

PROCESSING OF REMOTE METER-READING DATA TO ANALYSE CONSUMPTION MODES

Field of the invention

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The invention relates to the technical field of data processing, and in particular to the processing of water and/or energy consumption data.

Prior art

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The energy or water consumption of users, whether they be individual users or industrial users, is presently tracked by so-called remote reading operations, i.e. via the transmission to a remote site of readings of consumption meters.

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Today these operations may be used as a way of guiding users along a path toward a durable management of their consumption. Compared to an analysis carried out passively and *a posteriori*, changes in the consumption behavior of users may be more dependent on the quality of the information, i.e. of the analysis of the remotely read data.

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At a community level, local governments and public housing agencies in particular need to better know their consumption levels (their level of water consumption for example) over their jurisdictions. Many local governments expect and appreciate reliable and relevant data as it allows them to improve their water management policies and/or development programs. At a more local and individual scale, households also find it advantageous to better understand their water and/or energy (electricity and/gas for example) consumption levels.

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The prior art with respect to water (or electricity) consumption describes various technical solutions, corresponding to as many different

approaches. The patent literature is for example generally restricted to an approach that is oriented toward technology, methods and systems for acquiring data (for example in real-time as in CN104362756). Other accessible publications also remain limited to the use of statistical
5 techniques that remain essentially descriptive (e.g. data mining applied to raw consumption data).

Although advantageous, the limits of these known approaches do not allow the aforementioned need for analysis to be entirely met. There is
10 therefore a need for methods and systems for analyzing water and/or energy consumption behavior.

Summary of the invention

15 The invention relates to a method, implemented by computer, for determining a profile of a user of an energy and/or water resource, the method comprising steps of: receiving initial data on consumption of the resource from a plurality of users; determining strata of consumption of the resource; determining user groups; and determining at least one user
20 profile. Embodiments describe: the use of additional data, in particular cartographic data, that are correlated with the determined user profile; the determination of consumption trends; the determination of a reference consumption model; and the comparison of the remotely read consumptions with the reference model; furthermore, software and
25 system aspects are also described, in particular the remote consultation of information relating to consumption data, to user groups, to user profiles, to consumption trends or to reference consumption models.

The invention is advantageously applicable to the management of water
30 management data, but by extension also applies to the management of data on consumption of similar resources (such as the consumption of electricity or gas).

Specifically, embodiments of the invention are applicable to many activities in the utilities sector. The term “utilities” is understood to refer to services provided to communities, such as the production/generation and distribution of water, gas and electricity (non-exhaustive list).

- 5 Specifically, the consumption data may relate to any one of these resources (or even to composite or synthetic consumption data, for example data combining gas consumption data and electricity consumption data). The data manipulated by the method according to the invention may therefore be abstract (e.g. water-gas-electricity-refuse
10 consumption scores or points).

In particular embodiments, the invention may also be applied to the management of refuse. The volume of refuse produced by a user may be measured or at least estimated (e.g. “smart bins”, analysis and recognition of images or videos, etc.). Hence, embodiments of the
15 invention may be implemented.

Water consumption will for example be measured in m^3/year , electricity consumption in kWh, gas consumption in m^3/year and refuse production in m^3/year .

- 20 Advantageously, the method allows the uses that are made of the consumed water to be identified.

Advantageously, the method according to the invention allows water consumption to be tracked and diagnosed, in particular by local
25 governments and public housing agencies.

Advantageously, a multidisciplinary methodological approach allows users (domestic users, governmental users, industrial users, etc.) to understand, track and modify their consumption at various scales (from a
30 service-wide scale to a neighborhood scale).

Advantageously, the method according to the invention takes into account

time-related factors in the tracking of consumption (e.g. long-term variation in consumption levels, cyclical variations in consumption) and contextual factors (e.g. climate, region, consumption habits).

- 5 Advantageously, the method according to the invention allows the supply of resources to be improved, in addition to analyzing the demand for resources.

- 10 Advantageously, the analyses made possible by the method according to the invention allows mutual confidence and cooperation to be fostered between the service provider and a region's various consumers (e.g. local governments, associations, public housing agencies, individual users).

- 15 Advantageously, the method according to the invention makes use of data other than water consumption data. Known prior-art solutions do not implement data integration. In particular, according to the invention, the remotely read consumption data are enriched with socio-economic data. These socio-economic data result either from steps of aggregating data (for example neighborhood-specific census data obtained by the Census
20 Bureau) and/or are received directly from users (for example via surveys). These analyses allow new services to be developed, which will in return allow water consumption to be controlled i.e. modulated and possibly decreased. In one embodiment, the data integration is carried out by means of statistical and/or sociological classifying methods (e.g.
25 behavioral sociology).

- Advantageously, the method according to the invention allows initial and/or enriched data to be provided to users, local governments and public housing agencies.

