The right drive for the fleet

A GUIDELINE
VERSION 1.0, DECEMBER 2018
Introduction

This white paper should help you as a fleet manager to choose the drive systems (or drive system mixes) that are suitable for your fleet. It takes the current state of technology into account and uses generic representations.

THE SITUATION ON THE GERMAN FLEET MARKET IN AUTUMN 2018

Not long ago, fleet parks applied the following rule of thumb: employees who run up high mileages every year are given a diesel drive. Is this approach still up to date? A glance at the DAT Diesel Barometer from September 2018 (with a focus on fleets) provides an answer to this question: 84 percent of fleet managers still order diesel passenger cars. For Axel Schäfer, Managing Director of Bundesverband Fuhrparkmanagement (Federal German Fleet Management Association), there is a simple reason for this, which he explains in Firmenauto, a trade paper. “Company car drivers rarely have to drive only within cities”, and “the latest diesel technology is the best type of drive for long-distance journeys”. The total cost of ownership (TCO) represents a weighty decision criterion. However, the Diesel Barometer also shows that things are happening in German fleets: usage profiles are becoming ever more detailed, and procurement is becoming correspondingly more diverse, which means that petrol engines and alternative drive systems are increasingly used.

NUMEROUS DRIVE SYSTEMS ARE AVAILABLE

The vehicle market is moving. In order to comply with strict legal regulations, tried-and-tested engine concepts are being developed further and alternative drive solutions are also being advanced. Engineers are constantly working on the combustion engine, but also on entirely new concepts. These developments mean that fleet managers have to consider an ever-increasing number of parameters.

WHAT DRIVE TYPES ARE THERE?

<table>
<thead>
<tr>
<th>Conventional</th>
<th>Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petrol engine</td>
<td>Natural gas engine</td>
</tr>
<tr>
<td>Diesel engine</td>
<td>Plug-in hybrid</td>
</tr>
<tr>
<td>Mild hybrid&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Electric engine</td>
</tr>
</tbody>
</table>

<sup>1</sup>Technology can be combined with petrol and diesel engines.

WHAT DOES THAT MEAN FOR FLEET MANAGERS?

The current diversity of drive systems is undoubtedly attractive; after all, it allows mobility officers to choose exactly the things they need from an extensive portfolio. At the same time, the decision-making process becomes even more complex. Various questions come up, such as:

- Which mobility profiles can be covered by which drives?
- Which external factors need to be considered?
- How does the engine match the company’s car policy?
- What do user-choosers say about the drive?
- Which costs need to be factored in?

THE SOLUTION: A “FLEET FUNNEL”.

The following pages contain tools for triggering the decision-making process that underlies the question “What drive system is most suitable for my mobility needs?” while taking the most important parameters into account. As there may be individual deviations from this theoretical procedure – after all, every company sets itself different goals and has different boundary conditions – an additional personal consultation with a certified fleet consultant is recommended.
Drive types

**PETROL ENGINE**
Highly charged petrol engines are characterised by low consumption thanks to downsizing – i.e. lower capacity but the same performance – and direct injection. Modern engines as a rule reach their maximum torque very early and in general demonstrate zippy acceleration behaviour with simultaneously high pulling power. When fuel costs are compared in Germany, it turns out that one litre of petrol costs 16 percent more than diesel on average – and even 25 percent more than one kg of natural gas. This variance has different effects on the operating costs.\(^1\)

**Petrol engine and particulate matter**
When you compare the emissions of a petrol engine to those of a diesel engine, a general image emerges: petrol engines emit less nitrogen oxides NO\(_x\), but they produce up to 15 percent more carbon dioxide CO\(_2\).\(^2\)

Like all combustion engines, petrol engines generate particulate matter – but these particulars are extremely small. In order to reduce emissions in line with legal requirements, current petrol engines from the Volkswagen Group are equipped with so-called gasoline particulate filters.

In petrol engines with direct injection, the mix of fuel and air is combusted in the cylinder under high pressure. Even though this process is very efficient, several tiny oil and fuel droplets are always deposited on the cylinder wall and the piston, in particular during cold start. They do not combust fully there, so they exit the engine as extremely small soot particles – or, in other words: as particulate matter.

**Gasoline particulate filter (GPF)**
The gasoline particulate filter “catches” the particulates with the help of highly porous and highly heat-resistant ceramic material, and the particulates are simultaneously combusted by the high temperature of the exhaust gas. A gasoline particulate filter can reduce particulate emissions by up to 90 percent.

