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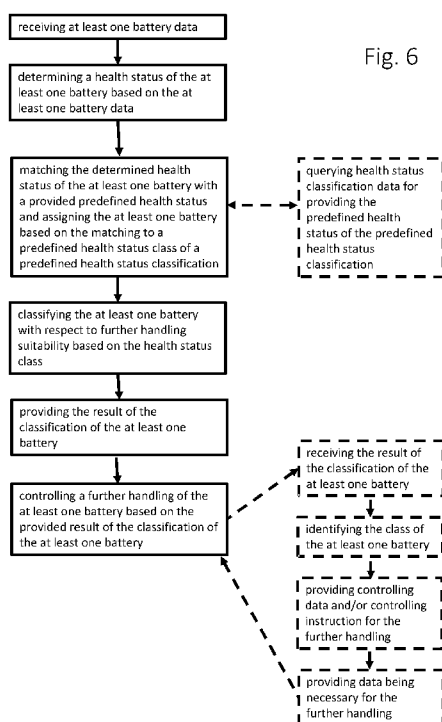


Fig. 6

(57) Abstract: A computer implemented method for generating processing instructions for further processing of at least one battery, the method comprising: - receiving at least one battery data; - determining a health status of the at least one battery based on the at least one battery data; - matching the determined health status of the at least one battery with a provided predefined health status and assigning the at least one battery based on the matching to a predefined health status class of a predefined health status classification; - classifying the at least one battery with respect to further processing based on the health status class; and - providing the result of the classification of the at least one battery.

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BATTERY CELL PROCESSING

TECHNICAL FIELD

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The present disclosure relates to a computer-implemented method for recommending a further handling of at least one battery or waste product, a battery or waste product recommender system for recommending a further handling of at least one battery or waste product, a use of battery or waste product data of a battery or waste product for recommending a further handling of at least one battery or waste product, and a computer program element with instructions.

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TECHNICAL BACKGROUND

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The general background of this disclosure concerns the further handling of used, not-used or not-useable batteries. The further handling of batteries is a subject of growing interest in a world with an increasing amount of portable electronic devices and automation. It is to be expected that a growing number of spent lithium ion batteries will emerge with the advent of e-mobility. Since batteries contain important transition metals such as, cobalt, nickel, lithium, spent lithium ion batteries may form a valuable source of raw materials for a new generation of lithium ion batteries. For that reason, increased research work has been performed with the goal of finding/deciding for proper further handlings of the used, not-used or not-useable batteries.

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Typically, it is difficult, time-consuming, complex and obscure to decide, if or how a further handling of batteries can be carried out. Experience shows that, based on these complex decisions, a high amount of used, not-used or not-usable batteries are further handled in a non-profitable/non-proper manner, e.g. shipping the batteries to a landfill or an incineration plant. Further handling of batteries in a non-profitable/non-proper manner leads to high environmental pollution and therefore high environmental impacts, high CO₂ emissions, high ecological footprint, bad sustainability of batteries, and/or bad recycling rates. Similarly the further handling of waste products is challenging.

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Hence, there is a need to enable an easy, timesaving, less complex and non-obscure way to decide if or how to further handle with used, not-used, not-useable batteries in order to further handle the batteries in a profitable/proper manner.

5 SUMMARY OF THE INVENTION

In one aspect of the present disclosure, a computer implemented method for recommending a further handling or for generating processing instructions for further processing of at least one battery is presented, the method comprising:

- 10 - receiving at least one battery data;
- determining a health status of the at least one battery based on the at least one battery data;
- matching the determined health status of the at least one battery with a provided predefined health status and assigning the at least one battery based on
- 15 the matching to a predefined health status class of a predefined health status classification;
- classifying the at least one battery with respect to further processing or handling suitability based on the health status class; and
- providing the result of the classification of the at least one battery.

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In a further aspect of the present disclosure, a battery recommender system for recommending a further handling or for generating processing instructions for further processing of at least one battery is presented, comprising:

- a receiving unit for receiving at least one battery data;
- 25 a determination unit for determining a health status of the at least one battery based on the at least one battery data;
- a matching unit for matching the determined health status of the at least one battery with a provided predefined health status and assigning the at least one battery based on the matching to a predefined health status class of a predefined health status
- 30 classification;
- a classification unit for classifying the at least one battery with respect to further handling suitability or processing based on the health status class; and
- a providing unit for providing the result of the classification of the at least one battery.

In a further aspect, an use of battery data of a battery obtained by the computer-implemented method for recommending a further handling or for generating processing instructions for further processing of at least one battery disclosed herein is presented.

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In a further aspect, a computer program element with instructions, which, when executed on computing devices of a computing environment, is configured to carry out the steps of the method disclosed herein in a system disclosed herein is presented.

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In one aspect of the present disclosure a computer implemented method for recommending a further handling or for generating processing instructions for further processing of at least one waste product is presented, the method comprising:

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- receiving at least one waste product data;
- determining a status of the at least one waste product based on the at least one waste product data;
- matching the determined status of the at least one waste product with a provided predefined status and assigning the at least one waste product based on the matching to a predefined status class of a predefined status classification;
- classifying the at least one waste product with respect to further handling suitability or processing based on the status class; and
- providing the result of the classification of the at least one waste product.

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In a further aspect of the present disclosure, a waste product recommender system for recommending a further handling or for generating processing instructions for further processing of at least one waste product is presented, comprising:

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- a receiving unit for receiving at least one waste product data;
- a determination unit for determining a status of the at least one waste product based on the at least one waste product data;
- a matching unit for matching the determined status of the at least one waste product with a provided predefined status and assigning the at least one waste product based on the matching to a predefined status class of a predefined status classification;
- a classification unit for classifying the at least one waste product with respect to further handling suitability or processing based on the status class; and

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a providing unit for providing the result of the classification of the at least one waste product.

In a further aspect, an use of waste product data of a waste product obtained by the computerimplemented method for recommending a further handling or for generating processing instructions for further processing of at least one waste product disclosed herein is presented.

In a further aspect, a computer program element with instructions, which, when executed on computing devices of a computing environment, is configured to carry out the steps of the method disclosed herein in a system disclosed herein is presented.

This and embodiments described herein relate to the method, the system, and the computer program element lined out above and vice versa. Advantageously, the benefits provided by any of the embodiments and examples equally apply to all other embodiments and examples and vice versa.

As used herein „determining“ also includes „estimating, calculating, initiating or causing to determine“, „generating“ also includes „initiating or causing to generate“, „providing“ also includes „initiating or causing to determine, generating, selecting, sending, exporting, showing“, „receiving“ also includes „initiating or causing to receive, querying“, „matching“ also includes „correlating“, and „controlling“ also includes „providing control data, sending control data, causing and/or initiating a control of another object“.

Alternatively or additionally, „controlling“ include a predefined order of control steps to be executed by the controlling, e.g. the order of decisions for the further handling starts with an investigation if the further handling is the disposal, than if the further handling is the 2nd life recycling, and then if the further handling is the third reuse.

The computer implemented method, system, computer program element, disclosed herein provide an easy, time-saving, less complex and non-obscure way to decide if or how to further handle with batteries in a profitable/proper manner, i.e. to reuse or to recycle the batteries. In particular, the computer-implemented method, system, computer program element, disclosed herein provide an effective, sustainable and robust way to facilitate the decision if or how to further handle with batteries such that

the total life time of the batteries can be increased, the environmental impact can be decreased, the ecological footprint can be decreased, sustainability targets can be reached, and/or the recycling rates can be reached.

- 5 It is an object of the present invention to provide an efficient, sustainable and robust way to decide if or how to further handle with batteries. These and other objects, which become apparent upon reading the following description, are solved by the subject matters of the independent claims. The dependent claims refer to preferred embodiments of the invention.

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The term battery may denote any structure configured to store electric power based on an electrochemical basis. Batteries may be structures comprising a group of two or more cells connected together, but are not limited thereto. The term battery may include device batteries, starter batteries, rechargeable batteries, battery packs, accumulators, and parts of these. Additionally or alternatively, the term battery may also include a housing and/or a battery management system. The batteries may be car batteries, E-scooter batteries, E-bike batteries, power tool batteries, cellphone batteries, notebook batteries, power bank batteries, kitchen appliances batteries, E-cigarette batteries, tablet batteries, but are not limited thereto.

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The term battery data may relate to a physical and/or chemical property of the at least one battery or battery cell. The battery data may relate to any data being appropriate to identify and/or to describe the physical and/or chemical property, e.g. composition, of the used, not-used or not-useable batteries. Battery data may comprise battery identification data, material specific data and/or lifetime data. The battery identification data may include an identifier uniquely identifying the battery. It may include any information being appropriate, adequate, and able to identify a single occurrence of an article, device, or product, in particular a battery. Battery identification data may be provided as a serial number, a battery ID, but are not limited thereto. The battery identification data can be provided by using a battery identification element. The battery identification element may include a physical identification element such as a tag. The identification of the battery may be associated with battery identification data. The battery identification element may comprise passive elements or active elements, e.g. QR-code, RFID-tag, or read data of the BMS "battery management system" out, but is

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not limited thereto. The material specific data may relate to the materials contained in the battery cell. Material data may be associated with the material configuration of one or more component(s) of the battery such as the material(s) contained in the battery.. The material data may be presented in a table, wherein specific material configurations of specific components of the battery, e.g. of the anode unit and/or cathode unit, are also presented in or separated in the table. The material configuration represents information about the material type, the material properties, and all the chemical composition of at least one component of the battery. Material type may include plastic, metal containing materials, polymer containing materials, composite materials or end-products, intermediate products, by-products, and raw material used to produce the battery or cell. Material properties may include physical material properties, i.e. thermodynamic, mechanic, electrodynamic, optic and acoustic material properties, and chemical material properties, e.g. Standard electrode potential and electronegativity, but are not limited thereto. The chemical composition may correspond to the relative amounts of the elements that constitute the substance itself. The term component of a battery may include one or more components included or contained in a battery, e.g. cathode unit and anode unit. The lifetime data may relate to monitoring data collected during the life time of the battery. The lifetime data may be provided by a battery management system. It may include any information like the production time, the age of the battery, the used time of the battery and/or the cycles/loading cycles of the battery, but are not limited thereto. The battery data may be provided by a battery management system. The battery data may be provided or received by data providing means or a data providing interface. The battery data may be provided via the identification element of the battery. The battery type and/or physical condition data may be provided, e.g. via pictures of the batteries in order to identify physical damages, e.g. by a camera. Additionally or alternatively, the battery data may be received from chemical identification means for providing chemical condition data like basic information (e.g. battery type, battery manufacture), usage data, capacitance of the battery cell, quick-charged total amount of power, mileage of a transportation vehicle including the battery, discharging/charging curve, and/or chemical composition data like data about raw materials, material specific data.

The term recommending or further processing may relate to the at least one battery and/or the re-use of the at least one battery. Depending on the health status of the

battery the further processing instructions may be generated and/or the further processing may be initiated. Generating further processing instructions for further processing at least one battery may include classification of the battery based on health status. Processing instruction may relate to further processing of the battery including
5 any re-use of the battery. The processing instruction may be provided to a user and/or to a further processing system. In case of user, any proposal, suggestion and/or decision-making help to find a way to further handle or process used, not-used or not-usable battery cells may be displayed.

10 The health status of the battery may be a measured health status. The health status may relate to at least one electric, magnetic and/or electromagnetic property of the battery or battery cell. The health status may relate to health indicators measured by a battery management system or by a separate measurement system used on dismantling. The health status may relate to state of health (SOH) and/or state of
15 charge (SOC). State of health may relate to health indicator(s) of the at least one battery or battery cell and health indicator(s) of the new battery or battery cell. State of charge may relate health indicator(s) of the at least one battery or battery cell in one or more charging state(s), e.g. the fully charged battery or cell and the current battery or cell. For example, charge and/or discharge curves may indicate the SOH and/or SOC.
20 Techniques to determine the state of health are known in the prior art. For example, the level of degradation or the remaining capacity may be measured. Example measurement techniques are galvanostatic cycling, chronopotentiometry, constant current, electrochemical impedance or other techniques used in battery management systems.

25 The term recommender used herein is to be understood broadly in the present case and represents any system, device or apparatus providing proposals and/or suggestions and enabling a decision-making help to find a way to further handle or process used, not-used or not-usable batteries.

30 The term further handling, processing or further handling suitability used herein is to be understood broadly in the present case and may relate to any possible opportunity to further handle or process the batteries. The further handling or processing or further handling suitability may comprise straight 2nd use e.g. for the same purpose or a

different purpose, reuse, repair, reuse by modification, recycling and/or disposal but are not limited thereto. Additively or alternatively, the further handling, further processing or further handling suitability may comprise specific reuses, repairs, disposals or recycling processes for the at least one battery. For instance, the specific reuses may be the 2nd life use of used car batteries within a wind power plant, but is not limited thereto. Depending on each further handling or processing, respective data being necessary for that specific further handling can be provided. For instance, for 2nd life, specific information indicating the kind of reuse may be provided, e.g. for recycling, information indicating the raw materials are important, but are not limited thereto.