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Advantageously, the tracking and monitoring of consumption may be carried out in a manner that is specific to each user profile. For example, each user will possibly be able to access his consumption profile, in order to obtain an overall understanding of his consumption. Each user will also

be able to access one or more models representing his consumption (i.e. predictions). Having access to data representing consumption over various time horizons (short-, medium- and long-term horizons), i.e. to data that have actually being observed and to predictions specific to each
5 user, the user or users in question may then modify (where appropriate) his/their consumption behavior (i.e. feedback loop, virtuous cycle). For example, the user will possibly as a result modify his consumption by exploring changes to factors that determine his consumption level and by measuring the effectiveness of his approach with respect to his peers
10 (keep tabs), i.e. with respect to users with the same profile.

Advantageously, the invention provides analyzing means with a view to defining strategies for guiding a decrease in consumption in light of consumption trends in a preset zone. The data may be gathered on a
15 local (i.e. neighborhood-specific) scale or on a service-wide (set of jurisdictions) scale (i.e. on a larger scale).

Advantageously, the invention makes use of remotely read consumption data to determine overall consumption profiles and these primary data are
20 then integrated with declared uses (obtained by survey, online questionnaire, etc.). Thus, the obtainment of consumer profiles allows other data obtained from other sources to be exploited. In other words, without the invention, consumption data on the one hand and consumption uses on the other hand would remain at least partially
25 compartmentalized or incompatible or separate.

Advantageously, embodiments of the invention allow users to compare their consumptions with one or more reference profiles.

30 Advantageously, the invention allows man's impact on his surroundings to be characterized - or even quantified - allowing corrective actions to be implemented. Advantageously, synthetic data analyses may be fed back to users so as to change consumption behavior, creating a durable virtuous cycle. Since the analysis scales are configurable, the correlation

between (bottom-up) field data and the (top-down) analyses of consumption uses may be improved.

Advantageously, certain embodiments of the invention make it possible to
5 provide help with and/or regulate the water/energy consumption of a user
or household via calculation of and reference to a consumption model,
this model in particular incorporating data other than the remote readings
(in particular by integration with sociodemographic and/or cartographic
data).

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Advantageously, as a result of such comparisons between modelled and
actual consumption, interactions with users may include notifications
(feedback of information) and/or physical, tangible and flexible
interventions (selective and/or gradual decrease or stoppage of delivery of
15 the energy/water resource).

Advantageously, according to the invention, the application of specific
statistical methods (e.g. integration of consumption data with other data,
in particular socio-economic data) allows geographically contextualized
20 standards to be defined.

Description of the figures

Other features and advantages of the invention will become apparent
25 from the following description and the figures of the appended drawings,
in which:

figure 1 shows examples of steps of the method according to the
invention;

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figure 2 shows an example of classification of users as a function of
consumption levels or strata;

figure 3 shows an example of classification of users into consumption

variation groups;

figure 4 shows an example of the average daily consumption of consumers with various example user profiles over one year;

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figure 5 shows an example of integration of consumption data with sociodemographic data;

figure 6 illustrates an example of an analysis compared with a user's
10 consumption;

figure 7 illustrates an example of a regional analysis of consumption profiles; and

15 figure 8 illustrates an example of access to consumption analyses and data.

Detailed description of the invention

20 A user according to the invention is also called a customer or consumer, depending on the context.

A user is a generator of data on consumption of a given resource (water, electricity, gas, refuse, etc.). A consumer may correspond to an physical
25 individual or to an aggregate of physical individuals. A consumer may be a judicial entity (e.g. a company or an organization such as a hospital). In one large-scale embodiment, a user or a consumer may for example be a community or a public housing agency or a region. The fields of application of the invention relate to domestic users, industrial users or
30 even governmental users.

A method, implemented by computer, for managing a water and/or energy resource is disclosed, the method comprising the steps of: - receiving initial data on water and/or energy resource consumption from at least

one user, said consumption data being read remotely from a plurality of smart meters; - determining a user profile; - determining a so-called reference consumption model associated with the user profile; - comparing the water and/or energy resource consumption of the user with
5 said reference consumption model; and - notifying the user in case of a difference with respect to a predefined threshold.

Remotely reading a meter allows this meter to be read remotely i.e. without requiring physical access to the meter. The meter is then what is
10 called a "smart meter".

According to the invention, feedback is generated and fed back to the consumers of the resources, i.e. the users.

15 A first type of feedback is the feedback of information (for example in the form of notification) to the user (e.g. the household in question). This feedback of information aims to improve the awareness (e.g. behavioral awareness) and/or to facilitate savings (the user may himself define savings objectives). Advantageously, a connected object according to the
20 invention allows personalized, i.e. "local" and "continuous", feedback (e.g. for each of the meters, or some thereof)

Unfavorable differences with respect to the standard may be notified but also favorable differences. Advantageously, notifications are delivered, for
25 example by LED status lights that are located in discreet locations in the dwelling (in order not to exert "social pressure").

