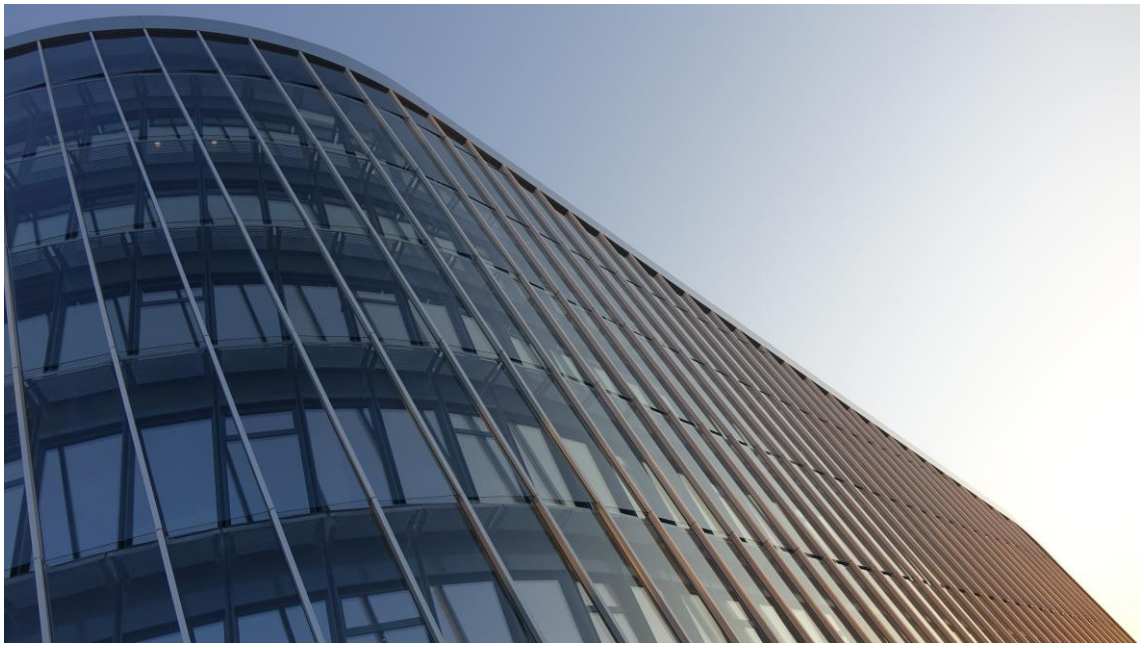
Energy Efficiency Performance-Tracking Platform for Benchmarking Savings and Investments in Buildings

Towards achieving data governance for improving energy efficiency: A Protocols and Procedures Guide for owners of large building stocks.



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It is necessary to include background for the work reported in the deliverable, reasons for choosing a solution, discussion among possible solutions before choosing one, relation to other project deliverables, tasks, and WPs (inputs used, outputs created), as well as concrete conclusions of the documents.

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Abbreviations and Acronyms

Acronym	Description
EEM	Energy Efficiency Measures
EPC	Energy Performance certificate

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1 Executive summary

This report provides recommendations on the data governance of the organisation archetypes defined in D3.2. The three types of organisations were the Basic level (re-named as Passive organisations), Middle level (re-named as Active energy management organisations) and Advanced level (re-named as Advanced energy management organisation). All three were differentiated by how they tackled the data and how the data informed their future planning. The recommendations presented here are based on the different organisations defined and the experience and requests obtained during the preparation of the previous reports. The aim of this work is to establish a framework within which a wide range of institutions can locate a representative or similar situation to their own and thus be able to extract relevant guidance to help them adapt their databases to meet their any future needs.

Following a brief background and introduction, the report summarises all the data types and information sources in a table. The table organised in terms of information types, identified sources for each information type, common tools used to manage the information.

The information sources analysed in the context of building owners are: energy consumption, energy cost, building properties, energy audits and EPCs, and energy efficiency measures. The table has been designed to make it easy for any reader to find the information types they're interested in and offer guidance on how this information can best be organised, managed and exploited.

The main section of the report focuses on providing key recommendations for all organisation types on how to improve their data governance and ease future transformations of their data management practices. The main focus is on their energy, building and financial data to help with building management and decision making. The recommendations defined are tailored to the experiences and needs of each archetype of organisations, addressing more specific needs at the higher tiers.

To summarise:

- The needs of passive organisations revolve around the coordination of the different units in charge of energy, financial and building data within any organisations.
- In active energy management organisations, the focus is on data interoperability and defining how to register the information and ensure that it can later be combined with other internal databases. There is also advice on combining similar databases from different organisations.
- For advanced energy management organisations, the recommendations focus on the challenges of automating of data gathering.
- The most essential recommendations are on data interoperability which affects all organisations, regardless of size.

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2 Background

Energy efficiency investments, particularly in buildings, have often been highlighted as one of the most cost-effective means for the EU to address climate change, delivering not only energy savings and carbon reductions, but also providing numerous non-energy ancillary benefits, such as improving the wellbeing and/or productivity of building occupants. However, progress on building energy efficiency in the EU (and indeed globally) is being held back by numerous barriers, including a lack of standardised data on the performance of buildings and efficiency measures, notably in energy and carbon terms.

This data gap creates risks and barriers to investments in building efficiency upgrades, particularly since energy and carbon savings – not to mention potential maintenance regime improvements, increased wellbeing (and/or productivity) of occupants, and other ancillary benefits – can translate into significant cost savings. In this context, the EU funded EN-TRACK project is working to provide a new data platform with insights on the performance of thousands of public and private buildings and the efficiency measures applied within them.

EN-TRACK aims to be a 'one-stop-shop' for insights on the energy and financial performance of buildings. In order to work the platform has to be a useful and appealing tool for buildings owners and managers; they are the ones who deal with the building and energy consumption data. Therefore, if the platform is to have an active user base willing to entrust their data to it, the creation of the platform must be influenced and shaped by the users themselves. In this context, a particularly relevant aspect of user interactions is information management: which are the sources of information used? where are they found? how is the information managed (data governance)? and who needs access to what? The work documented here answers these questions, builds on earlier work in the EN-TRACK project on information sources, and defines courses of actions to ensure smooth data interoperability and promote a general approach to data governance.

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3 Introduction

This report provides recommendations on data governance within an organisation for each of the organisation archetypes defined in D3.2. The aim is to provide recommendations towards achieving data governance for energy management and planning of investments, tailored and arranged so that any organisation can find the recommendation that fit their particular situation and that suit their requirements at any particular moment.

The report has two main sections: a summary of data types and information for reference (section 4), recommendations organised by organisation types (section 5). These two sections, combined, enable any organisation to discover at a glance how to prepare their data neatly and appropriately in preparation for future applications and developments. The EN-TRACK platform is just one of the possible applications.

Section 4 lists the main types of the information to be targeted for good energy management (and necessary for EN-TRACK). It also highlights sources for these types of information and the tools used to gather and manage it.

