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(54) **GENERATING DYNAMIC ENERGY TRANSACTION PLANS**

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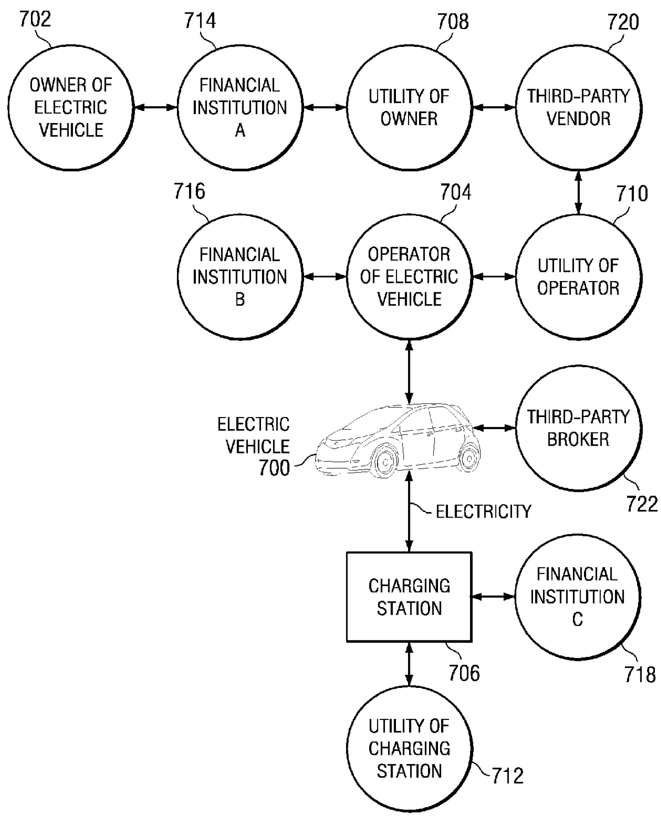
(57) **ABSTRACT**

A computer implemented method, apparatus, and computer program product for generating a dynamic energy transaction plan to manage an electric vehicle charging transaction. The dynamic energy transaction planner generates a dynamic energy transaction plan based on the charging transaction information. The dynamic energy transaction plan comprises a first set of terms of the charging transaction. An initial portion of the charging transaction is controlled according to the first set of terms of the dynamic energy transaction plan. The dynamic energy transaction planner receives updated charging transaction information during execution of the charging transaction; and updates the dynamic energy transaction plan based on the updated charging transaction information to form an updated dynamic energy transaction plan. The updated dynamic energy transaction plan comprises a second set of terms. A second portion of the charging transaction is implemented according to the second set of terms in the updated dynamic energy transaction plan.



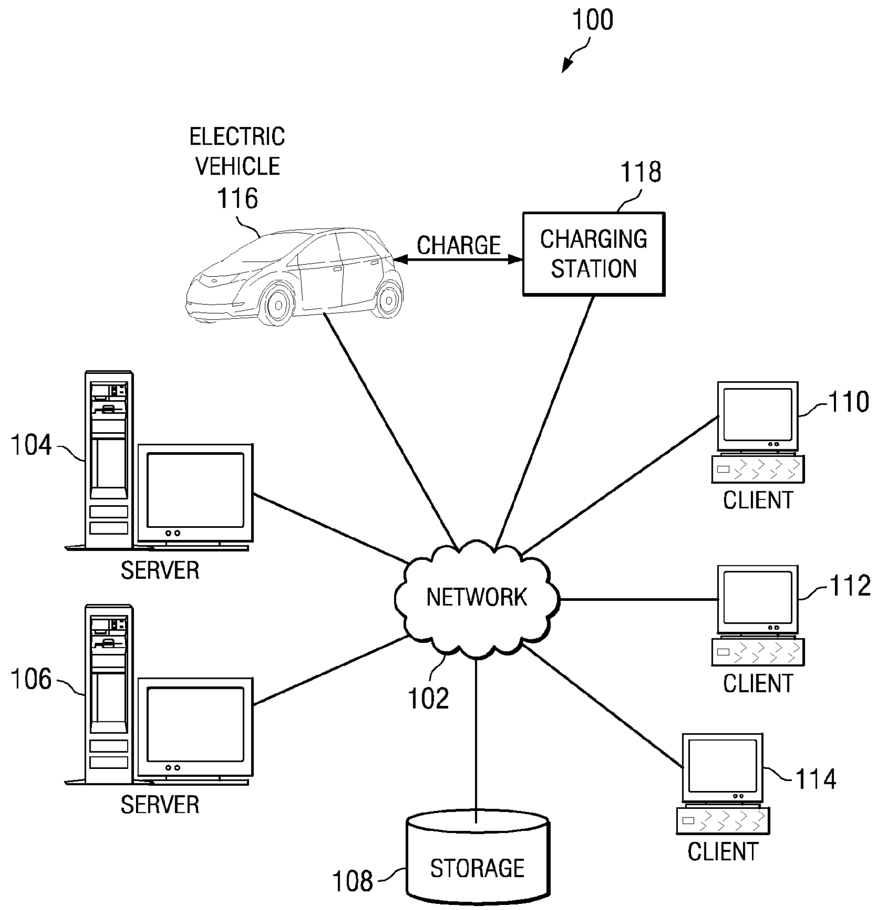

100
ELECTRIC
VEHICLE
116
CHARGE
118
CHARGING
STATION
104
SERVER
106
SERVER
NETWORK
102
STORAGE
108
110
CLIENT
112
CLIENT
114
CLIENT

FIG. 1

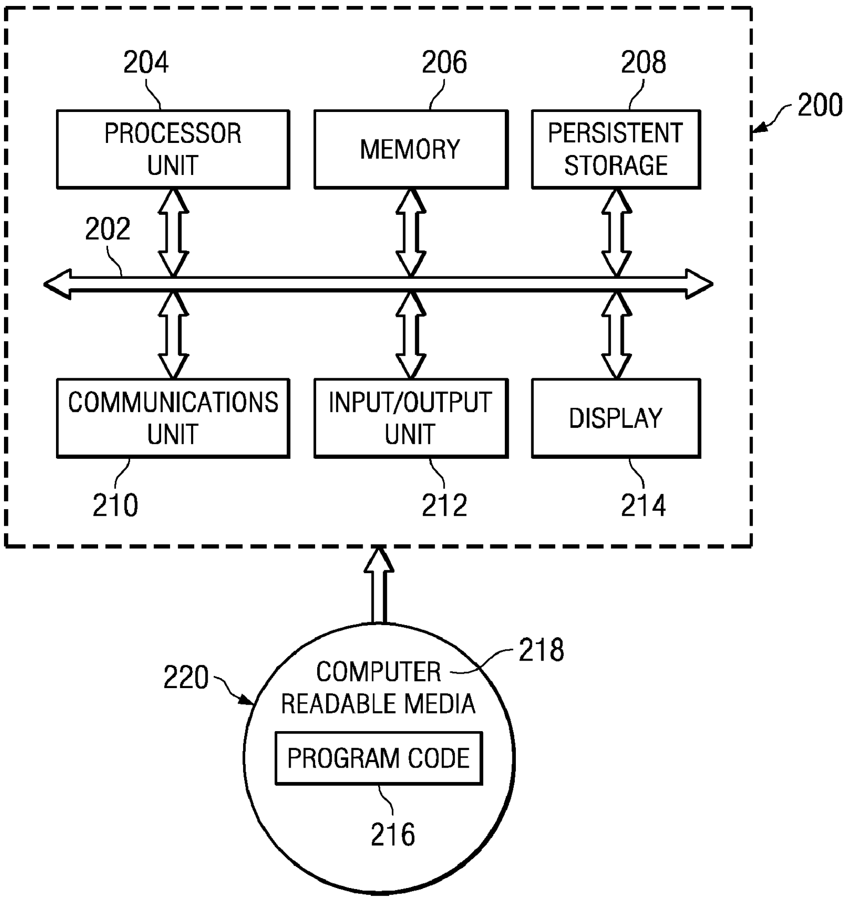

204
206
208
200
PROCESSOR UNIT
MEMORY
PERSISTENT STORAGE
202
COMMUNICATIONS UNIT
INPUT/OUTPUT UNIT
DISPLAY
210
212
214
220
COMPUTER READABLE MEDIA
218
PROGRAM CODE
216

FIG. 2

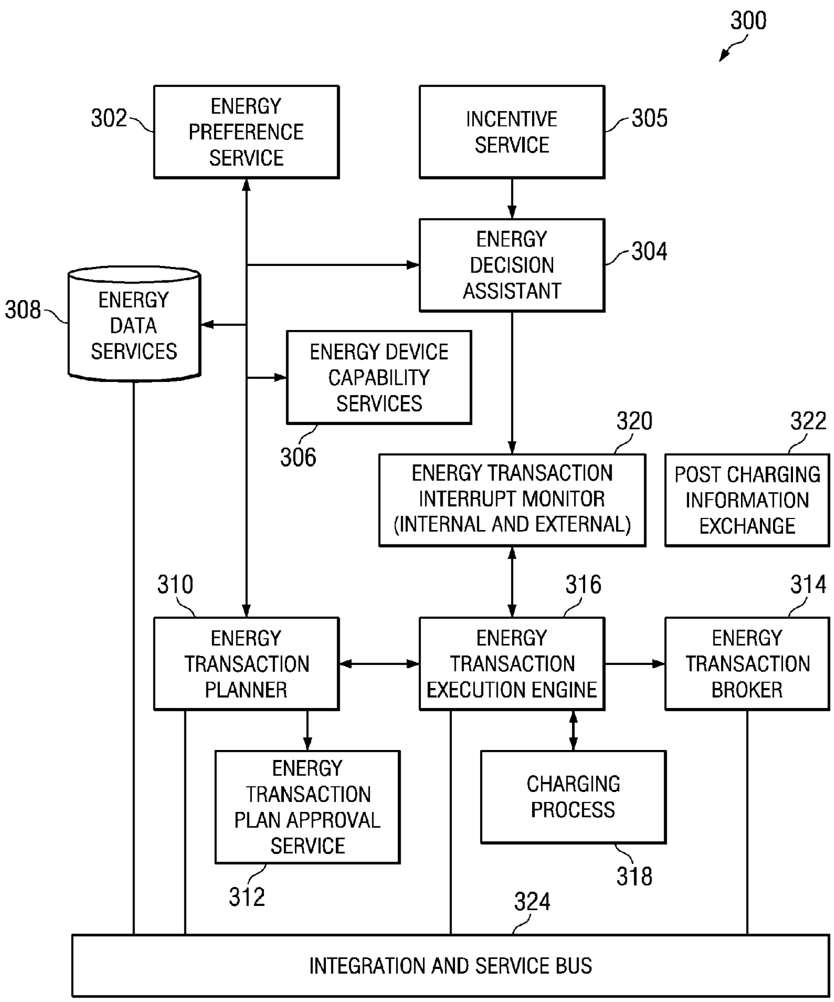

300
302
ENERGY PREFERENCE SERVICE
INCENTIVE SERVICE
305
ENERGY DECISION ASSISTANT
304
308
ENERGY DATA SERVICES
ENERGY DEVICE CAPABILITY SERVICES
306
320
322
ENERGY TRANSACTION INTERRUPT MONITOR (INTERNAL AND EXTERNAL)
POST CHARGING INFORMATION EXCHANGE
310
316
314
ENERGY TRANSACTION PLANNER
ENERGY TRANSACTION EXECUTION ENGINE
ENERGY TRANSACTION BROKER
ENERGY TRANSACTION PLAN APPROVAL SERVICE
CHARGING PROCESS
312
318
324
INTEGRATION AND SERVICE BUS

FIG. 3

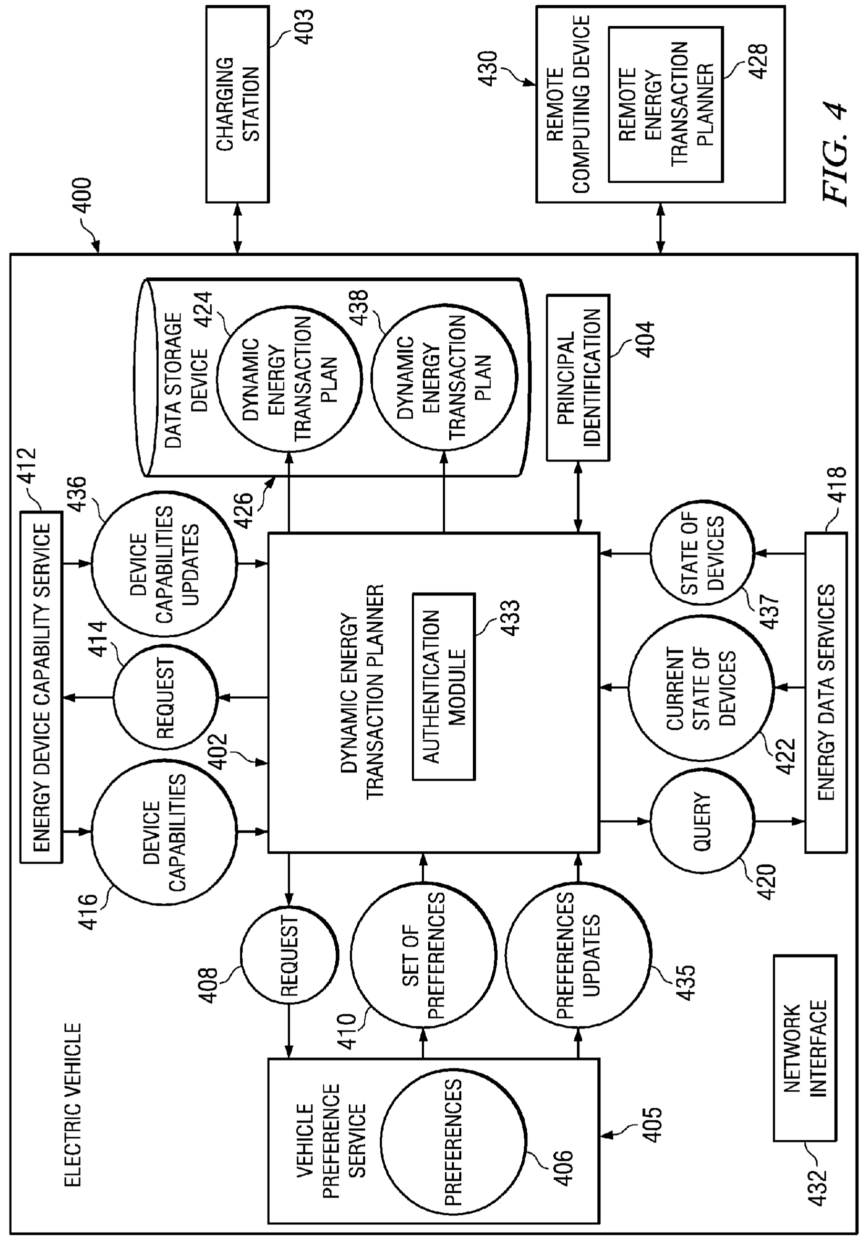

400
CHARGING STATION
403
REMOTE COMPUTING DEVICE
430
REMOTE ENERGY TRANSACTION PLANNER
428
ELECTRIC VEHICLE
ENERGY DEVICE CAPABILITY SERVICE
412
DEVICE CAPABILITIES UPDATES
436
REQUEST
414
DEVICE CAPABILITIES
416
402
426
DATA STORAGE DEVICE
DYNAMIC ENERGY TRANSACTION PLAN
424
DYNAMIC ENERGY TRANSACTION PLAN
438
PRINCIPAL IDENTIFICATION
404
DYNAMIC ENERGY TRANSACTION PLANNER
AUTHENTICATION MODULE
433
STATE OF DEVICES
437
CURRENT STATE OF DEVICES
422
QUERY
420
ENERGY DATA SERVICES
418
REQUEST
408
SET OF PREFERENCES
410
PREFERENCES UPDATES
435
VEHICLE PREFERENCE SERVICE
PREFERENCES
406
405
NETWORK INTERFACE
432

