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Sustainable reading
from the Oeko-Institut

A quiet climate champion

The future of e-mobility

Debunking myths Interview with Drs. Auke Hoekstra

Making headway at last

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Electromobility was the outlier for a long time, until just a few years ago. In 2016, electric vehicles still accounted for less than 1% of new registrations. 2020 saw the figure soaring to 13%, and the number of models available almost quadrupled between 2015 and 2020. When it comes to two-wheelers, electric drives have also followed a clear upward trajectory. E-vehicles are making headway at last. They are, after all, a key element in the urgently needed transformation of the transport sector and automotive industry.

If e-mobility is to stay on track, stability for forward planning is required and the right frameworks must be in place. The pace and direction of travel are becoming increasingly clear: under plans put forward by the EU, only carbon-neutral vehicles will be permitted on Europe's roads from 2035, while Germany's coalition agreement sets targets of 15 million fully electric cars and a million public charging stations by the end of 2030. What is lacking in the coalition's proposals, however, are effective mechanisms for achieving these ambitious targets. Many different measures are required: in addition to infrastructural development and expansion, they must include a further tightening of emission limits, as well as financial incentives and appropriate support schemes. There is another aspect which should not be overlooked here: our mobility must radically change. With all due respect to e-mobility, it goes without saying that a kilometre travelled on foot, by bicycle or by electric bus rather than by car is still the greener option.

Speaking of green: one frequent point of criticism is the resource consumption associated with e-mobility, and we will be looking at this topic in detail in the following pages. Anyone who complains about electric cars' resource requirements should take a moment to compare them with the alternative, namely fossil-fuelled vehicles, and look at the quantity of resources consumed and the conditions and implications of their extraction in each case. Overall, the balance is clearly in favour of electric drives. But of course, we need to address the issues of battery recycling and sustainable resource extraction here as well.

Electromobility is also moving ahead at the Oeko-Institut. Since 2020, we have been offering our staff a "work bicycle" as part of their benefits package. Various options are available, including electric bicycles, which are especially popular with staff who have long commutes. For them and for us, electromobility is a convincing technology. We expect more bicycle manufacturers who are investing in e-mobility to make further technological advances in the years to come. What are your expectations here?

Yours,
Jan Peter Schemmel

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"Most people who are opposed to e-vehicles have probably never even sat in one"

The batteries run down too fast and can't be recycled and the emissions are far too high. These are just some of the countless myths surrounding e-mobility. Drs. Auke Hoekstra has heard them all – and is constantly debunking misleading or even false statements about electric vehicles for his 25,000+ Twitter followers. A Program Director at Eindhoven University of Technology, Auke Hoekstra looks at how the energy system and mobility can become greenhouse gas-neutral. In this interview with eco@work, he explains how these myths arise, why they are wrong and how they can best be debunked.

Drs. Auke Hoekstra, which of the myths about e-mobility has annoyed you the most?
The fable that e-vehicles have to clock up extremely high mileage in order to offset the additional emissions from their production. At one point, there was talk of 100,000 kilometres and more. The real figure for most cars is closer to 30,000 km.

How did these inaccurate figures arise?
First of all, the emissions from battery production are often exaggerated, or obsolete data are used. Of course, it makes a significant difference whether the batteries are manufactured in a modern gigafactory or a small, outdated production unit, although there are very few of those still in existence. What's more, the emissions are often calculated on the basis of the current electricity mix, ignoring the fact that our electricity is becoming increasingly green and emissions performance is constantly improving. And in the comparison with combustion engine vehicles, estimates of their fuel consumption tend to be far more optimistic than the reality, while emissions from petrol and diesel production are rarely factored in.

And battery lifetimes are often underestimated.
That's true. In fact, nowadays, they last longer than the cars themselves. The rule of thumb is that a battery should be replaced when it still has 80% of its capacity. The new electric cars would have to clock up mileage well in excess of 500,000 kilometres for that, and the figure is likely to increase further over time.

