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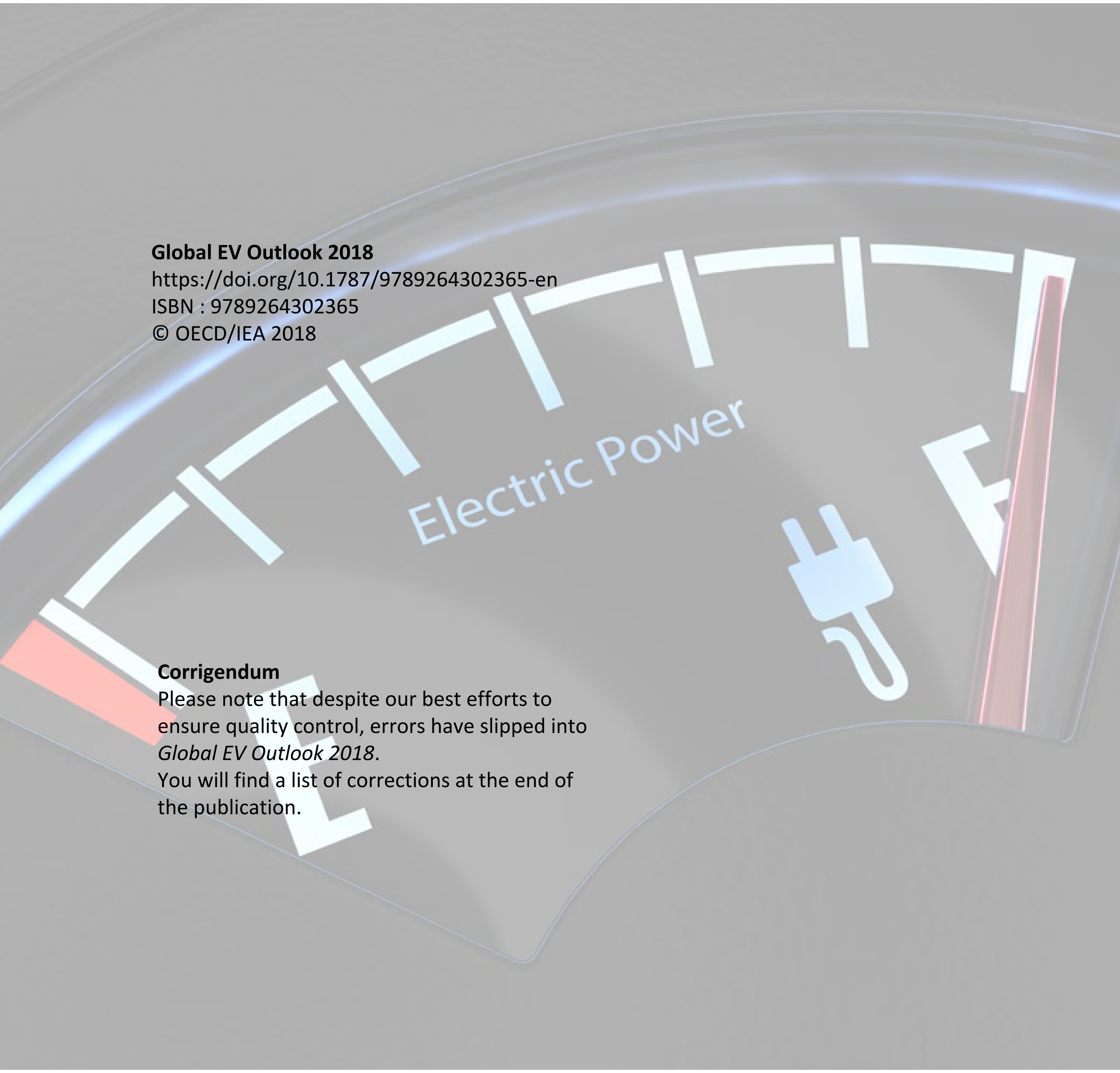
Accelerating the Global Clean Energy Transition

Electric Vehicles Initiative



Global EV Outlook 2018
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Corrigendum
Please note that despite our best efforts to ensure quality control, errors have slipped into *Global EV Outlook 2018*.
You will find a list of corrections at the end of the publication.

