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Delivery vehicle temperature management systems and methods

Abstract

A refrigerated delivery vehicle is disclosed. The vehicle may include a refrigerated cargo zone configured to store a plurality of delivery packages. The refrigerated cargo zone may include an access door. The vehicle may further include a detection unit configured to detect a user movement in the refrigerated cargo zone and an access door movement when the vehicle may be traversing a delivery route or parked. The vehicle may further include a processor configured to obtain inputs from the detection unit, and determine a user inefficiency parameter based on the inputs. The processor may be further configured to compare the user inefficiency parameter with a threshold inefficiency parameter. The processor may output a notification instructing the user to reduce the user movement or the access door movement when the user inefficiency parameter may be greater than the threshold inefficiency parameter.

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Background/Summary

FIELD
(1) The present disclosure relates to delivery vehicle temperature management systems and methods and more particularly to systems and methods to facilitate efficient temperature management in a refrigerated delivery vehicle based on delivery personnel actions.
BACKGROUND
(2) Refrigerated cargo trucks or refrigerated tractor trailers are typically used to transport perishable delivery items that may need cold storage temperature. For example, such cargo trucks are used to transport food items, medicines, or other similar items that require cold temperature during transportation.
(3) To ensure that the items stored in a refrigerated zone of a cargo truck do not perish, it is important to maintain a cold/desired temperature in the refrigerated zone. The temperature in the refrigerated zone may increase above the desired temperature when there may be a fault in a cargo truck cooling system, and/or when a vehicle user may be unloading (or loading) delivery items from the refrigerated zone via a refrigerated zone access door. The cargo truck may be required to expend excess energy to cool the temperature in the refrigerated zone back to the desired temperature, when such instances occur. Excess energy usage may affect vehicle performance cause, and hence cause inconvenience to the vehicle user and/or a fleet operator.
(4) Thus, there is a need for system and method to facilitate efficient management of temperature in a refrigerated cargo truck.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) The detailed description is set forth with reference to the accompanying drawings. The use of the same reference numerals may indicate similar or identical items. Various embodiments may utilize elements and/or components other than those illustrated in the drawings, and some elements and/or components may not be present in various embodiments. Elements and/or components in the figures are not necessarily drawn to scale. Throughout this disclosure, depending on the context, singular and plural terminology may be used interchangeably.
(2) FIG. **1** depicts an example environment in which techniques and structures for providing the systems and methods disclosed herein may be implemented.
(3) FIG. **2** depicts a block diagram of an example system to facilitate temperature management in a refrigerated delivery vehicle in accordance with the present disclosure.
(4) FIG. **3** depicts example cargo zone areas in a refrigerated cargo zone of a refrigerated delivery vehicle in accordance with the present disclosure.
(5) FIG. **4** depicts a flow diagram of an example first method to facilitate temperature management in a refrigerated delivery vehicle in accordance with the present disclosure.
(6) FIG. **5** depicts a flow diagram of an example second method to facilitate temperature management in a refrigerated delivery vehicle in accordance with the present disclosure.
DETAILED DESCRIPTION
(7) Overview
(8) The present disclosure describes system and method to facilitate temperature management in a refrigerated delivery vehicle. The vehicle may include a refrigerated cargo zone that may be configured to store a plurality of delivery packages including perishable items such as food products, medicines, and/or the like. The refrigerated cargo zone may include an access door using which a vehicle user may load/unload the delivery packages to/from the refrigerated cargo zone.

The system may obtain vehicle information, delivery package information, and delivery route information before the vehicle commences a delivery trip. Responsive to obtaining the information, the system may calculate an energy that may be required by the vehicle to traverse the delivery trip and maintain a desired cool temperature (that may be preset by a fleet operator) in the refrigerated cargo zone based on the obtained information. The system may further compare the calculated energy with an energy level that may be present in the vehicle before the vehicle commences the delivery trip. The system may output a charge notification instructing the vehicle user to charge/refill the vehicle when the energy level present in the vehicle may be less than the calculated energy.

(9) In further aspects, when the vehicle may be traversing the delivery trip or parked during transit, the system may obtain inputs associated with user movement in the refrigerated cargo zone and access door movement from vehicle sensors and/or vehicle interior cameras. The system may further determine a user inefficiency parameter (or user behavior parameter) based on the obtained inputs. The system may then compare the user inefficiency parameter with a threshold inefficiency parameter (that may be pre-set by the fleet operator). The system may output a notification instructing the user to reduce the user movement and/or the access door movement when the system determines that the user inefficiency parameter may be greater than the threshold inefficiency parameter. For example, the system may output the notification when the system determines that the user may be opening the access door frequently or more than a permissible count of times, which may result in loss of cooling in the refrigerated cargo zone. As another example, the system may output the notification when the system determines that the user may be opening the access door for a time duration that may be greater than a permissible time duration.

(10) In some aspects, the system may additionally transmit the notification, and/or inputs associated with the user movement and the access door movement, to a user device or a server associated with the fleet operator. The fleet operation may plan training program(s) and/or rewards for the vehicle user based on the information received from the system.

(11) The system may be additionally configured to recommend modifications in delivery package storage locations in the refrigerated cargo zone based on the inputs associated with the user movement and the access door movement, and the delivery package information. Specifically, the system may recommend modifications in the delivery package storage locations such that user movement in the refrigerated cargo zone and/or the access door movement may be reduced. For example, the system may recommend moving a heavy delivery package closer to or in proximity to the access door, so that the user movement in the refrigerated cargo zone to load/unload such heavy delivery package may be reduced.

(12) The system may be further configured to determine one or more areas in the refrigerated cargo zone that may have non-uniform temperatures, based on inputs obtained from vehicle sensors and/or interior vehicle infrared cameras. The system may increase cooling of such area(s) by using a vehicle cooling unit, and/or may output a maintenance notification instructing the user to get such area(s) repaired.

(13) In additional aspects, the system may be configured to determine if one or more delivery packages may be left in the refrigerated cargo zone when the delivery vehicle may have finished the delivery trip. The system may continue to operate the vehicle cooling unit when the system determines that a delivery package may be left in the refrigerated cargo zone. The system may further output a notification instructing the user to remove the delivery package. In addition, when the user desires to cool the refrigerated cargo zone for a predetermined time duration after the delivery vehicle finishes the delivery trip, the system may calculate an energy required to cool the refrigerated cargo zone for the predetermined time duration. The system may then compare the calculated energy with an energy level that may be present in the vehicle after the vehicle finishes the delivery trip. The system may output the charge notification instructing the user to charge/refill the vehicle when the energy level present in the vehicle may be less than the calculated energy.

