GLOBAL FUEL ECONOMY INITIATIVE
FOR ZERO CARBON VEHICLES BY 2050

VEHICLE EFFICIENCY AND ELECTRIFICATION: A GLOBAL STATUS REPORT

FIA FOUNDATION · UN environment, United Nations Environment Programme · iea · UC DAVIS INSTITUTE OF TRANSPORTATION STUDIES · icct THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION · International Transport Forum

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FOR ZERO CARBON VEHICLES BY 2050

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GFEI PARTNERS' STATEMENT

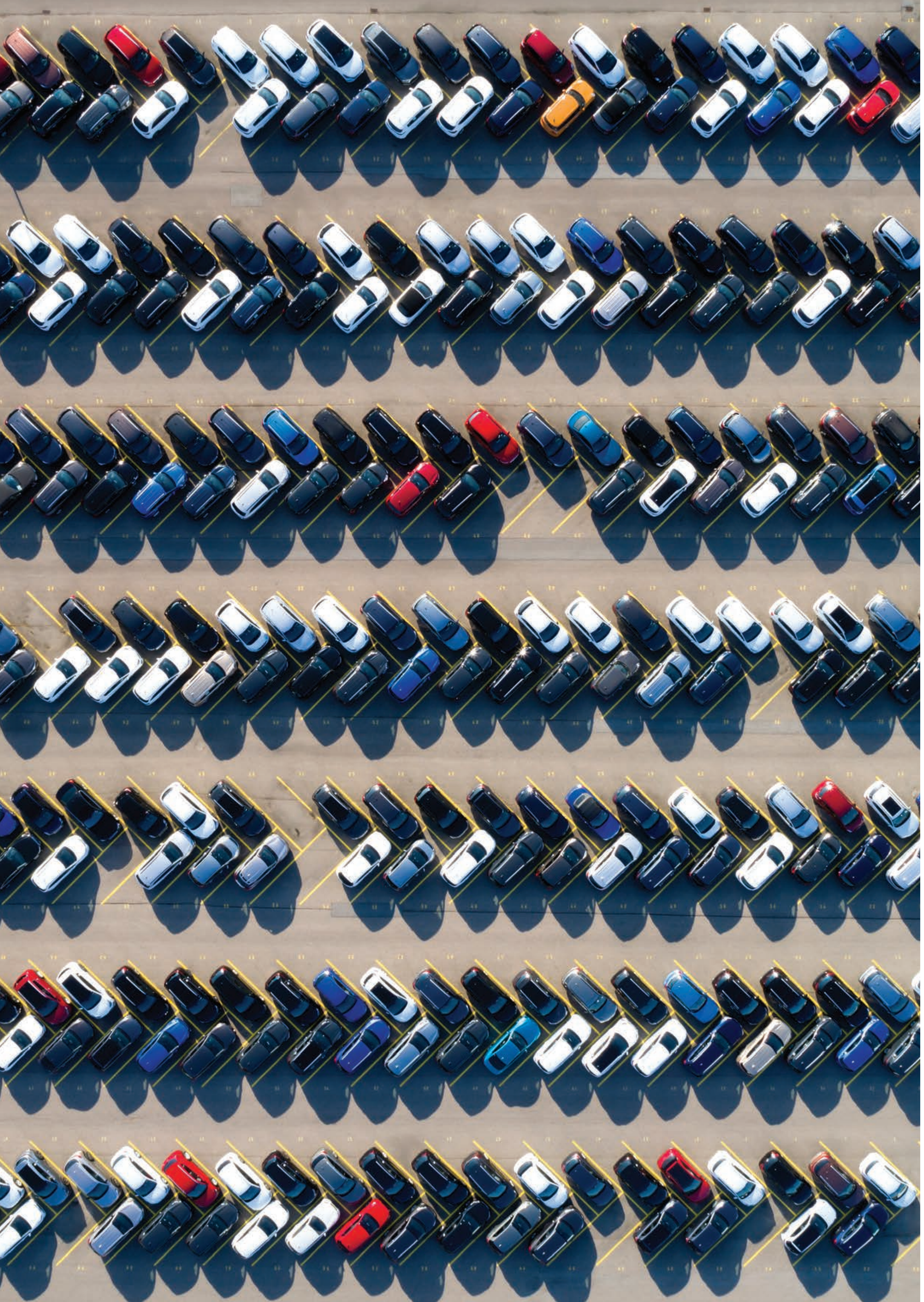
The world is seeing increased evidence of the pressing issue of climate change. Transport remains a key contributor to our carbon footprint as a species, and so must be addressed. In this context, the partners of the Global Fuel Economy Initiative (GFEI) remain committed to reducing the fuel consumption and carbon emissions of road vehicles dramatically by 2050. We are optimistic that the very high profile role which the issue has played in global processes such as the development of the Sustainable Development Goals (SDGs), the UNFCCC's climate negotiations the Lima-Paris Action Agenda (LPAA) at COP21 in Paris 2015 and the G20's Energy Ministers Declaration in Turkey in 2015, augurs well for future progress.

We have come to see both improvements in internal combustion engine vehicle fuel economy, and market uptake of electric vehicles as critical to reaching our targets. However, we have produced this global status report because there remains a great deal to be done, and major policy efforts are still needed around the world. The ultimate success of any attempts to achieve a very low carbon world fleet of road vehicles will depend on the progress we can make on a country by country basis. It is essential that all key stakeholders are fully engaged, open and positive in their involvement in this work. We at GFEI remain open to further engagement, and to working together to achieve this.

We acknowledge the FIA Foundation (FIAF), Global Environment Facility (GEF) and European Commission (EC) in supporting our work, as well as the substantial resources committed by each GFEI partner to the initiative, and we look forward to greater successes in the future.

GFEI partners, May 2019, left to right, Lew Fulton, UC Davis, Steve Perkins ITF, Sheila Watson, FIA Foundation, Rob de Jong, UNEP, Pierpaolo Cazzola, ITF.

THE GFEI PARTNERS



INTRODUCTION AND BACKGROUND – 10 YEARS OF THE GFEI

The world needs an urgent transition to zero emission mobility. In the decade since it was established, the Global Fuel Economy Initiative (GFEI) has brought together the unique expertise of its partner organizations to support policy frameworks for clean and efficient vehicles around the world. By gathering, synthesizing and disseminating data, offering practical tools and in-country support and seeking to influence at the highest levels, GFEI has helped establish and consolidate international policy frameworks – not just in developed economies such as the EU, but also in developing and emerging economies across Africa, Asia and South America.

GFEI was founded in the first decade of the 21st century. Now, at the start of the third decade, the original climate imperative has only increased whilst new challenges such as the economic fallout of the COVID-19 pandemic, growing pressure for cleaner air, and renewed concerns about energy security add further impetus to our cause. More specifically, the pandemic has provided opportunities to make quicker progress on CO_2 via inclusion of low-carbon strategies in economic recovery policies and packages.

In responding to this opportunity for bold action, it is also important that we learn the lessons of the past, and build on what has already been learned and achieved. We must continue to imagine a new reality where efficient, zero emission mobility is normal, using the tools which we already know to work and crafting new ones where needed. The GFEI Toolkit[1] exists to do just this, and is an open resource for anyone engaged in this field.

From the beginning, GFEI partners developed and promoted a target of doubling passenger vehicle fuel economy (halving fuel consumption per kilometre) by 2030, relative to 2005 levels. This target was achievable using existing, cost effective fuel economy technologies as well as full hybridization, but did not require plug-in hybrid or full electric vehicles (EVs). In the following decade, continued policy and technology developments have resulted in increased availability of cost-effective internal combustion engine (ICE) technologies, along with substantial reductions in the costs of battery electric and plug-in hybrid vehicles.

In 2015, the Paris Agreement on global climate change codified the consensus of ambition among world governments to further limit warming to well below 2 degrees celsius and to pursue efforts to limit the temperature increase to 1.5 degrees celsius. It also established a framework for national commitments to reduce emissions. With respect to the decarbonization of road transport, previous studies, including those conducted by GFEI partners, underscore the vital role of policies that improve vehicle fuel economy and accelerate the transition to zero emission vehicles, in combination with measures that avoid the need for motorized travel and shift activity to less carbon-intensive modes.

GFEI TIMELINE

2009:
- GFEI launched at Geneva motor show with '50by50' target
- President Obama's Major Economies Forum backs GFEI

2010:
- GEF funds GFEI to pilot support in 4 countries
- European Commission and US EPA support GFEI work
- GFEI launches first working paper on fuel economy in South East Asia

2011:
- GFEI publishes first international comparison of vehicle fuel economy

2012:
- Fifty participants from twenty countries attend 'GFEI Africa' launch in Kenya
- World leading experts ICCT and UC Davis join GFEI
- GFEI part of sustainable transport commitments at Rio+20

2013:
- Fuel economy label introduced in Chile
- GFEI report shows how fuel economy savings can help fund transition to plug-in electric vehicles

2014:
- G20 Summit in Brisbane mentions GFEI and prioritises action on vehicle fuel economy
- GFEI briefs UN Secretary General at Abu Dhabi climate summit
- GFEI centre stage at UN Climate Summit in New York

2015
- GFEI launches 100 for 50by50 campaign at SE4ALL Forum
- UN agrees Sustainable Development Goals including energy efficiency
- Thailand and Vietnam introduce new fuel economy labels
- G20 Summit in Turkey confirms GFEI's role
- GFEI part of Action Agenda at Paris Climate Change conference

2016:
- Largest ever global networking event in Paris
- First estimate of fuel economy potential of HDVs

2017:
- GFEI contributes to SDG7 events ahead of HLPF
- China publishes updated FE standards with EV mandate
- GFEI update report for COP23 show fuel economy support reaches around 70 countries

2018
- Ukraine exempts EVs from VAT after GFEI support
- Montenegro launches new fuel economy label
- GFEI included in SDG7 report for UN High Level Political Forum
- G20 Transport Task Group discuss HDV fuel economy
- ASEAN countries adopt fuel economy roadmap (image)
- EU announces progress on fuel economy standards for 2030
- GFEI contributes to COP24 climate talks in Poland

2019
- GFEI launches updated global report tracking fuel economy progress
- South Africa includes FE standards in Green Transport Strategy
- GFEI 2.0 launched
- Philippines agrees fuel economy labelling
- Argentina adopts fuel economy label
- Ambitious new 2030 CO2 emissions targets for LDVs agreed in EU
- Japan extends and tightens standards to 2030

2020:
- West Africa adopts ECOWAS regional fuel economy roadmap
- Uruguay adopts fuel economy label
- South Korea updates fuel economy targets to 2030

2019: THE NEW GFEI TARGETS

The GFEI partnership's original focus was on establishing policy frameworks for passenger vehicles, over time. This has expanded to include heavy-duty trucks and freight, as well as also covering motorbikes and buses. We need action across all forms of on-road mobility in order to substantially cut emissions. New technologies and cost reductions are making electric options more financially attractive, combined with policy frameworks incentivizing manufacturers to produce more efficient vehicles, and increasing numbers of city policies that target vehicle emissions, but more must be done.

During 2019 GFEI, led by ICCT, undertook a thorough review of our existing targets and developed a new, comprehensive set of fuel economy and CO_2 emissions targets across all modes, and out to 2050. This is reported on in detail in our GFEI Working Paper 20.[2]

In the GFEI targets the GFEI partners sought to account for ongoing developments in technology and vehicle fuel efficiency potentials, expanded the focus to incorporate all road transportation vehicles, and framed the targets in terms of both vehicle efficiency and greenhouse gas emissions.

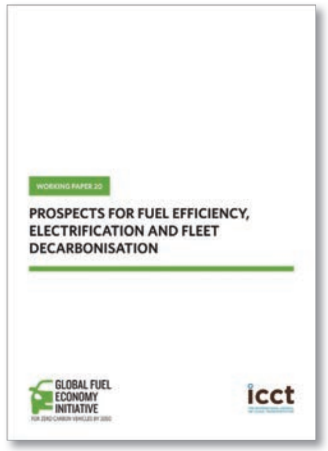
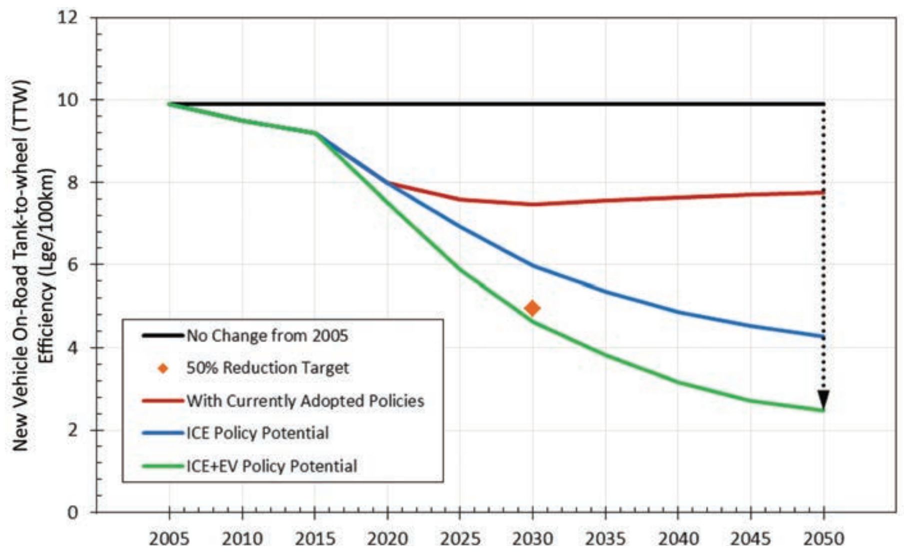


FIGURE 1: On-Road Efficiency for New LDVs



Source: GFEI Working Paper 20

BACKGROUND TO THE TARGETS

The basis for developing the new targets was that they should be appropriately ambitious, trackable, policy relevant, and easily communicated. Potential efficiency improvements were evaluated separately for internal combustion engine technology alone and internal combustion engine technology in combination with vehicle electrification. The effect of electric vehicles on total CO_2 emissions of the fleet (per distance travelled) was linked to estimates of electric carbon intensity around the world, and projections out to 2050, to support a "well-to-wheel" approach. The resulting targets are shown for light-duty vehicles in Figures 1 (for fuel efficiency) and 2 (for CO_2eq emissions), and for all vehicle types in Table 1.

From the analysis performed, GFEI partners:

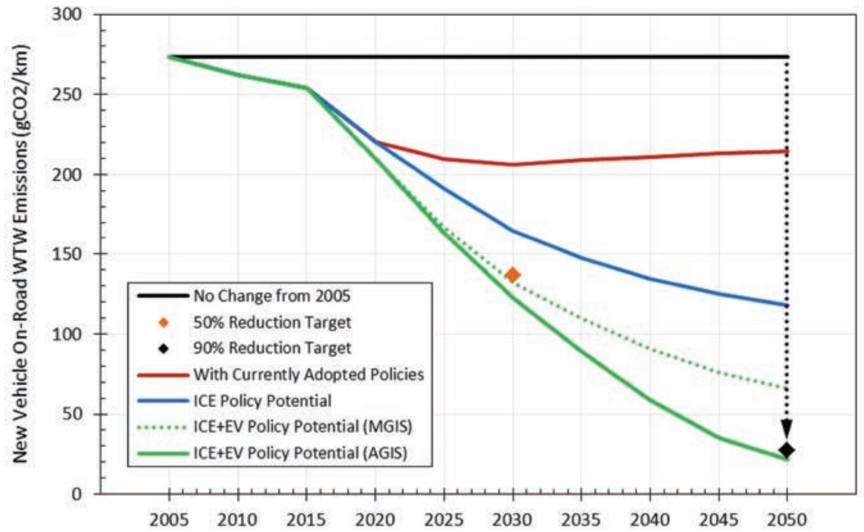
1. Reaffirmed our existing targets for new light- and heavy-duty vehicles in 2030 and 2035 respectively,
2. Established new 2050 targets for new light- and heavy-duty vehicles,
3. Established the first-ever targets for 2 and 3 wheeled vehicles and buses in 2035 and 2050,
4. Compiled these targets into a vision for achieving major reductions in greenhouse gas emissions from the transportation sector by mid-century.

Taking each of these targets in greater detail below:

1. **Light duty (passenger) vehicles (LDVs).** The GFEI partners reaffirm our target of doubling fuel economy of new passenger vehicles globally by 2030 (relative to 2005) through continued improvements in internal combustion engine efficiency plus the introduction of electric passenger vehicles. We extend this target to a 50% reduction in new passenger vehicle per-kilometer CO_2 emissions by 2030 (see Figures 1 and 2, and Table 1).

   The GFEI partners also established a new passenger vehicle per-kilometer CO_2 emissions reduction target for 2050 of 90% (also relative to 2005). To achieve this target:

FIGURE 2: On-Road Well-to-wheel (WTW) CO_2 Emissions for New LDVs



Source: GFEI Working Paper 20

- Combustion engine fuel consumption will need to improve by an average of 2.1% per year from 2020 to 2050,

- The global sales fraction of electric passenger vehicles will need to increase to 35% of sales in 2030 and 86% of sales in 2050, and

- The carbon intensity of the global electricity grid will need to decrease by at least 90% between 2020 and 2050 (Aggressive GHG Intensity reduction Scenario).

2. **Heavy-duty (freight) trucks (HDTs).** The GFEI partners reaffirmed our target of cutting per-kilometer fuel consumption from new heavy-duty trucks by 35% by 2035 (relative to 2005) through continued improvements in internal combustion engine efficiency plus the introduction of electric heavy-duty trucks, extended this target to a 35% reduction in new heavy-duty truck per-kilometer CO_2 emissions by 2035. The GFEI partners also established a heavy-duty truck per-kilometer CO_2 emissions reduction target for 2050 of 70% (also relative to 2005). To achieve this target, combustion engine fuel consumption will need to improve by an average of 1.7% per year from 2020 to 2050, the global sales fraction of electric heavy-duty trucks will need to increase to 19% of sales in 2030 and 66% of sales in 2050, and the carbon intensity of the global electricity grid will need to decrease by at least 90% between 2020 and 2050.

3. **Two and three wheeled vehicles (2Ws and 3Ws).** The GFEI partners established new targets for 2 and 3 wheeled vehicles to reduce per-kilometer CO_2 emissions by 80% by 2035 and 95% by 2050 (both relative to 2005). To achieve these new targets, the fuel efficiency of internal combustion engine powered 2 and 3 wheelers will need to improve by 1.4% per year from 2020 to 2050, the global sales fraction of electric 2 and 3 wheelers will need to increase to 74% of sales in 2030 and 100% of sales in 2050, and the carbon intensity of the global electricity grid will need to decrease by at least 90% between 2020 and 2050.

4. **Transit buses.** The GFEI partners established new targets for buses to reduce per-kilometer CO_2 emissions by 65% by 2035 and 95% by 2050. To achieve these new targets, the fuel efficiency of internal combustion engine powered

TABLE 1: Targets in 2030 and 2050 for new vehicles by type, and comparison to 2005 levels

	New Vehicles 2005		New Vehicles 2030/2035*			New Vehicles 2050		
	Efficiency (L/100km)	CO_2eq (g/km)	Efficiency (L/100km)	CO_2eq (g/km)	CO_2eq % reduction	Efficiency (L/100km)	CO_2eq (g/km)	CO_2eq % reduction
LDVs	10	275	5	135	50%	2.5	65	90%
Trucks	22	725	14	460	35%	9	290	65%
Buses	24	770	12	250	70%	6	40	94%**
Motorized 2-3 wheel	2.8	78	1.1	12	85%	0.6	2	97%**

Table and figure notes: vehicle efficiency estimates are in litres of gasoline equivalent (for light-duty vehicles) or diesel equivalent (for trucks and buses), as a weighted average of gasoline and electric vehicles with electricity converted to gallon equivalent, per 100 kilometres of driving. CO_2-equivalent emissions are well-to-wheel, using the AGIS (aggressive GHG Intensity reduction Scenario across electric power systems around the world). CO_2-eq % reduction is compared to 2005 levels.
* Targets are for 2030 for LDVs and 2035 for other modes.
** GFEI 2050 targets for Buses and Motorized 2-3 wheel are for clarity set at 95%

buses will need to improve by 2.0% per year from 2020 to 2050, the global sales fraction of electric buses will need to increase to 37% of sales in 2030 and 93% of sales in 2050, and the carbon intensity of the global electricity grid will need to decrease by at least 90% between 2020 and 2050. These targets are summarised in Table 1.