Global EV Outlook 2018

Towards cross-modal electrification

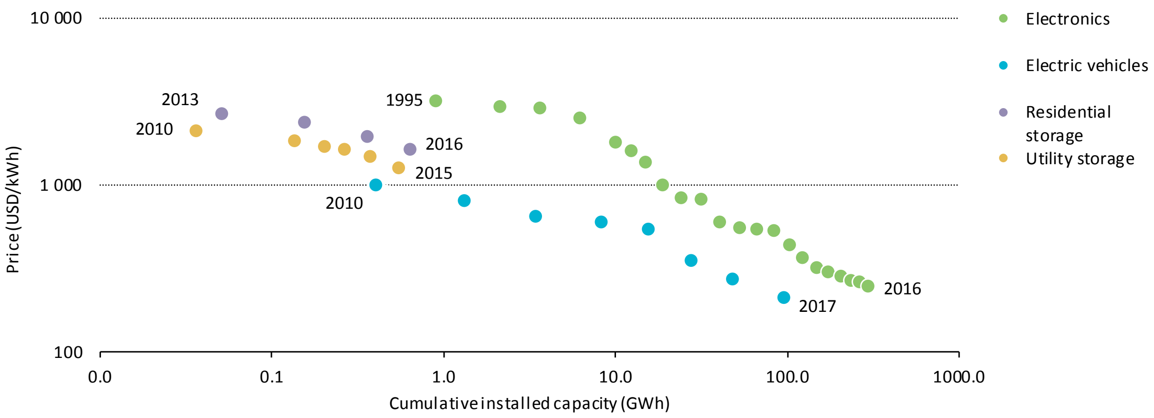
5. Batteries

Current status

Figure 5.1 illustrates the cost reductions relative to cumulative manufactured capacity across lithium-ion (Li-ion) storage technologies used in various applications. It shows that Li-ion batteries have experienced significant cost reductions since their market introduction in the 1990s.

The early development of batteries for consumer electronics provided invaluable experience in the production of Li-ion cells, underpinning the attainment of cumulative production capacity of 100 gigawatt-hours (GWh) by 2010 (Schmidt et al., 2017), enabling the achievement of very significant cost reductions and performance improvements over the past decade. These same developments made the development of Li-ion battery packs for EVs increasingly viable. Over the last five years, cost and performance improvements for EV battery packs supplemented continued technology developments in consumer electronics to become a major driver in the competitiveness of Li-ion storage systems for stationary applications.

Figure 5.1 • Lithium-ion storage technology price developments



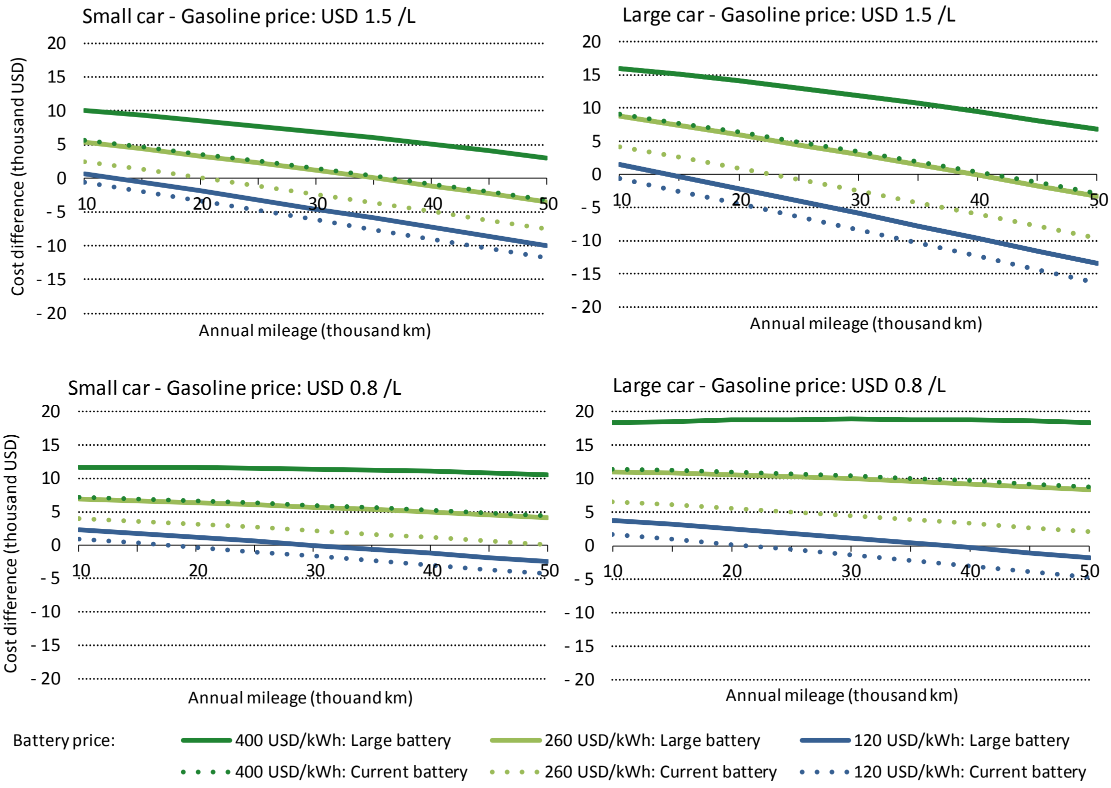
Notes: Axes are on a logarithmic scale. Electronics refer to power electronic batteries (only cells); electric vehicles refer to battery packs for EVs; utility and residential storage refer to Li-ion battery packs plus power conversion system and includes costs for engineering, procurement and construction.

