**System, devices and method for charging a battery of an electric vehicle.**

Energy exchange station for a battery of an electric vehicle, comprising at least one power output for a vehicle, means for determining whether a vehicle coupled to the at least one power output is able to be charged with an AC voltage and/or a DC voltage, a plurality of power inputs, comprising at least one AC power input and at least one DC power input and at least one controllable switch, for switching the at least one power output to any of the power inputs a controller for the switch, for controlling the switch at least based on the determination.
System, devices and method for charging a battery of an electric vehicle

The present invention relates to a system, devices and method for charging a battery of an electric vehicle, in particular for charging a battery of an electric vehicle with either

AC or DC power.

Popularity of electric vehicles increases, as fossil fuel becomes sparser, and well as a result of a desire to decrease exhaust pollution, especially in urban areas. A disadvantage however, is that charging of the vehicles is not yet possible at all locations. One reason that slows down the placement of charging stations for electric vehicles is a lack of regulation and standardization. Batteries deliver DC when they are discharged and require DC power sources with voltages that depend on the type of battery to be charged. As most grids are AC, various types of power converters are required as part of a battery charger in these cases. Herein, a risk is present that vehicles are coupled to a charging station that does not comply to the required power for the specific vehicle or battery.

In order to be able to charge a vehicle from an AC grid, the solution to provide electric vehicles with on-board chargers comprising an AC/DC converter has been proposed.

However, size and weight of these converters increases as required charging power increases, or allowed charging time decreases, and for reasons of power efficiency it is undesired to carry voluminous and heavy chargers along on the vehicle.

It is a goal of the present invention to provide a system, devices and method for charging a battery of an electric vehicle that overcome at least part of the above disadvantages, and/or delivers a useful alternative to the state of the art.

The invention thereto proposes an energy exchange station, for charging a battery of an electric vehicle, comprising at least one power output for a vehicle, means for determining whether a vehicle coupled to the at least one power output is able to be charged with an AC voltage and/or a DC voltage, a plurality of power supplies, comprising at least one AC power supply and at least one DC power supply, at least one controllable switch, for switching the at least one power output to any of the power supplies and a controller for the switch, for controlling the switch at least based on the
determination. It needs to be remarked here that both power supplies and power outputs may be bi-directional.

The means for determining whether a vehicle coupled to the at least one power output is able to be charged with an AC voltage and/or a DC voltage can be located at various places. They can be in the energy exchange station itself, or in the connector, but also on board of the vehicle, or at a remote location, that determines vehicle details based on communication between the vehicle and the charging station, of which the charging station transmits data to said remote location, which may be a data processing device, such as a central database.

The energy exchange station according to the invention, which may for example be embodied as a charging station for an electric vehicle, offers the advantage that both AC and DC charging may be provided at the same location. AC power may be directly derived from the grid, while DC power may be derived from the grid by means of an electric power converter. Since this power converter stays at a charging location, it can be dimensioned for delivering high DC power, and, as a result, low charging times.

In case a vehicle to be charged does not provide a possibility to receive DC power, or when available grid power is low, for example due to momentary peak energy absorbance elsewhere in the grid or due to the presence of another vehicle to be charged at the same location, AC power may be provided to the vehicle, which then uses its on-board charger to charge its battery. As on-board chargers generally have a lower power rating, switching to AC charging lowers the grid load. When a very powerful on-board charger is detected, the system might switch to the better controllable DC power supply in order to lower the grid load.

In an embodiment, the means for determining are configured for detecting the presence of an on-board battery charger of the vehicle, and the controller is configured to switch the output to an AC power input when an on-board battery charger is detected.

This way, optimal use is made from the hardware present in the vehicle, while converters at a charging station may be used for charging vehicles that lack an on-board charger, or vehicles that have been decided to obtain priority for any reason.
In another embodiment, the controller is configured to switch to AC power after an interval of being switched to DC power, to firstly charge the battery fast on DC power, and to secondly continue charging the battery slower on AC power. High power DC charging can for example be applied until a so called constant voltage point in the charging curve of the battery is reached, and afterwards, charging is switched to AC, for finalizing the charging of the battery by the on-board charger of the vehicle, fed by the AC power source, and thus freeing the DC power source for charging other vehicles. This results in a further optimization of the available hardware. Especially since on board chargers usually have limited power, but still sufficient to finalize the charging from the constant voltage point on in an acceptable amount of time.

In another embodiment, the controller is configured to charge the vehicle from the AC power supply for a predetermined time. During this time the energy exchange station determines characteristics of the on-board charger, for example its power rate. From that knowledge, the decision can be made to charge at AC or DC or when it would be beneficial to change from charging using AC to DC or vice versa.

In yet another embodiment, the energy exchange station is configured to deliver AC power and DC power simultaneously. Thereto, a plurality of outputs may be present, for coupling multiple vehicles to the outputs, wherein each of the vehicles may be coupled to either AC or DC power.

It is also thinkable that AC and DC power are delivered to the same output, for charging a battery of a vehicle directly with DC power, and via an on-board battery charger with AC power indirectly. For that purpose, the vehicle may be coupled to the system by multiple connectors, or the system may be configured to deliver DC power with a superposed AC component.