**The petrol engine** scores points on short to medium distances and for low yearly mileages.

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**STRENGTHS**
- Moderate acquisition cost
- Low weight-to-power ratio
- Fewer nitrogen oxide emissions than the diesel engine
- Agile driving behaviour

**LIMITATION**
- Gasoline particulate filter required to reduce particulate matter
- High fuel costs

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**WHERE DOES PARTICULATE MATTER OCCUR?**
Particulate matter is released by road traffic (for example combustion processes, tyre and brake wear), by bulk handling and by agriculture. Depending on their size, these particulates can impact human health in various ways.

**WHO GENERATES PARTICULATES IN GERMANY?**

\[ \begin{array}{l}
\text{23% Bulk handling} \\
\text{23% Agriculture} \\
\text{16% Industry} \\
\text{14% Energy industry} \\
\text{14% Road traffic} \\
\text{10% Wood firing} \\
\end{array} \]

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\(^1\) This comparison is based on the average prices for 2017. Source: Federal Ministry for Economic Affairs and Energy.

\(^2\) The Federation of German Industries (BDI), 2018

Source: German Environment Agency (UBA), 12/2016
DIESEL ENGINE
Among combustion engines, diesel engines are still the most efficient units. They also convince with a constant high torque in a broad engine speed range. Thanks to technological solutions such as high-pressure direct injection and turbocharging, diesel engines today demonstrate an agile driving behaviour. By the way: A general comparison between petrol and diesel engines shows that diesel engines emit up to 15 percent less CO₂.¹)

The drawbacks of diesel engines are their high emission of nitrogen oxides (NOₓ) and particulate matter. In order to ensure that diesel engines comply with the strict legal regulations, they have been equipped for some time with soot particulate filters to reduce particulate emissions – and are also fitted with so-called SCR catalytic converters for NOₓ reduction. Thanks to this exhaust gas treatment, modern diesel engines comply with the strict nitrogen oxide requirements of the European emission standards (Euro 6d-TEMP and Euro 6d).

SCR catalytic converter
The SCR catalytic converter (selective catalytic reduction) converts the nitrogen oxide (NOₓ) component of the exhaust emissions selectively into nitrogen (N₂) and water (H₂O). The conversion is performed using a synthetically produced watery urea solution – such as AdBlue®, for example – which is carried along in an additional tank.

THE DIESEL ENGINE convinces above all on long distances thanks to low consumption and a correspondingly long range.

STRENGTHS
> High torque in broad speed range
> Lower CO₂ emissions than the petrol engine while complying with strict emission standards

LIMITATION
> Extensive exhaust gas treatment increases acquisition costs
> Potential driving bans for older diesel generations

RANGES in kilometres of a typical compact class fleet vehicle in Germany (as per the NEDC)

<table>
<thead>
<tr>
<th>PRIMARY FUEL</th>
<th>SECONDARY FUEL</th>
<th>DEVELOPMENT OF ELECTRICAL RANGE UNTIL 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>PETROL ENGINE</td>
<td></td>
<td>700</td>
</tr>
<tr>
<td>DIESEL ENGINE</td>
<td></td>
<td>900</td>
</tr>
<tr>
<td>GAS ENGINE (CNG)²</td>
<td></td>
<td>690</td>
</tr>
<tr>
<td>PLUG-IN HYBRID³</td>
<td></td>
<td>880</td>
</tr>
<tr>
<td>ELECTRIC ENGINE</td>
<td></td>
<td>300/650⁴</td>
</tr>
</tbody>
</table>

As of 09/2018

¹The Federation of German Industries (BDI), 2/2018  ²Quasi-monovalent natural gas engine  ³Plug-in hybrid (petrol/electric)  ⁴Preview of electrical ranges until 2020

EU requirements for passenger cars have been tightened several times since the Euro 3 standard was introduced in 2000.

1.5 AdBlue® for up to 1,000 km
The ADAC (General German Automobile Club) has tested the consumption of AdBlue® in diesel vehicles: it comes in at around three to five percent of fuel consumption.

This is roughly the equivalent of 1.5 to 3 litres of AdBlue® per 1,000 kilometres.