In addition to these specific targets across transportation modes, the GFEI also made several very important overarching findings:

- **Government role:** The GFEI partners recognize the importance of supporting government actions and policies that bring the transportation sector into compliance with the Paris Agreement. Our toolkit[1] is designed to support this process.

- **Decarbonizing the electricity grid** is instrumental so that, by 2035 as EV sales approach or exceed 90% in all but the heavy-duty truck sector, their transport decarbonisation potential is maximised. Grid CO_2 intensity becomes the dominant influence on the CO_2 impacts of these EVs.

- **Fleet growth**: On a fleetwide basis, growth in the population and annual usage rates of on-road vehicles results in significant growth in total vehicle kilometers of travel (VKT), which offsets some of the net fleetwide CO_2 emission reduction achievable through efficiency technology and electrification.

- **Overall CO_2 target:** We established a fleetwide well-to-wheel CO_2 emissions target of 2.2 gigatonnes in 2050. This target draws on recent modeling that complies with the Paris Agreement commitment to limit the global average temperature increase to "well below" 2°C.

- **EV benefits:** While not quantified in this analysis, it is important to recognize that introducing zero emissions vehicles, such as EVs, will also deliver major air quality benefits in areas where people are exposed to tailpipe pollutant emissions regardless of the level of grid decarbonization.

- **Additional policies and measures:** As expected, there will be a need for additional policies to further reduce road transport emissions. Such policies can include those targeting vehicle kilometers travelled (VKT) reduction, congestion mitigation, vehicle class shifting, incentives for the purchase and utilization of more fuel-efficient vehicles, and incentives designed to accelerate the transition to a zero emission fleet more quickly than assumed in this analysis.

GFEI has begun to promote these targets and is working with governments to gain commitments to them, and develop strategies to achieve them. This is further documented in various sections below.

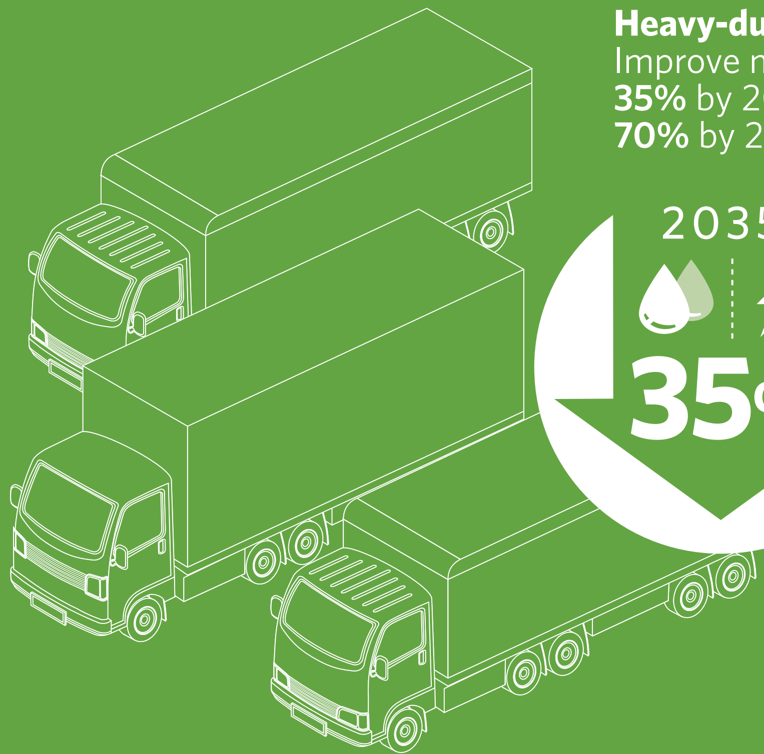
GFEI TARGETS

Passenger light-duty vehicle targets
Double global fuel economy of new vehicles by 2030, reduce CO_2 emissions by **90%** by 2050

2030
50%

2050
CO_2
90%

Heavy-duty vehicle targets
Improve new vehicle fuel consumption **35%** by 2035 - CO_2 reduction target of **70%** by 2050



2035
35%

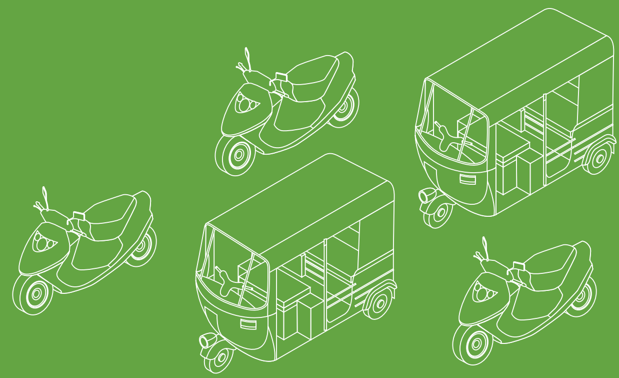
2050
CO_2
70%

Transit bus targets
Improve fuel economy to reduce CO_2 emissions by **65%** by 2035 and **95%** by 2050

2035
CO_2
65%

2050
CO_2
95%

Two & three wheel vehicle targets
Improve fuel economy to reduce CO_2 emissions by **80%** by 2035 and **95%** by 2050



2035
CO_2
80%

2050
CO_2
95%

Decarbonising road transport to tackle climate change
A new fleetwide CO_2 reduction target of **65%** by 2050 compared with 2005. To comply with the Paris Agreement's less than 2 degree scenario, better fuel efficiency of conventional vehicle technologies; a faster transition to electric vehicles; a faster decarbonisation of the electricity grid; and additional 'avoid' and 'shift' measures eg more non-motorised mobility, are all needed

2050
CO_2
65%

To achieve these targets, the carbon intensity of the global electricity grid will need to decrease by at least 90% between 2020 and 2050

Source: GFEI Working Paper 20 - Data based upon 2005 baseline

FUEL ECONOMY IMPROVEMENTS, 2010-2020

The IEA has provided GFEI with on-going tracking of light-duty vehicle fuel economy progress around the world, and here we provide the latest updates to this work which summarizes the analysis in the 2019 GFEI benchmarking report[3] and additionally includes data for 2018 and 2019, where available. In particular, the focus here is on countries that have active fuel economy regulations: Canada, China, the European Union (including European Economic Area), India, Japan, South Korea and the United States. These countries accounted for approximately 85% of new light-duty vehicle sales in 2017. While the GFEI has published fuel economy and vehicle CO_2 emissions targets for heavy-duty vehicles, transit buses, and two- and three-wheel vehicles,[4] this analysis focuses on the GFEI targets for light-duty vehicles.

STATUS AND TRENDS

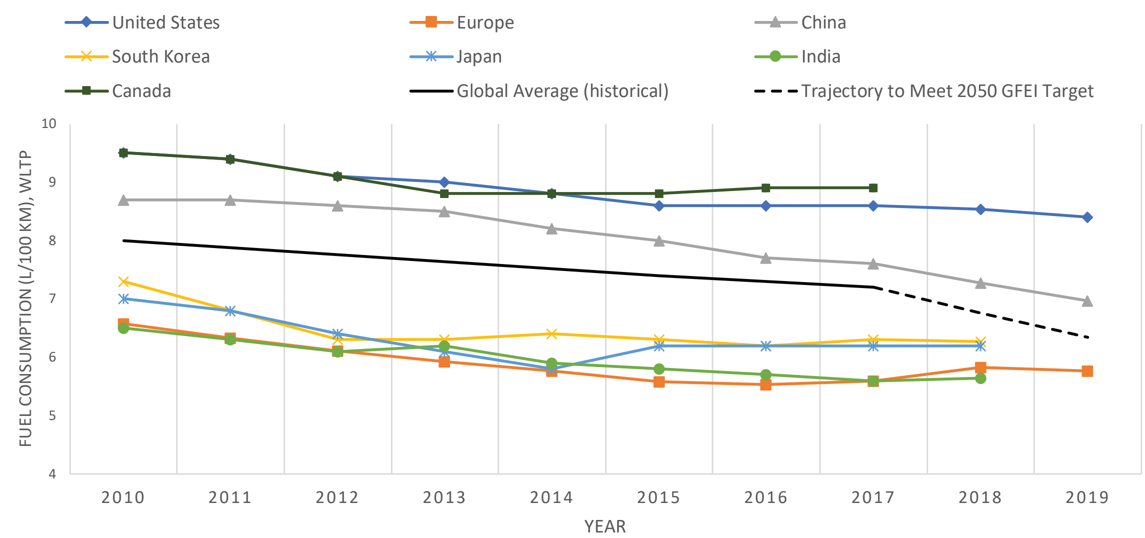
As shown in Figure 3, in 2017, the global average fuel consumption of newly registered light-duty vehicles was 7.2 Lge/100 km.[5] Given the continued 50% reduction target for new LDV fuel use per kilometre between 2005 and 2030, with the 2005 average (for tested fuel economy) set at about 8 Lge/100 km, an improvement of about 10% has been achieved in the 12 years since 2005, equivalent to an overall improvement of about 1.7% per year. This means that an annual decrease in fuel consumption of 3.7% will be required to meet the 2030 GFEI target. Figure 3 shows the trend in average fuel consumption since 2010. Considering the 2050 target, an even greater annual decrease in fuel consumption will be required, approximately 6.2% per year from 2017. Such an ambitious target will only be achievable by shifting to zero-emission vehicle (ZEV) powertrains that rely on energy carriers (electricity and/or hydrogen) that are produced at very low carbon intensities.

In both 2018 and 2019, new LDVs sold in China exceeded the required 3.7% required improvement rate from the previous year, achieving a sales-weighted average reduction in fuel consumption of 4.3% and 4.1%, respectively. China has, however, along with the US, an average fuel consumption level greater than the global average and so despite recent progress is still not on the trajectory required to meet the 2030 GFEI target (4.4 Lge/100 km), much less the 2050 target. In the US, the average fuel consumption decreased by 0.8% from 2017 to 2018, and another 1.5% from 2018 to 2019. Based on previously published results, Canada also has a relatively high average annual fuel consumption, at 8.9 Lge/100 km in 2017.

In 2018, India had the lowest average fuel consumption of the countries analysed, with an average fuel consumption remaining roughly equivalent to the 2017 level of 5.6 Lge/100 km (a 0.7% increase). The average fuel consumption of newly registered light-duty vehicles in Europe increased from 2017 to 2018 by 4.3%, but decreased by 1.1% from 2018 to 2019. There was no change in Japan's average fuel economy from 2017 to 2018, and only a small decrease of 0.5% in South Korea over the same timeframe. Table 2 describes the progress in regional fuel economy improvements since 2010.

As Table 2 shows, of the countries analysed, only China, Europe, Japan, and India have experienced this level of annual improvement since 2010 (and only China since 2015). However, as none have sustained this rate of improvement, the average annual improvement rates in all these countries from 2010 to 2018 were all less than 2.5%, and the global average improvement rate from 2010 to 2017 was 1.5%.

FIGURE 3: Comparison of light-duty fuel consumption since 2010



Source: IEA for GFEI, 2020

TABLE 2: Progress in average fuel economy improvement in different regions and GFEI target for 2030

Region	Indicator	2010	2015	2017	2018	2030
Canada	average fuel economy (Lge/100km)	9.5	8.8	8.9	NA	4.4
	annual improvement rate (% per year)		-1.5%	0.6%	NA	
				-0.9%	NA	
China	average fuel economy (Lge/100km)	8.7	8	7.6	7.3	
	annual improvement rate (% per year)		-1.7%	-2.5%	-4.3%	
					-2.2%	
Europe	average fuel economy (Lge/100km)	6.6	5.6	5.6	5.8	
	annual improvement rate (% per year)		-3.2%	0.1%	4.3%	
					-1.5%	
India	average fuel economy (Lge/100km)	6.5	5.8	5.6	5.6	
	annual improvement rate (% per year)		-2.3%	-1.7%	0.7%	
					-1.8%	
Japan	average fuel economy (Lge/100km)	7	6.2	6.2	6.2	
	annual improvement rate (% per year)		-2.4%	-1.7%	0.0%	
					-1.5%	
South Korea	average fuel economy (Lge/100km)	7.3	6.3	6.3	6.3	
	annual improvement rate (% per year)		-2.9%	0.0%	-0.5%	
					-1.9%	
United States	average fuel economy (Lge/100km)	9.5	8.6	8.6	8.5	
	annual improvement rate (% per year)		-2.0%	0.0%	-0.8%	
					-1.3%	
Global Average	average fuel economy (Lge/100km)	8	7.4	7.2	NA	
	annual improvement rate (% per year)		-1.5%	-1.4%	NA	
				-1.5%	NA	
GFEI Target	Required annual improvement rate (% per year) – 2010 base year					-2.9%
	Required annual improvement rate (% per year) – 2017 base year					-3.7%

Source: IEA for GFEI, 2020

BOX 1:

KEY DRIVERS OF FUEL CONSUMPTION

FUEL PRICE

Fuel prices have an important impact on key vehicle attributes including weight, footprint and power, which are themselves key determinants of fuel economy. Higher fuel prices (including taxes) tend to steer markets toward smaller, lighter and more fuel efficient[6] cars (see Figure 4).

VEHICLE SIZE

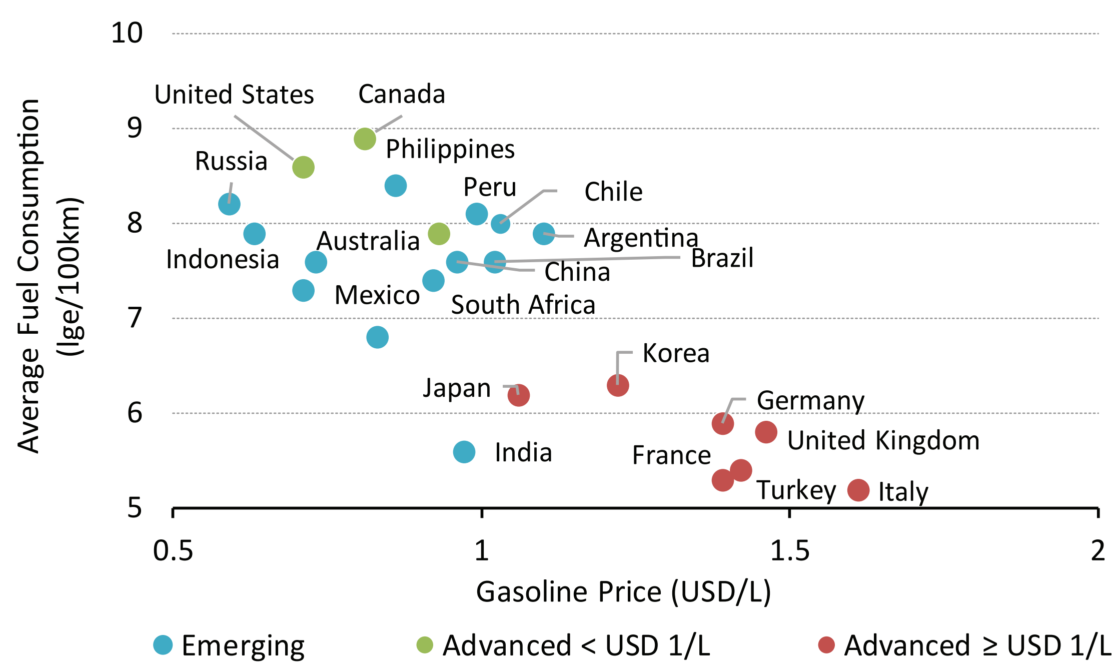
Despite ongoing efficiency improvements within each vehicle segment, consumer demand for larger vehicles has risen significantly. This trend is common to all vehicle markets and has led to a slackening – or in some cases even reversal – of national rates of fuel consumption improvements.

As Figure 5 shows, the worldwide market share of sports utility vehicles (SUVs) rose 15 percentage points between 2014 and 2019, to make up 40% of the global LDV market. SUV market shares in North America and Australia were particularly high, at around 50%. In addition to SUVs, pickup trucks – which tend to be even larger – also make up a significant share of sales in these markets. In Canada, in particular, light trucks (including minivans, SUVs, pickup trucks, and vans) have increased in share from 68% in 2017 to 75% in 2019.

POWERTRAIN TECHNOLOGY

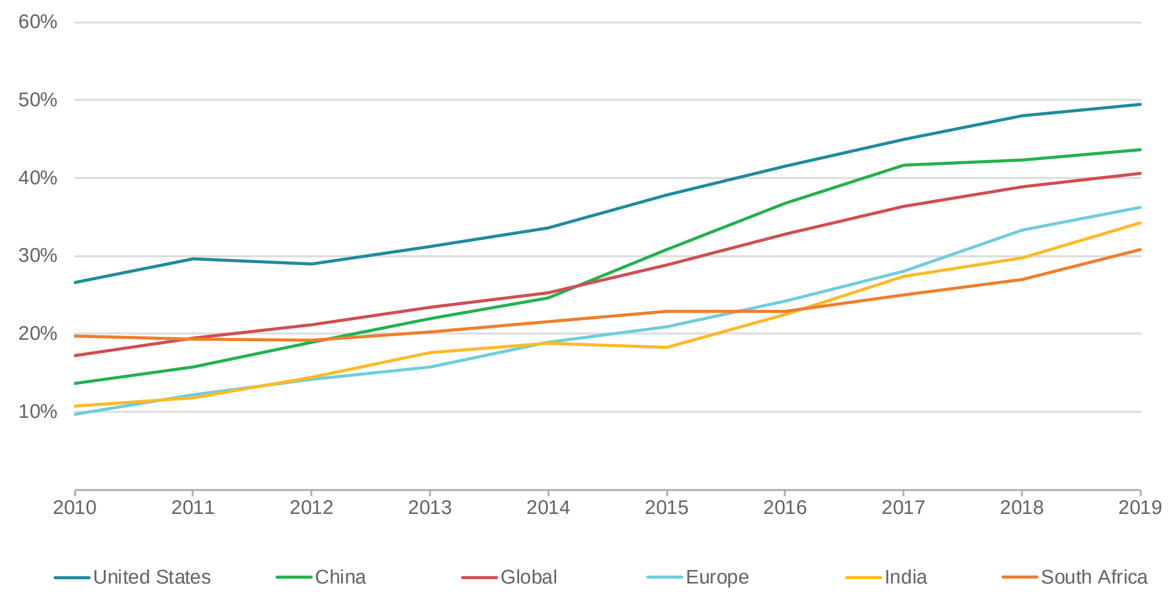
In addition to vehicle size or weight, powertrain technology is a fundamental determinant of a vehicle's fuel consumption. Gasoline vehicles, which comprise the majority of light-duty vehicles, have higher fuel consumption than diesel powertrains. Gasoline hybrids tend to have lower fuel consumption than diesel vehicles, while plug-in hybrids consume significantly less fuel.[7] Battery electric vehicles consume the least energy (and no liquid fuel), and along with PHEVs, they are less influenced by vehicle weight than other powertrains, with respect to fuel consumption.

FIGURE 4: Fuel economy in major car markets plotted against gasoline prices



Source: IEA for GFEI (2019)[8]

FIGURE 5: Share of SUVs in total car sales in key markets, 2010-2019



Source: IEA (2020) Fuel Consumption of Cars and Vans[9]

POLICY PROGRESS: FUEL ECONOMY STANDARDS

Over the past 15 years, fuel economy standards have had among the biggest impact on vehicle fuel economy of any policy or other factor in the major markets. Many new technologies have become commonplace on vehicles as a result; and there are still many known technologies that are able to dramatically improve the efficiency of the average conventional light and heavy duty vehicles. Key technologies driving improvement in LDV efficiency include hybridization, high-efficiency engine designs, engine downsizing with turbocharging, and improved aerodynamics. In addition, electric powertrains that are the primary source of energy and power on battery electric vehicles, plug-in hybrid electric vehicles and fuel cell electric vehicles, are three-to-five times more energy efficient than conventional internal combustion engine powertrains. Their introduction on the market therefore significantly supports automakers in meeting fuel economy standards. Key technological developments for Heavy Duty Vehicles (HDVs) are improvements in engine efficiency, reductions in aerodynamic drag, reductions in tire rolling resistance, and hybridization.

