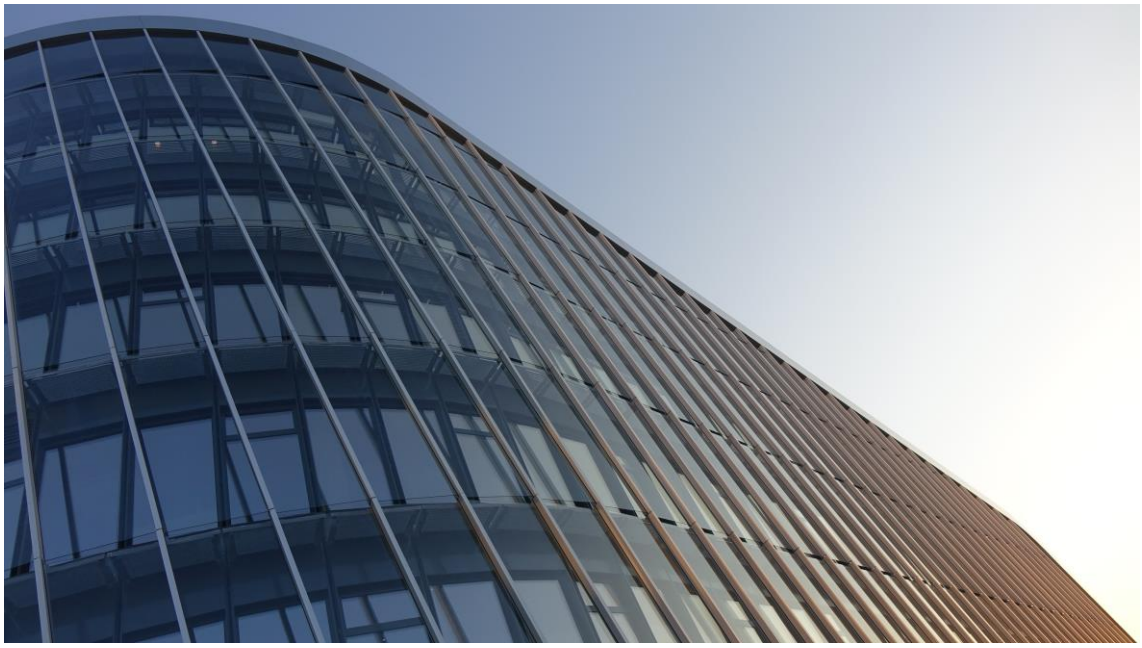
Energy Efficiency Performance-Tracking Platform for Benchmarking Savings and Investments in Buildings

Current building data management practices report



This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 885395

Deliverable nº:	**D3.2**
Deliverable name:	**Current building data management practices report**
Version:	**Final document**
Release date:	**30/06/2022**
Dissemination level:	**Public report**
Status:	**Submitted**
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This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 885395

Document history:

Version	Date of issue	Content and changes	Edited by
0.2	13/06/2022	First draft version	Oriol Escursell Jové
0.8	17/06/2022	Second draft version	Oriol Escursell Jové
0.9	20/06/2022	Third draft version	Oriol Escursell Jové
0.9	21/06/2022	Third draft version	Stanislav Andreev
1	28/06/2022	Final version	Oriol Escursell Jové

Peer reviewed by:

Partner	Reviewer
DTES	Mònica Pascual Fabra
Subcontractor (CIMNE)	Mike Barker (23/06/22)

Deliverable beneficiaries:

WP / Task / Deliverable
WP3 task 3.3
WP6 all task

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Abbreviations and Acronyms

Acronym	Description
EEM	Energy Efficiency Measures
BEPC	Building Energy Performance **Certificate**
EPC	Energy Performance **certificate**
EEI	Energy Efficiency Investment
EM	Energy manager
EM	Energy management department

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1 Executive summary

EN-TRACK, which stands for *Energy Efficiency Performance-Tracking Platform for Benchmarking Savings and Investments in Buildings*, is a critical and timely project that seeks to address key barriers holding back greater investments in building energy efficiency. The core objectives of the project, which is funded through the European Union (EU) Horizon 2020 research and innovation programme under grant agreement number 885395, are to:

- enable massive gathering of data on the energy performance of buildings before-and-after the application of energy efficiency measures;
- create a continuous data collection process through structured engagement with stakeholders;
- adopt standard data descriptions that align with current international standards and existing data platforms, notably the De-Risking Energy Efficiency Platform (DEEP); and,
- create a self-sustaining solution that continues to be viable after the completion of the project in 2023.

This report provides an up-to-date review and analysis of current data management practices of energy, financial and building data used for the day-to-day building management. This information has been obtained via structured conversations and surveys with some of the major potential users of the system. The value of the report is the insight it contains, from users about their data management practices, that will contribute to the design of the templates and guiding material related to data governance that will be produced in the next deliverable of work package three (D3.3).

Following a brief background and introduction, the report explains the information gathering methods and describes the surveys performed. The survey responses came from a wide range of professions ranging from energy managers and maintenance to accounting and financiers from the target institutions in both countries. Altogether, the responses represent a significant number of buildings (around 4000) and thus provide a relevant reference in terms of current data management practices.

The main section of the report focuses on the identified organisation archetypes, based on their data management practices. The main focus is on their energy, building and financial data to help with building management and decision making. The archetypes can be divided into three main groups and four subgroups. The basic level organisations are those that, although they do have some information about energy consumption and cost, do not take action based on it, and that do not share any information among the different departments. The middle level organisations are those that start to use the information sources to track the building evolution, normalise the energy data with building properties to compare different buildings and that share information among different departments of their organisation. The advanced level organisations are those that use the information to act, start implementing advanced monitoring equipment that facilitate the modelling of the building to create baselines and future consumption forecast.

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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 has an ambitious yet timely objective 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 achieve the aims of the project, the platform has to be useful and appealing to buildings owners and managers, because they are the ones that have access to the building and energy consumption data. The creation of the platform has to be influenced and shaped by the users themselves if the platform is to have an active user base willing to entrust their data. 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 they are managed? and who needs access to what? The work documented here has identified the main relevant sources of information required for the day-to-day operations of any organisation, the ones required for the planning of future energy efficiency actions to implement, as well as, the required to finance the future energy actions.

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3 Introduction

This report identifies the current building data management practices and defines archetypes of organisations based on them. It focuses on the energy, building and necessary financial data to manage the building and plan for energy efficiency investments. The requirements of D3.2, defined in the EN-TRACK Grant Agreement, are as follow:

- Define archetypes of organisations based on their data management practices: where the data is within each organisation, who has the data and how is the data stored.
- Focus on the information required to perform evaluation of energy efficiency investments (in line with the EN-TRACK project objectives).
- The work focuses primarily on public administrations from municipalities to public companies.

The main objective of the report is to understand the current data management practices for EN-TRACK to be able to use all the different sources of information. The results will also be used in D3.3 to define a common methodology for any organisation to collect the necessary data to feed the EN-TRACK system, as well as, to reach the desired level of data governance within any organisation.

The report is divided in two main sections covering data gathering (section 4) and current building data management practices (section 5).

The data gathering section (section 4) explains how the data for the report has been obtained using surveys, and which were the main findings in each of the different organisations. The range of organisations includes Bulgarian municipalities, Catalan (Spain) government departments and public companies.

The current building data management practices section (section 5) covers the results obtained by defining the organisations archetypes divided into three main groups and four subgroups. The section starts by explaining the general organisation archetypes (5.1) identified. Then each of the organisation archetypes are defined in more detail including an explanation of the sources of information used and the interactions among them, starting from the basic level (5.1.1), followed by the middle (5.1.2) and finally the advanced level (5.1.3).