In yet another embodiment the energy exchange station can provide both AC and DC power at the same time where the DC power is used to charge the battery while the AC power is used to power an onboard AC powered system such as an air conditioning, heater or other device. It is also thinkable that the DC power is used for these other devices and the AC power to charge the battery via the onboard charger.
The DC power source may comprise a power converter, for delivering a switched DC power. More in particular, the energy exchange station may comprise a number of power converters, for delivering suitable form of DC power (for example switched or with a predetermined voltage) to each port to which a vehicle is coupled. It is remarked here that DC power in the sense of the present invention does not only comprise a constant DC power but also switched forms like PWM (Pulse-Width Modulation, PDM (Pulse-Duration Modulation), and voltage and current gradients, as well as random signals (random/noise) and time-division multiplexing signals.

Controlling the switch may further be based on external parameters, such as power available at at least one of the power inputs, and/or power required from electric vehicles at further power outputs. The switch may for example be controlled based on input by a data processing device, such as a central, remote or external web server, database or control server. Such a data processing device may collect data from multiple vehicles, charge stations and/or current grid information, and/or other settings, such as priorities given to various vehicles by an operator or fleet owner. The energy exchange station may further be configured for data communication with the vehicle for retrieving information on the ways the vehicle can be charged.

The energy exchange station, may comprise a connector for connecting the vehicle to the output, the connector being configured for both AC and DC power transfer. In particular, the invention relates to exchanging multi-phase AC power via multiple power contacts of the power connector when a vehicle is charged with AC power; and exchanging DC power via at least two contacts of said power connector when charging a vehicle with DC power. The AC power supply may be two or three phase, but configurations up to six or more phase are thinkable too.

Using a single connector for both AC and DC power transfer makes the use of the energy exchange station more convenient. When exchanging energy with a vehicle, in particular when charging it, a user does not have to choose a particular connector that matches a (contra) connector of his vehicle. Moreover, a single connector enables the energy exchange station to switch between AC and DC power sources during energy transfer without requiring interaction from the user. This may be done over the same
connections, or the connector may comprise multiple connections, as will be explained in the following.

The invention further relates to the use of a power connector in an energy exchange station as described above. The use according to the invention comprises using at least three power contacts for exchanging three phase AC power and a common ground, wherein at least one pair of contacts is used to feed a DC power through them. Power connectors suitable to be used are the IEC62196 standard, for example the REMA REV-3. Another suitable connector is the 63A Mennekes CEE connector.

In a further embodiment, the invention relates to using a power connector comprising at least 4 power contacts, of which two pairs of contacts are dimensioned such that a DC power can be fed through them. For delivering AC power, three of the four contacts are used, and a fourth may be used as a common ground. For DC power, one pair forms the positive connection, and another pair forms the negative connection. In particular, the invention makes use of a power connector that is suitable for transferring 126 Ampere DC current.

In a further embodiment, at least a connection for data transfer is made using the connector. The connection may be a serial data connection or a connection according to any data communication protocol, or just a simple binary signaling, wherein a specific connector corresponds to specific data. For example, a pair of connectors for data transfer may be configured to be short circuited when the vehicle is suitable for AC charging. The short circuit can also be formed by a passive circuit element, such as a resistor an inductor or a capacitor. Such a resistance or impedance can be used to detect a configuration for AC or DC Communication may take place over the same connections (or using some of the pins) as the AC and/or DC power. This can be achieved by super imposing the communications signal onto the power signal.

A single connector provides the advantage that the vehicle requires only one opening for coupling a connector in this case, and only one standard is required when a single type of connector is used. Several AC connectors are available that could be used for DC power transfer according to the present invention.
The invention further relates to an electric vehicle, comprising a battery, an on-board charger, a power input, for receiving charging power and a switch, for coupling the power input to the battery or to the on-board charger, and a controller, for controlling the switch.

In general, the controller of such a vehicle may determine whether the vehicle is charged with AC or DC power. The controller may be coupled to or even form part of on-board logic such as a vehicle management system, or a battery management system, or to sensors for determining whether an AC or DC power is present at the input, but it may also be influenced by external inputs, for example via data communication with an energy exchange station or a data processing device such as a database and/or central controlling server.

The controller may be configured to couple the power input to the on-board charger when an AC power is determined to be present at the power input, and it may further be configured to couple the power input to the battery when a DC power is determined to be present at the power input.

The invention will now be elucidated with reference to the following non-limiting figures, wherein:

- Figure 1 shows a general overview of a system according to the present invention, to which a vehicle is coupled;
- Figure 2 shows a high level overview of the system from figure 1, with multiple vehicles coupled to it, being charged with either AC or DC power;
- Figure 3 shows a high level overview of the system of figure 1;
- Figure 4 shows a schematic overview of a system according to the present invention;
- Figure 5 shows a detailed view on the present invention in a vehicle;
- Figure 6 shows a schematic overview 600 how a connector gets energy from the charger;
- Figure 7 shows an embodiment with multiple switches;
- Figure 8 shows an embodiment wherein the energy exchange station has power outputs that are not directed via the switch.
- Figure 9 shows an embodiment showing that the energy station can also be used to deliver power from the vehicles’ batteries to the grid;
- Figure 10 shows an embodiment wherein a converter is used to charge one or more vehicles from the DC battery power of other one or more vehicles;
- Figure 11 shows an embodiment wherein a DC power source delivers DC power to a DC/AC converter;
- Figure 12 shows a charging station having more outputs than it can serve with DC-power; and
- Figures 13 a-h show various flowcharts of a method according to the present invention.

