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DYNAMICALLY MOVING DEVICE FOR ENERGY

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DYNAMICALLY MOVING DEVICE FOR ENERGY TRANSFER TO THE POWER STORAGE OF AN E-VEHICLE

Current condition:

The increasing number of e-vehicles in the current charging infrastructure and the associated problem of availability of free charging spots for energy absorption often leads to customer annoyance and slows down the transformation „away from the combustion engine to the e-vehicle".
Charging stations along highly frequented traffic routes, e.g., highways, are statically anchored locally to the parking area in the area of rest stops/or overnight accommodations according to the state of the art in designated areas. It is annoying when a charging station is occupied by a customer for longer than necessary, e.g., when a battery/electricity storage unit is already fully charged and the customer is still lingering at the rest stop. Displeasure also arises when the driver of an e-vehicle, out of ignorance, does not use the full potential of his device to draw power from his e-vehicle, even though the e-charging station is designed for this purpose. The future of e-mobility will also be decided by the acceptance and satisfaction of the customer when „refueling"

New idea:

The idea describes a method with control for a dynamically moving device for transferring energy to a power storage device of an e-vehicle, which is designed to optimize the vehicle throughput at a power charging point.
The proposed method takes into account the charging infrastructure along a route, the temporal utilization of electricity charging points at an electricity charging/rest area, and the preferences and propensities of drivers' consumption behavior during travel interruption due to energy consumption.

The idea of the invention consists of two interconnected individual methods operated by a control tool to increase the efficiency of a power charging/resting period with an e-vehicle. Cf. Figs. 1, 2, 5.

The LTA area is advantageously used by the e-provider as a buffer when the charging capacity in the LTA area is exhausted and for customers who do not want complementary services, consumption.

Aim of the invention:

The method describes a future-oriented, highly flexible solution in the form of an IT architecture for „requirements and needs" of „machine and man" in the environment of a general mobility and charging infrastructure. Drive, e-load and pause features are to be optimally coordinated with the control software in order to find an efficient and satisfactory solution. The process stands analogously for „Future mobility solution" in connection with an e-premium vehicle.

The method focuses on increasing the efficiency in a charging infrastructure, especially in an e-charging zone area by increasing a vehicle throughput with the help of a dynamic method and an intelligent, variable control, which combines an „individual resting behavior of the customer" with the „e-charging desire" and thereby utilizes the full potential of a motor vehicle with respect to a function of „electric charging".
In simple terms, two timed services (DL) are offered „on air" by an e-provider when a power draw is intended and requested by the driver. DL1 is designed for the motor vehicle and DL2 for the driver.
The method determines, adapted to the boundary conditions in the charging/resting zone, the most efficient type of a service pact consisting of several individual services. Cf. Fig. 4, (40). In this process, motor vehicle-specific characteristics of the e-vehicle are also transmitted for the standard charging plug connections. Fig. 4, (2, 2', 2'') For example, whether the e-vehicle is equipped with alternating current (AC) or direct current (DC), with a fast charging facility (CCS), or with an inductive charging facility.
The two procedures are described in an IT management for „man and e-machine". The procedures describe at least two processes for service provisioning that are timed to each other and completed synchronized at the time of „checkout".

At the heart of the control procedure is a „charging belt control tool" (CB control tool) of a power charging facility with a variety of variable control variables that can accommodate and charge multiple e-vehicles. Cf. Fig. 3
Flexible CB control/actuating variables provide flexibility to adapt to personalized consumption behavior during a driving interruption. In addition, a change in a consumption request during the driving interruption can also influence the charging belt. Cf. Fig. 4, (32)

The CB control tool is structurally analogous to the design of a motor vehicle washing line and is equipped with an underfloor conveyor system. The conveying speed, i.e. the belt speed in x-direction, is variable. Several platform zones are arranged on the charging belt for positioning e-vehicles, which can be coupled via a power supply line running synchronously above or below the platform in the z-direction. Optionally, different charging sockets with different charging cable connections for an

AC/DC power supply can be connected to the motor vehicle. The motor vehicles are positioned at a fixed distance from one another on a „conveyor belt" and each parking space/platform zone is assigned a charging module/charging column, which is supplied via a common synchronous power supply line. Cf. Fig. 3

1. The invention describes a highly flexible automated method for receiving an electrical energy (DL1) from a dynamically moving current charging point into an e-vehicle. The focus is on a structural device for an externally controlled vehicle movement during a charging process in an environment of an e-charging station of parking/rest areas.