Though more efforts are needed, over the past two years there has been progress on fuel economy policies for light and heavy-duty vehicles in many countries. These are reviewed below in the context of longer-term fuel economy policymaking in the relevant jurisdictions. The standards are generally set to either fuel use per kilometre or CO_2 emissions per kilometre, with a tightening over time. Figures 6 and 7 show the current schedules in countries with standards for light-duty vehicles and trucks respectively.

As Figure 6 shows, to date, ten governments worldwide have established or proposed fuel economy or greenhouse-gas emission standards for passenger vehicles.

Figure 7 shows that currently 6 markets have efficiency or CO_2 standards in place for heavy duty vehicles. The figure shows the relative stringency of the different long-haul truck efficiency standards with respect to the baseline defined when the standards were introduced. Japan established the first mandatory fuel-efficiency standards for HDVs in 2006, targeting CO_2 emissions reductions of 1.2% per year. A second stage, finalized in 2017, incorporates additional technologies such as aerodynamics and tires, and targets 13%-14% reductions on average for trucks and buses and 3.7% for tractors.

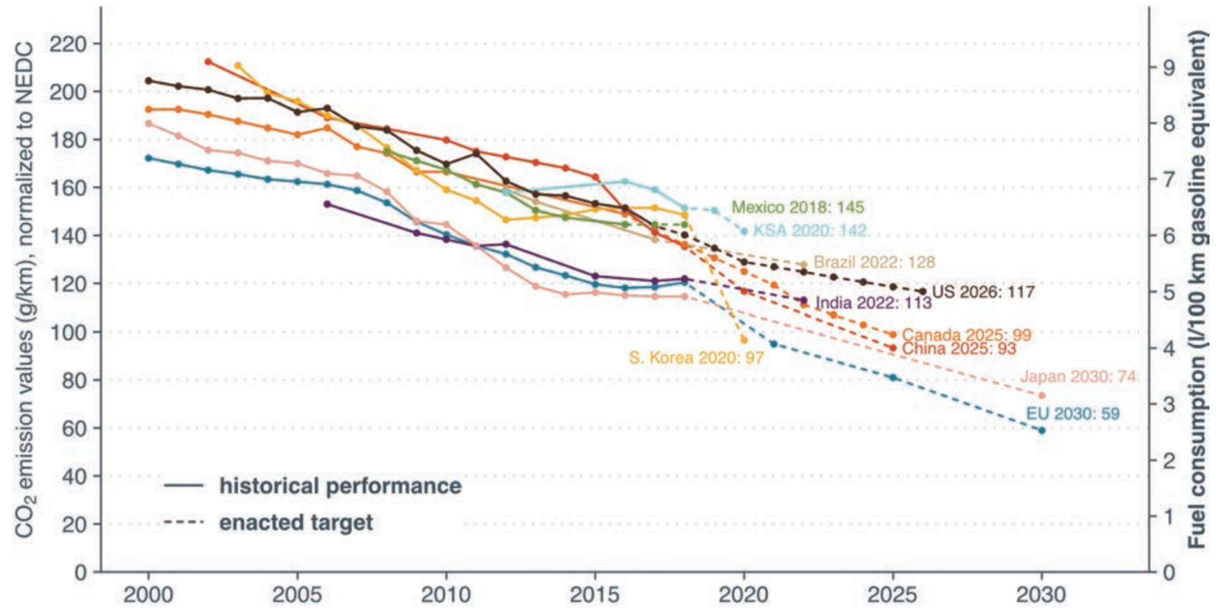
China has issued three stages of progressively more stringent fuel-consumption standards. The first stage was implemented in 2012 and covers three segments— tractors, straight trucks, and coach buses. The second stage went into effect in 2014, incorporated city buses and dump trucks, and tightened the limits by up to 14.5%. The Stage 3 standards tightenened fuel-consumption limits by an additional 12.5%-15.9% and began to take effect in July 2019.

The U.S. Phase 1 and Phase 2 greenhouse gas (GHG) standards for HDVs incorporate a large set of technologies and include separate standards for engines and trailers. The highest fuel-consuming segment, tractor-trailers, will see reductions of approximately 50% in 2027 with respect to the Phase 1 baseline.

Canada's GHG standards for HDVs closely align with the U.S. national standards. In 2017, India finalized its first fuel-efficiency standards for commercial HDVs. Phase 1 goes into effect in 2018, and Phase 2, in 2021. The target reductions are about 11% on average. The EU targets will reduce the average CO_2 emissions from the highest emitting HDV segments by 15% in 2025 and by 30% in 2030, both relative to a baseline determined from 2019 and 2020 data.

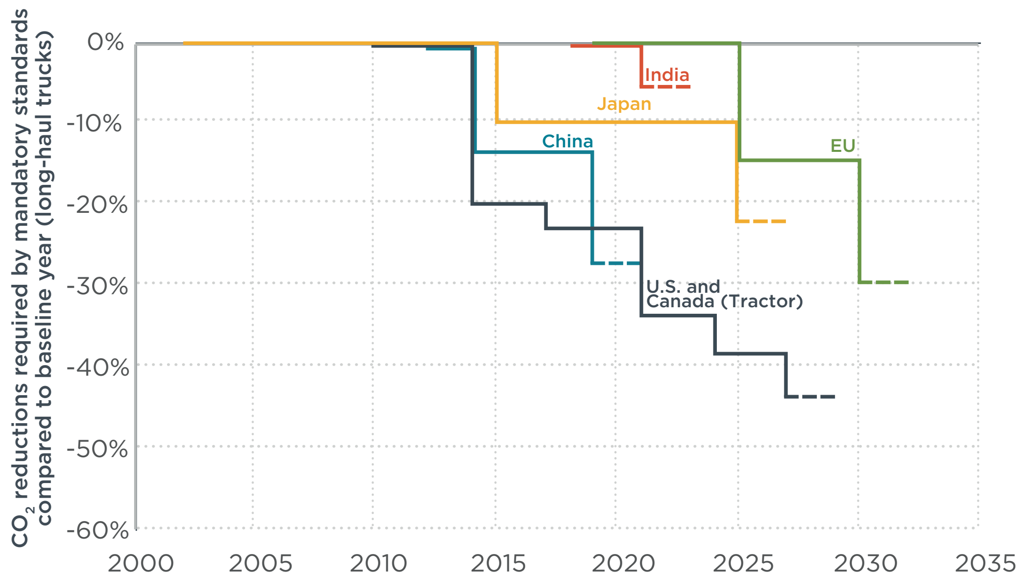
The regulations in these markets, covering more than 80 percent of global passenger vehicle sales, influence the business decisions of major vehicle manufacturers around the world, and are among the most effective climate-change mitigation measures to have been implemented over the past decade. These governments have taken differing approaches to designing their regulations, using different drive cycles and vehicle certification test procedures. Converting the standard values—that is, the fuel efficiency mandates or emissions limits—between different regulations involves not just converting physical units but also accounting for the impacts of differences in test cycles. The data in figure 7 represents a comparison of the targets in different markets after being converted using the ICCT's conversion methodology.

FIGURE 6: Passenger car CO_2 emission and fuel consumption values, normalized to NEDC



Source: Passenger car CO_2 emissions chart[10]

FIGURE 7: Truck CO_2 reduction standards, future schedules by country



Source: Updated from ICCT (2018) CO_2 Standards for Heavy-Duty Vehicles in the European Union ICCT (2020)[11]

COUNTRY AND REGION FUEL ECONOMY POLICY REVIEWS

The following reviews of country policy changes correspond to this latest set of schedules. This discussion highlights recent policy updates in key global car markets. Further discussion on these and other updates is available in Chapter 2 of the IEA's Global EV Outlook 2020[12], and in recent ICCT policy updates.[13]

EUROPE

Beginning in 2009, the European Union put in place a corporate average CO_2 emissions standard that requires OEMs to reach target emission levels for cars sold within the European Union. They are based on the EU fleet-wide targets, taking into account the average test mass of a manufacturer's newly registered vehicles. The target mandated for all new vehicles sold in 2021 was established to be 95 g/km (4.1 Lge/100 km for gasoline-powered vehicles (WLTC test) and 3.6 Lge/100km for diesel vehicles (WLTC test)). In April 2019, the European Council and the European Parliament approved new CO_2 emissions standards for LDVs.

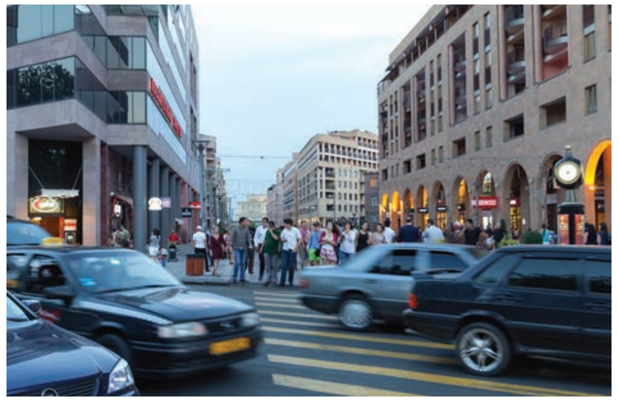
These targets are defined as a percentage reduction from the 2021 starting points:

- Cars: 15% reduction from 2025 onwards and 37.5% reduction from 2030 onwards
- Vans: 15% reduction from 2025 onwards and 31% reduction from 2030 onwards

Achieving the 2025 target of a 15% reduction in average CO_2 emissions will require an annual improvement rate of 4%. Europe last achieved such a high annual improvement rate over a single year, from 2010 to 2011.

The EU's impact assessment[14] projects a 2030 CO_2 per km reduction of around 50% for passenger cars, compared to the 2021 target.

Also in 2019, the European Union introduced a CO_2 emissions performance standard for heavy-duty vehicles (European Union Regulation 2019/1242). The standards apply for large trucks which account for around 65-70% of the CO_2 emissions from heavy-duty road transport in the European Union. On an average, these trucks will need to be 15% more fuel efficient by 2025 and at least 30% more efficient by 2030, relative to a mid-2019 to mid-2020 period. As part of the 2022 review of the legislation, the Commission will assess whether the scope should be extended to other types of vehicles (European Commission, 2019c).



NORTH AMERICA

In early 2020, US EPA and NHTSA finalised Part II of the Safer Affordable Fuel-Efficient Vehicles (SAFE) fuel economy and CO_2 requirements for 2021-26. The new SAFE vehicles rule, which went into force in March 2020, sets Corporate Average Fuel Economy (CAFE) and CO_2 requirements for 2026 model vehicles at 5.82 Lge/100 km (EPA two-cycle test) – an annual improvement of 1.5% from the 2020 level of 6.39 Lge/100 km (EPA two-cycle test).

The SAFE vehicles rule drastically scales back the previous administration's MY 2025 target of 4.31 Lge/100 km (EPA two-cycle test), which would have required a 4.6% year-on-year improvement from 2017. Compliance pathways and flexibility options remain largely unchanged, but of particular concern is the phasing out of the credit multiplier for EVs and FCEVs after 2021 and for natural gas vehicles through 2026. The penalty for noncompliance is $5.50 per 0.1 mpg per vehicle under the fuel economy standard.

INDIA

In 2015, India adopted a two-phase implementation of its mandatory corporate average fuel consumption (CAFC) regulations.[15] The regulation specifies the calculation of the average fuel consumption standard during each implementation phase based on an assumed average vehicle curb weight. In phase 1 (fiscal year 2017/2018 to 2021/2022), the sales-weighted average fuel consumption standard was set at 5.49 Lge/100 km (Indian Driving Cycle test). For phase 2 (FY 2022/2023 onward), the average fuel consumption standard is 4.77 Lge/100 km.

Given that average annual fuel consumption in FY 2017/2018 was 5.5 Lge/100 km, an annual improvement of 1.5% is need to meet the phase 2 targets, taking into account flexibility mechanisms. This annual improvement is less than India's 2.1% average annual improvement observed from FY 2006/2007 to FY 2017/2018.

CHINA

China's Phase V passenger car fuel consumption standards, published at the end of 2019, include a minimum weight-indexed fuel consumption rate per vehicle (ranging from 5.2 Lge/100 km to 11.9 Lge/100 km) and a fleetwide CAFC regulation. China's CAFC targets have been progressively tightened by 30-40% with each phase from its Phase III limit of 6.9 Lge/100 km for 2015 to 5 Lge/100 km for 2020 under Phase IV. As of July 2020, China has shifted from the NEDC test procedure to the more dynamic and realistic WLTC.[16]

The current Phase IV standards incentivise electrified powertrains by granting credits: 1.5 credits for ultra-low fuel consumption vehicles; and 2-5 credits for NEVs (New Energy Vehicles) - EVs, PHEVs, and FCEVs (see the IEA Global EV Outlook 2020 for more details on these credits). NEV mandates are based on NEV credits (and not on sales targets) and are expressed as a percentage of total passenger car sales. The target for 2020 is 12% NEV credits, with a 2% increase every year to 18% in 2023.

Phase V of China's CAFC targets 4.0 Lge/100 km by 2025 (NEDC test). This represents a 20% decrease from the 2020 target, or an average 4.4% annual improvement rate, which exceeds the global average improvement rate needed to reach the GFEI 2030 target. This level of annual improvement is higher than any realized by China since 2010, though only slightly higher than that observed from 2017 to 2018. In this next phase, both the targets and minimum fuel economy standards will be measured against the WLTC. Incentives for NEVs will also continue, albeit with modified coefficients[17], which will be reduced to 1 by 2025.

JAPAN

In 2019, Japan approved a rule to tighten its fuel economy standards for LDVs through 2030 and shifted from using the JC08 to the WLTC testing procedure. The new standards require corporate average fuel efficiency of 3.95 Lge/100 km (WLTC test) by 2030, which implies an improvement of about 32% from average consumption in 2016 – or 2.9% average annual improvement. The new standards measure vehicle efficiency on a well-to-wheel basis to enable vehicle performance comparisons across powertrains, including for EVs.[18]

SOUTH KOREA

Korea's fuel economy standards have been in place since 2006. The target of 4.15 Lge/100 km (EPA two-cycle test) by 2020 was recently updated to 3.56 Lge/100 km (EPA two-cycle test) by 2030, which implies an annual average improvement of 1.4%. Korea's Ministry of Energy recently announced an update of standards to 2030, with a target of 70 g/km for new light-duty vehicles sold in that year. Some amendments are still in development and their new target has not yet been added to the chart above.

ASEAN

There are not yet any mandatory fuel economy standards in ASEAN countries, though in 2019, the ASEAN worked with GFEI to develop a Fuel Economy Roadmap with detailed plan to reduce fuel consumption in ASEAN countries and support the establishment of mandatory fuel economy standards. In ASEAN countries, the sales-weighted fuel consumption of the LDV fleet was 7.3 Lge/100 km in 2015 (NEDC cycle). The ASEAN Fuel Economy Roadmap adopts an aspirational target of average fuel consumption of 5.4 Lge/100 km by 2025. This would require a 26% reduction in fuel consumption between 2016 and 2025, or an annual average improvement rate of 2.8% – a significant increase from historical improvements of 1.5% during 2005-2015.[19]

ECOWAS

15 West African countries working together in the Economic Community of West African States (ECOWAS) on 7 September 2020 jointly introduced a new harmonized fuel economy roadmap. This was prepared with the support of the GFEI partners and proposes to go down to 5 litres per gasoline equivalent (Lge) per 100 km by 2025, and 4.2Lge/100km by 2030 (in line with the global GFEI targets). Countries will now collect data to establish detailed baselines, develop labeling, outreach and awareness campaigns, and regulatory frameworks, fiscal policies and standards. ECOWAS countries will also introduce policies to promote the import of used electric vehicles (including electric motorcycles).

BOX 2:

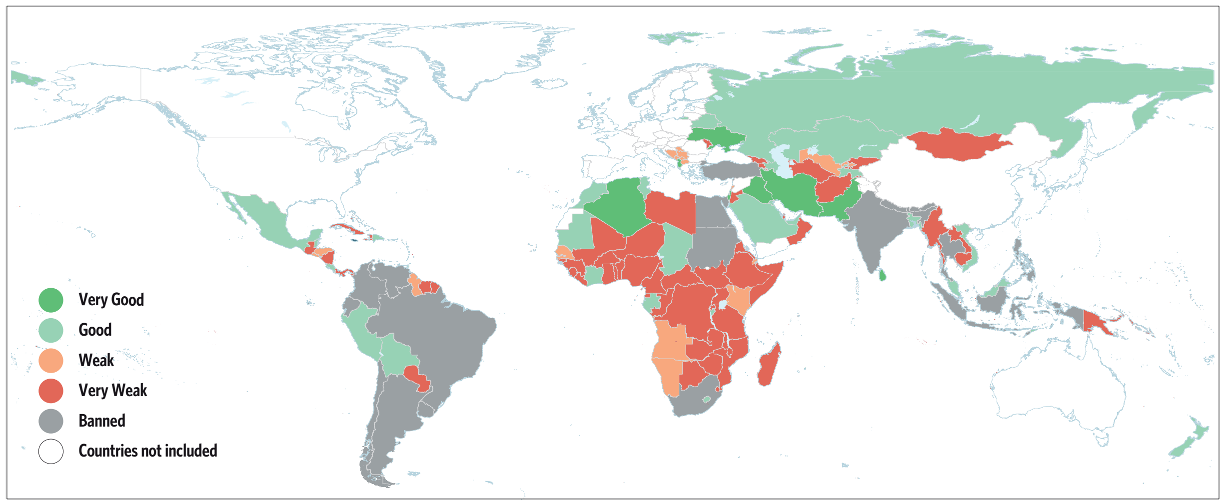
UNEP: USED VEHICLES AND THE ENVIRONMENT GLOBAL OVERVIEW OF USED LIGHT VEHICLES - FLOW, SCALE AND REGULATION

UNEP's landmark report[20], released in November 2020, covers the trade in used vehicles around the world. The analysis supports GFEI's work to improve the fuel economy of road vehicles across all energy types, including internal combustion engines, hybrids engines, and electric vehicles. Key concerns include pollutant and climate emissions of used vehicles; the quality and safety of used vehicles; energy consumption; and the costs to operate used vehicles.

One of the main findings of the report is that despite the critical role used vehicles play there are currently no regional or global agreements on the trade and flow in used vehicles. Of the 146 countries studied, about two-thirds have "weak" or "very weak" policies regulating the import of used vehicles (see figure below). Regulations can take many forms from complete import bans to age restrictions, fiscal incentives, labelling and awareness requirements. The analyses show there is little harmonization between countries. Most developing countries have limited or no regulations on governing the quality and safety of imported used vehicles and rules which do exist are often poorly enforced.

The report concludes that more research is needed to detail further the impacts of the trade in used vehicles, including that of heavy-duty used vehicles. Exporting and importing countries have a shared responsibility to improve and regulate used vehicles to minimize their negative impacts and enable a shift towards shifting to cleaner, safer, and affordable mobility. The report recommends harmonised global or regional regulations and a strong implementation and enforcement mechanism to check compliance. Regulations should be gradually tightened in the coming decade and used low and no emissions vehicles should be promoted as an affordable way for middle- and low-income countries to access advanced technologies.