(14) The present disclosure discloses system and method to facilitate temperature management in a refrigerated delivery vehicle. The system outputs a charge notification instructing the user to charge/refill the vehicle when the system determines that the vehicle may not have enough energy to traverse the delivery trip. In this manner, the system prevents any inconvenience the user may experience when the vehicle may be in transit on the delivery trip. The system further outputs instructions facilitating the user to reduce user movement in the refrigerated cargo zone and/or the access door movement, thus ensuring that minimal cooling is lost during transit. The system further identifies areas in the refrigerated cargo zone that may have non-uniform temperatures, thus facilitating the user in repairing areas that may be causing loss of cooling in the refrigerated cargo zone.
(15) These and other advantages of the present disclosure are provided in detail herein.
Illustrative Embodiments
(16) The disclosure will be described more fully hereinafter with reference to the accompanying drawings, in which example embodiments of the disclosure are shown, and not intended to be limiting.
(17) FIG. **1** depicts an example environment **100** in which techniques and structures for providing the systems and methods disclosed herein may be implemented. The environment **100** may include a delivery vehicle **105** that may be a truck, a van (including walk-in vans), a truck trailer, and/or the like. The vehicle **105** may include any powertrain such as, for example, a gasoline engine, one or more electrically-actuated motor(s), a hybrid system, etc. The vehicle **105** may be a Battery Electric Vehicle (BEV) or an Internal Combustion Engine (ICE) vehicle. Furthermore, the vehicle **105** may be a manually driven vehicle and/or be configured and/or programmed to operate in a fully autonomous (e.g., driverless) mode (e.g., Level-5 autonomy) or in one or more partial autonomy modes which may include driver assist technologies.
(18) In some aspects, the vehicle **105** may be a refrigerated cargo truck or a refrigerated tractor trailer that may include a refrigerated cargo zone **110**. The vehicle **105** may be configured to transport perishable items such as food products, medicines, etc. by storing the items in the refrigerated cargo zone **110**. Specifically, the refrigerated cargo zone **110** may be configured to store a plurality of delivery packages that may include the perishable items. The vehicle **105** may be configured to maintain a desired cool temperature in the refrigerated cargo zone **110** by using a vehicle cooling unit (not shown). The vehicle cooling unit may be a vehicle heating, ventilation, and air-conditioning (HVAC) system, a third party cooling system that may be installed in the vehicle **105**, or a combination thereof.
(19) The refrigerated cargo zone **110** may include an access door **115** using which a vehicle user (shown as user **210** in FIG. **2**) may access the refrigerated cargo zone **110**. Specifically, by opening the access door **115**, the user may enter the refrigerated cargo zone **110** and may load/unload packages to/from the refrigerated cargo zone **110**.
(20) The vehicle **105** may include a temperature management system (shown as temperature management system **216** in FIG. **2**) that may be configured to facilitate efficient management of temperature in the refrigerated cargo zone **110**, so that the perishable items stored in the refrigerated cargo zone **110** do not perish. For example, in an exemplary aspect, before the vehicle **105** commences a delivery trip on a delivery route (e.g., a delivery route **120**), the temperature management system ("system") may estimate whether the vehicle **105** has enough energy and/or fuel to traverse the entire delivery route, and maintain the desired cool temperature in the refrigerated cargo zone **110**. Responsive to determining that the vehicle **105** may not have enough energy and/or fuel, the system may transmit a notification to a user device and/or a vehicle Human-Machine Interface instructing the user to charge the vehicle **105** (if the vehicle **105** is a BEV) or refill the fuel (if the vehicle **105** is an ICE vehicle).
(21) In some aspects, to estimate whether the vehicle **105** has enough energy and/or fuel to traverse the delivery route, the system may obtain vehicle information, delivery route information, and

delivery package information. The system may obtain the information described here from a vehicle memory (shown as memory **250** in FIG. **2**), the user device, and/or one or more external server(s) (shown as servers **206** in FIG. **2**). The vehicle information may include, but is not limited to, vehicle weight, refrigerated cargo zone size/dimensions, and/or the like. The delivery route information may include, but is not limited to, a delivery route or travel distance, locations of a plurality of waypoints on the delivery route **120**, a desired refrigerated cargo zone temperature in the delivery route **120**, ambient weather condition or solar energy/load information in the delivery route **120**, estimated vehicle speed in the delivery route **120**, and/or the like. The delivery package information may include, but is not limited to, a count of the plurality of delivery packages stored in the refrigerated cargo zone **110**, a delivery schedule of each delivery package, weight, size and content of each delivery package, a storage location of each delivery package in the refrigerated cargo zone **110**, specific temperature requirement (if any) for each delivery package, and/or the like. In some aspects, the system may obtain some information described above from historical vehicle usage information or pattern that may be stored in the vehicle memory.

(22) Responsive to obtaining the vehicle information, the delivery route information, and the delivery package information, the system may estimate a driving energy required by the vehicle **105** to travel the delivery route **120**, and a climate energy required by the vehicle **105** to maintain desired cool temperature in the refrigerated cargo zone **110** in the delivery route **120** based on the obtained information. The system may then calculate a total energy required by the vehicle **105** to traverse the delivery route **120** by adding the driving energy and the climate energy. The system may then compare the calculated total energy with a current energy that may be available in the vehicle **105** before the vehicle **105** commences the delivery trip. The system may output the notification (as described above) to charge/refill the vehicle **105** when the current energy is less than the calculated total energy. In some aspects, the system may calculate the total energy by adding a predefined buffer (e.g., 20%) to the sum of the driving energy and the climate energy, to ensure that the vehicle **105** has some energy available at the end of the delivery trip and/or to account for any unplanned instance (excess traffic or vehicle repair) that may be experienced by the vehicle **105** on the delivery route **120**.

(23) The system may be further configured to facilitate efficient management of temperature in the refrigerated cargo zone **110** when the vehicle **105** may be travelling on the delivery route **120**. For example, the system may use vehicle sensors and/or cameras to detect user movement in the refrigerated cargo zone **110** when the user loads/unloads the delivery packages to/from the refrigerated cargo zone **110** when the vehicle **105** may be traversing on the delivery route **120**. In addition, the system may use the vehicle sensors and/or the cameras to detect access door movement, e.g., a count of times the access door **115** may be opened by the user, a percentage of times the access door **115** may be fully opened by the user, a total time duration for which the access door **115** may be opened by the user over a predefined time duration on the delivery route **120**, and/or the like. Responsive to detecting the user movement and/or the access door movement, the system may determine "user performance" in managing temperature in the refrigerated cargo zone **110** based on the detected user and access door movements. The system may output one or more recommendation notifications to facilitate the user in efficiently managing temperature in the refrigerated cargo zone **110** when the determined user performance may be less than a predetermined expected user performance (that may be pre-set by, e.g., a fleet operator). For example, the system may output a notification to the user to close the access door **115** when the system determines that the user may have kept the access door **115** open for a time duration longer than a permissible time duration. As another example, the system may output a notification to the user instructing the user to reduce the count of times the user opens the access door **115** during loading/unloading operation when the system determines that the user opens the access door **115** frequently.

