

SYSTEM AND METHOD OF MONITORING AN LPG SUPPLY

5 TECHNICAL FIELD

The present disclosure relates broadly to a system and a method of monitoring a Liquid Petroleum Gas (LPG) supply at a usage location.

10 BACKGROUND

The business of distributing Liquid Petroleum Gas (LPG) in cylinders to users and customers has traditionally been done on a manual basis. It has been recognised that existing practices in the industry are labour intensive and inefficient, resulting in low productivity.

One aspect of operations involves periodic monitoring of LPG supply available on-site through either physical checks or reading of meters. This can be required to be performed as frequently as every few hours, few days, weekly or monthly. Current practices are heavily dependent on human resources, and are error prone and open to fraudulent practices e.g. pilferage.

Further, it has also been recognised that performing physical meter readings on-site during certain hours of a day can be met with resistance from customers as it may affect their business operations. This can cause friction between the supplier and its customers.

Moreover, when dealing with delinquent accounts which require a manual shutting down of the LPG supply on-site, the supplier may be met with unwelcomed confrontations from the customer. Even if there may be a legitimate need to physically turn-off the valves of LPG cylinders, the customers may object and altercations may occur as a result.

In view of the above there exists a need for a system for monitoring an LPG supply at a usage location that seek to address at least one of the above problems.

SUMMARY

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In accordance with an aspect of the present disclosure, there is provided a system for monitoring an LPG supply at a usage location, the system comprising a sensor unit configured to measure a physical property of the LPG supply at the usage location; a processing unit coupled to the sensor unit, the processing unit configured to
10 determine usage data based on the measured physical property, and to transmit the usage data; and a remote server comprising a database configured to receive and store the usage data; and an application interface to allow one or more user devices to retrieve the usage data from the database.

15 The physical property may comprise volume or weight of the LPG supply.

The system may comprise a conversion unit configured to convert an analogue signal received at the sensor unit.

20 The LPG supply may comprise an LPG storage unit placed at the usage location, the sensor unit may comprise a weighing scale to measure a weight of the LPG storage unit, and wherein the processing unit may determine the usage data based on the measured weight of the LPG storage unit.

25 The weighing scale and processing unit may be housed in an integrated single housing.

The integrated single housing may be configured to receive the LPG storage unit, such that the integrated single housing serves as a base of the LPG storage unit.

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The sensor unit may comprise an analogue gas meter.

The conversion unit may comprise a reed switch for converting analogue changes in the analogue gas meter into electrical pulses.

5 The processing unit may be coupled to additional sensor units, the processing unit being configured to determine usage data based on the additionally measured physical properties obtained from the additional sensor units.

10 The processing unit may be configured to periodically obtain the measured physical property from the sensor unit and to transmit determined usage data to the remote server.

The processing unit may be further configured to receive instructions from the one or more user devices, via the remote server.

15 Upon receipt of the instruction, the processing unit may be configured to obtain the measured physical property from the sensor unit and to transmit a determined real-time usage data.

20 The system may further comprise one or more valves for controlling the LPG supply at the usage location, wherein the valves are controllable by the processing unit.

Upon receipt of the instruction, the processing unit may be configured to enable or disable the LPG supply at the usage location.

25 The sensor unit may be configured to detect gas leakage of the LPG supply at the usage location.

The processing unit may comprise a processing unit memory.

30 In accordance with another aspect of the present disclosure, there is provided a method of monitoring an LPG supply at a usage location, the method comprising, measuring a physical property of the LPG supply at the usage location; determining usage data based on the measured physical property; transmitting the usage data;

receiving and storing the usage data in a database remotely located from the usage location; and retrieving the usage data from the database.

5 The method may further comprise converting an analogue signal on the measured physical property.

10 The method may further comprise receiving instructions from one or more user devices, via a remote server, and upon receipt of the instruction, obtaining the measured physical property and transmitting a determined real-time usage data.

The method may further comprise detecting gas leakage of the LPG supply at the usage location.

15 The method may further comprise providing a processing unit memory.

20 In accordance with another aspect of the present disclosure, there is provided a non-transitory tangible computer readable storage medium having stored thereon software instructions that, when executed by a computer processor of a system to monitor an LPG supply at a usage location, cause the computer processor to perform a method of monitoring an LPG supply at a usage location, by executing the steps comprising, measuring a physical property of the LPG supply at the usage location; determining usage data based on the measured physical property; transmitting the usage data; receiving and storing the usage data in a database; and retrieving the usage data from the database.

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BRIEF DESCRIPTION OF THE DRAWINGS

30 Exemplary embodiments of the invention will be better understood and readily apparent to one of ordinary skill in the art from the following written description, by way of example only, and in conjunction with the drawings, in which:

FIG. 1 is a schematic diagram of a system for monitoring a Liquid Petroleum Gas (LPG) supply at a usage location in an exemplary embodiment.

FIG. 2 is a schematic diagram of a system for monitoring a Liquid Petroleum Gas (LPG) supply at a usage location in another exemplary embodiment.

5 FIG. 3 is a schematic diagram of a system for monitoring a Liquid Petroleum Gas (LPG) supply at a usage location in another exemplary embodiment.

FIG. 4A is a schematic flowchart for illustrating an existing method of operation.

10 FIG. 4B is a schematic flowchart for illustrating a method of operation in an exemplary embodiment.

FIG. 5 is a schematic diagram of a system for monitoring a Liquid Petroleum Gas (LPG) supply at a usage location in another exemplary embodiment.

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FIG. 6A is a schematic flowchart for illustrating an existing method of operation.

FIG. 6B is a schematic flowchart for illustrating a proposed method of operation in an exemplary embodiment.

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FIG. 7 is a schematic drawing of a computer system suitable for implementing an exemplary embodiment.

25 FIG. 8 is a schematic drawing of a wireless communication device suitable for implementing an exemplary embodiment.

FIG. 9 is a schematic flowchart illustrating a method of monitoring a Liquid Petroleum Gas (LPG) supply at a usage location in an exemplary embodiment.

30 FIG. 10A is a schematic drawing illustrating an isometric view of a weighing scale in an exemplary embodiment.

FIG. 10B is a schematic drawing illustrating an exploded view of a weighing scale in an exemplary embodiment.

FIG. 11A is a schematic drawing illustrating a side view of the weighing scale of
5 FIGs. 10A and 10B.

FIG. 11B is a schematic drawing illustrating an isometric view of the weighing scale of FIGs. 10A and 10B.

FIG. 11C is a schematic drawing illustrating a top view of the weighing scale of FIGs.
10 10A and 10B.

FIG. 11D is a schematic drawing illustrating a cross-sectional view of the weighing scale of FIGs. 10A and 10B.
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FIG. 11E is a schematic drawing illustrating another side view of the weighing scale of FIGs. 10A and 10B.

DETAILED DESCRIPTION

20 Exemplary embodiments described below may provide a system for monitoring a Liquid Petroleum Gas (LPG) supply at a usage location.

Detailed examples of various exemplary, non-limiting embodiments are
25 described below.

FIG. 1 is a schematic diagram of a system for monitoring a Liquid Petroleum Gas (LPG) supply at a usage location in an exemplary embodiment. In the exemplary embodiment, the system 100 comprises a sensor unit 102 configured to measure a
30 physical property of the LPG supply at the usage location. The system 100 also comprises a processing unit 104 coupled to the sensor unit 102, the processing unit 104 configured to determine usage data based on the measured physical property, and to transmit the usage data. In the exemplary embodiment, the system 100 further

comprises a remote server 106, the remote server comprising a database 108 configured to receive and store the usage data, and an application interface 110 to allow one or more user devices 112 to retrieve the usage data from the database 108.

5 In the exemplary embodiment, the physical property may comprise volume or weight of the LPG supply (at the usage location).

 In the exemplary embodiment, the system 100 may comprise a conversion unit (not shown) configured to convert an analogue signal for subsequent use by the sensor
10 unit 102 or processing unit 104. The conversion may comprise for example, digitising an analogue signal as measured into a digital signal. The conversion unit may be housed within the sensor unit 102. In the exemplary embodiment, the sensor unit 102 may comprise one or more analogue sensors, each analogue sensor provided with a respective conversion unit.

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 In the exemplary embodiment, the LPG supply may comprise an LPG storage unit placed at the usage location and the sensor unit 102 may comprise a weighing scale to measure the weight of the LPG storage unit, wherein the processing unit 104 may determine the usage data based on the measured weight of the LPG storage unit.
20 The LPG storage unit may be, for example, an LPG cylinder. In the exemplary embodiment, the sensor unit 102 may be configured to determine weight of the LPG remaining in the LPG storage unit, and the processing unit 104 may be configured to determine the usage data based on the measured weight of the LPG remaining in the LPG storage unit. The processing unit 104 may be configured to determine the usage
25 data by comparing the measured (current) weight of the LPG storage unit to a pre-determined weight of the LPG storage unit completely filled with LPG, to determine a change in the weight of the LPG in the LPG storage unit. In the exemplary embodiment, the processing unit 104 may thus determine the usage data based on the change in the weight of the LPG in the LPG storage unit.

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 In the exemplary embodiment, the weighing scale may be in the form of an analogue weighing scale with piezoelectric load cells. The piezoelectric load cells may be capable of generating a voltage output corresponding to the weights put upon them.

Thus, in the exemplary embodiment, the voltage generated (analogue output) by the piezoelectric load cells may then be digitised by a conversion circuitry into a digital signal, before the digital signal is used and/or processed by the processing unit 104 to obtain the usage data. The conversion circuitry may be housed within the sensor unit 102.