FIGURE 8: UNEP assessment of current regulatory regime for importing used light-duty vehicles (July 2020)



Source: UNEP (2020) Used Vehicles and the Environment: A Global Overview of Used Light Vehicles - Flow, Scale and Regulation

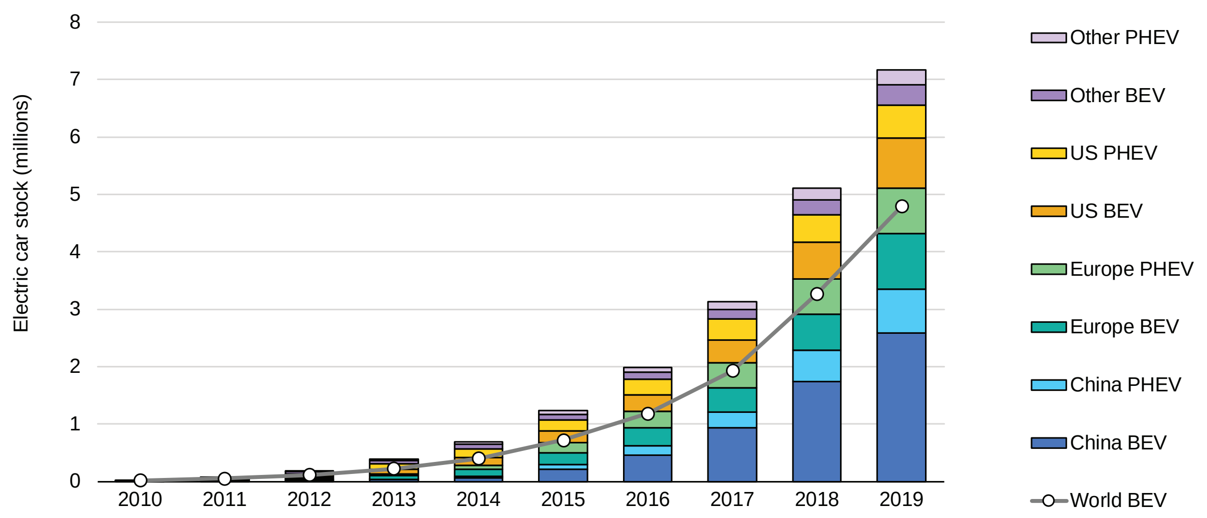
THE GLOBAL TRANSITION TO EVs

Electric vehicles, including pure battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEVs), are key technologies to reduce both air pollution and CO_2 emissions, as well as supporting energy diversification for the transport sector. These objectives are major drivers behind countries' policy support in the development and deployment of electric powertrains for transport.

The IEA Global Electric Vehicle Outlook (GEVO) 2020[21] provides a comprehensive review of electric vehicle trends and prospects. It shows that EVs have experienced tremendous sales growth around the world over the past 10 years. By the end of 2019, electric vehicles had been deployed in over 100 countries. Cumulative passenger electric vehicle sales surpassed 7 million in 2019, roughly twice as fast as it took conventional hybrids to do so, despite having greater cost and infrastructure barriers to overcome.

Annual sales of electric cars topped 2.1 million globally in 2019, surpassing 2018 and accounting for 2.6% of global car sales in 2019. This brought the total number of electric cars in circulation globally by the end of 2019 to 7.2 million, up from just 17,000 in 2010. The global electric car stock is mostly concentrated in China, Europe and the US (see Figure 9). Moreover, 350 million electric two/three-wheelers are in circulation globally, making up one quarter of all two/three-wheelers worldwide. In comparison, the global fleet of electric trucks totaled about 380,000 light commercial vehicles and 22,000 medium- and heavy-duty trucks in 2019. The vast majority of electric vehicles other than light-duty vehicles, including half a million electric buses, are located in China.

FIGURE 9: Global electric car stock, 2010 - 2019



Source: IEA Global EV Outlook 2020

Key Points: Electric cars, which expanded by an annual average of 60% in the 2014 - 2019 period, totalled 7.2 million in 2019.

As the infrastructure for electric vehicle charging continues to expand, most charging is done at home and work. In 2019, an estimated 90% of the 7.3 million chargers worldwide were private, light-duty vehicle slow chargers[22] (Figure 10), located in homes, multi-dwelling buildings and workplaces. Convenience, cost-effectiveness and a variety of support policies (such as preferential rates, equipment purchase incentives, and rebates) are the main drivers for the prevalence of private charging.

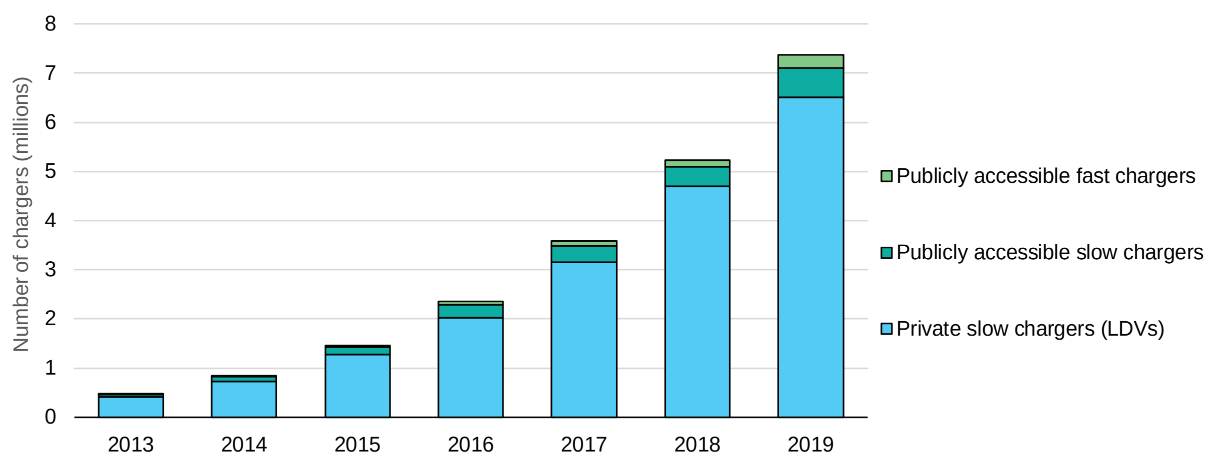
For the first time a decrease in government spending for electric car purchase incentives was observed in 2019, while both consumer spending and total expenditure on electric cars continued to increase. At the national level, both China and the United States witnessed substantial purchase subsidies reductions or partial phase out in 2019. In China the central government extended its subsidy scheme through to 2022. Other countries extended or implemented new purchase incentives schemes in 2019 or early 2020, for example, Germany and Italy.

A variety of regulatory and fiscal measures are likely to gradually replace subsidies as the main driver of electric vehicle deployment. Many regulatory policies compel vehicle makers to sell a greater number or share of electric or otherwise more efficient vehicles. The European Union approved a new fuel economy standard for cars and vans for

2021-30 and a CO_2 emissions standard for heavy-duty vehicles (2020-30).

In 2019, China announced a tightening of its New Energy Vehicle mandate scheme. California extended its zero-emission vehicle (ZEV) policy to require trucks and buses of all kinds to be a rising percentage of sales through 2035 (see also Box 10 on page 37).

FIGURE 10: Global stock of electric LDV chargers, 2013 - 2019



Source: IEA Global EV Outlook 2020

Key Points: LDV chargers topped 7 million in 2019 and the vast majority are private chargers.

BOX 3:

EVs IN FLEETS

Electric vehicles are a natural fit for vehicle fleets that travel relatively high mileage over a year, since their per-mile running costs are typically well below those of ICE vehicles. These include commercial car and truck fleets in general and especially vehicles used in on-demand mobility systems such as Uber, Didi, Ola, etc. Here EVs can provide large cost savings given intensive driving, as assessed by Leaseplan 2019.[23]

While the "total cost of ownership" (TCO) is already better for EVs than for ICE vehicles in many distance-oriented applications, the purchase price of the EVs remains higher in most cases, and there are non-cost tradeoffs like driving range and refueling/recharge time. So it is not a given that fleets will move in the direction of electric vehicles even if they will ultimately save costs. Thus even for high mileage fleets, some incentives may be needed to bring about a massive shift in use.

In California, an innovative approach is being undertaken: the "Clean Miles Standard". This will require on-demand mobility fleets (or Transportation Network Companies, TNCs) to adopt an increasing share of electric vehicles in their fleets (despite not owning most of these vehicles) in the coming years.

Key features include:

- The California Air Resources Board established a baseline for emissions of GHGs for vehicles used in transportation network companies on a per-passenger-mile basis using 2018 as the base year.
- GHG reduction targets are to be set by ARB beginning in 2023, and must be technically and economically feasible. The reduction targets must reflect vehicle miles traveled on zero emission vs conventional ICE vehicle modes.
- By January 1, 2022, and every two years thereafter, each TNC shall develop a GHG emission reduction plan.

This approach appears to have great promise to rapidly accelerate electric vehicle adoption by TNCs, in the context of one of the most important market niches for these vehicles, and where they can have among the biggest GHG impacts given the high mileage conditions they will serve.

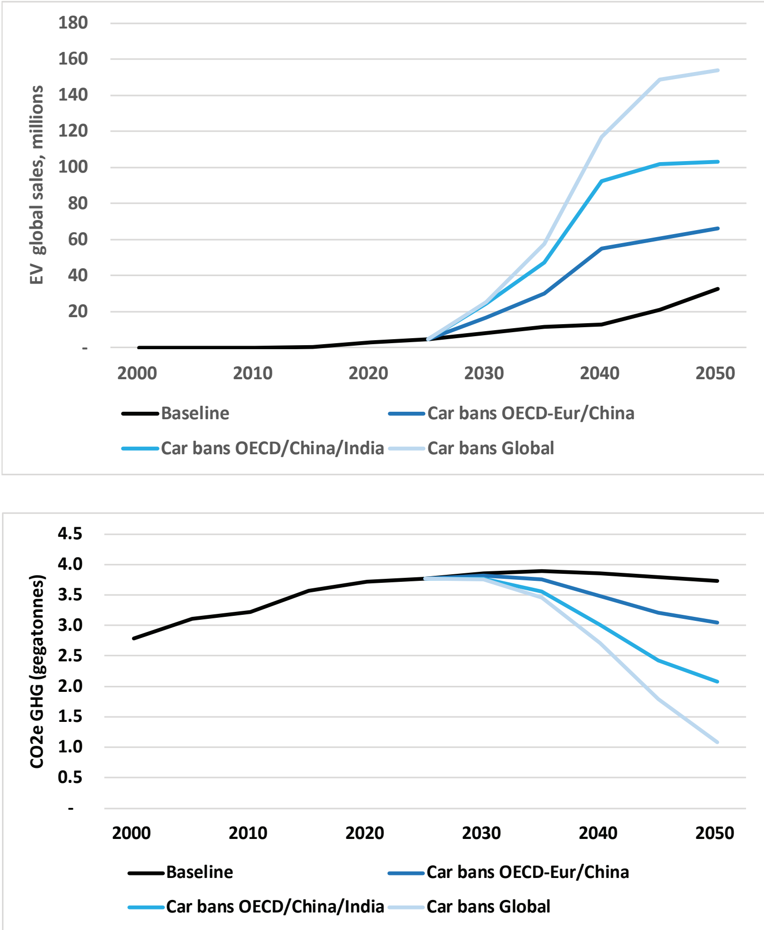
BOX 4:

EV TARGETS AND ICE BANS

To date, 17 countries have announced 100% zero-emission vehicle sales targets or the phase-out of internal combustion engine vehicles by 2050.[24] Many countries have set bans for 2040 or sooner, with the earliest known ban targeted for 2025 by Norway. The complete ban of ICE vehicle sales suggest that all sales will instead be electric drive (BEV, PHEV or FCEV). But ICE bans without complementary policies promoting electric vehicles may not result in a smooth transition. Policies to discourage ICE purchases and encourage EV purchases must begin well before (e.g. 10-15 years) the target full ban date such as shown in Figure 11.[25] The clearest pathway to do this is through promoting sales of electric vehicles.

Policy actions for electric vehicles depend on the status of the electric vehicle market or technology (from vehicle and charger standards and public procurement schemes, tax rates that reflect tailpipe CO_2 emissions, fiscal incentives and low/zero emission zones in urban areas, and implementing regulatory action (e.g. via stringent fuel economy standards or vehicle mandates) once the technology and an early commercial market are proven. Additionally, provisions in building codes to encourage charging facilities and the "EV-readiness" of buildings are becoming more common and are essential to support the deployment of charging infrastructure at pace.

FIGURE 11: ICE bans/EV sales ramp-ups, four scenarios. A global ban by 2040 could cut CO_2 from LDVs worldwide by 90%.



Source: Fulton, L. M, Jaffe, A., & McDonald, Z. (2019)[26]

BOX 5:

GOVERNMENT RESPONSES TO COVID-19 WILL LIKELY INFLUENCE THE PACE OF THE TRANSITION TO ELECTRIC VEHICLES

The COVID-19 pandemic is affecting global automotive markets, although electric vehicle markets seem to be less impacted than the overall passenger car market. Our current estimate is that the passenger car market will contract by 15% over the year relative to 2019, while electric sales for passenger and commercial light-duty vehicles will match or even slightly exceed 2019's total to reach more than 2.3 million. Second waves of the pandemic and slower-than-expected economic recovery could lead to different outcomes.

As part of economic recovery efforts from the COVID-19 crisis, a focus on promoting clean transport is being called for at national and local levels. Targeted measures to support low and zero-emission vehicles will be required to ensure that the electrification of road transport remains on track. In China, policy makers identified the auto market as a primary target for economic stimulus. The central government encouraged cities to relax car permit quotas (temporarily), but also strengthened targeted New Energy Vehicle measures. In the European Union, existing policies and regulations are being maintained and countries like France and Germany announced increased financial support measures towards electric vehicles for the remainder of 2020.

Support for the auto industry can be tied to ambitious fuel economy regulations, which in the past triggered innovation and helped jumpstart key parts of today's electric car industry. In theory, vehicle scrappage schemes can reduce the potential for households to delay new car purchases and instead continue to rely on old vehicles that have higher pollutant and CO_2 emissions. But while vehicle scrappage schemes are undeniably beneficial for car buyers and car makers, merely making cars more affordable could boost the overall number of cars on the road. Therefore, unless programmes are carefully crafted to support the uptake of more efficient (e.g. hybrid) and electric vehicles, their climate benefits are not clear-cut and they may even prompt net increases in CO_2 emissions.

Conditional automaker bailouts linked with subsidies for electric and hybrid vehicles (France), exclusively for electric cars (Germany), or with vehicles' environmental performance (Italy) can help stem the immediate impacts of the crisis while encouraging manufacturers to manage the transition to electromobility.

Source: IEA Global EV Outlook 2020

PROSPECTS FOR ELECTRIFICATION IN TRANSPORT IN THE COMING DECADE

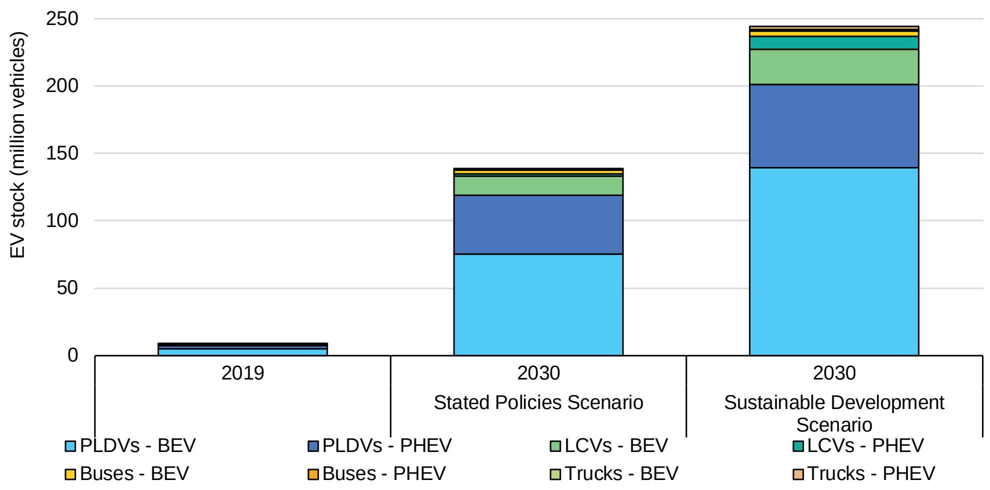
Given the critical role that EVs are expected to play in the decarbonization of the transport sector, their sales must continue to grow exponentially in the coming decade. In the Sustainable Development Scenario of the IEA's GEVO 2020 report, the global electric vehicle stock (excluding two/three-wheelers) reaches 245 million vehicles in 2030 – more than 30 times above 2019 levels. This is consistent with the sales growth needed to meet the new GFEI targets and with the climate goals of the Paris Agreement.

As shown in Figure 12 (which includes cars, trucks and buses but not two/three-wheelers), growth in the scenario is fastest for the light-duty vehicle segment where electric powertrain technologies are most readily available. Electric two/three-wheelers will continue to represent the lion's share of the total electric vehicle fleet as this category is most suited to rapid transition to electric drive. The future electric two/three-wheeler fleet is concentrated in China, India and the ten countries of ASEAN. The electrification of buses and medium- and heavy-duty trucks occurs mainly in urban areas due to their shorter ranges and driving cycles suitable for electrification.

This scenario is linked to rapid deployment of slow and fast charging infrastructure. It is projected that the breakdown of charger types will be similar to current market conditions, with the majority of chargers to remain private slow chargers (see Figure 13). As shown in Figure 14, the growth in chargers consistent with the growth in EVs is dramatic, on the order of 35-fold between 2019 and 2030 for private chargers (6.5 to 240 million), and 25-fold for public chargers (0.9 to 21 million, of which 1.2 million fast chargers).

The use of these chargers also results in substantial electricity demand growth for transport, the CO_2 emissions impacts of which are mitigated by decarbonising grids; by 2030, EVs will be responsible for just one-third of the well-to-wheel emissions than would have occurred from an equivalent fleet of internal combustion engine vehicles, in the Sustainable Development Scenario.[27]

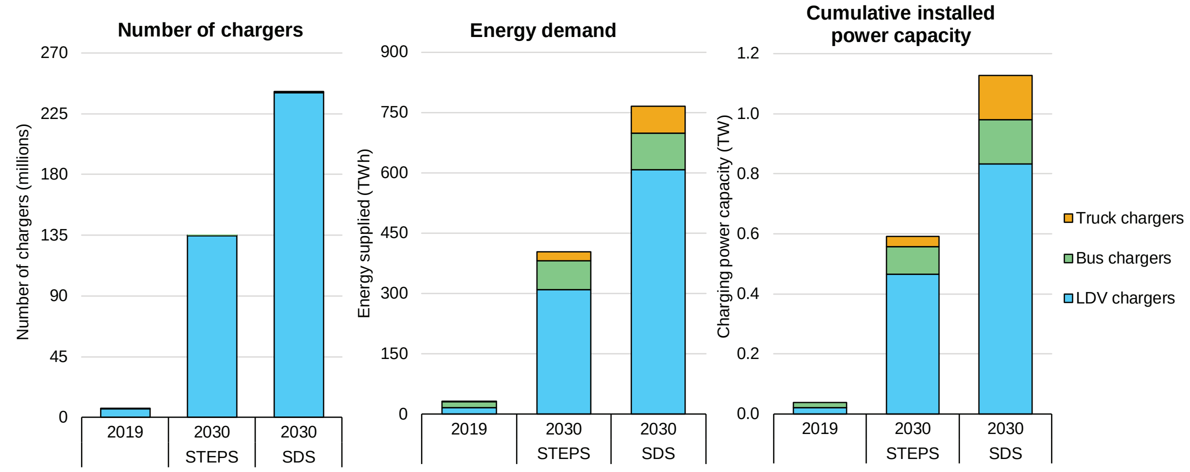
FIGURE 12: Global electric vehicle stock by scenario, 2019 and 2030



Source: IEA Global EV Outlook 2020

Key Points: PLDVs = passenger light duty vehicles; LCVs = light commercial vehicles; BEV = battery electric vehicle; PHEV = plug-in hybrid electric vehicle.

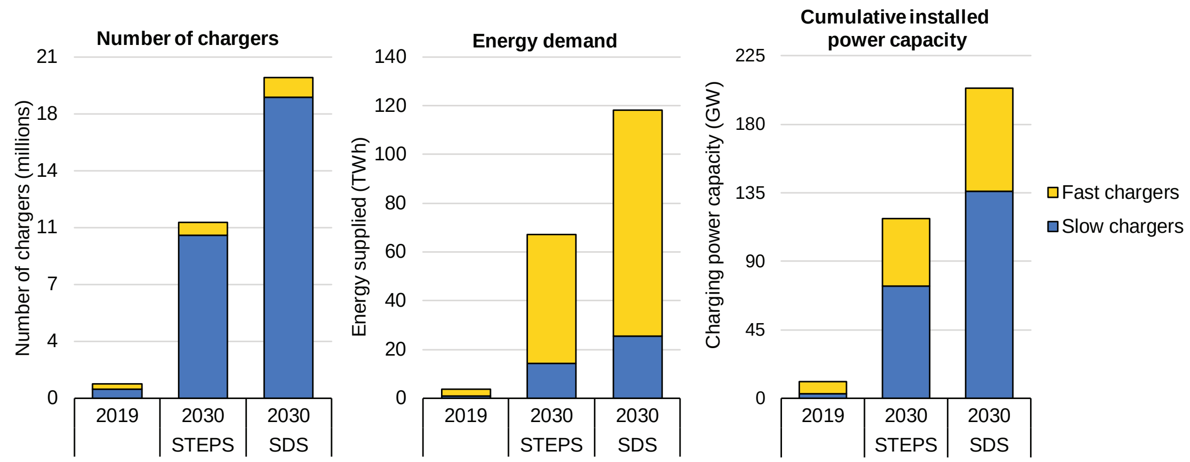
FIGURE 13: Global number of private chargers, associated energy demand and cumulative installed charging power capacity in 2019 and by scenario in 2030.