(24) In some aspects, the system may also transmit the determined user performance (or detected

user movement and access door movement information) to an external server that may be managed by the fleet operator. The fleet operator may use the received information to determine training needs for the user. In other aspects, the fleet operator may also use the received information to provide rewards to the user, e.g., if the user efficiently manages temperature in the refrigerated cargo zone **110** by reducing access door movement over a predetermined time duration (e.g., over 1 month, 3 months, 6 months, etc.).

(25) The system may be further configured to recommend adjustment of delivery package storage locations in the refrigerated cargo zone **110**, based on the detected user movement, the access door movement and the delivery package information. For example, the system may recommend the user to move heavy delivery packages and/or packages with early delivery schedule to be placed in proximity to the access door **115**, so that the user may limited user movement and access door movement during unloading operation of such packages.

(26) The system may be additionally configured to detect areas within the refrigerated cargo zone **110** where the temperature may be non-uniform or more than the desired temperature by using the vehicle sensors and/or the cameras. The system may increase cooling of such areas by using the cooling unit and/or vehicle air conditioning vents, responsive to detecting such areas with non-uniform temperature. The system may also check historical recorded temperature at such areas (that may be stored in the vehicle memory), and may transmit a maintenance notification to the user device and/or the vehicle HMI when the historical recorded temperature indicates that temperature may be historically non-uniform in such areas. The user may then get such areas checked for any refrigeration leaks or similar faults, responsive to receiving the maintenance notification.

(27) In further aspects, when the vehicle **105** completes the delivery trip (e.g., by traversing the delivery route **120**), the system may be configured to detect whether any delivery package may be left in the refrigerated cargo zone **110** by using the vehicle sensors and/or the cameras. Responsive to detecting that a delivery package may be left in the refrigerated cargo zone **110**, the system may keep the cooling unit switched ON and may transmit an alert notification to the user instructing the user to remove the delivery package from the refrigerated cargo zone **110**.

(28) These and other operations performed by the system are described in detail in conjunction with FIG. **2**.

(29) The vehicle **105**, the user and/or the system implements and/or performs operations, as described here in the present disclosure, in accordance with the owner manual and safety guidelines.

(30) FIG. **2** depicts a block diagram of an example system **200** to facilitate temperature management in a refrigerated delivery vehicle **202** in accordance with the present disclosure. While describing FIG. **2**, references may be made to FIG. **3**.

(31) The system **200** may include the vehicle **202**, a user device **204**, and one or more servers **206** communicatively coupled with each other via one or more networks **208**. The vehicle **202** may be same as the vehicle **105** described in conjunction with FIG. **1**. The user device **204** may be associated with a vehicle operator or user **210**. The user device **204** may be, for example, a mobile phone, a laptop, a computer, a tablet, a wearable device, or any other similar device with communication capabilities. The server(s) **206** may be part of a cloud-based computing infrastructure and may be associated with and/or include a Telematics Service Delivery Network (SDN) that provides digital data services to the vehicle **202** and other vehicles (not shown in FIG. **2**) that may be part of a commercial vehicle fleet. In this case, a vehicle fleet operator (not shown) may operate the server(s) **206**. In additional aspects, the server(s) **206** may store vehicle information associated with the vehicle **202**, the delivery route information associated with the delivery route **120**, and delivery package information associated with the plurality of packages that may be stored in the refrigerated cargo zone **110**. The server(s) **206** may be configured to transmit the vehicle information, the delivery route information, and the delivery package information to the vehicle **202**, via the network(s) **208**, at a predefined frequency or at the start of a delivery trip of the

vehicle **202**. Examples of the vehicle information, the delivery route information and the delivery package information are already described above in conjunction with FIG. **1**.

(32) The network(s) **208** illustrates an example communication infrastructure in which the connected devices discussed in various embodiments of this disclosure may communicate. The network(s) **208** may be and/or include the Internet, a private network, public network or other configuration that operates using any one or more known communication protocols such as, for example, transmission control protocol/Internet protocol (TCP/IP), Bluetooth®, BLE®, Wi-Fi based on the Institute of Electrical and Electronics Engineers (IEEE) standard 802.11, UWB, and cellular technologies such as Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA), High-Speed Packet Access (HSPDA), Long-Term Evolution (LTE), Global System for Mobile Communications (GSM), and Fifth Generation (5G), to name a few examples.

(33) The vehicle **202** may include a plurality of units including, but not limited to, an automotive computer **212**, a Vehicle Control Unit (VCU) **214**, and a temperature management system **216**. The VCU **214** may include a plurality of Electronic Control Units (ECUs) **218** disposed in communication with the automotive computer **212**.

(34) The user device **204** may connect with the automotive computer **212** and/or the temperature management system **216** via the network **208**, which may communicate via one or more wireless connection(s), and/or may connect with the vehicle **202** directly by using near field communication (NFC) protocols, Bluetooth® protocols, Wi-Fi, Ultra-Wide Band (UWB), and other possible data connection and sharing techniques.

(35) In some aspects, the automotive computer **212** and/or the temperature management system **216** may be installed in a vehicle engine compartment (or elsewhere in the vehicle **202**), in accordance with the disclosure. Further, the automotive computer **212** may operate as a functional part of the temperature management system **216**. The automotive computer **212** may be or include an electronic vehicle controller, having one or more processor(s) **220** and a memory **222**. Moreover, the temperature management system **216** may be separate from the automotive computer **212** (as shown in FIG. **2**) or may be integrated as part of the automotive computer **212**.

(36) The processor(s) **220** may be disposed in communication with one or more memory devices disposed in communication with the respective computing systems (e.g., the memory **222** and/or one or more external databases not shown in FIG. **2**). The processor(s) **220** may utilize the memory **222** to store programs in code and/or to store data for performing aspects in accordance with the disclosure. The memory **222** may be a non-transitory computer-readable memory storing a temperature management program code. The memory **222** can include any one or a combination of volatile memory elements (e.g., dynamic random-access memory (DRAM), synchronous dynamic random-access memory (SDRAM), etc.) and can include any one or more nonvolatile memory elements (e.g., erasable programmable read-only memory (EPROM), flash memory, electronically erasable programmable read-only memory (EEPROM), programmable read-only memory (PROM), etc.).