Section 5 outlines data management scenarios for each organisation type and provides recommendations on how each type can improve their data governance. It includes summary architype profiles, including an outline description and main characteristics list, and appropriate recommendations to improve the data governance of the various organisation types.

The scenarios build on previous work (D3.2), highlighting commonly used information sources and uses for them. These are summarised in Table 1 (below). This table illustrates the transition towards increasing complexity and depth of data and the increased levels of understanding that comes with this progression. To summarise the organisation types:

- **"Passive organisations"** don't engage on active energy management, they just have some data as a by-product of their day-to-day operations (e.g. energy invoices and maintenance logs). Recommendations for them focus on coordinating the different departments with relevant data and training their workforce to detect and understand the data.
- **"Active energy management organisations"** have planned energy management actions to reduce energy consumption. Recommendations for them focus on ensuring that the expanding amounts of data they collect are properly labelled to easily be able to access the right data when it is needed for either planning or improvements.
- **"Advanced energy management organisations"** are already using smart meters or an expanded monitoring system to capture data automatically and need to manage large amounts of data efficiently. Recommendations for them focus on reducing the day-to-day burden of data related management.

All the recommendations are cumulative: it is assumed that any organisation at a high tier will have the measures recommended at lower levels. In this way, they effectively provide an implementation roadmap enabling any organisation to quickly find out where

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they are and where they need to go next in order to improve their energy management. This is illustrated in a figure in section 5.4.

Table 1: Archetypes of organisations main characteristics, data sources and information used at each level of organisation.

	1. Passive	**2. Active energy management**	**3. Advanced monitoring**
Energy invoices	Focused on the energy cost	Cost, energy consumption and CO2 emissions	
Maintenance log for energy efficiency actions	Actions are carried out as replacements are needed	Actions are planned based on savings targets for energy and CO2 emissions	
Internal building database		Provides data about the building, total surface, heated surface, etc.	
Cadastral data		Provides data about the building, total surface, heated surface, building location, etc.	
EPC and energy audits		Provides detailed data about all building characteristics, insulation, openings, main installations and equipment inventory; with details about use patterns and even maintenance	
Monitoring system		Digital monitoring tools from accounting to energy consumption	Constant collecting of data: energy consumption (higher resolution than smart meter) and environmental conditions (humidity, temperature, etc.)
Smart meter data			Constant collection of total energy consumption data for the building

The conclusions and future work (section 6) finish the report and summarise all the findings of this deliverable linking it with future actions to expand the types of organisations cover in the current report to complete the recommendations provided and the types of data analysed.

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4 Data and information sources

Data governance is the process of managing the availability, usability, integrity and security of the data in enterprise systems. It matters because within one organisation each team will tend to work independently without common storing and naming protocols, leading to data inconsistencies and even errors and data loses. The aim of data governance is to ensure that all of an organisation's data can be combined without risk of loses or errors. It also covers data security aspects that are beyond the scope of the current report.

This document plots the course to achieving data governance for the three main organisations defined by the EN-TRACK project (in D3.2). The course for each organisation depends on the objectives it sets and the availability of technical and human resources, and assumes that the technical and human resources can be acquired, installed and trained as required.

The data sources[1] covered here are those collected by the building owners and operators. The data sources can be in all forms, but most of them are currently digitalised and stored in pdf or excel-like files, they include:

- building data (surface, insulation, working hours, location, etc.),
- building installations (illumination type, heating and cooling equipment, etc.),
- energy invoices, energy consumption data, maintenance actions and monitoring data

4.1 Information types, sources and use

The decision making process that leads to the implementation of energy efficiency measures (EEM) requires several sources of information that range from financial parameters, such as cost of the energy, to building properties, such as overall surface.

The information required to manage buildings from the energetic perspective and plan for energy related investments has been summarised in Table 2. The five categories of information are Energy consumption, Energy cost, Building properties, Energy audits and EPC, and Energy efficiency measures (see D3.2 for more extensive explanations of how this information has been collected and what the relevant interconnections are).

[1] The data information types and sources handled by EN-TRACK are already well-defined in project deliverables D1.3-D3.2 and D6.1. For example, See D3.2 for detailed descriptions and D6.1 for examples of data sources ranging from energy bills to energy accounting platforms.

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Table 2: Summary of information types, sources and tools used to gather the information. Source: D3.2 (public)

Information	Source	Tools used
Energy consumption	1- Energy invoices 2- Real energy consumption based on smart meter data 3- Real energy consumption based on monitoring system	1- Energy invoices/Energy accounting software 2- Building's smart meter 3- Monitoring system (usually with visualisation and analysis platform)
Energy cost	Energy invoices	1- Energy invoices recorded in excel-like software 2- Energy accounting software (examples: Gemweb/SIE/EBO)
Building properties	1- Energy accounting software 2- Corporative building database 3- Cadastral information	1- Energy accounting tool building repository 2- Excel-like files/building database 3- Cadastral information in excel, xml files.
Energy audits and EPC	1- User collected information 2- Building EPC 3- Energy audit	1- Excel file and corporative database 2- Excel file/EPC tool 3- Excel file/Energy audit tool
Energy efficiency measures	1- EEM information registered by Energy Managers, manually 2- Extracted from maintenance actions/software 3- Extracted from tendering or accounting software	1 -Excel file 2- Maintenance software (example GMAO) 3- Accounting system

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5 Scenarios and recommendations

This chapter proposes recommendations to achieve data governance at each level, starting with a brief description of each scenario followed by their recommendations. The recommendations are cumulative from one level to the next and, in combination provide a roadmap for improved energy management through good data governance. The highest level scenarios assume that organisations have implemented the basic level protocols and procedures. In line with EN-TRACK's aim of promoting energy efficiency investment, all this work focusses on building data, energy data (cost and consumption) and energy efficiency measures (EEM) data.

The organisational levels described in D3.2 (summarised in appendix A) began with the organisations that did not engage with the energy information to inform their behaviour (previously described as Basic level organisations) and expanded with the organisations that started to combine data sources (previously described as Middle level organisations) and finally monitor their whole organisation energy consumption (previously described as Advanced level organisations). The reason for differentiating these types of organisations was based on how they approached their energy information (basic and the rest), and how they gathered the information (monitoring, data collection and management software).

In order to organise any organisation three organisation types were defined and characterised (see D3.2 and appendix A) and are illustrated in Figure 1 below. This is followed by Table 3 which expands on data collection, data holders and data processing aspects, highlighting the additional data types that start to be collected as an organisation moves to a higher level.

