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(54) **KIOSK VEHICLE CHARGING AND SELECTING SYSTEMS**

(52) **U.S. Cl. 320/109**

(57) **ABSTRACT**

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A vehicle charging and selection system for kiosk operated electrical vehicles. The system includes a utility connected AC charging source, a battery-to-battery DC charging source, a number of vehicle charging stations, a local power bus connectable to both charging sources and each of the charging stations and a system controller connected to each of the charging stations. The system controller evaluates the vehicle battery condition of each electric vehicle connected to one of the charging stations and determines the most efficient method for charging the largest number of vehicle batteries based on current condition of the individual batteries, weather conditions, time of day, status of the utility electrical grid, etc. The system controller also selects one of the connected electric vehicles for customer use by using the battery charging information and additional information about the desired trip provided by the customer and other external data sources monitored by the system controller.

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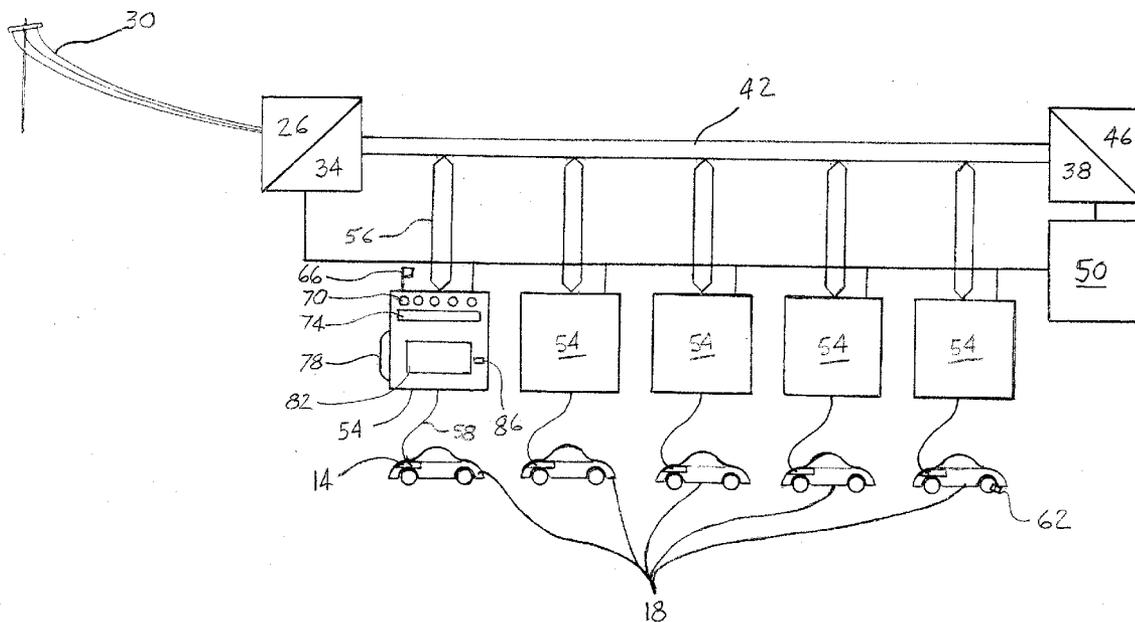
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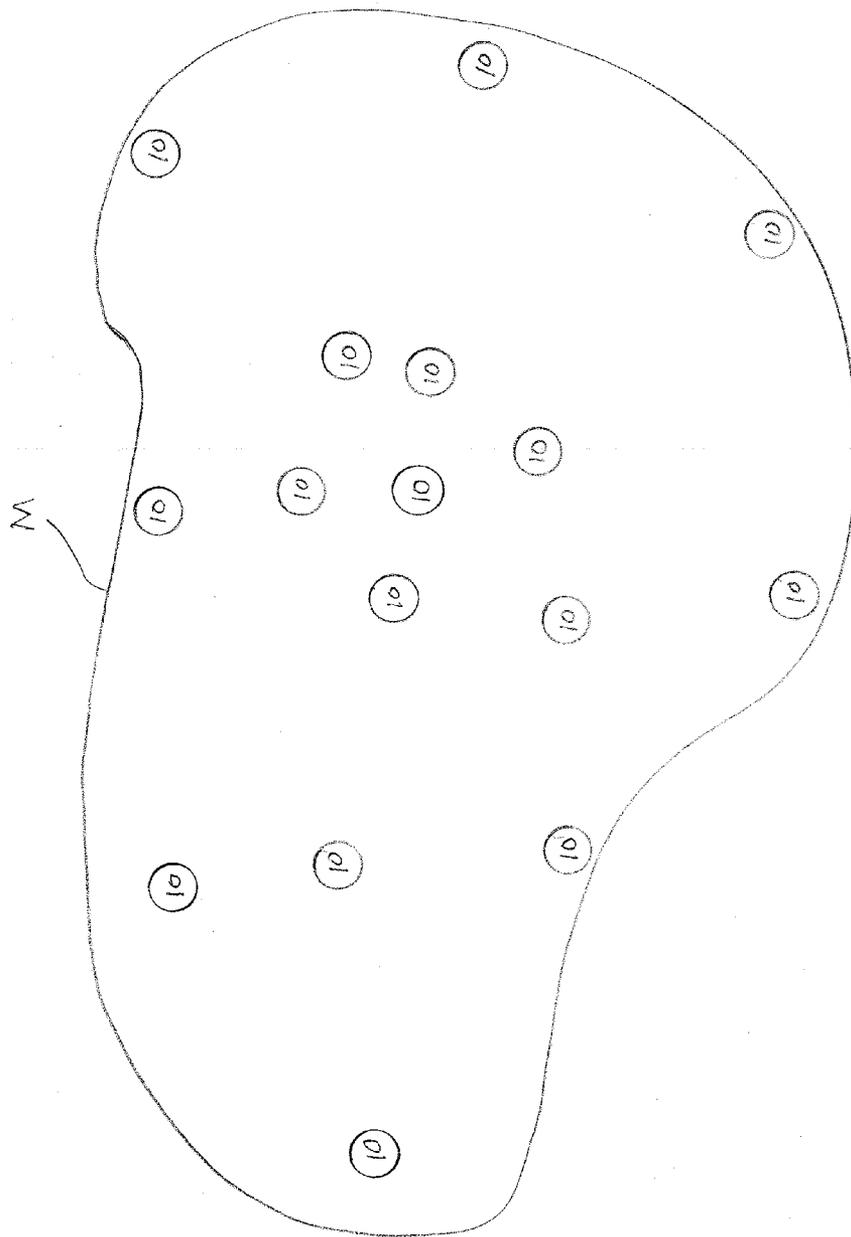