In one embodiment, the user is notified (only) in case of a favorable difference with respect to a predefined threshold (lower consumption for
30 example).

In one embodiment, the user is notified (only) in case of an unfavorable difference with respect to a predefined threshold (higher consumption for example).

In one embodiment, the user is notified in case of an unfavorable or favorable difference with respect to a predefined threshold (in both cases).

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In the above, a threshold may be replaced by a plurality of thresholds or a range of thresholds (existence of a tolerance in the comparison). The threshold may also be calculated dynamically - for example it may be modulated by system-wide coefficients dependent on external factors, for example the time of day, the season or an event such as a football match having a significant effect on the energy/water network.

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In one embodiment, the method furthermore comprises the step of modifying the water and/or energy supply depending on the difference with the predefined threshold.

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In one embodiment, the method furthermore comprises a physical/tangible feedback loop. In one embodiment, the method comprises a step of "adjusting" or "modifying" the supply or provision or distribution of water and/or energy.

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By modification of the supply, what is meant is a decrease and/or increase (these intercessions not being mutually exclusive, i.e. a decrease may be followed by an increase or vice versa, depending on variations about the determined reference level).

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In one embodiment, for example with the consent of the user/household, physical i.e. tangible feedback may be provided. This feedback may be provided automatically by a means for controlling a water and/or energy supply valve of the user/household, said controlling means being connected to a means for making the comparison between the water and/or energy resource consumption of the user and said reference consumption model. The consumption of the user/household may then be

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adjusted in light of a user/household preapproved hierarchy of resource consumption uses.

5 In one embodiment, the step of determining a user profile comprises a step of determining resource consumption strata, each consumption stratum being associated with a resource consumption value in a first time interval; - a step of determining user groups, each user group being associated with a rate of variation in the consumption value in a second time interval; and - a step of determining at least one user profile
10 depending on the determined user groups and the determined consumption strata.

In one embodiment, the method furthermore comprises a step of receiving additional data that may be correlated with the determined user profile
15 and a step of determining a consumption trend on the basis of the determined user profile and said received additional data.

In one embodiment, the step of determining consumption strata is carried out so as to minimize intra-stratum variance.

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In one embodiment, the step of determining user profiles comprises a step of determining user profiles, each user profile being associated with one stratum and one consumption variation group.

25 In one embodiment, the method furthermore comprises a step of aggregating a plurality of user profiles.

In one embodiment, the method furthermore comprises a step of providing remote access to information relating to consumption data, to
30 user groups, to user profiles, to consumption trends or to reference consumption models.

In one embodiment, the modification of the water and/or energy supply depends on criticality levels associated with the smart meters.

Specifically, the “connected objects” or “smart meters” may be associated with different criticality levels. In one embodiment, a connected object or smart meter is associated with one criticality level among a plurality of criticality levels.

With respect to a supply of water, the meters may in particular comprise individual meters of “drinking/cooking water” type, meters of “washing water” type, the latter meters themselves being divided into meters of “dishwashing water” type, “clothes washing water” type, and “shower/bath water” type, meters of “garden water” type, etc.

With respect to a supply of energy, the meters in particular comprise gas supply meters and electricity supply meters that are divided into various classes depending on the criticality of the associated use (in order of decreasing importance: refrigeration, lights, household appliances or computer equipment, etc.).

Advantageously, this adjustment/modification, which may decrease or increase supply, may be gradual and/or selective. With respect to selectiveness, lights and/or the supply of water to non-essential taps (e.g. garden taps) will possibly, for example, be dimmed/decreased automatically. In contrast, access to drinking water or the supply of electricity to the refrigerator of the household will possibly be preserved or even guaranteed. The gradualness of the adjustments is also advantageous, because if access to a particular resource is denied and flagged as such, user awareness will be raised.

In one embodiment, a criticality level associated with a smart meter is configurable by the user.

In one embodiment, the criticality level of a connected object and therefore of the resource associated with this object is configurable. A user/household may configure a hierarchy of the various consumption

points according to his own preferences (a household will possibly for example prioritize to computer equipment over the lights).

5 In one embodiment, the modification of the water and/or energy supply is gradual and/or selective.

The gradualness of the modulation of the supply may advantageously induce learning curves that are relatively steep and/or acceptable to the user (for example dictated by the needs/constraints on the supplier and/or
10 by local preferences). Selectiveness refers to the various physical locations associated with the consumption, said locations being distributed throughout the dwelling, and/or refers to various categories of consumption point, which may optionally be organized into a hierarchy of criticality levels).

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A computer program is disclosed, said computer program comprising code instructions allowing one or more of the steps of the method to be carried out, when said program is executed by a computer.

20 A system is disclosed, said system comprising a plurality of smart meters for implementing one or more of the steps of the method.

A “connected object” or “smart meter” is a home-automation device that carries out one or more of these remote water and/or energy readings.