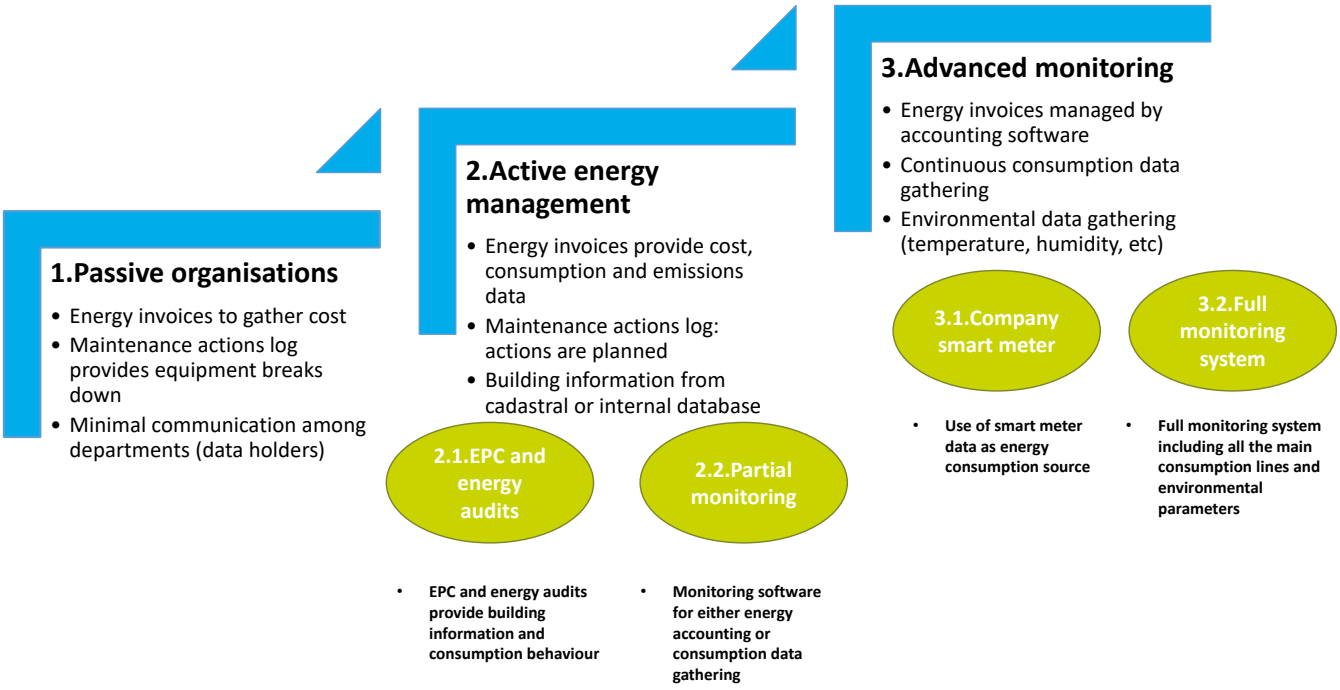

Figure 1: Archetype of organisations main with main data sources.

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Table 3: Summary of Data collected, Data holders and main Data processing of each archetype of organisation.

	Data collection	Data holders	Data processing
Passive organisations	1-Energy invoices (cost and consumption) 2-Maintenance actions log	1-Accounting and Legal department 2-Maintenance department	1-Collection of energy cost and consumption data in excel files 2-Collection of energy efficiency actions within maintenance log
Active energy management	1-Energy invoices (cost, consumption and emissions) 2-Maintenance actions log 3-Building information and location 4-EPC and energy audits data	1-Accounting and Legal department 2-Maintenance department 3-Energy management obtains cadastral information 4-Energy management	1-Energy invoice received by accounting department (cost) and share with energy management for consumption (kWh) and CO2 data in excel files 2-Energy efficiency actions carried out based on planning and maintenance, information shared with energy management by maintenance team 3-Energy management collects all data to create a single database, from cadastral database and internal building database 4-Energy management compares use and design of buildings 1-2-3-4-Energy management creates common database of all information
Advanced monitoring	1-Energy invoices (cost, consumption and emissions) 2-Maintenance actions log 3-Building information and location 4-EPC and energy audits data 5-Energy consumption monitoring 6-Building monitoring	1-Accounting and Legal department 2-Maintenance department 3-4-5-6-Energy management	1-Energy accounting software provides both accounting and energy management with detailed cost, consumption and emissions data 5-Energy monitoring provides large quantities of data managed by a platform 6-Building monitoring data provides environmental data for comfort conditions (temperature, humidity, etc) shared with building management to handle occupants comfort.

Each of the three organisation types is summarised below along with a series of step-by-step recommendations for each, on the road towards functional data governance organised starting with the most effective, widespread actions and working down to more precision, niche type, actions.

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5.1 Passive organisations

Passive organisations carry out only very minor data gathering, usually as a by-product of their daily operations. Their focus is on the cost of energy use, invoice payment and day-to-day buildings maintenance. They do not dedicate resources to active energy management and planning. Any data control is generally limited to periodic checking of energy cost to identify trends and ensure that the costs are within reasonable and expected limits. Another data type comes from maintenance registers, for example, equipment failure, repair or replacement. In most cases this inevitably leads to replacement by more efficient technologies that can effectively be classed as energy efficiency measures (EEM).

Passive organisations are identified by the following characteristics:

- Energy invoices used for cost information, the energy consumption data is a by-product
- Energy efficiency measures can be found in maintenance logs, and are due to equipment replacements and/or upgrades and/or modernisation
- Lack of communication among the different departments of the company
- The main departments involved with energy information are accounting and maintenance

5.1.1 Recommendations for Passive organisations

The lack of a structure to collect the information and share it among the different departments is the main limitation to take a more active energy management approach. Therefore, **main recommendations at this stage are focus on establishing communication among the different departments** (information holders) and **preparing the workforce to be able to identify and manage the information** (processing and storage of the information). These two steps are pre-requisites for the future changes needed for improved building energy management and more refined use of data enabling advanced energy management. The following actions will ease the transition towards higher data energy management and integration and also save time and money.

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A. Workforce training

Context: Administrative staff are typically those who handle energy and maintenance invoices and the management of this data is limited to record it in the financial system. They do not have any training (or logical interest) in the technical (non-financial) aspects of the data and therefore cannot be expected to know which data is the relevant or how to ensure that it is recorded correctly and accurately.

Training must include all types of data and involve staff beyond general administrative to ensure that everyone that manages energy related information is aware of it and can identify it. This case is less important for the financial data since it is usually the most audited and over checked information of any organisation. Awareness is a key aspect since the recording of the right data will inform the capabilities to perform more advanced analysis and use of platform such as EN-TRACK.

B. Organisational changes

A change in approach is needed. Responsibility needs to be assigned for each data type or source (data stewards). Data stewards are trained and made responsible for keeping the information in order, ensuring it is properly collected, and periodically updating the information in line with the standards adopted by the organisation. The next logical step is for them to become responsible for exchanging information with other departments and participating in the organisation's transformation towards higher tiers of data management (towards a more active energy and data management approach). In the future, these data stewards will become the core of the data governance team, managing the data of the organisation.

5.2 Active energy management organisations

In active energy management organisations, several departments of the company, ranging from accounting to maintenance, are involved in providing energy related data. The information types expand to include energy data (consumption and cost), building properties and EEM information. These sources of information are all used in combination for the day-to-day management of the buildings and the planning of future actions. These actions include pro-active energy efficiency investments that go beyond upgrades as a result of repair and replacement of equipment. The information is used to analyse energy use in buildings, normalising the data using building properties to track energy performance and even compare energy use across groups of buildings. The information gathered and the generated results can be used by more than one department for different purposes, ranging from energy cost control to finance and forecasting of economic returns of proposed energy efficiency investments and management scenarios.