FIG. 1

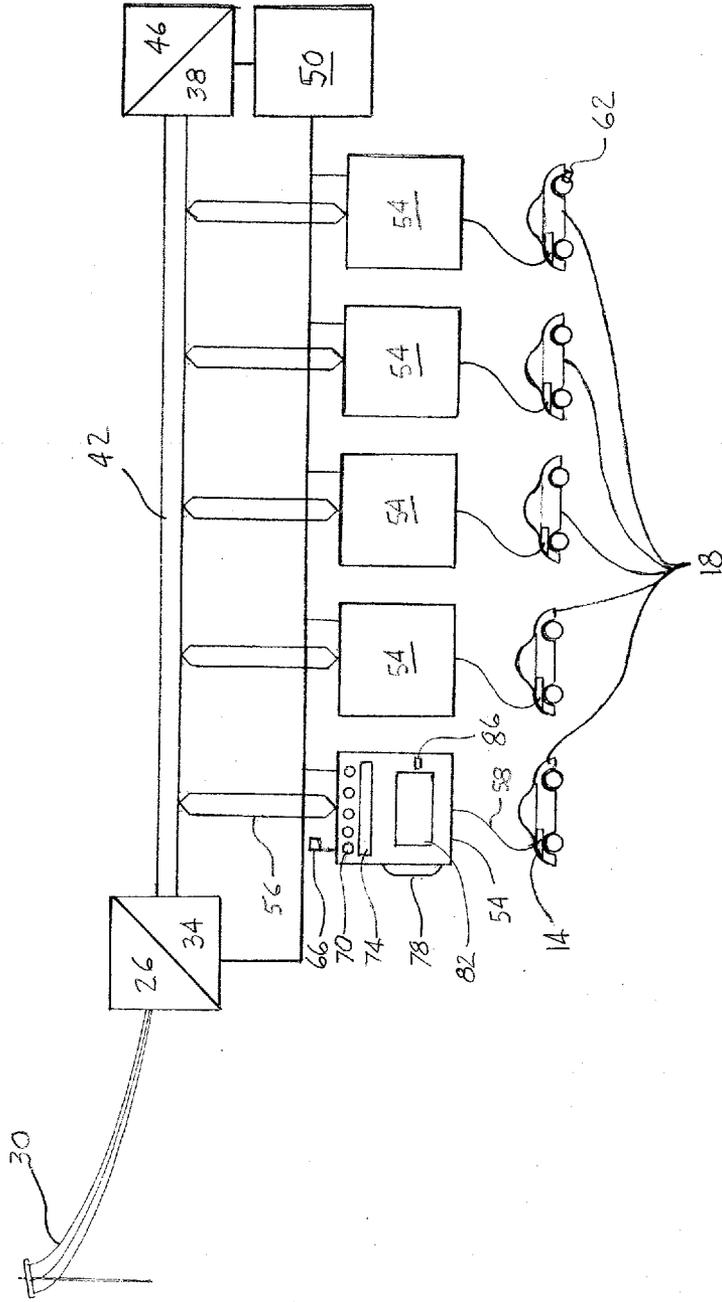


fig. 2A

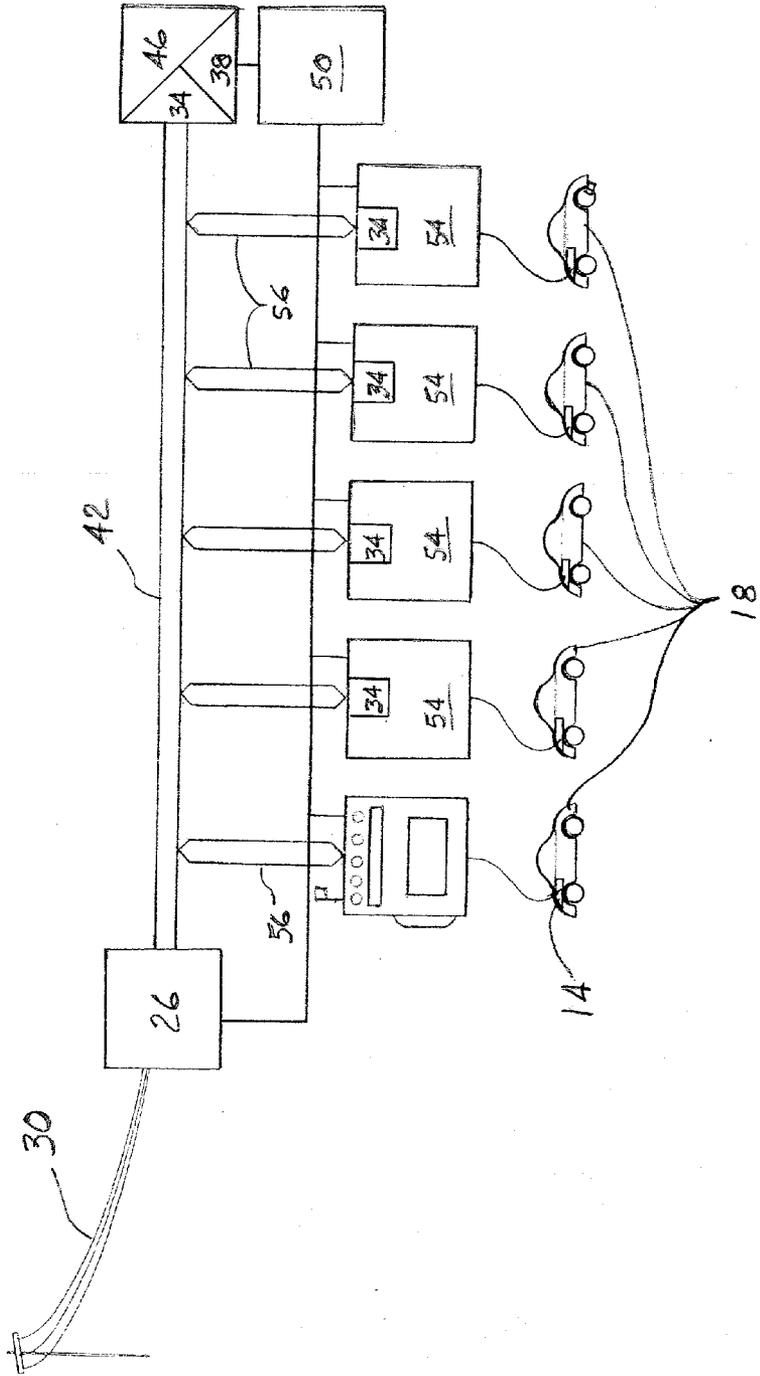


FIG. 2B

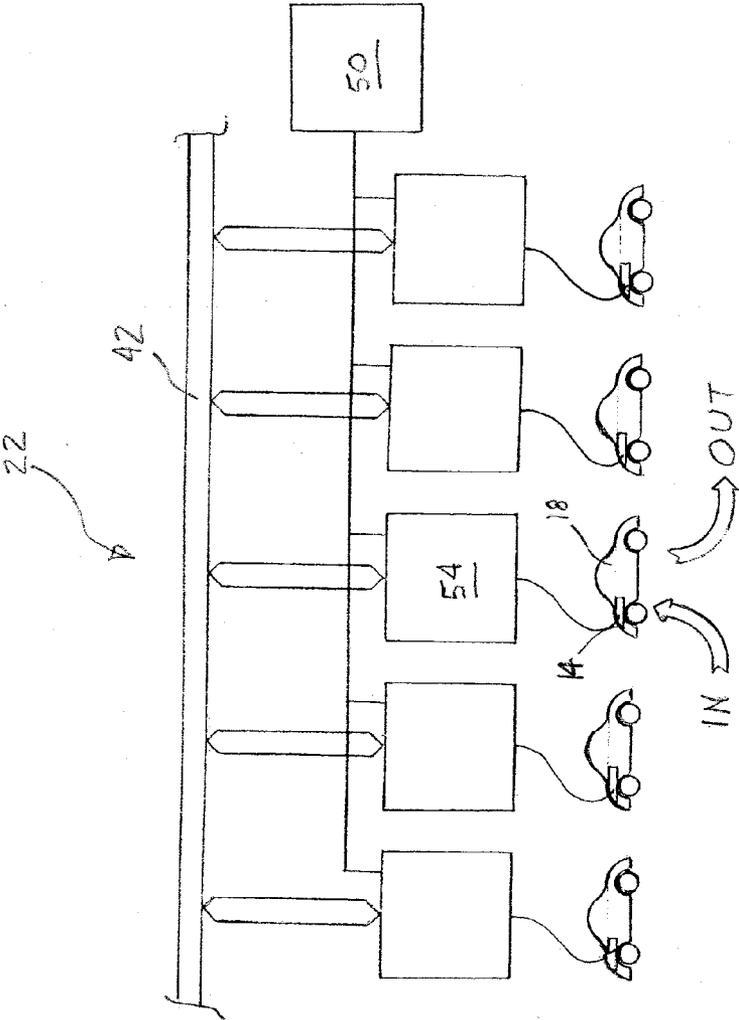


fig. 3

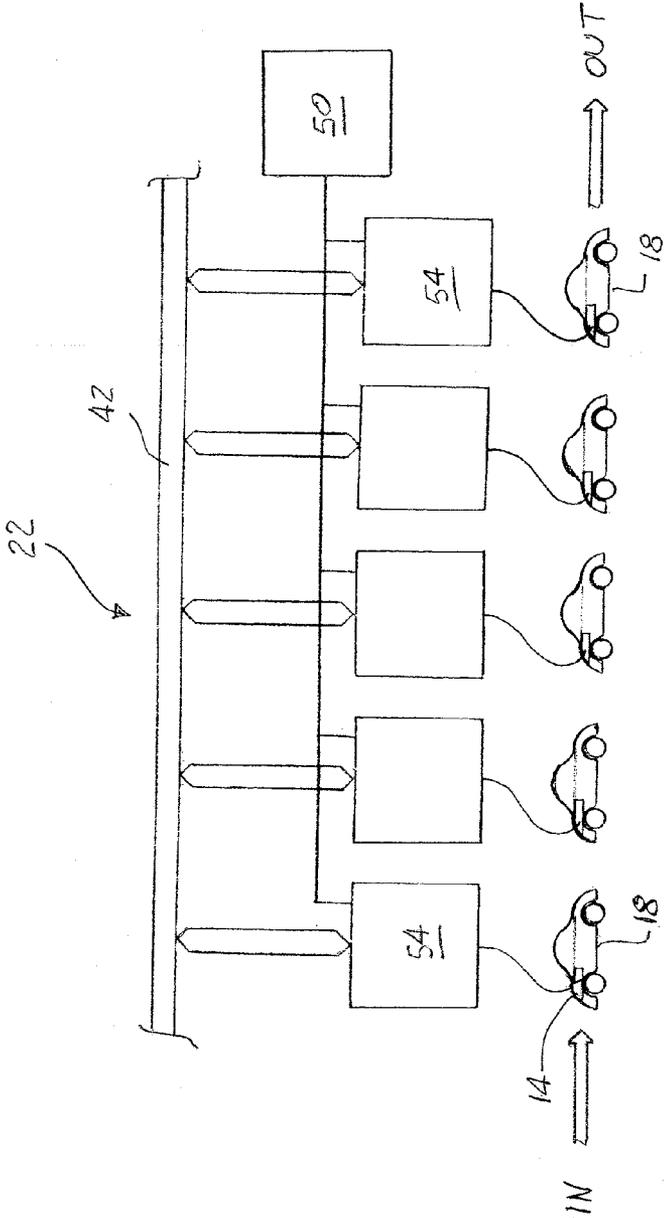


FIG. 4

**KIOSK VEHICLE CHARGING AND
SELECTING SYSTEMS**

CROSS-REFERENCE TO RELATED PATENTS

[0001] This application claims the benefit of the filing date of prior-filed provisional application No. 61/246870.

**STATEMENT REGARDING FEDERALLY
SPONSORED RESEARCH OR DEVELOPMENT**

[0002] Not applicable

FIELD OF THE INVENTION

[0003] The present invention relates to electric vehicles, and particularly to an electric vehicle kiosk charging and selection system.

BACKGROUND OF THE INVENTION

[0004] In many large cities ownership of a personal car or motor scooter is prohibited by the cost for parking and/or the lack of a garage or storage area at the individual's residence or apartment. Public transportation, such as light rail buses or subways, are available in most large metropolitan areas. All