Source: ADAC
MILD HYBRID (MILD HYBRID ELECTRIC VEHICLE, MHEV)
The new mild hybrid technology can make combustion engines even more efficient. The Audi brand, for example, is currently electrifying more and more of its vehicles. This is possible even with the existing 12 volt vehicle electrical system: the most important components are a lithium-ion battery and a belt starter generator that also functions as the starter.

Belt starter generator
This component makes new functions possible: the start-stop phase, for example, can already begin at a remaining speed of around 15 km/h. If the driver releases the accelerator at a higher speed, the car glides along with a deactivated engine for a short time. At a maximum of 5 kilowatts the recovery performance is considerable – and the generator can also assist the combustion engine. This allows both petrol and diesel engines to be operated closer to their respective ideal load points. The belt starter generator can lower fuel consumption accordingly on a 12 volt basis.

The 48 volt vehicle electrical system
A new 48 volt partial electrical system makes the mild hybrid even more powerful. The lithium-ion battery contains 10 ampere hours of power capacity, but the belt starter generator has an output of 12 kilowatts, which makes further consumption savings possible. 48 volts allow the same mild hybrid functions to be displayed as 12 volts, but with an increased scope – the gliding phase with the combustion engine switched off, for example, can take up to 30 seconds.

The 48 volt network offers many other advantages beyond hybridisation. Its higher voltage permits much lower lead cross-sections, reducing the weight of the cable harness as well as the power loss. Above all, it can provide four times the performance as the 12 volt network, enabling completely new attractive technologies for the drive system and chassis.

STRENGTHS
> Fuel savings when compared to a combustion engine without mild hybrid technology
> Battery charging through recovery of braking energy
> Belt starter generator supports engine
> Suitable for petrol and diesel engines

LIMITATION
> Higher acquisition costs than for conventional engines
> Pure electric mode not possible
NATURAL GAS ENGINE

Because compressed natural gas (CNG) fuel enters the petrol engine in gas form, it combusts effectively and cleanly. Its high octane number of 130 makes efficient combustion processes possible. Compared to a petrol engine that runs on regular unleaded (95 RON), the CNG engine emits around 20 percent less carbon dioxide (CO₂). In addition, the combustion of natural gas generates far less particulate matter and other pollutants than conventional fuels. Of particular interest for urban environmental zones; CNG drives are characterised by very low noise and nitrogen oxide emissions (NOₓ).

When deciding whether to run natural gas vehicles, it is important to examine the refuelling infrastructure: there are currently around 900 stations available in Germany, so it is necessary to be more strategic in terms of availability and range than it would be for petrol and diesel engines. However, once the gas has been consumed the vehicle switches to petrol automatically – and the journey can continue without a stop for around 190 kilometres. By the way: more than 12 percent of German CNG stations are already supplied with pure renewable CNG produced from waste.

Gas in a tank?

Before the natural gas can be transported in the vehicle, it is compressed at high pressure (200 bar) and forced into special underfloor gas tanks. These are constructed according to the most stringent industry standards and designed for a maximum pressure of at least 450 bar. In the unlikely event of a fire, a safety valve also discharges the natural gas into the outside air in controlled fashion. By the way: thanks to special safety pumps, filling up with natural gas is very safe – and convenient: the brands in the Volkswagen Group install universal filler nozzles that can be used throughout Europe.

### STRENGTHS

- Cheaper fuel
- Economical in terms of consumption
- Better CO₂ balance and lower emissions than petrol and diesel engines

### LIMITATION

- High acquisition costs
- Refuelling infrastructure still fragmented

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**COST** in euros per kilogram of natural gas or natural gas equivalent in Germany

<table>
<thead>
<tr>
<th></th>
<th>CNG</th>
<th>PETROL</th>
<th>DIESEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural gas</td>
<td>1.080</td>
<td>2.024</td>
<td>1.512</td>
</tr>
</tbody>
</table>

Natural gas has a higher energy content than other fuels; one kilogram is the rough equivalent of 1.5 litres of petrol or 1.3 litres of diesel.

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**FUEL COSTS PER KILOMETRE** in euro cents for a typical compact class fleet vehicle (DE) and including average primary fuel costs

<table>
<thead>
<tr>
<th></th>
<th>PETROL ENGINE</th>
<th>DIESEL ENGINE</th>
<th>NATURAL GAS ENGINE</th>
<th>PLUG-IN HYBRID</th>
<th>ELECTRIC ENGINE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6.6</td>
<td>5.0</td>
<td>3.9</td>
<td>3.6</td>
<td>4.2</td>
</tr>
</tbody>
</table>

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**THE NATURAL GAS ENGINE** is suitable for short and medium distances.