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Active energy management organisations can be further divided in sub-groups when expanded sources of information are used, such as EPC and energy audits, or a partial monitoring system is installed.
The first sub-group use the information gathered with the EPC or the energy audits to reach different depth of knowledge about the buildings, and their expected behaviour along a typical year (building use, climate conditions, and equipment staying as assumed). The theoretical knowledge about the building then can be compared with the actual consumption of the building (invoices or real consumption of the whole year) to compare use and design.

The second sub-group start implementing digital monitoring tools, either for the accounting or for the energy consumption. These organisations have access to tools that allow them to manage both the invoices and the associated energy consumption or just the energy consumption and facilitate the data logging and storage processes. These organisations are actively collecting data which will create several files and databases by each different department. All these data will have aspects in common, it may even be the same data obtained from two different sources. The challenge for these organisations will be to ensure that the data can be compared and used without having to invest lots of time and resources on preparing it.

They common identifiable characteristics of active energy management organisations are:

- Energy invoices are used to gather energy cost, consumption and associated CO_2 emissions
- Energy efficiency measures are planned based on targets for energy and CO_2 savings.
- Expanded sources of information include building information from cadastral and internal database
- The main departments involved with energy information are energy management, maintenance and accounting and legal.

Each of the above described sub-groups can be identified for the use of:

- EPC and energy audits as building information sources
- Monitoring software for either energy accounting or consumption data gathering

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5.2.1 Recommendations for Active energy management organisations

Active organisations must all **face the challenge of starting to organise large quantities of stored data and interconnect it to support and facilitate decision making**. The recommendations, below, focus on meeting this challenge and achieving a smooth transition to data integration and the implementation of energy efficiency measures. The recommendations address the need to **connect the data with common identifiers and labels to ensure that all types of information**, whether recorded manually or automatically, **gets stored and marked properly for later use**. These recommendations apply to all levels of organisations but are particularly important when managing large quantities of information from several sources. Examples of real databases types are provided in a summarised version in Appendix A.

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C. Common identifier: building ID – use alphanumeric codes (avoid names)
Defining a common identifier system is essential for any organisation to ensure data integrity and interconnections. It requires an initial effort to coordinate all the departments of an organisation by agreeing on a common identifier system. In the case of a platform to promote energy efficiency savings the building will be the pivot point of all the data. Therefore, the common identifier is the Building ID. **Using a building ID as the identifier ensures that all the information is linked to the right building.** There are few considerations to take into account when defining the type of building ID to use. As a general rule, when defining a building ID system, **using numbers or an alphanumerical combination minimises the risk of duplicating a building within an organisation.** There is also a lower chance of common writing mistakes (such as typos) and different users will not change the ID based on their writing habits (as can happen with names). A numeric or alphanumerical combination does also provide flexibility to create sub-building ID's just by adding letters and numbers to define rooms or sections of a building, such as 00598.R54, or 00598.001.
Building ID examples: 00598, Sub-buildings: 00598.R54, or 00598.001
The previous consideration is important because using names as building ID is a common practice in municipalities and small organisations that have a low chance of repeating the names and therefore to wrongly assign the data. However, **the use of a name as building ID will become a challenge to manage** for several factors, some affect any organisation and other have a pronounced affect for larger organisations. At any level **the use of a name will be a source of errors** due to writing typos or common mistakes (misplacements of letters, blank spaces, punctuation, missing accents, etc.). There is a high chance that every user will write the name on a slightly different way making impossible the association among databases of the same building. These kind of errors will probably increase when using languages with a higher array of accents, and punctuation rules such as Catalan and French. One example of a common name: Casal d'en Martí (correct one) / Casal d'en Martí (it has an extra blank space) / Casal d'en Marti (missing an accent, which is a common error) At a higher level of organisation, supramunicipal companies or public entities, the use of names as a building ID may lead to confusion when comparing data from several sources, it can lead to several building with the same name, usually relevant characters or places of a given country or culture. The similarities of the given names will prevent the proper use of the data by mixing the data of different buildings, requiring lots of time to entangle and clean for a later use.
Prone to error ID examples (names): Casal d'en Martí (correct one) / Casal d'en Martí (it has an extra blank space) / Casal d'en Marti (missing an accent, which is a common error)

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D. Combining databases of different organisations: considerations for the common ID

The use of a numerical identifier for buildings, such as the one described above, can lead to challenges when combining database with other organisations that used the same methodology. Because there may be a series of similar ID's between the different organisation. The simplest way of solving this problem is to use the above rule to define a unique identifier for each organisation, probably a combination of a few letters.

For example: we have two different organisations that have 10 and 16 buildings respectively. Their building ID system start both at 01 up to 10 or 16, meaning that both may have problems when combining their databases because there will be overlap of IDs. To prevent the overlap both agree to add "-A" or "-B" to their buildings for the first and second organisations, respectively. The addition of this extra mark turns each building ID into a unique feature again allowing to combine both databases without any risk.

This problem does not occur on EN-TRACK since the system assigns an internal unique ID to each new building, then when combining the two databases EN-TRACK could just display the internal ID to prevent overlap.

Examples of ID combinations:

Original ID 016 for 2 organisations.

Differentiated ID: 016-A, 016-B

E. Energy audits (and EPC) data labelling

Energy audits (and EPC in a minor scale) provide large quantities of detailed information about a building, its energy systems and the expected energy consumption based on the information and past consumptions. These large sets of data must be stored using an identification system to ensure that they relate to the correct building, which is essential when comparing different buildings to prioritize actions to pursue.

The information collected can also be divided between facts, assumption and proposals. The facts are the equipment of the buildings, its properties (openings and walls) and the past consumption (with the cost and emissions). The assumptions are the forecasted behaviour of the building and the associated consumption. The proposals are guiding examples (not all will be used and some will use equivalent equipment not the specified ones) of the actions to take to reduce the impacts of the building, reducing the energy consumption, shifting towards renewable energies and behaviour changes of the occupants. The proposals are provided with estimated cost and savings. The three types of information must be labelled (and specify the type of information) and ideally stored in different linked files to ensure that third parties using the information (and not well versed on the differences) within and outside the same organisation, due not use assumptions and proposals as current facts of a building.

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5.3 Advanced energy management organisations

Advanced energy management organisations use multiple sources of information and, in most cases, advanced digitalised tools to gather, process, analyse and display building, energy and financial data. The active acquisition of data allows them to compare use and design of the building based on actual readings of energy consumption. These organisations can be grouped by the information gathering method they use. The first sub-group use the company smart meter to provide the building energy consumption from which they then extract an overall behaviour and patterns. Once the information has been gathered, it can be used in the same way as described above for all the advanced level organisations. The second sub-group have a complete monitoring system, integrated with the rest of the energy management platforms, to provide all the data required to the energy management department.