In the exemplary embodiment, the weighing scale and the processing unit 104 may be housed in an integrated single housing.

In the exemplary embodiment, the integrated single housing may be configured to receive the LPG storage unit, such that at least a portion of the integrated single housing serves as a base of the LPG storage unit.

In the exemplary embodiment, the sensor unit 102 may comprise an analogue gas meter. A conversion unit in the form of a reed switch may be coupled to the analogue gas meter to convert the analogue changes in the analogue gas meter (or analogue output from the gas meter) into electrical pulses which are then further converted into a digitised output by the sensor unit 102. Based on the digitised output generated, the sensor unit 102 comprising the analogue gas meter may be configured to determine the proportional flow rate of LPG leaving the LPG storage unit, or the consumption rate. The processing unit 104 may accordingly be configured to determine the usage data based on the digital data received from the sensor unit 102. That is, the processing unit 104 may be configured to determine the usage data by determining the change in the volume of LPG based on the inputs from the sensor unit 102. The processing unit 104 may thus determine the usage data based on the volume of gas used or consumed.

In the exemplary embodiment, the processing unit 104 may be coupled to additional sensor units (not shown) and the processing unit 104 may be configured to determine usage data based on the additionally measured physical properties obtained from the additional sensor units. In use, the processing unit 104 may be coupled to and may be configured to determine usage data of up to eleven sensor units.

In the exemplary embodiment, the server 106 may be cloud-based. In use, the server 106 may be in remote two-way communication with or remotely located from the sensor unit 102 and the processing unit 104. Further, the server 106 may be in remote two-way communication with or remotely located from users via the one or more user devices 112. See the double arrows shown in FIG. 1.

In the exemplary embodiment, the processing unit 104 may be configured to periodically (or at pre-set intervals) obtain the measured physical property from the sensor unit 102 and to transmit a determined usage data to the remote server 106. The processing unit 104 may for example, obtain the measured physical property from the sensor unit 102 every twelve-hourly. The transmitted usage data may be stored in the database 108 of the remote server 106. Further, the remote sever 106 may be configured to process the received usage data to determine whether the usage data exceeds a predetermined usage amount. If the usage data exceeds a predetermined threshold (i.e. a predetermined usage amount), the remote server 106 may be configured to send a prompt to the one or more user devices 112. The prompt may alert or trigger the user via the one or more user devices 112 (e.g. an LPG supplier) that the LPG usage at the usage location has exceeded a predetermined threshold and that the LPG supply requires replenishment. The alert or the trigger may usefully prompt the supplier to make arrangements to replenish the LPG supply at the usage location.

In the exemplary embodiment, the processing unit 104 may be configured to receive instructions from the one or more user devices 112 via the remote server 106.

In the exemplary embodiment, upon receipt of the instruction, the processing unit 104 may be configured to obtain the measured physical property from the sensor unit 102 and to transmit a determined real-time usage data.

In the exemplary embodiment, the system 100 may further comprise one or more valves for controlling the LPG supply at the usage location. In the exemplary embodiment, the valves may be controllable by the processing unit 104.

In the exemplary embodiment, upon receipt of the instruction from the remote server 106, the processing unit 104 may be configured to enable or disable the LPG supply at the usage location. In the exemplary embodiment, the processing unit 104 may for example, enable or disable the LPG supply by controlling the one or more valves.

In the exemplary embodiment, the sensor unit 102 may be configured to detect gas leakage of the LPG supply at the usage location. That is, the sensor unit 102 may comprise a safety device, such as a gas leak detector, to detect gas leakage at the usage location.

In the exemplary embodiment, the processing unit 104 may comprise a processing unit memory. In use, the processing unit memory may store data, such as measured physical property of the LPG supply at the usage location and the usage data, previously obtained. Advantageously, the data stored in the processing unit memory may act as backup data.

In the exemplary embodiment, the processing unit 104 may be configured to transmit data (e.g. the usage data, the determined real-time usage data) over one or more of NB-IoT, Wi-Fi, 3G, 4G, M2M, Lora and Sigfox.

In the exemplary embodiment, the usage location is a remote usage location, wherein the usage location is separately located from the server 106.

FIG. 2 is a schematic diagram of a system for monitoring a Liquid Petroleum Gas (LPG) supply at a usage location in another exemplary embodiment. In this exemplary embodiment, the system 200 functions similarly to the system 100 described with reference to FIG. 1. For ease of reference, like numerals and/or naming conventions are used for exemplary implementations of similar units as described in FIG. 1 and FIG. 2.

In the exemplary embodiment, the system 200 comprises one or more sensors 202 configured to measure one or more physical properties of the LPG supply at the usage location. Compare sensor unit 102 of FIG.1. The system 200 also comprises a

controller 204 coupled to the one or more sensors 202, and a data gateway 206 coupled to the controller 204. In the exemplary embodiment, the controller 204 is configured to determine usage data based on the measured physical properties of the LPG supply, as measured by the one or more sensors 202. The data gateway 206 is configured to transmit the usage data determined by the controller 204. Compare processing unit 104 of FIG. 1.

The system 200 further comprises a cloud-based server 208. The cloud-based server 208 comprises a database (not shown) configured to receive and store the usage data received from the controller 204, via the data gateway 206, and an application interface (also not shown). The entire system 200 and its various components and linkages are being centrally managed, supervised and maintained by user devices of a system integrator 216.

In the exemplary embodiment, user devices of LPG suppliers 210, commercial users (or industrial users) 212 and household users 214 are configured to retrieve the usage data from the database of the cloud-based server 208. The application interface of the cloud-based server 208 acts as the interface between the database of the cloud-based server and the user devices, and allows the user devices to query the database for the usage data. Compare server 106 of FIG. 1, comprising database 108 and application interface 110, and the one or more user devices 112 of FIG. 1.

In exemplary embodiments, the one or more sensors 202 may be an analogue sensor and the system 200 may be provided with a conversion unit (not shown) that is configured to convert an analogue signal received at the one or more analogue sensors. In the exemplary embodiment, the conversion may comprise digitising an analogue signal received from the one or more analogue sensors into a digital signal.

A process for monitoring the LPG supply at the usage location may be carried out with the system 200. The process may start with using the one or more sensors 202 to measure physical properties of the LPG supply so as to monitor the LPG usage. The types of the one or more sensors 202 made available in the system 200 may be varied depending on the intended groups of users of the system 200. For example, it will be

appreciated that industrial and household users utilise different LPG storage tanks/units which may require different sensor types/configurations.

Next, the controller 204 coupled to the one or more sensors 202 may determine
5 the usage data based on the measured physical properties of the LPG supply. After processing by the controller 204, the usage data (or consumption data) may be logged/stored (e.g. onto a memory unit of the controller 204) and may be relayed to the data gateway 206 for onward transmission over a data network to the cloud-based server 208 (i.e. a cloud-based data centre). The transmitted usage data may be stored
10 in the database of the server 208 within the cloud.

In the exemplary embodiment, access to the usage data may be provided to the LPG suppliers 210 via their user devices, i.e. via e.g., purpose-written apps (software applications) or programs on PCs, tablets or smart phones. In use, each LPG supplier
15 210 may usefully process the usage data and to obtain processed information, which can be relayed to its respective groups of customers. Further, in use, apart from being used for billing customers, the usage data (or consumption data) obtained in the system 200 may usefully provide a source of information the analysis of which may form the basis for optimising delivery routes (e.g. for delivering LPG supply to the usage
20 location), inventory keeping, improving customer service, price setting, as well as developing targeted sales and marketing programs. In the exemplary embodiment, access to the usage data may also be provided to groups of other users, such as the commercial users 212 (i.e. users of 50.0 kg gas cylinders) and the household users 214 (i.e. users of smaller 12.7kg or 14.0kg gas cylinders).

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In the exemplary embodiment, the system 200 may comprise various custom-built components incorporating firmware which are specially designed and configured to provide the desired functionality. For example, the sensor 202 is in the form of a specially configured weighing scale, the conversion unit (not shown) is in the form of a specially configured reed
30 switch, the processor 204 is in the form of a specially configured micro-processor control unit, and the data gateway 206 is in the form of a specially configured data transmission unit. It will be appreciated that the components are not limited to the above-mentioned examples and that alternatives may be applicable, without deviating from the spirit of the invention. For

example, in an alternative configuration, the system 200 may be configured with available pulse ready meters and devices as sensors 202 for measuring usage.

5 In the exemplary embodiment, the system 200 may provide an end-to-end solution that comprises interfaces for communication between devices and between backend and frontend.

10 In the exemplary embodiment, the system 200 may utilise Internet-of-Things components to provide real-time monitoring without incurring excessive data communication costs. Also, the system 200 may utilise existing cloud services for remote data storage and retrieval. In the system 200, the data gateway 206 may be configured to transmit data over one or more of NB-IoT, GSM, 3G or 4G, M2M, Wi-fi, LoRa and Sigfox networks. The selection may be based for example, on the infrastructure available and accessible at the usage location. In one example, WiFi, 3G, 4G and other types of communications may be
15 available. In another example, Lora and Sigfox with dedicated relay/receiving stations may be deployed. The exemplary embodiments are thus not limited to any particular communication network type and may select different configurations and/or communication network types, depending on e.g., the accessibility and cost-effectiveness of available infrastructure.

