

STATEMENT OF CLAIMS

I/We claim:

1. A method for providing swappable batteries to a vehicle, the method comprising

determining at least one battery (102) for a vehicle by a swapping station (101), on receiving an indication from an application server (AS) (105) that the vehicle is approaching the swapping station (101) for changing at least one battery (102), wherein the AS (105) receives an indication from at least one of the battery (102) or a user device (104) that a battery needs to be swapped;

determining conditioning to be performed by the swapping station (101) for the at least one determined battery (102), based on information related to the vehicle, information related to the vehicle, at least one battery being used by the vehicle, and batteries available in the swapping station (101), wherein the information is provided by the AS (105) to the swapping station (101); and

enabling removal of the determined at least one battery (102) from a docking station (103) in the swapping station (101) and placement of the determined at least one battery (102) in the vehicle by the swapping station (101).

2. The method, as claimed in claim 1, wherein the method further comprises providing location and guidance to a swapping station (101) with available batteries by the AS (105) through the user device (104).
3. The method, as claimed in claim 1, wherein the method further comprises authenticating the vehicle and the user by at least one of the swapping station (101) and the AS (105).
4. The method, as claimed in claim 3, wherein the method further comprises unlocking the at least one determined battery (102) from the docking station (103), on successfully authenticating the vehicle and the user.
5. The method, as claimed in claim 1, wherein the method further comprises

performing at least one test and diagnostic function to test the battery (102) by the swapping station (101), before determining conditioning to be performed for the at least one determined battery (102); and

characterizing the battery (102) by the swapping station (101) based on the at least one test and diagnostic function.

6. The method, as claimed in claim 5, wherein the diagnostics comprise

performing high discharge of the battery (102) to check for degradation in performance of the battery (102); and

performing battery discharge to check capacity of the battery (102).

7. The method, as claimed in claim 5, wherein the tests comprise measuring parameters comprising actual capacity of the battery (102), state of charge variation of the battery (102), state of function variation of the battery (102), impedance build up of the battery (102) and temperature changes with usage and ageing of the battery (102).

8. The method, as claimed in claim 1, wherein the method further comprises

determining a suitable docking station (103) in the swapping station (101) for at least one battery used by the vehicle by the swapping station (101); and

placing the used battery in the determined docking station (103).

9. The method, as claimed in claim 1, wherein the method further comprises forecasting energy requirements for a period of time by the AS (105), based on a plurality of factors comprising consumption pattern at each swapping station (101), characteristics of batteries present at each swapping station (101), number of vehicle using the batteries currently, forecasted number of vehicles which will use the batteries in the period of time, weather conditions, and seasonality.

10. The method, as claimed in claim 9, wherein the method further comprises determining a charging rate for each battery (102) by the AS (105) based on the forecasted energy requirements.

11. The method, as claimed in claim 9, wherein the method further comprises determining an optimal time of charging for each battery (102) by the AS (105) based on the forecasted energy requirements.
12. The method, as claimed in claim 1, wherein the method further comprises performing an on-boarding process for each battery (102) by the swapping station (101).
13. The method, as claimed in claim 1, wherein the method further comprises assigning a dynamic key to each battery present in the swapping station (101) by the swapping station (101).
14. The method, as claimed in claim 1, wherein the method further comprises configuring a variable depth of discharge for each battery (102).
15. The method, as claimed in claim 1, wherein the method further comprises determining a charge profile for a battery (102) by the swapping station (101), wherein the charge profile comprises type of charging, charging current/voltage values, limits of charging voltage/temperature, and heating/cooling required, and the charge profile is based on a plurality of factors comprising temperature of the battery (102), remaining SOC (State of Charge) of the battery (102), SOH (State of Health) of the battery (102), demand for batteries/energy, and time required for charging the battery (102).
16. The method, as claimed in claim 15, wherein the swapping station (101) charges the battery (102) based on the charge profile using at least one power source, wherein the at least one power source is at least one of a power grid, at least one alternative energy source and at least one other battery present in the swapping station (101).
17. The method, as claimed in claim 1, wherein the method further comprises authenticating the battery (102), the vehicle where the battery is inserted and a dock present in the vehicle into which the battery is inserted by the AS (105), before enabling power out of the battery (102).
18. The method, as claimed in claim 1, wherein the method further comprises determining at least one second life application for the battery (102) by the AS (105).