The common characteristics of **advanced energy management organisations** are:

- Energy invoices are managed by accounting software which provides energy cost, consumption and associated CO_2 emissions
- Gathered energy consumption data can guide maintenance actions (detection of equipment malfunction and degradation)
- Energy efficiency measures are planned, analysed and evaluated based on targets for energy and CO_2 savings using the gathered data
- Building information data can be updated overtime and analysed based on real consumption (EPC data compared with actual behaviour of the building)
- The main departments involved with energy information are energy management, maintenance and Accounting and legal.

Each of the above described sub-groups can be identified for the use of:

- Use of smart meter data as energy consumption source
- Full monitoring system covering all the main consumption lines

When the smart meter is the only data source for energy consumption (first sub-group) only hourly data of the buildings (as a single point of data gathering) is available. This is a limitation to more precise analysis of the building sections or installations. The consumption differentiation has to come from assumptions and AI analysis, for example by comparing the consumption of a building with different weather conditions to differentiate the building with and without cooling.

The use of a full monitoring system (second sub-group) overcomes the limitations described above by providing more data points with extra measuring devices. The measuring system can detect changes in consumption at any circuit (illumination, HVAC,

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equipment, EV chargers, etc.) with a higher degree of precision and less uncertainty because the detection is directly based on measurement instead of inferred from consumption patterns or indirect assumptions. The detailed knowledge, combined with the rest of sources of information, allows baselines to be established for each measurement device, and savings due to EEM actions to be measured, forecast, calculated, monitored, etc. The monitoring can expand beyond energy consumption to include, for example, temperature, indoor conditions such as CO_2 concentrations, building occupation, etc. The main limitation to this type of system is the amount of human resource that can be dedicated to analyse the data and propose EEI suited to the particularities of each building. If the organisations do not allocate sufficient human resources to the task, the amount of data received could overwhelm them and render the monitoring system ineffective in comparison with the simpler, smart meter based, approach that is less data intensive and requires less detailed information.

All these organisations are implementing advanced digital tools to collect, combine and analyse the information, to finally process it all using algorithms to establish baselines, perform building benchmarking based on multiple criteria and detect outliers to focus on. The advanced energy management organisations level is the one that is expanding along with the project since some of the functionalities are in constant development, being EN-TRACK one of the initiatives working on them.

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5.3.1 Recommendations for Advanced energy management organisations

F. Data loggers identifiers
Identification of data sources when using several data logging systems. When using a full monitoring systems each main equipment of a building has a sensor assigned to ensure clear control of the data obtained. Because of the large quantities of sensors lots of data will be collected for each building of the organisation, requiring a robust ID system to ensure that the data is properly stored and assigned to the right buildings, and sub-sections or equipment. The identification follows a similar pattern as the one described for the building ID approach. First the building ID is used to identify the building, then extra identifiers are defined for each sensor, ideally by typology of sensor (HVAC, lighting, humidity, etc). The last step is to define for each building a mapping system (a legend for future references) referring to each of the sensors, what it does measure and where are they located (both within the system and physically in the building). Verification of the measurements is needed during the set-up of the system to ensure that all the readings are reliable and that the selected lines do not contain unexpected signals.
Example: Building with ID 015 has several sensors of two typologies, energy consumption and temperature, one of each per floor of the building. The ID for each sensor should be 015.E0 and 015.T0. Building ID + type identifier (E for energy or T for temperature) + a number for the floor (0 for ground floor).
The use of smart meter data (single points of consumption) requires clear identification of the data sources collected for each building, ensuring that all the energy consumption data (especially electricity and natural gas) are collected for the building. The challenge is that large buildings that have multiple consumption points which all need to be properly registered to enable correct monitoring of the building, or groups of buildings, and ensure that information is not lost. The loss of information will lead to miscalculations.

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G. Use of support software: the case of maintenance software

All organisations use additional software to manage their day-to-day activities, some of which will provide additional information that could be helpful for the energy management. The example below shows the case of the maintenance software and the information that can be obtained (search for similar useful software not available on release of this document)

The maintenance software (such as GMAO) is usually used to log all the maintenance tasks carried out. The log typically records the type of action carried out, the problem solved and the solution applied. However, as this kind of software tends to be external from the main organisation, the maintenance team has to use the previously defined common ID to ensure interoperability of the data.

Also, these types of software do not normally include options to highlight sustainability or energy efficiency actions, beyond the name or comments section. This lack of differentiation leads to data loses that are either missed or require time-intensive recovery from the whole maintenance actions log. Providing the option to highlight or flag actions will simplify data collection for energy managers, as well as, providing the savings calculation algorithms with all the information, reducing the risk of affecting the savings estimations.

5.4 Recommended order of actions

The following Figure 2 shows the order in which the recommended actions should be applied to ensure a smooth access to the data of an organisation.

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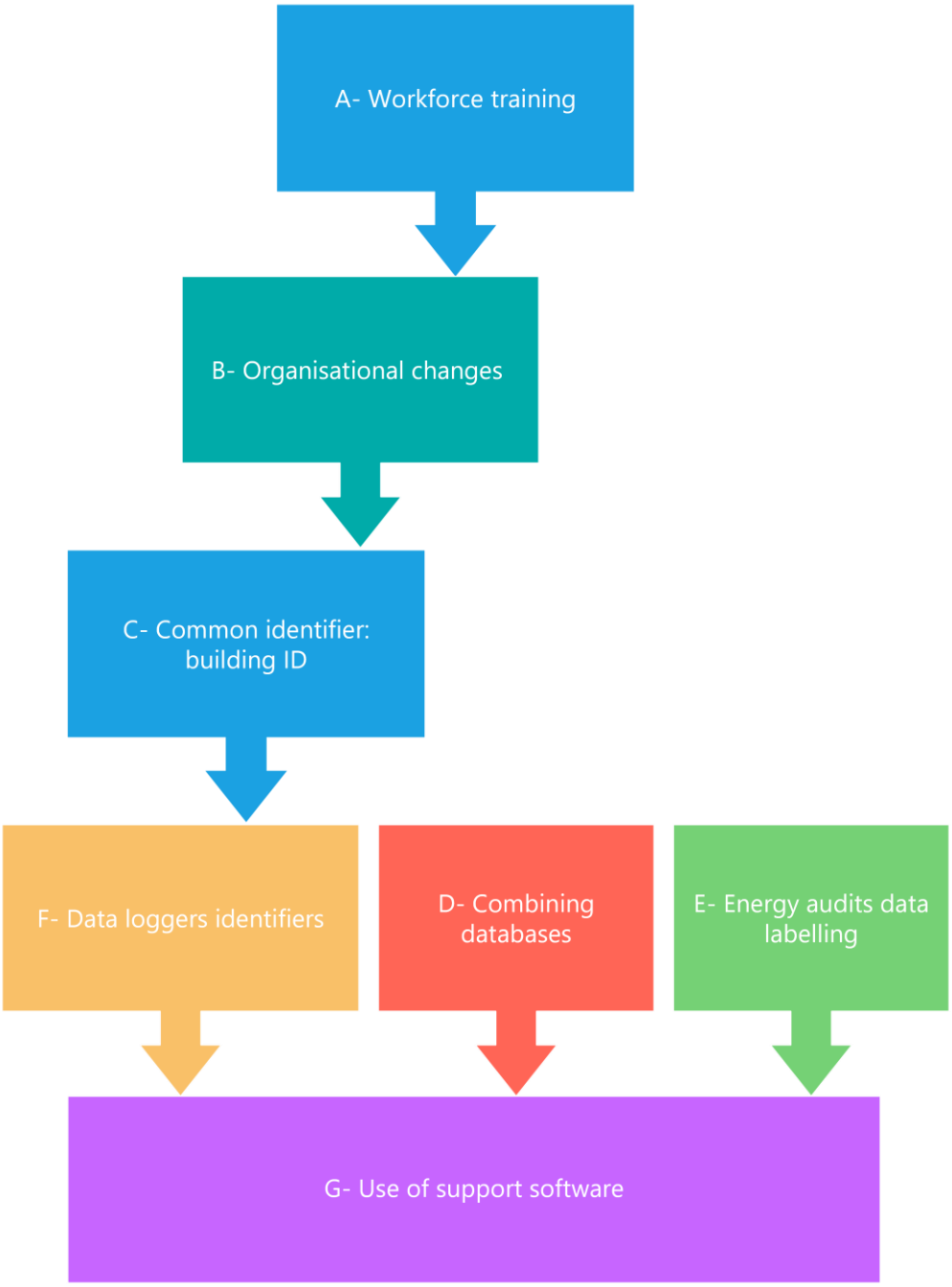