Figure 1 shows a general overview of an energy exchange station for a battery of an electric vehicle system 100 according to the present invention, to which a vehicle 300 is coupled, comprising a power output for the vehicle 300, formed by a connector 200. The station comprises means (not explicitly shown) for determining whether the vehicle 300 is able to be charged with an AC voltage and/or a DC voltage, and an AC power input 102 and a DC power input 103. In this case, the DC power source is embodied by a power converter 102 derived def by the AC power input 101, formed by the mains. The energy exchange station further comprises a controllable switch 103, for switching the power output 200 to any of the power inputs 101, 102.

The vehicle 300 comprises a battery 303 and a charger 302, as well as a switch 301. The switch couples the power input from the connector 200 to the charger 302 when there is an AC input, and directly 303 to the battery when there is a DC input.

The switch 301 detects if DC power is available for example by communicating with the switch 103 and can reroute the connection directly to the battery 303. The switch 103 detects if a switch 301 is present (by communication) and can provide DC power if applicable.

Figure 2 shows the energy exchange station 100 from figure 1, wherein multiple vehicles 300a-300d are coupled to the station by means of separate connectors (not shown). Vehicle 300c is charged with DC power, vehicles 300a, 300b, 300d are charged with AC power. Such configuration may be used when there is one vehicle that requires
fast charging, and multiple vehicles that have an on-board charger, or when the charging station has only one limited DC power source available.

Figure 3 shows another embodiment, where there’s (momentarily) only an AC power source 101 available at the energy exchange station 100, that is switched to vehicles 300a and 300b. These vehicles deliver DC power, which is switched by the energy exchange station to vehicle 300c. This way, the energy exchange station can be used to transfer energy from one vehicle to another one, for example when the latter has no on-board charger.

Figure 4 shows an energy routing system comprising an energy exchange system 400 according to the invention. When a vehicle 300a, 300b is connected to the energy exchange station, it can communicate with the station controller through a data line. The identity of the vehicle 300a, 300b (possibly with its requirements) is then sent to the decision making server. Based on the requirements (and the requirements of the other vehicles connected) the server orders the charge station controller to have the connection matrix connect one or more AC/DC converters to the outlet of the vehicle, or order the outlet to switch to AC power. When no communication can be established the system can use AC as a default option, or use local knowledge (i.e. users that return more than once) to determine the appropriate profile.

When a vehicle is added to the system or leaves, this is updated to the decision server, which then orders a new optimal power distribution.

As shown above, the energy exchange station can have multiple outlets and has a multitude of AC/DC converters 401-405. These DC converters can, through a connection matrix, be dynamically assigned to any power output 406 - 410, and one power output can, through this same matrix, be connected to one or more DC converters. Additionally, each output can be connected to the AC supply chain instead of the DC connection matrix.

The energy exchange station is connected to a central decision-making server 411, which calculates the optimal division of power over the connected vehicles, based on their power requirements, possible “premium accounts” of their owners, costs of energy, grid availability, power of on-board chargers and other parameters. Based on
this the central server calculates the optimal solution and orders the energy exchange station controller 412 to connect the vehicles in that way. Because of the possibility of the outlets to provide AC, some of the available DC power can be reserved for other vehicles by switching to AC for a vehicle that has an on-board charger. Upon the departure or arrival of one or more vehicles it might occur that the optimal solution changes. When this happens the entire configuration of the station can dynamically be changed mid-charge.

The energy exchange station also has local storage (DC) to be able to compensate for peak-loads (e.g. rush hour) which can be charged when no or few vehicles are connected (or when these vehicles prefer AC). This way, the following advantages can be reached.

- All vehicles can be guaranteed an optimal charge time, based on their battery type, account (premium might give a faster charge), other vehicles present and grid availability.
- When a vehicle has a more powerful on-board charger than available DC power left, this system can switch to AC power for that vehicle, freeing DC power for other vehicles.
- When grid power is sparse in the region of the charger, charge power can be lowered.
- A vehicle that can only be charged through its on-board charger can also connect to this system.
- Because the data is available, a time-to-go indication can be given to the owner of the vehicle.
- When an AC charging infrastructure is already present, it can easily be upgraded to supply both AC and DC, as the outlets only need to switch between AC and DC power
  - When the (high current) CC charging phase of a battery is replaced by a (lower current) CV charge phase, the power can be switched from the high power DC supplies to the (lower power) on-board charger, freeing up DC power to be used by other connected vehicles.

Figure 5 shows an embodiment 500 of the electrical system inside a vehicle. The connector can carry either DC or AC power. In this case a single phase solution is
presented, but it can be easily read as a system that uses a two, three or more phase connection. In this example, the power selector can switch power to either an on-board charger, in the case of AC power or even by default, or directly to the battery. In some cases the on-board charger can be connected to the connector at all times, because it can withstand DC on its input or it can even operate under that condition.

Figure 6 shows a schematic overview 600 how a connector receives energy from the charger. The power may be AC, multiphase AC or DC. The charge controller knows (via a vehicle communication system or some other information source, such as a detection system) whether AC or DC power is on the line. When AC current is supplied, the power bus of the system is disconnected from the power selector (and thus from the charger) and the On-Board charger is switched on by the charge controller. If DC power is supplied to the connector, the on-board charger is switched off and the DC power is routed straight to the vehicles power bus. In some cases the on-board charger can be connected to the connector at all times, because it can handle DC power on its input or even in some situations operate with DC on its input.