How do you respond to the claim that the batteries can't be recycled?
I say that it is factually incorrect. We can already recycle more than 95% of the basic materials nowadays. In practice, that is rarely achieved, for one simple reason: very few electric cars are being scrapped at present because they haven't been around for long enough, so very few batteries need to be recycled. Of course, it is not worth setting up a recycling plant for batteries that are simply not there. But I am sure this will come in time, also because recycling will reduce the costs of battery production.

What is the best way to debunk the myths about e-mobility?
There is an apt saying: nature cannot be fooled. I am convinced that science works and that through science, the facts will become increasingly clear. And the facts are that electricity production is emitting less and less CO_2 and battery production is constantly improving. We need to explain this so that people understand. At the same time, we should be demonstrating the countless benefits of e-mobility: the cars are fast and quiet – and they are fun to drive. That's the narrative that we need to be sharing. Most people who are opposed to electric vehicles have probably never even sat in one.

You yourself can often be found sitting in an electric car.
Oh yes, I bought an electric car as soon as I could afford one; that was seven years ago. My first electric car had a range of 140 km in summer and 100 km in winter. I like pushing my boundaries, so I often ended up stranded somewhere along the way. That happened on one occasion because I didn't consider that there was a strong headwind, which reduced the range. That kind of thing doesn't happen to me now. My current electric car has a range of 350-400 km.

Thank you for talking to eco@work.
The interviewer was Christiane Weihe.

Talking to eco@work:
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From resource to recycling

E-mobility's resource demand

E-mobility is no stranger to criticism – whether it is about ranges, charging infrastructure or CO_2 emissions from vehicle manufacturing. Another aspect which is often the focus of attention is e-vehicles' resource demand and the associated impacts – on water consumption in Latin America, for example. E-vehicle batteries contain substantial quantities of precious metals. Depending on the type of battery, they can contain 5-12 kg of cobalt and 4-15 kg of lithium, although some batteries already contain no cobalt at all. Clearly, from a social and environmental perspective, we need to look carefully at electromobility as well. That means analysing its resource demand and ensuring that it is met as sustainably as possible while fully utilising and expanding the opportunities for recycling. But let's not forget that the rival product, namely the combustion engine, requires a vast amount of resources. So how does e-mobility compare, and what are the options for a resource supply that is sustainable in the long run? These questions are being addressed by researchers at the Oeko-Institut.

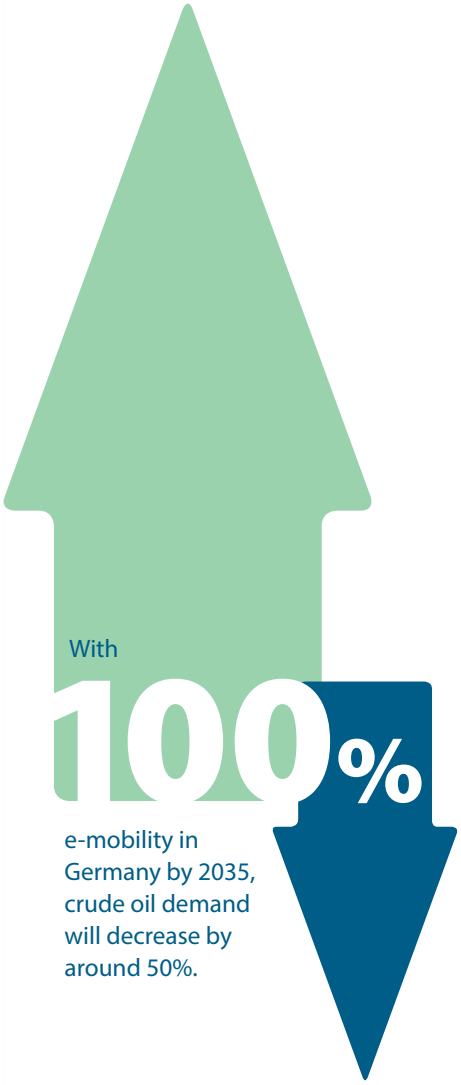
When investigating resource demand in the e-mobility sector, it is essential to look at the whole life cycle: from resource extraction to the production of lithium-ion batteries and, finally, recycling. The Oeko-Institut is working on this topic as part of the current EU-funded RE-SOURCING project. In a consortium with 11 other partners, coordinated by Vienna University of Economics and Business, the researchers are analysing the renewable energy, electronics and mobility sectors. "We are developing a roadmap that shows how the lithium-ion battery supply chain can become sustainable by 2050. We are looking at resource extraction, battery production and recycling, with a focus on lithium, cobalt, nickel and graphite," says Dr Johannes Betz, a researcher in the Oeko-Institut's Resources and Transport Division. "As the first step, we charted the as-is state, and we are now analysing examples of good practice." In addition, the project team is examining standards and legal frameworks in these sectors. "RE-SOURCING is intended to assist policy-makers to develop the right strategies and effective measures. However, companies and civil society have a role to play as well – with regard to sustainable business practices, for example, or raising awareness of more sustainable resource extraction."