The basic level organisations are the ones that, even though they have sources of information, do not take action based on this information. The middle level organisations are the ones that start to use the information sources to track the building evolution and do share information among the different departments. The advanced level organisations that implement advanced monitoring equipment coupled with data modelling software to create building baselines and estimate savings.

The conclusions and future work (section 6) finish the report and summarise all the findings of this deliverable linking it with the final deliverable of work package 3 (D3.3).

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4 Information gathering: surveys and interviews

The EN-TRACK platform is being designed to encourage energy efficiency investments (EEI) by providing an interoperable ecosystem of data and tools supporting building energy management and refurbishment decision making. In order to do so, building owners, ranging from municipalities to public companies, have been engaged to understand how the data is currently managed within their organisations. The information sources considered include energy invoices (provide energy cost and consumption), energy certificates and audits, budgets for energy efficiency investments, databases with building properties such as the Cadastral database; among others.

This chapter describes the methods used to gather information as well as the profiles of the participants and the principal pilot scenarios.

4.1 The pilot organisations

The EN-TRACK project is divided among two different pilot sites, Bulgaria and Catalonia, that aim to cover a wide range of scenarios. The Bulgarian case focuses on municipalities that focus on meeting the day to day challenges of their citizens and have very limited additional capacity to analyse and manage the energy behaviour of their buildings. In contrast the Spanish case involving the Government of Catalonia and associated public companies, in addition to a similar day to day duty to citizens, also has the capacity to also focus on the energy management of public buildings due to the large size, scale and resources of the public administration. Another contrast is the greater penetration of monitoring systems and the almost complete coverage of smart meters in the Spain pilot. The smart meters enable access to hourly electricity consumption readings that can be used to manage and control the energy behaviour of those buildings much more precisely. For the Bulgarian case, the smart meter implementation is still under deployment, being already available for any consumption above 100 kW, which only represents a small share of municipal buildings.

4.1.1 Bulgarian municipalities

The main source of energy consumption information is the monthly energy invoice which provides cost and consumption information. It is available for all the municipalities. As schools and kindergartens have a delegated budget, in most cases, they purchase the energy they need themselves and are invoiced accordingly. In this case, some municipalities require cost information on a monthly basis from the building accounting team, others on an annual basis and others only on an as-needed basis. For the other municipal buildings, energy and fuel are purchased based on public procurement process and, depending on tender specifications, the supplier may be obliged to send copies of the invoices to both the respective payer (e.g. municipal companies) and to the municipal administration. In any case, energy consumption information is available on a monthly basis and whether or not it is collected and processed in a

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form suitable for subsequent analysis depends solely on the municipal management and the motivation of the relevant municipal officials

Beyond the energy information, buildings energy characteristics and implemented energy efficiency measures are analysed when developing the energy audits, which are mandatory for all public buildings with gross floor area over 250 m^2. Unfortunately, at this stage, not all public buildings have up-to-date energy audits, mostly due to the insufficient budget of municipalities. In this context it is relevant that the energy audit is a mandatory attribute when municipalities apply for funding to renovate municipal buildings.

The two main methods of collecting the information (when it is collected) are the use of MS Excel (MS Excel or similar software from here referred as Excel) tables or in rare occasions the use of the free online platform (https://municipalenergy.net/). This platform, developed in the MEMS project funded within the framework of the European Climate Initiative (EUKI) of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, automatically process the data and provides various reports and statistics both for the energy consumption and the buildings energy characteristics. Usually, the invoices are received in PDF format or on paper, in which cases a manual extraction of the data is needed for further processing of the energy information. Another useful source of information is the standardised Excel form, which is an integral part of the energy audit. From there, municipalities get useful and easy to process information about their buildings.

One of the main challenges for Bulgarian municipalities in the process of renovation of their building stock is the lack of effective energy management. Only through summarising and processing the energy data the local authorities can perform adequate energy planning and monitoring processes. Although some of the municipalities already have personnel dedicated to the collection of the information, in most cases they lack the resources to process such large amounts of data, since most of them do not have a dedicated energy manager. This lack of processing capabilities is one of the reasons why the required actions by the legislation Municipal Energy Efficiency Programmes are not implemented and, in most cases, quantified monitoring data of numerical indicators is lacking.

Another challenge detected is the rate of implementation of monitoring technologies that provide a source of continuous monitoring. Currently, hourly consumption information is only available for municipal buildings are connected to the electricity grid with a maximum capacity of more than 100 kW (as these are the only buildings equipped with smart meters). Unfortunately, even in this case, the hourly data is not available in real time and is only received monthly, along with the monthly invoice.

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4.1.2 Catalan government departments and public companies (Spain)

In the Catalan pilot, the energy invoice is still the main source of energy information for both energy consumption and cost. However, the digitalisation of the energy invoice combined with the smart meters enables the provision of hourly energy consumption in all of the buildings in addition to the invoice. The accounting team of each organisation manages the invoices. The information can then be used by the rest of the departments involved in building management to decide on future plans for energy efficiency improvements. Finally, the information is also used by the energy management team to design and implement both short and longer term actions. The energy consumption from smart meters can be accessed using the distributor company website or the combined website of all the distributing companies (Datadis). Another source of energy consumption are the monitoring systems that measure whole building and specific lines (HVAC, boilers, illumination, together and split by section of the building). These are present in over 200 of the buildings of the Catalan administration.

The building information can be accessed from three different sources that feed into each other. The first one is the cadastral database, which is external and provides building properties, surface area and location. The second one is the corporative database of the Catalan government that has the building properties, surface area, heated area, location, along with administrative information about which department or company is in charge of each building. The third source of building information are the EPC and energy audits, both of which provide similar information relating to building use, installations, properties and expected changes due to weather effects and. The energy audits provide a more detailed analysis than the EPC.

The information is collected using several methods depending on the source, consumption and billing information. In some cases specialised software is used to manage the information, in others, Excel files are used to store and analyse the information. SIE, Gemweb and EBO are the most commonly used specialised software (based on the participants' responses). The building energy information can be managed using the corporative database or with Excel files for building, EPC and energy audits. The EPC information has to be also collected using the dedicated software to generate them (CE3X, Hulc and others) that export the results in .xml files.

The main challenge detected, as in the case of the Bulgarian municipalities, is the struggle to handle and effectively use the vast amounts of information obtained. Increasing digitalisation has vastly increased the amount of information available to work with. However, this information is stored in numerous different proprietary systems that do not interconnect well. The need to individually extract each information and then used Excel to analyse it hampers the capability to properly analyse and take action on the results.

The analysis of the participants' roles and duties revealed that the energy manager role is still being deployed and, in several organisations, it does not exist as a sole role. As can be seen in Figure 1, the maintenance department (when the energy role does not exist), is often managing almost the same sources of information as the energy management department (where it does exist). The combination of both roles into the already existing maintenance department can be counter-productive because of the nature of both roles. The maintenance duties in most cases take priority over the future planning of energy efficiency measures, since maintenance takes care of present day needs (broken down equipment for example) that cannot be delayed. Therefore, the focus in maintenance actions can take resources from planning and executing an

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energy efficiency plan. An ideal situation is that of maintenance actions being coordinated with the energy efficiency planning to define the priorities for action for the whole organisation taking into account the available resources both human and financial to implement the actions and maintain them over time.