Figure 7 shows an embodiment with multiple switches wherein some switches are configured for charging a single vehicle, and some switches are configured to charge multiple vehicles at a time.

Figure 8 shows an embodiment wherein the energy exchange station has power outputs that are not directed via the switch. Thereto, shared or dedicated off-board chargers may be present.

Figure 9 shows an embodiment showing that the energy station can also be used to deliver power from the vehicles’ batteries to the grid. This can happen by converting battery DC power in the on board charger to the grid or by transferring DC battery power from the at least one vehicle to the at least one off-board charger (102) or one or more DC/AC converters (103), to deliver the power to the AC mains.

Figure 10 shows an embodiment wherein a (multiple-input) DC/DC converter (102 and/or 103) is used to charge one or more vehicles from the DC battery power of other one or more vehicles. In this case the AC mains and/or the power converter (102) are
not required to be used. Because the vehicles and the charging station comprise AC/DC, DC/AC and DC/DC converters, in this configuration the vehicles that deliver power can be AC or DC (or a mix) and the vehicles that receive power can get AC or DC.

Figure 11 shows an embodiment wherein a DC power source (e.g. local storage or PV panel) (104) delivers DC power to a DC/AC converter (102) which converts it to AC to supply the mains or supply one of the on-board chargers.

Figure 12 shows that the charging station can have more outputs than it can serve with DC-power. This is an embodiment where the number of vehicle connections exceeds the number of DC power inputs. For example the Off-board charger may have 3 DC power outputs. The station can have 5 charge connections.

Figures 13a shows an a flowchart wherein the system decides based on input from the customer (requested time before leaving) and input from the electricity grid (maximum available power) what the best charging strategy is. In this example the maximum DC power which the system can provide is 50 kW. Furthermore the system is equipped with a data processing device to make decisions and data input devices, in this case a user terminal and a connection to a smart-grid computer.

Figure 13b shows a system which is equipped with means to control the onboard charger of vehicles through a data connection (wired or wireless) with the vehicle. In this example the maximum DC charging power of the energy exchange system is limited to 50 kW. Two vehicles arrive at the station. One has a 50 kW DC charging capability. The other vehicle has a 30 kW onboard charger and a DC charging capability.

Figure 13c shows an energy exchange station equipped with two charge connections with a 50 kW DC power output possibility and the possibility to deliver 40 kW AC per output. The 50 kW DC power is made through the use of a 50 kW AC/DC converter. The whole system is connected to a grid connection which can deliver a maximum of 100 kW.
Figure 13d shows a case wherein the energy exchange station cannot detect what available onboard charging power is, it can send AC to the vehicle and measure the power which the vehicle draws. After measuring this power for some time the data processing device can determine the power of the onboard charger.

Figure 13e shows a case wherein a vehicle can have an onboard system (such as an air conditioning) which can be powered by AC during charging.

Figure 13f shows an energy exchange station transferring DC power from the battery to the grid.

Figure 13g shows how an energy exchange station uses the onboard charger to charge a second vehicle connected to a second outlet.

Figure 13h shows how the power load to the grid is controlled by switching the onboard charger on and off if it is not possible to control the charging power of the onboard charger.
Conclusies

1. Station voor energieoverdracht voor een accu van ten minste een elektrisch voertuig, omvattende:
   - ten minste een vermogensuitgang voor een voertuig;
   - middelen om te kunnen vaststellen of een voertuig dat is verbonden met de ten minste ene vermogensuitgang kan worden opgeladen met een wisselspanning en/of een gelijkspanning;
   - een aantal voedingen, omvattende
     - ten minste een wisselstroomvoeding; en
     - ten minste een gelijkstroomvoeding;
   - ten minste een regelbare schakelaar, voor het verbinden van de ten minste ene vermogensuitgang met een van de voedingsbronnen;
   - een regelaar voor de schakelaar, voor het ten minste op basis van de vaststelling aansturen van de schakelaar.

2. Station voor energieoverdracht volgens conclusie 1, waarbij:
   - de vaststellingsmiddelen zijn ingericht voor het detecteren van de aanwezigheid van een ingebouwde acculader van het voertuig; en
   - waarbij de regelaar is ingericht voor het schakelen van de uitgang naar een wisselstroomvoeding wanneer een ingebouwde acculader wordt gedetecteerd.

3. Station voor energieoverdracht volgens conclusie 1 of 2, waarbij:
   - de regelaar is ingericht voor het schakelen van de uitgang naar een gelijkstroomvoeding wanneer er een rechtstreekse verbinding wordt vastgesteld met de accu.

4. Station voor energieoverdracht volgens conclusie 2 of 3, waarbij de regelaar is ingericht voor het omschakelen naar de wisselstroomvoeding na een periode naar de gelijkstroomvoeding te zijn geschakeld, ten eerste voor het snel opladen van de accu met gelijkstroom en ten tweede voor het langzamer verder opladen van de accu met wisselstroom.
5. Station voor energieoverdracht volgens één der voorgaande conclusies, ingericht voor gelijktijdige afgifte van wisselstroom en gelijkstroom.