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1) This calculation is based on the average prices for 2017.

Source: Federal Ministry for Economic Affairs and Energy.
PLUG-IN HYBRID (PLUG-IN HYBRID ELECTRIC VEHICLE, PHEV)

In a plug-in hybrid, a combustion engine and an electric engine work together. The energy storage of the vehicle is charged via recovery during the journey, and by means of a charge cable connected to the mains grid when it is parked. This measure allows fuel consumption to be reduced.

In urban traffic – particularly in case of traffic restrictions for combustion engines – the plug-in hybrid can drive emission-free with its electric drive. Over longer distances, the combustion engine makes greater ranges possible.

THE PLUG-IN HYBRID is particularly suitable for commuting and occasional long-distance trips; its battery allows local trips without emissions.

<table>
<thead>
<tr>
<th>STRENGTHS</th>
<th>LIMITATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>› Fuel savings through partial operation in pure electrical mode and hybrid function</td>
<td></td>
</tr>
<tr>
<td>› Pure electric mode for local driving possible</td>
<td></td>
</tr>
<tr>
<td>› High system performance due to two partial drives</td>
<td></td>
</tr>
<tr>
<td>› Higher acquisition costs than for conventional engines</td>
<td></td>
</tr>
<tr>
<td>› Charging infrastructure required</td>
<td></td>
</tr>
<tr>
<td>› Larger batteries are required for more storage capacity – and they increase the overall weight</td>
<td></td>
</tr>
</tbody>
</table>

COMPARISON OF CARBON DIOXIDE EMISSIONS in g/km using a typical compact class fleet vehicle (DE) as the example and allowing for the average primary fuel consumption

<table>
<thead>
<tr>
<th>PETROL ENGINE</th>
<th>DIESEL ENGINE</th>
<th>NATURAL GAS ENGINE</th>
<th>PLUG-IN HYBRID</th>
<th>ELECTRIC ENGINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>234</td>
<td>402</td>
<td>534</td>
<td>85</td>
<td>200</td>
</tr>
<tr>
<td>69</td>
<td>81</td>
<td>329</td>
<td>9</td>
<td>1034</td>
</tr>
<tr>
<td>85</td>
<td>81</td>
<td>329</td>
<td>9</td>
<td>1034</td>
</tr>
<tr>
<td>264</td>
<td>195</td>
<td>1262</td>
<td>195</td>
<td>1262</td>
</tr>
</tbody>
</table>

Tank-to-wheel approach. The bars serve as indicators for the combined CO₂ emissions of the respective engine in dependence on capacity and performance. As of 09/2018

Charging points – the infrastructure in Germany

There are currently around 6,060 publicly accessibly charging points for electric cars in Germany. The Federal Network Agency started providing an overview map in 2017 that helps drivers of electric and plug-in vehicles find possible charging points nearby.

www.bundesnetzagentur.de/ladesaeulenkarte

Joint venture: IONITY is a joint venture between the BMW Group, Daimler AG, the Ford Motor Company and the Volkswagen Group with the purpose of developing a network of quick-charge stations along the motorways with an output of up to 350 kW. By 2020 there will be a total of 400 IONITY stations in 25 countries, with 340 of them in Europe alone – and 100 of those in Germany.

Source: IONITY, as of 10/2018
Source: Federal Network Agency, as of 10/2018
ELECTRIC ENGINE

Electric vehicles convince with numerous positive properties that make them interesting in environmental policy terms, for example. Electrically powered automobiles emit absolutely no pollutants such as NOₓ – and are therefore suitable for use in cities and metropolitan regions, and in particular in environmental zones or areas affected by driving restrictions. In order to make full use of the ecological advantage, it makes sense to use power from renewable sources. This makes it possible to further reduce the climate footprint of an electric vehicle. As electric vehicles require less space for their drive system than conventionally powered cars, the Volkswagen Group’s concepts allow more space for users in the interior. Electric drives are also highly efficient (less than 90 percent) and have a much higher torque from standstill than combustion engines do. By the way, electric vehicles will soon become even more interesting to German user-choosers, as the so-called one-percent rule will drop to half a percent for private use of electric cars and hybrid vehicles from 2019.

