GLOBAL FUEL ECONOMY INITIATIVE

International Energy Agency

THE ROLE OF PLUG-IN ELECTRIC VEHICLES TO IMPROVE FUEL ECONOMY

Working Paper 18

The role of plug-in electric vehicles to improve fuel economy

Integrating electric mobility in GFEI activities

INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA), an autonomous agency, was established in November 1974.

Its primary mandate was – and is – two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply, and provide authoritative research and analysis on ways to ensure reliable, affordable and clean energy for its 29 member countries and beyond. The IEA carries out a comprehensive programme of energy co-operation among its member countries, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports.

The Agency's aims include the following objectives:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
- Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
- Find solutions to global energy challenges through engagement and dialogue with non-member countries, industry, international organisations and other stakeholders.

IEA member countries:

Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

The European Commission also participates in the work of the IEA.

International Energy Agency

Website: www.iea.org

Acknowledgements

This publication was prepared by the Energy Technology Policy Division of the Directorate of Sustainability, Technology and Outlooks (STO) of the International Energy Agency (IEA), under the direction of David Turk. Pierpaolo Cazzola led the preparation and drafting of the report. Marine Gorner supported this work.

The first version of the manuscript was prepared as supporting material for a meeting of Global Fuel Economy Initiative (GFEI) partners, held in October 2017, and then finalised, reflecting the consensus that emerged from the discussion. Participants to this meeting included Sheila Watson and Richard Clarke of the FIA Foundation, Drew Kodjak of the International Council on Clean Transportation (ICCT), Stephen Perkins and Elisabeth Windisch of the International Transport Forum (ITF), Rob de Jong of the United Nations Environment Programme (UN Environment), and Lew Fulton of the University of California, Davis.

The final manuscript was shared for review with GFEI partners and benefited from additional comments from Richard Clarke of the FIA Foundation, Alexander Koerner of UN Environment, Lew Fulton of the University of California, Davis and Stephen Perkins from the ITF. Rebecca Gaghen, David Turk, Paul Hugues, George Kamiya and Simon Bennett reviewed this manuscript in the IEA. Erin Crum copy-edited the final draft.

The FIA Foundation provided funding for the development of this work.

Table of contents

List of figures

List of tables

Executive summary

The transition to electric mobility[1] has many positive implications for energy diversification, air quality and greenhouse gas (GHG) emission mitigation, given that low-carbon energy sources for power generation already account for the majority of new capacity additions worldwide, and this is expected to continue in the future.

Recent estimates of battery costs and performance show rapid improvements, well beyond the expectations of 2009, when the Global Fuel Economy Initiative (GFEI) first set its target. This indicates that the cost of achieving fuel economy improvements from PEVs, which is significantly influenced by battery costs, is likely to be significantly lower than initially anticipated.

The prospects for further cost reduction and the achievement of cost parity, combined with the evidence of the multiple benefits of the electrification of transport vehicles, have led to significant developments in the policy area. Key examples include:

- the introduction of zero-emission vehicle (ZEV) mandates in the People's Republic of China (hereafter, "China");
- the proposal for a significant reduction of the average carbon dioxide (CO_2) emissions per kilometre (km) in the European Union – including clear signals calling for the increased deployment of BEVs and PHEVs; and
- a number of announcements from major governments banning conventional car technologies between 2030 and 2040.

Ride-hailing services and continuous progress on vehicle automation are likely to place an upward pressure on average mileages, favouring PEVs over competing technologies because of their greater efficiency and lower operational and maintenance costs.

All these developments underscore the dynamic changes occurring in the area of transport electrification. Major original equipment manufacturers (OEMs) are mobilising resources and investments to integrate PEVs into the light-duty vehicle (LDV) market, as demonstrated by recent announcements for ambitious targets to be reached in the 2020s.

GFEI's view on electric vehicles

GFEI partners are aware of the significant benefits offered by PEVs for energy efficiency, diversification, and the reduction of local pollution and GHG emissions as well as their role in facilitating the transition to a clean energy system. Thus, while the GFEI 2030 fuel economy target (of a 50% reduction in new car fuel consumption compared to 2005 levels) can be met even without electrification, GFEI partners **welcome the developments taking place on the electrification of transport and embrace a strong roll-out of PEVs in helping to reach the GFEI target.**

GFEI partners are also aware of the strong synergies between policies supporting improved fuel economy and policies favouring a successful deployment of PEVs. **GFEI partners will therefore work proactively to integrate policies stimulating the adoption of PEVs in their technical assistance and capacity building work for the development of fuel economy policies.**

[1] Electric mobility refers here to plug-in electric vehicles (PEVs), including battery-electric (BEVs) and plug-in hybrid vehicles (PHEVs).