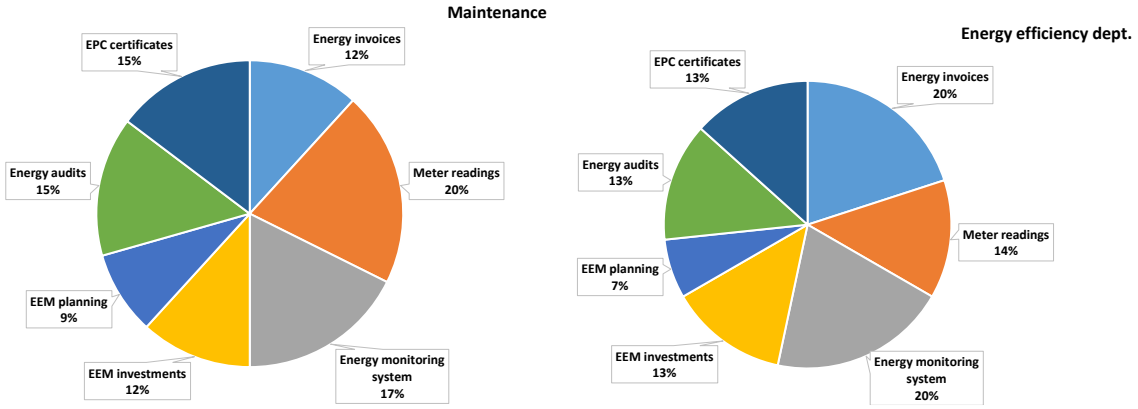

Figure 1: Department in charge of the different sources of information at the Catalan government, comparison of Maintenance and Energy efficiency departments.

4.2 The survey

The information gathering used the results obtained from surveys and some follow up conversation with the pilot organisations. The main survey used is the following, and the results were combined with the survey responses collected during the preparation of D3.1. The following survey (link to the Catalan version) was used to gather information in both pilot scenarios:

Name and Surname:

Organisation name/type:

1. Which types of energy information sources do you have? And what type of information do you get from each one?
    a. *Some examples for it are: energy invoices; energy monitoring system; Energy efficiency measures investment cost (invoice); Energy efficiency measures action plan (with measures and expected savings); energy audits; energy certificates; other (specify).*
    b. *Example: Energy invoices provide total energy consumed and cost of that energy*

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	Energy consumption	Energy cost	Energy efficiency actions cost	CO2 emissions associated to energy	Cost, consumption and emissions	Cost, consumption, emissions and savings
Energy invoices						
Smart meter readings						
Energy monitoring system						
Energy efficiency measures action plan						
Energy audits						
Energy performance certificates						
Other						

2. Which areas/departments of the organisation take care of the energy information and manage it?
    a. *Some examples: Accounting; Maintenance; Management; Energy management department; building management; other (specify)*
    b. *Example: Accounting takes care of energy invoices*

3. Which type of tools do you use to manage energy information? Specify if needed for the different types of data.
    a. *For example: Specific accounting service for the invoice management; Excel files for consumption; Excel file for energy efficiency measures; the invoices themselves.*
    b. *Explain if possible how each source is managed.*

4. Do you do a follow up on the energy invoices?
    a. *Examples: energy cost, invoice details, other costs associated to energy)*

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5. *Is it straight forward to do a follow up on the energy invoices?*

Energy efficiency actions section

6. Do you have any plans to implement energy efficiency measures and/or renewable energies in the foreseeable future? Which ones?

7. How do you execute them?
    a. Maintenance company
    b. tender process
    c. both

8. (optional, only if above the answer was a. Maintenance company) Which type of EEM action does the maintenance company execute by contract?
    a. *We have seen that some maintenance contracts include replacing broken or old equipment (one example are lighting systems for LED) for more efficient ones during the normal maintenance.*

9. Which type or size of investment does require a tender process?

10. Which type of information about the energy efficiency actions and renewable energies installed do you have?
    a. *Examples: The budget; invoices; type of measure; forecasted savings; forecasted production; date of action, total investment; payback time; NPV of the investment; or any other economic indicator (specify).*
11. Do you have an energy management system? Which ones?

12. Do you have a system to log and manage maintenance actions?
    a. Yes
    b. No

13. (If Yes on the above question) Can you identify/flag the actions related to energy efficiency within the maintenance system?

14. Do you have energy audits of your buildings? How old are they/how often do you need to update them? Do all buildings have them?

15. Do all buildings have EPC certificates?
    a. Yes
    b. No

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16. If not all, which share of them have EPC?
    a. <25%
    b. Around 50%
    c. 50%-75%
    d. >75%

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5 Current building data management practices

This section describes the archetypes of organisations found, their general data practices and the diversity within each typology of organisation, based on the organisations analysed, from municipalities (section 4.1.1) to government departments and public companies (4.1.2). The comments on each type are used to describe the general archetypes of data management. An initial proposal, based on the combined experience of ICAEN and EnEffect, is described in the following section.

The EN-TRACK project aims to provide building and energy management tools that also facilitate decision making for energy efficiency investments. The current report focuses on identifying all the different sources of information: who is managing them and how they are used. It also aims to detect the information required to ensure that building management can be performed well and also that energy efficiency investment opportunities can be detected and pursued effectively.

5.1 General archetypes of data management

The information gathered indicates that there is a tendency towards improved data management practices due to, or facilitated and enabled by, modernisation of the data management tools and the digitalisation process of the different data sources. This evolution, from a scarcity of data availability and management to large amounts of data to be managed and advanced monitoring practices, can be summarised, tracked and characterised by defining three main groups and four sub-groups of organisations based on their data management practices, see Figure 2 below.

The archetypes are:

1. Basic level organisations	2. Middle level organisations	3. Advanced level organisations
	2.1 EPC and energy audits	3.1 Company smart meters
	2.2 Partial monitoring systems	3.2 Full monitoring system

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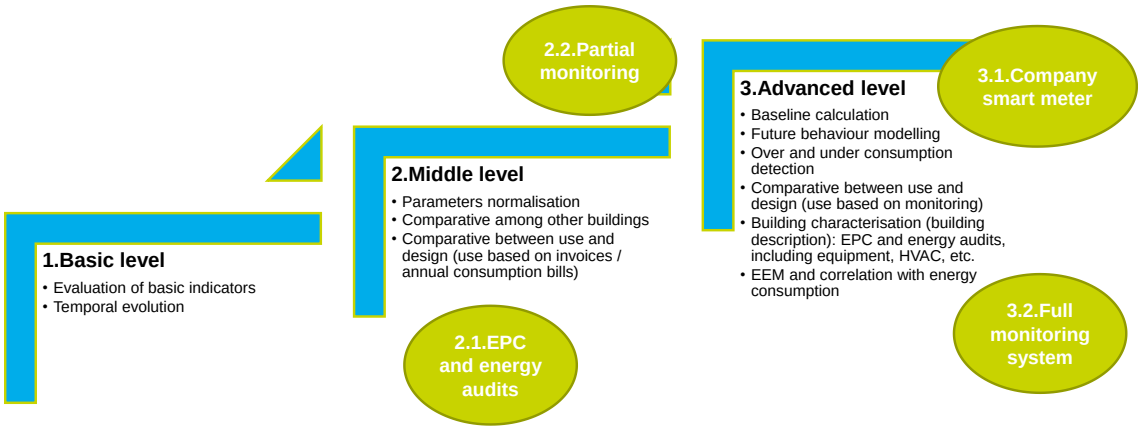

Figure 2: Organisation archetypes based on their current data management.

The information sources encountered may not be available to an organisation unless they dedicate resources to understanding them and extracting the information. Resources means both technological tools to gather and process the information, and dedicated trained personnel. Therefore the zero level, below the Basic level, would be any organisation that does have all sources of information but due to a lack of dedicated resources is not able to extract any information from them.