2. The invention also describes an ordering/reservation method for a consumption-oriented service delivery (DL2) from a company/operator of an e-charging/parking/rest facility. The DL2 is designed for consumption by a customer and describes, for example, a beverage/dining menu, an outlet offering, a relax offering, an entertainment/play offering, or a business/office component.

The two coordinated sub-processes are controlled with the aid of an IT architecture and the associated IT management for the different service areas (DL1/DL2). Cf. Fig. 1 and Fig. 5

Overall objective:

The overall objective of the invention is time-optimized „synchronized completion" of

1. Requirements for maintaining an e-mobility on a motor vehicle

and

2. personalized needs of a driver ...

in a time slot, i.e. the time slot of a trip interruption requested by a customer or demanded by a motor vehicle, e.g. due to falling below a lower limit value of the SOC (State of Charge).

In colloquial terms, the application of the procedure makes optimal use of the time of the interruption of the journey, both for an operator, e-provider of a „charging station" and for the customer. The e-charging process is intelligently matched to the e-vehicle potential and timed, according to the vehicle requirements, e.g. for a target SOC, or an electrical energy charge (kWh), or adjusted to a customer-specific desired pause duration. The procedure coordinates two service offers „e-load and private consumption" DL1/DL2 within the framework of the trip interruption.

In both use cases, the control of the procedure is oriented to the customer's request and provides at least two services that match each other in terms of time so that unnecessary waiting times are avoided and electricity charging points are not blocked unnecessarily.

The task is solved with:

- an e-vehicle
- an IT architecture of an e-provider for electrical energy, with ..
- an IT management system for data processing of ..
- Parameters for the e-machine/e-power storage/charging sockets and ..
- Customer requests for an energy consumption and ..
- a personalized consumption request during the driving interruption
- a mobile device
- a check-in area with Near Field Communication (NFC)
- an e-charging point, statically fixed in an e-provider environment according to SDT in a charging area (LTA)
- a dynamic „charging belt" with adjustable throughput speed
- a vehicle control system, advantageously an underfloor conveyor, located at the end of the charging belt
- an electronic guest pager
- a checkout area for vehicle collection

Functional sequence (cf. Fig. 5):

1. The IT architecture includes described with an IT management for „machine and human" that, ..

- in a first processing step, records/orders requirements for the power storage of the e-machine and needs for the traveler
- in a second processing step, determines a suitable environment and sends an order request to an e-provider
- in a third processing step, the driver of a motor vehicle is sent an offer from an e-provider DL1/DL2)
- in a fourth processing step, a booking confirmation is sent for a charging area LTA or LZS
- in a fifth processing step, a check-in takes place at the charging area for DL1
- in a sixth processing step, consumption takes place with reference to DL2
- in a seventh processing step, synchronization is performed by the controller with respect to a synchronized checkout
- in an eighth processing step, the customer is notified via a guest pager
- in a ninth processing step, the checkout and the vehicle pickup for the continuation of the journey takes place

The IT management manages and stores user and vehicle specific data of regular and temporary customers, VIP, ... with a view to future e-handling

Service 1 (DL1) consists of a package describing an electrical power consumption. The package for DL1 is variable selectable from S (Small) over M (Medium), over L (large) and XL (X-large)

Example: S = 5-10 kWh, M = 11-30 kWh, L = 31-50 kWh, XL = >51 kWh

Service 2 (DL2) describes a service for a driver according to his personal resting wishes. The service or menu package for a rest request is timed to match service 1.

Example: S = coffee, M = coffee and cake, L = coffee, cake and relaxing-feature, e.g. playing entertainment device or shopping slot, XL = breakfast, or lunch, or dinner, ...