Why EVs matter for fuel economy

Background on the GFEI target

The GFEI has set the target to double the average fuel economy of new LDVs globally by 2030 compared with 2005 (i.e. a 50% reduction of fuel consumption in litres per 100 km, and 50% reduction of carbon emissions in grams of CO_2 per kilometre). This target was set in 2010, building on analytical assessments showing that it could be met cost-effectively using technologies that do not require the full electrification of the powertrain (see IEA, 2009).

Meeting the GFEI target

When benchmarked against average test values in 2005, many vehicles currently on the market already achieve the level of fuel economy required for the global target for GFEI for 2030. This includes hybrids and vehicles using non-hybridised internal combustion engines (ICEs) in small to medium vehicle classes, as well as PEVs – including both BEVs and PHEVs. Many of the countries having both fuel economy standards and fiscal fuel economy policies in place are on track to reach the GFEI target.

The potential for PEVs to help meet the GFEI target

PEVs are a pivotal technology for the transition of transport to clean energy

PEVs clearly offer the best efficiency advantage over the conventional ICE powertrains. They also promote a shift from petroleum fuels to electricity, helping to diversify the transport energy mix. Overall, PEVs are best suited to enable a transition towards a greater reliance on low-carbon energy sources in transport, capitalising on the shift towards renewable energy taking place in the power sector (IEA, 2017a).

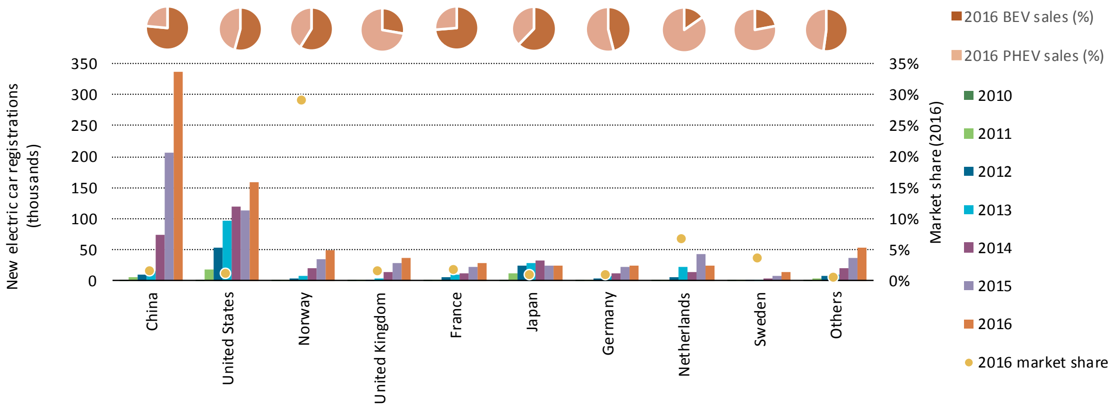
PEVs are the best option available to fully comply with the GFEI target

The gap between on-road fuel economy and the fuel economy assessed from test procedures accounts for up to 40% of the test results in g CO_2/km, according to Tietge et al. (2017). If vehicles are benchmarked against on-road performance, non-hybridised ICEs face significant hurdles to meet the ambition of GFEI targets, and even hybrids may struggle to achieve enough energy savings. The on-road fuel economy gap is also relevant for PEVs (especially if the energy use from auxiliaries is factored in). Despite this, PEVs are about three times as efficient as conventional cars and almost twice as efficient as hybrids. Their large efficiency advantage clearly indicates that PEVs are currently the best option available to fully comply with the GFEI target.

Market uptake of PEVs

In 2016, PEV sales reached about 750 000 worldwide, representing less than 1% of all new LDVs (IEA, 2017b). In 2017, PEV sales were close to 1 million. Given the higher costs of PEVs and other market barriers such as sparse recharging infrastructure, current sales are mainly driven by the policy context: market shares are highest in countries that have adopted a number of measures to support PEV market uptake. As the number of countries that have set up a comprehensive set of policy support measures is still limited, PEV market shares exceeded 1% in only six countries (Figure 1).

Figure 1 • Electric car sales, market share, and BEV and PHEV sales shares in selected countries, 2010-16