FIG. 4

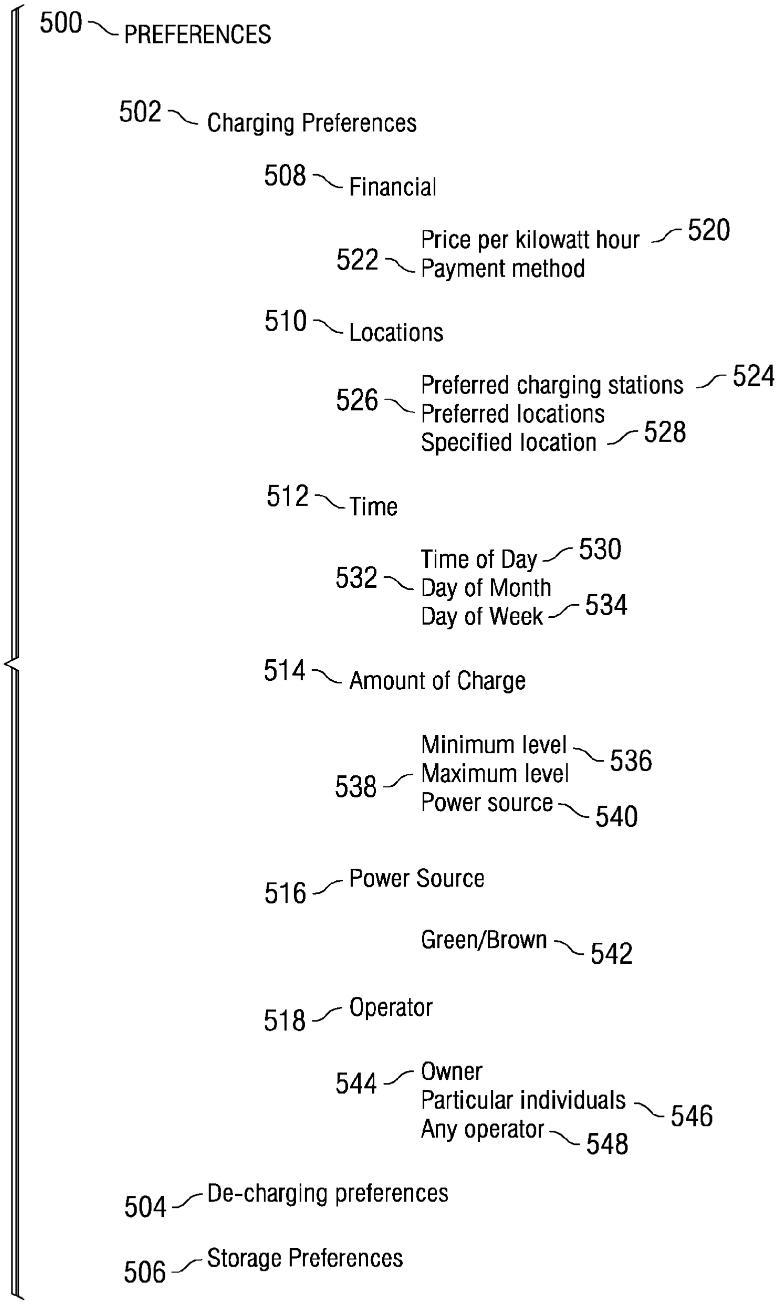

500 PREFERENCES
502 Charging Preferences
508 Financial
520 Price per kilowatt hour
522 Payment method
510 Locations
524 Preferred charging stations
526 Preferred locations
528 Specified location
512 Time
530 Time of Day
532 Day of Month
534 Day of Week
514 Amount of Charge
536 Minimum level
538 Maximum level
540 Power source
516 Power Source
542 Green/Brown
518 Operator
544 Owner
546 Particular individuals
548 Any operator
504 De-charging preferences
506 Storage Preferences

FIG. 5

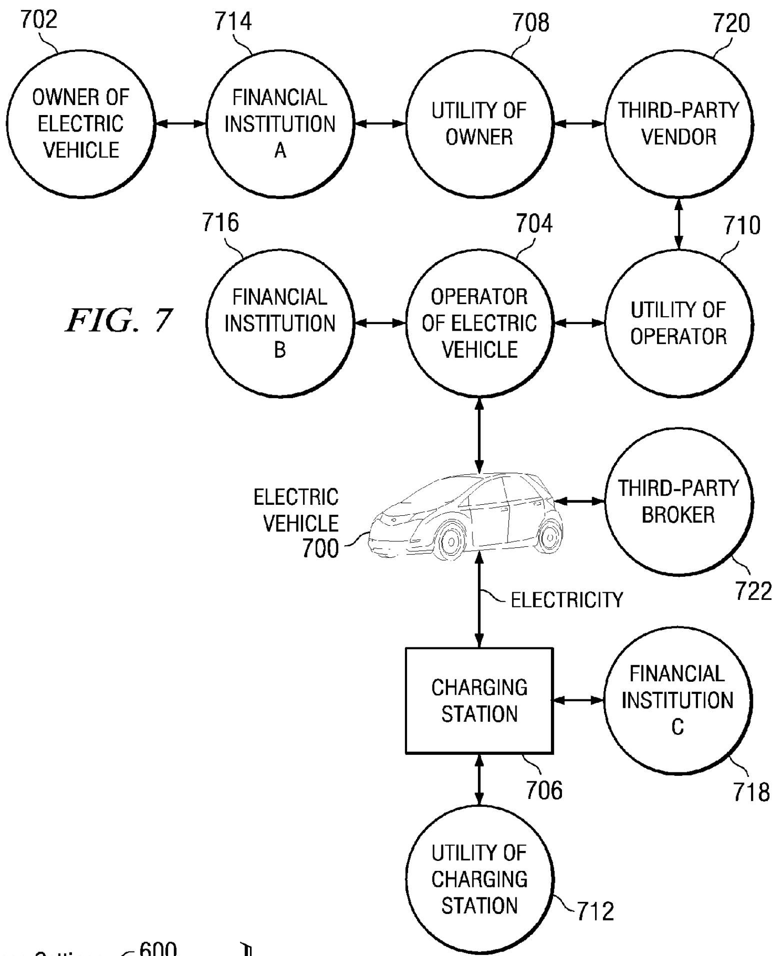

702
OWNER OF ELECTRIC VEHICLE
714
FINANCIAL INSTITUTION A
708
UTILITY OF OWNER
720
THIRD-PARTY VENDOR
716
FINANCIAL INSTITUTION B
704
OPERATOR OF ELECTRIC VEHICLE
710
UTILITY OF OPERATOR
ELECTRIC VEHICLE
700
THIRD-PARTY BROKER
722
ELECTRICITY
CHARGING STATION
706
FINANCIAL INSTITUTION C
718
UTILITY OF CHARGING STATION
712

FIG. 7

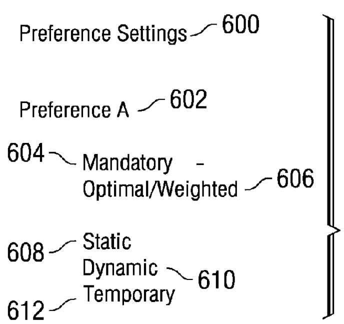

Preference Settings 600
Preference A 602
604 Mandatory -
Optimal/Weighted 606
608 Static
Dynamic 610
612 Temporary

FIG. 6

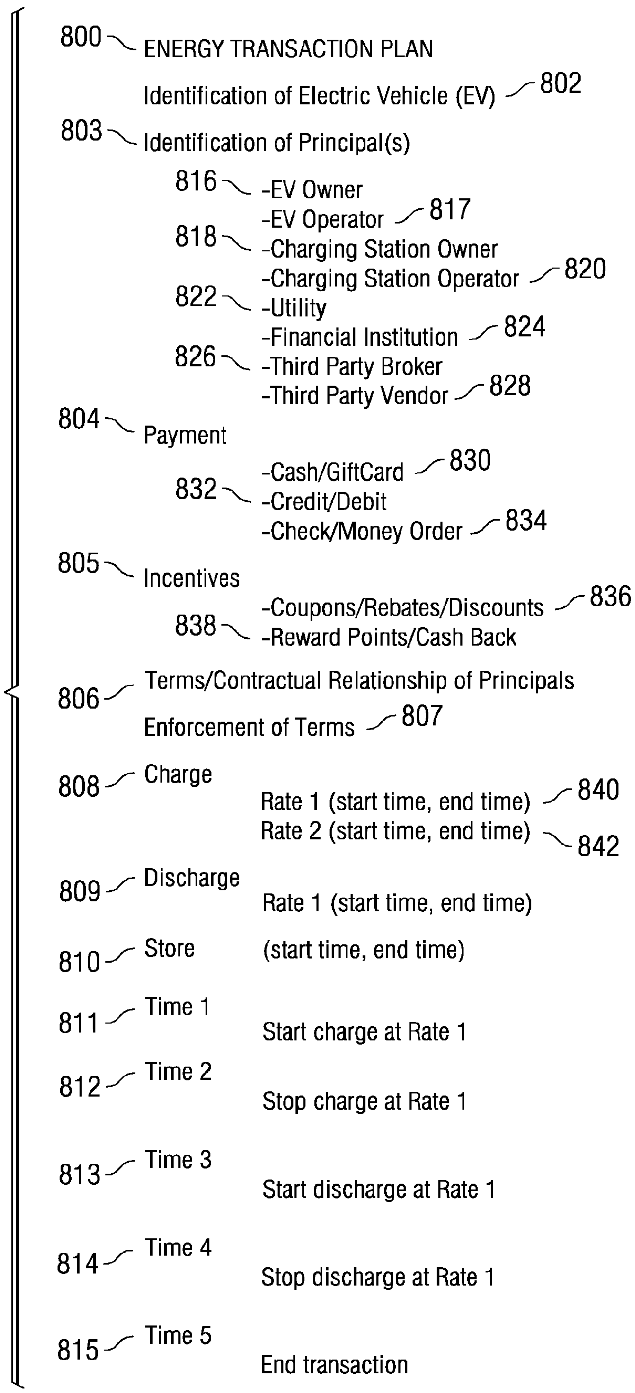

800
ENERGY TRANSACTION PLAN
Identification of Electric Vehicle (EV)
802
803
Identification of Principal(s)
816
-EV Owner
-EV Operator
817
818
-Charging Station Owner
-Charging Station Operator
820
822
-Utility
-Financial Institution
824
826
-Third Party Broker
-Third Party Vendor
828
804
Payment
-Cash/GiftCard
830
832
-Credit/Debit
-Check/Money Order
834
805
Incentives
-Coupons/Rebates/Discounts
836
838
-Reward Points/Cash Back
806
Terms/Contractual Relationship of Principals
Enforcement of Terms
807
808
Charge
Rate 1 (start time, end time)
840
Rate 2 (start time, end time)
842
809
Discharge
Rate 1 (start time, end time)
810
Store
(start time, end time)
811
Time 1
Start charge at Rate 1
812
Time 2
Stop charge at Rate 1
813
Time 3
Start discharge at Rate 1
814
Time 4
Stop discharge at Rate 1
815
Time 5
End transaction

FIG. 8

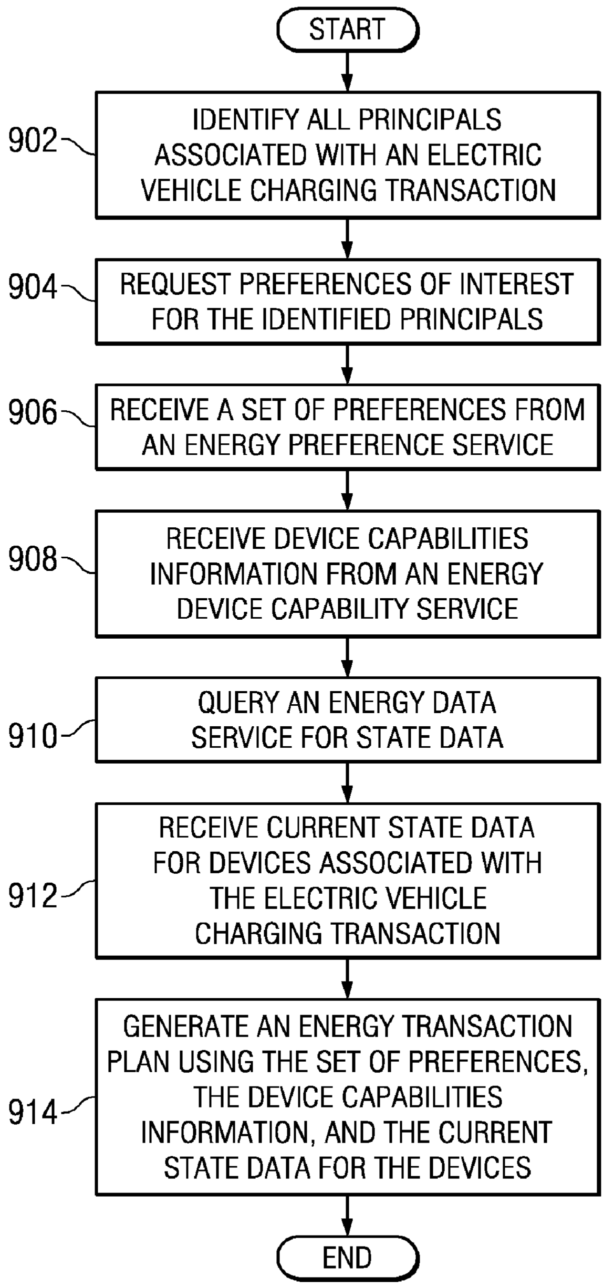

START
902
IDENTIFY ALL PRINCIPALS ASSOCIATED WITH AN ELECTRIC VEHICLE CHARGING TRANSACTION
904
REQUEST PREFERENCES OF INTEREST FOR THE IDENTIFIED PRINCIPALS
906
RECEIVE A SET OF PREFERENCES FROM AN ENERGY PREFERENCE SERVICE
908
RECEIVE DEVICE CAPABILITIES INFORMATION FROM AN ENERGY DEVICE CAPABILITY SERVICE
910
QUERY AN ENERGY DATA SERVICE FOR STATE DATA
912
RECEIVE CURRENT STATE DATA FOR DEVICES ASSOCIATED WITH THE ELECTRIC VEHICLE CHARGING TRANSACTION
914
GENERATE AN ENERGY TRANSACTION PLAN USING THE SET OF PREFERENCES, THE DEVICE CAPABILITIES INFORMATION, AND THE CURRENT STATE DATA FOR THE DEVICES
END

FIG. 9

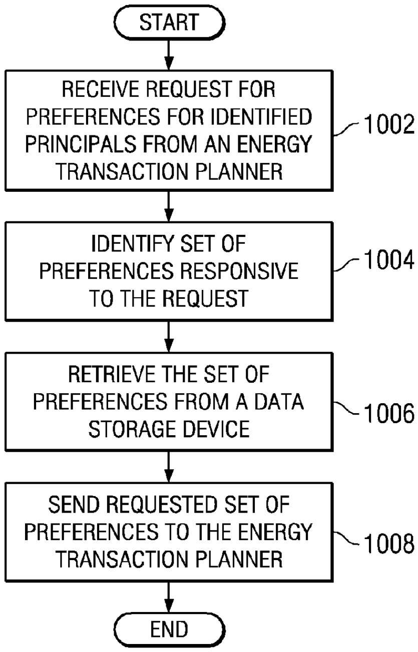

START
RECEIVE REQUEST FOR PREFERENCES FOR IDENTIFIED PRINCIPALS FROM AN ENERGY TRANSACTION PLANNER
1002
IDENTIFY SET OF PREFERENCES RESPONSIVE TO THE REQUEST
1004
RETRIEVE THE SET OF PREFERENCES FROM A DATA STORAGE DEVICE
1006
SEND REQUESTED SET OF PREFERENCES TO THE ENERGY TRANSACTION PLANNER
1008
END

