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SOC AGAINST ELECTRIC VEHICLES

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Technical task:
The object of the technical innovation is to provide a recuperation potential for long descents by means of free-hold load capacity of the traction battery to prevent overheating of the brake system.

Initial situation:
During long trips in the mountains it can happen that the brake has to endure high temperatures for a long time. In addition to discs and pads this permanent temperature entry also leads to a significant increase in temperature in the brake fluid. If the liquid temperature exceeds the boiling point of the brake fluid, the brake fluid suddenly changes to the gaseous state when the brake is released. When the brake is pressed again, this gas is compressed without significant pressure in the system and thus build up braking torque. The vehicle does not delay. This is especially true for vehicles with not regular
exchanged brake fluid.
In a sudden braking, the driver is surprised by the loss of braking or total failure. This costs valuable seconds reaction time and makes it difficult to safely decelerate the vehicle significantly. Ultimately, this can lead to serious accidents.
A solution is known that prompts the driver to relieve the brake by engaging the gear D or a suitable gear.
In electric vehicles, it is not possible to achieve in this way a relief of the brake, since electric motors do not build up an engine braking effect analogous to that of internal combustion engines. So it must be found other mechanisms to relieve the brake.
Also known is the idea to ensure the relief of the brake on a long downhill by recuperation even in the case of a full battery. However, the recuperation potential of these measures may not be sufficient.

Solution:
Already before the start of a downhill run, it is ensured that sufficient energy can be taken up for the recuperation during departure from the battery. The maximum permissible SOC (state of charge, state of charge of the battery) at the beginning of the downhill run can be stored permanently or can be calculated according to the situation.

The necessary measures of energy destruction can already occur while driving or at a standstill, or when charging the required amount of energy is not brought on board (for example, loading only up to 95%).

In order to be able to compensate for errors, the customer is informed optionally about the measure and can prevent it if necessary.

Also, a message to the customer is conceivable, which warns him in time if he threatens to come into a situation where at the beginning of departure in the battery is not enough free capacity for the expected Rekuperationsenergie available.
Substantial degree of innovation of the idea are the strategies shown below to recognize the relevant downhill. A development goal would be to ensure as few or as little as possible a situation-adapted SOC provision. Optionally, the measures are reported to the driver and are overruled by the driver.
A logic, when the measures should come before a relevant, long downhill to bear, still to be worked out.
Criteria for a relevant, long downhill run (selection from the following options, as average or profile / course) would be:

- slope of the track (including consideration of flat sections)
- Length of the route
- estimated vehicle speed
- Time of energy input by braking
- expected brake disc temperature
- Pre-load of the brake (eg repeated downhill descent, hot brake at the beginning of the descent)
- still to be covered until the start of the descent or the while occurring energy consumption
- Altitude and change, e.g. from GPS or via air pressure
- Behavior of the vehicle on the last kilometers covered
- Route information (for example, all possible routes (the likelihood of each route can be entered) in the navigation system
entered route)

An exact logic on how to identify whether an SOC requirement will be necessary would also need to be developed.
The following variants are conceivable:

Variant 1: Geofencing:
Variant 1a - Online:
The vehicle reports its location, online it is calculated whether in a defined radius a relevant downhill is possible and how high the SOC requirement for it must be. An advantage of this would be that the calculations only need to be made once, as soon as all used charging stations are known. However, GPS data and Internet connection are required for this, or a „probable location“ must be defined if there is no GPS reception, such as in parking garages. So it must be deposited strategies for the case when the vehicle is offline.

Variant 1b - Offline: In the vehicle, the areas (geofences) from which a long downhill run would be possible and SOC values are stored.
For this, however, large amounts of data would have to be stored and the available map material must be kept up to date.

Based on this assumption is described by measures similar to a known technical innovation that allows a Rekuperationspotenzial full battery. Or the SOC allowance is maintained in the case of a loading vehicle directly when loading. In both cases, the distance to be traveled or the energy consumption up to the start of the downhill run must be taken into account (site-specific including all possible routes, or based on a route already entered in the navigation system).

Variant 2: manufacturer-independent:
Charging columns get a signature when setting up (long uphill drive possible yes / no, SOC value) and report this to the vehicle before starting the charging process. This then meets the necessary measures manufacturer and concept specific. The advantage of this is that the logic in the vehicle can be kept slim. One challenge would be worldwide standardization. The behavior of transmission errors and incompatibilities or unavailability of the information must be defined and can only be applied to loading vehicles.

Variant 3: „The last x kilometers“:
If the vehicle has traveled a y-meter difference in altitude for the last x kilometers in front of the store, it is on a peak from which it is most likely going down the same or steeper.
An advantage of this is again that the logic can be kept slim in the vehicle. However, a GPS reception is necessary.
The behavior when the info is not available must be redefined and the logic can only be applied to loading vehicles.

Variant 4: Altitude of the charging station
Based on the position of the charging station via NN, a maximum SOC is restricted from the outset. An advantage of this is again that the logic can be kept slim in the vehicle.
The behavior when the info is not available must be redefined and the logic can only be applied to loading vehicles.

Vehicles on high plateaus are automatically confronted with a SOC bias, which can be executed permanently switched off for such applications, if necessary.

Variant 4a:
The height of the charging post minus the minimum height value of the last x hours of operation or the last x kilometers is considered as a measure of the need for an SOC allowance.
The pros and cons would be the same as in variant 4, but with potential improvement on high plateaus.

Variant 5: Meaningful combination of the previous possibilities:
When the vehicle is online, the online geofencing option from variant 1a is used.
If it is not online, but height information is available, the altitude is evaluated as in version 4a.
If the vehicle is not online, but no altitude information is available, a pre-determined SOC provision is met, which also provides a customer deselection option. Such a query can also be used for the variants beforehand in the case of SOC provision.

It would make sense to vary the SOC bias. That could be done on the basis of certain data.
For example, in geofencing:
The SOC estimate is adjusted depending on the route, the gradient and the road conditions or the assessment of the hazard potential. This can be, for example, a frequently used road that is wide and well secured and has no speed limit, allowing high speeds with little danger. The danger potential or the „most dangerous route“ is calculated and the SOC provision adjusted accordingly. Or depending on the height difference is sometimes more and sometimes less SOC requirement requested. The criterion is the height of the mountain. The higher it is, the longer the descent will be. Possibly. Offline navigation data can be used similar to geofencing.

Advantages:
- Relief of the (mechanical hydraulic) brake system
- No additional hardware needed
- No over-dimensioning of components necessary

Possible application:
- All vehicles with fully or partially electric drive and recuperation option.