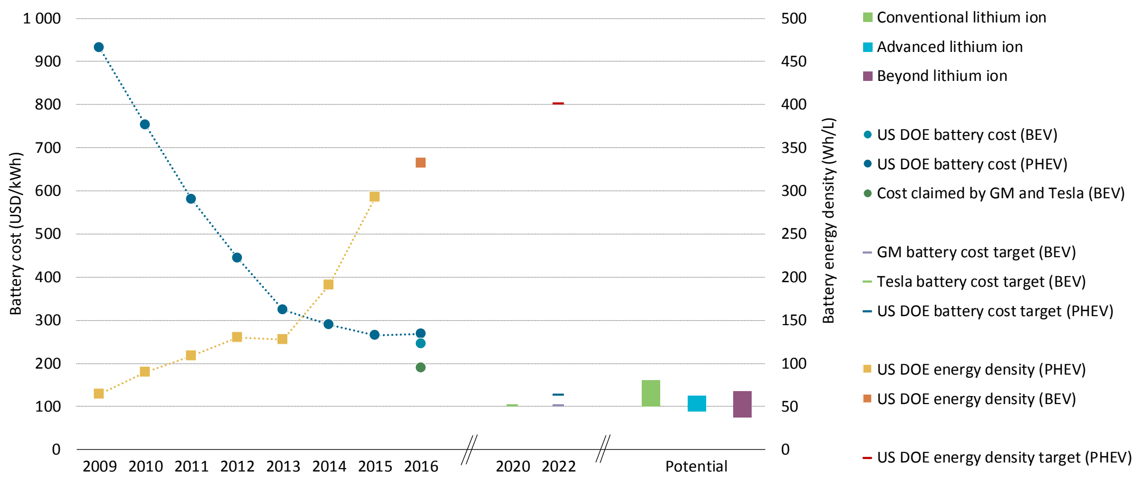
Source: IEA (2017b), *Global EV Outlook 2017*, www.iea.org/publications/freepublications/publication/GlobalEVOutlook2017.pdf.

Key point: The two main electric car markets are China and the United States. Six countries reached market shares for electric cars of more than 1% in 2016: Norway, the Netherlands, Sweden, France, the United Kingdom and China (in descending order).

The main barrier for PEV market penetration today is their purchase cost. Driving range and recharging time for BEVs are also concerns, although there are now several models with a driving range of 300 km or more, which is a major achievement. The availability of charging stations is also an important consideration. This varies significantly across countries and cities, and is still a major constraint in most areas of the world.

Figure 2 provides encouraging indications on the recent and expected evolution of key parameters characterising batteries, the main contributor to the high PEV costs. Since battery costs decline and energy density rises, PEV prices may soon be on par with conventional cars.

Figure 2 • Evolution of battery energy density and cost



Note: USD/kWh = United States dollar per kilowatt hour; Wh/L = watt hours per litre; US DOE = United States Department of Energy.

Source: IEA (2017b), *Global EV Outlook 2017*, www.iea.org/publications/freepublications/publication/GlobalEVOutlook2017.pdf.

Key point: Prospects for future cost reductions from the main families of battery technologies confirm the encouraging signs in cost and performance improvements observed over the past decade.

Prospects for future developments

Cost competitiveness

PEVs may achieve cost parity with ICEs, even with current mileage, if battery costs approach USD 100/kWh

The total cost of ownership (TCO) for first owners[2] of PEVs may achieve parity with ICEs if battery costs approach USD 100/kWh[3]. The actual achievement of parity also depends on mileage and fuel costs, and these parameters vary across different global regions (IEA, 2017b; Wolfram and Lutsey, 2016).

PEVs are already cost-competitive today in fleets with intensive usage

Already today, the TCO of battery-electric cars is on par with conventional cars if adopted in fleets with intensive usage, such as taxis, vehicles providing ride-hailing services and shared cars.

Given the average speed in urban environments and the profile of utilisation of taxis and vehicles providing ride-hailing services, it is also important to note that ranges exceeding 350 km would be fully sufficient to enable a transition to PEVs for these fleets. Improvements in battery durability and low maintenance costs also align well with the increased appeal of PEVs for these solutions.

Transportation is likely to be subject to a dynamic evolution

Vehicle automation is getting closer to market deployment

Significant progress in the technology readiness of autonomous driving technologies follows years of engagement from major players in the information technology industry. Enabled by advances in connectivity, artificial intelligence, technological progress and cost reductions in high computational power and sensing technologies (such as lidars[4]), this progress is now increasing the likelihood of the deployment of vehicles capable of driving autonomously (levels 4 and 5[5]). The first trials of robot taxis (e.g. Waymo, 2017) demonstrate the rapid developments taking place in this field.

Automation is likely to induce increased reliance on ride-hailing services

The combination of vehicle automation and transportation as a service can induce an increased reliance on robot taxis, i.e. autonomous vehicles providing ride-hailing services. By eliminating the need for a dedicated driver, these services are likely to experience cost reductions, inducing greater rates of usage.

[2] This is calculated as the ratio between the purchase and usage costs of a vehicle and the kilometres driven. It considers the cost of the vehicle purchase, fuel, and maintenance and insurance costs, and takes into account the residual reselling price after a few years, typically three to six.

[3] Down from the estimate of roughly USD 250/kWh for high volume production, shown in Figure 2.

[4] An acronym for *light imaging, detection and ranging*, a detection system that works on the principle of radar, but uses light from a laser (OED, 2017).

[5] Motor vehicle driving automation systems that perform part or all of the dynamic driving task on a sustained basis can range in level from no driving automation (level 0) to full driving automation (level 5). The SAE International standard J3016 (SAE International, 2016) provides definitions of these levels, along with additional supporting information.