FIG. 10

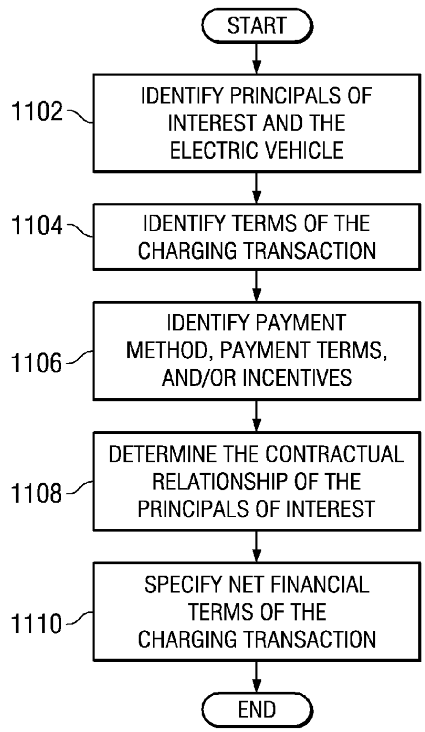

START
IDENTIFY PRINCIPALS OF INTEREST AND THE ELECTRIC VEHICLE
1102
IDENTIFY TERMS OF THE CHARGING TRANSACTION
1104
IDENTIFY PAYMENT METHOD, PAYMENT TERMS, AND/OR INCENTIVES
1106
DETERMINE THE CONTRACTUAL RELATIONSHIP OF THE PRINCIPALS OF INTEREST
1108
SPECIFY NET FINANCIAL TERMS OF THE CHARGING TRANSACTION
1110
END

FIG. 11

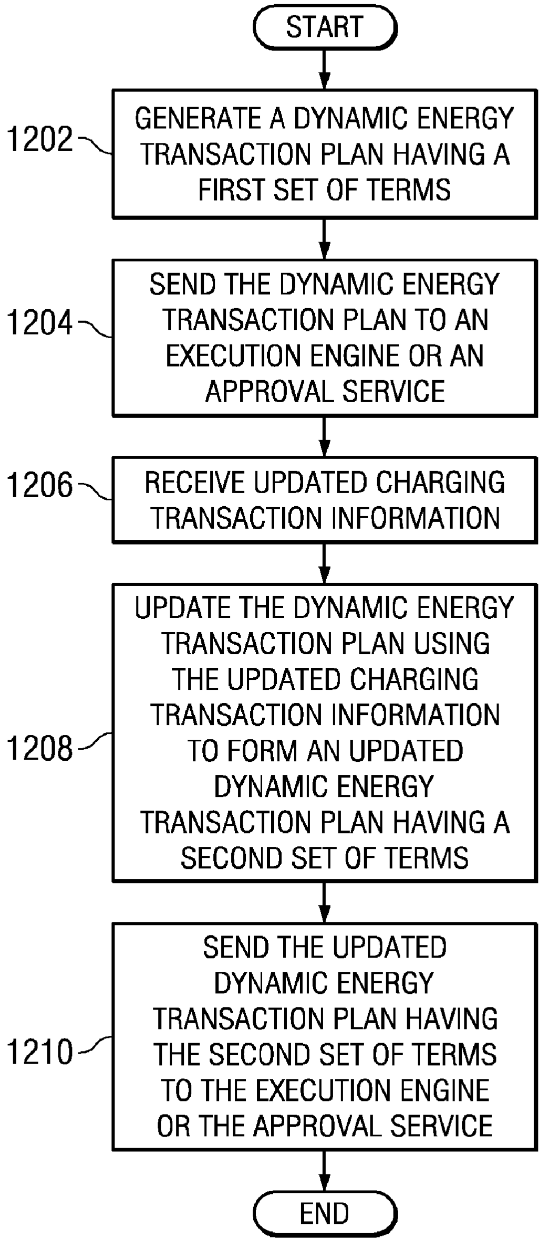

START
1202
GENERATE A DYNAMIC ENERGY TRANSACTION PLAN HAVING A FIRST SET OF TERMS
1204
SEND THE DYNAMIC ENERGY TRANSACTION PLAN TO AN EXECUTION ENGINE OR AN APPROVAL SERVICE
1206
RECEIVE UPDATED CHARGING TRANSACTION INFORMATION
1208
UPDATE THE DYNAMIC ENERGY TRANSACTION PLAN USING THE UPDATED CHARGING TRANSACTION INFORMATION TO FORM AN UPDATED DYNAMIC ENERGY TRANSACTION PLAN HAVING A SECOND SET OF TERMS
1210
SEND THE UPDATED DYNAMIC ENERGY TRANSACTION PLAN HAVING THE SECOND SET OF TERMS TO THE EXECUTION ENGINE OR THE APPROVAL SERVICE
END

FIG. 12

GENERATING DYNAMIC ENERGY TRANSACTION PLANS

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention is related generally to an improved data processing system, and in particular, to a method and apparatus for managing electric vehicle charging transactions. More particularly, the present invention is directed to a computer implemented method, apparatus, and computer usable program code for generating dynamic energy transaction plans for controlling charging an electric vehicle, de-charging the electric vehicle, and/or storing of electric power in an electric vehicle in real-time during an electric vehicle charging transaction.

[0003] 2. Description of the Related Art

[0004] Electric vehicles (EV) can be divided into two categories: totally electric vehicles (TEV) and plug-in hybrid electric vehicles (PHEV). Plug-in hybrid vehicles utilize two or more power sources to drive the vehicle. With the increasing costs of fossil fuels and concern over reliance on non-renewable resources, electric vehicles are poised to become a critical component of transportation systems throughout the world. Gasoline powered vehicles utilize the explosive power of a mixture of gasoline and air to propel the vehicle. In contrast, electric vehicles rely in whole or in part on electric power to drive the vehicle.

[0005] Electric vehicles contain electric storage mechanisms, such as batteries, to store electricity until it is needed to power the electric vehicle. The electric storage mechanisms require periodic charging to replenish the electric charge for continued operation. The electricity used to charge the electric storage mechanisms may be provided by any type of on-vehicle power generation and charging mechanism. The on-vehicle power generation and charging mechanisms may include consumptive power generation systems and/or non-consumptive power generation systems, such as, without limitation, fuel cells, gasoline powered combustion engines, bio-diesel powered engines, solar powered generators and regenerative braking systems.

[0006] In totally electric vehicles and plug-in hybrid electric vehicles, charging of the electric vehicles can also be accomplished by plugging the electric vehicle into an off-vehicle charging station. The off-vehicle charging station provides an external source of electricity, such as, an electric power grid. Totally electric vehicles require this type of off-vehicle charging in all cases. Off-vehicle charging is also likely to be significantly less expensive for plug-in hybrid electric vehicles than on-vehicle charging given currently available technology. Consequently off-vehicle charging may be the preferred charging mode for electric vehicle owners.

[0007] The power stored in the electric storage mechanisms on the electric vehicles and on-vehicle power generation mechanisms may be used to provide electricity back to the electricity grid. For electric vehicles to be used as suppliers of electric power to an electric power grid, electric vehicles are connected to an off-vehicle infrastructure which can efficiently consume the electricity generated or stored by the electric vehicle. To date, electric vehicle manufacturers and electric utility companies have only planned and provided infrastructure and methods for the most rudimentary charging scenario in which the electric vehicle is plugged into a common electric outlet.

BRIEF SUMMARY OF THE INVENTION

[0008] According to one embodiment of the present invention, a computer implemented method, apparatus, and computer program product for generating a dynamic energy transaction plan to manage an electric vehicle charging transaction is provided. The dynamic energy transaction planner generates a dynamic energy transaction plan based on the charging transaction information. The dynamic energy transaction plan comprises an identification of the electric vehicle, an identification of a principal in the set of principals to pay for the charging transaction, an identification of at least one utility associated with the charging transaction, an owner of the charging station, and a first set of terms of the charging transaction. An initial portion of the charging transaction is controlled in accordance with the first set of terms of the dynamic energy transaction plan. The dynamic energy transaction planner receives updated charging transaction information during execution of the charging transaction; and updates the dynamic energy transaction plan based on the updated charging transaction information to form an updated dynamic energy transaction plan. The updated dynamic energy transaction plan comprises a second set of terms. A second portion of the charging transaction is implemented in accordance with the second set of terms in the updated dynamic energy transaction plan.

[0009] In one embodiment, the updated charging transaction information is a first updated charging transaction information. The dynamic energy transaction planner receives a next set of updated charging transaction information during execution of the charging transaction. The dynamic energy transaction planner updates the updated dynamic energy transaction plan with a new set of terms based on the next set of updated charging transaction information. A portion of a remainder of the charging transaction is implemented in accordance with the new set of terms in the updated dynamic energy transaction plan. The dynamic energy transaction planner iteratively receives updated charging transaction information and updates the updated dynamic energy transaction plan with a new set of terms based on a most recently received updated charging transaction information until the electric vehicle charging transaction is complete.

[0010] The charging transaction information may include, without limitation, a set of preferences for the set of principals, charging transaction information, and/or device capabilities information. The set of preferences comprises a subset of preferences for each principal in the set of principals. A preference in the set of preferences specifies a parameter of the charging transaction that is to be minimized, maximized, or optimized. The charging transaction information comprises current state information describing a current state of one or more devices associated with the electric vehicle and the charging station. The device capabilities information describes the capabilities of devices associated with at least one of the electric vehicle and the charging station.

[0011] In another embodiment, the dynamic energy transaction planner generates a static energy transaction plan and completes the charging transaction in accordance with the static energy transaction plan. The terms of the static charging transaction plan controls a remainder of the charging transaction without regard to updates or changes to the charging transaction information.

[0012] In yet another embodiment, a computer implemented method for generating a dynamic energy transaction plan for governing an electric vehicle charging transaction is provided. A dynamic energy transaction planner receives an updated set of charging transaction information from a set of charging transaction information sources. The set of charging transaction information sources comprises an energy preference service. The updated set of charging transaction information comprises an updated set of preferences for a set of principals associated with the electric vehicle charging transaction. The dynamic energy transaction planner retrieves an original energy transaction plan having a first set of terms. The original energy transaction plan is being utilized to control the electric vehicle charging transaction. The dynamic energy transaction planner modifies the original energy transaction plan using the updated set of charging transaction information to form an updated energy transaction plan. The updated energy transaction plan comprises a second set of terms. The dynamic energy transaction planner sends the updated energy transaction plan to the execution engine, wherein the original energy transaction plan is disregarded and the updated energy transaction plan is utilized to control a remaining portion of the electric vehicle charging transaction.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0013] FIG. **1** is a block diagram of a network of data processing systems in which illustrative embodiments may be implemented;

[0014] FIG. **2** is a block diagram of a data processing system in which illustrative embodiments may be implemented;

[0015] FIG. **3** is a block diagram of an energy transaction infrastructure in accordance with an illustrative embodiment;

[0016] FIG. **4** is a block diagram of a dynamic energy transaction planner on-board an electric vehicle in accordance with an illustrative embodiment;

[0017] FIG. **5** is a block diagram of electric vehicle charging preferences in accordance with an illustrative embodiment;

[0018] FIG. **6** is a block diagram of preference settings in accordance with an illustrative embodiment;

[0019] FIG. **7** is a block diagram of parties to an electric vehicle charging transaction in accordance with an illustrative embodiment;

[0020] FIG. **8** is a block diagram of a set of fields in a dynamic energy transaction plan in accordance with an illustrative embodiment;

[0021] FIG. **9** is flowchart illustrating a process for generating a first set of terms for a dynamic energy transaction plan in accordance with an illustrative embodiment;

[0022] FIG. **10** is a flowchart illustrating a process for requesting preferences from an energy preference service in accordance with an illustrative embodiment;

[0023] FIG. **11** is a flowchart illustrating a process for identifying terms of a charging transaction for utilization in generating a dynamic energy transaction plan in accordance with an illustrative embodiment; and

[0024] FIG. **12** is a flowchart illustrating a process for generating an updated dynamic energy transaction plan in accordance with an illustrative embodiment.

DETAILED DESCRIPTION OF THE INVENTION

[0025] As will be appreciated by one skilled in the art, the present invention may be embodied as a system, method, or computer program product. Accordingly, the present invention may take the form of an entirely hardware embodiment, an entirely software embodiment (including firmware, resident software, micro-code, etc.) or an embodiment combining software and hardware aspects that may all generally be referred to herein as a "circuit," "module" or "system." Furthermore, the present invention may take the form of a computer program product embodied in any tangible medium of expression having computer-usable program code embodied in the medium.

[0026] Any combination of one or more computer-usable or computer-readable medium(s) may be utilized. The computer-usable or computer-readable medium may be, for example but not limited to, an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus, device, or propagation medium. More specific examples (a non-exhaustive list) of the computer-readable medium would include the following: an electrical connection having one or more wires, a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or Flash memory), an optical fiber, a portable compact disc read-only memory (CDROM), an optical storage device, a transmission media such as those supporting the Internet or an intranet, or a magnetic storage device. Note that the computer-usable or computer-readable medium could even be paper or another suitable medium upon which the program is printed, as the program can be electronically captured, via, for instance, optical scanning of the paper or other medium, then compiled, interpreted, or otherwise processed in a suitable manner, if necessary, and then stored in a computer memory. In the context of this document, a computer-usable or computer-readable medium may be any medium that can contain, store, communicate, propagate, or transport the program for use by or in connection with the instruction execution system, apparatus, or device. The computer-usable medium may include a propagated data signal with the computer-usable program code embodied therewith, either in baseband or as part of a carrier wave. The computer-usable program code may be transmitted using any appropriate medium, including but not limited to wireless, wired, wireline, optical fiber cable, RF, etc.

[0027] Computer program code for carrying out operations of the present invention may be written in any combination of one or more programming languages, including an object oriented programming language such as Java, Smalltalk, C++ or the like and conventional procedural programming languages, such as the "C" programming language or similar programming languages. The program code may execute entirely on the user's computer, partly on the user's computer, as a stand-alone software package, partly on the user's computer and partly on a remote computer or entirely on the remote computer or server. In the latter scenario, the remote computer may be connected to the user's computer through any type of network, including a local area network (LAN) or a wide area network (WAN), or the connection may be made to an external computer (for example, through the Internet using an Internet Service Provider).

[0028] The present invention is described below with reference to flowchart illustrations and/or block diagrams of methods, apparatus (systems) and computer program products according to embodiments of the invention. It will be understood that each block of the flowchart illustrations and/or block diagrams, and combinations of blocks in the flowchart illustrations and/or block diagrams, can be implemented by computer program instructions.

[0029] These computer program instructions may be provided to a processor of a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions, which execute via the processor of the computer or other programmable data processing apparatus, create means for implementing the functions/acts specified in the flowchart and/or block diagram block or blocks. These computer program instructions may also be stored in a computer-readable medium that can direct a computer or other programmable data processing apparatus to function in a particular manner, such that the instructions stored in the computer-readable medium produce an article of manufacture including instruction means which implement the function/act specified in the flowchart and/or block diagram block or blocks.

[0030] The computer program instructions may also be loaded onto a computer or other programmable data processing apparatus to cause a series of operational steps to be performed on the computer or other programmable apparatus to produce a computer implemented process such that the instructions which execute on the computer or other programmable apparatus provide processes for implementing the functions/acts specified in the flowchart and/or block diagram block or blocks.

[0031] With reference now to the figures, and in particular, with reference to FIGS. **1-2**, exemplary diagrams of data processing environments are provided in which illustrative embodiments may be implemented. It should be appreciated that FIGS. **1-2** are only exemplary and are not intended to assert or imply any limitation with regard to the environments in which different embodiments may be implemented. Many modifications to the depicted environments may be made.

[0032] FIG. **1** depicts a pictorial representation of a network of data processing system in which illustrative embodiments may be implemented. Network data processing system **100** is a network of computers in which the illustrative embodiments may be implemented. Network data processing system **100** contains network **102**, which is the medium used to provide communications links between various devices and computers connected together within network data processing system **100**. Network **102** may include connections, such as wire, wireless communication links, or fiber optic cables.

[0033] In the depicted example, server **104** and server **106** connect to network **102** along with storage unit **108**. In addition, clients **110**, **112**, and **114** connect to network **102**. Clients **110**, **112**, and **114** may be, for example, personal computers or network computers. In the depicted example, server **104** provides data, such as boot files, operating system images, and applications to clients **110**, **112**, and **114**. Clients **110**, **112**, and **114** are clients to server **104** in this example. Network data processing system **100** may include additional servers, clients, and other devices not shown.

[0034] Electric vehicle **116** is any vehicle that utilizes electric power in whole or in part to drive the vehicle that is capable of being plugged into charging station **118**. Electric vehicle **116** may be a totally electric vehicle or a plug-in hybrid electric vehicle. The plug-in electric hybrid vehicle may be a gasoline/electric hybrid, a natural gas/electric hybrid, a diesel/electric hybrid, a biodiesel/electric hybrid, or any other type of plug-in electric hybrid. Electric vehicle **116** may optionally include an on-vehicle power generation mechanism such as, but without limitation, solar power electric generators, gasoline powered electric generators, biodiesel powered electric generator, or any other type of on-vehicle electric power generation mechanism.