20 In the exemplary embodiment, the usage data provided by the system 200 may be accessed by users (e.g. commercial users 212 and household users 214) and LPG suppliers 210. This usage data may be made available through the use of the application interface of the server 208 and user devices (e.g. through apps on smart phones).

25 The exemplary embodiment may thus provide a simplified system for remotely monitoring LPG usage by users/customers, processing the usage data collected and storing/keeping the usage data in a database. In the exemplary embodiment, the usage date (or consumption data) may be made available to LPG suppliers for completing its
30 commercial transactions such as invoicing and the like. The usage data can also be utilised by the LPG supplier for business planning purposes to optimise its operational efficiencies and competitiveness. For example, the LPG supplier can e.g., trigger an instruction to a

delivery personnel to contact the household, when it is determined from the LPG usage data that a household's LPG supply is running low.

In the exemplary embodiment, the one or more sensors 202 may further comprise a
5 safety device, e.g. in the form of a gas leak detector, to monitor and to detect any gas
leakage. In the exemplary embodiment, the gas leak detector may be configured to
implement an algorithm for detecting gas leaks. The exemplary embodiment may thus not
require a separate control box for the gas leak detector and may therefore advantageously
provide cost savings without compromising on safety, since the gas leak detector may be
10 integrated into the system 200. In use, during the process of monitoring the LPG supply at
the usage location, the safety device may set off an alarm should the safety device detect a
gas leakage to alert users/persons at the usage location. The safety device may also be
configured to send a notification (or an alert) to the controller 204 on the detected gas
leakage. The notification may then be transmitted by the data gateway 206 to the user
15 devices of the LPG suppliers 210 and/or users (e.g. commercial users 212 and household
users 214) to alert them of the detected gas leakage.

In the exemplary embodiment, the controller 204 may be configured to be capable of
two-way communication with the cloud-based server 208. The two-way communication may
20 advantageously allow the controller 204 to receive instructions and/or commands from the
user devices of the LPG suppliers 210, via the cloud-based server 208, to for example,
remotely control on-site equipment such as gas shut-off valves (i.e. supply valves) to enable
or disable LPG supply at the usage location or tank switching valves, and reset the safety
device (e.g. the gas leak detector). In the exemplary embodiment, in use, in the event of a
25 gas leakage or a delinquent account, supply of gas may be remotely managed by the LPG
suppliers 210.

In the exemplary embodiment, in use, the system 200 may be provided with a plug
and play capability such that different plug and play devices can be used without having to
30 redesign or re-configure for each individual user. Further, the system 200 may be configured
to ensure data portability with other management productivity applications such that the data
can be easily transferred to be used in other application programs without further re-
formatting. That is, plug and play devices can be used without having to redesign or re-

configure for each individual user. With data portability, the data can be easily transferred for use in other application programs without further re-formatting.

5 The exemplary embodiment can provide an approach to make use of information technology to help with simplifying and automating the LPG supply process, resulting in greater productivity and improved efficiency. The exemplary embodiment may provide a fully integrated system, linking the critical stages of the order-to-cash process. The exemplary embodiment may not only improve efficiency and productivity, but may also provide crucial data which can help to further enhance operations and business performance.

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 The exemplary embodiment may also advantageously allow for remote reading of meters. That is, the meters which determine LPG usage may be read remotely, without requiring a staff member deployed to perform a physical reading of meters at the usage location. This would advantageously reduce the potential for human error, i.e. reduce
15 occurrences of poor visibility, lighting or eyesight resulting in error. Further, providing remote reading may reduce potential for undesirable collusion between the employed staff of the LPG supplier and the end user of the LPG supply.

 Also, as physical readings of meters by personnel are not required, manpower costs
20 may also be reduced accordingly. The LPG supplier may also be able to better attract and retain staff and reduce turn-over as the nature of the job may more attractive.

 In the exemplary embodiment, the system 200 may, in use, be able to usefully provide savings on capital investments (e.g. fewer trucks needed), a scalable system to
25 meet business growth, added customer service and safety features, higher productivity and connectivity for businesses, optimised staffing and administrative costs, skill upgrading and job redesign, and improved cash flow through better control on inventory and potential leakages.

30 The exemplary embodiment may therefore, in use, provide advantages and benefits over the conventional mode of operations in the distribution of LPG, especially for LPG distributors/suppliers.

FIG. 3 is a schematic diagram of a system for monitoring a Liquid Petroleum Gas (LPG) supply at a usage location in another exemplary embodiment. In this exemplary embodiment, the system 300 functions similarly to the system 200 described with reference to FIG. 2. For ease of reference, like numerals and/or naming conventions are used for exemplary implementations of similar units as described in FIG. 1, FIG. 2 and FIG. 3.

In the exemplary embodiment, the system 300 comprises a weighing scale 302A and a gas leak detector 302B (compare one or more sensors 202 of FIG. 2). The weighing scale 302A and the gas leak detector 302B may be located within a household (i.e. the usage location of the exemplary embodiment). In the exemplary embodiment, the LPG supply may comprise an LPG storage unit placed at the household, and the LPG storage unit may be, for example, an LPG/gas cylinder (or tank). In the exemplary embodiment, the weighing scale 302A may be configured to measure a weight of the LPG storage unit and in turn, determine a weight of the LPG remaining at the household (i.e. to measure weight of the LPG supply remaining in an LPG cylinder located at the household), and the gas leak detector 302B may be configured to detect gas leakage of the LPG supply at the household. The system 300 also comprises a micro-processor control unit 304 (compare controller 204 of FIG. 2) coupled to the weighing scale 302A and the gas leak detector 302B, and a data transmission unit 306 (compare data gateway 206 of FIG. 2) coupled to the micro-processor control unit 304. The micro-processor control unit 304 is configured to determine usage data based on the measured weight of the LPG remaining at the household, as measured by the weighing scale 302A. The data transmission unit 306 is configured to transmit the usage data received from the micro-processor control unit 304.

The system 300 further comprises a cloud-based server 308. The server 308 comprises a database (not shown) configured to receive and store the usage data received from the micro-processor control unit 304, via the data transmission unit 306, and an application interface (also not shown).

In the exemplary embodiment, user devices of LPG suppliers 310 and household users 312 are configured to retrieve the usage data from the database of the cloud-

based server 308. In the exemplary embodiment, system integrators (not shown) may have an overall view and control of the entire system and act as the gate-keeper for both the system hardware and software. The application interface of the cloud-based server 308 acts as the interface between the database of the cloud-based server 308 and the user devices, and allows the user devices to query the database for the usage data.

In the exemplary embodiment, the weight of the LPG remaining in the LPG cylinder may be measured, for example, in grams (g). The weighing scale 302A may be configured to cater for local conditions, such as its weight range and its dimensions.

In the exemplary embodiment, the weighing scale 302A, the micro-processor control unit 304 and the data transmission unit 306 may be fitted within an integrated single housing (or a single unit) and be concealed within a plastic structure which also serves as a base of the LPG cylinder.

In the exemplary embodiment, the weighing scale 302A may comprise a conversion unit comprising piezoelectric load cells to measure the weight of the gas remaining, and a conversion circuitry. When weights are put upon the piezoelectric load cells, the piezoelectric load cells will generate a voltage which is proportional to the weight placed on them, and the conversion circuitry will digitise the voltage generated (analogue output) by the piezoelectric load cells into a digital signal. The digital signal is then converted by the micro-processor control unit 304 into a digital reading of the measured weight of the LPG remaining in the LPG cylinder. In the exemplary embodiment, the load cell digital signal may be usefully electronically filtered to eliminate unwanted noise.

In the exemplary embodiment, the gas leak detector 302B may be configured, in case of a gas leakage being detected, to send out an alert signal to the micro-processor control unit 304. Subsequently, the alert signal may be transmitted to an end-user and/or homeowner at the household (the usage location) in the event of gas leak. Gas leak detector 302B will be positioned within the housing as an integral device.

FIGs. 10A and 10B are schematic drawings illustrating an isometric view and an exploded view respectively of a weighing scale in an exemplary embodiment. In the exemplary embodiment, the weighing scale 1000 functions similarly to the weighing scale 302A described with reference to FIG. 3. For ease of reference, like numerals and/or naming conventions are used for exemplary implementations of similar components as described in FIG. 3.

In the exemplary embodiment, the weighing scale 1000 may comprise a housing 1002, a plurality of piezoelectric weight sensors 1004A, 1004B, 1004C, 1004D, and a controller and data gateway unit 1006 (compare micro-processor control unit 304 and data transmission unit 306 of FIG. 3), wherein the controller and data gateway unit 1006 is incorporated with a gas leak detector as an integral device within the unit 1006. The housing 1002 is shaped and dimensioned to receive a standard gas cylinder to be placed on top of the housing 1002. In the example embodiment, the housing 1002 is in the form of an annular ring dimensioned to receive the circular base of the LPG cylinder (not-shown). The piezoelectric weight sensors 1004 are respectively placed within the housing, and spaced apart from each other such they are 90 degrees apart from each other, relative to the center of the annular ring. It will be appreciated that in alternative embodiments, there may be a different number of sensors, and that they may be positioned differently.

In the exemplary embodiment, the housing 1002 may serve as a base of an LPG cylinder. The LPG cylinder may be placed directly above the housing 1002, such that the weight of the LPG cylinder may be sensed/obtained by the piezoelectric weight sensors 1004A, 1004B, 100C and 1004D, in conjunction with the controller and data gateway unit 1006.