Automation is also likely to induce increased mileage in vehicles owned by individuals

Given the greater opportunities it provides to carry out other activities while moving and the lower value of time loss attached to driving, automation is also likely to induce increased mileage on vehicles owned by individuals.

Automation and ride-hailing services tend to increase mileages, strengthening the case for PEVs

Both these dynamics lead to an increase in mileage per vehicle, strengthening the case for PEVs, given the savings from their lower operational and maintenance costs.

The policy context is changing rapidly

Global procedures used to measure the fuel economy of LDVs are moving to the Worldwide Harmonised Light Vehicle Test Procedure (WLTP) cycle, which reflects "real-world" driving more closely. Pollutant emissions are also now being tested with portable emissions measurement systems. These changes make it more challenging to meet regulatory requirements from ICE and after-treatment technologies aiming to abate pollutant emissions in the exhaust pipe.

Some of the major global vehicle markets are adopting policies that clearly support the uptake of PEVs. Key examples include:

- The recent rule of China's Ministry of Industry and Information Technology on passenger car fuel economy standards, which includes a new mandate for ultra-low/zero-emission electric vehicles (EVs), with percentage requirements of 10% in 2019 and 12% in 2020 for new energy vehicles (including PEVs) and penalties limiting access to the market in case of non-compliance (MIIT, 2017).
- The recent proposal of the European Commission for an update of the regulations regarding the fuel economy of passenger cars and light commercial vehicles, aiming for 30% reduction of the average CO_2 emissions in 2030 compared with 2021, which includes an incentive for the uptake of zero- and low-emission vehicles for market shares exceeding 15% in 2025 and 30% in 2030 (EC, 2017).
- The strong ambition stated by the Indian government on EV adoption and the initial implementing steps undertaken in the country, with very significant tenders for the public procurement of EVs from the state-owned company Energy Efficiency Services Limited (GOI, 2017).

Other announcements and commitments from governments further provide proof of this same momentum. Announcements include:

- The ambition announced by the Dutch and Norwegian political parties to phase out ICE sales by 2030 (Kroese, 2017 and Færaas, 2016a) and, following the presentation of a parliamentary report on energy policy (Regjeringen, 2016) in Norway, possibly even earlier (Færaas, 2016b).
- The announcements from France and the United Kingdom to ban ICEs in 2040 (MTES, 2017; GOV.UK, 2017).
- The EV30@30 campaign of the Electric Vehicles Initiative (EVI), launched at the Clean Energy Ministerial meeting in June 2017 and supported by major global economies, setting the collective aspirational goal for all EVI members of a 30% market share for EVs in the total of all passenger cars, light commercial vehicles, buses and trucks by 2030 (CEM-EVI, 2017).

The strong governmental interest in electric mobility is not only driven by the desire to cut GHG and pollutant emissions, but is also likely to be part of an industrial policy that aims at acquiring a leadership position in the early phase of the development of the market for PEVs. This is especially strong in the case of China, and consistent with scenarios that suggest that PEVs will gain relevance.

The automotive industry is mobilising investments

OEMs and component providers are mobilising investments to respond to the dynamic evolution of transportation services and the policy environment, integrating PEVs in the light vehicle market. Several OEMs announced plans to deploy PEVs, and a number of them indicated deployment targets for the 2020 to 2025 time frame (Table 1).

Table 1 • List of OEM announcements on electric car ambitions, as of April 2017

OEM	Announcement	Source
BMW	0.1 million electric car sales in 2017 and 15-25% of the BMW group's sales by 2025	Lambert (2017)
Chevrolet (GM)	30 000 annual electric car sales by 2017	Loveday (2016)
Chinese OEMs	4.52 million annual electric car sales by 2020	CNEV (2017)
Daimler	0.1 million annual electric car sales by 2020	Daimler (2016)
Ford	13 new EV models by 2020	Ford (2017)
Honda	Two-thirds of the 2030 sales to be electrified vehicles (including hybrids, PHEVs, BEVs and fuel-cell electric vehicles)	Honda (2016)
Renault-Nissan	1.5 million cumulative sales of electric cars by 2020	Cobb (2015)
Tesla	0.5 million annual electric car sales by 2018 1 million annual electric car sales by 2020	Goliya and Sage (2016), Tesla (2017)
Volkswagen	2-3 million annual electric car sales by 2025	Volkswagen (2016)
Volvo	1 million cumulative electric car sales by 2025	Volvo (2016)

Note: Chinese OEMs include BYD, BJEV-BAIC Changzhou factory, BJEV-BAIC Qingdao factory, JAC Motors, SAIC Motor, Great Wall Motor, GEELY Auto Yiwu factory, GEELY Auto Hangzhou factory, GEELY Auto Nanchong factory, Chery New Energy, Changan Automobile, GAC Group, Jiangling Motors, Lifan Auto, MIN AN Auto, Wanxiang Group, YUDO Auto, Chongqing Sokon Industrial Group, ZTE, National Electric Vehicle, LeSEE, NextEV, Chehejia, SINGULATO Motors, Ai Chi Yi Wei and WM Motor.