(37) In accordance with some aspects, the VCU **214** may share a power bus with the automotive computer **212** and may be configured and/or programmed to coordinate the data between vehicle **202** systems, connected servers (e.g., the server(s) **206**), and other vehicles (not shown in FIG. **2**) operating as part of a vehicle fleet. The VCU **214** can include or communicate with any combination of the ECUs **218**, such as, for example, a Body Control Module (BCM) **224**, an Engine Control Module (ECM) **226**, a Transmission Control Module (TCM) **228**, a telematics control unit (TCU) **230**, a Driver Assistances Technologies (DAT) controller **232**, etc. The VCU **214** may further include and/or communicate with a Vehicle Perception System (VPS) **234**, having connectivity with and/or control of one or more vehicle sensory system(s) **236** (or a “detection unit”). The vehicle sensory system **236**/detection unit may include one or more vehicle sensors including, but not limited to, a Radio Detection and Ranging (RADAR or “radar”) sensor configured for detection and localization of objects inside and outside the vehicle **202** using radio

waves, sitting area buckle sensors, sitting area sensors, a Light Detecting and Ranging (LiDAR or "lidar") sensor, door position sensors, proximity sensors, temperature sensors, wheel sensors, weight sensors, ambient weather sensors, vehicle interior and exterior cameras, infrared cameras, etc. In some aspects, the door position sensors may be configured to determine position of the access door **115** (e.g., whether the access door **115** is closed, partially open or fully open). The infrared cameras and/or the temperature sensors may be configured to determine real-time temperature in various areas/portions of the refrigerated cargo zone **110**. Specifically, the refrigerated cargo zone **110** may include a plurality of cargo zone areas (shown as cargo zone areas **305***a-n* in FIG. **3**), and the infrared cameras and/or the temperature sensors may be configured to determine real-time temperature in each cargo zone area when the vehicle **202** travels on the delivery route **120**.

(38) In some aspects, the VCU **214** may control vehicle operational aspects and implement one or more instruction sets received from the user device **204**, from one or more instruction sets stored in the memory **222**, including instructions operational as part of the temperature management system **216**.

(39) The TCU **230** can be configured and/or programmed to provide vehicle connectivity to wireless computing systems onboard and off board the vehicle **202**, and may include a Navigation (NAV) receiver **238** for receiving and processing a GPS signal, a BLE® Module (BLEM) **240**, a Wi-Fi transceiver, a UWB transceiver, and/or other wireless transceivers (not shown in FIG. **2**) that may be configurable for wireless communication between the vehicle **202** and other systems (e.g., a vehicle key fob, not shown in FIG. **2**), computers, and modules. The TCU **230** may additionally have cellular communication capabilities that may enable the TCU **230** to communicatively couple with one or more external devices. The TCU **230** may be disposed in communication with the ECUs **218** by way of a bus.

(40) The ECUs **218** may control aspects of vehicle operation and communication using inputs from human drivers, inputs from an autonomous vehicle controller, the temperature management system **216**, and/or via wireless signal inputs received via the wireless connection(s) from other connected devices, such as the user device **204**, the server(s) **206**, among others.

(41) The BCM **224** generally includes integration of sensors, vehicle performance indicators, and variable reactors associated with vehicle systems, and may include processor-based power distribution circuitry that can control functions associated with the vehicle body such as lights, windows, security, camera(s), audio system(s), speakers, door locks and access control, and various comfort controls. The BCM **224** may also operate as a gateway for bus and network interfaces to interact with remote ECUs (not shown in FIG. **2**). In some aspects, the BCM **224** may be additionally configured to control operation of a vehicle cooling unit (not shown) that may cool the plurality of cargo zone areas **305***a-n* in the refrigerated cargo zone **110**. The vehicle cooling unit may include an external (e.g., a third-party) refrigeration system that may be installed in the vehicle **202** and/or the vehicle HVAC system, and a plurality of vents that may cool the plurality of cargo zone areas **305***a-n* to a temperature desired (e.g., the desired refrigerated cargo zone temperature) and pre-set by the user **210** or the fleet operator.

(42) The DAT controller **232** may provide Level-1 through Level-3 automated driving and driver assistance functionality that can include, for example, active parking assistance, vehicle backup assistance, adaptive cruise control, and/or lane keeping, among other features. The DAT controller **232** may also provide aspects of user and environmental inputs usable for user authentication.

(43) In some aspects, the automotive computer **212** may connect with an infotainment system **242** and a speaker **244**. The automotive computer **212** and/or the temperature management system **216** may control operation of the speaker **244** via the BCM **224**. The infotainment system **242** may include a touchscreen interface portion, and may include voice recognition features, biometric identification capabilities that can identify users based on facial recognition, voice recognition, fingerprint identification, or other biological identification means. In other aspects, the

infotainment system **242** may be further configured to receive user instructions via the touchscreen interface portion, and/or display notifications, navigation maps, etc. on the touchscreen interface portion.

(44) The computing system architecture of the automotive computer **212**, the VCU **214**, and/or the temperature management system **216** may omit certain computing modules. It should be readily understood that the computing environment depicted in FIG. **2** is an example of a possible implementation according to the present disclosure, and thus, it should not be considered limiting or exclusive.

(45) In accordance with some aspects, the temperature management system **216** may be integrated with and/or executed as part of the ECUs **218**. The temperature management system **216**, regardless of whether it is integrated with the automotive computer **212** or the ECUs **218**, or whether it operates as an independent computing system in the vehicle **202**, may include a transceiver **246**, a processor **248**, and a computer-readable memory **250**.

(46) The transceiver **246** may be configured to receive information/inputs from one or more external devices or systems, e.g., the user device **204**, the server(s) **206**, and/or the like via the network **208**. Further, the transceiver **246** may transmit notifications (e.g., alert/alarm signals) to the external devices or systems. In addition, the transceiver **246** may be configured to receive information/inputs from vehicle **202** components such as the infotainment system **242**, the sensory system **236**, and/or the like. Further, the transceiver **246** may transmit notifications (e.g., alert/alarm signals) to the vehicle **202** components such as the infotainment system **242**, the speaker **244**, etc.

(47) The processor **248** and the memory **250** may be same as or similar to the processor **220** and the memory **222**, respectively. Specifically, the processor **248** may utilize the memory **250** to store programs in code and/or to store data for performing aspects in accordance with the disclosure. The memory **250** may be a non-transitory computer-readable memory storing the temperature management code. In some aspects, the memory **250** may additionally store the vehicle information, the delivery route information, and the delivery package information described above in conjunction with FIG. **1**. The memory **250** may be additionally configured to store historical vehicle usage information and/or historical user movement information associated with historical movement patterns of the user **210** in the refrigerated cargo zone **110** (or another cargo zone of a different vehicle). The memory **250** may receive (and aggregate) the historical vehicle usage information and/or the historical user movement information from the server(s) **206** and/or the VCU **214**. In some aspects, the historical vehicle usage information may include information associated with historical delivery routes traversed by the vehicle **202**, average distance travelled per delivery route, historical waypoints on the delivery routes, weight/size/dimensions of delivery packages historically delivered by the vehicle **202**, average vehicle speeds on the delivery routes, historical vehicle energy consumption pattern on the delivery routes, and/or the like. The historical user movement information may include information associated with typical pattern of user movement in the refrigerated cargo zone **110** to move delivery packages from the plurality of cargo zone areas **305***a-n* to the access door **115**, historical count of times the user **210** opened the access door **115** per delivery trip, historical time durations for which the user **210** opened the access door **115** per delivery trip, historical percentage of times the user **210** fully opened the access door **115** per delivery trip, average time duration per delivery trip the user **210** moves in the refrigerated cargo zone **110**, and/or the like.

