Smart charging for your electric buses

Whitepaper

THE MOBILITY HOUSE

Contents

Electric buses – Investment in the future

Mobility means movement – on the streets as well as inside people's heads. Anyone who hangs on to old concepts does not notice that things are changing. Sustainable transit concepts that rely on electric mobility are in demand. That means new challenges and of course - new opportunities!

Why electric buses?

Subways, city trains and trams are showing how it's done: an electrical motor without local emissions. Electric buses also avoid burning fossil fuels for energy. When the battery is charged using electricity from renewable energy sources, they operate practically emission-free. That's good for the environment, the air and the passengers.

At the same time, switching to electric buses imposes changes on familiar processes. It is a good idea to consider the operations as a whole and rethink them completely. During the planning process, it is worth taking a close look at the complex relationships between transit line planning, vehicle schedule planning, vehicle needs, charging station requirements, charging power and energy supplies.

Many experts today recommend charging vehicles at a central depot, primarily or entirely. This can reduce the amount of construction needed: When setting up charge points along the routes, this can lead to extended construction efforts when the bus routes change in the future. Sophisticated concepts and smart systems also provide further advantages, including charging with self-generated photovoltaic electricity, procurement of the least expensive energy for charging and, in the future, the possibility for power supply companies to integrate unused vehicle batteries into their power networks.

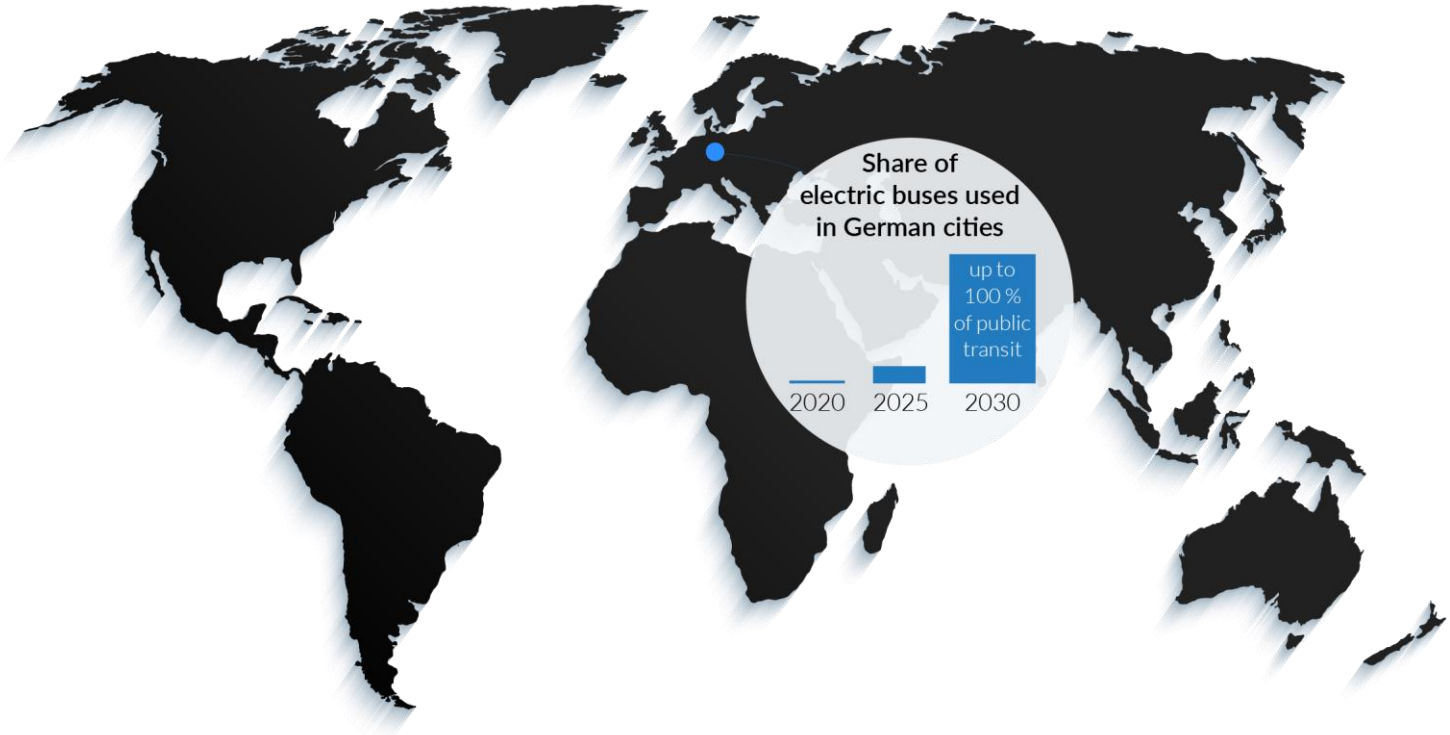
Incidentally, purchase of electric buses and the charging infrastructure is subsidized by public funding. Smart systems and digitalization receive public financial support as well. ChargePilot, the smart Charging and Energy Management system by The Mobility House, may also be covered by these subsidies.