Source: IEA (2017b), *Global EV Outlook 2017*, www.iea.org/publications/freepublications/publication/GlobalEVOutlook2017.pdf. See References section for the sources cited in the Table.

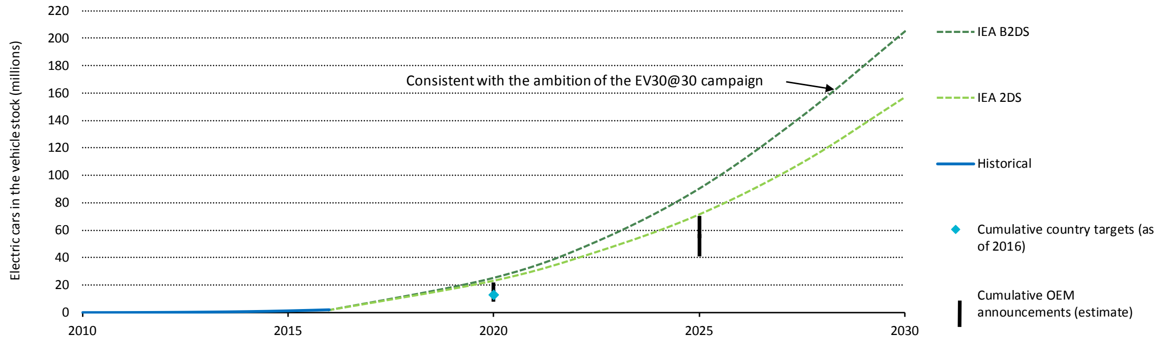
Key point: By April 2017, nine global OEMs had publicly announced their willingness to create or significantly widen their electric model offer over the next five to ten years. Several Chinese OEMs also announced plans for a very significant scale-up in production capacity of electric cars.

All these moves suggest that there is significant action currently taking place to transform the global vehicle market. IEA scenarios (Figure 3) attempt to grasp these dynamics, giving priority to the policy analysis and cost developments on PEV technologies over other options for the achievement of transport sustainability targets.

- In the 2°C Scenario (2DS), the IEA projections fall in the upper end of the range indicated by the assessment of cumulative sales achievable when all OEM targets listed in Table 1. By 2030, the level of deployment of PEVs exceeds 150 million. By 2050, fuel economy continues to improve, and so does the decarbonisation of other sectors of the energy system. The aim is to reach net-zero emissions across the energy system in the 2080 to 2090 time frame.
- Results in the Beyond 2°C Scenario (B2DS) are driven primarily by the need to meet the ambition of the Paris Agreement, and therefore to decarbonise the whole energy system by 2060. Given the 2060 constraint and the greater challenges to decarbonise long-distance modes, LDV travel

is nearly fully reliant on electricity or other low-carbon energy carriers by 2060 in B2DS. By 2030 there will need to be more than 200 million PEVs on the road in B2DS.

Figure 3 • PEV stock shares for 2020 and 2030



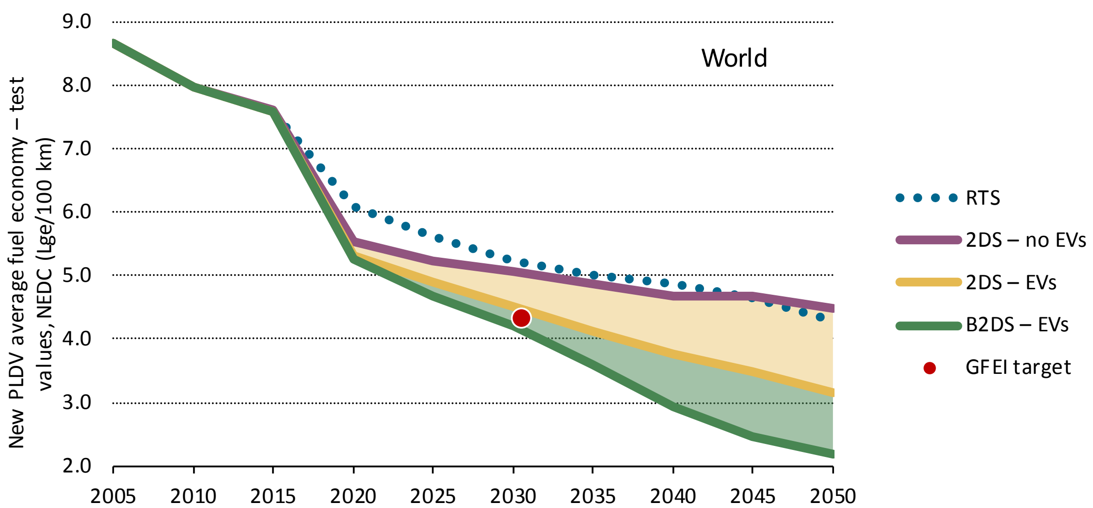
Notes: 2DS: consistent with a 50% chance to limit the increase of the global average temperature to 2°C; B2DS: aiming at 1.75°C

Source: IEA (2017b), *Global EV Outlook 2017*, www.iea.org/publications/freepublications/publication/GlobalEVOutlook2017.pdf.