Funding measures

Different countries can provide different funding for electric vehicles. One example is the environment bonus in Germany: for this process, the carmakers provide financial support for buyers. They benefit from subsidies of up to 4,000 euros for plug-in hybrids, and even 2,000 euros for pure electric vehicles. The Federal Office for Economic Affairs and Export Control contributes the same amounts respectively in order to promote electric mobility – the current end date for this program is 30 June 2019, and it complies with all applicable regulations.

THE ELECTRIC ENGINE is suitable for short and medium distances. Ideal for urban use.

STRENGTHS

> Maximum torque even when pulling away
> Low running costs (long service life, little maintenance)
> Simple design and great driving comfort (no need to press the clutch and change gears)
> Temporary relief from vehicle tax in Germany
> Lower tax rate for personal use (from 1 Jan 2019)

LIMITATION

> Range still small
> Charging infrastructure still fragmented
> Availability still restricted (long charging times)
> Acquisition costs even higher, for example because of battery
> Potential costs for an own charging infrastructure

VEHICLE TAX in euros for a typical compact class fleet vehicle in Germany

Source: Federal Ministry of Finance

<table>
<thead>
<tr>
<th>Engine Type</th>
<th>Tax Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel engine</td>
<td>222</td>
</tr>
<tr>
<td>Petrol engine</td>
<td>72</td>
</tr>
<tr>
<td>Natural gas engine</td>
<td>34</td>
</tr>
<tr>
<td>Plug-in hybrid</td>
<td>28</td>
</tr>
<tr>
<td>Electric engine</td>
<td>0</td>
</tr>
</tbody>
</table>

CHARGING – BUT WHAT WITH?2)

Electric vehicles are increasingly fitted with the “Combined Charging System (CCS)”, which supports the various charging options:

<table>
<thead>
<tr>
<th>Charging Option</th>
<th>Power</th>
<th>Charging Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household Power Socket</td>
<td>2.3 kW</td>
<td>approx. 17 h</td>
</tr>
<tr>
<td>Wall Box</td>
<td>7.2 kW</td>
<td>approx. 6 h</td>
</tr>
<tr>
<td>CCS Charging Station</td>
<td>40 kW</td>
<td>approx. 45 min</td>
</tr>
</tbody>
</table>

1) The efficiency of an engine specifies the ratio between the movement energy released and the power absorbed.
2) If registered before 31 Dec 2020, electric vehicles are exempt from the tax for a duration of ten years. 3) Calculative value; depending on the age, temperature and charging condition of the battery. 4) Charging times for a typical compact class fleet vehicle. 5) The battery is 80 percent charged after 45 minutes.
WLTP and RDE – an overview

WORLDWIDE HARMONIZED LIGHT-DUTY VEHICLES TEST PROCEDURE (WLTP)
The principle of the WLTP test procedure introduced in Europe and the other countries that apply it on 1 September 2017 realistically records consumption and exhaust values. As part of type testing for newly developed passenger car models and light commercial vehicles in category N1 class I, the consumption and CO₂ values are measured by means of a 30-minute driving cycle as per WLTP, making them representative and suitable for international comparison.

Starting on 1 September 2018, all newly registered passenger cars and light commercial vehicles in category N1 class I must be type-tested under WLTP. In addition, manufacturers of light commercial vehicles are obligated to conduct type testing for newly developed vehicles in categories N1 classes II and III and in vehicles of category N2 according to the WLTP. Starting on 1 September 2019 manufacturers of light commercial vehicles must specify the consumption and exhaust emission values as per WLTP for all vehicles in category N1 classes II and III as well as for vehicles in category N2.

SPECIFYING WLTP VALUES
Starting in September 2017, the 28 EU Member States are required by the EU Commission to conduct WLTP type approval for new models. The Member States can choose when the WLTP values have to be displayed to customers on the consumption label, and final rulings have not been made for every country. For now, it is mandatory to specify the values on the Certificate of Conformity (CoC). Until the end of 2020, both the NEDC and the WLTP values will be specified on the CoC, so it is in principle possible to compare the WLTP and the NEDC. It is however not useful to do so because both values are determined using different test procedures. The situation is similar for taxation, where responsibility lies with the respective EU Member States. Some Member States – such as Germany, for example – started taxing on the basis of WLTP CO₂ values on 1 September 2018.