Advantages at a glance:

- **Fewer emissions and less noise**
- **Better reputation for your company**
- **Tax benefits and subsidies**
- **Reduced operating and maintenance costs**
- **Greater riding comfort**

Electric bus fleets around the world*

China is showing what is possible: 400,000 electric buses are already on the road, which is 14% of the total Chinese fleet. Europe, with about 0.2% and Germany with 0.4%, or only 150 all-electric battery-powered electric buses, are still lagging far behind at the moment. However, the future is electric here in this country as well. Within the next five years, German cities and municipalities are planning to purchase more than 2000 electric buses. Berlin, Hamburg, Munich and others are even striving to operate all-electric bus fleets for their short-range public transit systems by 2030.

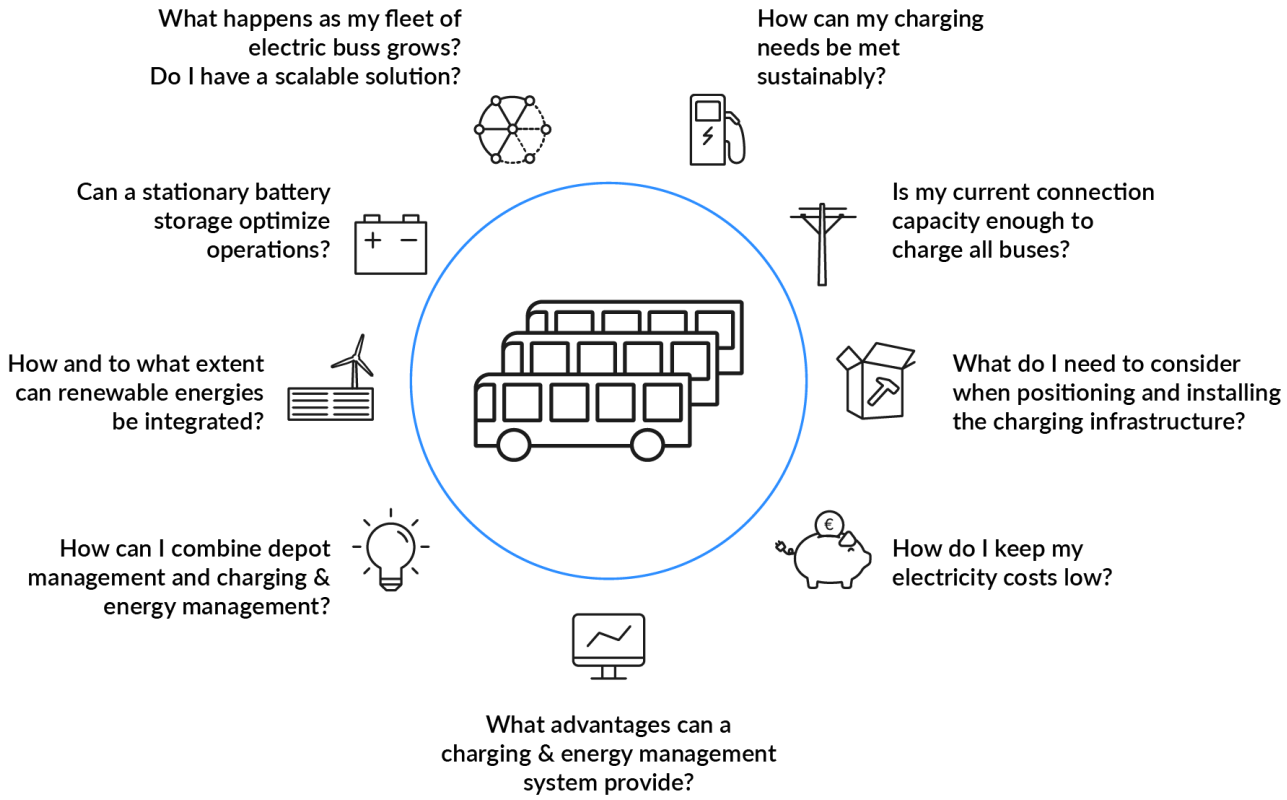


* Sources:
"E-Bus-Radar", PwC, July 31, 2019
"Electric Vehicle Outlook 2019", BloombergNEF
"Buses – Global Market Trends 2019", SCI Verkehr, Nov. 20, 2019

Fueling becomes charging

Charging Ecosystem

Electric buses need to be charged. That means you need a sufficient charging infrastructure for your fleet operation. But it is unwise to just throw something together when building your charging solution.
There are important questions that need to be answered ahead of time – good planning saves significant costs and increases the availability of your electric buses.



Too many questions?

We can help you answer the most important ones with a customized *charging concept*.

Important factors for your planning

Depot charging

In this setup, electric buses are charged at the depot. Usually this is done with a plug-in system, i.e. the electric bus is connected to a charging station with a charging cable. Charging via induction or a pantograph is also possible. Charging is done overnight or during longer idle periods. Usually a bus does not need to charge for the entire time it is idle, which means that charging processes can be flexibly managed in order to considerably reduce electricity costs.

Interval charging

Electric buses are not charged at the depot but rather in transit, e.g. at the final stations or stops. Pantographs, inductive charging stations or docking systems are used for this. Interval charging is especially good for electrifying long stretches, but the disadvantage is that the window for charging is short and that means high charging power is needed. This is expensive and effortful.

