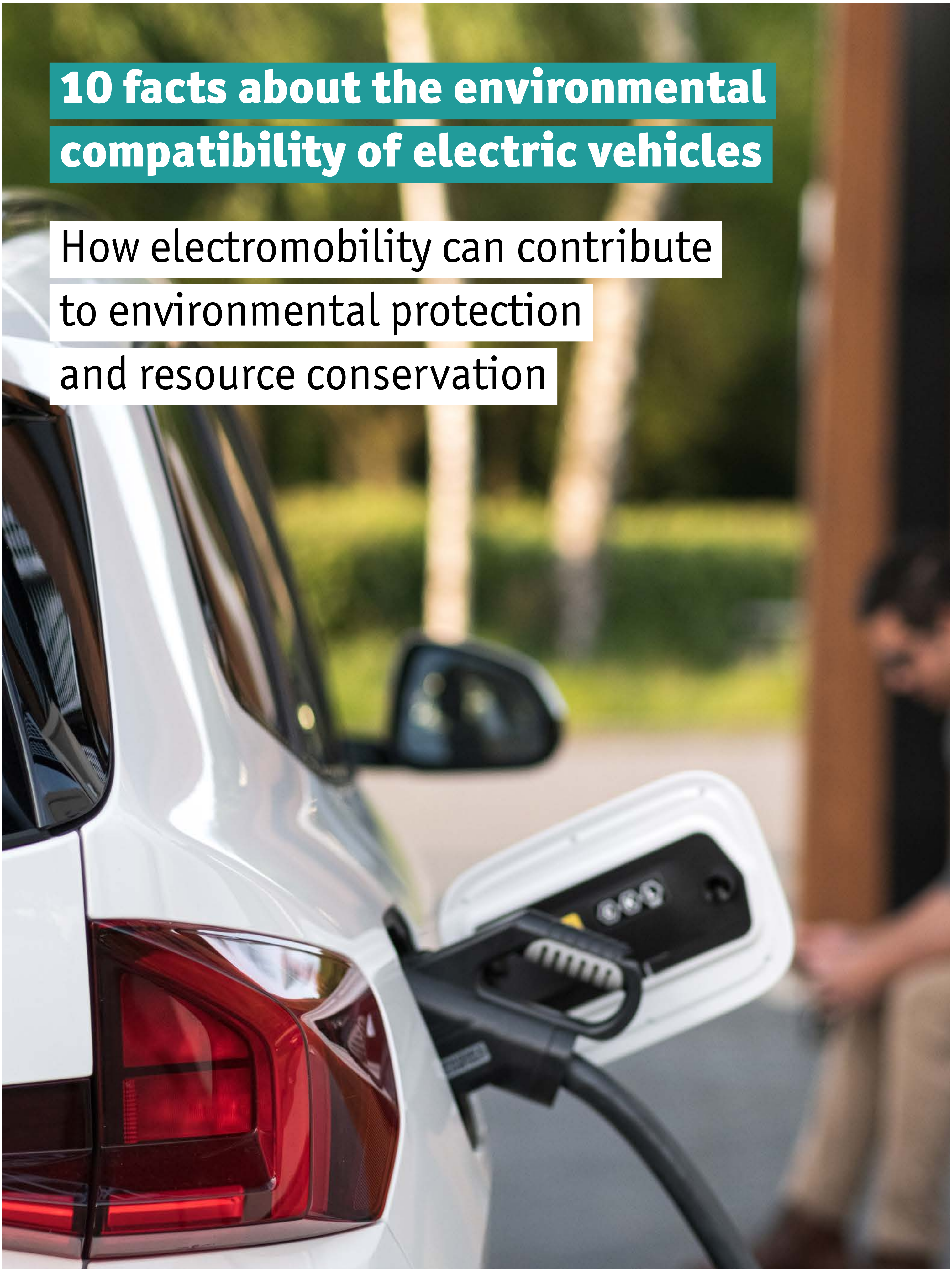
Deutsche Umwelthilfe

10 facts about the environmental compatibility of electric vehicles

How electromobility can contribute to environmental protection and resource conservation



