

## Qbuzz frontrunner in emission-free driving

Bus operator Qbuzz in Utrecht has been working on zero-emission bus transport for quite some time. In addition, Qbuzz has researched smart charging of buses as a partner in the European IRIS project. With smart charging, charging sessions are postponed to favorable times, sparing the electricity at peak times. In the coming period, Qbuzz is implementing smart charging and the carrier is investigating the effects of purchasing energy from other energy markets, as well as feed-in of electricity back to the grid. For electricity feed-in, the company is looking at discharging buses to the grid, also known as Vehicle-to-Grid (V2G). In addition, Qbuzz is looking at using used bus batteries as stationary energy storage. Tim van Twuijver, Sustainability Manager at Qbuzz, is happy to tell us more about it.



## One of the most sustainable bus operators in the Netherlands

"In 2015, a sector-wide agreement was reached with public transport authorities, bus operators and the Dutch government that bus transport would be completely emission-free by 2030. Qbuzz started as one of the first in 2014 to figure out how 'emission-free driving' is possible," Tim says. Since then, a lot of knowledge and experience has been gained about driving on hydrogen, charging batteries with various charging technologies, and the necessary ICT solutions to optimize the operation of zero-emission buses. "Qbuzz has gradually worked to improve the quality and deployability of the bus fleet. By 2022, as much as 37.6% of all service hours were already driven emission-free. This makes Qbuzz one of the most sustainable bus operators in the Netherlands."

In the upcoming tender until 2027, client Province of Utrecht is setting high requirements in terms of emission-free public transport. "Technically, emission-free driving in 2023 is already quite feasible on a regional scale. Development of new technology around electric buses and chargers is important to enable the transition to completely emission-free public transport. The technology is developing rapidly and becoming more mature. We do see that the electricity supply in the Netherlands is starting to become a problem." This is because, with the electrification of society, electricity demand is rising. In addition, new renewable energy projects cannot be connected because the electricity grid is overloaded.

## Smart charging distributes energy demand

Current developments in the energy market are having an impact on Qbuzz's operations. Energy prices have reached record highs and in the coming years the supply of power from wind and solar will continue to increase. These energy sources are difficult to control, which means that fluctuations in the electricity market will become increasingly pronounced and the electricity grid will be overloaded at certain times. "By applying smart charging, bus charging sessions can be partially shifted to favorable times." Favorable times are at times of low electricity demand and/or high energy generation, typically from 10:00 to 17:00 and from 23:00 to 07:00. "This spares the network during peak times and Qbuzz also makes a social contribution."

In addition to the social contribution, smart charging also offers benefits for Qbuzz itself. Smart charging helps to improve operational reliability by preventing outages of network connections due to overcharging. Additionally, smart charging lessens battery wear and operational costs.

## Data-driven innovation

The switch to emission-free driving has a major impact on almost all facets of Qbuzz's operations. To manage the increased complexity, intensive data collection has been carried out for several years. Tim: "By analyzing data and gaining better insight into operational systems, the vehicles can be deployed even more efficiently in the coming years. By setting up operations in an increasingly 'data-driven' way, Qbuzz can continue to distinguish itself." Qbuzz now has an entire team dedicated solely to data by employing its own data analysts. "The lesson learned for Qbuzz is that we need to be in control of the data ourselves so that we are not dependent on third parties. That way you can react faster and innovate."

To achieve emission-free driving as soon as possible, Qbuzz has been engaged in innovation for years. This includes being a partner in the European IRIS Smart Cities project, in which the bus operator focuses on smart charging. At the start of IRIS, eleven electric buses were operating in the Utrecht bus fleet. "Fifty-five new electric buses have been running since last year, so there is a wider variety of data available for the studies within IRIS." Qbuzz wants to gain better insight into the further application of smart charging. "To do this, it is very important to collect charging data and combine this data with other available data sources such as weather data, energy price data and vehicle planning data. The data is used within IRIS as input for analyses and models to ultimately arrive at a smarter charging process."