Key point: The level of ambition resulting from the OEM announcements assessed shows a fairly good alignment with country targets to 2020. To 2025, the range estimated suggests that OEM ambitions monitored in Table 1 are close to the 2DS projections from the IEA.

The IEA 2DS results are broadly consistent with the ambition of the GFEI target, while the B2DS requires exceeding the GFEI ambition (Figure 4). B2DS also sees a stronger decline in energy use per kilometre after 2030, placing a stronger focus on the need for an early deployment of zero-emission technologies for LDVs. Millions of PEVs will need to be on the roads by 2030 in order to have a chance to achieve strong market dominance in the 2040-50 time frame, necessary to meet the ambition of the Paris Agreement.

Figure 4 • Contribution of PEVs for fuel economy improvements in IEA scenarios, 2005 to 2050



Notes: PLDV = passenger light-duty vehicle; NEDC = New European Driving Cycle; Lge/100 km = litres of gasoline equivalent per 100 km. The scenario labelled as “2DS – no EVs” takes into account that the PEVs included in the 2DS would be replaced by gasoline-powered ICEs having an average fuel use that comes with the full potential improvement characterising this technology, consuming 32% less fuel per kilometre than the current global average.

Key point: Meeting the GFEI 2030 target of doubling the average fuel economy of new LDVs globally will require moving beyond ICE technologies, at least into hybridisation. PEVs are the best option available to fully comply with and then exceed the GFEI target, meeting the ambition of the Paris Agreement.

Conclusion

At the time of the establishment of the GFEI targets (2009), expectations on the costs for battery technologies was much higher than the values being discussed today, suggesting that vehicle electrification would come at very high cost. Recent estimates of battery costs and performances show major improvements, well beyond the expectations of 2009. This indicates that the cost of achieving fuel economy improvements from PEVs is likely to be significantly lower than initially anticipated.

The transition to electric mobility has many positive implications for energy diversification, air quality and GHG emission mitigation, given that low-carbon energy sources for power generation already account for the majority of new capacity additions, and this is expected to continue in the future. Although PEVs may not be needed to reach GFEI 2030 targets, they are necessary to achieve the very low CO_2 emissions per kilometre that are likely to be targeted by polices aiming to meet the ambition of the Paris Agreement in the years following 2030.

The prospects for cost reduction and the achievement of cost parity with ICE vehicles, combined with the evidence of the multiple benefits of the electrification of transport vehicles, have led to significant developments in the policy area. Key examples include the introduction of ZEV mandates in China, the proposal for a significant reduction of the average CO_2 emissions per kilometre in the European Union (including clear signals calling for the increased deployment of BEVs and PHEVs), and a number of announcements from major governments on bans of conventional car technologies between 2030 and 2040.

The strong governmental interest in electric mobility is not just driven by the desire to cut GHG and pollutant emissions, but is also likely to be part of an industrial policy that aims at acquiring a leadership position in the early phase of the development of the market for PEVs. Ride-hailing services and continuous progress on vehicle automation are also likely to place upward pressure on average mileages, favouring PEVs over competing technologies because of their greater efficiency and lower operational costs.

All of these developments underscore the dynamic changes occurring in the area of transport electrification. Major OEMs are mobilising resources and to integrate PEVs into the LDV market, as demonstrated by recent announcements for ambitious targets to be reached in the 2020s.

Given the significant benefits offered by PEVs for energy efficiency, diversification, and the reduction of local pollution and GHG emissions, GFEI partners welcome the dynamic developments taking place on the electrification of transport.

In particular, **GFEI partners welcome policy measures that could help achieve, at once, a greater deployment and uptake of EVs, the improvement of fuel economy, and the facilitation of a transition to a clean energy system**, such as:

- Vehicle taxation based on fuel economy or CO_2 emissions per kilometre (including feebate schemes), thereby enhancing the short-term cost-competitiveness of PEVs.
- The continued tightening of fuel economy standards, ensuring that the ambition of the GFEI target for 2030 is fully met and mobilising investments in the private sector for the development of capacity to produce PEVs and diversify the offer of models available to consumers.
- The use of ZEV mandates or deployment incentives to crystallise the market deployment of PEVs in the next decade, warning about the need to avoid trade-offs between PEV uptake and the average improvement in fuel economy of the whole vehicle fleet (e.g. because of double counting of EVs).