(48) In operation, the transceiver **246** may receive the vehicle information, the delivery route information, and the delivery package information from the server **206** and/or the user device **204** via the network **208**. The transceiver **246** may additionally receive some part of the vehicle information from the VCU **214**. In some aspects, the transceiver **246** may receive the vehicle information, the delivery route information, and the delivery package information a predefined time duration (e.g., 15 minutes or 30 minutes) before the vehicle **202** commences a delivery trip. The transceiver **246** may send the received information to the memory **250** for storage purpose.

(49) The processor **248** may obtain the vehicle information, the delivery route information, and the delivery package information from the memory **250**. The processor **248** may further obtain the historical vehicle usage information and the historical user movement information from the memory **250**. Responsive to obtaining the information, the processor **248** may estimate the driving energy required by the vehicle **202** to travel the delivery route **120** and the climate energy required by the vehicle **202** to cool the refrigerated cargo zone **110** in the delivery route **120** based on the obtained information, as described above in conjunction with FIG. **1**. The processor **248** may further calculate a total required energy by adding the driving energy and the climate energy, and adding a buffer energy (e.g., 10-20% of the sum of the driving energy and the climate energy). Responsive to calculating the total required energy, the processor **248** may obtain a current vehicle battery state of charge (SOC) level (if the vehicle **202** is a BEV) or a fuel level (if the vehicle **202** is an ICE vehicle) from the VCU **214**. Stated another way, the processor **248** may obtain a current vehicle energy level available in the vehicle **202** before the vehicle **202** commences the delivery trip, responsive to calculating the total required energy. The processor **248** may then compare the total required energy with the current vehicle energy level. The processor **248** may output a vehicle charge notification, via the transceiver **246**, instructing the user **210** to charge or refill the vehicle **202** when the current vehicle energy level may be less than the total required energy. The processor **248** may output the vehicle charge notification via the user device **204**, the server(s) **206**, the infotainment system **242** and/or the speaker **244**.
(50) The vehicle **202** may commence the delivery trip when the user **210** charges/refills the vehicle **202**, or when the current vehicle energy level may be equivalent to or greater than the total required energy. When the vehicle **202** may be travelling on/traversing the delivery route **120** or when the vehicle **202** may be parked on the delivery route **120**, the processor **248** may obtain the real-time temperature in each cargo zone area of the refrigerated cargo zone **110** from the sensory system(s) **236**. An exemplary interior view of the refrigerated cargo zone **110** including a plurality of cargo zone areas **305***a*, **305***b*, **305***c*, **305***n* (cargo zone areas **305***a-n*) is shown in FIG. **3**. The sensory system(s) **236** may be configured to determine the real-time temperature in each cargo zone area **305***a-n*, and may transmit the determined real-time temperature to the processor **248** at a predefined frequency (e.g., every 5 or 10 seconds) when the vehicle **202** may be travelling on the delivery route **120**.
(51) Responsive to obtaining the real-time temperature, the processor **248** may compare the real-time temperature for each cargo zone area **305***a-n* with the desired refrigerated cargo zone temperature (that may be part of the delivery route information, as described above). The processor **248** may determine that a specific cargo zone area (e.g., the cargo zone area **305***a*) may have non-uniform temperature when the real-time temperature at the cargo zone area **305***a* may be more (or less) than the desired refrigerated cargo zone temperature. Responsive to determining that the cargo zone area **305***a* may have non-uniform temperature, the processor **248** may send a command to the BCM **224** to cause the vehicle cooling unit to increase or activate cooling at the cargo zone area **305***a*. In some aspects, each cargo zone area **305***a-n* may have a different associated desired temperature. In this case, the processor **248** may compare the real-time temperature at the cargo zone area **305***a* with the associated desired temperature to determine that the cargo zone area **305***a* may have non-uniform temperature.
(52) In further aspects, responsive to determining that the cargo zone area **305***a* may have non-uniform temperature, the processor **248** may obtain historical temperature values/information for the cargo zone area **305***a* (that may be stored in the memory **250**) from the memory **250**. The processor **248** may then determine whether the cargo zone area **305***a* historically has non-uniform temperature based on the obtained historical temperature information. Stated another way, based on the historical temperature information, the processor **248** may determine if one or more historical temperature values associated with the cargo zone area **305***a* may be greater (or less) than the desired refrigerated cargo zone temperature. Responsive to determining that the cargo zone area

305*a* may historically have non-uniform temperature, the processor **248** may output, via the transceiver **246**, a maintenance notification indicating that the cargo zone area **305***a* may require repair or maintenance. In some aspects, the processor **248** may output the maintenance notification via the user device **204**, the server(s) **206**, the infotainment system **242** and/or the speaker **244**. Responsive to receiving/hearing the maintenance notification, the user **210** may check whether there may be leakage or any other fault in the cargo zone area **305***a*.

(53) In further aspects, when the vehicle **202** may be travelling on/traversing the delivery route **120** or when the vehicle **202** may be parked on the delivery route **120**, the processor **248** may obtain inputs associated with the user movement in the refrigerated cargo zone **110** and the access door movement from the sensory system(s) **236** over a predefined time duration (e.g., a time duration for which the vehicle **202** may be travelling on the delivery route **120**). Specifically, the processor **248** may obtain inputs associated with the user movement in the refrigerated cargo zone **110** from vehicle radar sensors and/or vehicle interior cameras. The inputs for the user movement may include information associated with a count of times the user **210** has entered the refrigerated cargo zone **110**, a count of times the user **210** has moved from each cargo zone area **305***a-n* to the access door **115**, a total time duration the user **210** has spent in the refrigerated cargo zone **110**, and/or the like. Similarly, the processor **248** may obtain inputs associated with the access door movement from the vehicle interior cameras and/or the door position sensors. The inputs for the access door movement may include information associated with a count of times the access door **115** may be opened by the user **210**, a percentage of times the access door **115** may be fully opened by the user **210**, a total time duration for which the access door **115** may be opened by the user **210**, and/or the like.