Naturally, the operation of e-vehicles plays an important role in their sustainability performance as well. When it comes to reducing CO_2 emissions, as the Oeko-Institut's expert explains, they are slightly ahead of combustion engine vehicles. "Every reliable scientific study that uses current data shows that e-vehicles perform better here; that's the bottom line. Granted, manufacturing an electric car produces more greenhouse gas emissions, but this is cancelled out once the car is on the road. What's more, if you opt for e-mobility, you are helping to improve air quality because the emissions of air pollutants at the local level are much lower."

ELECTRIC VS. COMBUSTION ENGINE

When analysing e-mobility's resource demand, one aspect is often overlooked: the fact that mobility powered by combustion engines also requires substantial resource inputs, mainly oil. In the study "Resource consumption of the passenger vehicle sector in Germany until 2035 – the impact of different drive systems", commissioned by the German Environment Ministry, the Oeko-Institut, together with ifeu and T&E, conducted an initial evaluation of Germany's passenger vehicle sector from a resource perspective until 2035. One scenario – which assumes a switch to 100% e-mobility by 2035 – shows the potential reduction in annual crude oil demand. "In this scenario, the annual crude oil demand is more or less halved," says Johannes Betz. "This could also help to alleviate the numerous social and environmental problems associated with the extraction and use of oil." The Oeko-Institut expert is referring, for example, to the contamination of vast land areas in Russia, the main provider of crude oil for Germany's refineries, and the major environmental problems in the United States. "In Nigeria, too, oil production is creating problems on a massive scale – from accidents and fires caused by oil spills from tapped pipelines to the contamination of the Niger Delta. On top of that, most of the profits go to a tiny elite."

The project team has also looked at metals such as lithium, cobalt and copper. "In our scenario, we assume that the peak in primary metal demand will be reached by 2035 at the latest," says Dr Betz. "The share of recycled metal content from traction batteries will increase continuously, which means that the demand for primary inputs will fall. However, ambitious recycling targets are needed here." In his view, there is no reason to be concerned that we will run out of the key materials for e-mobility in future. "Even if there were a tenfold increase in global demand for lithium by 2035, for example, this would still amount to less than 1% of the current known resources." There is enough lithium available to meet demand, although temporary shortages caused by factors such as a lack of suppliers cannot be ruled out.



Batteries are the centrepiece of e-vehicles and play a vital role in ensuring their sustainability, so the question of what happens to the battery when the vehicle is scrapped is key. "In Europe, all the batteries that are collected are recycled and raw materials such as cobalt, nickel and copper are recovered," says Dr Betz. "Unfortunately, with lithium, this still poses technical challenges, so in most cases, it is not being recycled yet." From his perspective, there is also a lack of appropriate regulatory frameworks at present. "The current regulations look solely at mass and set a recycling

target of 50%. But in the past, this was sometimes reached merely by handing in the battery housing for recycling." Targets are therefore required to ensure that all components can be recovered whenever feasible with best available technology. The European Commission's new Batteries Regulation, whose adoption is expected in mid-2022, can provide significant impetus here. "The European Commission is proposing to raise the targets for the total amount of the recycled mass while setting specific recycling targets for nickel, cobalt, copper and also lithium." In addition, there will be provisions on the use of recycled content in new batteries. The definition of what genuinely counts as recycling is also important, says Dr Betz. "Currently, if the materials are subsequently used in road-building, this counts as recycling in many European countries." It is also important to start thinking now about comprehensive recycling. "At present, there are still no major battery material flows, partly because the vehicles have a long lifespan. But if the number of e-vehicles increases significantly, that will change, of course."