REAL DRIVING EMISSIONS (RDE)
The introduction will take place in two stages. RDE (I): From September 2019 it will apply to all newly registered passenger car models. NOₓ emissions must be no higher than 2.1 times the value (conformity factor [CF]) of the value determined under the NEDC or WLTP. RDE (II): From January 2020 it will apply for all new type-tested passenger car models. NOₓ emissions must not exceed the level of the NOₓ lab value (allowing for a measuring tolerance of 0.43 = maximum value 1.43). From January 2021 it will apply to all newly registered vehicles.

Note: Starting in September 2018, the particulate quantity for all newly registered vehicles must comply with the lab value when on the road (allowing for a measuring tolerance of 0.5 = maximum value 1.5).
HOW DOES THE “FLEET FUNNEL” TAKE YOU TO THE RIGHT DRIVE?
This analysis tool visualises five topical areas that you should go through in the decision-making process.

IN THE PROCESS, A VARIETY OF QUESTIONS ARISE, SUCH AS:

- **Purpose**: What usage profile does the required vehicle have?
- **External Factors**: Which factors have an effect on the fleet?
- **Internal Requirements and Specifications**: What targets is the car policy designed to achieve (e.g. CO₂ neutrality)?
- **Total Cost of Ownership (TCO)**: What are the overall costs for the vehicle?
- **User-Choosers**: What are the user’s personal preferences (e.g. acceptance of the technology)? Are the potential costs within the personal budget (e.g. taxation in case of personal use)?

RESULT
The “fleet funnel” allows you to precisely determine the right drive types.
PURPOSE: HOW IS THE DRIVING PROFILE STRUCTURED?

Or, to put it another way: what does the employee use their car for? Are they allowed to use it for professional and personal purposes? Is it a company car or a pool car? Climatic and topographic conditions play a role here, as does the deployment area (in towns, motorway...), the necessary ranges, the overall mileage, and even just stationary times for the vehicle. Based on everyday practice, it is possible to outline example cases with various driving profiles.

A PERSON ENTITLED TO A COMPANY CAR speed in km/h, over the course of an average working day

THE FIVE DRIVE TYPES IN A PRACTICAL CHECK

The right drive type depends on the user groups and their mobility profiles. If service employees, for example, mostly just cover short distances in the city, diesel vehicles make no sense. In this case, petrol engines are more suitable, as are mild and plug-in hybrids and even, in light of potential driving restrictions, battery-operated vehicles. However, a modern diesel engine remains “the best solution, particularly for people who cover long overland distances”, says Professor Thomas Koch from the Karlsruhe Institute of Technology (KIT). Koch hopes that in future there will be a “sensible mixture of drive systems in which the diesel engine will continue to play an important role”.

PETROL ENGINE

<table>
<thead>
<tr>
<th>SHORT</th>
<th>DISTANCE</th>
<th>LONG</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEW</td>
<td>STARTS/STOPs</td>
<td>MANY</td>
</tr>
<tr>
<td>LOW</td>
<td>URBAN SHARE</td>
<td>HIGH</td>
</tr>
<tr>
<td>LOW</td>
<td>MOTORWAY SHARE</td>
<td>HIGH</td>
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</table>

DIESEL ENGINE

<table>
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NATURAL GAS ENGINE

<table>
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<tr>
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<tr>
<td>LOW</td>
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<td>HIGH</td>
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</tbody>
</table>

PLUG-IN HYBRID

<table>
<thead>
<tr>
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<tbody>
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<tr>
<td>LOW</td>
<td>MOTORWAY SHARE</td>
<td>HIGH</td>
</tr>
<tr>
<td>SHORT</td>
<td>PARKING TIMES</td>
<td>LONG</td>
</tr>
</tbody>
</table>

ELECTRIC ENGINE

<table>
<thead>
<tr>
<th>SHORT</th>
<th>DISTANCE</th>
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<tbody>
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<td>PARKING TIMES</td>
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</tr>
</tbody>
</table>

DRIVE CHECK

These example illustrations take up daily mobility behaviours and represent various factors for deployment scenarios. Which routes are relevant? How is the vehicle used? Are urban trips common – or is it used mainly on overland and motorway routes?

1) The dotted bar depicts projected developments until 2020.
2) Parking times are important for electric vehicles and plug-in hybrids because they can be charged during this phase.
Short overland journey to work, almost no driving intervals and long stationary periods make up the driving profile at the end of the day.

But: the employee is allowed to use the vehicle for private purposes. They would therefore like to use it on holiday, for example, to visit relatives who live far away. For long distances with short stationary periods, the replacement mobility option is not available.