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A smart meter is generally fixed in place, i.e. attached to an electricity and/or gas and/or power source. Certain meters may be removable.

In one embodiment, a smart meter may comprise a communication
30 module, such as for example a radio emitter or an emitter of pulses (over a power cable). A communication module may be integrated into the body of the meter or be accessible remotely, for example via a wired link (difficult environment, basement for example).

In one embodiment, a smart meter may be “smart” in that it may incorporate local processing resources.

In one embodiment, a smart meter may be connected to an Internet box,
5 by Wi-Fi or by PLC.

In one embodiment, a smart meter may be “remotely programmable”.

In one embodiment, a smart meter may be equipped with a device
10 allowing supply to be cut off remotely.

A counter may for example be a “smart” electric plug or a “smart” tap, which comprise communicating means and/or physically actuating means and/or measuring means. Optionally, a connected object may comprise a
15 display (e.g. indicator lights such as green or red LEDs, or even a screen), allowing information to be fed back to the user.

The communicating means generally allow two-way communication (or at least one-way communication: a connected object may be remotely
20 controlled). The physically actuating means for example comprise switches, resistors, capacitors, valves, screws, windings, etc.) in order to (gradually) decrease or even stop access to the water or energy resource (electricity for example). The measuring means comprise sensors (e.g. of current, movement, temperature, water flow rate, etc.) allowing water or
25 energy consumption to be quantified.

Various remote reading technologies implemented in and by smart meters are envisionable and in particular the “walk by/drive by” technology, a (one-way) AMI fixed installation or a (two-way) AMR fixed installation.
30 Various types of networks may be used (AMI or AMR network, *inter alia*). An AMI network generally corresponds to small remotely read networks (single reading). AMR (automatic meter reading) networks are two-way, i.e. the meter transmits and receives information, possibly in real-time. The use of hubs and/or repeaters may allow the management of the

network of meters to be improved. For example, a hub may send the collected data in a secure manner to a digital control platform via a wireless internet connection.

- 5 In one embodiment, the system for managing a water and/or energy resource comprises: - a plurality of smart meters that are configured to measure and to communicate to a remote reader initial data on water and/or energy resource consumption; - one or more processors that are configured to - determine a user profile; - to determine a so-called
10 reference consumption model that is associated with the user profile; and - to compare the water and/or energy resource consumption of the user with said reference consumption model; and - a plurality of user interfaces that are configured to notifying the user in case of an unfavorable or favorable difference with respect to a predefined threshold.

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The meter remote reading may be direct but also indirect. For example, domestic robots may move about the dwelling in order to access data that are not included in the network transmissions. The measurements may also be indirect, i.e. inferred or deduced. For example, a television set
20 may measure its own power consumption and transmit it itself or on request to the remote reading service.

In one embodiment, a smart meter comprises measuring means and/or communicating means and/or physically actuating means.

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Measuring means comprise measuring instruments (sensors). Communicating means comprise communicating modules (network card, transmitter, etc.). Actuating means comprise actuators or activators (e.g. valves, switches) of pneumatic, hydraulic, electrical, mechanical (*inter*
30 *alia*) type.

The installed meters may not all be the same, i.e. they may be meters with various functionalities. In order of increasing complexity, a smart meter may meter i.e. measure a physical quantity; additionally, but

optionally, a smart meter may directly or indirectly communicate its measurement data; and additionally, but optionally, a smart meter may act on its environment (valves or switches for example).

- 5 In one embodiment, a user interface is accessible from a customer terminal that has access to a data server via at least one communication network and/or is accessible from at least one smart meter.

10 Figure 1 shows examples of steps of the method according to the invention.

A method, implemented by computer, for determining a profile of a user of a water and/or energy resource is disclosed, the method comprising: a first step of receiving initial data on a plurality of users' consumption of the resource; a second step of determining resource consumption strata, each consumption stratum being associated with one resource consumption value in a first time interval; a third step of determining user groups, each user group being associated with a rate of variation in its consumption value in a second time interval; and a fourth step of determining at least one user profile depending on the determined user groups and the determined consumption strata.

25 A stratum corresponds to a consumption level. A consumption stratum corresponds to an average volume of a resource consumed over a given period (for example annually). It is bounded by a lower consumption limit and an upper consumption limit. A limit is a consumption value (for example expressed in m³ per year).

30 The amount of a resource (for example a water resource) consumed by a set of users may be estimated in various ways. Patent document WO2014/060655 for example describes a method for estimating, in real-time, the total consumption of a fluid distributed to users.

In the receiving or collecting first step 110, various databases are queried

or accessed. Statistical sampling techniques may be implemented (for example a subset of meters may be determined) in order to meet the specific needs of the analysis or to improve the study of consumption behavior.