of these modes of public transportation are directed to mass transit, restricted to defined routes, run on set schedules and stop at defined locations that are not always in or near a particular area that one or two individuals may want to visit. Therefore, a system of small, electric vehicles, e.g. cars that can be rented by kiosk members or individuals from a kiosk in one location and driven to a kiosk at another location closer to the desired area where the kiosk member of individual wanted to go would be desirable. For such a system to be profitable the kiosk must have a battery charging system that can quickly recharge the most vehicle batteries at the least cost and also select a vehicle with an appropriately charged battery for the individual's desired trip to their selected destination kiosk.

SUMMARY OF THE INVENTION

[0005] The present invention provides a system for charging the batteries of one or more electric vehicles in an electric vehicle kiosk in the most efficient and economical method based on battery condition, energy cost, present or expected demand on the utility energy system and other external information relevant to a batteries ability to receive a charge. The charging system can also select a kiosk vehicle, from those available at the kiosk, with sufficient charge for a vehicle user's defined trip to a desired destination kiosk base on the vehicle battery condition, destination kiosk, route selection and current traffic and weather conditions.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The features of the invention will be more clearly understood from the following detailed description of the invention read together with the drawings in which:

[0007] FIG. 1 illustrates in general a metropolitan area with electric vehicle kiosks placed at strategic locations.

[0008] FIG. 2A illustrates in general a typical electric vehicle kiosk charging system using an DC charging source connected to the utility grid in accordance with the present invention.

