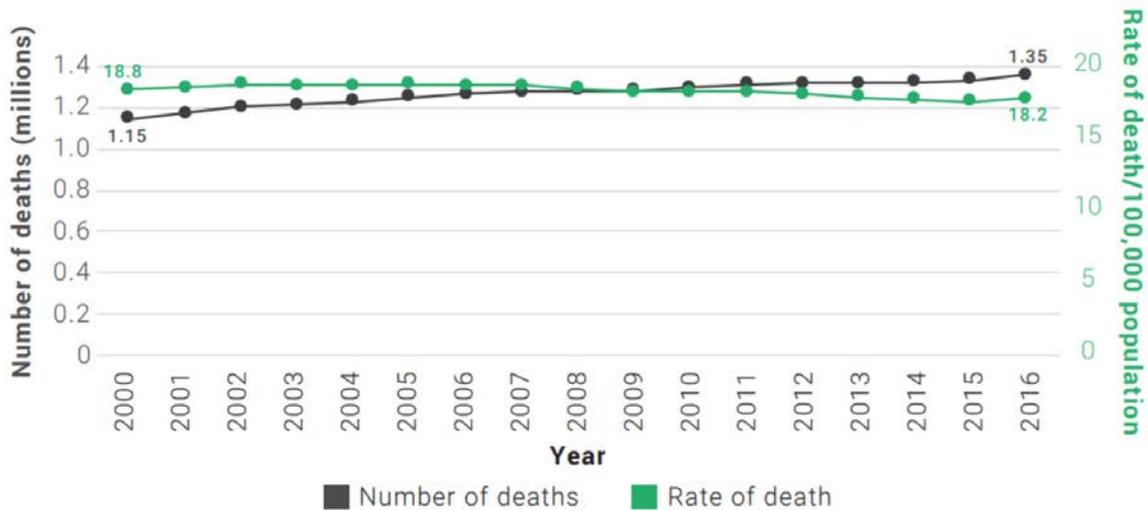


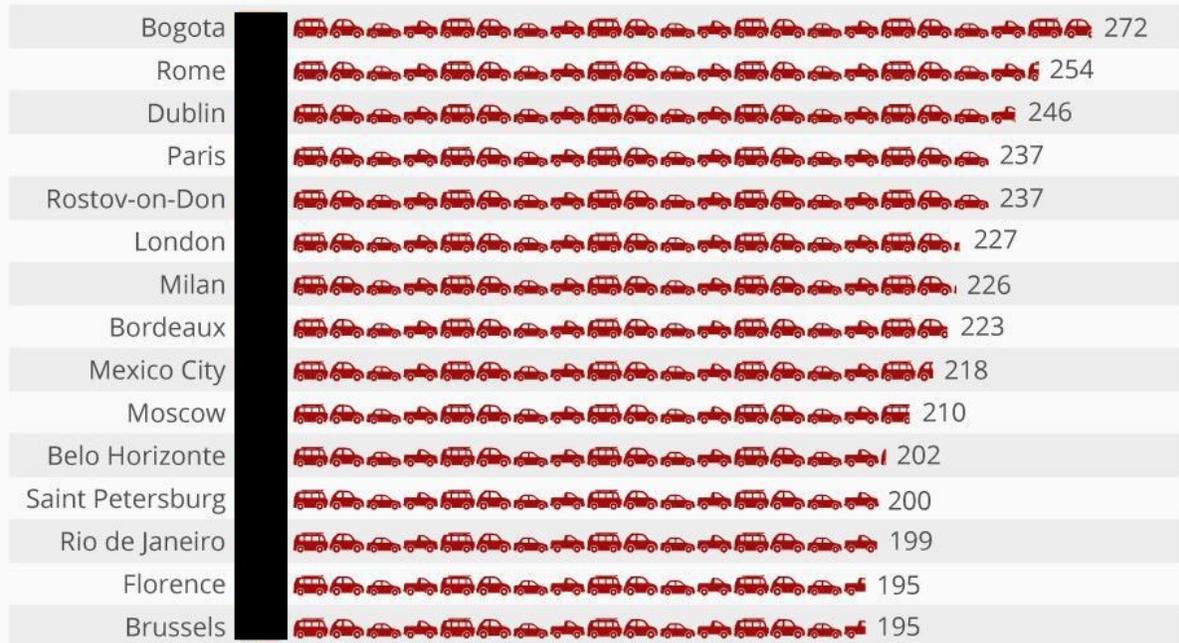
Figure 4: Number and rate of road traffic death per 100,000 population: 2000-2016

¹⁵ World Health Organization, 2018, *Global Status Report on Road Safety 2018*, Geneva: WHO, <https://www.who.int/publications/i/item/9789241565684>.

Figure 5 shows commute times in key cities. As the figure indicates, commuters in many cities spend hundreds of additional hours per year in their vehicles because of congestion. This is a substantial economic issue as well as a social one. Experts estimate the economic cost of congestion at hundreds of billions of dollars or more each year.¹⁶ A study by HERE technologies reported the global impact at \$1.4 trillion each year, much of it in developing economies.¹⁷

The Cities with the Biggest Traffic Jams

Major world cities where the average commuter spent the most hours in congestion in 2018



@StatistaCharts Source: INRIX Global Traffic Scorecard

statista

Figure 5: The cities with the biggest traffic jams in 2018

AVs may offer an avenue to reduce both traffic accidents and urban congestion. There are many forms or levels of automation, ranging from modest Level 1 driver assistance to dramatic Level 5 full automation, and the technology continues to evolve at a rapid pace. Depending on the context, experts forecast that AVs could reduce traffic accidents from a minimum of 10 percent to as much as 90 percent. The story with urban congestion is a bit less clear. Some argue that the sudden, widespread

¹⁶ Centre for Economics and Business Research, 2014, *The Future Economic and Environmental Costs of Gridlock in 2030*, London: CEBR, [https://www.ibtta.org/sites/default/files/documents/MAF/Costs-of-Congestion-INRIX-Cebr-Report%20\(3\).pdf](https://www.ibtta.org/sites/default/files/documents/MAF/Costs-of-Congestion-INRIX-Cebr-Report%20(3).pdf).

¹⁷ HERE Technologies, 2017, *How Autonomous Vehicles Could Relieve or Worsen Traffic Congestion*, https://www.here.com/sites/g/files/odxsiz166/files/2018-12/HERE_How_autonomous_vehicles_could_relieve_or_worsen_traffic_congestion_white_paper.pdf.

adoption of AVs could increase congestion. However, the common view is that, if appropriately regulated, AVs will lead to significant congestion improvement.

Level 1 and 2 automation adoption continues to grow as manufacturers increasingly roll out AV convenience features. However, the rate of higher-level AV growth is less certain as stakeholders are taking considerable care in developing and commercializing the technology while working to evaluate the pros and cons of specific AV applications. At the same time, research proceeds and technology advances. Because of the widely varying forms of AVs and the rapidly changing technology landscape, it is extremely difficult to develop a projection of AV market size. If we focus solely on lower-level driver assistance, the great majority of vehicles will be AVs within a few years. On the other hand, if we are considering higher level autonomy, the AV share of the vehicle market may remain well under 1 percent for decades as the developers work to fully master complex driving scenarios safely.

Given this diversity, even published estimates of the current AV market size can vary by orders of magnitude. By most definitions, the AV market is projected to be a multi-hundred-billion-dollar business within decades. Figure 6 shows a forecast for AV sales and AV-related services based on recent work by McKinsey.¹⁸ It shows that AVs themselves could be nearly a trillion-dollar business within decades, and AV-related services an even larger business, at slightly over one trillion dollars. As the name implies, AV services refer to commercial activities that rely on AVs such as autonomous ridesharing and food delivery.

¹⁸ Nathan Associates analysis based on McKinsey & Company, *The Future of Mobility is at our Doorstep: Compendium 2019/2020*.