Figure 2: Proposed order to implement the recommended actions.

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6 Conclusions and Future Work

The analysis documented here is based on the EN-TRACK project pilots (D3.2) that included a wide range of public institutions, from municipalities to regional government, including small and large public companies. This breath of organisations analysed has given the analysis robustness, ensured that the basic archetypes are representative and provides confidence that the data governance recommendations made here are widely relevant and applicable. The organisations analysed ranged from small institutions to large supra-municipal public entities that cover a wide range of locations and even climate zones (leading to different building requirements and equipment).

The key conclusions that can be drawn from the analysis are:

- In general, most organisations lack sufficient planning when preparing their databases and, as a result, these databases tend not to be designed to be interconnectable. For example, they tend to lack identifiers that easily facilitate the data use and connection.
- As an inevitable consequence of this lack of foresight, human resources need to be invested on both for the data gathering and identification and the management of the databases.
- This kind of challenge is increased when using automatic data gathering systems such as smart meter or full monitoring systems. The more advanced the system, the higher the level of precision required to fully exploit the potential of the system itself and obtain a clear picture of all the buildings. Rising to the challenge of using advanced data gathering systems and precise designations of the system components will ensure that the data received is from the correct equipment, recorded accurately and identified rigorously thus enabling better insights, conclusions and decisions.
- Therefore the key recommendations provide methods and examples into how defining common identifiers to properly handle the databases to ensure interoperability and prevent data loses.

The findings covered in the report focus on the experience of adapting the pilots' databases to be uploaded and use with EN-TRACK, providing real situations as learning examples, but with the risk of centring it on the encountered challenges.

The learnings reported are of use to any organisation because they lay the groundwork for any data governance plan. They are based on the experiences gathered from pilots with extensive experience with, and knowledge about, their data and data governance. They provide the essential steps to take for any organisation aiming to use its data for managing their energy behaviour. The pilots involved have greatly improved their data handling capabilities as a result of collaboration with the EN-TRACK project. In the case of the Catalan Institute of Energy (ICAEN), the recommendations are already being applied to its databases to improve them and smoothen the data upload process into the EN-TRACK platform.

Future work will involve expanding the data governance analysis to include news types of datasets and organisations encountered with the expansion and adoption of EN-

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TRACK by a myriad of new organisations. The expanded analysis will include experiences from private-sector enterprises and sectors such industry and hospitality.

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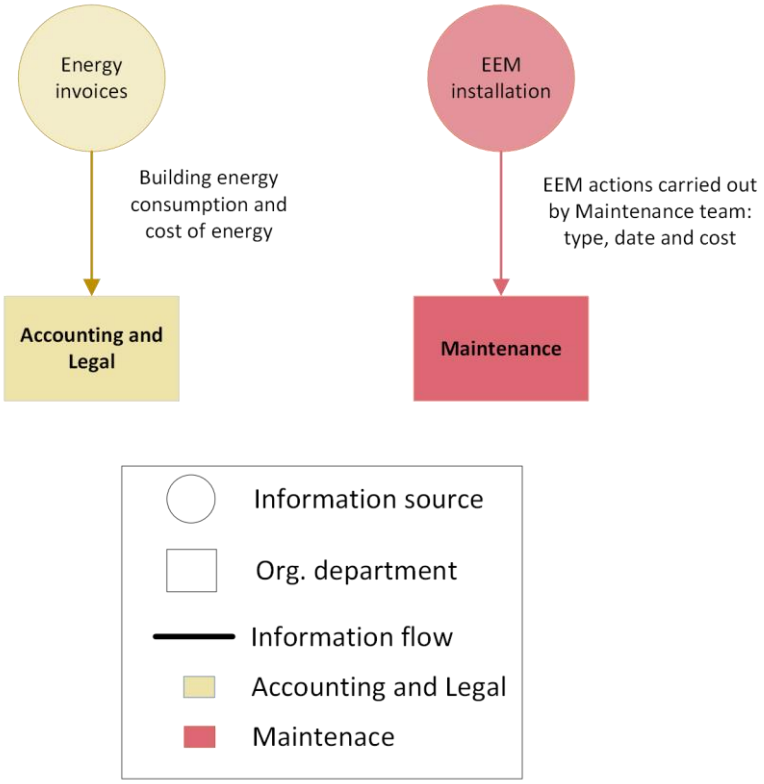
7 Appendix