Building, energy and financial data can be obtained from different sources, the availability of each source will depend on several factors, from the smart meter implementation at the national level to the rules for performing energy audits in buildings. Depending on the situation of each organisation certain data will be more accessible than others, and it will also change due to the targets for each organisation. For example, for a certain organisation, electricity is the main energy source, reaching >95% of the overall consumption. Therefore most of the analytical tools, internal processes and personnel focus on gathering electricity information which will be of high quality. On the other hand, biomass (which represents less than 1%) data may not even be registered. This example aims to illustrate the fact that, while the following archetypes offer a generalised indication of the main sources found, there are also organisations that do not fit well into any of them because their specific needs do not correlate very well with the trends used to define the archetypes based on the sampled organisations.

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5.1.1 Basic level organisations

The information gathering revealed that the most basic or initial data management practices revolve around the cost of using the energy and the need to pay for that cost, which is recorded and managed by the accounting team (see Table 1). The organisations that are at this stage do not check their energy behaviour, they just receive the information enclosed within invoices associated to the energy consumption. The invoices usually represent the monthly consumption (sometimes every two months), with information of both energy and cost of the month in question. The information is then processed to be paid and filed within their accounting system. The only interaction with the energy information is the accounting team with responsibility for selecting the energy provider (usually based on the energy cost) and authorising payment. The only analysis tends to be periodic comparison with previous invoices to checked that the costs are within reasonable, expected margins.

The second source of information for this type of organisation is the log of actions taken by the maintenance team (either internal or third company). The registry of maintenance actions contains improvements due to equipment failure and repair or replacement which, in most cases, leads to replacement by efficient technologies that effectively can be classed as energy efficiency measures (EEM). The challenge for this type of information is to register/highlight the EEM actions as energy efficiency actions so they can later be easily retrieved from the whole log, otherwise they will not be accessible within the whole log of maintenance actions.

Table 1: Basic level organisations information requirements, data source, department in charge of the source, tools used to manage the information and use of the information for the organisation.

Information	Source	Department in charge	Tools used	Use of information
Energy consumption and cost	Energy invoices	Accounting and Legal	Accounting system	Only to pay the cost and track an evolution of the cost for the company
EEM list, cost and date of action	Extracted from maintenance actions/software/files	Maintenance	Excel file /Maintenance software (GMAO)	EEM information used to account for the actions taken. The cost information can be used to calculate financial parameters, NPV, ROI, etc, if savings can be estimated

Figure 3 describes the two main departments that hold energy and EEM information at the Basic level of organisations and how the information flows. The figure clearly shows that the different departments tend to only focus on their sources of information and do not process it further, even though it may include essential sources of information for the energy management of a building and the control of the energy efficiency measures. As has been explained above, the information is only collected because is needed and there is not awareness of its energy management relevance, or an expectation to use it to inform the decision-making process.

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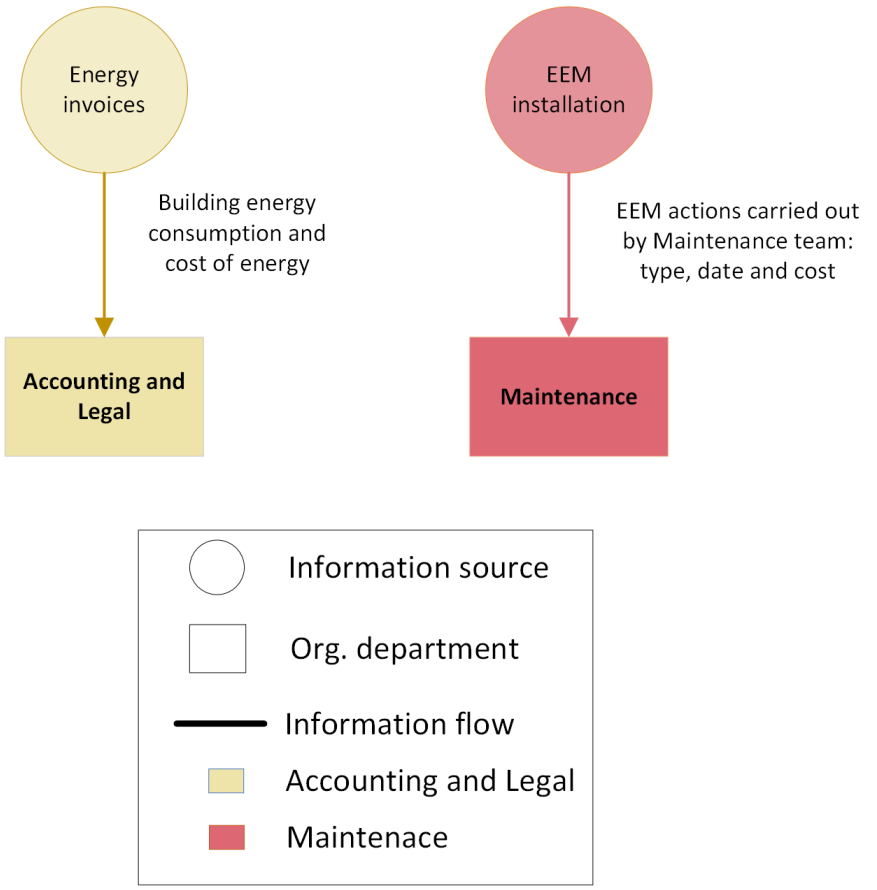

Figure 3: 1.Basic Level summary of stakeholders and information flow.

5.1.2 Middle level organisations

The middle level organisations differ from the basic level in the number of sources of information available and used to analyse the building behaviour, as well as, the exchanges of information among the different departments. Figure 4 describes the three main departments (Accounting and Legal, Maintenance and Energy management) that hold energy, building and EEM information at the Middle level organisations and how the information flows. These sources of information are all used in combination for the day-to-day management of the buildings and the planning of future actions, including energy efficiency investments. The information is used to analyse their buildings' energy behaviour, normalising the data using building properties to track their evolution and even compare groups of buildings, more than one department can use the same information for different purposes. The figure also shows that at this stage the energy information can come from several sources, sometimes the same information can be obtained from more than one source, which can be internal databases and external ones.