In the exemplary embodiment, the housing 1002 may comprise a reset button 1008 and an indicator light 1010. The housing 1002 may further comprise a battery compartment 1012 which may be closed off by a battery compartment cover 1014. In the exemplary embodiment, the reset button 1008 when pressed/activated will energise/trigger the data gateway unit 1006 to alert a cloud server (compare cloud-based server 308 of FIG. 3) when a fresh cylinder is placed on the weighing scale 1000. In the

exemplary embodiment, the indicator light 1010 will show/indicate that the system (or the weighing scale 1000) is active.

FIGs. 11A, 11B, 11C, and 11D are schematic drawings illustrating a side, isometric, top and cross-sectional view respectively of the weighing scale of FIGs. 10A and 10B. FIG. 11E is a schematic drawing illustrating another side view of the weighing scale of FIGs. 10A and 10B.

In the exemplary embodiment, as shown in FIG. 11A, the housing 1002 of the weighing scale 1000 may have a height of about 33.0 mm. The width (or the outer diameter) of the housing 1002 may be about 322.0 mm, i.e. the radius may be about 161.0 mm. See FIGs. 11A, 11C and 11E for example. Further, as shown in FIG. 11C, the inner diameter of the housing 1002 may be about 189.9 mm.

Returning to FIG. 3, in the exemplary embodiment, the micro-processor control unit 304 may be configured to determine usage data based on the measured weight of the LPG remaining in the LPG cylinder obtained from the weighing scale 302A. The usage data may be determined by comparing the currently measured weight of the LPG cylinder to a pre-determined weight of the LPG cylinder when completely filled with LPG to determine a change in the weight of the LPG in the LPG cylinder. In the exemplary embodiment, the micro-processor control unit 304 may be configured to thus determine the usage data based on the change in the weight of the LPG in the storage unit.

In the exemplary embodiment, the micro-processor control unit 304 may be configured to analyse, parse, modulate, and store in memory (e.g. in a memory of the micro-processor control unit 304) the determined usage data. Further, the micro-processor control unit 304 may be configured to schedule the determined usage data for transmission to the cloud-based server 308 via the data transmission unit 306. As an example, the default frequency of transmission may be every twelve-hourly but it can be reset by the household users 312 to as often as every hourly using an application installed in their user devices.

In the exemplary embodiment, the micro-processor control unit 304 may be provided with memory capacity to store data (e.g. the usage data) on-site in a local memory unit (e.g. in a memory of the micro-processor control unit 304), temporarily. Advantageously, on-site storage of data may prevent accidental data loss while in transit
5 during transmission. Further, the micro-processor control unit 304 may be able to remotely control on-site equipment such as retrieving usage data (i.e. related to measured weight data) on request or resetting of the gas leak detector 302B.

In the exemplary embodiment, the data transmission unit 306 may be configured
10 to send filtered data remotely through a communication network to a cloud service (i.e. the cloud-based server 308). Compare cloud-based server 208 of FIG. 2. For the transmission, one or more of the following communication networks may be utilised: Wi-fi, GSM, 3G, 4G or NB-IoT networks. In the exemplary embodiment, the Wi-fi network option may be chosen as this option may usefully be utilised at no cost if tagged onto a
15 household's Wi-fi network.

In the exemplary embodiment, the cloud service may be subscribed from a service provider e.g. Amazon Web Services (AWS) or Google Cloud. The cloud-based server 308 may comprise of 3 components: (1) a data broker; (2) a database server;
20 and (3) an Application Program Interface (API) server. In the exemplary embodiment, the data broker may handle the data received via the internet before passing them onto the database server. The database server may store the data in a prescribed format for subsequent retrieval and update. MongoDB is one program that may be used for managing the data. In the exemplary embodiment, the API server may provide an
25 interface for querying and updating of data through a GraphQL query language. In the exemplary embodiment, the cloud-based server 308 may provide data security, reduce system redundancy and a means for data encryption. The exemplary embodiment may advantageously provide security of client's sensitive data through data encryption. Further, the provision of the cloud-based server 308 may advantageously allow the
30 system 300 to be more easily scalable, have a stable up-time and not require as much hardware maintenance.

In the exemplary embodiment, apps written for use on various user devices (e.g. user devices of the LPG suppliers 310, the household users 312 and the system integrators) may be linked through the API to the API server to update or query the database server. In the exemplary embodiment, the apps may be written using Flutter
5 UI Framework for mobile devices (both Android and iOS). If desired, the apps may be adapted to communicate through Windows OS. In the exemplary embodiment, any suitable software tool for building cross platform apps so that usage data can be made available in a wide range of user devices may be used.

10 In the exemplary embodiment, the LPG suppliers 310 may have access to the LPG usage/consumption data of the household users 312, who may be their customers, through their user devices. The user devices of the LPG suppliers 310 may be provided with an app which is configured to allow access to the usage data of the household users 312 stored in the database server of the cloud-based server 308.

15 In the exemplary embodiment, the usage data collected may be used in one or more of the following ways: order-to-cash process, inventory planning, delivery scheduling, monitoring of the customers (i.e. LPG suppliers 310 monitoring the LPG usage data of the household users 312), marketing and promotion based on data
20 analytics, and safety checks (i.e. gas leak detection).

In the exemplary embodiment, interfaces may be made available on the user devices of the LPG suppliers 310 to port the usage data directly to other business software tools for analysis, such as an enterprise resource planning (ERP) system, a
25 transport management system, a sales accounting system, an inventory management system etc. As one example, the LPG suppliers 310 may be able to optimise on the use of its delivery resources through planned deliveries of LPG tanks/cylinders, including route optimisation. As a result, idle time of delivery trucks may be reduced significantly. The LPG suppliers 310 may then be able to provide better customer service by pre-empting the need for replenishment of the LPG supply at the usage location (i.e. within
30 a household) and providing pre-planned on-time deliveries. In the exemplary embodiment, there may also be a mobile app provided in the user devices of the LPG

suppliers 310 that allow delivery personnel to plan routes and stock so as to meet demands more efficiently.

5 In the exemplary embodiment, the household users 312 may be provided with an app which may usefully allow the household users 312 to track their usage (i.e. gas usage) through the app and also track historical usage trend. The exemplary embodiment may thus facilitate repeat purchases. Further, the app may be configured to notify the household users 312 when gas is running low (i.e. when the usage data obtained by the micro-processor control unit 304 indicates that the LPG remaining in the
10 LPG cylinder is below a predetermined threshold). In the exemplary embodiment, in response to the notification, the household users 312 may arrange through the app for replenishment of the LPG supply within their household (i.e. the usage location) to avoid an unexpected run-out.

15 In the exemplary embodiment, the system integrators may have an overall view and control of the entire system 300 via their user devices coupled to the cloud-based server 308. Thus, the user devices of the system integrators may allow the system integrators to act as the gate-keeper for both the system hardware and software. In the exemplary embodiment, the user devices of the system integrators (e.g. a PC) may be
20 provided with a computer program configured to grant the LPG suppliers 310 password-secured access to parts/components of the system 300 but the LPG suppliers' confidential customer information may not be visible to the system integrators through their user devices. This may be useful because LPG suppliers 310 may wish to guard against third parties knowing their customer base. In the exemplary embodiment, the
25 system 300 may usefully allow the LPG suppliers' confidential customer information (i.e. end-user data) to be stored in their user devices without the system integrators having access to such details from the user devices of the system integrators. In the exemplary embodiment, in use, the system integrators may assist LPG suppliers 310 to integrate the rest of the system 300 with a backend office of the LPG suppliers 310, create an app
30 (i.e. for use on the user devices of the LPG suppliers 310 for monitoring the LPG supply at the usage location), or manage their operations (e.g. monitoring the LPG supply at the usage location), leaving the LPG suppliers 310 to concentrate on sales.

In the exemplary embodiment, the various functions of the system 300 may be supported by both software and hardware. If a need or wish for customisation of the system 300 arises, the user devices of the system integrators may be configured to allow customisation of the system 300 according to specific requirements of the LPG suppliers 310. Thus, in the exemplary embodiment, post-implementation system upgrade may be provided.

FIG. 4A is a schematic flowchart for illustrating an existing method of operation. The method 400 is an existing method of operation relating to an order-to-cash process for replenishing Liquid Petroleum Gas (LPG) supply at a usage location, i.e. within a household. At step 402, a driver (e.g. employed at an office supplying LPG) is on standby. At step 404, a customer (e.g. a household user) calls the office for replenishment of LPG at their household. At step 406, the office dispatches the driver for delivery. At step 408, the driver makes delivery. At step 410, the driver issues an invoice with an invoice book and/or collects cash payment from the household user. At step 412, the driver returns the cash and/or invoice book to the office. At step 414, the office reconciles paperwork and inventory. At step 416, the office updates their records and accounts.

FIG. 4B is a schematic flowchart for illustrating a method of operation in an exemplary embodiment. In the exemplary embodiment, the system 300 described with reference to FIG. 3 may prompt the method 418 to be implemented, which relates to an order-to-cash process for replenishing LPG supply at the usage location, i.e. within the household. That is, an LPG supplier (compare LPG supplier 310 of FIG. 3) may receive a notification on their user devices that the LPG supply within the household is below a predetermined threshold and therefore, requires replenishment of the LPG supply. At step 420, an office (i.e. an office supplying LPG; compare LPG supplier 310 of FIG. 3) calls a customer (compare household user 312 of FIG. 3) to arrange for delivery of a new LPG supply. At step 422, the office dispatches the driver based on a planned schedule and route. In the exemplary embodiment, the schedule and route may be an optimised schedule and route which takes into account of e.g., all deliveries to be made on that delivery run, including to other households. etc. At step 424, the driver makes

delivery. At step 426, the customer makes payment, e.g. pays through electronic banking (eBanking).