Charging power and times

The speed of charging a bus also depends on the type of charging. In general, batteries are charged with direct current (DC). Alternating current (AC) in the power circuit needs to be converted with a rectifier. If it is built into the vehicle, it is called alternating current or AC charging. If it is built into the charging station, it is called direct-current or DC charging. In DC charging, there is a large rectifier in the charging station which makes greater charging power possible and thus shorter charging times. Buses are usually charged using DC charging stations because they can be ready for service more quickly. The efficiency factor, battery status, temperature and age of the battery also all have an influence on the time needed for charging. In general, the condition and life of the batteries is not necessarily worsened by charging. Using smart charging logic normally contributes to a longer battery life though. At the same time, a state of charge (SoC) of 100% is not recommended from the perspective of optimal usage.

Overview of conductive charging

	Plug-in systems*		Docking systems
Technology	AC charging (type 2 plug) usually used for passenger cars up to 43 kW	DC charging (CCS plug) common standard for buses 30-150 kW	DC charging Pantograph up to 600 kW
Communication standards	> Communication between charging station and bus should be ISO 15118 > Communication between charging station and backend system should be OCPP 1.6J or higher		
Advantages	> Existing standards > Many already existing charging stations > High efficiency factors		> High capacity possible > High efficiency factor
Disadvantages	> Manual operation > Cable routing necessary		> Not weatherproof > Large, expensive charging Infrastructure

*Type 1 and CHADeMO plugs do not play a role for electric buses.

Charging at the depot

Charging electric buses at the depot requires detailed, forward-looking planning. Which charging infrastructure fits your space requirements, transportation schedules, and operational processes? How can you stay flexible when electrifying your bus fleet gradually and remain independent of manufacturers?

