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

EN-TRACK overall requirements and data model

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Abbreviations and Acronyms

Acronym	Description
APIs	Application Programming Interfaces
BO	building owners and operators
BPD	Building Performance Database
BREEAM	Building Research Establishment Environmental Assessment Method
CA	Consortium Agreement
CAPEX	Capital Expenditure
CO2	Carbon Dioxide
COMBI	Calculating and Operationalising the Multiple Benefits of Energy Efficiency in Europe Project
DEEP	De-Risking Energy Efficiency Platform
DoA	Description of Action (annex I of the Grant Agreement)
EBaR	energy-budgets-at-risk
EC	European Commission
EE	Energy Efficiency
EEFIG	Energy Efficiency Financial Institutions Group
EEI	energy efficiency investment
EEMs	energy efficiency measures
ENUM	Enumerated List data type
EU	European Union
EUI	Energy use intensity
FI	Financial Institution Stakeholders
GA	Grant Agreement
HVAC	Heating, Ventilation & Air Conditioning
ICP	Investor Confidence Project
ID	Identifier

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Acronym	Description
IEA	International Energy Agency
Int	Integer Data Types
IRR	Internal Rate of Return
ISO50001	ISO 50001 Energy management systems standard
KYC	Know Your Customer
LBNL	Lawrence Berkeley National Laboratory
LEED	Leadership in Energy and Environmental Design
M&V	Monitoring and Verification
MBenefits	The EU Multiple Benefits Project
MS (or EU MS)	Member States of the European Union
NEBs	Non-Energy Benefits
NPV	Net Present Value
NPVq	Net Present Value Quotient
O&M	operations and maintenance
OPEX	Operational Expenditure
PC	Project Coordinator
PMC	Project Management Committee
PO	Project Officer
PS	Project Secretariat
QM	Quality Management
ROI	Return on Investment
SC	Scientific Coordinator
TL	Task Leader
TMT	Technical Management Team
ToC	Table of Contents
UID	Unique Identifier
UML	unified modelling language

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Acronym	Description
VaR	value-at-risk
WP	Work Package
WPL	Work Package Leader

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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 a number of 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 before-and-after performance of energy efficiency measures in buildings;
- 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, which defines the platform's overall requirements and data model, represents the first deliverable (D1.1) of EN-TRACK within the project's first work package (WP1): data collection, interoperability, and financial institutions' requirements. It has been prepared primarily by colleagues from consortium partners ep group (formerly EnergyPro), CIMNE and Joule Assets.

In addition to a brief background and introduction, the report contains a methodology that outlines how the main data model requirements have been developed using an iterative and collaborative approach between the project partners. It identifies the main expected platform user types, and relevant drivers for decision-making within those user types, to inform the more detailed data input requirements, calculations, outputs, etc.

The report then identifies the main service categories envisioned for EN-TRACK, which are based primarily on the ability of platform users, notably building owners and operators and financial institution stakeholders, to benchmark the performance of buildings and energy efficiency measures. EN-TRACK will also be designed to support the work of policy makers assessing the impact of building efficiency subsidies, among other services.

Recommendations to inform the specifications of the platform's data model are featured within the main sections of the report.

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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, financial and other performance of buildings. EN-TRACK builds on the extensive work done under the auspices of the Energy Efficiency Financial Institutions Group (EEFIG)[1] to create the De-Risking Energy Efficiency Platform (DEEP)[2], which contains ex-ante information on thousands of building efficiency projects. EN-TRACK will also leverage other currently available European databases and tools, such as eQuad[3] and EnerInvest[4]. Relevant databases and resources from outside of Europe, notably the Building Performance Database (BPD)[5] developed by the Lawrence Berkeley National Laboratory (LBNL) at the University of California Davis, provide further inputs for EN-TRACK whereas relevant and feasible.

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3 Introduction

This report represents the first EN-TRACK deliverable (D1.1), which is to provide the specifications and recommendations for the implementation of EN-TRACK's data model. As per the EN-TRACK Grant Agreement (GA), the requirements of D1.1 are as follows:

- Define the required data collection to ensure functional energy efficiency investment (EEI) de-risking database including all data fields of the De-Risk Energy Efficiency Platform (DEEP) and additional information such as energy consumption time series, energy price and weather data necessary for evaluation and tracking of energy savings and financial performance of EEI.
- Collection of information about the drivers for investment decisions and the non-energy benefits obtained by these investments will be also considered through user-supplied and operations and maintenance (O&M) data.
- Define all the investment risk indicators used in DEEP, eQuad, EnerInvest as well as other indicators required by Financial Institution Stakeholders (FI) and used in accepted risk assessment methodologies, e.g., value-at-risk (VaR) or energy-budgets-at-risk (EBaR).
- The dataset definition will be sufficiently comprehensive to allow the development of investment benchmarking and for performing the prescribed standardised procedures and certification (Investor Ready Energy Efficiency or IREE-certification[6]) of the Investor Confidence Project (ICP)[7].

To summarise, this document provides the specifications and recommendations for the development of the platform database's data model, capable of supporting all key functionalities and the definition of the EEI and risk indicators together with calculation procedures to relate these indicators to primarily to energy efficiency measures (EEMs).

Data fields related to the drivers for investments and the non-energy benefits are also included in order to enable the collection of information, which is necessary for further extending the services beyond the current state of art in the area of recommendations of EEM and decision support.

4 Methodology

The methodology to deliver the platform's data model is based on an iterative approach involving several parallel processes.

The first step, as discussed in section 5, is the identification of user profiles or types, based on an understanding of users' potential pain points, including drivers for building energy/operational and investment decisions, as noted in the introduction.

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Based on this, potential services, or service categories – and related data requirements – can be defined, whereby services are based mainly on the objective of gathering large amounts of data on the performance of buildings across Europe and using this data to benchmark and compare building performance, related to building energy use and EEMs. This can provide insights to building owners and operators (BO) and financial institution stakeholders (FI), as well as policy makers (PMs). This topic is explored further in section 6.

In section 7, based on the identified service areas, data requirements and data sources are analysed, considering exchanges and compatibilities with other platforms such as DEEP and eQuad, while ensuring the alignment of key terminology, such as the financial and project related terminology used in ICP documentation. The collection of information about the drivers for investment decisions and any relevant non-energy benefits are also considered.

An important consideration here is the alignment of terminology related to EEMs, particularly around the definition of investment and risk indicators since these may be classified or described differently across various platforms. The EN-TRACK solution also aligns with the Building Energy Data Exchange Specification (BEDES)[8]. Section 8 discusses the issue of indicator alignment in detail.

A brief description of state-of-the-art approaches to gathering and analysing non-energy benefit data is presented in Section 9, along with recommendations for how this data could be collected and analysed within the EN-TRACK platform.

In parallel, a preliminary EN-TRACK dataset is defined in an incremental manner, using the existing fields within the DEEP database as a starting point. The fields are revised where necessary to ensure interoperability between the platforms and any redundancies are also identified and eliminated. This is discussed further in section 10.

Subsequently, a reduced set of questions for the EN-TRACK users and data fields that can capture their answers in the EN-TRACK platform, are defined. These data fields can be further used in the development of the services and the benchmarking and are included in the preliminary dataset mentioned above.

In terms of defining investment and risk related indicators, the indicators user DEEP, eQuad, and EnerInvest are used as a starting point, but more precise definitions are examined. In addition, calculation procedures for financial and risk indicators are defined based on the preliminary data set.

Finally, a more comprehensive dataset is established, comprising all the data fields identified previously, including those related to financial and risk indicators and also to non-energy benefits where possible. This dataset is also defined in the structure or form of a unified modelling language (UML) diagram, available separately and managed by CIMNE.

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5 Identifying users and drivers for decision making

This section identifies three main types of potential EN-TRACK users and discusses how these audiences can be profiled. This important initial allows the database developers to understand who the platform's users might be, and what value they would derive from the platform.

Table 1 provides an overview of the EN-TRACK user groups or types. It shows that some of the drivers are common to various users. (This typology is indicative and informative, it is not exhaustive, exclusive or definitive).

Table 1: Potential EN-TRACK users and their drivers for decision-making

User	Drivers for decision making
Building Owners and Operators (BO)	Operational strategies and how EEMs can support those
	Comparative benchmarking of building energy performance
Financial Institution Stakeholders (FI)	Identifying low-performing building representing an investment opportunity
	The outcomes and returns of EEMs in various settings
	Comparing and benchmarking building energy / EEM investments compared to other investment opportunities
Policy Makers	Assessing the impact of EEM subsidisation across national/regional borders
	Assessing the energy/carbon savings of various EEM portfolios within their national context (or a comparable context)
Multiple User Groups (shared drivers)	Targets related to energy use, operating costs, and carbon footprint reductions (all groups)
	Comparative benchmarking of EEM performance (all groups)
	Assessing the cost-effectiveness of EEMs for building portfolios (public or otherwise) (all groups)
	The risks and sensitivity of various EEM portfolios in various settings (all groups)
	Identifying low-performing building representing an investment opportunity (BO and FI)

The following is a more detailed look at the three main user types identified in Table 1.

5.1 Building owners and operators (BO)

BO are considered primary EN-TRACK users given the platform's focus on gathering buildings and measures related data. Within this user category, we can imagine some specific roles or job types and the value they might derive from EN-TRACK, for example:

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- Property asset managers & portfolio managers

These individuals can obtain insights from the platform to inform energy related investment and/or operational strategies both in individual buildings and in portfolios of buildings. They can also compare and benchmark the performance of their buildings against similar buildings.

- Energy managers

Energy managers can compare and benchmark the performance of their EEMs against EEMs being carried out in other buildings, deriving insights and recommendations for the deployment of future EEMs.

5.2 Financial institution stakeholders (FI)

EN-TRACK is expected to offer insights and value for FI, but the expectation of EN-TRACK partners is that it is unlikely that senior executives in financial institutions will use the platform directly. Instead, the management staff are more likely to refer to EN-TRACK as part of their due diligence and internal reporting on investment opportunities, associated risks, etc.

These individuals could include:

- Financial analysts

Financial analysts represent a key user type of the EN-TRACK platform because they currently lack sufficient and consistently reliable data, and data sources, to enable them to complete their analysis and due diligences efficiently and effectively.

For certain data needs well established processes and data portals exist (credit rating, Know Your Customer, etc.). However, there is currently no robust energy efficiency related data collection and provision to the financial industry. Instead, at best, specific project-related data for energy efficiency investments is being gathered in-house. Performance of energy efficiency projects therefore is usually being assessed by looking at the track record of the implementing entity, and "trusting" their assumptions for the project being proposed. Surrounding elements such as occupancy, energy price and regulatory risk factors cannot be assessed soundly due to this lack of data.

EN-TRACK will fill this gap and thus become a valuable tool facilitating the project analysis and due diligence work of financial analysists.

- Underwriters

An underwriter is a party which evaluates and takes on another party's risk in return for a fee. This fee is often in the form of a commission, interest, or a premium. Underwriters play a critical role in various industries of the financial world, e.g., mortgage industry and insurance industry. What an underwriter concretely does, is to determine the level of risk of an investment or the likelihood that the investment's outcome will differ from the expected outcome for the stakeholders. EN-TRACK will be a valuable tool for underwriters because it will make it determining risk factors in the decision-making process easier, more transparent, and more

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consistent. It will also become progressively more valuable and the decisions made over time will be more comparable. The data provided through the EN-TRACK platform could decrease the workload substantially in this process.

- Risk managers

Risk management is an activity of identifying, analysing, and accepting or mitigating uncertainty in investment decisions. This occurs when financial institutions analyse and quantify potential losses for an investment and then make decisions about this investment based on the fund's objectives and tolerance to risk. Risk is attached to return. All investment opportunities involve some degree of risk. Risk is quantifiable both in absolute and in relative terms. A solid understanding of risk and the different forms of risk can help risk managers and investors alike to get a better grasp of the opportunities and trade-offs at hand. To understand these risks, you need data. The EN-TRACK platform will provide risk managers with a solid base for weighing in on the opportunity at hand and analysing whether the risk is tolerable or not.

5.3 Policy makers (PMs)

While not identified in the EN-TRACK Grant Agreement (GA) as a core user group, the partners expect that the platform can provide insights to government / public officials. The following are some examples:

- National ministry officials

Assessing the impact of subsidy and/or technology promotion programmes funded by taxpayers is a highly valuable service sought by ministries. EN-TRACK could help here, by tracking any increase in energy efficiency measure implementation following the introduction of public funding in markets.

- Policy officers / analysts in international organisations (EU, IEA, World Bank, etc.)

EN-TRACK will be able to support tracking of progress towards, for example, objectives under the EU Taxonomy for sustainable activities.

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6 Identifying service categories

This section provides an overview of the main service categories and outputs that the platform will provide to the three main user types identified in section 5, and the indicators and information necessary to produce these services. Table 2 summarises the three service categories each of which is then fully elaborated in the following sections (6.1, 6.2, 6.3). More information about the indicators listed in this section can be found in section 8 (Definitions of investment and risk indicators).

