

What are the important factors when you want to operate an electric vehicle fleet?
These lecture notes give insight in the most important factors that are different compared to operating a conventional fleet.

Acquisition process

Before the acquisition process of a fleet it is good to identify the needs of your drivers. Does your fleet need to be uniform or would different types of vehicles be better? One of the important things to consider when looking at electric vehicles is the range. Whether or not an electric car provides enough range depends on driving patterns. When your cars drive more than 500 km a day without barely stopping, electric vehicles might not be the best choice. However, when on average more than 90% of the daily mileage is below 100 km, which is below the average range of a full electric vehicle, an EV can be a good fit to the driving cycle. But possible exceptions in the driving patterns should also be considered, in these cases a differentiation in the fleet with Plug in Hybrid or Fuel Cell electric, can still offer an EV solution.

When building a new fleet one frequently chooses the option to lease the vehicles instead of purchasing them. This has the advantage that many of the uncertainties regarding for example battery life and maintenance, insurance and depreciation costs are covered. Also, one does not have to manage the reselling



of the vehicles. For electric vehicles the resale value is an uncertain factor due to the fast technical developments and financial incentives in the markets. Leasing requires payments on a monthly basis therefore no high investments have to be booked. When considering purchasing the vehicles a tender process could be most suitable. In this process, multiple contractors are asked to come with an offer from which the best one, based on your companies' criteria, can be chosen.

EV availability

When looking for zero emission alternatives for gasoline or diesel driven cars, in many cases one finds that currently there are not many electric options available. This picture from Transport and Environment shows that only less than 20 full electric passenger car models were on the market in 2017.

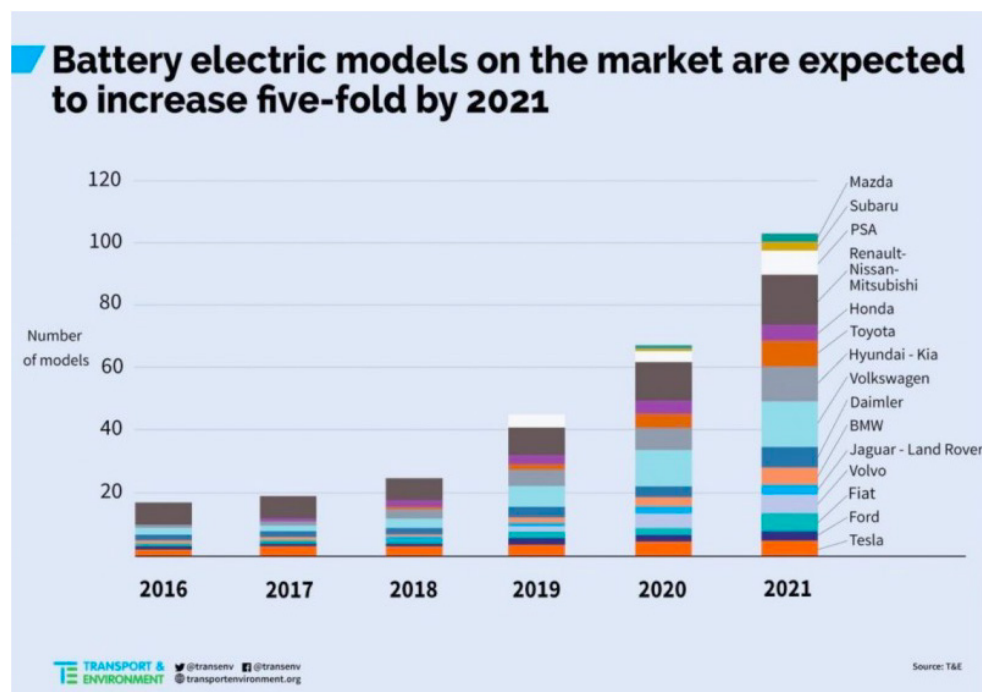


Image source: Number of Battery Electric Vehicles expected in the market. Credit: Transport & Environment.



This could mean that a vehicle in your segment with the desired size and range is not yet available. Based on product planning information from the OEMs, it's forecast that by 2022 more than 100 different models from nearly all major automobile makers are available. Also in all other automotive segments this shift to EV will happen in due time.