The term health status used herein is to be understood broadly in the present case and represents any information about the status, state, conditions or functionality of the at least one battery. The health status may relate indicators derived from measurement data during the lifetime of the battery or at end-of-life to at least one pre-defined health status. The health status may include one the following following indicators derived from measurement data during the lifetime of the battery or at end-of-life: very good, rather good, moderate, rather bad, very bad, but is not limited thereto. Additionally or alternatively, the health status may include one of the following: used, intensively used, underused, misused, totally damaged, critical damage (i.e. functionality or usability of the battery is not given anymore), minor damage (e.g. existence of only superficial damage, i.e. functionality or usability of the battery is given), non-damaged, shredded battery material, dissolved battery materials, but are not limited thereto. The health status may be determined by an algorithm, a battery model, and/or a statistical analysis on basis of the battery data, but is not limited thereto. The determination/selection of the health status may be provided by a plurality of respective thresholds.

The term predefined health status used herein is to be understood broadly in the present case and represents any predefined information about the status, state, conditions or functionality of the at least one battery. The pre-defined health status may relate one or more indicator(s) derived from measurement data during the lifetime of the battery or at end-of-life to a pre-defined health status class related to the one or more indicator(s). For example, the predefined health status may relate to predefined thresholds for the one or more indicator(s). The predefined health status may be one of

the following: very good, rather good, moderate, rather bad, very bad, but is not limited thereto. Additionally or alternatively the predefined health status may include one of the following: used, intensively used, underused, misused, totally damaged, critical damage (i.e. functionality or usability of the battery is not given anymore), minor damage (e.g.

5 existence of only superficial damage, i.e. functionality or usability of the battery is given), non-damaged, shredded battery material, dissolved battery materials, but are not limited thereto. The predefined health status may be provided by an algorithm, a battery model, a statistical analysis, and/or a selection of an user. Each of the

predefined health status corresponds, is assigned to, belongs to, is affixed to a

10 predefined health status class of a predefined health status classification. The

predefined health status and the (determined) health status may be identical or

different. Therefore, the predefined health status class may be one of the following

classes: very good, rather good, moderate, rather bad, very bad, but is not limited

thereto. Additionally or alternatively the predefined health status class may be the class

15 of one of the following: used, intensively used, underused, misused, totally damaged,

critical damage (i.e. functionality or usability of the battery is not given anymore), minor

damage (e.g. existence of only superficial damage, i.e. functionality or usability of the

battery is given), non-damaged, shredded battery material, dissolved battery materials,

but are not limited thereto. In this context, the use of the same status and therefore

20 classes increases significant the running time of the method. The predefined health

status classification may be a preset/predefined classification of batteries containing the

predefined health status classes. The classification can be adapted, amended, changed

by a user or a computer.

25 The term battery model used herein is to be understood broadly in the present case and represents any model providing the health status of the battery as an output. The

battery model may receive the battery data as an input and uses these data in order to

provide the health status of the battery as an output. Battery model may process

variables and performance parameters of the batteries in order to determine/provide the

30 health status of the at least one battery. The possible determined/modelized health

status of the battery may be one of the following: very good, rather good, moderate,

rather bad, very bad, but is not limited thereto.

The term querying used herein is to be understood broadly in the present case and represents a taking of data describing the health status classification from database, model, in particular prediction model, cloud, UUID, DID or other storage means.

- 5 In an embodiment of the method for recommending a further handling or for generating processing instructions for further processing of at least one battery, the determination of the health status of the at least one battery is provided by a battery model. The battery cell model may relate battery cell data or the determined health status to the pre-defined classification for further processing based on health status. The use of a
10 battery model in order to determine the health status of at least one battery may lead to a more accurate and exact determination/estimation of the health status of the at least one battery.

- In a further embodiment of the method for recommending a further handling or for
15 generating processing instructions for further processing of at least one battery, the predefined health status of the predefined health status classification may be provided by querying health status classification data. Querying of health status classification data in order to provide the predefined health status enables an time-saving way to decide if or how to further handle or process used, not-used, not-useable batteries in
20 order to further handle or process the batteries in a profitable/proper manner, because no time intensive studies or determinations have to be made in order to provide a predefined health status.

- In a further embodiment of the method for recommending a further handling or for
25 generating processing instructions for further processing of at least one battery, the classification of the further handling suitability or processing based on the health status class may comprise the at least one class of straight reuse, repair, reuse by modification, recycling, in particular recycling to black mass, and/or disposal. The use of easy proposal/instruction/decision help regarding the further handling suitability enables
30 an easy, time-saving, less complex and non-obscure way to decide if or how to further handle or process used, not-used, not-useable batteries in order to further handle or process the batteries in a profitable/proper manner.

In a further embodiment of the method for recommending a further handling or for generating processing instructions for further processing of at least one battery, the controlling of the further handling or processing indicates specific reuses or recycling processes for the at least one battery. The use of specific reuses or recycling processes enables an easy, timesaving, less complex and non-obscure way to decide if or how to further handle or process used, not-used, not-useable batteries in order to further handle or process the batteries in a profitable/proper manner.

In a further embodiment of the method for recommending a further handling or for generating processing instructions for further processing of at least one battery, the method further comprises the step of controlling a further handling or processing of the at least one battery based on the provided result of the classification of the at least one battery. The use of the results of the classification in order to control a further handling or processing of the at least one battery leads to an automatic controlling of the logistics such that an easy, time-saving, less complex and non-obscure way to decide if or how to further handle or process used, not-used, not-useable batteries for further handling the batteries in a profitable/proper manner can be provided.

In a further embodiment of the method for recommending a further handling or for generating processing instructions for further processing of at least one battery, the controlling of the further handling or processing of the at least one battery based on the provided result of the classification of the at least one battery comprises receiving the result of the classification of the at least one battery, identifying the class of the at least one battery, providing controlling data and/or controlling instruction for the further handling, and providing data related to the further handling or processing.

In a further embodiment of the method for recommending a further handling or for generating processing instructions for further processing of at least one battery, the controlling of the further handling or processing of the at least one battery comprises determining or estimating which further handling or processing yields the highest profit, in particular the highest reduction of environmental impacts, the highest CO₂ reduction, highest reduction of the ecological footprint, fastest and/or efficientest way to reach sustainability targets, fastest and/or efficientest way to reach recycling rates, and adapting the controlling of the further handling or processing of the at least one battery

based on the determination or estimation of the highest profit. By estimating which further handling or processing yields the highest profit, the further handling or processing in a profitable/proper manner of the used, not-used, not-useable batteries can be ensured.

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In a further embodiment of the battery recommender system for recommending a further handling or for generating processing instructions for further processing of at least one battery, the system further comprises health status classification storage means or model for providing the health status classification data.

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In a further embodiment of the battery recommender system for recommending a further handling or for generating processing instructions for further processing of at least one battery, the system further comprises a controlling unit for controlling a further handling or processing of the at least one battery based on the result of the classification of the at least one battery.

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The computer implemented method, system, computer program element, disclosed herein provide an easy, time-saving, less complex and non-obscure way to decide if or how to further handle or process waste products in a profitable/proper manner, i.e. to reuse or to recycle the waste products. In particular, the computer-implemented method, system, computer program element, disclosed herein provide an effective, sustainable and robust way to facilitate the decision if or how to further handle or process waste products such that the total life time of the waste products can be increased, the environmental impact can be decreased, the ecological footprint can be decreased, sustainability targets can be reached, and/or the recycling rates can be reached.

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It is an object of the present invention to provide an efficient, sustainable and robust way to decide if or how to further handle or process waste products. These and other objects, which become apparent upon reading the following description, are solved by the subject matters of the independent claims. The dependent claims refer to preferred embodiments of the invention.

The term waste product used herein is to be understood broadly in the present case and represents any material, product, device or apparatus being thrown away, sorted out, rejected, removed or separated by a user but is not limited thereto. The waste product may also be a defective, erroneous, broken, functioning, workable, non-defective material, product, device or apparatus. The waste products may comprise biological material, chemical material, metal material, or a combination thereof but are not limited thereto. In particular, waste products may be all products which are received or obtained by household waste, garden waste and/or industrial waste.

The at least one waste product may be a used or not-useable waste product. The at least one waste product may be an end-of-life waste product. End-of-life may relate to the specific use of the product during its life time. At end-of-life the product may not be further usable for the specific use.

The term recommending or further processing may relate to the at least one waste product, and/or the re-use of the at least one waste product. Depending on the health status of the waste product the further processing instructions may be generated and the further processing may be initiated. Generating further processing instructions for further processing at least one waste product may include classification of the waste product based on health status. Processing instruction may relate to further processing of the waste product including any re-use of the waste product. The processing instruction may be provided to a user and/or to a further processing system. In case of user, any proposal, suggestion and/or decision-making help to find a way to further handle or process the used, not-used or not-usable waste product may be displayed.

The term recommender used herein is to be understood broadly in the present case and represents any system, device or apparatus providing proposals and/or suggestions and enabling a decision-making help to find a way to further handle or process waste products.

The term further handling, further processing or further handling suitability used herein is to be understood broadly in the present case and may relate to any possible opportunity to further handle or process the waste products. The further handling, processing or further handling suitability may comprise 2nd use for the same or different

purpose, reuse, repair, reuse by modification, recycling and/or disposal but are not limited thereto. Additively or alternatively, the further handling, processing or further handling suitability may comprise specific reuses, repairs, disposals or recycling processes for the at least one waste product. For instance, the specific reuses may be the 2nd life use of waste wood boards within a new table, but is not limited thereto. Depending on each further handling or processing respective data being necessary for that specific further handling or processing can be provided. For instance, for 2nd life , specific information indicating the kind of reuse may be provided, e.g. for recycling, information indicating the raw materials are important, but are not limited thereto.

The term waste product data may relate to a physical and/or chemical property of the at least one waste product. The waste product data may relate to any data being appropriate to identify and/or to describe the physical and/or chemical property, e.g. composition, of the waste products. Waste product data may comprise waste product identification data, material specific data and/or lifetime data. The waste product data may include an identifier uniquely identifying the battery or cell. It may include any information being appropriate, adequate, and able to identify a single occurrence of an article, device, or product, in particular a waste product. Waste product identification data may be provided as a serial number, an ID, but are not limited thereto. The waste product identification data may be provided by a waste product identification element. The waste product identification element may include a physical identification element such as a tag. The identification of the waste product may be associated with waste product identification data. The waste product identification element may comprise passive elements or active elements, e.g. QR-code, RFID-tag, but is not limited thereto. The material specific data may relate to the materials contained in the waste product. Material data may be associated with the material configuration of one or more component(s) of the battery such as the material contained in the cell. The material data may be presented in a table, wherein specific material configurations of specific components of the waste product are also presented in or separated in the table. The material configuration may relate to the material type, the material properties, and all the chemical composition(s) of at least one component of the waste product. Material type may include end-products, intermediate products, by-products, and/or raw material used to produce. Material properties may include physical material properties, i.e. thermodynamic, mechanic, electrodynamic, optic and acoustic material properties, and

chemical material properties, but are not limited thereto. The chemical composition may relate to the relative amounts of the elements that constitute the substance itself. The term component of a waste product may include one or more component(s) included or contained in a waste product. The lifetime data may relate to monitoring data collected during the life time of the waste product. It may include any information like the production time, the age of the waste product, the used time of the waste product, but are not limited thereto. The waste product data may be provided or received by data providing means or a data providing interface. The waste product data may be provided via the identification element of the waste product. The waste product type and/or physical condition data may be provided, e.g. via pictures of the waste products in order to identify physical damages or composition, e.g. by a camera. Additionally or alternatively, the waste product data may be received from chemical identification means for providing chemical condition data like basic information (e.g. waste product type, waste product provider), usage data, and chemical composition data like data about raw materials, material specific data.

The term status or health status may be a measured status. The status may relate to a measureable status of the waste product. The status or health status used herein is to be understood broadly in the present case and may relate to a status, state, condition or functionality of the at least one waste product. The status may relate to health indicators measured for the waste product and/or related to state, condition or functionality of the waste product. Measurement methods and indicators may be electromagnetic, electric, magnetic, optical or other measurement methods available for indicators like degradation level of material, degradation of functionality status like charge capacity or the like. The status may relate indicators derived from measurement data during the lifetime of the battery or at end-of-life to at least one pre-defined status. The status may include one the following indicators derived from measurement data during the lifetime or at end-of-life: very good, rather good, moderate, rather bad, very bad, but is not limited thereto. Additionally or alternatively, the status may include one of the following: used, intensively used, underused, misused, totally damaged, critical damage (i.e. functionality or usability of the waste product is not given anymore), minor damage (e.g. existence of only superficial damage, i.e. functionality or usability of the waste product is given), non-damaged, shredded waste product material, dissolved waste product materials, but are not limited thereto. The status may be determined by an algorithm, a

waste product model, and/or a statistical analysis on basis of the waste product data, but is not limited thereto. The determination/selection of the status may be provided by a plurality of respective thresholds.