Charging station & charging point

A charging station is often set up for each bus. In practice, however, not every bus needs its own charging station. This should be carefully examined during the planning stage. Charging stations with two charging points should also be considered. This can reduce the investment costs and the space requirements for your charging infrastructure. We still recommend providing each bus with its own charging point to avoid time-consuming plugging in, unplugging and re-parking. A Charging and Energy Management system manages and optimizes the flow of electricity on these “multi-charging stations", so that the buses’ range is not restricted. However, you should always include a safety buffer in your planning because, like any technology, even charging stations can fail.

Bumper buffer

A bumper buffer helps to keep the charging electronics safe from smaller and larger accidents. Depending on the installation of the charging station, different options are available – e.g., steel protection, raised approach board or a wrap-around, protective band of the type found on gasoline pumps. No matter which solution you choose, your charging stations will thank you.

Space requirements & vehicle placement

Designing the right charging infrastructure also depends on the space requirements of the depot. The available space determines important factors, such as the possible number of charging stations, cable lengths and placement for the switching cabinets. In addition, placement of the electric buses determines how flexibly the charging points can be used. A herring bone placement allows the vehicles to park relatively flexibly in relation to the charging points while an end-to-end placement means that parking slots need to be filled from front to back. The charging point is then determined by the time of arrival. Many operators prefer charging with pantographs at the depot to avoid dealing with charging cables. To save space, it is also possible to install charging hardware above ground-level. However, you should definitely consider the fact that a DC charging station often weighs from one to several tons.

Expert tip: Planned preconditioning

The option of preconditioning provides many advantages for your electric bus fleet. This brings the battery and bus interior to the proper temperature before starting the trip. This helps the battery work more efficiently, which improves the range of your fleet on cold and warm days. Ideally, preconditioning can be activated remotely and is also factored into your Charging and Energy Management system’s planning calculations, to avoid unplanned load peaks. The system can precisely provide the required charging power to the bus via the charging station. This also has a positive effect on the battery and the range. In addition, the driver and passengers appreciate a bus that is already at a pleasant temperature.

Mobility meets energy

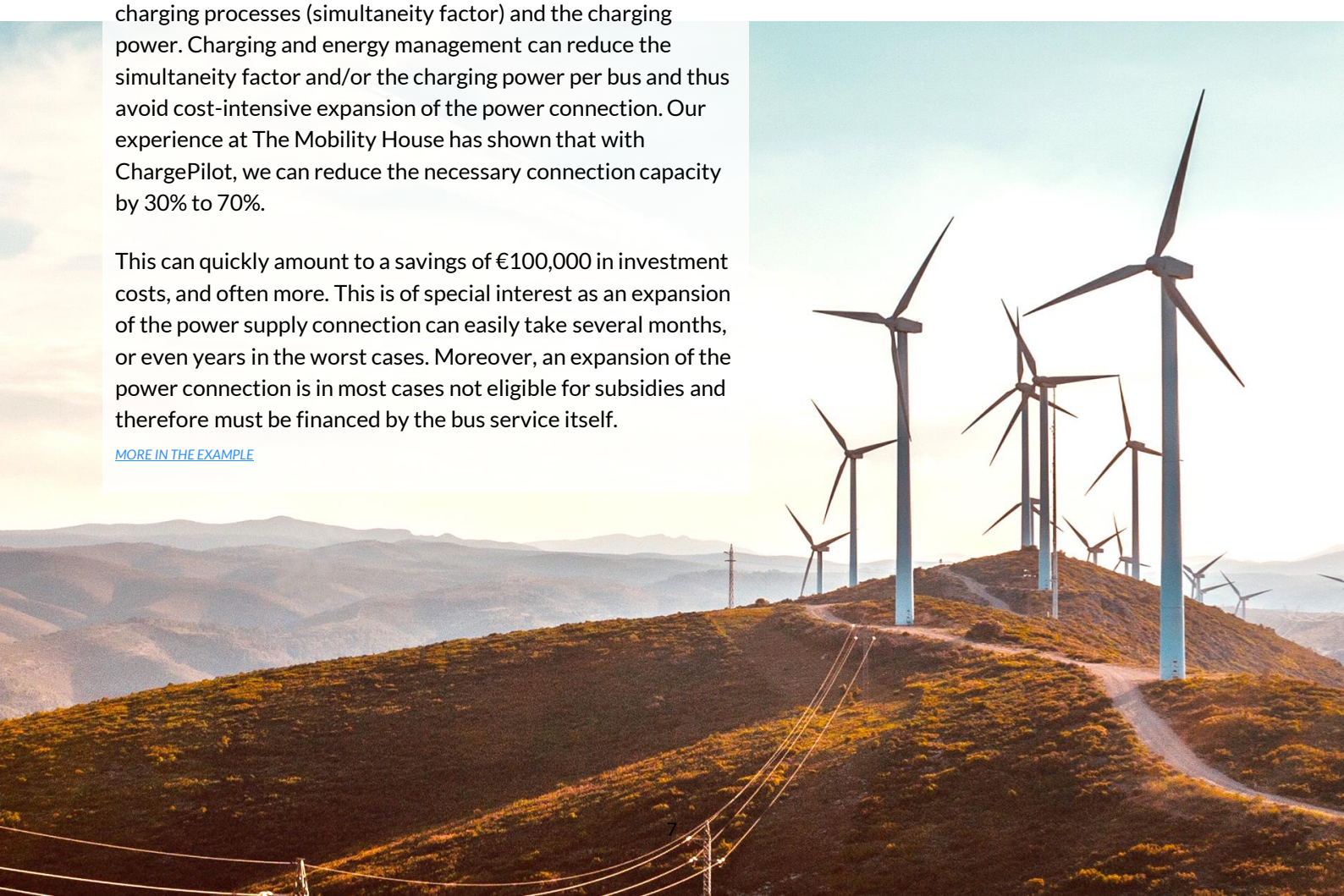
What is the power connection?