[0009] FIG. 2B illustrates in general a typical electric vehicle kiosk charging system using an AC charging source in accordance with the present invention.

[0010] FIG. 3 illustrates an electric vehicle kiosk using a random charging priority in accordance with the present invention.

[0011] FIG. 4 illustrates an electric vehicle kiosk using a first-in-first-out charging priority in accordance with the present invention.

[0012] Before one embodiment of the invention is explained in detail, it is to be understood that the invention is not limited in its application to the details of construction described herein or as illustrated in the drawings. The invention is capable of other embodiments and of being practiced or being carried out in various other ways. Further, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting.

DETAILED DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 illustrates in general a metropolitan area M with a system of strategically placed electric vehicle kiosks 10, where kiosk members or individuals (vehicle users) can rent a kiosk operated electric vehicle 14 (kiosk vehicle) for a one way trip to a destination kiosk 10 at or near their desired destination. At the destination kiosk 10 the vehicle battery 18 of the kiosk vehicle 14 will be recharged for the next vehicle user's rental.

[0014] Referring now to FIGS. 2A and 2B, each kiosk 10 has a charging system 22 that includes an AC charging source 26, connected to the utility grid 30, an AC to DC converter or rectifier 34, and a DC (battery-to-battery) charging source 38. The AC charging source 26 and DC charging source 38 are both connectable to a local power bus 42. The DC charging source 38 includes the vehicle batteries 18 and a bank of backup batteries 46. The charging system 22 also includes a system controller 50 that determines the most efficient method for charging the vehicle batteries 18 and selecting a kiosk vehicle 14 with sufficient vehicle battery charge for a vehicle user's trip. A number of charging stations 54 are connected to the local power bus 42 by a bus or cable 56 and to the system controller 50. The connection between the local power bus 42 and each charging station 54 permits each charging station 54 to receive power from the local power bus 42 or transmit power to the local power bus 42 from a connected vehicle battery 18. As shown in FIG. 2A, the AC-to-DC converter 34 can be connected between the utility grid 30 and the local power bus 42, in which case the local bus 42 is a DC bus. As shown in FIG. 2B, an AC-to-DC/DC-to-AC converter 34 can be located in each of the charging stations 54 and at the backup battery bank 46, in which case the local bus 42 is an AC bus. Each charging station 54 also has a means for connecting 58 to a vehicle battery 18 of one of the kiosk vehicles 14. The means for connecting 58 can be a cable or a wireless power coupling that permits charging or discharging of the vehicle battery 18 through the charging station 54. The system controller 50 monitors the battery charge level and temperature (which affects the charge and discharge rate of vehicle battery 18) and evaluates the condition of the vehicle battery 18 in each kiosk vehicle 14 connected to the charging system 22 at predetermined intervals. The system controller 50 also monitors a number of external information sources, such as ambient temperature, time of day, utility grid demand projections, etc., that provide information used to determine

the most efficient order for charging each vehicle battery **18** and which charging source, AC **26** or DC **38**, will be used to charge the vehicle batteries **18**. The external sources are monitored by known means such as sensors. The system controller **50** also determines which of the available kiosk vehicles **14** has sufficient charge on its battery **18** for a particular vehicle user's requested trip. The vehicle **14** selection is based on the current condition of the vehicle battery **18**, as determined during the charging cycle, and information from external sources, such as ambient temperature (very hot or very cold conditions can effect the available battery voltage and rate of discharge), traffic information (accident and road work detours, traffic lights, etc.), weather forecast (rain and snow may require the use of other electric motor such as wipers, lights, etc.), and trip information provided by the prospective vehicle user (stops, hills, etc.) at the time he or she requests a kiosk vehicle **14**.

[0015] The Kiosk vehicle **14** selected by the system controller **50** would be picked up by the vehicle user (kiosk member or individual) at the convenient kiosk **10** and left at another kiosk **10**, located at or near the vehicle user's desired destination. When the vehicle user has reached the destination kiosk **10**, the kiosk vehicle **14** will be connected to one of the kiosk charging stations **54**. The charging station **54** can include a kiosk vehicle restraint **62**, such as a cable lock, wheel lock or an electronic lock in the kiosk vehicle **14** electrical system, that prevents unauthorized use of the kiosk vehicles **14**. The system controller **50** will immediately evaluate the percent of charge remaining on the vehicle battery **18** and other battery conditions such as battery temperature, etc. of the newly connected kiosk vehicle **14**. The system controller **50** then sets a flag or charge indicator **66** at the vehicle charging station **54** indicating the current minimum battery charge level (full, $\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{4}$ or discharged) of the newly connected kiosk vehicle **14**. The flag **66** can be any one of a visual interpretation of a flag, an illuminated indicator (LED) **70** or a display **74** indicating the approximate percent of charge graphically or by actual numbers to any potential vehicle user approaching the charging station **54**. The system controller **50** will then compare the charge on vehicle batteries **18** and other monitored characteristics of all kiosk vehicles **14** connected to the kiosk charging system **22**. Any vehicle batteries **18** that are fully charged will be placed in a standby mode to prevent overcharging, but will remain connected to the system controller **50** such that the charge and other battery conditions can be evaluated at predetermined intervals and when any new kiosk vehicles **14** are connected to the kiosk charging system **22**. The system controller **50** will also monitor the utility grid **30** and determine its current status, such as low demand or usage period, peak or high demand or usage period, low cost period or high cost period. For economic reasons it is most desirable to use the AC charging source **26** only during low grid usage periods and low cost periods.