[0035] Charging station **118** is any station, kiosk, garage, power outlet, or other facility for providing electricity to electric vehicle **116**. Electric vehicle **116** receives electricity from, or provides electricity to, an electric grid at charging station **118**. In other words, electric charge may flow from an electric grid through charging station **118** to electric vehicle **116** or the electric charge may flow from electric vehicle **116** back into the electric grid through charging station **118**. Charging station **118** is a selected charge/discharge site, such as an outlet or kiosk, for providing electric vehicle **116** with access to the electric grid. For example, and without limitation, charging station **118** may be a power outlet in a privately owned garage, an electric outlet in a docking station in a commercially owned electric vehicle charging kiosk, or a power outlet in a commercially owned garage.

[0036] Electric vehicle **116** connects to charging station **118** via an electrical outlet or other electricity transfer mechanism. The electricity may also be optionally transferred via wireless energy transfer, also referred to as wireless power transfer, in which electrical energy is transferred to a load, such as electric vehicle **116**, without interconnecting wires. The electricity may flow from charging station **118** into electric vehicle to charge electric vehicle **116**. The electricity may also flow from electric vehicle **116** into charging station **118** to sell electricity back to the power grid.

[0037] Electric vehicle **116** and charging station **118** are optionally connected to network **102**. Electric vehicle **116** and charging station **118** send and receive data associated with the charging of electric vehicle, the capabilities of electric vehicle, the capabilities of charging station **118**, the current charge stored in electric vehicle, the rate of charging electric vehicle, the price of electricity received from a power grid, identity of the owner and/or operator of electric vehicle **116** and/or any other data relevant to charging or de-charging electric vehicle **116** over network **102**.

[0038] In the depicted example, network data processing system **100** is the Internet with network **102** representing a worldwide collection of networks and gateways that use the Transmission Control Protocol/Internet Protocol (TCP/IP) suite of protocols to communicate with one another. At the heart of the Internet is a backbone of high-speed data communication lines between major nodes or host computers, consisting of thousands of commercial, governmental, educational and other computer systems that route data and messages. Of course, network data processing system **100** also may be implemented as a number of different types of networks, such as for example, an intranet, a local area network (LAN), or a wide area network (WAN). FIG. **1** is intended as an example, and not as an architectural limitation for the different illustrative embodiments.

[0039] With reference now to FIG. **2**, a block diagram of a data processing system is shown in which illustrative embodiments may be implemented. Data processing system **200** is an example of a computer, such as server **104** or client **110** in FIG. **1**, in which computer-usable program code or instructions implementing the processes may be located for the illustrative embodiments. Data processing system **200** may also be implemented as a computing device on-board an electric vehicle, such as electric vehicle **116** in FIG. **1**.

[0040] In this illustrative example, data processing system **200** includes communications fabric **202**, which provides communications between processor unit **204**, memory **206**, persistent storage **208**, communications unit **210**, input/output (I/O) unit **212**, and display **214**. Processor unit **204** serves to execute instructions for software that may be loaded into memory **206**. Processor unit **204** may be a set of one or more processors or may be a multi-processor core, depending on the particular implementation. Further, processor unit **204** may be implemented using one or more heterogeneous processor systems in which a main processor is present with secondary processors on a single chip. As another illustrative example, processor unit **204** may be a symmetric multi-processor system containing multiple processors of the same type.

[0041] Memory **206**, in these examples, may be, for example, a random access memory or any other suitable volatile or non-volatile storage device. Persistent storage **208** may take various forms depending on the particular implementation. For example, persistent storage **208** may contain one or more components or devices. In another example, persistent storage **208** may be a hard drive, a flash memory, a rewritable optical disk, a rewritable magnetic tape, or some combination of the above. The media used by persistent storage **208** also may be removable. For example, a removable hard drive may be used for persistent storage **208**.

[0042] Communications unit **210**, in these examples, provides for communications with other data processing systems or devices. In these examples, communications unit **210** is a network interface card. Communications unit **210** may provide communications through the use of either or both physical and wireless communications links.

[0043] Input/output unit **212** allows for input and output of data with other devices that may be connected to data processing system **200**. For example, input/output unit **212** may provide a connection for user input through a keyboard and mouse. Further, input/output unit **212** may send output to a printer. Display **214** provides a mechanism to display information to a user.

[0044] Instructions for the operating system and applications or programs are located on persistent storage **208**. These instructions may be loaded into memory **206** for execution by processor unit **204**. The processes of the different embodiments may be performed by processor unit **204** using computer implemented instructions, which may be located in a memory, such as memory **206**. These instructions are referred to as program code, computer-usable program code, or computer-readable program code that may be read and executed by a processor in processor unit **204**. The program code in the different embodiments may be embodied on different physical or tangible computer-readable media, such as memory **206** or persistent storage **208**.

[0045] Program code **216** is located in a functional form on computer-readable media **218** that is selectively removable and may be loaded onto or transferred to data processing system **200** for execution by processor unit **204**. Program code **216** and computer-readable media **218** form computer program product **220** in these examples. In one example, computer-readable media **218** may be in a tangible form, such as, for example, an optical or magnetic disc that is inserted or placed into a drive or other device that is part of persistent storage **208** for transfer onto a storage device, such as a hard drive that is part of persistent storage **208**. In a tangible form, computer-readable media **218** also may take the form of a persistent storage, such as a hard drive, a thumb drive, or a flash memory that is connected to data processing system **200**. The tangible form of computer-readable media **218** is also referred to as computer-recordable storage media. In some instances, computer-recordable media **218** may not be removable.

[0046] Alternatively, program code **216** may be transferred to data processing system **200** from computer-readable media **218** through a communications link to communications unit **210** and/or through a connection to input/output unit **212**. The communications link and/or the connection may be physical or wireless in the illustrative examples. The computer-readable media also may take the form of non-tangible media, such as communications links or wireless transmissions containing the program code.

[0047] The different components illustrated for data processing system **200** are not meant to provide architectural limitations to the manner in which different embodiments may be implemented. The different illustrative embodiments may be implemented in a data processing system including components in addition to or in place of those illustrated for data processing system **200**. Other components shown in FIG. **2** can be varied from the illustrative examples shown.

[0048] As one example, a storage device in data processing system **200** is any hardware apparatus that may store data. Memory **206**, persistent storage **208**, and computer-readable media **218** are examples of storage devices in a tangible form.

[0049] In another example, a bus system may be used to implement communications fabric **202** and may be comprised of one or more buses, such as a system bus or an input/output bus. Of course, the bus system may be implemented using any suitable type of architecture that provides for a transfer of data between different components or devices attached to the bus system. Additionally, a communications unit may include one or more devices used to transmit and receive data, such as a modem or a network adapter. Further, a memory may be, for example, memory **206** or a cache such as found in an interface and memory controller hub that may be present in communications fabric **202**.

[0050] Currently, electric vehicle manufacturers and electric utility companies have only planned and provided infrastructure for the most rudimentary charging scenarios, such as, merely plugging the electric vehicle into a common electric outlet that is owned by the owner and operator of the electric vehicle. The illustrative embodiments recognize that charging electric vehicles will frequently be conducted under much broader and more complex sets of circumstances than this simple scenario and infrastructure is needed to accommodate these complex transactions. For example, owners and operators of electric vehicles will frequently be required to charge their electric vehicle at a charging station that is remote from the home of the electric vehicle owner. In most circumstances, it is unlikely that the electric vehicle owner will own the off-vehicle charging stations from which the owner obtains electricity to recharge the electric vehicle. In such a situation, the owner or operator of the electric vehicle will likely be required to pay for the charge obtained from the off-vehicle charging station.

[0051] The illustrative embodiments recognize that the charging transactions by which electric vehicles obtain electricity from an off-vehicle charging station to charge the electric vehicle requires a much more complete, flexible, and interoperable system governing all aspects of the charging transaction. Electric vehicle charging transactions can be divided into the pre-charge phase, the charge phase, and the post-charge phase. During the pre-charge phase of decision enablement, a charging plan is generated and all parties are presented with the conditions governing the charging transaction. During the charging phase, electricity flows to, from, or is stored in the electric vehicle. Finally, during the post-charge phase of the transaction, an analysis is performed to provide incentives and induce specific behaviors on the part of any party involved in the transaction. Additional charging infrastructure may also be provided to meter electricity at the point of charge, identify the various parties involved in the transaction, and provide flexible business rules governing the flow of funds between those parties.

[0052] FIG. **3** is a block diagram of an energy transaction infrastructure in accordance with an illustrative embodiment. Electric vehicle energy transaction infrastructure **300** is a charging infrastructure for managing all phases of an electric vehicle charging transaction. During the pre-charge phase, all parties of the transaction are presented with the conditions governing the charging transaction. The parties may include, without limitation, the owner of the electric vehicle to be charged, the operator of the electric vehicle, the owner of the charging station, and an electric utility company providing electricity to an electric power grid associated with the charging station. Parties agree to conditions relevant to their role in the transaction prior to the charge commencing. There are likely to be many special circumstances in the terms and conditions which are presented in standard formats which are universally understood and which can be readily communicated and agreed upon by all parties.

[0053] During the pre-charge phase, electric vehicle energy transaction infrastructure **300** utilizes energy preference service **302**, energy decision assistant **304**, energy device capability services **306**, energy data services **308**, dynamic energy transaction planner **310**, and optionally, dynamic energy transaction plan approval service **312** to generate a plan governing the charging transaction to the parties involved in the transaction.

[0054] Energy preference service **302** is a software component that generates, stores, and retrieves preference information associated with an electric vehicle and the preference information associated with the parties to the transaction. Preferences may include, without limitation, a maximum price per kilowatt hour of electricity to be paid by a party, a location where charging may occur, a location where charging may not occur, a rate of charging the electric vehicle, a minimum amount of charge, or any other preferences associated with charging an electric vehicle. The preferences may be pre-generated by one or more of the parties to the transaction.

[0055] Energy decision assistant **304** is an optional service that provides real-time options and trade-offs for a particular trip. For example, energy decision assistant **304** may monitor available incentives, weather conditions, a travel route, traffic information, and other real-time data to identify the best electric vehicle charging options for a particular trip.

[0056] Incentive service **305** receives offers of incentives from third party vendors. The incentives may be offers of discounts, rebates, rewards, and/or other incentives associated with charging an electric vehicle to encourage an operator of the electric vehicle to perform one or more behaviors associated with charging the electric vehicle. For example, and without limitation, an incentive may offer to charge the electric vehicle for free at a particular charging station if the owner or operator of the electric vehicle purchases one or more products from the third party vendor. Incentives service **305** provides information describing current incentives to dynamic energy transaction planner **310**. In one embodiment, incentives service **305** provides the information describing the incentives to energy decision assistant **304**. Energy decision assistant **304** then provides the incentives information to dynamic energy transaction planner **310**.

[0057] Energy device capability service **306** is a software component that identifies and validates device capabilities. For example, and without limitation, energy device capability service **306** may include information describing the charging capabilities of the charging station, the charging requirements of the electric vehicle, the maximum storage capacity of the electric vehicle on-vehicle storage mechanisms, the existing amount of charge in the electric vehicle, the number of amps of electricity the charging station is capable of providing, and any other information associated with the capabilities and requirements of the electric vehicles and the charging station.

[0058] Energy data services **308** are a set of one or more third party data sources providing information relevant to the energy transaction. Energy data services **308** may include, without limitation, weather information sources, traffic information sources, map and travel information sources, charging station price information sources, or any other third party information sources.

[0059] Dynamic energy transaction planner **310** is an application that creates a transaction plan for governing electric vehicle charging transactions based on preferences of one or more principals. Dynamic energy transaction plan approval service **312** approves the transaction plan and validates with energy transaction broker **314**. Dynamic energy transaction plan approval service **312** may be required to notify one or more parties of the terms of the transaction and obtain approval of one or more of the terms from the party. For example, and without limitation, if an operator of the electric vehicle is not the owner of the electric vehicle, dynamic energy transaction plan approval service **312** may require approval from the owner of the vehicle before allowing the vehicle to receive power at a charging station if the charging station and/or a utility will charge the owner of the electric vehicle a fee for the charging transaction.

[0060] In this example, the charging phase begins when energy transaction execution engine **316** sends the transaction plan generated by dynamic energy transaction planner **310** for approval by dynamic energy transaction plan approval service **312**, initiates the request to begin charging the electric vehicle, monitors and logs the health and safety of charging process **318**, and receives requests from energy transaction interrupt monitor **320**. During charging process **318**, electricity flows into the electric vehicle or out of the electric vehicle and back into the power grid. Energy transaction interrupt monitor **320** monitors data transmissions to detect interrupt conditions that may terminate the flow of electric power to or from a vehicle. The interrupts may originate from the power grid, suppliers, and/or vehicles. For example, if a price of energy exceeds a predefined threshold in violation of a user-selected preference, energy transaction interrupt monitor **320** detects this interrupt condition and initiates appropriate actions to handle the cessation of electric power flow to the electric vehicle.

[0061] Energy transaction broker **314** supports settling an electric vehicle charging and discharge transaction independent of electricity supplier, parking space supplier, electrical infrastructure supplier, taxing authority, incentive provider, or other interested party. Elements include pricing schedules, time based pricing, facility recovery, tax collection, incentives, and/or fixed plans. Energy transaction broker **314** may also be used by energy transaction approval service **312** to validate the financial elements of the dynamic energy transaction plan prior to plan approval and prior to charging the electric vehicle.

[0062] The post-charge phase comprises analysis of the completed energy transaction to provide incentives, redeem credits or benefits, and induce specific behaviors by one or more parties involved in the charging transaction. The post-charge phase also includes payment of the appropriate parties for the energy transaction in accordance with the dynamic energy transaction plan governing the transaction. Various programs may be available to incent specific behaviors on the part of consumers. For example, a vehicle owner or user may receive reduced electricity rates if vehicle charging is conducted during off-peak times, such as during the night rather than during daylight hours when electricity usage is higher. Post charging information exchange **322** accumulates data pertinent to these incentives or redemption programs, authenticates the incentives data, and analyzes the incentives data to identify the most effective business process and optimize incentives for the parties.

[0063] During this charging phase, payment or fees for the charge are also recorded. Operational and financial parameters are conveyed for an optimum charge to occur. For example, a dynamic representation of an electric vehicle capability to consume charge should be understood at all times during the charging process to ensure the vehicle is not damaged or that the protections of the charging system are preserved. Electricity metering of the power flow may also be conducted and reported. Standards representing the acceptable charging voltage and amperage ranges, for example may be communicated and maintained for a safe charging transaction to occur. All data pertinent to the financial transaction is conveyed and recorded.

[0064] The components shown in FIG. **3** may be implemented on a data processing system associated with an electric vehicle. In such case, the components communicate and transfer data using integration and service bus **324**. Integration and service bus **324** is an internal communication system within the electric vehicle, such as any wired or wireless communications system. A wired communications system includes, without limitation, a data bus or a universal serial bus (USB). If one or more components shown in FIG. **3** are located remotely, the components may transfer data using any type of wired or wireless network connection to connect to a network, such as network **102** in FIG. **1**. A wireless network connection may be implemented over a cell-phone network, satellite, two-way radio, WiFi networks, or any other type of wireless network.

[0065] Presently, current processes for charging electric vehicles involve connecting the electric vehicle directly to a conventional electrical outlet. These methods provide no mechanism for establishing and enforcing the terms surrounding the electric vehicle charging transaction. The embodiments recognize that these limited methods severely restrict the conditions under which an electric vehicle charge can occur. For example, charge/discharge outlet site owners, such as outlets at a charging station, will likely restrict access to charging station facilities if the owners are not assured of reimbursement for the electricity consumed by one or more electric vehicles.

[0066] According to one embodiment of the present invention, a computer implemented method, apparatus, and computer program product for generating a dynamic energy transaction plan to manage an electric vehicle charging transaction is provided. The dynamic energy transaction planner generates a dynamic energy transaction plan based on charging transaction information. The dynamic energy transaction plan comprises an identification of the electric vehicle, an identification of a principal in a set of principals to pay for the charging transaction, an identification of at least one utility associated with the charging transaction, an owner of the charging station, and a first set of terms of the charging transaction. A utility is an electric energy provider. An electric energy provider typically provides electric power to a charging station via an electric power grid. The set of principals is a set of one or more principals having an interest in the electric vehicle charging transaction. An initial portion of the charging transaction is controlled in accordance with the first set of terms of the dynamic energy transaction plan.