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In an optional filtering step 120, one or more filters are applied in order to exclude certain users or certain data that are considered not to meet the objectives of the study or to be unreliable. The various data are formatted, i.e. made compatible, then merged and/or aggregated. According to the
10 invention, the reliability of the data is increased by excluding users for which too little data is available (e.g. users having a history of less than one year), users for whom the degree of receipt of indicators is lower than 75%, users for whom consecutive indicators are missing over a week, etc. In other words, aberrant and abnormal data may be excluded in order in
15 particular to improve the consumption modelling steps.

In an optional correcting step 130, certain data are corrected statistically. In one embodiment, this correcting step comprises two substeps. In a first substep, a statistical analysis of the consumption indicators (analysis of
20 trends, identification of a mid-point in slots of 6 h, etc.) allows certain data to be validated. In contrast, any technical anomalies are identified. In a second substep, the identified invalid data are corrected by linear interpolation. Lastly, in one embodiment, the daily consumptions are synced. The calculation in particular consists in syncing the indicators to
25 set times (e.g. 00h, 06h, 12h and 18h), in calculating the consumed volume (difference between two indicators) over these time ranges and lastly in aggregating the data on a daily scale.

In one embodiment, the raw consumption data 100 may in particular
30 comprise a time-and-date stamped consumption indicator (i.e. a cumulative consumption). In one example embodiment, the data are available at intervals of six hours (since each user will have his own transmission time, the indicators will not necessarily be transmitted synchronously).

The initial consumption data may be preprocessed in various ways (120, 130). Duplicate data may be removed. In the case of the presence of negative indicators, confidence intervals may be determined at various
 5 time intervals, then the data may be synced to set times. In one embodiment, data are collected over a time period longer than or equal to one year.

In this embodiment, the method comprises a second step 140 of
 10 determining resource consumption strata. Each consumption strata is associated with an overall resource consumption volume in the reference time interval of the study (days, month(s), year). The consumptions are qualified or structured into at least two consumption strata. The uniformity of the strata increases asymptotically with the number of strata. In one
 15 embodiment, the number of strata is increased iteratively until the total intra-stratum variance is lower than a predefined threshold (the asymptote). The classification may in particular be carried out so that a) the dispersion or variance in the consumptions is substantially uniform for a given group of consumers, and b) the number of consumers is
 20 substantially the same in the various groups of consumers.

In one embodiment, the second step of determining consumption strata is carried out so as to minimize the total intra-stratum variance. This is equivalent to saying that the number of consumption strata is iteratively
 25 increased until the increase in uniformity achieved when an additional strata is added is lower than a predefined threshold. In other words, the number of consumption strata is iteratively increased until the variance in any one stratum is lower than a predefined threshold.

30 In one embodiment, the method comprises a third step 150 of determining user groups, each user group being associated with a rate of variation in the consumption value in a second time interval. Once again, at least two user groups 150 are determined. The stratification of the users dependent on their consumption level is a step that is independent of the structuring

of the users into consumption variation groups (these steps may be carried out successively or in parallel).

5 A group of consumers is characterized by its consumption variation (for example, the consumption of water fluctuates depending on rainfall, the weekly rhythms of households, school vacations, non-working days, sporting events, etc.). Various types of indicators may be used to characterize the variation in consumption and various statistical methods may be used to categorize users depending on these consumption
10 variation indicators (ascending hierarchical classification, principal component analysis, etc.).

In one embodiment, the method comprises a fourth step 160 consisting in determining a consumption profile for each user, depending on the
15 consumption stratum and the consumption variation group to which he belongs.

In one embodiment, the method furthermore comprises a fifth step consisting in receiving additional data that may be correlated with the
20 determined user profile.

The additional data may be of social, demographic and/or economic nature.

25 In one embodiment of the invention, the additional data 145 may be correlated with the one or more determined user profiles. This step allows a consumption trend to be identified or explained on a regional scale (building, neighborhood, borough, inter-borough cooperation, etc.)

30 In one embodiment, the additional data comprise cartographic data (i.e. data of spatial nature, comprising geo-positioning data).

The integration of the user profiles with third-party data 145, which is for example of sociodemographic nature, in particular allows consumption

trends in a preset zone to be determined. For example, existing or public data such as Census Bureau data will possibly be used and allow the spatial distribution of the user profiles to be determined in each geographic zone; it will also be possible to deduce therefrom sociodemographic information on the user profiles in a given geographic zone or to explain observed consumption trends in light of the socio-economic characteristics of the studied populations.

Furthermore, consumption trends may be integrated with regional data, in order to allow, subsequently, strategies to be adopted in a preset zone with a view to decreasing the consumption of water and/or energy resources.

In one embodiment, the method furthermore comprises a sixth step consisting in determining a consumption trend from the determined user profile and said received additional data.

In one embodiment, the fourth step of determining user profiles comprises a step of determining user profiles, each user profile being associated with one stratum and one consumption variation group.

In one embodiment, the method furthermore comprises a seventh step of aggregating (or grouping) a plurality of user profiles.