A comprehensive perspective on resource demand in e-mobility must also include the issue of re-use. The option of exporting scrap e-vehicles and batteries to countries of the Global South is already being mooted. "If that happens, minimum criteria must apply, not only to the quality of the batteries but also as regards the question of who will be responsible for recycling further down the line. We cannot have a situation in which poor-quality goods are exported and the lithium-ion batteries then cause major problems at the local level, such as fires at waste dumps."

of lithium-ion batteries were used in e-mobility.

Regardless of whether the issue is mining, production, use, re-use or recycling – as a rule, the best option, including from a resource perspective, is of course to manage without a car altogether, Dr Betz concludes. "Even then, of course, you can still enjoy the benefits of e-mobility – by using an e-bike, for example, or by taking an e-bus operated by the local transport company."

Christiane Weihe

ON TWO WHEELS – OR TWELVE

Anyone wishing to get on board with e-mobility has plenty of options nowadays. Electric vehicles come in all shapes and sizes: e-bikes, e-scooters, electric mopeds, electric cars in a range of vehicle classes, e-buses and even e-trucks *(on this topic, see "Nine years to add 14 million" on page 8)*.

Two-wheeled e-mobility in particular is enjoying a surge in popularity here in Germany. In 2020, sales of e-bikes reached almost two million, up from half a million in 2015. E-scooters have seen substantial growth, especially in cities: in Berlin alone, there were around 11,000 on the road in 2019. However, as they are often used for short journeys that would otherwise be made on foot or by bike, they do not have the best reputation when it comes to sustainability. This is partly due to e-scooters' generally short lifespans at present. However, they have the potential to contribute to more sustainable mobility if they remain in service for longer and replace car journeys. A broad range of e-mopeds is now available as well; this is another growth market.

Besides electric two-wheelers, larger vehicles with electric drives are also making headway. E-buses are just one example: their numbers more than doubled from 2019 to 2020. They still account for a very small proportion of local public transport – around 1.4 % – but further growth is expected.

Chemist Dr Johannes Betz was awarded his PhD at the University of Münster's MEET Battery Research Center in 2020 and joined the Oeko-Institut's Resources and Transport Division the same year. He now works on electromobility, resource consumption and recycling management, plastics recycling, mining and raw material refining.
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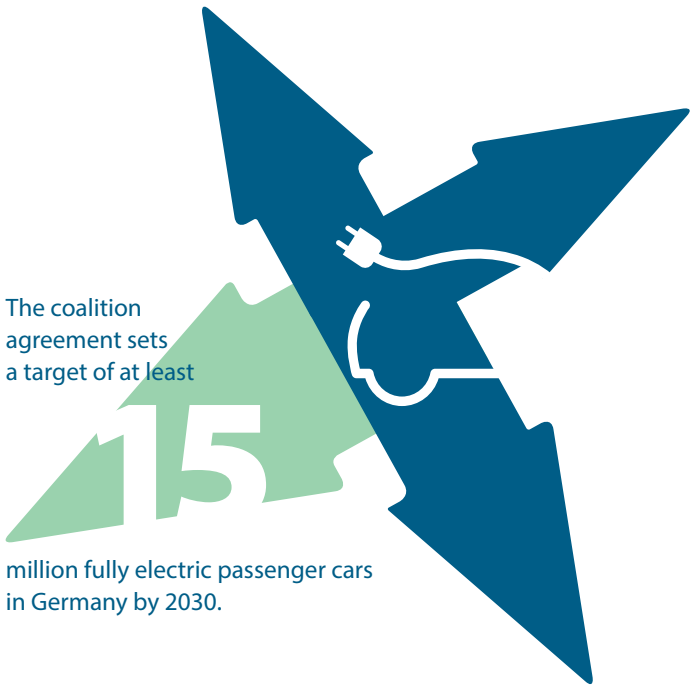
Nine years to add 14 million