A PERSON WORKING IN THE FIELD speed in km/h, over the course of an average working day

Few customer visits per day, however with long distances between appointments. As a rule, conversations take no more than one hour. The employee wants to be home again in the evening. The user-chooser also uses the vehicle regularly for longer distances on holiday.

YOUR EMPLOYEE speed in km/h, over the course of an average working day

What does the personal driving profile of your company car driver look like? Outline an example of your employees’ working days and find out what drive matches their individual driving profiles. This process is likely to yield multiple driving profiles for your fleet.

NOTE: INVOLVE YOUR EMPLOYEES IN YOUR DECISION IN ORDER TO CREATE TRANSPARENCY AND ENSURE THEY UNDERSTAND YOUR DECISIONS.
EXTERNAL FACTORS: WHICH FACTORS HAVE AN EFFECT ON THE FLEET?

FACTORS THAT A COMPANY CANNOT INFLUENCE
Examples based on the German fleet market (helpful links on page 16)

- Refuelling/charging infrastructure
- Environmental zones
- Limits
- Standards

INTERNAL REQUIREMENTS: WHAT DOES THE CAR POLICY SAY, FOR EXAMPLE?
Or, to make the question more comprehensive: What factors can a company determine itself and adapt if necessary? The car policy is obviously one of the most important factors here. It specifies available options for company car drivers and user-choosers, but it also specifies rules of behaviour. In addition, it controls any CO₂ limits that the company may have specified. So it is possible to determine at a glance whether a specific drive is even relevant. Strategic company objectives and specifications regarding total cost of ownership (TCO) also come into play here. The aim is to identify and weight the internal factors. In addition, potential individual communal and municipal driving restrictions can play a role, because the CO₂ and particulate emissions of the vehicle are also relevant.

Example Germany: Adapting a car policy to the WLTP
The emissions of a tested vehicle remain unchanged, but they are identified more realistically in the new WLTP emission-measuring procedure and are therefore higher. Companies who want to control their fleets with the help of CO₂-assisted guidelines should perform a stock analysis and identify the usage profiles that are needed for a user-group-specific car policy and then incorporate the relevant changes. The following adaptation scenarios are conceivable:

The upper CO₂ limit specified in the car policy is retained.
Due to the introduction of the new type testing procedure, the identified CO₂ values are higher than before. Such a defined upper limit that must not be exceeded could ensure that some models can no longer be selected. For an average assessment, the aim is to control the vehicle mix so that the vehicles for a user group or the company are below the required CO₂ limit. Alternative drives such as natural gas vehicles, plug-in hybrids and, in particular, electric vehicles can have a positive effect. For car policies with plus and minus points, a maximum CO₂ limit for user-choosers can directly affect the user: As additional equipment affects the CO₂ value during the WLTP test due to its weight and for reasons of aerodynamics, it can be helpful to add it to the car policy.

Raise the upper CO₂ limit according to the new measurement results.
By adapting the CO₂ limit in the car policy to the average changes in CO₂ emissions (due to the introduction of WLTP), the existing model range can be retained. As the CO₂ values according to WLTP will be used to determine the tax rate in Germany from 1 September 2018, higher identified emissions make for higher tax expenses.

Switch to another measure, for example performance (kW).
The model variance can be designed according to the usage profiles. In the context of a car policy, there are various criteria that can be used to define the available vehicle models for a user group, such as capacity and acquisition costs, for example.
TOTAL COST OF OWNERSHIP (TCO): IS THE COST APPROPRIATE?

When it comes to the acquisition of a company car, the TCO are the be-all and end-all – even when you are going through the “fleet funnel”. To calculate these costs, both for conventional drives and for alternative drives, it is necessary to examine the relevant variables individually. The TCO can be broken down into acquisition costs (for example amortisation, financing and acquisition tax) as well as maintenance costs (including insurance policies, fuel costs and servicing).

WHICH FACTORS ARE IMPORTANT?

At first glance, the acquisition costs are the quickest way to find out which vehicles are cheap. But to fleet managers the pure acquisition costs are less important than the TCO – which must be assessed to determine how the vehicle costs will develop over the entire ownership period. Certain influence factors such as a good residual value or low consumption costs can mean that a vehicle with a high list price ultimately costs less than a comparable vehicle with a low list price.