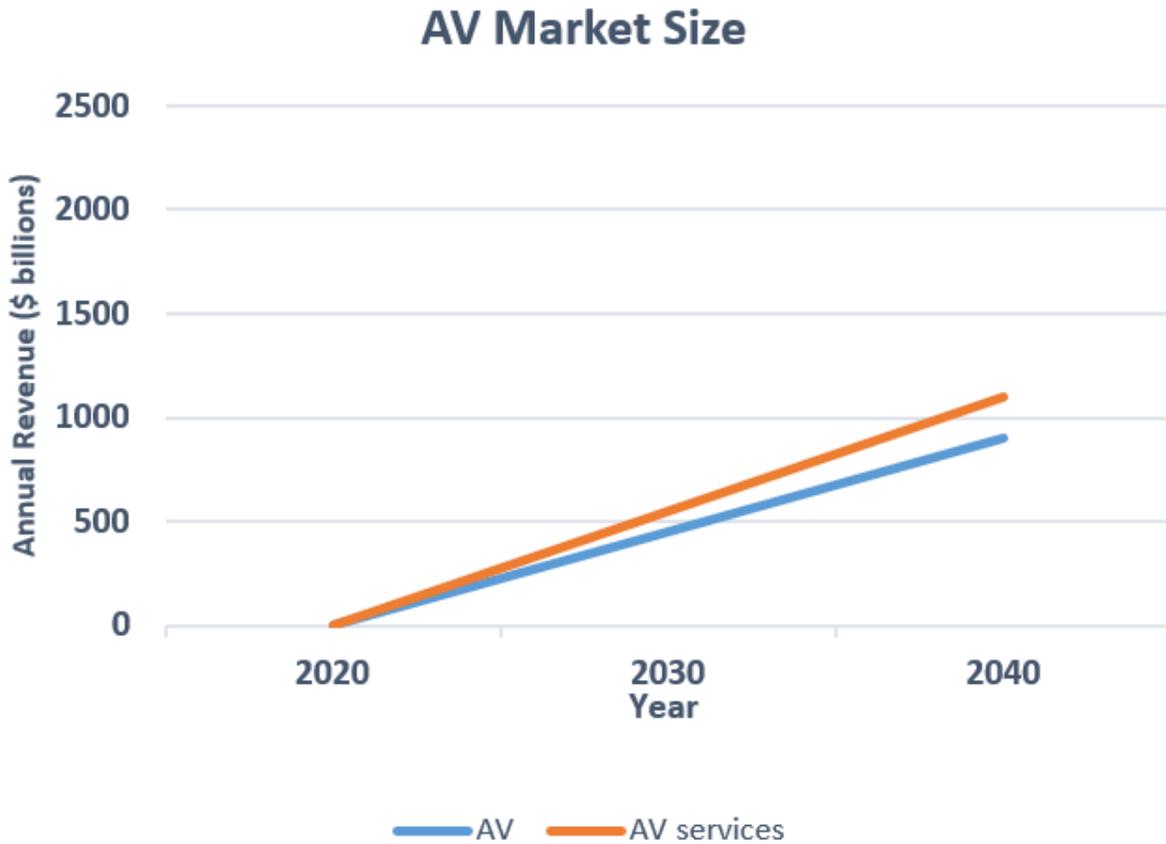


Figure 6: AV Market Size

Together, advanced vehicles – AVs and EVs – are important on two levels. First, they represent an opportunity to address critical environmental and social issues such as climate change and urban congestion. Second, even with the diversity in estimates, they will likely constitute a massive global economic force.

OVERVIEW OF EV/AV ECOSYSTEM

While “ecosystem” is becoming an overused term in business, it is still helpful to note that the EV market and the AV market are both effectively ecosystems. By this, we mean that the markets have numerous critical public and private participants who play different and essential roles and who interact in a tightly coordinated fashion. Figure 7 provides a simple view of the EV ecosystem.

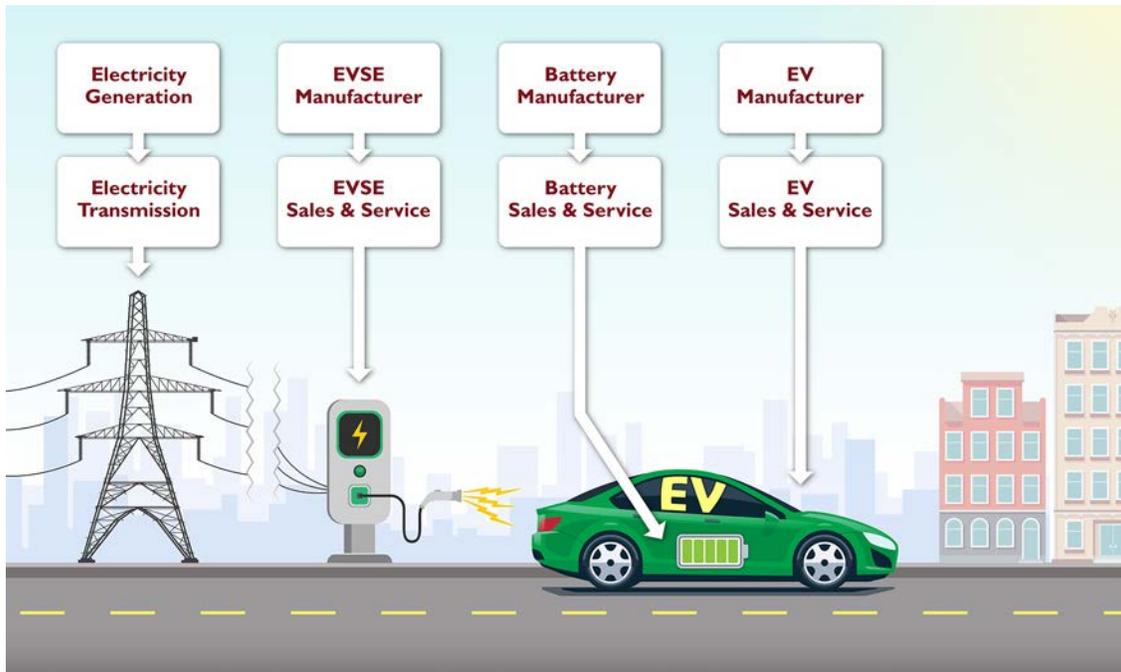


Figure 7: Electric Vehicle Ecosystem

As the figure indicates, there are four fundamental components: the EV itself, the EV battery, the EVSE, and the grid. Each has its own dedicated supply/value chain. We refer to the EVSE and the grid together as the charging infrastructure. In addition to these four essential components, there are two additional related components: the roads that accommodate the EV and the buildings that accommodate the EVSE. We refer to these together as the built environment.

Figure 8 shows an equivalent view of the AV ecosystem. As the figure indicates, the AV ecosystem has three essential components: the AV itself, the onboard AV control, and the remote communication. Each of these components has its own dedicated supply/value chain. Communication occurs both with the network and other AVs. We refer to communication and control together as the communication infrastructure. The electricity grid is no longer shown since AVs may or may not be electric. The built environment (roads and buildings) completes the picture and is particularly relevant in the world of autonomous driving.

We will use this view of the EV and AV ecosystems to characterize standards and regulations. Each standard/regulation is associated with one or more elements of the EV or AV ecosystem.

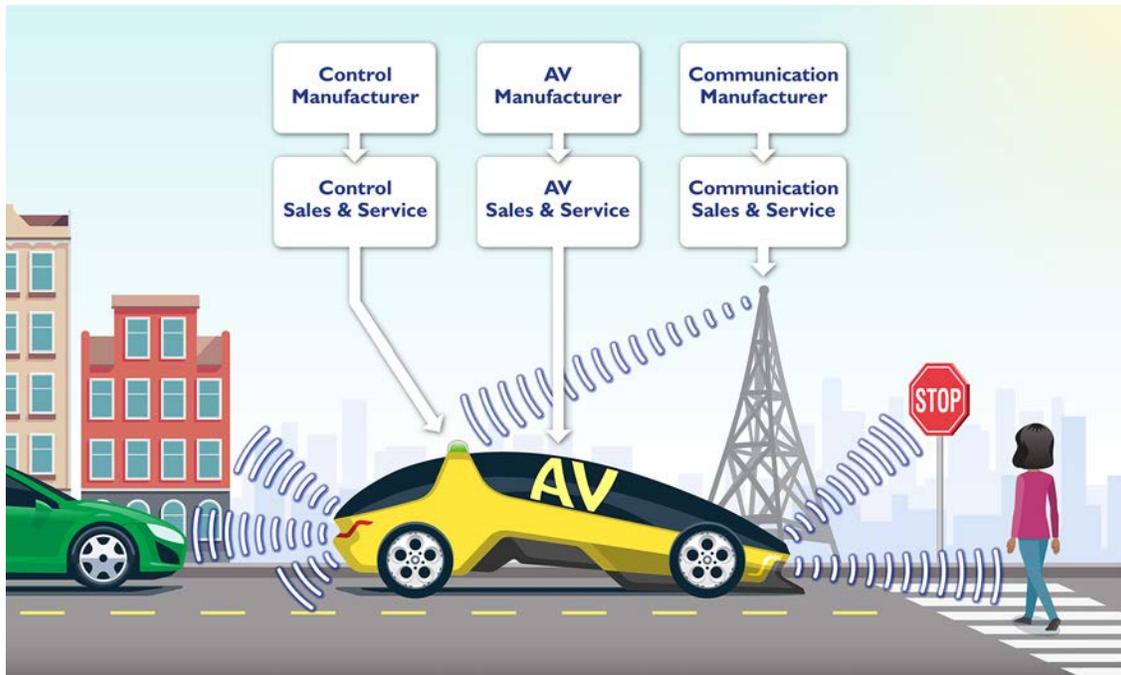


Figure 8: Autonomous Vehicle Ecosystem

STANDARDS AND REGULATIONS

WHAT ARE THEY?