THE NUMBER OF PRIVATE CHARGERS, THEIR ENERGY DEMAND AND THE NEEDED CUMULATIVE INSTALLED CAPACITY NEAR DOUBLES IN 2030 IN THE SUSTAINABLE DEVELOPMENT SCENARIO RELATIVE TO THE STATED POLICIES OUTLOOK.

Source: IEA Global EV Outlook 2020

FIGURE 14: Number of publicly accessible LDV chargers, associated energy demand and cumulative installed charging power capacity in 2019 and by scenario in 2030.



The number of publicly accessible chargers in 2030 is 11 million in the Stated Policies Scenario and almost twice that in the Sustainable Development Scenario. Fast chargers represent 8% of the total installations yet consume 80% of total energy in both scenarios.

Source: IEA Global EV Outlook 2020

Key Points: STEPS = stated policies scenario; SDS = sustainable development scenario.

BOX 6:

REAL-WORLD EMISSIONS

ICCT's *From Laboratory to Road studies*[28] have explored real-world fuel economy by monitoring actual fuel consumption of vehicles. The latest study[29], published in January 2019, found that the average gap between official fuel consumption figures and actual fuel use for new cars in the EU had slightly decreased, to a level of 39 per cent in 2017, compared with 40 per cent a year earlier – but more than double a decade earlier (16% in 2007).

Increased scrutiny on the real-world performance of vehicles may have acted as a deterrent to further test optimization. The decline in diesel shares of new car registrations also plays a role in the stabilization of the gap, as diesel vehicles tend to exhibit a higher gap than their gasoline counterparts.

THE TRUE EMISSIONS INITIATIVE

The Real Urban Emissions (TRUE) initiative was set up to measure the real-world emissions of vehicles in city streets. By June 2020, the TRUE initiative had celebrated two years of testing real-world emissions in cities, and the TRUE database now includes over 1 million vehicles. Testing has taken place in Paris and London, as well as a number of other cities, most recently in Poland.

The testing focuses on pollutant emissions, particularly particulate matter (PM) and nitrogen oxides (NOx). The TRUE rating is based on NOx emissions, as this was the key issue in the 'dieselgate' scandal, with ICCT research showing around 11,400 people die early each year in Europe as a result of 'excess' diesel NOx emissions. The testing has helped inform the design of London's Ultra-Low Emissions Zone (ULEZ) and T-Charge, and directly influenced policies to accelerate the transition to fully electric taxis.

www.trueinitiative.org

BOX 7:

PHEVs ELECTRIFY MANY TRIPS, BUT CURRENTLY EMIT ON AVERAGE 2-4 TIMES MORE CO_2 THAN ADVERTISED

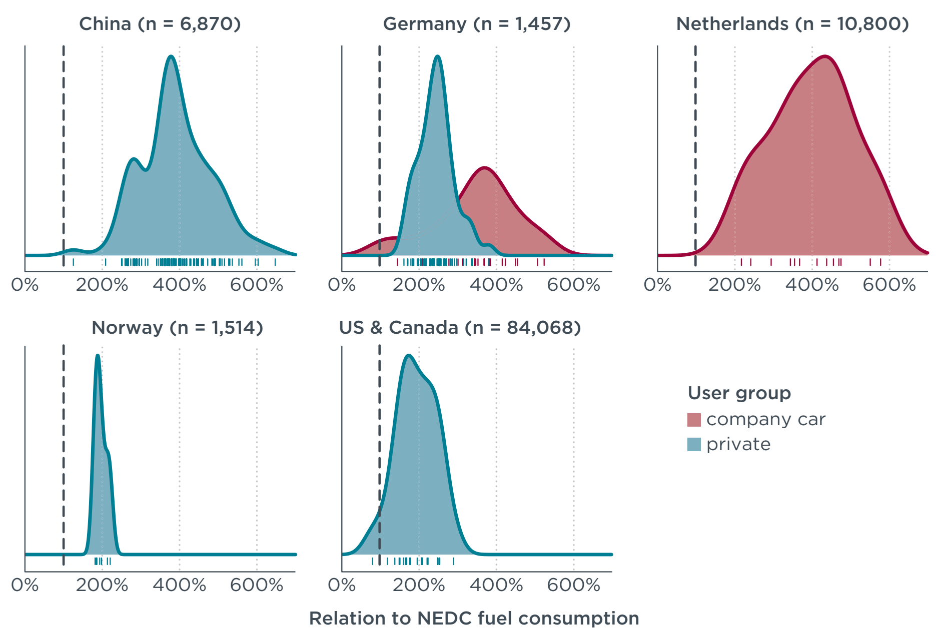
Plug-in hybrid electric vehicles (PHEVs), which combine an electric and a conventional combustion engine drive train, offer the potential to reduce global greenhouse gas (GHG) emissions and local air pollution if they drive mainly on electricity. However, there is limited evidence on how much driving PHEVs actually do on electricity and how much conventional fuel they use in real-world operation ICCT undertook analysis[30] of real-world usage and fuel consumption of approximately 100,000 PHEVs in China, Europe, and North America, and found:

PHEV fuel consumption and tail-pipe CO_2 emissions in real-world driving, on average, are approximately two to four times higher than type-approval values. Real-world values are two to four times higher for private cars and three to four times higher for company cars.

The real-world share of electric driving for PHEVs, on average, is about half the share considered in the type-approval values. For private cars, the average utility factor (UF)—the portion of kilometers driven on electric motor versus kilometers driven on combustion engine—is 69% for NEDC type approval but only around 37% for real-world driving. For company cars, an average UF of 63% for NEDC and approximately 20% for real-world driving was found.

There are noteworthy differences between markets, with the highest real-world UF found for Norway at 53% for private vehicles and the United States at 54% for private vehicles. The lowest UFs were for China at 26% for private vehicles, Germany with 18% for company cars and 43% for private vehicles, and the Netherlands with 24% for company cars.

FIGURE 15: Distribution of real-world fuel consumption in relation to NEDC test cycle



Source: ICCT (2020) Real-world usage of plug-in hybrid electric vehicles: Fuel consumption, electric driving, and CO_2 emissions[31]

PHEVs are not charged every day. Private users in Germany charge their PHEVs an average of three out of four driving days. For company cars, charging takes place only about every second driving day. The low charging frequency clearly reduces the share of kilometers driven on electricity. The very low UF for PHEVs in China also indicates low charging frequency, whereas PHEVs in Norway and the United States appear to be charged more often than in Germany or China.

PHEVs electrify many kilometers per year. Most PHEVs have type-approval all-electric ranges of 30–60 km and electrify 5,000–10,000 km a year. PHEVs with high all-electric ranges of 80 km or more achieve 12,000–20,000 km mean annual electric mileages, which is comparable to the annual mileage of the car fleet in Germany and the United States. The high annual electric kilometers reflect high annual mileages of PHEVs despite low UFs. The share of kilometers that PHEVs electrify results in a total of 15%–55% less tailpipe CO_2 emissions compared to conventional cars. This is much lower than expected from type-approval values.

Decreasing combustion engine power while increasing all-electric range and frequency of charging improve real-world fuel consumption and CO_2 emissions of PHEVs. Real-world fuel consumption and CO_2 emission levels decrease by 2%–4% with each 10 kW of system power taken out of a PHEV. At the same time, adding 10 km of all-electric range improves real-world values by 8%–14%.

RECOMMENDATIONS

At the **European Union level**, the CO_2 emission threshold for super credits should be lowered, or the qualification of a specific PHEV model should be demonstrated by using real-world usage data.

At **the national level**, fiscal and other incentives should prefer PHEVs with a high all-electric range and a high ratio of electric motor power to combustion engine power. Whenever possible, incentives should be tied to demonstrating the proper real-world performance of the vehicles, for example by using UF data collected from on-board fuel consumption meters or during regular technical inspections. Furthermore, the legal and financial barriers for the installation of home charging points should be reduced.

Vehicle manufacturers should increase the all-electric range of their PHEVs from an average of about 50 km today to a level of about 90 km in future years. This would be sufficient to cover the full daily distance electrically on about 85% of driving days or approximately 70% of total distances driven by German private car owners if charged every day. Some PHEV models on the market today provide an all-electric range of this order and show mean UFs greater than 50%.

Fleet managers should carefully assess which of their company car users' driving and usage behaviour is appropriate for PHEVs. They should incentivize frequent charging of PHEVs, for example by allowing unlimited charging while limiting the budget for gasoline or diesel on a fuel card provided by the company.

EV POLICIES AND PLANS AROUND THE WORLD

Governments at all levels have leveraged a variety of policy tools to overcome EV barriers and stimulate the market. The policy measures include regulations encouraging automakers to expand their EV model offer, financial incentives to make EVs purchase cost competitive with other options, charging infrastructure to ensure EVs are convenient, and campaigns to increase consumer awareness. The highest EV-uptake markets have all such actions in place, and they also tend to learn from international cooperation platforms to accelerate their transition to electric vehicles. Although regulation at the EU-level has been set in place until 2030, European governments have by and large not converted their 100% zero-emission goals to enforceable laws. The other top markets of China and the United States have several pioneering local markets, but otherwise are due for updated policies to ensure they are on paths toward a full transition to zero-emissions.[32] Recent actions in a range of countries are reviewed below.

UNITED STATES

In the US, the Trump administration continues its effort to deregulate the US automotive industry and move the US away from its global leadership on vehicle regulations. Most notably, by finalizing in April 2020, its move to roll back CAFE standards which were aimed at dramatically improving car efficiency over the next 5 years. That being said, there are other positive developments regarding the transition to electrification in the U.S. mostly being led by progressive states and cities.

However, in July of 2020, the U.S. House Select Committee on the Climate Crisis majority staff released its report, "Solving the Climate Crisis," an extensive action plan to tackle climate change, promote environmental justice, and spur infrastructure investment. Transportation, the largest source of domestic greenhouse gas (GHG) emissions, is a focal point of the report, which includes policy proposals to drive GHG reductions through efficiency improvements, new infrastructure, and renewable energy deployment. The committee report includes a goal of 100% zero emissions car sales by 2035. Though unlikely to be acted upon by this administration, it may provide a sign of future policy making under a new administration in 2020.

BOX 8:

CARMAKERS' RACE TO MEET EU TARGETS

T&E's new report points out the big year that electric vehicles are having in Europe, but also sounds out caution and the need for stronger regulations going forward. As T&E notes:

Driven by the entry into force of EU 2020/21 car CO_2 emission standards and proof of their success, the sales of electric cars (battery electric, BEV and plug-in hybrid electric, PHEV) boomed in the first half of the year, reaching a market share of 8% (European Economic Area, EEA). This is more than triple the H1 2019 share as EV sales reach new heights with Volvo at 23%, BMW at 13%, Hyundai-Kia at 11% and Renault at 8%. Sales kept rising since January, so before and despite COVID-19, weathering the pandemic better than diesel or petrol cars. Post-COVID purchase incentives in Germany, France and other countries kicked in mid-summer, and are undoubtedly continuing the e-mobility momentum with recent reports of EV sales surpassing 10% in Germany and France.

However, the report notes that there is a real danger that they supply of electric cars will stagnate through the 2020s, despite surging market demand. The project a 33% increase rather than a 4-fold increase that is possible, due to the existing regulatory structure. They call for the EU to set revised CO_2 standards with more ambitious annual targets from 2025 onwards in order to increase pressure to produce electric vehicles, and achieve 100% zero emission vehicle sales in 2035.[33]

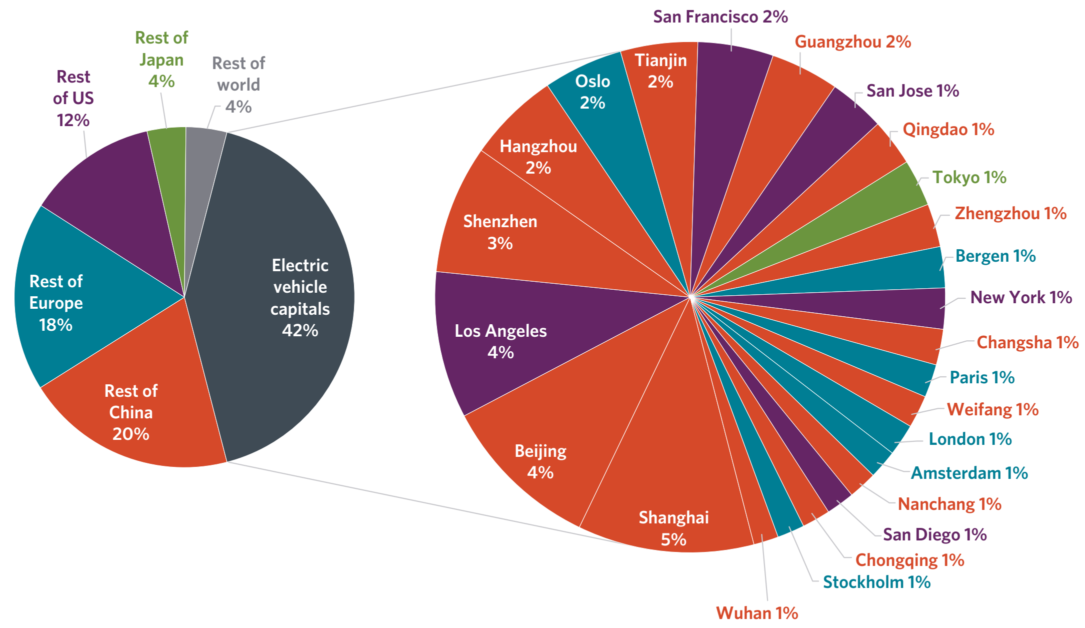
BOX 9:

ELECTRIC VEHICLE CAPITALS

ICCT's briefing paper[34] analyzes the contribution of major cities to the global electric vehicle market and the factors behind the success of these cities. It provides an update on the 25 largest electric passenger vehicle markets worldwide, which together represent 40% of global cumulative electric vehicle sales. Of these 25 markets, 14 are in China, 6 are in Europe, 4 are in the United States, and 1 is in Japan.

Of the 25 electric vehicle capitals, 17 have established 100% electric bus targets. Ten of the 25 cities, all in Europe or the United States, have 100% electric vehicle goals for passenger vehicles. Thirteen cities in China have low-emission zones, which could be progressively strengthened and pave the way for zero-emission areas. In addition, four of the global electric capitals also have building codes that require 100% of spaces within specified building types be electric vehicle-ready. Many cities also have policies to convert municipal, taxi, and ride-hailing fleets to all-electric. Setting all-electric goals is a critical first step for cities to set follow-on action plans, policies, and city agency responsibilities.

FIGURE 16: Global electric vehicles in 25 electric vehicle capitals as a share of the global electric vehicle stock



Source: ICCT (2020) Electric vehicle capitals: Cities aim for all-electric mobility[35]

CHINA

China is the world's largest vehicle market for electric vehicle (EV) production and sales, as well as EV batteries. China is also the largest market for LDVs for most global OEMs. This means that these OEMs will be making vehicles for their largest market, and based on economies of scale, will want to use these technologies for the rest of the world. China's market also drives up sales and lower cost of EVs and batteries in the same way that happened with solar cells.

China's central government and its major cities have shown themselves capable of developing and implementing world-class policies – sometimes borrowing from other countries, sometimes with their own strategies. Over the past five years, the country has promoted vehicle electrification using a combination of policy tools including purchase subsides, sales mandates modeled after the California Zero Emission Vehicle regulation, and novel local measures such as giving registration priority and driving privileges to EVs.

The latest adjustment to China's central subsidy program for new energy vehicles (NEVs) was released on April 23, 2020 and will fully take effect on July 23, 2020, after a three-month transition period. Key aspects include:

- Although national subsidies were set to expire at the end of 2020, the update extends them for another two years, until the end of 2022. This stems from a desire to stimulate the automobile market amid the global downturn in the industry and the COVID-19 pandemic and intends to respond to weak pale NEV sales in the second half of 2019 as subsidies were being reduced.
- The adjustment for the first time introduces sales limits—subsidies will be limited to 2 million NEVs per year from 2020 to 2022. A vehicle price limit for passenger cars of CNY300,000 including tax is also introduced. Related to this, Tesla announced on April 30, 2020 that it would cut the pre-subsidy price of its standard-range Model 3 made in China from CNY355,800 to CNY291,800 to maintain eligibility.
- China also stopped providing subsidies for fuel cell electric vehicles (FCVs) on April 23, 2020. Instead, a new four-year pilot program focused on research and development and application demonstrations of FCVs is being launched in select cities.[36]

EUROPEAN UNION

In Europe, the deployment of EVs is largely driven by the combination of EU-wide vehicle CO_2 emission performance standards and in-country purchase incentives and other consumer-oriented policies. There are a number of policies in Europe being driven by the European Green Deal and COVID-19 recovery packages. As part of the Green Deal, the European Commission has been asked to come forward with a regulatory proposal for revising the 2025/30 CO_2 targets for LDVs and HDVs and potentially adding an ICE phase-out target for LDVs. A revised proposal for LDVs is expected in 2021 and for HDVs 2022.

FRANCE AND GERMANY

France and Germany have both updated their electric vehicle fiscal incentive programs during 2020. In June, the German government agreed to a €130 billion COVID-19 economic recovery package. A significant portion of that stimulus, about €8 billion, is earmarked for the automotive industry in Germany. After increasing, in early 2020, the government subsidy for BEVs to €3000, it doubled to €6,000 for vehicles under €40k, and from €2,500 to €5,000 for vehicles costing between €40k and €65k. For PHEVs the government subsidy doubled from €2,250 to €4,500 for vehicles costing up to €40k, and from €1,875 to €3,750 for vehicles between €40k and €65k. In addition, manufacturers remain obliged to pay an additional purchase premium of €2,500 to €3,000 for BEVs and €1,875-€2,250 for PHEVs.

In France, President Emmanuel Macron previously announced a similar €8 billion COVID-19 support package for the automotive industry in France. The purchase incentive for battery-electric vehicles (BEVs) increased from €6,000 to €7,000 for vehicles with a purchase price of up to €45k. Plug-in hybrid electric vehicles (PHEVs) will be newly eligible for a purchase premium of €2,000.

These recent decisions will have a significant impact on the competitiveness of BEVs, for example, the cost associated with buying a popular BEV, the VW e-Golf, in Germany, France, and Spain. The EV policies in place in key EU markets at the beginning of 2020, plus the additional support responding to the Covid-19 crisis, are having a significant impact on the competitiveness of BEVs and their adoption. The costs for the vehicle itself only vary slightly (about €32k to €34k) between the three countries when ignoring subsidies. When subsidies are included, however, net costs are remarkably different, ranging from €23k in Germany to €27k in France and €33k in Spain. This is because in Germany a customer would benefit from €6,000 of government support, plus an additional €3,000 purchase premium from the manufacturer. In France, the government support amounts to €7,000. In Spain, the adoption of a national purchase premium for electric vehicles, the 'Plan Moves II', is pending. In comparison with a conventional gasoline-powered VW Golf, the BEV version – as of today – economically looks highly attractive in Germany, somewhat attractive in France, and unattractive in Spain.[37]

BOX 10:

CALIFORNIA - A CASE STUDY

On June 25, 2020, the California Air Resources Board (CARB) adopted the final rule for new standards that require the sale of zero-emission heavy-duty trucks (HDTs), starting with the 2024 model year. The Advanced Clean Trucks (ACT) regulation is the first of its kind in the world to require manufacturers to sell increasing percentages of zero-emission trucks. The ACT rule ZEV sales requirements will begin with model year 2024, and define separate sales share targets for medium duty (Class 2b-3) trucks and vans, larger (Class 4-8) rigid trucks, and heavy duty (Class 7-8) tractor-trailer trucks. Purchase requirements for larger fleets are also being considered as a follow-on policy.