The power connection connects your depot to the electricity grid. All electricity for your operation is drawn from the grid power connection – unless you generate part of your electricity yourself. The power connection and transformers must have enough dimensions to meet high power demand.
It implies that the power grid must be capable of providing the necessary capacity at that location. If the network operator has to upgrade the power connection, they can demand a surcharge from you. This can quickly become a six-digit number for a medium-sized electric bus fleet without a Charging and Energy Management system.
In addition, your contract must allow, or be upgraded to allow, the required connection capacity, which in turn has associated costs. The same is true if new transformers are needed.

For electric buses, a connection with enough capacity is important to ensure dependable operations. The required capacity depends mainly on the number of simultaneous charging processes (simultaneity factor) and the charging power. Charging and energy management can reduce the simultaneity factor and/or the charging power per bus and thus avoid cost-intensive expansion of the power connection. Our experience at The Mobility House has shown that with ChargePilot, we can reduce the necessary connection capacity by 30% to 70%.

This can quickly amount to a savings of €100,000 in investment costs, and often more. This is of special interest as an expansion of the power supply connection can easily take several months, or even years in the worst cases. Moreover, an expansion of the power connection is in most cases not eligible for subsidies and therefore must be financed by the bus service itself.

MORE IN THE EXAMPLE

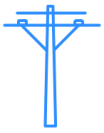


General electrical costs

Electrical costs for industrial and commercial customers* are comprised of three components:

Energy costs

The energy costs are accrued for the actual consumed energy (kWh). These rates (€/kWh) differ based on time-of-use during the day. In such cases, it can be a good idea to charge electric buses during the less expensive energy periods, when possible.



Grid usage fees

Grid usage fees (network charges) are accrued for use of the power grid. The amount of the grid usage fees is determined by the volume price (€/kW/a), calculated according to the highest volume used. In other words, whoever uses high volumes from the grid, pays more. High peak loads are therefore expensive and should be avoided. This is where charging and energy management can help. In Germany, the volume price is generally between €60 - €120 kW/a. Metering and billing charges are also included in the network charges.