(54) Responsive to obtaining the inputs associated with the user movement and the access door movement over the predefined time duration, the processor **248** may determine a user inefficiency parameter or a user behavior parameter based on the obtained inputs. The user inefficiency parameter may be associated with user behavior in the refrigerated cargo zone **110** that may affect temperature in the refrigerated cargo zone **110**. For example, the user inefficiency parameter may be associated with a time duration the user **210** spends in the refrigerated cargo zone **110** leaving the access door **115** open (as shown in FIG. **3**), which may result in increase of temperature or loss of cooling in the refrigerated cargo zone **110**. As another example, the user inefficiency parameter may be associated with the total time duration the user **210** has spent in the refrigerated cargo zone **110**, resulting in increase of thermal mass in the refrigerated cargo zone **110**. A person ordinarily skilled in the art may appreciate that if the user **210** spends considerable time duration in the refrigerated cargo zone **110** (in addition to leaving the access door **115** open), the vehicle cooling unit may be required to expend excess energy to decrease the temperature back to the desired temperature value (i.e., cool the refrigerated cargo zone **110**). Therefore, an efficient user may spend less time in the refrigerated cargo zone **110** and may keep the access door **115** closed (as much as possible) during delivery package loading/unloading process.

(55) In an exemplary aspect, the user inefficiency parameter may be a linear average or a weighted average of the count of times the access door **115** may be opened by the user **210**, the percentage of times the access door **115** may be fully opened by the user **210**, the total time duration for which the access door **115** may be opened by the user **210**, the count of times the user **210** has entered the refrigerated cargo zone **110**, the count of times the user **210** has moved from each cargo zone area **305***a-n* to the access door **115**, and the total time duration the user **210** has spent in the refrigerated cargo zone **110**. In other aspects, each aspect/information described above (e.g., the count of times the access door **115** may be opened, the percentage of times the access door **115** may be fully opened, etc.) may be associated with a different user inefficiency parameter.

(56) Responsive to determining the user inefficiency parameter, the processor **248** may fetch a threshold inefficiency parameter from the server **206** or the memory **250** (that may pre-store in the memory **250**). In some aspects, the threshold inefficiency parameter may be associated with an

expected or minimum user performance or user behavior in the refrigerated cargo zone **110** that may be pre-set by the fleet operator. As an example, the threshold inefficiency parameter may be associated with a threshold (or expected) count of times the access door **115** may be opened by the user **210**, a threshold percentage of times the access door **115** may be fully opened by the user **210**, a threshold total time duration for which the access door **115** may be opened by the user **210**, a threshold count of times the user **210** may enter the refrigerated cargo zone **110**, a threshold count of times the user **210** may move from each cargo zone area **305***a-n* to the access door **115**, a threshold total time duration the user **210** may spend in the refrigerated cargo zone **110**, and/or the like. In some aspects, the threshold inefficiency parameter too may be linear average or weightage average of the information described above. In other aspects, each aspect/information described above may be associated with a different threshold inefficiency parameter.
(57) Responsive to fetching the threshold inefficiency parameter, the processor **248** may compare the user inefficiency parameter with the threshold inefficiency parameter. The processor **248** may output a first notification (e.g., a user performance enhancement notification), via the transceiver **246**, when the user inefficiency parameter may be greater than the threshold inefficiency parameter. For example, the processor **248** may output the first notification when the user **210** may be opening the access door **115** for more times on the delivery route **120** than an expected count of times, or when the user **210** may be spending more time duration in the refrigerated cargo zone **110** than an expected time duration. The processor **248** may output the first notification via the user device **204**, the infotainment system **242**, the speaker **244** and/or the server(s) **206**.
(58) In some aspects, the first notification may include instructions for the user **210** to reduce the user movement in the refrigerated cargo zone **110** and/or reduce the access door movement. The user **210** may receive/hear the first notification, and may reduce user movement and/or access door movement, thus facilitating in efficiently managing temperature in the refrigerated cargo zone **110**. In additional aspects, the processor **248** may output the first notification based on the historical user movement information that the processor **248** obtains from the memory **250** (as described above). In this case, the first notification may include instructions based on the historical user movement pattern/information. For example, if the historical user movement information indicates that the user **210** historically or typically keeps the access door **115** open for a substantial time duration while loading/unloading delivery packages, the first notification may specifically include instructions to close the access door **115** when the user **210** loads or unloads the delivery packages.
(59) In further aspects, the fleet operator may use the first notification received at the server(s) **206** to plan training needs for the user **210**. In yet another aspect, the fleet operator may plan rewards for the user **210** based on the first notification, as described above in conjunction with FIG. **1**.
(60) In further aspects, in addition to determining the user inefficiency parameter, the processor **248** may determine that the access door **115** may be opened (and kept in open state) by the user **210** for a time duration greater than a permissible time duration, based on the obtained access door movement. For example, the processor **248** may determine that the user **210** may have kept the access door **115** open for more than 45 seconds or 60 seconds continuously. Responsive to determining that the user **210** may have kept the access door **115** open for a time duration greater than the permissible time duration, the processor **248** may output a second notification in real-time, via the transceiver **246**, instructing the user **210** to close the access door **115**. The processor **248** may output the second notification via the infotainment system **242**, the speaker **244** and/or the user device **204**. In yet another aspect, the processor **248** may output the second notification when the processor **248** determines, via the sensory system **236**, that the user **210** may have kept the access door **115** open and may have left the vehicle **202** or the refrigerated cargo zone **110**. In this case, the second notification may include instructions for the user **210** to return to the vehicle **202** or the refrigerated cargo zone **110**, and close the access door **115**.
(61) In yet another aspect, when the vehicle **202** may be traversing the delivery route **120**, the processor **248** may determine an expected user movement time duration required by the user **210** to

move each delivery package from respective storage location to the access door **115** during package unloading operation, based on the delivery package information, the user movement and the historical user movement pattern/information. Responsive to determining the expected user movement time duration, the processor **248** may output a third notification (via the transceiver **246** and the user device **204**/speaker **244**) that may include instructions to facilitate the user **210** to reduce the time duration that the user **210** may spend in the refrigerated cargo zone **110** during the package unloading operation. For example, the processor **248** may output the third notification instructing the user **210** to move (or adjust storage location of) a heavy delivery package closer to the access door **115**, when the processor **248** determines that the user **210** may spend substantial time duration (e.g., more than a predefined time duration) to move the heavy delivery package from a current storage location to the access door **115**. In this manner, the processor **248** may facilitate the user **210** in reducing time duration that the user **210** may spend in the refrigerated cargo zone **110** (by adjusting delivery package storage locations) while the vehicle **202** may be in transit on the delivery route **120**.

(62) In additional aspects, the processor **248** may determine when the vehicle **202** may finish traversing the delivery route **120** based on the delivery route information and inputs received from the TCU **230**. Responsive to determining that the vehicle **202** may have traversed the delivery route **120**, the processor **248** may determine if one or more delivery packages may be left behind in the refrigerated cargo zone **110** based on inputs received from the sensory system **236** (e.g., vehicle interior cameras). Responsive to determining that a delivery package may be left behind, the processor **248** may output a fourth notification, via the transceiver **246** and the user device **204**/speaker **244**, instructing the user **210** to remove the delivery package. In addition, the processor **248** may send a command signal to the BCM **224** to keep the vehicle cooling unit switched ON or operational till the user **210** removes the delivery package from the refrigerated cargo zone **110**. In some aspects, the processor **248** may cause the vehicle cooling unit to switch OFF when the processor **248** obtains a request from the user **210** (via the user device **204** or the infotainment system **242**, and the transceiver **246**) to switch OFF the vehicle cooling unit.