Table 2: Overview of EN-TRACK audiences, service categories and indicators

Audience	Service Categories	Indicators
Building Owners & Operators (BO)	Benchmark and compare the performance of buildings before and after projects / EEMs	▪ Energy use intensity (EUI) expressed in kWh/m^2 ▪ Actual / forecast electricity and/or thermal energy consumption expressed in kilowatt hours per month (kWh/m^2/year)
Financial Institution Stakeholders (FI)	Benchmark and compare the financial performance of EEMs. As below, FI are similarly interested in the impacts of Grant Funding, especially recommending grant eligibility, and tracking the performance of these grant-funded projects.	▪ Return on investment (ROI) ▪ Internal rate of return (IRR) ▪ Net present value quotient (NPVq)[1] or Net present value (NPV) ▪ Value at risk (VaR) ▪ Energy-budgets-at-risk (EBaR).
Policy Makers (PMs)	Track the impact of grant funding on building energy efficiency or EEM implementation, and track projects certified by ICP or other rating systems	▪ € values ▪ Number of certified sites ▪ Proportion of sites utilising grant funding ▪ €/tCO_2e saved per € spent on grant funding ▪ Average % difference in savings (€/tCO_2e) between certified and non-certified projects

[1] While less commonly used by FI, NPVq can provide a more granular view on assessing the value of an investment and under which conditions a decision to make an investment is likely to proceed or not. EN-TRACK is considering plans to incorporate NPVq into the final data model to support the functionality of the platform.

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6.1 Benchmark and compare the performance of buildings before and after projects/EEMs

This service will utilise a visualisation engine to graph distributions of building and EEM performance across the EN-TRACK data portfolio. These visualisations will not only provide a quick reference but will also provide information on key parameters, such as the value of the median and quartiles, and parameters describing the distribution of the data, e.g., skewness and kurtosis.

These latter parameters (skewness and kurtosis) indicate, respectively, the variability of the performance, and whether there is a greater trend towards underperformance or overperformance compared to the median value. These distributions are highly flexible, both in the inputs that they can handle, and in the useful outputs that a user can derive and analyse, as such a large range of variables are considered in the services below.

6.1.1 Envisaged Audience(s)

This service will likely be used by all three audiences profiled in section 5, though each audience will have a slightly different use-case, dependent on the key drivers that concern them.

6.1.2 Audience Drivers

Building owners and operators will likely be concerned with:

- Operational strategies
- Comparative benchmarking of their buildings
- Comparative benchmarking of EEM performance

Financial Institutions and investors will likely be concerned with:

- Identifying the characteristics of under-performing buildings that may represent an investment opportunity
- The outcomes and returns of EEMs in various settings
- The risks and sensitivity of various EEM portfolios in various settings
- Assessing the energy/carbon savings of various EEM portfolios

Policy Makers will likely be concerned with:

- Assessing the cost-effectiveness of EEMs for public buildings
- Assessing the impact of EEM subsidisation across national/regional borders
- Assessing the energy/carbon savings of various EEM portfolios within their national context (or a representative context)

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6.1.3 Audience Use Cases and their Objectives

A brief overview of the use cases relevant to each audience is presented below, collating the objectives of each audience and the information necessary to produce useful outputs and meet these objectives. An expanded version of each use case is available as an annexes of this document (section 12.1).

A. Benchmarking of building energy use intensity (EUI) in kWh/m^2/y

Audience	Audience Objectives
Building Owners and Operators	▪ Comparing the EUI of various buildings in their portfolio to identify underperforming buildings ▪ Comparing the performance of a whole building portfolio to similar portfolios to understand the effectiveness of their operational strategy
Policy Makers	▪ Identifying sectors or building typologies with high EUI to target policy interventions ▪ Comparing the EUI across various policy frameworks in search of effective policy interventions
Necessary Information: ▪ **Broad EUI data** ▪ **Filtering variables for building typology, location etc.** ▪ **Statistical outputs describing benchmarked distributions (i.e. Kurtosis, Skewness)** ▪ **Statistical outputs describing benchmarked distributions**	

B. Benchmarking and prediction of electrical consumption in kWh/m^2/year

Audience	Audience Objectives
Building Owners and Operators	▪ Comparing the electrical consumption (kWh/m^2/year) of various buildings in their portfolio to identify underperforming buildings. This could be a longitudinal comparison considering one building over an extended timeframe, or a cross-sectional comparison with other comparable buildings. ▪ Comparing the performance of a whole building portfolio to similar portfolios to understand the effectiveness of their operational strategy

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Policy Makers	▪ Identifying sectors or building typologies with high energy consumption within a given region to target policy interventions ▪ Comparing the energy consumption of like buildings across various policy frameworks in search of effective policy interventions
Necessary Information: ▪ **Accurate monthly energy consumption data, e.g., time series based on meter readings** ▪ **Filtering variables for building typology, location etc.** ▪ **Statistical Outputs describing benchmarked distributions (i.e. Kurtosis, Skewness)**	

C. Benchmarking and prediction of thermal energy consumption in kWh/m^2/year

Audience	Audience Objectives
Building Owners and Operators	▪ Comparing the thermal energy consumption (kWh/m^2/year) of various buildings in their portfolio to identify underperforming buildings ▪ Comparing the thermal energy performance of a whole building portfolio to similar portfolios to understand the effectiveness of their operational strategy ▪ Comparing the seasonality of thermal energy usage of one or more buildings to a representative sample portfolio.
Policy Makers	▪ Identifying sectors or building typologies with high thermal energy consumption within a given region to target policy interventions ▪ Comparing the thermal energy consumption, and embodied carbon emissions of like buildings across various policy frameworks in search of effective policy interventions, particularly around decarbonising heat.
Necessary Information: ▪ **Accurate monthly energy consumption data, e.g., time series based on meter readings** ▪ **Normalising thermal variables such as outside air temperature or humidity.** ▪ **Emissions intensity data linked to various sources of thermal energy (such as fuel oil or gas)** ▪ **Filtering variables for building typology, location etc.** ▪ **Statistical Outputs describing benchmarked distributions (Kurtosis, Skewness)**	

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▪ **Statistical Outputs describing benchmarked distributions**

D. Benchmarking and estimation of EEM energy savings (kWh/y), or ratio of EEM energy savings to the EUI of the building (kWh/y / kWh/m^2/y)

Audience	Audience Objectives
Building Owners and Operators	▪ Comparing the thermal energy consumption savings / savings ratio (kWh/m^2/year) of various buildings in their portfolio to identify underperforming buildings ▪ Comparing the thermal energy performance / savings ratio of a whole building portfolio to similar portfolios to understand the effectiveness of their operational strategy ▪ Comparing the seasonality of thermal energy usage of one or more buildings to a representative sample portfolio.
Policy Makers	▪ Identifying sectors or building typologies with low high thermal energy consumption energy savings /savings ratio within a given region to target policy interventions ▪ Comparing the energy savings /savings ratio thermal energy consumption, and embodied carbon saving emissions of like buildings across various policy frameworks in search of effective policy interventions, particularly around decarbonising heat.
Necessary Information: ▪ **Energy consumption data such as time series** ▪ **Normalising thermal variables for general consumption, such as outside air temperature or humidity/occupancy** ▪ **Occupancy** ▪ **Emissions intensity data linked to various sources of thermal energy (such as fuel oil or gas used in processes)** ▪ **Filtering variables for building typology, location etc.** ▪ **Statistical Outputs describing benchmarked distributions (Kurtosis, Skewness)** ▪ **Statistical Outputs describing benchmarked distributions**	

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6.1.4 Recommendations for the Data Model

A. Necessary Fields

This section provides a brief overview of the fields necessary for benchmarking. For a more detailed explanation of all fields relevant to EN-TRACK services, see section 5: Data Sources and Requirements.

The necessary fields for services in this section are presented below, along with an explanation of why they will be gathered in a given format:

Field in Question	Explanation of why data will be gathered in the given form
i **Broad EUI data**	Energy Use Intensity inherently normalises consumption across various building sizes by dividing total consumption by the useful building area
ii **Filtering variables for building typology, location etc.**	These filtering variables will be gathered in categorical forms in order to provide exclusive data that can easily filter the EN-TRACK portfolio from within the data visualisation engine
iii **Statistical Outputs describing benchmarked distributions (i.e. Kurtosis, Skewness)**	These parameters will have to be calculated by the EN-TRACK platform, as they will vary as the input building portfolio is modified/filtered.
iv **Broad Energy Consumption data**	This energy consumption data should be as broad as possible in order to capture all aspects of energy utilisation. This could include a variety of energy vectors, from onsite generation of electricity to the purchase of steam.
v **Broad Thermal Energy Consumption data as time series**	The thermal energy consumption data could include a range of vectors, including purchased heat in the form of steam, or the generation of thermal energy from burning fuels on-site. This data must be gathered as time series in order to enable the seasonal normalisation of consumption as outside temperature and humidity changes.
vi **Normalising thermal variables such as outside air temperature or humidity.**	This data must be gathered as time series in order to enable the seasonal normalisation of thermal energy consumption, for example as outside temperature and humidity changes.

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vii **Emissions intensity data linked to various sources of thermal energy (**e.g. **fuel oil or gas)**	These emissions intensities will allow various thermal energy vectors to be equivalated to CO2 emissions. This could include the emissions intensity of various fuels consumed on site, or of producing purchased energy vectors such as steam. There is a question here around whether the disclosure of purchased emissions attributes should be allowed, for example where purchased electricity has energy attribute certification. Where non-standard emissions factors are utilised, an additional question should gather the building owner's justification for using a non-standard emissions factor.
viii **Broad Energy Consumption data as time series**	This energy consumption data should be as broad as possible in order to capture all aspects of energy utilisation. This could include a variety of energy vectors, from onsite generation of electricity to the purchase of steam. This data must be gathered as time series in order to enable the energy consumption to be normalised by variables changing over time, for example occupancy, production volume etc.
ix **Normalising variables for general consumption such as occupancy**	This data must be gathered as time series in order to enable the energy consumption to be normalised by variables changing over time, for example occupancy, production volume etc.
x **Emissions intensity data linked to various sources of energy (such as gas used in processes)**	These emissions intensities will allow various energy vectors to be equivalated to CO2 emissions. This could use a national fuel mix for the emissions intensity of consumed electricity, or could include the emissions intensity of various fuels consumed on site. There is a question here around whether the disclosure of purchased emissions attributes should be allowed, for example where purchased electricity has energy attribute certification. Where non-standard emissions factors are utilised, an additional question should gather the building owner's justification for using a non-standard emissions factor.

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6.2 Benchmark and compare the financial performance of EEMs

This use case is primarily concerned with how EEMs impact the financial performance of a building, process or institution. It will use a range of financial data, some of which may be provided by the user, whilst other fields may be calculated within EN-TRACK to increase data availability.

During early stakeholder engagement activities, financial institutions have participated in a forum where the participants were introduced to the EN-TRACK project, were given an overview of the platform that will be developed, and also gave their feedback on what the platform needs to offer in order to be of value to them. This first edition of the financial institution's forum took place as a series of bilateral interviews between Joule Assets and financial institutions.

While there were many service descriptions that were appealing to the participants, such as CO_2 tracking, analyzing trends in EE investments, risk identification, etc., impact measurement was in particular mentioned and strongly advocated for by all. The ability to clearly portray the impact the implemented measured had in the building, and report on the ROI of each EEM, would be extremely valuable to all in determining the success rates of their projects.

6.2.1 Envisaged Audience(s)

This service will likely be used by all three audiences profiled in section 5, though with a stronger focus on FI, and less on PMs. Each audience will have a slightly different use-case, dependent on their particular key drivers.

6.2.2 Audience Drivers

BO are primarily concerned with:

- Costs and Savings that may be associated with their buildings
- Trends that may impact further investment in EEMs
- Risks that may impact the performance of EEM investments or their building's financial performance

Financial Institutions and investors are primarily concerned with:

- Identifying low-performing building typologies/characteristics representing an investment opportunity
- The costs and savings that may be associated with a building or investment portfolio
- The risks and sensitivity of various EEM portfolios in various settings
- Assessing the energy/carbon savings of various EEM portfolios

Policy Makers are primarily concerned with:

- Assessing the cost-effectiveness of EEMs for public buildings

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- Assessing the impact of EEM subsidies, where these exist, on EEM financial performance. This include identifying EEMs that need greater subsidisation to increase uptake, or EEMs that are already cash-positive and no longer require deep subsidisation.
- Assessing the returns of investment portfolios, to better direct monies from public investment funds. This includes looking for portfolios that are highly sensitive to risk or are experiencing diminishing returns, in order to provide public support or warn consumers of the investment risk within these portfolios.

6.2.3 Audience Use Cases and their Objectives

A brief overview of the use cases relevant to each audience is presented below, collating the objectives of each audience and the information necessary to produce useful outputs and meet these objectives. An expanded version of each use case is available in the annexes of this document (section 12.1).

A. Benchmarking the financial performance of EEMs

Audience	Audience Objectives
Building Owners and Operators	▪ Comparing the average financial returns of various EEMs to identify those with the greatest potential of providing energy savings within their building ▪ Analysing the skewness (bias towards over- or underperformance) and kurtosis (degree of "clustering" around the mean) of the energy/cost saving distributions of various EEMs to determine the reliability and risk associated with the financial performance of various EEMs.
Financial Institutions	▪ Tracking the returns of various types of EEM investment, in order to direct investment/divestment. ▪ Identifying trends in EEM financial performance in order to improve investment strategies and financial forecasting ▪ Looking at variations in financial performance across EEM portfolios in order to determine the portfolio's risk of underperformance
Policy Makers	▪ Using the average financial returns of various EEMs to fine-tune policy incentives and avoid subsidising "low-hanging" fruit. ▪ Identifying the best performing EEM project types suitable for national infrastructure investment or loan schemes. ▪ Determining differences in cost-effectiveness between policy & incentive schemes in order to design better energy interventions.