Taxes and reallocation charges

Of all fees, the EEG** reallocation charge is the largest item on the electricity bill in Germany. The reallocation charge, which is used for expanding renewable energies, is currently 6.756 cents/kWh, but there could soon be equal treatment for electric buses with overhead line and rail vehicles. These already benefit from an 80 percent reduced EEG reallocation charge. Equal treatment was already recommended by the Association of German Transport Companies (VDV - Verband Deutscher Verkehrsunternehmen) in 2016, but it has not yet been approved.

Taxes and charges also include the CHP levy for the promotion of combined heat and power plants and the concession levy.

* Usually starting at an annual power requirement of 100,000 kilowatt hours. Corresponds approximately to the power requirements of three electric buses with an annual mileage of 30,000 kilometers per vehicle.
** Renewable Energy Sources Act (German: Erneuerbare-Energien-Gesetz), click here for more information.

What is charging & energy management?

Charging and energy management optimizes charging for your electric buses and ensures that the vehicles are charged dependably without driving the costs up. In addition to the cost optimization, the possibility of monitoring and evaluating the charging processes is an important advantage.

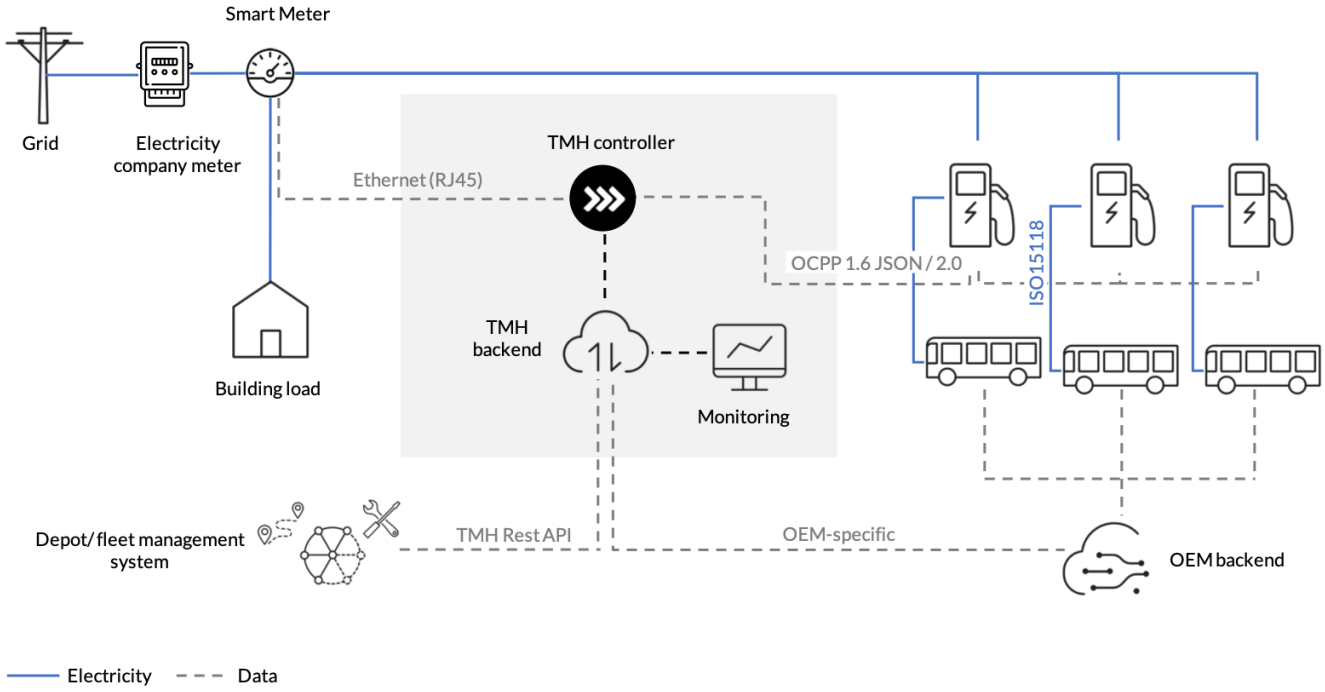


Fig. 1: Systematic design of ChargePilot, the Charging and Energy Management system by The Mobility House

Prevent load peaks

Load management lowers expensive peak loads and, with that, the costs of grid connection and grid fees. Loads are balanced intelligently by temporally offsetting vehicles or charging them at lower capacities. A charging management system is often necessary for charging several buses on the existing grid connection. Incorporating the cycle data, battery state of charge (SoC), energy requirements, desired pre-conditioning settings and other factors allows you to precisely optimize the charging process for your operations.