Data flows within archetypes of organisations, figures from D3.2

1. Basic level organisations



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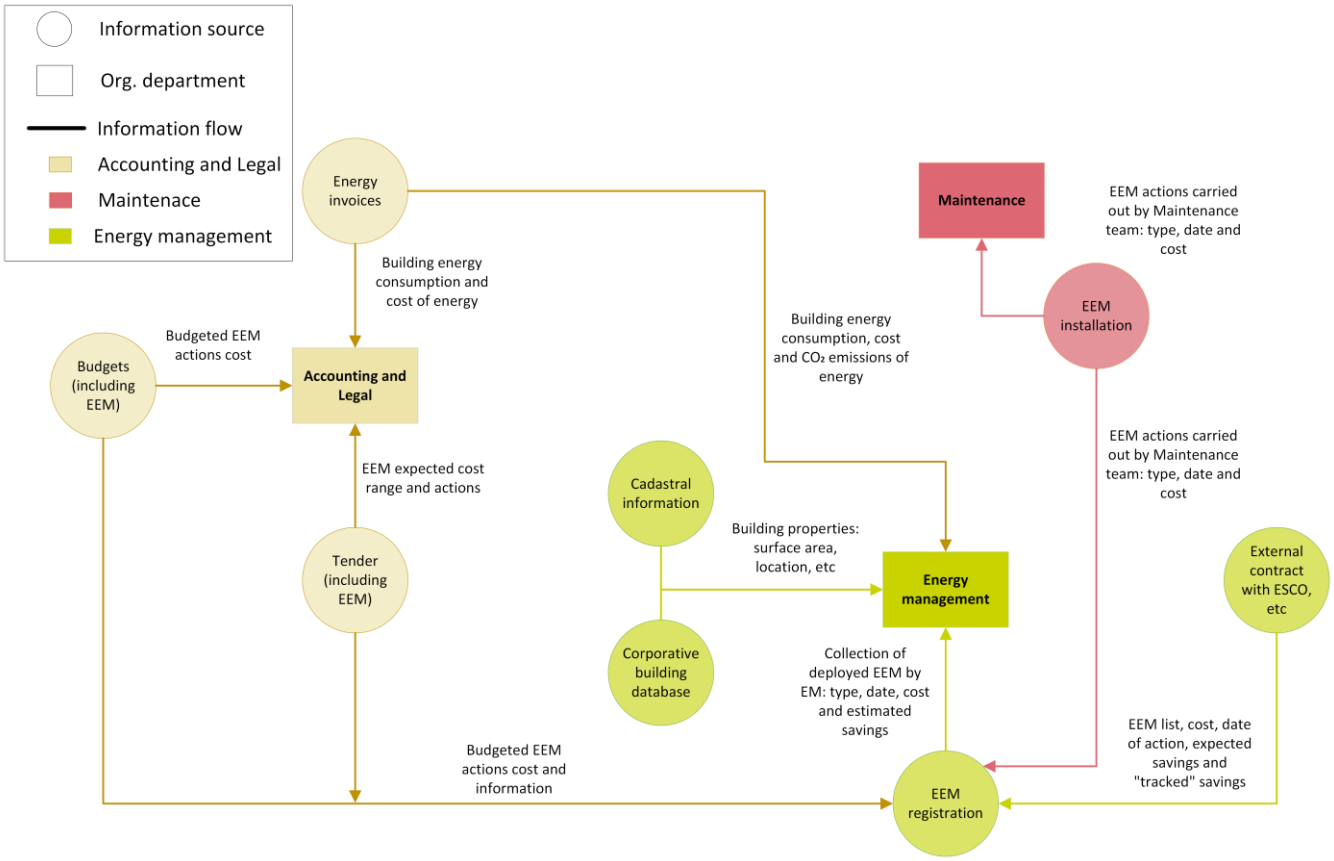
2. Middle level organisations



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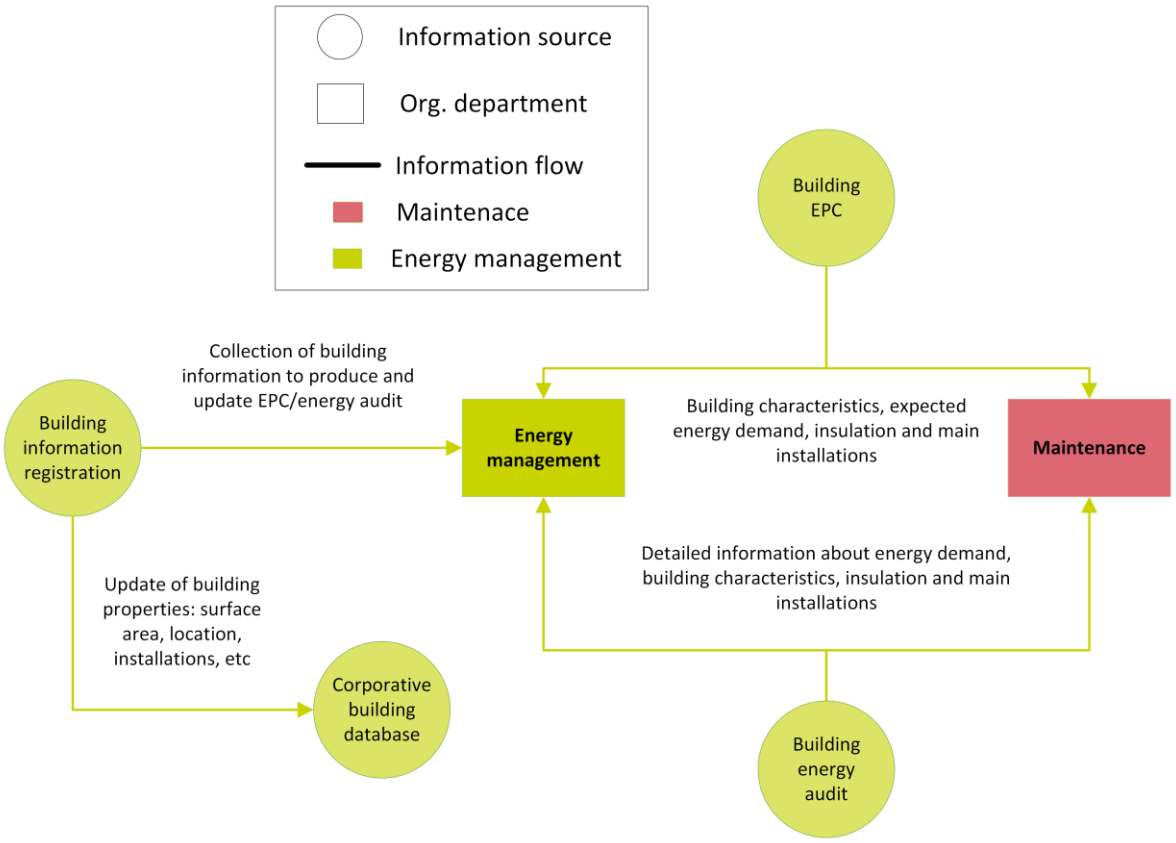
2.1. EPC and energy audits organisations