Driving behaviour

Once purchased a fleet manager will try to keep the driving costs to a minimum. Energy efficiency in electric vehicles is even more important for electric vehicles due to the limited range but also because of the differences in the behavior of the drive-line between the electric motor compared to gasoline engine. By laws of physics, the force needed to move a vehicle increases in a quadratic manner to the speed, as is shown in the formula.

$$F_d = \frac{1}{2} * C_d * \rho * V^2 * A$$

↑	↑	↑	↑	↑
Force needed	Drag coefficient	Air density	Velocity	Surface



This only partly holds for gasoline engines. Due to the gear system and poor idling and low speed energy efficiency, we became used to the effect that internal combustion vehicles have high consumption at city cycles, the consumption gets even better at more constant higher speeds. Electric vehicles show constant high energy efficiency independent from speed. Therefore they are very suited for city driving with low speeds. Following laws of physics, at zero speed they use no energy, but at increasing speed the energy consumption increases and as a consequence, the range decreases.

This better urban efficiency of EVs is reinforced at fluctuating or stop and go traffic. Thanks to the characteristics of the electric motors EVs come with regenerative braking. Regenerative braking captures energy lost during deceleration and normal braking. In urban environment, the regeneration can be up to 35% of the energy to propel the vehicle. This regeneration works also positive in hilly areas, what's needed to go up is recuperated while going down. Only hard braking reduces the fuel economy and limits the range. But due to the lack of waste heat there and the need to warm the batteries there is a substantial differences in the range that can be reached in winter and summer. Especially in cold temperatures and when the electric heating in the car is on, the range and efficiency of the vehicles can drop significantly. These changes require a different driving style and climate control strategy from your drivers they may need to get used to. Fortunately, in modern EVs pre-trip heating and heat pump technology limits this effect to a minimum.



Asset utilization

It is a known fact that on average cars are parked 95% of the time. The asset utilization rate is therefore very low. In a shared pool system this can be optimized. This can also be a good way to shift to electric vehicles without creating range anxiety among your drivers, always having a fresh horse available. Keeping a few plug-in hybrid, fuel cell electric or even gasoline driven vehicles in the pool for longer trips could serve all your driving needs. Going even further is the concept of Mobility as a Service in which your drivers can choose between the most suitable modes which can include public transport and bikes on demand.

Recharging

Recharging the electric car happens in a completely different way compared to refueling gasoline driven cars. When switching to electric cars you need to have enough chargers at the office or at your depot, but what is enough? This question depends on the number of vehicles and the number of parking spaces. Under- or overutilization of charging points can be a source of complaints. Energy management should also be considered, the grid connection of your building might not have enough capacity to charge a large fleet at once or upgrading this connection can be costly. Looking for solutions such as “smart charging”, in which the vehicle is only charged when enough renewable power is available, can significantly reduce costs. Of course, smart charging should not be in conflict with the availability of the vehicles.

For accessing charging points on the road most charging point operators require



a charging card or an app. Such charging cards are provided by so-called mobility service providers, these have a similar role as fuel card providers. It should be noted that in many countries not all charging cards are interoperable with all charging points. Especially when going abroad planning is needed. Refueling costs are an important aspect of fleet management. Cost of charging can vary significantly from completely free to prices that are more expensive than driving on gasoline (+/- €0,50 kWh). A good overview of the costs of different chargers can save a lot of money.

Experiences from the Netherlands show that charging plug-in hybrids can be problematic. Plug-in hybrids are only more economically efficient than gasoline engines if charged enough. Research shows that 50% of all daily trips can be made in the vehicle is charged overnight. It is therefore important to motivate the drivers to charge by for example offering home charging, through gamification or making it obligatory by an energy budget.

It is better not use normal parking place chargers to completely fill your battery and only use fast chargers up to 80% full when needed on the route. The last 20% recharge will take much more energy and time, this is due to battery characteristics and the thermal battery management system to avoid significant battery degradation when fast charging. Often fast charging, when not needed, is risking unnecessary reduced lifetime of the vehicle.



Fleet monitoring

Fleet monitoring is often a process that is quite cumbersome. Drivers have to keep logs of when and how far the car has been driven for which purpose. From this the fleet manager makes calculations on the fuel economy, expected maintenance and replacement needs. Most modern electric vehicles are connected and offer already some monitoring functions, as also many other new vehicles are becoming more often connected. The performance of the fleet is available instantly through an app making the life of an EV fleet manager and also the driver much easier.