6. Station voor energieoverdracht volgens conclusie 5, waarbij de wissel- en gelijkstroom worden geleverd aan dezelfde uitgang, voor het rechtstreeks opladen van een voertuigaccu met gelijkstroom en indirect opladen met wisselstroom via een ingebouwde acculader.

7. Station voor energieoverdracht volgens één der voorgaande conclusies, waarbij de gelijkstroomvoeding een vermogensomvormer omvat, voor het leveren van een geschakelde gelijkstroom.

8. Station voor energieoverdracht volgens één der voorgaande conclusies, waarbij het aansluiten van de schakelaar bovendien is gebaseerd op externe parameters, zoals het beschikbare vermogen ter plaatse van ten minste een van de vermogensingangen en/of het vermogen dat wordt gevraagd door elektrische voertuigen ter plaatse van andere vermogensuitgangen.

9. Station voor energieoverdracht volgens één der voorgaande conclusies, waarbij het aansluiten van de schakelaar wordt uitgevoerd op basis van invoer van een inrichting voor dataverwerking, zoals een externe besluitvormingsvoorziening.

10. Station voor energieoverdracht volgens één der voorgaande conclusies, ingericht voor datacommunicatie met het voertuig om te bepalen of een voertuig kan worden opgeladen met een wisselspanning en/of een gelijkspanning.

11. Station voor energieoverdracht volgens één der voorgaande conclusies, die middelen omvat voor het aansluiten van een ingebouwde oplader, in het bijzonder het laadvermogen van de ingebouwde oplader.

12. Station voor energieoverdracht volgens conclusie 11, waarbij middelen voor het aansluiten van het laadproces van een ingebouwde oplader een verbinding omvatten voor datacommunicatie met het voertuig.
13. Station voor energieoverdracht volgens één der voorgaande conclusies, omvattende een stekker voor het verbinden van het voertuig met de uitgang, waarbij de stekker is ingericht voor de overdracht van zowel wissel- als gelijkstroom.

14. Gebruik van een elektriciteitsstekker, omvattende:
   - het overdragen van meerfasige wisselstroom via meerdere elektrische contacten van de elektriciteitsstekker wanneer een voertuig wordt opgeladen met wisselstroom; en
   - het overdragen van gelijkstroom via ten minste twee contacten van de elektriciteitsstekker wanneer een voertuig wordt opgeladen met gelijkstroom.

15. Gebruik van een elektriciteitsstekker volgens conclusie 14, waarbij het overdragen van gelijkstroom plaatsvindt via twee sets contacten, die ieder ten minste een contact omvatten dat wordt gebruikt voor de overdracht van wisselstroom.

16. Gebruik van een elektriciteitsstekker volgens conclusie 14 of 15, waarbij datacommunicatie plaatsvindt via ten minste een aantal van de pennen dat wordt gebruikt voor het overdragen van wissel- en/of gelijkstroom, bijvoorbeeld door het superponeren van het communicatiesignaal op een vermogenssignaal.

17. Elektriciteitsstekker voor gebruik volgens één der voorgaande conclusies 14-16, gedimensioneerd voor het geleiden van een gelijkstroom van 126 Ampère via het ten minste ene paar contacten.

18. Elektriciteitsstekker volgens conclusie 17, verder omvattende ten minste een verbinding voor dataoverdracht.

19. Elektriciteitsstekker volgens conclusie 17 of 18, omvattende een paar contacten voor dataoverdracht, ingericht om te worden kortgesloten wanneer het voertuig is ingericht voor opladen met wisselstroom.

20. Elektrisch voertuig, omvattende:
   - een accu;
   - een ingebouwde oplader;
   - een vermogensingang, voor het opnemen van laadvermogen;
- een schakelaar, voor het verbinden van de vermogensingang met de accu of met de ingebouwde oplader;
- een regelaar, voor het aansturen van de schakelaar.

21. Voertuig volgens conclusie 20, waarbij de regelaar is ingericht voor het verbinden van de vermogensingang met de oplader wanneer wordt vastgesteld dat er een wisselstroom aanwezig is ter plaatse van de voeding.

22. Voertuig volgens conclusie 20 of 21, waarbij de regelaar is ingericht voor het verbinden van de voeding met de accu wanneer wordt vastgesteld dat er een gelijkstroom aanwezig is ter plaatse van de vermogensingang.

23. Voertuig volgens één der conclusies 20-22, waarbij het bepalen van de aanwezigheid van wissel- of gelijkstroom wordt mogelijk gemaakt door een dataverbinding tussen voertuig en station voor energieoverdracht.

24. Werkwijze voor het opladen van een accu van een elektrische voertuig, omvattende:
- vaststellen of een voertuig dat is verbonden met een vermogensuitgang kan worden opgeladen met een wisselspanning en/of een gelijkspanning;
- dienovereenkomstig omschakelen van de vermogensuitgang naar hetzij een wisselstroomingang dan wel een gelijkstroomingang.

25. Werkwijze volgens conclusie 24, waarbij het vaststellen omvat:
- schakelen van de vermogensuitgang naar de wisselstroomingang wanneer de aanwezigheid van een ingebouwde oplader wordt vastgesteld, en
- schakelen van de vermogensuitgang naar de gelijkstroomingang wanneer er geen ingebouwde oplader wordt gedetecteerd.