[0067] The dynamic energy transaction planner receives updated charging transaction information during execution of the charging transaction and updates the dynamic energy transaction plan based on the updated charging transaction information to form an updated dynamic energy transaction plan. The updated dynamic energy transaction plan comprises a second set of terms. A second portion of the charging transaction is implemented in accordance with the second set of terms in the updated dynamic energy transaction plan.

[0068] In one embodiment, the updated charging transaction information is a first set of updated charging transaction information. The dynamic energy transaction planner receives a next set of updated charging transaction information during execution of the charging transaction. The dynamic energy transaction planner updates the updated dynamic energy transaction plan with a new set of terms based on the next set of updated charging transaction information. A portion of a remainder of the charging transaction is implemented in accordance with the new set of terms in the updated dynamic energy transaction plan. In other words, the electric vehicle charging transaction continues under the terms of the updated dynamic energy transaction plan rather than the terms of the previous energy transaction plan. The dynamic energy transaction planner iteratively receives updated charging transaction information and updates the updated dynamic energy transaction plan with a new set of terms based on a most recently received updated charging transaction information until the electric vehicle charging transaction is complete.

[0069] The charging transaction information is information describing the set of principals, devices associated with the electric vehicle, devices associated with one or more charging stations, the preferences of the set of principals, and any other information relevant to the charging transaction. The charging transaction information may include requirements, constraints, and preferences applicable to the charging transaction. For example, the charging transaction information may include, without limitation, a set of preferences for the set of principals, information describing a current state of devices associated with the electric vehicle and/or the charging station, and/or information describing the capabilities of the devices associated with the electric vehicle and/or the charging station. The set of preferences comprises a subset of preferences for each principal in the set of principals. A preference in the set of preferences specifies a parameter of the charging transaction that is to be minimized, maximized, or optimized. The current state information may describe a current state of one or more devices associated with at least one electric vehicle and/or at least one charging station. The device capabilities information describes the capabilities of devices associated with at least one of the electric vehicle and/or at least one charging station.

[0070] The first set of terms comprises a first set of charging transaction time driven event sequences, and wherein the second set of terms comprises a second set of charging transaction time driven event sequences. Charging transaction time driven event sequences specifies charging, discharging, or storing of power at a given rate during a particular time interval. The time interval may be denoted by a start time and a stop time or by a length of time to continue charging, discharging, or storing. For example, the time interval may specify that charging is to occur from 1:00 to 2:00 or the time interval may specify the charging is to occur for one hour following a given event, such as, and without limitation, initiation of the electric vehicle charging transaction or the event of cessation of discharging power back to the electric grid.

[0071] In another embodiment, the dynamic energy transaction planner generates a static energy transaction plan and completes the charging transaction in accordance with the static energy transaction plan. The terms of the static charging transaction plan controls a remainder of the charging transaction without regard to updates or changes to the charging transaction information.

[0072] In yet another embodiment, a computer implemented method for generating a dynamic energy transaction plan for governing an electric vehicle charging transaction is provided. A dynamic energy transaction planner receives an updated set of charging transaction information from a set of charging transaction information sources. Charging transaction information is information relevant to charging the electric vehicle. The charging transaction information may include information associated with the electric vehicle device capabilities, the charging station device capabilities, the electric vehicle current state, the state of the charging station device, and preferences of the principals having an interest in the charging transaction.

[0073] In this example, the set of charging transaction information sources comprises an energy preference service. The updated set of charging transaction information comprises an updated set of preferences for a set of principals associated with the electric vehicle charging transaction. The dynamic energy transaction planner retrieves an original energy transaction plan having a first set of terms. The original energy transaction plan is being utilized to control the electric vehicle charging transaction. The dynamic energy transaction planner modifies the original energy transaction plan using the updated set of charging transaction information to form an updated energy transaction plan. The updated energy transaction plan comprises a second set of terms. The dynamic energy transaction planner sends the updated energy transaction plan to the execution engine, wherein the original energy transaction plan is disregarded and the updated energy transaction plan is utilized to control a remaining portion of the electric vehicle charging transaction.

[0074] An initial portion of the charging transaction is controlled in accordance with the first set of terms of the dynamic energy transaction plan. The dynamic energy transaction planner receives updated charging transaction information during execution of the charging transaction; and updates the dynamic energy transaction plan based on the updated charging transaction information to form an updated dynamic energy transaction plan. The updated dynamic energy transaction plan comprises a second set of terms. A second portion of the charging transaction is implemented in accordance with the second set of terms in the updated dynamic energy transaction plan.

[0075] This process of receiving updated charging transaction information and creating an updated dynamic energy transaction plan with different terms may be repeated multiple times during a single electric vehicle charging transaction. In other words, the energy transaction plan is dynamic and constantly updating to reflect changing conditions in real time as the electric vehicle is charging, discharging, or storing power in accordance with the terms of the energy transaction plan. The energy transaction plan may update a third time with a third set of terms, update a fourth time with a fourth set of terms, and so forth until the charging transaction is complete.

[0076] Turning now to FIG. **4**, a block diagram of a dynamic energy transaction planner on-board an electric vehicle is shown in accordance with an illustrative embodiment. Electric vehicle **400** is an electric vehicle that relies in whole or in part on electricity to drive the vehicle, such as, without limitation, electric vehicle **116** in FIG. **1**. Dynamic energy transaction planner **402** is a software component that creates a transaction plan for controlling a charging transaction for electric vehicle **400** coupled to charging station **403**, such as dynamic energy transaction planner **310** in FIG. **3**. Charging station **403** is a station or kiosk for permitting electric vehicle **400** to connect to an electric grid to charge or de-charge electric vehicle, such as charging station **118** in FIG. **1**.

[0077] A charging transaction is a transaction that involves at least one of charging the electric vehicle, storing electric power in an electric storage mechanism associated with the electric vehicle, and/or de-charging the electric vehicle. De-charging refers to removing or drawing electric power from electric vehicle **400** and returning the electric power to a power grid associated with charging station **403**. As used herein the phrase "at least one of" when used with a list of items means that different combinations of one or more of the items may be used and only one of each item in the list is needed.

[0078] For example, at least one of charging the electric vehicle, storing electric power in an electric storage mechanism, and de-charging the electric vehicle may include, for example and without limitation, only charging the electric vehicle or a combination of charging the electric vehicle and storing electric power in an electric storage mechanism associated with the electric vehicle. This example also may include a transaction that involves any combination of charging the electric vehicle, storing electric power in an electric storage mechanism associated with the electric vehicle, and de-charging the electric vehicle. In addition, the charging, storing, and de-charging may occur more than one time during a given charging transaction. For example, during a single transaction, the electric vehicle may be de-charged, then charged, used to store electric power in the electric storage mechanism for a given time, then de-charged for a second time, and after a given time period, the electric vehicle may be re-charged again. All these occurrences of charging, storing, and de-charging may occur in a single charging transaction or in a series of two or more charging transactions.

[0079] Dynamic energy transaction planner **402** gathers information from a variety of sources necessary for it to calculate and structure a complete dynamic energy transaction plan **424** in preparation for an energy transfer transaction to or from electric vehicle **400** and/or to or from the electric grid at a selected charge/discharge site, such as charging station **403**.

[0080] Dynamic energy transaction planner **402** requests an identification of all principals associated with a charging transaction from one or more components, such as principal identification **404**. Principal identification **404** is a component to identify one or more principals. A principal is any entity that may have an interest or role in the energy transaction, including but not limited to the vehicle operator, owner, charging kiosk, utilities associated with any or all of the other principals. The owner and operator of electric vehicle **400** may be the same person or the owner and operator of the vehicle may be different people. Principal identification **404** may include a badge reader, a radio frequency identification tag reader, a biometric device, a prompt requesting a password and/or user login, or any other type of identification mechanism. The biometric device may include, without limitation, a fingerprint scanner, a thumbprint scanner, a palm scanner, a voice print analysis tool, a retina scanner, an iris scanner, a device for reading deoxyribonucleic acid (DNA) patterns of the user, or any other type of biometric identification device.

[0081] Likewise, the identification of the user may include, without limitation, a user name, a password, a personal identification (PIN) number, an identifier, a fingerprint, a thumbprint, a retinal scan, an iris scan, or any other type of identification. The identification is associated with the set of preferences to map the set of preferences with the identification of the user that created the set of preferences. In another embodiment, security authentication, authorization, and/or identification information for the principal's identity may also be provided. The identification of an operator of electric vehicle **400** may also be accomplished via the driver preference settings available on electric vehicle **400**.

[0082] Principal identification **404** may also authenticate users of vehicle preference service **405** that requests input/access to vehicle preference service **405** to create, update, modify, delete, view, or otherwise access their electric vehicle charging preferences, such as for example and without limitation, to initiate a planning phase. Vehicle preference service **405** is a software component for creating, managing, storing, requesting, updating, and/or retrieving preferences **406** for electric vehicle **400**. Preferences **406** may include preferences for a single principal, as well as preferences for two or more principals.

[0083] In this embodiment, vehicle preference service **405** is included within or bolted on electric vehicle **400**. In other words, vehicle preference service **402** is a preference service that is a system incorporated within electric vehicle **400** or added onto electric vehicle **400** as an after-market component. For example, and without limitation, vehicle preference service **402** may be added onto an electric vehicle as an add-on in a manner similar to the way in which global position system (GPS) navigation systems are added on to vehicles. In another embodiment, a given principal associated with the electric vehicle charging transaction may utilize an energy preference service that is located on a computing device that is remote from electric vehicle **400** to create and/or manage preferences for the given principal. In this example, the remote energy preference service communicates with dynamic energy transaction planner **402** through a wired or wireless network connection.

[0084] Preferences **406** are choices selected by one or more principals setting preferences for managing, governing, and/or controlling one or more parameters of an electric vehicle charging transaction. Dynamic energy transaction planner **402** utilizes one or more preferences of interest to a particular charging transaction to create a charging transaction plan to control the charging, de-charging, or storing of electric power associated with electric vehicle **400**. In other words, a preference specifies a parameter or aspect of the charging transaction that is to be minimized, maximized, or optimized. A parameter of the charging transaction is any feature of the charging transaction, such as, without limitation, a rate of charging, a length of time for charging, a time to begin charging, a time to cease charging, a maximum level of charge, a minimum level of charge, or any other aspect of the charging transaction.

[0085] It will be appreciated by one skilled in the art that the words "optimize", "optimization" and related terms are terms of art that refer to improvements in speed, efficiency, accuracy, quality, and/or improvement of one or more parameters of electric vehicle charging transactions, and do not purport to indicate that any parameter of the charging transaction has achieved, or is capable of achieving, an "optimal" or perfectly speedy, perfectly efficient, and/or completely optimized state.

[0086] Each preference may optionally be associated with a weighting value. Dynamic energy transaction planner **402** identifies the weighting value associated with each preference in set of preferences **410**. The weighting value indicates a priority of each preference relative to other preferences in the set of preferences. If two or more preferences in set of preferences **410** are conflicting preferences, dynamic energy transaction planner **402** uses the weighting value to determine which preference is given priority. In other words, dynamic energy transaction planner **402** uses the weighting value to determine the extent to which each preference will be maximized, minimized or optimized.

[0087] For example, a preference may specify that charging at charging stations that obtain power from environmentally friendly, "green", wind farms is to be maximized while charging at charging stations that obtain power from "brown", coal powered plants that may be harmful to the environment and should be minimized. Brown energy refers to power generated from polluting sources, as opposed to green energy that is produced from renewable or less polluting energy sources.

[0088] Preferences **406** may also specify the price per kilowatt hour the user is willing to pay to charge the electric vehicle, identify certain charging stations the user prefers to fully charge electric vehicle **400** and identify other charging stations at which the user prefers to partially charge electric vehicle **400**, perhaps due to proximity to the user's home or due to the source of the electricity used by charging station **403**. For example, preferences may indicate that charging when the price per kilowatt hour is less than thirteen cents is to be maximized and charging when prices are higher than thirteen cents per kilowatt hour is to be minimized or prohibited all together. In another example, preferences **406** may specify a limit, such as, without limitation, buy electricity up to a certain price or optimize the cost of the return trip home given the current prices of gas and electricity.

[0089] Preferences **406** may be static, dynamic, or temporary preferences. A static preference is a preference that is effective until the user changes the preference. A static preference may be referred to as a default preference. A dynamic preference is a preference that does not have a predetermined value. A dynamic preference requires a user to enter a value for the dynamic preference in real time as the set of preferences responsive to the request of dynamic energy transaction planner **402**. Thus, if a preference for the operator of the vehicle charging electric vehicle **400** is a dynamic preference, the principal is always prompted to enter a preference value indicating whether a particular operator of electric vehicle **400** is authorized to charge the electric vehicle. A user may choose to make a preference for operator charging electric vehicle **400** a dynamic preference so that the owner of electric vehicle **400** will always be informed of who is attempting to charge electric vehicle **400** and have the option of preventing the charging of electric vehicle **400** in real time prior to commencing of the charging transaction. A temporary preference is a preference that is only valid for a predetermined period of time. When the period of time expires, the temporary preference is invalid and no longer used. For example, a user may set a temporary preference that indicates no charging is to be performed for the next ten minutes at the charging station where the user is parked because the user is only going to be parked for five minutes. At the end of the ten minute time period, the temporary preference expires and electric vehicle **400** can begin charging if the electric vehicle **400** is still parked at the charging station.

[0090] Dynamic energy transaction planner **402** requests preferences of interest for a particular charging transaction by sending request **408** to vehicle preference service **405** and/or one or more energy preference services located remotely from electric vehicle **400**. Request **408** includes an identification of one or more principals and a request for a set of preferences that are of interest to the particular charging transaction. In other words, dynamic energy transaction planner **402** does not request every preference for every principal. Instead, dynamic energy transaction planner **402** identifies particular principals and requests specific preferences that are needed for creating a transaction plan for a particular charging transaction for those identified principals. In response to request **408**, vehicle preference service **405** identifies the requested preferences and retrieves those requested preferences for the identified principals to form set of preferences **410**. Vehicle preference service **405** sends set of preferences **410** to dynamic energy transaction planner **402**. Set of preferences **410** includes a subset of preferences for each principal identified by dynamic energy transaction planner **402** in request **408**.

[0091] Set of preferences **410** may be sent to dynamic energy transaction planner **402** over a universal serial bus (USB) or other wired or wireless connection within electric vehicle. Set of preferences **410** may also be transferred to dynamic energy transaction planner **402** from a remote energy preference service that is not located on electric vehicle **400**. In other words, the energy preference service may be located on a mobile computer, such as a personal digital assistant (PDA), cellular telephone, or laptop computer. The energy preference service may also be located on a remote energy preference server or on a remote client computer. In such cases, set of preferences **410** may be sent to dynamic energy transaction planner **402** by the remote energy preference service using a wired or wireless network connection. The remote energy preference service may also save set of preferences **410** onto a removable data storage medium, such as a memory stick, flash memory, or jump drive. When a user plugs the removable data storage medium having set of preferences **410** stored thereon into a removable data storage medium port on electric vehicle **400**, vehicle preference service **405** is able to retrieve set of preferences **410** from the removable data storage medium and send set of preference **410** to dynamic energy transaction planner **402**.

[0092] In this example, dynamic energy transaction planner **402** sends request **408** to a single energy preference service, such as vehicle preference service **405**. However, dynamic energy transaction planner **402** may also send multiple requests for preferences of interest to two or more energy preference services located on electric vehicle **400** and/or one or more computing devices. In such a case, dynamic energy transaction planner **402** may receive a set of preferences from two or more different energy preference services. For example, dynamic energy transaction planner **402** may receive set of preferences **410** from vehicle preference service **405**, a second set of preferences from a remote energy preference service on a mobile personal digital assistant (PDA), a third set of preferences from a remote energy preference service on a remote server, and a fourth set of preferences retrieved from a removable data storage device.

[0093] A principal may create preferences for managing parameters of the electric vehicle's charging transactions using a user input/output device associated with the computing device hosting the energy preference service. In this embodiment, the principal may use an input/output device located on-board the electric vehicle to create the preferences. In other words, in this embodiment, the principal uses an on-board system for maintaining, inputting, storing, and retrieving preferences that are used to manage the charging, de-charging, and/or storing of electric power associated with the electric vehicle.