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Necessary Information: ▪ **Broad Financial performance data, pre-calculated as various indicators (i.e. NPV, IRR etc.)** ▪ **Energy consumption and cost data (across multiple vectors) along with standardised calculation methods allow in-platform calculation of financial performance** ▪ **Filtering variables for building typology, location etc.** ▪ **Statistical Outputs describing benchmarked distributions (i.e. Kurtosis, Skewness)**

B. Analysing trends in EEM investment

Audience	Audience Objectives
Building Owners and Operators	▪ Highlighting areas of high EEM investment in similar building typologies and regions, in order to select possible EEMs for further analysis. ▪ Highlighting areas where the returns of EEM investments are rapidly changing/highly variable, for example due to the provision/recall of a specific financial incentive.
Financial Institutions	▪ Identifying trends in EEM investment in order to improve investment strategies and financial forecasting. ▪ Tracking investments in competing technologies, where a financial institution has invested in a particular type of EEM, or the underlying technology. ▪ Identifying investment trends that could be replicated within a given region of operation or building portfolio.
Policy Makers	▪ Highlighting areas where the return on investment of various EEMs is changing significantly, in order to better target incentives and support. ▪ Reviewing trends of EEM investment and their returns in order to reveal areas where governmental infrastructure programmes may be exposed to unacceptable losses/low returns.
Necessary Information: ▪ **Broad Financial performance data, which may be pre-calculated as various indicators (i.e. NPV, IRR etc.), or presented at higher level (i.e. Value of EEM investments)**	

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- **Energy consumption and cost data (across multiple vectors) before and after the installation of the EEM.**
- **Dates of application of the EEM in order to evaluate the trends in savings**
- **Filtering variables for building typology, location etc.**
- **Statistical Outputs describing benchmarked distributions (i.e. Kurtosis, Skewness)**

C. Sensitivity analysis of risks related to EEMs

Audience	Audience Objectives
Building Owners and Operators	▪ Highlighting sources of risk throughout the lifecycle of an EEM that is currently, or may be installed within their building, and the potential impact of such risks on project outcomes.
Financial Institutions	▪ Reviewing the cumulative risk present in portfolios of various EEMs, along with their potential impacts on the financial performance of the portfolio, and related risks of default.
Policy Makers	▪ Tracking portfolios that are highly sensitive to risk or are experiencing diminishing returns, in order to provide public support or warn consumers of the investment risk within these portfolios. ▪ Identifying risks that could undermine a governmental investment portfolio or emissions reduction pathway.

Necessary Information:

- **Specific financial performance indicators, which may be pre-calculated as an absolute value indicator (i.e., NPVq, IRR, PBT etc.), or calculated as a delta (changing) variable within the platform.**
- **Energy consumption and cost data (across multiple vectors) before and after the installation of the EEM.**
- **Other risk variables related to default, such as occupancy rates.**
- **Filtering variables for building typology, location etc.**
- **Statistical Outputs describing benchmarked distributions (i.e. Kurtosis, Skewness)**

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6.2.4 Recommendations for the Data Model

A. Necessary Fields

This section provides a brief overview of the fields necessary for benchmarking. A comprehensive listing of all fields relevant to EN-TRACK services is provided in section 7: Data Sources and Requirements.

The necessary fields for services in this section are presented below, along with an explanation of why they will be gathered in a given format:

Field in Question	Explanation of why data will be gathered in the given form
i **Broad Financial performance data, pre-calculated as various indicators (i.e. NPVq, IRR etc.)**	This data should be gathered in a pre-calculated format, with the user advised on the appropriate calculation method. This is most relevant, as not al cashflows will have appropriate data fields to be gathered and integrated in calculations within the EN-TRACK platform.
ii **Energy consumption and cost data (across multiple vectors) along with standardised calculation methods allow in-platform calculation of financial performance**	This data should be gathered using the user's own figures, as these are more likely to integrate all aspects (i.e. the cost of burning biomass pellets may need to include the cost of delivery and certification required for regulatory compliance). The standardised calculation methods will be input in a centralised manner to allow for equivalent calculations of cost/energy savings
iii **Broad Financial performance data, which may be pre-calculated as various indicators (i.e. NPVq, IRR etc.), or presented at higher level (i.e. Value of EEM investments)**	This data should be gathered in a pre-calculated format, with the user advised on the appropriate calculation method. This is most relevant, as not all cashflows will have appropriate data fields to be gathered and integrated in calculations within the EN-TRACK platform. Where these positive and negative cashflows and other data needed for presenting financial indicators is not available, higher level data may be used, such as the value of the data investment or revenue (income cashflows only) generated over the measures lifetime.

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iv **Energy consumption and cost data (across multiple vectors) before and after the installation of the EEM.**	This field is equivalent to field ii (see second row in this table) but must include one or more point values both before and after the EEM installation. Preferably this data would be input as a timeseries with sufficient data coverage both before and after the EEM installation.
v **Dates of application of the EEM in order to evaluate the trends in savings**	This is a simple date or date range which describes the time period over which the EEM was installed/applied. This will be used to test the sufficiency of data for use in field iv (see row above), and will be used to exclude the use of data gathered during the installation period.
vi **Specific Financial performance indicators, which may be pre-calculated as an absolute value indicators (i.e. NPVq, IRR, etc.), or calculated as a delta (changing) variable within the platform.**	This field uses specific financial performance indicators, which may be expressed as a point value or a change over time (delta or vector). If a delta is used, the time period involved should be specified (i.e. a doubling of efficiency in one week is not equivalent to a doubling of efficiency which takes a year to occur).
vii **Other risk variables related to default, such as occupancy rates.**	These risk indicators will be provided as categorical variables to allow filtering by present risk, and to see how the presence of various risks impact financial performance. These risks should be selected from a centralised enumerated list, possibly with an "Other, Please Specify:" option that will allow emerging risks to be tracked and integrated into EN-TRACK.

6.3 Track the impact of subsidies and incentives on building energy performance or EEM implementation, and track projects certified by ICP or other rating systems

PMs could obtain useful insights from EN-TRACK on the performance of subsidy programmes and on the uptake of building certifications such as BREEAM[9] or LEED[10], for example. Whilst the services described above refer to use cases relating to the impact of EEMs on building energy- or financial performance, this use case is primarily concerned with how institutional interventions, such as grant funding or centralised certification, affect EEM uptake. These use cases will use a range of both energy and financial data, along with certification or grant-funding tags. These tags will be provided by the user, whilst other fields may be automatically imported,

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or calculated within EN-TRACK to increase data availability. This section outlines each of these use cases in more detail, beginning with the tracking of subsidies.

6.3.1 Envisaged Audience(s)

This service will likely be used by all three audiences profiled in section 5, though each audience will have a slightly different use-case or primary service, depending on the key drivers that concern them.

6.3.2 Audience Drivers

Building owners and operators will likely be concerned with:

- Grant Funding available in their region/sector
- The EEMs which are frequently grant funded
- The impact of grant funding/certification on project indicators (such as energy saved, financial performance, impact on valuation etc)

Financial Institutions and investors will likely be concerned with:

- The impact of grant funding/certification on project indicators (such as energy saved, financial performance, impact on valuation etc)
- The impact of grant funding/certification on portfolio performance (particularly with regards to financial performance)

Government Officials will likely be concerned with:

- How the uptake of grant funding/certification affects the uptake and performance of EEMs within their region/sector.
- How the usage of grant funding/certification has successfully improved EEM uptake/performance in other comparable regions.
- How grant funding/certification affects governmental building portfolio performance.

6.3.3 Audience Use Cases and their Objectives

A brief overview of the use cases relevant to each audience will be presented below, collating the objectives of each audience and the information necessary to produce useful outputs and meet these objectives. An expanded version of each use case is available in the annexes of this document.

A. Tracking the impact of subsidies and incentives on building energy performance or EEM implementation

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Audience	Audience Objectives
Building Owners and Operators	▪ Determining the usage patterns of grant funding available in their region/sector, including which EEMs which are frequently grant funded. ▪ Determining the impact of grant funding on project indicators (such as energy saved, financial performance, impact on valuation etc)
Financial Institutions	▪ Determining the impact of grant funding on project indicators (such as energy saved, financial performance, impact on valuation etc) ▪ The impact of grant funding on portfolio performance (particularly with regards to financial performance)
Policy Makers	▪ Monitoring the level of uptake of subsidies and incentives in their markets ▪ Assessing the extent to which subsidies are improving building energy performance in general ▪ Assessing the extent to which subsidies are driving the adoption of specific EEMs ▪ Determining how grant funding affects governmental building portfolio performance.
Necessary Information: ▪ **Yes / No field to allow users to confirm whether or not a subsidy or incentive was used** ▪ **If yes, type of subsidy or incentive used for a specific EEM / project (drop down list: grant, loan, tax break, other subsidy), the presence of grant funding conditions (Boolean yes-no), conditions of grant funding (matched, non-matched etc), grant funding source (Government, Non-profit, Development Agency etc)** ▪ **Amount of subsidy** ▪ **Correlation to single or multiple EEMs / projects** ▪ **Broad Financial and Energy performance data, p**rovided by the user through **various indicators (i.e. NPV, IRR, Emissions reductions etc.)** ▪ **Energy consumption and cost data (across multiple vectors) along with standardised calculation methods allow in-platform calculation of energy and financial performance** ▪ **Filtering variables for building typology, location etc.**	

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▪ **Statistical Outputs describing benchmarked distributions of financial/energy performance indicators (i.e., Kurtosis, Skewness)**

B. Tracking levels of certification of ICP, LEED, BREEAM and other relevant green building standards or protocols

Audience	Audience Objectives
Policy Makers	▪ Monitoring the level of uptake of ICP or green building certification systems in their markets ▪ Tracking changes in certifications over time ▪ Understanding any correlations between the uptake of certifications and subsidy programmes
Necessary Information: ▪ **Yes / No field to allow users to confirm whether or not a building has been certified** ▪ **If yes, type of certification (drop down list: ICP, LEED, BREEAM, DGNB, other - specify)** ▪ **Date of certification** ▪ **Yes / No field to allow users to confirm whether or not a certification was supported by a subsidy / incentives**	

C. Tracking the impact of certification (ICP or other rating systems) on building energy efficiency or EEM implementation

Audience	Audience Objectives
Building Owners and Operators	▪ Determining the usage patterns of various certification types available in their region/sector, including which projects are frequently certified. ▪ Determining the impact of certification on project indicators (such as energy saved, financial performance, impact on valuation etc)
Financial Institutions	▪ Determining the impact of certification on project indicators (such as energy saved, financial performance, impact on valuation etc.) ▪ The impact of certification on portfolio performance (particularly with regards to financial performance)

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Policy Makers	▪ Determining how the uptake of certification affects the uptake and performance of EEMs within their region/sector. ▪ Determining how the usage of certification has successfully improved EEM uptake/performance in other comparable regions.

Necessary Information:

- **Broad Financial and Energy performance data,** provided by the user through **various indicators (i.e. NPV, IRR, Emissions reductions etc.)**
- **Energy consumption and cost data (across multiple vectors) along with standardised calculation methods allow in-platform calculation of energy and financial performance**
- **Categorical variables tracking the use of certification (Boolean yes-no), type of certification (ICP, Energy Performance Certification, ISO50001), the name or unique identifier of the accredited professional who has undertaken the project certification.**
- **Filtering variables for building typology, location etc.**
- **Statistical Outputs describing benchmarked distributions of financial/energy performance indicators (i.e. Kurtosis, Skewness)**

6.3.4 Recommendations for the Data Model

A. Necessary Fields

A brief overview of the fields necessary for benchmarking is introduced in this section. For a detailed overview of all fields relevant to EN-TRACK services, see section 7: Data Sources and Requirements.

The necessary fields for services in this section are presented below, along with a description of why they will be gathered in a given format:

Field in Question	Explanation of why data will be gathered in the given form
1) **Categorical/boolean variables tracking the use of grant funding (Boolean yes-no), type of grant funding (matched, non-matched etc), the presence of grant funding**	This data should be gathered directly through the user interface or initial data submission, as it cannot be imported automatically. The data should be in categorical or Boolean formats, as it will be used as a filtering variable for financial

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conditions (Boolean yes-no), grant funding source (Government, Non-profit, Development Agency etc)	and energy benchmarking, or the independent variable for simple categorical histograms. There may be a requirement to collate and curate a list of grant funding types and sources, which can be gathered through consultations with data providers and users.
2) **Categorical/boolean variables tracking the use of certification (Boolean yes-no), type of certification (ICP, Energy Performance Certification, ISO50001), the name or unique identifier of the accredited professional who has undertaken the project certification.**	This data should be gathered directly through the user interface or initial data submission, as it cannot be imported automatically. The data should be in categorical or Boolean formats, as it will be used as a filtering variable for financial and energy benchmarking, or the independent variable for simple categorical histograms. There may be a requirement to collate and curate a list of certification types and sources, which can be gathered through consultations with data providers and users. Additionally, a text tag is required to provide the name or unique identifier of the accredited professional who has undertaken the project certification. This data field will be used for internal confirmation/verification only.

B. Necessary Calculations

There are no necessary calculations for this service, save those described in prior sections for calculating broad Financial and Energy performance data. A simple verification/confirmation task is required however, which can be coded into the user interface to disallow submission of certification tags where the name or unique ID of the accredited certification professional has not been provided.

6.4 Additional Services

The EN-TRACK platform intends to provide additional services that do not correlate to specific audiences and use cases, but generally aid the development of a robust data model and data collection procedures. One such service is the definition of Monitoring and Verification (M&V) procedures, which describe not only data collection methodologies, but robust and appropriate methods for adjusting and presenting the data within the context of monitoring and verifying energy savings. This service, and other similar supporting services (around valuation and comfort) will be described briefly in the annex of this document, and where necessary, in separate supporting documents.

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7 Data requirements and data sources

This section briefly discusses the data requirements and initial data sources, that have been selected as they align with each of the service categories discussed in Section 6. Table 3 provides an overview.

As part of the wider EN-TRACK project, a more detailed set of data sources will be defined within deliverable 1.2 (D1.2), to be completed in month 12 (October 2021) of the project. It is important to note that data provided via application programming interfaces (APIs) and databases will be complemented with user-supplied data directly through a functionality in the EN-TRACK user interface (UI). A key element of the project is to incentivise users to supply data in exchange for additional services.