19. The method, as claimed in claim 1, wherein the method further comprises providing energy to a power grid connected to the swapping station (101) by the swapping station (101).
20. A system (100) for providing swappable batteries to a vehicle, the system comprising a swapping station (101) configured for
 - determining at least one battery (102) for a vehicle, on receiving an indication from an application server (AS) (105) that the vehicle is approaching the swapping station (101) for changing at least one battery (102), wherein the AS (105) receives an indication from at least one of the battery (102) or a user device (104) that a battery needs to be swapped;
 - determining conditioning to be performed for the at least one determined battery (102), based on information related to the vehicle, information related to the vehicle, at least one battery being used by the vehicle, and batteries available in the swapping station (101), wherein the information is provided by the AS (105) to the swapping station (101); and
 - enabling removal of the determined at least one battery (102) from a docking station (103) in the swapping station (101) and placement of the determined at least one battery (102) in the vehicle.
21. The system, as claimed in claim 20, wherein the AS (105) is further configured for providing location and guidance to a swapping station (101) with available batteries through the user device (104).
22. The system, as claimed in claim 20, wherein the system is further configured for authenticating the vehicle using at least one of the swapping station (101) and the AS (105).
23. The system, as claimed in claim 22, wherein the swapping station (101) is further configured for unlocking the at least one determined battery (102) from the docking station (103), on successfully authenticating the vehicle and the user.

24. The system, as claimed in claim 22, wherein the swapping station (101) is further configured for
- performing at least one test and diagnostic function to test the battery (102), before determining conditioning to be performed for the at least one determined battery (102); and
 - characterizing the battery (102) based on the at least one test and diagnostic function.
25. The system, as claimed in claim 24, wherein the diagnostics comprise
- performing high discharge of the battery (102) to check for degradation in performance of the battery (102); and
 - performing battery discharge to check capacity of the battery (102).
26. The system, as claimed in claim 24, wherein the tests comprise measuring parameters comprising actual capacity of the battery (102), state of charge variation of the battery (102), state of function variation of the battery (102), impedance build up of the battery (102) and temperature changes with usage and ageing of the battery (102).
27. The system, as claimed in claim 20, wherein the swapping station (101) is further configured for
- determining a suitable docking station (103) in the swapping station (101) for at least one battery used by the vehicle; and
 - placing the used battery in the determined docking station (103).
28. The system, as claimed in claim 20, wherein the AS (105) is further configured for forecasting energy requirements for a period of time, based on a plurality of factors comprising consumption pattern at each swapping station (101), characteristics of batteries present at each swapping station (101), number of vehicle using the batteries currently, forecasted number of vehicles which will use the batteries in the period of time, weather conditions, and seasonality.

29. The system, as claimed in claim 28, wherein the AS (105) is further configured for determining a charging rate for each battery (102) based on the forecasted energy requirements.
30. The system, as claimed in claim 28, wherein the AS (105) is further configured for determining an optimal time of charging for each battery (102) based on the forecasted energy requirements.
31. The system, as claimed in claim 20, wherein the swapping station (101) is further configured for performing an on-boarding process for each battery (102).
32. The system, as claimed in claim 20, wherein the swapping station (101) is further configured for assigning a dynamic key to each battery present in the swapping station (101).
33. The system, as claimed in claim 20, wherein the AS (105) is further configured for configuring a variable depth of discharge for each battery (102).
34. The system, as claimed in claim 20, wherein the swapping station (101) is further configured for determining a charge profile for a battery (102), wherein the charge profile comprises type of charging, charging current/voltage values, limits of charging voltage/temperature, and heating/cooling required, and the charge profile is based on a plurality of factors comprising temperature of the battery (102), remaining SOC of the battery (102), SOH of the battery (102), demand for batteries/energy, and time required for charging the battery (102).
35. The system, as claimed in claim 34, wherein the swapping station (101) is configured for charging the battery (102) based on the charge profile using at least one power source, wherein the at least one power source is at least one of a power grid, at least one alternative energy source and at least one other battery present in the swapping station (101).
36. The system, as claimed in claim 20, wherein the AS (105) is further configured for authenticating the battery (102), the vehicle where the battery is inserted and a dock present in the vehicle into which the battery is inserted, before enabling power out of the battery (102).