The TCO is also affected by country-specific factors such as taxes, but also by individual and state subsidies; in Germany, for example, companies in the industrial economy that want to purchase electrically powered light commercial vehicles or passenger cars may be able to take advantage of an investment subsidy as part of the “Saubere Luft” (clean air) program.

Individual usage profiles can only be affected in limited fashion, but it is still worth taking a look at the employees’ driving balances: After what mileage does the vehicle need to be serviced? Is one set of tyres enough for the entire ownership period? These questions provide an impression of the parameters that the fleet manager can also adjust.

YOU WILL FIND MORE INFORMATION ON THE TOPIC OF TCO IN THE “TIME FOR A RETHINK” ARTICLE PUBLISHED IN JANUARY 2018 BY THE FLOTTENMANAGEMENT TRADE PAPER. SEE PAGE 16.
USER-CHOOSERS: ARE THERE ANY PERSONAL PREFERENCES?
At this point in the “fleet funnel”, the decision in favour of a specific drive has already been narrowed down. But there is still one parameter to define: what does the employee think? Do they have personal preferences or requirements for the vehicle that have to be considered or incorporated? After all, they have to travel frequently in their vehicle, and may have to rethink their daily routines or even adapt their driving behaviour to a new infrastructure. Are they ready to do so? Or are their demands different? Will they support the chosen drive? Or do they possibly even see themselves as a “first mover”?

By the way: alternative drives can also be attractive to company car drivers due to tax advantages. In the UK, for example, CO₂ emissions determine the percentage of the vehicle list price that must be taxed; from 2019, the German government will halve the assessment basis specifically for company car drivers of electric and hybrid vehicles who also use them for private purposes.

### ACCEPTANCE OF ALTERNATIVE DRIVES
Percentage share in fleets (EU 28) that have introduced, or are planning to introduce, hybrids, plug-in hybrids, natural gas or electric vehicles

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<tr>
<th>Region</th>
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<th>2018</th>
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Source: CVO, Arval/CSA Research, 2017

### ALTERNATIVE DRIVES
Percentage share of new registrations on the fleet market, using Germany as the example

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<tr>
<th>Year</th>
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Source: Dataforce (press release 2018)

### WHAT IS IMPORTANT TO THE USER-CHOOSER? POTENTIAL FACTORS:

- Driving enjoyment
- Image
- Monetary benefit
- Comfort/equipment/safety
- Refuelling and charging infrastructure
- Space provided in the vehicle
Further links

**Subsidies**

**Subsidies for Natural Gas Vehicles**
https://www.erdgas.info/erdgas-mobil/erdgas-fahren-rechnet-sich/foerderung-erdgas-fahrzeuge/

**Subsidies for Electric Vehicles (Environmental Bonus)**
www.bafa.de/DE/Energie/Energieeffizienz/Elektromobilitaet/elektromobilitaet_node.html
https://www.foerderinfo.bund.de/elektromobilitaet

**Subsidy Program for the Federal Government to Support Electric Mobility**
http://www.schaufenster-elektromobilitaet.org/de/content/index.html

**Petrol Stations/Electricity (EU)**
www.e-tankstellen-finder.com

**Petrol Stations/Natural Gas (DE)**
www.erdgas.info

**Petrol Stations/Electricity (DE)**
https://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/HandelundVertrieb/Ladesaeulenkarte/Karte/Ladesaeulenkarte-node.html

**Petrol Stations/Electricity (DE)**
www.goingelectric.de/stromtankstellen/

**Petrol Stations/Electricity (EU)**
www.plugsurfing.com/de/privatkunden/ladestations-karte.html

**Fleet Management**

**Environmental Zones**

**Environmental Zones (EU)**
www.urbanaccessregulations.eu

**Environmental Zones (DE)**
http://gis.uba.de/website/umweltzonen/index.html

**Refuelling Infrastructure**

**Information**

**Environmental Zones**

**WLTP**
www.volkswagenag.com/de/group/fleet-customer/WLTP.html

**CNG**
www.discover-cng.com

www.gibgas.de

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**Do you need assistance for your decision-making process?**
Your fleet customer adviser at Volkswagen AG and the Group brands’ certified fleet management consultants are happy to help. Arrange a personal consultation.

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**For more information about the Volkswagen AG Fleet Customer Business, go to:**
WWW.VOLKSWAGENAG.COM/EN/GROUP/FLEET-CUSTOMER.HTML