Source: Adapted and updated from Schmidt et al. (2017).

Key point: Lithium-ion storage technology prices have decreased as manufacturing volumes increased. Experience in manufacturing batteries for consumer electronics has driven cost reductions to the benefit of EV packs as well as stationary storage.

Today typical batteries used in EVs are based on the lithium-ion technology which has reached a development level enabling the design of vehicles that begin to match the performance of ICE vehicles. Current battery packs for light-duty applications have gravimetric energy densities of 200 Watt-hours per kilogram (Wh/kg) (Meeus, 2018) and volumetric pack energy densities of 200 - 300 Watt-hours per litre (Wh/l) (ANL, 2018). The lifetime of the battery is another important parameter. For EV batteries, a good proxy is the expected mileage associated with a battery's lifetime and its ability to retain a good share of its initial capacity (usually 80%). Available literature suggests that modern Li-ion chemistry for EV batteries can withstand 1 000 cycle degradation (Warner, 2015). Assuming a battery capacity of 35 kWh and an average consumption of 0.2 kWh/km suggests that

Figure 5.5 • Comparative total cost of ownership of a different sized BEV and ICE at three battery price levels



Notes: High fuel price level: USD 1.5 per litre of gasoline equivalent (Lge). Low fuel price level: USD 0.8/Lge. Assumptions used for the small car example: power of 85 kW, 60 kWh for the large battery case, 40 kWh for the current battery , electric vehicle fuel economy of 0.20 kWh/km and ICE vehicle on-road fuel economy of 6.6 Lge/100 km. Assumptions used for the large car example: power of 172 kW, 93 kWh battery for the large battery example, 62 kWh for current battery case, electric vehicle fuel economy of 31 kWh/100 km and ICE vehicle on-road fuel economy of 10.3 Lge/100 km. These assumptions are consistent with a range of about 300 km for both car sizes. The calculations assume an electricity price of USD 0.12/kWh and an additional charging cost of USD 0.04/kWh. The capital costs of buying the vehicle are differentiated between a BEV and an ICE vehicle according to the difference in powertrain costs. These costs are subject to an annual depreciation rate that is variable depending on the annual mileage level (higher levels experience higher annual depreciation rates). An average ownership time of 3.5 years is assumed. Annual maintenance costs of a BEV are approximately 20% of the costs for an ICE vehicle. The cost of tyres per km is nearly double for a BEV compared with an ICE vehicle. The large battery case represents the battery sizes we anticipate around 2030. The current battery case reflects battery sizes expected around 2020. Results shown here assume constant energy use per km for ICEVs and BEVs.

Key point: Choosing a BEV over an ICE vehicle is more attractive for small cars if battery costs are low, fuel prices are high and daily distances driven are high.

A number of lessons can be drawn from Figure 5.5[4], including:

- The TCO gap between BEV and ICE cars reduces significantly for vehicles with high annual mileage.
- Battery and gasoline prices have a larger influence on the TCO gap than the size of the car.
- With a battery price of USD 120/kWh and a high gasoline price (comparable to today's price level in Europe), a BEV is an economical choice for all driving mileage profiles.