[0094] Energy device capability service **412** is an application software component that identifies and validates device capabilities of electric vehicle **400**, charging station **403**, and/or the electric power grid, such as energy device capability server **306** in FIG. **3**. Dynamic energy transaction planner **402** sends request **414** to energy device capability service **412**. Request **414** includes an identification of electric vehicle **400**. The request may also include an identification of charging station **403**. Energy device capability service **412** identifies device capabilities **416** of electric vehicle **400** and/or charging station **403** and sends device capabilities **416** to dynamic energy transaction planner **402**.

[0095] Device capabilities **416** is information describing the capabilities and limitations associated with a particular device, such as, for example and without limitation, information describing the charging capabilities of the charging station, the charging requirements of the electric vehicle, the maximum storage capacity of the batteries on electric vehicle **400**, the charging capacity of other on-vehicle storage mechanisms on electric vehicle **400**, the existing amount of charge in the storage mechanism on-board electric vehicle **400**, the number of amps of electricity charging station **403** is capable of providing to electric vehicle **400**, and/or any other information associated with the capabilities and requirements of the electric vehicles and the charging station.

[0096] Dynamic energy transaction plan **424** includes an identification of electric vehicle **400**, an identification of the principal paying for the charging and/or the principal that is to be paid for storing electric power or de-charging electric vehicle **400**. Dynamic energy transaction plan **402** specifies method of payment, amount of payment, incentives, terms of the transaction, and enforcement of the terms of the charging transaction.

[0097] Dynamic energy transaction plan comprises a set of terms for governing all aspects of the charging transaction based on the set of preferences. The charging transaction is implemented and completed in accordance with the terms of the charging transaction. After the charging transaction begins in accordance with dynamic energy transaction plan **424**, dynamic energy transaction planner **402** continues to receive set of preferences updates **435**, device capabilities updates **436**, and current sate of devices updates **437**. The updates inform dynamic energy transaction planner **402** of any changes in the preferences of the principals, changes in the state of device, and/or changes in device capabilities. For example, during the charging transaction, a battery cable associated with electric vehicle may become disconnected rendering one battery on electric vehicle inoperable. If electric vehicle contains one or more other batteries, the charging transaction may be able to continue. Dynamic energy transaction planner **402** updates dynamic energy transaction plan **424** to reflect this change in the storage capacity of electric vehicle **400**.

[0098] Likewise, during the charging transaction, the operator may update preferences to indicate that instead of leaving the charging station at 5:00 p.m., the operator will not be leaving until 7:30 p.m. As a result, dynamic energy transaction planner **402** may alter dynamic energy transaction plan **424** to permit electric vehicle **400** to discharge electric power in the afternoon when electric power usage is higher and then charge electric vehicle **400** beginning at 6:00 p.m., when electricity rates are lower so that electric vehicle will have sufficient charge to return to the operators home when the operator is ready to leave at 7:30 p.m. In this manner, dynamic energy transaction plan **424** is able to change in response to changing conditions to maximize the benefits of charging, discharging, and/or storing electricity associated with electric vehicle **400** at charging station **403**.

[0099] In another scenario, dynamic energy transaction planner **402** may receive charging information that includes preferences that specifies that the electric vehicle should be charged if the rate for purchasing electricity is lower than a given amount, such as "$0.XX". In this example, dynamic energy transaction planner **402** may not be able to determine far enough in advance if the rate will drop that low. Dynamic energy transaction planner **402** can only react to that preference in real-time when the rate actually drops. In such a case, dynamic energy transaction planner **402** modifies dynamic energy transaction plan **424** in real time to initiate charging of electric vehicle **400** when the rate falls below the given amount. When the charging transaction information indicates that the rate has risen above the given amount, dynamic energy transaction planner **402** modifies dynamic energy transaction planner **402** again in real-time to stop the charging of electric vehicle **400**.

[0100] Dynamic energy transaction plan **424** may be stored on data storage device **426** or sent to another component, such as dynamic energy transaction plan approval service **312** or energy transaction execution engine **316** in FIG. **3**. Data storage device **426** may be implemented as any type of known or available device for storing data, such as, without limitation, a hard drive, a flash memory, a main memory, read only memory (ROM), a random access memory (RAM), a magnetic or optical disk drive, tape, or any other type of data storage device. Data storage device **426** may be implemented in a single data storage device or a plurality of data storage devices. Data storage device **426** in this example is located locally on electric vehicle **400**. However, data storage device **426** may optionally be located in whole or in part on a remote computing device that is accessed by dynamic energy transaction planner **402** using a network connection. Data storage device **426** may optionally be used to store preferences **406** locally on electric vehicle **400**.

[0101] Energy data services **418** provide information describing the current state of one or more devices. The devices may include, without limitation, electric vehicle **400** and/or charging station **403**. For example, and without limitation, the state information may describe the current level of charge on one or more batteries on electric vehicle **400**, the operational state of one or more charging ports associated with charging station **403**, or any other state information. Energy data services **418** may also include information relevant to the energy transaction from third party data sources, such as, without limitation, weather information, traffic information, map and travel information, charging station prices, charging station locations, or any other relevant third party information. Energy data services **418** may obtain the information from a single third party information source or multiple different third party information sources. Dynamic energy transaction planner **402** sends query **420** to energy data services **418** requesting information from one or more third party sources. In response to request **420**, energy data services **418** sends current state of devices **422** to dynamic energy transaction planner **402**.

[0102] Dynamic energy transaction planner **402** creates dynamic energy transaction plan **424** based on set of preferences **410**, device capabilities **416**, and/or current state of devices **422**. In other words, dynamic energy transaction planner **402** may user preferences, device capabilities information, and current state information to create dynamic energy transaction plan **424** or dynamic energy transaction planner **402** may use only preferences and device capabilities if current state information is unavailable. Likewise, if preferences are unavailable, dynamic energy transaction planner **402** may create dynamic energy transaction plan **424** using only the available device capabilities **416** and current state of devices **422**.

[0103] Dynamic energy transaction plan **424** is a plan that manages every aspect of charging electric vehicle **400**, using electric vehicle **400** as a temporary electric storage device, discharging/selling electric power back to the electric grid, or any combination of charging, de-charging, or storing. Energy transaction plan **424** is created to meet the needs of all the identified principals, is consistent with the capabilities of the physical components of electric vehicle **400**, charging **403**, and the electric power grid. To construct energy transaction plan **424**, a number of the following entities should be specified: a user paying for the charging transaction, the electric vehicle to be charged, the electric vehicle owner, the supplier of electricity, such as a utility, the owner of the charging station or outlet, and additional information related to incentives or credits, such as, for example, a clean energy generation source.

[0104] In addition, energy transaction plan **424** may optionally determine the contractual relationships between all principals by collecting information from the principals' preferences or from one or more energy data services, such as energy data services **418**, where these contractual relationships are managed. Energy transaction planner **402** queries vehicle preference service **405** and energy data services **418** for this information describing the contractual relationships of the principals and the preferences of the principals. Energy transaction planner **402** uses this information to generate energy transaction plan **424**. For example, if a contractual relationship allows an operator only to charge electric vehicle **400** and not to discharge or store electric power in electric vehicle **400**, then this information factors into the terms of energy transaction plan **424** created by energy transaction planner **402**.

[0105] In this example, dynamic energy transaction planner **402** is located on electric vehicle **400**. However, in another embodiment, remote dynamic energy transaction planner **428** is located on remote computing device **430** that is not bolted or coupled to electric vehicle **400**. In such a case, remote dynamic energy transaction planner **428** requests set of preferences **410**, device capabilities **416**, and/or current state of devices **422** using a network connection. Remote dynamic energy transaction planner **428** then transmits dynamic energy transaction plan **424** to an energy transaction approval service, an energy transaction execution engine, or a data storage device, such as data storage device **426**. Remote dynamic energy transaction planner **428** may also store dynamic energy transaction plan **424** on a removable data storage device. The removable data storage device is then plugged into electric vehicle **400** or a computing device associated with either the energy transaction approval service or the energy transaction execution engine.

[0106] Network interface **432** is any type of network access software known or available for allowing electric vehicle **400** to access a network. Network interface **432** connects to a network connection, such as network **102** in FIG. **1**. The network connection permits access to any type of network, such as a local area network (LAN), a wide area network (WAN), or the Internet. Electric vehicle **400** utilizes network interface **432** to connect to remote computing device **430** and/or one or more other remote servers and/or client computing devices. Remote computing device **430** may also include a network interface (not shown) to permit remote computing device to connect to electric vehicle **400** and/or one or more other remote servers and/or clients.

[0107] Dynamic energy transaction planner **402** may include authentication module **433**. Authentication module **433** comprises any type of known or available encryption technology and/or security protocols. Authentication module **433** authenticates and/or encrypts communications between vehicle preference service **405** and dynamic energy transaction planner **402**. Authentication module **433** may be used to authenticate vehicle preference service **405** itself or authenticate tokens provided by vehicle preference service **405** for each of the principals for which vehicle preference service **405** is providing preferences to dynamic energy transaction planner **402**.

[0108] Authentication module **433** may also be used to authenticate information received from vehicle preference service **405**, such as set of preferences **410**. In addition, authentication module **433** may be used to identify and authenticate charging station **403** and authenticate information received from charging station **403**, such as, without limitation, device capabilities **416** preferences of the owner, operator, utility, and/or financial institution associated with charging station **403**, information describing the capabilities of one or more devices associated with charging station **403** and/or information describing the current state of one or more devices associated with charging station **403**. This information may only be available from a computing device associated with charging station **403**. In such a case, dynamic energy transaction planner **402** uses authentication module **433** to identify and authenticate charging station **403** and information exchanged with charging station **403**. Remote dynamic energy transaction planner **428** may also include an authentication module (not shown) for authenticating communications with electric vehicle **400** and/or one or more other remote computing devices.

[0109] Thus, in this illustrative embodiment, the process for generating dynamic energy transaction plan **424** begins when electric vehicle **400** arrives at charging station **403** and indicates an intention to charge, de-charge, or store electric energy on electric vehicle **400**. Electric vehicle **400** may indicate an intention to begin a charging transaction by plugging into an electric outlet for charging/discharging electric power, selecting an option for charging/discharging electric power at an input/output device associated with charging station **403**, informing an operator or attendant of charging station **403**, or otherwise indicating a desire to begin a charging transaction.

[0110] In response, dynamic energy transaction planner **402** obtains set of preferences **410** for all principals that may possibly have an interest in this specific energy transaction from one or more energy transaction preference services, such as, without limitation, vehicle preference service **405**, a proxy preference service, a network based preference service located on a remote server, or any other energy preference service. The energy preference services maintain preferences for one or more principals for the purpose of structuring dynamic energy transaction plans in accordance with the principals selected requirements, limitations, preferences, and/or constraints on the charging transaction. For example, the present operator of electric vehicle **400** may be an employee of the owner of electric vehicle **400**. In this case, the set of principals may include the owner of charging station **403**, the operator of electric vehicle **400**, the employer that owns electric vehicle **400**. Set of preferences **410** in this example includes a subset of preferences for each of these principals.

[0111] Dynamic energy transaction planner **402** gathers information related to the capabilities of devices involved in this energy transaction from device capability service **412**. For example, the charge/discharge kiosk associated with charging station **403** that electric vehicle **400** is connected to, may have a maximum safe amperage rating that the kiosk can deliver to electric vehicle **400**. Conversely, electric vehicle **400** may have a maximum amperage that electric vehicle's electric storage mechanisms can safely absorb. Dynamic energy transaction planner **402** considers these constraints when structuring dynamic energy transaction plan **424**.

[0112] Dynamic energy transaction planner **402** then queries energy data services **418** to determine the current state of the devices participating in this particular charging transaction. For example, the present charge state of the batteries on electric vehicle **400**, the present and projected capabilities of the electric grid to deliver and/or accept electric energy at the current time period and for the expected duration of the charging transaction, the present and projected energy rates, including fees and incentives, associated with the charging transaction, as well as any other information associated with the current state of the devices.

[0113] Dynamic energy transaction planner **402** takes these inputs, including set of preferences **410**, device capabilities **416**, and current state of device **422**, and calculates dynamic energy transaction plan **424**. Dynamic energy transaction planner **402** submits dynamic energy transaction plan **424** to an energy transaction execution engine for implementation once the vehicle is connected at the charge/discharge outlet at charging station and/or electric vehicle **402** is authorized to begin charging/discharging after electric vehicle is connected to the outlet. Optionally, prior to submitting dynamic energy transaction plan **424** to the execution engine, dynamic energy transaction planner **402** may submit dynamic energy transaction plan **424** to an energy plan approval service for approval by one or more principals, such as the operator of electric vehicle and/or the operator associated with charging station **403**.

[0114] Dynamic energy transaction planner **402** receives set of preferences updates **435**, device capabilities updates **436**, and current state of devices updates **437**. In response to one or more updated preferences, device capabilities', and/or changes in device state, dynamic energy transaction planner **402** modifies dynamic energy transaction plan **424** to create updated dynamic energy transaction plan **438**.

[0115] For example, if an operator parks electric vehicle **400** at charging station **403** at an airport and indicates in the operator's preferences that the operator will not return for two weeks, the operator selects a mandatory preference that electric vehicle **400** be fully charged by 7:00 p.m. on the day the operator will return. The operator also indicates that the operator would prefer that electric vehicle be used to charge, discharge, and store electric power during the two weeks to maximize the value of using electric vehicle **400** for electric power storage. In this case, during the two weeks that the operator leaves electric vehicle **400** parked at charging station **403**, dynamic energy transaction planner **402** monitors the price of electricity and charges electric vehicle **400** when the price of electricity falls below a low price threshold. When dynamic energy transaction planner determines that the price of electricity reaches a certain high threshold, dynamic energy transaction planner **402** modifies dynamic energy transaction plan **424** to begin selling electricity back to the power grid for a profit. Dynamic energy transaction planner **402** continues this process of charging electric vehicle **400** when the price is low and selling electric power back to the power grid when electricity usage is high and the price of electricity is consequently high until the time for the operator to return approaches. At such a time, dynamic energy transaction planner **402** may create a static energy transaction plan that will control charging electric vehicle **400** to a fully charged state by 7:00 a.m.

[0116] In one embodiment, dynamic energy transaction planner **402** continuously sends requests for updates to the energy preference services, energy device capability service **412**, and/or energy data services **418**. In response to these requests, the energy preference services, energy device capability service **412**, and/or energy data services **418** send an indication that no updates have been made or sends the updates, such as preferences update **435**, device capabilities update **436**, and state of devices updates **437**, to dynamic energy transaction planner **402**.

[0117] In another embodiment, the energy preference services, energy device capability service **412**, and/or energy data services **418** send the updates in response to an update or change occurring. In this embodiment, dynamic energy transaction planner **402** is always listening for updates to be received from the energy preference services, energy device capability service **412**, and/or energy data services **418**. Therefore, it is unnecessary for dynamic energy transaction planner **402** to send requests for updates.

[0118] Referring to FIG. **5**, a block diagram of electric vehicle charging preferences is shown in accordance with an illustrative embodiment. Preferences **500** are types of preferences that may be included within preferences for one or more users, such as preferences **406** in FIG. **4**. Preferences **500** may be charging preferences **502** for governing energy transaction to charge an energy storage device associated with the electric vehicle, de-charging preferences **504** for governing energy transactions for de-charging or depleting the energy stored in an energy storage device, or storage preferences **506** for governing the storage of electricity in the electric vehicle's energy storage mechanisms.

[0119] A user may wish to de-charge or transfer power from the electric vehicle to a charging station if the price of the electricity is higher than when the electricity was purchased and stored in the electric vehicle. For example, if a user charges an electric vehicle at night when the price of the electricity is only nine cents per kilowatt hour, the user may wish to de-charge or provide electricity from the electric vehicle back to the charging station at noon when the price per kilowatt hour is fifteen cents because the user is able to make a profit from storing the electricity in the electric vehicle until the price of electricity increases and then selling the electricity back to the electric grid.