In one embodiment, the fourth step 160 of identifying consumption profiles may be carried out by directly integrating the groups of levels and consumption variations, but it may also involve an additional aggregation process if the number of profiles is considered to be too large. This reclassification, or aggregation of profiles, may be carried out by applying multivariate statistical analysis or clustering methods (e.g. PCA, K-means, ascending hierarchical classification, etc.).

In one embodiment, the method furthermore comprises an eighth step of determining a so-called reference consumption model that is associated

with a user profile.

One so-called reference consumption module 170 may be associated with one user profile. For each studied user, the consumption model allows an expected, so-called reference, consumption (value) to be determined from the consumption history of the user and/or its technical or his social characteristics (type of household for example, type of dwelling, type of household appliance).

The creation, for each user, of a reference consumption model and the identification of cases of over consumption and under consumption allows, by aggregation, makes it possible to identify the potential resource saving achievable by the studied user body (building, housing project, neighborhood, borough, inter-borough cooperation) and the number of households that need to be targeted by proactive strategies promoting ways of saving resources.

In one embodiment, the method furthermore comprises a ninth step consisting in comparing the water and/or energy resource consumption of a user with the reference consumption model.

The ninth step 190 consists in comparing the water and/or energy resource consumption of a user 180 with the reference consumption model.

In one embodiment, the method furthermore comprises a tenth step consisting in notifying the user in case of an unfavorable or favorable difference with respect to a predefined threshold.

The tenth step 192 may in particular consist in notifying or warning the user in case of an unfavorable or favorable difference with respect to this reference consumption (over consumption or under consumption), with a view to taking corrective actions to decrease the resource consumption. If the difference is favorable (under consumption), a questionnaire might for

example be sent in step 191 to the user in question, so as to discern good practices, which may then be passed on 193 to an over consuming user.

In one embodiment, the consumption data are remotely read data.

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Figure 2 shows an example of consumption strata.

In a second step 140, the consumptions are classified into groups of consumption levels (or strata, into groups that are separate i.e. that do not overlap, a given user belonging to one and only one stratum).

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The groups are not necessarily of equal size. The number of groups may be high (analysis of high granularity) or low (rapid analyses). The number of groups and the number of users per group may be iteratively optimized in order to allow the required analysis granularity to be obtained. The number of groups and the number of users per group may be static or defined once for all (e.g. constant studying perimeter) but also be dynamic (i.e. configurable by way of study parameter, in particular in order to attenuate or compensate for edge effects due to regional discretization for example).

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The definition of the consumption strata is an iterative process between the choice of the number of strata and the choice of the limits, this iterative process allowing user groups that are uniform in terms of water consumption to be obtained. In one embodiment, the limits of the strata may be defined using a method derived from the method proposed by *Dalenius and Hodges*, which allows uniformity within strata to be maximized.

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Figure 3 shows an example of classification of users into consumption variation groups.

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Consumption variation may be defined on the basis of indicators such as the distribution of the consumption over the days of the week, over each

month of the year, between working days and non-working days and holidays, the correlation between consumption and temperature or rainfall, etc. These various indicators are grouped into uniform groups, using an ascending hierarchical classification, then converted into synthetic variables, by virtue of a principal component analysis (for example). On the basis of these synthetic variables, the users are grouped together (step 150), for example using the K-means method, in order to here form variation groups an example of which is shown in figure 3.

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On the basis of independent indicators, the users may therefore be segmented or classified (i.e. without overlap) into a plurality of coherent consumption variation groups (third step 150) that are characterized by one or more synthetic variables (here three groups 301, 302, 303). The users may be classified into separate groups using various statistical classification techniques.

Advantageously, in one embodiment, the groups are defined using the K-means method. The determined groups are then characterized by means of a plurality of synthetic variables, for example using a discriminant factor analysis (or another multivariate statistical analysis technique).

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Figure 4 shows an example of four user consumption profiles with presentation of their average daily consumption over one year.

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The fourth step 160 of the method determines at least one user profile.

The x-axis of the graph represents time and the y-axis of the graphs represents average consumption in cubic meters per day. The example groups or profiles shown (P1, P2, P3, P4) differ both in their annual consumption variation but also in their weekly consumption variation. The profiles P1 and P2 differ from the profiles P3 and P4 in their respectively low and high consumption levels. The profiles P2 and P4 differ from the profiles P1 and P3 in their respectively large and small annual

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consumption variation.

In the example, the consumer profiles identified as being stable over the year (P2 and P4) have a higher consumption at the weekend than during the week. The opposite is observed for the consumption profiles identified as being variable over the year (P1 and P3). For example, the weekly consumption of users living in residential housing may exhibit a consumption peak on Wednesday whereas the consumption peak for multi-family housing is observed on Thursday.

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According to the invention, user segments are determined by integration between the consumption strata and the variation groups (annual consumption, weekly consumption). In the example, four user profiles are identified. The profile P1 corresponds to so-called thrifty consumers (i.e. low consumption level and small consumption variation). The profile P2 corresponds to so-called seasonal consumers (low-level, large variation). The profile P3 corresponds to so-called "heavy" consumers (i.e. high-level, small variation). Lastly, the profile P4 corresponds to what are called variable consumers (i.e. low level, large variation).