Cost-optimized energy use

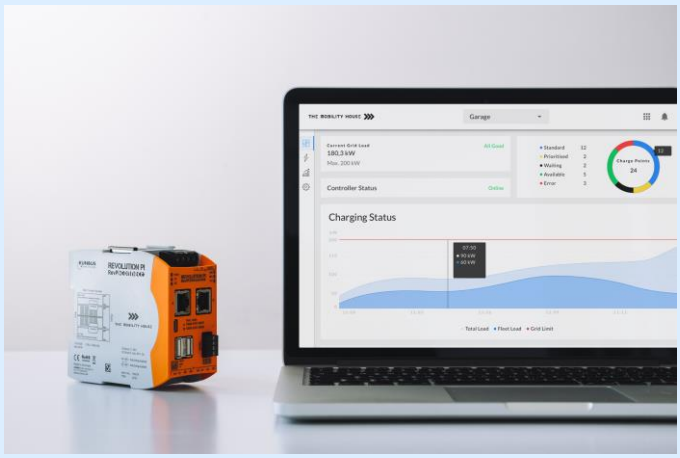
Under some circumstances, there may be financial incentives to optimize charging of your bus fleet, and not just in terms of peak loads. This could be the case if your electricity rate is cheaper at certain times of day or if you generate your own electricity at certain times. If you can use these times for charging, you can save additional money.

Dynamic load management

Is there an especially tight margin on the available electrical power capacity for charging your electric buses or do you have electrical consumers at your location that require very high capacities on a short-term basis?
A dynamic load management system might be the solution, because it takes into account all the electricity consumers on site. For example, if your depot has a washing facility for the vehicles, a dynamic load management system reduces the charging power during washing so as not to overload the power connection.
This is possible by integrating a smart meter into the system, which continuously provides information about the power draw.

Monitoring and evaluation

Monitoring gives you an overview of charging processes and costs, providing certainty and flexibility in your load management. Unexpected changes in operating procedures can quickly be compensated and the availability of your electric buses maximized. Monitoring can be integrated into a depot management system using interfaces. That way all information is available in one place.
Are you interested in using ChargePilot, the Charging and Energy Management system by The Mobility House? Ask about our interface for the depot management system and other fleet management systems.



With ChargePilot, you can manage loads and bill for charging processes with only one system. The included monitoring keeps an eye on all the data and activities for you.
Click here for the video!
More at: mobilityhouse.com/charging-and-energy-management

READING TIPS

The bus company **Connexxion**, with one of the largest bus fleets in Europe, depends on ChargePilot
mobilityhouse.com/our-references/connexxion

Bus operator rnv achieves a cost savings of 33% with smart charging *mobilityhouse.com/our-references/rnv*

ChargePilot efficiently and cost-effectively charges the bus fleet at the **Oslo airport**
mobilityhouse.com/magazine/oslo

Basel city transport is laying the cornerstone for the electric future of its bus fleet with its infrastructure concept
mobilityhouse.com/our-references/bvb

Case study: Smart charging for your electric bus fleet

The following case study shows how ***ChargePilot***, the smart Charging and Energy Management system by The Mobility House, can optimize charging for your bus fleet resulting in huge potential savings. By preventing peak loads and providing optimized charging strategies, there is a great potential for savings, even during the construction phase: With 15 electric buses, each with a battery capacity of 250 kWh, the one-time costs for the power connection and the charging infrastructure with ChargePilot can be €316,000 cheaper than they would be without a load management system. On the one hand, usage of the existing power connection is optimized and does not need to be expanded.