26. Werkwijze volgens conclusie 24, waarbij het vaststellen omvat:
- schakelen van de vermogensuitgang naar de gelijkstroomingang wanneer er een rechtstreekse verbinding beschikbaar is met de accu;
- schakelen van de vermogensuitgang naar de wisselstroomingang wanneer er geen rechtstreekse verbinding kan worden gemaakt met de accu en wordt vastgesteld dat er een ingebouwde accu aanwezig is.

27. Werkwijze volgens één de conclusies 24-26, waarbij het aansturen van de schakelaar wordt uitgevoerd op basis van invoer door een inrichting voor dataverwerking, zoals een externe besluitvormingsvoorziening.
FIG. 5
2. The user uses a computer interface to tell the system that he has to leave in about 1 hour time.

3. The data processing device calculates the best charging method for this situation: it is decided that the vehicle should receive a DC charge at 20 kW.

4. The energy exchange receives settings from the data processing device and sends 20 kW DC to the vehicle.

5. A second vehicle connects to the energy exchange station.

6. The user of the second vehicle enters uses a computer interface to tell the system that he has to leave in about 15 minutes.

7. The data processing device contact the smart grid to request the maximum available power at the grid and calculates the best charging method for this situation: it is decided that the first vehicle should switched to AC power and the second vehicle should receive 50 kW DC power in order to be ready in 15 minutes.

8. The energy exchange receives settings from the data processing device and sends AC power the first vehicle and 50 kW DC power to the second vehicle.
1. A vehicle connects to the energy exchange station. Via a data communication channel it is determined that the vehicle has a possibility to receive DC power. The state of charge of the battery is also communicated.

2. The user uses a computer interface to tell the system that he has to leave in about 30 minutes.

3. The data processing device calculates the best charging method for this situation: it is decided that the vehicle should receive a DC charge at 40 kW.

4. The energy exchange receives settings from the data processing device and sends 40 kW DC to the vehicle.

5. A second vehicle connects to the energy exchange station. Via a data communication channel it is determined that the vehicle has a 30 kW onboard charger. The state of charge of the battery is also communicated.

6. The user of the second vehicle enters uses a computer interface to tell the system that he has to leave in 1 hour.

7. The data processing device contacts a battery knowledge base. This battery knowledge base holds information that says that a battery should never be charged faster than required in order to optimize battery life. Based on this information the data processing device calculates that the battery should receive no more than 20 kW. This is enough to charge the battery in our hour.

8. The energy exchange receives settings from the data processing device, connects the vehicle to the AC power and communicates to the onboard charger that it should charge at 20 Kw.
2. The user of the vehicle uses a computer interface to tell the system that he wants a medium fast charge and has a preference for DC charge.

6. The user of the second vehicle enters uses a computer interface to tell the system that he wants the fastest possible charge.

3. The data processing device calculates the best charging method for this situation: it is decided that the vehicle should receive 20 kW DC power.

7. The data processing device calculates the optimum in this situation and decides that vehicle 1 should be switched to AC to make all DC power available for vehicle 2.

4. The energy exchange station receives settings from the data processing device and sends 20 kW DC power to the vehicle.

8. The energy exchange receives settings from the data processing device, connects the first vehicle to AC power and sends 50 W DC power to the second vehicle.

1. A vehicle connects to the energy exchange station. Via a data communication channel it is determined that the vehicle has a possibility to receive DC and AC power. The onboard charger can charge at 20 kW.

5. A second vehicle connects to the energy exchange station. Via a data communication channel it is determined that the vehicle has a DC input only.
2. The user of the vehicle uses a computer interface to tell the system that he wants a medium fast charge.

4. Based on the knowledge that the vehicle has a 3 kW onboard charger the data processing device decides that the vehicle should receive 20 kW DC power for 15 minutes and DC power for 45 minutes and sends this info to the e.e.s.

3. The energy exchange station turns on the AC power and detects that the onboard charger draws 3 kW for some time. It sends this information to the data processing device.

1. A vehicle connects to the energy exchange station. It has a DC and an AC input possibility. There is no detailed communication on the onboard charger between vehicle and energy exchange station.

5. The energy exchange station receives settings from the data processing device and outputs 20 kW DC for 15 minutes and then switches to AC.

FIG. 13d
2. This particular vehicle is owned by a fleet owner who runs a vehicle identification software system. This system tells the data processing device that the vehicle has a powerful onboard airconditioning system which needs AC power to run during charging.

3. Bases on the knowledge that the vehicle has an airconditioning running on AC and a DC input connection it decides that the vehicle should receive DC and AC power at the same time.

4. The energy exchange station turns connects the vehicle both to AC and DC power on separate pins of the connector.

1. A vehicle connects to the energy exchange station. It has a DC and AC input possibility. The vehicle has a powerful airconditioning system mounted onboard. This however cannot be communicated to the energy exchange station.
1. A vehicle connects to the energy exchange station. Via a data communication channel it is determined that the vehicle has a possibility to receive DC power but also transmit DC power.

2. The user of the vehicle uses a computer interface to tell the system that the charging can last as long as 8 hours.

3. The data processing device calculates the best charging power and sets the energy exchange station to the DC charge.

4. Via a smart grid interface the grid tells the data processing device that there is a shortage on the local grid.

5. The data processing device decides that the car should deliver DC power to the bidirectional energy exchange station.

6. The bidirectional energy exchange station draws DC current from the car and delivers this to the grid.

FIG. 13f
3. The user of the second vehicle indicates that he needs a very fast charge. The first user only needs a slow charge.