(63) In additional aspects, the processor **248** may keep the vehicle cooling unit switched ON after the vehicle **202** has traversed the delivery route **120** (even after all the delivery packages are removed from the refrigerated cargo zone **110**), based on an input obtained from the user **210** via the user device **204** or the infotainment system **242**, and the transceiver **246**. For example, the user **210** may transmit inputs to the processor **248** to keep the vehicle cooling unit operational/switched ON for two hours after the vehicle **202** has traversed the delivery route **120**. In this case, the processor **248** may calculate an energy required by the vehicle **202** to keep the vehicle cooling unit operational for two hours at the desired refrigerated cargo zone temperature, based on the vehicle information. Responsive to calculating the required energy, the processor **248** may fetch a vehicle current charge/fuel level from the VCU **214**. The processor **248** may then compare the required energy with the current charge/fuel level. The processor **248** may output a fifth notification to charge/refill the vehicle **202** when the current charge/fuel level may be less than the required energy. In this case, the required energy may include some buffer charge/fuel level, to ensure that the vehicle **202** has energy left at the end of the two hour time duration (when the vehicle cooling unit may be switched OFF).

(64) FIG. **4** depicts a flow diagram of an example first method **400** to facilitate temperature management in the vehicle **202** in accordance with the present disclosure. FIG. **4** may be described with continued reference to prior figures, including FIGS. **1-3**. The following process is exemplary and not confined to the steps described hereafter. Moreover, alternative embodiments may include more or less steps that are shown or described herein and may include these steps in a different order than the order described in the following example embodiments.

(65) The method **400** starts at step **402**. At step **404**, the method **400** may include obtaining, by the processor **248**, the vehicle information, the delivery package information, and the delivery route

information. As described above, the processor **248** may obtain the information described here before the vehicle commences the delivery trip.
(66) At step **406**, the method **400** may include estimating, by the processor **248**, an energy required by the vehicle **202** to traverse the delivery route **120** based on the obtained information. As described above, the required energy may be the sum of the driving energy, the climate energy, and a buffer energy. At step **408**, the method **400** may include obtaining, by the processor **248**, a current vehicle energy level via the VCU **214**. At step **410**, the method **400** may include comparing, by the processor **248**, the required energy with the current vehicle energy level. At step **412**, the method **400** may include outputting, by the processor **249**, a vehicle charge notification instructing the user **210** to charge/refill the vehicle **202** when the current vehicle energy level may be less than the required energy.
(67) The method **400** may end at step **414**.
(68) FIG. **5** depicts a flow diagram of an example second method **500** to facilitate temperature management in the vehicle **202** in accordance with the present disclosure. FIG. **5** may be described with continued reference to prior figures, including FIGS. **1-4**. The following process is exemplary and not confined to the steps described hereafter. Moreover, alternative embodiments may include more or less steps that are shown or described herein and may include these steps in a different order than the order described in the following example embodiments.
(69) The method **500** starts at step **502**. At step **504**, the method **500** may include obtaining, by the processor **248**, inputs associated with the user movement in the refrigerated cargo zone **110** and the access door movement from the sensory system **236**. At step **506**, the method **500** may include determining, by the processor **248**, the user inefficiency parameter based on the inputs obtained from the sensory system **236**. At step **508**, the method **500** may include comparing, by the processor **248**, the user inefficiency parameter with the threshold inefficiency parameter.
(70) At step **510**, the method **500** may include outputting, by the processor **248**, an alert notification when the user inefficiency parameter may be greater than the threshold inefficiency parameter. As described above, the alert notification may include instructions for the user **210** to reduce the user movement and/or the access door movement.
(71) The method **500** may end at step **512**.
(72) In the above disclosure, reference has been made to the accompanying drawings, which form a part hereof, which illustrate specific implementations in which the present disclosure may be practiced. It is understood that other implementations may be utilized, and structural changes may be made without departing from the scope of the present disclosure. References in the specification to “one embodiment,” “an embodiment,” “an example embodiment,” etc., indicate that the embodiment described may include a particular feature, structure, or characteristic, but every embodiment may not necessarily include the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a feature, structure, or characteristic is described in connection with an embodiment, one skilled in the art will recognize such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described.
(73) Further, where appropriate, the functions described herein can be performed in one or more of hardware, software, firmware, digital components, or analog components. For example, one or more application specific integrated circuits (ASICs) can be programmed to carry out one or more of the systems and procedures described herein. Certain terms are used throughout the description and claims refer to particular system components. As one skilled in the art will appreciate, components may be referred to by different names. This document does not intend to distinguish between components that differ in name, but not function.
(74) It should also be understood that the word “example” as used herein is intended to be non-exclusionary and non-limiting in nature. More particularly, the word “example” as used herein indicates one among several examples, and it should be understood that no undue emphasis or

preference is being directed to the particular example being described.
(75) A computer-readable medium (also referred to as a processor-readable medium) includes any non-transitory (e.g., tangible) medium that participates in providing data (e.g., instructions) that may be read by a computer (e.g., by a processor of a computer). Such a medium may take many forms, including, but not limited to, non-volatile media and volatile media. Computing devices may include computer-executable instructions, where the instructions may be executable by one or more computing devices such as those listed above and stored on a computer-readable medium.
(76) With regard to the processes, systems, methods, heuristics, etc. described herein, it should be understood that, although the steps of such processes, etc. have been described as occurring according to a certain ordered sequence, such processes could be practiced with the described steps performed in an order other than the order described herein. It further should be understood that certain steps could be performed simultaneously, that other steps could be added, or that certain steps described herein could be omitted. In other words, the descriptions of processes herein are provided for the purpose of illustrating various embodiments and should in no way be construed so as to limit the claims.
(77) Accordingly, it is to be understood that the above description is intended to be illustrative and not restrictive. Many embodiments and applications other than the examples provided would be apparent upon reading the above description. The scope should be determined, not with reference to the above description, but should instead be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. It is anticipated and intended that future developments will occur in the technologies discussed herein, and that the disclosed systems and methods will be incorporated into such future embodiments. In sum, it should be understood that the application is capable of modification and variation.
(78) All terms used in the claims are intended to be given their ordinary meanings as understood by those knowledgeable in the technologies described herein unless an explicit indication to the contrary is made herein. In particular, use of the singular articles such as “a,” “the,” “said,” etc. should be read to recite one or more of the indicated elements unless a claim recites an explicit limitation to the contrary. Conditional language, such as, among others, “can,” “could,” “might,” or “may,” unless specifically stated otherwise, or otherwise understood within the context as used, is generally intended to convey that certain embodiments could include, while other embodiments may not include, certain features, elements, and/or steps. Thus, such conditional language is not generally intended to imply that features, elements, and/or steps are in any way required for one or more embodiments.