[0120] Some examples of charging preferences include, without limitation, financial **508**, locations **510**, time **512**, amount of charge **514**, power source **516**, and/or operator **518**. For example, financial **508** preferences may specify price per kilowatt hour **520** that the user is willing to pay to charge the electric vehicle or payment method **522** for purchasing the electricity from the charging station and/or the electricity grid. Payment method **522** may include, without limitation, credit cards, cash, debit card, credit, or any other type of payment. The payment type preferences may even specify a particular credit card or bank account for debit to pay for the charging transaction.

[0121] Locations **510** preferences may specify preferred charging station **524**, preferred locations **526** of the charging stations, and/or specified locations **528** for charging. For example, the user may specify that any time the electric vehicle is parked at a charging station that is at a specified location, the electric vehicle is not to be charged at all, to be charged to a particular charge level, or to be fully charged. The user may wish to set these preferences because the charging stations are a given distance from the user's home or workplace, due to past service received at the charging station, or any other factors.

[0122] Time **512** preferences may specify, without limitation, time of day **530** for charging the vehicle, time of day to stop charging the vehicle, day of month **532** for charging, and/or day of the week **534** for charging the electric vehicle.

[0123] Amount of charge **514** preferences may specify minimum level **536** of charge in the electric vehicle's storage device, a maximum level of charge **538**, or specify different levels of charge depending on power source **540** of the electricity used to charge the electric vehicle. If the power source is a "green" source, such as solar power, the user may specify a higher charge level than if the power source is a more environmentally harmful, or "brown" power source, such as coal or oil.

[0124] Power source **516** preferences specify types of power sources that are acceptable or preferred and/or provide weighting values for different power sources. The power sources may be identified as "green" or "brown" **542**. The power sources may also be identified specifically by the type of power source, such as wind, solar, coal, oil, and so forth.

[0125] Operator **518** preferences are preferences for allowing particular operators to charge the electric vehicle. Owner **544** is a preference that permits an owner to charge, particular individuals **546** permits identified individuals to charge the vehicle, and any operator **548** is a preference that permits anyone to charge the electric vehicle. The operator **518** preference may permit a user to prevent or impede theft of the electric vehicle. For example, if a user sets owner **544** as a mandatory preference that only permits the owner to charge the electric vehicle, a thief would not be permitted to recharge the electric vehicle. Therefore, a thief may not be able to transport the electric vehicle very far from the location at which the electric vehicle was stolen.

[0126] The preferences described for charging preferences **502** are only example of some preferences that may be used. A vehicle preference service is not required to utilize all of the preferences shown in FIG. **5**. Moreover, a vehicle preference service may utilize other preferences not shown in FIG. **5** without departing from the scope of the embodiments. Finally, the preferences shown for charging preferences **502** may also be used as preferences for de-charging preferences **504** and/or storage preferences **506**, in addition to other preferences not shown. For example, de-charging preferences **504** may include operator **518** preferences specifying operators that are permitted to de-charge or sell power back to the electric grid, financial **508** specifying prices at which the electricity may be transferred from the electric vehicle and sold back to the electric grid, time **512** when de-charging may occur, amount of charge **514** levels for de-charging, and power source **516** of the power that is de-charged.

[0127] FIG. **6** is a block diagram of preference settings in accordance with an illustrative embodiment. Preference settings **600** are settings that may be appended to a preference, such as preference A **602**. Preference A **602** may be any type of preference, such as, without limitation, financial, locations, time, amount of charge, power source, operator, or any other preferences. Mandatory **604** specifies that the requirements of a particular preference must be met or a charging transaction will not be permitted. For example, if a user sets an operator preference indicating that only the owner is permitted to charge the electric vehicle and the user sets the preference to mandatory, only the owner will be permitted to initiate charging of the electric vehicle. Any other operator of the electric vehicle will not be permitted to charge the electric vehicle unless the owner changes the preference settings.

[0128] Optional/weighted **606** is a setting that indicates that a preference is preferred or desirable, but not mandatory. For example, the user may specify that "green" power sources, such as wind and solar power sources, are preferred but not mandatory. In such cases, the dynamic energy transaction planner may still permit charging of the electric vehicle at charging stations that utilize electricity provided by coal powered electric generators. The weighting value permits a user to indicate how strongly the user wants a particular preference to be minimized, maximized, or optimized. In the example above, the user may indicate a high weighting value in favor of wind and solar power, a medium weighting value for nuclear power plants, and a low weighting value for coal power plants. The dynamic energy transaction planner may then use the weighting value to determine how much to charge or de-charge the electric vehicle or whether to charge or de-charge the electric vehicle at all.

[0129] Static **608** indicates that a preference is a default preference that should be used in all cases. A static preference does not change from one charging transaction to the next charging transaction. Dynamic **610** setting indicates that a user wants to provide or select a value or choice for this preference every time a charging transaction plan is generated. A dynamic preference is selected in real time as the charging transaction is commencing. Temporary **612** indicates that a temporary preference value is to be used in place of a static preference for a limited period of time. For example, a user may wish to override a static preference that the electric vehicle should always be fully charged at a particular charging station with a temporary preference indicating that the electric vehicle is not to be charged because the user will only be parked at the charging station for a few minutes.

[0130] Turning now to FIG. **7**, a block diagram of parties to an electric vehicle charging transaction is depicted in accordance with an illustrative embodiment. Each party may have a set of preferences for charging the electric vehicle that is managed by the vehicle preference service. A principal is any entity that may have an interest or role in the energy transaction for charging an electric vehicle, including but not limited to, the vehicle operator, owner of the electric vehicle, the owner of the charging station, the operator of the charging station, financial institutions associated with one or more of the parties, utilities associated with one or more of the principals, or third parties having an interest in the charging transaction. FIG. **7** illustrates the different relationships between principals. Any one or more of the principals shown in FIG. **7** may have preferences stored in the on-vehicle preference service.

[0131] Electric vehicle **700** is a vehicle that relies in whole or in part on electric power to drive the vehicle, such as electric vehicle **118** in FIG. **1** or electric vehicle **400** in FIG. **4**. Owner of electric vehicle **702** is a principal that creates a set of preferences in vehicle preference service on electric vehicle **700**. Operator of electric vehicle **704** is a principal that may be the owner or only someone that has borrowed electric vehicle **700**. Each operator may optionally create their own set of preferences in the vehicle preference service on electric vehicle. Charging station **706** is a station or kiosk at which electric vehicle obtains charge or de-charges to provide electricity back to the electric grid, such as charging station **118** in

FIG. **1** or charging station **434** in FIG. **4**. Charging station **706** may also have a set of preferences for governing the charging of electric vehicle **700**.

[0132] Each party may have a utility associated with the party. Each utility may also have preferences for governing the charging transaction. For example, utility of owner **708**, utility of operator **710**, and utility of charging station **712** may each be parties with an interest in the charging transaction and preferences for governing the charging of electric vehicle **700**. A utility is a provider of electric power, such as, without limitation, via an electric power grid.

[0133] Each party may also have a financial institution for paying for the electricity purchased, or for being reimbursed for electricity provided back to the electric grid. A financial institution may be a bank, a credit card company, a broker, a lender, or any other financial institution. For example, financial institution A **714** may be associated with owner of electric vehicle **702**, financial institution B **716** may be associated with operator of electric vehicle **704**, and financial institution C **718** may be associated with charging station **706**. Each of these financial institutions may have preferences for controlling how amounts due are received, how charges of payments are received and accepted, how credits are issued and received, and other aspects of financial transactions associated with charging electric vehicle **700**.

[0134] Third party vendor **720** is a third party that is not associated with charging station **706** or electric vehicle **700**. For example, and without limitation, third party vendor **720** may be a grocery store, a convenience store, a car wash, a repair shop, or any other type of vendor. Third party broker **722** is a third party that may provide financing or manage financial transactions associated with charging electric vehicle **700**.

[0135] Each of the parties shown in FIG. **7** may optionally have preferences, constraints, limitations, or requirements associated with charging electric vehicle **700**. The vehicle preference service on electric vehicle **700** may optionally store, manage, and retrieve some or all of these preferences, constraints, limitations, and requirements in data storage device on electric vehicle **700**. The vehicle preference service retrieves the information of interest that is responsive to a request by a dynamic energy transaction planner and sends the preferences of interest to the dynamic energy transaction planner for use in generating a plan to govern the charging of electric vehicle **700** at charging station **706**.

[0136] FIG. **8** is a block diagram of a set of fields in an energy transaction plan in accordance with an illustrative embodiment. Energy transaction plan **800** is a plan for managing an electric vehicle charging transaction, such as energy transaction plan **424** in FIG. **4**. Energy transaction plan **800** defines an energy transfer transaction encompassing the charge, discharge, and storage of electric energy in an electric vehicle and the incumbent financial exchanges related to those energy exchanges and storage of electric power in the electric vehicle. Energy transaction plan **800** may include, without limitation, identification of electric vehicle **802**; identification of principal(s) **803**; payment **804** terms; incentives **805**; terms/contractual relationship of the principals **806**; enforcement of terms **807**; charge **808**, discharge **809**, store **810**, and/or a series of time fields indicating the electric flow direction at each time mark, such as, without limitation, time **1 811**, time **2 812**, time **3 813**, time **4 814**, and/or time **5 815**.

[0137] Identification of principal(s) **803** identifies one or more principals for a particular charging transaction, such as, without limitation, electric vehicle (EV) owner **816**; electric vehicle operator **817**; charging station owner **818**; charging station operator **820**; utility **822** of the owner; operator; or charging station; financial institution **824** of the owner; operator; or utility; third party broker **826**; and/or a third party vendor **828**. Payment **804** may specify the type of payment method, such as, without limitation, cash/gift card **830**; credit/debit **832**; and/or check/money order **834**. Incentives **805** are terms in energy transaction plan **800** associated with coupons/rebates/discounts **836**, and/or reward points/cash back **838**, or any other rewards, discounts, rebates, coupons, or other benefits.

[0138] Charge **808** orders the flow direction of electricity from the charging station into the electric vehicle during one or more specified time intervals. Rate **1 840** is a first time interval during which the electric vehicle receives electricity from the charging station at a specified rate of electricity flow. Rate **2 842** is a second time interval during which the electric vehicle receive electricity from the charging station at a specified rate. Discharge **809** indicates each time interval during which electricity flows out of the electric vehicle and back into the electric grid through the charging station. Store **810** indicates time intervals during which electricity is neither flowing into the electric vehicle nor flowing out of the electric vehicle's electricity storage mechanisms. In other words, during the one or more time intervals indicated in store **810**, the electric vehicle stores electricity in the electric vehicle's storage mechanisms without charging or discharging power.

[0139] The time intervals **811-815** optionally indicate start and end times for charging, discharging, and/or storing. Energy transaction plan **800** may have multiple charge, discharge or store time windows. In this example, and without limitation, time **1 811** starts charging the electric vehicle at a given rate of electricity flow until time **2 812**. At time **2 812**, charging stops. At time **3 813**, the electric vehicle begins discharging power back to the electric grid and continues discharging electricity until time **4 814**. Time **5 815** indicates a time when the electric vehicle charging transaction ends. However, the embodiments are not limited to this example. The field for time **1 811** may have been an entry for discharging the electric vehicle instead of charging. The field for time **4 814** may be a field for storing electric power.

[0140] The time intervals may be any standard clock time, such as Greenwich Mean Time, Central Time, Pacific Time, an internal clock time for the electric vehicle, or any other standard clock time. In another embodiment, the time may be a time relative to beginning the electric vehicle charging transaction. For example, instead charge **808** stating that charging begins at 2:24 p.m. and ends at 4:24 p.m., charge **808** may state that charging begins when the charging transaction begins and ends two hours later, regardless of what time it may be.

[0141] Energy transaction plan **800** is not required to include every field shown in FIG. **8**. For example, and without limitation, energy transaction plan **800** may include fields for charge **808**, discharge **809**, and store **810** but omit fields for time entries, such as time **1** to time **5 811-815**. In addition, energy transaction plan **800** may include additional fields not shown in FIG. **8**. For example, energy transaction plan may include a time **5** to begin storing electricity, time **6** to stop storing, time **7** to charge, time **8** to stop charging, time **9** to discharge, time **10** to stop discharging, and time **11** to end the transaction. In other words, energy transaction plan **800** may include any number of fields and any combination of fields to provide terms for charging, discharging, and/or storing electricity in an electric vehicle.

[0142] Turning now to FIG. **9**, a flowchart illustrating a process for generating a first set of terms for a dynamic energy transaction plan is shown in accordance with an illustrative embodiment. The process in FIG. **9** is implemented by software for generating dynamic energy transaction plans, such as dynamic energy transaction planner **402** in FIG. **4**.

[0143] The process begins by identifying all principals associated with an electric vehicle charging transaction (step **902**). The principals associated with the electric vehicle charging transaction are the entities having an interest in the charging transaction. The dynamic energy transaction planner requests preferences of interest for the identified principals (step **904**). The dynamic energy transaction planner receives a set of preferences from an energy preference service (step **906**). The dynamic energy transaction planner receives device capabilities information from an energy device capability service (step **908**). The dynamic energy transaction planner queries an energy data service for state data (step **910**). The dynamic energy transaction planner receives current state data for devices associated with the electric vehicle charging transaction (step **912**). The dynamic energy transaction planner generates a first set of terms for a dynamic energy transaction plan using the set of preferences, the device capabilities information, and the current state data from the device (step **914**) with the process terminating thereafter.

[0144] FIG. **10** is a flowchart illustrating a process for requesting preferences from an energy preference service in accordance with an illustrative embodiment. The process in FIG. **10** is implemented by a software component for creating, managing, and retrieving electric vehicle charging preferences, such as, without limitation, energy preference service **302** in FIG. **3**, vehicle preference service **405** in FIG. **4**, an off-vehicle preference service, a proxy preference service, or any other type of energy preference service.

[0145] The process begins by receiving a request for preferences for identified principals from a dynamic energy transaction planner (step **1002**). The energy preference service identifies a set of preferences responsive to the request (step **1004**). The energy preference service retrieves the set of preferences from a data storage device associated with the energy preference service (step **1006**). The set of preferences includes a subset of preferences for each principal. The energy preference service sends the set of requested preferences to the dynamic energy transaction planner (step **1008**) with the process terminating thereafter.

[0146] FIG. **11** is a flowchart illustrating a process for identifying terms of a charging transaction for utilization in generating a dynamic energy transaction plan in accordance with an illustrative embodiment. The process in FIG. **11** is implemented by software for generating dynamic energy transaction plans, such as dynamic energy transaction planner **402** in FIG. **4**.

[0147] The process begins by identifying principals of interest and identifying the electric vehicle (step **1102**). The energy transaction planner identifies the terms of the charging transaction (step **1104**) in the energy transaction plan. The energy transaction planner identifies the payment method, payment terms, and/or incentives (step **1106**) associated with the charging transaction in the energy transaction plan. The energy transaction planner determines the contractual relationship of the principals of interest (step **1108**) based on the preferences and the energy data services information. The contractual relationships of the principals include rules that govern the energy transaction planner as the energy transaction planner builds the energy transaction plan. The energy transaction planner specifies the net financial terms of the charging transaction in the energy transaction plan (step **1110**) with the process terminating thereafter. The net financial terms may optionally include, without limitation, non-monetary terms, such as incentives, carbon credits, rewards, discounts, and other non-monetary commodities.

[0148] FIG. **12** is a flowchart illustrating a process for generating an updated dynamic energy transaction plan in accordance with an illustrative embodiment. The process in FIG. **12** may be implemented by software for generating dynamic energy transaction plans based on dynamically updating information from a variety of sources in real-time, such as dynamic energy transaction planner **402** in FIG. **4**.

[0149] The process begins by generating a dynamic energy transaction plan having a first set of terms to control a first portion of a charging transaction (step **1202**). The dynamic energy transaction plan having the first set of terms is generated based on charging transaction information, such as a set of preferences, device capabilities information, and/or current state of device information. The dynamic energy transaction planner sends the dynamic energy transaction plan having the first set of terms to an execution engine, such as energy transaction execution engine **316** in FIG. **3**, or an approval service, such as energy transaction approval service **312** in FIG. **3** (step **1204**). The dynamic energy transaction planner may monitor for updates or changes to the charging transaction information.

[0150] The dynamic energy transaction planner receives updated charging transaction information, such as, without limitation, an updated set of preferences, updated device capabilities information, and/or updated state of device information (step **1206**). The dynamic energy transaction planner updates the dynamic energy transaction plan based on the updated charging transaction information (step **1208**). The updated dynamic energy transaction plan includes a second set of terms. The dynamic energy transaction planner sends the updated dynamic energy transaction plan to an execution engine or an approval service (step **1210**) with the process terminating thereafter.