In modern society, private markets are often overseen by government departments and influenced by industry associations. These entities exert control and influence over markets through various rules and guidelines. In common parlance, a distinction is made between government **regulations** that have the force of law and voluntary **standards** that reflect customary or recommended practice and technical specifications. However, sometimes there is overlap. Governments can use laws to impose standards, and industry associations can suggest guidelines that effectively dictate the behavior of key market participants.

For the purpose of this report, we are taking a broad view. We consider both mandatory and voluntary market rules. We also consider rules that affect both the characteristics of a product or service directly and the role that the product or service plays in the market.

WHY ARE THEY IMPORTANT?

Market rules are important because they play a significant role in determining the social, environmental, and economic impacts of markets across the population. This importance is seen both in their presence and absence.

Following our vehicle theme, consider the social impact of seat belt rules. In most, but not all, jurisdictions, these rules have the force of law. They affect both the vehicle itself (vehicles must/should have seat belts) and the way that vehicle is used (vehicle passengers must/should use seat belts). Figure 9 shows that the combined intended effect of these rules – standards and regulations – in the United States was to reduce the number of vehicle fatalities dramatically.¹⁹ It is no exaggeration to say that seat belt rules in the United States alone have saved millions of lives.

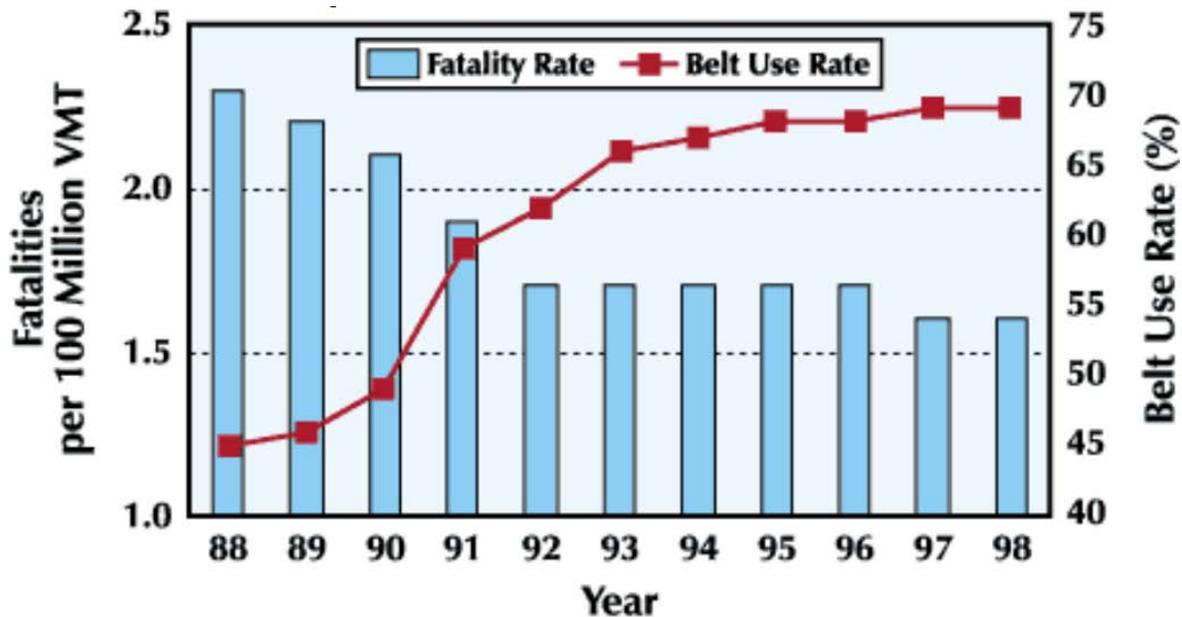


Figure 9: Seat belt use rate and fatalities per 100 million vehicle miles travelled (VMT), 1988-98

Market rules also play a central role in economic growth. It is difficult to establish cause and effect, but numerous studies have attempted to estimate the impact of regulations and standards on key economic metrics such as gross domestic product (GDP) and labor productivity (LP). In a study across a range of economies, the International Organization for Standardization (ISO) estimated that standards were responsible for between 10 and 40 percent of GDP and LP growth.²⁰ Even at the low end of this estimate, this represents hundreds of billions of dollars in annual benefit.

OVERVIEW OF STANDARDS/REGULATIONS IDENTIFIERS AND ATTRIBUTES

¹⁹ M. G. Solomon, W. A. Leaf, W. J. Nissen, 2001, *Process and Outcome Evaluation of the Buckle Up America Initiatives*, U.S. Department of Transportation National Highway Traffic Safety Administration, May, <https://rosap.nhtl.bts.gov/view/dot/1695..>

²⁰ ISO, *Standards & economic growth: ISO members' research on the impact of standards on their national economies*, 2021.

There are a large number of standards and regulations affecting EVs and AVs, and these standards and regulations vary tremendously. For organizational clarity, we characterize them using identifiers and attributes:

- Identifiers:
 - Organization: APEC Economy or International Organization; International organizations include British Standards Institution (BSI), European Committee for Standardization (CEN), European Telecommunications Standards Institute (ETSI), International Electrotechnical Commission (IEC), Institute of Electrical and Electronics Engineers (IEEE), International Organization for Standardization (ISO), Society of Automotive Engineers (SAE), and Underwriters Limited (UL).
 - Status: Current, Planned
- Attributes:
 - Technology: EV, AV
 - Mode: Light-Duty Vehicle (LDV), Heavy-Duty Vehicle (HDV), 2&3 Wheeler
 - Element: For EV – Vehicle, Battery, Charging Infrastructure, Built Environment; for AV – Vehicle, Communication Infrastructure, Built Environment
 - Objective: Safety/Liability, Privacy/Security, Compatibility/Interoperability, Environment/Sustainability, Equity/Justice, Efficiency/Performance, Economics/Adoption

EV STANDARDS/REGULATIONS OVERVIEW AND HIGHLIGHTS

OVERVIEW

As noted above, EVs are a large and evolving market. A wide range of standards and regulations have been in place for many years. At the same time, because of the growing and changing market, there is a constant flow of new rules. With respect to regulations and standards, the most active jurisdictions in EVs share three important characteristics.

First, they have in place explicit targets for the market adoption of EVs. As noted above, APEC economies with such targets include Canada; Indonesia; Singapore; and Thailand. Canada's mandate of 100 percent net zero emissions vehicles by 2035 is among the most ambitious.