TABLE 3: California ACT rule ZEV sales share requirements by truck class and year

Year	Class 2b-3	Class 4-8	Tractor
2025	7%	11%	7%
2030	30%	50%	30%
2035	55%	75%	40%

Since California holds a sizeable share of the HDT market in the United States, this regulation will have implications far beyond the state's borders. The truck brands that represent the majority of sales in California sell in multiple regions around the world. As these companies look to disperse their research and development costs by introducing similar technology platforms across international markets, California's ACT regulation is expected to accelerate the deployment of zero-emission and near zero-emission HDTs globally. To learn more about electric trucks in other countries, see IEA Global EV Outlook 2020.[38]

INDIA

The Government of India already provides several incentives that improve the cost-competitiveness of EVs relative to conventional vehicles. The second phase of FAME (FAME-II) incentive program was announced in April 2019. About 90% of the funds under FAME-II are apportioned towards purchase incentives for two-wheelers, three-wheelers, commercial four-wheelers and buses. Remaining funds are allocated towards the creation of charging infrastructure and public awareness activities.

Additionally, there is the recent approval of the National Mission on Transformative Mobility and Energy Storage, which aims to localize the entire EV value chain. A phased manufacturing program for battery manufacturing at "giga-scale" is the highlight, and the goal is to have large-scale integrated cell manufacturing capacity in India by fiscal year 2021–22.

Several other policies have been declared in India towards improving cost-competitiveness of EVs, such as a preferential GST tax rate (5% vs 28% for conventional vehicles), tax breaks on EV loan interest, green loan programs for EVs, and reductions in insurance and registration costs.

While these all appear to reflect a policy environment that encourages electrification, the absence of certain policies—particularly sufficiently stringent fuel economy standards or even zero-emission vehicle mandates—leaves ambiguity about the rate at which the Indian government is envisioning this transition. Most major OEMs in India have not yet launched an EV model in either two wheeler or four wheeler segments.[39]

BOX 11:

TECHNOLOGICAL PROGRESS, IN PARTICULAR IN BATTERIES, CONTINUES TO IMPROVE EV PERFORMANCE AND DRIVE WIDER EV ADOPTION

As battery technologies improve and manufactured volumes increase, battery costs drop. Industry reports show that battery pack prices have decreased substantially, almost 10-fold, between 2010 and 2019. For the next decade, the Li-ion battery is likely to continue dominating the electric vehicle market, with cost- and performance-optimized chemistries. After 2030, a number of new battery technologies might be able to push the boundaries beyond the performance limits imposed by Li-ion battery technology in terms of cost, density and cycle life. However, not a single technology reaps all these benefits at the same time. In addition, deployment and scale-up of these new technologies will take time and compete with the more established Li-ion technology.

By 2030, battery electric vehicles are assumed to increase their average driving range considerably, which will markedly increase battery capacities and put pressure on the demand for raw materials. For the most widely used battery chemistries of today, it is expected that the material demand for minerals such as cobalt, lithium, manganese and nickel could increase several-fold by 2030.

BOX 12:

CONTINUOUS TECHNOLOGY IMPROVEMENTS AND BETTER CONSUMER AWARENESS AS ANSWERS TO EV BARRIERS AND MYTHS

EVs are not well-known to many consumers, and there are barriers to them becoming widespread in many countries. Some barriers are real, but some are "myths" that can be addressed through consumer awareness campaigns and other measures by policy-makers and stakeholders can help alleviate. At least four key barriers exist to the widespread adoption of EVs, although they are progressively being lifted, at least in the most advanced EV markets. These include:

- Lack of model availability (the numbers and types of electric vehicles are limited, selection is not great);
- Upfront cost (vehicle price),
- Charging convenience, and
- Consumer awareness.

For policy-makers, supporting the electrification of vehicle fleets, in particular public fleets, can serve as proof-of-concept and make EVs familiar in the daily landscape of consumers in nascent EV markets (in addition to other benefits, such as the deployment of charging infrastructure that may benefit all drivers).

There are many actions that governments can take to help overcome these barriers and grow the EV market, as outlined in our policy discussions in this document. However, when it comes to consumer awareness, it has been found that there are a number of prevalent myths surrounding EVs that are not generally true and that must be debunked if EVs are to become mainstream in most countries. The most prevalent myths are:

MYTHS	REALITY
Electric vehicles cannot travel far enough on a single charge, electric vehicles take too long to charge to be practical for daily use.	Research shows that EVs serve the vast majority of households and commercial purposes quite well.
There are not enough public charging stations to ensure that EV drivers will not become stranded.	Most EV owners charge mainly at home or work, and most of the successful EV markets have implemented large numbers of public chargers.
EVs are no better for the climate than conventional internal combustion engine vehicles.	Not true in most countries today, and even where electricity carbon intensities are high, such as India and China, the expected carbon intensity of electricity will fall dramatically over the coming decade.
EVs are too expensive for average households.	Though more expensive to buy compared to similar ICE vehicles, they save money on fuel and maintenance, making their "total cost of ownership" competitive today. And costs are dropping.

GFEI is working to develop more accessible materials (such as explainer videos and other social media ready content) directly aimed at consumers to debunk these (and other) EV myths.

GFEI SUPPORT TO POLICYMAKING

The Global Fuel Economy Initiative has offered consistent support to governments and policy makers around the world for more than a decade. During this time, policies for cleaner, more efficient vehicles have been adopted in every continent, and many regions are now taking a coordinated regional approach. GFEI's bold targets have helped raise ambition among policy makers, and global advocacy has kept the issue prominent in several global policy processes, including the Sustainable Development Goals, G20 and Sustainable Energy and Mobility for All.

GFEI partners provide in-depth support and capacity building to enable countries to develop and implement appropriate policies to cut emissions from vehicles. This includes in-country training and support for policymakers, regional and global networks, and an online repository of tools and case studies - the GFEI toolkit.[40] Before implementing any policy, it is vital that countries understand the current situation and trends by putting together a 'baseline' analysis of current average fuel economy of vehicles based on vehicle registration data. Gathering this data and establishing this information is a key first step that enables assessments to be made of the impact of potential policies.

The GFEI partners work together to share materials and combine expertise. GFEI's capacity building and training in the most developed and emerging economies is principally led by ICCT, IEA and ITF, whereas UNEP are leading and coordinating extensive support to over fifty low- and middle-income countries. Funding for these projects has come from a range of sources, but the largest amounts have come from the European Commission, FIA Foundation and the Global Environment Facility (GEF), as well as the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (CCAC) and Hewlett Foundation and others.

GLOBAL INFLUENCE AND TECHNICAL SUPPORT

Over the past decade, GFEI has ensured that improving vehicle efficiency and the rapid transition to electric vehicles is centre-stage in a number of key global policy processes:

Climate Change

GFEI has been influential at the United Nations Framework Convention on Climate Change (UNFCCC) conference of parties (COP). GFEI was recognized as a key part of the action agenda of the COP21 Paris Agreement in 2015, and is working with a number of countries to ensure that transport is included as part of their Nationally Declared Contributions (NDCs) to reduce emissions.

At **COP25 in Madrid** in 2019, Sheila Watson Deputy Director of the FIA Foundation, spoke on the panel 'Decarbonizing transport: Promoting E-Mobility in Developing Countries', which highlighted the new GEF Global E-Mobility Program, which was launched at the event. GFEI has also been engaging extensively in preparations for COP26, particularly around the electric vehicles taskforce.

G20

GFEI provides support to the G20's Transport Task Group (TTG), which serves as a voluntary platform for G20 countries to share experience and work together to improve the energy and environmental performance of motor vehicles, especially heavy-duty vehicles (HDVs). The second in-person TTG meeting was held from 28-31 October 2019 in Tokyo, Japan, following the initial meeting in Argentina in 2018. Attendees included representatives from eleven G20 countries, five additional countries in the region, and ten intergovernmental organisations. The ICCT provided an update on technical activities in India, Argentina, and South Africa, which included a proof-of-concept modelling in India, HDV aerodynamic drag determination tests and on-road fuel consumption measurement in Argentina, and an analysis of policy pathways for cleaner fuels and vehicles in South Africa.

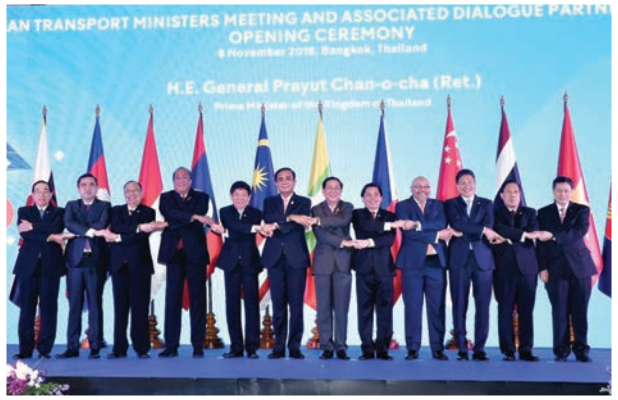
SEforALL

GFEI has also been recognized by Sustainable Energy for All (SEforALL) as a key accelerator intervention as part of its 3% energy efficiency initiative which supports action to drastically reduce CO_2 emissions. SEforALL aims to double the share of renewable energy in the global energy mix, and double the global rate of improvement in energy efficiency. This is a key target of Sustainable Development Goal target 7.3 on doubling energy efficiency by 2030, and GFEI continues to emphasize the need for equitable access to safe, clean and sustainable transport globally.

IN-COUNTRY SUPPORT AND REGIONAL COLLABORATION

The GFEI partnership started offering in-country support to countries in 2009, with 'pilot' support in four countries – Chile, Ethiopia, Indonesia and Kenya. Over the past decade this has expanded rapidly across Africa, Latin America, the Middle East and West Asia, and Asia Pacific regions. As the number of countries developing fuel economy policies in each region has increased, there is increasingly a new role to help establish common regional approaches through dialogue and the establishment of regional roadmaps. The country experiences of GFEI national country projects provide a strong regional context for a coordinated approach so other countries can leapfrog to the most effective approaches.

Regional support



GFEI is now working with ASEAN in South-East Asia, ECOWAS in West Africa, and Latin American and Caribbean states to develop and implement regional fuel economy 'roadmaps'. The ASEAN region was the first to establish a roadmap, launched in November 2018, which sets out priorities over 7 years to 2025 including aims to adopt national fuel economy standards for cars, with the objective of moving towards a regional standard in the long term, and new vehicle labeling schemes.

In February 2020, ECOWAS countries in **West Africa** adopted the first African fuel economy roadmap at a meeting in Burkina Faso. 11 of the 16 ECOWAS countries have received GFEI support to develop a baseline. The roadmap requires countries to develop a regionally harmonised framework for vehicle data and labeling. At the same time countries are required to introduce fiscal incentives to promote cleaner vehicles including electric mobility. Countries also agreed to consider the impact of dieselization of the regional fleet in their regulation as well as better communication and awareness-raising on fuel saving policies.

In October 2019, UNEP held a meeting in the Dominican Republic with Ministers of Energy and Ministers of Environment of **Central America and the Caribbean** through the Energy Coordination Unit of the Central America Integration System – SICA and the Central America Commission of Environment and Development (CCAD). The project aims to update and develop regional harmonized vehicle emission standards, fuel quality, and energy efficiency policies, with action plans and roadmaps to move to cleaner and more efficient fuels and vehicles for the countries under the Central America Integration System.

A two-day regional **Latin American** event was held in Lima, Peru in May 2019, hosted by UNEP and the Ministry of Environment of Peru. The purpose of the event was to bring together countries from South and Central America to share experiences and knowledge from GFEI countries in the region and discuss a roadmap for cleaner, more efficient vehicles across the Latin America region. In August 2020, GFEI was also involved in a regional event.

GFEI was involved in a three-day regional event (26-28 August 2020) hosted online by **Mercosur** representatives from Argentina, Brazil, Chile, Paraguay, and Uruguay to discuss progress in adopting measures to improve the energy efficiency of their transport sector. Centro Mario Molina Chile presented Chile's experience and highlighted efforts supported by the Global Fuel Economy Initiative to develop new fuel economy labeling schemes in Argentina and Uruguay.

In December 2018 regional discussions on fuel economy were held in Jamaica for the **Caribbean** which included delegates from government agencies responsible for transport, environment, energy and finance from Antigua and Barbuda, Bahamas, Barbados, Bermuda, Belize, Dominica, Dominican Republic, Grenada, Guyana, Jamaica, St Vincent and the Grenadines, St Kitts and Nevis, St Lucia, and Trinidad and Tobago, as well as regional bodies such as the Caribbean Community (CARICOM).

Country support

GFEI continues to provide in-country fuel economy support to countries across the world. This includes input and analysis in markets with established policy processes, such as in the EU, Japan, India and the US which the ICCT continues to provide. This support to the largest markets is lso increasingly looking beyond passenger cars, with ICCT also recently completing a baseline analysis of the fuel consumption of new two/three-wheelers in India, which account for 20 million annual sales, but are not currently subject to fuel efficiency standards.[41]

The bulk of GFEI's in-country support in developing countries is led by UNEP, which delivers fuel economy support as part of a comprehensive approach to cleaner and more efficient mobility, which increasingly incorporates electric mobility. New GEF funding for UNEP's e-mobility programme, which is being implemented with the IEA, also allows countries to continue to develop their policy approach to take an integrated approach. Out of the 29 countries included in the programme, 16 are directly following up on GFEI work – including Ukraine, Chile, St. Lucia, Costa Rica, Peru, Jamaica, Ecuador, Uruguay, Philippines, Bangladesh, Sri Lanka, Mauritius, Togo, Cote d'Ivoire, Sierra Leone, and Burundi.

Recent activities include:

Europe

- On 1 January 2020, **North Macedonia** introduced a new tax to promote fuel economy for passenger vehicles. GFEI, through UNEP and the Regional Environment Center (REC), have provided extensive training and policy support for more than five years and have been instrumental in advising on the design.

  The new vehicle tax covers new and used motor vehicles that are imported and / or put into free circulation in the country for the first time. The tax is based on the value of the vehicle and its CO_2 emissions (the amount of average CO_2 emissions multiplied by the value of 1 gram of carbon dioxide - CO_2 for a given category, depending on the fuel type of the vehicle). Hybrid vehicles are eligible for a 50% reduction in the tax.

Asia-Pacific

- **Nepal** is working to develop new policies for efficient and zero-emission vehicles and has recently completed a fuel economy baseline and policy options modelled by FEPIT (Fuel Economy Policy Implementation Tool). These were presented at the 8th Kathmandu Sustainable Urban Mobility Forum in january 2020.

- In **Bangladesh**, the fuel economy baseline and policy recommendations were presented to relevant stakeholders at the National Workshop on Developing Clean and Efficient Vehicle Policies in April 2019. The event was led by the Road Transport and Highway Division Secretary and highlighted the need to have a national clean vehicle policy if the country wants to achieve middle-income status soon. Discussions focused on policy recommendations on fiscal policies, local manufacturing, and electric mobility.

- In **Fiji** the fuel economy baseline report was completed and finalized in December 2019. The results show a fuel economy baseline of 7.8 Lge/100km in 2012 improving to 6.7 Lge/100km in 2015. However, the fuel economy increased to 7.7 Lge/100km in 2016 due to an increase in bigger engine vehicles. Fortunately, due to the influx of hybrid second-hand vehicles, overall fuel economy again increased to 6.9 Lge/100km in 2018.

- A workshop on developing the vehicle emission standards and fuel quality roadmap in **Myanmar** was organized in September 2019. The workshop started discussions in the development of the vehicle emission standards and fuel quality roadmap for Myanmar.

- UNEP held a meeting in **Nauru** in September 2019 when UNEP met with relevant government officials and stakeholders. The vehicle fleet data was provided in January 2020 and the analysis was conducted. The results show a very poor fuel economy baseline and trends with 11.9 Lge/100km in 2014 increasing to 12.4 Lge/100km in 2015 and improving to 11.7 Lge/100km in 2019. This poor fuel economy is largely due to the high number of old second-hand cars with large engines imported into the country.

Africa

- **Namibia** organized a national stakeholder workshop in September 2019 where fuel economy baseline findings were shared. The average fuel economy of light-duty vehicles imported into Namibia in 2018 was 6.7 litres per 100 kilometres, compared to 8.3 litres per 100 kilometres in 2005. Vehicle labeling was identified as a quick win for the country that could be implemented in the short term. Other proposals were to include heavy-duty vehicles in analysis to get a clear picture on the national trends towards a more fuel-efficient vehicle fleet.

- **Mozambique** has developed a national electric mobility strategy, which follows on from previous GFEI work in developing proposals for more efficient vehicles. Mozambique has a large share of its electricity from renewable sources, including hydropower.

- In December 2019, **Nigeria** concluded and disseminated the vehicle fuel economy baseline study and proposed policies that would help achieve better fuel economy in the country. The analysis showed an average fuel economy value of 9.56 Lge/100km which is higher compared to the global average of 7.2 Lge/100Km in 2017. Participants proposed a raft of measures to improve the average fuel economy including tax waivers for fuel-efficient vehicles, vehicle labeling as well as the establishment of a data capture system.

- Following a GFEI meeting in November 2018 which developed recommendations for electric mobility, **Ghana**'s Energy Commission in collaboration with the Ministry of Energy has rolled out a "Drive Electric Initiative" to promote electric vehicles on Ghana's roads. The initiative seeks to promote and create demand for electric vehicles with a target of having over 100 electric vehicles and at least 10 public charging outlets in Ghana by 2020. Through the Environment Protection Agency, Ghana went ahead to prioritize the electric mobility initiative to receive support through the NDC Action project.

- In 2018, **Egypt** made an exemption to its vehicle import policy to allow the import of used electric vehicles with an age restriction of three years. The Egyptian government has also been encouraging local manufacture of electric vehicles after launching a network for the transport and maintenance of electric cars. Through an electric mobility conference in 2019, stakeholders proposed, among other things, the introduction of fuel economy labeling schemes.

Latin America

- The first fuel economy baseline for light-duty vehicles in **Colombia** was successfully completed in 2018. Future work may include additionally creating a fuel efficiency baseline for heavy-duty vehicles; analysis of scenarios to improve the efficiency of the fleet, including through the introduction of electric vehicles; peer review of proposals developed by the government, including energy efficiency standards and labeling.

- GFEI held a workshop in **Paraguay** in July 2019, hosted by the Ministry of Environment and Sustainable Development (MADES). The fuel economy baseline period was between 2005 to 2018 and covered the new and used vehicles registered in the vehicle fleet. 80% of the registered vehicles correspond to second-hand cars. This produces a direct impact in the country's fuel economy result. The next steps are for the country to develop a policy framework to better regulate market entry of used vehicles, and to promote electric vehicles to reduce CO_2 and fuel consumption.

GFEI SUPPORT FOR VEHICLE LABELING PROGRAMS

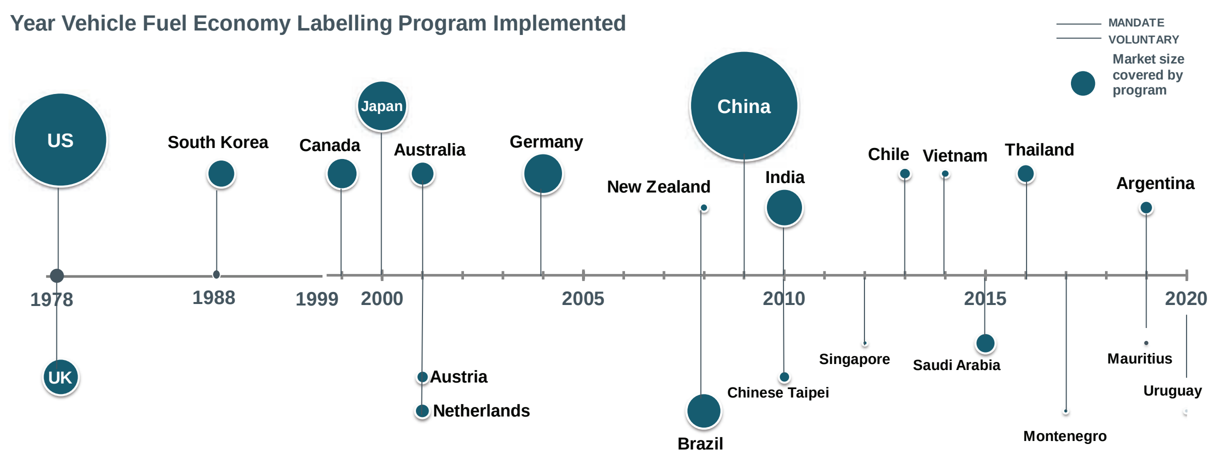
GFEI has supported a number of countries to introduce fuel economy labeling aimed at informing consumers about the relative fuel economy of different vehicles. Chile, Vietnam, Thailand and Montenegro have all introduced labeling schemes. These build on a long history of different countries introducing labels, starting with the US in 1978. In the past year, GFEI has supported Argentina, Uruguay and Mauritius to introduce new labeling schemes. (Figure 17).