37. The system, as claimed in claim 20, wherein the AS (105) is further configured for determining at least one second life application for the battery (102).
38. The system, as claimed in claim 20, wherein the swapping station (101) is further configured for providing energy to a power grid connected to the swapping station (101).
39. A swapping station (101) configured for
- determining at least one battery (102) for a vehicle, on receiving an indication from an application server (AS) (105) that the vehicle is approaching the swapping station (101) for changing at least one battery (102), wherein the AS (105) receives an indication from at least one of the battery (102) or a user device (104) that a battery needs to be swapped;
- determining conditioning to be performed for the at least one determined battery (102), based on information related to the vehicle, information related to the vehicle, at least one battery being used by the vehicle, and batteries available in the swapping station (101), wherein the information is provided by the AS (105) to the swapping station (101); and
- enabling removal of the determined at least one battery (102) from a docking station (103) in the swapping station (101) and placement of the determined at least one battery (102) in the vehicle.
40. The swapping station, as claimed in claim 39, wherein the swapping station (101) is further configured for authenticating the vehicle.
41. The swapping station, as claimed in claim 40, wherein the swapping station (101) is further configured for unlocking the at least one determined battery (102) from the docking station (103), on successfully authenticating the vehicle and the user.
42. The swapping station, as claimed in claim 39, wherein the swapping station (101) is further configured for

performing at least one test and diagnostic function to test the battery (102), before determining conditioning to be performed for the at least one determined battery (102); and

characterizing the battery (102) based on the at least one test and diagnostic function.

43. The swapping station, as claimed in claim 43, wherein the diagnostics comprise

performing high discharge of the battery (102) to check for degradation in performance of the battery (102); and

performing battery discharge to check capacity of the battery (102).

44. The swapping station, as claimed in claim 42, wherein the tests comprise measuring parameters comprising actual capacity of the battery (102), state of charge variation of the battery (102), state of function variation of the battery (102), impedance build up of the battery (102) and temperature changes with usage and ageing of the battery (102).

45. The swapping station, as claimed in claim 39, wherein the swapping station (101) is further configured for

determining a suitable docking station (103) in the swapping station (101) for at least one battery used by the vehicle; and

placing the used battery in the determined docking station (103).

46. The swapping station, as claimed in claim 39, wherein the swapping station (101) is further configured for performing an on-boarding process for each battery (102).

47. The swapping station, as claimed in claim 39, wherein the swapping station (101) is further configured for assigning a dynamic key to each battery present in the swapping station (101).

48. The swapping station, as claimed in claim 39, wherein the swapping station (101) is further configured for determining a charge profile for a battery (102), wherein the charge profile comprises type of charging, charging current/voltage values, limits of

charging voltage/temperature, and heating/cooling required, and the charge profile is based on a plurality of factors comprising temperature of the battery (102), remaining SOC of the battery (102), SOH of the battery (102), demand for batteries/energy, and time required for charging the battery (102).

49. The swapping station, as claimed in claim 48, wherein the swapping station (101) is further configured for charging the battery (102) based on the charge profile using at least one power source, wherein the at least one power source is at least one of a power grid, at least one alternative energy source and at least one other battery present in the swapping station (101).
50. The swapping station, as claimed in claim 39, wherein the swapping station (101) is further configured for providing energy to a power grid connected to the swapping station (101).
51. An apparatus (105) configured for
 - providing location and guidance to a swapping station (101) with available batteries through a user device (104), on determining that at least one battery (102) in a vehicle associated with the user device (104) requires swapping;
 - providing an indication to the swapping station (101) that the vehicle is approaching the swapping station (101) for changing at least one battery (102), wherein the apparatus (105) receives an indication from at least one of the battery (102) or a user device (104) that a battery needs to be swapped;
52. The apparatus, as claimed in claim 51, wherein the apparatus (105) is further configured for authenticating the vehicle.
53. The apparatus, as claimed in claim 51, wherein the apparatus (105) is further configured for forecasting energy requirements for a period of time, based on a plurality of factors comprising consumption pattern at each swapping station (101), characteristics of batteries present at each swapping station (101), number of vehicle using the batteries currently, forecasted number of vehicles which will use the batteries in the period of time, weather conditions, and seasonality.

54. The apparatus, as claimed in claim 53, wherein the apparatus (105) is further configured for determining a charging rate for each battery (102) based on the forecasted energy requirements.
55. The apparatus, as claimed in claim 53, wherein the apparatus (105) is further configured for determining an optimal time of charging for each battery (102) based on the forecasted energy requirements.
56. The apparatus, as claimed in claim 51, wherein the apparatus (105) is further configured for configuring a variable depth of discharge for each battery (102).
57. The apparatus, as claimed in claim 51, wherein the apparatus (105) is further configured for authenticating the battery (102), the vehicle where the battery is inserted and a dock present in the vehicle into which the battery is inserted, before enabling power out of the battery (102).
58. The apparatus, as claimed in claim 51, wherein the apparatus (105) is further configured for determining at least one second life application for the battery (102).