- A coordinated approach on policy development across different administrative levels, given the need to ensure that the increase in the number of PEVs on the road is adequately accompanied by the deployment of charging infrastructure.
- Co-ordinated measures covering not only PEV market uptake and charger availability but also the integration of PEVs in the power grid. In this respect, GFEI partners welcome demand management practices and policies that capitalise on the availability of energy storage capacity from PEVs to enable the greater integration of variable renewable energy in the power generation mix.

GFEI partners will work proactively to integrate these policies in the context of their technical assistance and capacity building work for the development of fuel economy policies.

References

CEM (Clean Energy Ministerial)-EVI (Electric Vehicles Initiative) (2017c), “EV30@30 campaign”, OECD/IEA, Paris, www.iea.org/media/topics/transport/3030CampaignDocumentFinal.pdf.

CNEV (2017), “A survey of investment and capacity planning of new energy vehicles in China”, www.chinanev.net/news/newscontent/id/9582.

Cobb, J. (2015), “How Nissan and Nenault are Dominating the Electric Car Game”, www.hybridcars.com/how-nissan-and-renault-are-dominating-the-electric-car-game.

Daimler (2016), “Interview Prof. Dr. Thomas Weber: ‘Electric mobility at Daimler will be in the six figures by 2020’”, http://media.daimler.com/marsMediaSite/en.

EC (European Commission) (2017), *Post 2020 Light Vehicle CO_2 Regulation(s)*, https://ec.europa.eu/info/law/better-regulation/initiatives/com-2017-676_en.

Færaas, A. (2016a), “Ap går inn for tilnærmet forbud av salg av nye bensin- og dieselbiler innen 2030” [Labour Party Calls for the Prohibition of the Sale of New Petrol and Diesel Vehicles by 2030], *Aftenposten*, 4 February, www.aftenposten.no/norge/politikk/i/mrkL/Ap-gar-inn-for-tilnarmet-forbud-av-salg-av-nye-bensin--og-diesebiler-innen-2030.

Færaas, A. (2016b), “DN: Frp, Høyre, KrF og Venstre har mål om salgsstopp av bensin- og dieselbiler i 2025 – Frp og Høyre: Det stemmer ikke – Venstre: Joda, det stemmer” [DN: Frp, Right, KrF and Left Have Targets for Sales of Gasoline and Diesel Cars in 2025 – Frp and Right: It Does Not Matter – Left: Yes, That's Right], *Aftenposten*, 8 June, www.aftenposten.no/norge/politikk/i/563kE/DN-Frp_-Hoyre_-KrF-og-Venstre-har-mal-om-salgsstopp-av-bensin--og-dieselbiler-i-2025---Frp-og-Hoyre-Det-stemmer-ikke---Venstre-Joda_-det-stemmer.

Ford (2017), “Media Ford”, https://media.ford.com/content/fordmedia-mobile/fna/us/en/news/2017/01/03/ford-addingelectrified-f-150-mustang-transit-by-2020.html.

GOI (Government of India) (2017), “EESL to procure 10,000 electric vehicles from TATA Motors”, http://pib.nic.in/newsite/PrintRelease.aspx?relid=171263.

Goliya and Sage (2016), “Tesla puts pedal to the metal, 500,000 cars planned in 2018”, http://www.reuters.com/article/us-tesla-results-idUSKCN0XV2JL.

GOV.UK (2017), “Air quality plan for nitrogen dioxide (NO_2) in UK (2017)”, www.gov.uk/government/publications/air-quality-plan-for-nitrogen-dioxide-no2-in-uk-2017.

Honda, (2016), “Honda adds all-new dedicated hybrid model to growing electrified lineup”, http://news.honda.com/newsandviews/article.aspx?id=9463-en.

IEA (International Energy Agency) (2017a), *Renewables 2017: Analysis and Forecasts to 2022*, OECD/IEA, Paris, www.iea.org/publications/renewables2017.

IEA (2017b), *Global EV Outlook 2017*, OECD/IEA, Paris, www.iea.org/publications/freepublications/publication/GlobalEVOutlook2017.pdf.

IEA (2009*), Transport, Energy and CO_2: Moving Toward Sustainability*, OECD/IEA, Paris, www.iea.org/publications/freepublications/publication/transport2009.pdf.

Kroese, B. (2017), “Regeerakkoord: dít zijn de autoplannen van het nieuwe kabinet [Coalition agreement: these are the car plans of the new cabinet]”, Autokopen, 10 October, https://www.autokopen.nl/autonieuws/2017/oktober/43717-regeerakkoord-dit-zijn-de-autoplannen-van-het-nieuwe-kabinet

Lambert, F. (2017), "BMW explains its electric vehicle plans in more details and it's going in the right direction", https://electrek.co/2017/03/22/bmw-electric-vehicle-plans.