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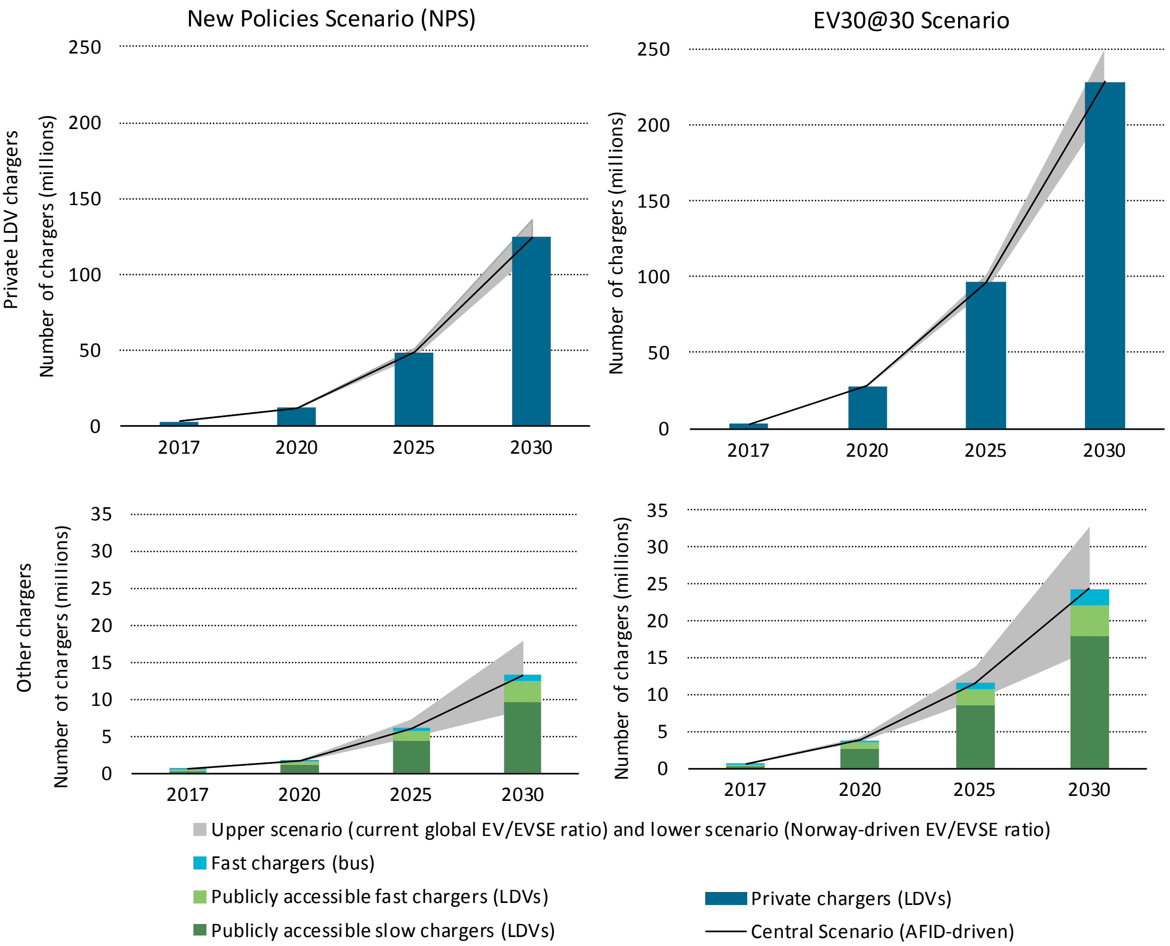
[4] Note that these considerations do not change even when accounting for a 30% reduction of the energy use per km of an ICE vehicle and a contextual 20% reduction for a BEV (a case not shown in Figure 5.5).

Figure 6.7 • Global LDV private chargers and publicly accessible LDV and bus chargers by scenario (2017-30)



Key point: Publicly accessible LDV and bus charging outlets expand from a total of 550 000 units in 2017 to up to 33 million by 2030 in the EV30@30 Scenario.

Impacts on energy demand and CO_2 emissions

The EV activity growth projected in the New Policies and EV30@30 scenarios result in an increase of electricity demand in each region. In 2030, the worldwide electricity consumption from EVs reaches 404 TWh in the New Policies Scenario and 928 TWh in the EV30@30 Scenario. These values represent, respectively, a 7-fold and 17-fold increase when compared with the electricity consumed by EVs in 2017.

Structure of electricity demand: New Policies Scenario

In the New Policies Scenario, EVs are projected to consume approximately 404 TWh of electricity in 2030. Light-duty vehicles overtake two- and three-wheelers and become the main electricity consumer among electric vehicles in 2030 (when they account for 62% of the total EV demand), followed by two- and three-wheelers (20%), buses (13%) and trucks (5%). The geographical distribution of the power consumption from EVs reveals that the EV stock in China remains the largest consumer, even if China's share in global electricity consumption from EVs