MONTENEGRO

GFEI has supported Montenegro with the development of a vehicle fuel economy baseline, the development of a national comprehensive policy that includes tax incentives for more fuel-efficient cars and an auto fuel economy label. The Ministry of Sustainable Development and Tourism, with support from the Regional Environmental Center (REC) Country Office Montenegro, issued the labeling Rulebook no. 40/17 on 27 June 2017 in accordance with EU Directive 1999/94/EC.

This is accompanied by a guide for new passenger vehicles available on the Montenegrin market which contains the annual list of models of new passenger vehicles available, fuel type and official data on fuel economy and CO_2 emissions for each given model and a list of ten models of new passenger cars with the most economical fuel consumption, ranked according to rising CO_2 emissions by fuel type.

FIGURE 17: Timeline of vehicle labeling program introductions



Source: GFEI update of ICCT (2016) graph[42]

URUGUAY

UNEP and its regional partner Centro Mario Molina Chile have been supporting Uruguay through the GFEI since 2015. The first activities were focused on developing a fuel economy baseline and complementary actions such as proposals for fuel and vehicle emissions standards. The resulting regulation established the requirements for the vehicle energy efficiency labeling of new vehicles of category M1 and N1 with internal combustion engine, pure electric, hybrid electric with and without external charging and hydrogen fuel cell vehicles. The labeling scheme is oriented to inform the vehicle fuel economy, carbon dioxide emission and emission standard for motor vehicles. The range of electric and hybrid electric vehicles with external charging is also indicated (Instituto Uruguayo de Normas Técnicas).

ARGENTINA

Argentina's Secretary of Monitoring and Environmental Control, Ministry of Environment and Social Development, and UNEP with the support of GFEI partners, including Centro Mario Molina Chile, have been working to develop annual fuel economy baselines for light and medium duty vehicles, along with key stakeholders such as the National Association of Car Manufactures (ADEFA). As part of the GFEI project, a website with the database was developed to provide information on fuel consumption for each make and model of the Argentine vehicle fleet.

In June 2019, a fuel economy label began to be enforced for 50% of all marketed models. By December 2020 it will be displayed by 100% of marketed models. In 2021, a new comparative vehicle label will be implemented, which will also show the efficiency category of the vehicle. By October 2021 it will be displayed by 100% of the models marketed. The GFEI project will continue to support these efforts as well as develop proposals for fuel economy regulations, including cost-benefit estimations, which are critical for negotiations with vehicle manufacturers and importers.

PHILIPPINES

GFEI partners and GIZ have been supporting the Department of Energy in developing a fuel economy label in cooperation with stakeholders such as vehicle manufacturers. An Implementing Rules and Regulations document (this is a document detailing the implementation of certain legislation) was prepared to outline the scope and implementation of the vehicle fuel economy label. In 2019, the government of the Philippines formally adopted the Energy Efficiency and Conservation Act, Republic Act 11285, that includes the new fuel economy labeling for vehicles.

FIGURE 18: Argentina's Fuel Economy Labels

Source: IRAM/AITA 10274-1 and 10274-2

BOX 13:

GFEI AND PROGRESS ON FISCAL MEASURES

Fuel and vehicle taxes can be used to encourage the purchase of more fuel-efficient vehicles. This includes initial registration taxes for new vehicles, and annual circulation taxes. To incentivise more efficient vehicles, vehicles with lower average CO_2 emissions pay less tax, or may even be eligible for a subsidy – particularly if they are electric and have zero emissions in use. GFEI's research[43] indicates that countries with regulations and/or efficiency-based purchase incentives in place improved on average 60% faster than countries without such policies.

GFEI works with countries to help them understand the potential impact of changing taxes on fuel economy, including through the FEPIT tool. For example in **Belize**, the tool was used to present projection scenarios to the year 2030 with the implementation of fuel economy policies, using data from the country's fuel economy baseline. In **Togo**, stakeholders at GFEI's project workshop proposed the introduction of a CO_2-based vehicle tax system that incentivizes fuel-efficient vehicles which is graduated according to the age of the vehicle form date of manufacture.

MAURITIUS

GFEI has been working with **Mauritius** since 2010, supporting the country to develop policies for more efficient vehicles. The country adopted a feebate ('fee or rebate') scheme as one of the fiscal measures to support the importation of more fuel-efficient vehicles in July 2011. As a result, the fuel economy of the vehicle fleet improved from 7.0 Lge/100km (in 2005) to 5.9 Lge/100km in 2015. In 2016 this scheme was replaced by a **new tax structure to incentivise more efficient vehicles including electric vehicles.**

In 2019, the tax measures were updated again to further **reduce excise duty on hybrid and electric vehicles**. Excise duty was reduced by between 5% and 15% depending on the type/rating of the electric vehicle (Table 4). This new taxation structure has resulted in a significant increase in hybrid and electric vehicles to 14,060 units and 206 units respectively by January 2020.

As a further measure to promote choice of more fuel-efficient vehicles, in May 2019 **Mauritius** adopted a mandatory requirement for a fuel consumption and carbon dioxide emission label on all vehicles sold.

TABLE 4: The excise duty rate for electric vehicles in Mauritius is being lowered as follows:

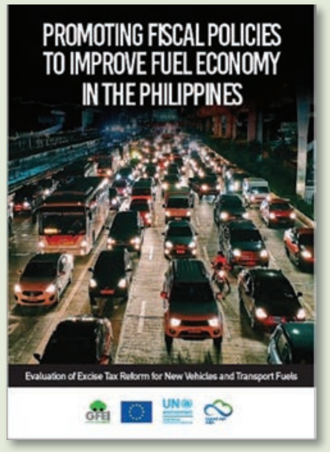
Type of Motor Car	Current	New
Electric Car		
Up to 180 kW	0%	0% (no change)
Above 180 kW	25%	15%
Plug-in Hybrid Car		
Up to 550 c.c.	0%	0% (no change)
551 - 1,000 c.c.	25%	10%
1,001 - 1,600 c.c.	25%	15%
1,601 - 2,000 c.c.	45%	30%
2,001 - 3,000 c.c.	70%	55%
Above 3,000 c.c.	70%	65%

UKRAINE

Following the October 2017 launch of the GFEI in **Ukraine**, the Ukrainian Parliament (Verkhovna Rada) has adopted a provisional **VAT and excise tax exemption for all EVs for 2018. The regulation was extended through 2022**. A more comprehensive regulation is being developed to create a sustainable environment for further development of electric mobility in Ukraine, as well as favourable conditions for investment opportunities in this market. The GFEI has actively supported the EV legislative act through its national partners the International Standardization Academy and the Ministry of Infrastructure.

Ukraine has experienced steady and strong growth in EV vehicles sales and has one of the strongest electrification rates in the world, with sales tripling in 2017 alone.

PHILIPPINES



GFEI has been supporting the **Philippines** in developing fuel economy policies since 2015. Together with Clean Air Asia, GFEI provided technical assistance to the Department of Finance to analyse the economic and environmental impact of the price-based vehicle excise tax scheme and fuel tax proposed for the Philippines. A **price-based vehicle excise tax scheme** was adopted and implemented in January 2018. This is expected to result in a 2% improvement in the light-duty vehicle fleet fuel economy leading to less fuel consumption and emissions. The approved vehicle excise tax also includes an **exemption for electric and hybrid vehicles**, meaning only half of the effective excise tax is applicable.

KENYA

GFEI, through UNEP, and the government of Kenya have worked on a fuel economy project since 2013. The government implementing agency was the Energy Regulatory Commission, which is under the Ministry of Energy.

The vehicle inventory study for Kenya in 2014 showed that the average fuel economy and CO_2 emissions per vehicle in the country was worsening over time, from an average CO_2 emission of 178.2 g/km in 2010 to 185.4 g/km in 2012. As a result of the study, the government amended the excise duty bill in 2014/15. All vehicles imports older than three years were required to pay a US$ 2,000 flat excise tax while those less than three years would pay an excise duty of US$1,500. This altered the vehicle quality and number of vehicles imported resulting in a fuel economy improvement of the national fleet.

In 2016, **excise duty was adjusted to be based on engine size and as a proportion of the import value.** In November 2019, additional measures **lowering the excise duty to 10% for fully electric vehicles** have since been enacted leading to an increase in the number of hybrid and fully electric vehicles.

TABLE 5: Excise rate for vehicles in Kenya

Type of motor car and cylinder capacity (c.c.)	Excise duty charged
Conventional cars: Up to 1500 c.c. 1500 - 2500 c.c.	 20% 25%
private passenger vehicles of cc rating exceeding 2500 and 3000 for diesel and petrol	35%
All fully Electric cars	10%

BOX 14:

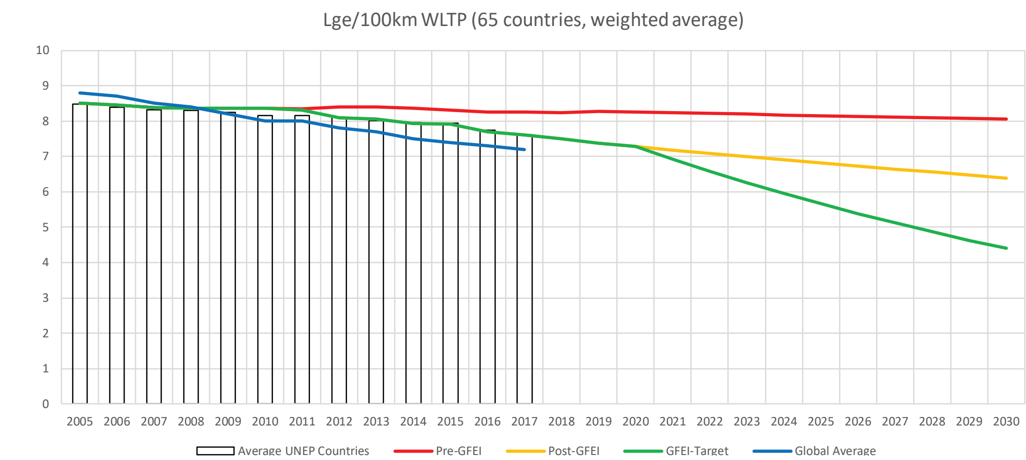
MEASURING THE IMPACT OF GFEI COUNTRY PROJECTS IN DEVELOPING COUNTRIES

UNEP recently conducted an initial analysis of the fuel economy baseline and trends of light-duty vehicles in 65 countries where they have supported efforts to develop cleaner and efficient fuels and vehicle policies since 2009. The analysis was based on the changes in the average fuel consumption data using first-time registered LDVs and vehicle sales data, actual and forecasted from 2005 to 2030 from OICA and available country information. The average fuel consumption data was based on the New European Drive Cycle (NEDC) and was converted to World Harmonised Light Vehicles Test Procedure (WLTP). Main assumptions include gasoline & diesel share of 82% & 18%; average life of 12 years for LDV; and average annual travel of 15000km were assumed in the analysis. The fuel economy baselines (for missing years) were adjusted through interpolation and using growth from similar income countries to determine a trend series from 2005-2020. Three scenarios were developed:

- The Pre-GFEI scenario considers fuel economy baseline for first time registered LDVs based on 2005-2010 growth, i.e. the 2030 projections were carried out using 2005-2010 growth rates.
- The Post-GFEI scenario considers fuel economy baseline for first time registered LDVs based on 2010-2017 trend, i.e. the 2030 projections were carried out using 2010-2017 growth rates.
- The GFEI-Target scenario considers 2020-2030 trend based on fuel economy target of 4.4 Lge/100km by 2030.

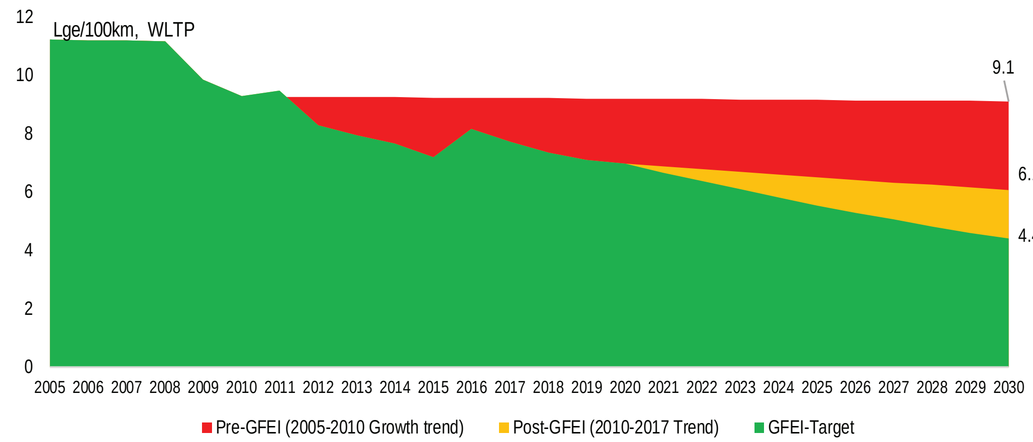
The results show that pursuing the GFEI 2030 goal of 4.4 lge/100km for first-time registered LDVs could save about 359 billion litres of gasoline-equivalent and 844 million tonnes of CO_2 emissions, cumulatively. In terms of the magnitude of reduction, the saving constitutes about 16% from the BAU (2005-2030, Pre-GFEI vs GFEI-Target). The vehicle sales of the countries included in the analysis accounts for about 15% of current global sales. UNEP GFEI countries would need to achieve a 4.9% rate of fuel economy improvement from 2020 in order to achieve the 2030 GFEI target of 4.4Lge/100km. Below is a sample of a country analysis for Kenya which shows pre- and post-GFEI average fuel consumption estimates. Kenya achieved a 1.8% rate of fuel economy policy improvement from 2010, when GFEI started supporting the country. The country would need to achieve a 5% rate of improvement from 2020 in order to achieve the GFEI target by 2030.

FIGURE 19: Actual and estimated average fuel consumption of light-duty vehicles in UNEP supported developing countries



Source: UNEP, 2020 (unpublished research)

FIGURE 20: Actual and estimated average fuel consumption of light-duty vehicles in Kenya



Source: UNEP, 2020 (unpublished research)

CONCLUSIONS AND RECOMMENDATIONS

As this report has shown, while many countries have some policies in place to promote fuel economy and/or uptake of electric vehicles, and there has been considerable updating of policies during 2019 and 2020, few countries today have the necessary policies in place to achieve the GFEI 2030 fuel economy targets or longer term CO_2 and EV uptake targets. Perhaps only Norway has achieved a policy package that holds a strong chance to achieve these. In nearly all other countries, new and stronger policies will be needed, going forward and policy systems must increasingly integrate both fuel economy and electrification goals, taking in a holistic approach, also considering all the major transport modes.

POLICIES TO PROMOTE VEHICLE FUEL ECONOMY AND/OR REDUCE CO_2 EMISSION RATES

For the world's largest markets, fuel economy standards are a foundational policy, but few countries have made these stringent enough, or set them out far enough into the future, to achieve the full potential. Standards in North America cover the period 2018 to 2025, and China's standards also currently end at this date. Europe and Japan have set fuel economy (CO_2) standards reaching to the year 2030. 2030 being only a decade away, targets and policies to this timeframe and beyond are needed very soon in all countries to help guide the transition.

Fiscal policies are also critical, and all countries can use these, using a combination of taxes or fees on vehicles and fuels that are not sustainable, and incentives for those that are (i.e. higher fuel economy and electric vehicles). One of the most important fiscal measures is to **eliminate current subsidies on fossil fuels**. The UN Secretary General has called to end fossil fuel subsidies now, and support clean energy transition and sustainable transport. It is a foundational step that all countries should undertake as soon as possible.

IEA's trends analysis has shown that countries with fuel economy standards and/or efficiency-based purchase incentives in place have improved on average 60% faster than countries without such policies. The higher improvement rate is also reflected by the higher market share of electrified LDVs (hybrids, PHEVs, BEVs and fuel cell electric vehicles).

The good news is that most of the policies to improve existing ICE vehicles and move to more zero carbon options that will be needed already exist in one or more countries, and these set some very good examples for other countries to follow. Together these allow for a general strategy that most countries can adopt.

Many major vehicle markets (US, Europe, China, Japan and Korea) have fuel economy and/or CO_2 per km emissions standards for new LDVs and for at least some types of trucks. These standards require meeting a maximum average energy use or CO_2 emissions rate, though the details of these policies can vary considerably. The stringency, duration, and coverage of these standards also varies considerably, and few jurisdictions have set standards beyond 2025. **Standards should be set to at least 2030 as soon as possible**, with a long lead time given manufacturers much better opportunities to plan for and innovate to meet the standards.

In addition to standards, and even for countries without standards, a range of supporting policies are recommended:

- **Achieving a uniform approach to testing vehicle fuel economy** (and emissions) around the world will provide important benefits in terms of creating a "level playing field" in all markets, improving and standardizing information, and better represent real world driving conditions.

  We strongly recommend that countries adopt the Worldwide Harmonized Light Vehicle Test procedure (WLTP) for PLDVs as Europe and other regions have already done.

- **Compliance and enforcement policies** can help achieve a more realistic representation of fuel economy in real world conditions. Most major vehicle markets have started to take action to develop these measures and currently have varying types of compliance policies in place, whereas enforcement policies are less abundant. The United States has the most comprehensive policy framework to ensure well-functioning compliance and enforcement.

- **Policies focused on heavy-duty vehicles (trucks and buses) are also very important**. Few countries have standards so far, and we are far from international harmonization on heavy duty CO_2/km standards. On-going efforts to set ambitious fuel economy standards for trucks in a harmonized way to 2030 should be a priority for major market countries, and internationally. Making sure that technical regulations and standards are updated to enable the large scale, safe and environmentally sound deployment of electric and hydrogen trucks is another near-term priority.

- **Policies to promote fuel economy for two/three-wheelers is also important**, though it may be easier to promote electrification directly without a major period of ICE 2-wheeler improvement. China leads on both standards and restrictions for ICE two/three-wheelers and other countries may find that as electric two/three-wheelers become increasingly cost-effective, a phased ban in ICE sales will become viable and attractive.

- **Fiscal measures** will help: countries with higher fuel taxes (and higher fuel prices) tend to have a better average fuel economy level than countries with lower taxes, both in terms of technology uptake and vehicle size mix. At a minimum, removing all fossil fuel subsidies is an urgent need for policy in this regard. Higher vehicle excise taxes for ICE vehicles compared to more efficient vehicles like hybrids, PHEV, and BEVs support overall improvement of fuel economy.

- An important policy consideration for many countries, mainly non-OECD but also some OECD countries, is the impact of **importation of used vehicles for the fuel economy of their fleet**. The import of used vehicles differs per country and region; while some countries have completely banned the import of used vehicles, in other countries used vehicles account for more than 90% of their vehicle growth. Large markets in Africa depend on used vehicles imports (in Nigeria, 85% of vehicles added to the fleet are used imports, in Kenya more than 95%). A new report by UNEP[44] shows that in many cases the quality of these used vehicles is very poor and the emissions, including fuel consumption, of these used vehicles is very high. The report also shows how some countries are targeting used (H)EV vehicles to leapfrog to (affordable) clean and efficient vehicles.

POLICIES TO PROMOTE ELECTRIC VEHICLES

A range of policy instruments related to the promotion of EVs have been adopted in major global markets. China, Europe, Japan, United States and recently India have spurred EV consumer demand through a combination of instruments including public procurement and investment plans, subsidies and other financial incentives addressing both EV purchase prices and refuelling/charging infrastructure, fuel-economy standards and zero-emission vehicle (ZEV) mandates.

Developing policies to promote vehicle electrification typically involves a multi-step process. This process should begin with a vision statement and identification of a set of EV sales targets, that may be linked to (or derived from) a broader goal of CO_2 reduction from the vehicle fleet.