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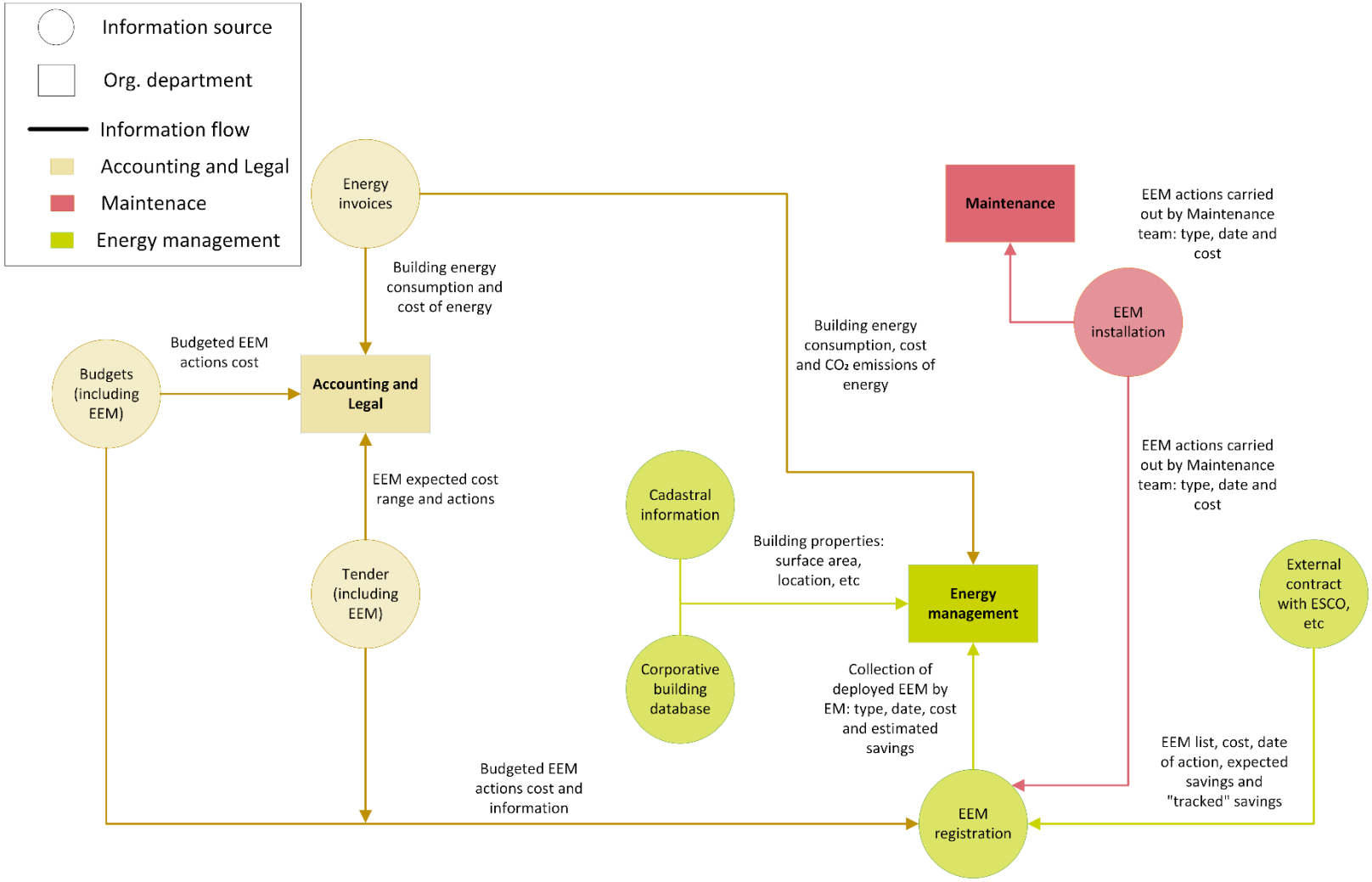

Figure 4: 2.Middle level organisations summary of stakeholders and information flow.

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The invoices, managed by the accounting department, are the main source of energy consumption, CO_2 emissions and cost for both the accounting and energy management departments. At this stage invoices are used as a source of information to act on, the evolution is recorded to check the building trends and to analyse if any of the applied EEM can be detected. The analysis also allows energy data to be combined with building properties (mainly surface area) to normalise the consumption, which then can be used to perform basic building comparisons using the kWh/m^2 as a reference value. The information is then stored in two systems, the accounting system and the energy management system. The latter usually uses Excel-like programs for the storage and analysis of the data.

Several sources that can provide information about building characteristics and properties, from internal databases to the external cadastral database. They include details about where the building is (climate region, insulation potential, etc.) and building information such as insulation, number of openings (windows, doors), construction date and major refurbishments of the building, overall surface, heated surface, etc. All these types of information are required by the energy managers to perform normalisation of the energy consumption and cost data as explained in the previous paragraph. This information is also vital when planning and prioritising interventions in parts of the building ranging from improving insulation to modifying openings in the heated areas. The building data may be obtained from several internally owned and managed sources and/or from external organisations. They can range from a corporative database where the desired main data is recorded, to external databases such as the cadastre that contain data of building surface area and location.

The energy efficiency actions are the final type of information found at this level of organisation, which also have multitude of possible sources of information. This information can be found in a variety of sources including accounting and legal department documentation, energy managers' own databases of manually recorded actions, maintenance records and third parties companies, such as ESCOs, contracted to perform energy management functions. The accounting and legal department have the information for EEM in the documents for the tendering processes that are usually required to execute them and the final approved budgets, which both provide similar information. However, these types of improvement actions are usually enclosed within bigger projects than involve several building improvements or actions that cannot all be counted as energy efficiency investments. The combination of actions within a budget requires that someone highlights the ones associated to energy efficiency investments to be able to extract the exact information. As explained in the basic level organisations, the maintenance actions records also require time investment to uncover all the cost associated to EEM from the whole record of actions undertaken. This problem, of having several items within a budget, can be found in all types of organisations. The effect diminishes as energy managers are informed about implemented EEM, and even more as when there is a dedicated energy manager responsible for the EEM proposal and implementation.

Finally, the middle level organisations have two compatible sub-groups that branch depending on the expanded sources of information that are available, the first (5.3.2.1) focusing on the building properties and characteristics using the EPC and energy audits, and the second (5.3.2.2) starting the path towards building monitoring using energy accounting software or partial monitoring systems.

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Table 2: Middle level organisations information requirements, data source, department in charge of the source, tools used to manage the information and use of the information for the organisation.

Information	Source	Department in charge	Tools used	Use of information
Energy consumption, cost and CO_2 emissions	Energy invoices	Accounting and Legal	Accounting system + Excel files	Used to track building evolution (energy accounting)
Building properties	Corporative building database	Energy Management (EM)	Data stored in Excel files	Provides data about the building, total surface, heated surface, etc. Used to normalise consumption based on ratios and compare buildings
Building properties	Cadastral information	Cadastral entity, in house it would be managed by EM	Data stored in Excel files	Provides data about the building, total surface, heated surface, building location, etc. It can be used to normalise consumption based on ratios and compare buildings. UTM coordinates can be used to define building location and climate/weather conditions, which are needed to perform climate adjustments
EEM list, cost, date of action and expected savings	EEM information registered by Energy Managers, manually	EM	Excel file	EEM information used to compare "expected/old" consumption with real one after EEM for an estimation of savings. The cost information can be used to calculate financial parameters, NPV, ROI, etc.
EEM range of cost and expected savings	Tendering processes/software	Accounting and Legal	Tendering tool/Excel file	Estimated cost of improvements if the EEM is singled out
EEM budgeted cost	Budget/Budget software	Accounting and Legal	Accounting system	Budgeted cost of improvements if the EEM is singled out
EEM list, cost, date of action and expected savings	EEM actions from maintenance software	Maintenance	Maintenance software (GMAO)	EEM information used to compare "expected/old" consumption with real one after EEM for an estimation of savings. The cost information can be used to calculate financial parameters, NPV, ROI, etc.
EEM list, cost, date of action and expected savings	External contracts (ESCO's, third companies, etc.)	ESCO to EM	Energy management tool, Excel file	EEM information used to compare "expected/old" consumption with real one after EEM for an estimation of savings. The cost information can be used to calculate financial parameters, NPV, ROI, etc.

5.3.2.1- EPC and energy audits

The first middle level sub-group identified focuses on the expanded information that can be obtained for building information in the form of building certification (EPC) and building energy audits (see Figure 5). The information gathered with the EPC or the energy audits allows to reach different depth of knowledge about the building, its expected behaviour along a typical year

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(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 of the energy consumption of the whole year). It can also be used to compare the certainty of the predictions made and to compare use and design.