E-mobility in the commercial sector

They are already a familiar sight on the roads: bikes, mopeds, cars and buses that are powered by batteries instead of petrol. And their numbers are increasing: according to Germany's Federal Motor Transport Authority, fully electric passenger cars accounted for a 13.6% share of new registrations in 2021, compared with just 6.7% the previous year. In August 2021, the number of e-vehicles on German roads reached the one million mark for the first time, with fully electric vehicles accounting for 54% of that figure. A success story – but still a long way off the target set by the new German government in its coalition agreement, namely to have at least 15 million fully electric passenger cars in Germany by 2030. Achieving this goal will require not only the positive development of a dynamic market but also appropriate frameworks and effective mechanisms. There is significant leverage in the commercial sector, which accounts for more than 60% of new registrations. So how can the share of e-vehicles be increased here? Various Oeko-Institut projects aim to answer that question.



There are many reasons why it is worth taking a closer look at the commercial sector. In Germany, commuting or business travel accounts for 38% of passenger-kilometres. "But in many cases, company cars are only kept for a short time and are then placed on the used car market – yet they could be giving a boost to e-mobility as the company sector is where more than 80% of private vehicle purchases are made," says Moritz Mottschall, a senior researcher at the Oeko-Institut. "What's more, company cars are a good way to convince large numbers of people of the benefits of e-mobility."

E-vehicles offer a great many benefits for companies – and yet on average, they make up just 3.3% of commercial fleets in Germany. Why so low? "Unfortunately, there are not enough incentives to make fleet operations more eco-friendly – quite the contrary," says Moritz Mottschall. "Indeed, under the current tax regulations, emissions-intensive vehicles are a financially attractive option, and there are very few fiscal incentives to limit the private use of company cars or improve their fuel efficiency." As he explains, this is partly due to the rules on deductibility of vehicle costs and the relatively low income tax assessment of the utility value if a company car is used for private purposes. "In fact, in many cases, there is no record of how often the car is used privately or for business." To boost the sustainability of fleet operations, it should not be more advantageous to use a company vehicle than a private passenger car. "What's more, it is mainly the more affluent who enjoy the benefits of company cars."

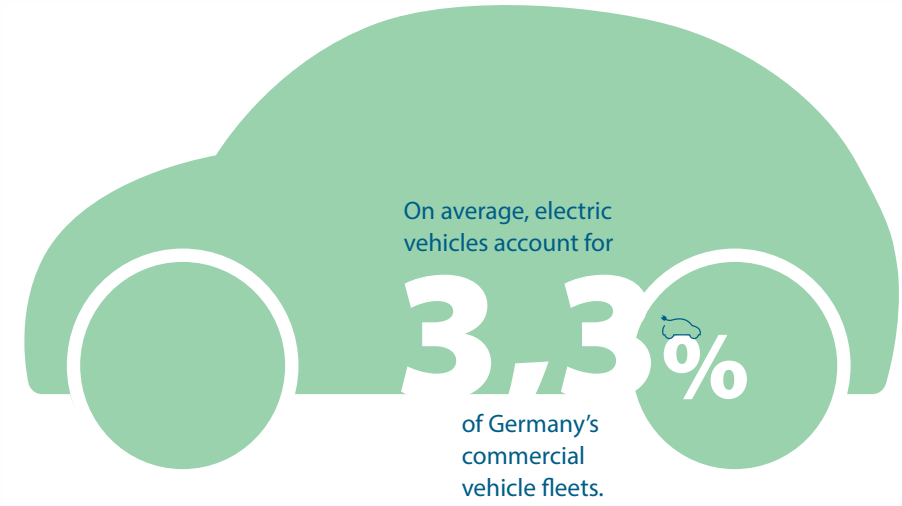
AN ELECTRICALLY POWERED CORPORATE FLEET

In the "Compan-e: Pathways towards Electric and Sustainable Corporate Mobility" project, the Oeko-Institut has been working with various project partners, including Agora Verkehrswende, Deutsche Bahn and R+V Versicherung, since 2019 to determine how the share of e-vehicles in the business sector can be increased. "It's a very exciting project because many practical partners are involved. We are supporting them as they switch their company fleets to e-mobility, and we are engaged in a lively dialogue. We are on quite a steep learning curve when it comes to the basic elements of their car policies – in