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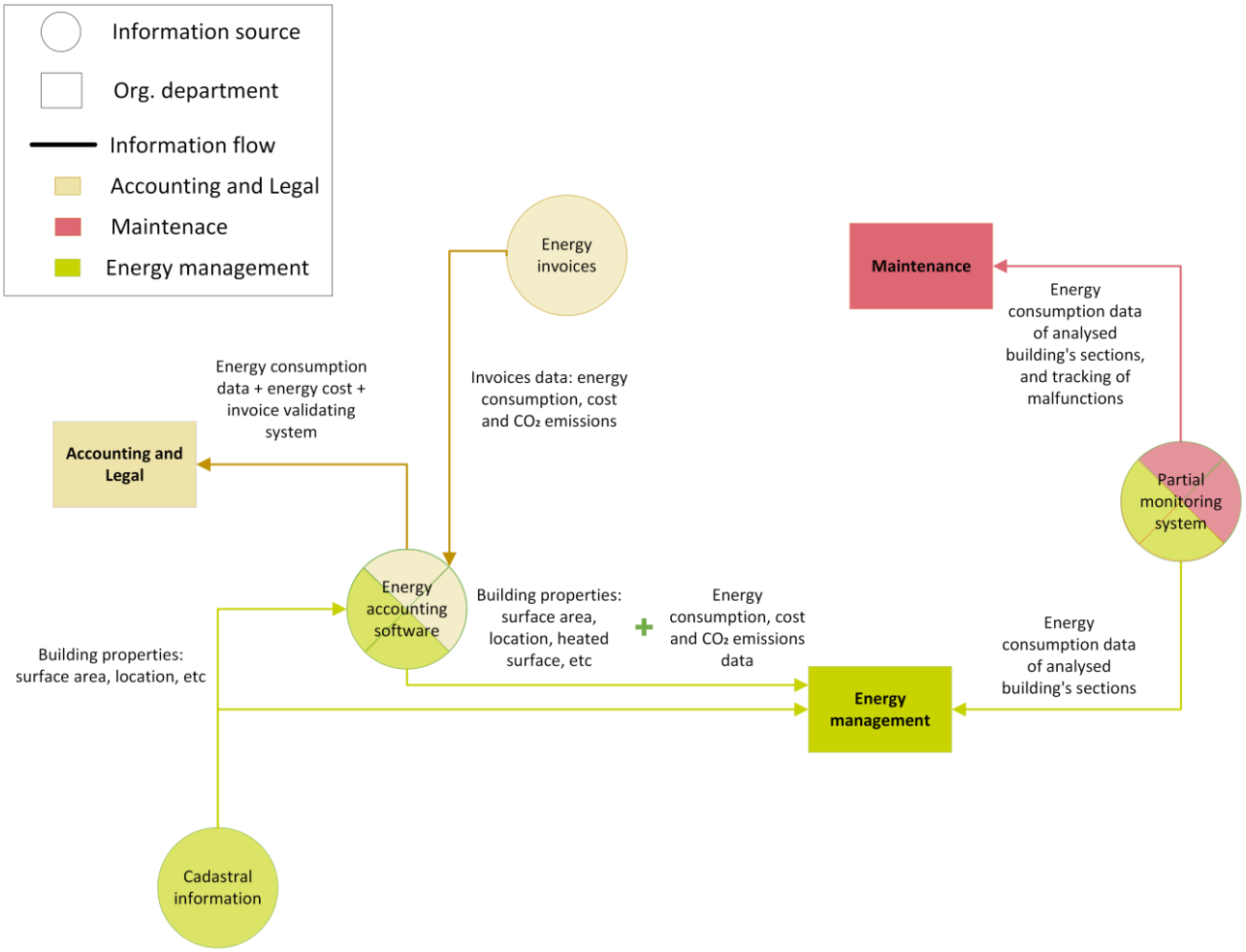
2.2. Partial monitoring organisations



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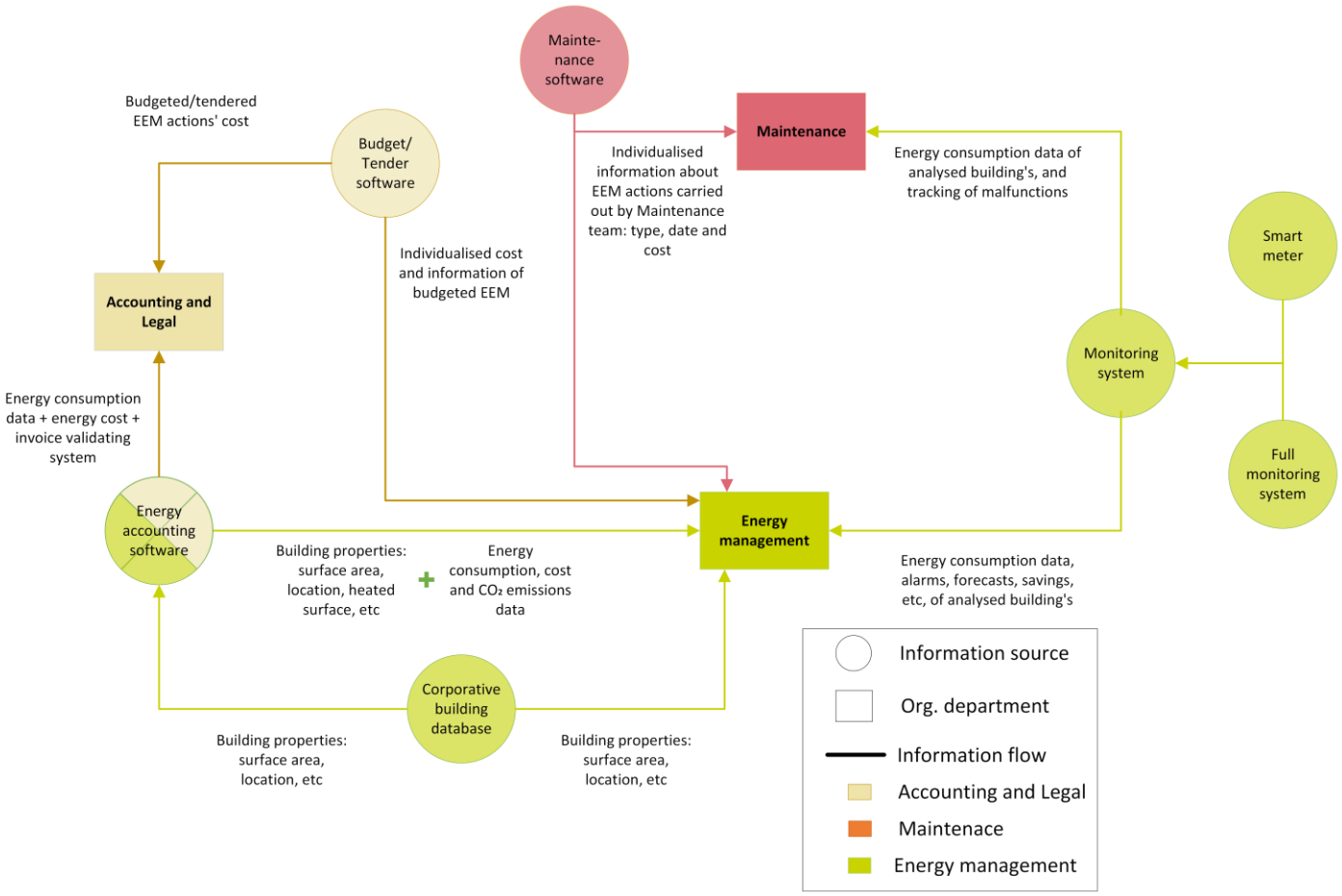
3. Advanced level organisations



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Examples of tables for reference: Building ID

The tables below are extracts of actual tables used to feed information to the EN-TRACK platform. The current system to link both tables would be to use the Building ID as a common reference point.

Building database table

Building ID	Building ID extended	Municipality	Street/Road	Street number	Postal code	Name of Building
00059	00059	Anywhere	Main road	329	BA7DGT	Farmers association
0065	0065.DX	Barcelona	Old square	14	9567A	Old square Clinic

EPC table

Building ID	Building surface (m^2)	HVAC equipment	Building global qualification energy	Building global emissions factor
00059	2000	Heat pump	D	C
0065	3500	Heat pump	F	F

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