- 5 The term predefined status used herein is to be understood broadly in the present case and represents any predefined information about the status, state, conditions or functionality of the at least one waste product. The pre-defined health status may relate one or more indicator(s) derived from measurement data during the lifetime or at end-of-life to a pre-defined health status class related to the one or more indicator(s). For
- 10 example, the predefined health status may relate to predefined thresholds for the one or more indicator(s). The predefined status may be one of the following: very good, rather good, moderate, rather bad, very bad, but is not limited thereto. Additionally or alternatively the predefined status may include one of the following: used, intensively used, underused, misused, totally damaged, critical damage (i.e. functionality or
- 15 usability of the waste product is not given anymore), minor damage (e.g. existence of only superficial damage, i.e. functionality or usability of the waste product is given), non-damaged, shredded waste product material, dissolved waste product materials, but are not limited thereto. The predefined status may be provided by an algorithm, a waste product model, a statistical analysis, and/or a selection of an user. Each of the
- 20 predefined status corresponds, is assigned to, belongs to, is affixed to a predefined status class of a predefined status classification. The predefined status and the (determined) status may be identical or different. Therefore, the predefined status class may be one of the following classes: very good, rather good, moderate, rather bad, very bad, but is not limited thereto. Additionally or alternatively the predefined status class
- 25 may be the class of one of the following: used, intensively used, underused, misused, totally damaged, critical damage (i.e. functionality or usability of the waste product is not given anymore), minor damage (e.g. existence of only superficial damage, i.e. functionality or usability of the waste product is given), non-damaged, shredded waste product material, dissolved waste product materials, but are not limited thereto. In this
- 30 context, the use of the same status and therefore classes increases significant the running time of the method. The predefined status classification may be a preset/predefined classification of waste products containing the predefined status classes. The classification can be adapted, amended, changed by a user or a computer.

The term waste product model used herein is to be understood broadly in the present case and represents any model providing the status of the waste product as an output. The waste product model may receive the waste product data as an input and uses these data in order to provide the status of the waste product as an output. Waste product model may process variables and/or performance parameters of the waste products in order to determine/provide the status of the at least one waste product. The possible determined/modelized status of the waste product may be one of the following: very good, rather good, moderate, rather bad, very bad, but is not limited thereto.

The term querying used herein is to be understood broadly in the present case and represents a taking of data describing the status classification from database, model, in particular prediction model, cloud, UUID, DID or other storage means.

In an embodiment of the method for recommending a further handling or for generating processing instructions for further processing of at least one waste product, the determination of the status of the at least one waste product is provided by a waste product model. The waste product model may relate waste product data or the determined status to the pre-defined classification for further processing based on status. The use of a waste product model in order to determine the status of at least one waste product may lead to a more accurate and exact determination/estimation of the status of the at least one waste product.

In a further embodiment of the method for recommending a further handling or for generating processing instructions for further processing of at least one waste product, the predefined status of the predefined status classification may be provided by querying status classification data. Querying of status classification data in order to provide the predefined status enables an time-saving way to decide if or how to further handle uor process waste products in order to further handle or process the waste products in a profitable/proper manner, because no time intensive studies or determinations have to be made in order to provide a predefined status.

In a further embodiment of the method for recommending a further handling or for generating processing instructions for further processing of at least one waste product,

the classification of the further handling suitability or processing based on the status class may comprise the at least one class of straight reuse, repair, reuse by modification, recycling and/or disposal. The use of easy proposal/instruction/decision help regarding the further handling suitability or processing enables an easy, time-

5 saving, less complex and non-obscure way to decide if or how to further handle or process waste products in order to further handle or process the waste products in a profitable/proper manner.

In a further embodiment of the method for recommending a further handling or for

10 generating processing instructions for further processing of at least one waste product, the controlling of the further handling or processing indicates specific reuses or recycling processes for the at least one waste product. The use of specific reuses or recycling processes enables an easy, time-saving, less complex and non-obscure way to decide if or how to further handle or process waste products in order to further handle

15 or process the waste products in a profitable/proper manner.

In a further embodiment of the method for recommending a further handling or for generating processing instructions for further processing of at least one waste product, the method further comprises the step of controlling a further handling or processing of

20 the at least one waste product based on the provided result of the classification of the at least one waste product. The use of the results of the classification in order to control a further handling or processing of the at least one waste product leads to an automatic controlling of the logistics such that an easy, time-saving, less complex and non-obscure way to decide if or how to further handle with or process waste products for

25 further handling or processing the waste products in a profitable/proper manner can be provided.

In a further embodiment of the method for recommending a further handling or for generating processing instructions for further processing of at least one waste product,

30 the controlling of the further handling or processing of the at least one waste product based on the provided result of the classification of the at least one waste product comprises receiving the result of the classification of the at least one waste product, identifying the class of the at least one waste product, providing controlling data and/or

controlling instruction for the further handling or processing, and providing data being necessary for the further handling or processing.

5 In a further embodiment of the method for recommending a further handling or for generating processing instructions for further processing of at least one waste product, the controlling of the further handling or processing of the at least one waste product comprises determining or estimating which further handling or processing yields the highest profit, in particular the highest reduction of the environmental impact, the highest reduction of the ecological footprint, the fastest or efficientest way to reach
10 sustainability targets, and/or the fastest and efficientest way to reach recycling rates, and adapting the controlling of the further handling or processing of the at least one waste product based on the determination or estimation of the highest profit. By estimating which further handling or processing yields the highest profit, the further handling or processing in a profitable/proper manner of the waste products can be
15 ensured.

In a further embodiment of the waste product recommender system for recommending a further handling or for generating processing instructions for further processing of at least one waste product, the waste product recommender system further comprises
20 status classification storage means or model for providing the status classification data.

In a further embodiment of the waste product recommender system for recommending a further handling or for generating processing instructions for further processing of at least one waste product, the waste product recommender system further comprises a
25 controlling unit for controlling a further handling or processing of the at least one waste product based on the result of the classification of the at least one waste product.

Embodiment 1 includes a computer implemented method for recommending a further handling or for generating processing instructions for further processing of at least one
30 waste product, the method comprising:
receiving at least one waste product data;
determining a status of the at least one waste product based on the at least one waste product data;

matching the determined status of the at least one waste product with a provided predefined status and assigning the at least one waste product based on the matching to a predefined status class of a predefined status classification;
classifying the at least one waste product with respect to further handling suitability or processing based on the status class; and
providing the result of the classification of the at least one waste product.

Embodiment 2 may include Embodiment 1 and may further include the determination of the status of the at least one waste product is provided by a waste product model.

Embodiment 3 may include Embodiments 1 and/or 2 (preceding embodiments) and may further include the predefined status of the predefined status classification is provided by querying status classification data.

Embodiment 4 may include any of the Embodiments 1, 2 and/or 3 (preceding embodiments) and may further include the classification of the further handling suitability or processing based on the status class comprises the at least one class of straight reuse, repair, reuse by modification, recycling and/or disposal.

Embodiment 5 may include any of the Embodiments 1, 2, 3 and/or 4 (preceding embodiments) and may further include the controlling of the further handling or processing indicates specific reuses or recycling processes for the at least one waste product.

Embodiment 6 may include any of the Embodiments 1, 2, 3, 4 and/or 5 (preceding embodiments) and may further include the method further comprises the step of controlling a further handling or processing of the at least one waste product based on the provided result of the classification of the at least one waste product.

Embodiment 7 may include Embodiment 6 and may further include the controlling of the further handling or processing of the at least one waste product based on the provided result of the classification of the at least one waste product comprises receiving the result of the classification of the at least one waste product, identifying the class of the at least one waste product, providing controlling data and/or controlling instruction for

the further handling or processing, and providing data being necessary for the further handling or processing.

Embodiment 8 may include Embodiments 6 and/or 7 and may further include the
5 controlling of the further handling or processing of the at least one waste product
comprises determining or estimating which further handling or processing yields the
highest profit, in particular the highest reduction of the environmental impact, the
highest reduction of the ecological footprint, the fastest or efficientest way to reach
sustainability targets, and/or the fastest and efficientest way to reach recycling rates,
10 and adapting the controlling of the further handling or processing of the at least one
waste product based on the determination or estimation of the highest profit.

Embodiment 9 may include a waste product recommender system for recommending a
further handling or for generating processing instructions for further processing of at
15 least one waste product, comprising:
a receiving unit for receiving at least one waste product data;
a determination unit for determining a status of the at least one waste product based on
the at least one waste product data;
a matching unit for matching the determined status of the at least one waste product
20 with a provided predefined status and assigning the at least one waste product based
on the matching to a predefined status class of a predefined status classification;
a classification unit for classifying the at least one waste product with respect to further
handling suitability or processing based on the status class; and
a providing unit for providing the result of the classification of the at least one waste
25 product.

Embodiment 10 may include Embodiment 9 and may further include status classification
storage means or model for providing the status classification data.

30 Embodiment 11 may include Embodiments 9 and/or 10, the system further comprising a
controlling unit for controlling a further handling or processing of the at least one waste
product based on the result of the classification of the at least one waste product.

Embodiment 12 may include the use of waste product data of a waste product in any of the methods according to any of the Embodiments 1 to 8.

Embodiment 13 may include a computer program element with instructions, which, when executed on computing devices of a computing environment, is configured to carry out the steps of the method(s) according to any one of the Embodiments 1 to 8 in a system according to any one of the Embodiments 9 to 11.

10 BRIEF DESCRIPTION OF THE DRAWINGS

In the following, the present disclosure is further described with reference to the enclosed figures:

- 15 Fig. 1 illustrates schematically a battery with a battery identification element;
- Fig. 2 illustrate example embodiments of a centralized computing environment with computing nodes;
- 20 Fig. 3 illustrate example embodiments of a decentralized computing environment with computing nodes;
- Fig. 4 illustrates an example embodiment of a distributed computing environment;
- 25 Fig. 5 illustrates a block diagram of an example system architecture of a system for recommending a further handling of at least one battery;
- Fig. 6 illustrates a flow diagram of a computer-implemented method for recommending a further handling of at least one battery;
- 30 Fig. 7 illustrates schematically a container for a waste product with a waste product identification element;

Fig. 8 illustrates a block diagram of an example system architecture of a system for recommending a further handling of at least one waste product;

5 Fig. 9 illustrates a flow diagram of a computer-implemented method for recommending a further handling of at least one waste product.

DETAILED DESCRIPTION OF EMBODIMENT

10 The following embodiments are mere examples for implementing the method, the system or application device disclosed herein and shall not be considered limiting. The following description is related to batteries as specific waste products. The description may similarly relate to other waste products. The description may hence be construed broadly with respect to different waste products and shall only serve as example.

15 Reference signs may refer to similar functionalities or components.

Fig. 1 illustrates schematically a battery 10 with a battery identification element 16. Similarly a container 10 for a waste product or the waste product 10 may include the identification element 16. The battery 10 may comprise a battery management system

20 11 and a plurality of battery cells 19 arranged inside a battery housing 18. The battery cells 19 may be arranged in battery packs or modules comprising multiple battery cells. The battery cell 19 may comprise an electrolyte 12, an anode 14, a cathode 15, and a separator 13.

25 The battery identification element 16, 17 may be associated with the battery 10. The identification element 16, 17 may be physically attached to the battery housing. The identification element 16, 17 may be arranged inside or outside the battery housing. The identification element 16, 17 may be a passive identification element 16. The passive element 16 may be arranged on the outer surface of the battery housing 18. The

30 passive element 16 may include a printed code such as a bar code or a QR code. The identification element 16, 17 may be an active identification element 17. The active element 17 may be a transmitter or transceiver tag, such as an RFID tag enabling communication through e.g. NFC, Bluetooth, Zigbee or other suitable near- to mid-range communication protocols. The identification element 17 may be part of the battery

management system 11 or the digital battery identifier may be stored in the battery management system 11.

The battery identification element 16, 17 may be associated with a digital battery identifier. The digital battery identifier may be unique for the battery. The digital battery identifier may be further associated with data relating to the identified battery. Such data may include any data collected during the production or lifetime of the battery. For instance, such data may include material data collected during production of the battery or monitoring data collected during use of the battery may be by associated with the digital battery identifier.

The digital battery identifier may include at least one decentral identifier. Decentral identifier may comprise any unique identifier uniquely associated with the data owner and the identified battery. The decentral identifier may include a Universally Unique Identifier (UUID) or a Digital Identifier (DID). The decentral identifier may be issued by a central or decentral identity issuer. The decentral identifier may include authentication information for authentication of the data relating to the identified battery. Via the decentral identifier and its unique association with the battery identified access to the data relating to the identified battery may be controlled by at least one data owner. This contrasts with central authority schemes, where identifiers are provided by central authority and access to data is controlled by such central authority. Decentral in this context refers to the usage of the identifier in implementation as controlled by any data owner. The identification element 16, 17 may be configured to provide the digital battery identifier for accessing data relating to the identified battery.