Second, they have in place comprehensive policy/regulatory frameworks or roadmaps that cover a range of objectives and ecosystem elements. Malaysia had such a roadmap as early as 2011. New Zealand announced its Electric Vehicles Programme in 2016, and Chile published its National Electromobility Strategy in 2017. Each year, more economies are taking this step. For example, the United Nations recently announced plans to help Papua New Guinea “develop ‘economy-level’ [sic] policy for deploying

and scaling up E-mobility and supporting sustainable infrastructure.”²¹ Similarly, the World Bank is developing an electric mobility roadmap for Viet Nam. In some cases, these EV plans are part of a bigger sustainability or green effort. Singapore, for example, has The Green Plan that includes EVs as well as solar power, energy efficiency, and the like.²² To accompany these economy-level efforts, international organizations also have comprehensive standards programs. For example, the IEC has a comprehensive program of standards development across numerous aspects of the EV ecosystem.²³

Third, several jurisdictions have identified a governmental or quasi-governmental body to take the lead or provide coordination in EVs, including regulations and standards. Since EVs often cross traditional legal and regulatory lines, such coordination is critical. Often the establishment of such bodies is tied to the adoption of an economy-level roadmap. In Chile, the Ministry of Energy is the lead EV regulatory body with a recently increased mandate from a new energy efficiency law. In Indonesia, the government has relied on the Ministry of National Development Planning (BAPPENAS) for coordination, with modest success. In the Philippines, the new *Electric Vehicles and Charging Stations Act* is nearing enactment.²⁴ This law both mandates a comprehensive EV roadmap and lays out specific responsibilities for different government agencies. The Department of Energy will take on a lead coordination role.

VEHICLE

Not surprisingly, the core element of the EV ecosystem is the EV itself. The primary focus of regulations or other government actions aimed directly at EVs is to improve their economics and increase adoption. To this end, economies often use direct subsidies, exemptions from vehicle taxes, changes to road usage, regulations or government purchases. Some regulations have an equity component to ensure that the benefits of EVs extend as deeply and widely in the economy as possible. For example, many economies provide incentives for EV adoption targeted at specific demographic groups. The nature and extent of these incentives vary widely, and they often are adjusted over time as market conditions change.

The Republic of Korea, for example, has had an EV subsidy program for many years. For 2021, the maximum subsidy of roughly \$7,000 is limited to lower price EVs.²⁵ Indonesia just modified its luxury tax rules to favor EVs with a 5 percent reduction or more over both conventional and hybrid vehicles.²⁶ As

²¹ <https://www.ungm.org/Public/Notice/134185>, accessed November 12, 2021.

²² “SG Green Plan,” website, <https://www.greenplan.gov.sg/>, accessed July 27, 2021.

²³ IEC, 2021, *The New Age of Mobility*, Geneva: IEC, June, <https://www.iec.ch/basecamp/new-age-mobility>.

²⁴ Drei Laurel, “EV and Charging Stations Act Passes PH Senate in Third Reading,” TopGear Philippines, May 31, 2020, <https://www.topgear.com.ph/news/motoring-news/ev-and-charging-stations-act-senate-a962-20210531>, accessed July 29, 2021.

²⁵ Hyundai Motor Group, “Has South Korea Changed Its Subsidy Plan for Green Vehicles in 2021?” February 25, 2021, <https://news.hyundaimotorgroup.com/Article/Has-South-Korea-changed-its-subsidy-plan-for-green-vehicles-in-2021>, accessed July 28, 2021.

²⁶ Arys Aditya, Grace Sihombing, and Clair Jiao, “Indonesia Offers More Aggressive Tax Perks for Electric Vehicles,” Bloomberg Green, March 15, 2021, <https://www.bloomberg.com/news/articles/2021-03-15/indonesia-offers-more-aggressive-tax-perks-for-electric-vehicles>, accessed July 28, 2021.

the world's largest EV manufacturer, People's Republic of China has taken an aggressive approach. The Chinese central government has been massively supporting the market upturn of electric mobility for years – starting with extensive support measures for industry and ending with financial incentives and strategic targets for the purchase of electric vehicles. In the United States, both the federal and state governments have subsidies and mandates to encourage EV adoption among lower-income and underserved groups. In the San Francisco Bay Area of California, this is referred to as “Clean Cars for All.”²⁷

Many economies also use non-monetary measures to encourage EV adoption. For example, in much of the United States, EVs can use high occupancy vehicle (HOV) lanes. In some cities in the People's Republic of China, EVs are exempt from traffic control measures that limit the number of vehicles on the road.

EV-specific safety issues are also an important factor in regulations and standards. Vehicle labels traditionally cover a variety of topics ranging from fuel economy to performance. For EVs, one important role that labels play is managing the potential electric shock hazard associated with the operation, maintenance, and accident recovery. Given their quiet sound profile, EVs also present a challenge to people who are blind or have low vision. This is both a safety and equity issue, and standards related to sound emission/audible warning systems can address this concern. In the United States, for example, the National Highway Traffic Safety Administration has issued a minimum sound requirement for EVs.

Most regulations and standards are aimed at light, medium, and heavy-duty vehicles. However, there is increasing demand for smaller two- and three-wheeled EVs, and standards and regulations are emerging as a result both internationally and in specific economies. Singapore, for example, has detailed regulations on the weight and power of two-wheeled electric vehicles, and on how and where they can be operated.²⁸ Thailand recently adopted specific new rules regarding the speed and power of a range of EVs including two- and three-wheelers.²⁹

BATTERY

The battery is essentially what differentiates an EV from a conventional fossil-fueled vehicle. It is not surprising then that many regulations and standards deal directly with the battery.

²⁷ Bay Area Air Quality Management District, “Clean Cars for All,” webpage, <https://www.baaqmd.gov/funding-and-incentives/residents/clean-cars-for-all>, accessed July 30, 2021.

²⁸ eBike.sg, “FAQ for LTA Regulations and Approval,” webpage, <https://ebike.sg/pages/lta-regulations-and-approval>, July 28, 2021.

²⁹ “DLT Unveils New Rules on Power, Speed of Electric Vehicles” The Nation, Thailand, <https://www.nationthailand.com/in-focus/30402252>, accessed July 28, 2021.

One of the most important issues with EV batteries is safety, and one of the most important ways of ensuring safety is adequate testing. Battery testing is typically handled by international standards groups, and there are a variety of such standards that outline testing regimes for electric vehicle batteries, including SAE J2464 and British Standard EN61982. Some economies, including Mexico, have adopted their own battery testing and compliance standards.³⁰

Other battery regulations and standards target both short and long term performance, which are also addressed by international groups. SAE Recommended Practice J1798 highlights common test and verification methods to determine EV battery performance. IEC 61982:2012 is an optional test procedure specifying performance and endurance tests for secondary batteries (except lithium) for the propulsion of electric road vehicles. Some economies have their own standards. The Republic of Korea, for example, has standards for testing traction battery performance. In the United States, there are voluntary procedures for battery performance testing established by the United States Advanced Battery Consortium (USABC), a collaborative effort between the United States domestic automakers (Chrysler, Ford, and GM). In some cases, voluntary standards have been incorporated directly into mandatory regulation, as with Chinese regulations QC/T743-2006, GB/Z 18333.1-2001 and others. Japan requires that manufacturers provide information concerning battery and motor capacity.

While EVs are considered more sustainable than their fossil-fuel counterparts, they do have their own environmental issues. As the number of EVs grows dramatically, the battery “lifecycle” – recycling, reuse, and disposal – is a key one.

International standards for the battery lifecycle are spotty and variable. Many topics, such as recycling, are barely covered. In most cases, there are no EV-specific standards, but EV batteries are incorporated as part of a broader scope. For example, the European Union adopted Directives 2000/53/EC on the end-of-life vehicles and 2005/64/EC on the recyclability, reusability, and recovery of automotive vehicles and parts do refer to vehicle batteries, but they do not have specific provisions for EV batteries. The EU is currently considering major new battery lifecycle rules with more EV specifics.³¹ Separately from international standards, some economies have their own EV battery standards and regulations. The People’s Republic of China, in particular, has extensive regulations on the EV battery lifecycle.³² These regulations require manufacturers to set up and operate networks for used battery collection and recycling.

CHARGING INFRASTRUCTURE

Many regulations and standards relevant to EVs are directed not at the vehicle and battery itself, but at the “fueling” or charging infrastructure: the grid that supplies electricity and the EVSE that supplies the

³⁰ “Mexico Lithium-Ion Battery Standard Takes Effect,” In Compliance, November 21, 2019, <https://incompliancemag.com/mexico-lithium-ion-battery-standard-takes-effect/>, accessed July 30, 2019.

³¹ European Commission, 2020, *Regulation of the European Parliament and of the Council Concerning Batteries and Waste Batteries, Repealing Directive 2006/66/EC and Amending Regulation (EU) No 2019/1020*, 2020.