Table 3: Exemplar data needs and data sources corresponding to service categories

Service Category	Example Data needs	Example Data sources
Benchmark and compare the performance of buildings before and after projects / EEMs	Technology performance data	Pilots
	Energy data	Utility bills, meter data, EPC or other energy audits
	Performance of individual / suites of EEMs or entire buildings	Data from energy performance certificates (EPCs), EEM lists.
Benchmark and compare the financial performance of EEMs	Financial performance and risk data including portfolios (standardised)	Financial statements
	Timeseries & M&V data comparable to other asset classes / project finance opportunities	Summary performance data
Track the impact of grant funding on building energy efficiency or EEM implementation, and track projects certified by ICP or other rating systems	ICP certified projects, LEED, BREEAM and other rating systems certifications across EU MS	Summary lists of certifications provided by accredited parties and/or accreditation providers
	Grant and subsidy information	National databases or summaries of spending

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7.1 Operations and Maintenance (O&M) data

While O&M data is not the primary concern of the EN-TRACK platform, it holds key insight for the platform's activities and services. One example would be the presence of non-energy benefits arising from reduced down-time and costs associated with O&M activities. O&M activities may also represent a significant risk for energy efficiency projects and their financial outcomes, and so this is another key area where O&M data is relevant. O&M costs can also be integrated into other cash flow data, and this may be easier to collect, though it would require an additional field or data tag recording the components of any aggregated (net) cash flows.

One key barrier to the collection of O&M data is the dispersal of data across several departments. Due to this it is advised that O&M data is collected through the User Interface (UI) where possible, in order to provide the user with the time and space necessary to assemble the data within their organisation. Collecting wide-ranging O&M data is a significant challenge and potential limiting factor to the feasibility of offering O&M services. For this reason a data-first approach, that can easily be appended to existing visualisation tools, must be taken to the development of these services.

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8 Definition of investment and risk indicators

The following chapter includes definitions of the key investment and risk indicators for financial institutions, relevant to the EN-TRACK platform and data model.

8.1 Investment indicators

Investment indications are metrics financial institutions use to track, measure, and analyse the financial health of the project. By using these metrics, financial institutions can better understand the financial valuation of the projects.

For each potential project, you need to consider whether the expected return warrants the investment and how the opportunity ranks among all the considered projects within a projected portfolio.

Internal rate of return (IRR). The internal rate of return is used to estimate the profitability of a potential investment. It is essentially a discount rate which makes the net present value of cash flows equal to zero. If the IRR of a project is higher than a company's required rate of return, that project is attractive. If IRR is lower than the required rate of return, the project is not attractive to the investor.

Net Present Value quotient (NPVq). The difference between the present values of cash inflows and outflows over a certain period of time, normalised by each unit of currency invested to allow comparison of projects with different investment costs. NPVq is used to analyse the potential profitability of an investment, and compare this profitability between projects with different investment costs. A positive NPVq indicates that investing in the project is more profitable than passing on the opportunity. NPV in comparison is an absolute measure, not normalised by investment cost, and therefore is best used when comparing the profitability between projects of a similar scale to give a straightforward comparison.

Payback years. Refers to the amount of time it takes (in years) for a project to reach break-even. This metric should only be used in conjunction with other metrics.

Investment multiplier. This metric express: [sum of future cashflows / CAPEX]. The investment multiplier indicates the stimulative effects of public or private investments. Theoretically, the higher the investment multiplier is, the larger stimulative effect the investment will have on the economy.

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Table : Summary of investment indicators

Indicator	Inputs	Unit	Calculation
Project CAPEX	Direct input	€ / £ / …	
Value of loan/investment	if different from Project CAPEX: 1) Project CAPEX 2) Self-finance amount	€ / £ / …	Project CAPEX [minus] Self-finance amount
Net annual income	either: 1) Direct input, or 1) Gross annual revenue 2) OPEX"	€ / £ / …	gross annual revenue [minus] OPEX
Energy savings	Direct input	kWh/y	
Gross annual revenue/savings	1) Energy savings [multiplied by] energy price 2) Other revenue/savings (e.g O&M) 3) incentives"	€ / £ / …	sum of all revenue
Simple payback	1) Value of EE investment 2) Net annual income"	years	Value of EE investment [divided by] Net annual income
NPV	1) CAPEX 2) Net annual income (assumed to be static?) 3) Discount rate	€ / £ / …	$NPV = \sum_{t=1}^{n} \frac{R_t}{(1+i)^t}$

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NPVq	Io = Investments in zero year	€ / £ / …	$NPVQ = \frac{NPV}{Io}$
IRR	1) CAPEX 2) Net annual income (assumed to be static?)	%	$0 = \mathrm{NPV} = \sum_{t=1}^{T} \frac{C_t}{(1+IRR)^t} - C_0$
VaR (parametric)	1) Distribution of performances (to derive its standard deviation) 2) Confidence level (90%/95%/99%) and respective z-score 3) Value of investment	€ / £ / …	VaR = [Expected weighted return of the portfolio - (z-score of the confidence interval x standard deviation of the portfolio)] x portfolio value

8.2 Risk indicators

Risk is inherent to all financial transactions, and its assessment occupies whole departments at large financial institutions, energy efficiency finance is no exception. Risk indicators are used by financial institutions to measure their exposure to a certain risk at a certain time. By comparing an appropriate set of risk indicators with internal thresholds, financial institutions can decide whether their risk exposures are within their risk appetite. The following shows a list of the relevant risk types.

- Credit - end client

Credit risk generally refers to the possibility of loss for a creditor due to failure by a debtor or borrower to pay back interest and/or principal amounts of debt. In the context of energy efficiency projects, the main (and many times only) source of repayment is the cash flow generated by projected and agreed upon savings.

- Market

Just like companies receive credit ratings, so can markets be assigned a rating. Consequently, markets with good credit ratings will have a reasonable level of debt, a good track record of paying it back, as well as a healthy earnings potential.

- Electricity price

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The price of electricity is far more volatile than that of other commodities.

- Technical

Technical risk relates to equipment malfunction and/or breakdown and its treatment is generally considered one of the most standardized for all risk categories.

- Performance

The main factors included in this risk type are as follows

  - Faulty design
  - Flaws in the implementation of EE measures
  - Incorrect operation after implementation of the measures
  - Fluctuation of usage patterns, including changes of user behaviour

- Operation and maintenance (O&M)
  - Historical O&M performance by O&M provider
  - Credit quality of O&M provider (in case it is different from the Contractor)
  - M&V systems used for outage detection
  - Downtime period estimation
  - Number of O&M staff compared with commercial growth
  - Presence and nature of any back-up O&M arrangements
- Occupancy
  - How are energy consumption baselines adjusted for change in occupancy levels?
  - Which % of drop in occupancy level is (still) financially sustainable?
  - Is there a contractual stipulation in case of decommissioning of the facility where measures were installed? (e.g. termination schedule)
  - Is there a contractual stipulation that specifies at which state the Promoter/Contractor is no longer obliged to provide services?
- Management
  - Type of entity
  - Sector of activity, including sector code
  - Number of employees
  - Ownership structure
  - Background and track record of key management personnel

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- Construction

Construction risk refers to the difference between the ex-post or real cost and the ex-ante or expected cost, usually expressed as a percentage of the ex-ante cost estimate.

8.3 Additional Use Cases: DEEP- and ICP-aligned Taxonomies and Calculation Methods

Although not described as a separate service, the alignment of calculation methods between the EN-TRACK platform and the DEEP system and the alignment of terminologies with the BEDES taxonomy present a particularly relevant use-case. For those working in the sector who are not familiar with the specific definitions of building terminologies, or financial indicators, the EN-TRACK platform can provide a central ecosystem for data submission and transformation that ensures institutional reporting is aligned with the current industry best-practice. This usefulness of this case is further developed by the EN-TRACK platforms Extract-Transform-Load (ETL) module, which can then feed aligned data streams directly into the relevant database.

9 Summary indicators

To assist in the development of the data model, this section summarises the main indicators that are relevant or required to enable various service categories related to building and EEM performance, and for the EN-TRACK platform to deliver recommendations for BO and FI in particular.

These indicators are organised around three main types of metrics – energy, financial and emissions – whereby the performance of buildings and EEMs can be benchmarked against these indicators in a longitudinal or cross-sectional manner[15]:

- Longitudinal benchmarking tracks the performance of a single building or set of measures in that building against itself, meaning how performance improves or worsens over time compared to prior years, for example.
- Cross-sectional benchmarking the performance of a building/measures against other peer buildings.

Tables 5 and 6 on the following pages provide an overview of summary indicators for BO and FI, respectively.

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Table 5: summary of indicators for BO

Building Owners & Operators (BO)						
				Energy metrics	Financial metrics	Emissions metrics
Service categories	Building performance	Cross-sectional benchmarking	consumption-related	kWh/m2/yr	€/m2/yr	gCO2/m2/yr
		Longitudinal benchmarking	consumption-related	kWh	€	gCO2
	EEM performance	Cross-sectional benchmarking	savings-related	kWh/m2/yr	€/m2/yr	gCO2/m2/yr
		Longitudinal benchmarking	savings-related	kWh/m2	€/m2	gCO2/m2
		Cross-sectional benchmarking	avoidance cost		€ cent/kWh	
		Cross-sectional benchmarking	ROI (payback, NPV, IRR)		years, €, %	
		Recommendations	EEMs for specific building characteristics	expected savings kWh/m2/yr	expected investment €/m2 savings €/m2/yr payback years	expected savings gCO2/m2/yr
		Recommendations	EEMs to achieve target	expected savings kWh/m2/yr	expected investment €/m2 savings €/m2/yr payback years	expected savings gCO2/m2/yr
		Recommendations	EEMs to prioritise budget	expected savings kWh/m2/yr	expected investment €/m2 savings €/m2/yr payback years	expected savings gCO2/m2/yr

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Table 6: summary of indicators for FI

Financial Institutions (FI)						
				Energy metrics	Financial metrics	Emissions metrics
Service categories	Building performance	Cross-sectional benchmarking	consumption-related	kWh/m2/yr	€/m2/yr	gCO2/m2/yr
		Longitudinal benchmarking	consumption-related	kWh	€	gCO2
	EEM performance	Cross-sectional benchmarking	savings-related	kWh/m2/yr	€/m2/yr	gCO2/m2/yr
		Longitudinal benchmarking	savings-related	kWh/m2	€/m2	gCO2/m2
		Cross-sectional benchmarking	avoidance cost		€ cent/kWh	
		Cross-sectional benchmarking	ROI (payback, NPV, IRR)		years, €, %	
		Recommendations	EEMs for specific building characteristics	expected savings kWh/m2/yr	expected investment €/m2	
		Recommendations	EEMs to achieve target	savings €/m2/yr		
		Recommendations	EEMs to prioritise budget	payback years"	expected savings gCO2/m2/yr	

10 Non-energy benefits

10.1 The need for non-energy benefits

The accounting of non-energy benefits in the energy efficiency investment process plays two important roles. Firstly, the accounting of non-energy benefits (NEBs) can have a drastic impact on the financial modelling of investments, enabling energy investments that would not be

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viewed as financially viable based upon energy cost savings alone. Inclusion of NEBs can improve accounting methodologies generally, connecting the costs and benefits of investments (energy or otherwise) to the process improvements which constitute the core business of many institutions.

Secondly, the internal corporate accounting of NEBs, and their subsequent reporting to ecosystems such as EN-TRACK, reveals much about the internal context of institutions, including their routines and management systems alongside their strategic vision. A focus on employee retention may indicate that an institution is skills-focussed, suffering labour shortages, or operating in a highly competitive employment environment. By focussing on the strategy and context of individual institutions, the accounting of energy investments can bypass the symptomatic barriers of the business, such as lack of capital and senior management resourcing, and focus on implementing a strategically relevant project. A database demonstrating the validity and effectiveness of this approach is required at an actuarial level to improve the market uptake of this aspect of energy accounting.

Finally, the accounting of non-energy impacts is essential in enabling "as-a-service" business models where the indoor environment quality and other NEBs form a core part of the value proposition of the business model. The inclusion of NEBs in the EN-TRACK system will support the measurement and verification of these approaches and their outcomes. These business models are in various stages of development and deployment and, although their social impact has yet to be recorded and studied comprehensively, it is clear that they have significant potential for better addressing socioeconomic issues such as health equity and fuel poverty. EN-TRACK will not offer services in this realm but does aim to develop the data ecosystem that will enable and support work in this realm.

10.2 State of the art approaches across the EU: MBenefits & COMBI

This section highlights two projects that are advancing the state of the art of NEB analysis in the EU:

- The COMBI project[11], working to model and quantify more than 35 individual NEB impacts arising from energy efficiency improvement action. The summary of the COMBI project's estimated quantification of NEB values can be found in Annex 12.2 (NEB).
- The MBenefits project[12], which aims to encourage the inclusion of NEBs in corporate decision making by developing a training platform, create NEB tools and working directly with organisations to evaluate these deliverables and their impact. The four analytical steps of the MBenefits project are presented in Annex 12.2 (NEB), along with an exemplar project description (Annex 12.2 (NEB)).

Finally the COMBI project aims to build on these estimations within the specific context of EN-TRACK, and their outputs will be integrated into the recommendations in this section to produce a rigorous and cutting-edge NEB estimation process.

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10.3 Recommended approaches for EN-TRACK: Estimation vs Surveying

It is envisaged that both the approaches discussed above will be integrated into the EN-TRACK platform, in order to capture data from institutions and building owners at various scales, both with and without the capabilities to carry out their own NEB analysis or surveying. Both of these methods will be supported by the upload of Comfortmeter[13] data, which will provide a proven methodological basis for these approaches in buildings and institutions with 30 or more occupants.