4. The data processing device notices that the energy exchange station can only deliver 50 kW. Therefore it decides that the onboard charger of the other vehicle will also be used. It tells the energy exchange station that vehicle 2 should be charged with 50 kW DC power from the station and 30 kW DC power from the onboard charger of vehicle 1.

5. The energy exchange station receives settings from the data processing device and sends 50 kW DC power to vehicle 2, also it connects the DC pins of vehicle 1 to the AC supply and the DC pins are internally connected to the DC output of vehicle 2. Therefore the onboard charger of vehicle 1 is now used to supply and additional 30 kW DC power to vehicle 2. Vehicle 2 now receives 80 kW DC in total and is charged very fast.

1. A vehicle connects to the energy exchange station via a data communication channel it is determined that the vehicle has a possibility to receive and transmit DC an AC power. The vehicle has a high power onboard charger.

2. A second vehicle connects to the energy exchange station. Via a data communication channel it is determined that the vehicle has a DC input only.
2. The smart grid connection indicates the maximum power is exceeded.

4. Bases on this information the data processing devices tells the energy exchange station to start switching the AC power on and off, thus creating a lower average power.

3. The energy exchange station switches the power on and off at the specified interval.

1. A vehicle connects to the energy exchange station. It has an AC input possibility only. The energy exchange station has noticed this because there is no communication with the vehicle. It determines the power of the onboard charger by supplying AC power for a brief period.
### SAMENWERKINGSVERDRAG (PCT)

**RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE**

<table>
<thead>
<tr>
<th>IDENTIFICATIE VAN DE NATIONALE AANVRAGE</th>
<th>KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE</th>
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<tr>
<td>Nederlands aanvraag nr.</td>
<td>1.599.006 NL</td>
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<tr>
<td>2004350</td>
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Aanvrager (Naam)

**Epyon B.V.**

Datum van het verzoek voor een onderzoek van internationaal type

**12-06-2010**

Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr.

**SN 54330**

### I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)

Volgens de internationale classificatie (IPC)

**B60L11/18**

**H02J7/00**

### II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimumdocumentatie

<table>
<thead>
<tr>
<th>Classificatiesysteem</th>
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<td>IPC</td>
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</table>

Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

### III. X GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES (opmerkingen op aanvullingsblad)

### IV. X GEBREK AAN EENHEID VAN UITVINDING (opmerkingen op aanvullingsblad)

Form PCT/ISA 201 A (11/2000)
ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar
de stand van de techniek
NL 2004350

A. CLASSIFICATIE VAN HET ONDERWERP

INV. B60L11/18 H02J7/00

ADD.

Volgens de internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOEK GEIEDEN VAN DE TECHNIEK

Onderzochte minimum documentatie (classificatie gevolgd door classificatiesymbolen)
B60L H02J

Onderzochte andere documentatie dan de minimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)
EPO-Internal

C. VAN BELANG GEACHTE DOCUMENTEN

<table>
<thead>
<tr>
<th>Categorie</th>
<th>Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages</th>
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<td>EENHEID VAN UITVINDING ONTBEERKT zie aanvullingsblad B ONVOLLEDIG ONDERZOEK zie aanvullingsblad C</td>
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<td>EP 1 785 310 A2 (CHILD NICHOLAS EDWARD [GB]) 16 mei 2007 (2007-05-16) * kolom 1, regel 22 - kolom 4, regel 16 * * figuur 1 * * samenvatting *</td>
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** Verdere documenten worden vermeld in het vervolg van vak C. **

** Leden van dezelfde octroifamilie zijn vermeld in een bijlage **

* Speciale categorieën van aangehaald documenten
  
  "**" na de indieningsdatum of de voorraadsdatum gepubliceerde literatuur die niet bezaaid is voor de octrooiaanvraag, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding
  
  "**" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

  "**" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

* Speciale categorieën van aangehaald documenten
  
  "**" na de indieningsdatum of de voorraadsdatum gepubliceerde literatuur die niet bezaaid is voor de octrooiaanvraag, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding
  
  "**" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

  "**" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid

5 november 2010

Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type

Naam en adres van de instantie

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2200 HV Rijswijk
Tel: (+31-70)340-2040
Fax: (+31-70)340-3016

De bevoegde ambtenaar

Bronold, Harald

bladzijde 1 van 2
<table>
<thead>
<tr>
<th>Categorie</th>
<th>Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages</th>
<th>Van belang voor conclusie nr.</th>
</tr>
</thead>
</table>
Dit verslag van het onderzoek heeft geen betrekking op bepaalde conclusies omdat deze betrekking hebben op delen van de nationale aanvraje die niet voldoen aan de voorgeschreven vereisten, en wel in die mate dat geen zinvol nieuwsheidsonderzoek verricht kan worden, in het bijzonder:

Volledig onderzoekbare conclusie(s):
14-23

Niet volledig onderzochte conclusie(s):
1-13, 24-27

Reden voor de beperking van het onderzoek:

Claims 1 and 24 claim to determine whether a vehicle coupled to at least one power output is able to be charged with an AC voltage and/or a DC voltage. However, no technical features resulting in this desired result are defined in claims 1 and 24. Therefore, the subject matter of claims 1 and 24 as well as that of dependent claims 2 to 13 and 25 to 27 are not clear.