Currently, suppliers of LPG may rely on routine inspection, trends (i.e. estimates
5 on consumption rate), or customers' calls before replenishment of LPG is carried out. Compare steps 404 and 406 of FIG. 4A for example. This may be because there are no other available ways of being alerted to the need for replenishment. Advantageously, in the exemplary embodiment, the system 300 may allow real-time feedback on the need for replenishment of LPG to be received and to prompt replenishment to be dispatched.
10 The exemplary embodiment may thus save time and allow better utilisation of resources.

In the exemplary embodiment, since a driver is not required to be on standby waiting for a customer order, there may be reduced idle time which translates to higher
15 productivity. Further, in the exemplary embodiment, pro-actively calling the customer as prompted by the system 300 may be a plus. That is, a run-out situation may be prevented and better customer service may be provided (e.g. more timely delivery).

In the exemplary embodiment, deliveries may no longer be ad hoc and optimised
20 routes may be planned, improving driver productivity and morale as drivers do not need to be waiting around. With pre-planned deliveries, customers may be better served and face less anxiety or avoid interrupted cooking due to gas run-out.

In the exemplary embodiment, the driver may no longer need to handle cash and
25 the system 300 may advantageously eliminate paperwork, i.e. reduce office work for reconciliation and documentation.

In the exemplary embodiment, the number of activities to complete an order-to-cash process may be reduced significantly.
30

FIG. 5 is a schematic diagram of a system for monitoring a Liquid Petroleum Gas (LPG) supply at a usage location in another exemplary embodiment. In this exemplary embodiment, the system 500 functions similarly to the system 200 described with

reference to FIG. 2. For ease of reference, like numerals and/or naming conventions are used for exemplary implementations of similar units as described in FIG. 1, FIG. 2 and FIG. 5.

5 In the exemplary embodiment, the system 500 comprises one or more gas meters 502A and one or more gas leak detectors 502B (compare one or more sensors 202 of FIG. 2). In the exemplary embodiment, the one or more gas meters 502A may be an analogue gas meter. The one or more gas meters 502A and the one or more gas leak detectors 502B may be located at a commercial site (i.e. the usage location of the
10 exemplary embodiment). In the exemplary embodiment, the one or more gas meters 502A may be configured to measure a volume of the LPG used (or consumed) at the commercial site (i.e. a change in volume of LPG supply in a LPG cylinder located at the commercial site), and the one or more gas leak detectors 502B may be configured to detect gas leakage of the LPG supply at the commercial site. A commercial site may
15 comprise an industrial site or a food outlet like a coffee shop. The system 500 also comprises a micro-processor control unit 504 (compare controller 204 of FIG. 2) coupled to the one or more gas meters 502A and the one or more gas leak detectors 502B, and a data transmission unit 506 (compare data gateway 206 of FIG. 2) coupled to the micro-processor control unit 504. In the exemplary embodiment, the micro-processor
20 control unit 504 is configured to determine usage data based on the measured volume of the LPG consumed, as measured by the gas meters 502A. The data transmission unit 506 is configured to transmit the usage data received from the micro-processor control unit 504.

25 In the exemplary embodiment, the one or more gas meters 502A and one or more gas leak detectors 502B have been described to be coupled to the micro-processor control unit 504. For the gas meters 502A, the system 500 may be provided with a plurality of sensors e.g. up to eleven sensors (or sensor units), and the micro-processor control unit 504 may be configured to determine usage data based on the
30 measured physical properties obtained from the plurality of sensors (or sensor units).

 The system 500 further comprises a cloud-based server 508. The server 508 comprises a database (not shown) configured to receive and store the usage data

received from the micro-processor control unit 504, via the data transmission unit 506, and an application interface (also not shown).

5 In the exemplary embodiment, user devices of LPG suppliers 510 and commercial users (or industrial users) 512 are configured to retrieve the usage data from the database of the cloud-based server 508. The application interface of the cloud-based server 508 may allow the user devices to query the database for the usage data.

10 In the exemplary embodiment, volumetric read-out from the one or more gas meters 502A may be in cubic cm and in analogue format. The one or more gas meters 502A may be configured to cater specifically to commercial users 512 with a LPG cylinder of 50.0kg.

15 In the exemplary embodiment, the one or more gas meters 502A may further comprise a conversion unit using a reed switch, said reed switch coupled to the one or more gas meters 502A so as to digitise the analogue signal (or analogue changes) from the analogue counter within gas meters 502A into a digital signal (or a digital pulse). In the exemplary embodiment, the reed switch may be activated by means provided in the one or more gas meters 502A configured to measure flow rate of LPG leaving the LPG
20 cylinder, and the activated reed switch digitises the analogue signal received from the one or more gas meters 502A. The digitised signal from the reed switch is processed through a specially configured firmware, converting the digitised signal into digital volumetric reading suitable for data processing.

25 In the exemplary embodiment, the one or more gas leak detectors 502B may be configured, in case of gas leakage being detected, to send out an alert signal to the micro-processor control unit 504. Thus, the one or more gas leak detectors 502B may act as a safety device to warn of any potential gas leaks. In the exemplary embodiment, the alert signal may be transmitted, via the micro-processor control unit 504, the data
30 transmission unit 506 and the server 508, to the user devices of the commercial users 512. That is, the alert signal may be transmitted to an end-user and/or an operator at the commercial site (the usage location) in the event of gas leak. For example, operators at the Fire Control Centre (FCC) at the commercial site may usefully receive the alert

signal via their user devices which are remotely connected/coupled to the server 508. The user devices may be configured to also provide other safety management functions and the operators at the FCC may, in response to the alert signal, activate the safety management functions. In use, the alert signal may also be sent as a text message to
5 user devices of personnel at a fire department to alert the personnel of a gas leak.

In the exemplary embodiment, the micro-processor control unit 504 may be configured to analyse, parse, and modulate the received digital signal indicating the volume of LPG used to determine the usage data. In the exemplary embodiment, the
10 (single) micro-processor control unit 504 may be configured to handle readings/measurements (in the form of digital signals) taken from up to eleven gas meters. The exemplary embodiment may advantageously reduce the number of data transmission units used at a usage location which may result in hardware and data transmission cost savings.

15

In the exemplary embodiment, the micro-processor control unit 504 may additionally be configured to store the determined usage data in memory (e.g. in a memory of the micro-processor control unit 504) as part of its on-site data storage capacity. Advantageously, on-site storage of data may prevent accidental data loss while being sent in
20 transit.

In the exemplary embodiment, the micro-processor control unit 504 may be further configured to schedule the determined usage data for transmission to the cloud-based server 508 via the data transmission unit 506, for example, every hourly by default or as
25 requested via any of the commercial users 512 using an application installed in their user devices.

The micro-processor control unit 504 may be configured to be capable of two-way communication with the cloud-based server 508. Advantageously, the two-way
30 communication may allow the micro-processor control unit 504 to receive instructions and/or commands from the user devices of the LPG suppliers 510, via the cloud-based server 508, to for example, remotely control on-site equipment such as gas shut-off valves (i.e. supply valves) to enable or disable LPG supply at the commercial site or

tank switching valves, and reset the one or more gas leak detectors 502B. In the exemplary embodiment, in use, in the event of a gas leakage or a delinquent user/account, supply of gas may be remotely managed by the LPG suppliers 510.

5 In the exemplary embodiment, the micro-processor control unit 504 may be configured to periodically check the one or more gas meters 502A to ensure the gas meters are running accurately and to ensure that the gas meters have not stopped operating. This may be done by the micro-processor control unit 504 pinging the one or more gas meters 502A at pre-set intervals for a positive response. In the exemplary
10 embodiment, a prompt may be issued/transmitted to the user devices of the LPG supplier 510 if meter malfunctions are detected by the micro-processor control unit 504.

 In the exemplary embodiment, the data transmission unit 506 may be configured to send the filtered data remotely to a cloud service (i.e. the cloud-based server 508).
15 Compare cloud-based server 208 of FIG. 2. For the transmission, one or more of the following communication networks may be utilised: Wi-fi, GSM, 3G, 4G or NB-IoT networks. In the exemplary embodiment, the cost of data transmission can be minimised through using the correct choice of transmission mode depending on network availability and location within the commercial site (i.e. the usage location).

20

 In the exemplary embodiment, the cloud service may be subscribed from a service provider e.g. Amazon Web Services (AWS) or Google Cloud. The cloud-based server 508 may comprise three components: (1) a data broker; (2) a database server; and (3) an Application Program Interface (API) Server. In the exemplary embodiment,
25 the data broker may handle the data received via the internet before passing them onto the database server. The database server may store the data in prescribed format for subsequent retrieval and update. MongoDB is one program that may be used for managing the data. In the exemplary embodiment, the API server may provide an interface for querying and updating of data through a GraphQL query language. In the
30 exemplary embodiment, the cloud-based server 508 may provide data security, reduce system redundancy and a means for data encryption. The exemplary embodiment may advantageously provide security of client's sensitive data through data encryption. Further, the provision of the cloud-based server 508 may advantageously allow the

system 500 to be more easily scalable, have a stable up-time and not require as much hardware maintenance.