In order to determine the nature of data input available to the user, the NEB module will first ask generic questions about the project in question, leading to further conditional questions, as displayed in Annex IV (NEB).

Estimation

The estimation methodology will not be finalised until the work of the COMBI project has been completed and made publicly available. The methodology will be simple, utilising characteristics of the building and the project (such as building type, measured installed, and value of the project), gathered above in questions 5-7. The estimation methodology should be used wherever the data owner has not conducted their own estimations.

Surveying:

The surveying methodology will capture both quantitative and qualitative information, whilst requiring minimal technical knowledge to complete. The survey can be found in Annex 12.2 (NEB).

The Comfortmeter approach

The Comfortmeter approach is a proven survey methodology for gathering data on comfort and other NEBs. The survey used a statistical approach to produce analysis and outputs, and therefore requires a minimal level of engagement: namely responses from 30 or more building occupants. Due to this condition, and the time required to engage occupants in two or more Comfortmeter surveys, it is not envisaged that many institutions will be able to provide this data. Nevertheless, the EN-TRACK platform should provide the option to input both pre-project and post-project Comfortmeter surveys to support the gathering of NEB data.

It is envisaged that this data will be presented to show changes in Comfortmeter outcomes across an institution's own building portfolio, until the point at which statistically significant portfolios of this data are available across representative market segments.

10.4 Recommendations for the analysis of non-energy benefits

NEB data analysis presents challenges which may not be present across other EN-TRACK services, namely due to the mixture of data types present in NEB data inputs. The presence of qualitative and long-form text data will make some forms of analysis impossible but will allow the transfer

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of lesson learnt between data owners within a single institution. Below the various types of suitable analysis are described for the various segments of NEB data.

The user's numerical estimations of the value of NEBs (as opposed to those generated within EN-TRACK) will be presented as numerical distributions, utilising the same benchmarking engine common to many of the EN-TRACK services.

The categoric variables gathered in the surveying approach will be presented as "count" bar charts, displaying the number of institutions that reported project contributions to each aspect of operational excellence (Safety, Quality, Costs, Time) (Question 4). The number of contributions from each measure type can be presented for each of these operational excellence aspects (Questions 5 and 6), providing a set of measures that can be used to influence each aspect. Finally, the value of impacts across each of the operational excellence aspects can be displayed as a numerical distribution (Question 9). Filtering variables for each of these analyses could be derived from Questions 3 and 9, which describe the investment drivers and the verification of NEB values.

Changes in Comfortmeter outcomes across an institution's own building portfolio will also be presented as numerical distributions, summing "before" and "after" surveys from multiple sites separately to present a general "before" and "after" picture across a varied building portfolio.

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11 EN-TRACK data model

This chapter presents the initial version of EN-TRACK's data model and the rationale behind the approach to its design. The model has been developed by an iterative process involving multiple stages of modification, re-arrangement, and joint revision with the consortium's members. The intention here is to explain the logic behind the model rather than providing an exact narration of what was done. Thus, the design steps were not necessarily performed in the same order, or the same number of times, as presented here.

The starting point for EN-TRACK's data model is represented by the information collected during the preliminary study of the user profiles, the use cases, and the external tools, reported in sections 5 to 9 of this document, with which the platform aims to be compatible. The core concepts around which EN-TRACK's model had to be built were extracted from the result of this work, grouped in wider core concepts, and modelled as classes in the UML diagram. Subsequently, the necessary attributes were defined for each class, selected once again from the finding of the use-cases study phase, and appropriate tables were created to include more detailed information, including a description, the data type, and, if applicable, mappings to the external sources.

In order to meet the compatibility requirements of EN-TRACK, presented in section 3, the procedure was conducted paying particular attention to the terminology adopted, ensuring compatibility with existing third-party applications wherever possible. This was particularly relevant for the attributes concerning investment indicators and project-level information, for which interoperability with DEEP, eQuad, EnerInvest, and other third-party solutions had to be ensured.

The current version of EN-TRACK's data model is fully captured by the combination of the Unified Modelling Language (UML) diagram and the tables, which can be found in the Annexes and present each field's data type, a definition of the information contained within, and any relevant correspondence/alignment with DEEP platform.

The model presented in this deliverable is still in a preliminary version and is therefore affected by some limitations. Although no significant structural changes are expected to take place in the future work phases, the design is still open for future modification, renaming, or complementing of the attribute data fields. Moreover, it is important to note that only the input data is extensively developed in the current model, whereas the structure of the output is still to be fully defined.

A description of individual attribute fields within the data model can be found in the Annexes, presenting each field's data type, a definition of the information contained within, and any relevant correspondence/alignment with the DEEP data model.

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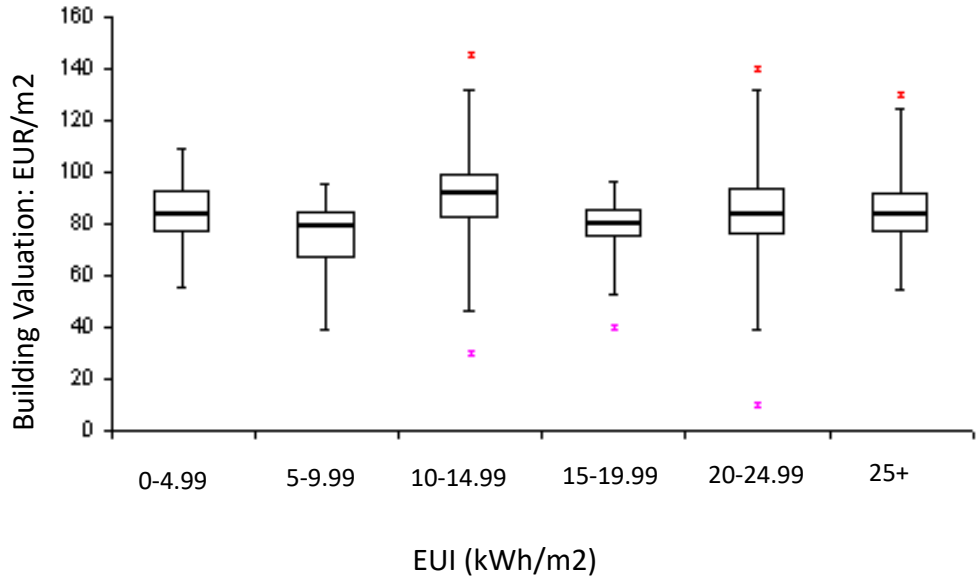
12 Annexes

12.1 Additional Use Cases (Valuation, Comfort and M&V)

The following valuation services have been proposed based upon the effects of energy performance certificates on increasing building valuations[14] which in turn links to investor valuations, determined by Capital Gains and the Rate of Return (rental surplus).

Code	Name
AN1	Benchmarking of EUI (modified by EEMs) effects on valuation (capital gains)
Description	
By selecting a building use/construction type or building age, the User Interface (UI) would display a valuation distribution for buildings of various EUIs	
	
Input fields	Valuation of Building (EUR/m2) across EUI brackets • Independent: EUI (kWh/m2 [gross internal or other]) • Dependent: Valuation of Building (EUR/m2 [gross internal or other])
Output fields	Average Valuation (EUR/m2) for a given EUI bracket, population parameters (variance, standard deviation, skewness, kurtosis)
Filtering fields	Country City/locality/ZIP code Building construction type Building use type Building age Level of Granularity of EUI brackets
Comments	
Opportunity for user to input a EUI/building valuation figure for one of their buildings, to highlight its relative position within the distributions.	

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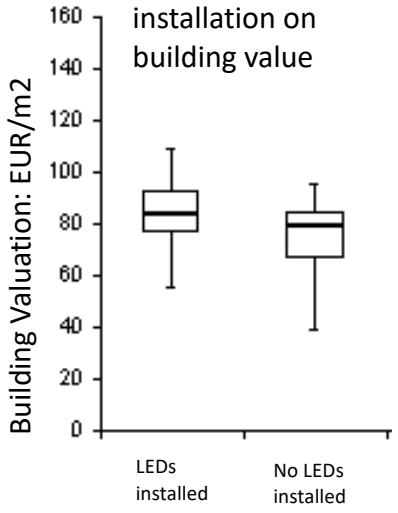
Code	Name
AN2	Benchmarking of the effects of implementing a specific EEM on valuation (capital gains)

Description

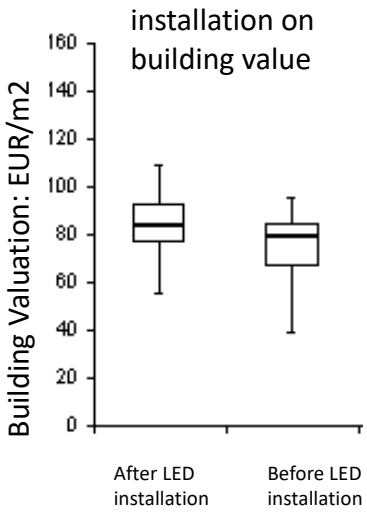
By selecting a building use/construction type or building age, the User Interface would display valuation distributions for buildings where 1) valuation data exists with or without the implementation of EEM; or 2) valuation data exists for before and after the implementation of EEM.

A third implementation exists, which would display (for a single selected EEM) a timeseries of valuation distributions (EUR/m2) for before the project, immediately after the project and for each following year where valuation data has been submitted. This implementation has not been mocked up as it would require large numbers of building completing regular valuations, collecting a statistically significant sample of which seems unfeasible.

1):



2):



Input fields	1. Valuation of Building Typologies with or without the implementation of various EEM/permutations of EEM. 2. Relative change in Value (%) before and after EEM of various types (EEM category) (would require valuation timeseries spanning the design and installation period or separate “before” and “after” figures) All implementations require the confirmation of an EEM installation for a given date
Output fields	1. Average difference in Valuation (EUR/m2) for building with/ without EEM of various types (EEM category) 2. Average change in Value (relative: % or absolute: EUR/m2) before and after EEM of various types (EEM category)
Filtering fields	Country City/locality ZIP code Building construction type

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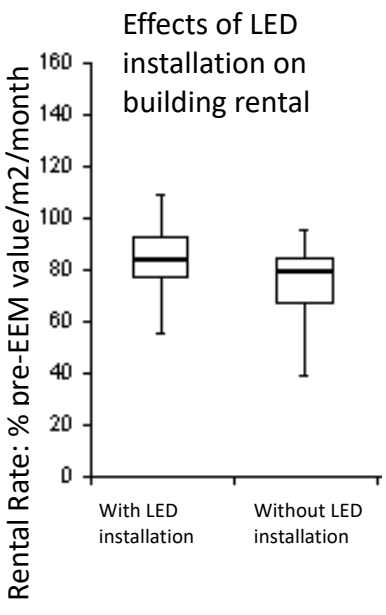
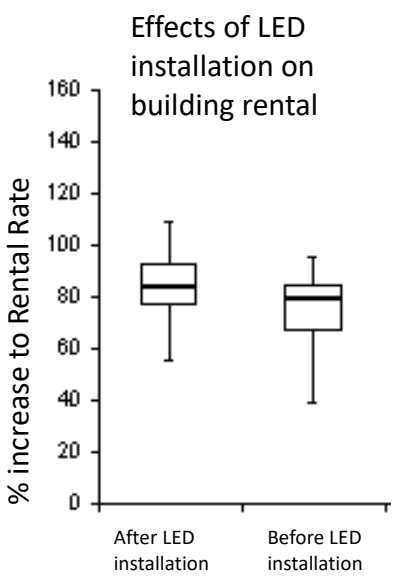
	Building use type Building age
Comments	
Implementation 1 builds in variation between buildings (as the portfolios contain different sets of buildings) & will include effects that co-correlate with increased investment with EEM (i.e. Grade A ranking for commercial properties). Implementation 2 excludes these co-variances, the buildings present in the "after" category are the same set of buildings as in the "before", however this implementation has additional data requirements. There is an opportunity for users to input a EUI/building valuation figure for one of their buildings, to highlight it's relative position within the distributions. Normality parameters may be useful for testing for skewness and kurtosis.	

Code	Name
AN3	Benchmarking of the effects of implementing specific EEM on rate of return (valuation derived from rental rate)
Description	
By selecting a building use/construction type or building age, the User Interface would display % rate of return (monthly rental rate/pre-EEM building valuation) distributions for buildings where 1) rental rate data exists with or without the implementation of EEM; or 2) rental rate data exists for before and after the implementation of EEM.	
1):  	2): 
Input fields	1. % rate of return (monthly rental rate/pre-EEM building valuation/m2) of Building Typologies with or without the implementation of various EEM/permutations of EEM. 2. Relative change in monthly rental rate (%) before and after EEM of various types (EEM category) (would require rental rate timeseries spanning the design and installation period or separate "before" and "after" figures) All implementations require the confirmation of an EEM installation for a given date

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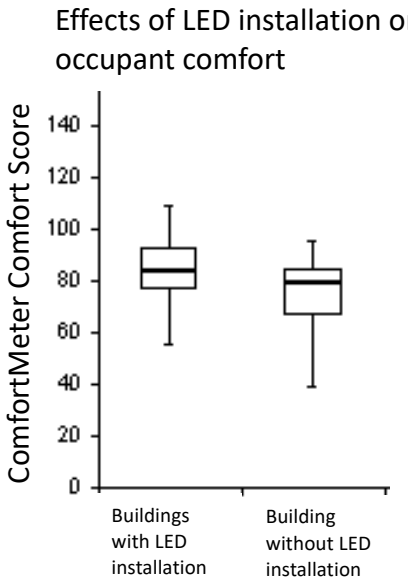
Output fields	1. Average absolute difference in rate of return (%) for building with/ without EEM of various types (EEM category) 2. Difference in relative change in rate of return (%) before and after EEM of various types (EEM category)
Filtering fields	Country City/locality/ZIP code Building construction type Building use type Building age
Comments	
Implementation 1 builds in variation between buildings (as the portfolios contain different sets of buildings) & will include effects that co-correlate with increased investment with EEM (i.e. Grade A ranking for commercial properties). Implementation 2 excludes these co-variances, the buildings present in the "after" category are the same set of buildings as in the "before", however this implementation has additional data requirements. These implementations work best with a short timeseries, where a "jump" in rental rates occurs post-EEM; or for longer timeseries provided there are sufficient "pre-EEM" datapoints to baseline changes to rental rates unrelated to EEMs.There is an opportunity for user to input a EUI/building valuation figure for one of their buildings, to highlight its relative position within the distributions. Normality parameters may be useful: skewness and kurtosis.	