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Figure 5 illustrates an integration of consumption data with socio-demographic data that are for example actively collected from users (surveys).

25 The integration of the consumption data with other data (for example socio-demographic data 145) in the fifth step of the method allows a matrix of factors that determine consumption to be constructed for each profile. The impact of each use may be qualified by its influence on the consumption level (N) or the consumption variation (V).

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The characterization of the profiles using socio-demographic data makes it possible to define the factors or water uses that explain whether or not an individual belongs to a given profile. To this end and for example, data on the uses that households make of water in their dwelling may be

collected by way of surveys. On the basis of the responses given to a questionnaire, certain uses that structure the consumption behavior of households may be identified. In one embodiment of the invention, about 30 so-called key factors are identified and may advantageously explain household water consumption.

Correlation tests, followed by discriminant analyses, in particular allow the weight of each factor on the structure of the consumption behavior of a user (in terms of impact on consumption level or consumption variation) to be evaluated and said factors to be organized hierarchically for each profile, but also for each user, in order to allow preselection of indicators of the progress users or user groups are making with regard to their consumption. This automatic analysis of consumption factors that are modulatable by individuals and groups of individuals, may help with the construction of strategies for decreasing water consumption.

In the optional eighth step 170 a consumption model associated with each user group is created, the groups being classed (without overlap) by the method according to the invention.

In other words, on the basis of remotely read raw consumption data, after operations comprising one or more operations chosen from statistical sampling operations and filtering and syncing operations, the user groups are classified into uniform groups, each uniform group being associated with a water consumption model daily.

Each consumption model allows water resource consumption to be anticipated or simulated on the basis of past behavior (model of chronological series) but also on the influence of external factors that may explain the consumption (regression model) such as temperature, certain calendar-related effects (days of the week, non-working days and holidays), or certain key technical and socio-economical parameters (size of the household, length of showers, water-saving equipment).

In one embodiment, a model 170 associated with a user group may be likened to an ARMAX model of the form:

$$y_t = \beta \vec{x}_t + u_t$$

- where y_t is the consumption at the time t , $\vec{x}_t$ is a vector of external factors and u_t an error that follows an ARMA model. In one simplified embodiment, not taking into account the time dimension, the applied model may be of multiple linear regression type. In this case, u is an error following a normal distribution. Whatever the model, the latter is fitted (i.e. estimation of the parameters) to each of the profiles.
- Such a model in particular allows the consumption of the group in question to be predicted short-term (for example to the end of the current month).

The determined consumption model allows the consumption of an individual or of a group to be compared to the consumption of other groups of the same profile (comparison between comparables). This comparison of consumptions may in particular be carried out at daily, weekly, monthly, or even annual time intervals.

- Other comparative analyses may be carried out on the basis of the consumption models determined by the method according to the invention (sample group for comparative analysis) such as the comparison of the consumption of an individual with the average consumption of users located nearby (in the same building, neighborhood or borough).

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Figure 6 illustrates an example of these various manners of comparing water consumptions.

- In a so-called individual mode, a user (belonging to a group) - or a user group - may compare his own current consumption to his actual consumption observed in the past under the same conditions (for example comparison of the consumption of the current month with the consumption of the same month the year before). The user or user group may also

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compare its consumption to its reference consumption (i.e. such as determined by the consumption model that is associated therewith, which may in particular represent a standard consumption and take into account calendar-related and climatic effects).

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In a so-called community mode, a user or a user group may compare its consumption to the consumption of individuals having the same profile (structural effect of the consumption, figure 6) or with its neighbor (regional effect, figure 7).

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Figure 7 illustrates an example of regional analysis of water consumption profiles, in the present case as a function of the concentration in the space of various groups of users determined by the method.

15 The aim of the regional analysis of consumption and uses is in particular to integrate previously obtained consumption data with data aggregated over the region in order to understand the spatial distribution of these effects.

20 The regional analysis of consumption profiles for example allows correlations that exist between the over representation of certain consumption profiles in certain neighborhoods and the generic characteristics of the latter in terms of population, dwelling types, and household activities to be determined.

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To identify the over representation of certain consumption profiles, a classification into quartiles is recommended. It allows the consumption profiles to be integrated with public data (for example Census Bureau data, Census Bureau data being available at a neighborhood scale) in a
30 form that is standardized beforehand. This integration of consumption data and regional data may for example be carried out by means of a discriminant factor analysis for example.