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Since 1990, the transport sector has only achieved a marginal reduction in its greenhouse gas emissions. Between 1990 and 2022, greenhouse gas emissions caused by transport in Germany fell by just 10 percent, from 164 million tons to around 148 million tons of CO_2 equivalents.[1, 2] For Germany to become climate-neutral, however, emissions from transport must fall to 84 million tons of CO_2 equivalents by 2030 and to zero by 2045.[3] The current measures in the transport sector are not nearly enough to achieve this. The gap to comply with the 1.5 degree limit is even larger; the transport sector in Germany is currently on course for around 3 degrees.[4]

In view of these challenges, an accelerated transition to a climate-friendly transport sector is urgently needed. A significant contribution can be made by switching to electric drives, which can offer major advantages over combustion engines in terms of efficiency, lower greenhouse gas emissions and reduced local noise and air pollutant emissions. However, the production and use of electric vehicles is associated with environmental impacts and is not a panacea, particularly with regard to resource-intensive battery production. In addition to the climate crisis, the supply of raw materials and the holistic sustainable design of the transport sector must increasingly be taken into account.

This fact sheet comprehensively analyzes the environmental compatibility of electric vehicles in the passenger car segment and dispels the most common myths about electromobility. It also presents ways to minimize the resource requirements and other environmental impacts during the switch to electric drives. Only by creating the right framework conditions, the transport sector can become sustainable and make an effective contribution to achieving climate targets without shifting environmental impacts to other problem areas.

Facts

Fact 1: Vehicles with an electric drive are more environmentally friendly than vehicles with a combustion engine in the overall view.

The production, use and disposal of every vehicle has a negative impact on the environment. Nevertheless, life cycle assessments show that over its entire life cycle (production, use and disposal), an electric car causes less impacts on the climate and the environment than a comparable combustion-powered vehicle.[5, 6, 7, 8] During use, electric cars do not emit any harmful exhaust gases and can cause less noise at low speeds. With the current electricity mix, a mid-range electric car is after approx. 60,000 kilometers more climate-friendly than a comparable combustion-powered vehicle. Over the entire life cycle, greenhouse gas savings of 66 to 69 percent can already be achieved today.[9, 10, 11] If the proportion of green electricity used in battery production and for charging processes continues to increase, greenhouse gas emissions will be further reduced.[12] Due to their batteries, electric vehicles contain critical resources such as lithium, cobalt and nickel, the extraction of which is associated with major environmental damage. However, unlike fossil fuels, battery raw materials can be reused through an effective circular economy system. This means that the environmental impact of extraction can be mitigated. In addition, it is very likely that other battery types will be used in the future that require fewer metals such as lithium, nickel and cobalt, which will lead to a further reduction of the environmental impact. Against this background, the electric drive is the most promising drive method for more environmentally friendly mobility.

Fact 2: Switching from combustion to battery drive is not enough to solve environmental problems - it must go hand in hand with a fundamental change in mobility and more resource and energy efficiency.

Limiting global warming to 1.5°C would mean that Germany has to be climate-neutral by 2031.[13] In Germany, transportation alone is currently responsible for around a fifth of total climate emissions. A significantly accelerated phase-out of combustion engines is required to achieve the necessary reduction in these emissions. This means that the sale of combustion vehicles must end before 2025. At the same time, the switch to battery drives must go hand in hand with a comprehensive mobility transition that avoids or largely shifts traffic away from motorized private transport towards walking, cycling and public transport.[14, 15, 16] This is necessary because the production of green electricity, vehicles and batteries is also associated with environmental impacts that must be kept to a minimum. Added to this are the negative effects due to high space requirements of private transport, especially in cities. The Federal Environment Agency of Germany recommends a target level for motorization of maximum 150 cars per 1000 inhabitants (including car sharing and cab vehicles), while the current figure is more than 570 cars per 1000 inhabitants.[17] As part of a mobility transition, walking, cycling and local public transport must be promoted much more strongly and made more attractive. Electric vehicles are an environmentally friendly solution for the remaining unavoidable motorized private transport, provided that small and light vehicles with the lowest possible consumption of electricity, materials and resources are used. This requires regulatory requirements that reverse the trend towards ever larger, heavier and overpowered vehicles that has been observed for years.

