SCHEMATIC DIAGRAM OF A TRIP SCHEDULING SYSTEM FOR AN EV

The patent WO2021123468, allows to know in a fast and exact way, the available energy ED, remaining in an electric battery, at any time.

An immediate application is to be able to manufacture a very reliable system that can schedule any type of journey in an EV.

With this, what we are aiming for is that the user, in a simple way, knows whether or not, with the battery available at a given moment, he can face a journey, that is to say, the autonomy. And in just a few seconds.

Or to put it another way, how to plan a long journey, where extra recharging will be needed, and where to do it. It is understood that the program integrates all available charging options and can offer several alternatives to the user.

In order to do so, the user has to inform the system of basic data, such as the route, the starting time of the journey, the number of passengers and their luggage.

Of course, more data is needed. Some, such as the temperature, will be supplied to us telematically and automatically, without requiring it manually.

In principle, the system assumes that the rest of the consumption/services will be standardized. The speed of the car at the different points will be the one allowed by the legal or physical limit of the road. If this is free at certain points, then it would be necessary to report the desired speed. Likewise, the temperature of the passenger compartment, the additional consumption of any equipment, videos, music, etc.

The first step will be for the patent to find out the battery status, and thus to have a first information on the autonomy.

Let's explain in more detail how this scheme is developed. We must start from some initial conditions in order to have a framework. We will divide these conditioning factors into endogenous and exogenous. We will call endogenous or internal, those that depend on the user and the particular conditions of the vehicle, but which, in one way or another, we can influence. And exogenous or external, those which depend on external

factors beyond our control, such as the temperature and its possible changes throughout the journey, traffic jams, the profile of the road to be travelled, etc.

It must be taken into account that this programming is not static, but dynamic, and must allow for constant updates, considering in real time unpredictable changes at first, such as the aforementioned traffic jams, atmospheric changes, etc., which can occur at any time very quickly, after the start of the journey.

With all the initial information, both internal and external, we can prepare a BEC, Balance of Electrical Consumption. The BEC is a table showing the different

consumers, with their corresponding intensities, and the times during which these consumptions occur. It must include not only the discharges resulting from driving, but also the loads caused by braking, discharges of super capacitors, even replacement loads, etc., as well as the foreseeable temperatures during each load or consumption.

If this BEC were static, and there were no temperature changes, it would be very easy to calculate the car's range. But clearly it is not, and we will consider the main sources of these changes.

We will start by looking at the internal constraints. In the chapter on weights, in addition to the weight of the vehicle, we must consider the weight of both the people travelling and their luggage. This data can be obtained automatically. It should be noted that it may vary over time, either because some passengers are picked up later or because not all of them make the full journey.

Attention should be drawn not only to the speed itself, but also to sudden changes in speed. EVs are vehicles that can have high acceleration, which will mean a high requirement for battery power consumption. Such acceleration can be electronically limited. Driving style has a major influence on energy consumption. Smooth changes in speed, together with the road profile, are some of the aspects that have the greatest impact.

All the differences that are introduced in the described consumptions will shape a dynamic BEC. This, in turn, will lead to a greater or lesser use of battery intensity and, finally, to a greater or lesser use of autonomy. All this without forgetting the exogenous conditioning factors, such as temperatures that can vary quite rapidly, even without following the forecasts.

In an ideal scenario in which we have the endogenous and exogenous data and the evolution of the variables in real time, and in which the BEC may have small variations, the range forecast will be accurate and will decrease in the same proportion as the distance we travel.

What could appear as a disadvantage, such as dense and slow traffic, although at a constant speed, in an EV is a great advantage, since the capacity of a battery increases when the intensity of consumption decreases in a proportion that favours the former. We could say that a 10% decrease in speed would increase range by 20%, with all other variables remaining constant.

During this process, we need to know the behaviour of the battery, not only when it is consumed in a linear way, but also when it is subjected to abrupt changes in its working conditions. That is, when discharging or charging with different intensities, at different times, and at different temperatures. And consider that these cycles are constantly repeated.

The patent sets out in detail the above assumptions about the battery's performance, at a technical development level. This behaviour can be reproduced with algorithms

that, used repeatedly, allow the state of the battery to be known at any given moment, from the point of view of theoretical consumption.

However, for a number of reasons, there are deviations between the above calculations and the reality of the battery. It is therefore advisable to periodically check the real and exact situation of the battery in order to be able to update its remaining energy. This real available energy, ED, will be provided by the patent. And it will allow us to adjust the autonomy.

The frequency with which we request this ED value from the patent will depend on the importance of the changes in the BEC. If we can consider them small, we will only need to check the ED two or three times every hour.

All of the above allows us to accurately and permanently calculate the real range of the vehicle at all times.