On the other, optimization of the charging processes and the time-dependent procedures make sure, fewer charging stations are needed to ensure the availability of the electric bus fleet. ChargePilot also makes possible great savings on ongoing operational costs: Thanks to the lower network load, the electrical costs are reduced by €85,250 per year. Calculated over ten years, that is a savings potential of nearly €1.2 million. With the integration of a fleet management system, there can be even more cost benefits: By coordinating the charging strategy with the bus schedules and the relevant technical data of the batteries, the potential savings goes up to €1.4 million in 10 years.

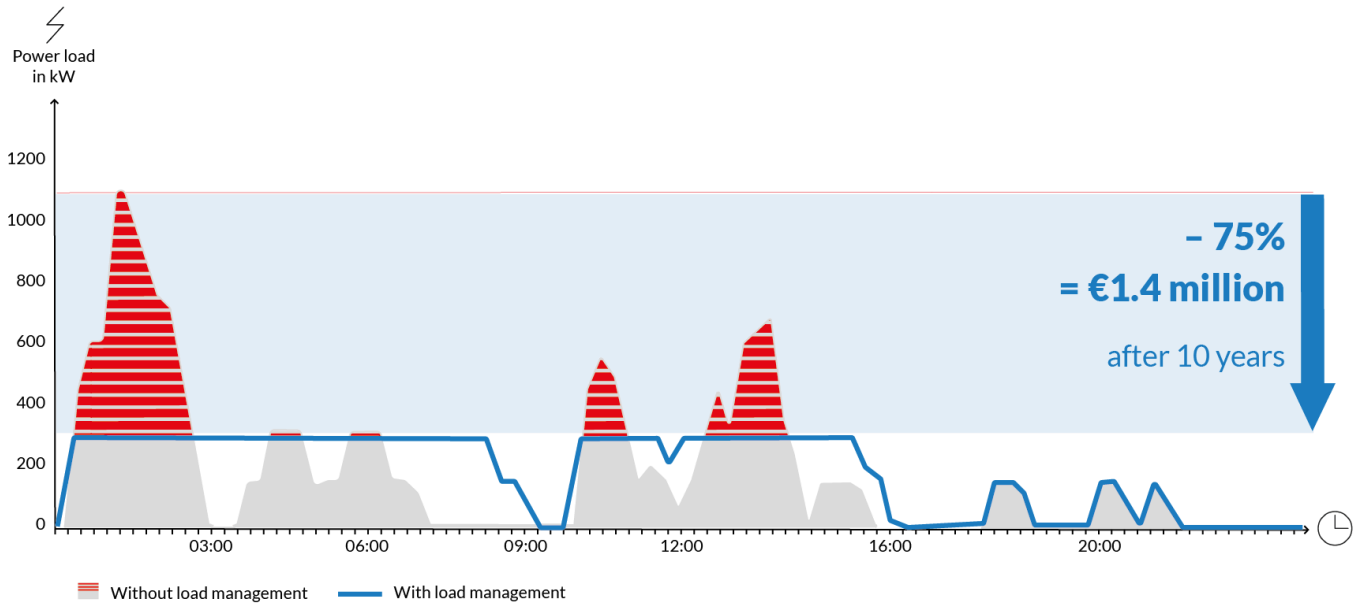


Fig. 2: Comparison of the network load with and without load management for 15 electric buses. Savings calculated over 10 years.

Functional tender contents

Are you interested in the smart Charging and Energy Management system ChargePilot?

Are you looking for a charging management system for your battery-powered, electric bus fleet? We're happy to work with you to find a smart, cost-optimized, and grid-stabilizing solution.

Simply scan the QR code and take advantage of our template for functional tender contents for a charging and energy management system.
Or click here.

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THE MOBILITY HOUSE

The mission of The Mobility House is an emission-free future for energy and mobility. Our technology platform brings together the automotive and energy sectors. We use smart charging, energy and storage solutions to integrate vehicle batteries with the power grid. By doing so, we promote the development of renewable energies, stabilize the power grid and make electric mobility more affordable.

The technology company The Mobility House was founded in 2009 and now operates worldwide in more than 10 countries from its locations in Munich, Zurich, and Sunnyvale (CA). Alongside many leading car manufacturers, our clients include fleet operators, installation companies, energy suppliers and electric car drivers.