³² “China Releases Battery Recycling Regulations,” Electrive.com, November 11, 2019, <https://www.electrive.com/2019/11/11/china-releases-battery-recycling-regulations/>, accessed July 28, 2021.

vehicle battery with that electricity. Standards and regulations for the charging infrastructure typically address safety, compatibility, and economic issues.

Charging infrastructure standards vary by region. Europe tends to follow guidelines imposed by the International Electrotechnical Commission (IEC), as do some APEC economies such as Chinese Taipei. Three series of standards are most relevant: IEC 61851 series for the charging system; IEC 62196 series for the plugs, socket-outlets, and vehicle couplers; and ISO/IEC 15118 series for vehicle to grid communication interface (V2G CI). IEC 61851-1 and IEC 62196-1 as well as ISO/IEC 15118 series are applicable to both alternating current (AC) and direct current (DC) connections. UL and SAE commonly set standards adopted in North America and Japan. Individual economies however may differ from this pattern and adopt their own guidelines. China formulates its own standards and regulations, often with reference to international guidelines. The Singapore Standards Council has its own 200-page document detailing specific EVSE requirements.³³ New Zealand has their own document specifically on charging safety.³⁴

One of the most important technical issues associated with charging infrastructure is interoperability – the idea that any EV can operate with any EVSE built compliant to the specific connection standard. In many jurisdictions, regulations are in place to encourage or mandate interoperability and sometimes connection standards. Chile, for example, recently passed its first energy efficiency law. One of the first efforts in implementing this law is to issue regulations for interoperability.³⁵ One approach to compatibility is to adopt international standards. Indonesia, for example, recently joined with other economies in adopting the CHAdeMO fast charging standard.³⁶ Economies frequently allow multiple standards to provide flexibility.

Increasingly, there are regulations and standards designed specifically to address the interaction between EVs and grid. Most of these involve compatibility and safety issues with a focus on vehicle-to-grid, or V2G. China and Japan both have what are called enterprise standards, which stipulate basic requirements relating to bidirectional charging equipment. In Japan, for example, emergency EV use as an electricity supply is permitted. In the United States, standards are available in the form of SAE-recommended practices. With V2G, significant privacy and cybersecurity issues can arise. In the way of standards, those like ISO 15118-2:2014 “Road vehicles – Vehicle-to-Grid Communication Interface – Part 2: Network and application protocol requirements” mandate transport layer security (TLS) and unilateral authentication, and other methods to protect consumers.

³³ Singapore Standards Council, 2020, *Technical Reference: Electric Vehicle Charging System*, <https://www.singaporestandardseshop.sg/Product/SSPdtDetail/d0f65145-e555-4c19-a796-3c05ceb24fab>.

³⁴ New Zealand Government, 2019, *Electric Vehicle: Charging Safety Guidelines, 2nd Edition*, May, <https://www.worksafe.govt.nz/laws-and-regulations/regulations/electrical-regulations/regulatory-guidance-notes/electric-vehicle-charging-safety-guidelines/>.

³⁵ “Vehicles Included in New Chile Energy Efficiency Law,” Global Fuel Economy Initiative, April 27, 2021, <https://www.globalfueleconomy.org/blog/2021/april/vehicles-included-in-new-chile-energy-efficiency-law>, accessed July 18, 2021.

³⁶ “Emerging Economies to Adopt CHAdeMO as National Standard,” CHAdeMO, September 7, 2020, <https://www.chademo.com/emerging-economies-to-adopt-chademo/>, accessed July 30, 2021.

Equity/justice issues have not historically been at the center of the EV revolution. However, they are increasingly gaining attention and importance with respect to key parts of the ecosystem. In the United States, for example, California has a requirement that a fraction of public EVSE be accessible to the disabled (California Building Code I 1B-228.3).

Privacy/security issues are typically viewed as a bigger problem for AVs than EVs. However, even fairly primitive, EVs are connected electronically to the rest of the world, particularly the electrical grid, when they are charging. Consequently, there is growing recognition that EVSE privacy/security issues must be considered. There is very little in place on this front, but international standards organizations and government regulators are actively engaged. For example, the United States Department of Transportation recently released a report on EVSE cybersecurity best practices for the government fleet.³⁷

BUILT ENVIRONMENT

As with the grid, the built environment is affected by a whole range of regulations and standards that can have little to do directly with EVs. And again, there is increasing interest in regulations and standards specifically to address the interaction of EVs with this built environment.

The EVSE is a critical piece of the EV ecosystem. In order to encourage EVs, more and more economies are adopting building codes that encourage or require buildings to be EV-ready. There are numerous examples of such codes in cities and states across the United States, as well as in Australia. The Electric Vehicle Council of Australia published a Local Government Resource Pack that includes numerous case studies of jurisdictions that are mandating EV-ready buildings.³⁸

AV STANDARDS/REGULATIONS OVERVIEW AND HIGHLIGHTS

OVERVIEW

Unlike EVs, AVs are what could be called a nascent market – small and just coming into being – particularly at the higher levels. As a result, AV standards and regulations are new and developing, and their extent is limited. Many APEC economies have few if any AV-specific regulations and standards. Similar to EVs, the most active jurisdictions in AVs share three important characteristics.

First, although the market is too young and diverse to support adoption targets (unlike EVs), several economies have established significant dedicated technology research and development (R&D) efforts to pave the way for future adoption. This is in addition to any purely private R&D efforts. Chinese Taipei,

³⁷ United States Department of Transportation, 2019, *Government Fleet and Public Sector Electric Vehicle Supply Equipment (EVSE) Cybersecurity Best Practices and Procurement Language Report*, November, <https://rosap.ntl.bts.gov/view/dot/43606>.

³⁸ Australia Electric Vehicle Council, 2020, *Local Government Resource Pack*, December, <https://electricvehiclecouncil.com.au/reports/local-government-resource-pack/>.

for example, established an Automotive Research and Testing Center in 1990, and many of its recent activities involve AVs.³⁹ Singapore has the Centre of Excellence for Testing and Research of Autonomous Vehicles (CETRA) that is operated jointly by its Land Transport Authority and Nanyang Technological University.⁴⁰

Second, despite the early stage of development, the United Nations Economic Commission for Europe (UNECE) Working Part on Automated/Autonomous and Connected vehicles (WP.29/GRVA) is working to draft regulations. Several APEC jurisdictions are also working to create comprehensive regulatory frameworks for AVs that cover many aspects of the ecosystem. In May 2020, the Republic of Korea passed comprehensive legislation aimed specifically at AVs: the *Act on Promotion and Support of Commercialization of Autonomous Vehicles (AVA)*. As the title indicates, AVA is designed to maintain and enhance Korea's position as an automotive world leader. Hong Kong, China recently opened its draft *Proposed Regulatory Framework for Autonomous Vehicles* for comment and discussion. In Russia, a bill entitled *On Experimental Operation of Innovative Vehicles* was recently introduced to provide a comprehensive framework for managing AVs.⁴¹ Similar to EVs, the IEC has a comprehensive program aimed at AVs. In December 2020, the SAE formed a new international committee specifically to develop AV standards.⁴² Most observers recognize that considerable progress must be made in the research, development, evaluating and understanding AVs before a definitive regulatory framework can be put in place. While the technology is still being created, premature regulations can stifle needed innovations.

Third, despite the early stage of development, some jurisdictions also have identified lead bodies responsible for the development and oversight of AV regulations and standards. For example, Australia has the Office of Future Transport Technology, and Singapore has a Committee on Autonomous Road Transport for Singapore (CARTS).⁴³

VEHICLE

The primary focus of regulations and standards for the vehicle element of the AV ecosystem is safety. In most of the world, AVs are a new and emerging issue, and regulations and standards involving vehicles

³⁹ "ARTC Approved by GM & Ford for Accrediting High-Voltage EV Parts" Automotive Research and Testing Center, https://www.artc.org.tw/index_en.aspx, accessed July 29, 2021.

⁴⁰ Abigail Ng, "Singapore Hopes to Take its Driverless Ambitions and the Pandemic is Unlikely to Stop Them," CNBC, September 21, 2021, <https://www.cnbc.com/2020/09/22/singapore-hopes-to-take-its-driverless-ambitions-to-the-public.html>, accessed July 18, 2021.

⁴¹ Eugene Gerden, "Russia to Accelerate Development of Autonomous Car Technology," Automotive Fleet, March 17, 2020, <https://www.automotive-fleet.com/353460/russia-to-accelerate-development-of-autonomous-car-technology>, accessed July 29, 2021.