Service 2 can also have the value „0" if no service is requested by the customer.
The control software of the IT management works with an algorithm that is focused on a time axis. I.e. the software control takes into account empirical values for a current consumption of an e-vehicle and brings these into alignment with empirical values from a consumption behavior of a person and an appropriate time.
In this way, the provider of the e-charging/resting station can offer an optimally matched service package (S/M/L/XL) consisting of DL1 and DL2. For example, a predetermined time duration for the two services „S/M/L/XL" corresponding to „20/40/60/80 minutes" can be stored in the control program. By variable control variables in the operation of the devices for energy consumption, the time duration DL1 can be optimally adapted to the time duration DL2 for a consumption request of a driver. Cf. Fig. 4, (32)

2. The hardware architecture includes different types of charging zones on a current charging area. The invention focuses on the charging zone type LZS! Static current loading bays, hereinafter referred to as loading zone area (LZA), and dynamically moving current charging stations, hereinafter described as loading zone street (LZS).

LTA: Electricity charging area with electricity charging columns according to the state of the art/statically fixed in one place
LZS: Compared to the SDT, the charging zone road with the associated charging equipment is not a static fixed facility in the form of a charging pole in a parking lot.
The LZS e-charging zone has several bays arranged at fixed intervals on a moving transport sled, comparable to the design of a vehicle washing line, and can be referred to as a „Charging Belt (CB)". Cf. Fig. 2

The necessary charging equipment moves with the vehicle in the x-direction and the energy supply/electrical charge is tapped from the z-direction, i.e. above or below the vehicle, from a synchronously moving high-voltage supply line.

Actuating/control variables of the CB are belt speed, current charging variant, number of vehicle passes of a loading zone line (LTA) Cf. Fig. 4, (32)

The arrangement of the circulating electrical supply lines from the high-voltage supply line to the motor vehicle can be compared to a bow-tie lift design. That is, the electrical supply line/charging cable is pulled out of a roller cassette/roller box under spring load and coupled to the charging socket of the motor vehicle. No tensile forces are exerted on the rotating electrical supply cable by the automatic charging cable retractor and the synchronously moving transport carriage on which the vehicle is located. Cf. Fig. 3

Which electric charging variant, AC/DC/CCS/... the provider offers to a customer depends on the equipment of the e-vehicles and the ordered electric energy (kWh) from other customers who charge their e-vehicles in the booked time slot.
The processing of all booking requests for an energy intake and the optimization of the overall efficiency of the provider's supply units take place in the third processing step of IT management. Cf. Fig. 3/Signal representation, block diagram
I.e., the boundary conditions of maximum power delivery on a „charging belt" specified by the charging infrastructure are taken into account in an e-schedule power charging plan in the third processing step of the method in such a predictive manner that the supply unit has the best possible utilization at maximum vehicle throughput. Thus, an overall efficiency of a power supply facility can be increased by a provider for variable booking requests.

The dispatch of an e-vehicle from the „charging belt" whose electricity storage is charged according to the order (DL1) is automated with an underfloor conveyor, and the provision for collection of the motor vehicle after the consumption is completed (DL2) is performed in a checkout area.

The checkout area can be colloquially referred to as a marshalling yard or pickup terminal. Notification of the customer is done with a guest pager the customer receives at the CeckIN or via a notification of his mobile device. Cf. Fig. 3 (1, S1)

Particular embodiments of HW architecture and IT management:

In a particular embodiment, the high-voltage supply line supplies an „inductive current charging zone" under, in front of, or behind a motor vehicle on the CB conveyor.
In another particular embodiment, several „charging belts" are connected in series or arranged in parallel next to each other, with different vehicle throughput speeds. Cf. Fig. 1 (gray arrows). The operation of several parallel operated mobile charging stations of the „charging belt" type with different transport carriage speeds and with variable power charging plugs of different power classes (11 kW/22 kW/...) allows the individual timing of a vehicle control at the calculated checkout time, i.e. an optimal timing to a „consumption behavior in a service provider environment of the charging rest station". For example, differently timed „charging belts" can be run through automatically one after the other and the power charge can be varied as desired between „Quick-charge 22 kWh" and „Normal-charge 11 kWh" in order to complete the partial services (DL1/DL2) at the provider of the charging/rest station as precisely as possible, i.e. synchronously. With this operation, the power distribution management for the whole charging area of the e-provider and the e-vehicles located in it can be efficiently designed. Cf. Fig. 3