Code	Name
AN4	Benchmarking of ComfortMeter survey outputs based upon implementation/non-implementation of an EEM
Description	
By selecting a singular EEM, the UI would display a ComfortMeter comfort score distribution for buildings that have or have not implemented said EEM.	



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Input fields	• Independent: confirmation of installation of specified EEM • Dependent: ComfortMeter Comfort Score (or score distribution) (Indoor Environment Quality or User well-being)
Output fields	Average Difference in statistical population parameters (mean comfort, standard deviation, skewness or kurtosis of survey results) between occupants of buildings with or without the specified EEM present
Filtering fields	Country City/locality/ZIP code Building construction type Building use type Building age Desired ComfortMeter Score type: IEQ or Well-being
Comments	
Opportunity for user to input an average ComfortMeter score for one of their buildings, to highlight its relative position within the distributions. Normality parameters may be useful: skewness and kurtosis.	

The following use cases provide analysis and benchmarking of M&V approaches, utilizing the following factors of the M&V outcomes: complexity (number of adjustments and normalisation variables: measure of possible “overfitting” or M&V “engineering”); accuracy (deviation from estimated savings), performance (relative overestimation vs underestimations, underperformance mechanism activation)

Code	Name
AN5	Benchmarking of Discrete M&V KPIs for each M&V option for a given EEM and independent variable set (production data, HDD, CDD, other).
Description	
By selecting a singular EEM, the UI would prompt the user to select the KPIs they are concerned with (see output variables), and enter the filter variables: independent variable set used to normalise their consumption data (i.e. HDD and occupancy equivalents for a boiler). Based upon this data the API would then present a distribution of said KPIs for each IPMVP option applied to an EEM measure record (or sufficient number thereof). The suggested user profile is an M&V professional looking for the best M&V approach for their project	

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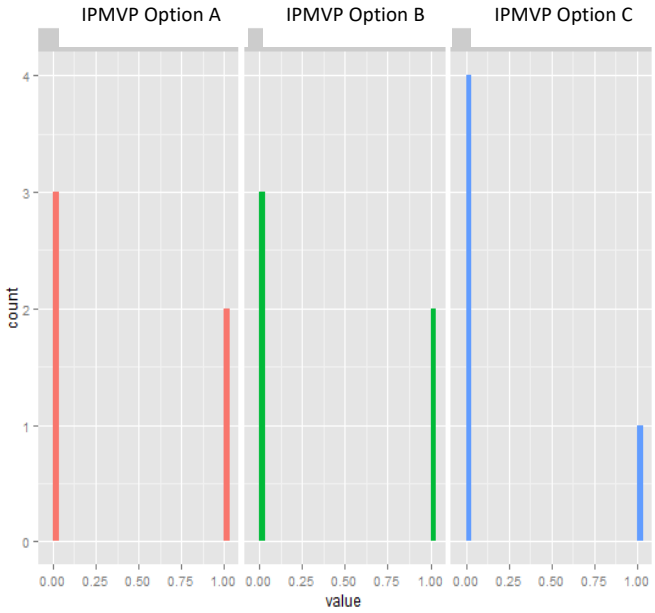
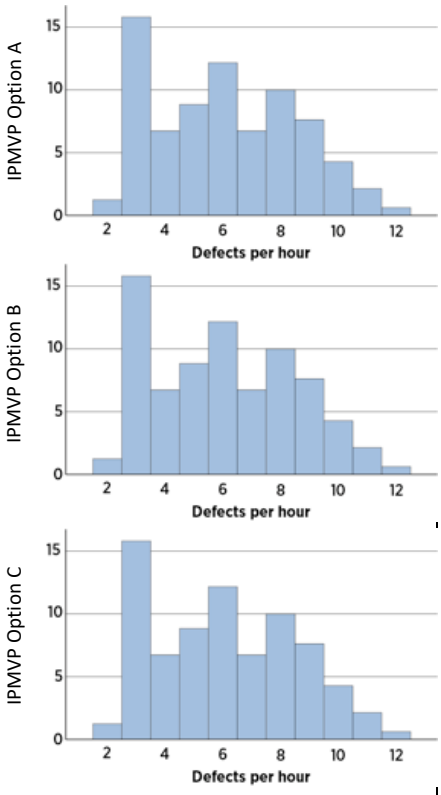
Activation of underperformance mechanisms for ground source heat pumps under various IPMVP Options



Number of non-routine adjustments for Boiler replacements



Input fields	• Independent:
	  ○ EEM in question
	  ○ Confirmation of IPMVP option for EEM records
	• Dependent: Selection of Desired/relevant KPIs (filtering)

Output fields	Distribution of Desired/relevant KPIs for each EEM:IPMVP option union sufficiently present in the dataset. A non-exhaustive list of discrete M&V KPIs includes: number of non-routine adjustments, activation of an underperformance mechanism, number of reactive maintenance events, reconciliation of changes to production/use changes with M&V models (i.e. production schedule changes, can M&V model reconcile differences: yes or no). Output as a categoric histogram listing discrete options: whole number of events, binary yes or no
Filtering fields	Country/City/locality/ZIP code Building construction type/ Building use type/Building age Independent modelling variable set (multiple selection: HDD, CDD, Production data, occupancy data, input material parameters [moisture content, surface area to volume ratio, etc.])
Comments	

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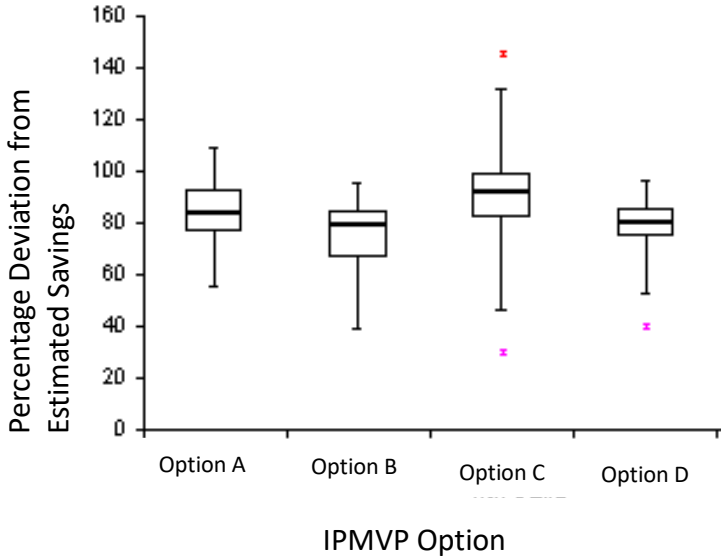
Code	Name
AN6	Benchmarking of percentage savings over/underestimation (bounded -100% with no upper bound) for each M&V option for a given EEM and independent variable set (production data, HDD, CDD, other).

Description
By selecting an EEM and independent variable set (used for M&V normalisation), the UI would display a percentage over/underestimation distribution for each IPMVP option sufficiently present in the database.



Vertical axis should read -100% to +100%, or whatever the maximum underestimation in the dataset it.

Input fields	Energy/Cost savings over/underestimation (%) across IPMVP Options • Independent: IPMVP Options, independent M&V Variable set (normalisation) • Dependent: Energy/Cost savings over/underestimations (%)
Output fields	Distribution of Energy/Cost savings over/underestimations (%): mean figure, skewness, kurtosis
Filtering fields	Country City/locality/ZIP code Building construction type Building use type Building age Independent M&V Variable set (normalisation)

Comments
Prepare for non-normal distributions, including zero-inflation and skewed tails.

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12.2 Non-Energy Benefits Annexes

Annex I (NEB)

Table YYY. Estimated Value of Participant-Reported Non-Energy Benefits — Extra NEB Value as a Percent of Energy Savings from the Measure (Source: Skumatz Economic Research Associates surveys)

End Use	Commercial	Residential
HVAC	100%	120%
Window measures	-	110%
Refrigerators	25%	100%
Washers	-	(small sample*)
Weatherization	-	60%
Lighting	40%	100% (multifamily only)
Education, associated with measure programs	-	10%(small sample*)
Water measures (comm' 1)	60%	-
Overall measures—all end uses	50%	-

Non-Energy Benefits in the Residential and Non-Residential Sectors- (seattle.gov)

Annex II (NEB)

Considering first the MBenefits project, we can see the MBenefits methodology integrates four analytical steps:

1) Company Analysis: Analysis at company level to better understand its business model and value proposition. Although the aspects of business modelling are less relevant to the EN-TRACK platform, the company's decision-making drivers can be integrated in the platform without compromising on anonymity.
2) Energy and Operations Analysis: This includes a conventional energy analysis, occurring at the project level. The dedicated operational analysis step determines a projects contribution to operational excellence, considering the four key components: Safety,

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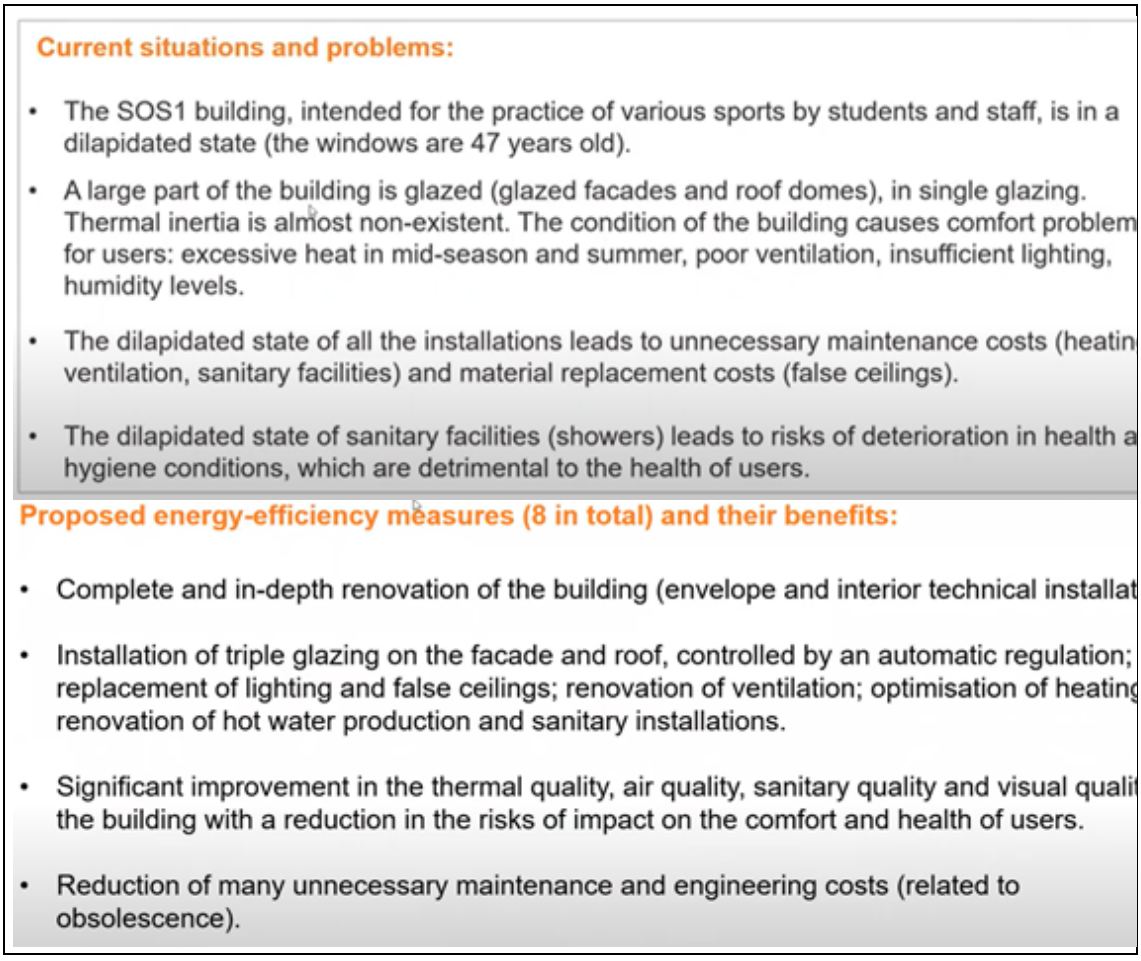
Quality, Costs and Time. Some components will be more relevant to some business sectors than others.

3) Strategic Impacts: This occurs at the project level, considering the impacts on value propositions, impacts on risks, and impacts on costs.

4) Financial impacts: This occurs at the project level, transferring the results of steps 2 and 3 into an impact on financial modelling parameters such as profitability.