Figs. 2 to 4 illustrate different computing environments, central, decentral and distributed. The methods, apparatuses, systems, computer elements of this disclosure may be implemented in decentral or at least partially decentral computing environments. In particular, providing of data may be realized by different computing nodes, which may be implemented in a centralized, a decentralized or a distributed computing environment. Furthermore, determination of data may be realized by different computing nodes, which may be implemented in a centralized, a decentralized, or a distributed computing environment.

Figs. 2 and 3 illustrate example embodiments of a centralized and a decentralized computing environment with computing nodes. Fig. 4 illustrates an example embodiment of a distributed computing environment.

5 Fig. 2 illustrates an example embodiment of a centralized computing system 20 comprising a central computing node 21 (filled circle in the middle) and several peripheral computing nodes 21.1 to 21.n (denoted as filled circles in the periphery). The term “computing system” is defined herein broadly as including one or more computing nodes, a system of nodes or combinations thereof. The term “computing node” is
10 defined herein broadly and may refer to any device or system that includes at least one physical and tangible processor, and/or a physical and tangible memory capable of having thereon computer-executable instructions that are executed by a processor. Computing nodes are now increasingly taking a wide variety of forms. Computing nodes may, for example, be handheld devices, production facilities, sensors, monitoring
15 systems, control systems, appliances, laptop computers, desktop computers, mainframes, data centers, or even devices that have not conventionally been considered a computing node, such as wearables (e.g., glasses, watches or the like). The memory may take any form and depends on the nature and form of the computing node.

20 In this example, the peripheral computing nodes 21.1 to 21.n may be connected to one central computing system (or server). In another example, the peripheral computing nodes 21.1 to 21.n may be attached to the central computing node via e.g. a terminal server (not shown). The majority of functions may be carried out by, or obtained from
25 the central computing node (also called remote centralized location). One peripheral computing node 21.n has been expanded to provide an overview of the components present in the peripheral computing node. The central computing node 21 may comprise the same components as described in relation to the peripheral computing node 21.n.

30 Each computing node 21, 21.1 to 21.n may include at least one hardware processor 22 and memory 24. The term “processor” may refer to an arbitrary logic circuitry configured to perform basic operations of a computer or system, and/or, generally, to a device which is configured for performing calculations or logic operations. In particular, the

processor, or computer processor may be configured for processing basic instructions that drive the computer or system. It may be a semi-conductor based processor, a quantum processor, or any other type of processor configured for processing instructions. As an example, the processor may comprise at least one arithmetic logic unit ("ALU"), at least one floating-point unit ("FPU"), such as a math coprocessor or a numeric coprocessor, a plurality of registers, specifically registers configured for supplying operands to the ALU and storing results of operations, and a memory, such as an L1 and L2 cache memory. In particular, the processor may be a multicore processor. Specifically, the processor may be or may comprise a Central Processing Unit ("CPU"). The processor may be a ("GPU") graphics processing unit, ("TPU") tensor processing unit, ("CISC") Complex Instruction Set Computing microprocessor, Reduced Instruction Set Computing ("RISC") microprocessor, Very Long Instruction Word ("VLIW") microprocessor, or a processor implementing other instruction sets or processors implementing a combination of instruction sets. The processing means may also be one or more special-purpose processing devices such as an Application-Specific Integrated Circuit ("ASIC"), a Field Programmable Gate Array ("FPGA"), a Complex Programmable Logic Device ("CPLD"), a Digital Signal Processor ("DSP"), a network processor, or the like. The methods, systems and devices described herein may be implemented as software in a DSP, in a micro-controller, or in any other side-processor or as hardware circuit within an ASIC, CPLD, or FPGA. It is to be understood that the term processor may also refer to one or more processing devices, such as a distributed system of processing devices located across multiple computer systems (e.g., cloud computing), and is not limited to a single device unless otherwise specified.

The memory 24 may refer to a physical system memory, which may be volatile, non-volatile, or a combination thereof. The memory may include non-volatile mass storage such as physical storage media. The memory may be a computer-readable storage media such as RAM, ROM, EEPROM, CD-ROM, or other optical disk storage, magnetic disk storage, or other magnetic storage devices, non-magnetic disk storage such as solid-state disk or any other physical and tangible storage medium which can be used to store desired program code means in the form of computer-executable instructions or data structures and which can be accessed by the computing system. Moreover, the memory may be a computer-readable media that carries computer-executable instructions (also called transmission media). Further, upon reaching various computing

system components, program code means in the form of computer-executable instructions or data structures can be transferred automatically from transmission media to storage media (or vice versa). For example, computer-executable instructions or data structures received over a network or data link can be buffered in RAM within a network interface module (e.g., a “NIC”), and then eventually transferred to computing system RAM and/or to less volatile storage media at a computing system. Thus, it should be understood that storage media can be included in computing components that also (or even primarily) utilize transmission media.

The computing nodes 21, 21.1 to 21.n may include multiple structures 26 often referred to as an “executable component, executable instructions, computer-executable instructions or instructions”. For instance, memory 24 of the computing nodes 21, 21.1 to 21.n may be illustrated as including executable component 26. The term “executable component” or any equivalent thereof may be the name for a structure that is well understood to one of ordinary skill in the art in the field of computing as being a structure that can be software, hardware, or a combination thereof or which can be implemented in software, hardware, or a combination. For instance, when implemented in software, one of ordinary skill in the art would understand that the structure of an executable component includes software objects, routines, methods, and so forth, that is executed on the computing nodes 21, 21.1 to 21.n, whether such an executable component exists in the heap of a computing node 21, 21.1 to 21.n, or whether the executable component exists on computer-readable storage media. In such a case, one of ordinary skill in the art will recognize that the structure of the executable component exists on a computer-readable medium such that, when interpreted by one or more processors of a computing node 21, 21.1 to 21.n (e.g., by a processor thread), the computing node 21, 21.1 to 21.n is caused to perform a function. Such a structure may be computer-readable directly by the processors (as is the case if the executable component were binary). Alternatively, the structure may be structured to be interpretable and/or compiled (whether in a single stage or in multiple stages) so as to generate such binary that is directly interpretable by the processors. Such an understanding of example structures of an executable component is well within the understanding of one of ordinary skill in the art of computing when using the term “executable component”. Examples of executable components implemented in hardware include hardcoded or hard-wired logic gates, that are implemented exclusively

or near-exclusively in hardware, such as within a field- programmable gate array (FPGA), an application-specific integrated circuit (ASIC), or any other specialized circuit. In this description, the terms “component”, “agent”, “manager”, “service”, “engine”, “module”, “virtual machine” or the like are used synonymous with the term “executable
5 component.

The processor 22 of each computing node 21, 21.1 to 21.n may direct the operation of each computing node 21, 21.1 to 21.n in response to having executed computer-executable instructions that constitute an executable component. For example, such
10 computer-executable instructions may be embodied on one or more computer-readable media that form a computer program product. The computer-executable instructions may be stored in the memory 24 of each computing node 21, 21.1 to 21.n. Computer-executable instructions comprise, for example, instructions and data which, when executed at a processor 21, cause a general purpose computing node 21, 21.1 to 21.n,
15 special purpose computing node 21, 21.1 to 21.n, or special purpose processing device to perform a certain function or group of functions. Alternatively or in addition, the computer-executable instructions may configure the computing node 21, 21.1 to 21.n to perform a certain function or group of functions. The computer executable instructions may be, for example, binaries or even instructions that undergo some translation (such
20 as compilation) before direct execution by the processors, such as intermediate format instructions such as assembly language, or even source code.

Each computing node 21, 21.1 to 21.n may contain communication channels 28 that allow each computing node 21.1 to 21.n to communicate with the central computing
25 node 21, for example, a network (depicted as solid line between peripheral computing nodes and the central computing node in Fig. 2). A “network” may be defined as one or more data links that enable the transport of electronic data between computing nodes 21, 21.1 to 21.n and/or modules and/or other electronic devices. When information is transferred or provided over a network or another communications connection (either
30 hardwired, wireless, or a combination of hardwired or wireless) to a computing node 21, 21.1 to 21.n, the computing node 21, 21.1 to 21.n properly views the connection as a transmission medium. Transmission media can include a network and/or data links which can be used to carry desired program code means in the form of computer-executable instructions or data structures and which can be accessed by a general-

purpose or special-purpose computing nodes 21, 21.1 to 21.n. Combinations of the above may also be included within the scope of computer-readable media.

The computing node(s) 21, 21.1 to 21.n may further comprise a user interface system 25 for use in interfacing with a user. The user interface system 25 may include output mechanisms 25A as well as input mechanisms 25B. The principles described herein are not limited to the precise output mechanisms 25A or input mechanisms 25B as such will depend on the nature of the device. However, output mechanisms 25A might include, for instance, displays, speakers, displays, tactile output, holograms and so forth.

Examples of input mechanisms 25B might include, for instance, microphones, touchscreens, holograms, cameras, keyboards, mouse or other pointer input, sensors of any type, and so forth.

Fig. 3 illustrates an example embodiment of a decentralized computing environment 30 with several computing nodes 21.1 to 21.n denoted as filled circles. In contrast to the centralized computing environment 20 illustrated in Fig. 2, the computing nodes 21.1 to 21.n of the decentralized computing environment are not connected to a central computing node 21 and are thus not under control of a central computing node. Instead, resources, both hardware and software, may be allocated to each individual computing node 21.1 to 21.n (local or remote computing system) and data may be distributed among various computing nodes 21.1 to 21.n to perform the tasks. Thus, in a decentral system environment, program modules may be located in both local and remote memory storage devices. One computing node 21 has been expanded to provide an overview of the components present in the computing node 21. In this example, the computing node 21 comprises the same components as described in relation to Fig. 2.

Fig. 4 illustrates an example embodiment of a distributed computing environment 40. In this description, “distributed computing” may refer to any computing that utilizes multiple computing resources. Such use may be realized through virtualization of physical computing resources. One example of distributed computing is cloud computing. “Cloud computing” may refer a model for enabling on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services). When distributed, cloud computing environments may be distributed internationally within an organization and/or across multiple organizations. In this

example, the distributed cloud computing environment 40 may contain the following computing resources: mobile device(s) 42, applications 43, databases 44, data storage and server(s) 46. The cloud computing environment 40 may be deployed as public cloud 47, private cloud 48 or hybrid cloud 49. A private cloud 47 may be owned by an organization and only the members of the organization with proper access can use the private cloud 48, rendering the data in the private cloud at least confidential. In contrast, data stored in a public cloud 48 may be open to anyone over the internet. The hybrid cloud 49 may be a combination of both private and public clouds 47, 48 and may allow to keep some of the data confidential while other data may be publicly available.

Referring back to Fig. 1, the battery or battery component identifiers provided by the identification element 177 may be processes in an at least partially decentralized computing environment. Similarly, the identifiers provided by the identification element 177 of any waste product may be processes in an at least partially decentralized computing environment. Battery or battery component identifiers may be configured to access battery or battery component data, such as material data. Further decentral identifiers may be associated with recycling or production plants participating in the recycling or production of batteries. Recycling or production plant identifiers may be configured to access recycling or production plant data, such as capacity data, process specific data or operator data. By associating such decentral identifiers to authentication information and optionally authorization rules data can be shared securely and reliably across players or systems of the production and/or recycling chain.

The above at least partially decentralized structure based on decentral identifiers allows for novel methods, apparatuses, systems, computer elements, computer executable instructions and their uses in the battery recycling process, which will be described in the following.