⁴² "SAE Launches Autonomous Vehicle Standards Committee," *Assembly*, December 16, 2020, <https://www.assemblymag.com/articles/96051-sae-launches-autonomous-vehicle-standards-committee>, accessed July 18, 2020.

⁴³ World Economic Forum, 2020, *Autonomous Vehicle Policy Framework: Selected National and Jurisdictional Policy Efforts to Guide Safe AV Development*, November, <https://www.weforum.org/reports/autonomous-vehicle-policy-framework-selected-national-and-jurisdictional-policy-efforts-to-guide-safe-av-development>.

are almost all about testing – where and under what conditions can AVs be tested. However, in some jurisdictions, the road is being paved for the day when AVs will be operating at scale.

Japan is the world’s third-largest automobile manufacturing economy by volume and provides a good example. In Japan, two key pieces of vehicle legislation, the *Road Transport Vehicle Act* and the *Road Traffic Act*, were recently revised to provide for AV safety.⁴⁴ The Republic of Korea is the world’s seventh-largest automobile manufacturing economy by volume and also provides an excellent example. Late in 2019, the Ministry of Land, Infrastructure and Transport (MOLIT) issued new safety rules for autonomous vehicles.

Given the rapidly evolving AV technology, AV regulations and standards are of course a moving target. The People’s Republic of China has a substantial ongoing effort to develop relevant standards/regulations for different AV levels and formulate Levels of AV and formulate plans for AV market access. It recently announced plans to incorporate AVs in its economy-level road safety law.⁴⁵ The new law will deal both with testing and broader adoption of AVs. Australia also recently embarked on a major reform documented in its *Automated Vehicle Program Approach*.⁴⁶ Under the heading “Why do we need reform?” this report succinctly summarizes the need:

Australia’s laws do not currently support the deployment of automated vehicles. Our laws are designed for vehicles with human drivers. A review in 2016 found over 700 barriers in current legislation – state, territory and Commonwealth laws – to the deployment of automated vehicles. Automated vehicles are expected to deliver safety, productivity and environmental benefits. Without reforms, Australians will not be able to gain these benefits.⁴⁷

Separate from safety, some jurisdictions have regulations and standards that are intended primarily to promote the short-term or long-term economic benefits of AVs. In several economies, AVs in particular are being encouraged as a means of improving both global competitiveness and urban mobility. For example, New Zealand has a formal Autonomous Vehicles Work Programme aimed in part at using AVs to make the urban environment more livable.⁴⁸

⁴⁴ Takeyoshi Imai, 2019, “Legal Regulation of Autonomous Driving Technology: Current Conditions and Issues in Japan,” *IATSS Research* 43(4), December, https://www.researchgate.net/publication/338185878_Legal_regulation_of_autonomous_driving_technology_Current_conditions_and_issues_in_Japan.

⁴⁵ “China Plans New Rules for Autonomous Vehicles,” Reuters, March 30, 2021, <https://www.reuters.com/article/china-autonomous/china-plans-new-rules-for-autonomous-vehicles-ministry-idUSL8N2LS2J2>.

⁴⁶ Australia National Transport Commission, 2020, *Automated Vehicle Program Approach*, September, <https://www.ntc.gov.au/sites/default/files/assets/files/Automated%20vehicle%20approach.pdf>.

⁴⁷ Ibid, p. XX.

⁴⁸ New Zealand Ministry of Transport, “Autonomous Vehicles Work Programme,” <https://www.transport.govt.nz/area-of-interest/technology-and-innovation/autonomous-vehicles-work-programme/>, accessed July 29, 2021.

Sustainability and equity are also issues that come up in dealing with AVs. For sustainability, the focus is not so much the sustainability of the individual AV, but the contribution of AVs to sustainable cities that rely on super-efficient environmentally benign transit. Many economies are looking at AVs in this context. Singapore, in particular, has made AVs an increasingly central part of its Sustainable Singapore Blueprint.⁴⁹ For equity, there is hope that AVs can play a role in making transportation more accessible. In several economies, including the United States, AV regulations call out accessibility as a key consideration in AV development.⁵⁰

COMMUNICATION INFRASTRUCTURE

Since safety depends on effectively communicating with and controlling the vehicle under a very wide range of circumstances, it is not surprising that there are numerous regulations and standards in this area aimed specifically at safety. Many economies, including Australia, have established regulations that set aside bandwidth specifically for intelligent transport systems⁵¹. This is designed to ensure that communication with, and control of, the vehicle are uninterrupted.

Interoperability and privacy are also important considerations. Interoperability has been a significant concern both with economies and international bodies, and much is being done to harmonize communication and control standards. China, in particular, has made considerable strides in this direction, including establishing economy-level standards to eliminate regional differences.⁵² Most economies have done relatively little so far on the privacy front, although interest is growing and there are exceptions. Australia has paid specific attention to AV privacy/security issues and has a set of AV-specific principles that have been endorsed by the domestic, state and territory governments.⁵³ In the United States, privacy/security issues are increasingly being addressed both at the state and federal levels.⁵⁴ As part of its broader AV effort, China has also drafted legislation entitled *Several Provisions on the Management of Automobile Data Security* to address privacy and security.⁵⁵

⁴⁹ Rahul Razdan, “Singapore and Autonomous Vehicles — Interesting Lessons in Governance, Planning, and Safety,” *Forbes*, March 1, 2020, <https://www.forbes.com/sites/rahulrazdan/2020/03/01/singapore-and-autonomous-vehicles---interesting-lessons-in-governance-planning-and-safety/?sh=5b3eb8e15fe2>.

⁵⁰ Dentons, 2021, *Global Guide to Autonomous Vehicles 2021*, <https://www.dentons.com/en/insights/guides-reports-and-whitepapers/2021/january/28/global-guide-to-autonomous-vehicles-2021>.

⁵¹ Joseph Waring, “Australia Clears 5-9 GHz for Connected Vehicles Service,” *Mobile World Live*, January 15, 2018, <https://www.mobileworldlive.com/asia/asia-news/australia-clears-5-9ghz-for-connected-vehicle-services>, accessed July 29, 2021.

⁵² “China Issues National Standards for the Testing of Autonomous Vehicles,” *Intelligent Transport*, August 14, 2018, <https://www.intelligenttransport.com/transport-news/70487/autonomous-technology-regulations-china/>, accessed July 30, 2021.

⁵³ Australia National Transport Commission, *Regulating Government Access to C-ITS and Automated Vehicle Data*, August 2019.

⁵⁴ D. Reed Freeman and Ali Jessani, 2020, *State Privacy Laws Concerning Connected Cars*, WilmerHale, April 23.

⁵⁵ Chelsey Colbert, “China: New Draft Car Privacy and Security Regulation is Open for Public Comment,” *Future of Privacy Forum*, May 18, 2021, <https://fpf.org/blog/china-new-draft-car-privacy-and-security-regulation-is-open-for-public-consultation/>.

BUILT ENVIRONMENT

In many jurisdictions, the most significant rules affecting AVs involve their interaction with the built environment – roads and buildings. As with rules aimed at other parts of the ecosystem, these rules are aimed at safety. Singapore, ranked number one in AV readiness, provides an excellent example.⁵⁶ The 2017 Road Traffic (Autonomous Motor Vehicles) Rules specify the roads where AVs may be tested and under what conditions.⁵⁷ Canada has similar rules that vary by province and by technology level – SAE Level 0 through 5.⁵⁸ Chinese Taipei is also exploring the implications that AVs have for roads, and road signs in particular. Standardization of road signage can be particularly important.

SELF-ASSESSMENT

As the discussion above makes clear, the landscape of advanced vehicle regulations and standards is complex and dynamic. There are hundreds of regulations and standards across different jurisdictions. These regulations and standards are associated with a variety of different technologies, modes, elements, and objectives, and they are evolving over time as conditions change. Given this landscape, it is a considerable challenge for APEC economies to understand clearly where they stand. Are all key elements of the EV and AV ecosystems being addressed adequately? Are all important objectives being considered? Are regulations and standards in particular areas missing or in need of updating?