Annex III (NEB)



Annex IV (NEB)

Question	Suitable Methodologies based upon response

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1) Would you like to receive an estimation of the NEBs that may be realised over the course of your project?	If yes, one or more surveys should be offered to the user. The estimation survey will be used unless the user answers "yes" to question 2 below.
2) Did you conduct a calculation/estimation of non-energy benefits during the pre-implementation stages of your project?	If yes, do not use the EN-TRACK estimation methodology. Do instead offer the survey methodology (presume "yes" for Q4).
3) Did your project include a Comfortmeter survey at any stage, and would a post-implementation comfortmeter survey be available?	If yes, Comfortmeter data should be input alongside estimation/surveying of NEB financials.
4) Are you able to complete a short, non-technical survey that describes the presence and value of NEBs within your project?	If yes, the short survey should be presented alongside other methodologies.
5) Please select any of the following energy improvement measures applied over the course of your project: ▪ HVAC ▪ Window measures ▪ Refrigerators ▪ Washers ▪ Weatherization ▪ Lighting ▪ Education, associated with measure programs ▪ Water measures (comm' 1) ▪ Other measures	For use in the estimation methodology, the default where other methodologies are not appropriate.
6) Please select whether your project occurred in a commercial or residential building.	For use in the estimation methodology, the default where other methodologies are not appropriate.
7) Please provide the most accurate figure you have for the value of the project's	For use in the estimation methodology, the default where other methodologies are not appropriate.

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energy benefits/cost savings (please exclude	

Annex V (NEB)

1) Please provide a short non-technical description of the current situations and problems your energy improvement measure aimed to address (long text):
2) Please provide a short non-technical description of the proposed energy improvement measures and their modelled benefits (long text):
3) What decision-making drivers underpinned your assessment of the investment project? (Open text or ENUM)
4) During the analysis of the project impacts, did you determine the projects contribution to any of the following components of operational excellence? (ENUM: not measured, improved, no impact, degraded)
    a) Safety
    b) Quality
    c) Costs
    d) Time
2) During the analysis of the project impacts, which energy services were determined to positively contribute to any of the following components of operational excellence? (ENUM: Heat, Ventilation, Cooling, etc)
    a) Safety
    b) Quality
    c) Costs
    d) Time
3) During the analysis of the project impacts, which energy services were determined to negatively contribute to any of the following components of operational excellence? (ENUM: Heat, Ventilation, Cooling, etc)
    a) Safety
    b) Quality
    c) Costs
    d) Time

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4) Did the energy improvement impact any of the three aspects of competitive advantage, and if so, how? (Free text following the ENUM: No investigation [default], No impact found, positive impact, negative impact, mixed impact)
   a) Impacts on Value Proposition:
   b) Impacts on Risks:
   c) Impacts on Costs:
5) Please describe and note the approximate net value of each component of operational excellence impacted by the energy improvement project:
   a) Safety: Value | Description
   b) Quality Value | Description
   c) Costs Value | Description
   d) Time Value | Description
6) Please state whether the approximate values above have been measured and verified, and describe the method used.

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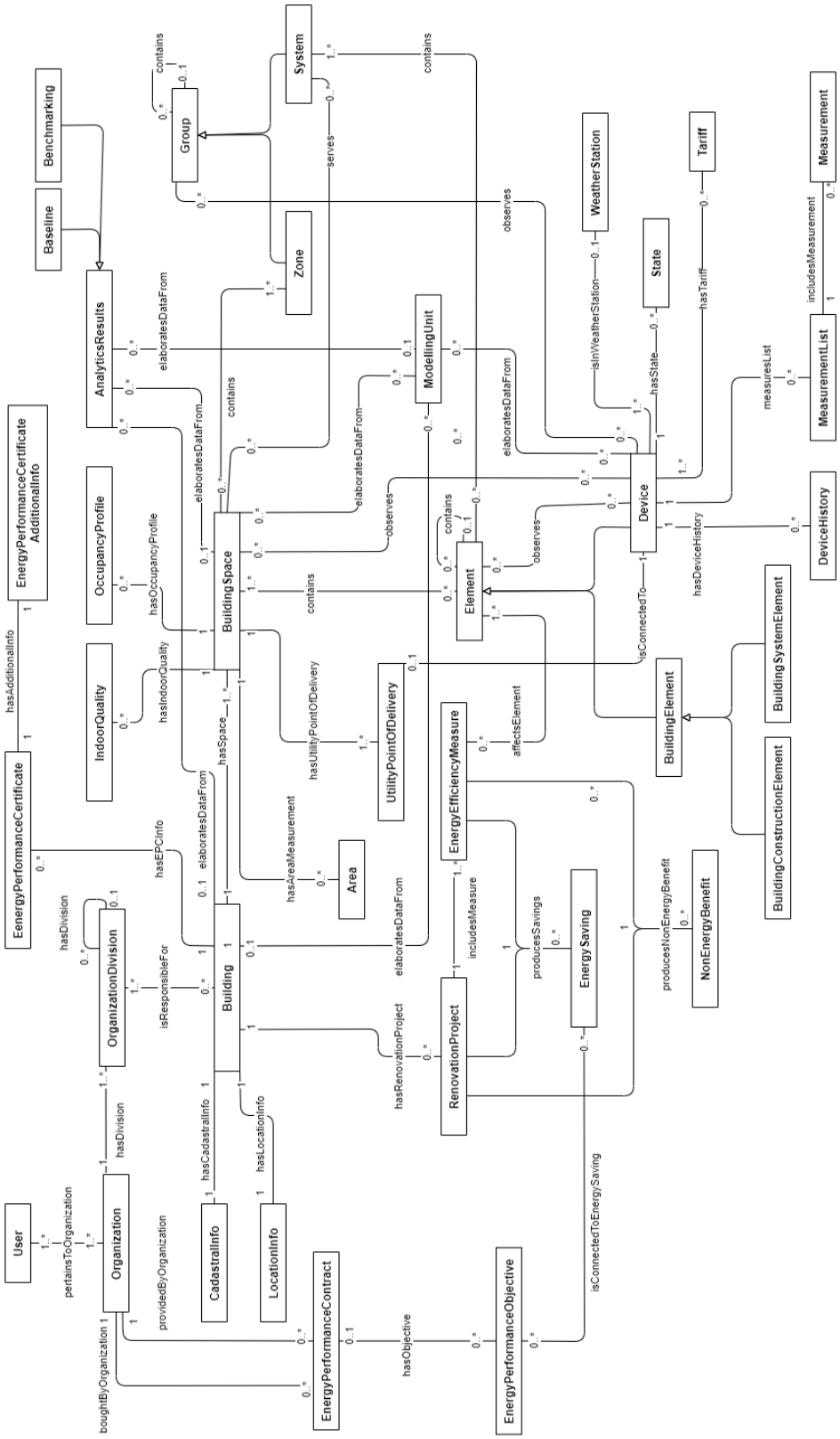
12.3 Data model UML diagram and data field tables.



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12.4 Data Field Definitions: UML Tables

Area			
An area measurement of a BuildingSpace.			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
areaType	enum	Type of measured area	
areaValue	float	Numerical value of the area	(17) Floor area of building m2 [if areaUnitOfMeasurement is m2]
areaUnitOfMeasurement	enum	Unit of measurement of the area value	

Baseline			
Energy performance of the company or a process before and after implementation of new actions for improving the energy efficiency			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
baselineDefinition	String	Short textual description of the baseline and the reference situation it describes	
baselinePerimeter	String	Definition of the baseline perimeter (eg. whole building, a given equipment, a group of equipment, a specific zone, a specific utility...)	
baselineInfluenceFactor	enum	Field to identify of the factors that impact the baseline and should be used to adjust it	
baselineNonAdjustedValue	Float	The value of the baseline before adjustment for the influence factors	
baselineAdjustedValue	Float	The value of the baseline after adjustment for the influence factors	
baselineUnit	String	The unit in which the baseline is defined	

Building			
A building for which data is provided in EN-TRACK's platform.			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
buildingID	UID	Unique identifier for the building	

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buildingName	string	Name of the building	(8) Site name - location of investment
buildingConstructionYear	int	Year of building construction or major renovation	
buildingConstructionType	enum	Building construction type	
buildingUseType	enum	Building purpose of use activity type	(15) Building type
buildingOwnership	enum	Indication of whether the building is owned or rented	(16) Ownership

BuildingConstructionElement			
Any static element of the building construction (e.g. walls, windows, roofs).			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
buildingConstruction ElementType	enum	Type of the building construction element	

BuildingElement			
Any element of the building which does not fall in the Device class. The type of the BuildingElement can be further specified through its subclasses BuildingConstructionElement and BuildingSystemElement.			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
buildingElementID	UID	Unique identifier for the building	
buildingElementState	boolean		
buildingElement PurchaseDate	date	Date of purchase of the building element	
buildingElement InstallationDate	date	Date of installation of the building element	
buildingElementBrand	string	Brand of the building element	
buildingElementModel	string	Model of the building element	
buildingElement SerialNumber	string	Serial number of the building element	
buildingElement Manufacturer	string	Manufacturer of the building system element	
buildingElement ManufactureDate	date	Manufacture date of the building system element	

BuildingSpace

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A space that can represent one or more rooms, floors, or zones of a Building, defined according to their use, or the necessity to separate monitoring and accounting of their energy use or performance. One BuildingSpace will be generated by default for each building, corresponding to the entire construction.			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
builidingSpaceID	UID	Unique identifier for the building space	
buildingSpaceName	string	Name of the building space	
buildingSpaceUseType	enum	Purpose of use or activity conducted in the building space	

BuildingSystemElement			
Any system providing a service to the Building (e.g. HVAC system, lighting system, electric power system, …) or any of their sub-components (e.g. boilers, luminaries, solar photovoltaic panels, …).			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
buildingSystemElement Type	enum	Type of the building system element	
buildingSystemElement MinOutput	float	Minimum output of the building system element in kW	
buildingSystemElement MaxOutput	float	Maximum output of the building system element in kW	
buildingSystemElement Efficiency	%	Percentual efficiency of the building system element	

CadastralInfo			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
buildingCadastralReference	string	Cadastral reference of the building	
landLocation	string		
landGeographicalArea	int		
landType	enum		
propertyClass	string		

Device
Any meter, sensor, or actuator that can capture a signal, emit a signal, or assume a state that can be recorded in the form of time series data.

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Attribute field	Data type	Definition	correspondence to DEEP
deviceID	UID	Unique identifier for the device	
deviceName	string	Descriptive name of the device	
deviceType	enum	Type of the device	
deviceManufacturer	string	Name of the device manufacturer	
deviceModel	string	Model of the device	
deviceNumberOfOutputs	int	Number of outputs the device produces. Each output should be connected to a different MeasurementList	
deviceElectricSupply	enum		
deviceOperatingSystem	string	Operating system of the device	
deviceLicence VersionNumber	string	Number of the license version of the device	
deviceInputSignalType	enum		
deviceInputProtocol	enum		

DeviceHistory			
A set of information collected to contemplate the replacement of a Device (e.g. a smart meter) for maintenance reasons, in order to keep track of the device serial number and the period of installation.			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
deviceSerialNumber	string	Serial number of the device	
deviceManufactureDate	date	Date of manufacturing of the device	
deviceInstallationDate	datetime	Date of installation of the device	
deviceRemovalDate	datetime	Date of removal of the device	
devicethresholdValue	float	Threshold of recorded value after which the device will have to be replaced	

Element
Any generic element of the building. The type of Element can be further specified through its subclasses BuildingElement and Device.

EnergyEfficiencyMeasure			
Any measure for the improvement of the efficiency of a Building or its Elements.			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**

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energyEfficiencyMeasureID	UUID	Unique identifier of the energy efficiency measure	
energyEfficiencyMeasure Type	enum	The type of energy efficiency measure	(18) Which Measures are included in the investment
energyEfficiencyMeasure Description	string	Description of the energy efficiency measure applied	
shareOfAffectedElement	%	Percentage of the element that is affected by the energy efficiency measure (e.g. 70% of the whole building fabric, 50% of the HVAC system, …)	
energyEfficiencyMeasure OperationalDate	date	Date on which the energy efficiency measure became operational	
energyEfficiencyMeasure Investment	float	Investment for the energy efficiency measure implementation	
energyEfficiencyMeasure InvestmentCurrency	enum	Original currency of the energy efficiency measure investment	
energyEfficiencyMeasure CurrencyExchangeRate	float	Exchange rate between the original investment currency and euros	
energyEfficiencyMeasure SavingsToInvestmentRatio	float	Estimated Savings to Investment Ratio (SIR) for the energy efficiency measure	
energySourcePrice EscalationRate	%	Escalation rate of the price of the energy source related to the described energy efficiency measure (if applicable)	

EnergyPerformanceCertificate			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
energyPerformanceCertificate ReferenceNumber	string	Reference number as reported on the energy performance certificate	
energyPerformanceCertificate DateOfAssessment	date	Date of assessment of the building for the production of the energy performance certificate	
energyPerformanceCertificate DateOfCertification	date	Date of release of the energy performance certificate	
energyPerformance CertificationTool	string	Tool utilized to realized the energy performance certification	
energyPerformance ProcedureType	string		

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energyPerformance CertificationMotivation	string	Description of the reason behind the realization of the energy performance certification	
energyPerformanceClass	string	Class letter assigned for the consumption of non-renewable primary energy	(32), (39)
annualPrimaryEnergy Consumption	float	Value of annual consumption of non-renewable primary energy [kWhm2*year]	
CO2EmissionsClass	string	Class letter assigned for CO2 emissions	
annualCO2Emissions	float	Value of annual CO2 emissions [kg CO2m2*year]	
annualFinalEnergy Consumption	float		
annualEnergyCost	float	Annual energy cost for the reference building	
heatingCO2EmissionsClass	string	Class letter assigned for CO2 emissions associated with the heating service	
annualHeatingCO2Emissions	float	Value of annual CO2 emissions associated with the heating service [kg CO2m2*year]	
coolingCO2EmissionsClass	string	Class letter assigned for CO2 emissions associated with the cooling service	
annualCoolingCO2Emissions	float	Value of annual CO2 emissions associated with the cooling service [kg CO2m2*year]	
hotWaterCO2EmissionsClass	string	Class letter assigned for CO2 emissions associated with the domestic hot water service	
annualHotWaterCO2Emissions	float	Value of annual CO2 emissions associated with the domestic hot water service [kg CO2m2*year]	
lightingCO2EmissionsClass	string	Class letter assigned for CO2 emissions associated with the lighting service	
annualLightingCO2Emissions	float	Value of annual CO2 emissions associated with the lighting service [kg CO2m2*year]	
heatingPrimaryEnergyClass	string	Class letter assigned for the consumption of non-renewable primary energy associated with the heating service	