Other important elements can include:

- **The adoption of electric vehicle and charging system standards.** In many cases there are already widely available standards (such as from ISO, IEC and SAE) that are being adopted in multiple countries, that can be used to rapidly develop a country's own systems.

- **Government vehicle procurement programmes.** These can kick-start demand and stimulate automakers to increase the availability of EVs on the market, plus provide impetus for an initial roll out of publicly accessible charging infrastructure.

- **EV purchase incentives,** such as purchase subsidies, are a powerful way to make EVs more competitive with ICE vehicles on the market. These are often coupled with other policy measures that increase the value proposition of EVs (such as waivers to access restrictions, lower toll or parking fees) which are often based on the better performance of EVs in terms of local air pollution. These can be funded by increased fees or taxes on the sale of ICE vehicles such as using a "bonus-malus" or "feebate" approach.

- **EV credits within fuel economy standard systems.** EVs provide fuel economy benefits but also CO_2 benefits and various credit systems existing to promote these within fuel economy standard systems. The more credits the sale of an EV provides, the more incentive manufacturers have to sell them; however, credit systems must avoid allowing the sale of less efficient ICE vehicles as a result of extra EV credits. It is an important balancing act.

- **Zero-emission vehicle sales requirements.** Requiring manufacturers to make a specific share of their vehicle sales be zero emission is a straight-forward way to increase those sales. There can be risks of non-compliance, for example, that some manufacturers could choose to exist certain markets rather than trying to comply.

- **ICE sales bans.** A converse approach to requiring ZEV sales is to ban ICE sales. Many countries have indicated they are considering ICE bans and some have set bans, with the earliest known ban in Norway in 2025. It is unclear how successful these approaches will be, without other supporting policies as outlined here. It will be critical for countries setting such bans to support an orderly transition leading to the year of the ban. For example, a sales ban set for 2040 probably should mean that robust ZEV sales are already occurring in 2030, and achieve a large market share by 2035.

- **Charging infrastructure.** Measures related to charging infrastructure include minimum requirements to ensure "EV readiness" in new or refurbished buildings and parking lots, deployment of publicly accessible chargers in cities and on highway networks, and are complemented by requirements regarding inter-operability and minimum availability levels for publicly accessible charging infrastructure. In China, researchers have found that "compared with consumer subsidies, investment in charging infrastructure is about four times as cost-effective in promoting EV sales."

- **EV integration with the electric sector.** Policies are crucial to ensure that electric mobility has positive impacts for flexibility in power systems. The use of EVs to provide flexibility services is a feature that has relevant implications to increase opportunities for the integration of variable renewable energy in the electricity generation mix and to reduce costs associated with the adaptation of the grid to increased EV uptake. This requires that power markets evolve in such a way as to include services (e.g. grid balancing) suitable for EV participation and to allow the participation of small loads for demand-side response through aggregators. The update of the European directive on common rules for the internal market in electricity, adopted in March 2019 by the European Parliament as part of the Clean Energy for All Europeans package, is an important milestone in this respect.

In the developing world, the 2nd hand importation of electric vehicles has begun with some notable leaders such as Sri Lanka. These early EV imports can provide a leg up in terms of gaining experience, building out the EV charging and support infrastructure, and beginning to consider benefits from EVs for grid management. If EVs eventually are sent to the developing world in large numbers for the "2nd half of their lives", they will likely die there. It will become critical to develop systems to recycle or repurpose batteries and address other end-of life issues. The possibility of using EV batteries for mini-grid projects has an interesting potential but is not well understood at this time.

As EV and charging infrastructure deployment evolves, policy measures will likely need to be adjusted as the markets and infrastructure mature. One example is how fuel and vehicle taxes are adjusted and their contribution to government revenue.

In the medium to long term, EV deployment will impact governmental revenues from fuel taxation, and the long-term stabilization of fiscal revenues from transportation cannot simply be based on marginal adjustments of vehicle and fuel taxes. To support the long-term transition to zero-emissions mobility while maintaining revenue from transport taxes, governments may consider a gradual increase of taxes on carbon-intensive fuels, combined with the transition towards distance-based charges. The latter are also well suited to recover infrastructure costs, to reflect the costs of pollution and to address congestion.

POLICIES FOR MAINLY VEHICLE IMPORTING COUNTRIES

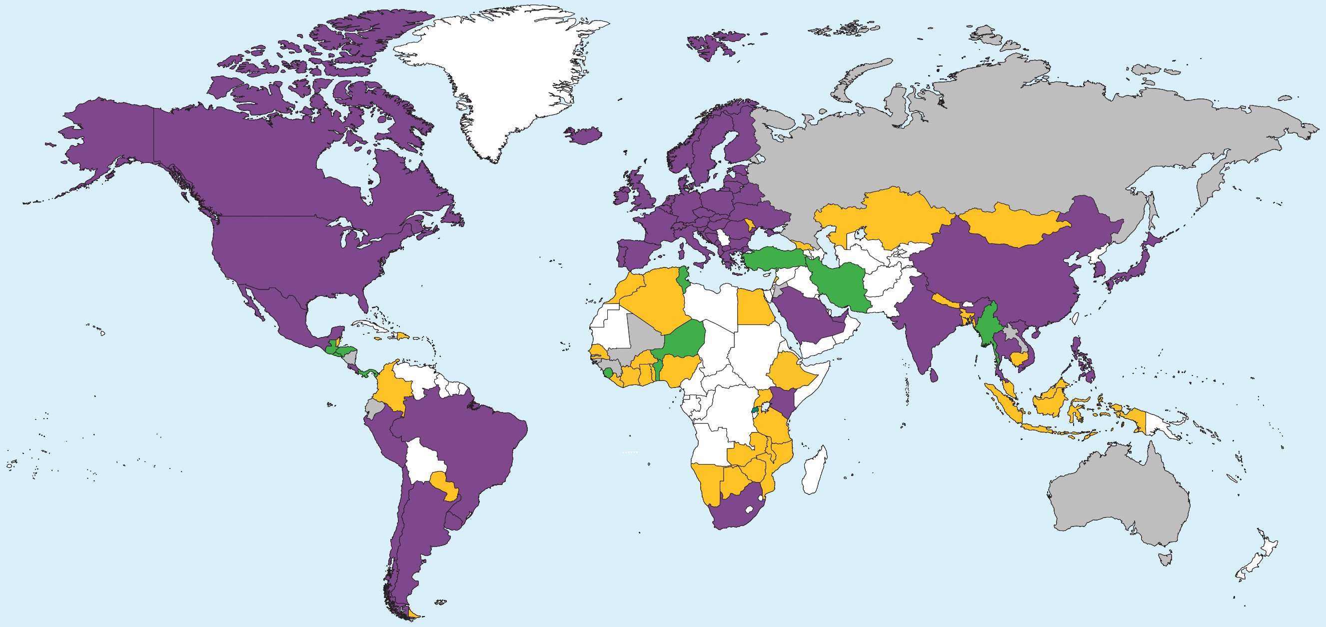
Countries that don't manufacture vehicles or have large new-vehicle sales markets have some disadvantages in setting fuel economy and electric vehicle policies. They are not in a position to require production or sales of new vehicles to be highly regulated, since they may simply drive manufacturers out of their small markets.

On the other hand, they have some advantages, mainly in terms of controlling what vehicles come into their countries. They can simply ban the sales of some types of vehicles (such as old ones or ones that don't meet safety or emissions requirements), and they can apply duties on imports that discourage the purchase of certain kinds of vehicles (such as inefficient ones) or promote certain kinds (such as electric vehicles).

There are also some fundamental policies that all countries can undertake, such as labeling all vehicles sold in the country for fuel economy and emissions.

ANNEX I: STATUS OF GFEI COUNTRY PROJECTS

GFEI LDV FUEL ECONOMY POLICY COUNTRY PROGRESS SUMMARY



KEY

GFEI engagement

GFEI Baseline completed

Policy proposals developed

Policy Implemented

The table below provides the status of GFEI Country Projects. The columns provide a general overview of the steps undertaken in each country in developing fuel economy policies, starting from project development and project signing through policy development and adoption. The arrows in each row show the progress of the various countries.

KEY

Baseline completed

Policy Implemented

Policy recommendations

G20 TTG member

ECOWAS

ASEAN

AFRICA			
Algeria	Baseline completed	Policy recommendations	
Benin	Baseline completed		
Botswana	Baseline completed	Policy recommendations	
Burkina Faso	Baseline completed	Policy recommendations	
Cabo Verde			
Cote d'Ivoire	Baseline completed	Policy recommendations	
Egypt	Baseline completed	Policy recommendations	
Ethiopia	Baseline completed	Policy recommendations	
Gambia			
Ghana	Baseline completed	Policy recommendations	
Guinea			
Guinea Bissau			
Kenya	Baseline completed	Policy recommendations	Policy Implemented
Liberia	Baseline completed	Policy recommendations	
Malawi	Baseline completed	Policy recommendations	
Mali			
Mauritius	Baseline completed	Policy recommendations	Policy Implemented
Morocco	Baseline completed	Policy recommendations	
Mozambique	Baseline completed	Policy recommendations	
Namibia	Baseline completed	Policy recommendations	
Niger	Baseline completed		
Nigeria	Baseline completed	Policy recommendations	
Rwanda	Baseline completed		
Senegal	Baseline completed	Policy recommendations	
Sierra Leone	Baseline completed		
South Africa	Baseline completed	Policy recommendations	Policy Implemented
Tanzania	Baseline completed	Policy recommendations	
Togo	Baseline completed	Policy recommendations	
Tunisia	Baseline completed		
Uganda	Baseline completed	Policy recommendations	
Zambia	Baseline completed	Policy recommendations	
Zimbabwe	Baseline completed	Policy recommendations	

MIDDLE EAST AND WEST ASIA			
Bahrain	Baseline completed		
Iran	Baseline completed		
Kazakhstan	Baseline completed	Policy recommendations	
Lebanon	Baseline completed	Policy recommendations	
Mongolia	Baseline completed	Policy recommendations	
Saudi Arabia	Baseline completed	Policy recommendations	Policy Implemented
UAE	Baseline completed	Policy recommendations	Policy Implemented

EASTERN EUROPE AND THE CAUCUSES			
Georgia	Baseline completed	Policy recommendations	
North Macedonia	Baseline completed	Policy recommendations	
Moldova	Baseline completed	Policy recommendations	
Montenegro	Baseline completed	Policy recommendations	Policy Implemented
Russia			
Turkey	Baseline completed		
Ukraine	Baseline completed	Policy recommendations	Policy Implemented

LATIN AMERICA AND CARIBBEAN			
Argentina	Baseline completed	Policy recommendations	Policy Implemented
Belize	Baseline completed	Policy recommendations	
Chile	Baseline completed	Policy recommendations	Policy Implemented
Colombia	Baseline completed	Policy recommendations	
Costa Rica	Baseline completed	Policy recommendations	Policy Implemented
Dominican Republic	Baseline completed	Policy recommendations	
Ecuador			
El Salvador	Baseline completed		
Guatemala	Baseline completed		
Honduras	Baseline completed		
Jamaica	Baseline completed	Policy recommendations	
Nicaragua			
Panama	Baseline completed		
Paraguay	Baseline completed	Policy recommendations	
Peru	Baseline completed	Policy recommendations	Policy Implemented
Uruguay	Baseline completed	Policy recommendations	Policy Implemented

ASIA			
Bangladesh	Baseline completed	Policy recommendations	
Cambodia	Baseline completed	Policy recommendations	
Fiji	Baseline completed		
Indonesia	Baseline completed	Policy recommendations	
Lao			
Malaysia	Baseline completed	Policy recommendations	
Myanmar	Baseline completed		
Nauru	Baseline completed		
Nepal	Baseline completed	Policy recommendations	
Philippines	Baseline completed	Policy recommendations	Policy Implemented
Singapore			Policy Implemented
Sri Lanka	Baseline completed	Policy recommendations	Policy Implemented
Thailand	Baseline completed	Policy recommendations	Policy Implemented
Vietnam	Baseline completed	Policy recommendations	Policy Implemented

OTHER G20 COUNTRIES			
Australia			
Brazil			Policy Implemented
Canada			Policy Implemented
China			Policy Implemented
EU			Policy Implemented
India			Policy Implemented
Japan			Policy Implemented
Mexico			Policy Implemented
South Korea			Policy Implemented
UK			Policy Implemented
US			Policy Implemented

ANNEX II: RECENT FUEL ECONOMY-RELEVANT REPORTS FROM GFEI PARTNERS

CROSS-CUTTING

IEA: Tracking Transport (2020)
https://www.iea.org/topics/transport summarises transport progress on carbon emissions and shows projected trends.

IEA: Impact of COVID-19 (2020)
https://www.iea.org/articles/changes-in-transport-behaviour-during-the-COVID-19-crisis, and **https://www.iea.org/reports/the-COVID-19-crisis-and-clean-energy-progress/transport**

LDV FUEL ECONOMY

ICCT: Japan 2030 Fuel Economy Standards
https://theicct.org/sites/default/files/publications/Japan_2030_fuel_standard_update_20191007.pdf outlines Japan's 2030 vehicle emissions standards, which include using the WLTP test cycle and including EVs (and 'upstream' energy).

UC Davis: Internal Combustion Engine Bans and Global Oil Use (2019)
https://escholarship.org/uc/item/52j400b1 considers the literature on proposed policies to ban ICE vehicles and develop scenarios to estimate the potential impacts of these proposed bans, to contribute to a peaking in oil demand and eventual reductions in CO_2 emissions. We find that national level ICE car bans in key markets such as China and Europe in 2040 could reduce oil use by five million barrels a day (b/d) by 2050, under five percent of projected global oil use. A global ban would eliminate three times that level of oil use but would likely take several decades for its full impact to be realized.

IEA/GFEI (2019). Fuel Economy in Major Car Markets: Technology and Policy Drivers 2005-2017
https://www.globalfueleconomy.org/data-and-research/publications/gfei-working-paper-19 provides an in-depth analysis of fuel economy trends and policy drivers.

ELECTRIC VEHICLES

ICCT: Electric vehicle guidance for Indian States
https://theicct.org/publications/electric-vehicle-guidebook-indian-states identifies five consumer barriers: model availability, cost competitiveness, fleet deployment, usage convenience, and consumer understanding. The guidebook outlines strategies to overcome each of these, with a total of 83 suitable policy actions.

ICCT: Electric vehicle capitals: Showing the path to a mainstream market
https://theicct.org/sites/default/files/publications/EV_Capitals_2018_20191121.pdf assesses metropolitan area-level data on electric vehicle registrations and identifies the 25 largest electric vehicle markets, which together represent 42% of new passenger electric vehicle sales globally.

ICCT: Funding the transition to all zero-emission vehicles: **https://theicct.org/publications/funding-ZEV-transition** sets out the costs, benefits, and appropriate government funding associated with the transition to all passenger zero-emission vehicles (ZEVs).

IEA: Global EV Outlook 2020
https://www.iea.org/reports/global-ev-outlook-2020 is an annual publication that identifies and discusses recent developments in electric mobility across the globe. It is developed with the support of the members of the Electric Vehicles Initiative (EVI).

UC Davis: An Examination of the Impact That Electric Vehicle Incentives Have on Consumer Purchase Decisions Over Time (2019)
https://its.ucdavis.edu/research/publications/?frame=https%3A%2F%2Fitspubs.ucdavis.edu%2Findex.php%2Fresearch%2Fpublications%2Fpublication-detail%2F%3Fpub_id%3D3017 investigates the impacts of a combination of incentives on the purchase decisions of electric vehicle (EV) buyers in California from 2010 through 2017.

UC Davis (2019) Electric Vehicle Incentives in 13 Leading Electric Vehicle Markets
https://its.ucdavis.edu/research/publications/?frame=https%3A%2F%2Fitspubs.ucdavis.edu%2Findex.php%2Fresearch%2Fpublications%2Fpublication-detail%2F%3Fpub_id%3D3016 provides an overview of incentive strategies in 13 leading plug-in electric vehicle (PEV) markets. The document looks at incentives for both battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs).

UC Davis (2019) Exploring the Role of Plug-In Hybrid Electric Vehicles in Electrifying Passenger Transportation
https://its.ucdavis.edu/research/publications/?frame=https%3A%2F%2Fitspubs.ucdavis.edu%2Findex.php%2Fresearch%2Fpublications%2Fpublication-detail%2F%3Fpub_id%3D3007 explores the potential of PHEVs and BEVs.

UC Davis (2019) Understanding the Impact of Reoccurring and Non-Financial Incentives on Plug-in Electric Vehicle Adoption – A Review
https://its.ucdavis.edu/research/publications/?frame=https%3A%2F%2Fitspubs.ucdavis.edu%2Findex.php%2Fresearch%2Fpublications%2Fpublication-detail%2F%3Fpub_id%3D2982 looks at the policy interventions, including non-financial incentives, including special lane access for PEVs (e.g HOV/carpool lanes, bus lanes), parking incentives, charging infrastructure development, road toll fee waivers, and licensing incentives, as well as disincentives such as gasoline tax or annual vehicle taxes.

HDVS (INCLUDING ELECTRIC HDVS)

ITF: Regulations and Standards for Clean Trucks and Buses - On the Right Track?
https://www.itf-oecd.org/regulations-and-standards-clean-trucks-and-buses. The report reviews progress on technical standards for heavy vehicles that could enable trucks and buses with zero or near-zero emissions. It focuses on plug-in and fuel cell electric vehicles that use technologies at the forefront of green and inclusive economic development. It includes information on technical standards on charging and refueling infrastructure, and identifies remaining barriers and opportunities for their future development.

ICCT: Future Emissions Standards – An Opportunity for International Harmonization
https://theicct.org/sites/default/files/publications/Future%20_HDV_standards_opportunity_20191125.pdf provides recommendations for the regulatory processes in the European Union and the United States, with an emphasis on harmonizing future HDV emission standards.

ICCT: Estimating the infrastructure needs and costs for the launch of zero-emission trucks
https://theicct.org/publications/zero-emission-truck-infrastructure quantifies the infrastructure needs and associated costs for implementing battery electric and hydrogen fuel cell trucks in three applications: long-haul intercity tractor-trailers, drayage trucks, and medium-duty delivery trucks.

ITF: Towards Freight decarbonisation (2018)
https://www.itf-oecd.org/towards-road-freight-decarbonisation identifies proven measures that decrease road freight's CO_2 emissions.

IEA: The Future of Trucks (2017)
https://www.iea.org/reports/the-future-of-trucks outlines the ways in which vehicle efficiency technologies, systemic improvements in logistics and supply chain operations, and alternative fuels can ensure that road freight transport will continue to support economic growth while meeting key energy and environmental policy objectives.

UC Davis: Analysis of advanced battery-electric long haul trucks: batteries, performance, and economics (2019)
https://ucdavis.app.box.com/s/6fuqpgsejcdsdpu0x5lqrucevsk2080u explores the performance and costs of a 500 mile (level road) class 8 battery-electric truck based on ADVISOR simulations and associated cost calculations.

MOTORCYCLES

ICCT: New two-wheeler vehicle fleet in India for fiscal year 2017–18
https://theicct.org/publications/new-two-wheeler-fleet-india-2017-18 Develops a fuel economy baseline of motorcycles sold in India and assesses implications for fuel economy policy.

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[4] **https://www.globalfueleconomy.org/data-and-research/publications/gfei-re-launch-document**

[5] Unless otherwise noted, fuel consumption is reported in liters of gasoline equivalent per 100 kilometres (Lge/100 km) and is normalized to the World Light-duty Test Cycle (WLTC) using the zero-intercept conversion multipliers (Conversion 5.2) from ICCT (2014). "Development of test cycle conversion factors among worldwide light-duty vehicle CO_2 emission standards."

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[7] There is evidence, however, that the average gap between rated and real-world fuel consumption is highest in PHEVs among all powertrains (see ICCT factsheet: **https://theicct.org/sites/default/files/FactSheet_FromLabToRoad_ICCT_2016_EN.pdf**).**https://theicct.org/sites/default/files/FactSheet_FromLabToRoad_ICCT_2016_EN.pdf**). However, the gap is also highly variable, as it depends on daily trips and driving style characteristics, as well as charging behavior, among others. The IEA will soon release an article exploring these and other aspects of PHEV regulation and fuel and electricity consumption.

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