Fig. 5 illustrates a block diagram of an example battery recommender system architecture of a battery recommender system 50 for recommending a further handling of at least one battery. The battery recommender system 50 for recommending a further handling of at least one battery comprises a receiving unit 51 for receiving at least one battery data. The receiving unit 52 receives the at least one battery data, and provides the at least one battery data to the battery recommender system 50 for further

processing. The battery data comprises the battery ID, material specific data of the battery and (optionally) lifetime data. The receiving unit 51 receives/provides the specific data from data providing means, e.g. means for visual identification of battery type, in particular machine learning means or a camera in order to receive physical

5 condition data, i.e. pictures, electrical condition data, i.e. basic info, usage data, operating duration of the battery, number of cycles of the battery, the capacitance of the battery, the quick-charged total amount of power, the mileage of a transportation vehicle including the battery, the discharging/charging curve, and/or chemical composition data, i.e. the raw materials and material specific data. Alternatively or additionally, the

10 receiving unit 51 receives/provides data of the battery manufacture. All data can be provided by a digital identifier, e.g. QR code, RFID chip, NFC chip, or data being read out from the battery management system. The battery recommender system 50 further comprises a determination unit 52 for determining a health status of the at least one battery based on the at least one battery data. The determination unit 52 uses the at

15 least one battery data as an input, uses the battery data for determining a health status, and provides the health status of the at least one battery for further processing to the battery recommender system 50. The health status is one of the following: very good, rather good, moderate, rather bad, very bad. Furthermore, the battery recommender system 50 comprises a matching unit 53 being configured for matching the determined

20 health status of the at least one battery with a provided predefined health status and assigning the at least one battery based on the matching to a predefined health status class of a predefined health status classification. The matching unit 53 uses the health status of the at least one battery as an input, receives or queries provided predefined health status from a health status classification storage means 56, matches the health

25 status of the at least one battery with the provided predefined health status, assigns the at least one battery to a predefined health status class of a predefined health status classification based on the matching, and provides the chosen predefined health status class to which the at least one battery is assigned for further processing to the battery recommender system 50. The predefined health status is one of the following: very

30 good, rather good, moderate, rather bad, very bad. The battery recommender system 50 further comprises a classification unit 54 being configured for classifying the at least one battery with respect to further handling suitability based on the chosen predefined health status class. The classification unit 54 receives the chosen predefined health status class to which the at least one battery is assigned, uses this class in order to

classify the battery with respect to a further handling suitability, and provides the classification of the at least one battery to the battery recommender system 50 for further processing. Furthermore, the battery recommender system 50 comprises a providing unit 55. The providing unit 55 receives the result of the classification of the at least one battery and provides the result for further processing to the battery recommender system 50. Further, the battery recommender system 50 comprises a controlling unit 57. The controlling unit 57 receives the result of the classification of the at least one battery and is configured for controlling a further handling of the at least one battery based on the result of the classification of the at least one battery.

Fig.6 illustrates a flow diagram of a computer-implemented method for recommending a further handling of at least one battery. In a first step, at least one battery data is received, wherein the battery data includes the battery ID, the material specific data, e.g. the chemical composition of the battery, and the lifetime data, e.g. the age of the battery and/or number of cycles/loading cycles of the battery. The receiving of the at least one battery data is provided by querying a QR code being arranged on the housing of the battery and data from the battery management system. In a second step, a health status of the battery is determined based on the at least one provided battery data. The health status is one of the following: very good, rather good, moderate, rather bad, very bad. The determination is a scoring/rating of the at least one battery based on the provided battery data. For instance, a battery having a short lifetime and a high number of cycles of the battery is ranked, rated, scored to a status of "rather bad or very bad". In contrast, a battery having a longer lifetime and a moderate number of cycles of the battery is ranked, rated, scored to a status of "rather good or very good". Additionally or alternatively, the determination of the health status of the battery can be provided by a battery model which receives the battery data as an input and provides the health status of the battery as an output. Battery model processes variables and performance parameters in order to determine/provide the health status of the at least one battery. The determination/selection of the health may be provided by a plurality of respective thresholds. In a third step, the determined health status of the at least one battery is matched with a provided predefined health status and the at least one battery is assigned to a predefined health status class of a predefined health status classification based on the matching. During matching, a predetermined counterpart of the determined health status is matched to the determined health status, wherein a

matching index can be used, e.g. correlation, in order to represent the degree of matching. For instance, a correlation of “1” represents that a determined health status “very good” of at least one battery is matched to a provided predetermined health status “very good”. The assigning of the at least one battery to a predefined health status class
5 of a predefined health status classification is based on the matching, in particular based on the highest degree of matching. Exemplary, the at least one battery is assigned to the predefined health class including the highest degree of matching between the determined and provided health status. In a fourth step, the at least one battery is classified with respect to further handling suitability based on the health status class.
10 The further handling suitability discloses the classes disposal, 2nd life, recycling, and/or reuse. The health status class indicates a further use of the at least one battery. In a fifth step, the result of the classification of the at least one battery is provided.

Optionally, the third step of method for recommending a further handling of at least one
15 battery comprises querying of health status classification data for providing the predefined health status of the predefined health status classification. The health status classification data are queried from a database, model, in particular prediction model, cloud, or other storage means and includes e.g. the battery type, the battery manufacturer, the number of load cycles, the age of the battery, the heat development,
20 scratches, bloating, and further information being used for determining/estimating the predefined health status.

Optionally, the method for recommending a further handling of at least one battery further comprises the step of controlling a further handling of the at least one battery
25 based on the provided result of the classification of the at least one battery. Depending on the result of the classification of the at least one battery, the data being necessary for the further handling varies, i.e. for the 2nd life information indicating the kind of reuse are used, for the recycling information indicating the raw materials are needed. The controlling further indicates an order of further handling, i.e. first disposal, 2nd life, third
30 recycling, and finally reuse. The controlling data can be controlling instructions leading to an automatic controlling of the logistics, directly controlling of the e.g. recycling plants.

Optionally, the step controlling a further handling of the at least one battery based on the provided result of the classification of the at least one battery comprises the sub steps of receiving the result of the classification of the at least one battery, identifying the class of the at least one battery, providing controlling data and/or controlling instruction for the further handling, and providing data being necessary for the further handling.

Fig. 7 illustrates schematically a container for a waste product with a waste product identification element;

The identification element 16, 17 may be physically attached to the container housing 18. The identification element 16, 17 may be arranged inside or outside the container housing 18. The identification element 16, 17 may be a passive identification element 16. The passive element 16 may be arranged on the outer surface of the container housing 18. The passive element 16 may include a printed code such as a bar code or a QR code. The identification element 16, 17 may be an active identification element 17. The active element 17 may be a transmitter or transceiver tag, such as an RFID tag enabling communication through e.g. NFC, Bluetooth, Zigbee or other suitable near- to mid-range communication protocols.

The waste product identification element 16, 17 may be associated with a digital waste product identifier. The digital waste product identifier may be unique for the waste product. The digital waste product identifier may be further associated with data relating to the identified waste product. Such data may include any data collected during the production or lifetime of the waste product. For instance, such data may include material data collected during production of the waste product or monitoring data collected during use of the waste product may be by associated with the digital waste product identifier.

The digital waste product identifier may include at least one decentral identifier. Decentral identifier may comprise any unique identifier uniquely associated with the data owner and the identified waste product. The decentral identifier may include a Universally Unique IDentifier (UUID) or a Digital IDentifier (DID). The decentral identifier may be issued by a central or decentral identity issuer. The decentral identifier may

include authentication information for authentication of the data relating to the identified waste product. Via the decentral identifier and its unique association with the waste product identified access to the data relating to the identified waste product may be controlled by at least one data owner. This contrasts with central authority schemes, where identifiers are provided by central authority and access to data is controlled by such central authority. Decentral in this context refers to the usage of the identifier in implementation as controlled by any data owner. The identification element 16, 17 may be configured to provide the digital waste product identifier for accessing data relating to the identified waste product.

Fig. 8 illustrates a block diagram of an example system architecture of a system 50 for recommending a further handling of at least one waste product.

The waste product recommender system 50 for recommending a further handling of at least one waste product comprises a receiving unit 51 for receiving at least one waste product data. The receiving unit 52 receives the at least one waste product data, and provides the at least one waste product data to the waste product recommender system 50 for further processing. The waste product data comprises the waste product ID, specific data of the waste product, and (optionally) lifetime data. The receiving unit 51 receives/provides the specific data from data providing means, e.g. means for visual identification of waste product type, in particular machine learning means or a camera in order to receive physical condition data, i.e. pictures, and/or chemical composition data, i.e. the raw materials and material specific data. Alternatively or additionally, the receiving unit 51 receives/provides data of the waste product manufacture. All data can be provided by a digital identifier, e.g. QR code, RFID chip, NFC chip. The waste product recommender system 50 further comprises a determination unit 52 for determining a status of the at least one waste product based on the at least one waste product data. The determination unit 52 uses the at least one waste product data as an input, uses the waste product data for determining a status, and provides the status of the at least one waste product for further processing to the waste product recommender system 50. The status is one of the following: very good, rather good, moderate, rather bad, very bad. Furthermore, the waste product recommender system 50 comprises a matching unit 53 being configured for matching the determined status of the at least one waste product with a provided predefined status and assigning the at least one waste

product based on the matching to a predefined status class of a predefined status classification. The matching unit 53 uses the status of the at least one waste product as an input, receives or queries provided predefined status from a status classification storage means 56, matches the status of the at least one waste product with the provided predefined status, assigns the at least one waste product to a predefined status class of a predefined status classification based on the matching, and provides the chosen predefined status class to which the at least one waste product is assigned for further processing to the waste product recommender system 50. The predefined status is one of the following: very good, rather good, moderate, rather bad, very bad.

The waste product recommender system 50 further comprises a classification unit 54 being configured for classifying the at least one waste product with respect to further handling suitability based on the chosen predefined status class. The classification unit 54 receives the chosen predefined status class to which the at least one waste product is assigned, uses this class in order to classify the waste product with respect to a further handling suitability, and provides the classification of the at least one waste product to the waste product recommender system 50 for further processing.

Furthermore, the waste product recommender system 50 comprises a providing unit 55. The providing unit 55 receives the result of the classification of the at least one waste product and provides the result for further processing to the waste product recommender system 50. Further, the waste product recommender system 50 comprises a controlling unit 57. The controlling unit 57 receives the result of the classification of the at least one and is configured for controlling a further handling of the at least one waste product based on the result of the classification of the at least one waste product.

Fig. 9 illustrates a flow diagram of a computer-implemented method for recommending a further handling of at least one waste product.

In a first step, at least one waste product data is received, wherein the waste product data includes the waste product ID, the specific data of the waste product, and the lifetime data, i.e. the age of the waste product. The receiving of the at least one waste product data is provided by querying a QR code being arranged on the housing of the container in which the waste product is arranged. In a second step, a status of the waste product is determined based on the at least one provided waste product data.

The status is one of the following: very good, rather good, moderate, rather bad, very bad. The determination is a scoring/rating of the at least one waste product based on the provided waste product data. Additionally or alternatively, the determination of the status of the waste product can be provided by a waste product model which receives the waste product data as an input and provides the status of the waste product as an output. The waste product model processes variables and performance parameters in order to determine/provide the status of the at least one waste product. The determination/selection of the status may be provided by a plurality of respective thresholds. In a third step, the determined status of the at least one waste product is matched with a provided predefined status and the at least one waste product is assigned to a predefined status class of a predefined status classification based on the matching. During matching a predefined counterpart of the determined status is matched to the determined status, wherein a matching index can be used, e.g. correlation, in order to represent the degree of matching. For instance, a correlation of "1" represents that a determined status "very good" of at least one waste product is matched to a provided predetermined status "very good". The assigning of the at least one waste product to a predefined status class of a predefined status classification is based on the matching, in particular based on the highest degree of matching. Exemplary, the at least one waste product is assigned to the predefined class including the highest degree of matching between the determined and provided status. In a fourth step, the at least one waste product is classified with respect to further handling suitability based on the status class. The further handling suitability discloses the classes disposal, 2nd life, recycling, and/or reuse. The status class indicates a further use of the at least one waste product. In a fifth step, the result of the classification of the at least one waste product is provided.

Optionally, the third step of method for recommending a further handling of at least one waste product comprises querying of status classification data for providing the predefined status of the predefined status classification. The status classification data are queried from a database, model, in particular prediction model, cloud, or other storage means and includes e.g. the waste product type, the waste product manufacturer, the age of the waste product, the heat development, scratches, bloating, and further information being used for determining/estimating the predefined status.

Optionally, the method for recommending a further handling of at least one waste product further comprises the step of controlling a further handling of the at least one waste product based on the provided result of the classification of the at least one waste product. Depending on the result of the classification of the at least one waste product, the data being necessary for the further handling varies, i.e. for the 2nd life information indicating the kind of reuse are used, for the recycling information indicating the raw materials are needed. The controlling further indicates an order of further handling, i.e. first disposal, second 2nd life, third recycling, and finally reuse. The controlling data can be controlling instructions leading to an automatic controlling of the logistics or to a directly controlling of the e.g. recycling plants.

Optionally, the step of controlling a further handling of the at least one waste product based on the provided result of the classification of the at least one waste product comprises the sub steps of receiving the result of the classification of the at least one waste product, identifying the class of the at least one waste product, providing controlling data and/or controlling instruction for the further handling, and providing data being necessary for the further handling.

The present disclosure has been described in conjunction with a preferred embodiment as examples as well. However, other variations can be understood and effected by those persons skilled in the art and practicing the claimed invention, from the studies of the drawings, this disclosure and the claims. Notably, in particular, the any steps presented can be performed in any order, i.e. the present invention is not limited to a specific order of these steps. Moreover, it is also not required that the different steps are performed at a certain place or at one node of a distributed system, i.e. each of the steps may be performed at a different nodes using different equipment/data processing units.

In the claims as well as in the description the word “comprising” does not exclude other elements or steps and the indefinite article “a” or “an” does not exclude a plurality. A single element or other unit may fulfill the functions of several entities or items recited in the claims. The mere fact that certain measures are recited in the mutual different dependent claims does not indicate that a combination of these measures cannot be used in an advantageous implementation.