Fact 3: Battery vehicles and combustion vehicles are both a burden for our water resources.

Electric vehicles are often associated with high water consumption due to battery production. However, large quantities of water are also consumed during the extraction of crude oil for the production of petrol or diesel. A mid-range car with a combustion engine and a mileage of 200,000 km requires around 170,000 to 407,000 liters of water due to fuel consumption.[18] A comparable car with a battery drive consumes only around 27,000 liters of water over the same distance.[19] This water consumption is linked to the provision of electricity and will decrease even further with the increased use of green electricity. During actual operation, electric cars therefore use relatively few water resources. However, it should be noted that the production of some battery raw materials also requires a lot of water. As a result, the production of an average battery for a mid-range car and the extraction and processing of the battery raw materials therein requires additionally around 50,000 liters of water.[20] Lithium, for example, is globally only found in a few regions with often scarce water reserves and requires large quantities of water during extraction (via mining or brine mining).[21] It can be seen that both, combustion and battery drives, place a burden on local and global water resources. During switching to battery drive systems, it is therefore particularly important to use water-intensive materials such as lithium efficiently during battery production and to recover them at the end of life.

Fact 4: Hydrogen, as an alternative fuel, is inefficient and expensive and therefore unsuitable for the passenger car sector.

Hydrogen is used as an alternative fuel for the fuel cell drive. Through this technology, hydrogen generates electricity that serves to drive an electric motor. To date, hydrogen is produced almost exclusively from fossil natural gas. This production is associated with high climate emissions and has no advantages over combustion engines. The production of hydrogen by electrolysis using electricity is more environmentally friendly if electricity comes 100 percent from additionally provided green sources. In this case one speaks of „green" hydrogen.[22] However, electrolysis and the storage and distribution of produced hydrogen are associated with high energy losses. For this reason, direct use of the electricity in a battery-powered electric vehicle is much more efficient. For example, a battery-powered electric car can travel more than twice as far as a hydrogen vehicle with the same amount of electricity, including charging losses (see fact 6).[23] As renewable energies are extremely scarce and precious, the widespread use of hydrogen in road transportation would be a massive waste of energy.[17] Despite enormous government funding, Fuel cell vehicles have only played a niche role on the market for

years; no German car manufacturer offers a fuel cell car in series production. Battery electric vehicles, on the other hand, are ready for the market, significantly cheaper and can already now bring about a rapid reduction in CO_2 emissions in the passenger car segment.

Fact 5: Agrofuels and e-fuels do not make the combustion engine environmentally friendly.

Agrofuels are fuels that are obtained from plants grown specifically for this purpose. E-fuels, on the other hand, are produced synthetically from hydrogen and CO_2 with high electricity consumption. Both types of fuel are therefore no fossil fuels, but have similar properties as petrol or diesel and thus can be used in conventional combustion vehicles. What sounds promising, however, turns out to be a sham solution on closer inspection:

Food and animal feed crops such as soy, rapeseed and grain are cultivated on large areas for the production of agrofuels. Fuel production is therefore in direct competition with food production and exacerbates the global food crisis. The land used worldwide in 2020 alone for the production of agrofuels for the German market could have met the calorie requirements of up to 35 million people.[24] This enormous land consumption and intensive farming on the cultivated areas also accelerates the climate crisis, the extinction of species and water, air and soil pollution. If the problem of land consumption would be included into the calculation of the carbon footprint of agrofuels, it would turn out that they are overall even more harmful to the climate than fossil fuels, as the huge cultivation areas consume precious land that would otherwise act as a natural CO_2 sink.[25, 26]