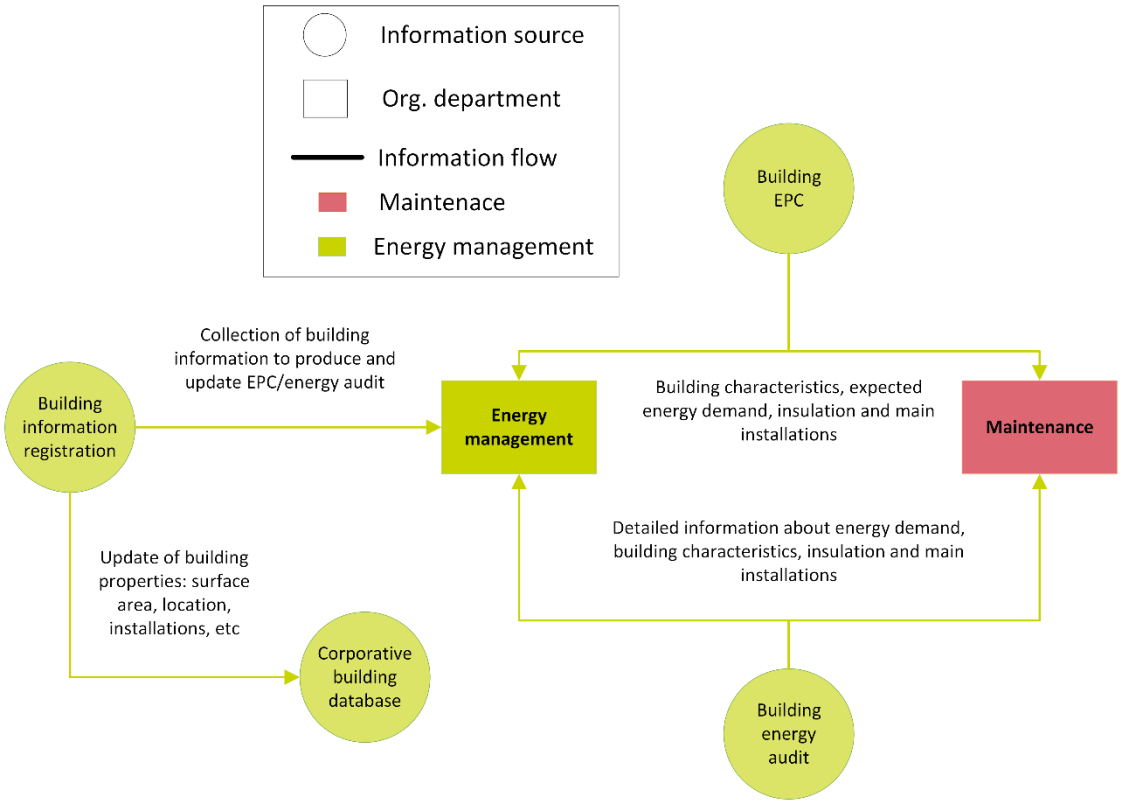

Figure 5: 2.1.Middle level organisations: "EPC and energy audits" summary of stakeholders and information flow

The building information found in the EPC and energy audits provides expanded insights into several layers of the building itself, from the insulation to the main equipment providing HVAC and even the illumination. For example, information about the level of insulation of the building allows prediction of the expected behaviour of the building under different weather conditions, and also the expected heating and cooling energy demand and consumption. The information collected by the EPC and energy audit processes provides the energy management department with a list of actions to improve the current state of their building.

Both the EPC and energy audits analyse similar aspects of the building characteristics and its use. They differ on the depth of the analysis carried out being the energy audits the most extensive version. In the case of Bulgaria, EPC's are generated using the data of an energy audits and they are not generated on their own. In contrast, in Spain, both types of information are generated and used separately.

The energy management teams have their own database of building information that they use to track the improvements carried out due to the energy audits and to update them over time. This internal database is also used to update the corporative building database and update it when actions affect the building and its installations.

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Table 3: Middle level organisations "EPC and energy audits" information requirements, data source, department in charge of the source, tools used to manage the information and use of the information for the organisation.

Information	Source	Department in charge	Tools used	Use of information
Detailed building properties and characteristics	Building EPC	EM	PDF (report)/Excel file/xml file	Provides data about all building characteristics, insulation, openings, and main installations
Detailed building properties and characteristics	Energy audits	EM	PDF (report)/Excel file/xml file	Provides detailed data about all building characteristics, insulation, openings, main installations and equipment inventory; with details about use patterns and even maintenance (more detailed than EPC)
Complementary building properties and characteristics	Building information registered by Energy Managers	EM	Excel file, energy audits and corporative database	Used to have building information data if EPC/Energy audits have not been carried out, and to update them over time

5.3.2.2- Partial monitoring systems

The second sub-group identified focuses on the organisations that 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. Figure 6 describes the three main departments that hold energy, building and EEM information at the partial monitoring level organisations and how the information flows.

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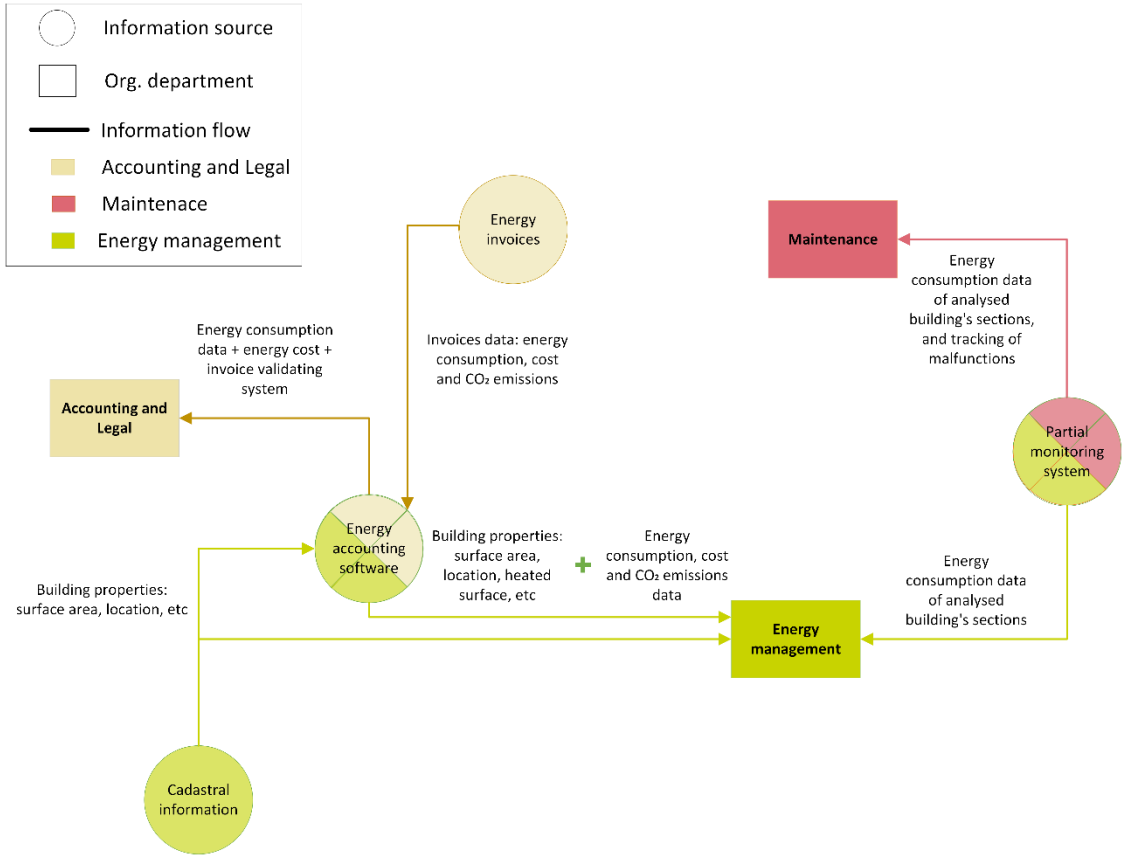

Figure 6: 2.2. Middle level organisations: "Partial monitoring systems" summary of stakeholders and information flow.