[0016] If the utility grid **30** is in a low usage low cost period the kiosk charging system **22** will begin charging all vehicle batteries **18** and backup batteries **46** from the AC charging source **26** in a selected order that will bring the most vehicle batteries **18** to full charge in the least time or before the next expected peak usage or high cost period begins.

[0017] If the utility grid **30** is determined to be in a peak usage or high cost period, or if the grid **30** is unavailable for any other reason, the controller will disconnect the AC charging source **26** and connect the battery-to-battery charging

source **38**. Based on the battery condition evaluations and the current and forecasted weather conditions the system controller **50** will determine which vehicle batteries **18** can be charged in the least amount of time and begin charging the selected battery or batteries **18** by using energy from those vehicle batteries **18** indicated as requiring the longest time to be fully charged. In certain situations it can be desirable to have a greater number of kiosk vehicles **14** with batteries **18** at a charge level that permits travel to most destination kiosks **10**, but is less than a full charge. In this case, the fully charged vehicle batteries **18** may be used to bring lesser charged vehicle batteries **18** up to the desired charge level. The backup batteries **46** of the battery-to-battery charging source **38** are generally charged from the AC source **26** during low usage low cost periods for use in high usage high cost periods. The battery-to-battery charging source **38** can also include electronics for enhancing the ability of lesser charged vehicle batteries **18** to charge higher charged vehicle batteries **18**.

[0018] The following step for charging vehicle batteries **18** are generally used for a kiosk charging system **22** that does random charging of the vehicle batteries **18** connected to the charging system **22** as shown in FIG. 3.

Random Kiosk Vehicle Battery Charging Process

[0019] 1. Monitor % of charge and physical characteristics of all kiosk vehicle batteries **18** connected to kiosk charging system **22**.

[0020] 2. Based on the monitored condition set the charge indicating flag **66** of each kiosk charging station **54** to full, $\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{4}$ or discharged to indicate the current minimum charge state of the kiosk vehicle battery **18** connected to that charging station **54**.

[0021] 3. If any kiosk vehicle batteries **18** are fully charged the charging station **54** to which they are connected is placed in a stand by mode to prevent overcharging of the vehicle battery **18**.

[0022] 4. Determine whether it is currently a peak grid usage period or a high cost period.

[0023] 5. If it is neither a peak usage nor a high cost period charge kiosk vehicle batteries **18** in a selected order (based on charge level, physical characteristics, current weather information, etc.) to bring the most batteries **18** to full charge in the least time from the AC charging source **26**.

[0024] 6. Top off the charge on all kiosk vehicle batteries **18** prior to the next anticipated peak usage or high cost period.

[0025] 7. If a peak usage or high cost period is determined switch from the AC source **26** to the battery-to-battery charging source **38** and charge kiosk vehicle batteries **18** in a selected order to bring the most batteries **18** to full charge in the least time from the kiosk vehicle batteries **18** having longest time to attain full charge and/or kiosk back-up batteries **46**.

[0026] It is also possible to use the battery-to-battery charging source **38** in combination with the AC charging source **26**, such that the system controller **50** can avoid overloading the grid connection during periods of peak demand. In this way, the system controller **50** can attempt to load level the grid power demand, drawing a more constant amount of power that is close to the time-average charging demand on the AC charging source **26**.

[0027] A kiosk **10**, as shown in FIG. 4, can also be arranged as a first-in-first-out (FIFO) queue, similar to the luggage cart

stacks found in many airports. In such a system, kiosk vehicles **14** enter the queue at the back, and travel toward the front of the queue as kiosk vehicles **14** are removed from the front. In other words, the system is now constrained as to which kiosk vehicle **14** must be the next one available for use. In this case, it is necessary to ensure that the vehicle battery **18** of each kiosk vehicle **14** is at full charge by the time it reaches the front of the queue. Accordingly, the charging system **22** will use the AC charging source **26** from the utility grid **30** (when available) to apply charge to the kiosk vehicle **14** closest to the front of the queue that is not yet fully charged. As that kiosk vehicle **14** reaches a full state-of-charge, the system controller **50** will switch to charging the next kiosk vehicle **14** back in the queue that is not yet fully charged. Again, if the utility grid **30** is determined to be in a peak usage or high cost period, or if the grid **30** is unavailable for any other reason, the system controller **50** will disconnect the AC charging source **26** from the local power bus **42** and connect the battery-to-battery DC charging source **38** to provide charge to the front-most kiosk vehicle **14** requiring a charge, from vehicle batteries **18** of kiosk vehicles **14** further back in the queue. A typical charging process for a FIFO queue kiosk is shown and described below.