The production of e-fuels requires hydrogen, the production of which requires large amounts of green electricity and is very inefficient (see fact 4). With an efficiency level of around 15 percent, e-fuels are even less efficient than fuel cell drives and require around 5-6 times more electricity to cover the same distance as battery electric vehicles.[27] In terms of emissions of toxic nitrogen oxides, e-fuel vehicles are just as bad as fossil-fuel vehicles.[28] Currently, e-fuels are only produced in extremely small quantities and in a few demonstration plants worldwide. E-fuels are therefore not currently commercially available and will probably only be accessible in small quantities for many years to come. Even if all currently announced e-fuel projects were to be realized, total global e-fuel production in 2035 together could only cover around 10 percent of Germany's current e-fuel requirements in the chemical, marine and aviation sectors.[29] There is thus no capacity for the use of e-fuels in road transport. These numerous problems show that switching to other fuels for the combustion engine is a mistake and would not bring the necessary rapid environmental and climate relief.

Fact 6: The electric drive has the highest efficiency compared to other drive methods.

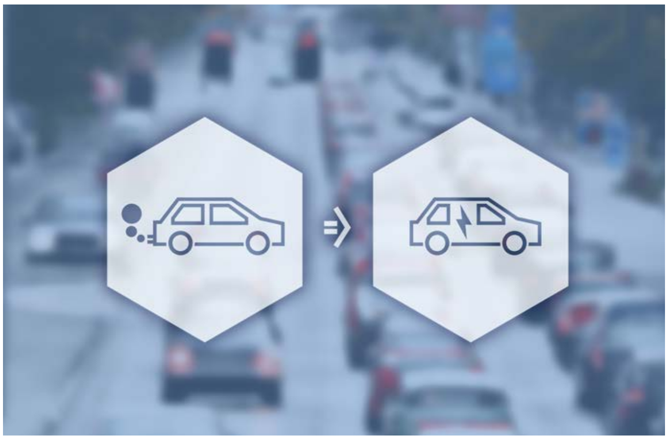
The generation of green electricity is not possible indefinitely and is associated with environmental impacts as well, such as e.g. land and resource consumption. For this reason, the energy demand in transport must be minimized through a consistent mobility transition and the energy produced must be used as efficiently as possible. For unavoidable car traffic, the drive technique with the lowest energy requirement per distance should therefore be preferred. The efficiency of a drive system indicates what proportion of the energy supplied is actually converted into useful energy. A diesel engine has an efficiency of around 45 percent, while a petrol engine has only 20 percent. An electric vehicle, on the other hand, achieves around 64 percent, including charging losses. Other so-called alternative drive methods are significantly inferior to electric drives in terms of efficiency: fuel cells only reach 27 percent and e-fuels 15 percent.[18, 30]

Fact 7: The mobility transition and electromobility can significantly improve the quality of life, especially in urban areas.

The dense volume of traffic in urban areas significantly restricts the quality of life of many people due to high noise pollution, poor air quality and sealed surfaces. Compared to combustion vehicles, electric vehicles do not emit any direct air pollutants, such as nitrogen oxides, while driving and can therefore contribute to improve air quality in urban areas in the medium to long term.[5,31, 32] In addition, vehicles with an electric motor are at slow speeds significantly quieter than conventional combustion vehicles. However, electric vehicles are not noise-free either. In addition, there are still considerable particulate emissions from brake and tire wear and the problem of high space consumption. Cycling, walking and local public transport take up significantly less space than private cars and lead to lower noise and pollutant emissions. Switching from combustion engines to battery-powered vehicles is therefore not the full solution. In order to improve the quality of life, a comprehensive mobility transition is necessary, especially in cities. The number of vehicles on the roads must be reduced substantially and the remaining unavoidable cars must become smaller, lighter, more efficient and locally emission-free.[8, 9, 10]

Fact 8: The expansion of electromobility requires a lot of resources, but in contrast to combustion engines, this resource requirement can be significantly reduced through circular economy.