The self-assessment document and spreadsheet that accompany this report are designed to help APEC economies assess their situation with respect to EV and AV regulations and standards in order to prioritize ongoing reform efforts. The self-assessment is based on answers to a series of questions using the attribute characterization outlined above. These answers – strongly agree, agree, neutral, disagree, or strongly disagree – help indicate where more effective regulations and standards may be desirable, and where capacity building may be needed for developing and overseeing those regulations and standards. The database is designed to provide supporting information to answer these questions.

CONCLUSIONS AND RECOMMENDATIONS

Advanced vehicles – both electric and autonomous – sit squarely at the center of the modern world – especially for the APEC economies. Their very existence is a reflection both of the considerable challenges we face with GHG emissions, ground-level air pollution, traffic accidents and urban congestion, and of the considerable opportunities that technological and economic development can provide to address those challenges. Appropriate regulations and standards are critical to ensuring that advanced vehicles play the largest possible role in creating a safer, healthier, more sustainable, and more prosperous future for all. As this report indicates, there is currently a complex, changing patchwork of

⁵⁶ KPMG, 2020, *Autonomous Vehicle Readiness Index, 2020*, <https://home.kpmg/xx/en/home/insights/2020/06/autonomous-vehicles-readiness-index.html>.

⁵⁷ Singapore Statutes Online, 2017, *Road Traffic (Autonomous Motor Vehicles) Rules 2017*, <https://sso.agc.gov.sg/SL/RTA1961-S464-2017?DocDate=20170823>, accessed July 7, 2021.

⁵⁸ Blake, Cassels & Graydon LLP, “Autonomous Vehicle Regulation in Canada,” May 6, 2021, <https://www.blakes.com/insights/articles/2021/autonomous-vehicle-regulation-in-canada>.

EV and AV regulations and standards across technologies, modes, elements, and objectives. Some issues are well-covered in some jurisdictions; others well-covered only in limited jurisdictions; some barely yet covered at all.

We strongly encourage APEC economies to use this report, together with the accompanying database and self-assessment, to identify areas where further work in regulations and standards is most needed and to build the capability necessary for developing and managing them. Based on initial discussions, high-priority areas may include:

- Two and three-wheeled vehicles play an important role in transportation in many APEC economies, and fossil-fueled versions create a considerable share of both GHG and ground-level emissions. However, regulations and standards for electric versions have not received sufficient attention and lag other vehicles. A focused effort on filling in gaps for two and three-wheeled electric vehicles would be beneficial. Potential candidate economies include Malaysia and Thailand.
- Electric vehicles depend on batteries, and there is increasing concern over the environmental impact of widespread battery use. Discussions have started to promote a battery “circular economy” enabled by suitable regulations and standards. A focused effort on the battery life cycle would be beneficial. Potential candidate economies include Australia and New Zealand.
- As noted above, both electric and autonomous vehicles are part of complex ecosystems. These ecosystems depend on rapid and widespread data sharing, and this sharing depends in turn on harmonization. A focused effort on regulations and standards to improve data harmonization for all advanced vehicles would be beneficial.

APPENDIX A: APEC ADVANCED VEHICLES SELF-ASSESSMENT TOOL

INTRODUCTION

The landscape of advanced vehicle (AV) regulations and standards is complex and dynamic. There are hundreds of regulations and standards across different jurisdictions. These regulations and standards are associated with a variety of different attributes – technologies, modes, elements, and objectives – and they are evolving over time as conditions change. Given this landscape, it is a considerable challenge for APEC economies to understand clearly where they stand. *Are all key elements of the ecosystem being addressed? Are all important objectives being considered? Are regulations and standards in particular areas in need of updating?*

The accompanying Excel tool *APEC Advanced Vehicles Self-Assessment Tool* is designed to help APEC economies assess their situation with respect to AV and electric vehicle (EV) regulations and standards. The self-assessment is based on answers to a series of questions using the attribute characterization noted above. The answers – strongly agree, agree, neutral, disagree, or strongly disagree – help indicate where more effective regulations and standards may be desirable, and where capacity building may be needed for developing and overseeing those regulations and standards.

EV SELF-ASSESSMENT EXAMPLE

Each EV self-assessment question is shown below, along with a sample answer for a representative APEC economy.

Q. Is there an explicit target for market adoption of EVs?

A. Thailand. Agree. The Energy Ministry recently announced plans to ensure that all vehicles produced in Thailand in 2035 are electric.

Q. Is there a published comprehensive legal/regulatory policy, roadmap, or framework in place?

A: Chile. Strongly agree. In 2017, the Ministries of Energy, Transportation and Communications, and Environment released a National Electromobility Strategy. Chile has since been taking significant strides to implement that strategy.

Q. Is there a designated governmental body with lead responsibility for laws and regulations?

A: The Philippines. Agree. The proposed *Electric Vehicles and Charging Stations Act* lays out specific responsibilities for different government agencies with the Department of Energy taking on a lead coordination role. *To answer this question completely, it may be important to explicitly consider laws and regulations for market access, market promotion and incentives, and after-market regulation and administration.*

Q. Are there other governmental bodies with appropriate responsibilities for regulation and administration?

A. Hong Kong, China. Agree. While the Environment and Ecology Bureau and the Environmental Protection Department are responsible for the EV policy formulation and promotion of wider use of EVs in Hong Kong, China, a number of other government departments have different roles in the installation, operation and maintenance of government EV chargers, depending on the location, ownership and target users of the EV chargers.

Q. Are regulations and standards in place to improve safety/liability?

A. New Zealand. Strongly agree. New Zealand maintains updated rules specifically on EV charging safety.

Q. Are regulations and standards in place to improve privacy/security?

A. United States. Neutral. The United States Department of Transportation recently released a report on EV supply equipment (EVSE) cybersecurity best practices for the government fleet. Specific regulations and standards are not yet in place.

Q. Are regulations and standards in place to improve compatibility/interoperability?

A. Chile. Agree. Chile recently passed its first energy efficiency law, and regulations for EVSE compatibility are a top priority.

Q. Are regulations and standards in place to improve environment/sustainability?

A. China. Strongly agree. China has extensive regulations on the EV battery lifecycle which require manufacturers to set up and operate extensive networks for used battery collection and recycling.

Q. Are regulations and standards in place to improve equity/justice?

A. The United States. Strongly agree. The recently enacted federal infrastructure legislation prioritizes EVSE in relatively underserved rural, low income and multi-unit dwelling (MUD) communities.

Q. Are regulations in place to improve efficiency/performance?

A. Malaysia. Strongly agree. Malaysia has extensive regulations for electric two- and three-wheelers with respect to durability, range, and the like.

Are regulations and standards in place to improve economics/adoption?

A. Korea. Strongly agree. Korea has had an EV subsidy program for many years to help with customer economics. For 2021, the maximum subsidy of roughly \$7,000 is limited to lower price EVs.

Q. Are regulations and standards in place to manage the vehicle?

A. Singapore. Strongly agree. Singapore has detailed regulations on the weight and power of two-wheeled electric vehicles, and on how and where they can be operated.

Q. Are regulations and standards in place to manage the battery?

A. Mexico. Agree. Mexico has adopted its own battery testing and compliance standards. *To answer this question completely, it may be important to explicitly consider the recycling mechanism.*

Q. Are regulations and standards in place to manage the charging infrastructure?

A. Indonesia. Agree. Indonesia recently joined with other [economies] in adopting the CHAdeMO fast charging standard.

Q. Are regulations and standards in place to manage the built environment?

A. Australia. Neutral. The Electric Vehicle Council of Australia publishes a Local Government Resource Pack that includes numerous case studies of jurisdictions that are mandating EV-ready buildings. There is minimal federal or state involvement.

A hypothetical EV self-assessment result is shown below. Responses to questionnaire questions are quantified: No (0), Some (1), Yes (2). Color coding allows for a quick check on whether your Economy is in the Green, or proactively managing the emergence of EV-AV technology.

Question	Answer
Is there an explicit target for the market adoption of EV's?	2
Is there a published comprehensive legal/regulatory policy, roadmap or framework in place?	1
...for market access?	
...for market promotion and incentives?	
...for after market supervision?	
Is there a designated governmental body with lead responsibility for laws and regulations?	0
Are there other governmental bodies with appropriate responsibilities for regulation and administration?	1
Are regulations and standards in place to achieve the following objectives:	
Safety/Liability	2
Privacy/Security	1
Compatibility/Interoperability	2
Environment/Sustainability	1
Equity/Justice	0
Efficiency/Performance	1
Economics/Adoption	2
Are regulations and standards in place to manage the following ecosystem elements:	
Vehicle	1
Battery	1
...including the recycling mechanism	
Charging Infrastructure	0
Built Environment	1

Figure 1: Example of Completed Electric Vehicle Regulations and Standards Self-Assessment

In this Figure 1, there are three areas that appear to warrant additional attention: a lead government body, regulations and standards focused on equity/justice objectives, and regulations and standards focused on the charging infrastructure.