5 In the exemplary embodiment, apps written for use on various user devices (e.g. user devices of the LPG suppliers 510 and the commercial users 512) may be linked through the API to the API server to update or query the database server. In the exemplary embodiment, the apps may be written using Flutter UI Framework for mobile devices (both Android and iOS). If desired, the apps may be adapted to communicate through Windows OS. In the exemplary embodiment, any suitable software tool for
10 building cross platform apps so that usage data can be made available in a wide range of user devices may be used.

In the exemplary embodiment, the LPG suppliers 510 may have access to the LPG usage/consumption data of the commercial users 512, who may be their
15 customers, through their user devices. The user devices of the LPG suppliers 510 may be provided with an app which is configured to allow access to the usage data of the commercial users 512 stored in the database server of the cloud-based server 508.

In the exemplary embodiment, the usage data collected can be used in one or
20 more of the following ways: order-to-cash process, inventory planning, delivery scheduling, remote control of gas (LPG) supply, monitoring of the customers (i.e. LPG suppliers 510 monitoring the LPG usage data of the commercial users 512), marketing and promotion based on data analytics, and safety checks (i.e. gas leak detection).

25 In the exemplary embodiment, interfaces may be made available on the user devices of the LPG suppliers 510 to port the usage data directly to other business software tools for analysis, such as an enterprise resource planning (ERP) system, a transport management system, a sales accounting system, an inventory management system etc. As one example, the LPG suppliers 510 may be able to optimise on the use
30 of its delivery resources through planned deliveries of LPG tanks/cylinders, including route optimisation. As a result, idle time may be reduced significantly. The LPG suppliers 510 may then be able to provide better customer service by pre-empting the need for replenishment of the LPG supply at the usage location (i.e. at the commercial

site) and providing pre-planned on-time deliveries. As another example, the usage data may be used directly by the ERP system and invoicing may usefully be generated based on the usage data.

5 In the exemplary embodiment, the user devices of the commercial users 512 may be provided with an app which may usefully allow the commercial users 512 to track their own gas (LPG) usage in real-time and track historical usage pattern. The exemplary embodiment may thus facilitate repeat purchases. The user devices of the commercial users 512 may also be configured to provide a notification when gas (LPG)
10 is running low (i.e. when the usage data obtained by the micro-processor control unit 504 indicates that the LPG remaining in the LPG cylinder is below a predetermined threshold). In the exemplary embodiment, in response to the notification, the commercial users 512 may make arrangements for replenishment of the LPG supply at the commercial site (i.e. the usage location) to avoid an unexpected run-out.

15

 The exemplary embodiment may make available real-time (or on-demand) reading of the one or more gas meters 502A. In the exemplary embodiment, the app on the user devices of the LPG suppliers 510 may be configured to receive instructions from the LPG suppliers 510 to obtain real-time usage data, and the instructions may be
20 transmitted to the micro-processor control unit 504. In response, the micro-processor control unit 504 may instruct the one or more gas meters 502A to measure the volume of LPG consumed. The micro-processor control unit 504 may determine the real-time usage data based on the obtained measurement and the real-time usage data may be transmitted to the user devices of the LPG suppliers 510. In use, obtaining the real-time
25 usage data may be useful to the LPG suppliers 510 who may be provided with the real-time usage data (i.e. data on consumptions) of customers, e.g. dormitories whereby end-users/tenants may come and go on short notice.

 FIG. 6A is a schematic flowchart for illustrating an existing method of operation.
30 The method 600 is the existing method of operation relating to an order-to-cash process for replenishing Liquid Petroleum Gas (LPG) supply at a usage location, i.e. a commercial site. At step 602, a driver (e.g. employed at an office supplying LPG) is deployed at the commercial site and conducts checks at the commercial site. The driver

may carry out one or more of the following: physically check, at the commercial site, if an LPG cylinder is running low in LPG supply and needs replacement, make periodic visits to the commercial site to record gas meter readings (where gas meters are installed), respond to ad hoc requests for cylinders, and go on site (i.e. the commercial site) to shut off LPG supply for customers (i.e. commercial users) who are delinquent in payment. Where there is a requirement for a cylinder to be delivered, at step 604, the driver deliver the cylinders. At step 606, the driver issues an invoice with an invoice book and/or collects cash payment from the commercial users. At step 608, the driver returns the cash and/or the invoice book to the office. At step 610, the office reconciles paperwork and inventory. At step 612, the office updates their records and accounts.

FIG. 6B is a schematic flowchart for illustrating a proposed method of operation in an exemplary embodiment. In the exemplary embodiment, the system 500 described with reference to FIG. 5 may prompt the method 614 to be implemented, which relates to an order-to-cash process for replenishing LPG supply at the usage location, i.e. the commercial site. That is, an LPG supplier (compare LPG supplier 510 of FIG. 5) may receive a notification on their user devices that the LPG supply at the commercial site is below a predetermined threshold and therefore, requires replenishment of the LPG supply. At step 616, the LPG supplier receives a notification/prompt on customers who need to have their gas/LPG cylinders changed out, and the LPG supplier dispatches the driver according to a planned schedule and optimal routing. At step 618, the driver makes the delivery.

In contrast with the existing method illustrated in FIG. 6A, in the exemplary embodiment of FIG. 6B, the drivers are relieved of responsibilities to conduct physical checks of cylinders or take meter readings. As such, they may be able to focus on gas deliveries

In the exemplary embodiment, the drivers may no longer need to handle any cash transactions. This may therefore lessen the exposure of the LPG suppliers to driver mischief.

In the exemplary embodiment, advantageously, gas meter reading at hazardous locations may not be necessary. That is, if the usage location is in a hazardous location (e.g. an industrial site and/or a manufacturing site with explosion risks), the use of the system 500 may advantageously allow for remote reading of meters to determine LPG usage at the hazardous location. In turn, in the exemplary embodiment, a staff member need not be deployed to perform a physical reading of the meters at the hazardous location. Allowing remote reading may additionally reduce the potential for human error, i.e. reduce occurrences of poor visibility, lighting or eyesight resulting in error. Further, providing remote reading may reduce potential for undesirable collusion between the employed staff of the LPG supplier and the end user of the LPG supply.

In the exemplary embodiment, potential conflict with customers over the shutting off of gas supply at the usage location (i.e. the commercial site) may be avoided. In the exemplary embodiment, when dealing with a delinquent account for example, the system 500 may allow for remote control of gas shut-off valves of LPG cylinders at the usage location and therefore, the LPG supplier may shut down the LPG supply at the usage location remotely, i.e. without having to do so manually. This may in turn, reduce the occurrences of the LPG supplier having to face potential confrontations from the customers at the usage location. The same may also apply in situations where there may be other legitimate needs to turn-off the valves of the LPG cylinders at the usage location.

In the exemplary embodiment, acknowledgement for delivery may be signed off on a user device (e.g. a smartphone). For example, after a successful delivery of LPG cylinders to the usage location, a customer may sign off on a user device of the driver as acknowledgement thereof. In turn, the acknowledgement may usefully be sent to a user device of the LPG supplier to inform the LPG supplier of the successful delivery.

In the system 500, usage data may be used directly by an enterprise resource planning (ERP) system and invoicing may be generated based on the usage data. In turn, in the exemplary embodiment, turnaround time may be shortened. That is, the time taken for completing each order-to-cash process may be significantly shortened.

In the exemplary embodiment, the order-to-cash process may be significantly simplified. The order-to-cash process may be simplified as a result of the use of information technology, resulting in greater productivity and improved efficiency. The system 500 may provide a fully integrated system and thus, in the exemplary embodiment, the various critical stages of the order-to-cash process may be linked. The system 500 may also provide crucial data which, in the exemplary embodiment, may further enhance operations and business performance vis-à-vis the order-to-cash process.

In the exemplary embodiment, paperwork may be reduced significantly, i.e. from reduced office work for reconciliation and documentation.

In the exemplary embodiment, real-time monitoring of the customers' usage/consumption may be performed. That is, the system 500 may provide a means for performing the real-time monitoring and may prompt the method 614 to be implemented when an actual need arises, i.e., when LPG supply at the commercial site is below the predetermined threshold and therefore, a replenishment of the LPG supply is needed at the commercial site. This may advantageously reduce the need to make periodic visits to the commercial site.

Different example embodiments can be implemented in the context of data structure, program modules, program and computer instructions executed in a computer implemented environment. A general purpose computing environment is briefly disclosed herein. One or more example embodiments may be embodied in one or more computer systems, such as is schematically illustrated in FIG. 7.

One or more example embodiments may be implemented as software, such as a computer program being executed within a specially configured computer system 700, and instructing the computer system 700 to conduct a method of an example embodiment.

The specially configured computer system 700 comprises a computer unit 702, input modules such as a keyboard 704 and a pointing device 706 and a plurality of output devices such as a display 708, and printer 710. A user can interact with the computer unit 702 using the above devices. The pointing device can be implemented with a mouse, track ball, pen

device or any similar device. One or more other input devices (not shown) such as a scanner, touch sensitive screen or the like can also be connected to the computer unit 702. The display 708 may include a cathode ray tube (CRT), liquid crystal display (LCD), field emission display (FED), plasma display or any other device that produces an image that is viewable by the user.