CLAIMS

1. A computer implemented method for generating processing instructions for further processing of at least one battery, the method comprising:
 - receiving at least one battery data;
 - determining a health status of the at least one battery based on the at least one battery data;
 - matching the determined health status of the at least one battery with a provided predefined health status and assigning the at least one battery based on the matching to a predefined health status class of a predefined health status classification;
 - classifying the at least one battery with respect to further processing based on the health status class; and
 - providing the result of the classification of the at least one battery.
2. The method according to claim 1, wherein the determination of the health status of the at least one battery is provided by a battery model.
3. The method according to any one of the preceding claims, wherein the predefined health status of the predefined health status classification is provided by querying health status classification data.
4. The method according to any one of the preceding claims, wherein the classification of the further processing based on the health status class comprises the at least one class of straight reuse, repair, reuse by modification, recycling, in particular recycling to black mass, and/or disposal.
5. The method according to claim 4, wherein the controlling of the further processing indicates specific reuses or recycling processes for the at least one battery.
6. The method according to any one of the preceding claims, wherein the method further comprises the step of controlling a further processing of the at least one battery based on the provided result of the classification of the at least one battery.

7. The method according to claim 6, wherein the controlling of the further handling of the at least one battery based on the provided result of the classification of the at least one battery comprises receiving the result of the classification of the at least one battery, identifying the class of the at least one battery, providing controlling data and/or controlling instruction for the further processing, and providing data being necessary for the further processing.
8. The method according to any one of claims 6 and 7, wherein the controlling of the further processing of the at least one battery comprises determining or estimating which further processing yields the highest profit, in particular the highest reduction of environmental impacts, the highest CO₂ reduction, highest reduction of the ecological footprint, fastest and/or efficientest way to reach sustainability targets, fastest and/or efficientest way to reach recycling rates, and adapting the controlling of the further processing of the at least one battery based on the determination or estimation of the highest profit.
9. A battery recommender system for generating processing instructions for further processing of at least one battery comprising:
- a receiving unit for receiving at least one battery data;
 - a determination unit for determining a health status of the at least one battery based on the at least one battery data;
 - a matching unit for matching the determined health status of the at least one battery with a provided predefined health status and assigning the at least one battery based on the matching to a predefined health status class of a predefined health status classification;
 - a classification unit for classifying the at least one battery with respect to further processing based on the health status class; and
 - a providing unit for providing the result of the classification of the at least one battery.
10. The battery recommender system according to claim 9, further comprising health status classification storage means or model for providing the health status classification data.

11. The battery recommender system according to any one of claims 9 and 10, the system further comprises a controlling unit for controlling a further processing of the at least one battery based on the result of the classification of the at least one battery.

5

12. Use of battery data of a battery in a method according to any one of claims 1 to 8.

13. Computer program element with instructions, which, when executed on computing devices of a computing environment, is configured to carry out the steps of the method according to any one of the claims 1 to 8 in a system according to any one of the claims 9 to 11.