There are mainly three sources of external data available on households

at various regional scales. Data collected on a dwelling-by-dwelling scale exist (most often collected by surveys), data collected on a building-by-building scale exist (such data being made available by housing agencies or by surveys), and data collected on a neighborhood or borough scale exist (data drawn from the census). At certain scales, it is possible to find common socio-regional data such as data on housing, living conditions, household demographics and economies, or indeed specific data (household appliances, representatives, history of occupation of the dwelling). After validation of the most reliable and relevant regional indicators, and depending on the needs of the study, it may be recommendable to parameterize the analyzed regional scale and the types of correlation to be analyzed.

Figure 8 illustrates an example of access to consumption analyses and data.

In one embodiment, the method furthermore comprises an eleventh step consisting in providing remote access to information relating to consumption data, to user groups, to user profiles, to consumption trends or to reference consumption models.

A computer program is disclosed, said computer program comprising code instructions allowing the steps of the method to be carried out when said program is executed by a computer.

A system is disclosed comprising means for implementing the steps of the method.

In one embodiment, the system comprises a least one client terminal that is able to access at least one data server via at least one communication network.

In one embodiment, the steps of the method are carried out by one or more servers 810, which are for example hosted in the Cloud. The users

831 (individual customers, industrial customers, governmental customers, community customers and their representatives and administrators, etc.) may access the initial data, or data that has been modified by the method, remotely via client terminals 830 that are able to access one or more computer networks 820.

Various (intermediate and/or final) results may be made accessible to users, for example via gateways or computer applications (e.g. the Web, the Internet, an intranet, a mobile application or app, etc.) that can be accessed from the terminals 830. The corresponding customer interfaces (which will be able to access one or more data servers 810) may in particular provide functionalities for tracking overall consumption, for tracking and analyzing consumption profiles, for carrying out regional analyses of consumption (at various scales e.g. on a neighborhood scale) and for viewing and analyzing profile-specific consumption trends, the state of the network in real-time, options for personalizing the tracking tools, tools for managing customer relations, etc.

Claims

1. A method, implemented by computer, for managing a water and/or energy resource, the method comprising steps of:
 - 5 - receiving initial data on the water and/or energy resource consumption of at least one user, said consumption data being read remotely from a plurality of smart meters;
 - determining a user profile;
 - determining a so-called reference consumption model that is associated
 - 10 with said user profile;
 - comparing the water and/or energy resource consumption of the user with said reference consumption model;
 - notifying the user in case of a difference with respect to a predefined threshold; and
 - 15 - automatically modifying the supply of water and/or energy depending on the difference with the predefined threshold.
2. The method as claimed in claim 1, wherein the step of determining a user profile comprises:
 - 20 - a step of determining resource consumption strata, each consumption stratum being associated with a resource consumption value in a first time interval;
 - a step of determining user groups, each user group being associated with a rate of variation in the consumption value in a second time interval; and
 - 25 - a step of determining at least one user profile depending on the determined user groups and the determined consumption strata.
3. The method as claimed in claim 2, further comprising a step of receiving additional data that may be correlated with the determined user profile and a
- 30 step of determining a consumption trend on the basis of the determined user profile and said received additional data.

4. The method as claimed in claim 2, wherein the step of determining consumption strata is carried out so as to minimize intra-stratum variance.
5. The method as claimed in claim 2, wherein the step of determining user profiles comprises a step of determining user profiles, each user profile being associated with one stratum and one consumption variation group.
6. The method as claimed in any one of the preceding claims, further comprising a step of aggregating a plurality of user profiles.
7. The method as claimed in any one of the preceding claims, further comprising a step of providing remote access to information relating to consumption data, to user groups, to user profiles, to consumption trends or to reference consumption models.
8. The method as claimed in claim 1, the modification of the water and/or energy supply depending on criticality levels associated with the smart meters.
9. The method as claimed in claim 8, a criticality level associated with a smart meter being configurable by the user.
10. The method as claimed in claim 1, the modification of the water and/or energy supply being gradual and/or selective.
11. A computer program, said computer program comprising code instructions allowing the steps of the method as claimed in any one of claims 1 to 10 to be carried out when said program is executed by a computer.
12. A system comprising a plurality of smart meters for implementing the steps of the method as claimed in any one of claims 1 to 10.
13. A system for managing a water and/or energy resource, comprising:

- a plurality of smart meters that are configured to measure and to communicate to a remote reader initial data on water and/or energy resource consumption;

- one or more processors that are configured to

5 - determine a user profile;

- to determine a so-called reference consumption model that is associated with the user profile; and

- to compare the water and/or energy resource consumption of the user with said reference consumption model; and

10 - a plurality of user interfaces that are configured to notify the user in case of an unfavorable or favorable difference with respect to a predefined threshold,

 wherein said one or more processors are further configured to automatically modify the supply of water and/or energy depending on the
15 difference with the predefined threshold.

14. The system as claimed in claim 13, a smart meter comprising measuring means and/or communicating means and/or physically actuating means.

20 15. The system as claimed in claim 13 or 14, a user interface being accessible from a customer terminal that has access to a data server via at least one communication network and/or being accessible from at least one smart meter.