In a very particular embodiment, if a „charging belt" is not used to capacity, the customer can be recommended/notified to stay in a consumption area to recharge the power storage with additional energy, or to perform an additional service (DL3), e.g., windshield cleaning. Cf. Fig. 1 (gray arrows)

Conclusion:

1. With the totality of variable and modular control variants offered by the method, a provider can optimize the e-schedule plan of its utility facility to serve a service request (DL1) from two package sizes to achieve efficient utilization of multiple „charging belts". A charging infrastructure can be better planned in terms of supply across regions, and „congestion" does not occur at the local „charging station"
2. Electricity resources are adapted to both the vehicle characteristics of e-vehicles and the temporal customer behavior in the consumption area, which increases the overall efficiency of the electricity/energy charging facility at the provider of the e-charging/resting station and increases a customer satisfaction.
3. The intelligent combination of service packages for „machine and man", which are optimally coordinated in terms of time, have a positive effect on the customer's consumption behavior at the e-charging/rest station.
4. The vehicle throughput at the e-charging/rest station is brought to an optimum by an extremely high flexibility with the vehicle/customer handling, during the stay in/at the e-charging/rest station.

The algorithm of the control system determines an e-schedule power charging plan that is optimally matched to the respective demand request in terms of time and energy using „variable control variables" for several e-vehicles. Cf. Fig. 4 and 3 (a), (b), (c)

The variable control variables offer a maximum of flexibility which is achieved via ...
the variable vehicle cycle time control on a „charging belt", i.e. the variable conveyor speed
the series connection of several „charging belts" with different transport speeds of the underfloor conveyor system
the variable use of different charging options on the electric vehicle
a variable clocked, synchronized consumption offer for a customer

Example for DL1 (50 % charge)/DL2 (interruption of journey 90 min):

E-vehicle 1/small/35 kWh e-driving battery/11 kW charging current/LVS for 6 vehicles/transport speed approx. 0.6 cm/s

E-vehicle 2/large/70 kWh e-driving battery/22 kW charging current/LVS for 6 vehicles/conveying speed approx. 0.6 cm/s

Length of the charging terminal (charging belt) approx. 36-40 m.

With the E-Schedule power charging plan from the indicated procedure, a power/energy requirement within a constrained charging infrastructure can be better planned and provided.

Advantages:

- Increase an overall charging efficiency of multiple e-vehicles at a provider's power/energy charging facility
- Targeted provision of an energy from power groups to a provider's power/energy charging facility in an inhomogeneous charging infrastructure
- Avoidance of an uncoordinated pause behavior in the context of a trip with an e-vehicle by combining services for machine and human (DL1/DL2)
- Increase of an overall efficiency regarding a vehicle throughput at an e-charging/resting station
- Reduction of a risk of accidents due to congestion of customers in an e-charging/service area!!!
- Clearly coordinated processes and no long queues in the e-load area
- Improvement of a customer satisfaction
- Increase of an acceptance for e-mobility and the associated break times as a result of an energy intake