Loveday, E. (2017), "LG Chem expects Chevrolet Bolt sales to exceed 30,000 in 2017", http://insideevs.com/lg-chem-expects-chevrolet-bolt-sales-exceed-30000-2017/.

MIIT (Ministry of Industry and Information Technology of the People's Republic of China) (2017), "乘用车企业平均燃料消耗量与新能源汽车积分并行管理办法" [Corporate average fuel consumption and accounting method related with new energy vehicles], www.miit.gov.cn/n1146295/n1146557/n1146624/c5824932/content.html.

MTES (Ministère de la Transition Ecologique et Solidaire) (2017), "Plan climat: 'Nous devons accélérer pour réussir la transition énergétique'", www.ecologique-solidaire.gouv.fr/plan-climat-quest-cest.

OED (Oxford English Dictionary) (2017), "Lidar", *OED*, https://en.oxforddictionaries.com/definition/lidar.

Regjeringen (2016), "Stortingsmelding om energipolitikken: Kraft til endring" [White paper on energy policy: Power for change], www.regjeringen.no/no/aktuelt/stortingsmelding-om-energipolitikken-kraft-til-endring/id2484248.

SAE International (2016), "Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles", http://standards.sae.org/j3016_201609.

Tesla (2017), "Tesla fourth quarter & full year 2016 update", http://files.shareholder.com/downloads/ABEA-4CW8X0/4066363333x0x929284/22C29259-6C19-41AC-9CAB-899D148F323D/TSLA_Update_Letter_2016_4Q.pdf.

Tietge, U., Díaz, S., Yang, Z. and Mock, P. (2017), "From laboratory to road. International. A comparison of official and real-world fuel consumption and CO_2 values for passenger cars in Europe, the United States, China, and Japan", International Council on Clean Transportation (ICCT) white paper, https://www.theicct.org/sites/default/files/publications/Lab-to-road-intl_ICCT-white-paper_06112017_vF.pdf

Volkswagen (2016), "New Group strategy adopted: Volkswagen Group to become a worldleading provider of sustainable mobility", www.volkswagenag.com/en/news/2016/6/2025.html.

Volvo (2016), "Volvo Cars announces new target of 1 million electrified cars sold by 2025", www.media.volvocars.com/global/en-gb/media/pressreleases.

Waymo (2017), "Waymo's fully self-driving vehicles are here", Medium, 7 November, https://medium.com/waymo/with-waymo-in-the-drivers-seat-fully-self-driving-vehicles-can-transform-the-way-we-get-around-75e9622e829a.

Wolfram, P. and Lutsey, N. (2016), "Electric vehicles: Literature review of technology costs and carbon emissions", International Council on Clean Transportation (ICCT) working paper no. 2016-14, www.theicct.org/sites/default/files/publications/ICCT_LitRvw_EV-tech-costs_201607.pdf.

Acronyms and abbreviations

2DS	2°C Scenario
B2DS	Beyond 2°C Scenario
BEV	battery-electric vehicle
CO2	carbon dioxide
EV	electric vehicle
EVI	Electric Vehicles Initiative
GFEI	Global Fuel Economy Initiative
GHG	greenhouse gas
ICCT	International Council on Clean Transportation
ICE	internal combustion engine
IEA	International Energy Agency
LDV	light-duty vehicle
OEM	original equipment manufacturer
PEV	plug-in electric vehicle
PHEV	plug-in hybrid electric vehicle
RTS	Reference Technology Scenario
STO	Sustainability, Technology and Outlooks
TCO	total cost of ownership
UN Environment	United Nations Environment Programme
US DOE	United States Department of Energy
WLTP	Worldwide Harmonised Light Vehicle Test Procedure
ZEV	zero-emission vehicle

What is the Global Fuel Economy Initiative?

The Global Fuel Economy Initiative believes that large gains could be made in fuel economy which would help every country to address the pressing issues of climate change, energy security and sustainable mobility. We will continue to raise awareness, present evidence, and offer support to enable countries to adopt effective fuel economy standards and policies that work in their circumstances and with their vehicle fleet.

GFEI
GLOBAL FUEL ECONOMY INITIATIVE

Secretariat

Global Fuel Economy Initiative
60 Trafalgar Square
London
WC2N 5DS
United Kingdom
+44 (0)207 930 3882 (t)
+44 (0)207 930 3883 (f)

Contact us

Email: **info@globalfueleconomy.org**
Web: **www.globalfueleconomy.org**

@GlobalFuelEcon | #GFEINetwork
www.youtube.com/GlobalFuelEcon
www.flickr.com/50by50campaign

FIA FOUNDATION | UN environment | UC DAVIS INSTITUTE OF TRANSPORTATION STUDIES | iea International Energy Agency | icct THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION | International Transport Forum

With the support of gef | FIA FOUNDATION