The search was therefore restricted to the technical solution of the above identified result as defined on pages 7 and 8 of the description defining that each vehicle comprises a switch coupling the power input to a charger when there is AC input and directly to the battery when there is DC input. Further, said switch needs to be detected by the exchange station via communication with the switch in the vehicle. Depending on said communication, DC power is provided if applicable.
De instantie belast met het uitvoeren van het onderzoek naar de stand van de techniek heeft vastgesteld dat deze aanvraag meerdere uitvindingen bevat, te weten:

1. conclusies: 1-13, 24-27
   Energy exchange station
   ***

2. conclusies: 14-19
   Power connector
   ***

3. conclusies: 20-23
   Electric vehicle
   ***

Het vooronderzoek werd tot het eerste onderwerp beperkt.

There is no single general concept linking claims 1 to 27.

To the contrary, it is evident, that the identified three groups of inventions are not so linked as to form a single general inventive concept.

The first group of inventions deals with identifying an on board battery charge in an electric vehicle and with charging the electric vehicle in response to said determination.

The second group of inventions deals with a power connector for vehicle charging.

The third group of inventions deals with an electric vehicle.

All three identified groups of inventions obviously deal with the solution of different technical problems by different technical features and do consequently not fulfill the requirement of unity.
<table>
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<tr>
<th>In het rapport genoemd octrooigeschrift</th>
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<td>EP 1785310</td>
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<td>JP 2010004731 A</td>
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OCTROOICENTRUM NEDERLAND

WRITTEN OPINION

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International Patent Classification (IPC)
INV. B60L11/18 H02J7/00

Applicant
Epyon B.V.

This opinion contains indications relating to the following items:

- [x] Box No. I  Basis of the opinion
- [ ] Box No. II Priority
- [x] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [x] Box No. IV Lack of unity of invention
- [x] Box No. V  Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI  Certain documents cited
- [ ] Box No. VII Certain defects in the application
- [ ] Box No. VIII Certain observations on the application

Examiner
Bronold, Harald

Form NL237A (Dekblad) (July 2006)
Box No. I  Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.

2. With regard to any nucleotide and/or amino acid sequence disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:
   a. type of material:
      □ a sequence listing
      □ table(s) related to the sequence listing
   b. format of material:
      □ on paper
      □ in electronic form
   c. time of filing/furnishing:
      □ contained in the application as filed.
      □ filed together with the application in electronic form.
      □ furnished subsequently for the purposes of search.

3. □ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:
Box No. III  Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

The questions whether the claimed invention appears to be novel, to involve an inventive step, or to be industrially applicable have not been examined in respect of

☐ the entire application
☒ claims Nos. 14-23(completely); 1-13, 24-27(partially)

because:

☐ the said application, or the said claims Nos. relate to the following subject matter which does not require a search (specify):

☐ the description, claims or drawings (indicate particular elements below) or said claims Nos. are so unclear that no meaningful opinion could be formed (specify):

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed (specify):

☒ no search report has been established for the whole application or for said claims Nos. 14-23(completely); 1-13, 24-27(partially)

☐ a meaningful opinion could not be formed as the sequence listing was either not available, or was not furnished in the international format (WIPO ST25).

☐ a meaningful opinion could not be formed without the tables related to the sequence listings; or such tables were not available in electronic form.

☐ See Supplemental Box for further details.

Box No. IV  Lack of unity of invention

1. The requirement of unity of invention is not complied with for the following reasons:

   see separate sheet

2. This report has been established in respect of the following parts of the application:

   ☐ all parts.

   ☒ the parts relating to claims Nos. (see Search Report)
Box No. V  Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

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<tr>
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<td>1-13, 24-27(all partially)</td>
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</tbody>
</table>

2. Citations and explanations

see separate sheet
Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following document(s):


1. Unity

The following three groups of inventions were identified:

1. conclusies: 1-13, 24-27
   Energy exchange station
2. conclusies: 14-19
   Power connector
3. conclusies: 20-23
   Electric vehicle

There is no single general concept linking claims 1 to 27.

To the contrary, it is evident, that the identified three groups of inventions are not so linked as to form a single general inventive concept.
The first group of inventions deals with identifying an on board battery charge in an electric vehicle and with charging the electric vehicle in response to said determination.

The second group of inventions deals with a power connector for vehicle charging.

The third group of inventions deals with an electric vehicle.

All three identified groups of inventions obviously deal with the solution of different technical problems by different technical features and do consequently not fulfill the requirement of unity.

2. Clarity

Claims 1 to 13 and 24 to 27 are not clear.

Claims 1 and 24 claim to determine whether a vehicle coupled to at least one power output is able to be charged with an AC voltage and/or a DC voltage. However, no technical features resulting in this desired result are defined in claims 1 and 24. Therefore, the subject matter of claims 1 and 24 as well as that of dependent claims 2 to 13 and 25 to 27 are not clear.

The search was therefore restricted to the technical solution of the above identified result as defined on pages 7 and 8 of the description defining that each vehicle comprises a switch coupling the power input to a charger when there is AC input and directly to the battery when there is DC input. Further, said switch needs to be detected by the exchange station via communication with the switch in the vehicle. Depending on said communication, DC power is provided if applicable.