FIFO Queue Kiosk Vehicle Battery Charging Process

- [0028] 1. Monitor % of charge and physical characteristics of all kiosk vehicle batteries **18** connected to kiosk charging system **22**.
- [0029] 2. Based on the monitored condition set the charge indicating flag **66** of each kiosk charging station **54** to full, $\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{4}$ or discharged to indicate current minimum charge state of the kiosk vehicle battery **18** connected to the charging station **54**.
- [0030] 3. If any kiosk vehicle batteries **18** are fully charged the charging station **54** to which they are connected is placed in a stand by mode to prevent overcharging the vehicle battery **18**.
- [0031] 4. Determine whether it is currently a peak grid usage period or a high cost period.
- [0032] 5. If it is neither a peak usage nor a high cost period charge kiosk vehicle batteries **18** in a selected order (based on position in the queue) to bring the most vehicle batteries **18** to full charge in the least time from the AC charging source **26**.
- [0033] 6. Top off the charge on all kiosk vehicle batteries **18** prior to the next anticipated peak usage or high cost period.
- [0034] 7. If a peak usage or high cost period is determined switch from the AC charging source **26** to the battery-to-battery charging source **38** and charge kiosk vehicle batteries **18** in a selected order (based on position in the queue) to bring the vehicle batteries **18** in kiosk vehicles **14** closest to the front of the queue to full charge, by taking charge from vehicle batteries **18** of one or more kiosk vehicles **14** further back in the queue.
- [0035] A kiosk member can request a kiosk vehicle **14** by telephone, internet or in person at the departure kiosk **10**. The kiosk member would have the option of receiving the most fully charged available kiosk vehicle **14** at the departure kiosk **10** or, by providing trip information such as the departure kiosk **10**, destination kiosk **10**, using a kiosk provided route between the departure and destination kiosk **10** or a variable route, receive a kiosk vehicle **14** that has sufficient vehicle battery **18** charge to accomplish the defined trip. In selecting

a sufficiently charged kiosk vehicle **14**, the kiosk charging system controller **50** considers current vehicle battery **18** conditions, as determined during the charging cycle, trip information provided by the kiosk member, current weather conditions, current traffic information and various kiosk provided routes to the destination kiosk. A typical selection process of the invention could be as shown below.

Kiosk Vehicle Selection Method

- [0036] 1 Kiosk member requests a kiosk vehicle **14**
 - [0037] 2 Kiosk member enters password or other unique identification
 - [0038] 3 Kiosk member selects destination kiosk **10**
 - [0039] 4 Kiosk member selects trip type: direct using kiosk map route (price break) or indirect
 - [0040] 5 System controller **50** determines minimum vehicle battery **18** charge to reach destination kiosk **10** based on variables comprising: trip type, time of day, traffic information, weather information, ambient temperature, etc.
 - [0041] 6 System controller **50** indicates which kiosk vehicle **14** has sufficient vehicle battery **18** charge for Kiosk member's trip
 - [0042] 7 Kiosk member proceeds to the indicated charging station **54** connected to the selected kiosk vehicle **14**
 - [0043] 8 Kiosk member enters password or other unique identification to release the kiosk vehicle restraint **62**
 - [0044] A display at each vehicle charging station **54** can indicate the minimum percent of battery **18** charge of the connected kiosk vehicle **14** and the kiosk member assigned to that particular kiosk vehicle **14**. It is also understood that the charging station **54** can include means, such a card swipe **78**, touch screen (key pad) **82**, finger print reader **86** or other input device, for releasing a mechanical or electronic vehicle restraint **62** on the connected kiosk vehicle **14** only to the assigned kiosk member or vehicle user renting the kiosk vehicle **14**.
- I claim:
1. A charging system for kiosk operated electric vehicles comprising:
 - an AC charging source connected to a utility grid system;
 - a battery-to-battery DC charging source;
 - a local power bus connected to both the AC and DC charging sources;
 - a plurality of charging stations, each being connected to the local power bus such that power can be received from or transmitted to the local power bus, each charging station having means for connecting to a vehicle battery of one of the kiosk operated electric vehicles; and
 - a system controller being connected to each of the plurality of charging stations, the system controller periodically monitors the condition of the vehicle batteries of all kiosk operated electric vehicles connected to charging stations and selected external sources, using the monitored information the system controller determines a priority for charging the vehicle batteries and the AC or DC charging source to be used for charging the vehicle batteries.
 2. The charging system of claim 1, wherein the monitored condition of the vehicle batteries include the percent of charge remaining on the battery.
 3. The charging system of claim 1, wherein the monitored condition of the vehicle batteries include the temperature of the vehicle battery.

4. The charging system of claim 2, wherein the priority for charging vehicle batteries can be based on the monitored charge levels of the vehicle batteries or the position of the electric vehicles in a kiosk queue.

5. The charging system of claim 1, wherein the DC charging source uses the charge from one or more vehicle batteries having a higher charge to increase the charge of one or more vehicle batteries having a lower charge to increase the number of vehicles having sufficient vehicle battery charge to reach most of the possible destinations kiosks.

6. The charging system of claim 1, wherein the monitored external sources include time of day, current weather conditions and utility grid status including high or low demand and current utility cost.

7. The charging system of claim 6, wherein the system controller selects the AC charging source for charging vehicle batteries when the grid status is low demand and low utility cost.

8. The charging system of claim 6, wherein the system controller selects the DC charging source for charging vehicle batteries when the grid status is high demand and/or high utility cost or the utility grid is not available.