Fig. 1

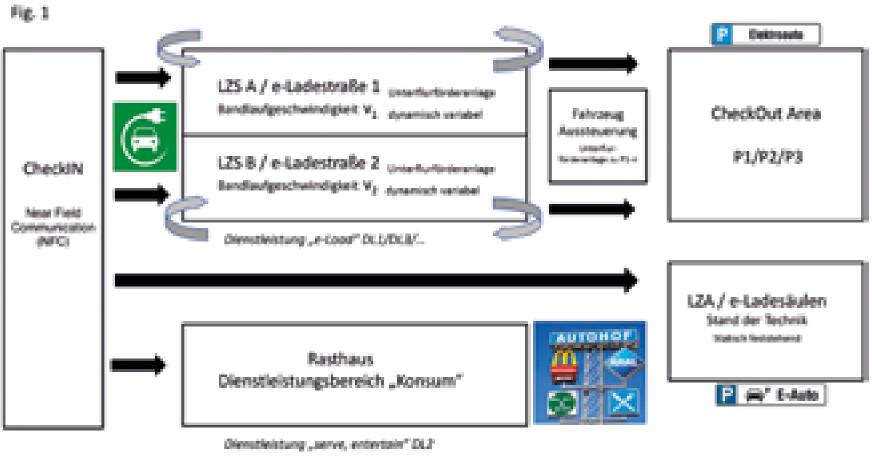
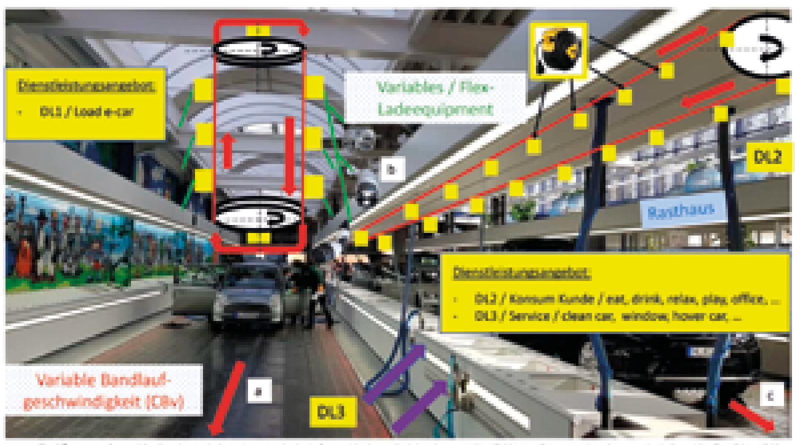


Fig. 2



Variable Steuerungsstellgrößen => a / variable Geschwindigkeit charging belt, b / variable Stromladebuchsen, 11kW/22kW, c / Variane der charging belt Durchläufe, LZSA, LZSB, ...

Fig. 3

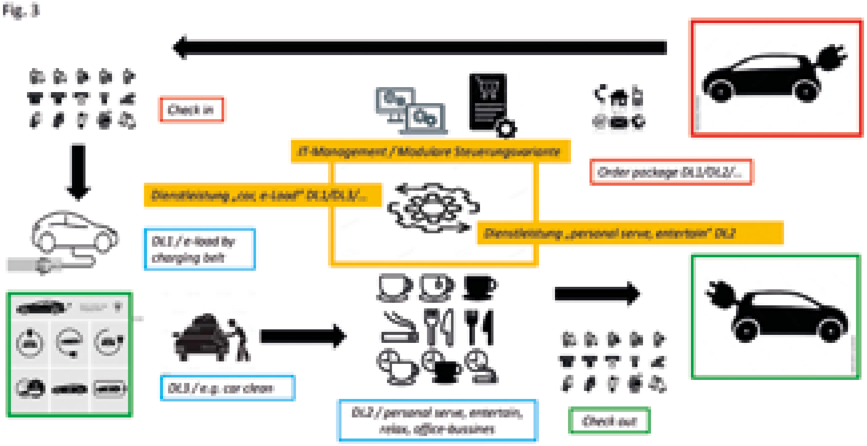


Fig. 4

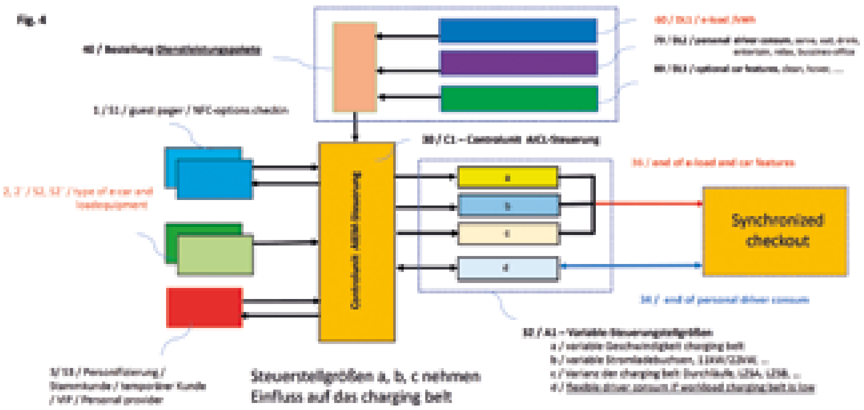


Fig. 5 / Systematische Signaldarstellung / Blockschaltbild