The energy accounting or management tools act as an energy invoices repository in which the invoices are linked to the respective buildings, they are tracked to check compliance with the contract and perform some analytics based on the complementary information uploaded. If smart meters are available, they can also have the hourly consumption data associated to them to provide both accounting and energy management with that information to precisely analyse the building and check the effect of any implemented action.

Another functionality of the energy management tools is the gathering of building information. They can store a wide range of data to characterise the buildings that have invoices associated to them. The data included ranges from the administrative information of the building and the consumption point to building properties such as surface and number of floors. The combination of all these information sources, relating to both energy cost and consumption, allows analysis of the behaviour of the building, including the normalisation of the data to start with building comparisons.

Energy monitoring is another source of energy consumption that requires the installation of additional data loggers to target individual systems of the building. It provides the energy consumption of the selected source over time (quarterly or hourly data) that can then be used to perform any of the before mentioned analysis when combined with building surfaces. The hourly data monitoring of certain equipment can also be used to estimate the savings obtained from implementing energy efficiency measures by comparing the metered consumption before and after.

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Table 4: Middle level organisations "Partial monitoring systems" information requirements, data source, department in charge of the source, tools used to manage the information and use of the information for the organisation.

Information	Source	Department in charge	Tools used	Use of information
Energy consumption	Energy accounting software	EM/Accounting	Energy accounting/management software	Tracks the building invoices in combination with building properties to analyse energy behaviour and compare buildings based on ratios (kWh/m^2) and total values
Energy consumption	Partial monitoring system	EM/Maintenance	Partial monitoring system (requires sensors to be installed)	Tracks parts of the building energy behaviour and compare buildings based on ratios (kWh/m^2) and total values
Basic building information	Energy accounting software	Accounting and Legal	Energy accounting/management software	Provides data about the building, total surface, heated surface, etc. This information allows consumption data to be normalised based on ratios and compare buildings at a basic level

5.1.3 Advanced level organisations

The third level of organisation (see Figure 7) actively uses multiple sources of information, most of them using advanced digitalised tools to gather, process, analyse and display the building, energy and financial data. The data sources are varied and some sources provide several types of information, as has already been shown in the middle level organisations. These organisations are implementing advanced digital tools to collect, combine and analyse the information and then process it all using algorithms to establish baselines, perform building benchmarking based on multiple criteria and detect outliers to focus on. The third 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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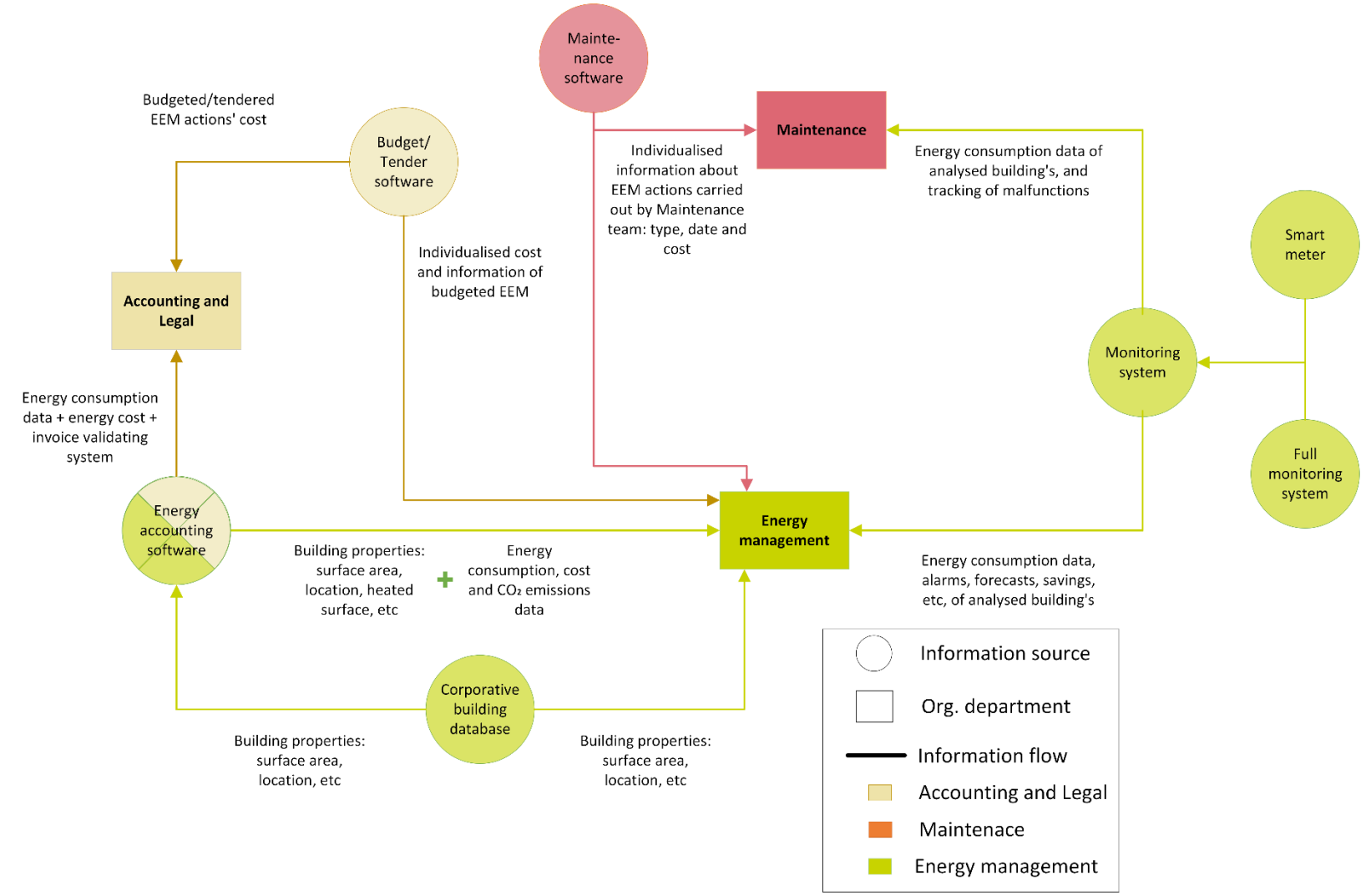

Figure 7: 3.Advanced level organisations summary of stakeholders and information flow.

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The energy consumption data can be obtained from the monitoring systems that record energy consumption and the energy accounting software that process the digital invoices. The main difference between the two sources is the rate at which they provide the information.

Energy monitoring systems provide the energy consumption instantly or the day after depending on the type of equipment used. If the organisation owns the monitoring system it can be set-up to constantly transmit data. On the other hand, if it is using the energy provider smart meter the data sharing rate will depend on the company, the country regulation or any agreement reached among partners (currently Spain has a 14 days window by law that some companies reduce to 1 day). The energy management department uses this information to analyse the evolution of the building, estimate the savings of any applied EEM, and detect any increases of consumption. The maintenance team also uses the information to ensure that the building installations are kept operating at their optimal conditions and detect any malfunctions.

The energy accounting systems process the energy and billing information to validate the invoices to ensure that the information provided is correct and to provide insight on the energy used by the company. They store all the received invoices acting as a repository of past consumption and cost. If the consumption is collected by a smart meter they can also display the information about the hourly energy consumption. The accounting department uses this information to take cost related action. The energy management department uses the information to keep track of the energy behaviour of the building. The rate at which the information will be received depends on the energy provider company, usually the information will be received at the end of each month.

The information about EEM actions provided by any combination of the budget, the tendering processes and the maintenance software will be used by the energy management department to analyse the impact of each action implemented. At this level of organisation, the software used has the option to highlight any actions as being energy efficiency related. This facilitates the extracting the information.