Claims

1. A vehicle comprising: a refrigerated cargo zone configured to store a plurality of delivery packages, wherein the refrigerated cargo zone comprises an access door; a detection unit configured to detect a user movement in the refrigerated cargo zone and an access door movement when the vehicle is traversing a delivery route; and a processor communicatively coupled with the detection unit, wherein the processor is configured to: obtain inputs associated with the user movement and the access door movement from the detection unit; determine a user inefficiency parameter based on the inputs; compare the user inefficiency parameter with a threshold inefficiency parameter; and output a first notification when the user inefficiency parameter is greater than the threshold inefficiency parameter.
2. The vehicle of claim 1, wherein the user inefficiency parameter is associated with at least one of: a count of times the access door is opened by a user in a predefined time duration, a percentage of times the access door is fully opened by the user in the predefined time duration, a total time duration for which the access door is opened by the user in the predefined time duration.
3. The vehicle of claim 2, wherein the user inefficiency parameter is greater than the threshold

inefficiency parameter when the count of times exceeds a threshold count of times, the percentage of times the access door is fully opened exceeds a threshold percentage, or the total time duration for which the access door is opened exceeds a threshold total time duration.

4. The vehicle of claim 1, wherein the processor is further configured to: determine that the access door is open for a time duration greater than a predefined permissible time duration based on the inputs obtained from the detection unit; and output a second notification responsive to a determination that the access door is open for the time duration greater than the predefined permissible time duration, wherein the second notification comprises instructions to close the access door.

5. The vehicle of claim 1, wherein the refrigerated cargo zone comprises a plurality of cargo zone areas, and wherein the detection unit is further configured to detect a real-time temperature in each cargo zone area.

6. The vehicle of claim 5, wherein the processor is further configured to: compare the real-time temperature in a cargo zone area of the plurality of cargo zone areas with a preset temperature; and activate a vehicle cooling unit to cool the cargo zone area when the real-time temperature in the cargo zone area is greater than the preset temperature.

7. The vehicle of claim 6, wherein the processor is further configured to: obtain historical temperature information associated with the cargo zone area; determine that a historical temperature associated with the cargo zone area is greater than the preset temperature, based on the historical temperature information; and output a maintenance notification responsive to a determination that the historical temperature associated with the cargo zone area is greater than the preset temperature.

8. The vehicle of claim 1, wherein the detection unit is further configured to detect a delivery package presence in the refrigerated cargo zone, and wherein the processor is further configured to: obtain inputs from a vehicle telematics control unit; determine that the vehicle has traversed the delivery route using the inputs obtained from the vehicle telematics control unit; determine that a delivery package is disposed in the refrigerated cargo zone based on the inputs obtained from the detection unit when the vehicle has traversed the delivery route; and output an alert notification comprising instructions to remove the delivery package from the refrigerated cargo zone based on a determination that the delivery package is disposed in the refrigerated cargo zone.

9. The vehicle of claim 1 further comprising a memory configured to store delivery package information, wherein the delivery package information comprises a count of the plurality of delivery packages stored in the refrigerated cargo zone, a delivery schedule of each delivery package, weight, size and content of each delivery package, and a storage location of each delivery package in the refrigerated cargo zone.

10. The vehicle of claim 9, wherein the processor is further configured to: obtain the delivery package information from the memory; and determine an expected movement time duration required by a user to move each delivery package from respective storage location to the access door, based on the delivery package information and the user movement in the refrigerated cargo zone, wherein the first notification comprises instructions to adjust a storage location of a delivery package when respective expected movement time duration associated with the delivery package exceeds a predefined threshold.

11. The vehicle of claim 9 further comprising a transceiver configured to receive delivery route information from a user device or a server, wherein the delivery route information comprises a route distance, locations of a plurality of waypoints on the delivery route, desired refrigerated cargo zone temperature in the delivery route, and ambient weather condition information in the delivery route.

12. The vehicle of claim 11, wherein the processor is further configured to: obtain the delivery package information from the memory and the delivery route information from the transceiver; estimate an energy required by the vehicle to traverse the delivery route based on the delivery

package information and the delivery route information; obtain a current vehicle energy level; compare the estimated energy with the current vehicle energy level; and output a vehicle charge notification when the current vehicle energy level is less than the estimated energy.

13. A method to facilitate temperature management in a vehicle, the method comprising: obtaining, by a processor, inputs associated with a user movement and an access door movement from a detection unit of the vehicle, wherein: the detection unit is configured to detect the user movement in a refrigerated cargo zone of the vehicle and the access door movement when the vehicle is traversing a delivery route, the refrigerated cargo zone is configured to store a plurality of delivery packages, and the refrigerated cargo zone comprises an access door; determining, by the processor, a user inefficiency parameter based on the inputs; comparing, by the processor, the user inefficiency parameter with a threshold inefficiency parameter; and outputting, by the processor, a notification when the user inefficiency parameter is greater than the threshold inefficiency parameter.

14. The method of claim 13, wherein the user inefficiency parameter is associated with at least one of: a count of times the access door is opened by a user in a predefined time duration, a percentage of times the access door is fully opened by the user in the predefined time duration, a total time duration for which the access door is opened by the user in the predefined time duration.

15. The method of claim 14, wherein the user inefficiency parameter is greater than the threshold inefficiency parameter when the count of times exceeds a threshold count of times, the percentage of times the access door is fully opened exceeds a threshold percentage, or the total time duration for which the access door is opened exceeds a threshold total time duration.

16. The method of claim 13, wherein the refrigerated cargo zone comprises a plurality of cargo zone areas, and wherein the detection unit is further configured to detect a real-time temperature in each cargo zone area and a delivery package presence in the refrigerated cargo zone.

17. The method of claim 16 further comprising: comparing the real-time temperature in a cargo zone area of the plurality of cargo zone areas with a preset temperature; and activating a vehicle cooling unit to cool the cargo zone area when the real-time temperature in the cargo zone area is greater than the preset temperature.

18. The method of claim 17 further comprising: obtaining historical temperature information associated with the cargo zone area; determining that a historical temperature associated with the cargo zone area is greater than the preset temperature, based on the historical temperature information; and outputting a maintenance notification responsive to a determination that the historical temperature associated with the cargo zone area is greater than the preset temperature.

19. The method of claim 16 further comprising: obtaining inputs from a vehicle telematics control unit; determining that the vehicle has traversed the delivery route using the inputs obtained from the vehicle telematics control unit; determining that a delivery package is disposed in the refrigerated cargo zone based on the inputs obtained from the detection unit when the vehicle has traversed the delivery route; and outputting an alert notification comprising instructions to remove the delivery package from the refrigerated cargo zone based on a determination that the delivery package is disposed in the refrigerated cargo zone.