It is undisputed that the battery drive consumes large quantities of metals such as lithium, cobalt, nickel and copper for the battery and rare earths for the electric motor.[33] The demand for these metals will continue to rise in the coming decades, among other factors also because of the expansion of electromobility.[34, 35] However, future increases in efficiency, new battery technologies and an expansion of circular economy will help to significantly reduce the need for new raw materials to be extracted (see facts 9 and 10).[28] Even if battery drives require more metal in the short to medium term, this will contribute to a significant reduction in the use of fossil fuels in the long term: An average combustion vehicle requires around 15,000 liters of fuel over its lifetime and the extraction of these fossil raw materials is associated with massive ecological damage.[36, 37] In comparison, the metals used in electromobility can be increasingly reduced, substituted or recycled.[38, 39, 40]



Fact 9: Efficiency and a circular economy are the key to resource-saving electromobility.

Raw materials such as lithium or cobalt must be reduced to an absolute minimum in the production of vehicles and batteries in order to curb the further extraction of primary raw materials. First of all, the number of cars on the roads must be significantly reduced as part of a consistent mobility transition (see Fact 2). Considerable resources can also be saved by using smaller, lighter and less motorized cars with a higher frequency of use. Vehicles and batteries also need a resource-efficient, durable and repair-friendly design. Critical materials such as cobalt or rare earths must be minimized or substituted. Additionally, long-term use can significantly reduce the environmental impact of vehicle production and contained batteries. A durable and easily repairable design and good repair conditions are crucial for this. Batteries are well reusable in a „second life“ after use as a traction battery: With a residual capacity of usually around 70 percent, for example, they can be used for another 7 to 10 years as stationary energy storage or for less demanding mobility applications.[32, 41, 42] Furthermore, recycling offers the opportunity to recover important key raw materials such as nickel, cobalt, copper, iron and aluminum from batteries.[43, 44] However, it is crucial to create good conditions for reuse, repair and recycling now, at the time of production of vehicles and batteries. This is the only way to exploit the full potential of circular economy.

Fact 10: Compared to combustion vehicles, there are many opportunities to reduce the environmental impact of electric cars further in the future.

The environmental impacts from electromobility depend heavily on the energy mix used for charging and production as well as the raw materials used. In future, however, a higher proportion of green electricity in the energy mix will significantly reduce the environ-

mental impact of electric cars, both during use and production. In addition, more efficient manufacturing processes, new battery types and the establishment of reuse and recycling structures will further reduce the amount of raw materials required for the production of batteries and electric vehicles.[3, 4, 5] The use of problematic raw materials can thus probably be significantly reduced in the future and in some cases avoided altogether, as indicated by promising current innovations such as the sodium ion battery, the lithium iron phosphate battery, the solid-state battery or vehicles without rare earths.[45, 46] However, the massive environmental and climate impact of combustion vehicles cannot be reduced. This is because the fossil fuel is burned and not reused or recovered. The environmental damage caused by oil production will raise even more in the future, as crude oil has to be extracted increasingly from sources that are more difficult to tap - such as oil sands, oil shale and the deep sea.[47]

Conclusion

Battery-powered vehicles can help to reduce CO_2 emissions in the transport sector during a comprehensive mobility transition. This significant contribution to climate protection can be further advanced through the consistent expansion of renewable energies in the electricity sector and specifications for energy-efficient and resource-saving vehicles and batteries.[48] However, in order to prevent the expansion of electromobility from merely shifting environmental problems to other areas, the switch to battery drives must be as resource-efficient as possible. First and foremost, this requires a significant reduction in individual car traffic as part of a consistent mobility transition and a trend reversal towards small, light and less motorized vehicles. In addition, the production, use and disposal of electric vehicles and batteries should be subject to strict legal requirements at an early stage in order to minimize the use of resources and other environmental impacts. Important criteria in this context are durability, the promotion of reuse, reparability and high quality recycling of batteries and vehicles. Under a legal framework that meets these requirements, electromobility will be able to make a valuable contribution to environmental protection and resource conservation in the long term.

Endnotes

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