AV SELF-ASSESSMENT EXAMPLE

Each AV self-assessment question is shown below, along with a sample answer for a representative APEC economy.

Q. Is there a dedicated research and development (R&D) effort?

A. Chinese Taipei. Agree. Chinese Taipei established an Automotive Research and Testing Center in 1990, and many of its recent activities involve AVs.

Q. Is there a comprehensive legal/regulatory policy, roadmap, or framework in development?

A. Hong Kong, China. Strongly agree. Hong Kong, China recently opened its draft *Proposed Regulatory Framework for Autonomous Vehicles* for comment and discussion.

Q. Is there a designated governmental body with lead responsibility for laws and regulations?

A. Singapore. Agree. Singapore has a Committee on Autonomous Road Transport for Singapore (CARTS). *To answer this question, it may be useful to explicitly consider laws and regulations for market access, market promotion and incentives, and after-market regulation and administration.*

Q. Are there other governmental bodies with appropriate responsibilities for regulation and administration?

A. China. Strongly agree. In China, a wide range of local, regional and [domestic] government bodies have a role in AVs, including the Ministry of Industry and Information Technology, the Ministry of Public Security, the Ministry of Transport and dozens of provinces and municipalities.

Q. Are regulations and standards in place to improve safety/liability?

A. Japan. Strongly agree. Two key pieces of vehicle legislation in Japan, the *Road Transport Vehicle Act* and the *Road Traffic Act*, were recently revised to provide specifically for AV safety. *To answer this question completely, it may be important to explicitly consider traffic accident liability.*

Q. Are regulations and standards in place to improve privacy/security?

A. Australia. Agree. Australia has paid specific attention to AV privacy/security issues and has issued guidelines.

Q. Are regulations and standards in place to improve compatibility/interoperability?

A. China. Strongly agree. China has made considerable strides in interoperability, including establishing [domestic] standards to eliminate regional differences.

Q. Are regulations and standards in place to improve environment/sustainability?

A. Singapore. Agree. Singapore has made AVs an increasingly central part of its Sustainable Singapore Blueprint.

Q. Are regulations and standards in place to improve equity/justice?

A. The United States. Neutral. In the United States, AV guidelines call out accessibility as a key consideration in AV development.

Q. Are regulations and standards in place to improve efficiency/performance?

A. Canada. Agree. In Canada, some provinces are allowing tests of AV truck convoys to improve long-haul shipping efficiency. *To answer this question completely, it may be important to explicitly consider over-the-air (OTA) update capability.*

Q. Are regulations and standards in place to improve economics/adoption?

A. New Zealand. Neutral. New Zealand is working to implement its formal Autonomous Vehicles Work Programme aimed in part at using AVs to make the urban environment more livable.

Q. Are regulations and standards in place to manage the vehicle?

A. China. Agree. China recently announced plans to incorporate AVs in its [domestic] road safety law to deal both with testing and broader adoption.

Q. Are regulations and standards in place to manage the communication infrastructure?

A. Australia. Agree. Australia has established regulations that set aside bandwidth specifically for what is called C-V2X or cellular-vehicle-to-everything communication, ensuring uninterrupted communication with, and control of, the AV. *To answer this question completely, it may be important to explicitly consider management of the radio infrastructure.*

Q. Are regulations and standards in place to manage the built environment?

A. Chinese Taipei. Neutral. Chinese Taipei is exploring the implications that AVs have for roads, including the standardization of road signs.

A hypothetical AV self-assessment result is shown below. In this Figure 2, there are two areas that require additional attention (regulations and standards focused on privacy/security and on compatibility/interoperability), and two areas that may warrant additional attention (a roadmap, and also regulations and standards focused on the built environment).

Question	Answer
Is there a dedicated R&D effort?	2
Is there a published comprehensive legal/regulatory policy, roadmap, or framework in development?	1
...for market access?	0
...for market promotion and incentives?	0
...for after-market regulation and administration?	0
Is there a designated governmental body with lead responsibility for laws and regulations?	0
Are there other governmental bodies with appropriate responsibilities for regulation and administration?	0
Are regulations and standards in place to achieve the following objectives:	
Safety/Liability	1
...including traffic accident liability	
Privacy/Security	-1
Compatibility/Interoperability	-1
Environment/Sustainability	1
Equity/Justice	1
Efficiency/Performance	1
...including over the air (OTA) update capability	
Economics/Adoption	2
Are regulations and standards in place to manage the following ecosystem elements:	
Vehicle	2
Communication Infrastructure	1
...including radio infrastructure	
Built Environment	0
...including traffic environment	

Figure 2: Example of Completed Autonomous Vehicle Regulations and Standards Self-Assessment

APEC ADVANCED VEHICLES REGULATIONS AND STANDARDS

ELECTRIC VEHICLE AND AUTONOMOUS VEHICLE REGULATIONS AND STANDARDS SELF-ASSESSMENT

The following questionnaires are intended to help APEC economies assess the state of regulations and standards (regs&stds) for electric vehicles (EVs) and autonomous vehicles (AVs). It accompanies our report: APEC Advanced Vehicle Regulations and Standards, 2021

Regulations and standards are categorized by the element of the ecosystem they affect and the objective they achieve.

For Electric Vehicles, the ecosystem elements include:

- E1 Vehicle
- E2 Battery
- E3 Charging Infrastructure
- E4 Built Environment

For Autonomous Vehicles, the ecosystem elements include:

- A1 Vehicle
- A2 Communication Infrastructure
- A3 Built Environment

For both EVs and AVs, the objectives include:

- V1 Safety/Liability
- V2 Privacy/Security
- V3 Compatibility/Interoperability
- V4 Environment/Sustainability
- V5 Equity/Justice
- V6 Efficiency/Performance
- V7 Economics/Adoption

Responses to questionnaire questions are quantified: No (0), Some (1), Yes (2).

Color coding allows for a quick check on whether your Economy is in the Green, or proactively managing the emergence of EV-AV technology.

For an Electric Vehicle Assessment, please answer each question on the EV Self-Assessment.

For an Autonomous Vehicle Assessment, please answer each question on the AV Self-Assessment

Electric Vehicle Regulations and Standards Self-Assessment

Question	Answer
Is there an explicit target for the market adoption of EV's?	2
Is there a published comprehensive legal/regulatory policy, roadmap or framework in place?	1
...for market access?	
...for market promotion and incentives?	
...for after market supervision?	
Is there a designated governmental body with lead responsibility for laws and regulations?	0
Are there other governmental bodies with appropriate responsibilities for regulation and administration?	1
Are regulations and standards in place to achieve the following objectives:	
Safety/Liability	2
Privacy/Security	1
Compatibility/Interoperability	2
Environment/Sustainability	1
Equity/Justice	0
Efficiency/Performance	1
Economics/Adoption	2
Are regulations and standards in place to manage the following ecosystem elements:	
Vehicle	1
Battery	1
...including the recycling mechanism	
Charging Infrastructure	0
Built Environment	1

Autonomous Vehicle Regulations and Standards Self-Assessment

Question	Answer
Is there a dedicated R&D effort?	2
Is there a published comprehensive legal/regulatory policy, roadmap, or framework in development?	1
...for market access?	0
...for market promotion and incentives?	0
...for after-market regulation and administration?	0
Is there a designated governmental body with lead responsibility for laws and regulations?	0
Are there other governmental bodies with appropriate responsibilities for regulation and administration?	0
Are regulations and standards in place to achieve the following objectives:	
Safety/Liability	1
...including traffic accident liability	
Privacy/Security	-1
Compatibility/Interoperability	-1
Environment/Sustainability	1
Equity/Justice	1
Efficiency/Performance	1
...including over the air (OTA) update capability	
Economics/Adoption	2
Are regulations and standards in place to manage the following ecosystem elements:	
Vehicle	2
Communication Infrastructure	1
...including radio infrastructure	
Built Environment	0
...including traffic environment	

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