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annualHeatingPrimary EnergyConsumption	float	Value of annual consumption of non-renewable primary energy associated with the heating service [kWhm2*year]	
coolingPrimaryEnergyClass	string	Class letter assigned for the consumption of non-renewable primary energy associated with the cooling service	
annualCoolingPrimary EnergyConsumption	float	Value of annual consumption of non-renewable primary energy associated with the cooling service [kWhm2*year]	
hotWaterPrimaryEnergyClass	string	Class letter assigned for the consumption of non-renewable primary energy associated with the hot water service	
annualHotWaterPrimary EnergyConsumption	float	Value of annual consumption of non-renewable primary energy associated with the hot water service [kWhm2*year]	
lightingPrimaryEnergyClass	string	Class letter assigned for the consumption of non-renewable primary energy associated with the lighting service	
annualLightingPrimary EnergyConsumption	float	Value of annual consumption of non-renewable primary energy associated with the lighting service [kWhm2*year]	
heatingEnergyDemandClass	string	Class letter assigned for the energy demand associated with the heating service	
annualHeatingEnergyDemand	float	Value of annual energy demand associated with the lighting service [kWhm2*year]	
coolingEnergyDemandClass	string	Class letter assigned for the energy demand associated with the cooling service	
annualCoolingEnergyDemand	float	Value of annual energy demand associated with the cooling service [kWhm2*year]	

EnergyPerformanceCertificateAdditional			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**

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electricVehicleCharger Presence	boolean	Boolean field to indicate whether the building is equipped with an electric vehicle charger	
solarThermalSystem Presence	boolean	Boolean field to indicate whether the building is equipped with a solar thermal system	
solarPVSystemPresence	boolean	Boolean field to indicate whether the building is equipped with a solar PV system	
biomassSystemPresence	boolean	Boolean field to indicate whether the building is equipped with a biomass system	
geothermalSystemPresence	boolean	Boolean field to indicate whether the building is equipped with a geothermal system	
districtHeatingOrCooling Connection	boolean	Boolean field to indicate whether the building is connected to a district heating or cooling grid	
buildingTechnical InspectionCode	string	Identification code of the conformity certificate obtained after the building technical inspection	
averageFacade Transmittance	float	Average value of transmittance of the building facade [Wm2*K]	
averageWindows Transmittance	float	Average value of transmittance of the building windows [Wm2*K]	
regulationValueFor FacadeTransmittance	float	Maximum value of facade transmittance as defined by the regulations [Wm2*K]	
regulationValueFor WindowsTransmittance	float	Maximum value of window transmittance as defined by the regulation [Wm2*K]	
constructionRegulation	string	Construction regulation that applies to the building	

EnergyPerformanceContract			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**

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contractID	UID	Unique identifier for the energy performance contract	
contractName	string	Name of the energy performance contract	
contractPerimeter	string	Definition of the boundaries of the contract in terms of buildings, zones, equipment that are included in its scope	
contractStartDate	date	Initial date of validity of the contract	
contractEndDate	date	Final date of validity of the contract	

EnergyPerformanceObjective			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
objectiveID	UID	Unique identifier for the energy performance contract objective	
objectiveName	string	Name of the energy performance contract objective	
objectiveDescription	string	Textual description of the objective	
objectiveTargetType	enum	Field used to indicate whether the target of the contract is expressed either by an absolute or a relative value	
objectiveTargetValue	float	Value of the target of the contract. It has to be considered in combination with the ObjectiveTargetType	
objectiveTargetValueUnit	enum	Indication of the unit of measurement of the target value	
objectiveDeadline	date	Deadline date for the achievement of the objective	

EnergySavings			
Any estimate or measure of energy savings triggered by a RenovationProject or EnergyEfficiencyMeasure			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
energySavingsType	enum	Energy savings type to be selected from a predefined list	(71) to (94) [in combination with energySavingsValu

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			e]
energySavingsValue	any	Energy savings value	(71) to (94) [in combination with energySavingsType]
energySavingsStartDate	date	Initial date of the reference period for the energy savings	
energySavingsEndDate	date	Final date of the reference period for the energy savings	
energySavings IndependentlyVerified	bool	Indication of whether the presented energy savings were independently verified or not	(42) [in combination with energySavingsVerif icationSource], (95)
energySavings VerificationSource	enum	Source of the verification, if the presented energy savings were independently verified	(42) [in combination with energySavingsInde pendentlyVerified]

Group			
A collection of entities. It can be further differentiated into Zone (collection of building spaces) or System (collection of elements).			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
groupID	UID	Unique identifier for the group	
groupName	string	Name of the group	

IndoorQuality			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
indoorQualityEvaluation ValidityStartDate	date	Initial date of the reference period for the indoor quality evaluation	
indoorQualityEvaluation ValidityEndDate	date	Final date of the reference period for the indoor quality evaluation	
indoorQualityUser Perception	enum		

LocationInfo			
The collection of information related to the geographical location of a Building.			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
addressCountry	enum	Country where the building is	(3) Country

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		located	
addressProvince	enum	Provinceadministrative district of the building location	(6) Full address
addressCity	enum	City where the building is located	(5) Citylocality
addressPostalCode	string	Postal code of the building location	(4) ZIP Code
addressStreetName	string	Street name of the building address	(6) Full address [in combination with addressStreetNumber]
addressStreetNumber	string	Street number of the building address	(6) Full address [in combination with addressStreetName]
addressCoordinates	point	Longitude and latitude coordinates of the building location	
addressClimateZone	enum	Identification of the climate zone that corresponds to the address coordinates	

Measurement			
Any timeseries record registered by a Device.			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
measurementValue	any	Value of the property measured by the device	(19) , (20) , (31), (36), (38), (96) to (205)
measurementStart	datetime	Initial timestamp of the reference period associated with the measurement	
measurementEnd	datetime	Final timestamp of the reference period associated with the measurement	

MeasurementList			
A collection of Measurements from the same Device that measure the same property in the same measurement units.			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
measuredProperty	enum	Physical property measured by the device	
measurementUnit	enum	Unit of measurement of the property values	
measurementDescription	string	Textual description of the measurement	

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measurementReadingType	string	Indication of the type of reading recorded and shown by the device (e.g. average value, counter, etc.)	
measurementSourceFor Energy	enum	Source from which the measurement list data was obtained (valid only for energy measurement lists)	(35), (37),
measurementTypeFor Energy	enum	Indication of whether the measurement is actual or predicted (valid only for energy measurement lists)	(36), (38) [in combination with measurement Value]
outputSignalType	enum		
outputProtocol	enum		

ModellingUnit			
A virtual unit capable of performing calculations, defined through a mathematical formula, and elaborating data from Buildings, BuildingSpaces, or Devices.			
formula	string	Formula of the calculation performed by the modelling unit	

NonEnergyBenefit			
Any additional benefit produced by Renovation Projects and Energy Efficiency Measures other than Energy Savings.			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
nonEnergyBenefitType	enum	Type of non-energy benefit produced by the project	(53), (67) Additional benefits triggered by the project
nonEnergyBenefit ImpactEvaluation	enum	Evaluation of the project impact over the selected non energy benefit	
nonEnergyBenefitService WithPositiveImpact	list (enum)	List of energy services that were determined to positively contribute to the selected non-energy benefit	
nonEnergyBenefitService WithNegativeImpact	list (enum)	List of energy services that were determined to negatively contribute to the selected non-energy benefit	
nonEnergyBenefitImpact ValueVerifiedAndMeasured	bool	Indication of whether the impact over the non-energy benefit has been measured and verifed	

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nonEnergyBenefitImpacted VerificationMethod	string	Description of the verificationmeasurment method used, in case the impact over the non-energy benefit has been verified or measured	
nonEnergyBenefit ImpactValue	any	Approximate net value of the impact of the project over the non-energy benefit	
nonEnergyBenefitImpact ValueDescription	string	Description of the value provided for the impact of the project over the non-energy benefit	

OccupancyProfile			
The information related to the occupancy of a Building.			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
occupancyProfileValidity StartDate	date	Initial date for the reference period of the given occupancy profile	
occupancyProfileValidity EndDate	date	Final date for the reference period of the given occupancy profile	
occupancyNumberOf Occupants	integer	Total number of occupants at full building occupation	
occupancyBuilding OpeningHour	time	Opening hour of the building in normal working days	
occupancyBuilding ClosingHour	time	Closing hour of the building in normal working days	
occupancyVacationDates	list of dates	List of vacation days when the building is closed	

Organization			
A company or institution that provides data to EN-TRACK's platform and/or benefits from its services.			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
organizationID	UID	Unique identifier for the organization	
organizationName	string	Name of the organization	(7) Company name
organizationType	enum	Nature of the organization	
organizationContact PersonName	string	Name of the contact person for the organization	(9) Contact person
organizationEmail	string	Contact email of the organization	(10) Email
organizationTelephone Number	string	Telephone number of the organization	(11) Telephone

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OrganizationDivision			
A department within an Organization that is responsible for or uses a building.			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
organizationDivisionName	string	Name of the organization division	

RenovationProject			
Any retrofit or renovation project that affects a whole Building or part of it, and that consists of one or more EnergyEfficiencyMeasures.			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
projectID	UID	Project unique identifier	(1) Project ID
projectTitle	string	Project title	(2) Project Title
projectDescription	string	Description of the project from the user	
projectStartDate	date	Date on which the project investment started	(28) Project Start Date
projectOperationalDate	date	Date on which the project became operational	(29) Date investment became operational
projectMotivation	enum	Key reasons for the investment	(66).
projectInvestment	float	Investment for the project implementation	(50) Total Value of investment (inclusive of EE component)
projectInvestmentCurrency	enum	Original currency of the project investment	
projectCurrency ExchangeRate	float	Exchange rate between the original investment currency and euros	
projectUsesIncentives	boolean	Yes or no data field to express whether the projects benefitted or will benefit from incentive schemes	
projectInventives ShareOfRevenues	%	Estimated share of the total project revenues that are represented by incentives schemes, in case the project benefitted will benefit from them	
projectReceivedGrantFunding	boolean	Yes or no data field to express whether the projects received grant funding	(61) Value of grantsubsidy (if any)
projectGrantsShareOfCosts	%	Estimated share of the total project costs that were covered with grant funding, in case the project received it	(61) Value of grantsubsidy (if any)

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projectDiscountRate	%	Discount rate used to calculate the financial metrics for the renovation project	
projectInterestRate	%	Interest rate used to calculate the financial metrics for the renovation project	(65) Interest rate
projectInternalRateOfReturn	%	Estimated Internal Rate of Return (IRR) of the renovation project	(58) IRR (computed prior to investment)
projectSimplePaybackTime	float	Estimated Simple Payback Time (SPB) of the renovation project	
projectNetPresentValue	float	Estimated Net Present Value (NPV) of the renovation project	(56) NPV (computed prior to investment)
projectSavingsTo InvestmentRatio	float	Estimated Savings To Investment Ratio (SIR) of the renovation project	
projectIncluded NonEnergyBenefitsEstimate	boolean	Indication of whether the non-energy benefits produced by the project were estimated	
projectIncluded ConfortmeterSurvey	boolean	Indication of whether the project included a Comfortmeter survey	

State			
A record of the particular condition that a Device is found in at a specific time.			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
stateType	enum	The state type category that applies to the device (e.g. Onoff, startstop, …)	
state	any	The state in which the device is found, within the selected state type category	
stateStart	datetime	Initial timestamp of the reference period associated with the state	
stateEnd	datetime	Final timestamp of the reference period associated with the state	

System			
A group of Elements.			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
systemType	enum	Type of the given system	

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Tariff			
The specifications of a tariff associated with one of the metered commodities.			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
tariffCompany	string	Company that offers the tariff	
tariffName	string	Name of the tariff	
tariffStartDate	datetime	Initial date of the reference period for the energy savings	
tariffEndDate	datetime	Final date of the reference period for the energy savings	

User			
An individual with access to EN-TRACK's platform.			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
userID	UID	Unique identifier for the organization	
userName	string	Complete name of the EN-TRACK user	
userEmail	string	Email address of the EN-TRACK user	

UtilityPointOfDelivery			
A point on the utility distribution system where the deliverer makes the utility available to a receiver or to serve load.			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
pointOfDeliveryID	UID	Unique identifier for the point of delivery (internal for BIGG)	
pointOfDeliveryIDFromUser	string	Unique identifier for the point of delivery as reported from the user	
utilityType	enum	Indication of the type of utility delivered at the point of delivery of interest	

WeatherStation			
A weather station that provides weather data of interest for one or more Buildings.			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
weatherStationLocation	point	Coordinates of the location of the weather station	
weatherStationType	enum	Type of the weather station	

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weatherStationStartDate	datatime	Initial date of data retrieval from the weather station	
weatherStationEndDate	datetime	Final data of data retrieval from the weather station	

Zone			
A group of Building Spaces.			
Attribute field	**Data type**	**Definition**	**correspondence to DEEP**
zoneType	enum	Type of the given zone	

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