The computer unit 702 can be connected to a computer network 712 via a suitable transceiver device 714, to enable access to e.g. the Internet or other network systems such as Local Area Network (LAN) or Wide Area Network (WAN) or a personal network. The network 712 can comprise a server, a router, a network personal computer, a peer device or other common network node, a wireless telephone or wireless personal digital assistant. Networking environments may be found in offices, enterprise-wide computer networks and home computer systems etc. The transceiver device 714 can be a modem/router unit located within or external to the computer unit 702, and may be any type of modem/router such as a cable modem or a satellite modem.

It will be appreciated that network connections shown are exemplary and other ways of establishing a communications link between computers can be used. The existence of any of various protocols, such as TCP/IP, Frame Relay, Ethernet, FTP, HTTP and the like, is presumed, and the computer unit 702 can be operated in a client-server configuration to permit a user to retrieve web pages from a web-based server. Furthermore, any of various web browsers can be used to display and manipulate data on web pages.

The computer unit 702 in the example comprises a processor 718, a Random Access Memory (RAM) 720 and a Read Only Memory (ROM) 722. The ROM 722 can be a system memory storing basic input/ output system (BIOS) information. The RAM 720 can store one or more program modules such as operating systems, application programs and program data.

The computer unit 702 further comprises a number of Input/Output (I/O) interface units, for example I/O interface unit 724 to the display 708, and I/O interface unit 726 to the keyboard 704. The components of the computer unit 702 typically communicate and interface/couple connectedly via an interconnected system bus 728 and in a manner known

to the person skilled in the relevant art. The bus 728 can be any of several types of bus structures including a memory bus or memory controller, a peripheral bus, and a local bus using any of a variety of bus architectures.

5 It will be appreciated that other devices can also be connected to the system bus 728. For example, a universal serial bus (USB) interface can be used for coupling a video or digital camera to the system bus 728. An IEEE 1394 interface may be used to couple additional devices to the computer unit 702. Other manufacturer interfaces are also possible such as FireWire developed by Apple Computer and i.Link developed by Sony. Coupling of
10 devices to the system bus 728 can also be via a parallel port, a PCI board or any other interface used to couple an input device to a computer. It will also be appreciated that, while the components are not shown in the figure, sound/audio can be recorded and reproduced with a microphone and a speaker. A sound card may be used to couple a microphone and a speaker to the system bus 728. It will be appreciated that several peripheral devices can be
15 coupled to the system bus 728 via alternative interfaces simultaneously.

 An application program can be supplied to the user of the computer system 700 being encoded/stored on a data storage medium such as a CD-ROM or flash memory carrier. The application program can be read using a corresponding data storage medium
20 drive of a data storage device 730. The data storage medium is not limited to being portable and can include instances of being embedded in the computer unit 702. The data storage device 730 can comprise a hard disk interface unit and/or a removable memory interface unit (both not shown in detail) respectively coupling a hard disk drive and/or a removable memory drive to the system bus 728. This can enable reading/writing of data. Examples of
25 removable memory drives include magnetic disk drives and optical disk drives. The drives and their associated computer-readable media, such as a floppy disk provide non-volatile storage of computer readable instructions, data structures, program modules and other data for the computer unit 702. It will be appreciated that the computer unit 702 may include several of such drives. Furthermore, the computer unit 702 may include drives for interfacing
30 with other types of computer readable media.

 The application program is read and controlled in its execution by the processor 718. Intermediate storage of program data may be accomplished using RAM 720. The method(s)

of the example embodiments can be implemented as computer readable instructions, computer executable components, or software modules. One or more software modules may alternatively be used. These can include an executable program, a data link library, a configuration file, a database, a graphical image, a binary data file, a text data file, an object
5 file, a source code file, or the like. When one or more computer processors execute one or more of the software modules, the software modules interact to cause one or more computer systems to perform according to the teachings herein.

The operation of the computer unit 702 can be controlled by a variety of different
10 program modules. Examples of program modules are routines, programs, objects, components, data structures, libraries, etc. that perform particular tasks or implement particular abstract data types. The example embodiments may also be practiced with other computer system configurations, including handheld devices, multiprocessor systems, microprocessor-based or programmable consumer electronics, network PCs,
15 minicomputers, mainframe computers, personal digital assistants, mobile telephones and the like. Furthermore, the example embodiments may also be practiced in distributed computing environments where tasks are performed by remote processing devices that are linked through a wireless or wired communications network. In a distributed computing environment, program modules may be located in both local and remote memory storage
20 devices.

Different example embodiments can be implemented in the context of data structure, program modules, program and computer instructions executed in a communication device. An exemplary communication device is briefly disclosed herein. One or more example
25 embodiments may be embodied in one or more communication devices e.g. 800, such as is schematically illustrated in FIG. 8.

One or more example embodiments may be implemented as software, such as a computer program being executed within a specially configured communication device 800,
30 and instructing the communication device 800 to conduct a method of an example embodiment.

The specially configured communication device 800 comprises a processor module 802, an input module such as a touchscreen interface or a keypad 804 and an output module such as a display 806 on a touchscreen.

5 The processor module 802 is coupled to a first communication unit 808 for communication with a cellular network 810. The first communication unit 808 can include, but is not limited to, a subscriber identity module (SIM) card loading bay. The cellular network 810 can, for example, be a 3G or 4G network.

10 The processor module 802 is further coupled to a second communication unit 812 for connection to a network 814. For example, the second communication unit 812 can enable access to e.g. the Internet or other network systems such as Local Area Network (LAN) or Wide Area Network (WAN) or a personal network. The network 814 can comprise a server, a router, a network personal computer, a peer device or other common network node, a
15 wireless telephone or wireless personal digital assistant. Networking environments may be found in offices, enterprise-wide computer networks and home computer systems etc. The second communication unit 812 can include, but is not limited to, a wireless network card or an ethernet network cable port. The second communication unit 812 can also be a modem/router unit and may be any type of modem/router such as a cable-type modem or a
20 satellite-type modem.

 It will be appreciated that network connections shown are exemplary and other ways of establishing a communications link between computers can be used. The existence of any of various protocols, such as TCP/IP, Frame Relay, Ethernet, FTP, HTTP and the like, is
25 presumed, and the communication device 800 can be operated in a client-server configuration to permit a user to retrieve web pages from a web-based server. Furthermore, any of various web browsers can be used to display and manipulate data on web pages.

 The processor module 802 in the example includes a processor 816, a Random
30 Access Memory (RAM) 818 and a Read Only Memory (ROM) 820. The ROM 820 can be a system memory storing basic input/ output system (BIOS) information. The RAM 818 can store one or more program modules such as operating systems, application programs and program data.

The processor module 802 also includes a number of Input/Output (I/O) interfaces, for example I/O interface 822 to the display 806, and I/O interface 824 to the keypad 804.

5 The components of the processor module 802 typically communicate and interface/couple connectedly via an interconnected bus 826 and in a manner known to the person skilled in the relevant art. The bus 826 can be any of several types of bus structures including a memory bus or memory controller, a peripheral bus, and a local bus using any of a variety of bus architectures.

10

It will be appreciated that other devices can also be connected to the system bus 826. For example, a universal serial bus (USB) interface can be used for coupling an accessory of the communication device, such as a card reader, to the system bus 826.

15 The application program is typically supplied to the user of the communication device 800 encoded on a data storage medium such as a flash memory module or memory card/stick and read utilising a corresponding memory reader-writer of a data storage device 828. The data storage medium is not limited to being portable and can include instances of being embedded in the communication device 800.

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The application program is read and controlled in its execution by the processor 816. Intermediate storage of program data may be accomplished using RAM 818. The method(s) of the example embodiments can be implemented as computer readable instructions, computer executable components, or software modules. One or more software modules may alternatively be used. These can include an executable program, a data link library, a configuration file, a database, a graphical image, a binary data file, a text data file, an object file, a source code file, or the like. When one or more processor modules execute one or more of the software modules, the software modules interact to cause one or more processor modules to perform according to the teachings herein.

25

30

The operation of the communication device 800 can be controlled by a variety of different program modules. Examples of program modules are routines, programs, objects,

components, data structures, libraries, etc. that perform particular tasks or implement particular abstract data types.

5 The example embodiments may also be practiced with other computer system configurations, including handheld devices, multiprocessor systems/servers, microprocessor-based or programmable consumer electronics, network PCs, minicomputers, mainframe computers, personal digital assistants, mobile telephones and the like. Furthermore, the example embodiments may also be practiced in distributed computing environments where tasks are performed by remote processing devices that are linked
10 through a wireless or wired communications network. In a distributed computing environment, program modules may be located in both local and remote memory storage devices.

15 An exemplary method of monitoring an LPG supply at a usage location is described with reference to FIG. 9.

FIG. 9 is a schematic flowchart illustrating a method of monitoring a Liquid Petroleum Gas (LPG) supply at a usage location in an exemplary embodiment. In the method 900, at step 902, a physical property of the LPG supply is measured at the usage location. At step
20 904, usage data is determined based on the measured physical property. At step 906, the usage data is transmitted. At step 908, the usage data is received and stored in a database remotely located from the usage location. At step 910, the usage data is retrieved from the database.

25 In the exemplary embodiment, the physical property comprises a volume or weight of the LPG supply. The weight or volume of the LPG supply may be measured using a weighing scale, the measured weight or volume of the LPG being used to determine the usage data by a processing unit.

30 In the exemplary embodiment, the method further comprises converting an analogue signal on the measured physical property. The conversion may comprise for example, digitising an analogue signal on the measured physical property into a digital signal. The analogue gas meter is deployed as a sensor for measuring the physical

property of the LPG supply. A reed switch acts as a conversion unit for converting analogue changes in the analogue gas meter into digital pulses.