other words, the rules governing the procurement of company vehicles and the obstacles that stand in the way of electric vehicle purchases." For example, there are often long delivery times, or manufacturers' ranges do not include models that are particularly relevant to companies, such as compact vehicles for the car pool, light commercial vehicles for the service team and estate cars for company car users. Instead, there is a predominance of SUVs, including in the e-vehicle ranges. "Often, users and managers do not have sufficient knowledge of the real potential of an electric fleet or the investment involved in establishing a charging infrastructure. So there are a great many information gaps which need to be addressed, and that is one of the goals of company-e."

There is certainly scope for a political steer to ensure that more needs-appropriate and efficient vehicles are made available. For example, the project team is calling for a bonus/penalty system which would ensure that the procurement costs of high-emission passenger cars exceed the costs of highly efficient vehicles with low carbon emissions. There is also considerable leverage in the taxation of company cars, which should be aligned more strongly with environmental criteria. In Germany, these taxes are still too low, including for emission-intensive vehicles. "Other countries have a graduated system for assessing the deductibility of vehicle costs or utility value, based on carbon emissions," Moritz Mottschall explains.

So for the time being, in the senior researcher's view, there will continue to be a need for active promotion of electric cars – which means fully electric vehicles. At present, many companies rely on plug-in hybrids, which combine an electric with a conventional drive. "Their climate benefits are massively exaggerated as they tend to be driven mainly in conventional mode on a day-to-day basis, with a very low share of electric driving. They should only benefit from tax relief if there is evidence that they have covered a specific proportion of mileage in electric mode. Apart from e-mobility, however, more could be done to improve sustainability in corporate mobility; one example is to boost the appeal of mobility budgets as an alternative to company cars."



ELECTRICITY AND HEAVY-DUTY VEHICLES

Of course, electromobility in the commercial sector does not just mean vehicle fleets and passenger cars. Road freight transport is another relevant aspect. Here, research is currently under way on heavy-duty vehicles that are powered by overhead lines, but battery electric trucks also play an important role. So how much potential do alternative drive systems offer here? This topic is currently being studied by the Oeko-Institut in the "Strategy for the Electrification of Road Freight Transport (StratES)" project in cooperation with Heilbronn University of Applied Sciences. "The project is very practically oriented and is intended to show how alternative drive systems can be used and which conditions need to be in place for that to happen," says Moritz Mottschall.

With funding from the German Environment Ministry, the project team has already looked at the status quo and the potential for overhead lines, battery systems, alternative fuels and hydrogen fuel cells. "Among other things, we found that battery electric heavy-duty vehicles currently appear to be most advanced in their development; over the next few years, we are expecting a market ramp-up with production models in local and regional transport. What's more, the direct use of electricity is far more efficient than using electricity-based hydrogen in fuel cells." In a previous project, the researchers identified the climate benefits of e-trucks: regardless of whether the e-trucks are powered by batteries or overhead lines, their overall efficiency is 73% – far better than the figure for fuel cells or e-diesel trucks – i.e. the use of electricity-based synthetic fuels – with 31% and 21%, respectively. "It is now important to capitalise on these benefits while also giving haulage companies the stability they need for long-term planning. And in our view, that should not focus primarily on hydrogen, which is needed more urgently in other sectors, such as the steel industry, or as a raw material for synthetic fuels for aviation."

Christiane Weihe

Energy efficiency in transport and alternative drive concepts are key topics in Moritz Mottschall's work. An engineering graduate specialising in technical environmental protection, he also conducts emissions audits for freight and passenger transport and assesses the environmental impacts of transport infrastructure.
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