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1/2 *Electric vehicle »CITYSAX« at the exhibition »Sachsen – Modellregion Elektromobilität«.*

BATTERY PRESERVING AND GRID SUSTAINING CHARGING DEVICE

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Motivation

Due to the increasing promotion of low and zero emission vehicles, the number of electric vehicles (EV) will rise in the near future. This change in mobility will be accompanied by an altering energy market with a growing share of renewable energies. This development poses a challenge, not only for storing the energy but also for the electric grid. By means of control and regulation on the demand side – here battery charging – there is the chance to minimize undesirable conditions like peak loads.

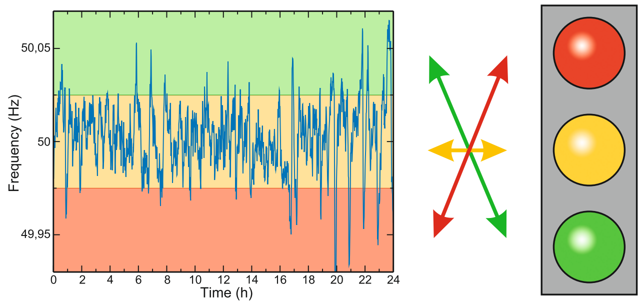
The Fraunhofer Institute for Transportation and Infrastructure Systems IVI develops innovative and cost-effective technologies. With the Battery preserving and grid sustaining charging device, a novel battery charging approach for electric vehicles is presented.

Concept

Since the utility frequency is directly correlated with the load of the grid, its evaluation provides the possibility to charge the battery with regard to the electric grid – hence grid sustaining. The charging procedure presented here is based on an autonomous decentralized measurement of the gridstate, i. e. without the need for an elaborate communication infrastructure between the EV and the grid operator. Hence, it is a cost-effective approach.

The additional incorporation of a battery model into the charging algorithm yields the following properties for this concept:

- grid sustaining
- battery preserving
- ease of use due to simple communication infrastructure
- cost-effective hardware.



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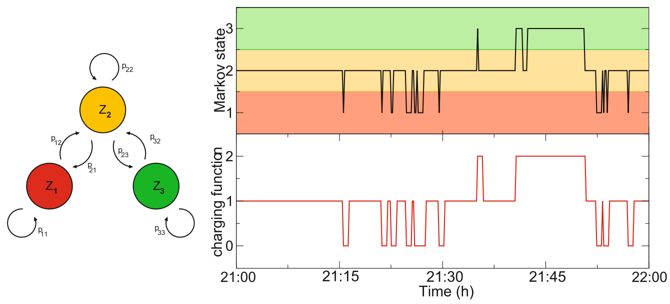

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Method

The charging algorithm is based on Markov chains. The frequency is assigned via different intervals to three different Markov states: state 1 (red) corresponds to an overloaded grid, state 2 (orange) to a grid in normal state and state 3 (green) to an under-loaded grid. Using Markov chains, it is possible to predict the frequency development for a certain time frame with a determinate probability. This, in combination with the condition that charging is only permitted if the grid is in state 2 or 3, builds the foundation for the charging algorithm.

On the other hand, next to the grid sustaining properties, also a battery model is included in the algorithm. The battery is charged with a constant current until the maximal permitted voltage is obtained. The charging process is completed by a short constant voltage part. By applying this battery charging rule, also the state of health of the battery is taken into consideration – hence, the algorithm is battery preserving.

Technique

The developed charging procedure requires merely a small number of adjustable parameters, e.g. the critical frequencies beyond which the grid is in an under- and overloaded state, respectively.

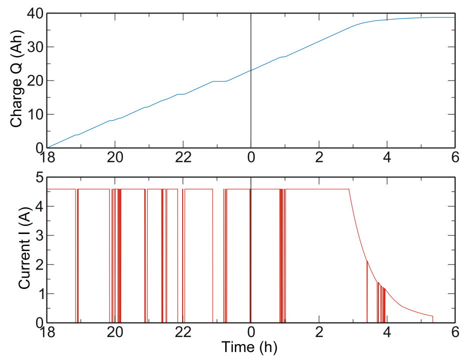
In order to specify the parameters for the algorithm, the utility frequency was measured over various periods. Furthermore, the charging procedure was verified for different application scenarios.

Target platform for an implementation of the charging algorithm is a low-cost microcontroller system, containing the following modules:

- measurement of the frequency
- Markov model for the frequency prediction
- control of the charging procedure
- safety device for emergency shut-down.

Conclusion

Therewith, a charging device is presented which has the advantageous properties that it charges the battery with respect to battery properties (battery preserving) as well as to the electric grid (grid sustaining). Additionally, it is well-priced due to the simple communication and hardware structure.



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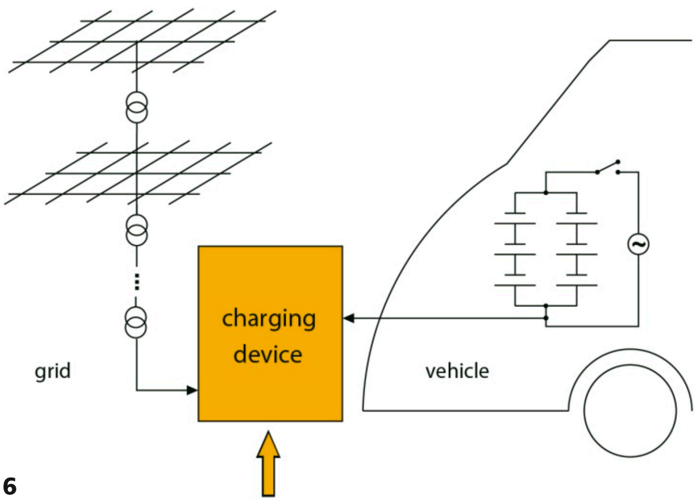

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3 Measured frequency and Markov states.
4 Markov states and charging function.
5 Current and charge loaded in the battery.
6 Interface between grid and electric vehicle.