5 In the exemplary embodiment, the method further comprises receiving instructions from one or more user devices, via a remote server, and upon receipt of the instruction, obtaining the measured physical property and transmitting a determined real-time usage data. In an exemplary embodiment, the method further comprises periodically obtaining the measured physical property and transmitting a determined real-time usage data.

10

In the exemplary embodiment, the method further comprises enabling or disabling the LPG supply at the usage location from a remote location.

15 In the exemplary embodiment, the method further comprises detecting gas leakage of the LPG supply at the usage location.

In the exemplary embodiment, the method further comprises providing a processing unit memory for storing usage data at the usage location.

20 In another exemplary embodiment, a non-transitory tangible computer readable storage medium having stored thereon software instructions may be provided. The instructions, when executed by a computer processor of a system to monitor an LPG supply at a usage location, cause the computer processor to perform a method of monitoring an LPG supply at the usage location, by executing the steps comprising measuring a physical
25 property of the LPG supply at the usage location; determining usage data based on the measured physical property at the usage location; transmitting the usage data; receiving and storing the usage data in a database remotely located from the usage location; and retrieving the usage data from the database. It will be appreciated that the steps described herein may be non-sequential and may not be ordered as listed.

30

The terms "coupled" or "connected" as used in this description are intended to cover both directly connected or connected through one or more intermediate means, unless otherwise stated.

The description herein may be, in certain portions, explicitly or implicitly described as algorithms and/or functional operations that operate on data within a computer memory or an electronic circuit. These algorithmic descriptions and/or functional operations are usually
5 used by those skilled in the information/data processing arts for efficient description. An algorithm is generally relating to a self-consistent sequence of steps leading to a desired result. The algorithmic steps can include physical manipulations of physical quantities, such as electrical, magnetic or optical signals capable of being stored, transmitted, transferred, combined, compared, and otherwise manipulated.

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Further, unless specifically stated otherwise, and would ordinarily be apparent from the following, a person skilled in the art will appreciate that throughout the present specification, discussions utilizing terms such as “scanning”, “calculating”, “determining”, “replacing”, “generating”, “initializing”, “outputting”, and the like, refer to action and processes
15 of an instructing processor/computer system, or similar electronic circuit/device/component, that manipulates/processes and transforms data represented as physical quantities within the described system into other data similarly represented as physical quantities within the system or other information storage, transmission or display devices etc.

20

The description also discloses relevant device/apparatus for performing the steps of the described methods. Such apparatus may be specifically constructed for the purposes of the methods, or may comprise a general purpose computer/processor or other device selectively activated or reconfigured by a computer program stored in a storage member. The algorithms and displays described herein are not inherently related to any particular
25 computer or other apparatus. It is understood that general purpose devices/machines may be used in accordance with the teachings herein. Alternatively, the construction of a specialized device/apparatus to perform the method steps may be desired.

30

In addition, it is submitted that the description also implicitly covers a computer program, in that it would be clear that the steps of the methods described herein may be put into effect by computer code. It will be appreciated that a large variety of programming languages and coding can be used to implement the teachings of the description herein.

Moreover, the computer program if applicable is not limited to any particular control flow and can use different control flows without departing from the scope of the invention.

Furthermore, one or more of the steps of the computer program if applicable may be performed in parallel and/or sequentially. Such a computer program if applicable may be stored on any computer readable medium. The computer readable medium may include storage devices such as magnetic or optical disks, memory chips, or other storage devices suitable for interfacing with a suitable reader/general purpose computer. In such instances, the computer readable storage medium is non-transitory. Such storage medium also covers all computer-readable media e.g. medium that stores data only for short periods of time and/or only in the presence of power, such as register memory, processor cache and Random Access Memory (RAM) and the like. The computer readable medium may even include a wired medium such as exemplified in the Internet system, or wireless medium such as exemplified in bluetooth technology. The computer program when loaded and executed on a suitable reader effectively results in an apparatus that can implement the steps of the described methods.

The example embodiments may also be implemented as hardware modules. A module is a functional hardware unit designed for use with other components or modules. For example, a module may be implemented using digital or discrete electronic components, or it can form a portion of an entire electronic circuit such as an Application Specific Integrated Circuit (ASIC). A person skilled in the art will understand that the example embodiments can also be implemented as a combination of hardware and software modules.

Additionally, when describing some embodiments, the disclosure may have disclosed a method and/or process as a particular sequence of steps. However, unless otherwise required, it will be appreciated the method or process should not be limited to the particular sequence of steps disclosed. Other sequences of steps may be possible. The particular order of the steps disclosed herein should not be construed as undue limitations. Unless otherwise required, a method and/or process disclosed herein should not be limited to the steps being carried out in the order written. The sequence of steps may be varied and still remain within the scope of the disclosure.

Further, in the description herein, the word “substantially” whenever used is understood to include, but not restricted to, “entirely” or “completely” and the like. In addition, terms such as “comprising”, “comprise”, and the like whenever used, are intended to be non-restricting descriptive language in that they broadly include elements/components recited after such terms, in addition to other components not explicitly recited. For an example, when “comprising” is used, reference to a “one” feature is also intended to be a reference to “at least one” of that feature. Terms such as “consisting”, “consist”, and the like, may, in the appropriate context, be considered as a subset of terms such as “comprising”, “comprise”, and the like. Therefore, in embodiments disclosed herein using the terms such as “comprising”, “comprise”, and the like, it will be appreciated that these embodiments provide teaching for corresponding embodiments using terms such as “consisting”, “consist”, and the like. Further, terms such as “about”, “approximately” and the like whenever used, typically means a reasonable variation, for example a variation of +/- 5% of the disclosed value, or a variance of 4% of the disclosed value, or a variance of 3% of the disclosed value, a variance of 2% of the disclosed value or a variance of 1% of the disclosed value.

Furthermore, in the description herein, certain values may be disclosed in a range. The values showing the end points of a range are intended to illustrate a preferred range. Whenever a range has been described, it is intended that the range covers and teaches all possible sub-ranges as well as individual numerical values within that range. That is, the end points of a range should not be interpreted as inflexible limitations. For example, a description of a range of 1% to 5% is intended to have specifically disclosed sub-ranges 1% to 2%, 1% to 3%, 1% to 4%, 2% to 3% etc., as well as individually, values within that range such as 1%, 2%, 3%, 4% and 5%. The intention of the above specific disclosure is applicable to any depth/breadth of a range.

In the exemplary embodiments, it is described that the system is for monitoring an LPG supply at a usage location. It will be appreciated that the exemplary embodiment is not limited to monitoring LPG supply and may be adapted for use in other industrial sectors where there remote sensing and data collection of other gases and liquids may be useful, e.g. industrial gases, other gaseous or liquid chemical distributions, or water. The exemplary embodiments may also be adapted for use in remote monitoring of electricity consumption.

It will be appreciated by a person skilled in the art that other variations and/or modifications may be made to the specific embodiments without departing from the scope of the invention as broadly described. For example, in the description herein, features of
5 different exemplary embodiments may be mixed, combined, interchanged, incorporated, adopted, modified, included etc. or the like across different exemplary embodiments. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive.

CLAIMS

1. A system for monitoring an LPG supply at a usage location, the system comprising

5 a sensor unit configured to measure a physical property of the LPG supply at the usage location;

a processing unit coupled to the sensor unit, the processing unit configured to determine usage data based on the measured physical property, and to transmit the usage data; and

10 a remote server comprising

a database configured to receive and store the usage data; and

an application interface to allow one or more user devices to retrieve the usage data from the database,

wherein the physical property comprises volume or weight of the LPG supply,

15 wherein the system comprises a conversion unit configured to convert an analogue signal received at the sensor unit,

wherein the LPG supply comprises an LPG storage unit placed at the usage location, the sensor unit comprises a weighing scale to measure a weight of the LPG storage unit, and wherein the processing unit determines the usage data based on the measured weight of the LPG storage unit,

20 wherein the weighing scale and processing unit are housed in an integrated single housing,

wherein the integrated single housing is configured to receive the LPG storage unit, such that the integrated single housing serves as a base of the LPG storage unit,

25 wherein the sensor unit comprises an analogue gas meter, and

wherein the conversion unit comprises a reed switch for converting analogue changes in the analogue gas meter into electrical pulses.

2. The system as claimed in claim 1, wherein the processing unit is coupled to additional sensor units, the processing unit configured to determine usage data based on the additionally measured physical properties obtained from the additional sensor units.

3. The system as claimed in any one of the preceding claims, wherein the processing unit is configured to periodically obtain the measured physical property from the sensor unit and to transmit determined usage data to the remote server.

5 4. The system as claimed in any one of the preceding claims, wherein the processing unit is further configured to receive instructions from the one or more user devices, via the remote server.

10 5. The system as claimed in claim 4, wherein upon receipt of the instruction, the processing unit is configured to obtain the measured physical property from the sensor unit and to transmit a determined real-time usage data.

15 6. The system as claimed in claim 4, further comprising one or more valves for controlling the LPG supply at the usage location, wherein the valves are controllable by the processing unit.

20 7. The system as claimed in claim 6, wherein upon receipt of the instruction, the processing unit is configured to enable or disable the LPG supply at the usage location.

8. The system as claimed in any one of the preceding claims, wherein the sensor unit is configured to detect gas leakage of the LPG supply at the usage location.

25 9. The system as claimed in any one of the preceding claims, wherein the processing unit comprises a processing unit memory.