The collaboration has already yielded results. "Qbuzz developed a model with Utrecht University to work out various charging strategies for electric buses. The model was then applied to a Qbuzz bus depot. The research shows that charging buses smarter results in halving peaks in electricity demand which leads to less load on the power grid and lower energy costs."

## From smart charging to feed-in to the grid

The new Qbuzz project "Smart Charging" consists of three phases. Phase 1 started in 2022, in which a temporary and relatively simple setup of the smart charging system is implemented. This is limited to the combination of the two charging strategies 'delayed charging' and 'load balancing'. Both strategies reduce the consumption of electricity during peak moments on the grid, and then further charge the battery at other times. 'Load balancing' prevents blackouts by intervening when a charging session requires too much energy, whereas 'deferred charging' actively looks for favorable times to charge. The charging strategies will be applied at all Qbuzz depots where charging of electric buses takes place. Controlling fast chargers at bus stop locations, as well as adjusting the energy procurement policy for electricity is not part of this subproject plan. "During the implementation of phase 1, Qbuzz has run into many practical issues," Tim said.

In parallel with phase 1, preparations are being made for phase 2 which focuses on purchasing electricity through other energy markets, such as the day-ahead market or imbalance markets. In the day-ahead market, electricity is traded for the next day and in the imbalance market, electricity can be offered for times when demand for electricity exceeds supply. "Using smart management, buses can be charged at cheaper hours. It takes a relatively complex system to achieve this. The keyword for this is therefore 'predictability'."

Phase 3 focuses on feed-in to the electricity grid. Qbuzz sees two options for delivering electricity back, either from bus batteries by discharging buses, also known as vehicle-to-grid (V2G), or from static "stand-alone" battery packs. These battery packs are used bus batteries. The technical and financial feasibility of different scenarios is currently being studied. "It is currently insufficiently known what the effects are on battery life and warranty. Research within IRIS does show that V2G can be interesting in combination with purchasing electricity through day-ahead or imbalance markets," according to Tim.

## Used bus batteries for energy storage

Especially for electricity feed-in, Qbuzz itself has an interesting asset available. Batteries that no longer provide enough capacity for the buses can still serve as energy storage. This way, Qbuzz can give these batteries a second life. "At the moment, Qbuzz has about 300 battery-electric buses running in the Netherlands. The capacity of the batteries in these buses decreases due to degradation. When the batteries have degraded to a certain value, the buses are insufficiently able to run according to schedule." The batteries are then replaced but are still suitable for other purposes, including energy storage.

Within a few years, therefore, many batteries will become available, and Qbuzz is keen to investigate how these batteries can be given a second life. "To gain a better understanding of the technical and financial feasibility, we have chosen to take this up within the IRIS project. By starting a pilot with a battery already made available from a bus, we hope to gain practical experience and collect data. This data can be used for research and for preparing business cases to further upscale battery storage with 'second life' batteries."

## Everything coincided for Qbuzz

Thanks to the collaboration with Utrecht University and We Drive Solar within the IRIS project, Qbuzz gained insight into the effect of the current charging strategy on the power grid and what alternatives exist. The collaboration consisted of sharing knowledge and doing research. The insights gained led to the decision to put the topic high on Qbuzz's priority list. "Based on the results of IRIS, a start was made on actually applying smart charging within Qbuzz. To this end, Qbuzz hired the student researcher from Utrecht University who researched Qbuzz's charging strategies for her graduation. Besides IRIS, the accelerated scaling up of the electrification of the buses also played an important role. Everything coincided at the right time."

Sessions with the other international partners within IRIS revealed that this scale-up is not at the same stage everywhere. "Many countries are still at the stage of tendering the buses. In that tender, it is important to keep in mind that it is not just about the purchase of the buses but that a different style of business management is involved. Think about maintenance of the buses but also the orientation towards data." Qbuzz has already made great strides to achieve completely emission-free public transport and will take the final steps in this sustainability task in the coming years. In addition, Qbuzz's efforts in the area of emission-free public transport are helping other transport companies make faster strides in their sustainability task.