9. The charging system of claim 6, wherein the system controller can select both the AC charging source and the DC charging source and use load leveling techniques to reduce the AC charging source's demand on the utility grid and maintain lower utility cost when the grid status indicates that one or both of the demand or utility cost is high.

10. The charging system of claim 6, wherein the DC charging source uses the charge from one or more vehicle batteries having a lower battery charge to increase the charge of one or more vehicle batteries having a higher battery charge.

11. The charging system of claim 7, wherein the AC charging source charges a bank of backup batteries in the DC charging source.

12. The charging system of claim 11, wherein the DC charging source backup batteries can be used to charge vehicle batteries when the utility grid status is high demand, high cost or the utility grid is not available.

13. The charging system of claim 6, wherein the system controller uses the monitored battery condition, the monitored external sources, a destination kiosk selected by a vehicle user and additional external source information such as current traffic information and possible routes to the destination kiosk to select one of the kiosk vehicles for the vehicle user's trip.

14. A vehicle charging and selecting system for kiosk operated electric vehicles comprising:

- an AC charging source connected to a utility grid system;
- a battery-to-battery DC charging source;
- a local power bus connected to both the AC and DC charging sources;
- a plurality of charging stations, each being connected to the local power bus such that power can be received from or transmitted to the local power bus and each charging station having means for connecting to a vehicle battery of one of the kiosk vehicles for monitoring, charging or discharging the vehicle battery and means for receiving vehicle user input related to a trip to a desired destination kiosk; and

a system controller being connected to each of the plurality of charging stations, the system controller periodically monitors the condition of the vehicle batteries of all kiosk operated electric vehicles connected to charging

stations and selected external sources, using the monitored information the system controller determines a priority for charging the vehicle batteries and the AC or DC charging source to be used for charging the vehicle batteries, the system controller further uses the monitored information and the vehicle user input to select one of the kiosk vehicles having sufficient battery charge for the trip to the desired destination kiosk.

15. The charging and selecting system of claim 14, wherein the monitored condition of the vehicle batteries include the percent of charge remaining on the vehicle battery and the vehicle battery temperature.

16. The charging and selecting system of claim 14, wherein the priority for charging vehicle batteries can be based on the monitored charge levels of the vehicle batteries or the position of the kiosk vehicles in a kiosk queue.

17. The charging and selecting system of claim 14, wherein the DC charging source uses the charge from one or more vehicle batteries having a higher charge to increase the charge of one or more vehicle batteries having a lower charge to increase the number of kiosk vehicles having sufficient vehicle battery charge to reach most of the possible destination kiosks.

18. The charging and selecting system of claim 14, wherein the monitored external sources include time of day, current weather conditions, utility grid status including high or low demand and current utility cost, current traffic conditions and possible routes to the destination kiosk.

19. The charging and selecting system of claim 18, wherein the system controller selects the AC charging source for charging vehicle batteries when the grid status is low demand and low utility cost.

20. The charging and selecting system of claim 18, wherein the system controller selects the DC charging source for charging vehicle batteries when the grid status is high demand and/or high utility cost or the utility grid is not available.

21. The charging and selecting system of claim 18, wherein the system controller can select both the AC charging source and the DC charging source and use load leveling techniques to reduce the AC charging source's demand on the utility grid and maintain lower utility cost when the grid status indicates that one or both of the demand or utility cost is high.

22. The charging and selecting system of claim 14, wherein the DC charging source uses the charge from one or more vehicle batteries having a lower battery charge to increase the charge of one or more vehicle batteries having a higher battery charge.

23. The charging and selecting system of claim 14, wherein the AC charging source also charges a bank of backup batteries in the DC charging source.

24. The charging and selecting system of claim 23, wherein the DC charging source backup batteries can be used to charge vehicle batteries when the utility grid status is high demand, high cost or the utility grid is not available.

25. Method for charging a vehicle battery of a kiosk operated electric vehicle comprising the steps of:

- monitoring the vehicle battery condition of all electric vehicles connected to a kiosk charging system;
- monitoring external conditions including current time, utility grid status and current weather conditions;
- selecting one of an AC charging source or a DC charging source based on the utility grid status;
- selecting one or more vehicle batteries to be charged based on the monitored conditions of all vehicle batteries con-

nected to the kiosk charging system or the location of the kiosk vehicles in a kiosk queue

26. Method for charging and selecting a kiosk operated electric vehicle comprising the steps of:

monitoring the vehicle battery condition of all electric vehicles connected to a kiosk charging system;

monitoring external conditions relative to the charging and discharging of the vehicle batteries;

selecting one of an AC charging source or a DC charging source based on a utility grid status;

selecting one or more vehicle batteries to be charged based on the monitored conditions of all vehicle batteries connected to the kiosk charging system or the location of the kiosk vehicles in a kiosk queue;

monitoring vehicle user information concerning a selected destination kiosk; and

selecting one of the kiosk vehicles with sufficient charge for the vehicle user's trip to the selected destination kiosk.

27. The method of claim **26** wherein the vehicle battery conditions include vehicle battery charge level and vehicle battery temperature.

28. The method of claim **26** wherein the monitored external conditions including current time, utility grid status, current weather conditions, current traffic information

29. The method of claim **26** wherein the grid status includes high demand, low demand, high utility cost and low utility cost.

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