10

Fig. 1

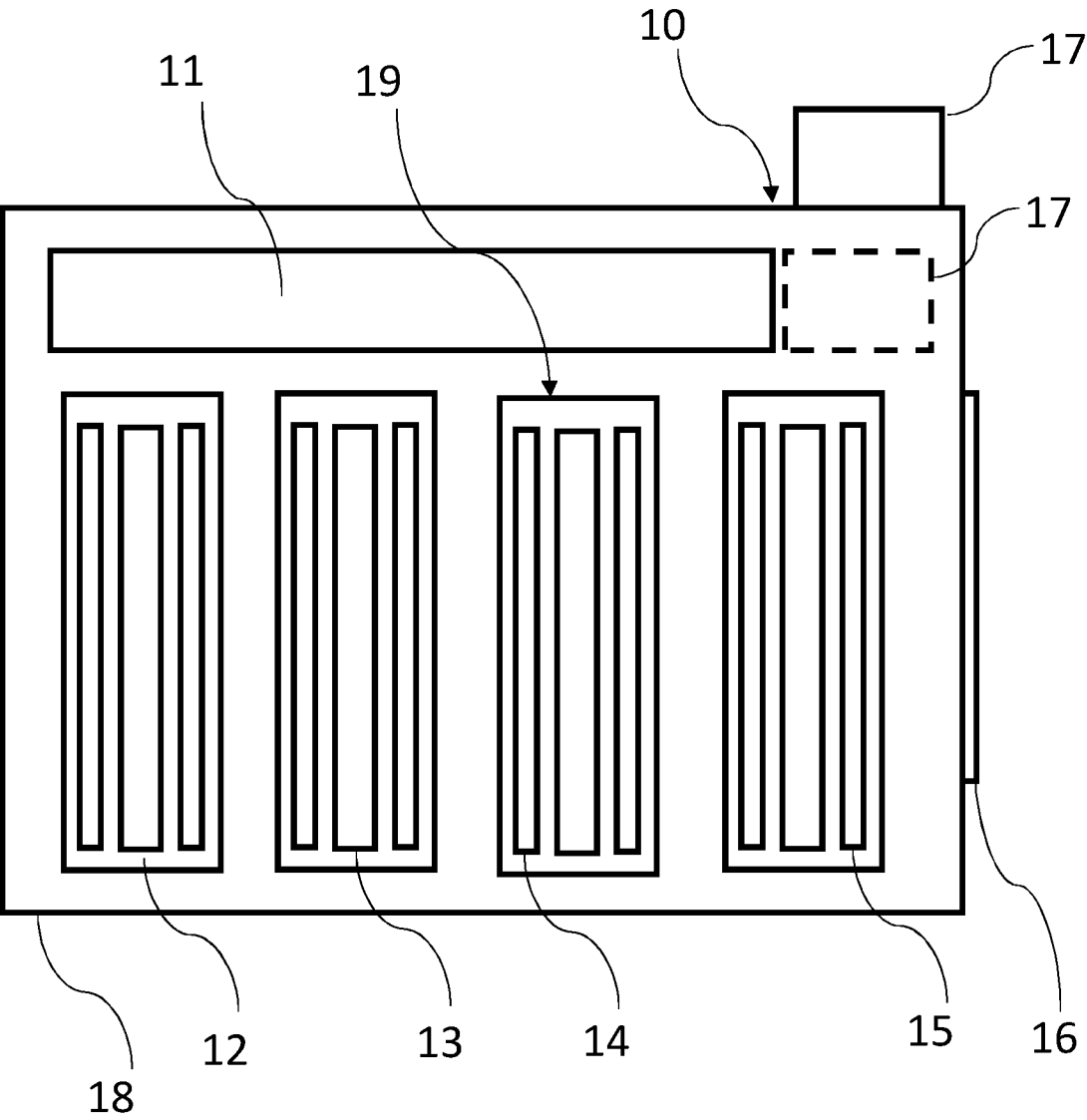


Fig. 2

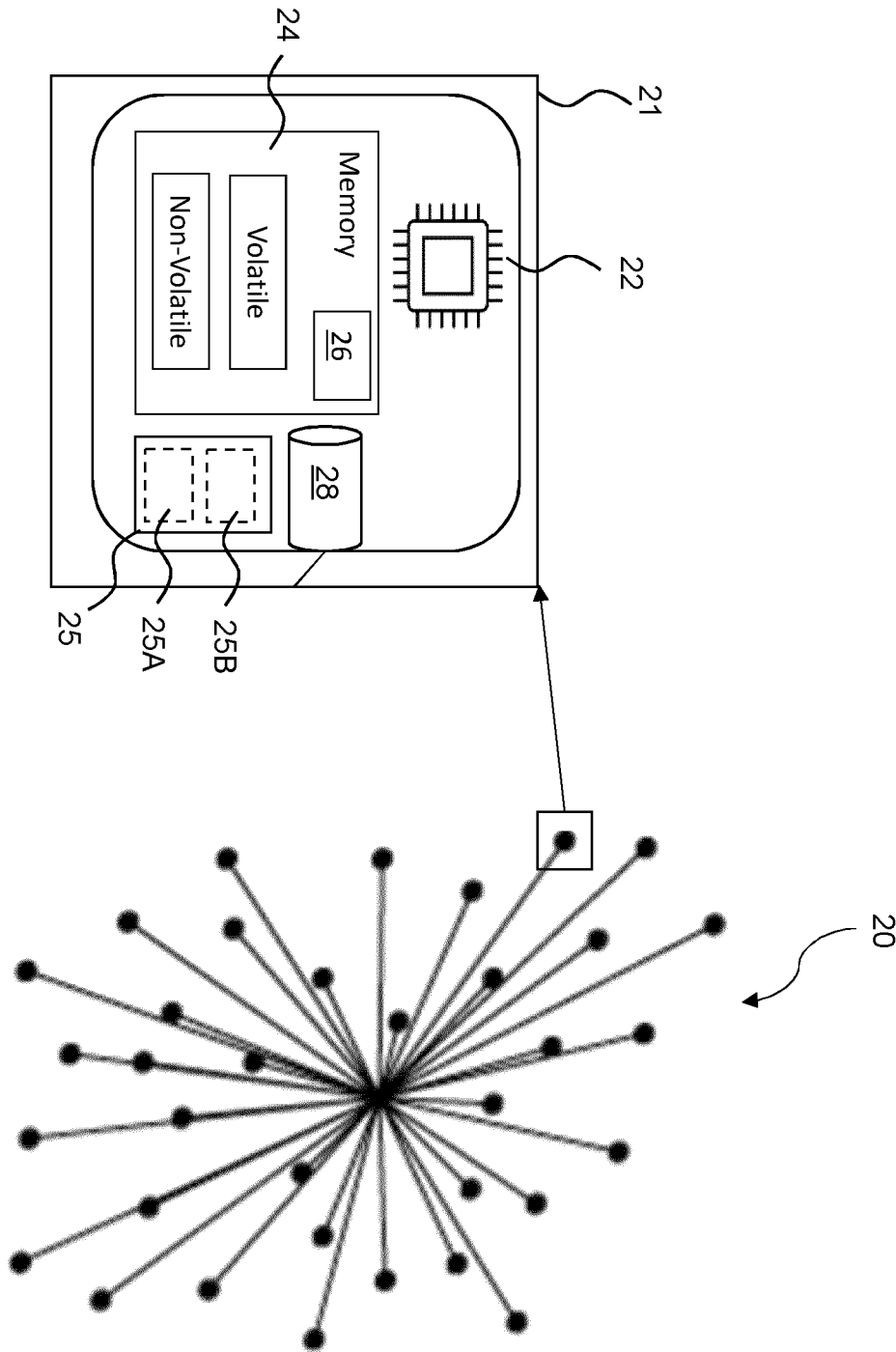


Fig. 3

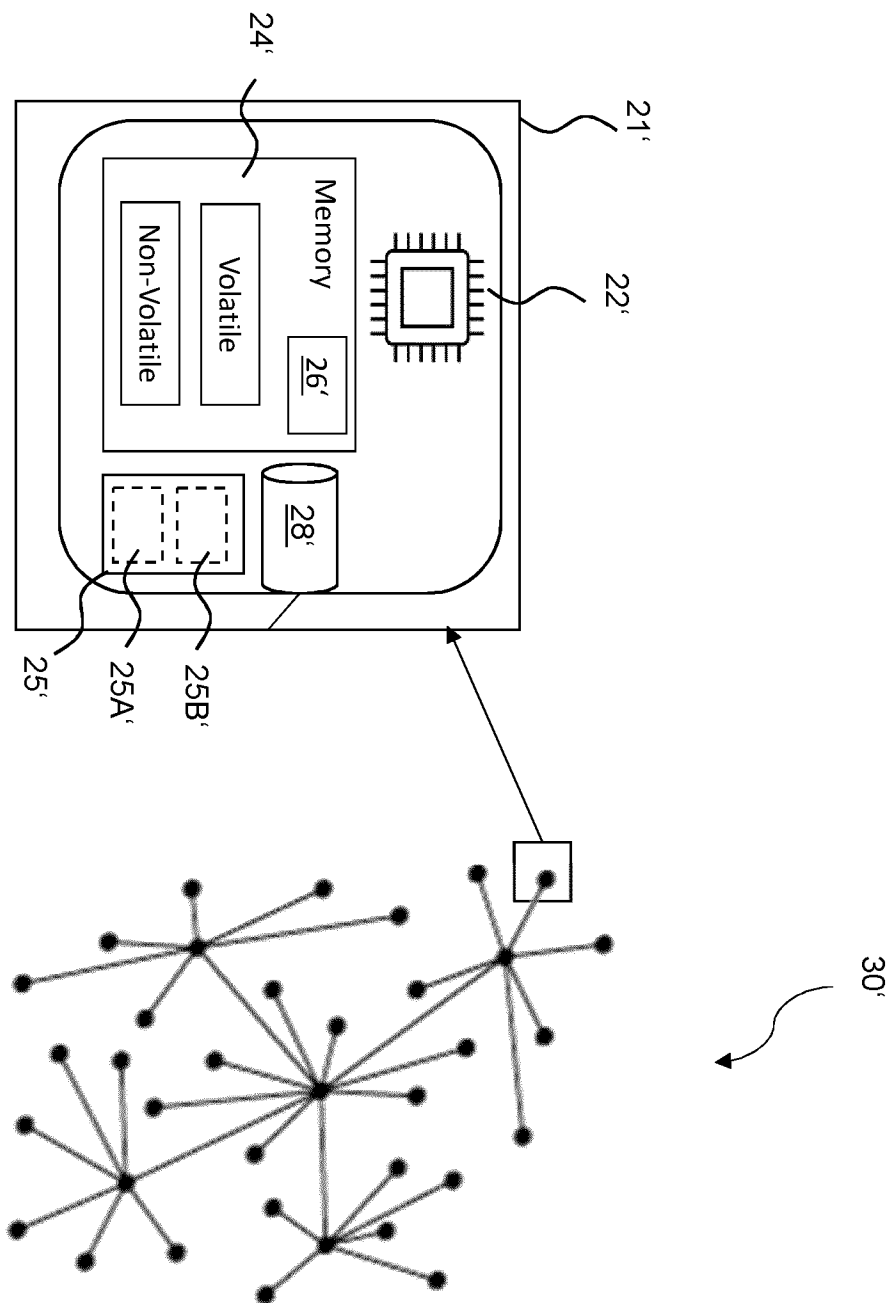


Fig. 4

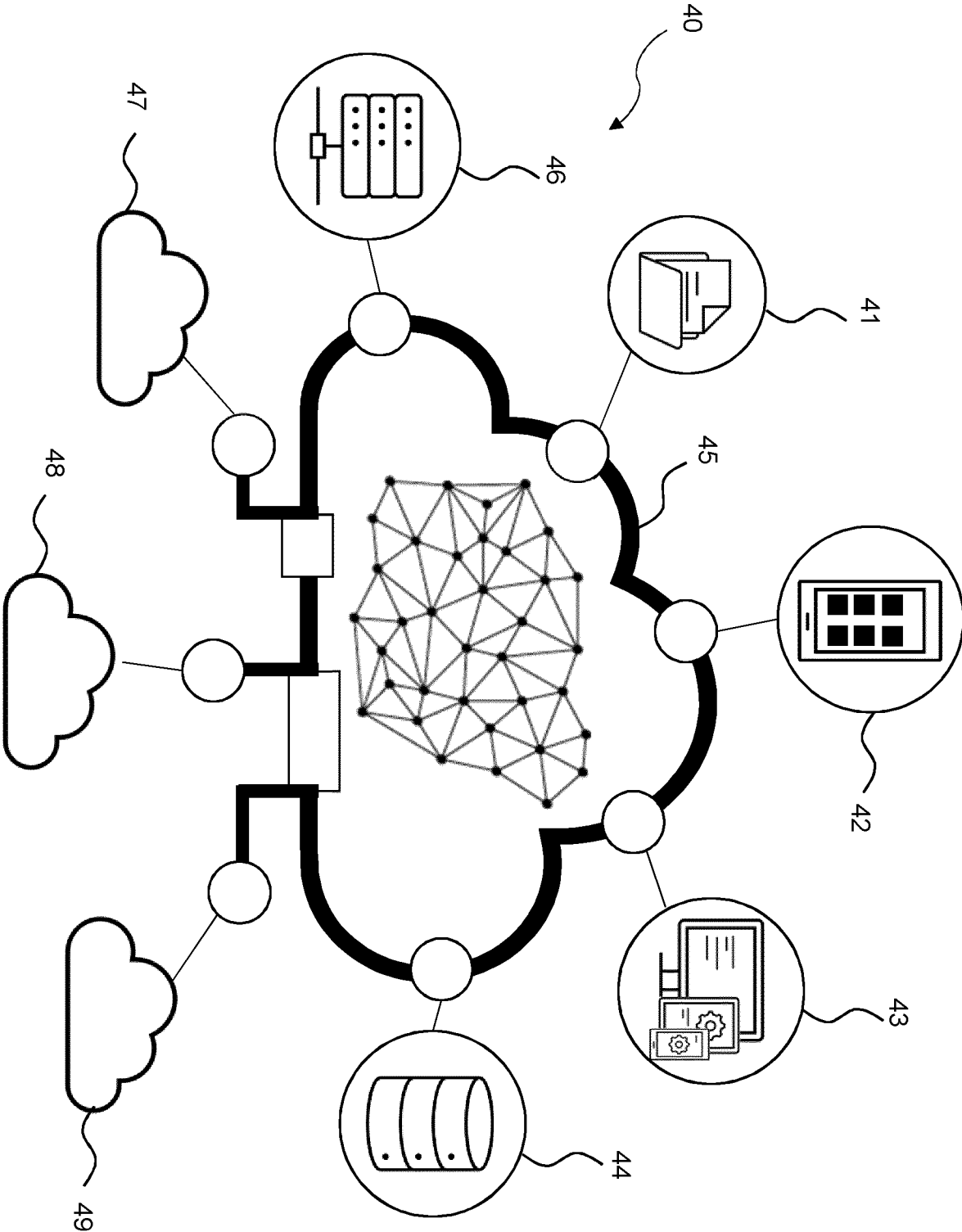


Fig. 5

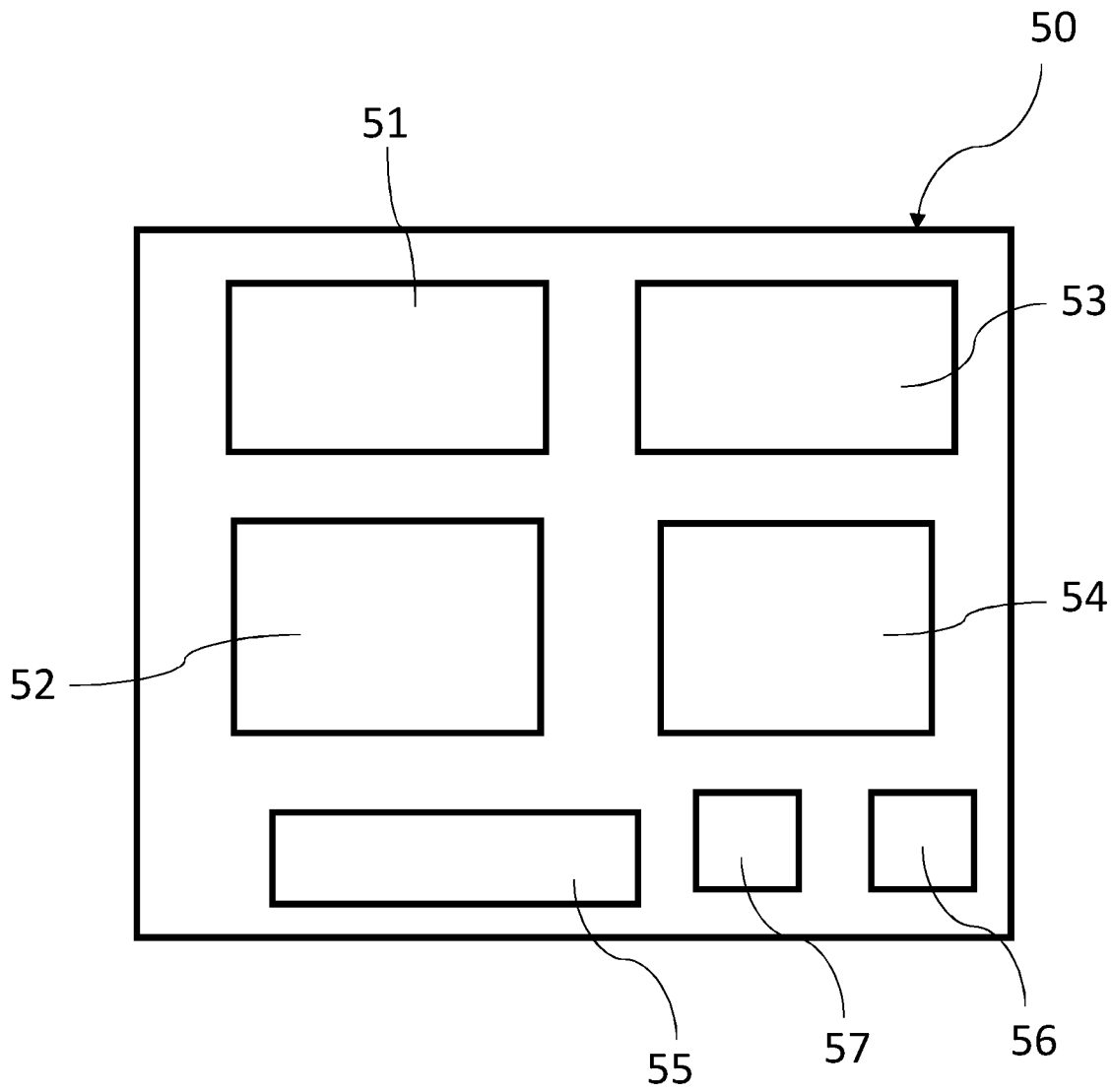


Fig. 6

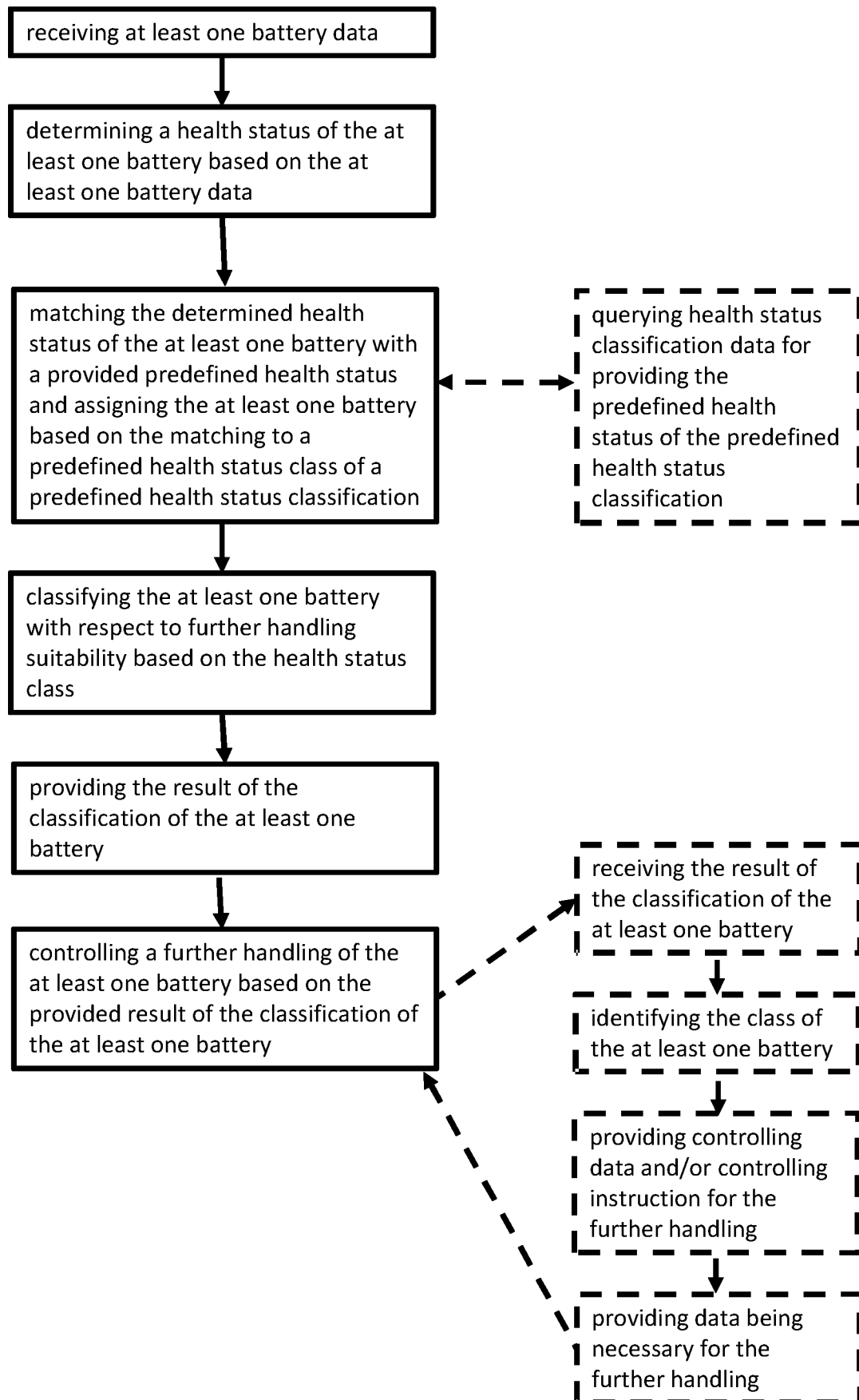


Fig. 7

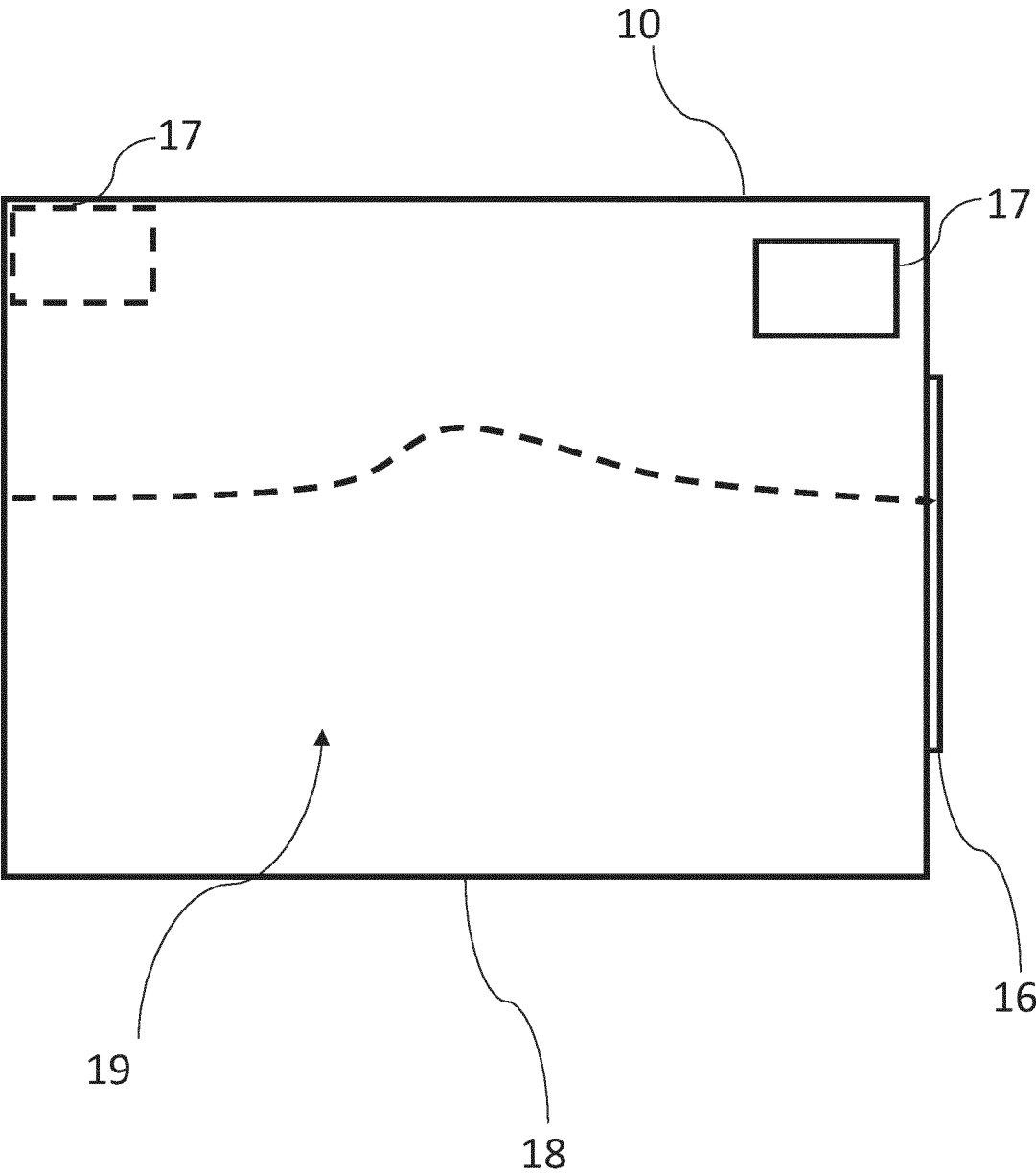


Fig. 8

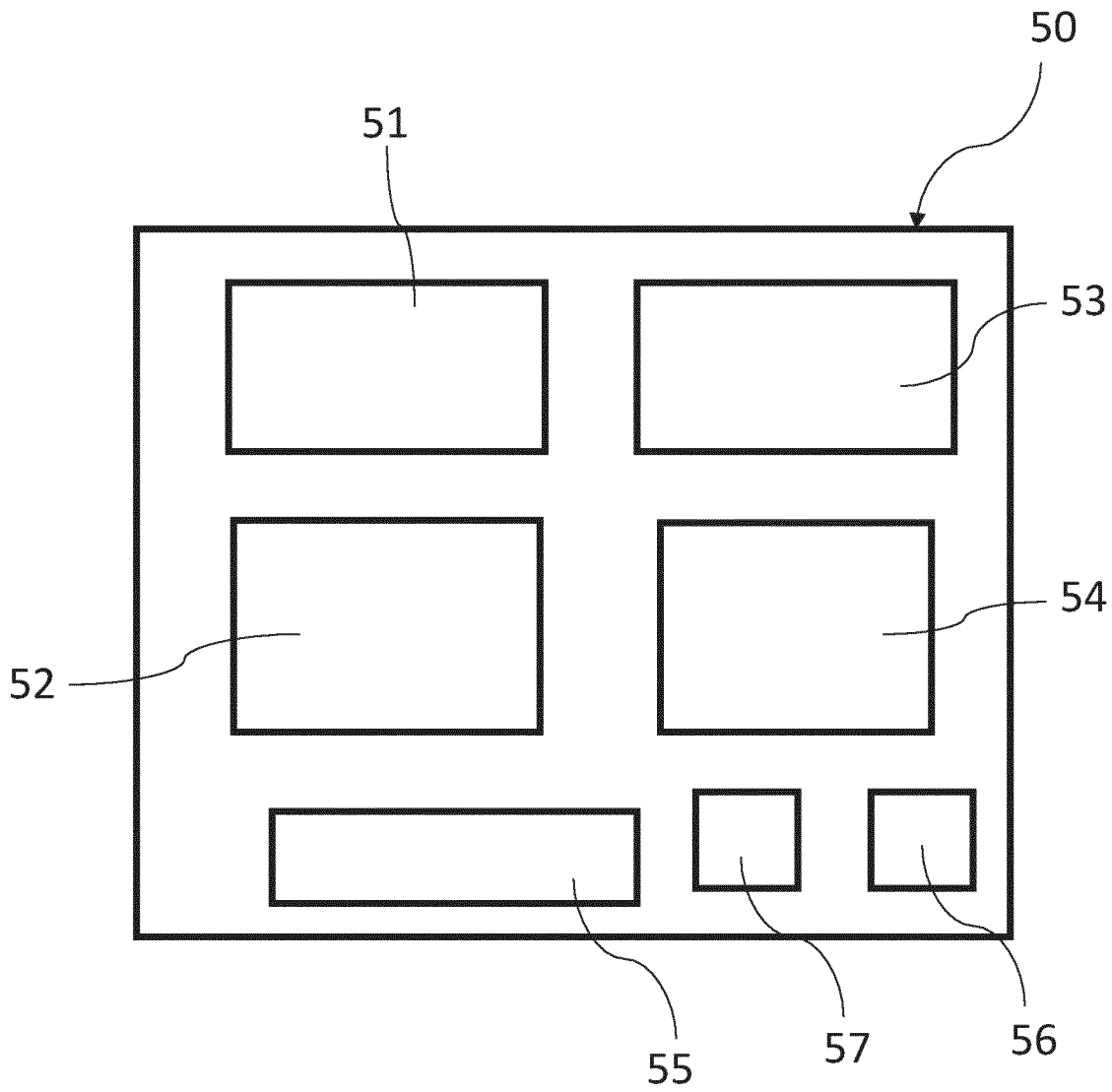
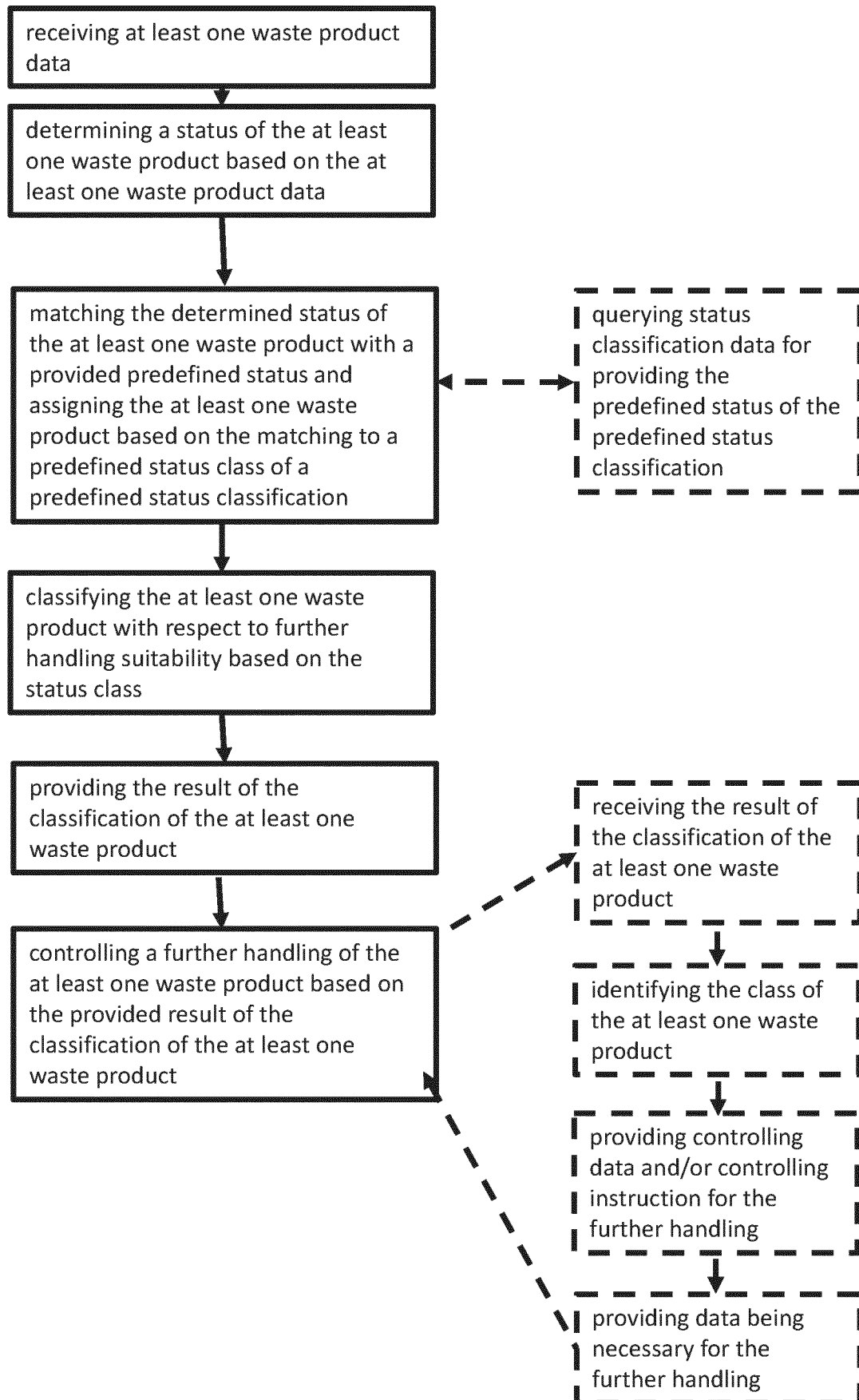


Fig. 9



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2023/062786

A. CLASSIFICATION OF SUBJECT MATTER

INV. G06Q10/00 H01M10/54
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G06Q H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2013/090872 A1 (KURIMOTO YASUhide [JP]) 11 April 2013 (2013-04-11) paragraphs [0008] - [0014], [0025] - [3156], [0095] - [0097], [0101], [0136], [0141] - [0145], [0154], [0167] - [0170] paragraphs [0202] - [0218], [0273] - [0277], [0290] - [0300]; claims; figures -----	1-13
X	US 2014/106185 A1 (KRUGLICK EZEKIEL [US]) 17 April 2014 (2014-04-17) paragraphs [0002], [0006] - [0010], [0025] - [0034], [0047], [0048], [0057], [0064], [0066], [0073], [0077], [0085] - [0089], [0092]; claims; figures 2-7 -----	1-13



Further documents are listed in the continuation of Box C.



See patent family annex.

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

7 July 2023

Date of mailing of the international search report

17/07/2023

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2023/062786

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2013090872 A1	11-04-2013	CN 103081213 A	01-05-2013
		JP 5500252 B2	21-05-2014
		JP WO2011162014 A1	19-08-2013
		US 2013090872 A1	11-04-2013
		WO 2011162014 A1	29-12-2011

US 2014106185 A1	17-04-2014	US 2014106185 A1	17-04-2014
		WO 2014062162 A1	24-04-2014