When all the sources of information are used in combination, they can be used to create building baselines (expected consumption of the building if nothing changes) that serve to detect unexpected high consumptions. They can also detect savings obtained from both changes in behaviour and EEM actions implemented. Moreover, they can be used to calculate financial indicators for the EEM implemented. The baseline can also be used to predict the consumption of the building in the future in combination with the price forecast to have an idea of the energy cost for the building and the impact that EEI can have.

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Table 5: Advanced level organisations information requirements, data source, department in charge of the source, tools used to manage the information and use of the information for the organisation.

Information	Source	Department in charge	Tools used	Use of information
Energy consumption and cost	Energy invoices	Accounting and Legal	Energy accounting software	Monitor the building evolution for both energy consumption and cost. Energy invoices management, returns and modifications of encountered errors, etc.
Energy consumption	Energy accounting software/Partial monitoring system	EM	Monitoring system	Tracks the building energy behaviour and compare buildings based on ratios (kWh/m2) and total values
Building properties	Corporative building database	External department: managed by EM	Data extracted in Excel files	Provides data about the building, total surface, heated surface, location, etc. Used to normalise consumption data based on ratios and compare buildings. UTM coordinates can be used to define building location and climate/weather conditions, which are needed to perform climate adjustments
EEM range of cost and expected savings	Tendering processes/software	Accounting and Legal	Tendering tool	Estimated cost of improvements if the EEM is singled out
EEM budgeted cost	Budget/Budget software	Accounting and Legal	Accounting system	Budgeted cost of improvements if the EEM is singled out
EEM list, cost, date of action and expected savings	EEM actions from maintenance software	Maintenance	Maintenance software (GMAO)	EEM information used to compare "expected/old" consumption with real one after EEM for an estimation of savings. The cost information can be used to calculate financial parameters, NPV, ROI, etc.

The two sub-groups of the advanced level diverge on the method to obtain the consumption data and the resources invested into the monitoring strategy, all of them are already represented in Figure 7.

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5.3.3.1- Company smart meter approach

The first sub-group of the advanced level 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 main limitation of using only the company smart meter as a source of energy consumption is that there is no system to measure parts of the building and differentiate consumptions by installations. The consumption differentiation has to come from assumptions and AI analysis, for example by comparing the consumption in different climate conditions to differentiate the building with and without HVAC.

Table 6: Advanced level organisations "Company smart meter approach" information requirements, data source, department in charge of the source, tools used to manage the information and use of the information for the organisation.

Information	Source	Department in charge	Tools used	Use of information
Energy consumption	Smart meter data	EM	Building's smart meter	Tracks the building real energy behaviour and creates baseline consumption models using the consumption, location and building properties

5.3.3.2- Full monitoring system

The final sub-group covers a range of approaches to monitoring that all use similar technical approaches and yet may differ from each other based on the resources assigned to the monitoring team. In all cases a complete monitoring system is integrated with the rest of the energy management platforms to provide all the data required to the energy management department.

These organisations have monitoring equipment installed into all the main installations of their organisation, which means that any changes in consumption (increase or decrease) at any of the lines (illumination, HVAC, equipment, EV chargers, etc.) will be detected precisely, unlike the previous group in which changes had to be tracked down. The detailed knowledge combined with the rest of sources of information allows to create exact baselines for each line, and the associated calculation of savings due to EEM actions. The monitoring can expand beyond energy consumption to include temperature level, in door conditions (CO_2 concentration) and others such as building occupation.

The main limitation to this type of system is the requirement to have personnel dedicated to the analysis of the vast amounts of data received, to then propose the best EEI suited to the particularities of each building. If the organisations due not allocate sufficient human resources to the task, the amount of data received could overwhelm them and render the monitoring system useless in comparison with the previous smart meter approach that has one source of less detailed information.

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Table 7: Advanced level organisations "Full monitoring system" information requirements, data source, department in charge of the source, tools used to manage the information and use of the information for the organisation.

Information	Source	Department in charge	Tools used	Use of information
Energy consumption	Monitoring system data	EM	Full building's monitoring system	Integrates the monitoring system into the building management operations. The monitoring system tracks the building real energy behaviour and create baseline consumption models using the consumption, the different measuring devices installed, the location and building properties.

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6 Conclusions and future work

The work carried out in work package 3 task 3.2 aimed to understand the current building data management practices to define archetypes of organisations, the findings are presented in this report. The data targeted by EN-TRACK is any building, financial or energy (cost and consumption) data that is required to manage a building. The main purpose of this report is to document and categorise this information in terms of level of information provision and data collection and availability. The report has also analysed what data is required to decide on energy efficiency investments. In order to better understand the different data management practices, the information gathering covered a representative sample of building owners from both pilots, Bulgarian municipalities and the Catalan government departments (Spain) and public companies. The profile of the attendees to the various events organised included not only energy managers, but also heads of maintenance, accounting teams and personal in charge of acquisitions.

The information provided by the Bulgarian municipalities highlighted that they lack a dedicated workforce to manage the large amounts of information currently available to them and that this situation is exacerbated by the fact that most of the available information and data is not digitalised or, at best, can only be found in Excel files. The lack of specific tools to manage the information makes it harder to share the data for the elaboration of roadmaps such as the implementation of energy efficiency measures over the years.

The information provided by the pilot in Spain, by the Catalan government and its public companies, showed that the implementation of specific software to manage information facilitates the sharing internally and externally of the data to elaborate roadmaps and for the day-to-day decision making. The size of the Catalan administration compared to the Bulgarian municipalities also means that more human resources are dedicated to the analysis and management of the energy information which obviously facilitates the task.

The data practices encountered in both pilots were analysed and archetypes of organisation were identified with 3 main groups and 4 subgroups. The Basic level organisations (1) are the ones that do have some information about their consumption and cost, but they do not act on them unless the costs exceed the expected values (mainly for the cost).

The middle level organisations (2) use their information to track the building evolution and progress, they also combine different sources of information to improve the analysis, for example normalising the consumption by the surface area, which allows then to approximately compare different buildings. They also expand their sources of information to include energy data, building properties and records of energy efficiency measures. The use of EPC and energy audits (subgroup 2.1) as a source of information is expanding because they provide detailed information coupled with hints of improvements to apply in order to reduce the energy consumption of the building, they also provide some estimation of the financial cost and return of such improvements. The second subgroups (2.2) focuses on the initial introduction of monitoring and energy accounting tools, both provide greater knowledge of the building, the first by providing exact details of the energy consumed on the monitored sections of the building. The second by providing a data management tool that eases the processing of the information

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and keeps in one place, opening the options to easily share and use the information for other purposes.

The advanced level organisations (3) improve the data gathering systems beyond the energy consumption, facilitating the collection and internal sharing of the information for decision making purposes. The collection of energy consumption is improved by introducing smart meters (3.1) as a source of information compatible with external systems or by introducing full monitoring systems (3.2). The combination of all digital sources of information then allows to start modelling the building behaviour, including factors such as weather to elaborate the building baseline. The building baseline can be used to detect any malfunction, increase of consumption, and to estimate the savings (energy and economic) derived from any energy efficiency measures applied, technical or behaviour change.

The archetypes of organisation presented in this deliverable will be used to create the necessary support material for any organisation to improve their data governance and to collect, prepare and feed their data to the EN-TRACK system. The support material will include any deemed material from tutorials to templates and data flow charts, so any organisation can pick their current situation and reach their desired state.

Future work will focus on displaying each of the possible uses for the different technical solutions to data gathering and management, to then mark how far each organisation has to go to reach their desired functionalities in both technological tools terms and training for the personnel. Combining the different technical solutions with the needs of each organisation. This will include the required data preparation in the internal company systems and how the data needs to be combined to reach the desired outcomes.

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