[0151] According to one embodiment of the present invention, a computer implemented method, apparatus, and computer program product for generating a dynamic energy transaction plan to manage an electric vehicle charging transaction in real-time is provided. The dynamic energy transaction planner generates a dynamic energy transaction plan based on the charging transaction information. The dynamic energy transaction plan comprises an identification of the electric vehicle, an identification of a principal in the set of principals to pay for the charging transaction, an identification of at least one utility associated with the charging transaction, an owner of the charging station, and a first set of terms of the charging transaction. An initial portion of the charging transaction is controlled in accordance with the first set of terms of the dynamic energy transaction plan. The dynamic energy transaction planner receives updated charging transaction information during execution of the charging transaction; and updates the dynamic energy transaction plan based on the updated charging transaction information to form an updated dynamic energy transaction plan. The updated dynamic energy transaction plan comprises a second set of terms. A second portion of the charging transaction is implemented in accordance with the second set of terms in the updated dynamic energy transaction plan.

[0152] The dynamic energy transaction plan identifies principals and facilities involved in an electric vehicle charging transaction and the terms of the principals' involvement in the charging transaction. The dynamic energy transaction plan identifies when to charge an electric vehicle, when to discharge electric power from the electric vehicle back to the power grid, where to charge or discharge the electric vehicle, takes into account the location of the electric vehicle, the destination of the electric vehicle, the time of use price for electric power charging or discharging to sell electric power back to the utility, identifies the capabilities of the electric vehicle, the power grid, and the charging station. The terms of the dynamic energy transaction plan remain in effect for the duration of the charging transaction to ensure that the charging transaction occurs in accordance with the terms of the charging transaction. If an anomaly occurs, the charging transaction may be terminated to prevent the charging transaction from deviating from the terms of the dynamic energy transaction plan.

[0153] Generation and utilization of this dynamic energy transaction plan enables users to dramatically broaden the potential availability of charging facilities and the flexibility of charge transactions business. The owners of charging facilities may actively facilitate access to their charging facilities if dynamic energy transaction plans are utilized to control charging transaction to assure the owners are assured of reimbursement for the energy delivered to customers.

[0154] Moreover, the dynamic energy transaction planner is able to optimize charging transactions based on dynamic attributes and conditions changing in real-time during the charging transaction. In other words, the dynamic energy transaction plan changes in response to changing conditions in real time as the changes occur.

[0155] The flowchart and block diagrams in the Figures illustrate the architecture, functionality, and operation of possible implementations of systems, methods and computer program products according to various embodiments of the present invention. In this regard, each block in the flowchart or block diagrams may represent a module, segment, or portion of code, which comprises one or more executable instructions for implementing the specified logical function (s). It should also be noted that, in some alternative implementations, the functions noted in the block may occur out of the order noted in the figures. For example, two blocks shown in succession may, in fact, be executed substantially concurrently, or the blocks may sometimes be executed in the reverse order, depending upon the functionality involved. It will also be noted that each block of the block diagrams and/or flowchart illustration, and combinations of blocks in the block diagrams and/or flowchart illustration, can be implemented by special purpose hardware-based systems that perform the specified functions or acts, or combinations of special purpose hardware and computer instructions.

[0156] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0157] The corresponding structures, materials, acts, and equivalents of all means or step plus function elements in the claims below are intended to include any structure, material, or act for performing the function in combination with other claimed elements as specifically claimed. The description of the present invention has been presented for purposes of illustration and description, but is not intended to be exhaustive or limited to the invention in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art without departing from the scope and spirit of the invention. The embodiment was chosen and described in order to best explain the principles of the invention and the practical application, and to enable others of ordinary skill in the art to understand the invention for various embodiments with various modifications as are suited to the particular use contemplated.

[0158] The invention can take the form of an entirely hardware embodiment, an entirely software embodiment or an embodiment containing both hardware and software elements. In a preferred embodiment, the invention is implemented in software, which includes but is not limited to firmware, resident software, microcode, etc.

[0159] Furthermore, the invention can take the form of a computer program product accessible from a computer-usable or computer-readable medium providing program code for use by or in connection with a computer or any instruction execution system. For the purposes of this description, a computer-usable or computer-readable medium can be any tangible apparatus that can contain, store, communicate, propagate, or transport the program for use by or in connection with the instruction execution system, apparatus, or device.

[0160] The medium can be an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system (or apparatus or device) or a propagation medium. Examples of a computer-readable medium include a semiconductor or solid state memory, magnetic tape, a removable computer diskette, a random access memory (RAM), a read-only memory (ROM), a rigid magnetic disk and an optical disk. Current examples of optical disks include compact disk-read only memory (CD-ROM), compact disk-read/write (CD-R/W) and DVD.

[0161] A data processing system suitable for storing and/or executing program code will include at least one processor coupled directly or indirectly to memory elements through a system bus. The memory elements can include local memory employed during actual execution of the program code, bulk storage, and cache memories which provide temporary storage of at least some program code in order to reduce the number of times code must be retrieved from bulk storage during execution.

[0162] Input/output or I/O devices (including but not limited to keyboards, displays, pointing devices, etc.) can be coupled to the system either directly or through intervening I/O controllers.

[0163] Network adapters may also be coupled to the system to enable the data processing system to become coupled to other data processing systems or remote printers or storage devices through intervening private or public networks.

Modems, cable modem and Ethernet cards are just a few of the currently available types of network adapters.

[0164] The description of the present invention has been presented for purposes of illustration and description, and is not intended to be exhaustive or limited to the invention in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art. The embodiment was chosen and described in order to best explain the principles of the invention, the practical application, and to enable others of ordinary skill in the art to understand the invention for various embodiments with various modifications as are suited to the particular use contemplated.

What is claimed is:

1. A computer implemented method for generating dynamic energy transaction plans for governing electric vehicle charging transactions, the computer implemented method comprising:

generating a dynamic energy transaction plan based on charging transaction information, wherein the dynamic energy transaction plan comprises an identification of an electric vehicle, an identification of a principal in a set of principals to pay for a charging transaction, an identification of at least one electric energy provider associated with the charging transaction, an owner of a charging station, and a first set of terms, wherein an initial portion of the charging transaction is controlled in accordance with the first set of terms of the dynamic energy transaction plan;

receiving updated charging transaction information during execution of the charging transaction; and

updating the dynamic energy transaction plan based on the updated charging transaction information to form an updated dynamic energy transaction plan, wherein the updated dynamic energy transaction plan comprises a second set of terms, and wherein a second portion of the charging transaction is implemented in accordance with the second set of terms in the updated dynamic energy transaction plan.

2. The computer implemented method of claim **1** wherein the updated charging transaction information is a first set of updated charging transaction information, and further comprising:

receiving a next set of updated charging transaction information during execution of the charging transaction; and

updating the updated dynamic energy transaction plan with a new set of terms based on the next set of updated charging transaction information, wherein a portion of a remainder of the charging transaction is implemented in accordance with the new set of terms in the updated dynamic energy transaction plan, wherein receiving updated charging transaction information and updating the updated dynamic energy transaction plan with a new set of terms based on a most recently received updated charging transaction information is performed iteratively until the electric vehicle charging transaction is complete.

3. The computer implemented method of claim **1** further comprising:

generating a static energy transaction plan; and

completing the charging transaction in accordance with the static energy transaction plan, wherein the terms of the static charging transaction plan controls a remainder of the charging transaction without regard to updates or changes to the charging transaction information.

4. The computer implemented method of claim **1** wherein the charging transaction information comprises a set of preferences for the set of principals, wherein the set of preferences comprises a subset of preferences for each principal in the set of principals, wherein a preference in the set of preferences specifies a parameter of the charging transaction that is to be minimized, maximized, or optimized.

5. The computer implemented method of claim **1** wherein the first set of terms comprises a first set of charging transaction time driven event sequences, and wherein the second set of terms comprises a second set of charging transaction time driven event sequences.

6. The computer implemented method of claim **1** wherein the charging transaction information comprises current state information describing a current state of one or more devices associated with the electric vehicle and the charging station.

7. The computer implemented method of claim **1** wherein the charging transaction information comprises device capabilities information, wherein the device capabilities information describes the capabilities of devices associated with at least one of the electric vehicle and the charging station.

8. The computer implemented method of claim **1** wherein the dynamic energy transaction plan further comprises information describing incentives associated with the charging transaction, wherein an incentive is a benefit or reward.

9. The computer implemented method of claim **4** wherein each preference in the set of preferences is associated with a weighting value and wherein generating the dynamic energy transaction plan further comprises:

identifying the weighting value associated with each preference in the set of preferences, wherein the weighting indicates a priority of each preference relative to other preferences in the set of preferences; and

generating the updated energy transaction plan to maximize, minimize or optimize each preference in the set of preferences in accordance with the weighting value associated with the each preference in the set of preferences.

10. A computer program product comprising:

a computer usable medium including computer usable program code for generating a dynamic energy transaction plan for governing an electric vehicle charging transaction, the computer program product comprising:

computer usable program code for generating a dynamic energy transaction plan based on charging transaction information, wherein the dynamic energy transaction plan comprises an identification of an electric vehicle, an identification of a principal in a set of principals to pay for a charging transaction, an identification of at least one electric energy provider associated with the charging transaction, an owner of a charging station, and a first set of terms, wherein an initial portion of the charging transaction is controlled in accordance with the first set of terms of the dynamic energy transaction plan;

computer usable program code for receiving updated charging transaction information during execution of the charging transaction; and

computer usable program code for updating the dynamic energy transaction plan based on the updated charging transaction information to form an updated dynamic energy transaction plan, wherein the updated dynamic energy transaction plan comprises a second set of terms, and wherein a second portion of the charging transaction is implemented in accordance with the second set of terms in the updated dynamic energy transaction plan.

11. The computer program product of claim **10** wherein the updated charging transaction information is a first set of updated charging transaction information, and further comprising:

computer usable program code for receiving a next set of updated charging transaction information during execution of the charging transaction; and

computer usable program code for updating the updated dynamic energy transaction plan with a new set of terms based on the next set of updated charging transaction information, wherein a portion of a remainder of the charging transaction is implemented in accordance with the new set of terms in the updated dynamic energy transaction plan, wherein receiving updated charging transaction information and updating the updated dynamic energy transaction plan with a new set of terms based on a most recently received updated charging transaction information is performed iteratively until the electric vehicle charging transaction is complete.

12. The computer program product of claim **10** further comprising:

computer usable program code for generating a static energy transaction plan; and

computer usable program code for completing the charging transaction in accordance with the static energy transaction plan, wherein the terms of the static charging transaction plan controls a remainder of the charging transaction without regard to updates or changes to the charging transaction information.

13. The computer program product of claim **10** wherein the charging transaction information comprises a set of preferences for the set of principals, wherein the set of preferences comprises a subset of preferences for each principal in the set of principals, wherein a preference in the set of preferences specifies a parameter of the charging transaction that is to be minimized, maximized, or optimized.

14. The computer program product of claim **10** wherein the charging transaction information comprises current state information describing a current state of one or more devices associated with the electric vehicle and the charging station.

15. The computer program product of claim **10** wherein the charging transaction information comprises device capabilities information, wherein the device capabilities information describes the capabilities of devices associated with at least one of the electric vehicle and the charging station.

16. The computer program product of claim **10** wherein the dynamic energy transaction plan further comprises information describing incentives associated with the charging transaction, wherein an incentive is a benefit or reward.

17. An apparatus comprising:

a bus system;

a communications system coupled to the bus system;

a memory connected to the bus system, wherein the memory includes computer usable program code; and

a processing unit coupled to the bus system, wherein the processing unit executes the computer usable program code to generate a dynamic energy transaction plan based on the charging transaction information, wherein the dynamic energy transaction plan comprises an identification of an electric vehicle, an identification of a principal in a set of principals to pay for the charging transaction, an identification of at least one electric energy provider associated with the charging transaction, an owner of the charging station, and a first set of terms, wherein an initial portion of the charging transaction is controlled in accordance with the first set of terms of the dynamic energy transaction plan; receive updated charging transaction information during execution of the charging transaction; and update the dynamic energy transaction plan based on the updated charging transaction information to form an updated dynamic energy transaction plan, wherein the updated dynamic energy transaction plan comprises a second set of terms, and wherein a second portion of the charging transaction is implemented in accordance with the second set of terms in the updated dynamic energy transaction plan.

18. The apparatus of claim **17** wherein the processor unit further executes the computer usable program code to receive a next set of updated charging transaction information during execution of the charging transaction; and update the updated dynamic energy transaction plan with a new set of terms based on the next set of updated charging transaction information, wherein a portion of a remainder of the charging transaction is implemented in accordance with the new set of terms in the updated dynamic energy transaction plan, wherein receiving updated charging transaction information and updating the updated dynamic energy transaction plan with a new set of terms based on a most recently received updated charging transaction information is performed iteratively until the electric vehicle charging transaction is complete.

19. A system for generating a dynamic energy transaction plan for governing an electric vehicle charging transaction, the system comprising:

a dynamic energy transaction planner, wherein the dynamic energy transaction planner generates a dynamic energy transaction plan based on charging transaction information;

the dynamic energy transaction plan, wherein the dynamic energy transaction plan comprises an identification of an electric vehicle, an identification of a principal in a set of principals to pay for the charging transaction, an identification of at least one electric energy provider associated with the charging transaction, an owner of a charging station, and a first set of terms, wherein an initial portion of the charging transaction is controlled in accordance with the first set of terms of the dynamic energy transaction plan;

a set of charging transaction information sources, wherein the set of charging transaction information sources monitors for changes to the charging transaction information, and wherein the set of charging transaction information sources sends updated charging transaction information to the dynamic energy transaction planner during execution of the charging transaction in response to identifying changes to the charging transaction information, wherein the dynamic energy transaction planner updates the dynamic energy transaction plan based on the updated charging transaction information to form an updated dynamic energy transaction plan, wherein the updated dynamic energy transaction plan comprises a second set of terms, and wherein a second portion of the charging transaction is implemented in accordance with the second set of terms in the updated dynamic energy transaction plan.

20. The system of claim **19** wherein the set of charging transaction information sources comprises:

an energy preference service, wherein the energy preference service sends an updated set of preferences for the set of principals to the dynamic energy transaction planner to form the updated charging transaction information.

21. The system of claim **19** wherein the set of charging transaction information sources comprises:

a device capabilities service, wherein the device capabilities service sends updated device capabilities information for the electric vehicle and the charging station to the dynamic energy transaction planner to form the updated charging transaction information.

22. The system of claim **19** wherein the set of charging transaction information sources comprises:

a current state device, wherein the current state device sends updated current state information for the electric vehicle and the charging station to the dynamic energy transaction planner to form the charging transaction information.

23. A computer implemented method of generating a dynamic energy transaction plan for governing electric vehicle charging transactions, the computer implemented method comprising:

receiving an updated set of charging transaction information from a set of charging transaction information sources, wherein the charging transaction information sources comprises an energy preference service, and wherein the updated set of charging transaction information comprises an updated set of preferences for a set of principals associated with a charging transaction;

retrieving an original energy transaction plan having a first set of terms, wherein the original energy transaction plan is being utilized by an execution engine to control the charging transaction;

modifying the original energy transaction plan using the updated set of charging transaction information to form an updated energy transaction plan, wherein the updated energy transaction plan comprises a second set of terms; and

sending the updated energy transaction plan to the execution engine, wherein the execution engine disregards the original energy transaction plan and utilized the updated energy transaction plan to control a remaining portion of the electric vehicle charging transaction.

24. The computer implemented method of claim **23** wherein the updated set of charging transaction information is a first updated set of charging transaction information, and further comprising:

receiving a next set of updated charging transaction information during the charging transaction; and

updating the updated energy transaction plan with a new set of terms based on the next set of updated charging transaction information, wherein a portion of a remainder of the charging transaction is implemented in accordance with the new set of terms in the updated dynamic energy transaction plan, wherein receiving updated charging transaction information and updating the updated dynamic energy transaction plan with a new set of terms based on a most recently received updated charging transaction information is performed iteratively until the charging transaction is complete.

25. The computer implemented method of claim **23** wherein the updated charging transaction information comprises current state information describing a current state of one or more devices associated with the electric vehicle and the charging station.

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